

|                     |       |
|---------------------|-------|
| $V_{DSS}$           | 60V   |
| $R_{DS(on)}$ (Max.) | 170mΩ |
| $I_D$               | 2A    |
| $P_D$               | 1.0W  |

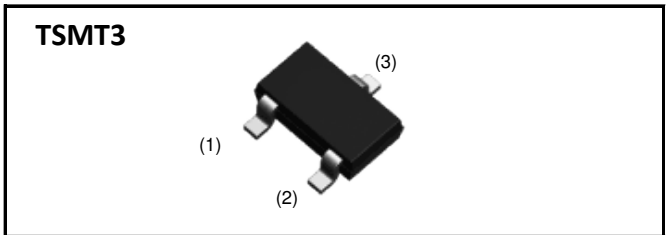
#### ●Features

- 1) Low on - resistance.
- 2) Built-in G-S Protection Diode.
- 3) Small Surface Mount Package (TSMT3).
- 4) Pb-free lead plating ; RoHS compliant

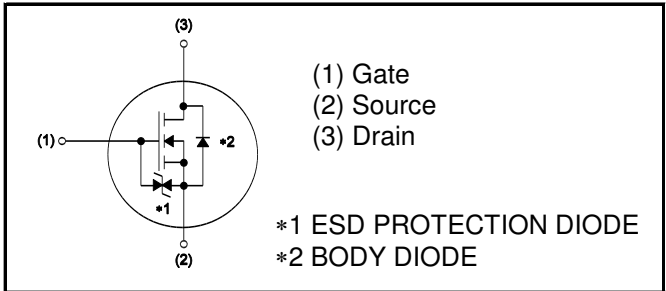
#### ●Application

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               | TL     |
|      | Marking                   | PZ     |

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

| Parameter                    | Symbol             | Value       | Unit |
|------------------------------|--------------------|-------------|------|
| Drain - Source voltage       | $V_{DSS}$          | 60          | V    |
| Continuous drain current     | $I_D^{*1}$         | ±2          | A    |
| Pulsed drain current         | $I_{D,pulse}^{*2}$ | ±8          | A    |
| Gate - Source voltage        | $V_{GSS}$          | ±20         | V    |
| Power dissipation            | $P_D^{*3}$         | 1.0         | W    |
|                              | $P_D^{*4}$         | 0.54        | 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 | $R_{thJA}^{*3}$ | -      | -    | 125  | °C/W |
| Thermal resistance, junction - ambient | $R_{thJA}^{*4}$ | -      | -    | 231  | °C/W |

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

| Parameter                                      | Symbol                                  | Conditions                                      | Values |      |          | Unit          |
|--|---|---|--------|------|----------|---------------|
|  |   |   | Min.   | Typ. | Max.     |               |
| Drain - Source breakdown voltage               | $V_{(BR)DSS}$                           | $V_{GS} = 0V, I_D = 1mA$                        | 60     | -    | -        | V             |
| Breakdown voltage temperature coefficient      | $\frac{\Delta V_{(BR)DSS}}{\Delta T_j}$ | $I_D = 1mA$<br>referenced to $25^\circ\text{C}$ | -      | 67   | -        | mV/°C         |
| Zero gate voltage drain current                | $I_{DSS}$                               | $V_{DS} = 60V, V_{GS} = 0V$                     | -      | -    | 1        | $\mu\text{A}$ |
| Gate - Source leakage current                  | $I_{GSS}$                               | $V_{GS} = \pm 20V, V_{DS} = 0V$                 | -      | -    | $\pm 10$ | $\mu\text{A}$ |
| Gate threshold voltage                         | $V_{GS(th)}$                            | $V_{DS} = 10V, I_D = 1mA$                       | 1.0    | -    | 2.5      | V             |
| Gate threshold voltage temperature coefficient | $\frac{\Delta V_{(GS)th}}{\Delta T_j}$  | $I_D = 1mA$<br>referenced to $25^\circ\text{C}$ | -      | -4.4 | -        | mV/°C         |
| Static drain - source on - state resistance    | $R_{DS(on)}^{*5}$                       | $V_{GS}=10V, I_D=2A$                            | -      | 120  | 170      | m $\Omega$    |
|  |   | $V_{GS}=4.5V, I_D=2A$                           | -      | 140  | 195      |               |
|  |   | $V_{GS}=4.0V, I_D=2A$                           | -      | 150  | 210      |               |
|  |   | $V_{GS}=10V, I_D=2A, T_j=125^\circ\text{C}$     | -      | 220  | 310      |               |
| Gate input resistance                          | $R_G$                                   | $f = 1\text{MHz}, \text{open drain}$            | -      | 3.0  | -        | $\Omega$      |
| Transconductance                               | $g_{fs}^{*5}$                           | $V_{DS} = 10V, I_D = 2A$                        | 1.3    | 3.0  | -        | 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 (12×20×0.8mm)

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

| Parameter                    | Symbol            | Conditions                         | Values |      |      | Unit |
|------------------------------|-------------------|------------------------------------|--------|------|------|------|
|                              |                   |                                    | Min.   | Typ. | Max. |      |
| Input capacitance            | $C_{iss}$         | $V_{GS} = 0V$                      | -      | 180  | -    | pF   |
| Output capacitance           | $C_{oss}$         | $V_{DS} = 10V$                     | -      | 50   | -    |      |
| Reverse transfer capacitance | $C_{rss}$         | $f = 1\text{MHz}$                  | -      | 22   | -    |      |
| Turn - on delay time         | $t_{d(on)}^{*5}$  | $V_{DD} \approx 30V, V_{GS} = 10V$ | -      | 6    | -    | ns   |
| Rise time                    | $t_r^{*5}$        | $I_D = 1.0A$                       | -      | 10   | -    |      |
| Turn - off delay time        | $t_{d(off)}^{*5}$ | $R_L = 30\Omega$                   | -      | 20   | -    |      |
| Fall time                    | $t_f^{*5}$        | $R_G = 10\Omega$                   | -      | 6    | -    |      |

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

| Parameter            | Symbol        | Conditions                                       | Values |      |      | Unit |
|----------------------|---------------|--|--------|------|------|------|
|                      |               |  | Min.   | Typ. | Max. |      |
| Total gate charge    | $Q_g^{*5}$    | $V_{DD} \approx 30V, I_D = 2A$<br>$V_{GS} = 5V$  | -      | 2.7  | -    | nC   |
|                      |               | $V_{DD} \approx 30V, I_D = 2A$<br>$V_{GS} = 10V$ | -      | 4.9  | -    |      |
| Gate - Source charge | $Q_{gs}^{*5}$ | $V_{DD} \approx 30V, I_D = 2A$                   | -      | 1.0  | -    |      |
| Gate - Drain charge  | $Q_{gd}^{*5}$ | $V_{GS} = 5V$                                    | -      | 0.6  | -    |      |

**●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 | $I_S^{*1}$    | $T_a = 25^\circ\text{C}$ | -      | -    | 0.8  | A    |
| Forward voltage                           | $V_{SD}^{*5}$ | $V_{GS} = 0V, I_S = 2A$  | -      | -    | 1.2  | V    |

\*5 Pulsed

●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

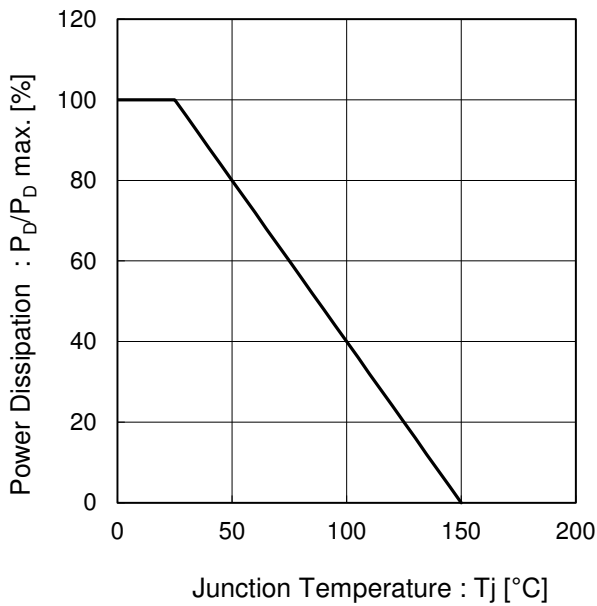


Fig.2 Maximum Safe Operating Area

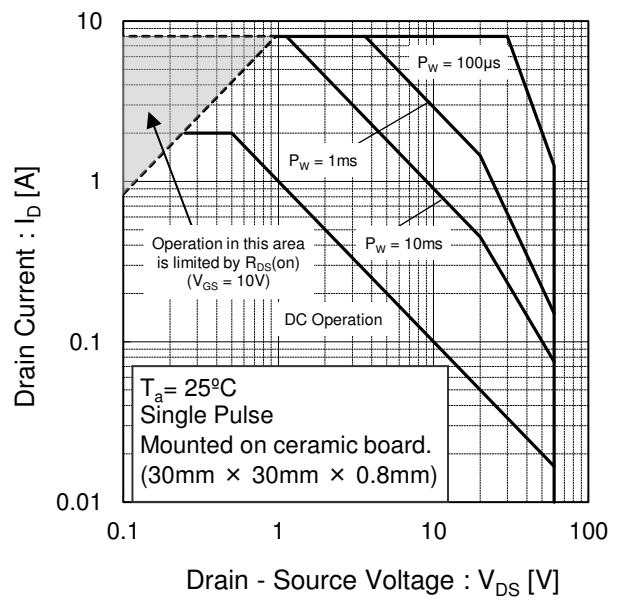


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

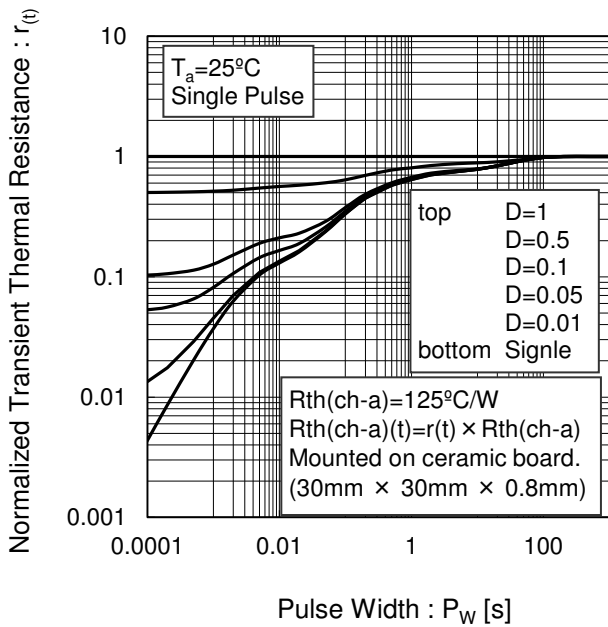
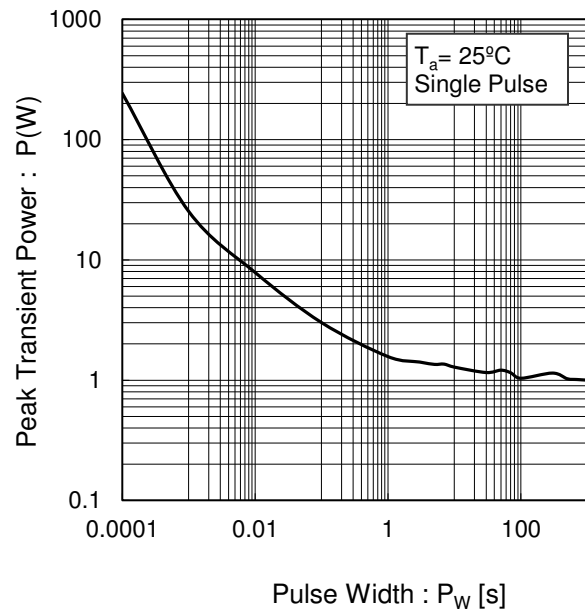


Fig.4 Single Pulse Maximum Power dissipation



●Electrical characteristic curves

Fig.5 Typical Output Characteristics(I)

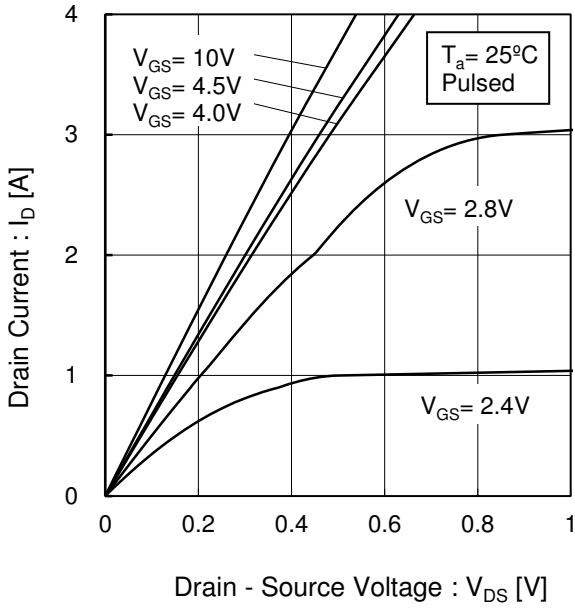
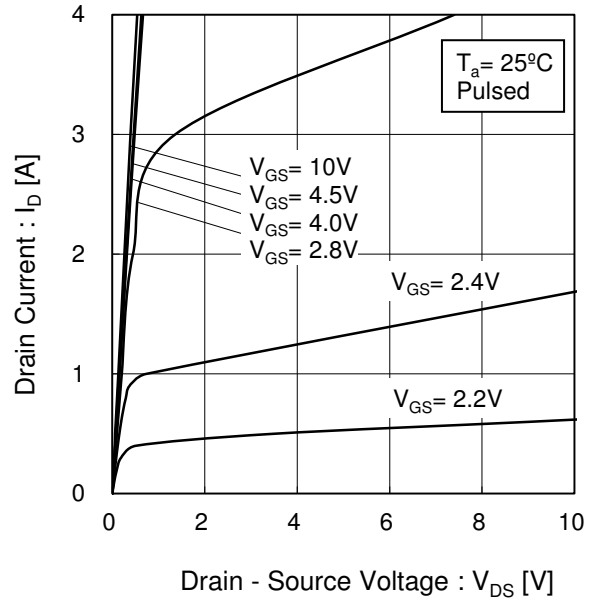


Fig.6 Typical Output Characteristics(II)



●Electrical characteristic curves

Fig.7 Breakdown Voltage vs. Junction Temperature

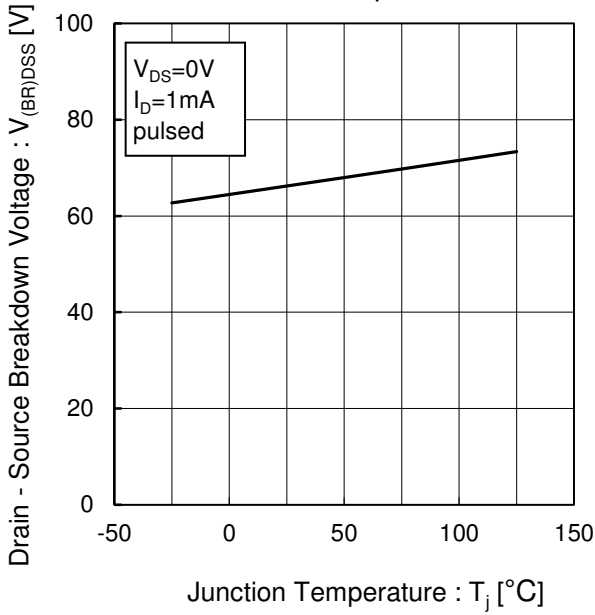


Fig.8 Typical Transfer Characteristics

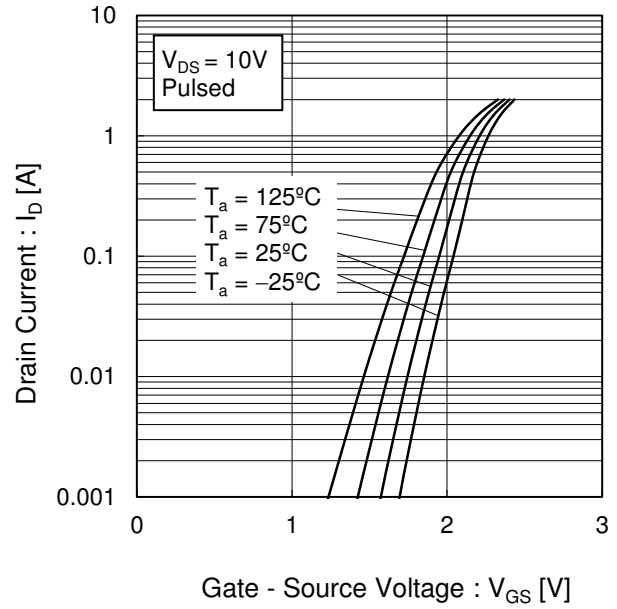


Fig.9 Gate Threshold Voltage vs. Junction Temperature

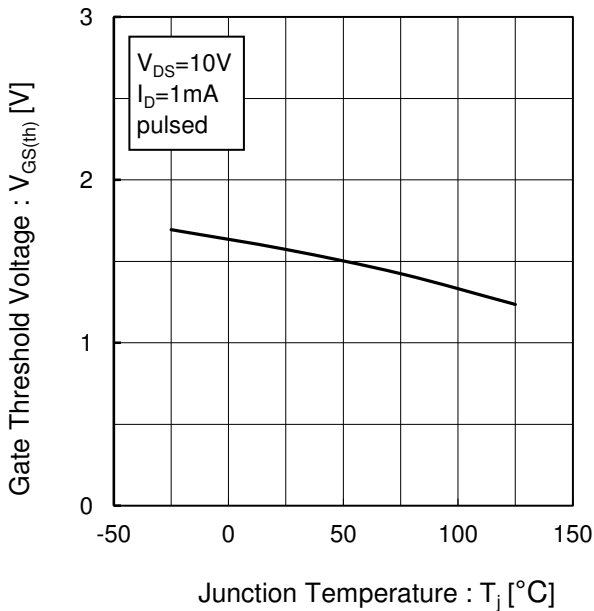
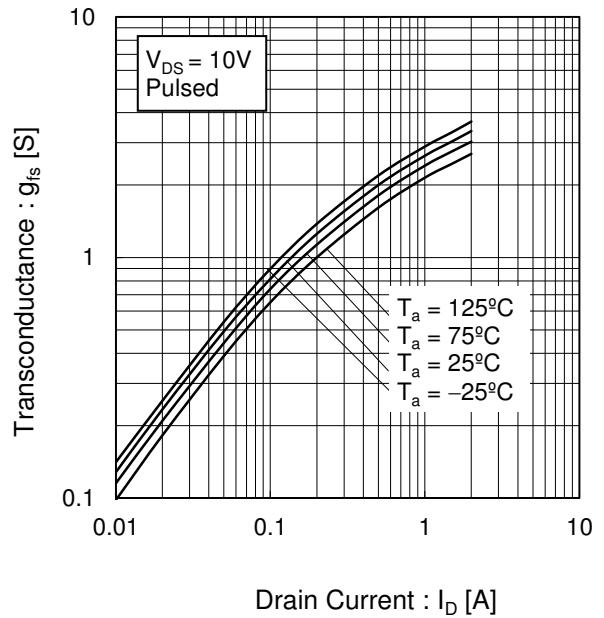


Fig.10 Transconductance vs. Drain Current



●Electrical characteristic curves

Fig.11 Drain Current Derating Curve

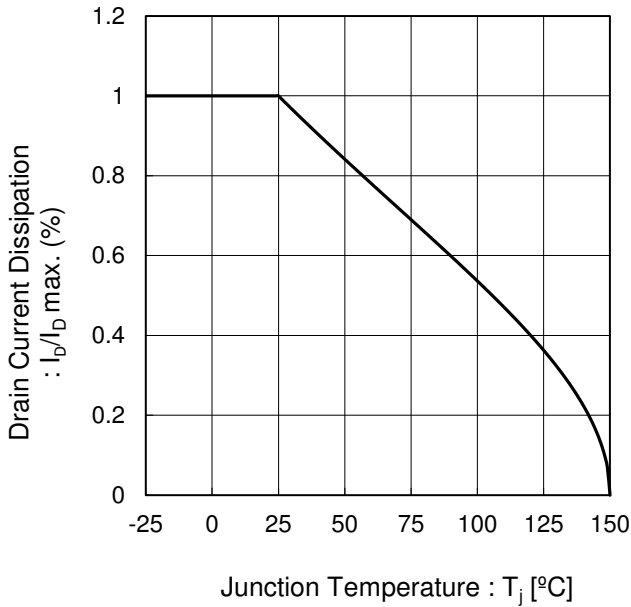


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

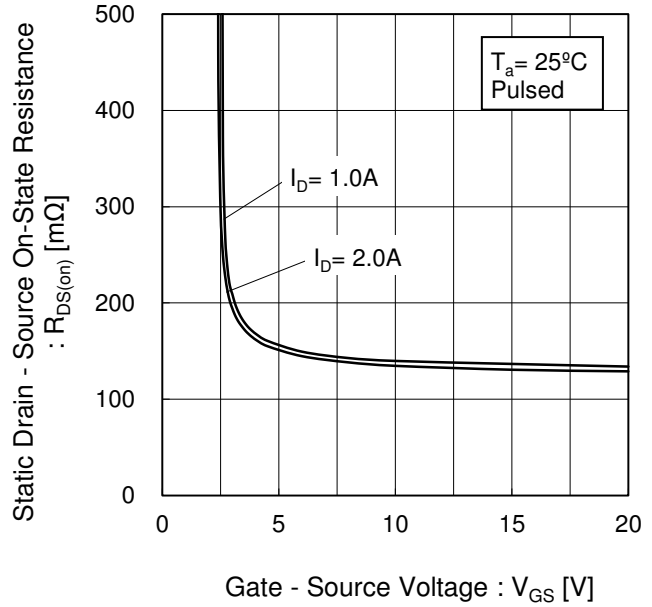


Fig.13 Static Drain - Source On - State Resistance vs. Drain Current ( $I$ )

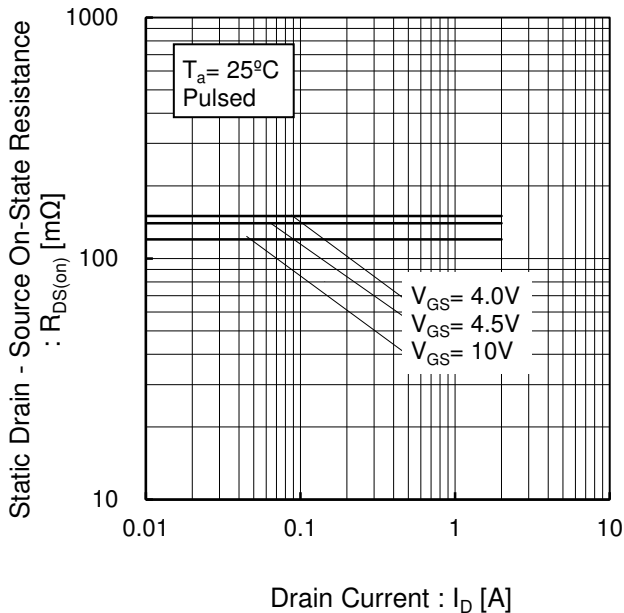
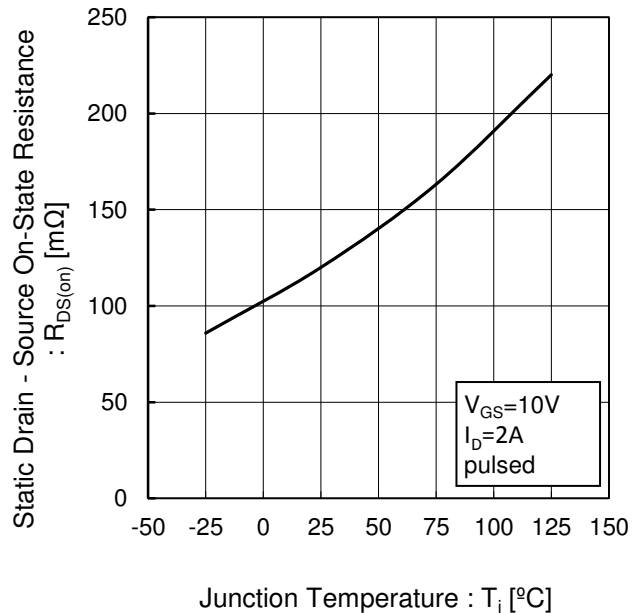


Fig.14 Static Drain - Source On - State Resistance vs. Junction Temperature



●Electrical characteristic curves

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

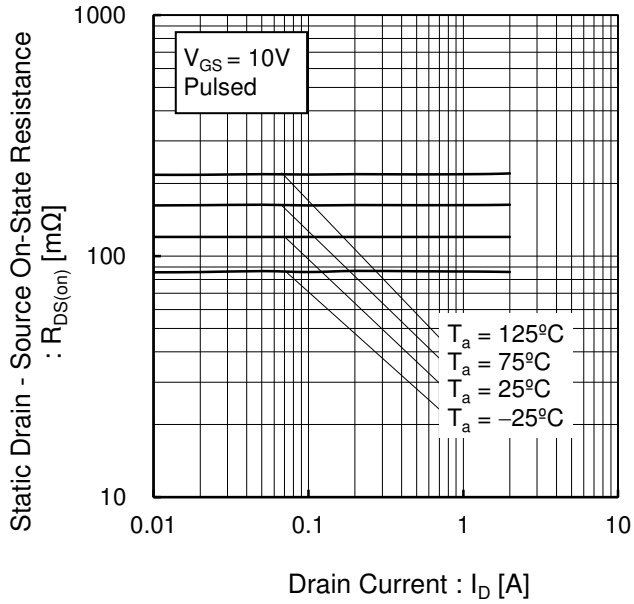


Fig.16 Static Drain - Source On - State Resistance vs. Drain Current(III)

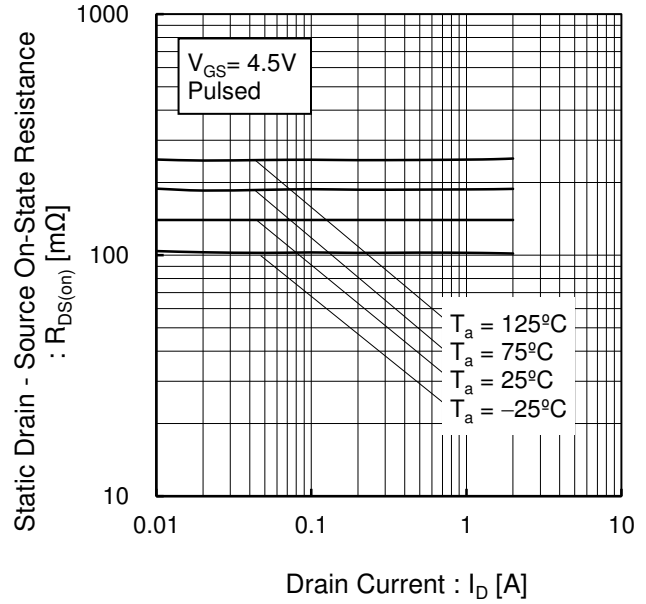
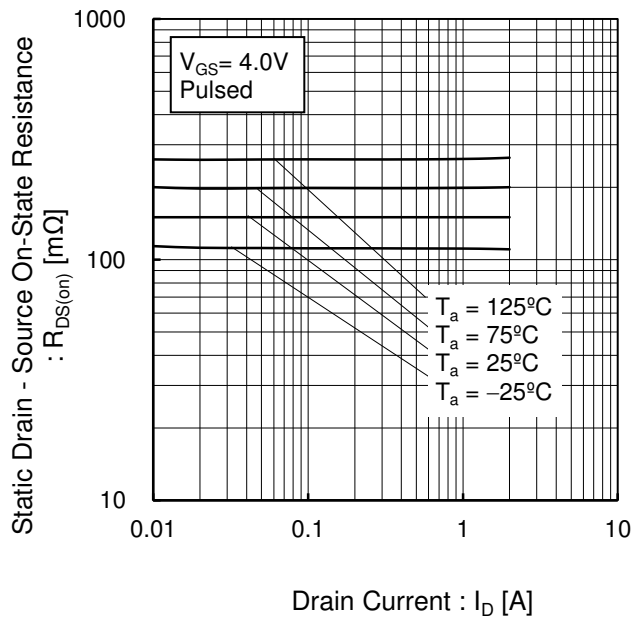


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current(IV)



●Electrical characteristic curves

Fig.18 Typical Capacitance vs. Drain - Source Voltage

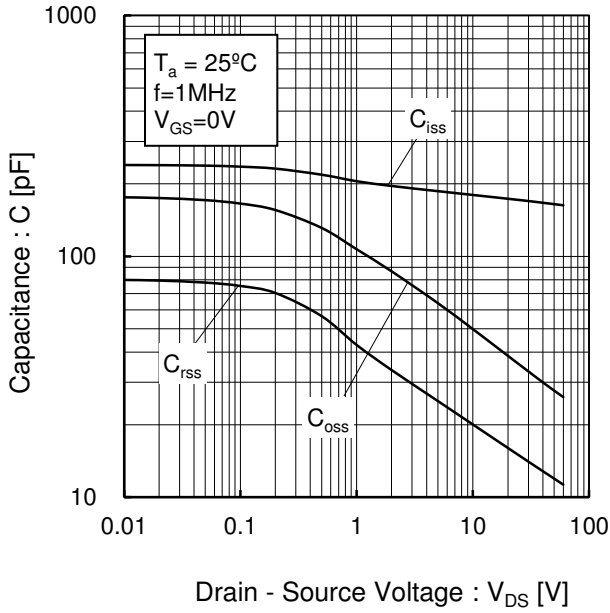


Fig.19 Switching Characteristics

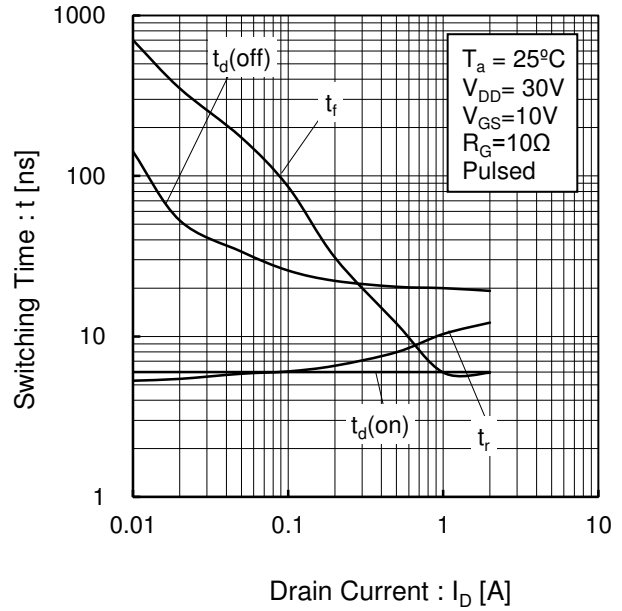


Fig.20 Dynamic Input Characteristics

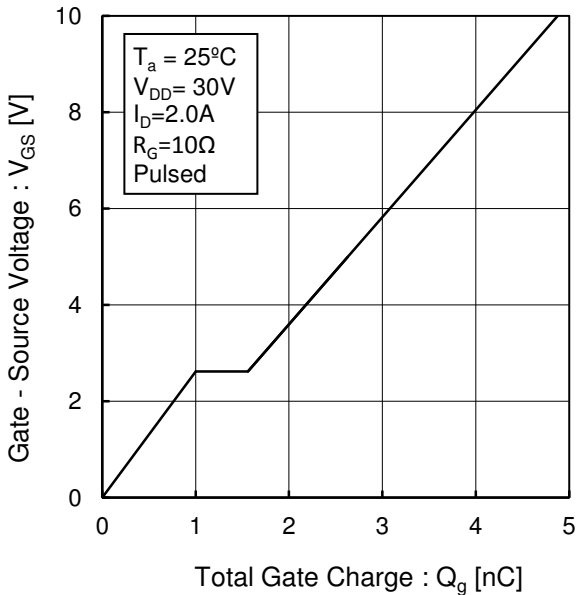
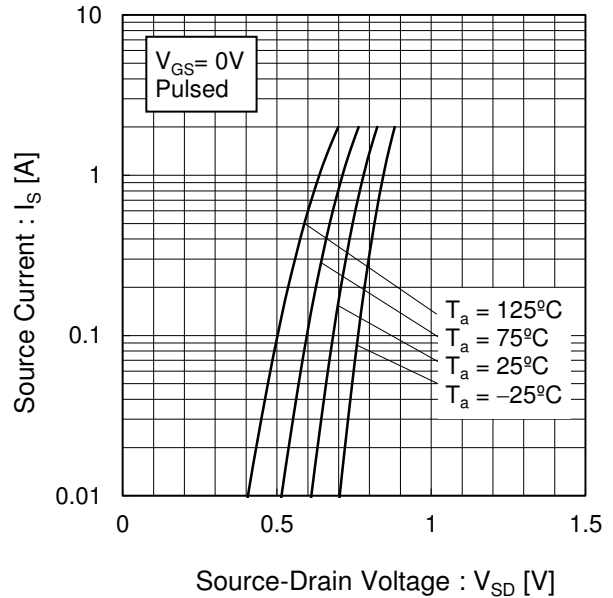


Fig.21 Source Current vs. Source Drain Voltage



● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

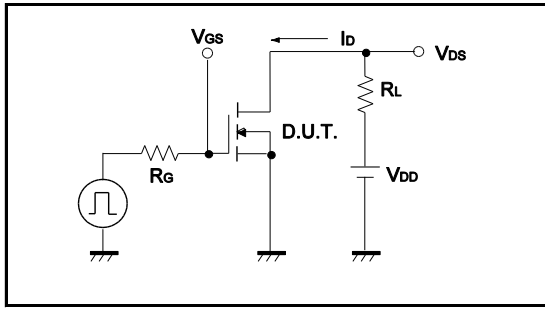


Fig.1-2 Switching Waveforms

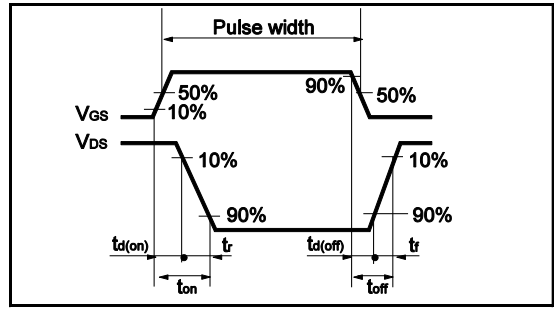


Fig.2-1 Gate Charge Measurement Circuit

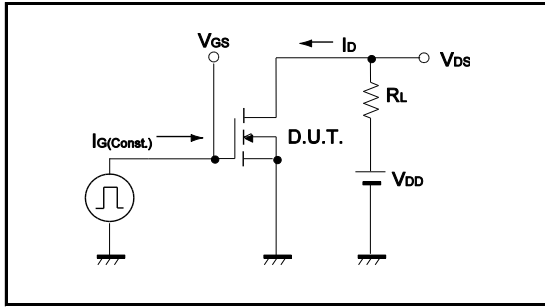
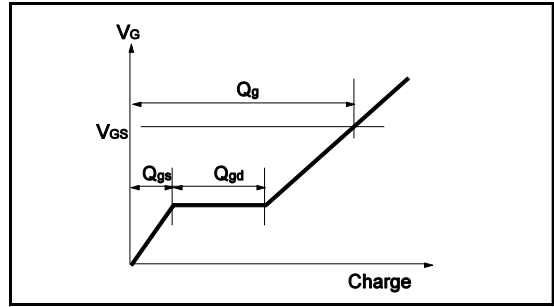
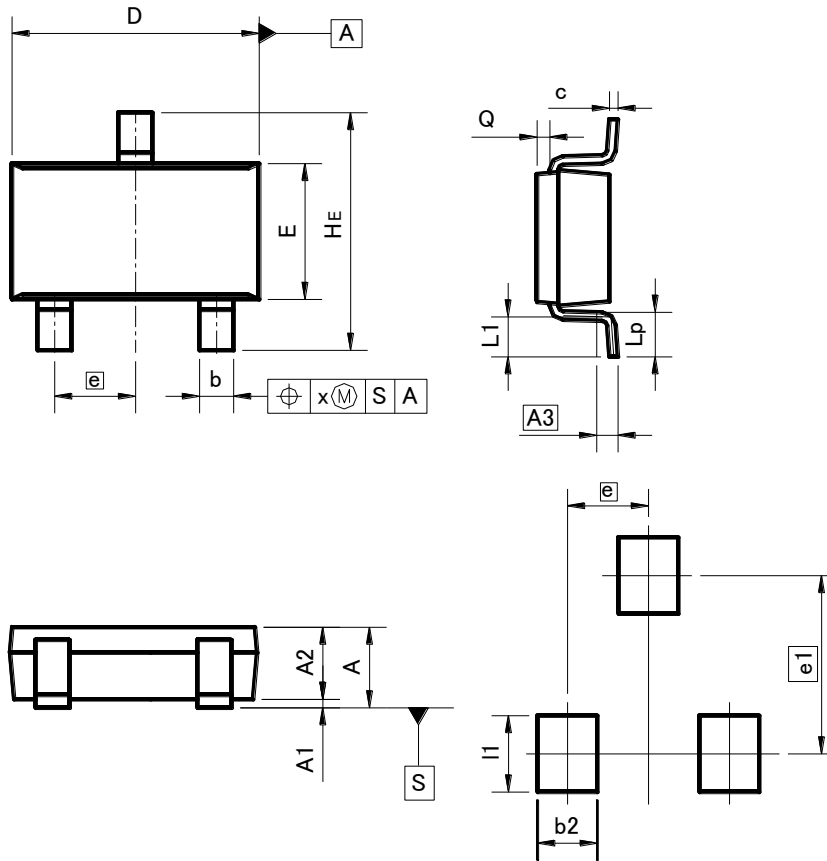


Fig.2-2 Gate Charge Waveform



●Dimensions (Unit : mm)

TSMT3



**Pattern of terminal position areas**

| DIM | MILIMETERS |      | INCHES |       |
|-----|------------|------|--------|-------|
|     | MIN        | MAX  | MIN    | MAX   |
| A   | -          | 1.00 | -      | 0.039 |
| A1  | 0.00       | 0.10 | 0      | 0.004 |
| A2  | 0.75       | 0.95 | 0.03   | 0.037 |
| A3  | 0.25       |      | 0.01   |       |
| b   | 0.35       | 0.50 | 0.014  | 0.02  |
| c   | 0.10       | 0.26 | 0.004  | 0.01  |
| D   | 2.80       | 3.00 | 0.11   | 0.118 |
| E   | 1.50       | 1.80 | 0.059  | 0.071 |
| e   | 0.95       |      | 0.04   |       |
| 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  | 0.01  |
| x   | -          | 0.20 | -      | 0.008 |

| DIM | MILIMETERS |      | INCHES |       |
|-----|------------|------|--------|-------|
|     | MIN        | MAX  | MIN    | MAX   |
| e1  | 2.10       |      | 0.08   |       |
| b2  | -          | 0.70 | -      | 0.028 |
| l1  | -          | 0.90 | -      | 0.035 |

Dimension in mm/inches

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