

$V_{DSS}$	500V
$R_{DS(on)}(Max.)$	0.38Ω
$I_D$	±13A
$P_D$	100W

### ●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

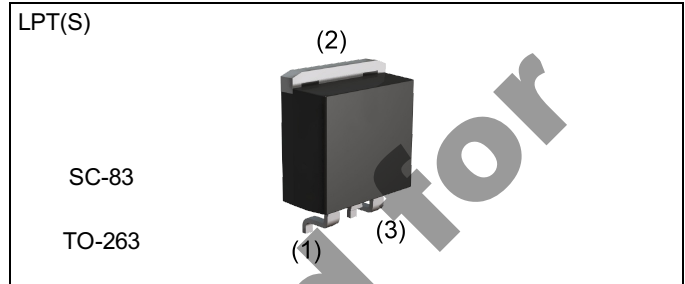
### ●Application

Switching Power Supply

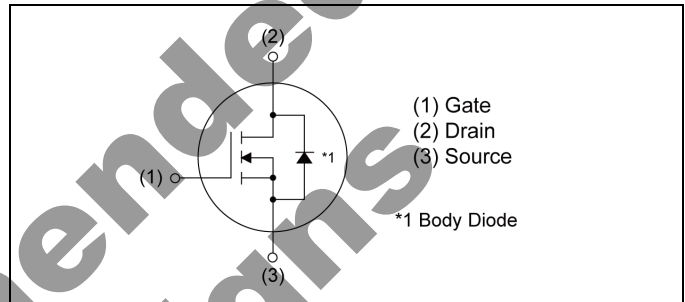
### ●Absolute maximum ratings ( $T_a = 25^\circ C$ )

Parameter	Symbol	Value	Unit	
Drain - Source voltage	$V_{DSS}$	500	V	
Continuous drain current	$T_C = 25^\circ C$	$I_D^{*1}$	±13	A
	$T_C = 100^\circ C$	$I_D^{*1}$	±6.4	A
Pulsed drain current	$I_{D,pulse}^{*2}$	±52	A	
Gate - Source voltage	$V_{GSS}$	±30	V	
Avalanche energy, single pulse	$E_{AS}^{*3}$	11.3	mJ	
Avalanche energy, repetitive	$E_{AR}^{*4}$	6.7	mJ	
Avalanche current	$I_{AR}^{*3}$	6.5	A	
Power dissipation ( $T_C = 25^\circ C$ )	$P_D$	100	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



### ●Inner circuit



### ●Packaging specifications

Type	Packing	Embossed Tape
	Reel size (mm)	330
	Tape width (mm)	24
	Basic ordering unit (pcs)	1000
	Taping code	TL
	Marking	R5013ANJ

### ● Absolute maximum ratings

Parameter	Symbol	Conditions	Values	Unit
Drain - Source voltage slope	dv/dt	$V_{DS} = 400V, I_D = 13A$ $T_j = 125^\circ C$	50	V/ns

### ● Thermal resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - case	$R_{thJC}$	-	-	1.25	$^\circ C/W$
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	80	$^\circ C/W$
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	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 1mA$	500	-	-	V
Drain - Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS} = 0V, I_D = 13A$	-	580	-	V
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 500V, V_{GS} = 0V$ $T_j = 25^\circ C$	-	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	$R_{DS(on)}^{*6}$	$V_{GS} = 10V, I_D = 6.5A$ $T_j = 25^\circ C$	-	0.29	0.38	$\Omega$
		$T_j = 125^\circ C$	-	0.56	-	
Gate input resistance	$R_G$	f = 1MHz, open drain	-	8.4	-	$\Omega$

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Transconductance	$g_{fs}^{*6}$	$V_{DS} = 10\text{V}, I_D = 6.5\text{A}$	4	9	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{V}$	-	1300	-	pF
Output capacitance	$C_{oss}$	$V_{DS} = 25\text{V}$	-	500	-	
Reverse transfer capacitance	$C_{rss}$	$f = 1\text{MHz}$	-	40	-	
Effective output capacitance, energy related	$C_{o(er)}$	$V_{GS} = 0\text{V},$ $V_{DS} = 0\text{V to } 400\text{V}$	-	85.5	-	pF
Effective output capacitance, time related	$C_{o(tr)}$		-	86.6	-	
Turn - on delay time	$t_{d(on)}^{*6}$	$V_{DD} \approx 250\text{V}, V_{GS} = 10\text{V}$	-	30	-	ns
Rise time	$t_r^{*6}$	$I_D = 6.5\text{A}$	-	32	-	
Turn - off delay time	$t_{d(off)}^{*6}$	$R_L \approx 38.5\Omega$	-	90	180	
Fall time	$t_f^{*6}$	$R_G = 10\Omega$	-	30	60	

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	$Q_g^{*6}$	$V_{DD} \approx 250\text{V}$	-	35	-	nC
Gate - Source charge	$Q_{gs}^{*6}$	$I_D = 13\text{A}$	-	8	-	
Gate - Drain charge	$Q_{gd}^{*6}$	$V_{GS} = 10\text{V}$	-	15	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} \approx 250\text{V}, I_D = 13\text{A}$	-	5.7	-	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.

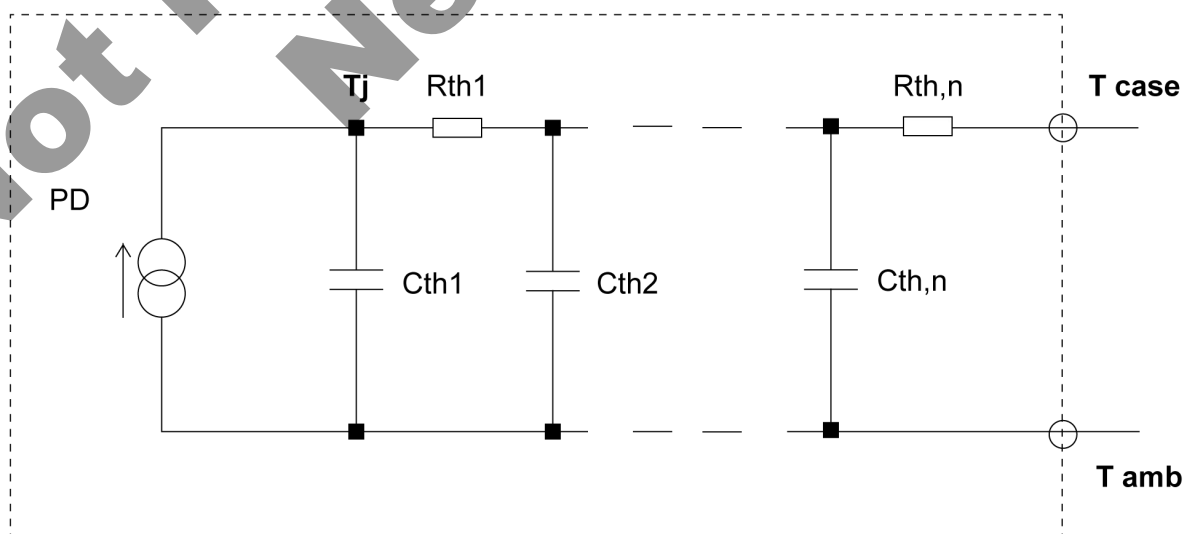
\*6 Pulsed

●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	$I_S^{*1}$	$T_C = 25^\circ\text{C}$	-	-	13	A
Inverse diode direct current, pulsed	$I_{SM}^{*2}$		-	-	52	A
Forward voltage	$V_{SD}^{*6}$	$V_{GS} = 0\text{V}, I_S = 13\text{A}$	-	-	1.5	V
Reverse recovery time	$t_{rr}^{*6}$	$I_S = 13\text{A}$ $di/dt = 100\text{A}/\mu\text{s}$	-	388	-	ns
Reverse recovery charge	$Q_{rr}^{*6}$		-	4.3	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rm}^{*6}$		-	22.1	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$	$T_j = 25^\circ\text{C}$	-	600	-	$\text{A}/\mu\text{s}$

●Typical transient thermal characteristics

Symbol	Value	Unit	Symbol	Value	Unit
$R_{th1}$	0.0736	K/W	$C_{th1}$	0.00198	Ws/K
$R_{th2}$	0.284		$C_{th2}$	0.00703	
$R_{th3}$	0.609		$C_{th3}$	0.19	



● Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

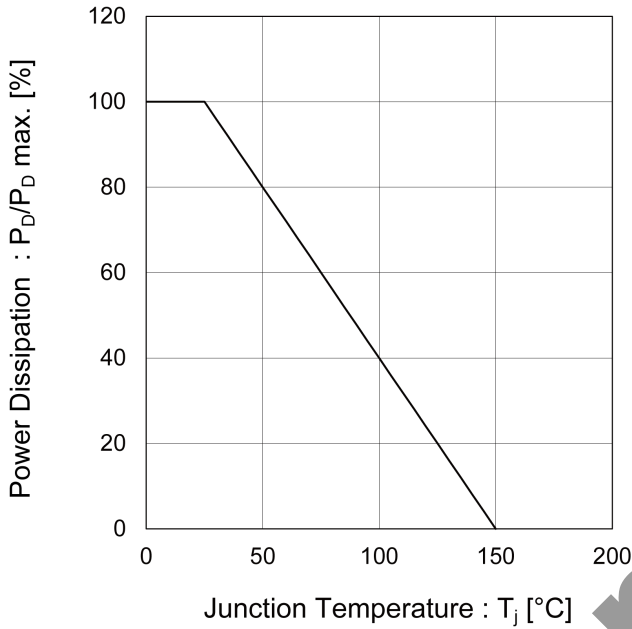


Fig.2 Maximum Safe Operating Area

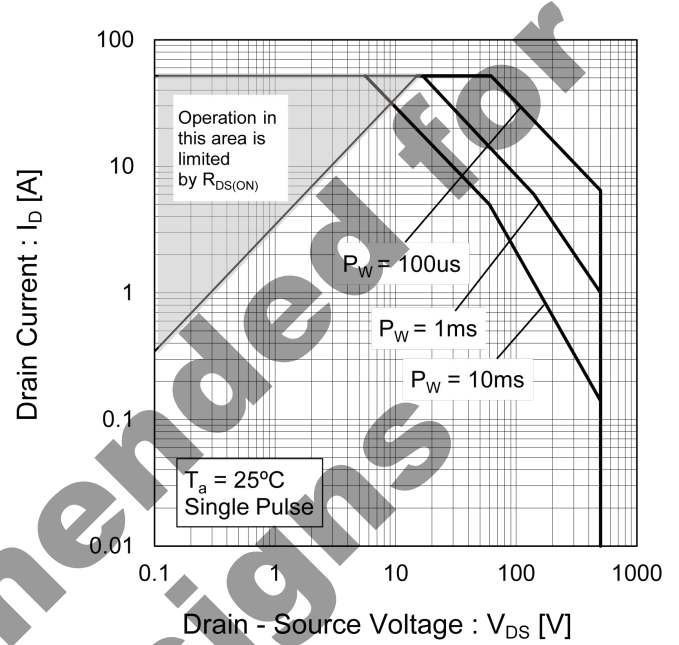
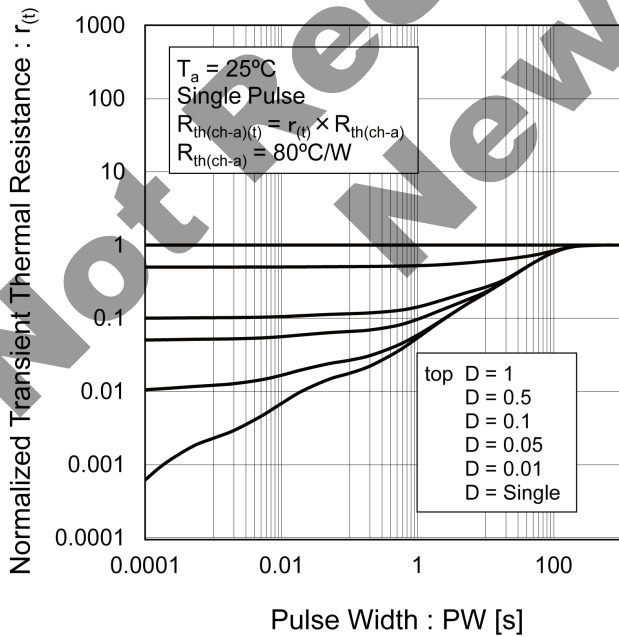


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width



● Electrical characteristic curves

Fig.4 Avalanche Current vs. Inductive Load

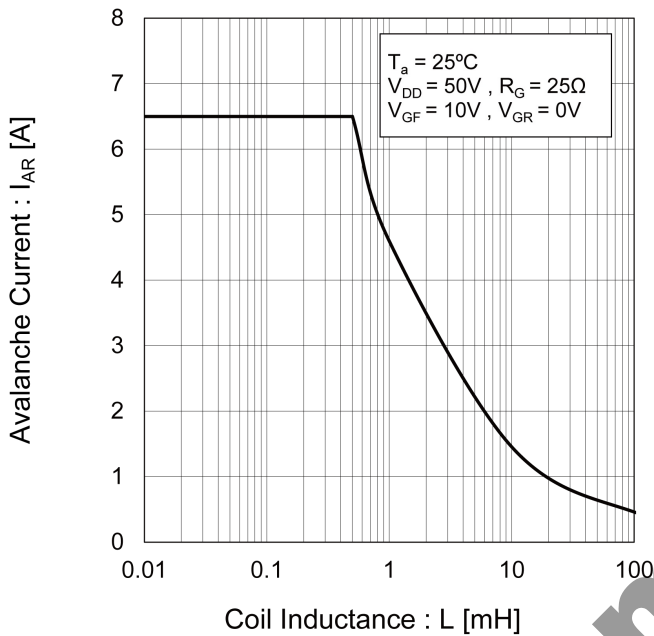


Fig.5 Avalanche Power Losses

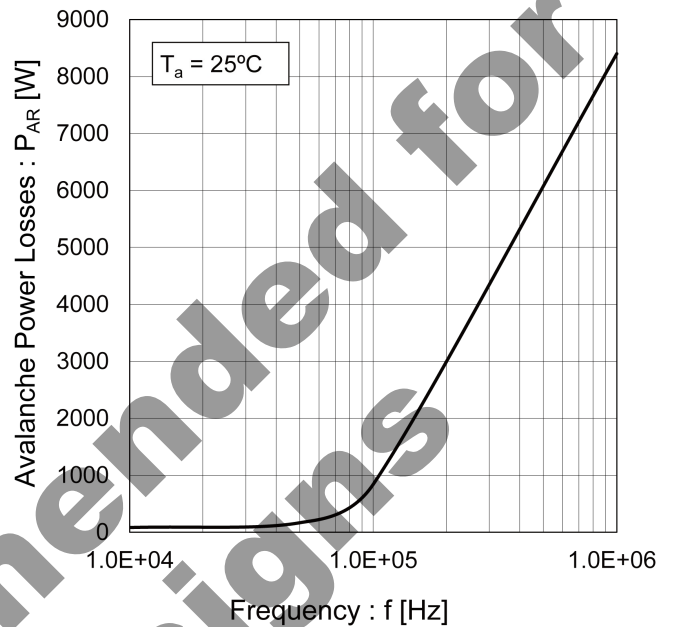
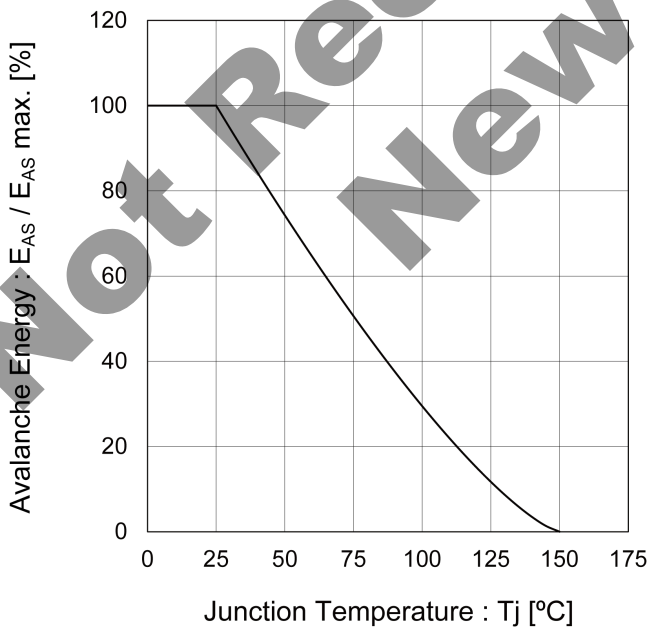


Fig.6 Avalanche Energy Derating Curve vs. Junction Temperature



●Electrical characteristic curves

Fig.7 Typical Output Characteristics(I)

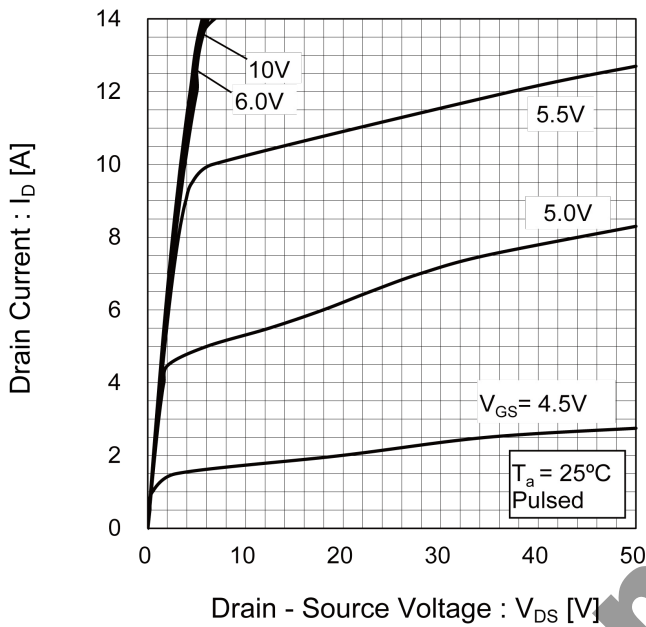


Fig.8 Typical Output Characteristics(II)

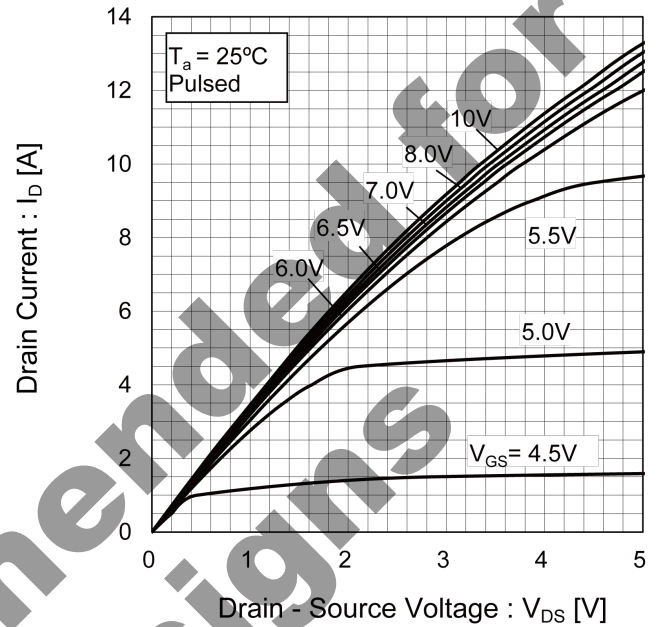


Fig.9 Tj = 150°C Typical Output Characteristics (I)

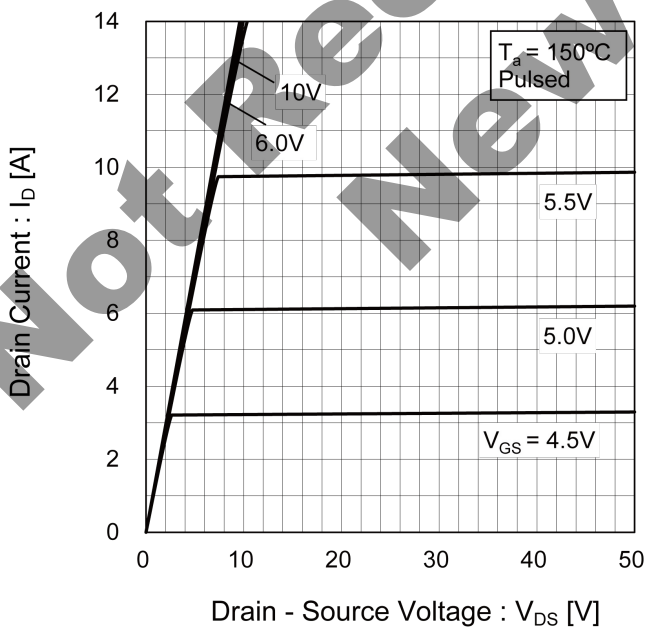
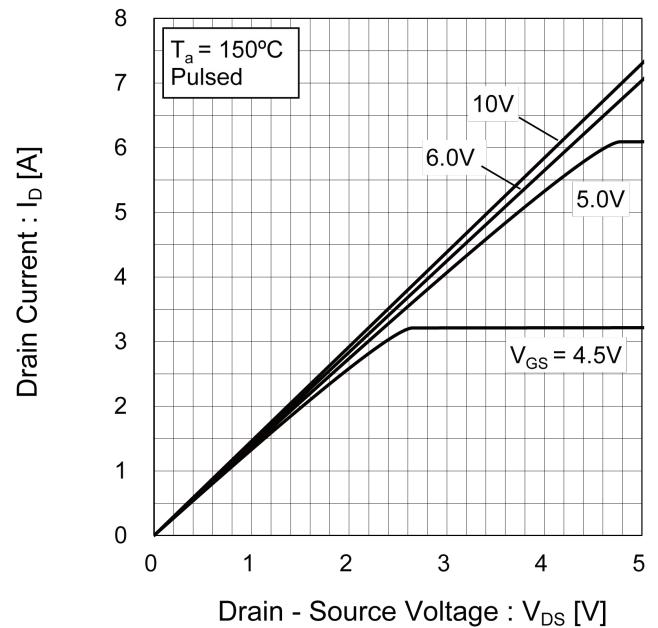


Fig.10 Tj = 150°C Typical Output Characteristics (II)



● Electrical characteristic curves

Fig.11 Breakdown Voltage vs. Junction Temperature

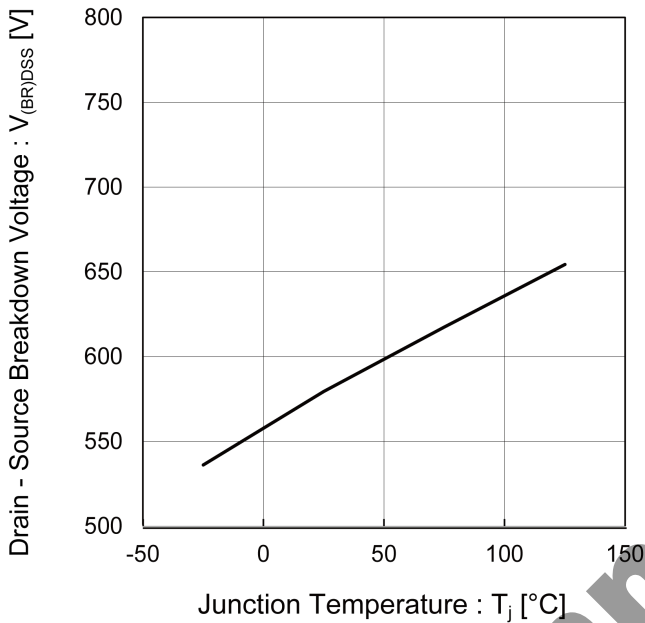


Fig.12 Typical Transfer Characteristics

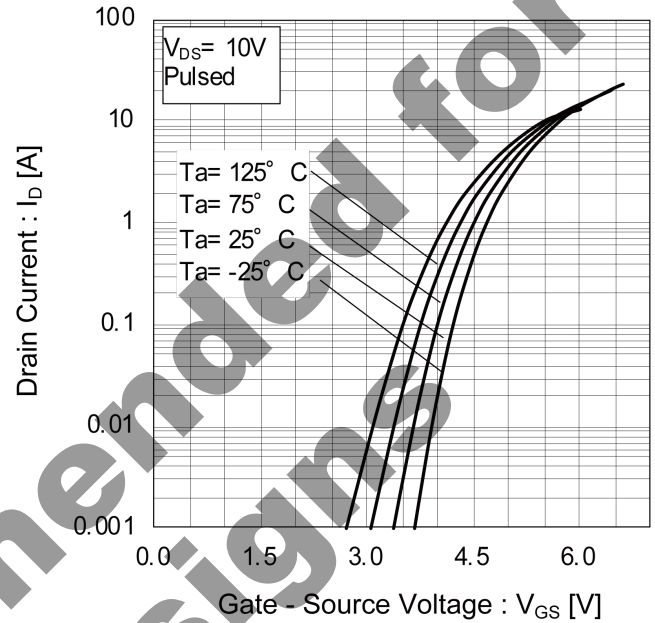


Fig.13 Gate Threshold Voltage vs. Junction Temperature

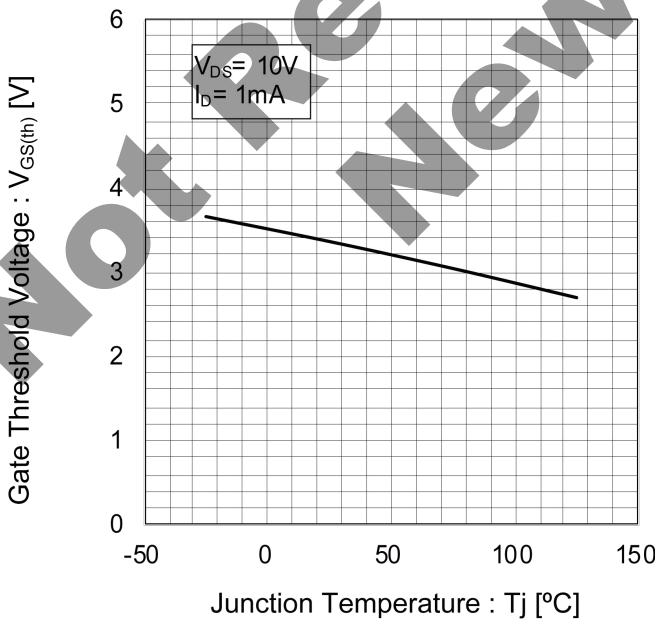
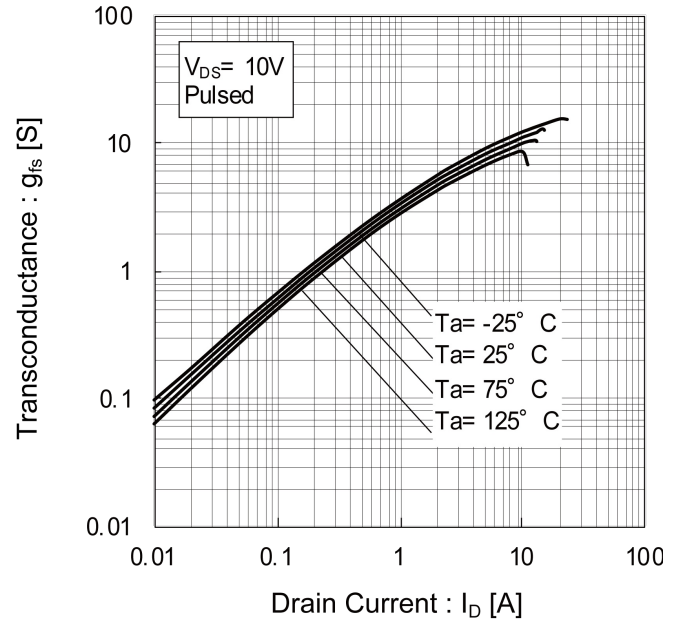


Fig.14 Transconductance vs. Drain Current





●Electrical characteristic curves

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

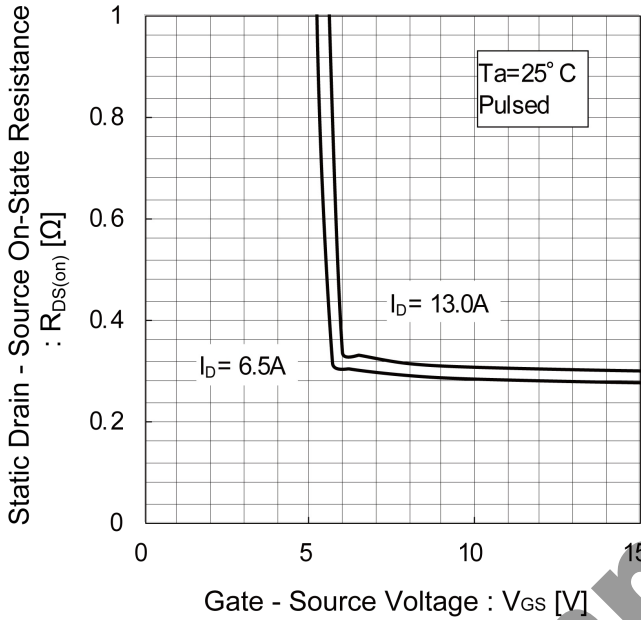


Fig.16 Static Drain - Source On - State Resistance vs. Junction Temperature

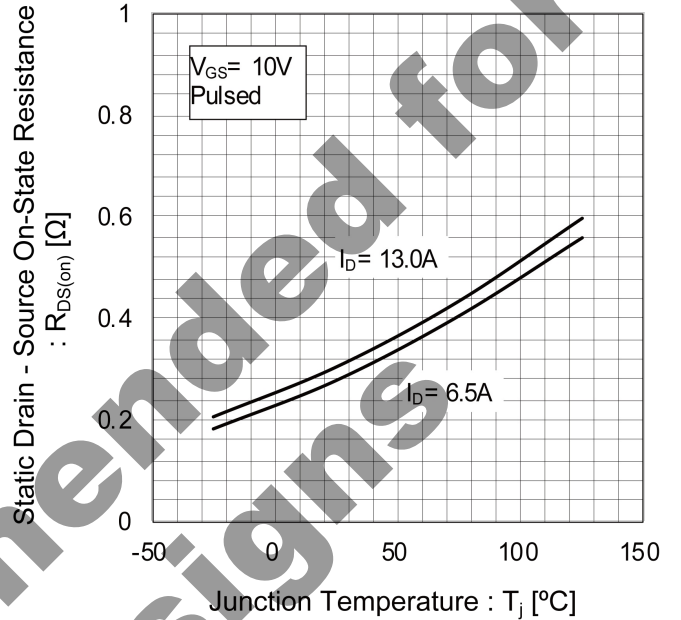
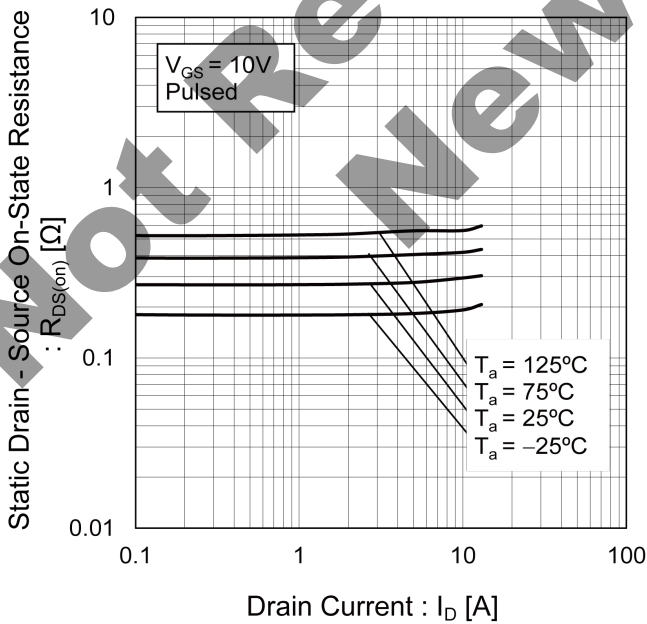


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current



● Electrical characteristic curves

Fig.18 Typical Capacitance vs. Drain - Source Voltage

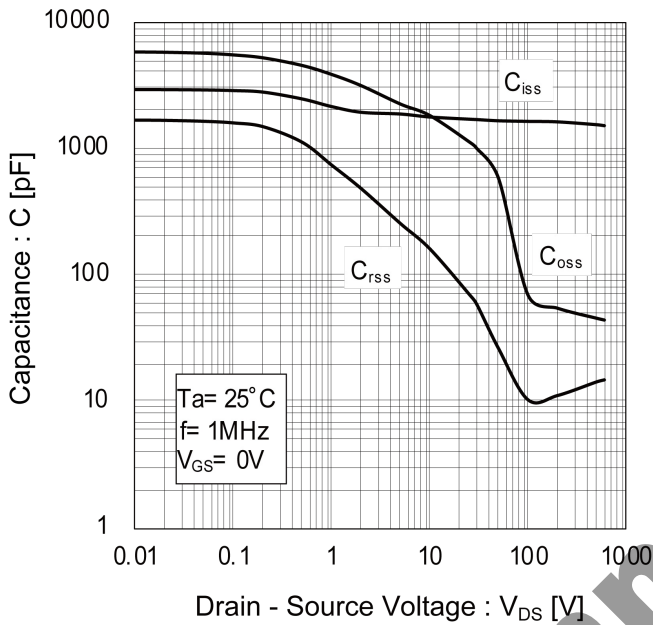


Fig.19 Coss Stored Energy

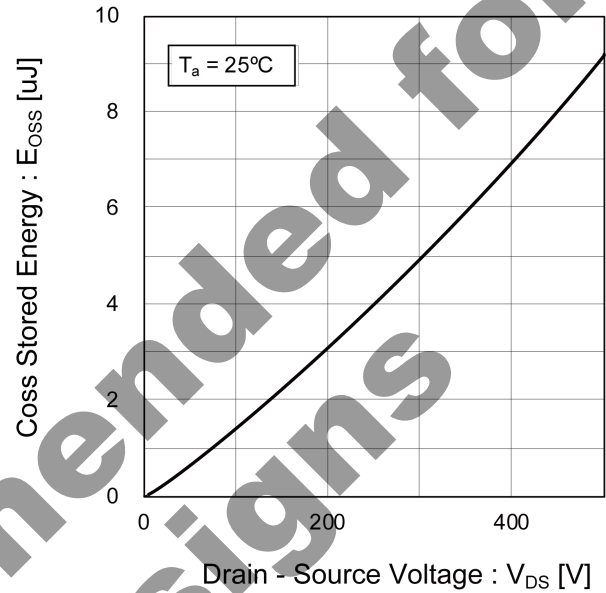


Fig.20 Switching Characteristics

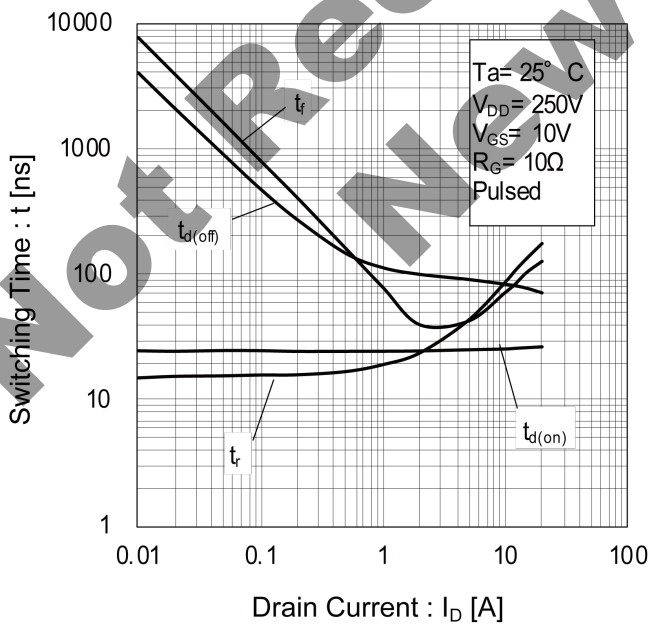
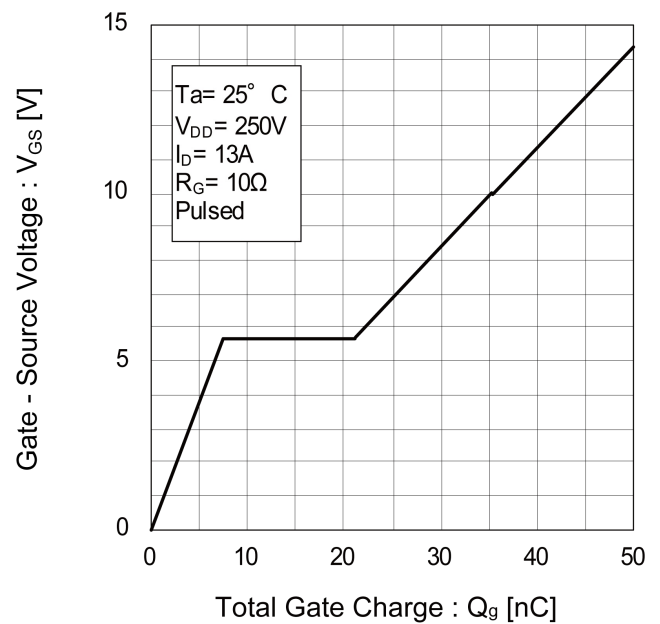


Fig.21 Dynamic Input Characteristics



●Electrical characteristic curves

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

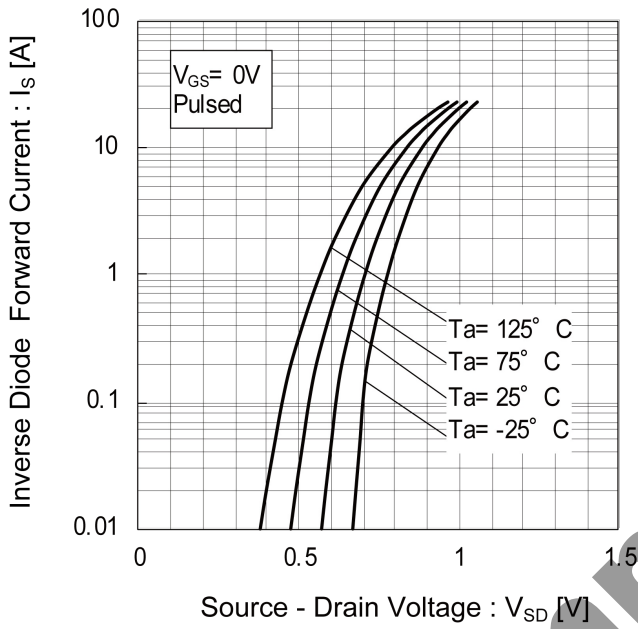
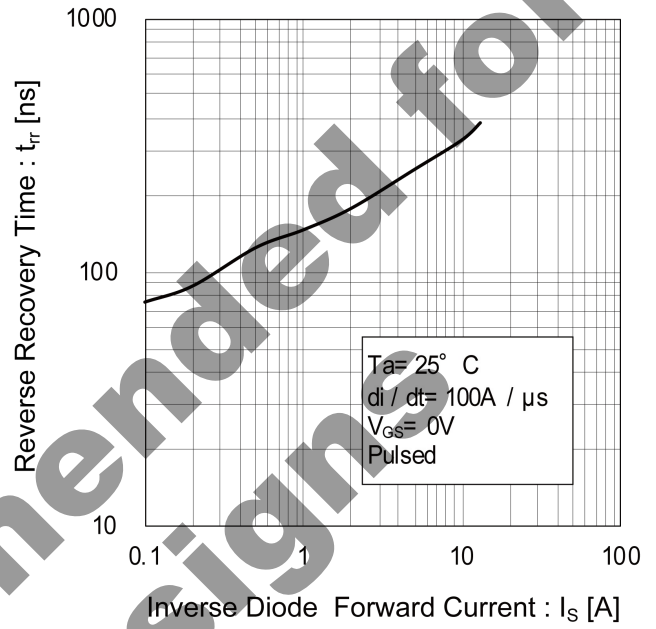


Fig.23 Reverse Recovery Time vs. Inverse Diode Forward Current



Not Recommended for New Design

● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

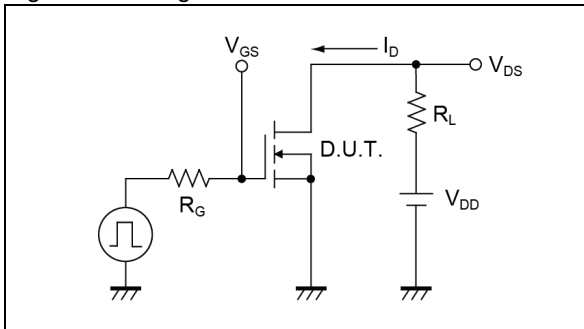


Fig.1-2 Switching Waveforms

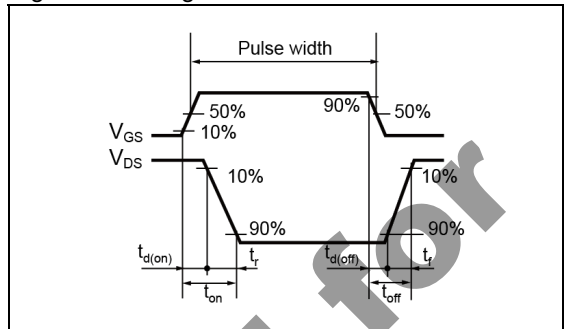


Fig.2-1 Gate Charge Measurement Circuit

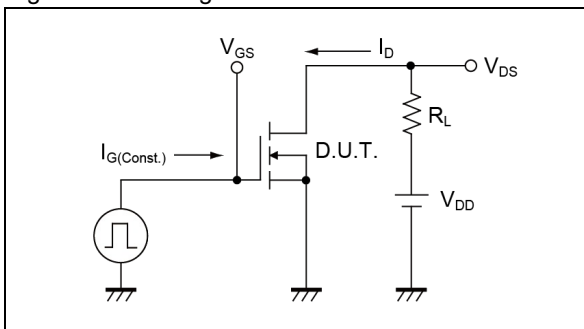


Fig.2-2 Gate Charge Waveform

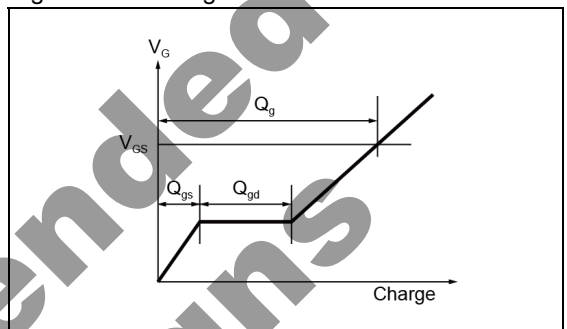


Fig.3-1 Avalanche Measurement Circuit

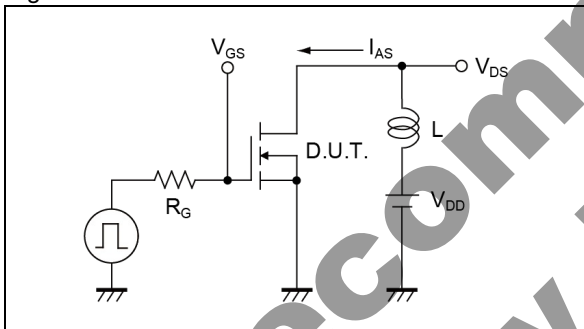


Fig.3-2 Avalanche Waveform

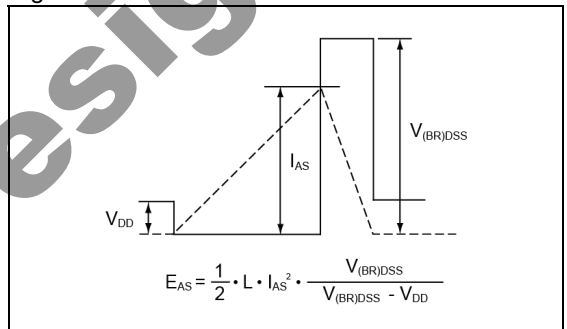


Fig.4-1 dv/dt Measurement Circuit

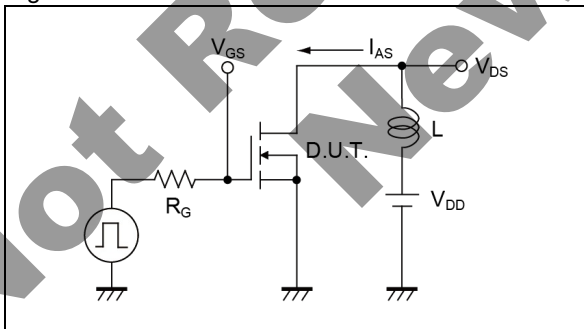


Fig.4-2 dv/dt Waveform

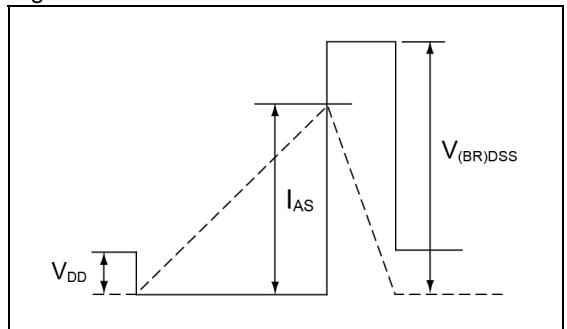


Fig.5-1 di/dt Measurement Circuit

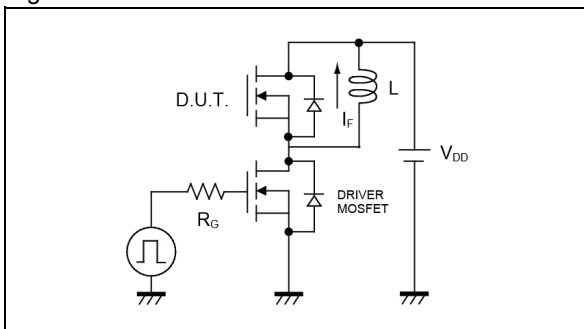
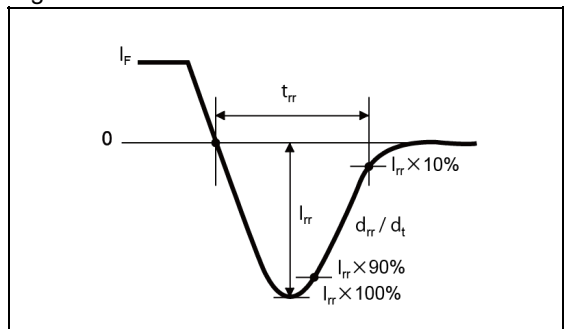
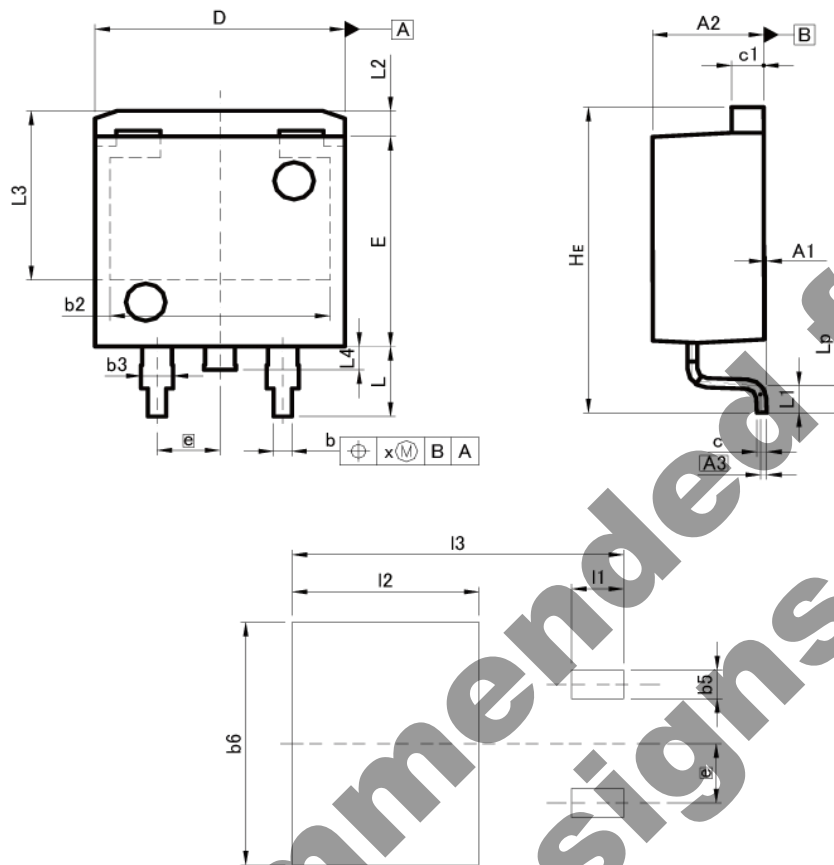


Fig.5-2 di/dt Waveform



●Dimensions

LPTS  
< TO-263 >  
( D2PAK )



Pattern of terminal position areas  
[Not a pattern of soldering pads]

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A1	0.00	0.30	0.000	0.012
A2	4.30	4.70	0.169	0.185
A3		0.25		0.010
b	0.68	0.98	0.027	0.039
b2		8.90		0.350
b3	1.14	1.44	0.045	0.057
c	0.30	0.60	0.012	0.024
c1	1.10	1.50	0.043	0.059
D	9.80	10.40	0.386	0.409
E	8.80	9.20	0.346	0.362
e		2.54		0.100
HE	12.80	13.40	0.504	0.528
L	2.70	3.30	0.106	0.130
L1	0.90	1.50	0.035	0.059
L2		1.10		0.043
L3		7.25		0.285
L4		1.00		0.039
Lp	0.90	1.50	0.035	0.059
x	-	0.25	-	0.010

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
b5	-	1.23	-	0.049
b6	-	10.40	-	0.409
I1	-	2.10	-	0.083
I2	-	7.55	-	0.297
I3	-	13.40	-	0.528

Dimension in mm/inches

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