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|                     |              |
|---------------------|--------------|
| $V_{DSS}$           | 30V          |
| $R_{DS(on)}$ (Max.) | 38m $\Omega$ |
| $I_D$               | 4.5A         |
| $P_D$               | 1.25W        |

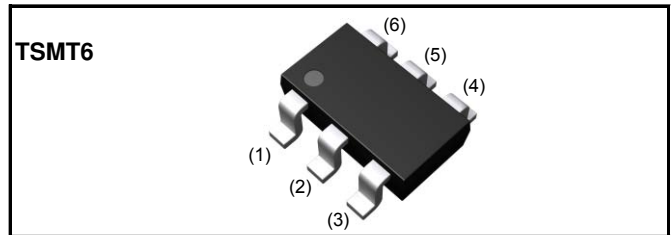
### ●Features

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

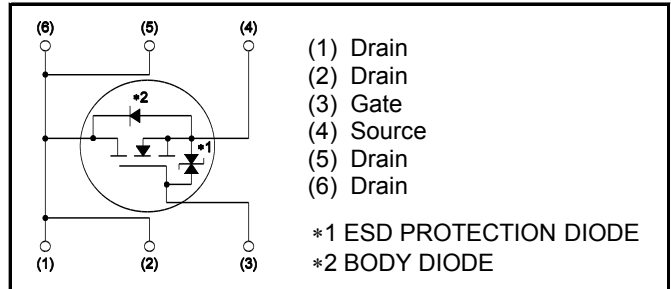
### ●Application

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                   | QL     |

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

| Parameter                    | Symbol             | Value       | Unit             |
|------------------------------|--------------------|-------------|------------------|
| Drain - Source voltage       | $V_{DSS}$          | 30          | V                |
| Continuous drain current     | $I_D^{*1}$         | $\pm 4.5$   | A                |
| Pulsed drain current         | $I_{D,pulse}^{*2}$ | $\pm 18$    | A                |
| Gate - Source voltage        | $V_{GSS}$          | $\pm 20$    | V                |
| Power dissipation            | $P_D^{*3}$         | 1.25        | W                |
|                              | $P_D^{*4}$         | 0.6         | W                |
| Junction temperature         | $T_j$              | 150         | $^\circ\text{C}$ |
| Range of storage temperature | $T_{stg}$          | -55 to +150 | $^\circ\text{C}$ |

### ●Thermal resistance

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

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

| Parameter                                      | Symbol                                  | Conditions  | Values |      |      | Unit          |
|--|---|---|--------|------|------|---------------|
|  |   |   | Min.   | Typ. | Max. |               |
| Drain - Source breakdown voltage               | $V_{(BR)DSS}$                           | $V_{GS} = 0V, I_D = 1mA$                            | 30     | -    | -    | V             |
| Breakdown voltage temperature coefficient      | $\frac{\Delta V_{(BR)DSS}}{\Delta T_j}$ | $I_D = 1mA$<br>referenced to $25^\circ\text{C}$     | -      | 26   | -    | mV/°C         |
| Zero gate voltage drain current                | $I_{DSS}$                               | $V_{DS} = 30V, V_{GS} = 0V$                         | -      | -    | 1    | $\mu\text{A}$ |
| Gate - Source leakage current                  | $I_{GSS}$                               | $V_{GS} = 20V, V_{DS} = 0V$                         | -      | -    | 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 | $\frac{\Delta V_{(GS)th}}{\Delta T_j}$  | $I_D = 1mA$<br>referenced to $25^\circ\text{C}$     | -      | -2.8 | -    | mV/°C         |
| Static drain - source on - state resistance    | $R_{DS(on)}^{*5}$                       | $V_{GS} = 10V, I_D = 4.5A$                          | -      | 27   | 38   | m $\Omega$    |
|  |   | $V_{GS} = 4.5V, I_D = 4.5A$                         | -      | 36   | 51   |               |
|  |   | $V_{GS} = 4.0V, I_D = 4.5A$                         | -      | 40   | 56   |               |
|  |   | $V_{GS} = 10V, I_D = 4.5A, T_j = 125^\circ\text{C}$ | -      | 50   | 70   |               |
| Gate input resistance                          | $R_G$                                   | $f = 1\text{MHz}, \text{open drain}$                | -      | 6    | -    | $\Omega$      |
| Transconductance                               | $g_{fs}^{*5}$                           | $V_{DS} = 10V, I_D = 4.5A$                          | 3.5    | 7.0  | -    | 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)

\*5 Pulsed

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

| Parameter                    | Symbol            | Conditions                         | Values |      |      | Unit |
|------------------------------|-------------------|------------------------------------|--------|------|------|------|
|                              |                   |                                    | Min.   | Typ. | Max. |      |
| Input capacitance            | $C_{iss}$         | $V_{GS} = 0V$                      | -      | 520  | -    | pF   |
| Output capacitance           | $C_{oss}$         | $V_{DS} = 10V$                     | -      | 150  | -    |      |
| Reverse transfer capacitance | $C_{rss}$         | $f = 1\text{MHz}$                  | -      | 95   | -    |      |
| Turn - on delay time         | $t_{d(on)}^{*5}$  | $V_{DD} \approx 15V, V_{GS} = 10V$ | -      | 12   | -    | ns   |
| Rise time                    | $t_r^{*5}$        | $I_D = 2.25A$                      | -      | 19   | -    |      |
| Turn - off delay time        | $t_{d(off)}^{*5}$ | $R_L = 6.67\Omega$                 | -      | 41   | -    |      |
| Fall time                    | $t_f^{*5}$        | $R_G = 10\Omega$                   | -      | 14   | -    |      |

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

| Parameter            | Symbol        | Conditions                                       | Values |      |      | Unit |
|----------------------|---------------|--|--------|------|------|------|
|                      |               |  | Min.   | Typ. | Max. |      |
| Total gate charge    | $Q_g^{*5}$    | $V_{DD} \approx 15V, I_D=4.5A$<br>$V_{GS} = 5V$  | -      | 6.8  | 9.5  | nC   |
|                      |               | $V_{DD} \approx 15V, I_D=4.5A$<br>$V_{GS} = 10V$ | -      | 13   | -    |      |
| Gate - Source charge | $Q_{gs}^{*5}$ | $V_{DD} \approx 15V, I_D=4.5A$                   | -      | 1.6  | -    |      |
| Gate - Drain charge  | $Q_{gd}^{*5}$ | $V_{GS} = 5V$                                    | -      | 2.3  | -    |      |

**●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    | A    |
| Forward voltage                           | $V_{SD}^{*5}$ | $V_{GS} = 0V, I_S = 1.0A$ | -      | -    | 1.2  | V    |

●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

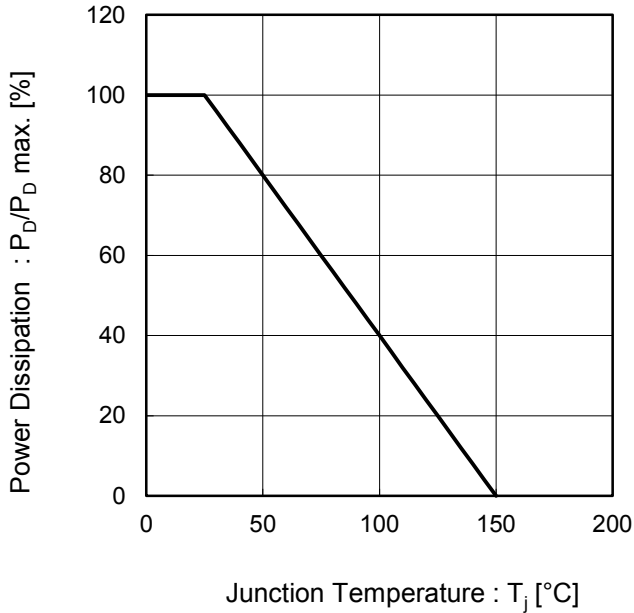


Fig.2 Maximum Safe Operating Area

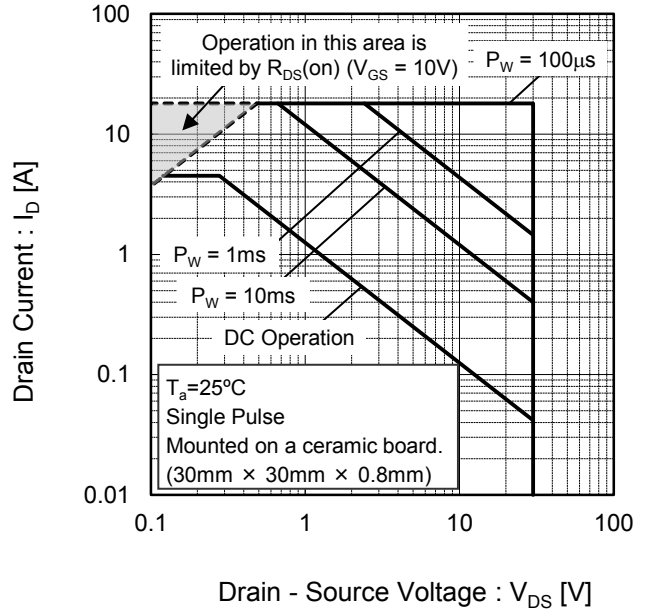


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

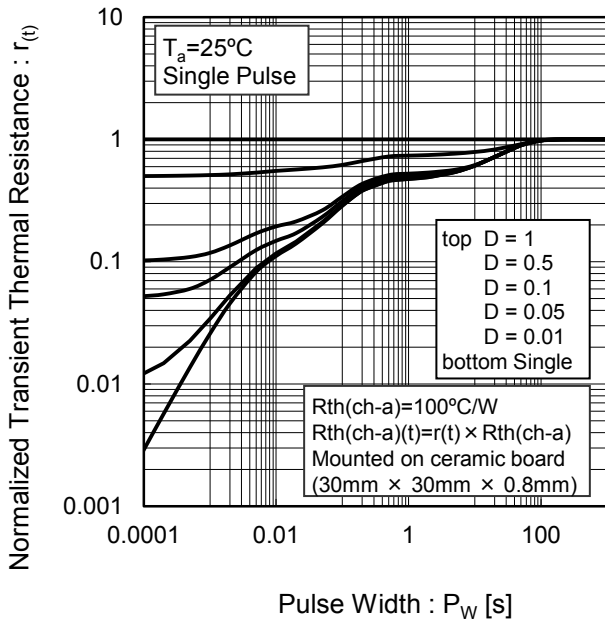
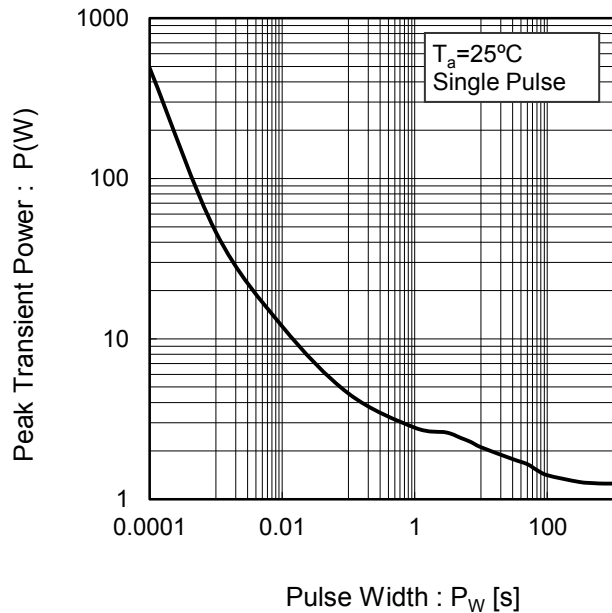


Fig.4 Single Pulse Maximum Power dissipation



●Electrical characteristic curves

Fig.5 Typical Output Characteristics(I)

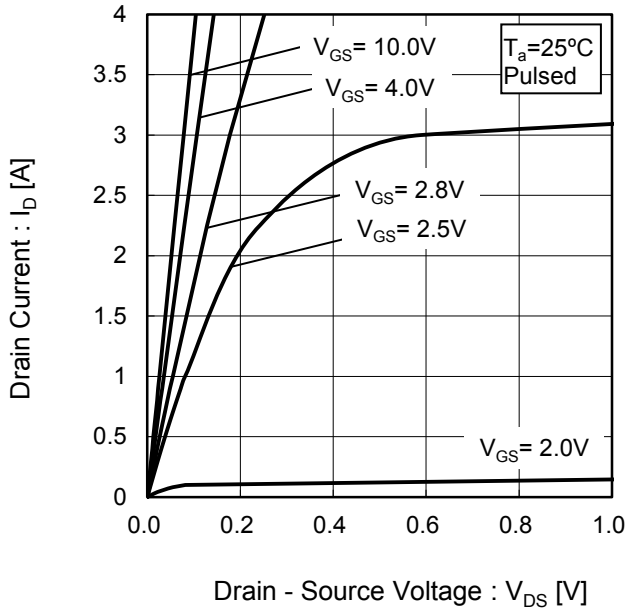


Fig.6 Typical Output Characteristics(II)

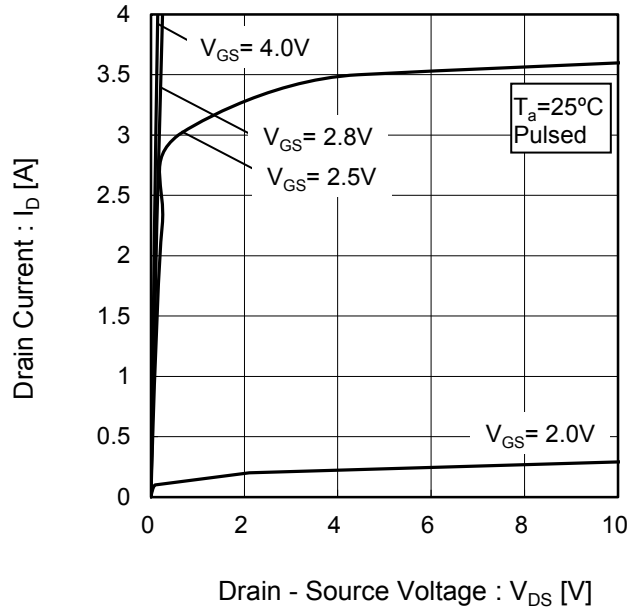


Fig.7 Breakdown Voltage vs. Junction Temperature

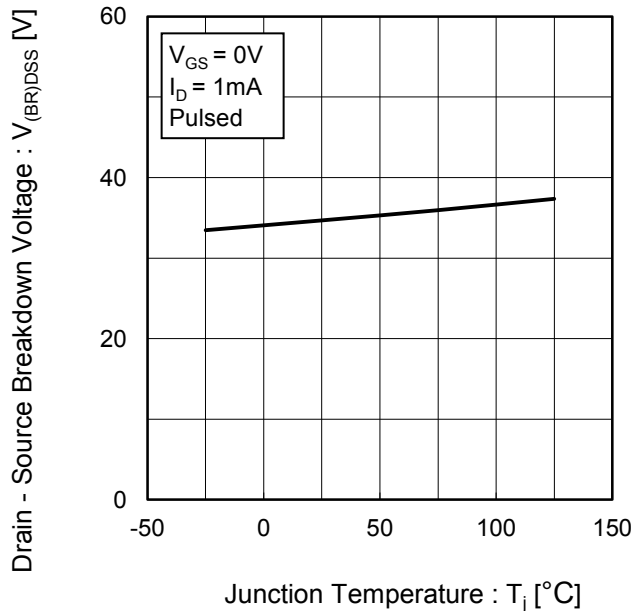
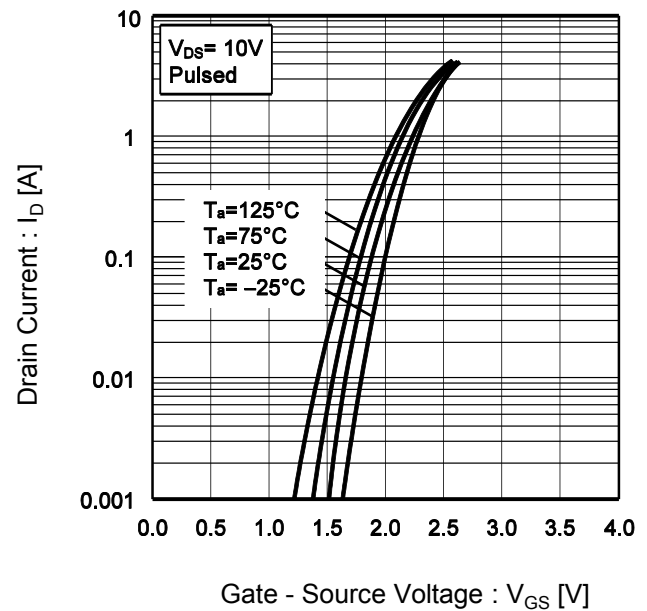


Fig.8 Typical Transfer Characteristics



●Electrical characteristic curves

Fig.9 Gate Threshold Voltage vs. Junction Temperature

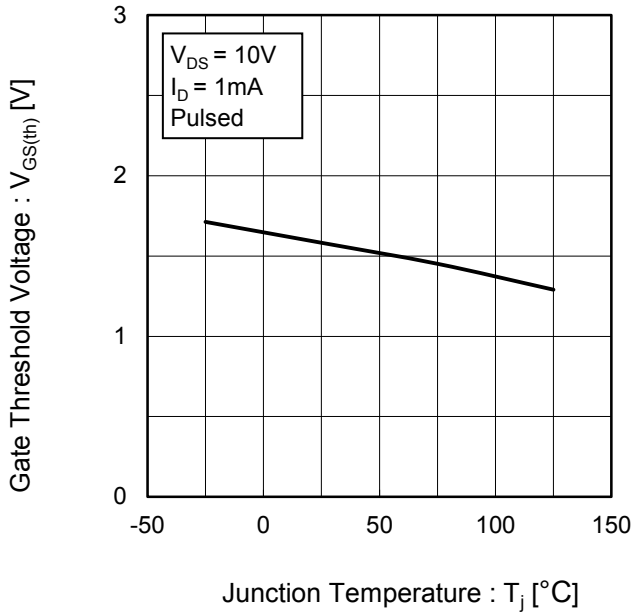


Fig.10 Transconductance vs. Drain Current

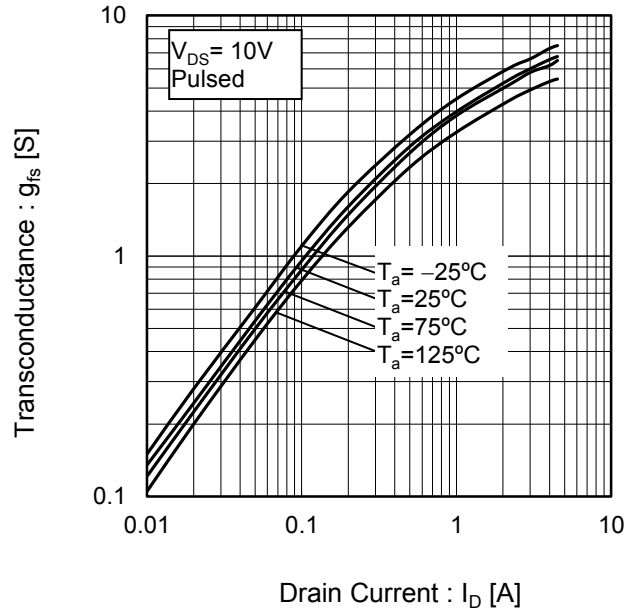


Fig.11 Drain Current Derating Curve

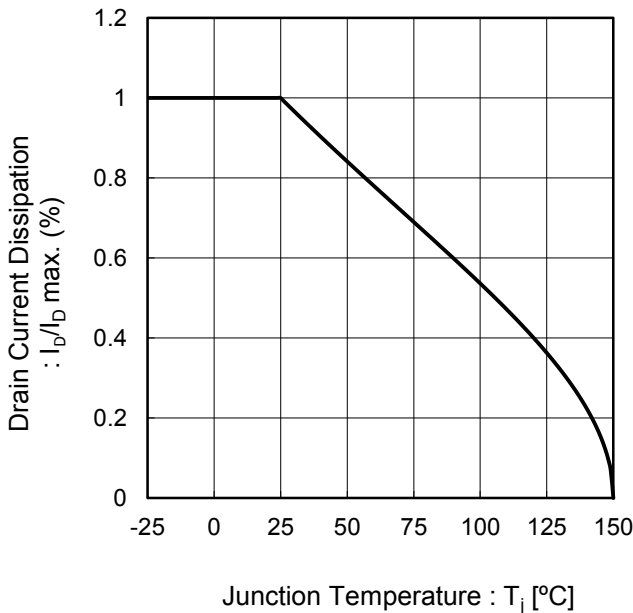
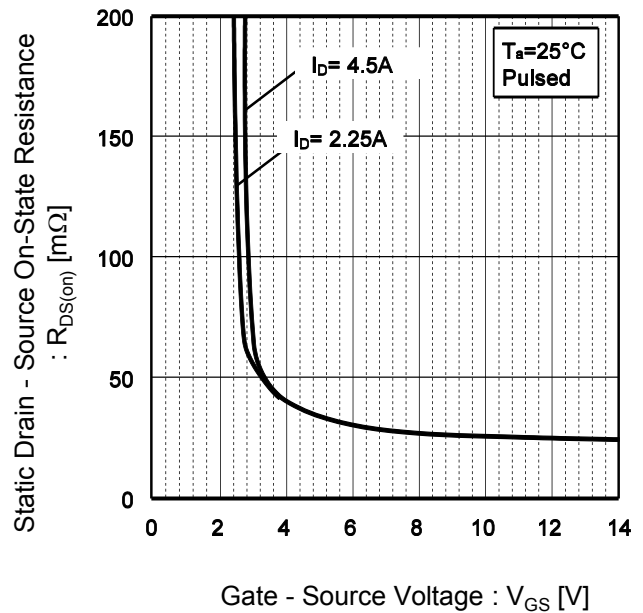


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage



●Electrical characteristic curves

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

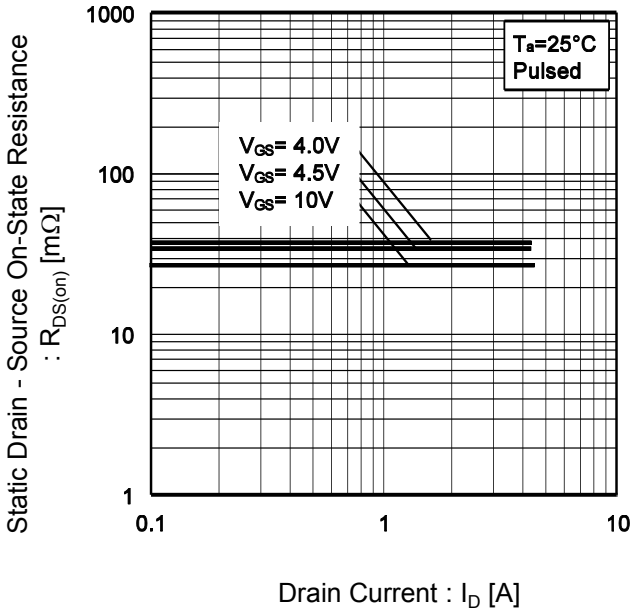


Fig.14 Static Drain - Source On - State Resistance vs. Junction Temperature

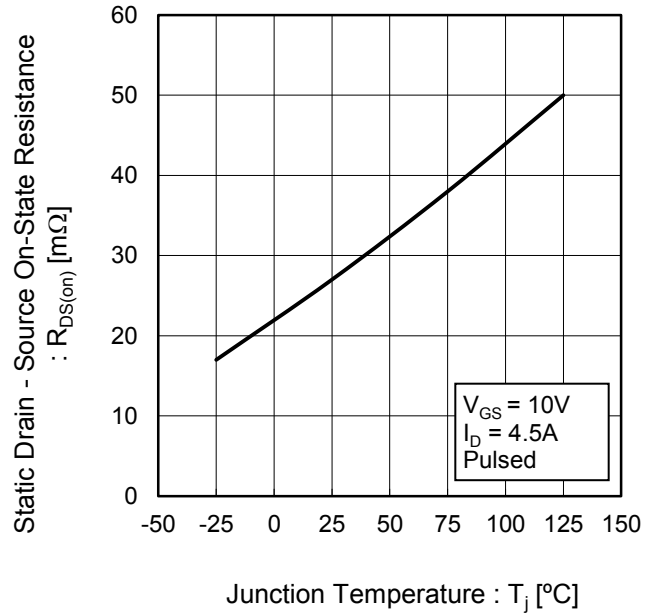


Fig.15 Static Drain - Source On - State Resistance vs. Drain Current(II)

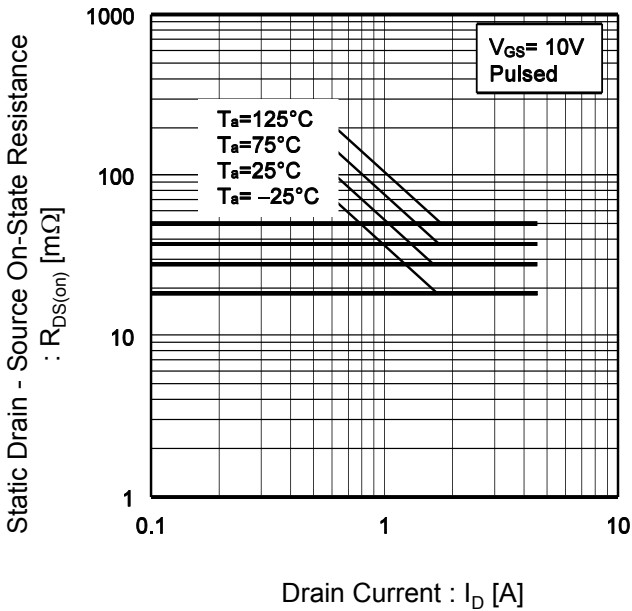
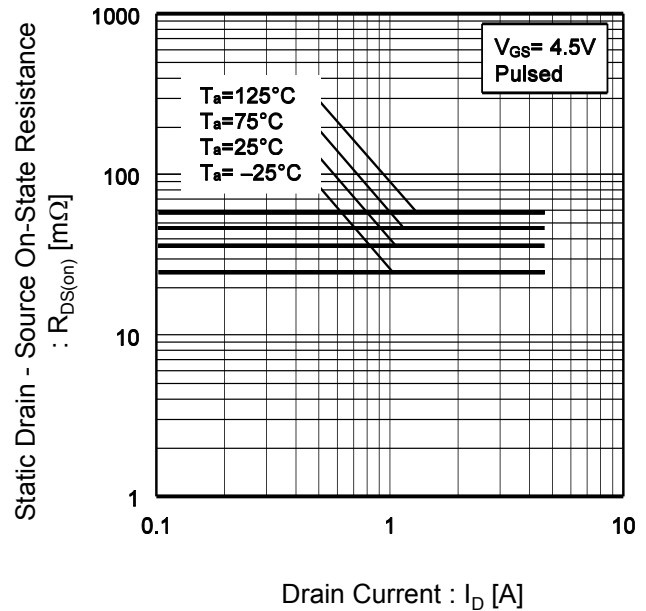


Fig.16 Static Drain-Source On-State Resistance vs. Drain Current(III)



●Electrical characteristic curves

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

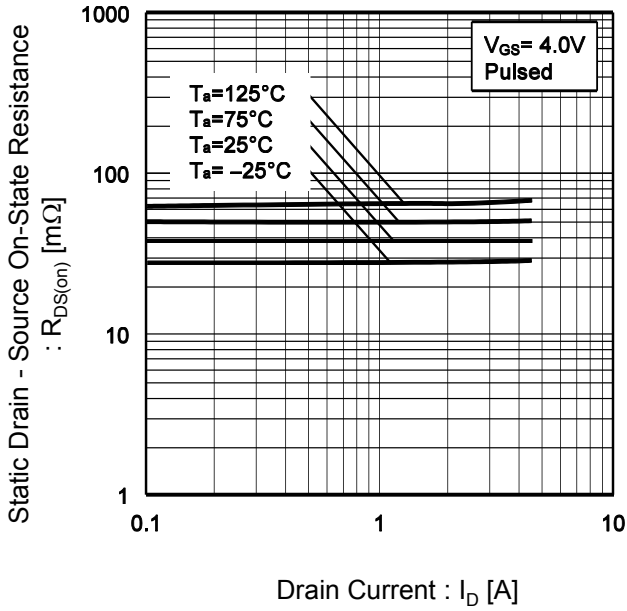


Fig.18 Typical Capacitance vs. Drain - Source Voltage

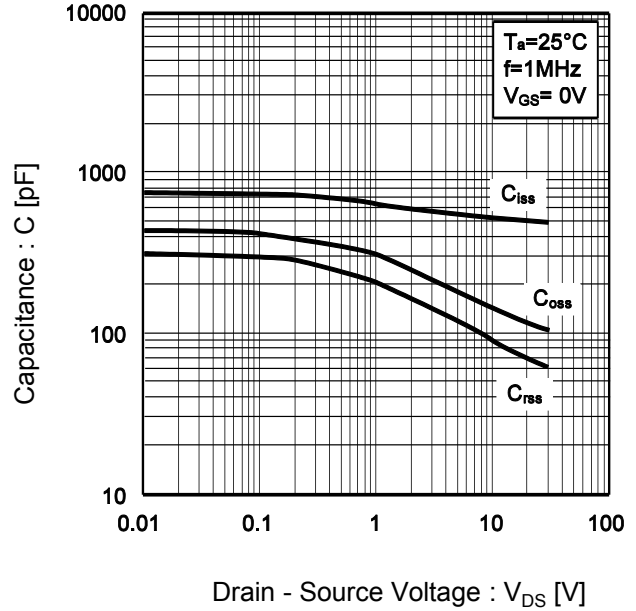


Fig.19 Switching Characteristics

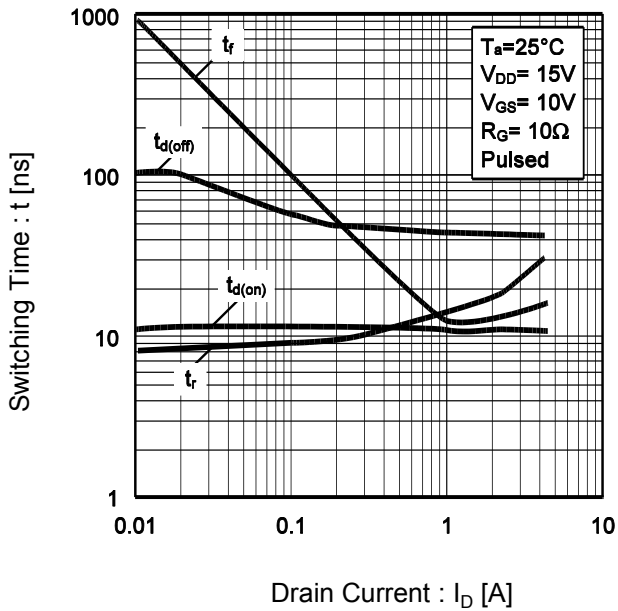
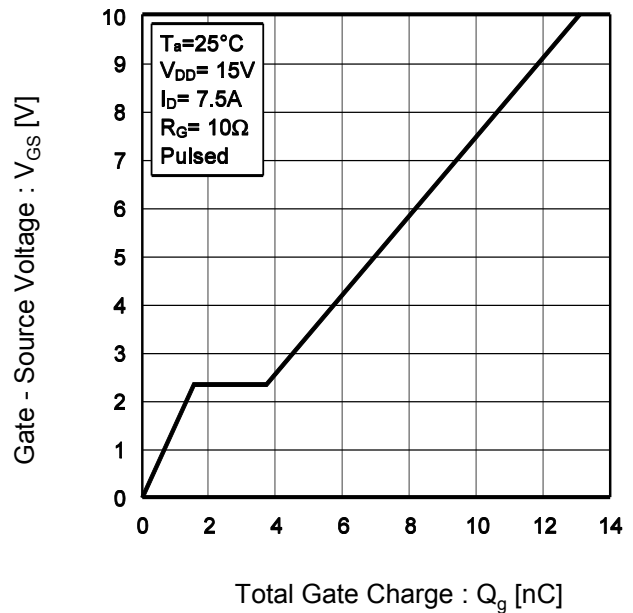
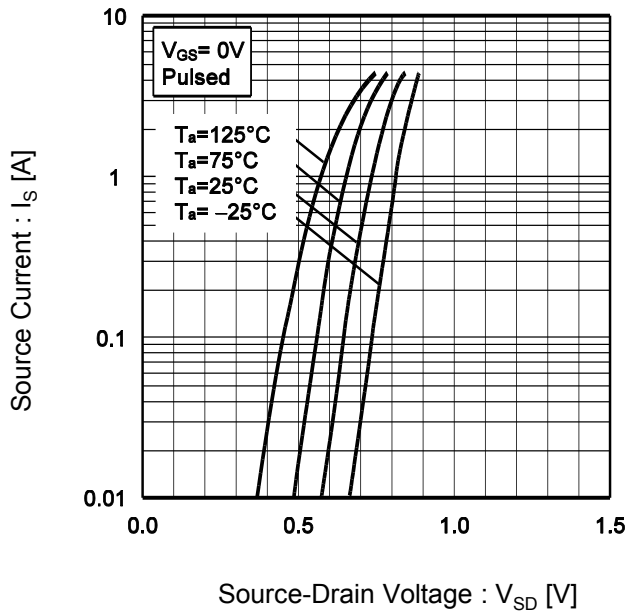


Fig.20 Dynamic Input Characteristics



## ●Electrical characteristic curves

Fig.21 Source Current  
vs. Source Drain Voltage

●Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

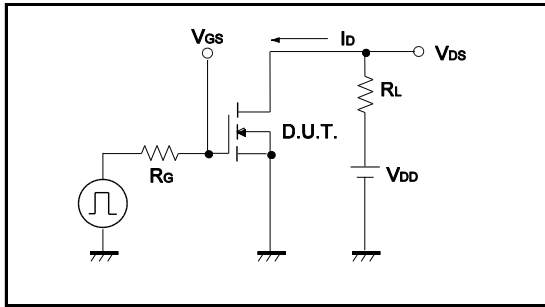


Fig.1-2 Switching Waveforms

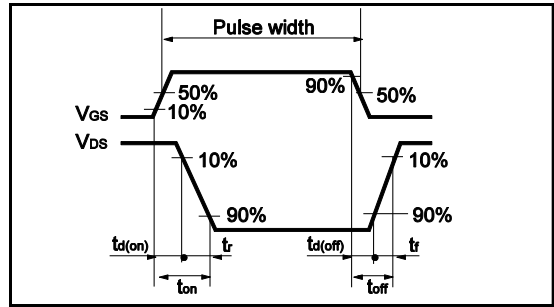


Fig.2-1 Gate Charge Measurement Circuit

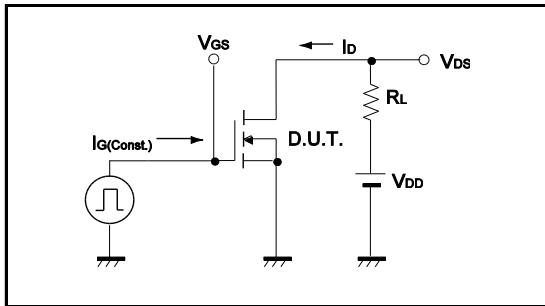
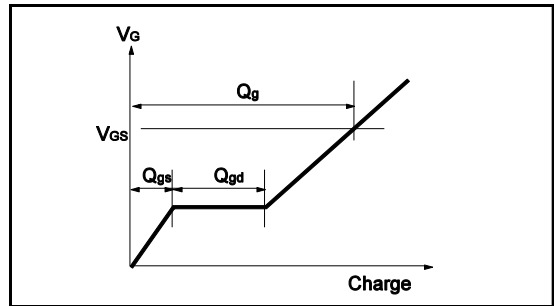
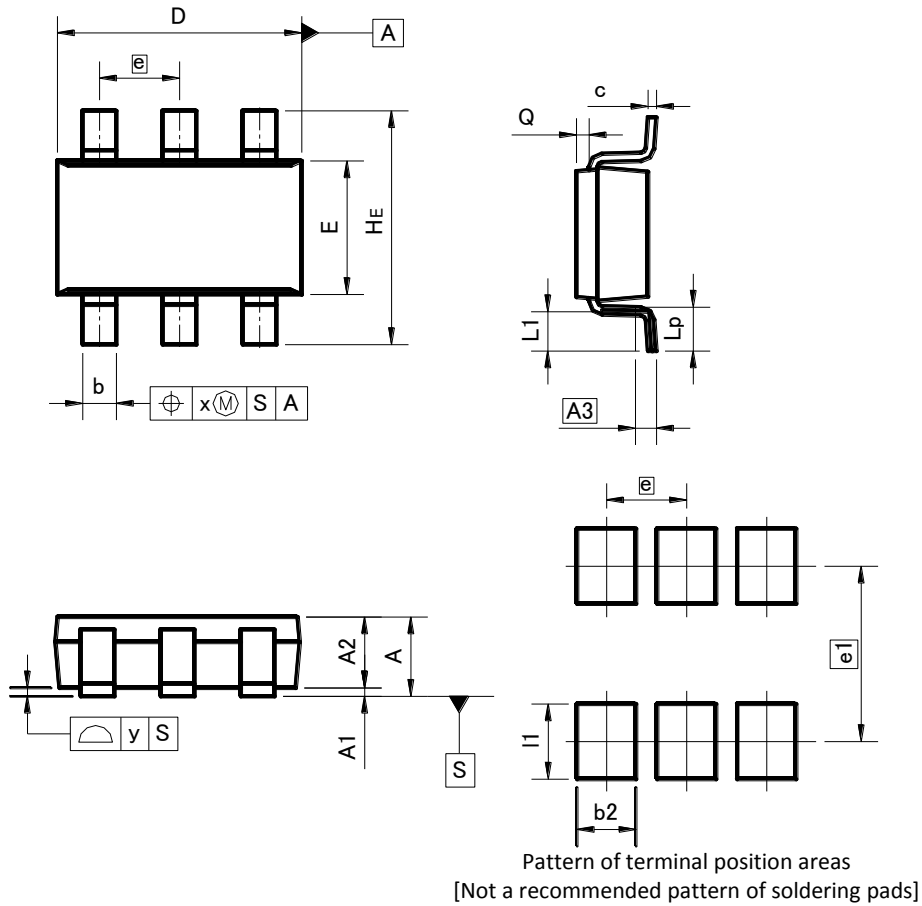


Fig.2-2 Gate Charge Waveform



●Dimensions (Unit : mm)

TSMT6



| 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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