

V_{DSS}	500V
$R_{DS(on)}(Max.)$	1.6Ω
I_D	±5A
P_D	40W

●Features

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

●Application

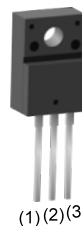
Switching Power Supply

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

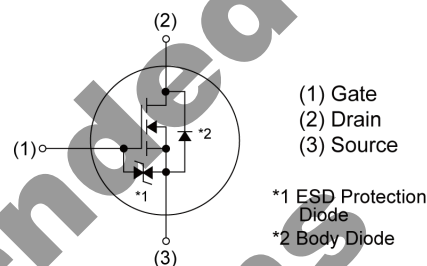
Parameter	Symbol	Value	Unit
Drain - Source voltage	V_{DSS}	500	V
Continuous drain current	$T_C = 25^\circ C$	I_D^{*1}	±5 A
	$T_C = 100^\circ C$	I_D^{*1}	±2.3 A
Pulsed drain current	$I_{D,pulse}^{*2}$	±20	A
Gate - Source voltage	V_{GSS}	±30	V
Avalanche energy, single pulse	E_{AS}^{*3}	1.6	mJ
Avalanche energy, repetitive	E_{AR}^{*4}	1.3	mJ
Avalanche current	I_{AR}^{*3}	2.5	A
Power dissipation ($T_C = 25^\circ C$)	P_D	40	W
Junction temperature	T_j	150	°C
Range of storage temperature	T_{stg}	-55 to +150	°C
Reverse diode dv/dt	dv/dt	15	V/ns

●Outline

TO-220FM



●Inner circuit



●Packaging specifications

Type	Packing	Bulk
	Reel size (mm)	-
	Tape width (mm)	-
	Basic ordering unit (pcs)	500
	Taping code	-
	Marking	R5005CNX

● Absolute maximum ratings

Parameter	Symbol	Conditions	Values	Unit
Drain - Source voltage slope	dv/dt	$V_{DS} = 400V, I_D = 5A$ $T_j = 125^\circ C$	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_{sld}	-	-	265	$^\circ C$

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Drain - Source breakdown voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 1mA$	500	-	-	V
Drain - Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS} = , I_D = 2.5A$	-	580	-	V
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 500V, V_{GS} = 0V$ $T_j = 25^\circ C$	-	0.1	100	μA
		$T_j = 125^\circ C$	-	-	1000	
Gate - Source leakage current	I_{GSS}	$V_{GS} = \pm 30V, V_{DS} = 0V$	-	-	± 10	μA
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = 10V, I_D = 1mA$	2.5	-	4.5	V
Static drain - source on - state resistance	$R_{DS(on)}^{*6}$	$V_{GS} = 10V, I_D = 2.5A$ $T_j = 25^\circ C$	-	1.3	1.6	Ω
		$T_j = 125^\circ C$	-	2.85	-	
Gate input resistance	R_G	$f = 1MHz, \text{open drain}$	-	7.4	-	Ω

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Transconductance	g_{fs}^{*6}	$V_{DS} = 10\text{V}, I_D = 2.5\text{A}$	1.5	2.8	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$	-	320	-	pF
Output capacitance	C_{oss}	$V_{DS} = 25\text{V}$	-	180	-	
Reverse transfer capacitance	C_{rss}	$f = 1\text{MHz}$	-	15	-	
Effective output capacitance, energy related	$C_{o(er)}$	$V_{GS} = 0\text{V},$ $V_{DS} = 0\text{V to } 400\text{V}$	-	15.5	-	pF
Effective output capacitance, time related	$C_{o(tr)}$		-	43.1	-	
Turn - on delay time	$t_{d(on)}^{*6}$	$V_{DD} \approx 250\text{V}, V_{GS} = 10\text{V}$	-	20	-	ns
Rise time	t_r^{*6}	$I_D = 2.5\text{A}$	-	25	-	
Turn - off delay time	$t_{d(off)}^{*6}$	$R_L = 100\Omega$	-	40	80	
Fall time	t_f^{*6}	$R_G = 10\Omega$	-	20	40	

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	Q_g^{*6}	$V_{DD} \approx 250\text{V}$	-	10.8	-	nC
Gate - Source charge	Q_{gs}^{*6}	$I_D = 5\text{A}$	-	3.2	-	
Gate - Drain charge	Q_{gd}^{*6}	$V_{GS} = 10\text{V}$	-	4.4	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} \approx 250\text{V}, I_D = 5\text{A}$	-	6.5	-	V

*1 Limited only by maximum temperature allowed.

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

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

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

*5 Reference measurement circuits Fig.5-1.

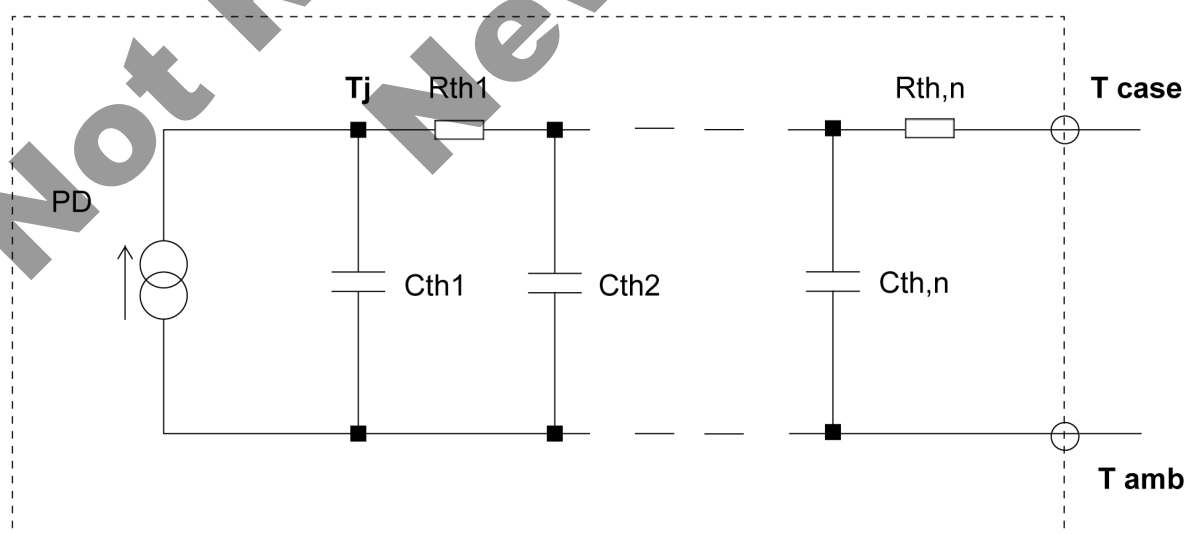
*6 Pulsed

●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}	$T_C = 25^\circ\text{C}$	-	-	5	A
Inverse diode direct current, pulsed	I_{SM}^{*2}		-	-	20	A
Forward voltage	V_{SD}^{*6}	$V_{GS} = 0\text{V}, I_S = 5\text{A}$	-	-	1.5	V
Reverse recovery time	t_{rr}^{*6}	$I_S = 5\text{A}$ $di/dt = 100\text{A}/\mu\text{s}$	-	300	-	ns
Reverse recovery charge	Q_{rr}^{*6}		-	1.94	-	μC
Peak reverse recovery current	I_{rm}^{*6}		-	12.9	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt	$T_j = 25^\circ\text{C}$	-	140	-	$\text{A}/\mu\text{s}$

●Typical transient thermal characteristics

Symbol	Value	Unit	Symbol	Value	Unit
R_{th1}	0.484	K/W	C_{th1}	0.00111	Ws/K
R_{th2}	1.46		C_{th2}	0.0103	
R_{th3}	2.23		C_{th3}	0.443	



●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

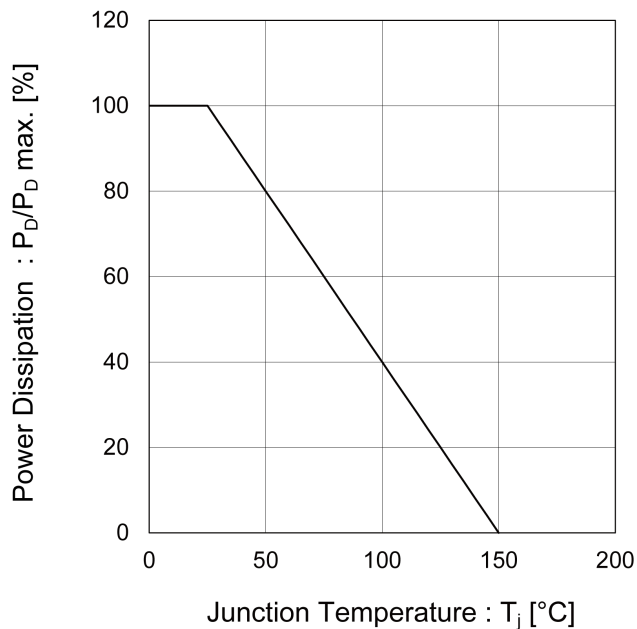


Fig.2 Maximum Safe Operating Area

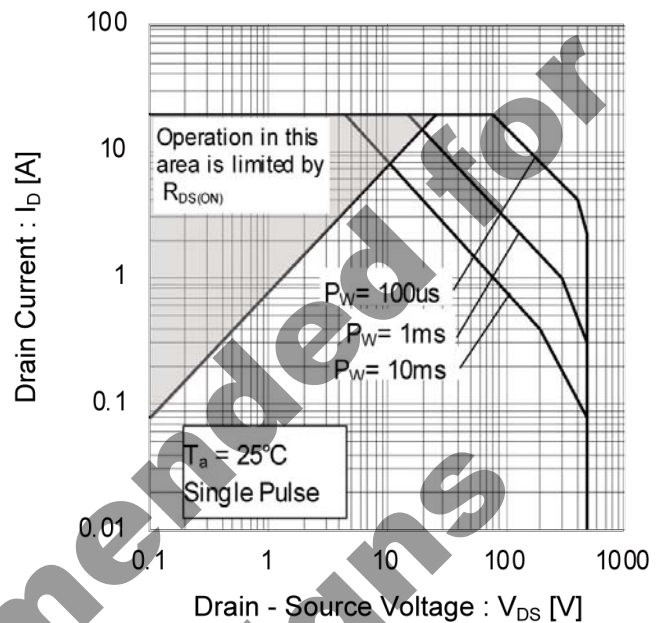
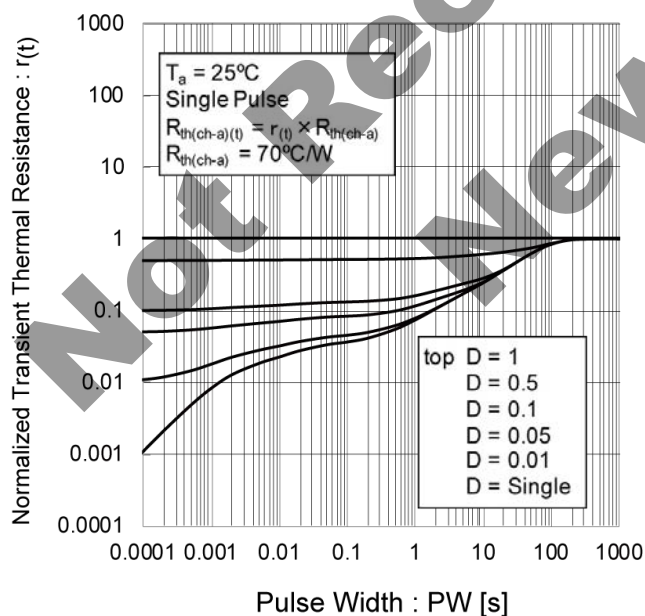


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width



●Electrical characteristic curves

Fig.4 Avalanche Current vs. Inductive Load

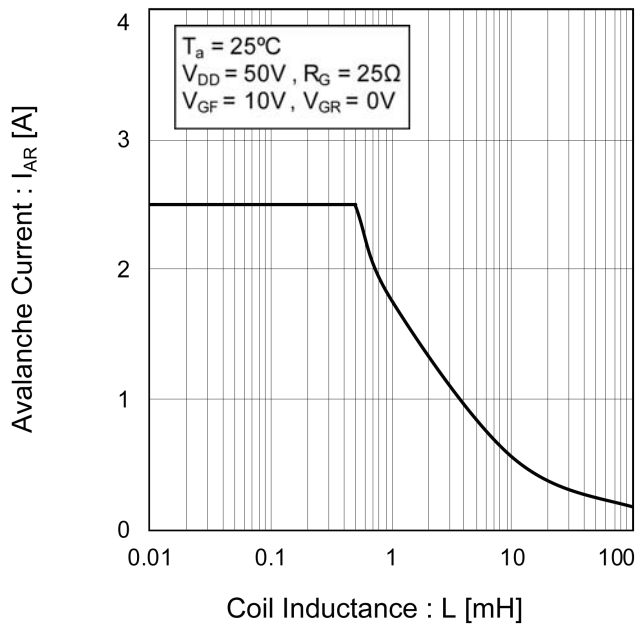


Fig.5 Avalanche Power Losses

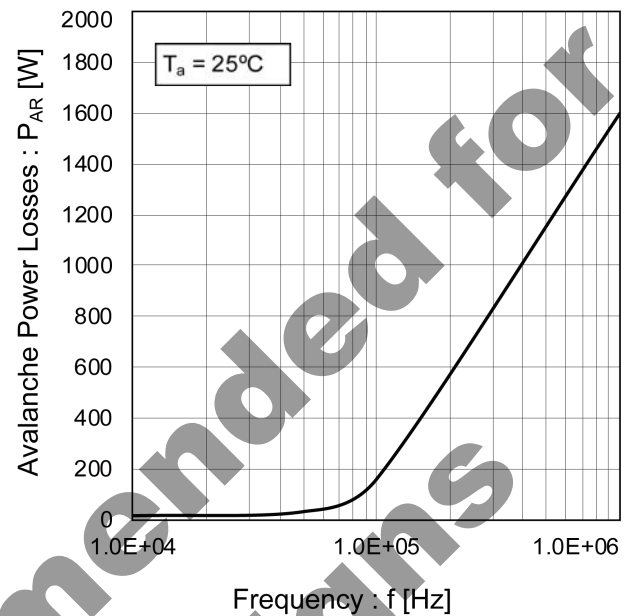
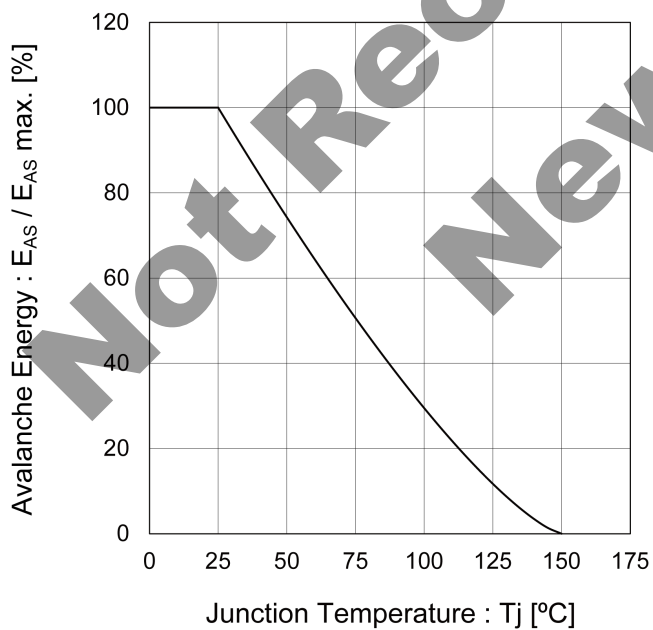


Fig.6 Avalanche Energy Derating Curve vs. Junction Temperature



●Electrical characteristic curves

Fig.7 Typical Output Characteristics(I)

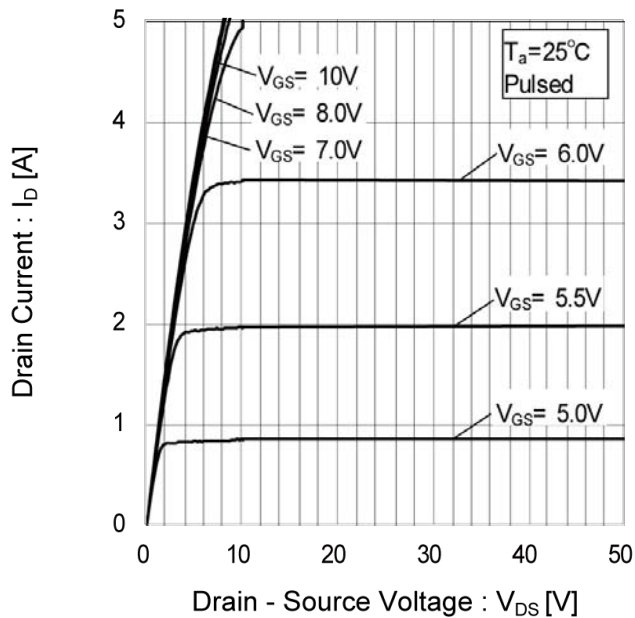
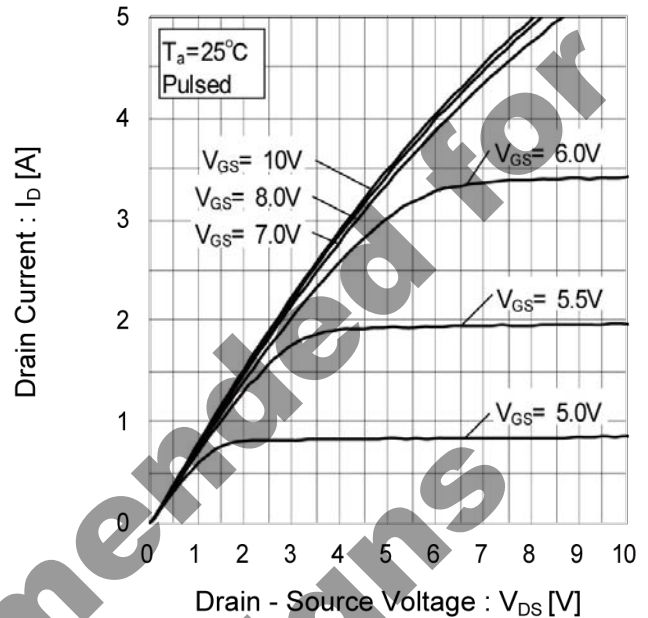
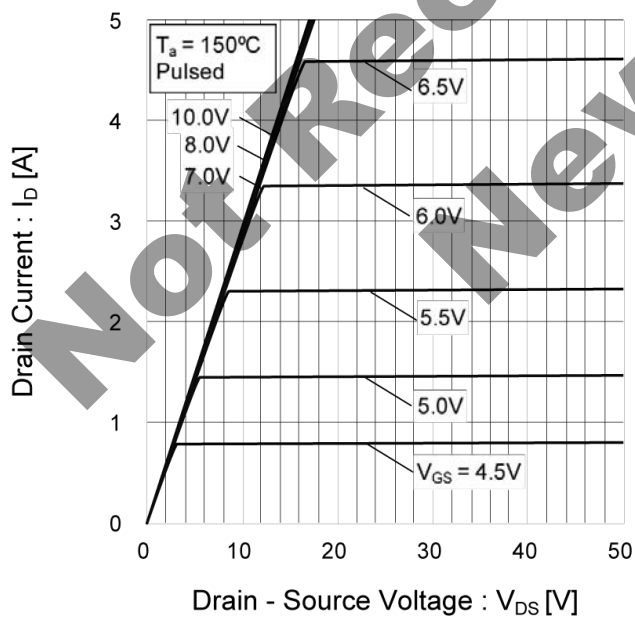
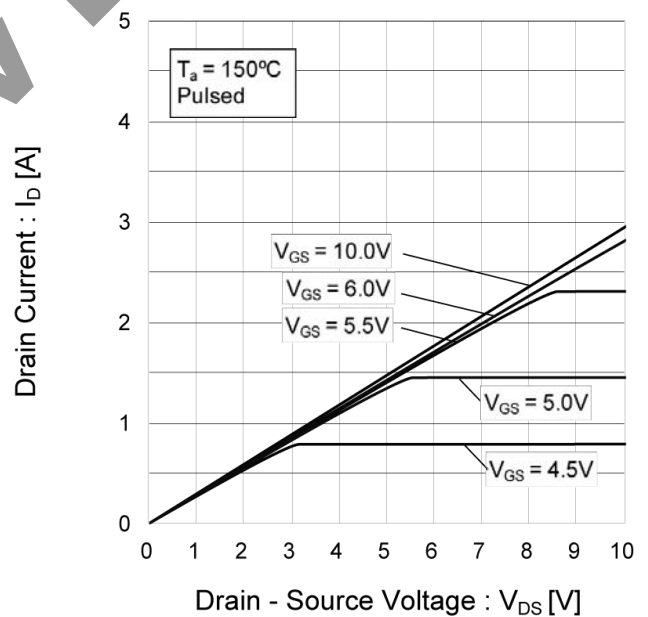


Fig.8 Typical Output Characteristics(II)

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

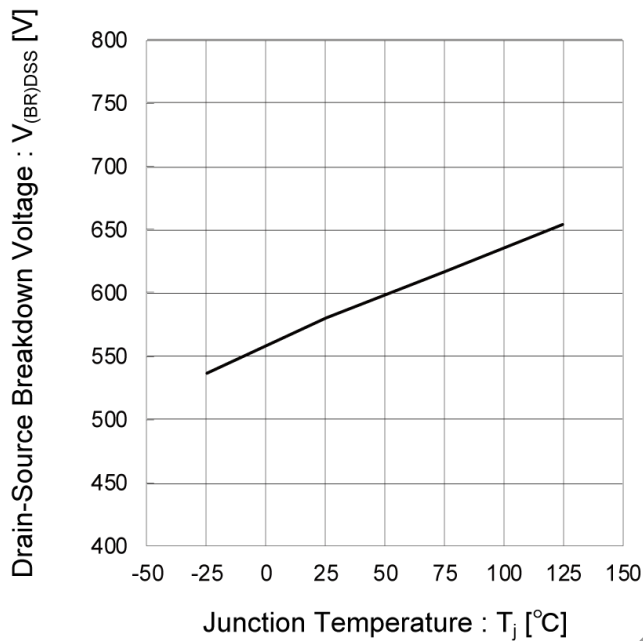


Fig.12 Typical Transfer Characteristics

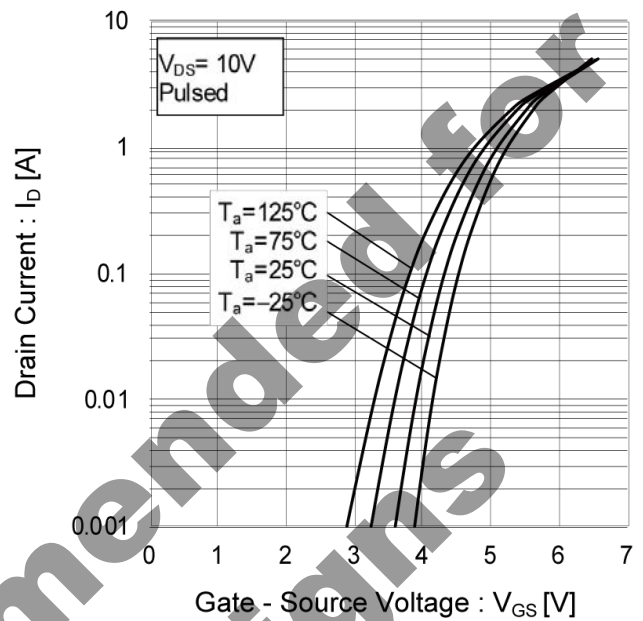


Fig.13 Gate Threshold Voltage vs. Junction Temperature

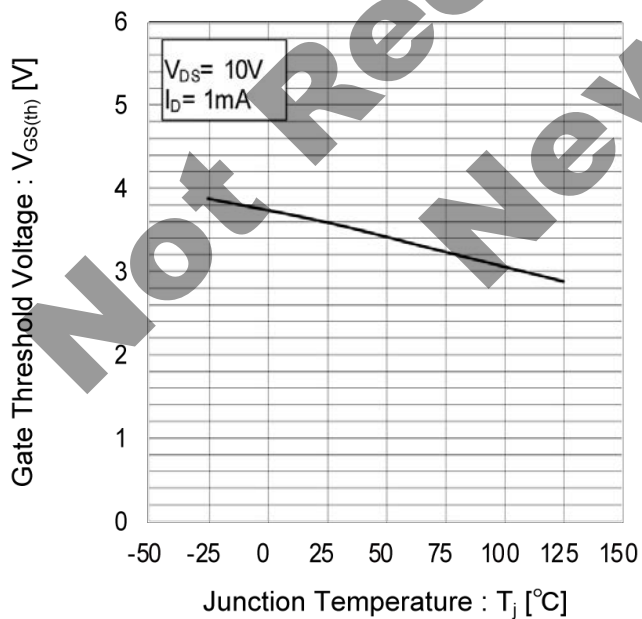
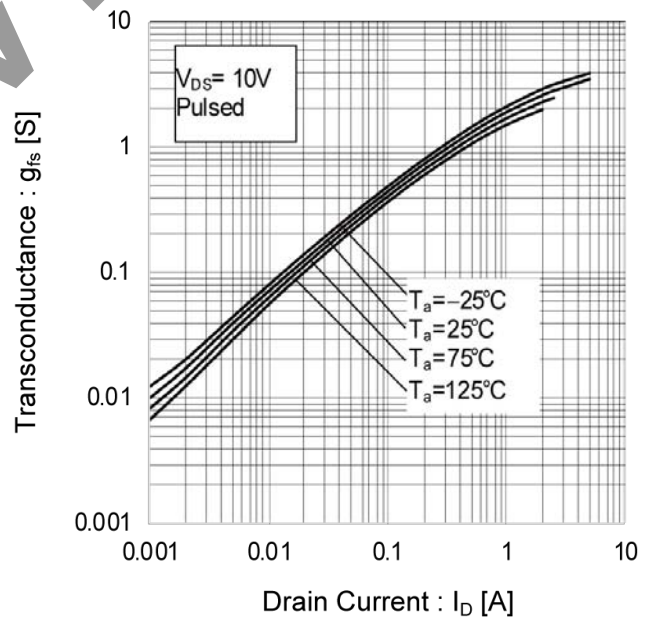


Fig.14 Transconductance vs. Drain Current



●Electrical characteristic curves

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

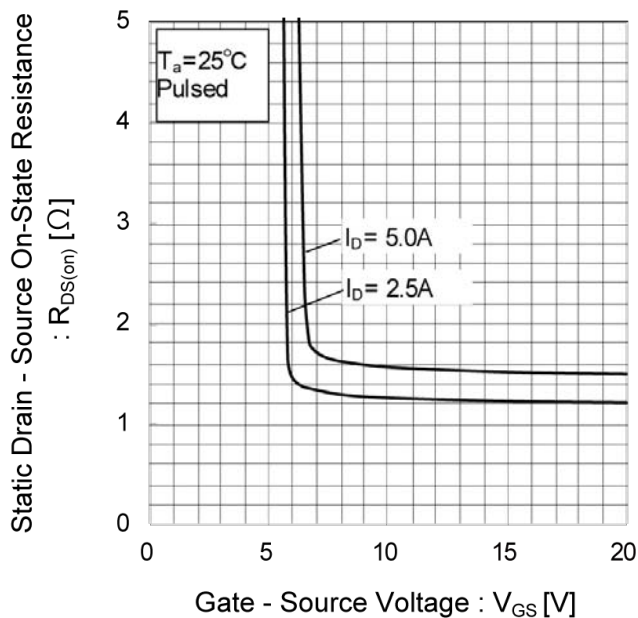


Fig.16 Static Drain - Source On - State Resistance vs. Junction Temperature

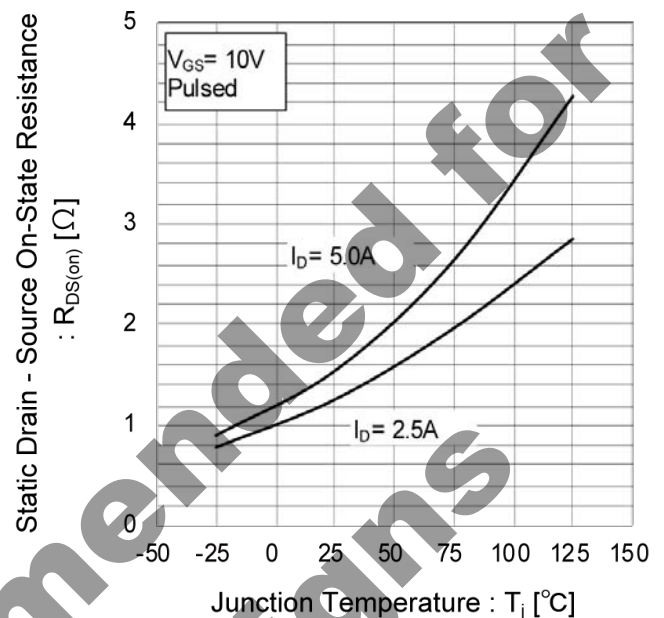
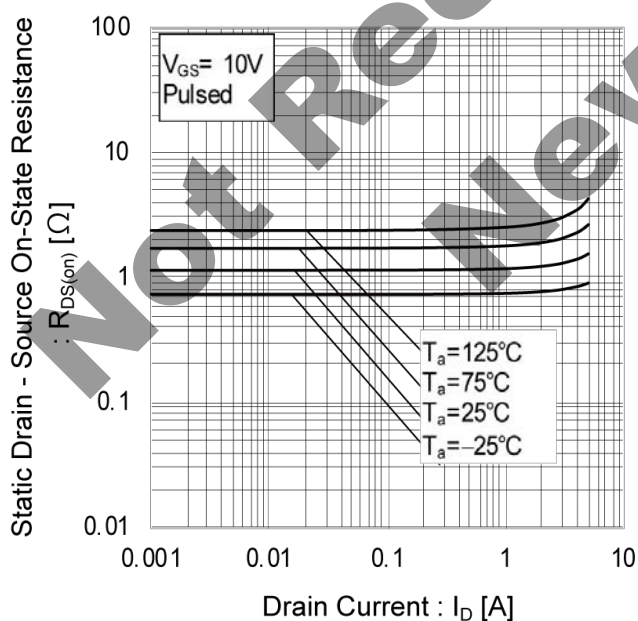


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current



●Electrical characteristic curves

Fig.18 Typical Capacitance vs. Drain - Source Voltage

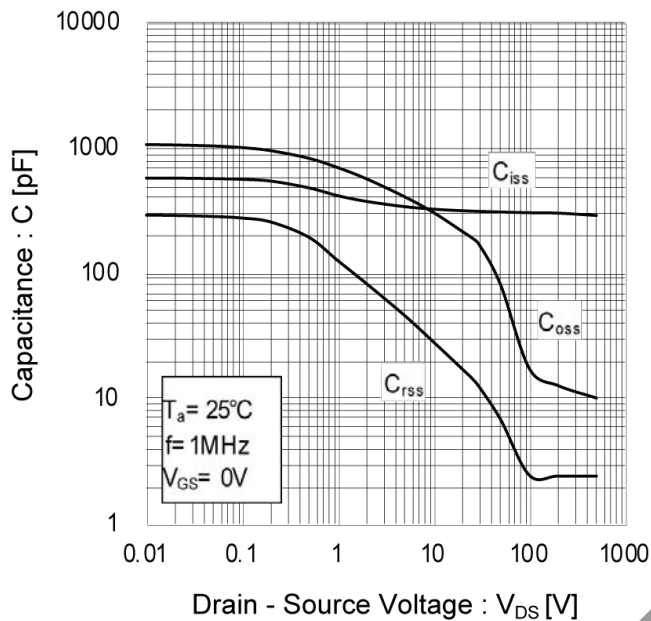


Fig.19 Coss Stored Energy

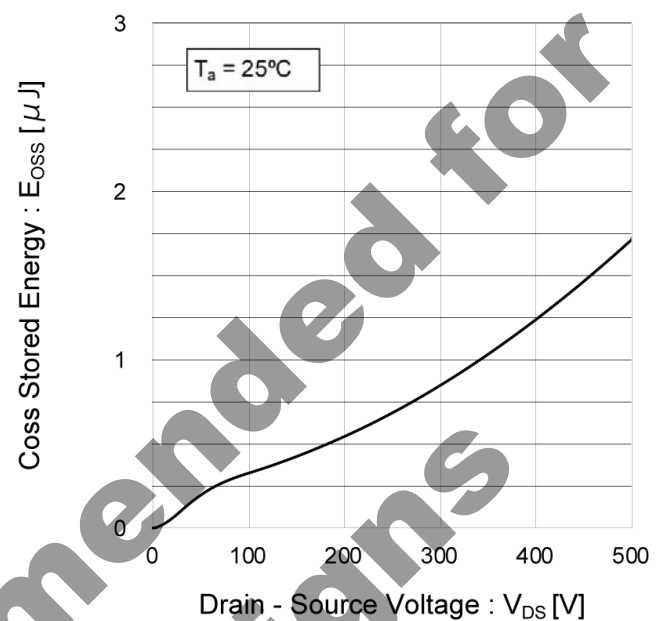


Fig.20 Switching Characteristics

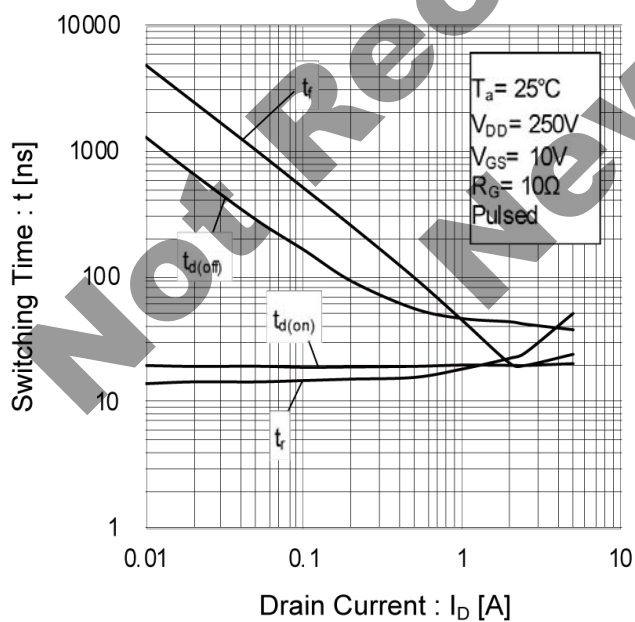
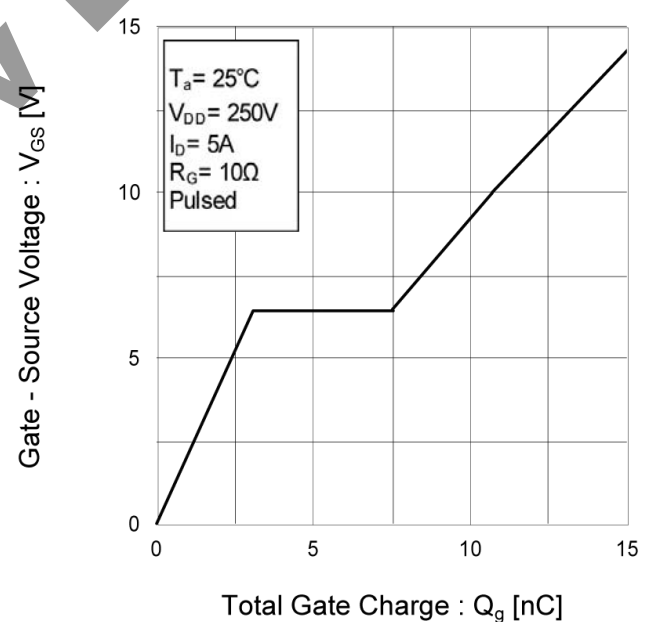


Fig.21 Dynamic Input Characteristics



●Electrical characteristic curves

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

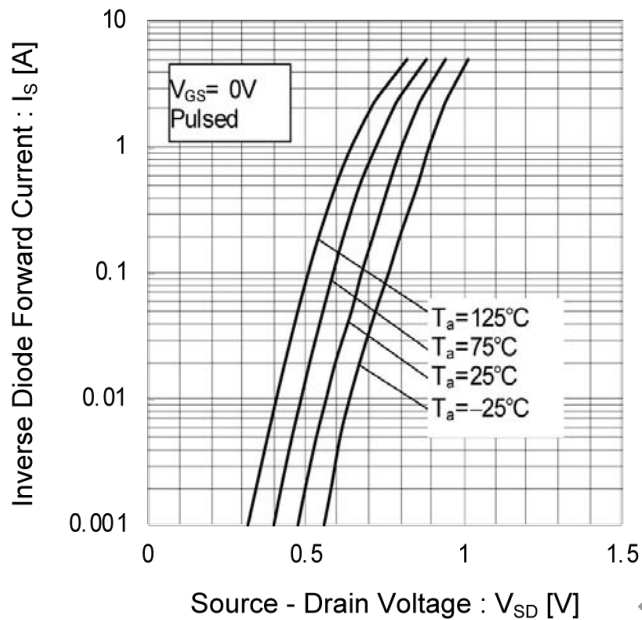
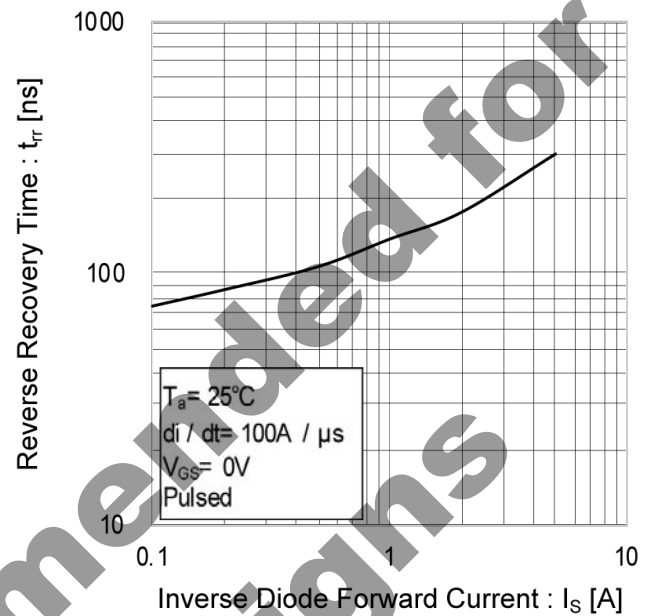


Fig.23 Reverse Recovery Time vs. Inverse Diode Forward Current



● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

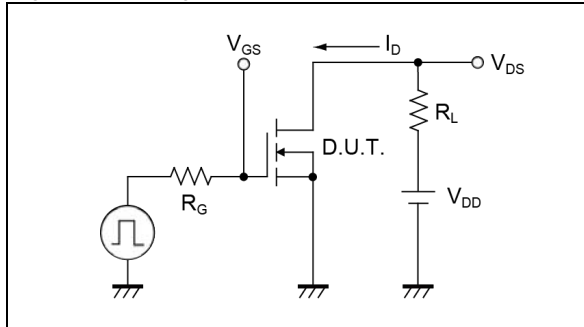


Fig.1-2 Switching Waveforms

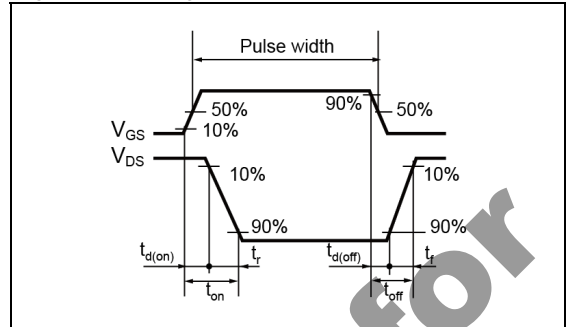


Fig.2-1 Gate Charge Measurement Circuit

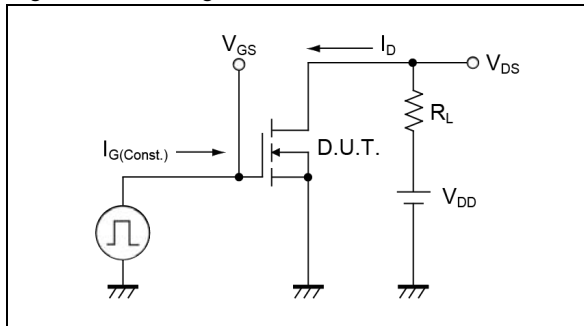


Fig.2-2 Gate Charge Waveform

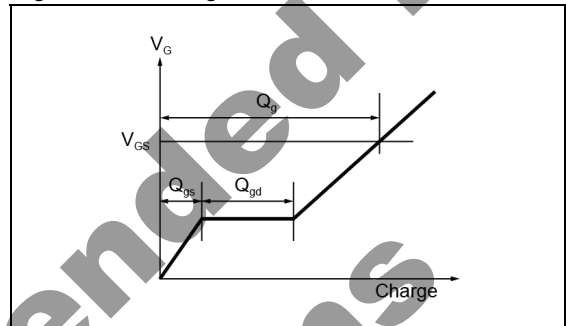


Fig.3-1 Avalanche Measurement Circuit

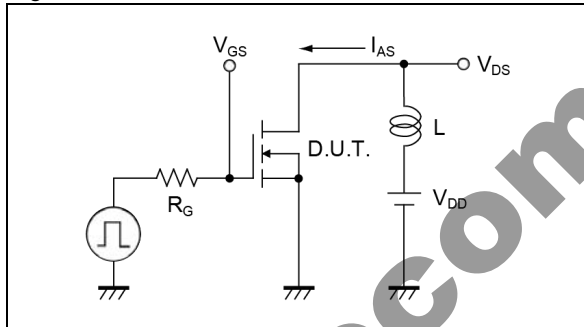


Fig.3-2 Avalanche Waveform

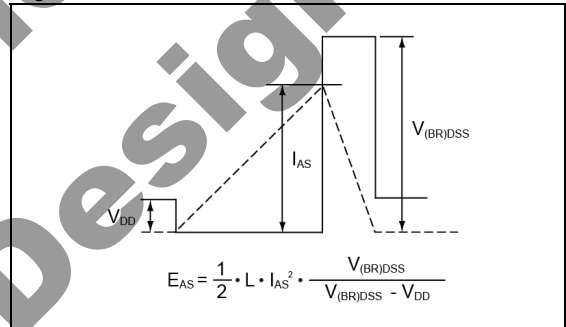


Fig.4-1 dv/dt Measurement Circuit

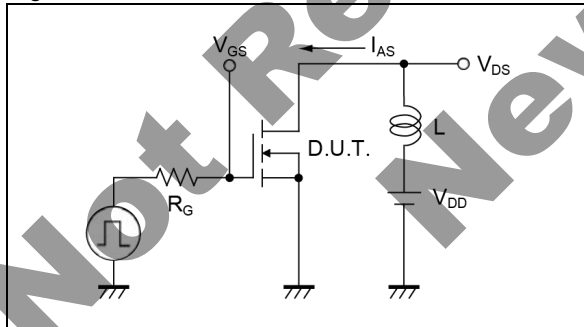


Fig.4-2 dv/dt Waveform

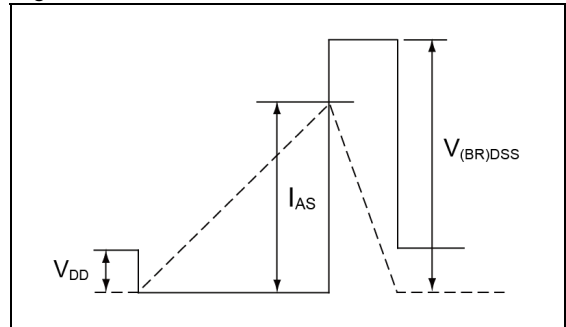


Fig.5-1 di/dt Measurement Circuit

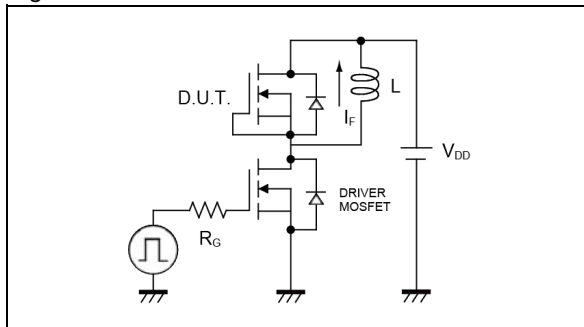
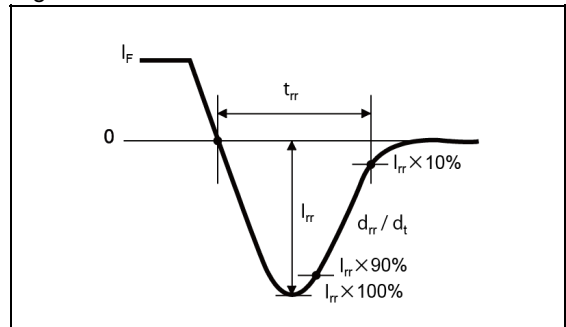
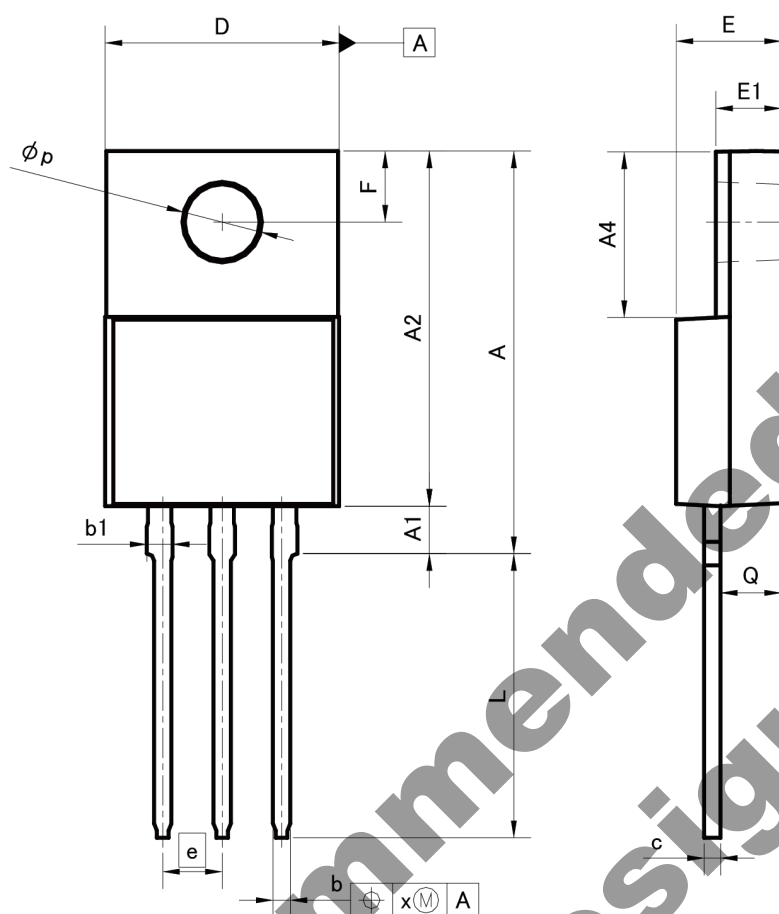


Fig.5-2 di/dt Waveform



●Dimensions

TO-220FM



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	0.390	0.406
E	4.40	4.80	0.173	0.189
e	2.54		0.100	
E1	2.70	3.00	0.106	0.118
F	2.80	3.20	0.110	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	—	0.38	—	0.015

Dimension in mm/inches

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