

| Symbol | Tr1:Nch | Tr2:Pch |
|--------------------|----------------|----------------|
| V_{DSS} | 30V | -30V |
| $R_{DS(on)}(Max.)$ | 16.0m Ω | 28.6m Ω |
| I_D | $\pm 9.0A$ | $\pm 8.0A$ |
| P_D | 2.6W | |

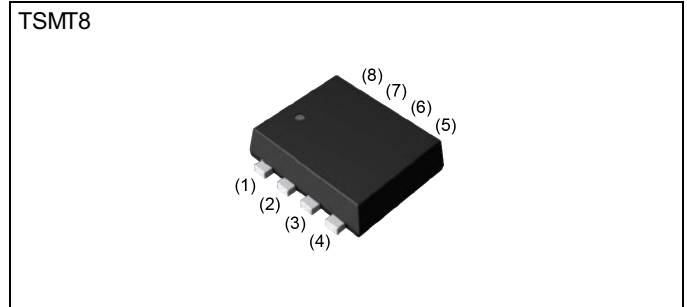
●Features

- 1) Low on - resistance.
- 2) Small Surface Mount Package (TSMT8).
- 3) Pb-free lead plating ; RoHS compliant.
- 4) Halogen Free.

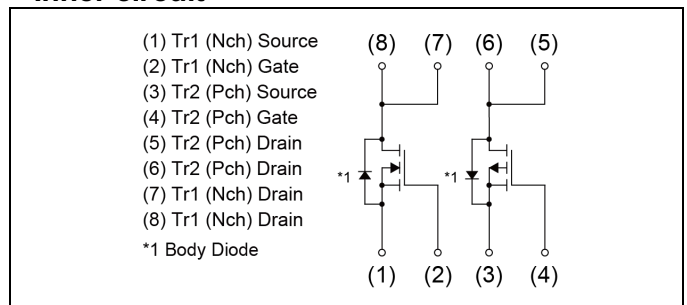
●Application

Switching

●Outline



●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 | MA4 | |

●Absolute maximum ratings ($T_a = 25^\circ C$), unless otherwise specified.

| Parameter | Symbol | Value | | Unit |
|--------------------------------|--------------------|-------------|------------|------|
| | | Tr1:Nch | Tr2:Pch | |
| Drain - Source voltage | V_{DSS} | 30 | -30 | V |
| Continuous drain current | I_D^{*1} | ± 9.0 | ± 8.0 | A |
| Pulsed drain current | $I_{D,pulse}^{*2}$ | ± 18 | ± 18 | A |
| Gate - Source voltage | V_{GSS} | ± 20 | ± 20 | V |
| Avalanche energy, single pulse | E_{AS}^{*4} | 3.5 | 2.2 | mJ |
| Avalanche current | I_{AS}^{*4} | 7.0 | -5.5 | A |
| Power dissipation | total | P_D^{*1} | 2.6 | W |
| | | P_D^{*3} | 1.5 | |
| | element | P_D^{*3} | 1.25 | |
| 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 | R_{thJA}^{*3} | - | - | 83.3 | °C/W |

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

| Parameter | Symbol | Type | Conditions | Values | | | Unit |
|--|---|------|---|--------|------|------|-------|
| | | | | Min. | Typ. | Max. | |
| Drain - Source breakdown voltage | $V_{(BR)DSS}$ | Tr1 | $V_{GS} = 0V, I_D = 1mA$ | 30 | - | - | V |
| | | Tr2 | $V_{GS} = 0V, I_D = -1mA$ | -30 | - | - | |
| Breakdown voltage temperature coefficient | $\frac{\Delta V_{(BR)DSS}}{\Delta T_j}$ | Tr1 | $I_D = 1mA$, referenced to 25°C | - | 21 | - | mV/°C |
| | | Tr2 | $I_D = -1mA$, referenced to 25°C | - | -22 | - | |
| Zero gate voltage drain current | I_{DSS} | Tr1 | $V_{DS} = 30V, V_{GS} = 0V$ | - | - | 1 | μA |
| | | Tr2 | $V_{DS} = -30V, V_{GS} = 0V$ | - | - | -1 | |
| Gate - Source leakage current | I_{GSS} | Tr1 | $V_{DS} = 0V, V_{GS} = \pm 20V$ | - | - | ±100 | nA |
| | | Tr2 | $V_{DS} = 0V, V_{GS} = \pm 20V$ | - | - | ±100 | |
| Gate threshold voltage | $V_{GS(th)}$ | Tr1 | $V_{DS} = V_{GS}, I_D = 1mA$ | 1.0 | - | 2.5 | V |
| | | Tr2 | $V_{DS} = V_{GS}, I_D = -1mA$ | -1.0 | - | -2.5 | |
| Gate threshold voltage temperature coefficient | $\frac{\Delta V_{GS(th)}}{\Delta T_j}$ | Tr1 | $I_D = 1mA$, referenced to 25°C | - | -3 | - | mV/°C |
| | | Tr2 | $I_D = -1mA$, referenced to 25°C | - | 2.9 | - | |
| Static drain - source on - state resistance | $R_{DS(on)}^{*5}$ | Tr1 | $V_{GS} = 10V, I_D = 9A$ | - | 12.3 | 16.0 | mΩ |
| | | | $V_{GS} = 4.5V, I_D = 7A$ | - | 18.2 | 23.7 | |
| | | Tr2 | $V_{GS} = -10V, I_D = -8A$ | - | 22.0 | 28.6 | |
| | | | $V_{GS} = -4.5V, I_D = -5.5A$ | - | 31.0 | 40.3 | |
| Gate input resistance | R_G | Tr1 | $f=1MHz$, open drain | - | 3.3 | - | Ω |
| | | Tr2 | | - | 6.0 | - | |
| Transconductance | g_{fs}^{*5} | Tr1 | $V_{DS} = 5V, I_D = 7A$ | 4.4 | - | - | S |
| | | Tr2 | $V_{DS} = -5V, I_D = -5.5A$ | 5.5 | - | - | |

*1 $P_w \leq 1s$, Limited only by maximum temperature allowed.

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

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

*4 Tr1: $L \approx 0.1mH$, $V_{DD} = 15V$, $R_G = 25\Omega$, STARTING $T_j = 25^\circ\text{C}$ Fig.3-1,3-2

Tr2: $L \approx 0.1mH$, $V_{DD} = -15V$, $R_G = 25\Omega$, STARTING $T_j = 25^\circ\text{C}$ Fig.6-1,6-2

*5 Pulsed

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

<Tr1>

| Parameter | Symbol | Conditions | Values | | | Unit |
|------------------------------|-------------------|------------------------------------|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Input capacitance | C_{iss} | $V_{GS} = 0V$ | - | 640 | - | pF |
| Output capacitance | C_{oss} | $V_{DS} = 15V$ | - | 110 | - | |
| Reverse transfer capacitance | C_{rss} | $f = 1\text{MHz}$ | - | 90 | - | |
| Turn - on delay time | $t_{d(on)}^{*5}$ | $V_{DD} \approx 15V, V_{GS} = 10V$ | - | 8 | - | ns |
| Rise time | t_r^{*5} | $I_D = 4.5A$ | - | 19 | - | |
| Turn - off delay time | $t_{d(off)}^{*5}$ | $R_L = 3.3\Omega$ | - | 33 | - | |
| Fall time | t_f^{*5} | $R_G = 10\Omega$ | - | 7 | - | |

<Tr2>

| Parameter | Symbol | Conditions | Values | | | Unit |
|------------------------------|-------------------|--------------------------------------|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Input capacitance | C_{iss} | $V_{GS} = 0V$ | - | 890 | - | pF |
| Output capacitance | C_{oss} | $V_{DS} = -15V$ | - | 160 | - | |
| Reverse transfer capacitance | C_{rss} | $f = 1\text{MHz}$ | - | 125 | - | |
| Turn - on delay time | $t_{d(on)}^{*5}$ | $V_{DD} \approx -15V, V_{GS} = -10V$ | - | 10 | - | ns |
| Rise time | t_r^{*5} | $I_D = -4A$ | - | 16 | - | |
| Turn - off delay time | $t_{d(off)}^{*5}$ | $R_L = 3.8\Omega$ | - | 55 | - | |
| Fall time | t_f^{*5} | $R_G = 10\Omega$ | - | 22 | - | |

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

<Tr1>

| Parameter | Symbol | Conditions | Values | | | Unit | |
|----------------------|---------------|--|------------------------|------|------|------|----|
| | | | Min. | Typ. | Max. | | |
| Total gate charge | Q_g^{*5} | $V_{DD} \approx 15\text{V}$ $I_D = 9\text{A}$ | $V_{GS} = 10\text{V}$ | - | 15.5 | - | nC |
| Gate - Source charge | Q_{gs}^{*5} | | $V_{GS} = 4.5\text{V}$ | - | 7.9 | - | |
| Gate - Drain charge | Q_{gd}^{*5} | | | - | 2.8 | - | |

<Tr2>

| Parameter | Symbol | Conditions | Values | | | Unit | |
|----------------------|---------------|--|-------------------------|------|------|------|----|
| | | | Min. | Typ. | Max. | | |
| Total gate charge | Q_g^{*5} | $V_{DD} \approx -15\text{V}$ $I_D = -8\text{A}$ | $V_{GS} = -10\text{V}$ | - | 19.6 | - | nC |
| Gate - Source charge | Q_{gs}^{*5} | | $V_{GS} = -4.5\text{V}$ | - | 3.0 | - | |
| Gate - Drain charge | Q_{gd}^{*5} | | | - | 3.7 | - | |

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

<Tr1>

| Parameter | Symbol | Conditions | Values | | | Unit |
|---------------------------------------|---------------|---------------------------------------|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Body diode continuous forward current | I_S | $T_a = 25^\circ\text{C}$ | - | - | 1.0 | A |
| Body diode pulse current | I_{SP}^{*2} | | - | - | 18 | |
| Forward voltage | V_{SD}^{*5} | $V_{GS} = 0\text{V}, I_S = 1\text{A}$ | - | - | 1.2 | V |

<Tr2>

| Parameter | Symbol | Conditions | Values | | | Unit |
|---------------------------------------|---------------|--|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Body diode continuous forward current | I_S | $T_a = 25^\circ\text{C}$ | - | - | -1.0 | A |
| Body diode pulse current | I_{SP}^{*2} | | - | - | -18 | |
| Forward voltage | V_{SD}^{*5} | $V_{GS} = 0\text{V}, I_S = -1\text{A}$ | - | - | -1.2 | V |

● Electrical characteristic curves <Tr1>

Fig.1 Power Dissipation Derating Curve

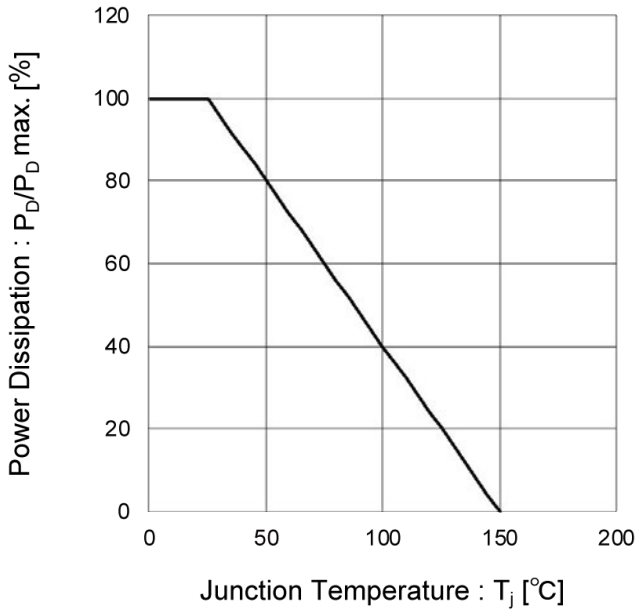


Fig.2 Maximum Safe Operating Area

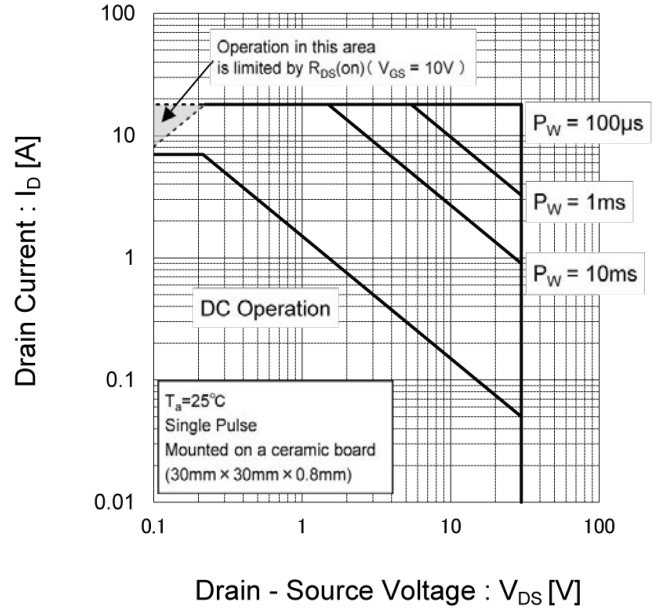


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

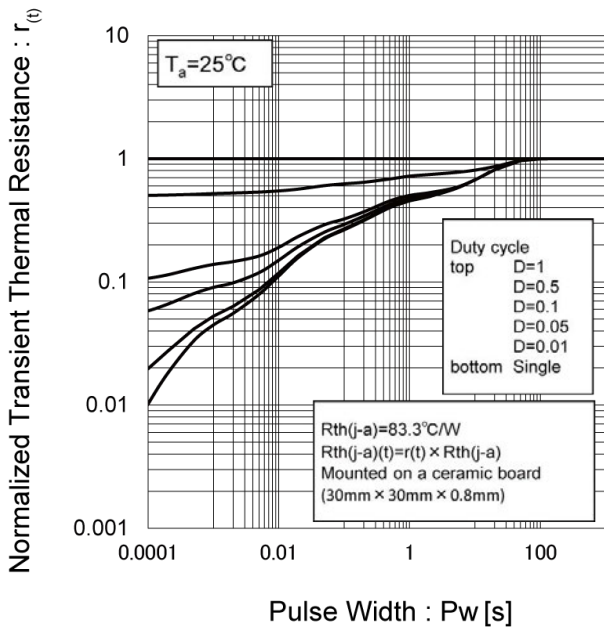
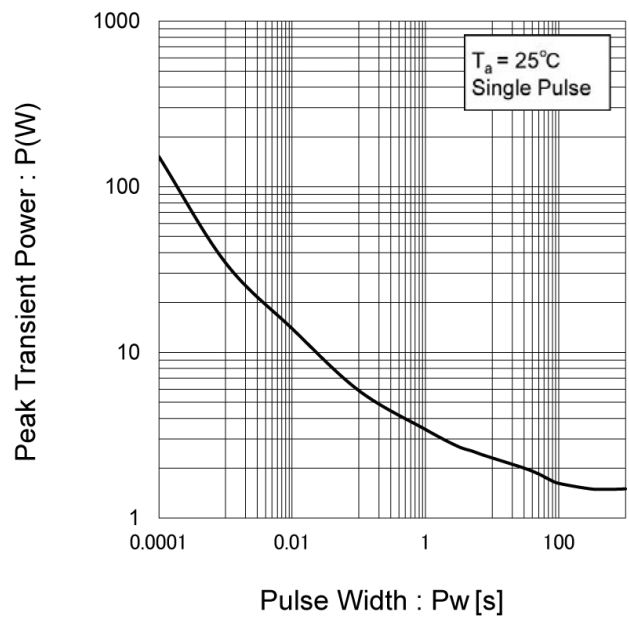


Fig.4 Single Pulse Maximum Power dissipation



●Electrical characteristic curves <Tr1>

Fig.5 Typical Output Characteristics(I)

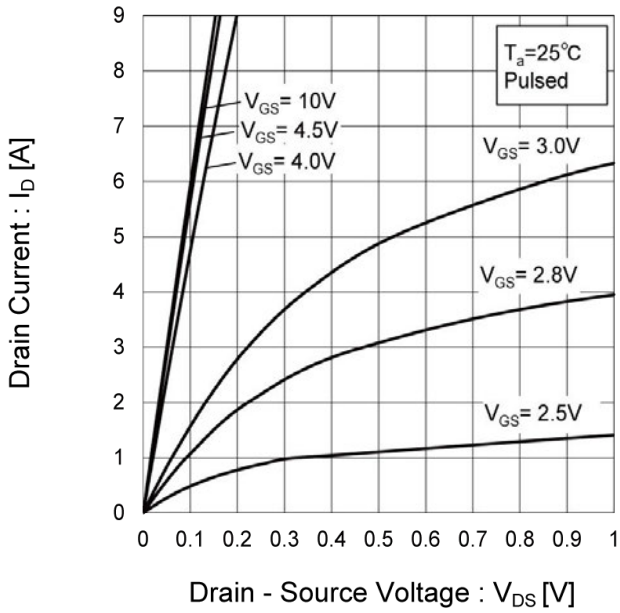


Fig.6 Typical Output Characteristics(II)

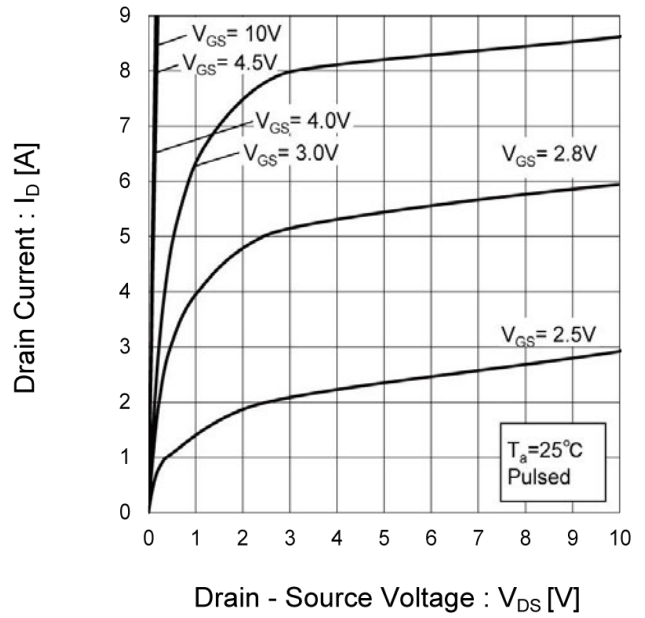
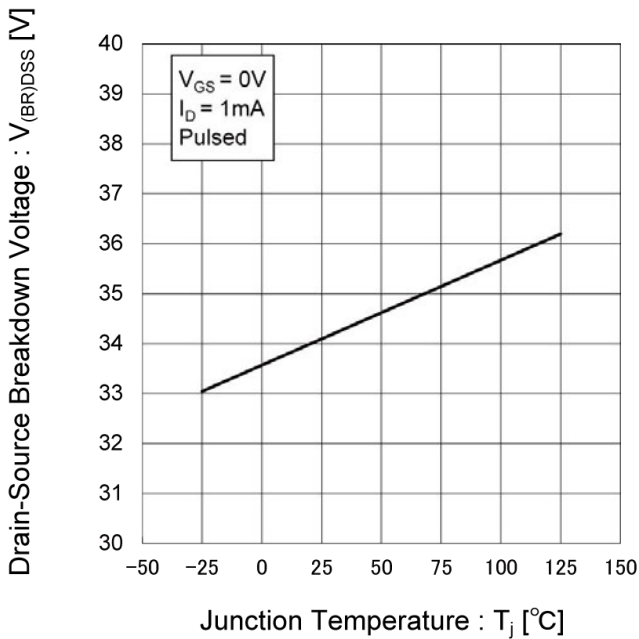


Fig.7 Breakdown Voltage vs. Junction Temperature



●Electrical characteristic curves <Tr1>

Fig.8 Typical Transfer Characteristics

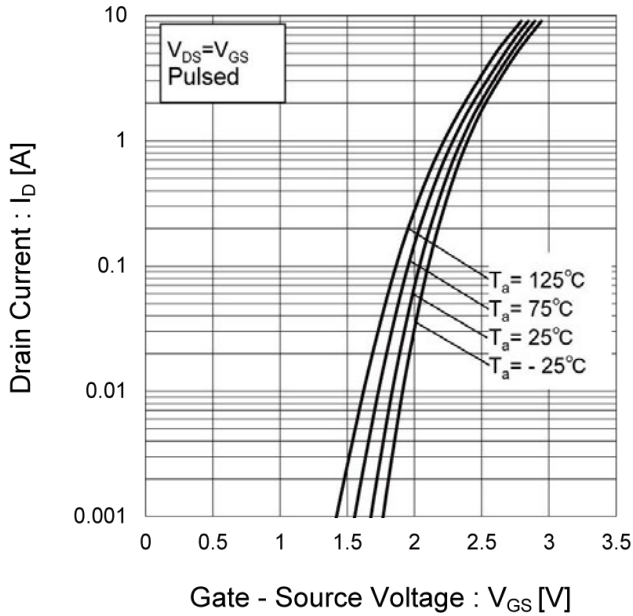


Fig.9 Gate Threshold Voltage vs. Junction Temperature

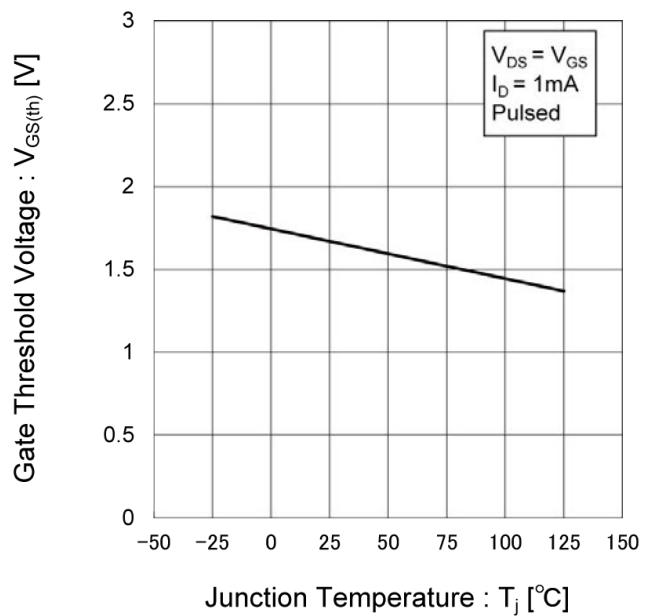
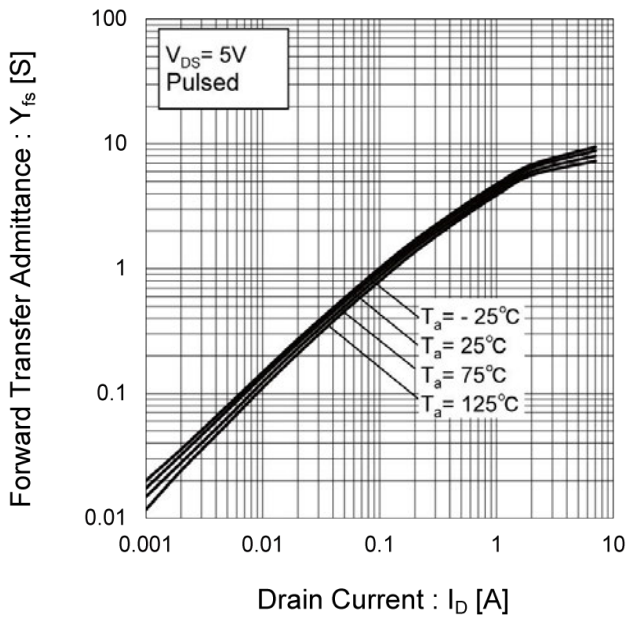


Fig.10 Transconductance vs. Drain Current



●Electrical characteristic curves <Tr1>

Fig.11 Drain Current Derating Curve

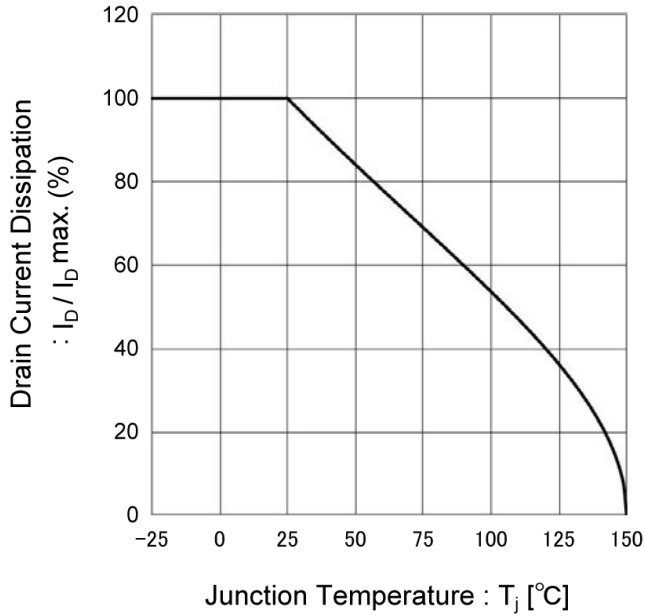


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

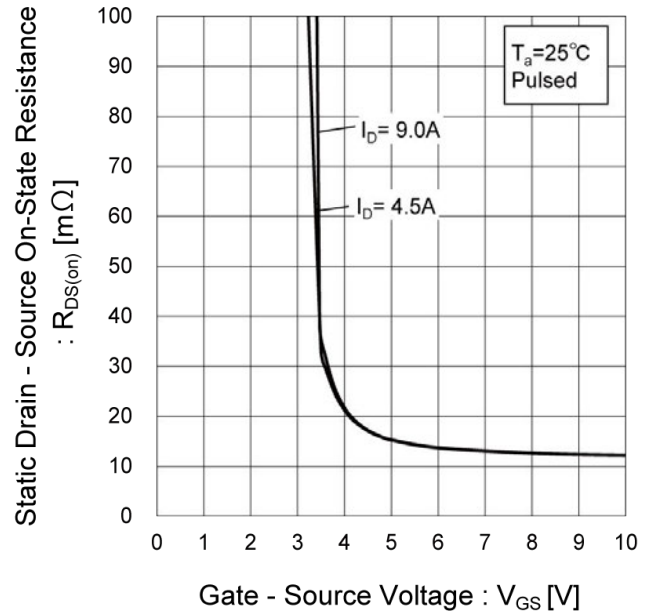
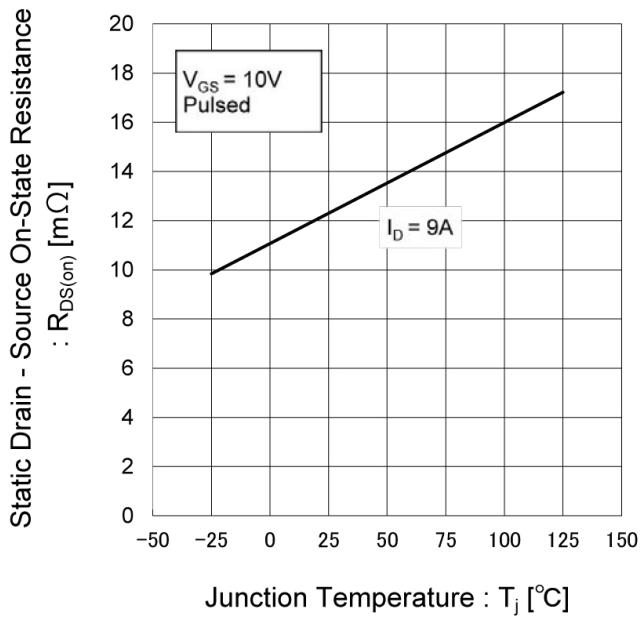


Fig.13 Static Drain - Source On - State Resistance vs. Junction Temperature



● Electrical characteristic curves <Tr1>

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

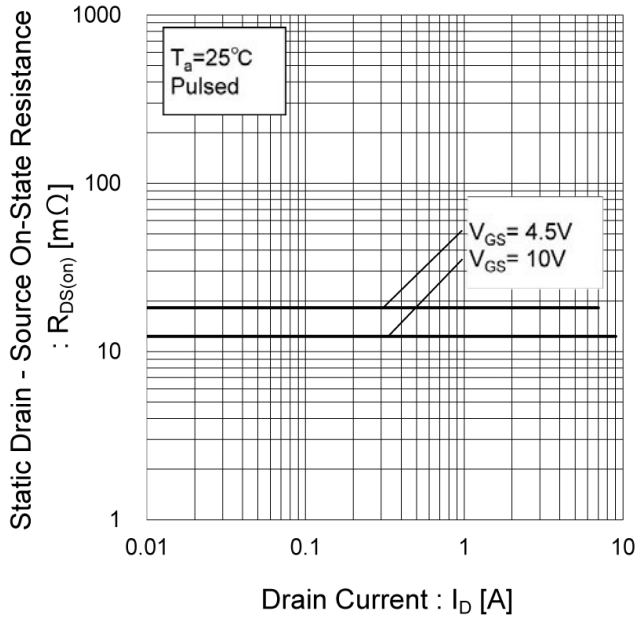


Fig.15 Static Drain - Source On - State Resistance vs. Drain Current(II)

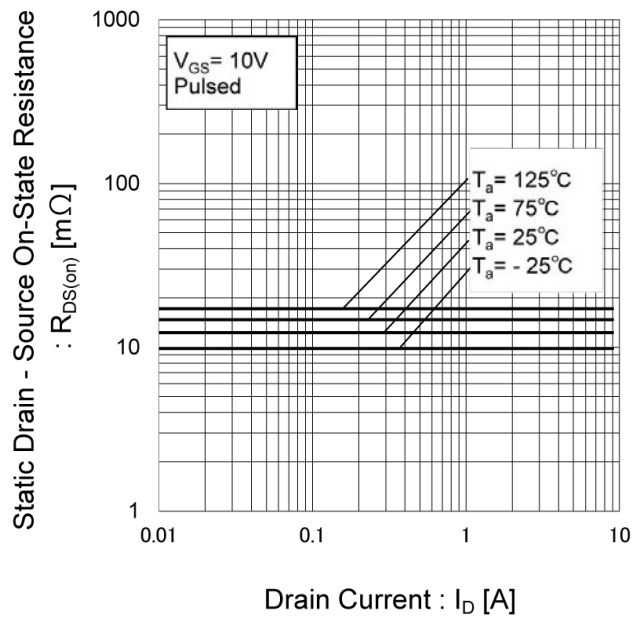
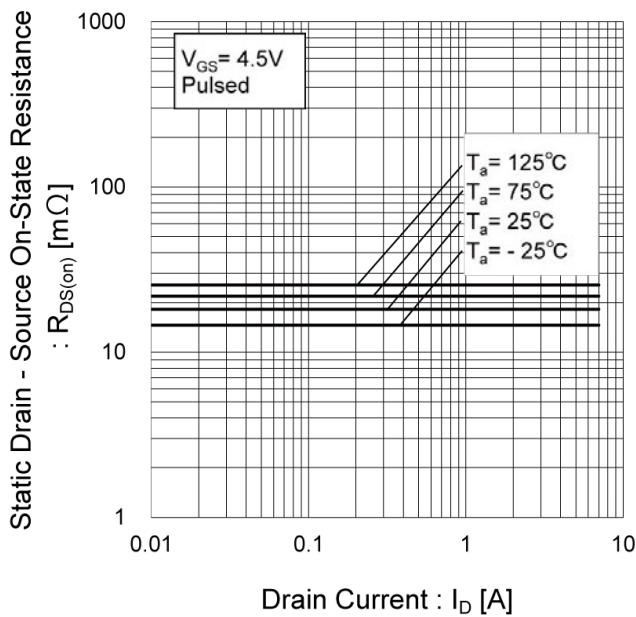


Fig.16 Static Drain - Source On - State Resistance vs. Drain Current(III)



●Electrical characteristic curves <Tr1>

Fig.17 Typical Capacitance vs. Drain - Source Voltage

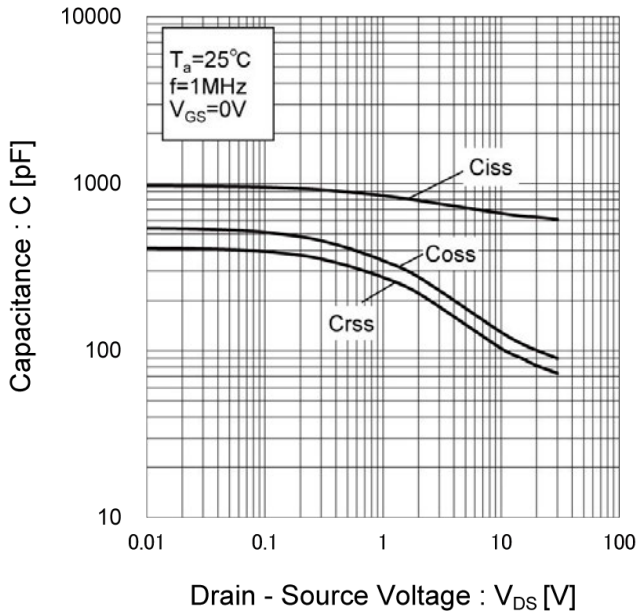


Fig.18 Switching Characteristics

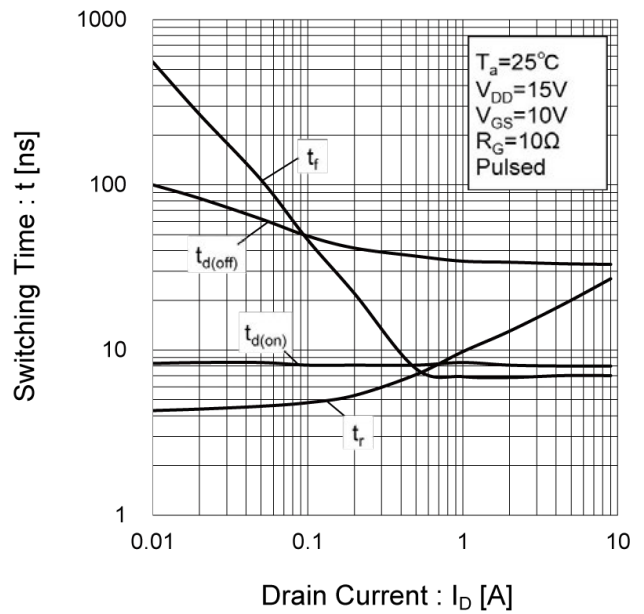


Fig.19 Dynamic Input Characteristics

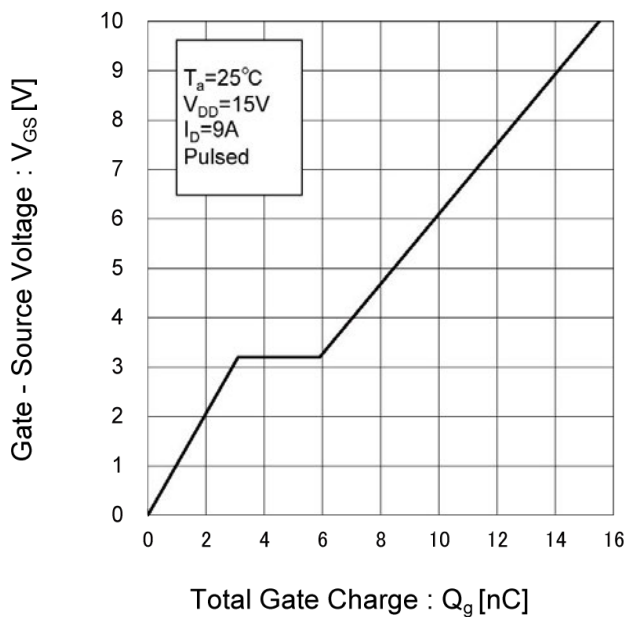
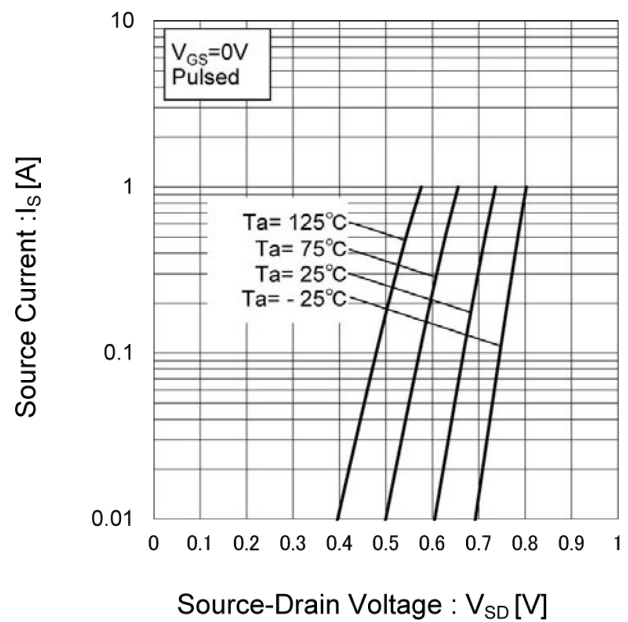


Fig.20 Source Current vs. Source Drain Voltage



●Electrical characteristic curves <Tr2>

Fig.1 Power Dissipation Derating Curve

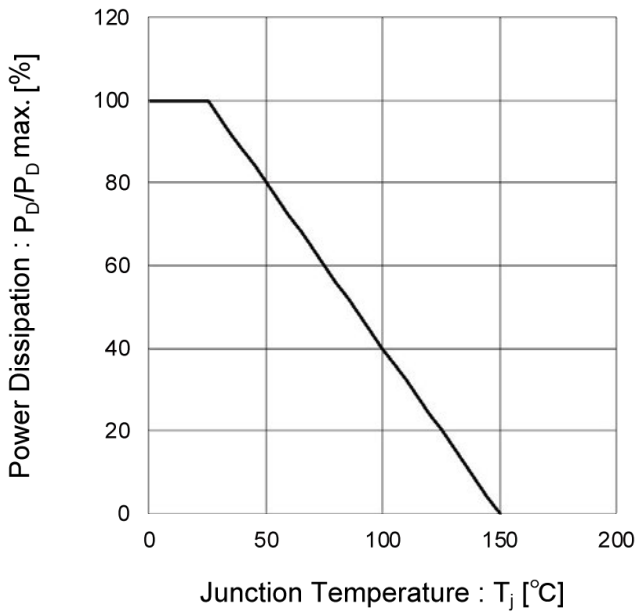


Fig.2 Maximum Safe Operating Area

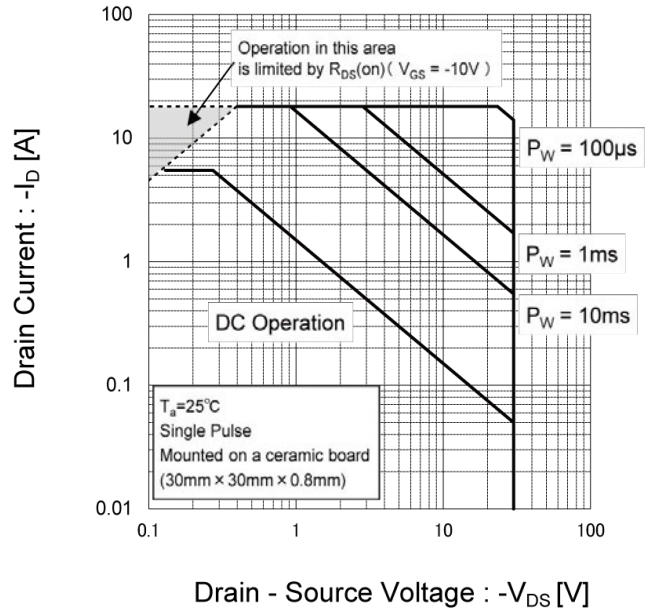


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

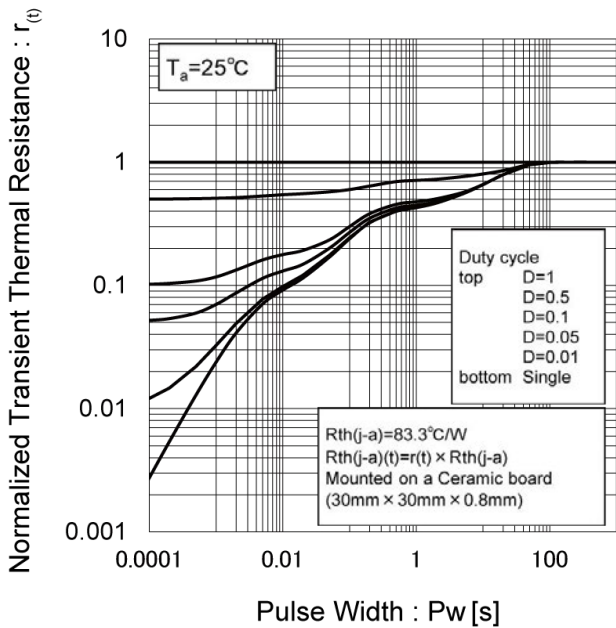
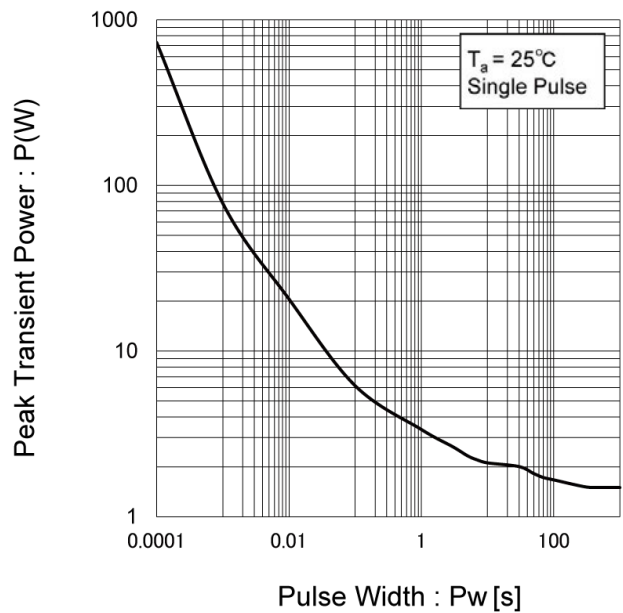


Fig.4 Single Pulse Maximum Power dissipation



●Electrical characteristic curves <Tr2>

Fig.5 Typical Output Characteristics(I)

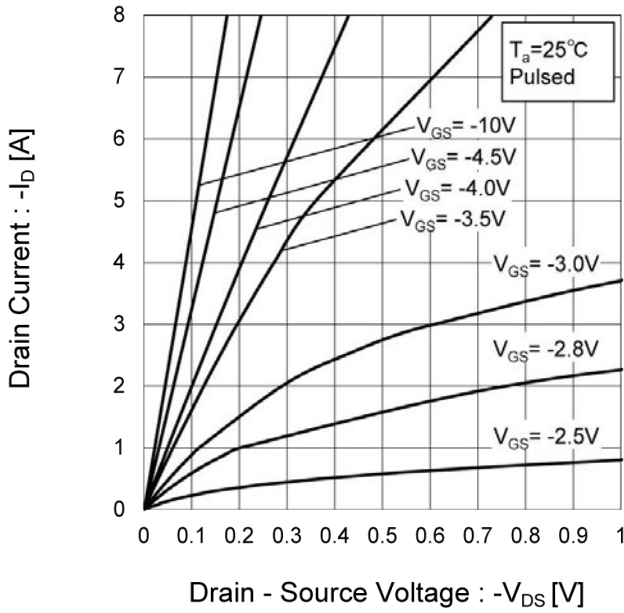


Fig.6 Typical Output Characteristics(II)

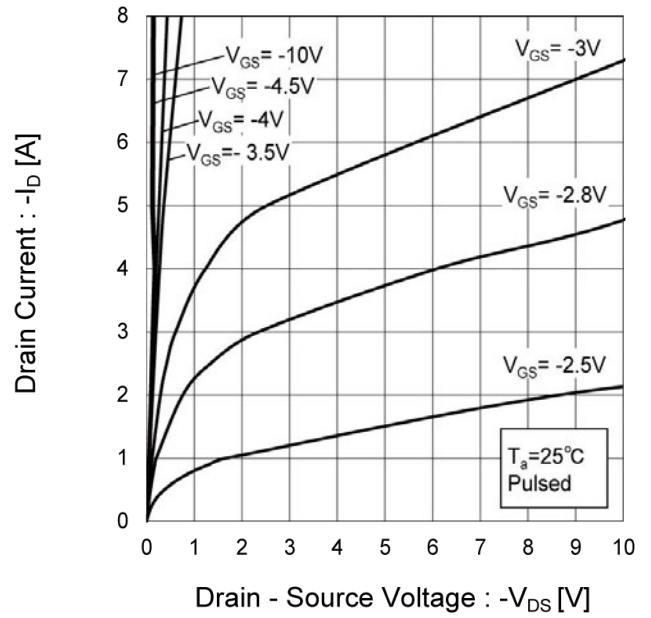
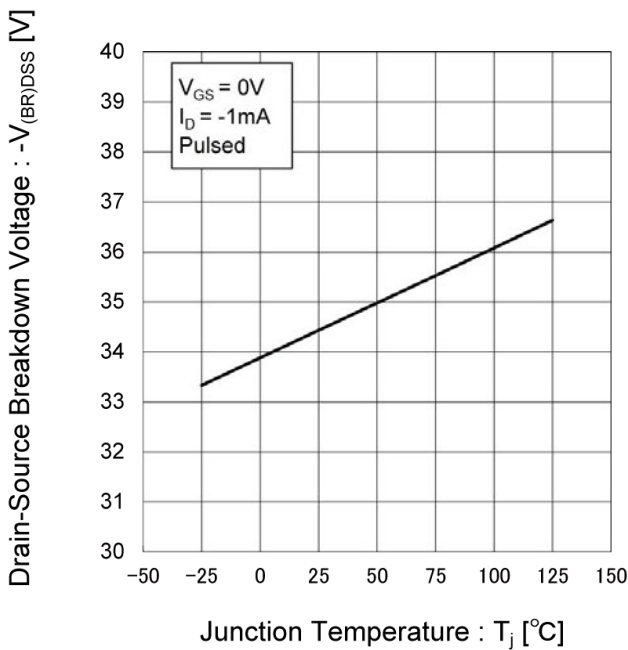


Fig.7 Breakdown Voltage vs. Junction Temperature



●Electrical characteristic curves <Tr2>

Fig.8 Typical Transfer Characteristics

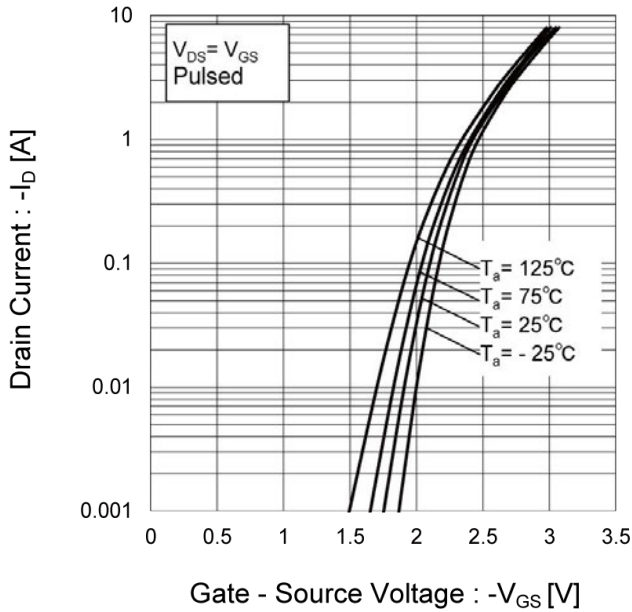


Fig.9 Gate Threshold Voltage vs. Junction Temperature

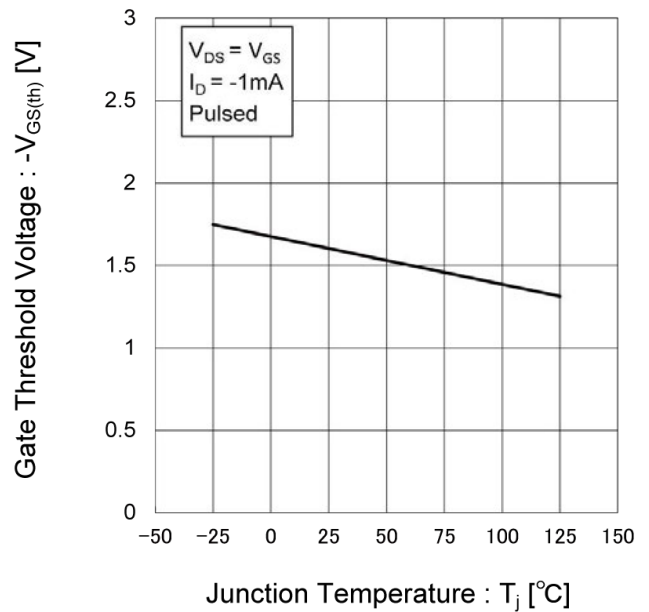
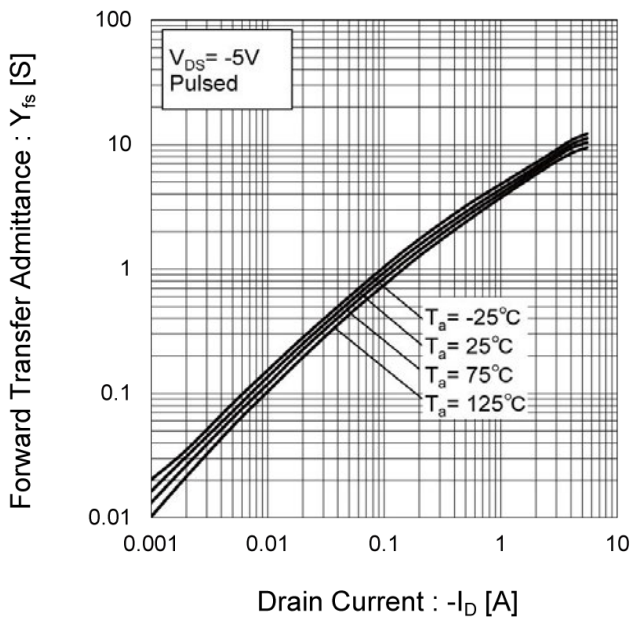


Fig.10 Transconductance vs. Drain Current



●Electrical characteristic curves <Tr2>

Fig.11 Drain Current Derating Curve

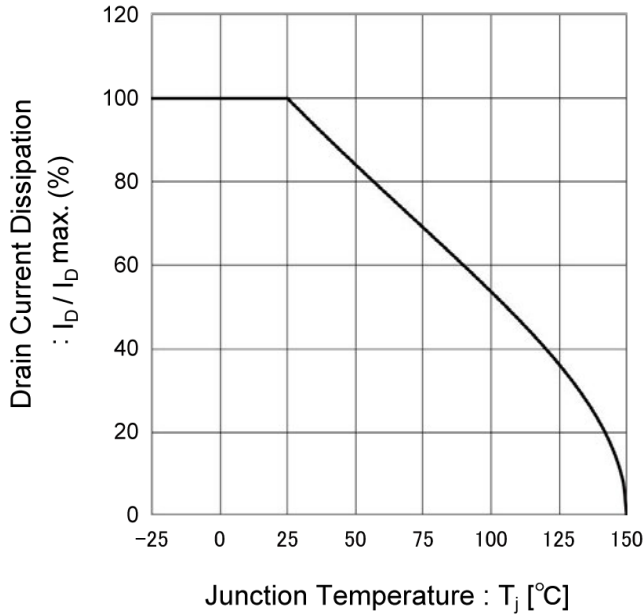


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

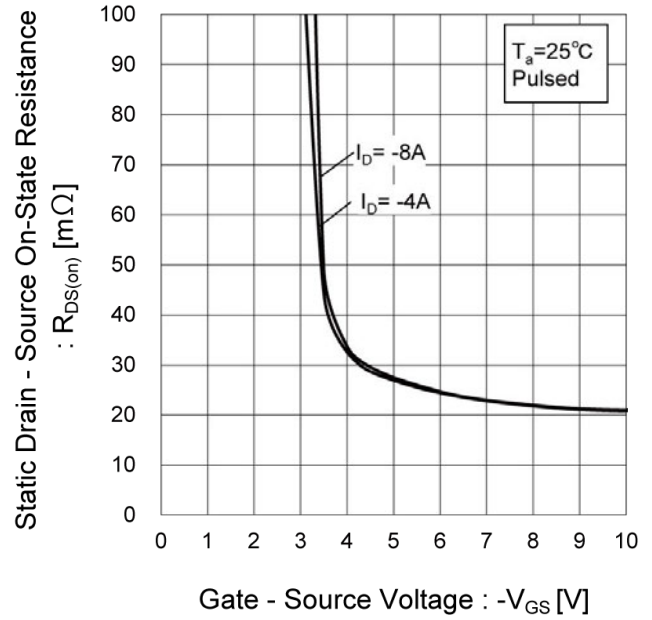
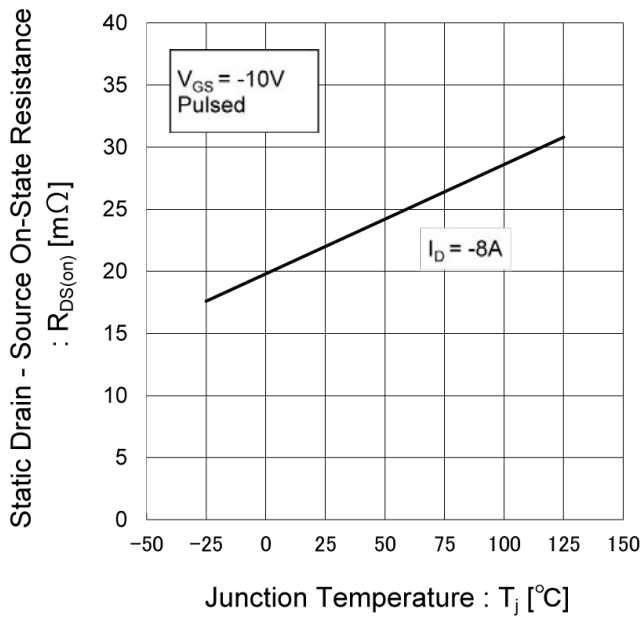


Fig.13 Static Drain - Source On - State Resistance vs. Junction Temperature



● Electrical characteristic curves <Tr2>

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

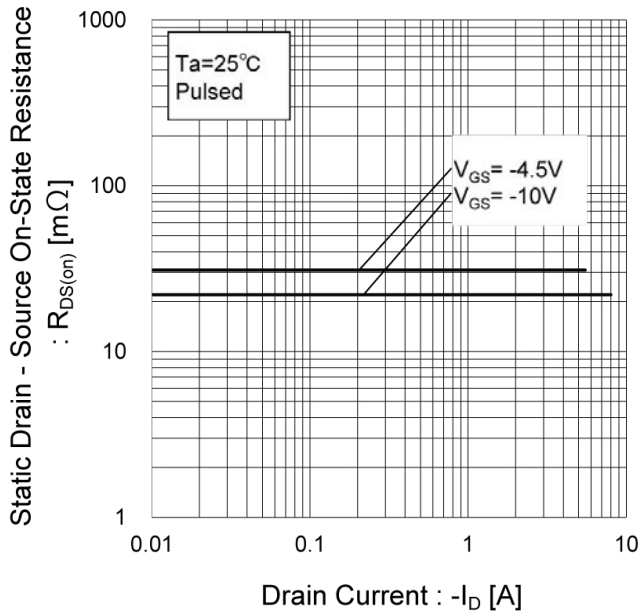


Fig.15 Static Drain - Source On - State Resistance vs. Drain Current(II)

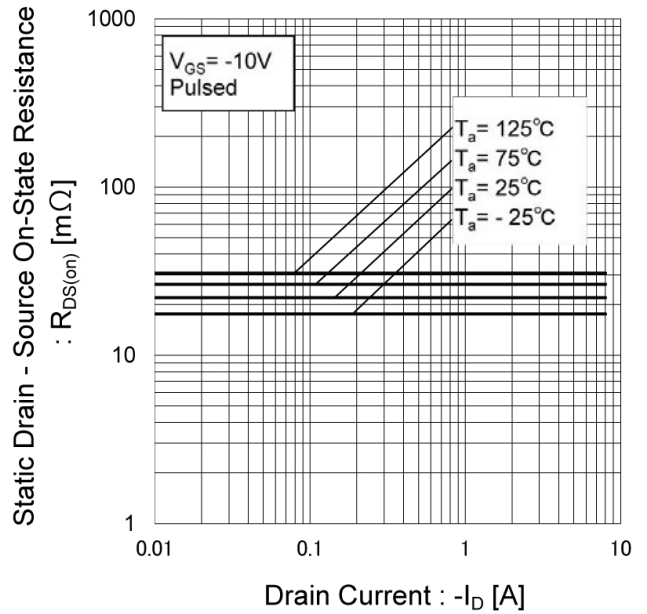
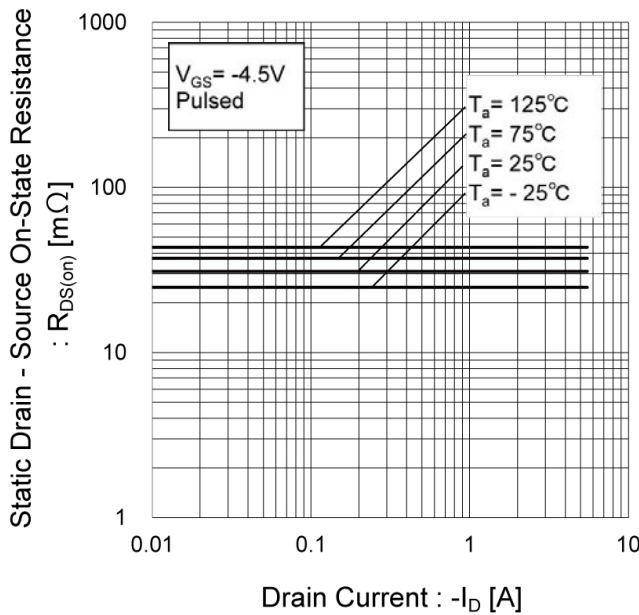


Fig.16 Static Drain - Source On - State Resistance vs. Drain Current(III)



●Electrical characteristic curves <Tr2>

Fig.17 Typical Capacitance vs. Drain - Source Voltage

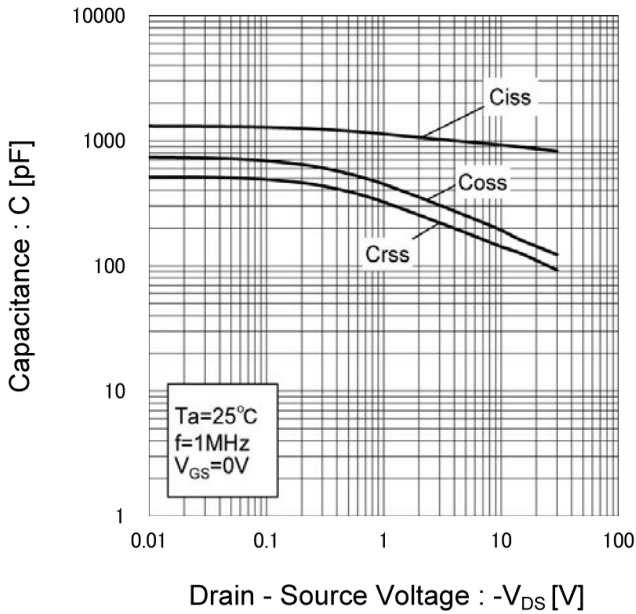


Fig.18 Switching Characteristics

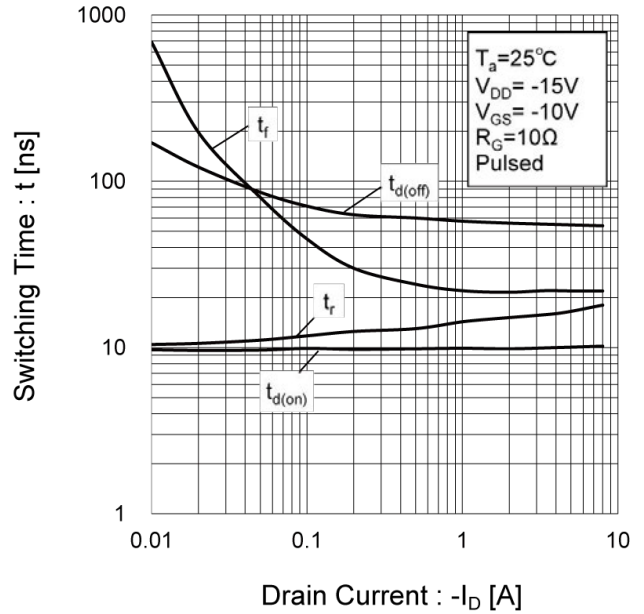


Fig.19 Dynamic Input Characteristics

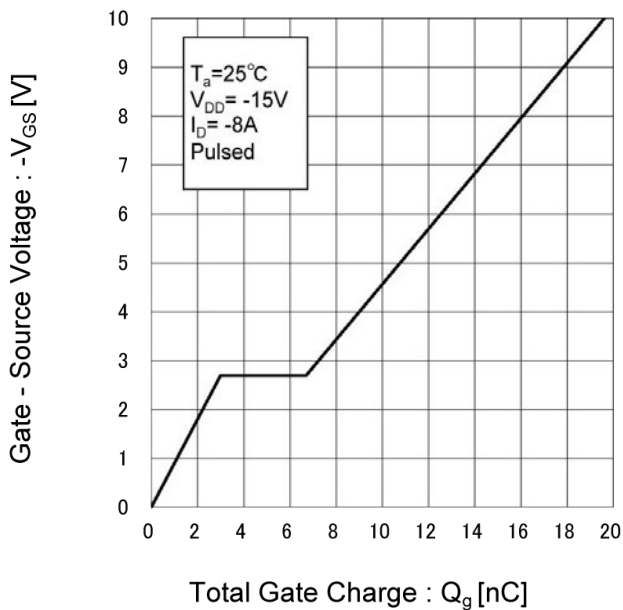
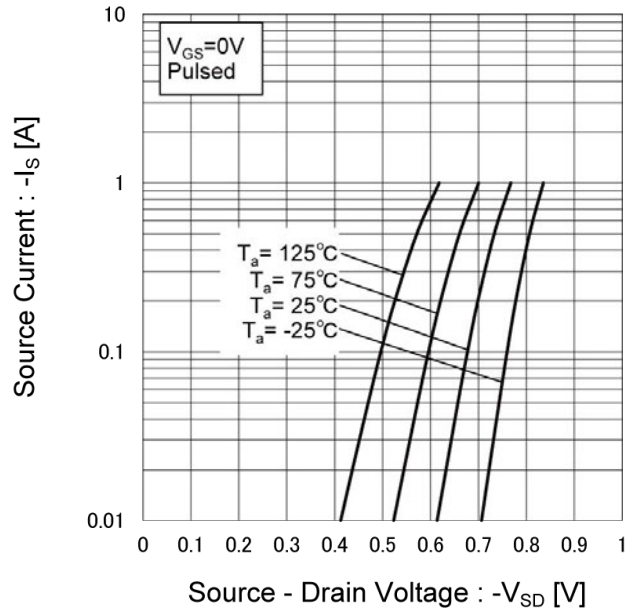


Fig.20 Source Current vs. Source Drain Voltage



● Measurement circuits <Tr1>

Fig.1-1 Switching Time Measurement Circuit

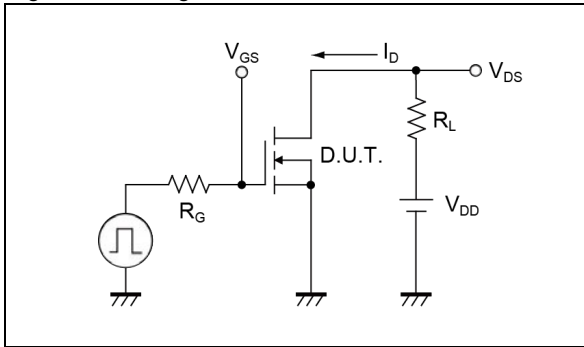


Fig.1-2 Switching Waveforms

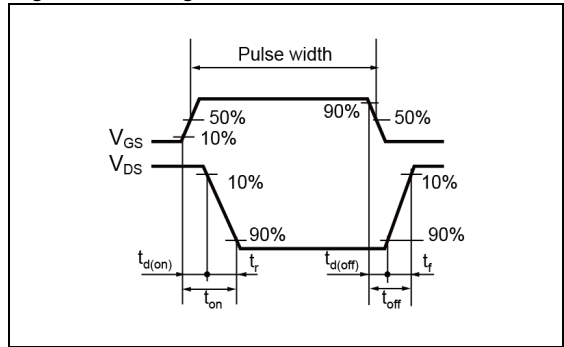


Fig.2-1 Gate Charge Measurement Circuit

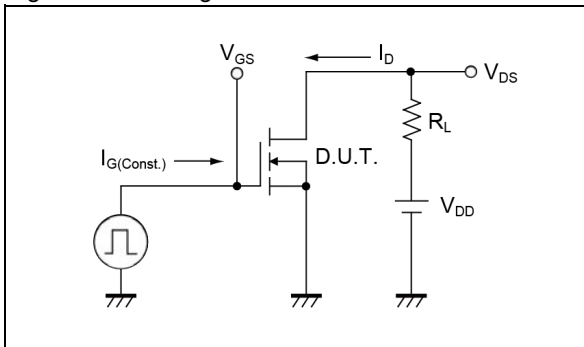


Fig.2-2 Gate Charge Waveform

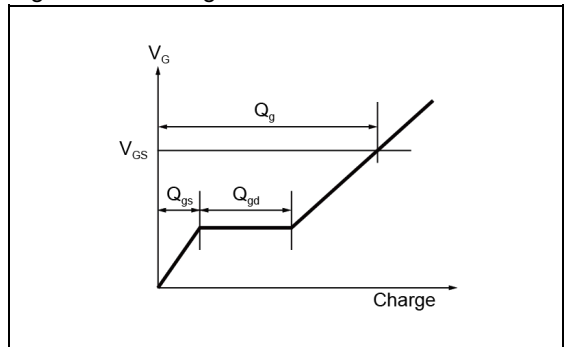


Fig.3-1 Avalanche Measurement Circuit

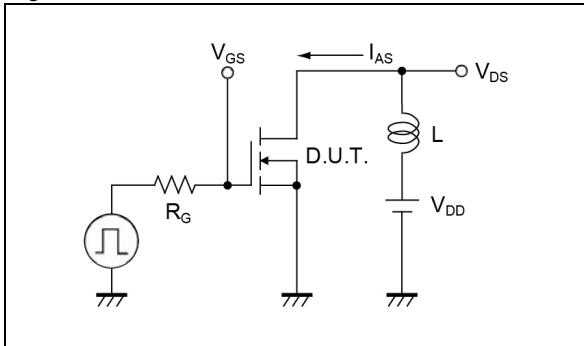
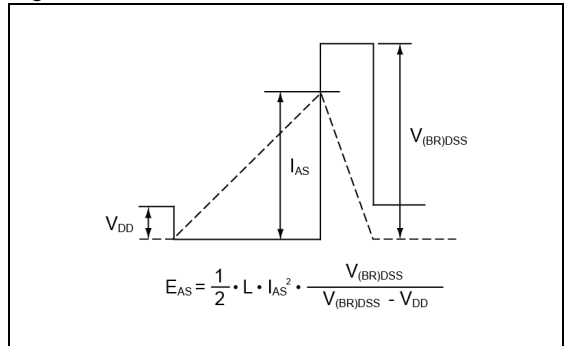


Fig.3-2 Avalanche Waveform



● Measurement circuits <Tr2>

Fig.4-1 Switching Time Measurement Circuit

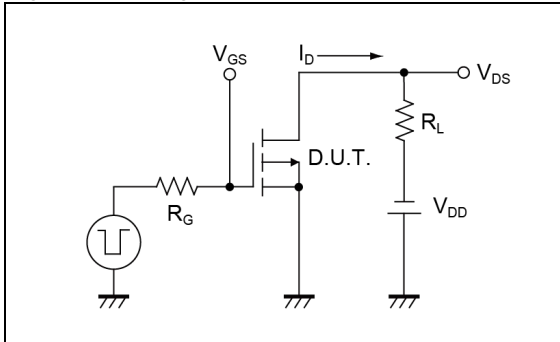


Fig.4-2 Switching Waveforms

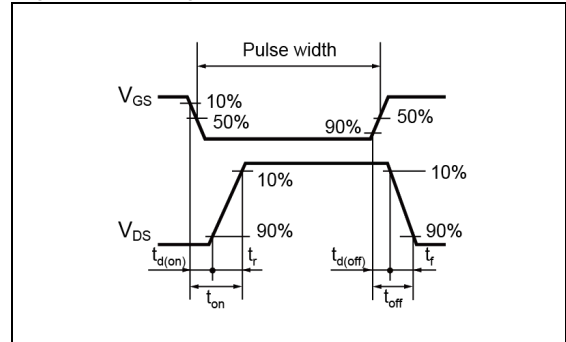


Fig.5-1 Gate Charge Measurement Circuit

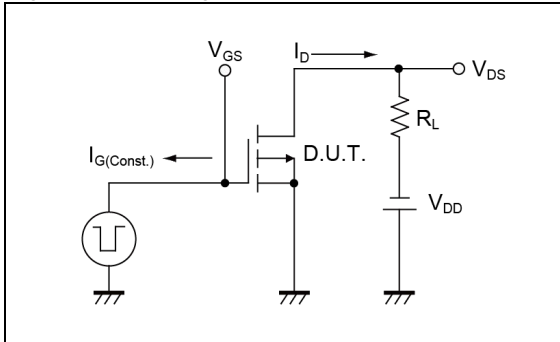


Fig.5-2 Gate Charge Waveform

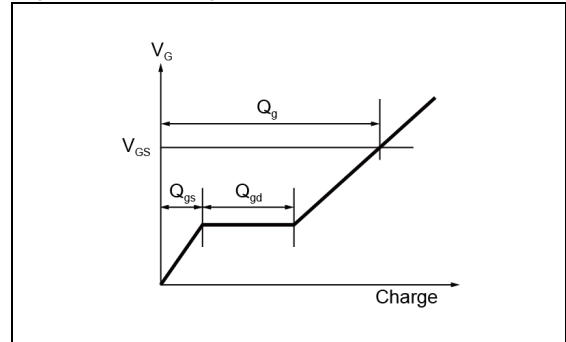


Fig.6-1 Avalanche Measurement Circuit

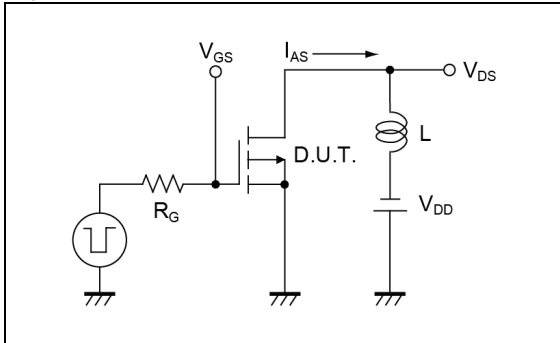
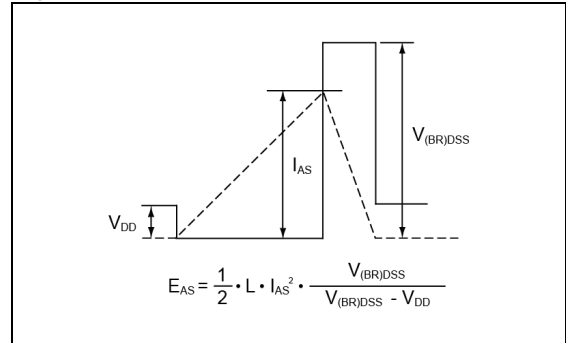


Fig.6-2 Avalanche Waveform

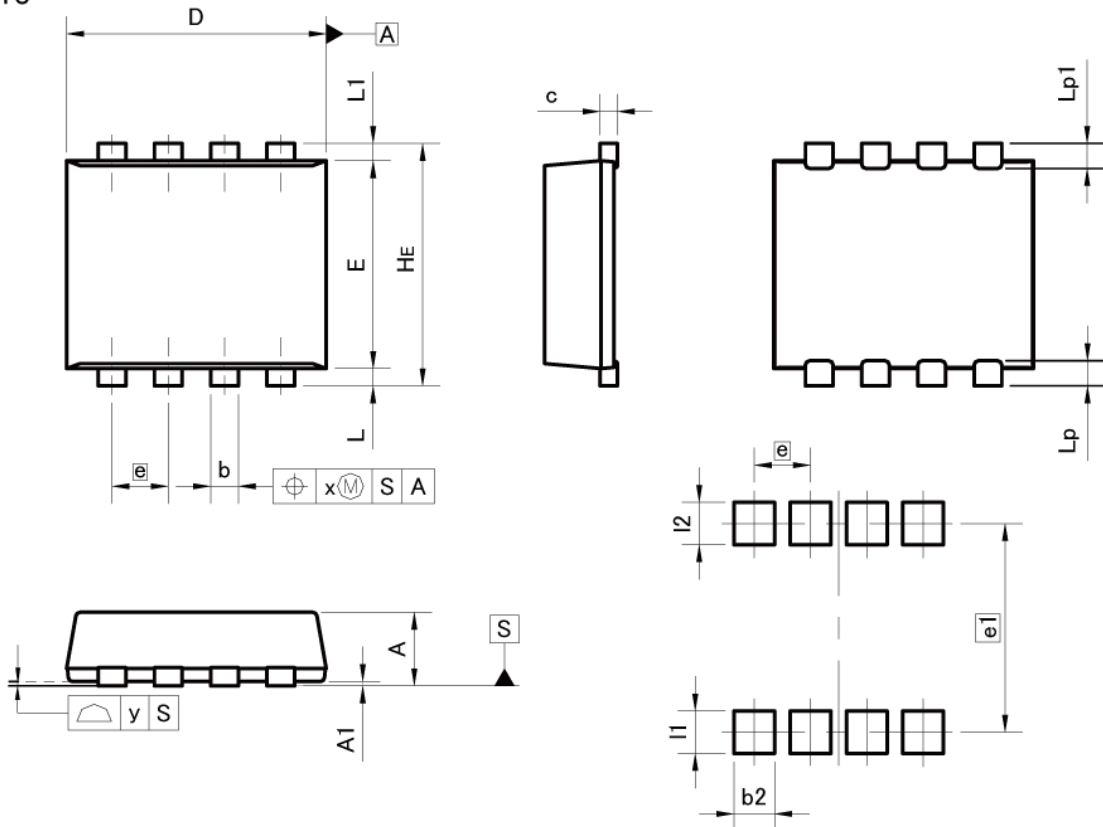


● Notice

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 | |
| I1 | - | 0.49 | - | 0.019 |
| I2 | - | 0.49 | - | 0.019 |

Dimension in mm/inches

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