

$V_{DSS}$	600V
$R_{DS(on)}$ (Max.)	0.42Ω
$I_D$	12A
$P_D$	50W

### ●Features

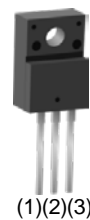
- 1) Low on-resistance.
- 2) Fast switching speed.
- 3) Gate-source voltage ( $V_{GSS}$ ) guaranteed to be  $\pm 30V$ .
- 4) Drive circuits can be simple.
- 5) Parallel use is easy.
- 6) Pb-free lead plating ; RoHS compliant

### ●Application

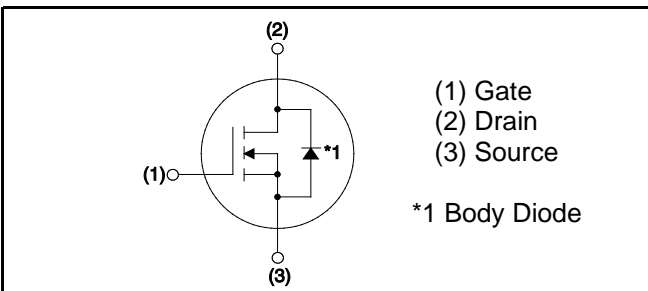
Switching Power Supply

### ●Outline

TO-220FM



### ●Inner circuit



### ●Packaging specifications

Type	Packing	Bulk
	Reel size (mm)	-
	Tape width (mm)	-
	Basic ordering unit (pcs)	500
	Taping code	-
	Marking	R6012ANX

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

Parameter	Symbol	Value	Unit	
Drain - Source voltage	$V_{DSS}$	600	V	
Continuous drain current	$T_c = 25^\circ C$	$I_D^{*1}$	$\pm 12$	A
	$T_c = 100^\circ C$	$I_D^{*1}$	$\pm 6.1$	A
Pulsed drain current	$I_{D,pulse}^{*2}$	$\pm 48$	A	
Gate - Source voltage	$V_{GSS}$	$\pm 30$	V	
Avalanche energy, single pulse	$E_{AS}^{*3}$	9.6	mJ	
Avalanche energy, repetitive	$E_{AR}^{*4}$	3.5	mJ	
Avalanche current	$I_{AR}^{*3}$	6	A	
Power dissipation ( $T_c = 25^\circ C$ )	$P_D$	50	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>*5</sup>	15	V/ns	

### ●Absolute maximum ratings

Parameter	Symbol	Conditions	Values	Unit
Drain - Source voltage slope	dv/dt	$V_{DS} = 480V, I_D = 12A$ $T_j = 125^\circ C$	50	V/ns

### ●Thermal resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - case	$R_{thJC}$	-	-	2.5	$^\circ C/W$
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
Drain - Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS} = 0V, I_D = 12A$	-	700	-	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	$I_{GSS}$	$V_{GS} = \pm 30V, V_{DS} = 0V$	-	-	$\pm 100$	nA
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = 10V, I_D = 1mA$	2.5	-	4.5	V
Static drain - source on - state resistance	$R_{DS(on)}^{*6}$	$V_{GS} = 10V, I_D = 6A$ $T_j = 25^\circ C$	-	0.32	0.42	$\Omega$
		$T_j = 125^\circ C$	-	0.6	-	
Gate input resistance	$R_G$	f = 1MHz, open drain	-	8.2	-	$\Omega$

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Transconductance	$g_{fs}^{*6}$	$V_{DS} = 10V, I_D = 6.0A$	3.5	8.5	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0V$	-	1300	-	pF
Output capacitance	$C_{oss}$	$V_{DS} = 25V$	-	890	-	
Reverse transfer capacitance	$C_{rss}$	$f = 1MHz$	-	45	-	
Effective output capacitance, energy related	$C_{o(er)}$	$V_{GS} = 0V$ $V_{DS} = 0V \text{ to } 480V$	-	63	-	pF
Effective output capacitance, time related	$C_{o(tr)}$		-	63	-	
Turn - on delay time	$t_{d(on)}^{*6}$	$V_{DD} \approx 300V, V_{GS} = 10V$	-	30	-	ns
Rise time	$t_r^{*6}$	$I_D = 6A$	-	30	-	
Turn - off delay time	$t_{d(off)}^{*6}$	$R_L = 50\Omega$	-	90	180	
Fall time	$t_f^{*6}$	$R_G = 10\Omega$	-	35	70	

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	$Q_g^{*6}$	$V_{DD} \approx 300V$	-	35	-	nC
Gate - Source charge	$Q_{gs}^{*6}$	$I_D = 12A$	-	7	-	
Gate - Drain charge	$Q_{gd}^{*6}$	$V_{GS} = 10V$	-	15	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} \approx 300V, I_D = 12A$	-	6.0	-	V

\*1 Limited only by maximum temperature allowed.

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

\*3  $L \approx 500\mu H$ ,  $V_{DD} = 50V$ ,  $R_G = 25\Omega$ , starting  $T_j = 25^\circ C$

\*4  $L \approx 500\mu H$ ,  $V_{DD} = 50V$ ,  $R_G = 25\Omega$ , starting  $T_j = 25^\circ C$ ,  $f = 10kHz$

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

\*6 Pulsed

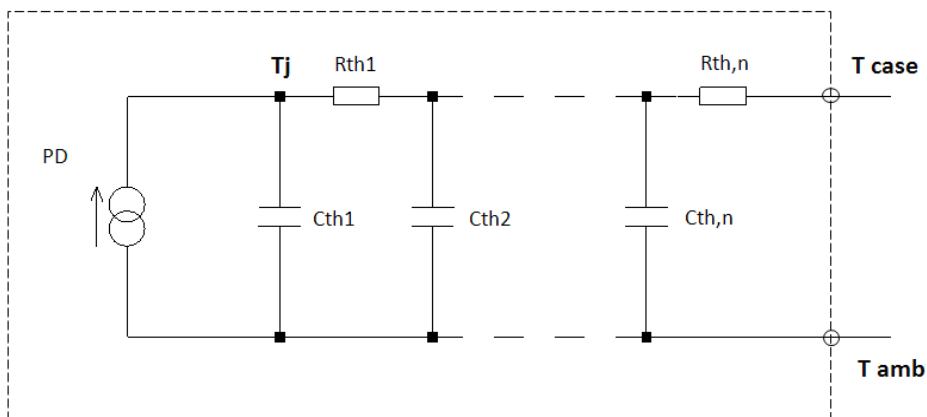
●Body diode electrical characteristics (Source-Drain) ( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Inverse diode continuous, forward current	$I_S^{*1}$	$T_c = 25^\circ\text{C}$	-	-	12	A
Inverse diode direct current, pulsed	$I_{SM}^{*2}$		-	-	48	A
Forward voltage	$V_{SD}^{*6}$	$V_{GS} = 0\text{V}, I_S = 12\text{A}$	-	-	1.5	V
Reverse recovery time	$t_{rr}^{*6}$	$I_S = 12\text{A}$ $di/dt = 100\text{A}/\mu\text{s}$	-	396	-	ns
Reverse recovery charge	$Q_{rr}^{*6}$		-	4.4	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}^{*6}$		-	22	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$	$T_j = 25^\circ\text{C}$	-	640	-	$\text{A}/\mu\text{s}$

●Typical Transient Thermal Characteristics

Symbol	Value	Unit
$R_{th1}$	0.158	K/W
$R_{th2}$	0.75	
$R_{th3}$	2.15	

Symbol	Value	Unit
$C_{th1}$	0.00247	Ws/K
$C_{th2}$	0.0317	
$C_{th3}$	0.485	



●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

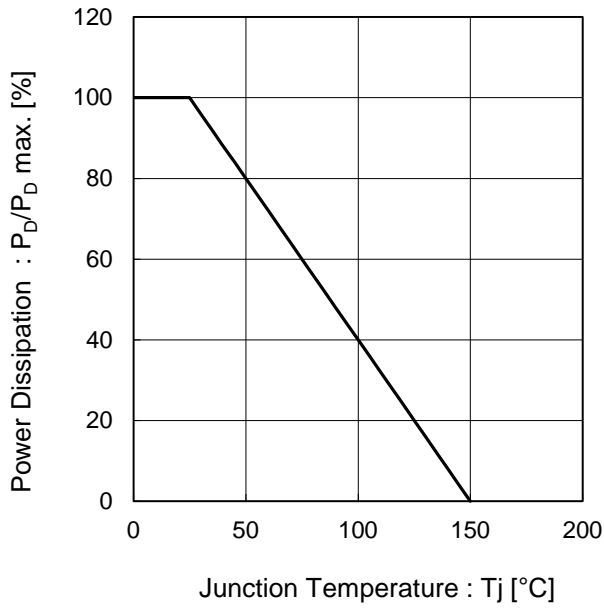


Fig.2 Maximum Safe Operating Area

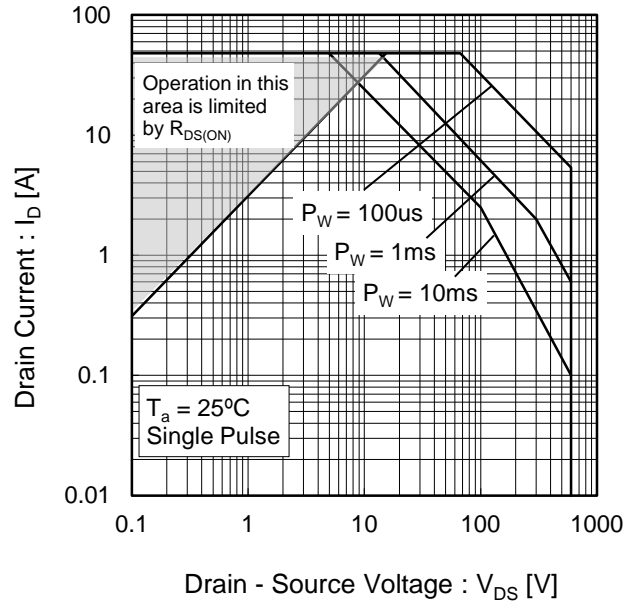
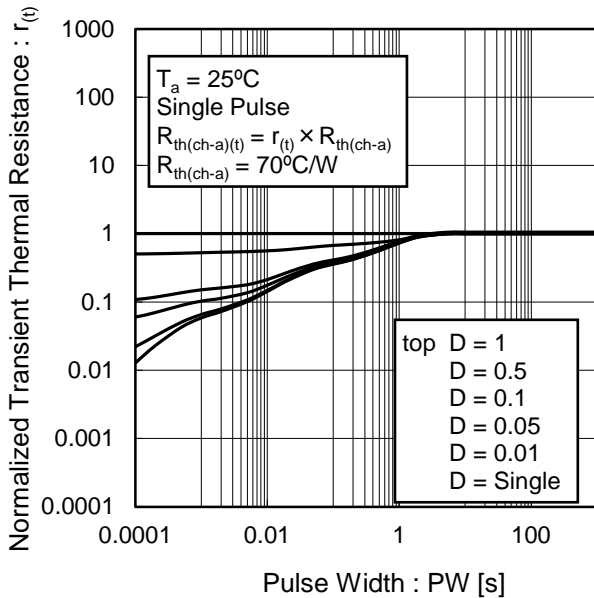


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width



●Electrical characteristic curves

Fig.4 Avalanche Current vs Inductive Load

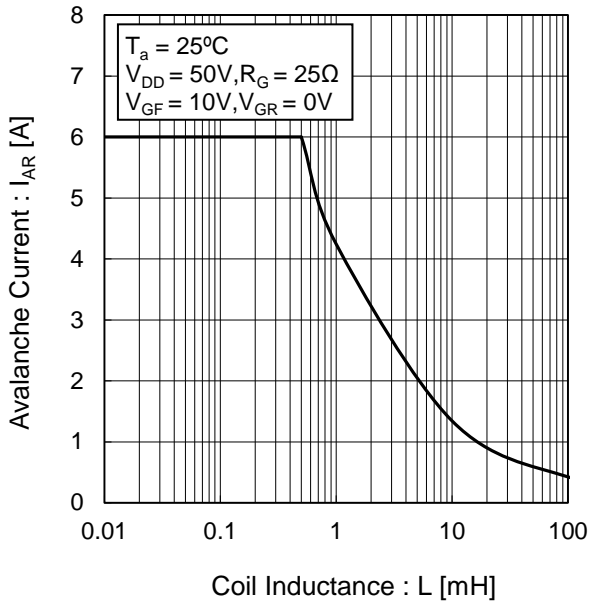


Fig.5 Avalanche Power Losses

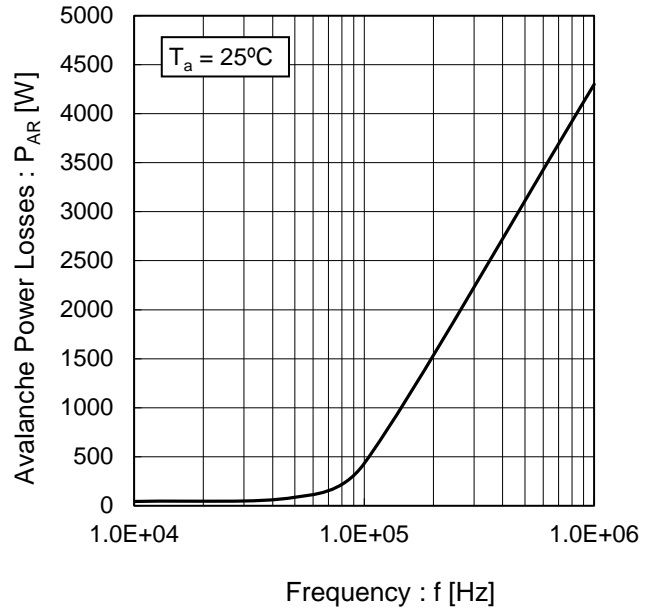
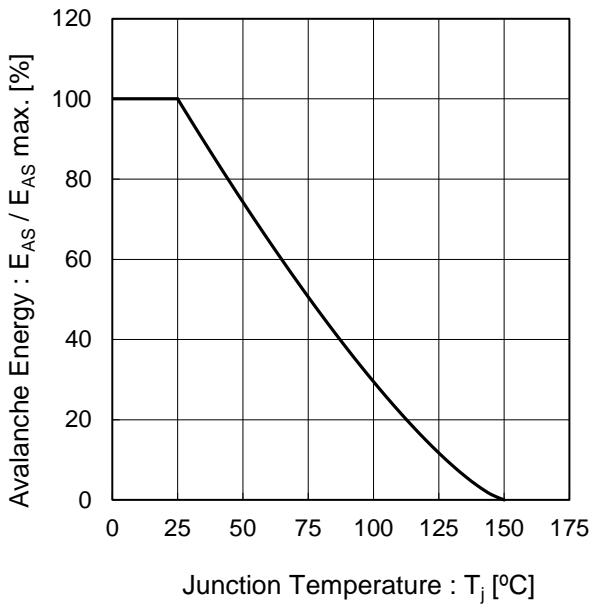


Fig.6 Avalanche Energy Derating Curve vs Junction Temperature



●Electrical characteristic curves

Fig.7 Typical Output Characteristics(I)

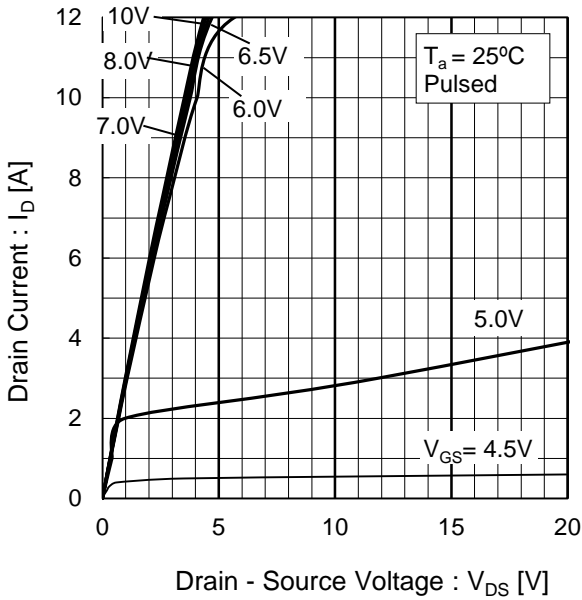


Fig.8 Typical Output Characteristics(II)

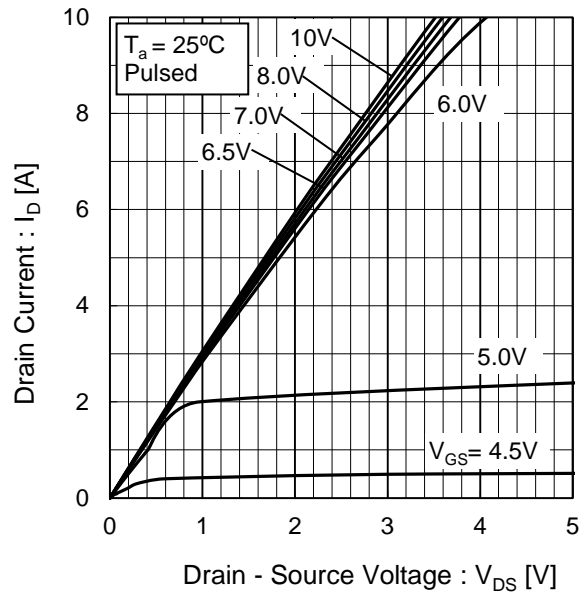


Fig.9  $T_j = 150^\circ\text{C}$  Typical Output Characteristics(I)

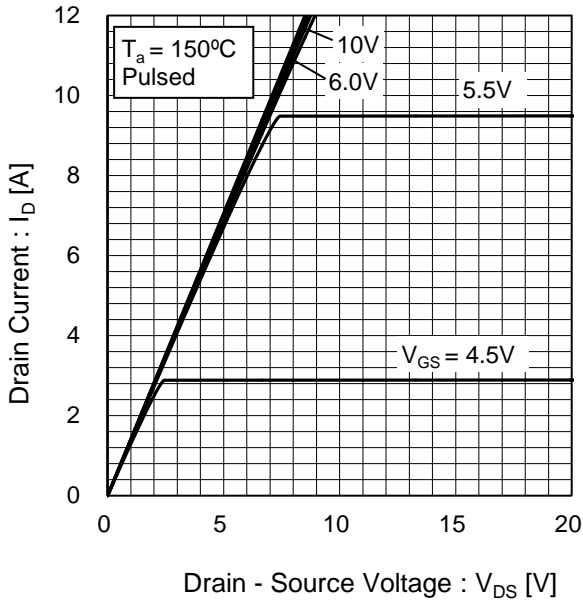
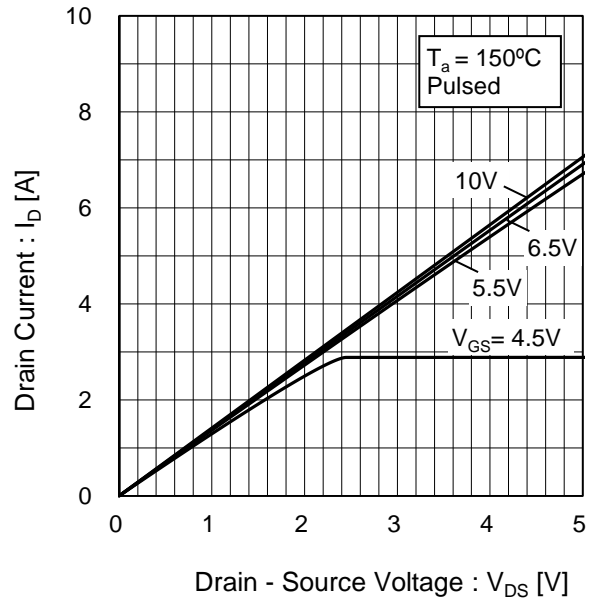


Fig.10  $T_j = 150^\circ\text{C}$  Typical Output Characteristics(II)



●Electrical characteristic curves

Fig.11 Breakdown Voltage vs. Junction Temperature

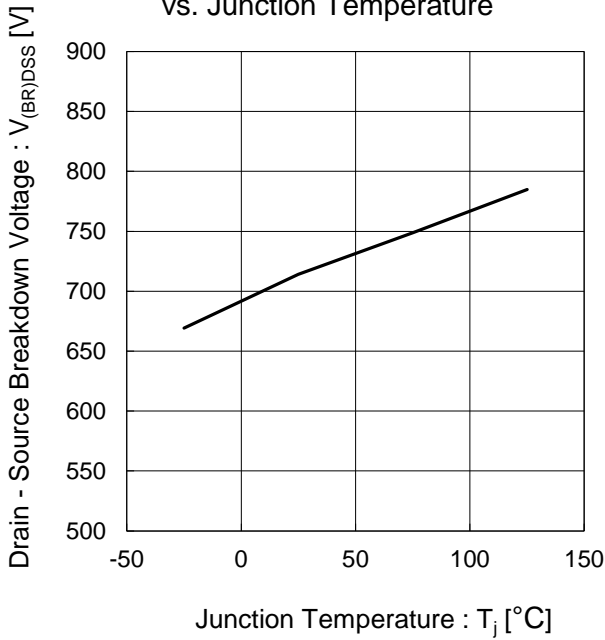


Fig.12 Typical Transfer Characteristics

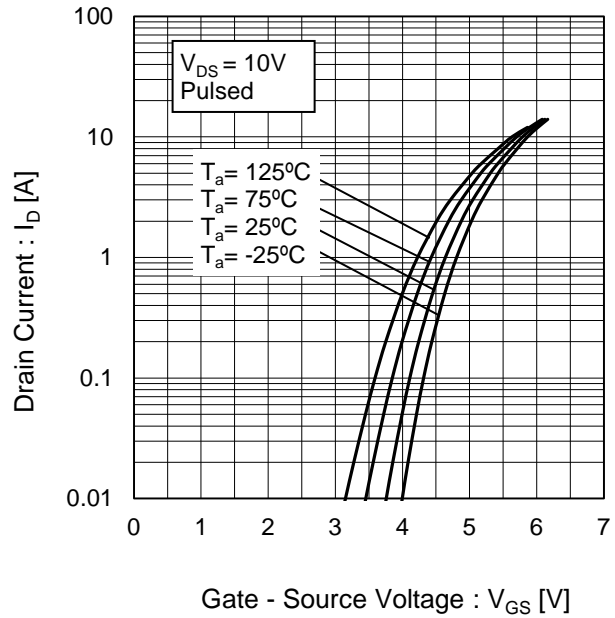


Fig.13 Gate Threshold Voltage vs. Junction Temperature

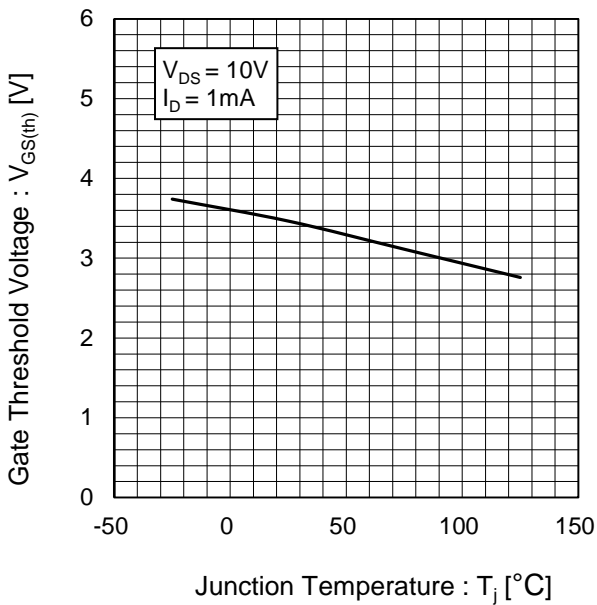
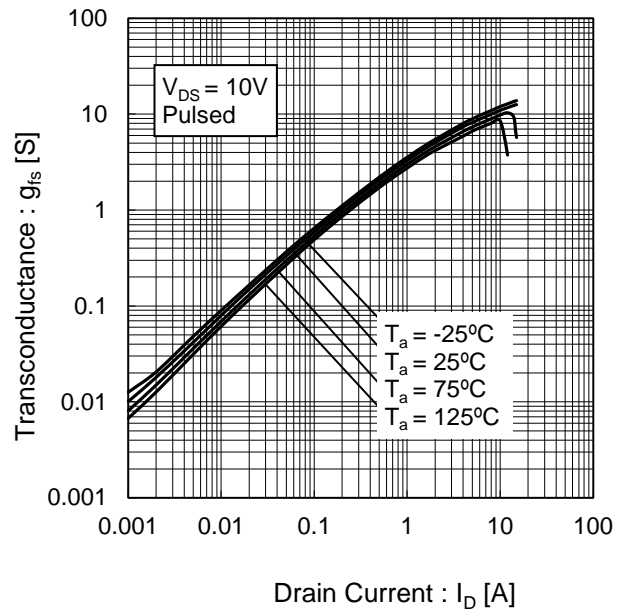


Fig.14 Transconductance vs. Drain Current





●Electrical characteristic curves

Fig.15 Static Drain - Source On - State Resistance vs. Gate Source Voltage

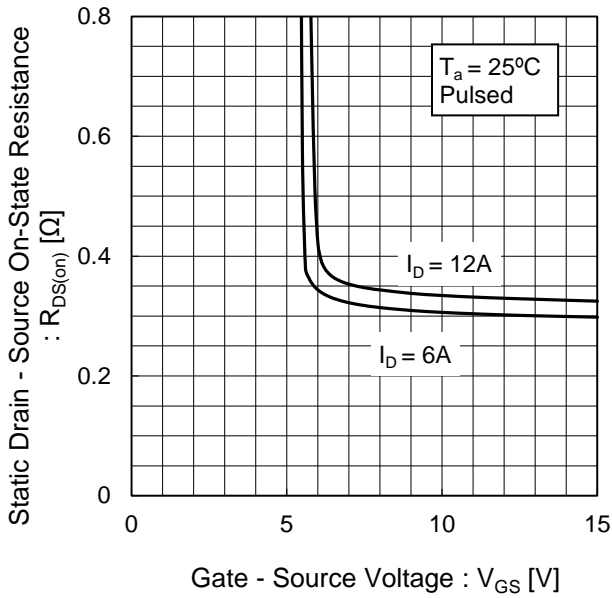


Fig.16 Static Drain - Source On - State Resistance vs. Junction Temperature

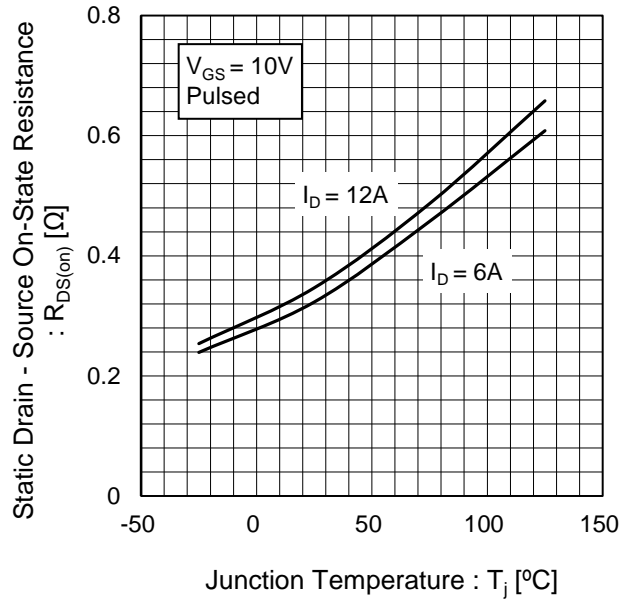
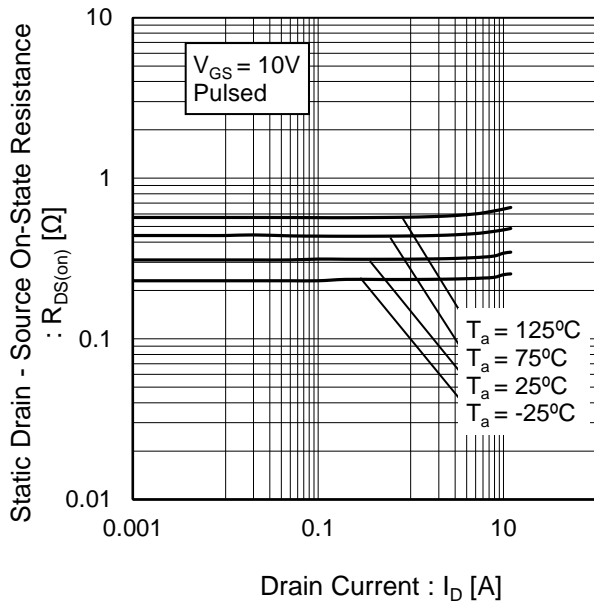


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current



●Electrical characteristic curves

Fig.18 Typical Capacitance vs. Drain - Source Voltage

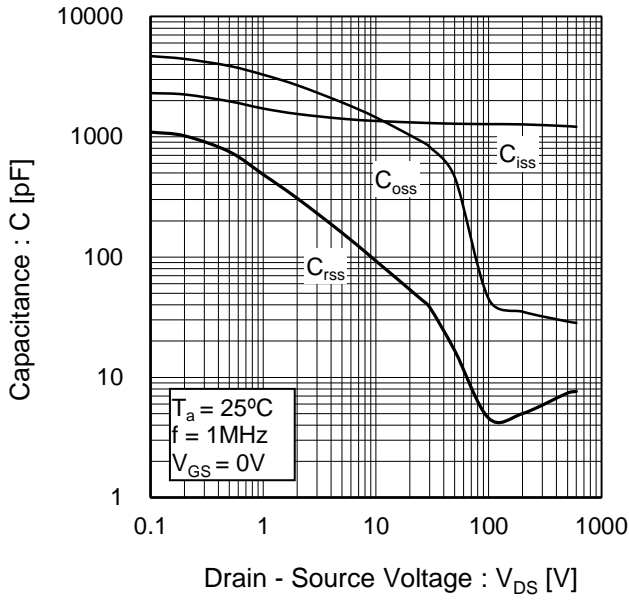


Fig.19 Coss Stored Energy

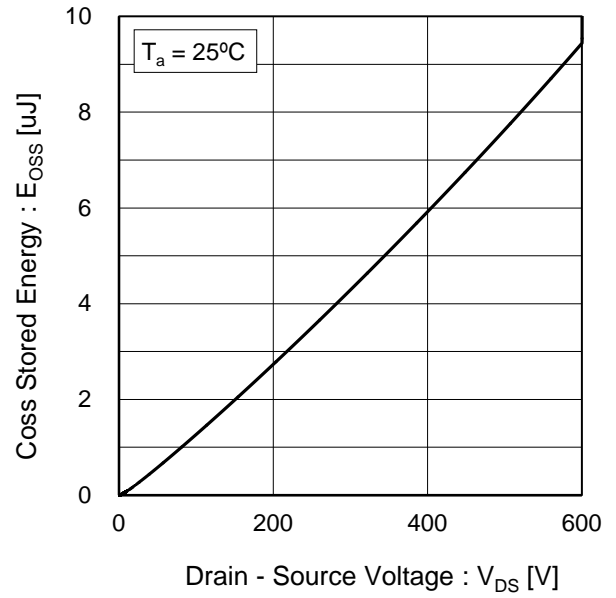


Fig.20 Switching Characteristics

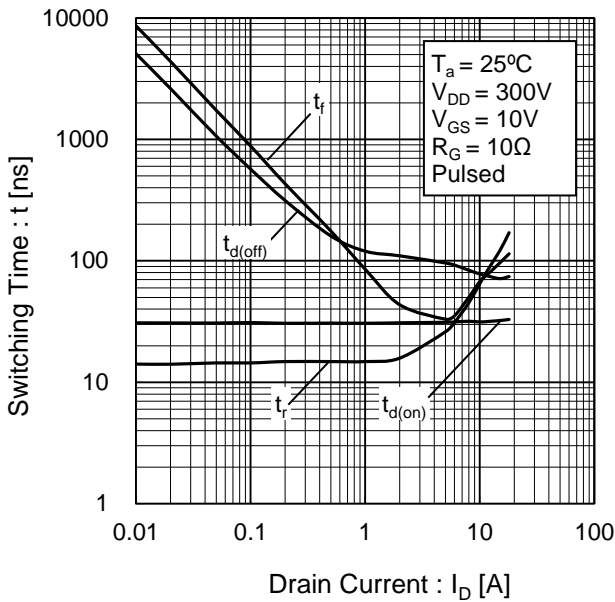
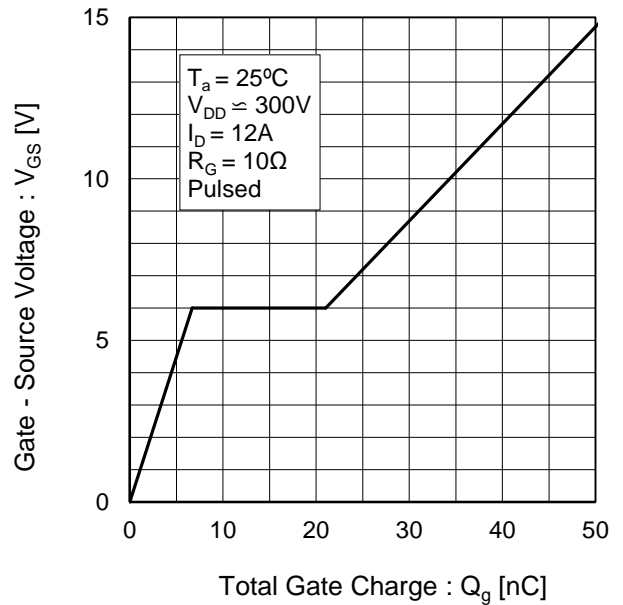


Fig.21 Dynamic Input Characteristics



●Electrical characteristic curves

Fig.22 Inverse Diode Forward Current vs. Source - Drain Voltage

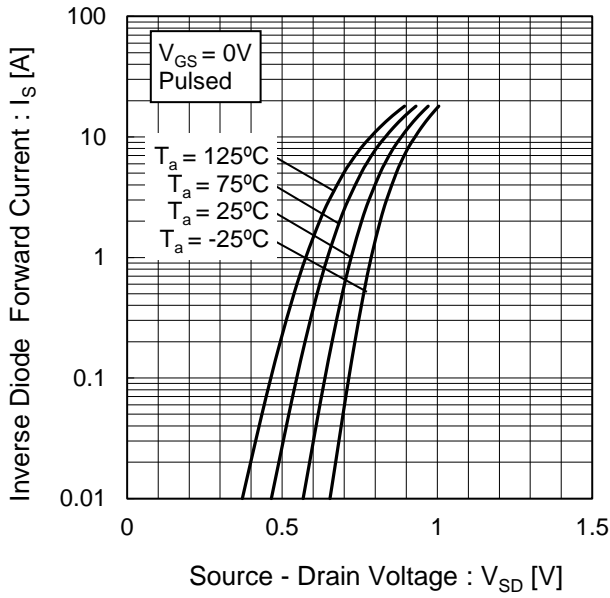
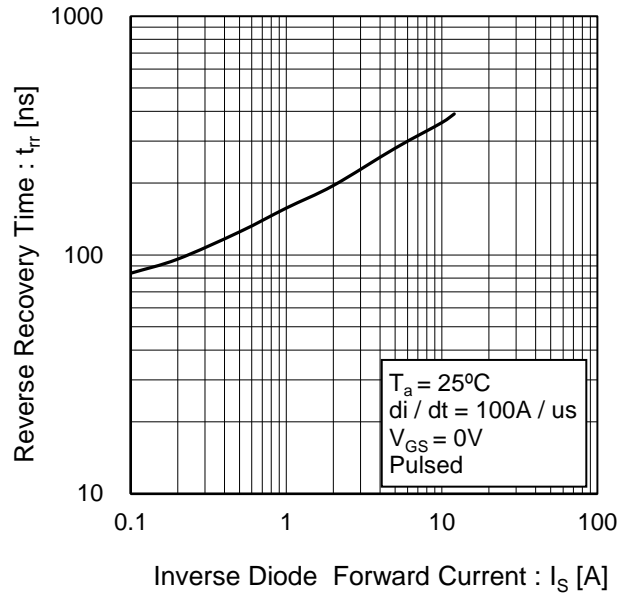


Fig.23 Reverse Recovery Time vs. Inverse Diode Forward Current



● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

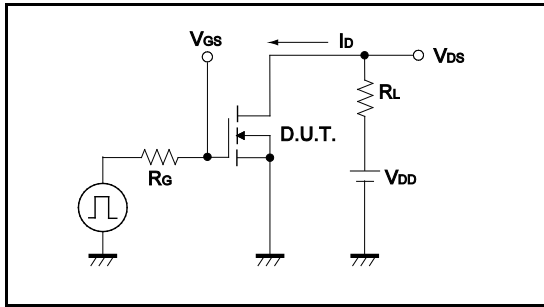


Fig.1-2 Switching Waveforms

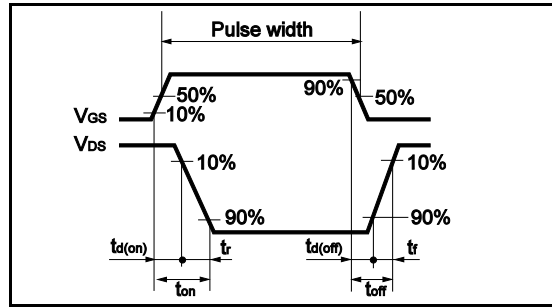


Fig.2-1 Gate Charge Measurement Circuit

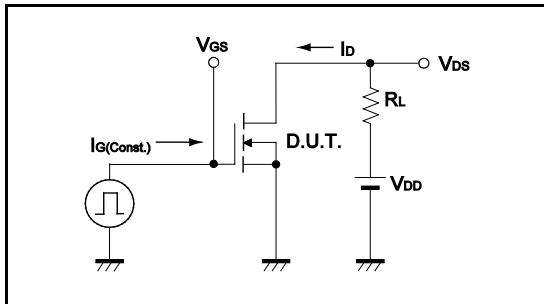


Fig.2-2 Gate Charge Waveform

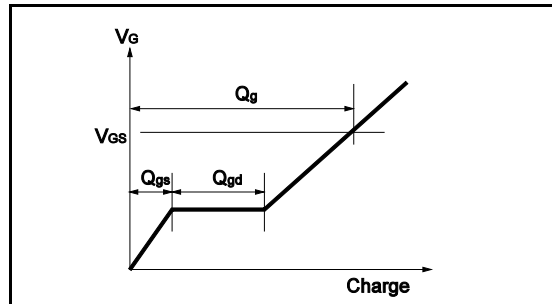


Fig.3-1 Avalanche Measurement Circuit

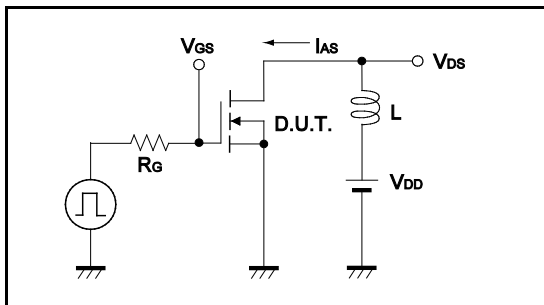


Fig.3-2 Avalanche Waveform

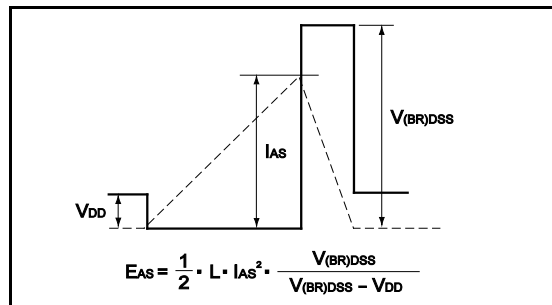


Fig.4-1 dv/dt Measurement Circuit

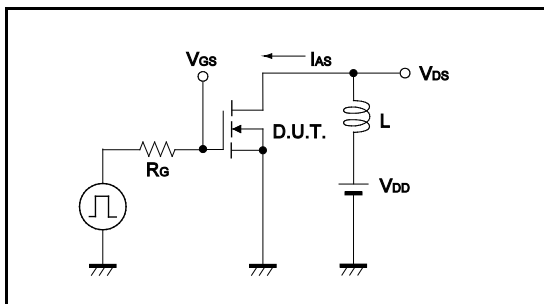


Fig.4-2 dv/dt Waveform

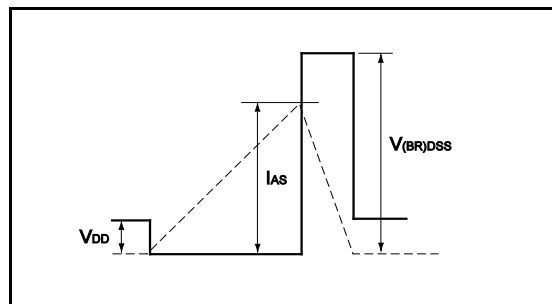


Fig.5-1 di/dt Measurement Circuit

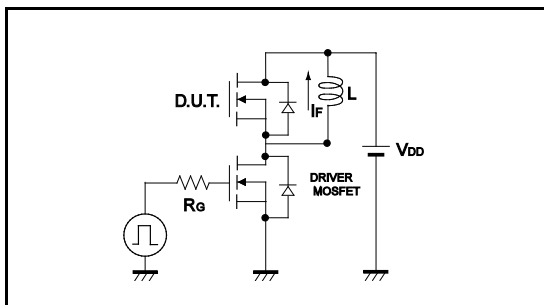
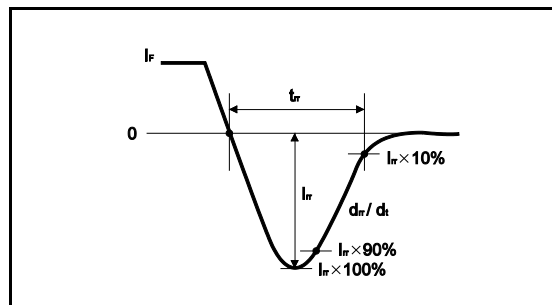
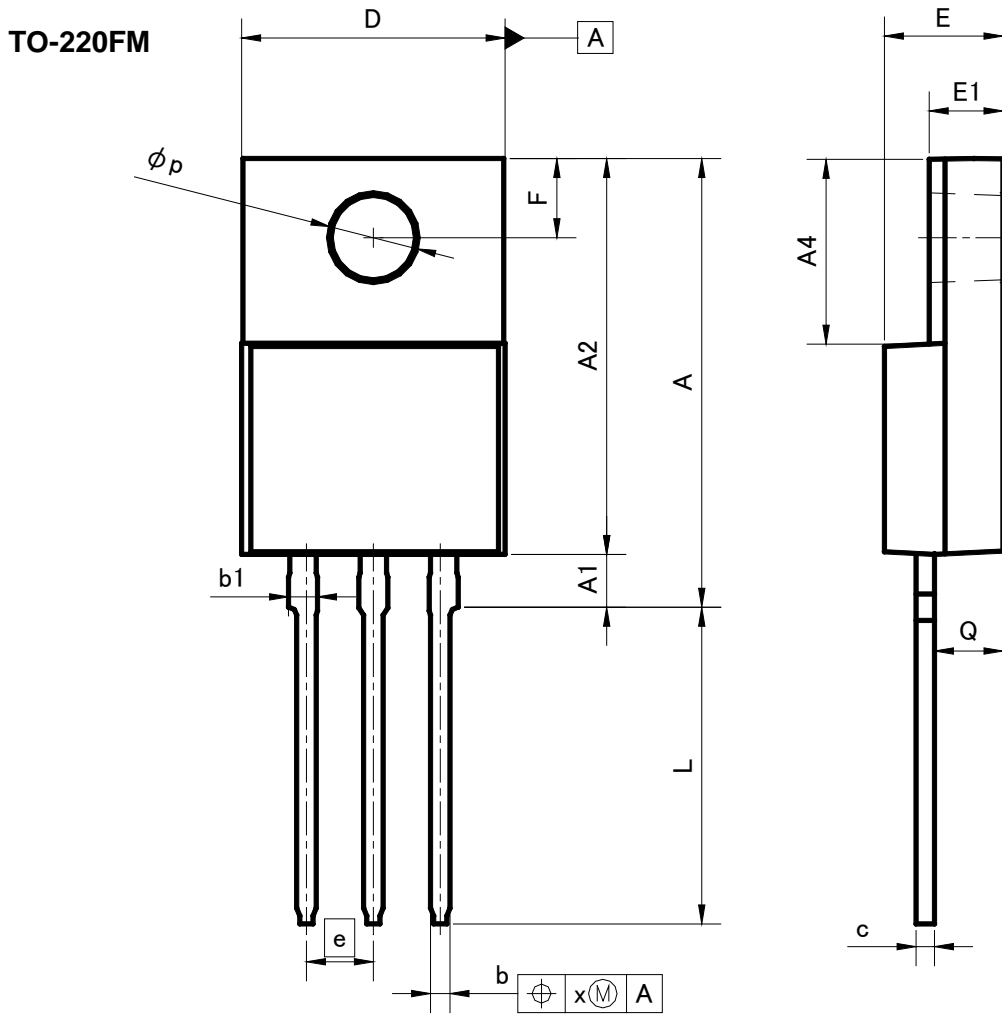


Fig.5-2 di/dt Waveform



●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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