

V_{DSS}	600V
$R_{DS(on)}(Max.)$	0.98Ω
I_D	±4.0A
P_D	40W

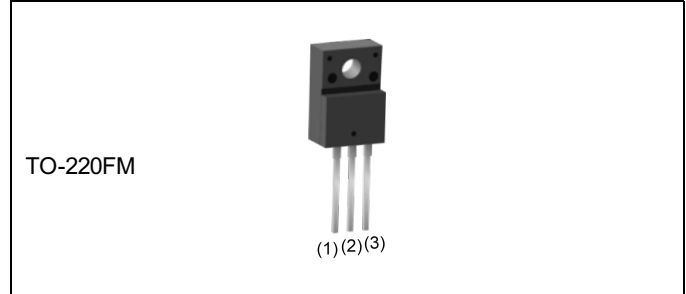
●Features

- 1) Low on-resistance.
- 2) Ultra fast switching speed.
- 3) Parallel use is easy.
- 4) Pb-free lead plating ; RoHS compliant

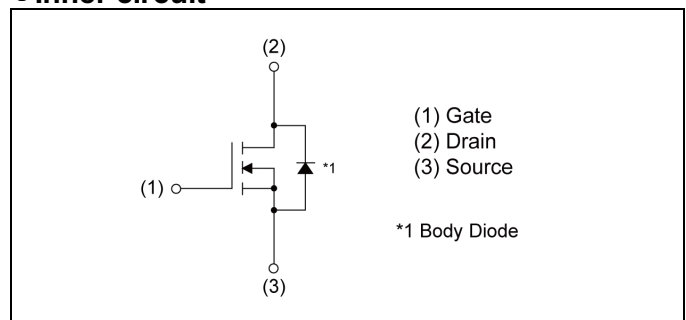
●Application

Switching

●Outline



●Inner circuit



●Packaging specifications

Type	Packing	Bulk
	Reel size (mm)	-
	Tape width (mm)	-
	Basic ordering unit (pcs)	500
	Taping code	-
	Marking	R6004KNX

●Absolute maximum ratings ($T_a = 25^\circ\text{C}$, unless otherwise specified)

Parameter		Symbol	Value	Unit
Drain - Source voltage		V_{DSS}	600	V
Continuous drain current ($T_c = 25^\circ\text{C}$)		I_D^{*1}	±4.0	A
Pulsed drain current		I_{DP}^{*2}	±12	A
Gate - Source voltage	static	V_{GSS}	±20	V
	AC($f > 1\text{Hz}$)		±30	V
Avalanche current, single pulse		I_{AS}	0.8	A
Avalanche energy, single pulse		E_{AS}^{*3}	46	mJ
Power dissipation ($T_c = 25^\circ\text{C}$)		P_D	40	W
Junction temperature		T_j	150	°C
Operating junction and storage temperature range		T_{stg}	-55 to +150	°C

●Thermal resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - case	R_{thJC}^{*4}	-	-	3.13	°C/W
Thermal resistance, junction - ambient	R_{thJA}	-	-	70	°C/W
Soldering temperature, wavesoldering for 10s	T_{sold}	-	-	265	°C

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

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}	$V_{DS} = 600V, V_{GS} = 0V$ $T_j = 25^{\circ}\text{C}$	-	-	100	μA
		$T_j = 125^{\circ}\text{C}$	-	-	1000	
Gate - Source leakage current	I_{GSS}	$V_{GS} = \pm 20V, V_{DS} = 0V$	-	-	± 100	nA
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = 10V, I_D = 1mA$	3	-	5	V
Static drain - source on - state resistance	$R_{DS(on)}^{*5}$	$V_{GS} = 10V, I_D = 1.5A$ $T_j = 25^{\circ}\text{C}$	-	0.90	0.98	Ω
		$T_j = 125^{\circ}\text{C}$	-	1.36	-	
Gate resistance	R_G	$f = 1\text{MHz, open drain}$	-	3.3	-	Ω

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Forward Transfer Admittance	$ Y_{fs} ^{*5}$	$V_{DS} = 10\text{V}, I_D = 2\text{A}$	1.5	3.0	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$	-	280	-	pF
Output capacitance	C_{oss}	$V_{DS} = 25\text{V}$	-	280	-	
Reverse transfer capacitance	C_{rss}	$f = 1\text{MHz}$	-	16	-	
Turn - on delay time	$t_{d(on)}^{*5}$	$V_{DD} \approx 300\text{V}, V_{GS} = 10\text{V}$	-	15	-	ns
Rise time	t_r^{*5}	$I_D = 2\text{A}$	-	10	-	
Turn - off delay time	$t_{d(off)}^{*5}$	$R_L \approx 150\Omega$	-	30	-	
Fall time	t_f^{*5}	$R_G = 10\Omega$	-	25	-	

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	Q_g^{*5}	$V_{DD} \approx 300\text{V}$	-	10.2	-	nC
Gate - Source charge	Q_{gs}^{*5}	$I_D = 4\text{A}$	-	2.5	-	
Gate - Drain charge	Q_{gd}^{*5}	$V_{GS} = 10\text{V}$	-	4.8	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} \approx 300\text{V}, I_D = 4\text{A}$	-	5.8	-	V

*1 Limited only by maximum channel temperature allowed.

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

*3 $L \doteq 100\text{mH}$, $V_{DD}=50\text{V}$, $R_G=25\Omega$, STARTING $T_j=25^\circ\text{C}$

*4 $T_C=25^\circ\text{C}$

*5 Pulsed

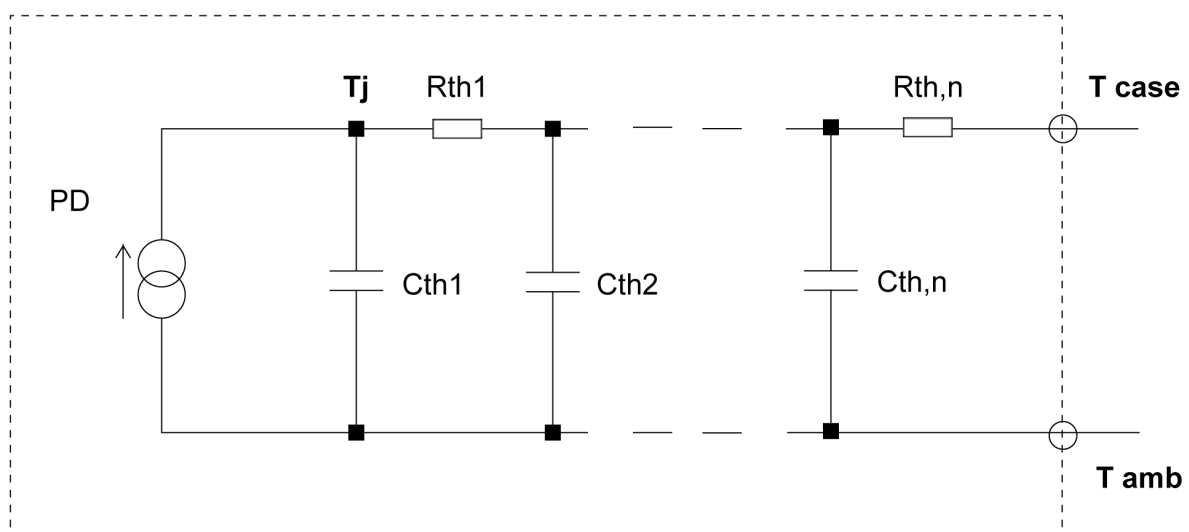
●Body diode electrical characteristics (Source-Drain) ($T_a = 25^\circ\text{C}$)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Continuous forward current	I_S^{*1}	$T_C = 25^\circ\text{C}$	-	-	4.0	A
Pulse forward current	I_{SP}^{*2}		-	-	12	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}	$I_S = 4\text{A}$ $di/dt = 100\text{A}/\mu\text{s}$	-	230	-	ns
Reverse recovery charge	Q_{rr}^{*5}		-	1.5	-	μC
Peak reverse recovery current	I_{rm}^{*5}		-	12	-	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

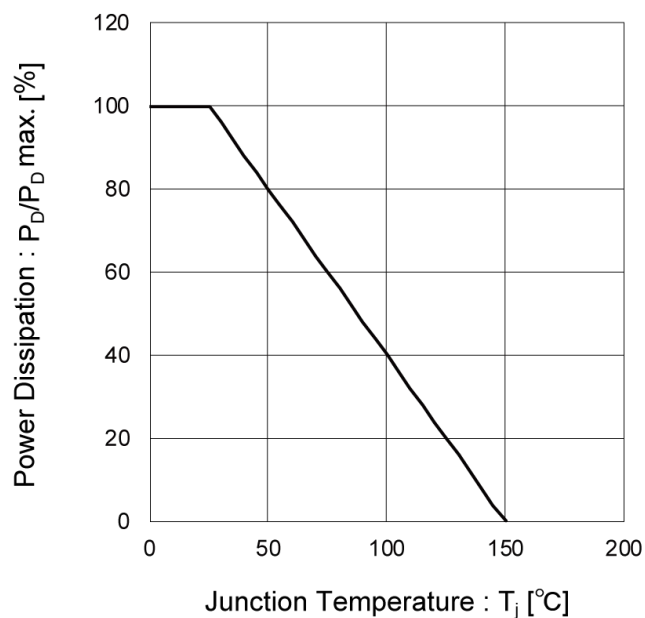


Fig.2 Maximum Safe Operating Area

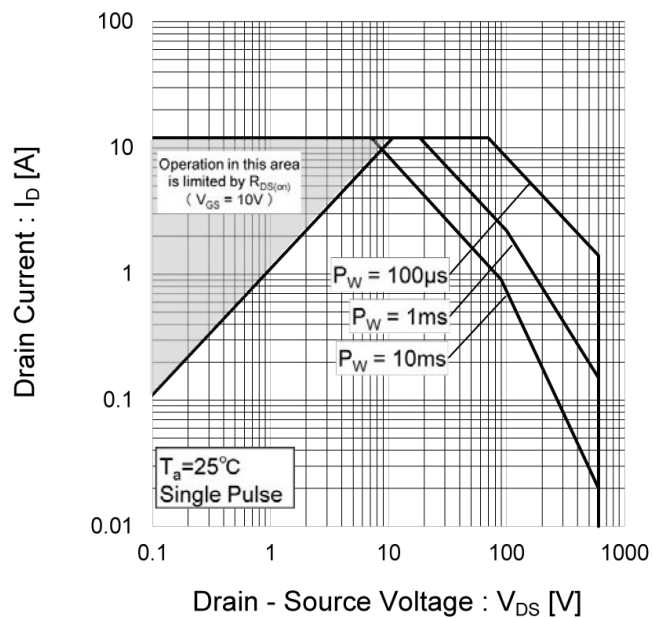
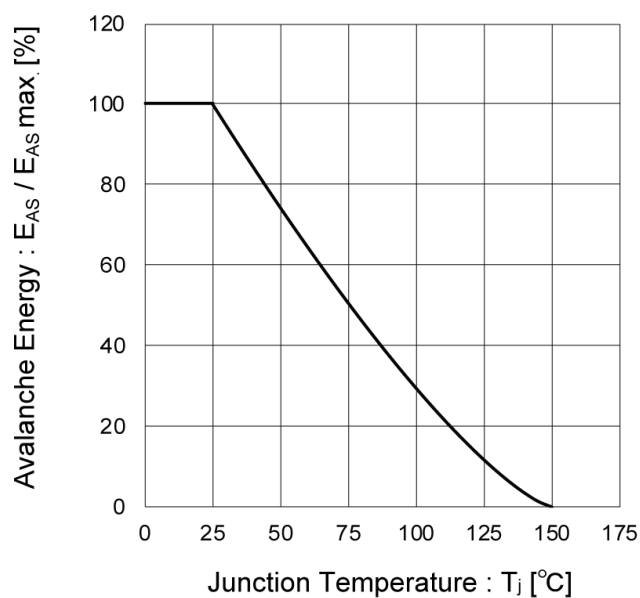


Fig.3 Avalanche Energy Derating Curve vs Junction temperature



●Electrical characteristic curves

Fig.4 Typical Output Characteristics(I)

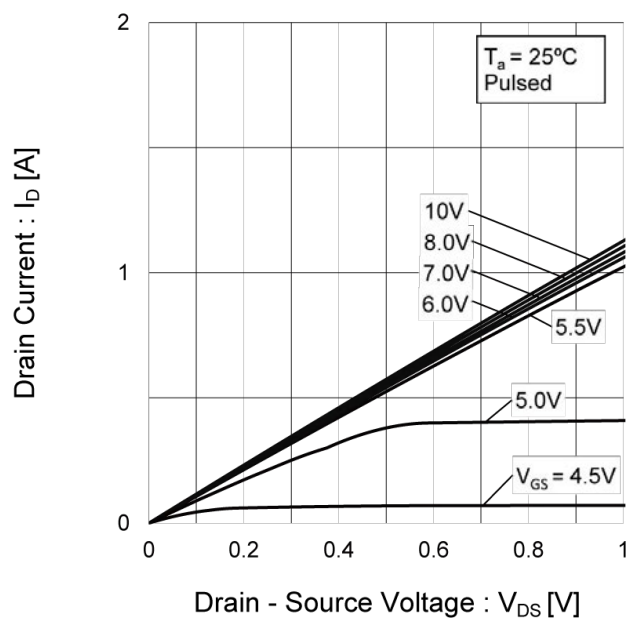
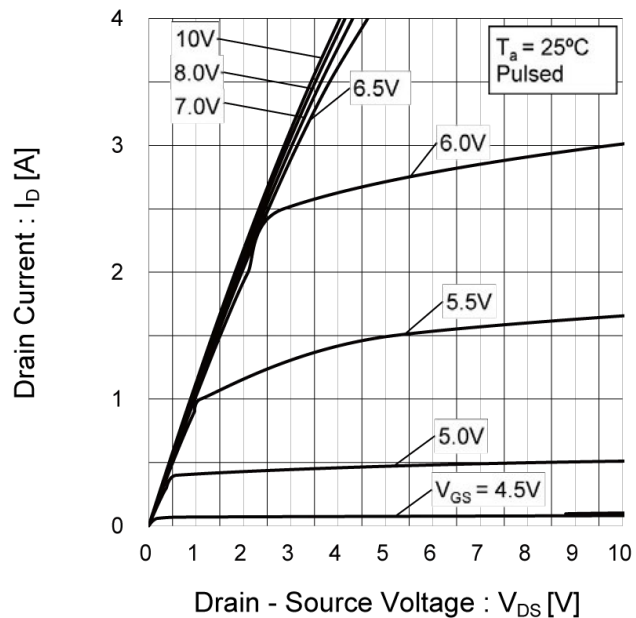


Fig.5 Typical Output Characteristics(II)



●Electrical characteristic curves

Fig. 6 Breakdown Voltage vs.
Junction Temperature

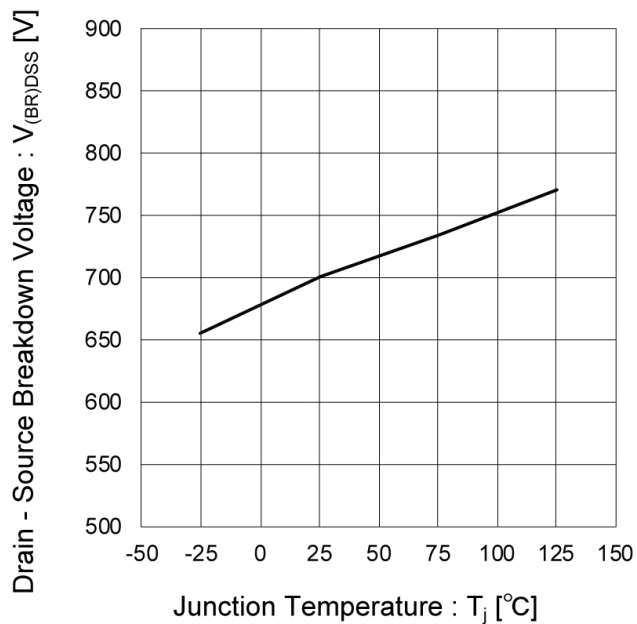


Fig.7 Typical Transfer Characteristics

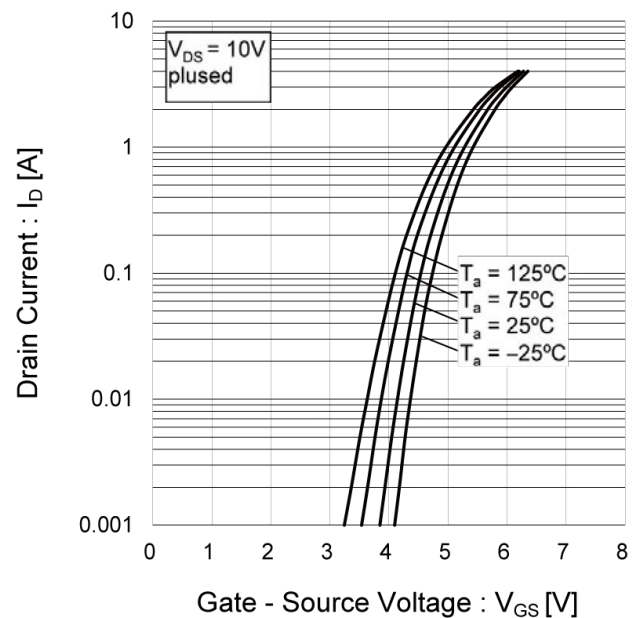


Fig.8 Gate Threshold Voltage vs.
Junction Temperature

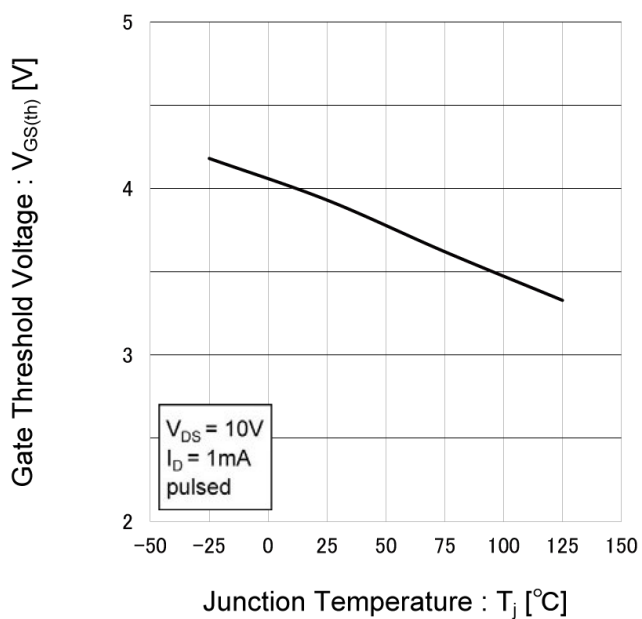
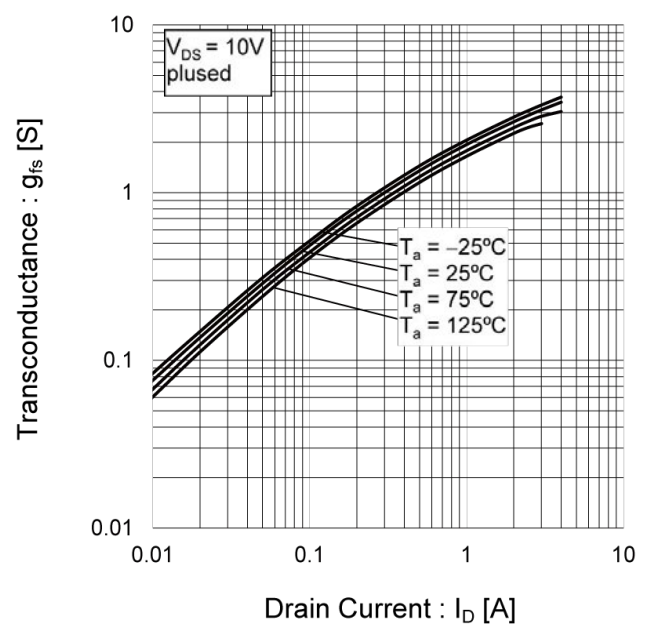


Fig.9 Forward Transfer Admittance vs.
Drain Current



●Electrical characteristic curves

Fig.10 Static Drain - Source On - State Resistance vs. Gate Source Voltage

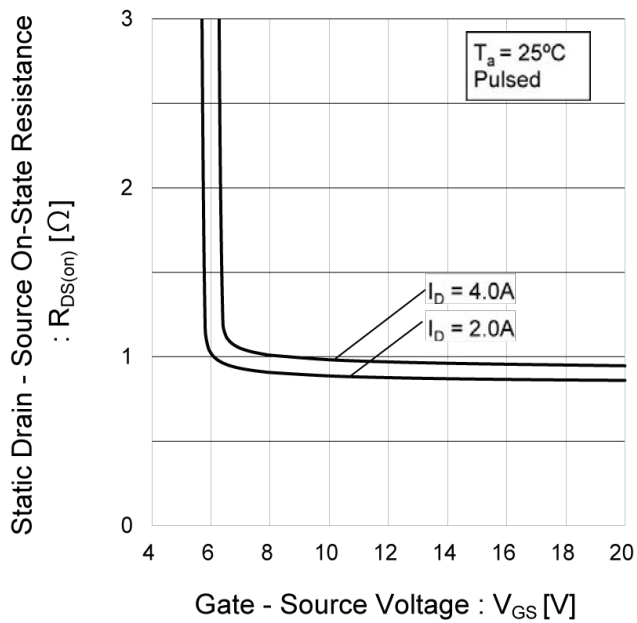


Fig.11 Static Drain - Source On - State Resistance vs. Junction Temperature

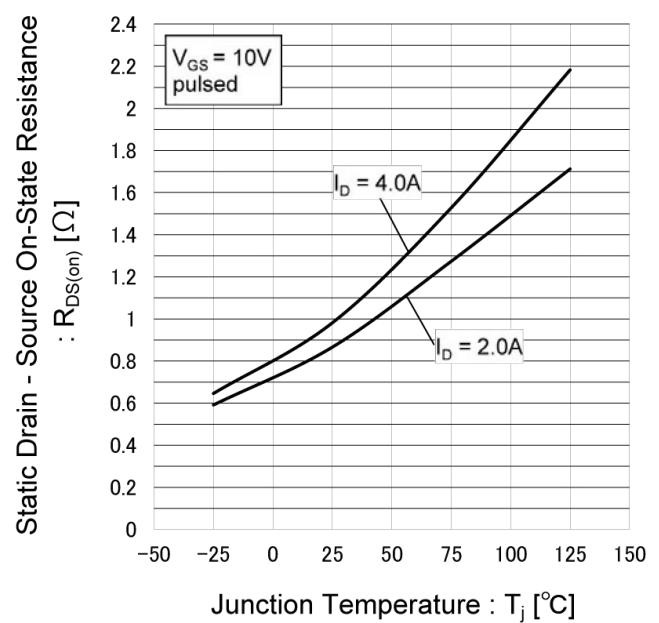
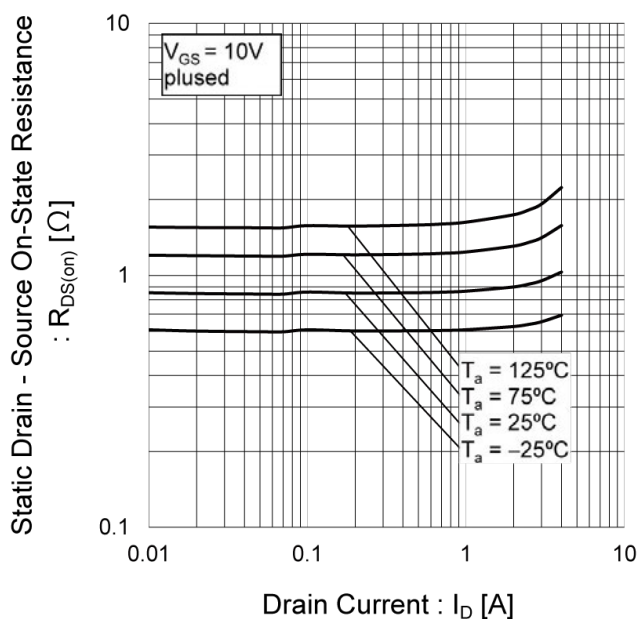


Fig.12 Static Drain - Source On - State Resistance vs. Drain Current(I)



●Electrical characteristic curves

Fig.13 Typical Capacitance vs.
Drain - Source Voltage

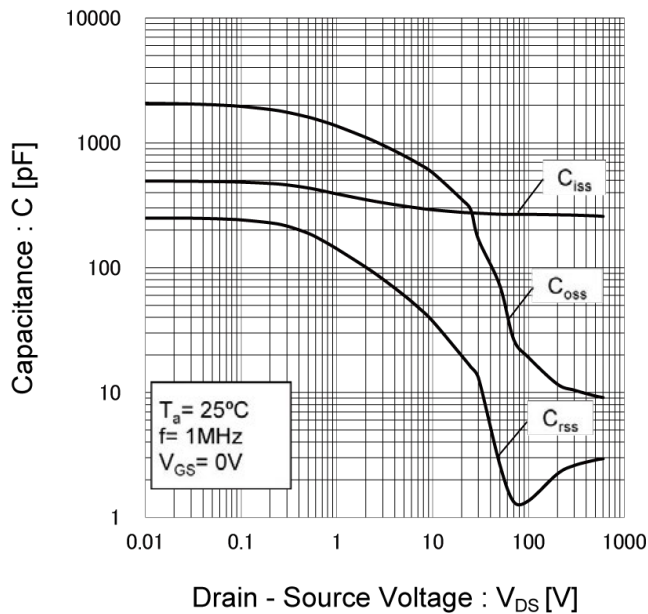


Fig.14 Switching Characteristics

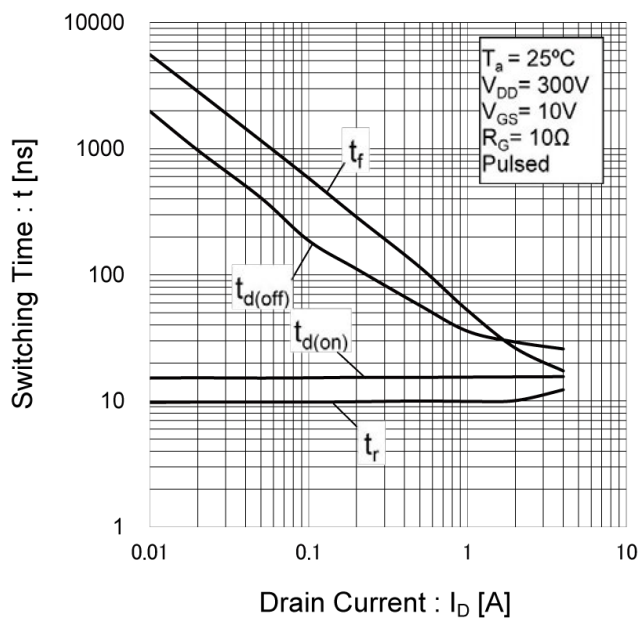
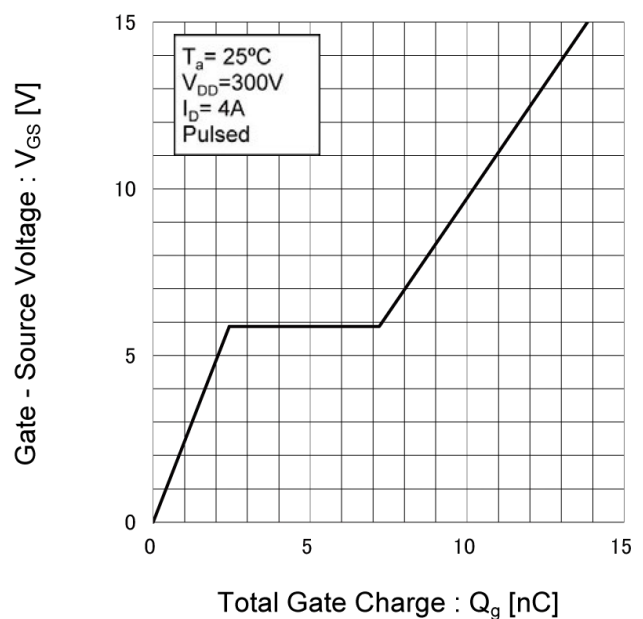


Fig.15 Dynamic Input Characteristics



●Electrical characteristic curves

Fig.16 Inverse Diode Forward Current
vs. Source - Drain Voltage

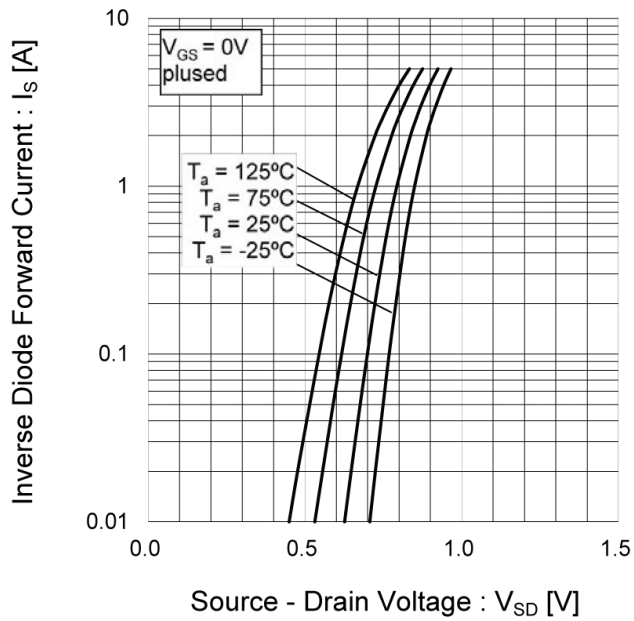
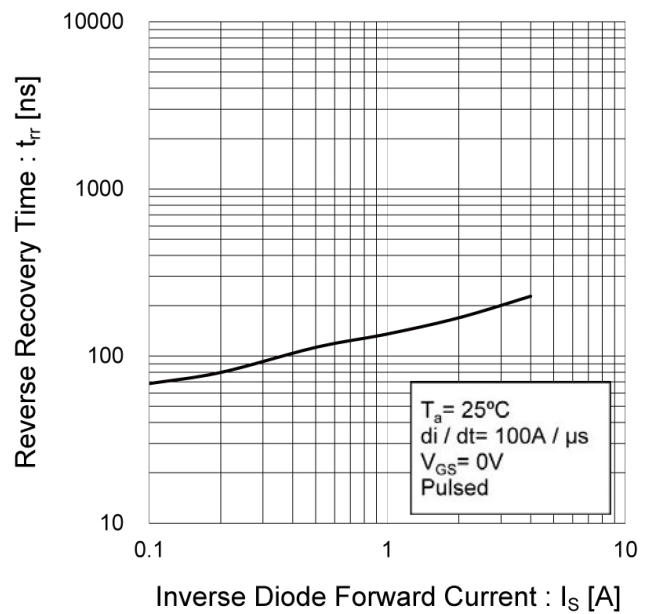


Fig.17 Reverse Recovery Time vs.
Inverse Diode Forward Current



● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

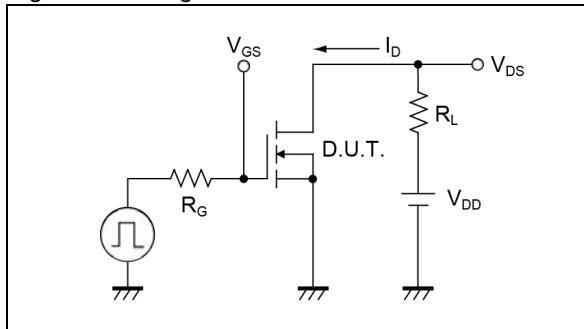


Fig.1-2 Switching Waveforms

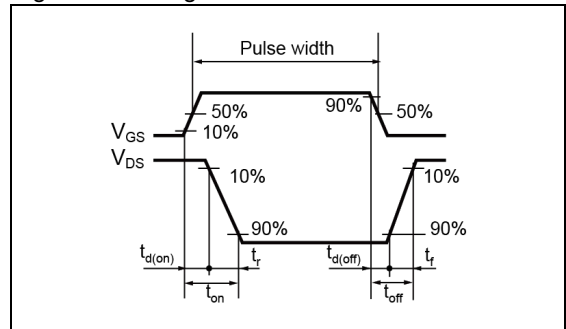


Fig.2-1 Gate Charge Measurement Circuit



Fig.2-2 Gate Charge Waveform

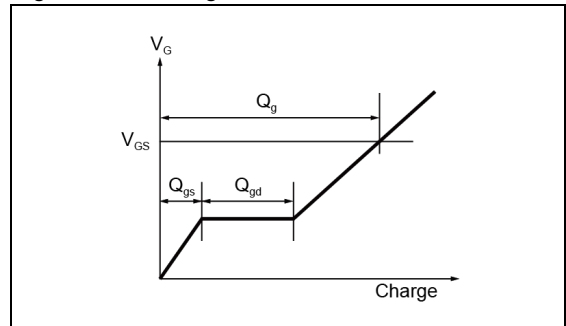


Fig.3-1 Avalanche Measurement Circuit

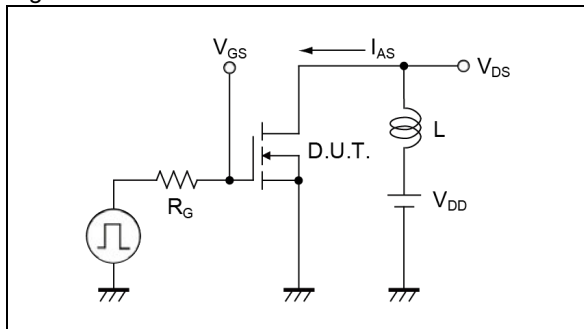


Fig.3-2 Avalanche Waveform

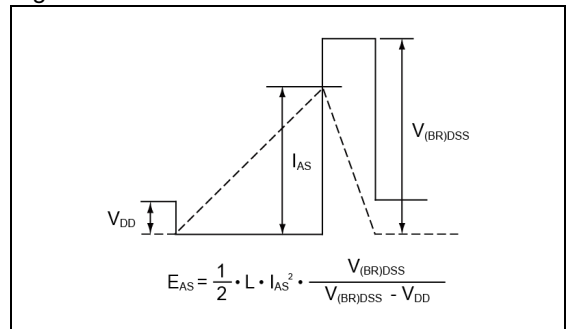


Fig.4-1 dv/dt Measurement Circuit

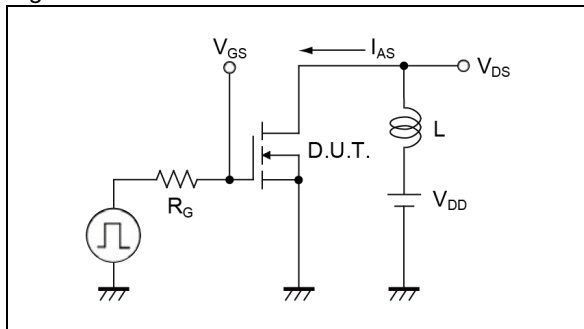


Fig.4-2 dv/dt Waveform

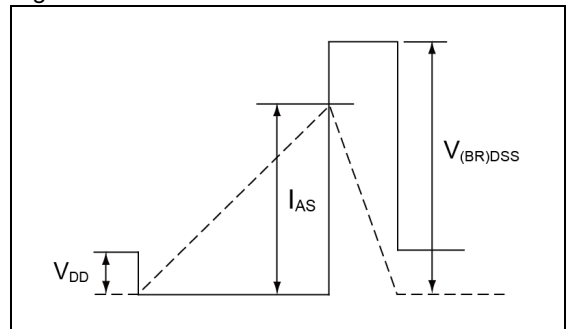


Fig.5-1 dv/dt Measurement Circuit

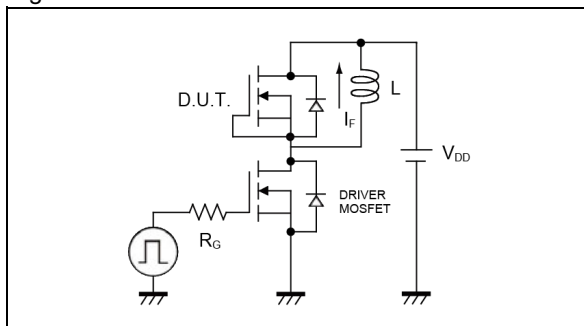
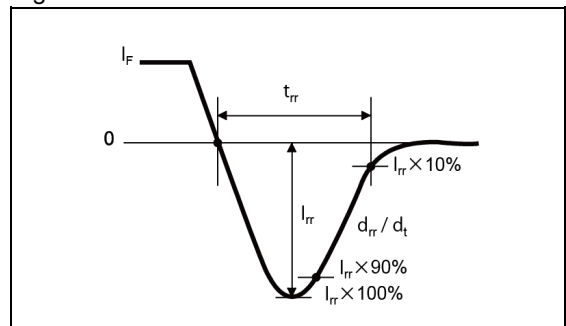
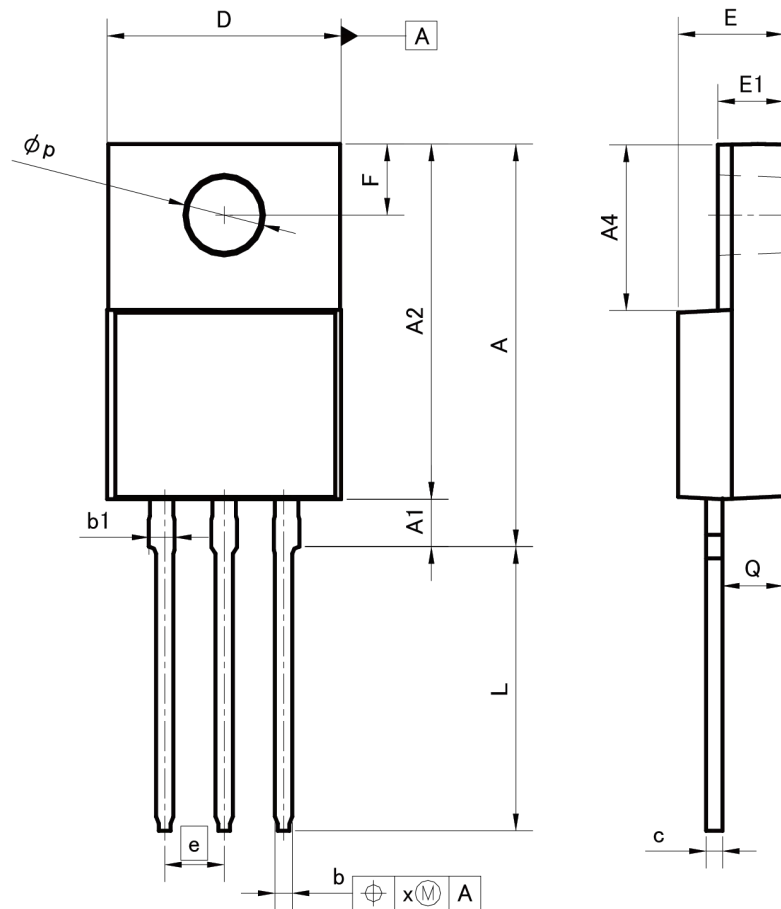


Fig.5-2 dv/dt Waveform



●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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