

$V_{DSS}$	600V
$R_{DS(on)}$ (Max.)	980m $\Omega$
$I_D$	4A
$P_D$	40W

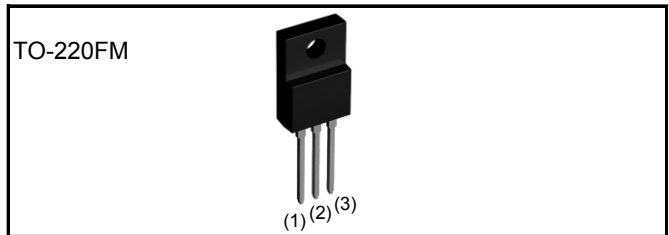
#### ●Features

- 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

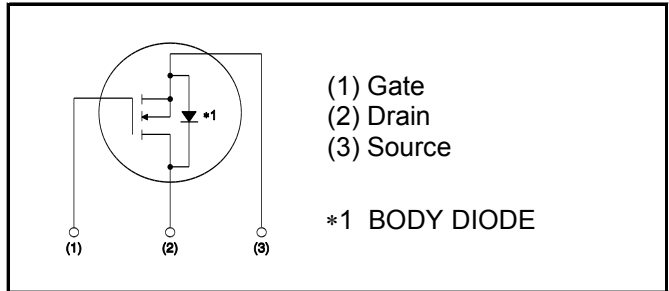
#### ●Application

Switching Power Supply

#### ●Outline



#### ●Inner circuit



#### ●Packaging specifications

Type	Packaging	Bulk
	Reel size (mm)	-
	Tape width (mm)	-
	Basic ordering unit (pcs)	500
	Taping code	-
	Marking	R6004ENX

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

Parameter	Symbol	Value	Unit
Drain - Source voltage	$V_{DSS}$	600	V
Continuous drain current	$T_c = 25^\circ C$	$I_D^{*1}$	$\pm 4.0$ A
	$T_c = 100^\circ C$	$I_D^{*1}$	$\pm 2.2$ A
Pulsed drain current	$I_{D,pulse}^{*2}$	$\pm 8.0$	A
Gate - Source voltage	$V_{GSS}$	$\pm 20$	V
Avalanche energy, single pulse	$E_{AS}^{*3}$	46	mJ
Avalanche energy, repetitive	$E_{AR}^{*3}$	0.13	mJ
Avalanche current, repetitive	$I_{AR}$	0.8	A
Power dissipation ( $T_c = 25^\circ C$ )	$P_D$	40	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 <sup>*4</sup>	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	$R_{thJC}$	-	-	3.13	$^\circ C/W$
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	70	$^\circ C/W$
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	$R_{DS(on)}^{*5}$	$V_{GS} = 10V, I_D = 1.5A$ $T_j = 25^\circ C$	-	0.90	0.98	$\Omega$
		$T_j = 125^\circ C$	-	1.36	-	
Gate input resistance	$R_G$	$f = 1MHz, \text{open drain}$	-	16.7	-	$\Omega$

**●Electrical characteristics ( $T_a = 25^\circ\text{C}$ )**

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Transconductance	$g_{fs}^{*5}$	$V_{DS} = 10\text{V}, I_D = 2\text{A}$	1.5	3.0	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{V}$	-	250	-	pF
Output capacitance	$C_{oss}$	$V_{DS} = 25\text{V}$	-	250	-	
Reverse transfer capacitance	$C_{rss}$	$f = 1\text{MHz}$	-	30	-	
Effective output capacitance, energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$ $V_{DS} = 0\text{V to } 480\text{V}$	-	14	-	pF
Effective output capacitance, time related	$C_{o(tr)}$		-	57	-	
Turn - on delay time	$t_{d(on)}^{*5}$	$V_{DD} \approx 300\text{V}, V_{GS} = 10\text{V}$	-	22	-	ns
Rise time	$t_r^{*5}$	$I_D = 2\text{A}$	-	22	-	
Turn - off delay time	$t_{d(off)}^{*5}$	$R_L = 150\Omega$	-	55	-	
Fall time	$t_f^{*5}$	$R_G = 10\Omega$	-	40	-	

**●Gate Charge characteristics ( $T_a = 25^\circ\text{C}$ )**

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	$Q_g^{*5}$	$V_{DD} \approx 300\text{V}$	-	15	-	nC
Gate - Source charge	$Q_{gs}^{*5}$	$I_D = 4\text{A}$	-	2.5	-	
Gate - Drain charge	$Q_{gd}^{*5}$	$V_{GS} = 10\text{V}$	-	10	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} \approx 300\text{V}, I_D = 4\text{A}$	-	6.5	-	V

\*1 Limited only by maximum temperature allowed.

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

\*3  $I_D = 0.8\text{A}$ ,  $V_{DD} = 50\text{V}$

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

\*5 Pulsed

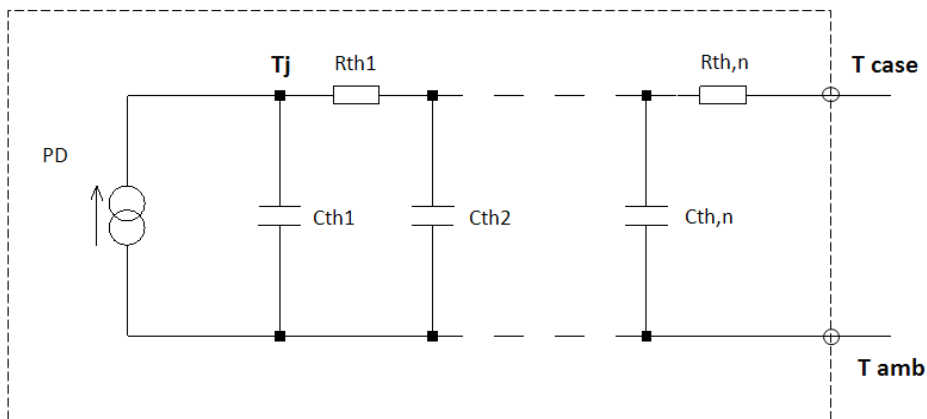
●Body diode electrical characteristics (Source-Drain) ( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Inverse diode continuous, forward current	$I_S^{*1}$	$T_c = 25^\circ\text{C}$	-	-	4.0	A
Inverse diode direct current, pulsed	$I_{SM}^{*2}$		-	-	8.0	A
Forward voltage	$V_{SD}^{*5}$	$V_{GS} = 0\text{V}, I_S = 4\text{A}$	-	-	1.5	V
Reverse recovery time	$t_{rr}^{*5}$	$I_S = 4\text{A}$ $di/dt = 100\text{A}/\mu\text{s}$	-	320	-	ns
Reverse recovery charge	$Q_{rr}^{*5}$		-	2.4	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}^{*5}$		-	15	-	A

●Typical Transient Thermal Characteristics

Symbol	Value	Unit
$R_{th1}$	0.557	K/W
$R_{th2}$	1.61	
$R_{th3}$	2.24	

Symbol	Value	Unit
$C_{th1}$	0.00102	Ws/K
$C_{th2}$	0.00898	
$C_{th3}$	0.440	



●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

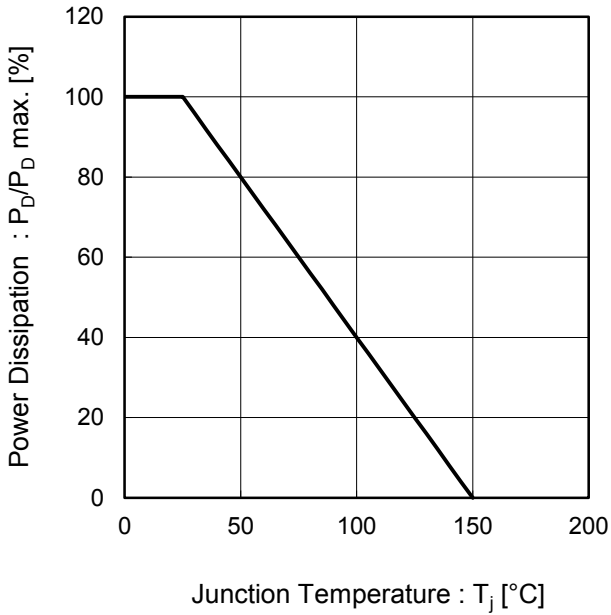


Fig.2 Normalized Transient Thermal Resistance vs. Pulse Width

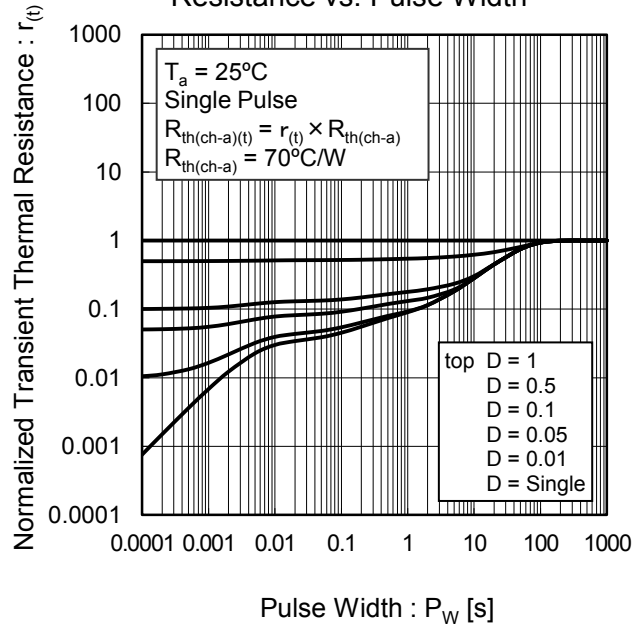
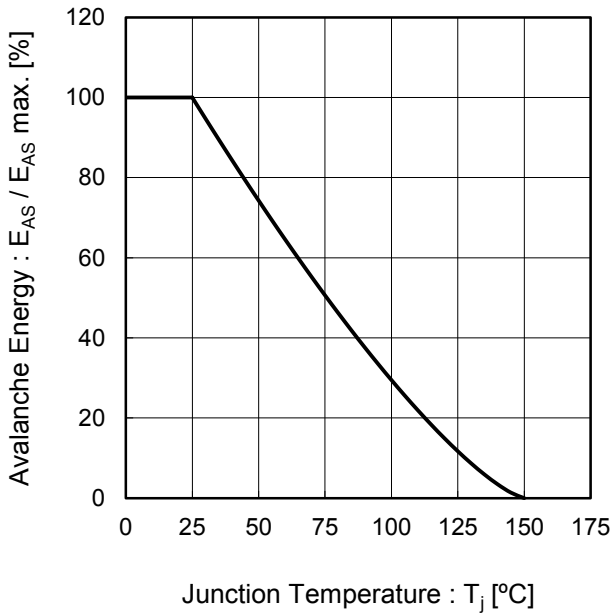


Fig.3 Avalanche Energy Derating Curve vs Junction Temperature



●Electrical characteristic curves

Fig.4 Typical Output Characteristics(I)

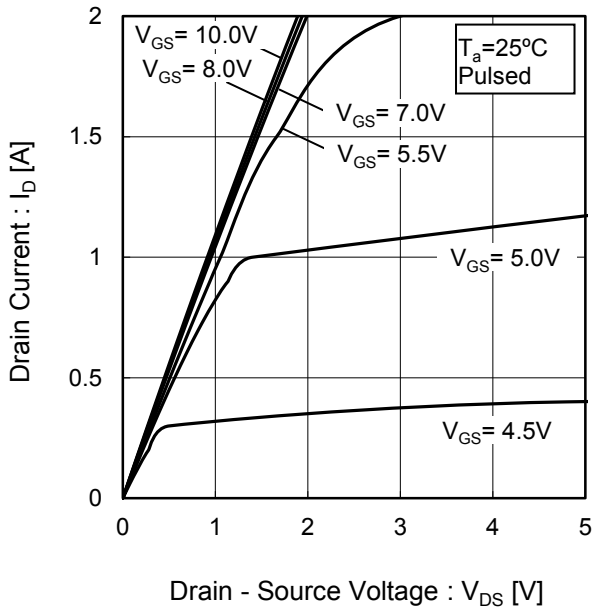


Fig.5 Typical Output Characteristics(II)

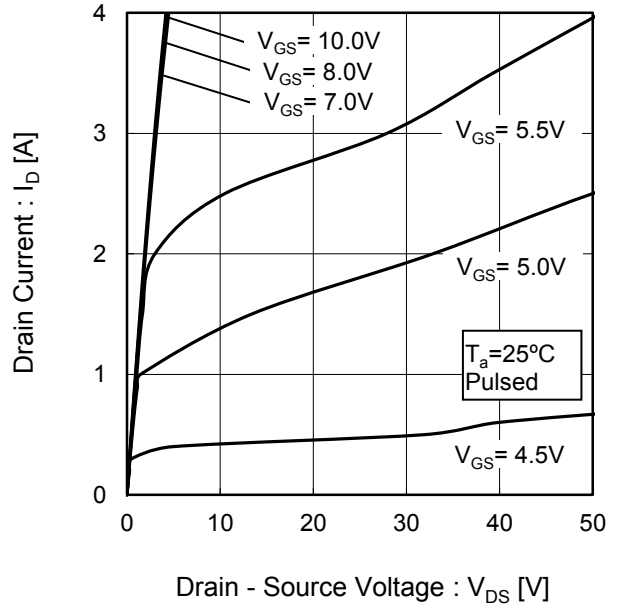


Fig.6  $T_j = 150^\circ\text{C}$  Typical Output Characteristics(I)

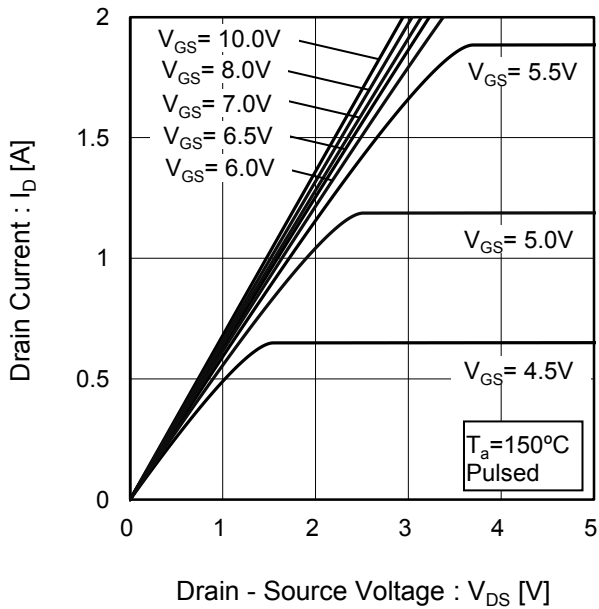
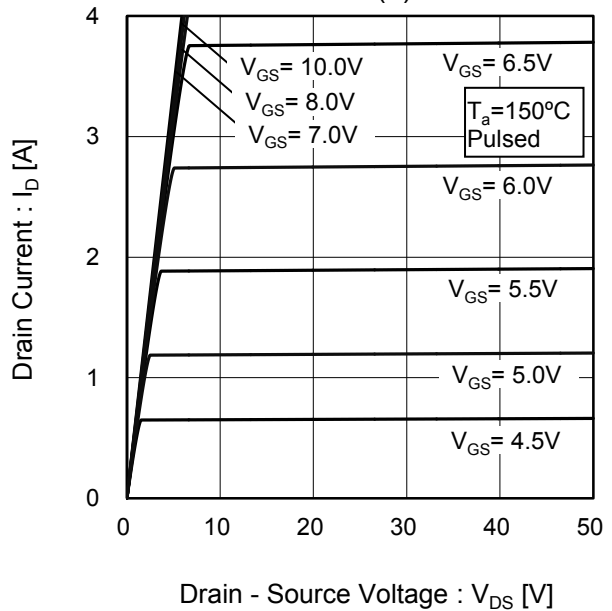


Fig.7  $T_j = 150^\circ\text{C}$  Typical Output Characteristics(II)



●Electrical characteristic curves

Fig.8 Breakdown Voltage vs. Junction Temperature

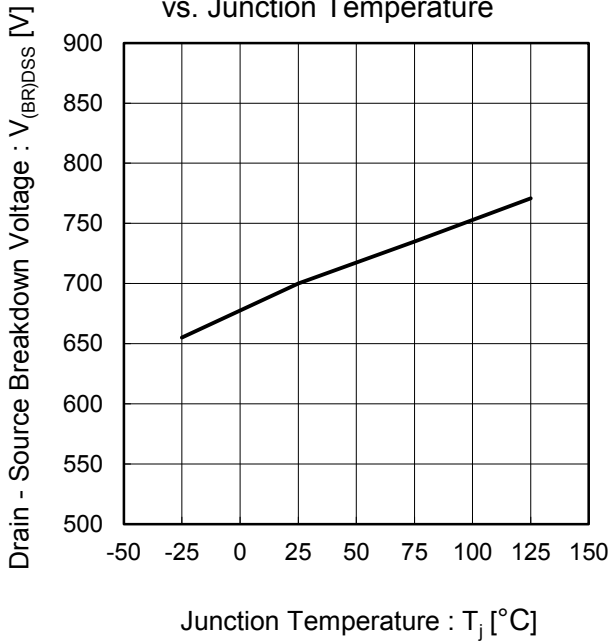


Fig.9 Typical Transfer Characteristics

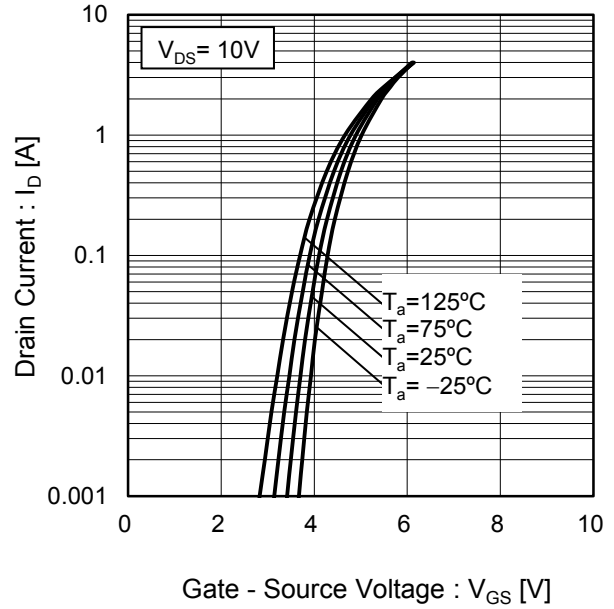


Fig.10 Gate Threshold Voltage vs. Junction Temperature

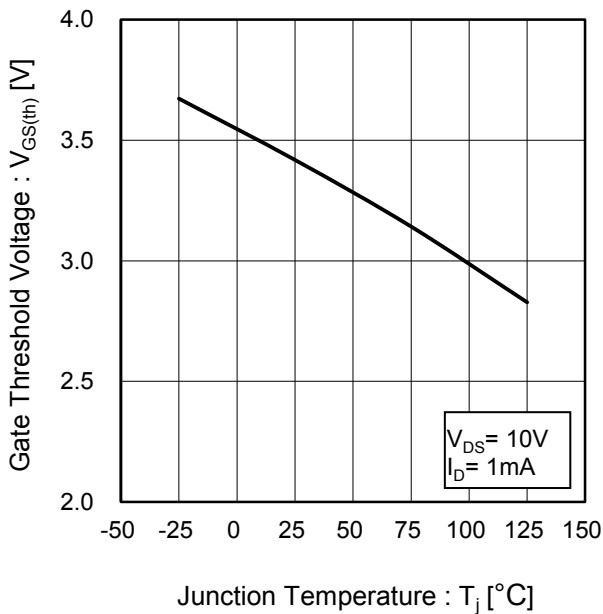
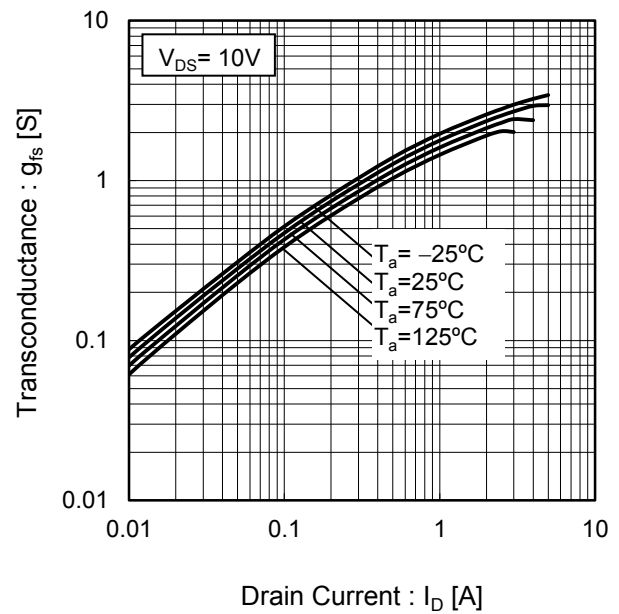


Fig.11 Transconductance vs. Drain Current



●Electrical characteristic curves

Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

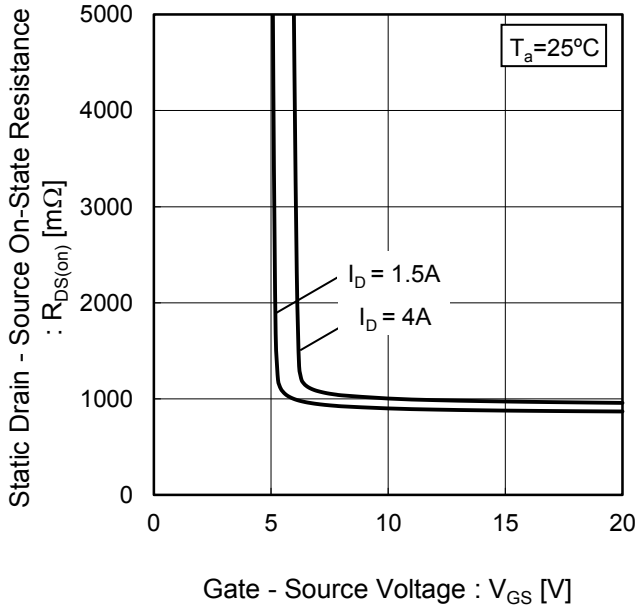


Fig.13 Static Drain - Source On - State Resistance vs. Junction Temperature

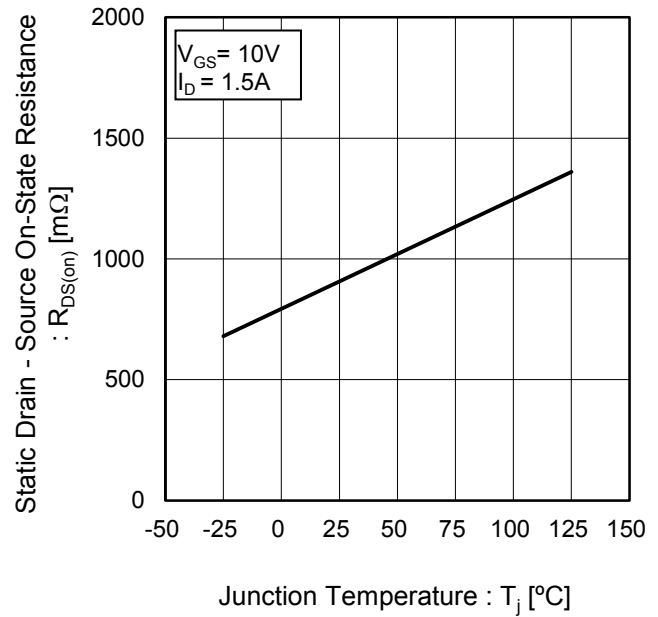


Fig.14 Static Drain - Source On - State Resistance vs. Drain Current

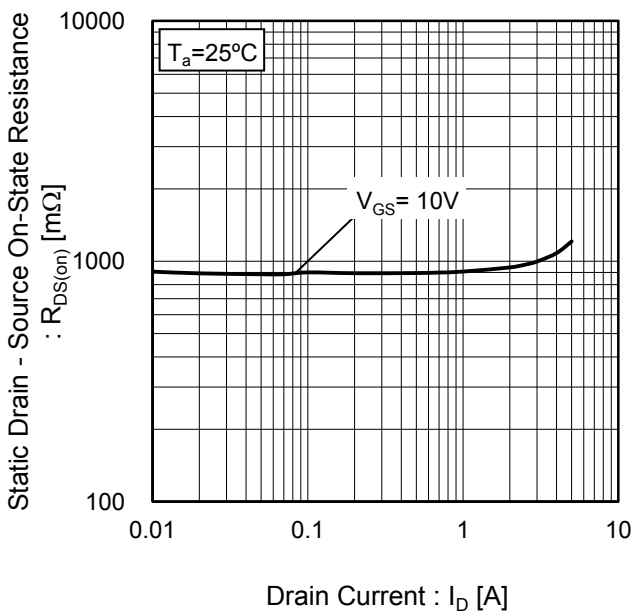
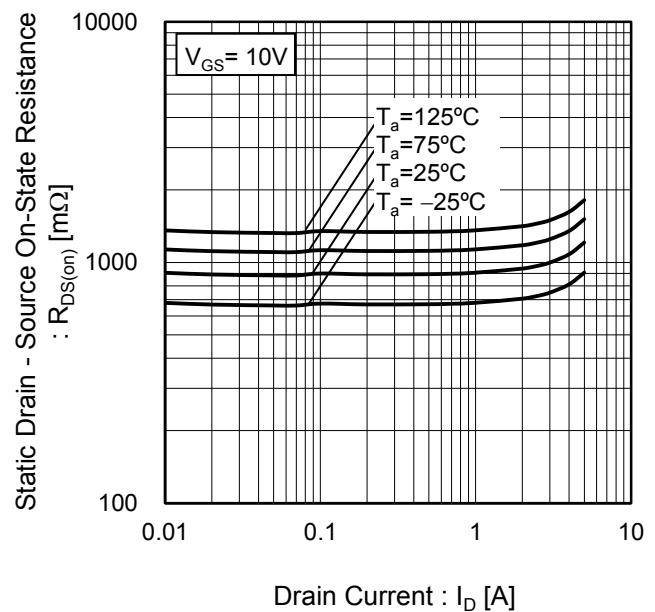


Fig.15 Static Drain - Source On - State Resistance vs. Drain Current





●Electrical characteristic curves

Fig.16 Typical Capacitance vs. Drain - Source Voltage

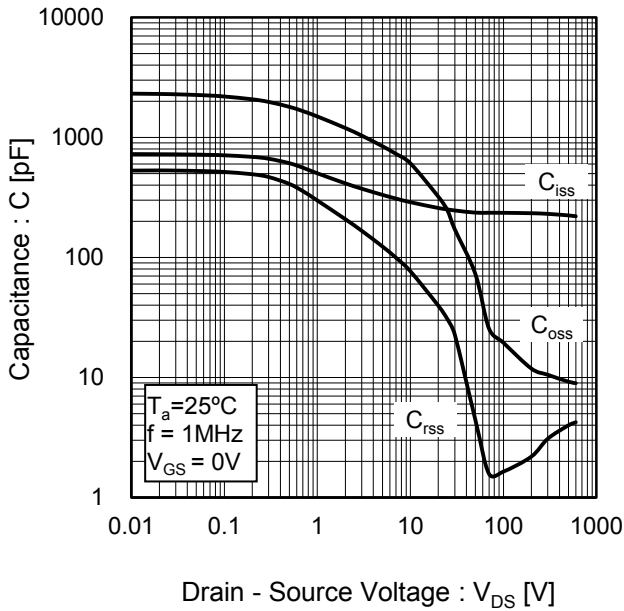


Fig.17 Coss Stored Energy

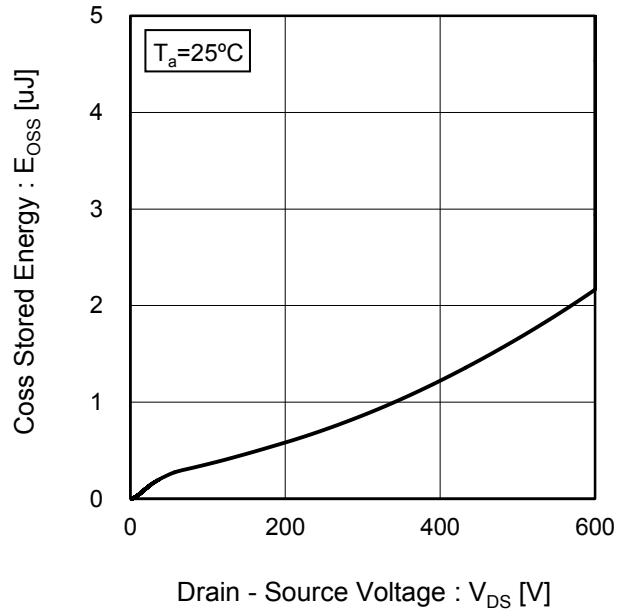


Fig.18 Switching Characteristics

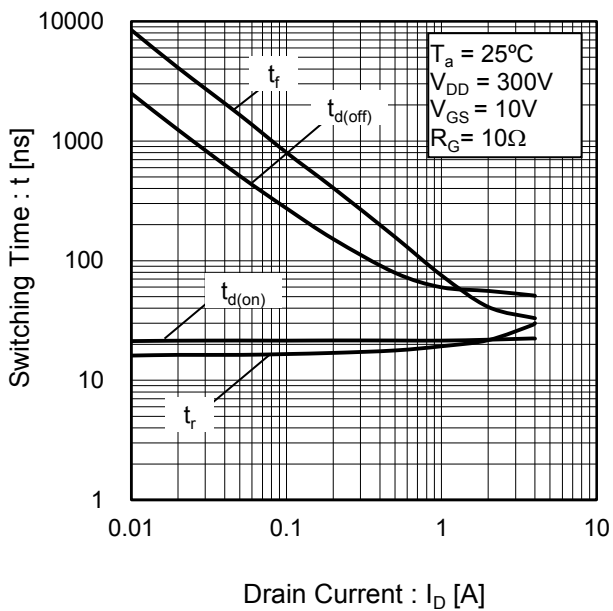
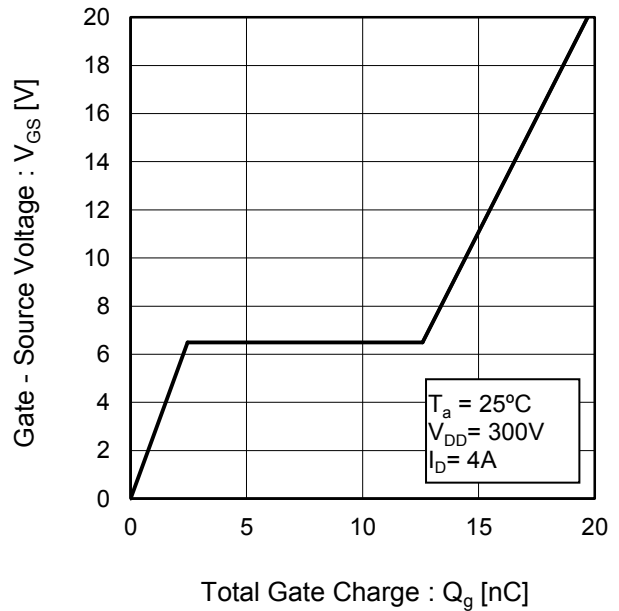


Fig.19 Dynamic Input Characteristics



●Electrical characteristic curves

Fig.20 Inverse Diode Forward Current vs. Source - Drain Voltage

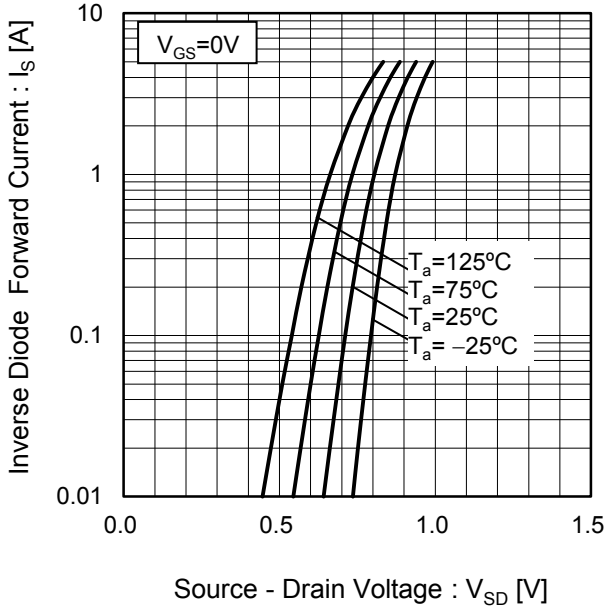
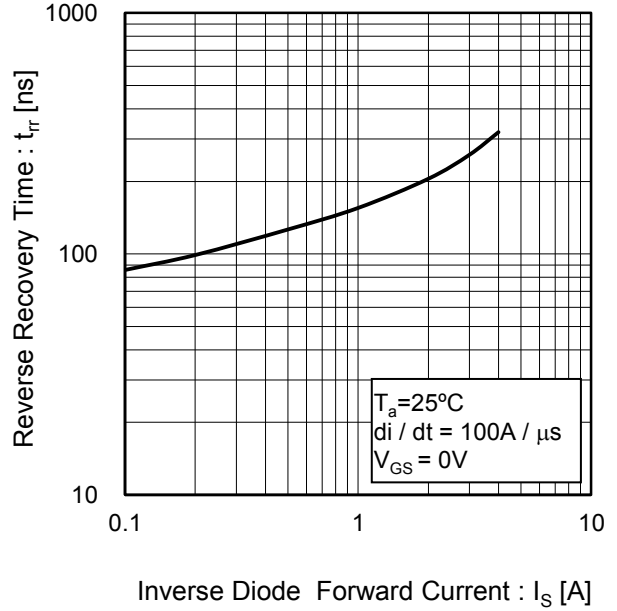


Fig.21 Reverse Recovery Time vs. Inverse Diode Forward Current



●Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

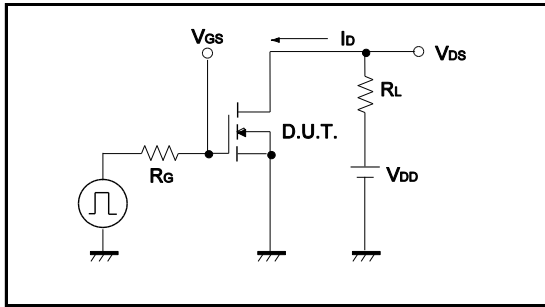


Fig.1-2 Switching Waveforms

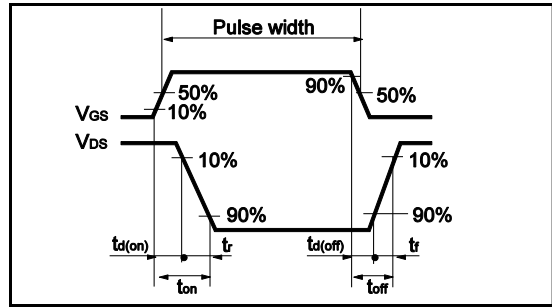


Fig.2-1 Gate Charge Measurement Circuit

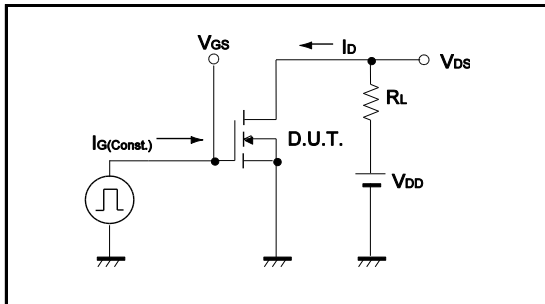


Fig.2-2 Gate Charge Waveform

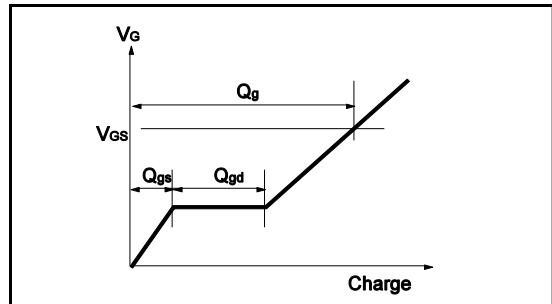


Fig.3-1 Avalanche Measurement Circuit

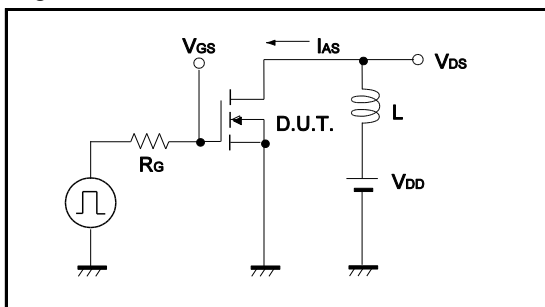


Fig.3-2 Avalanche Waveform

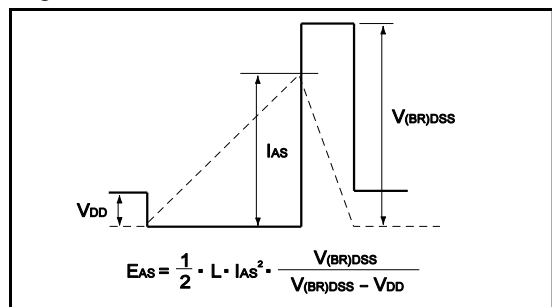


Fig.4-1 dv/dt Measurement Circuit

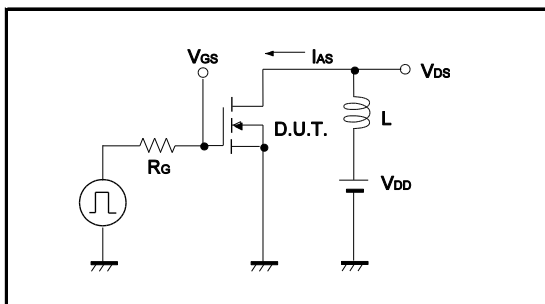


Fig.4-2 dv/dt Waveform

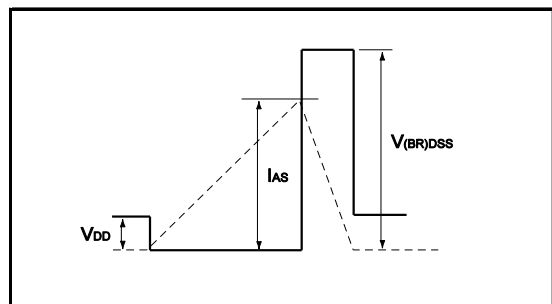


Fig.5-1 di/dt Measurement Circuit

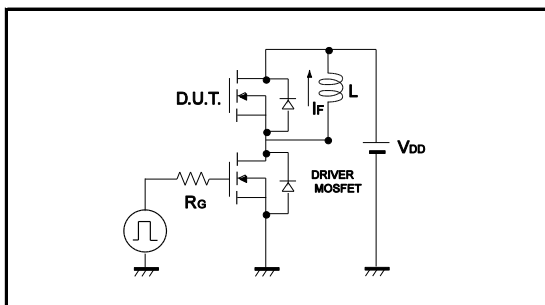
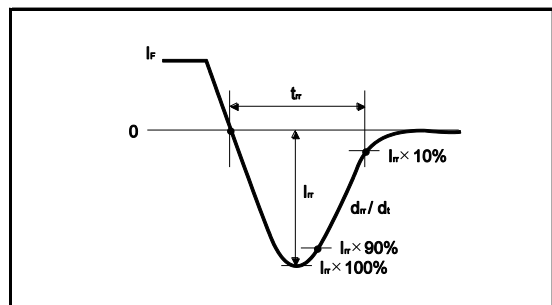
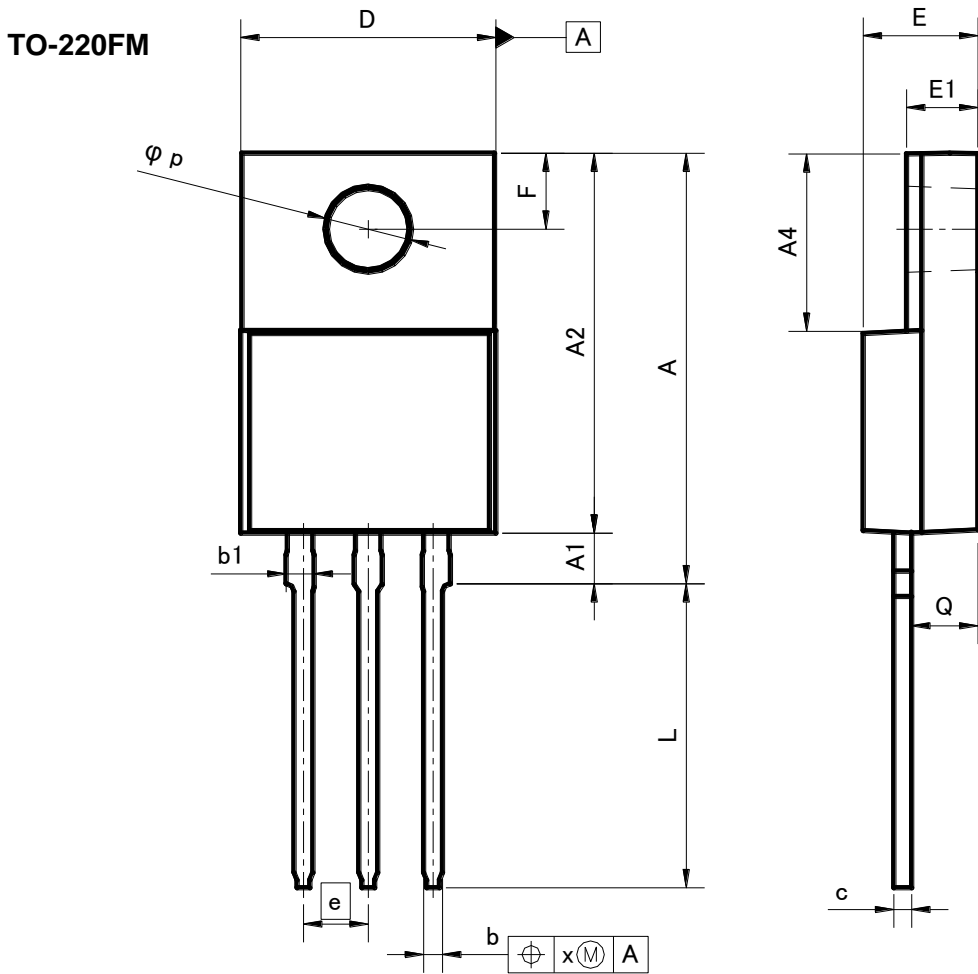


Fig.5-2 di/dt Waveform



●Dimensions (Unit : mm)



DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	16.60	17.60	0.654	0.693
A1	1.80	2.20	0.071	0.087
A2	14.80	15.40	0.583	0.606
A4	6.80	7.20	0.268	0.283
b	0.70	0.85	0.028	0.033
b1	1.10	1.50	0.043	0.059
c	0.70	0.85	0.028	0.033
D	9.90	10.30	0.39	0.406
E	4.40	4.80	0.173	0.189
e	2.54		0.10	
E1	2.70	3.00	0.106	0.118
F	2.80	3.20	0.11	0.126
L	11.50	12.50	0.453	0.492
p	3.00	3.40	0.118	0.134
Q	2.10	3.10	0.083	0.122
x	-	0.381	-	0.015

Dimension in mm/inches

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