

|                    |              |
|--------------------|--------------|
| $V_{DSS}$          | -12V         |
| $R_{DS(on)}(Max.)$ | 29m $\Omega$ |
| $I_D$              | $\pm 4.5A$   |
| $P_D$              | 1.5W         |

### ●Features

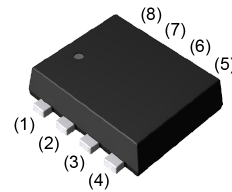
- 1) Low on - resistance.
- 2) -1.5V Drive.
- 3) Built-in G-S Protection Diode.
- 4) Small Surface Mount Package (TSMT8).
- 5) Pb-free lead plating ; RoHS compliant

### ●Application

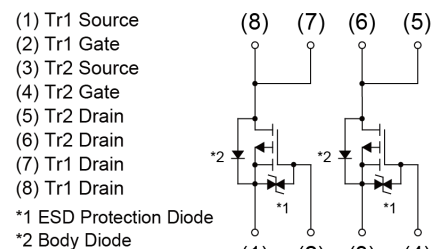
Switching

### ●Outline

TSMT8



### ●Inner circuit



### ●Packaging specifications

| Type | Packing                   | Embossed Tape |
|------|---------------------------|---------------|
|      | Reel size (mm)            | 180           |
|      | Tape width (mm)           | 8             |
|      | Basic ordering unit (pcs) | 3000          |
|      | Taping code               | TR            |
|      | Marking                   | J12           |

### ●Absolute maximum ratings ( $T_a = 25^\circ C$ ) <It is the same ratings for the Tr1 and Tr2>

| Parameter                    |         | Symbol             | Value       | Unit       |
|------------------------------|---------|--------------------|-------------|------------|
| Drain - Source voltage       |         | $V_{DSS}$          | -12         | V          |
| Continuous drain current     |         | $I_D$              | $\pm 4.5$   | A          |
| Pulsed drain current         |         | $I_{D,pulse}^{*1}$ | $\pm 18$    | A          |
| Gate - Source voltage        |         | $V_{GSS}$          | 0 ~ -8      | V          |
| Power dissipation            | total   | $P_D^{*2}$         | 1.5         | W          |
|                              | element |                    | 1.25        |            |
|                              | total   | $P_D^{*3}$         | 0.7         |            |
| Junction temperature         |         | $T_j$              | 150         | $^\circ C$ |
| Range of storage temperature |         | $T_{stg}$          | -55 to +150 | $^\circ C$ |

# ●Thermal resistance

| Parameter                              |         | Symbol          | Values |      |      | Unit |
|----------------------------------------|---------|-----------------|--------|------|------|------|
|                                        |         |                 | Min.   | Typ. | Max. |      |
| Thermal resistance, junction - ambient | total   | $R_{thJA}^{*2}$ | -      | -    | 83.3 | °C/W |
|                                        | element |                 | -      | -    | 100  |      |
|                                        | total   | $R_{thJA}^{*3}$ | -      | -    | 178  |      |

# ●Electrical characteristics ( $T_a = 25^{\circ}\text{C}$ ) <It is the same characteristics for the Tr1 and Tr2>

| Parameter                                      | Symbol                                  | Conditions                                                | Values |      |      | Unit  |
|------------------------------------------------|-----------------------------------------|-----------------------------------------------------------|--------|------|------|-------|
|                                                |                                         |                                                           | Min.   | Typ. | Max. |       |
| Drain - Source breakdown voltage               | $V_{(BR)DSS}$                           | $V_{GS} = 0\text{V}, I_D = -1\text{mA}$                   | -12    | -    | -    | V     |
| Breakdown voltage temperature coefficient      | $\frac{\Delta V_{(BR)DSS}}{\Delta T_j}$ | $I_D = -1\text{mA}$<br>referenced to $25^{\circ}\text{C}$ | -      | -5.0 | -    | mV/°C |
| Zero gate voltage drain current                | $I_{DSS}$                               | $V_{DS} = -12\text{V}, V_{GS} = 0\text{V}$                | -      | -    | -10  | μA    |
| Gate - Source leakage current                  | $I_{GSS}$                               | $V_{DS} = 0\text{V}, V_{GS} = -8\text{V}$                 | -      | -    | -10  | μA    |
| Gate threshold voltage                         | $V_{GS(th)}$                            | $V_{DS} = -6\text{V}, I_D = -1\text{mA}$                  | -0.3   | -    | -1.0 | V     |
| Gate threshold voltage temperature coefficient | $\frac{\Delta V_{GS(th)}}{\Delta T_j}$  | $I_D = -1\text{mA}$<br>referenced to $25^{\circ}\text{C}$ | -      | 2.7  | -    | mV/°C |
| Static drain - source on - state resistance    | $R_{DS(on)}^{*4}$                       | $V_{GS} = -4.5\text{V}, I_D = -4.5\text{A}$               | -      | 21   | 29   | mΩ    |
|                                                |                                         | $V_{GS} = -2.5\text{V}, I_D = -2.2\text{A}$               | -      | 27   | 38   |       |
|                                                |                                         | $V_{GS} = -1.8\text{V}, I_D = -2.2\text{A}$               | -      | 37   | 55   |       |
|                                                |                                         | $V_{GS} = -1.5\text{V}, I_D = -0.9\text{A}$               | -      | 49   | 98   |       |
| Gate input resistance                          | $R_G$                                   | $f = 1\text{MHz}, \text{open drain}$                      | -      | 20   | -    | Ω     |
| Forward Transfer Admittance                    | $ Y_{fs} ^{*4}$                         | $V_{DS} = -6\text{V}, I_D = -4.5\text{A}$                 | 5.5    | -    | -    | S     |

**●Electrical characteristics** ( $T_a = 25^\circ\text{C}$ ) <It is the same characteristics for the Tr1 and Tr2>

| Parameter                    | Symbol            | Conditions                           | Values |      |      | Unit |
|------------------------------|-------------------|--------------------------------------|--------|------|------|------|
|                              |                   |                                      | Min.   | Typ. | Max. |      |
| Input capacitance            | $C_{iss}$         | $V_{GS} = 0V$                        | -      | 4200 | -    | pF   |
| Output capacitance           | $C_{oss}$         | $V_{DS} = -6V$                       | -      | 350  | -    |      |
| Reverse transfer capacitance | $C_{rss}$         | $f = 1\text{MHz}$                    | -      | 330  | -    |      |
| Turn - on delay time         | $t_{d(on)}^{*4}$  | $V_{DD} \approx -6V, V_{GS} = -4.5V$ | -      | 16   | -    | ns   |
| Rise time                    | $t_r^{*4}$        | $I_D = -2.2A$                        | -      | 60   | -    |      |
| Turn - off delay time        | $t_{d(off)}^{*4}$ | $R_L = 2.7\Omega$                    | -      | 400  | -    |      |
| Fall time                    | $t_f^{*4}$        | $R_G = 10\Omega$                     | -      | 150  | -    |      |

**●Gate charge characteristics** ( $T_a = 25^\circ\text{C}$ ) <It is the same characteristics for the Tr1 and Tr2>

| Parameter            | Symbol        | Conditions           | Values |      |      | Unit |
|----------------------|---------------|----------------------|--------|------|------|------|
|                      |               |                      | Min.   | Typ. | Max. |      |
| Total gate charge    | $Q_g^{*4}$    | $V_{DD} \approx -6V$ | -      | 40   | -    | nC   |
| Gate - Source charge | $Q_{gs}^{*4}$ | $I_D = -4.5A$        | -      | 6.5  | -    |      |
| Gate - Drain charge  | $Q_{gd}^{*4}$ | $V_{GS} = -4.5V$     | -      | 6.0  | -    |      |

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

&lt;It is the same characteristics for the Tr1 and Tr2&gt;

| Parameter                             | Symbol        | Conditions                 | Values |      |      | Unit |
|---------------------------------------|---------------|----------------------------|--------|------|------|------|
|                                       |               |                            | Min.   | Typ. | Max. |      |
| Body diode continuous forward current | $I_S$         | $T_a = 25^\circ\text{C}$   | -      | -    | -1   | A    |
| Body diode pulse current              | $I_{SP}^{*1}$ |                            | -      | -    | -18  |      |
| Forward voltage                       | $V_{SD}^{*4}$ | $V_{GS} = 0V, I_S = -4.5A$ | -      | -    | -1.2 | V    |

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

\*2 Mounted on a ceramic board (30×30×0.8mm)

\*3 Mounted on a FR4 (20×20×0.8mm)

\*4 Pulsed

●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

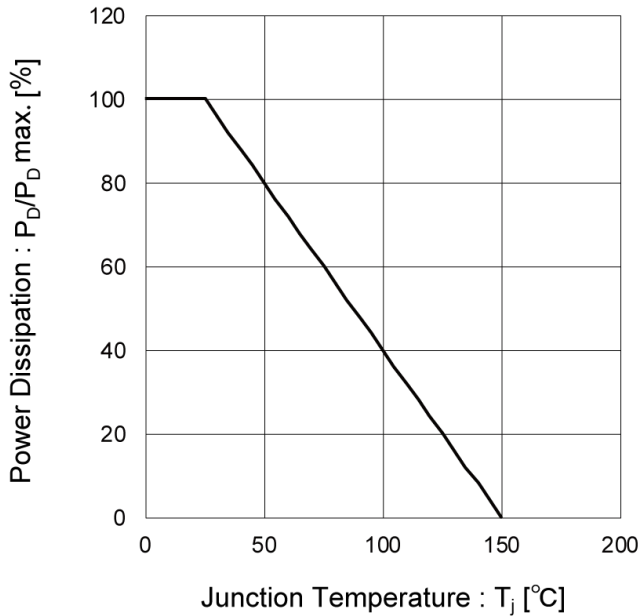


Fig.2 Maximum Safe Operating Area

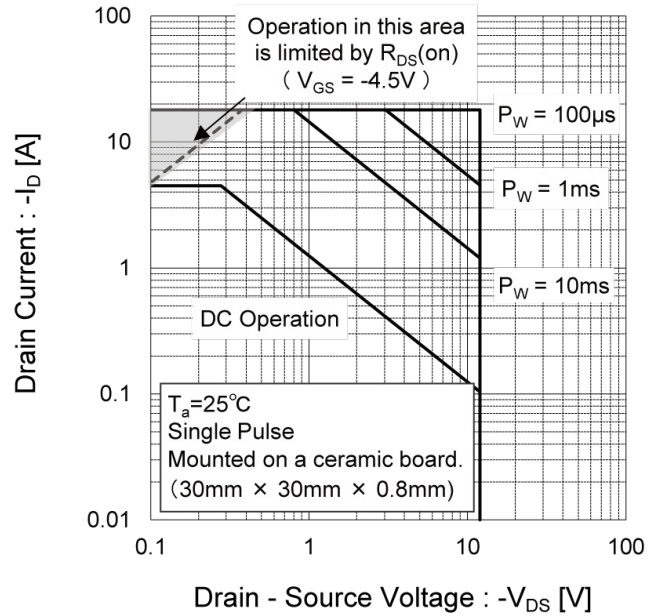


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

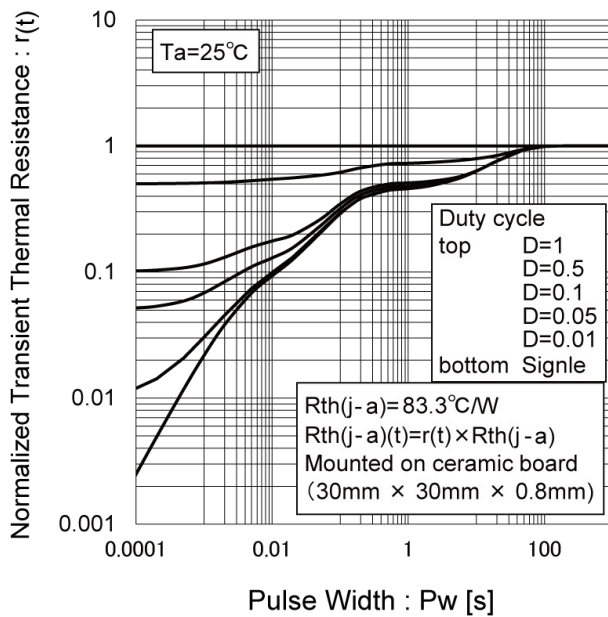
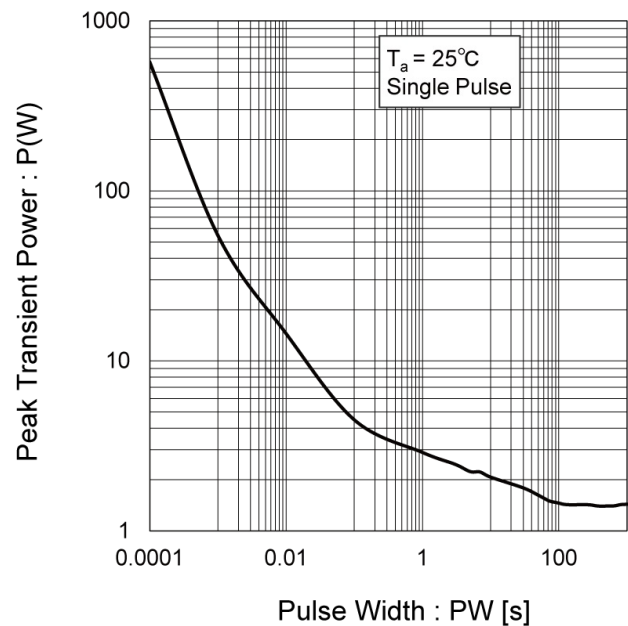


Fig.4 Single Pulse Maximum Power dissipation



# ●Electrical characteristic curves

Fig.5 Typical Output Characteristics(I)

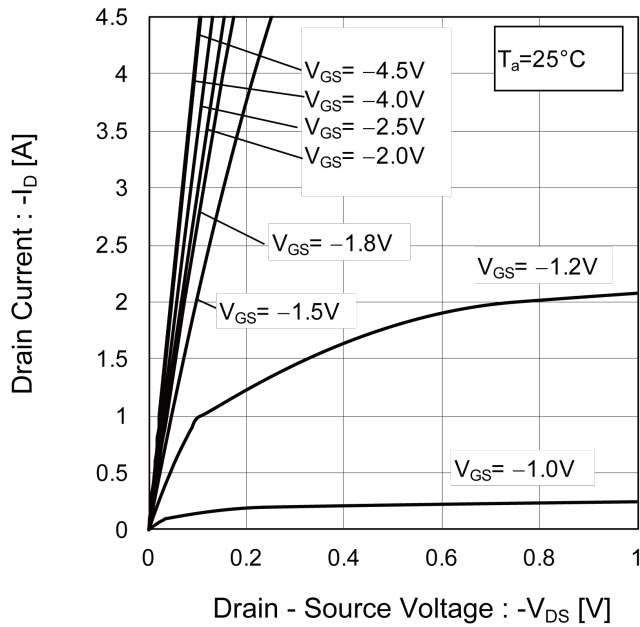


Fig.6 Typical Output Characteristics(II)

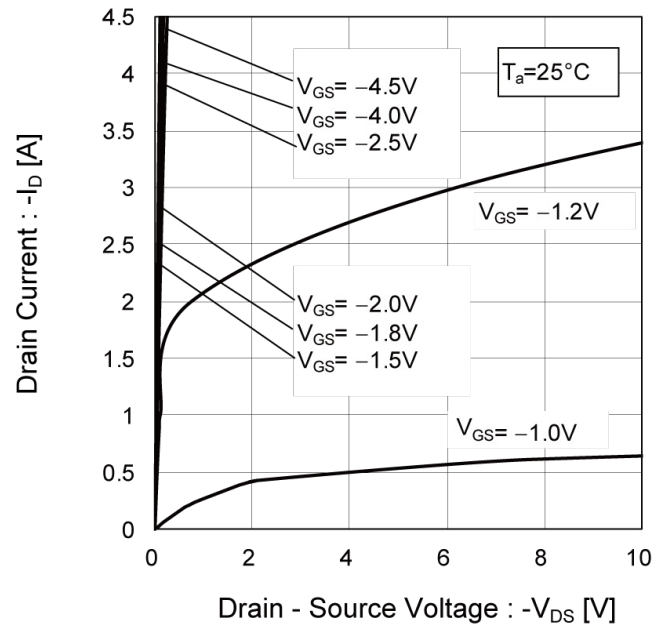


Fig.7 Breakdown Voltage vs. Junction Temperature

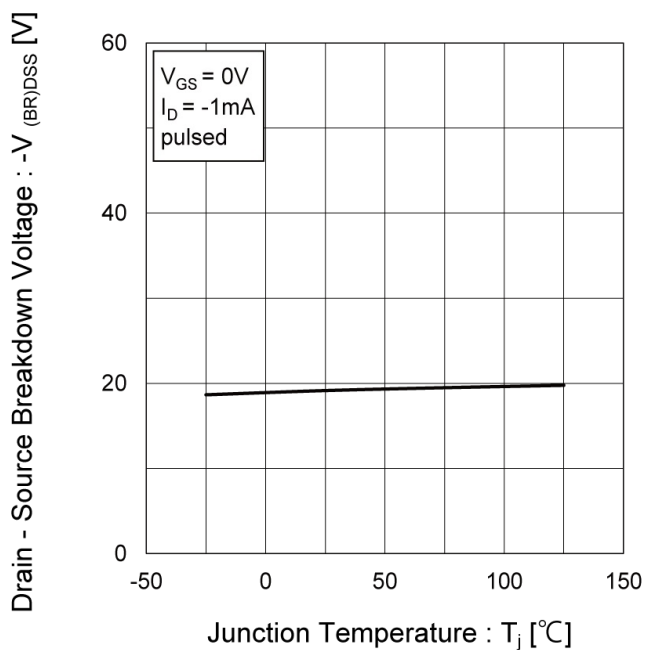
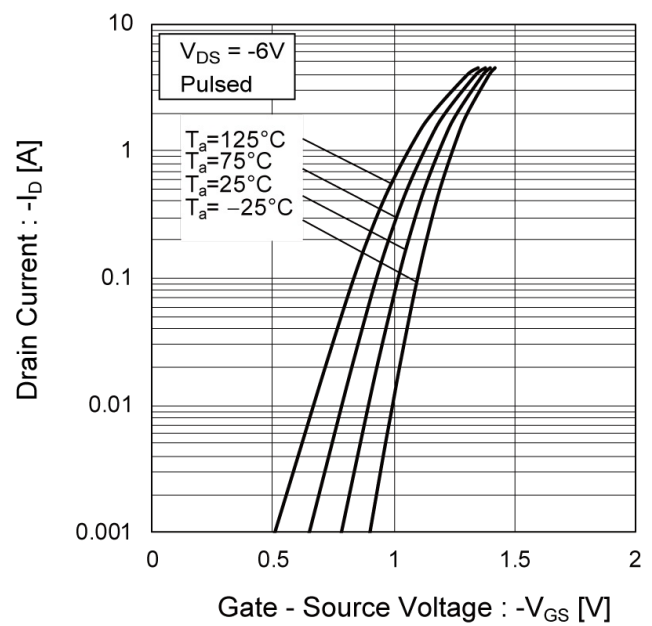


Fig.8 Typical Transfer Characteristics



# ●Electrical characteristic curves

Fig.9 Gate Threshold Voltage vs. Junction Temperature

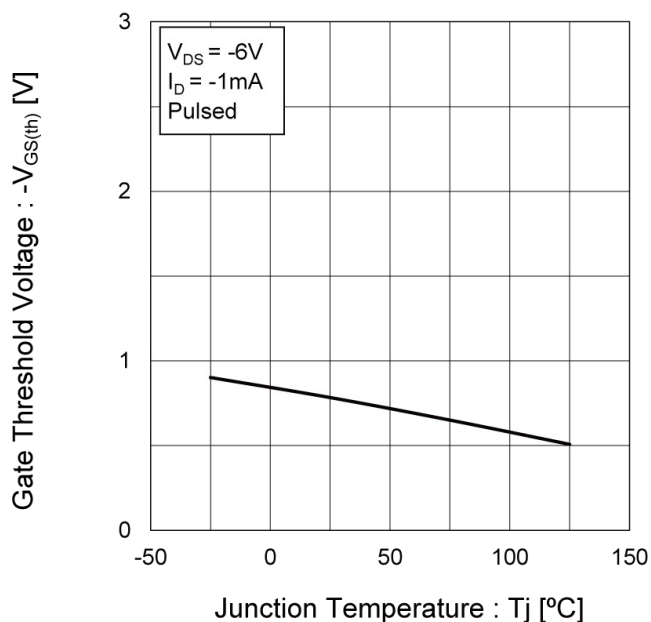


Fig.10 Forward Transfer Admittance vs. Drain Current

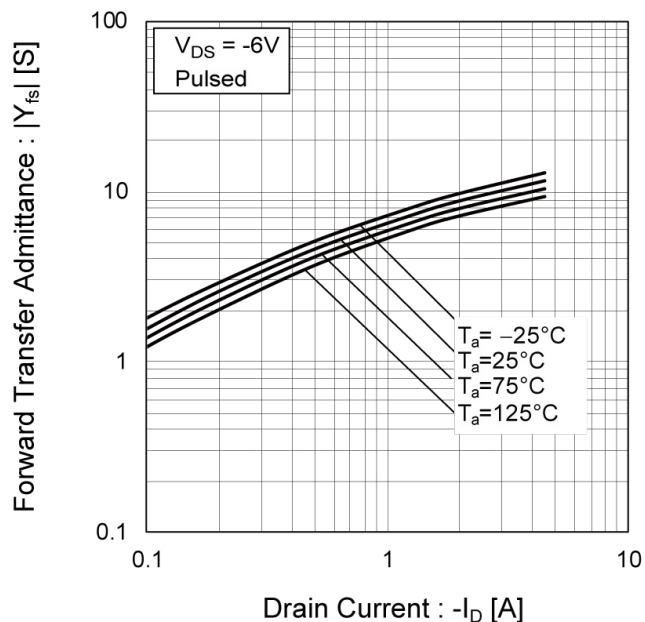


Fig.11 Drain Current Derating Curve

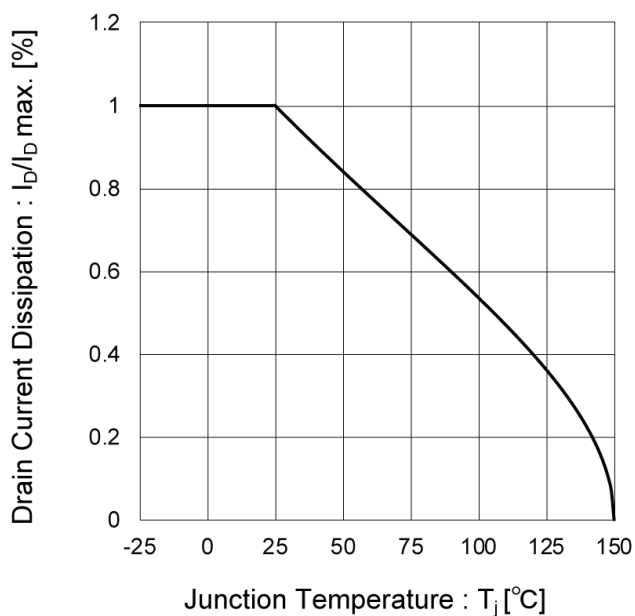
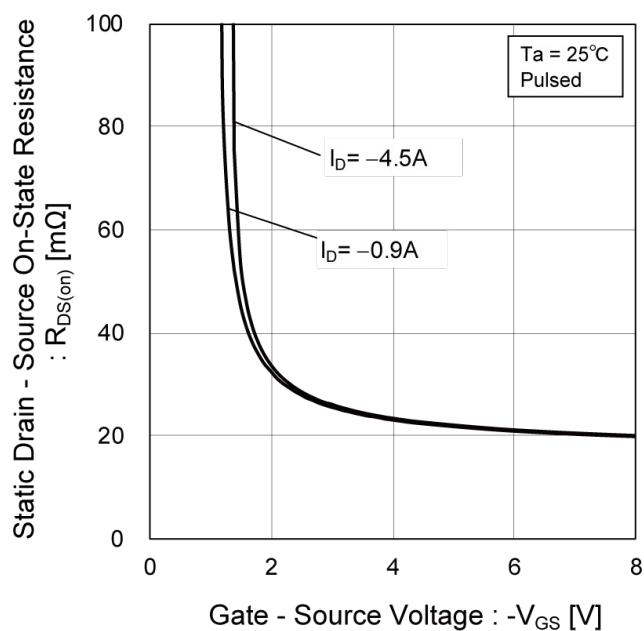


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage



●Electrical characteristic curves

Fig.13 Static Drain - Source On - State Resistance vs. Junction Temperature

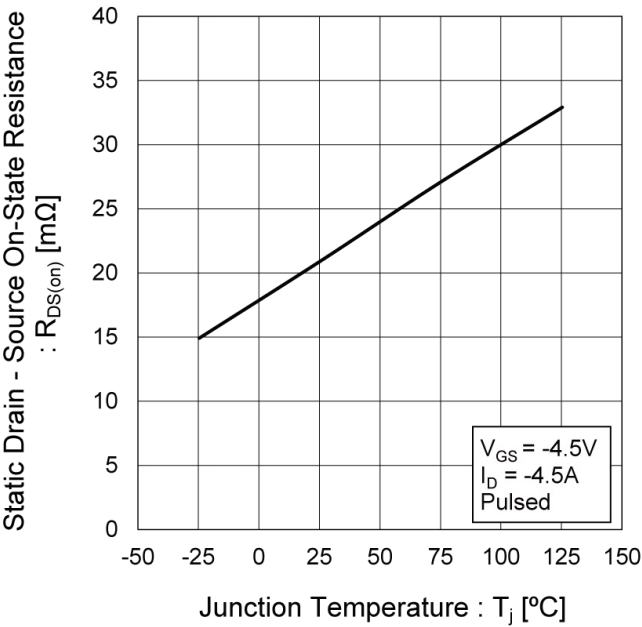
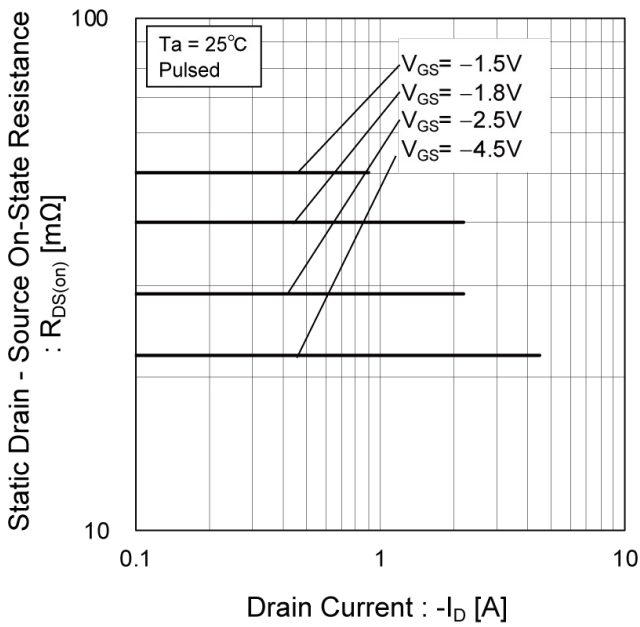


Fig.14 Static Drain - Source On - State Resistance vs. Drain Current (I)



●Electrical characteristic curves

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

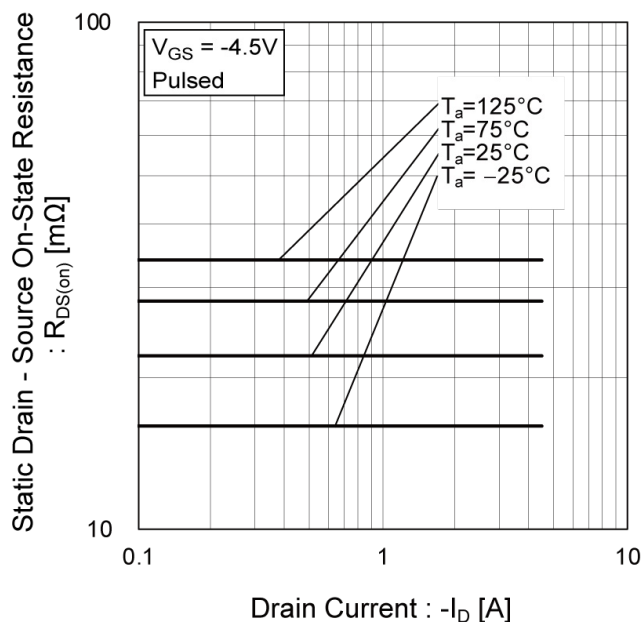


Fig.16 Static Drain - Source On - State Resistance vs. Drain Current (III)

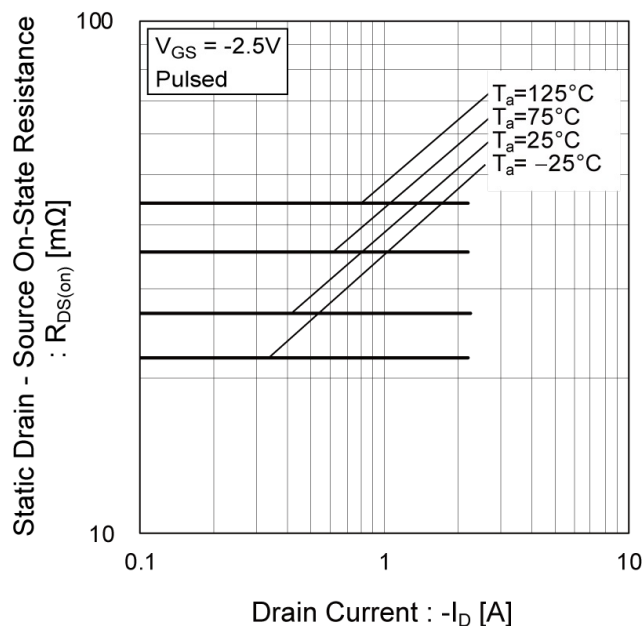


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current (IV)

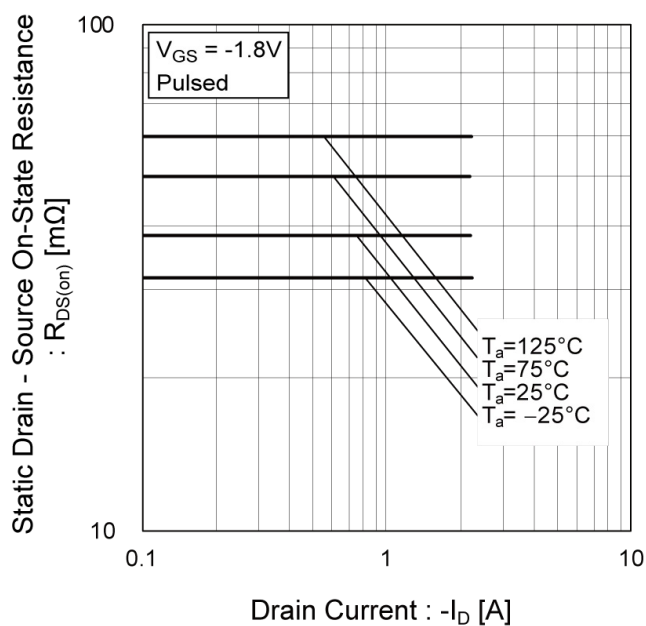
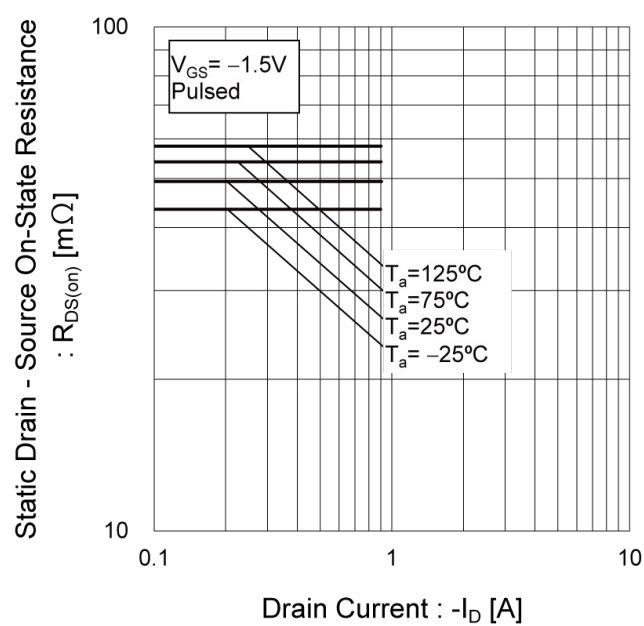


Fig.18 Static Drain - Source On - State Resistance vs. Drain Current (V)





# ●Electrical characteristic curves

Fig.19 Typical Capacitance vs.  
Drain - Source Voltage

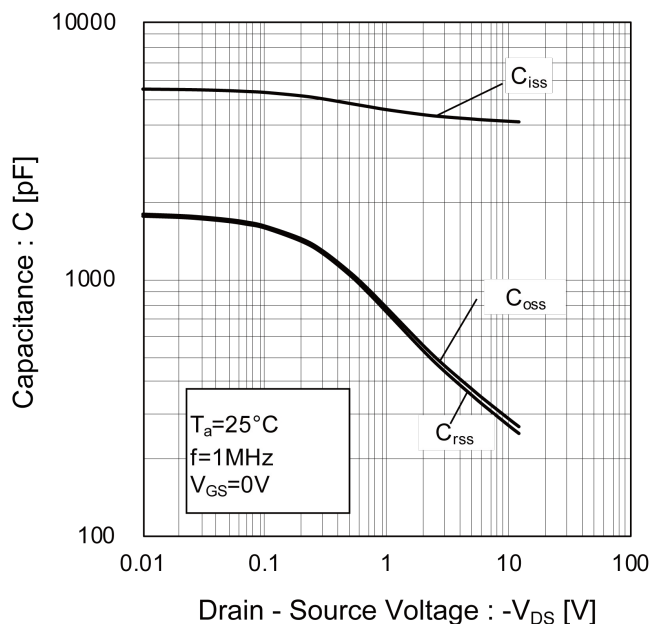


Fig.20 Switching Characteristics

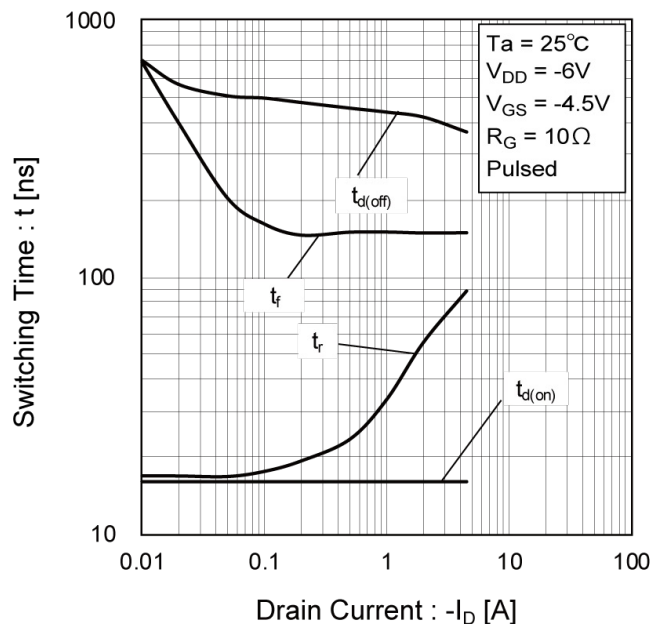


Fig.21 Dynamic Input Characteristics

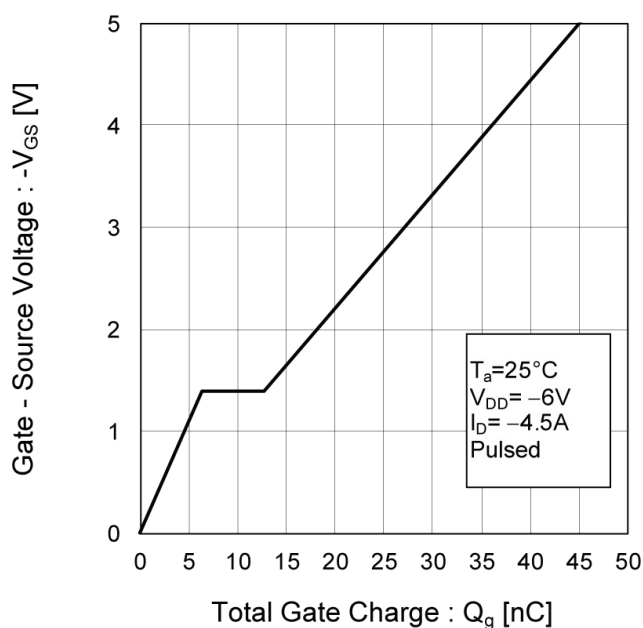
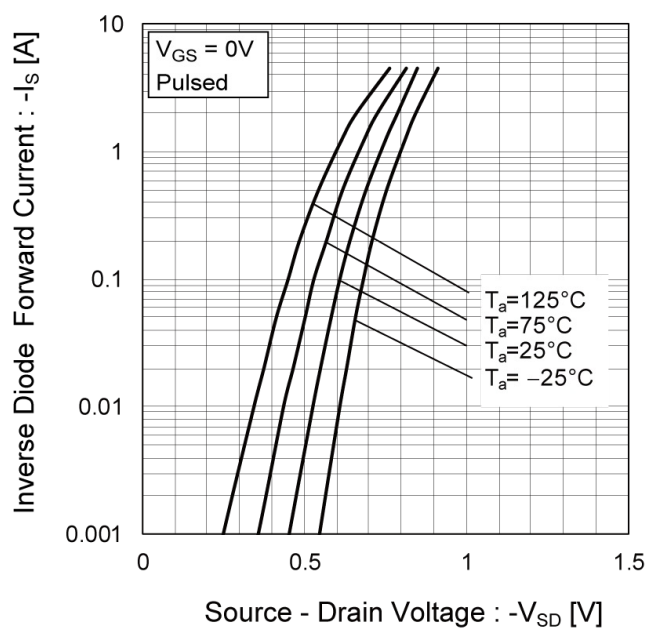


Fig.22 Source Current vs.  
Source Drain Voltage



● **Measurement circuits** <It is the same for the Tr1 and Tr2>

Fig. 1-1 SWITCHING TIME MEASUREMENT CIRCUIT

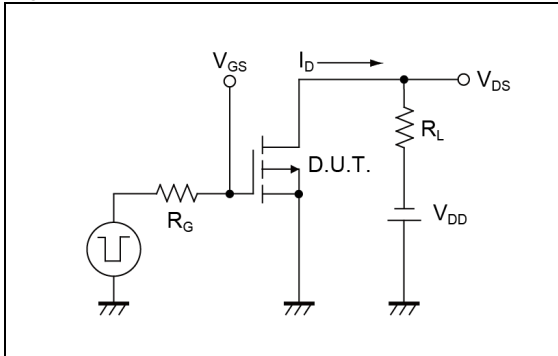


Fig. 1-2 SWITCHING WAVEFORMS

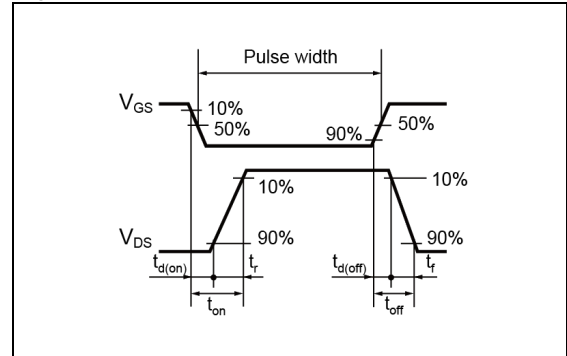


Fig. 2-1 GATE CHARGE MEASUREMENT CIRCUIT

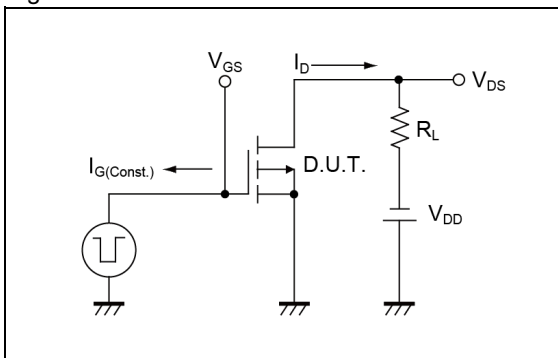
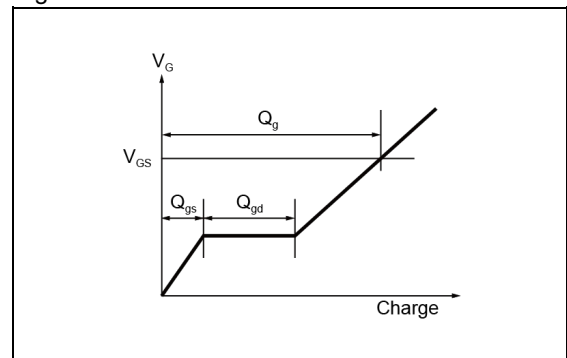


Fig. 2-2 GATE CHARGE WAVEFORM

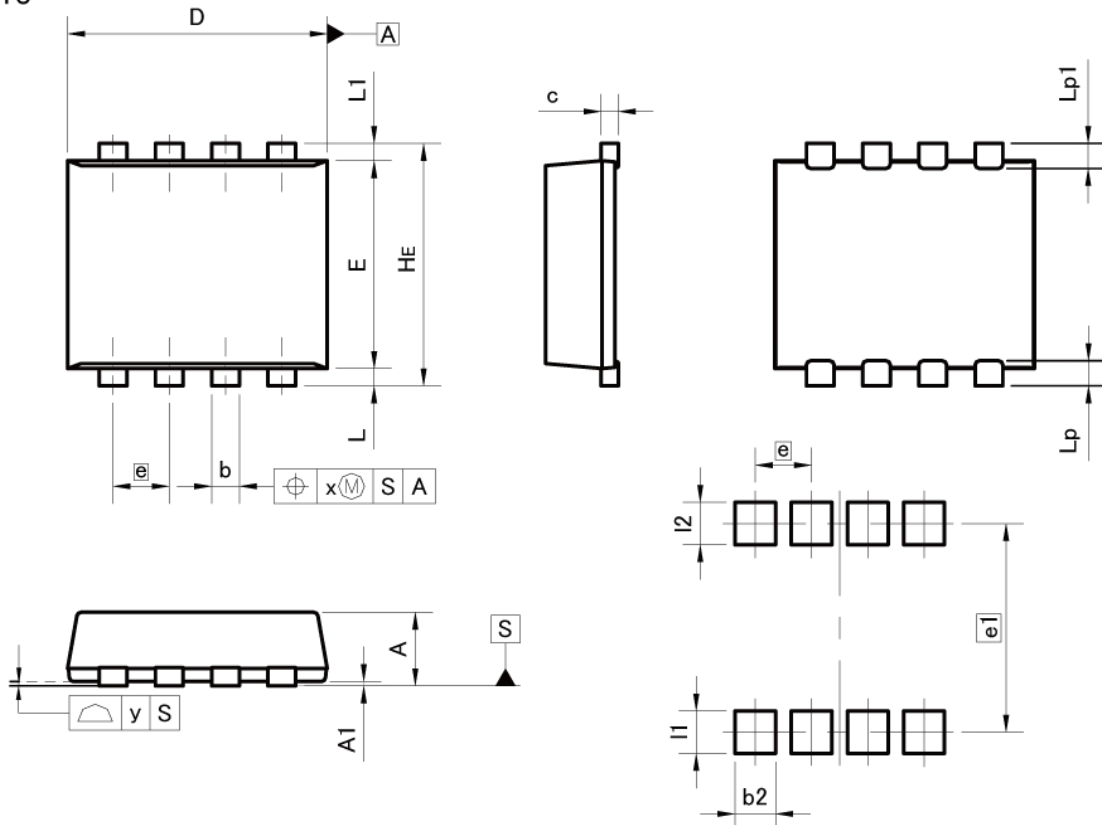


● **Notice**

This product might cause chip aging and breakdown under the large electrified environment.  
Please consider to design ESD protection circuit.

## ●Dimensions

TSMT8



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

| DIM | MILIMETERS |      | INCHES |       |
|-----|------------|------|--------|-------|
|     | MIN        | MAX  | MIN    | MAX   |
| A   | 0.75       | 0.85 | 0.030  | 0.033 |
| A1  | 0.00       | 0.05 | 0.000  | 0.002 |
| b   | 0.27       | 0.37 | 0.011  | 0.015 |
| c   | 0.12       | 0.22 | 0.005  | 0.009 |
| D   | 2.90       | 3.10 | 0.114  | 0.122 |
| E   | 2.30       | 2.50 | 0.091  | 0.098 |
| e   | 0.65       |      | 0.026  |       |
| HE  | 2.70       | 2.90 | 0.106  | 0.114 |
| L   | 0.10       | 0.30 | 0.004  | 0.012 |
| L1  | 0.10       | 0.30 | 0.004  | 0.012 |
| Lp  | 0.19       | 0.39 | 0.007  | 0.015 |
| Lp1 | 0.19       | 0.39 | 0.007  | 0.015 |
| x   | -          | 0.10 | -      | 0.004 |
| y   | -          | 0.10 | -      | 0.004 |

| DIM | MILIMETERS |      | INCHES |       |
|-----|------------|------|--------|-------|
|     | MIN        | MAX  | MIN    | MAX   |
| b2  | -          | 0.47 | -      | 0.019 |
| e1  | 2.41       |      | 0.095  |       |
| l1  | -          | 0.49 | -      | 0.019 |
| l2  | -          | 0.49 | -      | 0.019 |

Dimension in mm/inches

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