

|                     |      |
|---------------------|------|
| $V_{DSS}$           | -12V |
| $R_{DS(on)}$ (Max.) | 36mΩ |
| $I_D$               | -4A  |
| $P_D$               | 1.5W |

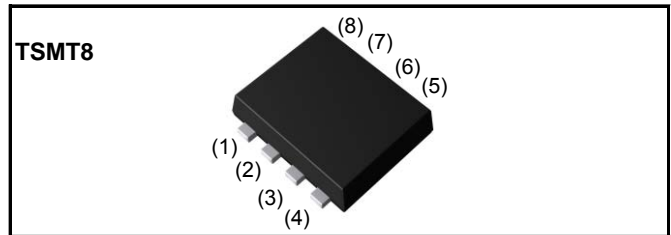
#### ●Features

- 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

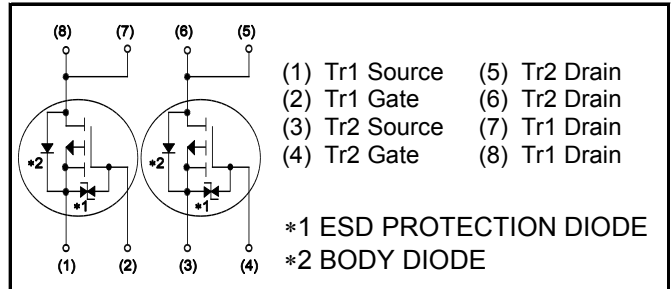
#### ●Application

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                   | J02    |

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

| Parameter                    | Symbol             | Value       | Unit        |
|------------------------------|--------------------|-------------|-------------|
| Drain - Source voltage       | $V_{DSS}$          | -12         | V           |
| Continuous drain current     | $I_D^{*1}$         | ±4          | A           |
| Pulsed drain current         | $I_{D,pulse}^{*2}$ | ±12         | A           |
| Gate - Source voltage        | $V_{GSS}$          | ±10         | V           |
| Power dissipation            | $P_D^{*3}$         | 1.5         | W / total   |
|                              |                    | 1.25        | W / element |
|                              | $P_D^{*4}$         | 0.55        | W / total   |
| 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 | $R_{thJA}^{*3}$ | -      | -    | 83.3 | °C/W |
|  | $R_{thJA}^{*4}$ | -      | -    | 227  | °C/W |

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

<It is the same characteristics for the Tr1 and Tr2>

| Parameter                                      | Symbol                                  | Conditions   | Values |      |      | Unit  |
|--|---|--|--------|------|------|-------|
|  |   |  | Min.   | Typ. | Max. |       |
| Drain - Source breakdown voltage               | $V_{(BR)DSS}$                           | $V_{GS} = 0V, I_D = -1mA$                            | -12    | -    | -    | V     |
| Breakdown voltage temperature coefficient      | $\frac{\Delta V_{(BR)DSS}}{\Delta T_j}$ | $I_D = -1mA$<br>referenced to $25^\circ\text{C}$     | -      | -17  | -    | mV/°C |
| Zero gate voltage drain current                | $I_{DSS}$                               | $V_{DS} = -12V, V_{GS} = 0V$                         | -      | -    | -1   | μA    |
| Gate - Source leakage current                  | $I_{GSS}$                               | $V_{GS} = \pm 10V, V_{DS} = 0V$                      | -      | -    | ±10  | μA    |
| Gate threshold voltage                         | $V_{GS(th)}$                            | $V_{DS} = -6V, I_D = -1mA$                           | -0.3   | -    | -1.0 | V     |
| Gate threshold voltage temperature coefficient | $\frac{\Delta V_{(GS)th}}{\Delta T_j}$  | $I_D = -1mA$<br>referenced to $25^\circ\text{C}$     | -      | 2.4  | -    | mV/°C |
| Static drain - source on - state resistance    | $R_{DS(on)}^{*5}$                       | $V_{GS} = -4.5V, I_D = -4A$                          | -      | 26   | 36   | mΩ    |
|  |   | $V_{GS} = -2.5V, I_D = -2A$                          | -      | 36   | 50   |       |
|  |   | $V_{GS} = -1.8V, I_D = -2A$                          | -      | 46   | 69   |       |
|  |   | $V_{GS} = -1.5V, I_D = -0.8A$                        | -      | 66   | 132  |       |
|  |   | $V_{GS} = -4.5V, I_D = -4A, T_j = 125^\circ\text{C}$ | -      | 42   | 59   |       |
| Gate input resistance                          | $R_G$                                   | $f = 1MHz, \text{open drain}$                        | -      | 15   | -    | Ω     |
| Transconductance                               | $g_{fs}^{*5}$                           | $V_{DS} = -6V, I_D = 4A$                             | 5.5    | 11   | -    | 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 (20×20×0.8mm)

\*5 Pulsed

●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            | $C_{iss}$         | $V_{GS} = 0V$                        | -      | 1940 | -    | pF   |
| Output capacitance           | $C_{oss}$         | $V_{DS} = -6V$                       | -      | 260  | -    |      |
| Reverse transfer capacitance | $C_{rss}$         | $f = 1\text{MHz}$                    | -      | 240  | -    |      |
| Turn - on delay time         | $t_{d(on)}^{*5}$  | $V_{DD} \approx -6V, V_{GS} = -4.5V$ | -      | 10   | -    | ns   |
| Rise time                    | $t_r^{*5}$        | $I_D = -2A$                          | -      | 60   | -    |      |
| Turn - off delay time        | $t_{d(off)}^{*5}$ | $R_L = 3\Omega$                      | -      | 300  | -    |      |
| Fall time                    | $t_f^{*5}$        | $R_G = 10\Omega$                     | -      | 180  | -    |      |

●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    | $Q_g^{*5}$    | $V_{DD} \approx -6V, I_D = -4A$<br>$V_{GS} = -4.5V$ | -      | 20   | -    | nC   |
| Gate - Source charge | $Q_{gs}^{*5}$ |   | -      | 3.5  | -    |      |
| Gate - Drain charge  | $Q_{gd}^{*5}$ |   | -      | 3.0  | -    |      |

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

<It is the same characteristics for the Tr1 and Tr2>

| 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                           | $V_{SD}^{*5}$ | $V_{GS} = 0V, I_s = -4A$ | -      | -    | -1.2 | V    |

●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

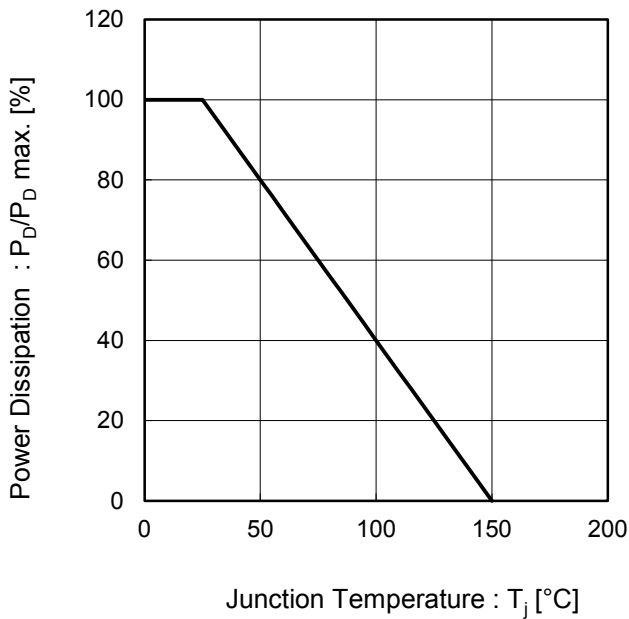


Fig.2 Maximum Safe Operating Area

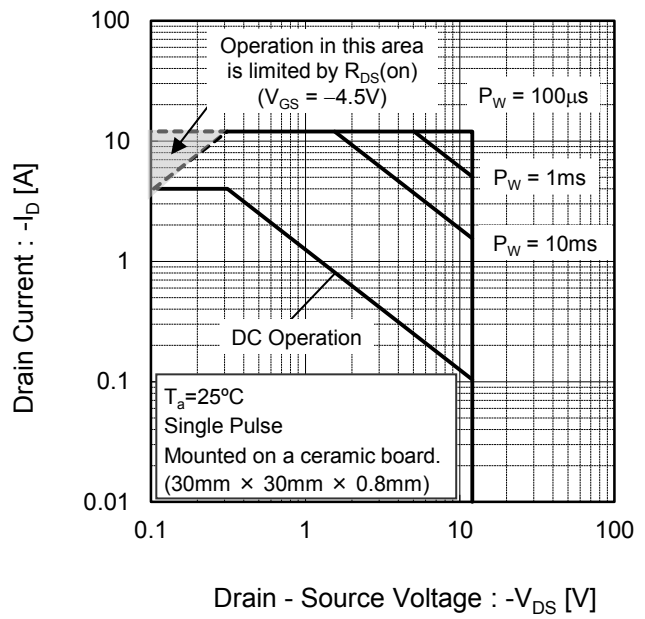


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

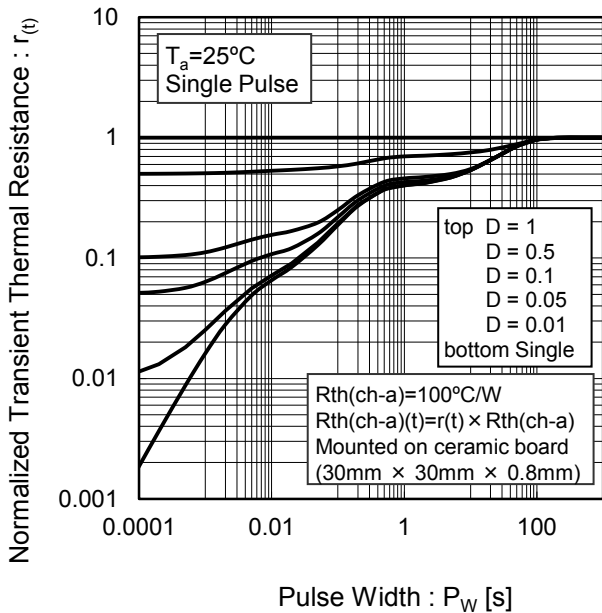
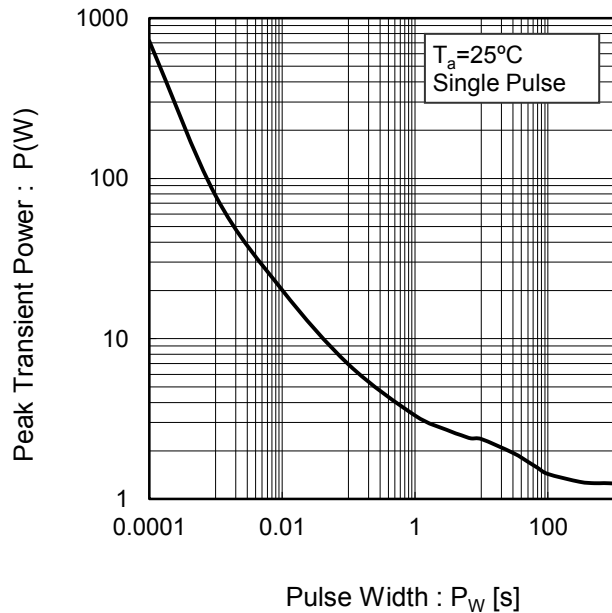


Fig.4 Single Pulse Maximum Power dissipation



●Electrical characteristic curves

Fig.5 Typical Output Characteristics(I)

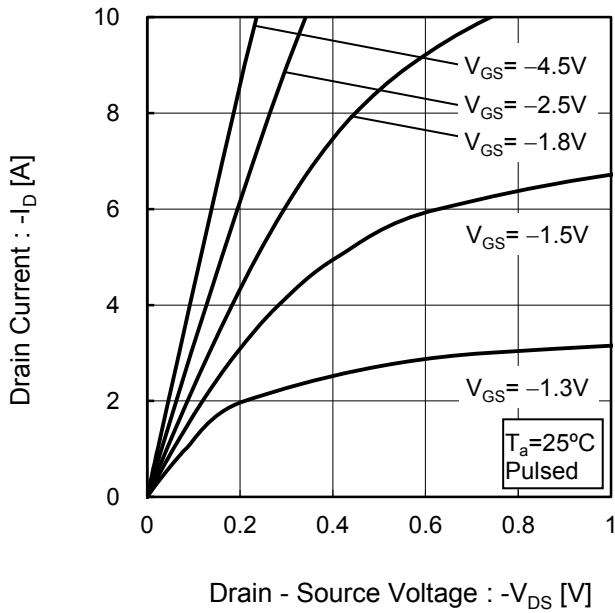


Fig.6 Typical Output Characteristics(II)

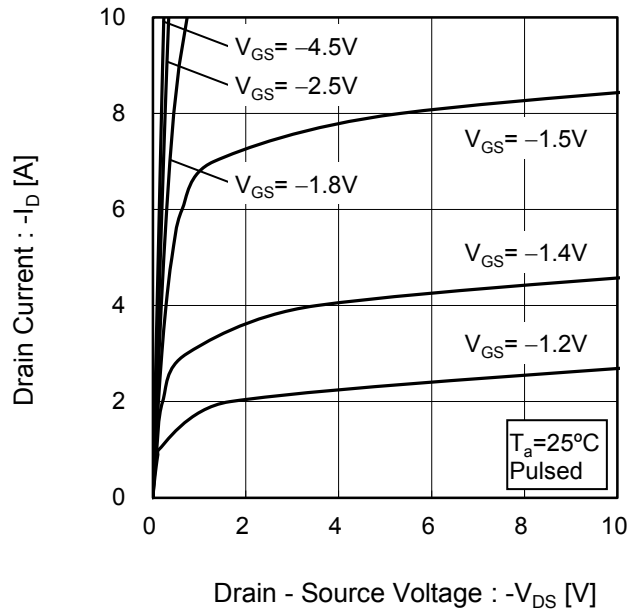


Fig.7 Breakdown Voltage vs. Junction Temperature

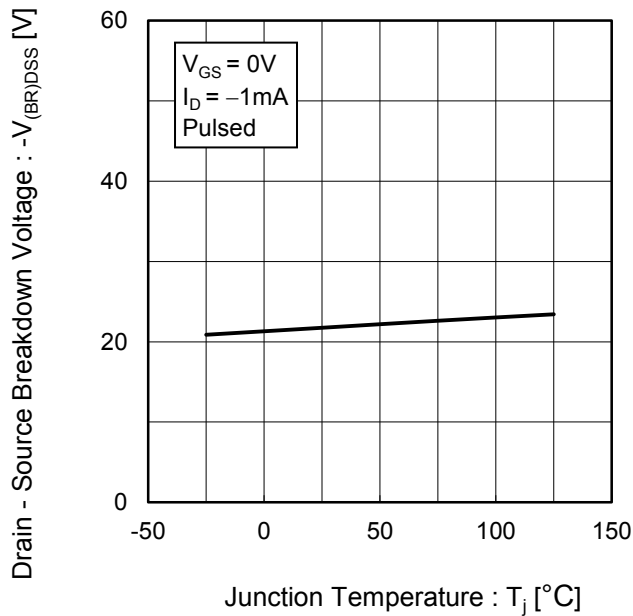
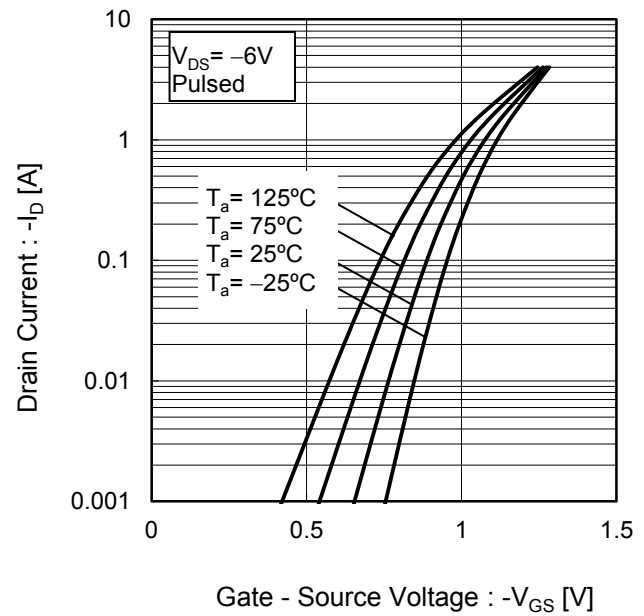


Fig.8 Typical Transfer Characteristics



●Electrical characteristic curves

Fig.9 Gate Threshold Voltage vs. Junction Temperature

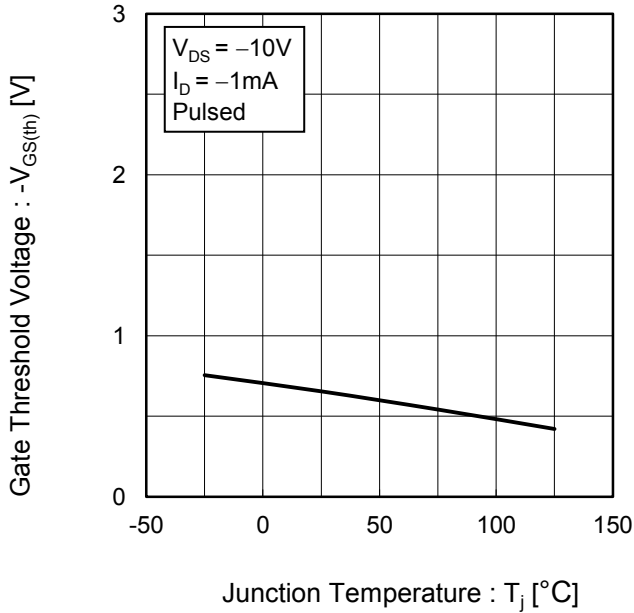


Fig.10 Transconductance vs. Drain Current

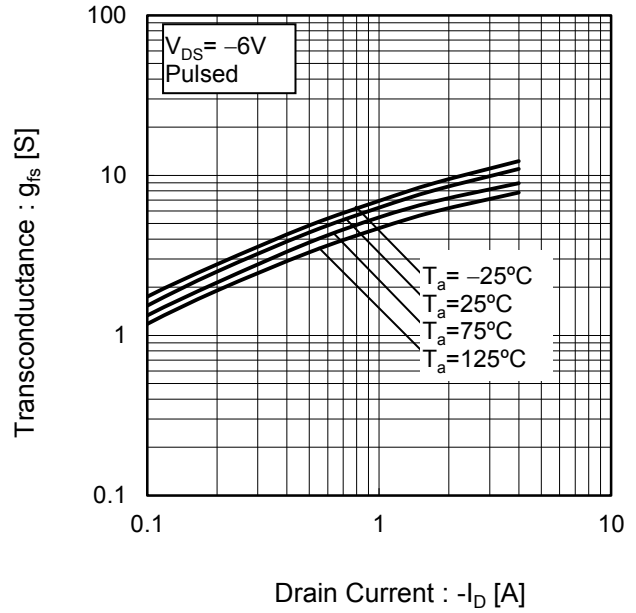


Fig.11 Drain Current Derating Curve

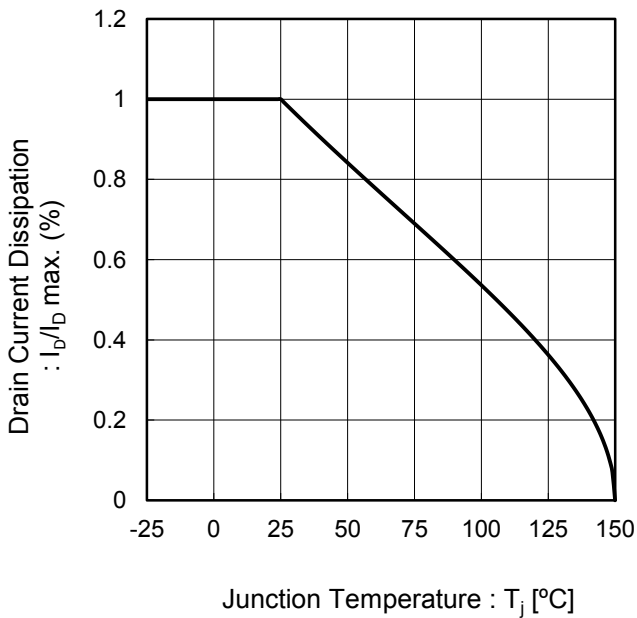
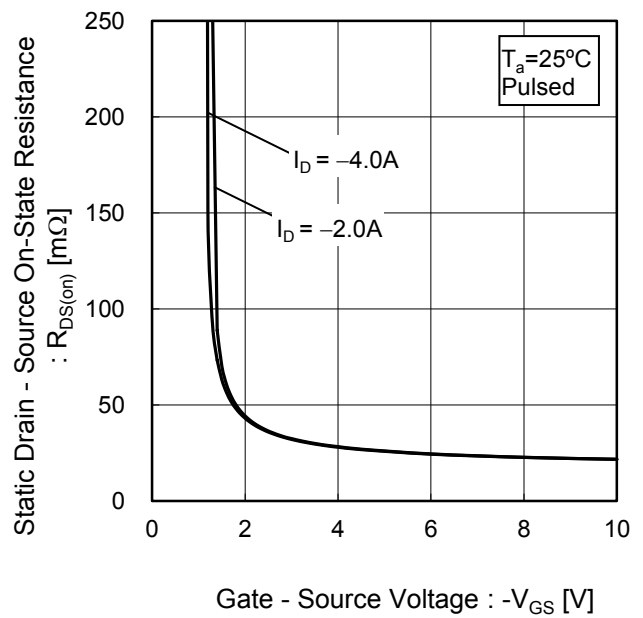


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage



●Electrical characteristic curves

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

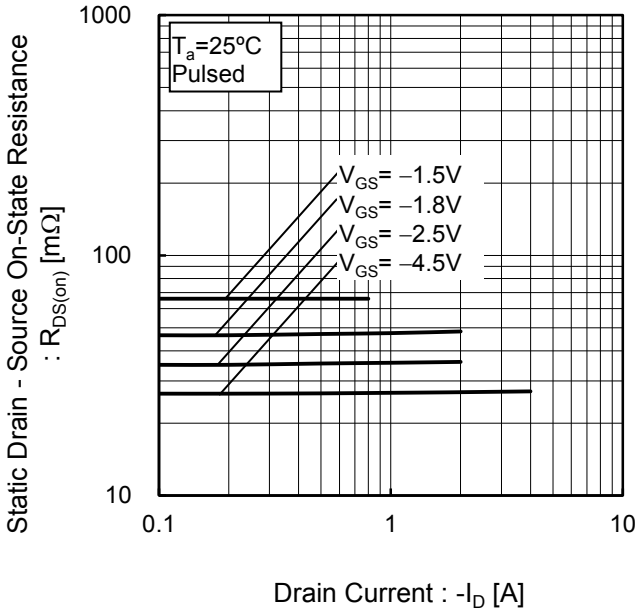
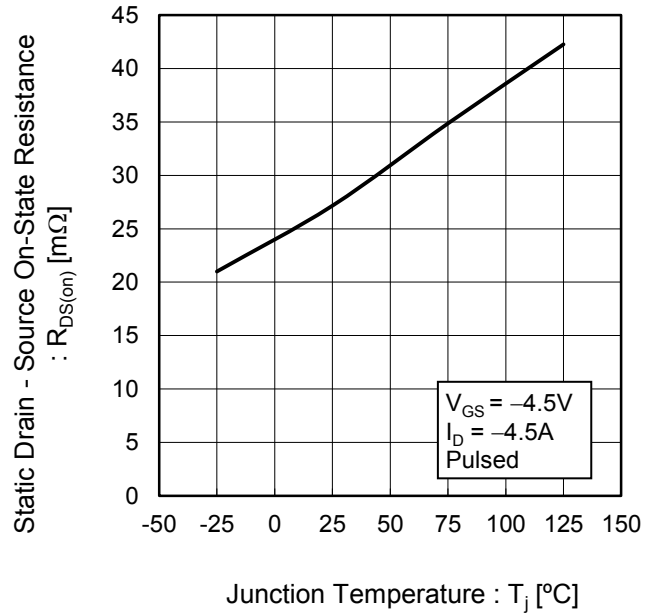


Fig.14 Static Drain - Source On - State Resistance vs. Junction Temperature



●Electrical characteristic curves

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

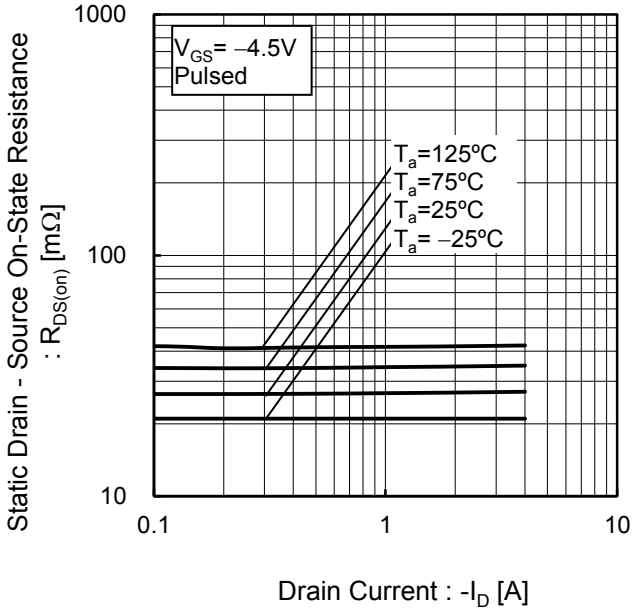


Fig.16 Static Drain-Source On-State Resistance vs. Drain Current(III)

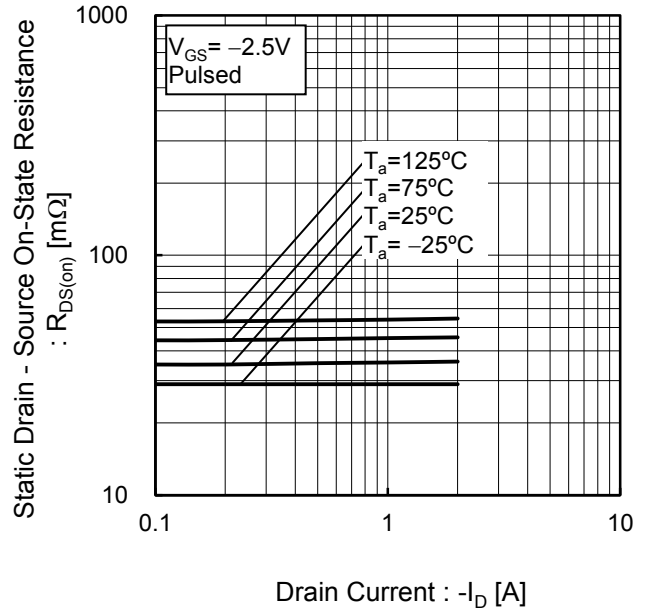


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current(IV)

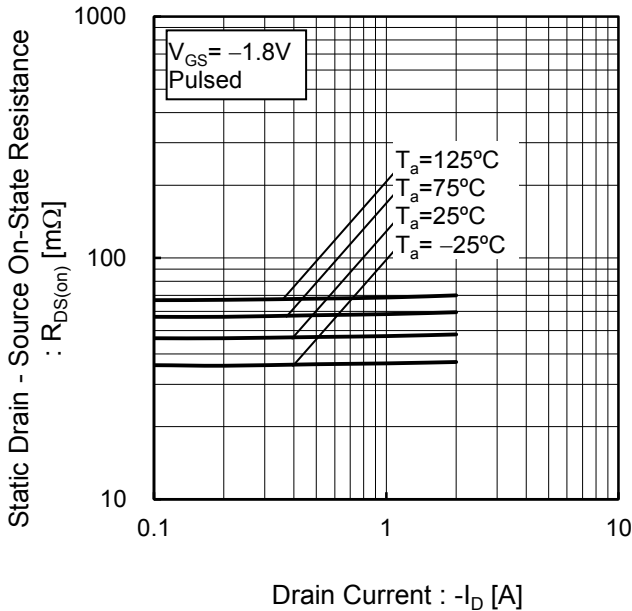
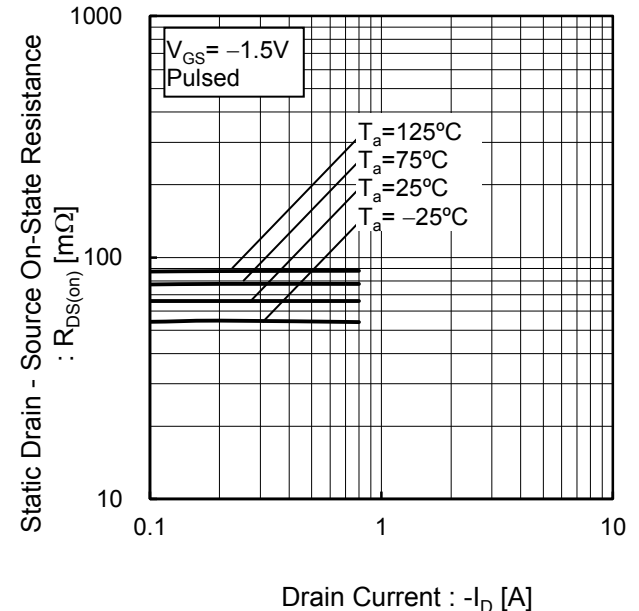


Fig.18 Static Drain - Source On - State Resistance vs. Drain Current(V)





●Electrical characteristic curves

Fig.19 Typical Capacitance vs. Drain - Source Voltage

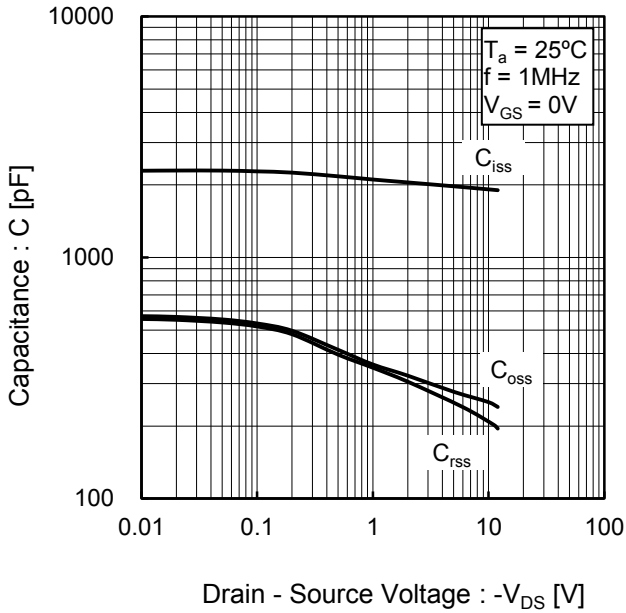


Fig.20 Switching Characteristics

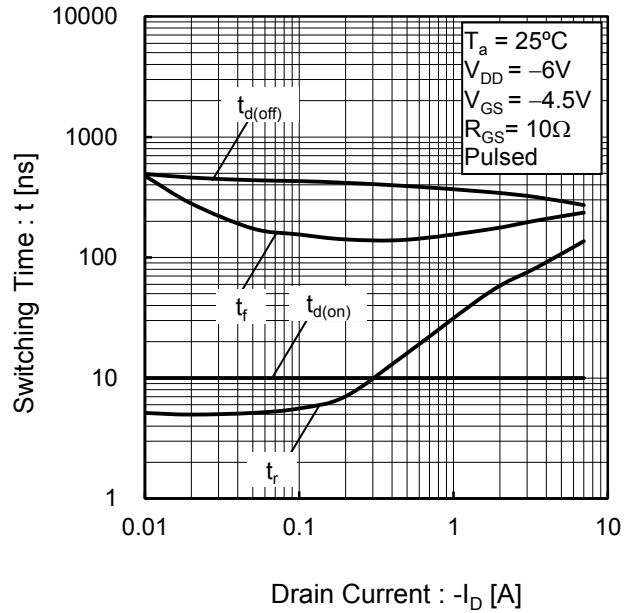


Fig.21 Dynamic Input Characteristics

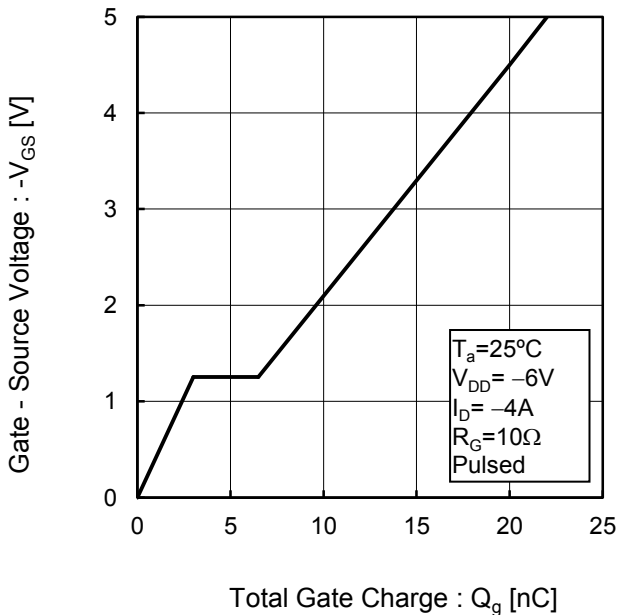
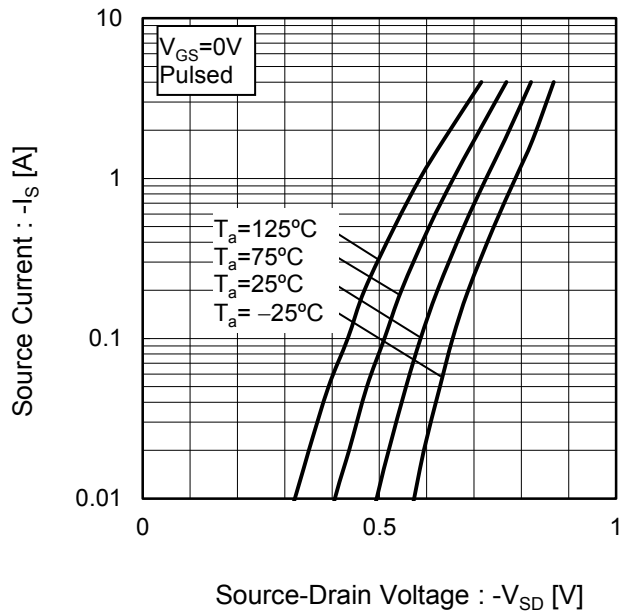


Fig.22 Source Current vs. Source Drain Voltage



●Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

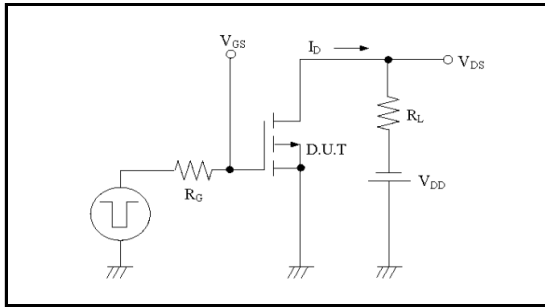


Fig.1-2 Switching Waveforms

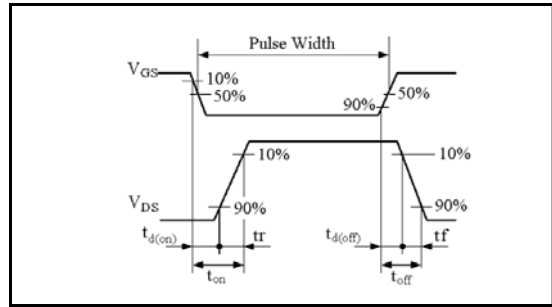


Fig.2-1 Gate Charge Measurement Circuit

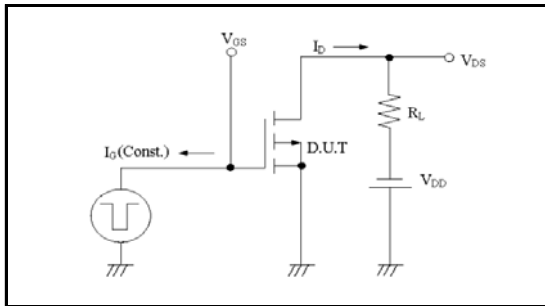
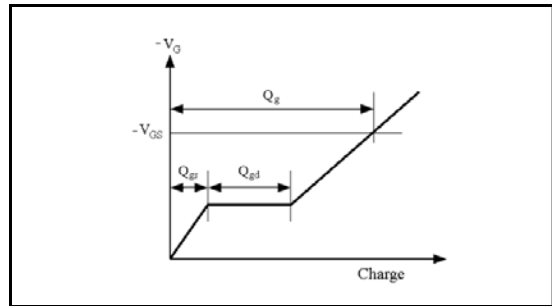
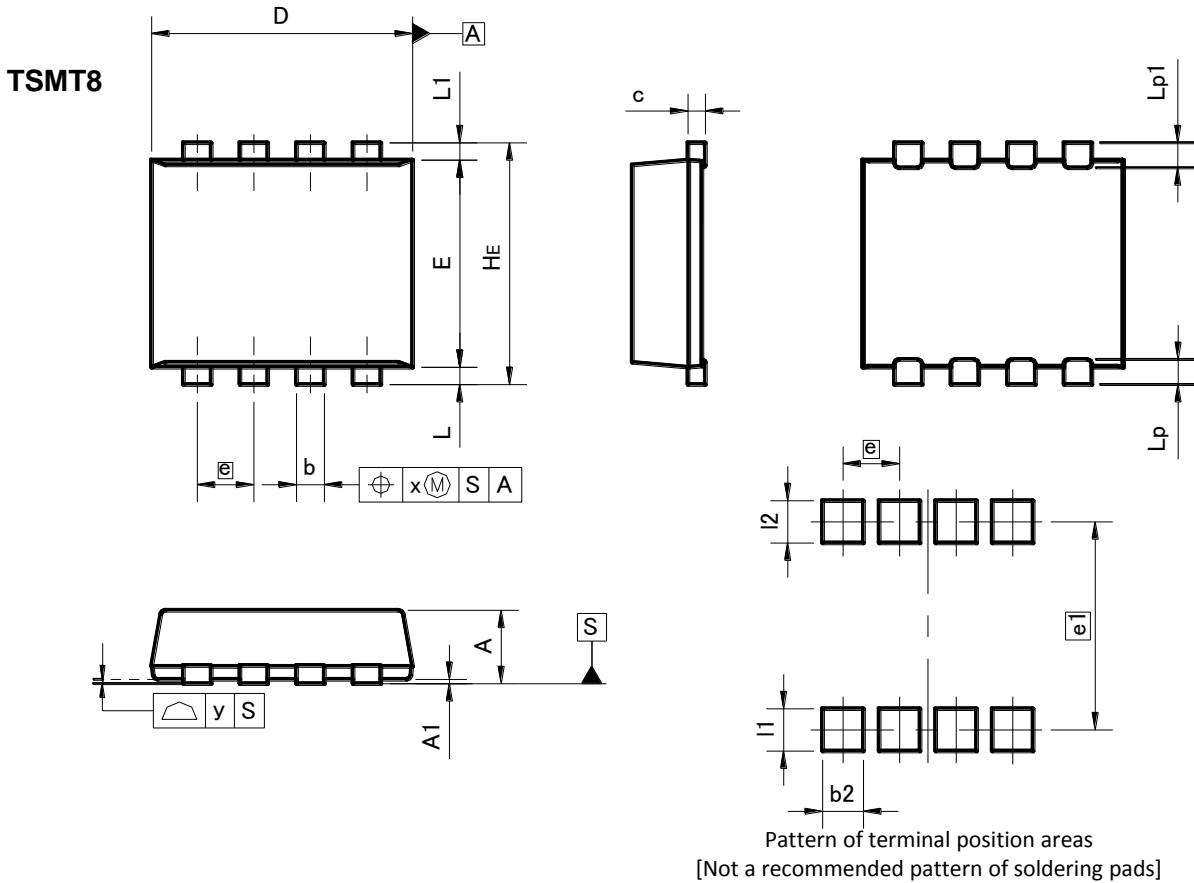


Fig.2-2 Gate Charge Waveform



●Dimensions (Unit : mm)



| 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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