

$V_{DSS}$	45V
$R_{DS(on)}$ (Max.)	53mΩ
$I_D$	4A
$P_D$	1.25W

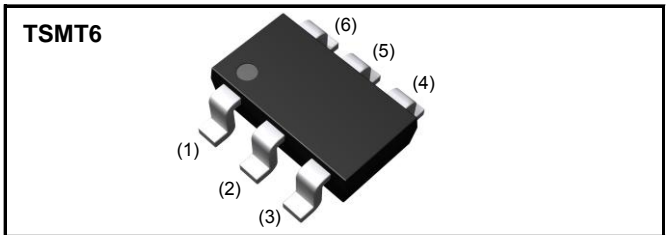
#### ●Features

- 1) Low on - resistance.
- 2) Built-in G-S Protection Diode.
- 3) Small Surface Mount Package (TSMT6).
- 4) Pb-free lead plating ; RoHS compliant

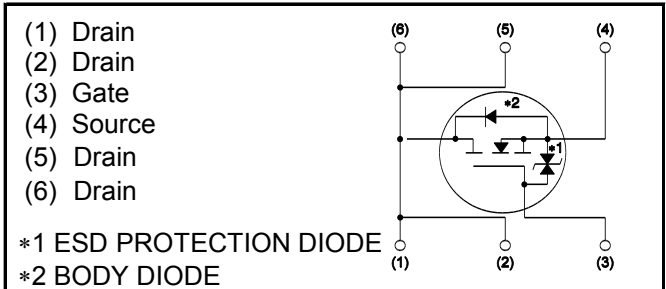
#### ●Application

DC/DC converters

#### ●Outline



#### ●Inner circuit



#### ●Packaging specifications

Type	Packaging	Taping
	Reel size (mm)	180
	Tape width (mm)	8
	Basic ordering unit (pcs)	3,000
	Taping code	TR
	Marking	QG

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

Parameter	Symbol	Value	Unit
Drain - Source voltage	$V_{DSS}$	45	V
Continuous drain current	$I_D^{*1}$	±4.0	A
Pulsed drain current	$I_{D,pulse}^{*2}$	±16	A
Gate - Source voltage	$V_{GSS}$	±21	V
Power dissipation	$P_D^{*3}$	1.25	W
	$P_D^{*4}$	0.6	W
Junction temperature	$T_j$	150	°C
Range of storage temperature	$T_{stg}$	-55 to +150	°C

### ●Thermal resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - ambient	$R_{thJA}^{*3}$	-	-	100	°C/W
Thermal resistance, junction - ambient	$R_{thJA}^{*4}$	-	-	208	°C/W

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Drain - Source breakdown voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 1mA$	45	-	-	V
Breakdown voltage temperature coefficient	$\frac{\Delta V_{(BR)DSS}}{\Delta T_j}$	$I_D = 1mA$ referenced to $25^\circ\text{C}$	-	42	-	mV/°C
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 45V, V_{GS} = 0V$	-	-	1	$\mu\text{A}$
Gate - Source leakage current	$I_{GSS}$	$V_{GS} = \pm 21V, V_{DS} = 0V$	-	-	$\pm 10$	$\mu\text{A}$
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = 10V, I_D = 1mA$	1.0	-	2.5	V
Gate threshold voltage temperature coefficient	$\frac{\Delta V_{(GS)th}}{\Delta T_j}$	$I_D = 1mA$ referenced to $25^\circ\text{C}$	-	-4.2	-	mV/°C
Static drain - source on - state resistance	$R_{DS(on)}^{*5}$	$V_{GS}=10V, I_D=4A$	-	38	53	m $\Omega$
		$V_{GS}=4.5V, I_D=4A$	-	47	66	
		$V_{GS}=4V, I_D=4A$	-	53	74	
		$V_{GS}=10V, I_D=4A, T_j=125^\circ\text{C}$	-	70	100	
Gate input resistance	$R_G$	$f = 1\text{MHz, open drain}$	-	7	-	$\Omega$
Transconductance	$g_{fs}^{*5}$	$V_{DS} = 10V, I_D = 4A$	3	6	-	S

\*1 Limited only by maximum temperature allowed.

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

\*3 Mounted on a ceramic board (30×30×0.8mm)

\*4 Mounted on a FR4 (15×20×0.8mm)

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Input capacitance	$C_{iss}$	$V_{GS} = 0V$	-	530	-	pF
Output capacitance	$C_{oss}$	$V_{DS} = 10V$	-	120	-	
Reverse transfer capacitance	$C_{rss}$	$f = 1\text{MHz}$	-	65	-	
Turn - on delay time	$t_{d(on)}^{*5}$	$V_{DD} \approx 25V, V_{GS} = 10V$	-	12	-	ns
Rise time	$t_r^{*5}$	$I_D = 2A$	-	15	-	
Turn - off delay time	$t_{d(off)}^{*5}$	$R_L = 12.5\Omega$	-	40	-	
Fall time	$t_f^{*5}$	$R_G = 10\Omega$	-	12	-	

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	$Q_g^{*5}$	$V_{DD} \approx 25V, I_D = 4A$ $V_{GS} = 5V$	-	6.3	8.8	nC
		$V_{DD} \approx 25V, I_D = 4A$ $V_{GS} = 10V$	-	10	-	
Gate - Source charge	$Q_{gs}^{*5}$	$V_{DD} \approx 25V, I_D = 4A$	-	2.0	-	
Gate - Drain charge	$Q_{gd}^{*5}$	$V_{GS} = 5V$	-	2.6	-	

**●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	$I_S^{*1}$	$T_a = 25^\circ\text{C}$	-	-	1.6	A
Forward voltage	$V_{SD}^{*5}$	$V_{GS} = 0V, I_S = 4.0A$	-	-	1.2	V

\*5 Pulsed

●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

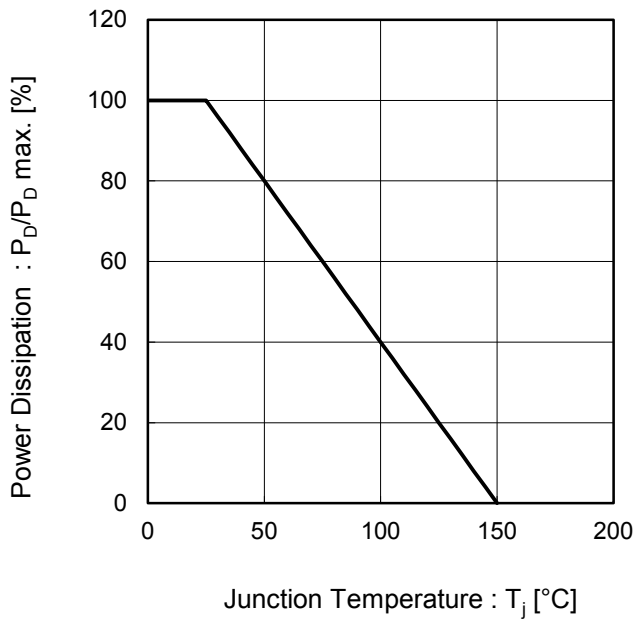


Fig.2 Maximum Safe Operating Area

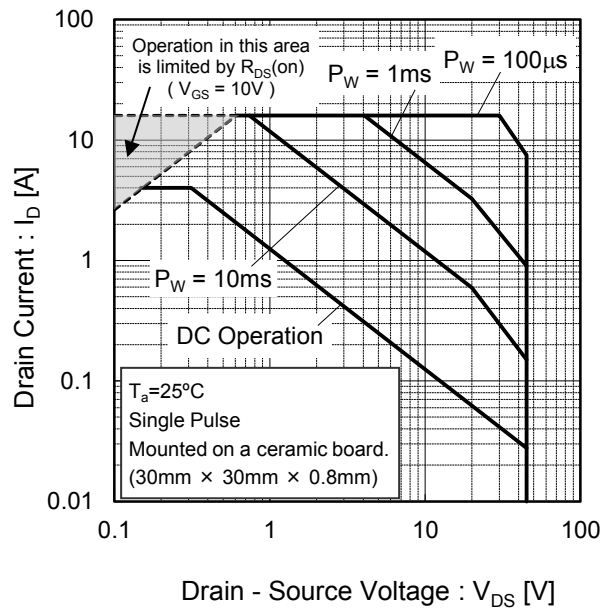


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

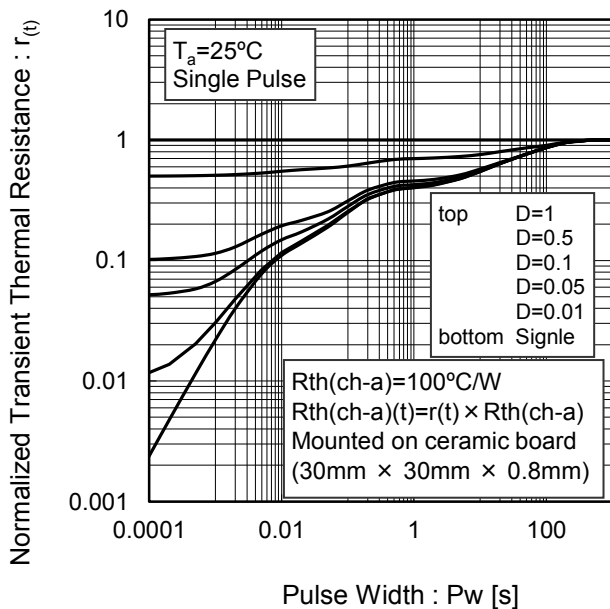
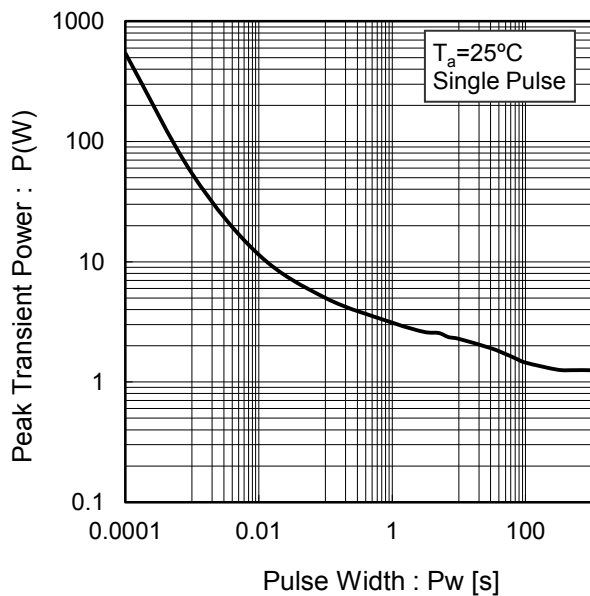


Fig.4 Single Pulse Maximum Power dissipation



●Electrical characteristic curves

Fig.5 Typical Output Characteristics(I)

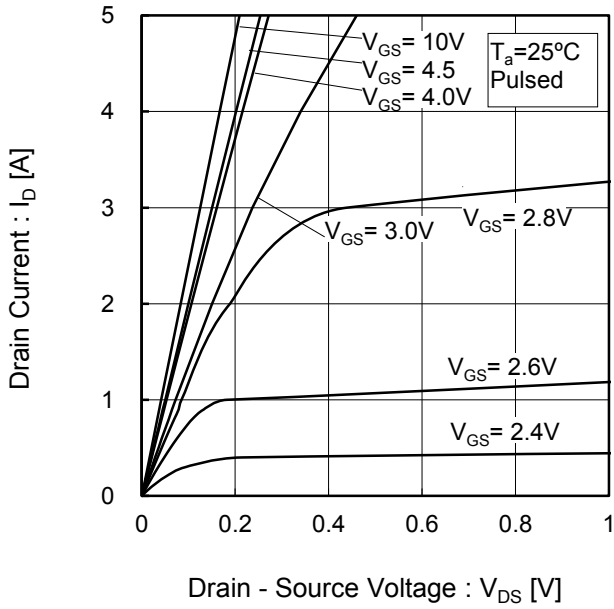
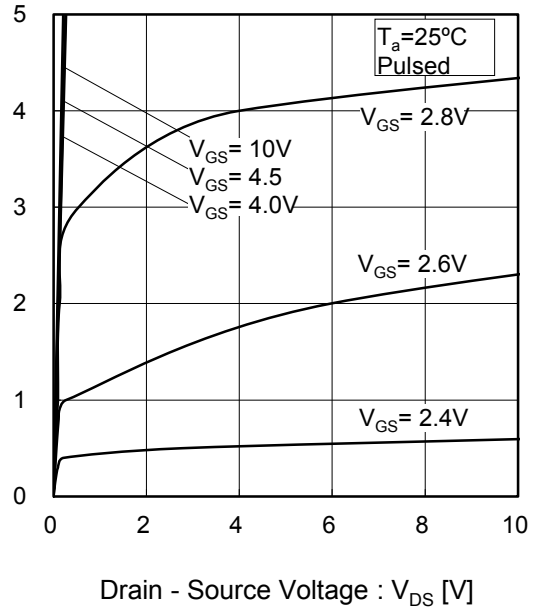


Fig.6 Typical Output Characteristics(II)



●Electrical characteristic curves

Fig.7 Breakdown Voltage vs. Junction Temperature

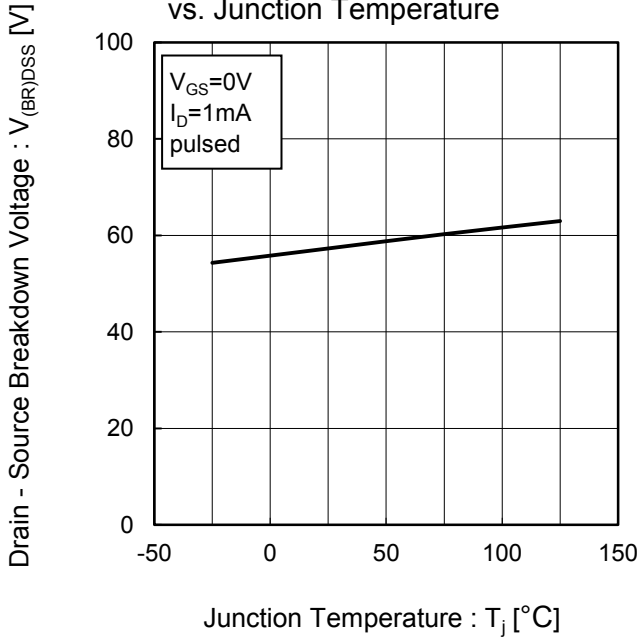


Fig.8 Typical Transfer Characteristics

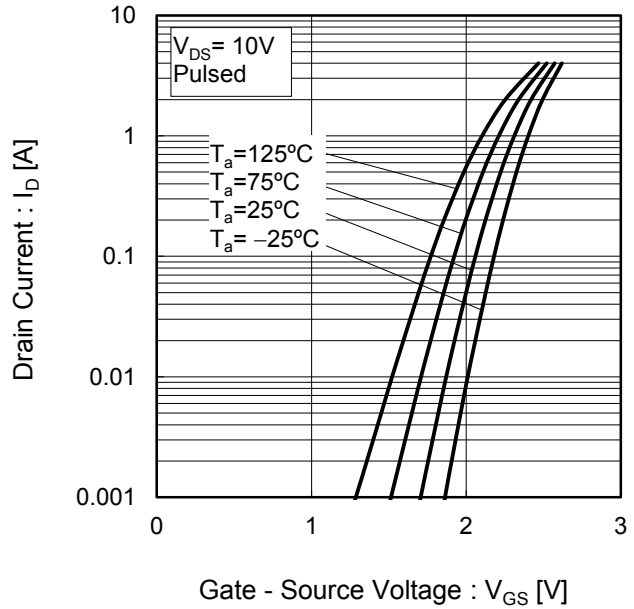


Fig.9 Gate Threshold Voltage vs. Junction Temperature

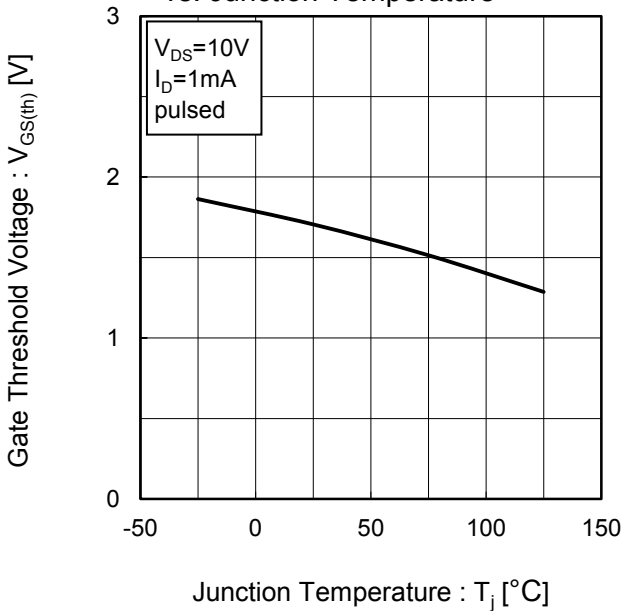
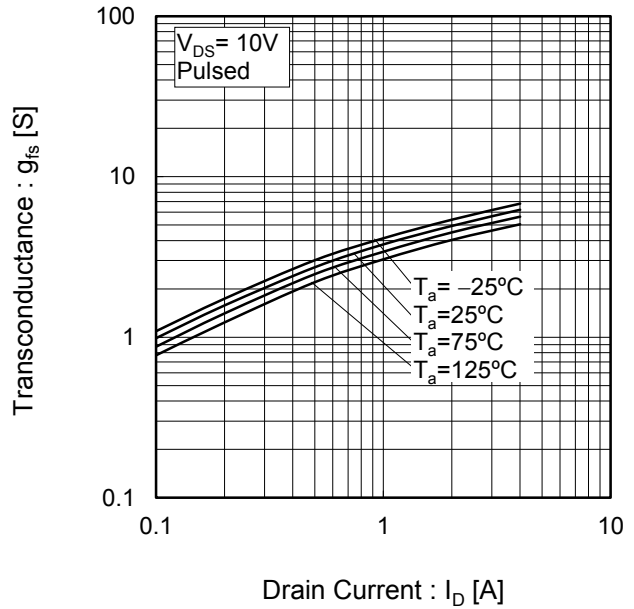


Fig.10 Transconductance vs. Drain Current



●Electrical characteristic curves

Fig.11 Drain Current Derating Curve

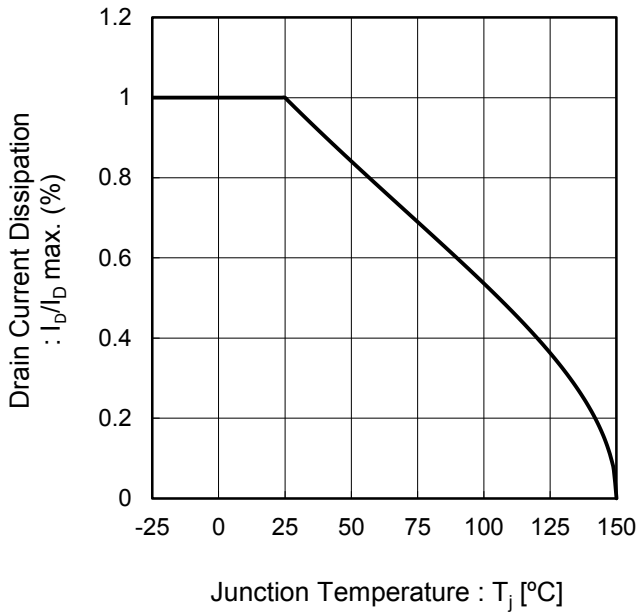


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

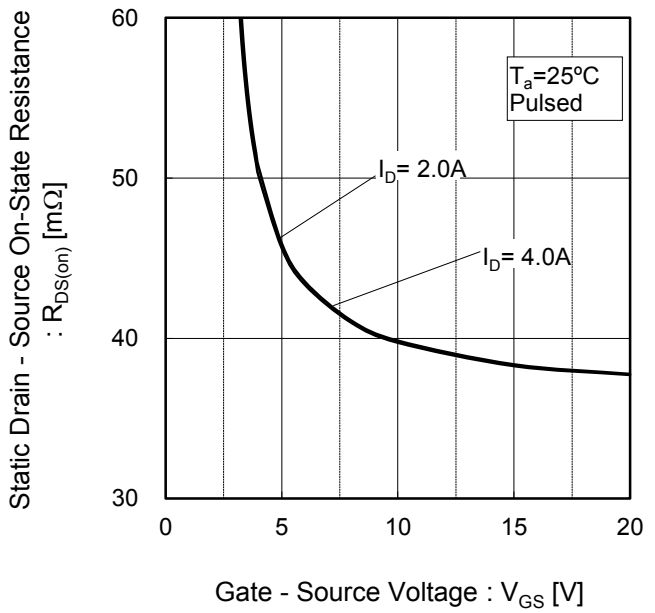


Fig.13 Static Drain - Source On - State Resistance vs. Drain Current(I)

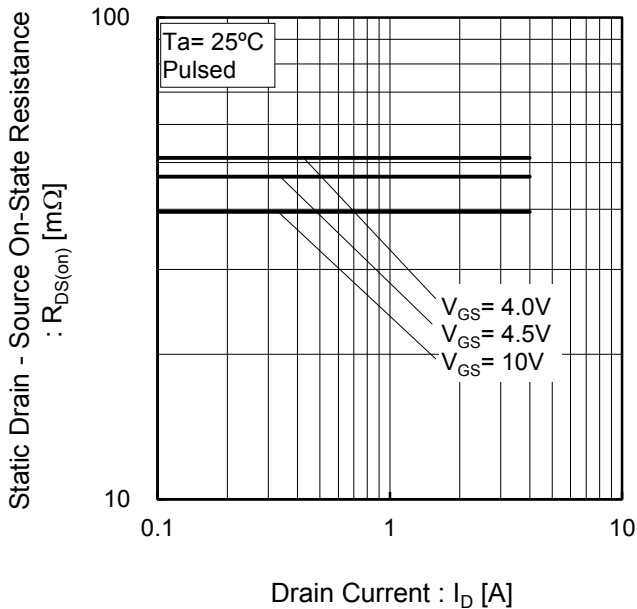
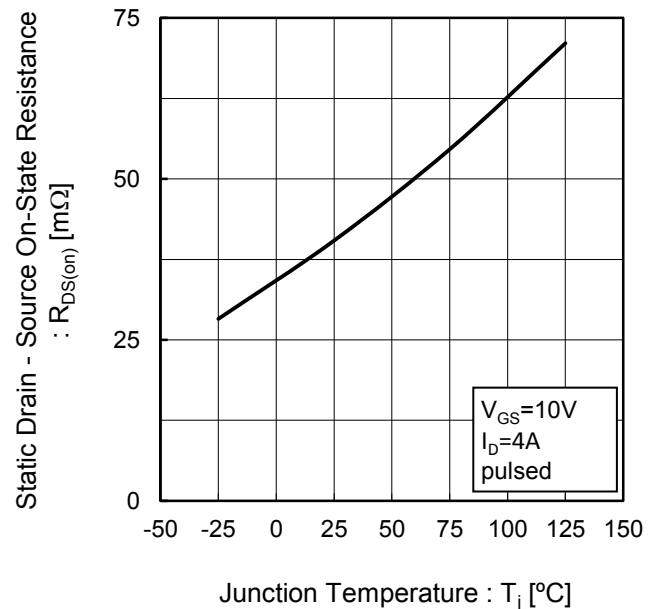


Fig.14 Static Drain - Source On - State Resistance vs. Junction Temperature



●Electrical characteristic curves

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

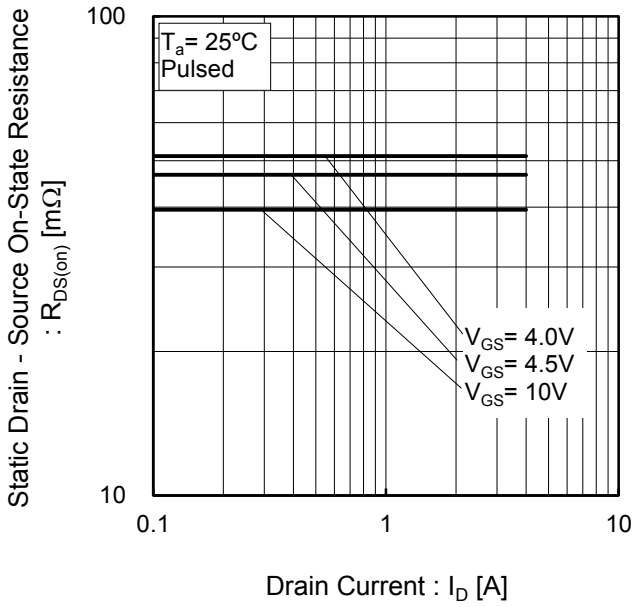


Fig.16 Static Drain - Source On - State Resistance vs. Drain Current(III)

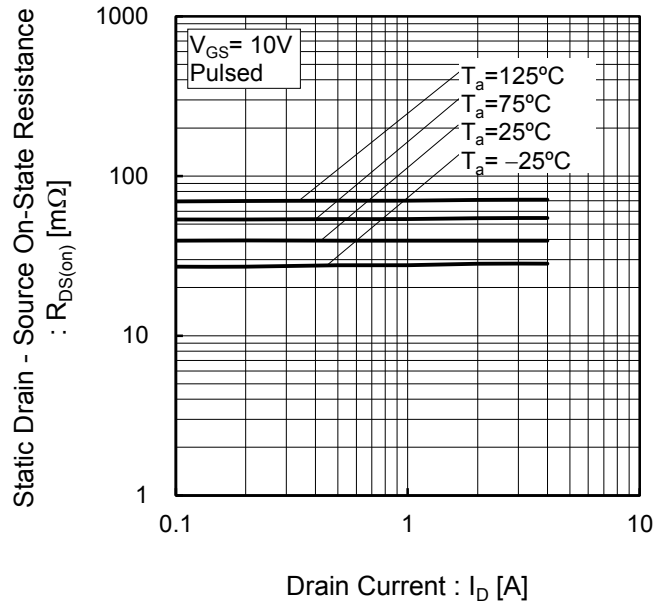
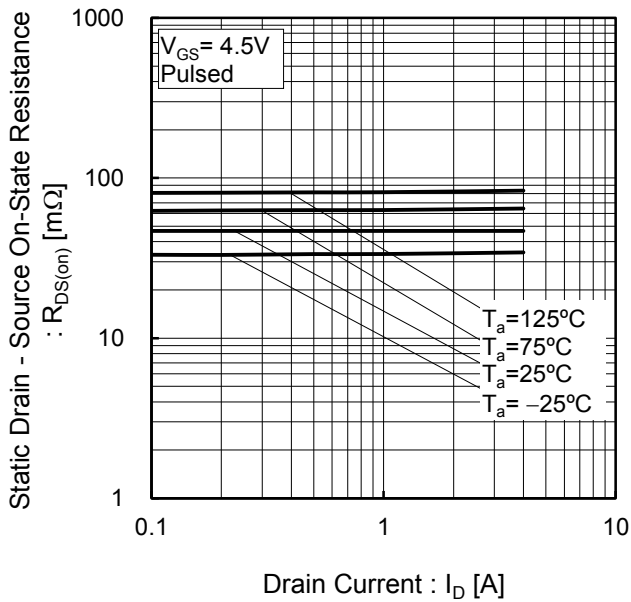


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current(IV)





●Electrical characteristic curves

Fig.18 Typical Capacitance vs. Drain - Source Voltage

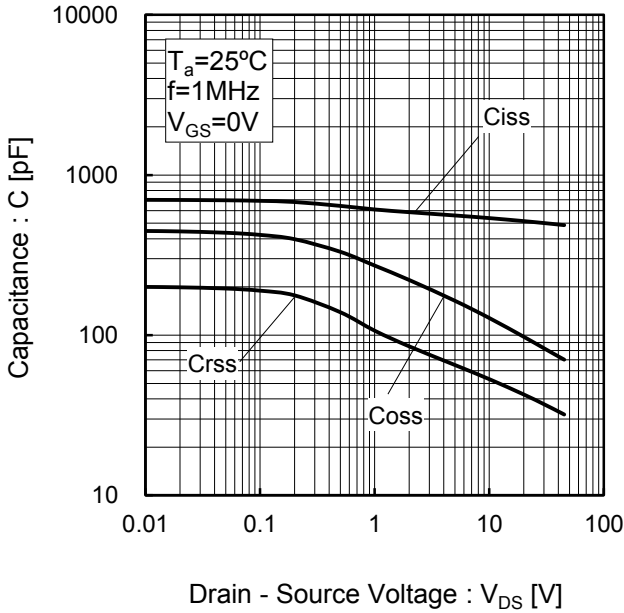


Fig.19 Switching Characteristics

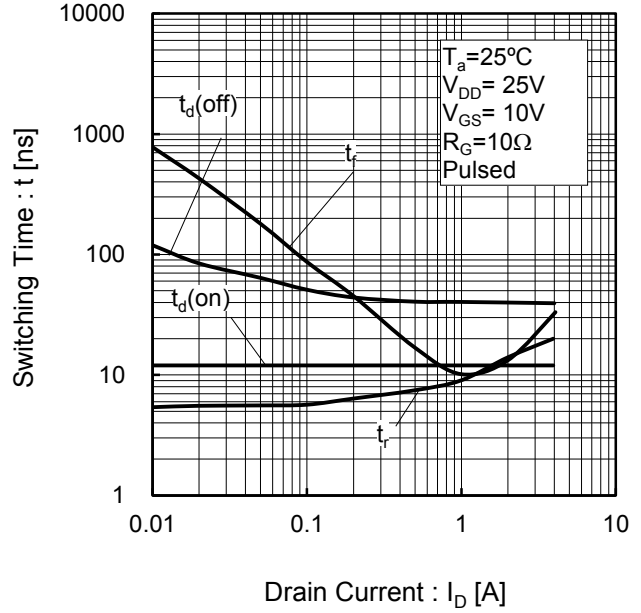


Fig.20 Dynamic Input Characteristics

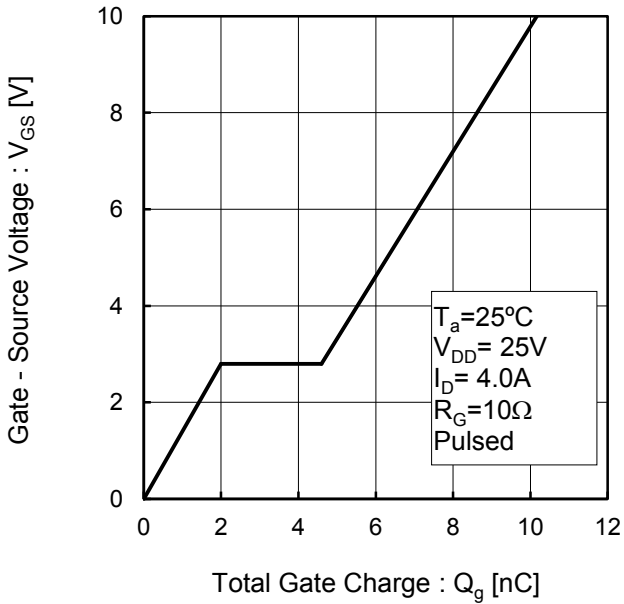
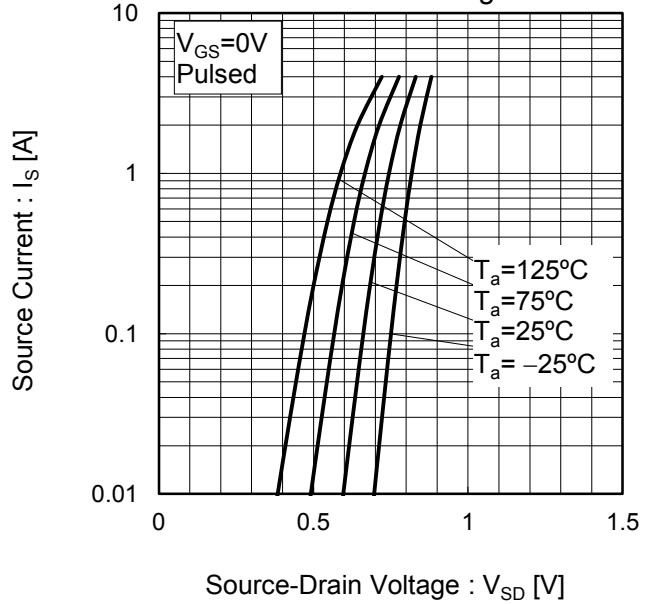


Fig.21 Source Current vs. Source Drain Voltage



●Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

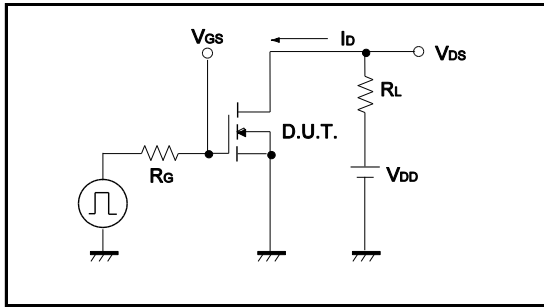


Fig.1-2 Switching Waveforms

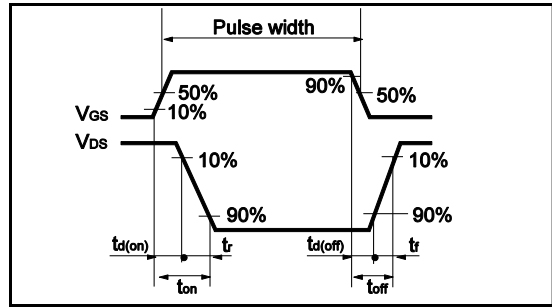


Fig.2-1 Gate Charge Measurement Circuit

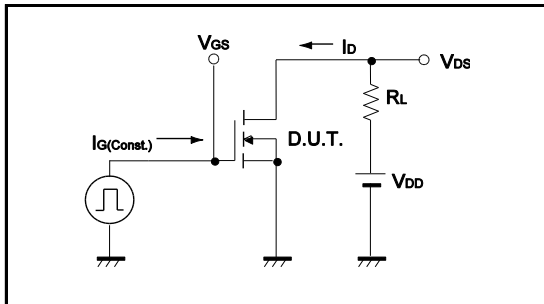
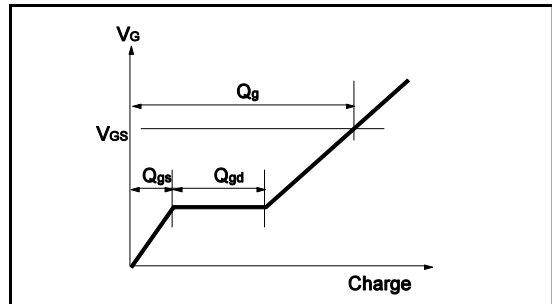
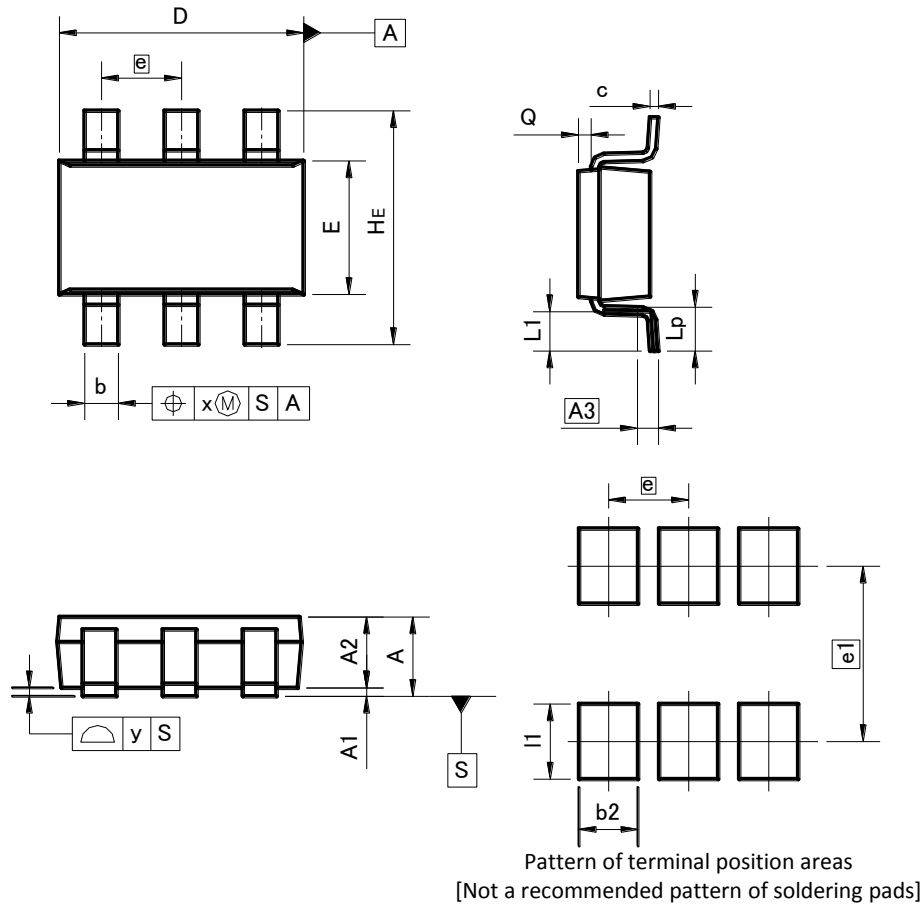


Fig.2-2 Gate Charge Waveform



●Dimensions (Unit : mm)

TSMT6



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

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	-	1.00	-	0.039
A1	0.00	0.10	0.000	0.004
A2	0.75	0.95	0.030	0.037
A3	0.25		0.010	
b	0.35	0.50	0.014	0.020
c	0.10	0.26	0.004	0.010
D	2.80	3.00	0.110	0.118
E	1.50	1.80	0.059	0.071
e	0.95		0.037	
HE	2.60	3.00	0.102	0.118
L1	0.30	0.60	0.012	0.024
Lp	0.40	0.70	0.016	0.028
Q	0.05	0.25	0.002	0.010
x	-	0.20	-	0.008
y	-	0.10	-	0.004

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
b2	-	0.70	-	0.028
e1	2.10		0.083	
l1	-	0.90	-	0.035

Dimension in mm / inches

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