

|                    |              |
|--------------------|--------------|
| $V_{DSS}$          | 500V         |
| $R_{DS(on)}(Max.)$ | 0.5 $\Omega$ |
| $I_D$              | $\pm 11A$    |
| $P_D$              | 75W          |

### ●Features

- 1) Low on-resistance.
- 2) Fast switching speed.
- 3) Gate-source voltage ( $V_{GSS}$ ) guaranteed to be  $\pm 30V$ .
- 4) Drive circuits can be simple.
- 5) Parallel use is easy.
- 6) Pb-free lead plating ; RoHS compliant

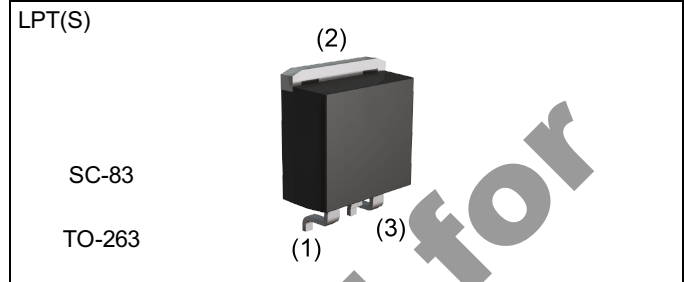
### ●Application

Switching Power Supply

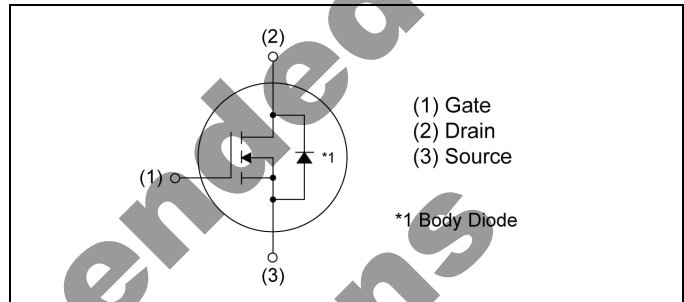
### ●Absolute maximum ratings ( $T_a = 25^\circ C$ )

| Parameter                                | Symbol                            | Value       | Unit       |
|------------------------------------------|-----------------------------------|-------------|------------|
| Drain - Source voltage                   | $V_{DSS}$                         | 500         | V          |
| Continuous drain current                 | $T_C = 25^\circ C$<br>$I_D^{*1}$  | $\pm 11$    | A          |
|                                          | $T_C = 100^\circ C$<br>$I_D^{*1}$ | $\pm 5.3$   | A          |
| Pulsed drain current                     | $I_{D,pulse}^{*2}$                | $\pm 44$    | A          |
| Gate - Source voltage                    | $V_{GSS}$                         | $\pm 30$    | V          |
| Avalanche energy, single pulse           | $E_{AS}^{*3}$                     | 8.1         | mJ         |
| Avalanche energy, repetitive             | $E_{AR}^{*4}$                     | 6.5         | mJ         |
| Avalanche current                        | $I_{AR}^{*3}$                     | 5.5         | A          |
| Power dissipation ( $T_C = 25^\circ C$ ) | $P_D$                             | 75          | W          |
| Junction temperature                     | $T_j$                             | 150         | $^\circ C$ |
| Range of storage temperature             | $T_{stg}$                         | -55 to +150 | $^\circ C$ |
| Reverse diode dv/dt                      | dv/dt                             | 15          | V/ns       |

### ●Outline



### ●Inner circuit



### ●Packaging specifications

| Type | Packing                   | Embossed Tape |
|------|---------------------------|---------------|
|      | Reel size (mm)            | 330           |
|      | Tape width (mm)           | 24            |
|      | Basic ordering unit (pcs) | 1000          |
|      | Taping code               | TL            |
|      | Marking                   | R5011ANJ      |

### ● Absolute maximum ratings

| Parameter                    | Symbol | Conditions                                        | Values | Unit |
|------------------------------|--------|---------------------------------------------------|--------|------|
| Drain - Source voltage slope | dv/dt  | $V_{DS} = 400V, I_D = 11A$<br>$T_j = 125^\circ C$ | 50     | V/ns |

### ● Thermal resistance

| Parameter                                    | Symbol     | Values |      |      | Unit         |
|----------------------------------------------|------------|--------|------|------|--------------|
|                                              |            | Min.   | Typ. | Max. |              |
| Thermal resistance, junction - case          | $R_{thJC}$ | -      | -    | 1.67 | $^\circ C/W$ |
| Thermal resistance, junction - ambient       | $R_{thJA}$ | -      | -    | 80   | $^\circ C/W$ |
| Soldering temperature, wavesoldering for 10s | $T_{sld}$  | -      | -    | 265  | $^\circ C$   |

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

| Parameter                                   | Symbol            | Conditions                                         | Values |      |           | Unit     |
|---------------------------------------------|-------------------|----------------------------------------------------|--------|------|-----------|----------|
|                                             |                   |                                                    | Min.   | Typ. | Max.      |          |
| Drain - Source breakdown voltage            | $V_{(BR)DSS}$     | $V_{GS} = 0V, I_D = 1mA$                           | 500    | -    | -         | V        |
| Drain - Source avalanche breakdown voltage  | $V_{(BR)DS}$      | $V_{GS} = 0V, I_D = 5.5A$                          | -      | 580  | -         | V        |
| Zero gate voltage drain current             | $I_{DSS}$         | $V_{DS} = 500V, V_{GS} = 0V$<br>$T_j = 25^\circ C$ | -      | 0.1  | 100       | $\mu A$  |
|                                             |                   | $T_j = 125^\circ C$                                | -      | -    | 1000      |          |
| Gate - Source leakage current               | $I_{GSS}$         | $V_{GS} = \pm 30V, V_{DS} = 0V$                    | -      | -    | $\pm 100$ | nA       |
| Gate threshold voltage                      | $V_{GS(th)}$      | $V_{DS} = 10V, I_D = 1mA$                          | 2.5    | -    | 4.5       | V        |
| Static drain - source on - state resistance | $R_{DS(on)}^{*6}$ | $V_{GS} = 10V, I_D = 5.5A$<br>$T_j = 25^\circ C$   | -      | 0.38 | 0.5       | $\Omega$ |
|                                             |                   | $T_j = 125^\circ C$                                | -      | 0.79 | -         |          |
| Gate input resistance                       | $R_G$             | f = 1MHz, open drain                               | -      | 9.0  | -         | $\Omega$ |

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

| Parameter                                    | Symbol            | Conditions                                                    | Values |      |      | Unit |
|----------------------------------------------|-------------------|---------------------------------------------------------------|--------|------|------|------|
|                                              |                   |                                                               | Min.   | Typ. | Max. |      |
| Transconductance                             | $g_{fs}^{*6}$     | $V_{DS} = 10\text{V}, I_D = 5.5\text{A}$                      | 3.5    | 8    | -    | S    |
| Input capacitance                            | $C_{iss}$         | $V_{GS} = 0\text{V}$                                          | -      | 1000 | -    | pF   |
| Output capacitance                           | $C_{oss}$         | $V_{DS} = 25\text{V}$                                         | -      | 400  | -    |      |
| Reverse transfer capacitance                 | $C_{rss}$         | $f = 1\text{MHz}$                                             | -      | 35   | -    |      |
| Effective output capacitance, energy related | $C_{o(er)}$       | $V_{GS} = 0\text{V},$<br>$V_{DS} = 0\text{V to } 400\text{V}$ | -      | 44.1 | -    | pF   |
| Effective output capacitance, time related   | $C_{o(tr)}$       |                                                               | -      | 114  | -    |      |
| Turn - on delay time                         | $t_{d(on)}^{*6}$  | $V_{DD} \approx 250\text{V}, V_{GS} = 10\text{V}$             | -      | 26   | -    | ns   |
| Rise time                                    | $t_r^{*6}$        | $I_D = 5.5\text{A}$                                           | -      | 28   | -    |      |
| Turn - off delay time                        | $t_{d(off)}^{*6}$ | $R_L \approx 45.5\Omega$                                      | -      | 75   | 150  |      |
| Fall time                                    | $t_f^{*6}$        | $R_G = 10\Omega$                                              | -      | 30   | 60   |      |

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

| Parameter            | Symbol          | Conditions                                     | Values |      |      | Unit |
|----------------------|-----------------|------------------------------------------------|--------|------|------|------|
|                      |                 |                                                | Min.   | Typ. | Max. |      |
| Total gate charge    | $Q_g^{*6}$      | $V_{DD} \approx 250\text{V}$                   | -      | 30   | -    | nC   |
| Gate - Source charge | $Q_{gs}^{*6}$   | $I_D = 11\text{A}$                             | -      | 7    | -    |      |
| Gate - Drain charge  | $Q_{gd}^{*6}$   | $V_{GS} = 10\text{V}$                          | -      | 12   | -    |      |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD} \approx 250\text{V}, I_D = 11\text{A}$ | -      | 6.7  | -    | V    |

\*1 Limited only by maximum temperature allowed.

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

\*3  $L \approx 500\mu\text{H}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\Omega$ , starting  $T_j = 25^\circ\text{C}$

\*4  $L \approx 500\mu\text{H}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\Omega$ , starting  $T_j = 25^\circ\text{C}$ ,  $f = 10\text{kHz}$

\*5 Reference measurement circuits Fig.5-1.

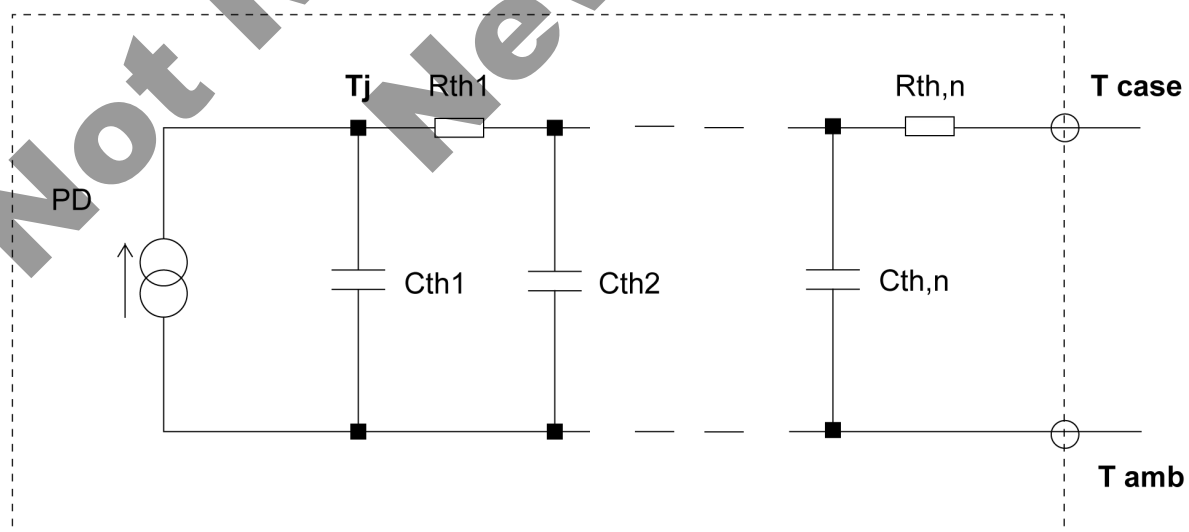
\*6 Pulsed

**●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     | $I_S^{*1}$    | $T_C = 25^\circ\text{C}$                                | -      | -    | 11   | A                      |
| Inverse diode direct current, pulsed          | $I_{SM}^{*2}$ |                                                         | -      | -    | 44   | A                      |
| Forward voltage                               | $V_{SD}^{*6}$ | $V_{GS} = 0\text{V}, I_S = 11\text{A}$                  | -      | -    | 1.5  | V                      |
| Reverse recovery time                         | $t_{rr}^{*6}$ | $I_S = 11\text{A}$<br>$di/dt = 100\text{A}/\mu\text{s}$ | -      | 343  | -    | ns                     |
| Reverse recovery charge                       | $Q_{rr}^{*6}$ |                                                         | -      | 3.1  | -    | $\mu\text{C}$          |
| Peak reverse recovery current                 | $I_{rm}^{*6}$ |                                                         | -      | 18.1 | -    | A                      |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$  | $T_j = 25^\circ\text{C}$                                | -      | 500  | -    | $\text{A}/\mu\text{s}$ |

**●Typical transient thermal characteristics**

| Symbol    | Value  | Unit | Symbol    | Value   | Unit |
|-----------|--------|------|-----------|---------|------|
| $R_{th1}$ | 0.0868 | K/W  | $C_{th1}$ | 0.00172 | Ws/K |
| $R_{th2}$ | 0.340  |      | $C_{th2}$ | 0.00589 |      |
| $R_{th3}$ | 0.613  |      | $C_{th3}$ | 0.18    |      |



# ●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

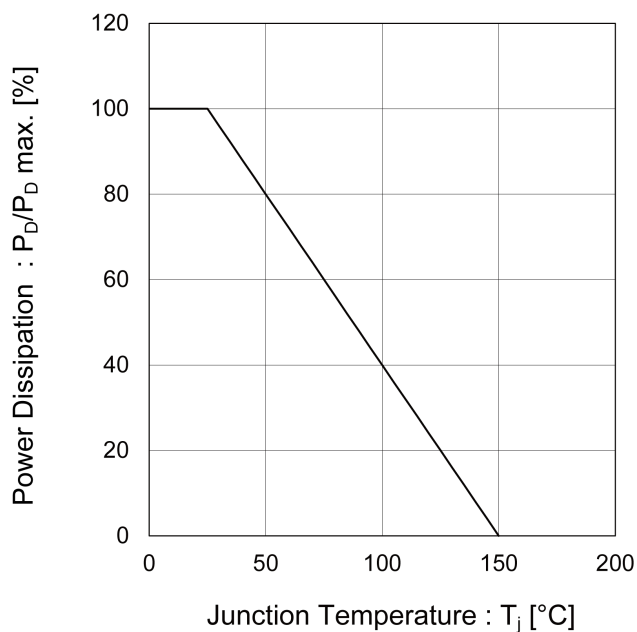


Fig.2 Maximum Safe Operating Area

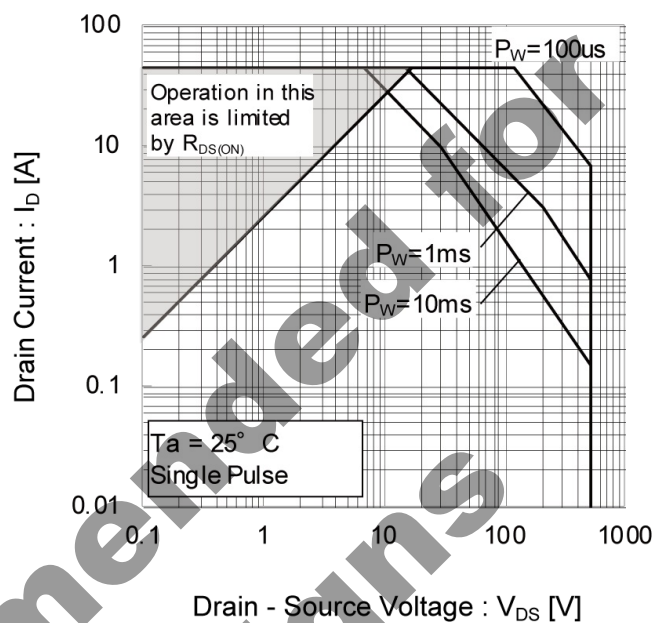
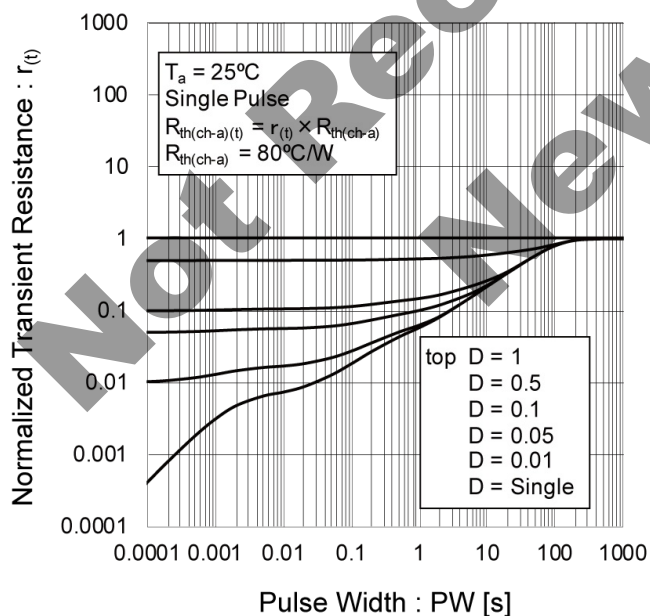


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width



## ●Electrical characteristic curves

Fig.4 Avalanche Current vs. Inductive Load

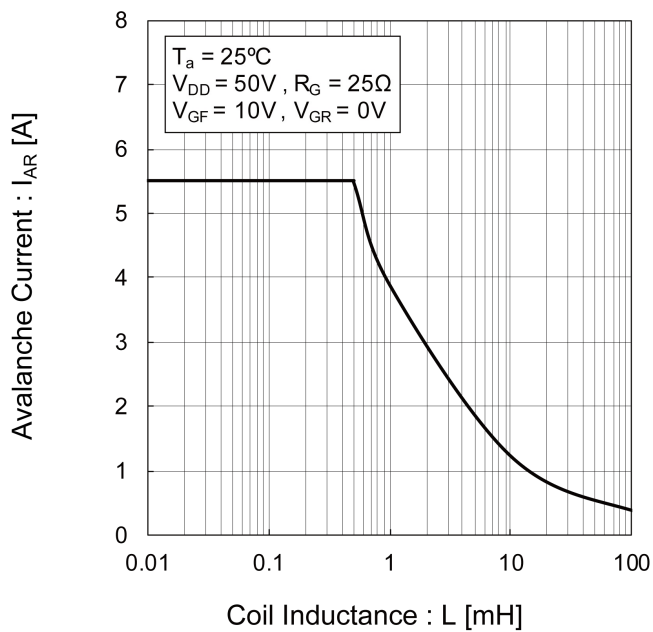


Fig.5 Avalanche Power Losses

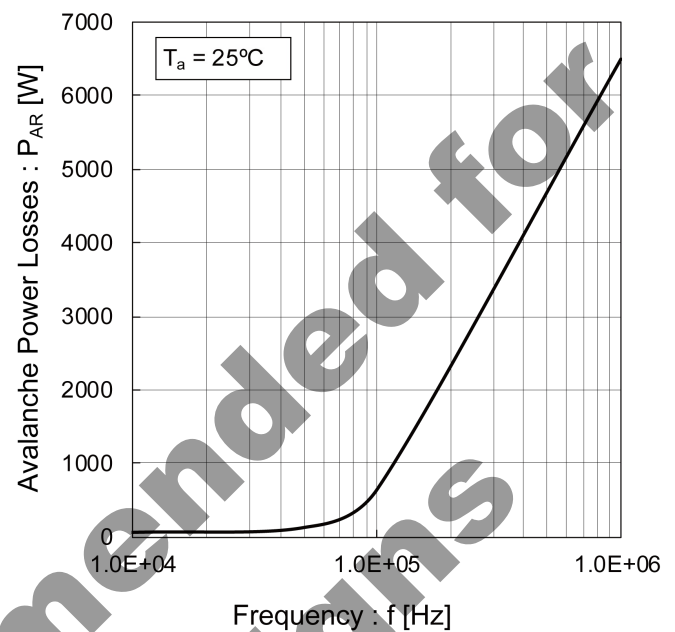
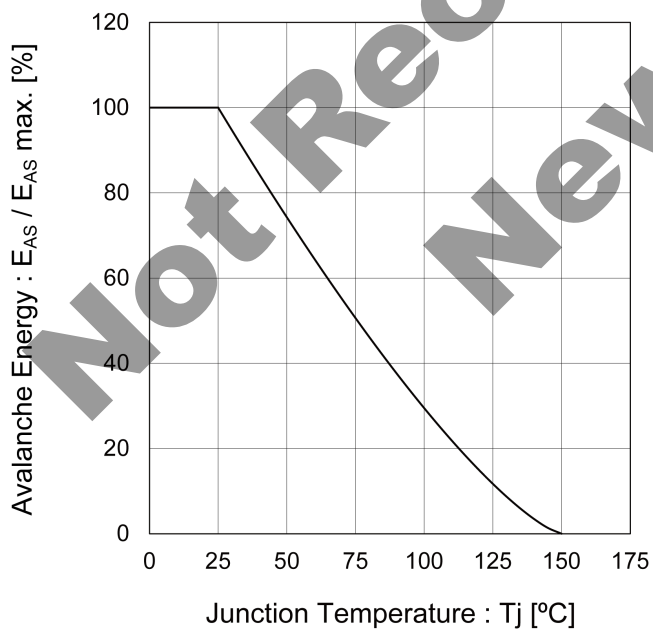


Fig.6 Avalanche Energy Derating Curve vs. Junction Temperature



# ●Electrical characteristic curves

Fig.7 Typical Output Characteristics(I)

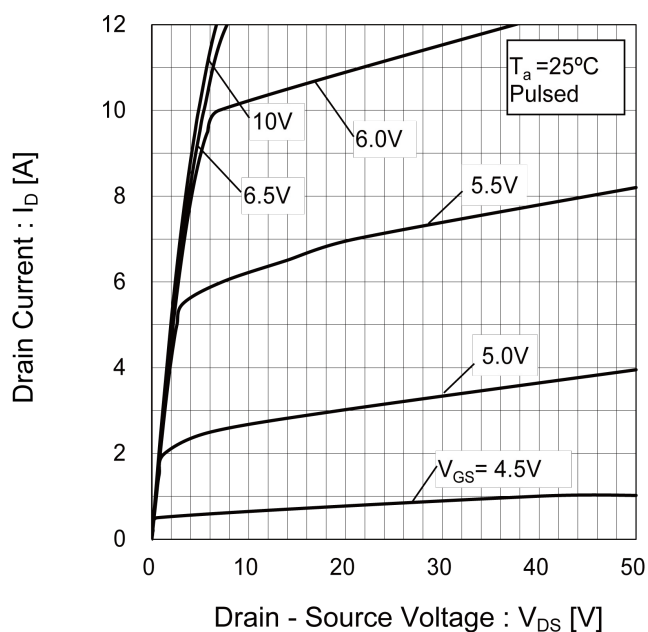
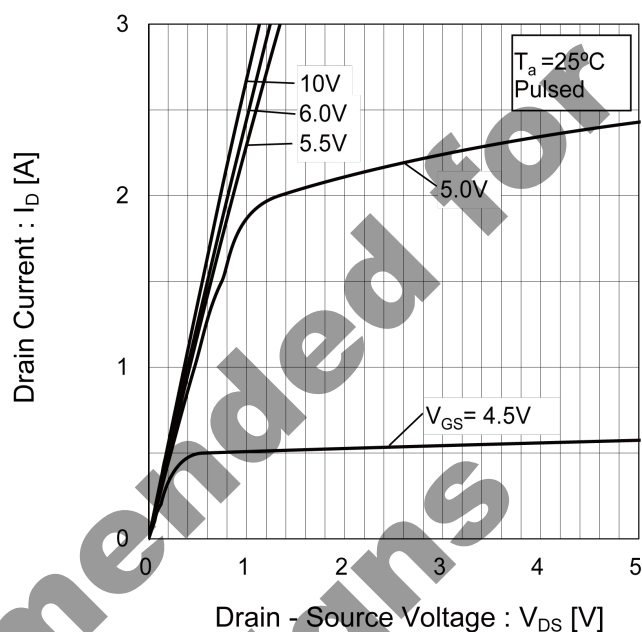
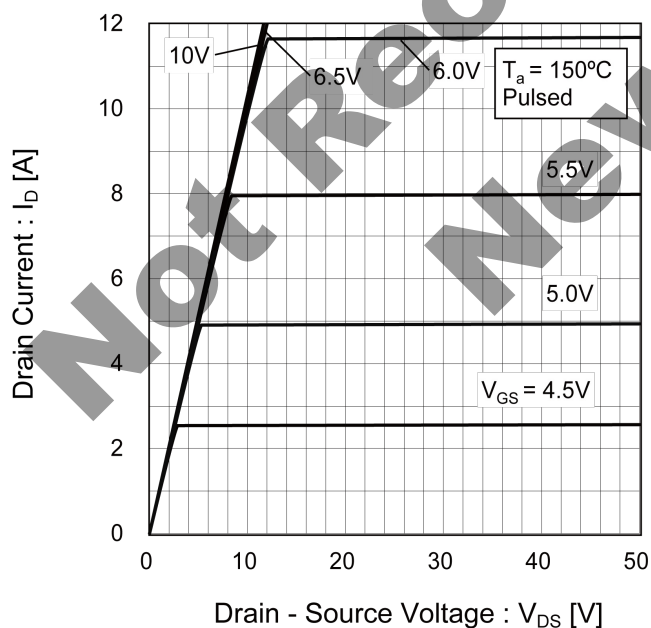
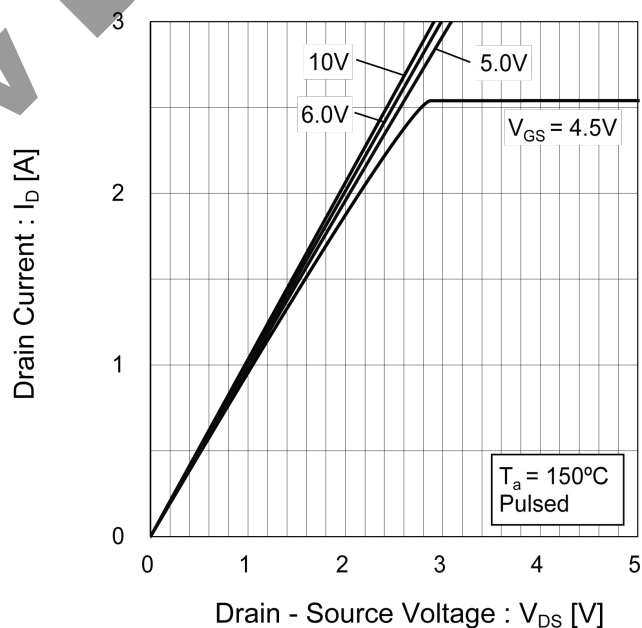


Fig.8 Typical Output Characteristics(II)

Fig.9  $T_j = 150^\circ\text{C}$  Typical Output Characteristics (I)Fig.10  $T_j = 150^\circ\text{C}$  Typical Output Characteristics (II)

## ●Electrical characteristic curves

Fig.11 Breakdown Voltage vs. Junction Temperature

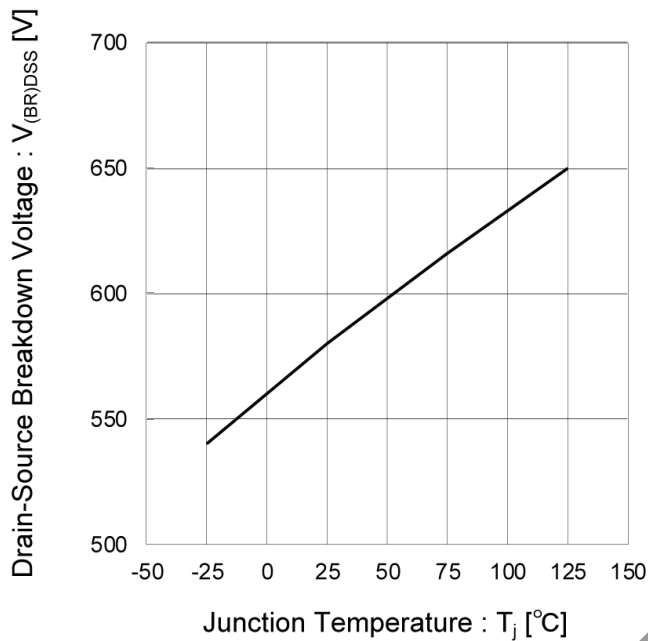


Fig.12 Typical Transfer Characteristics

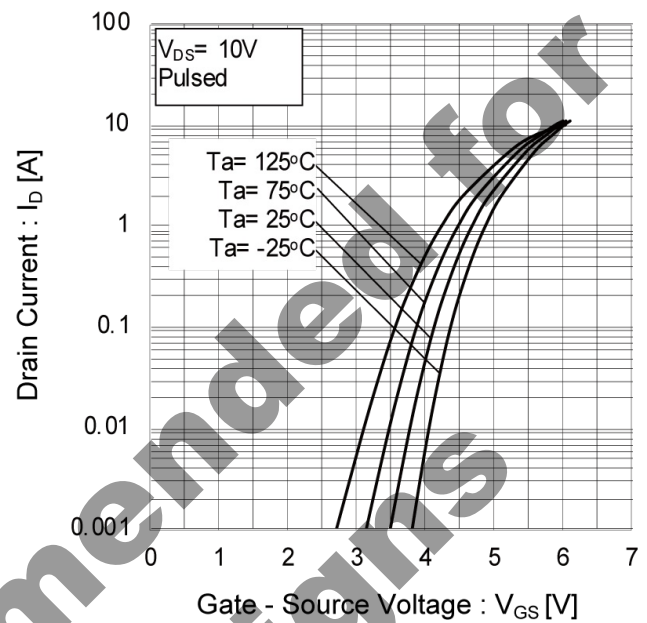


Fig.13 Gate Threshold Voltage vs. Junction Temperature

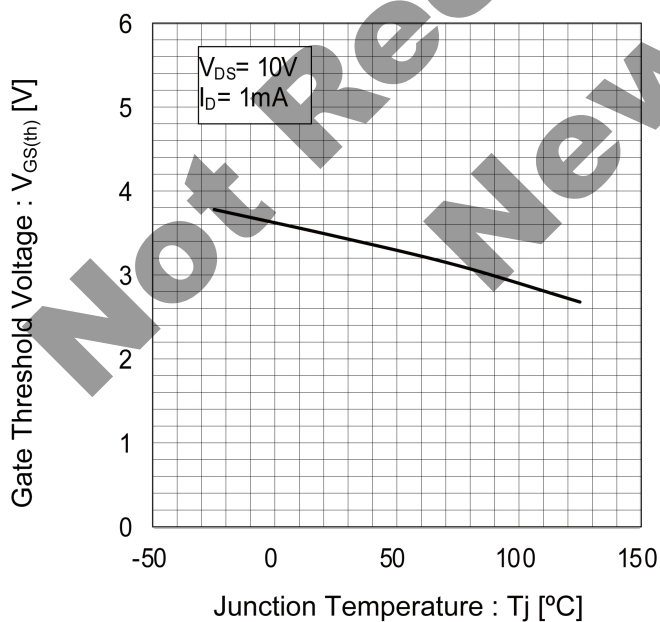
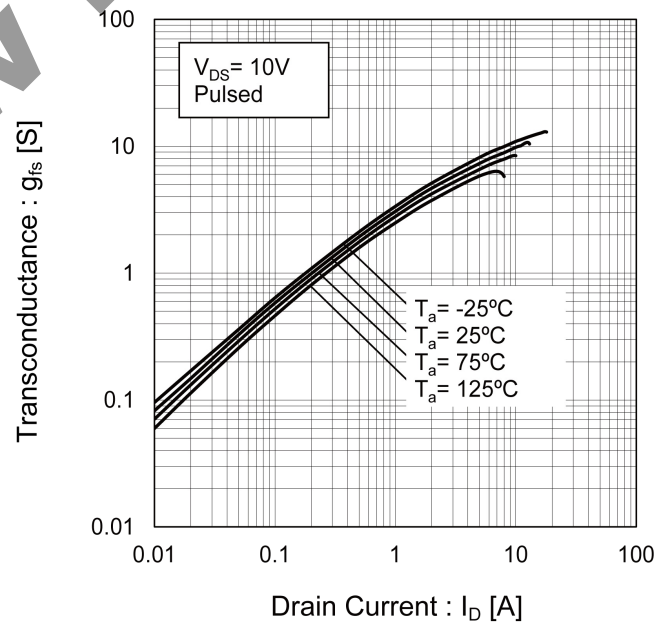


Fig.14 Transconductance vs. Drain Current



# ●Electrical characteristic curves

Fig.15 Static Drain - Source On - State Resistance vs. Gate Source Voltage

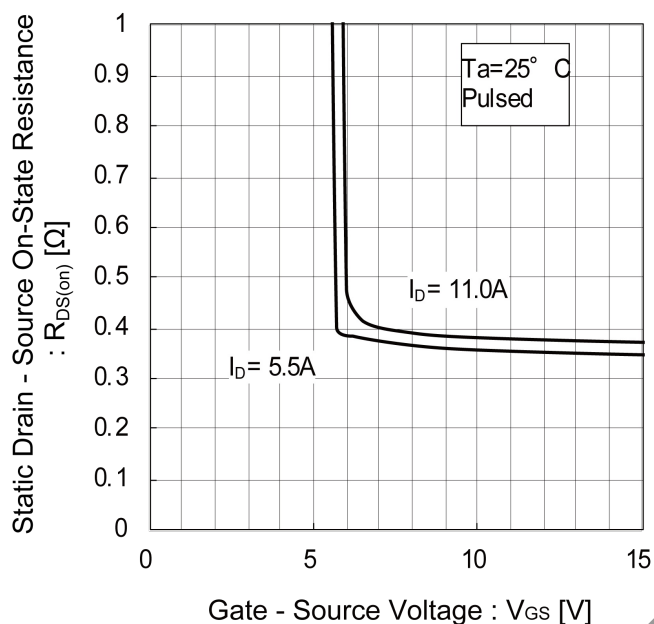


Fig.16 Static Drain - Source On - State Resistance vs. Junction Temperature

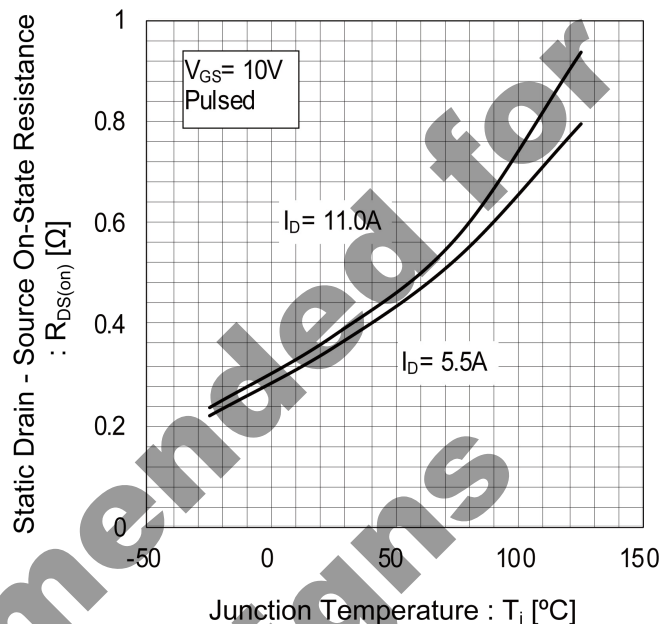
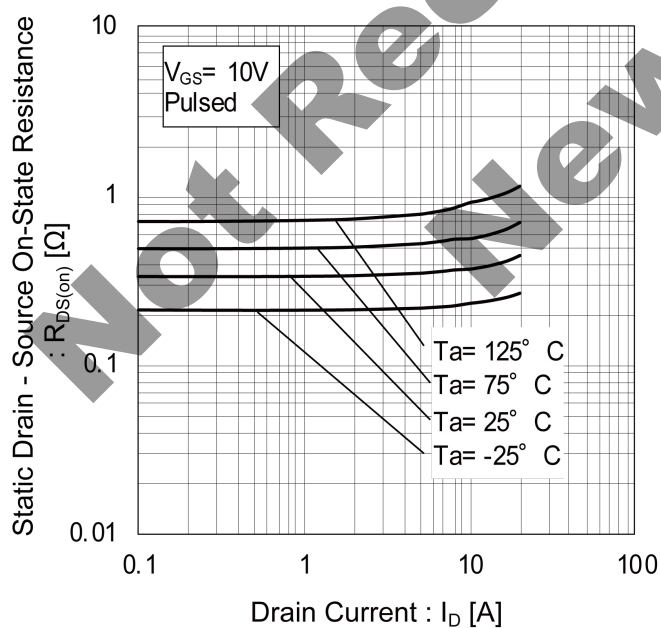


Fig.17 Static Drain - Source On - State Resistance vs. Drain Current



# ●Electrical characteristic curves

Fig.18 Typical Capacitance vs. Drain - Source Voltage

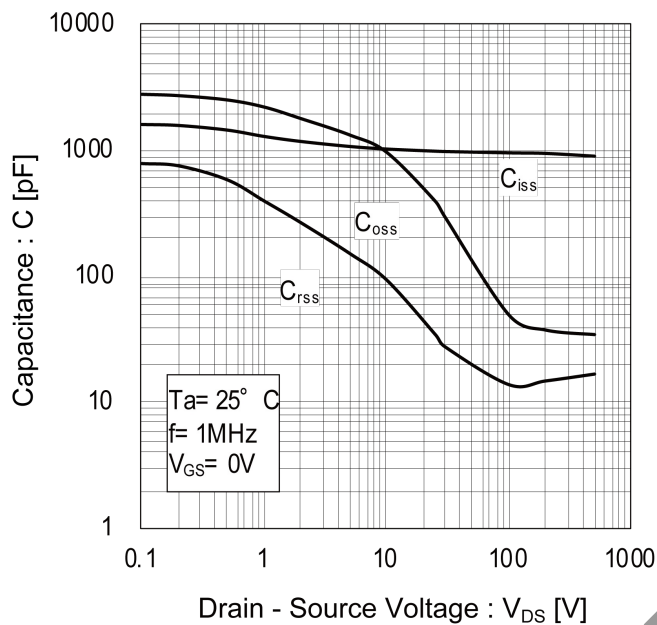


Fig.19 Coss Stored Energy

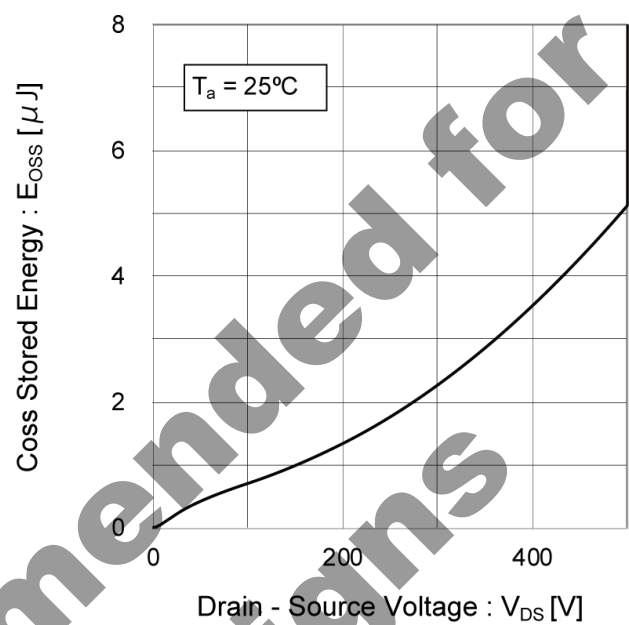


Fig.20 Switching Characteristics

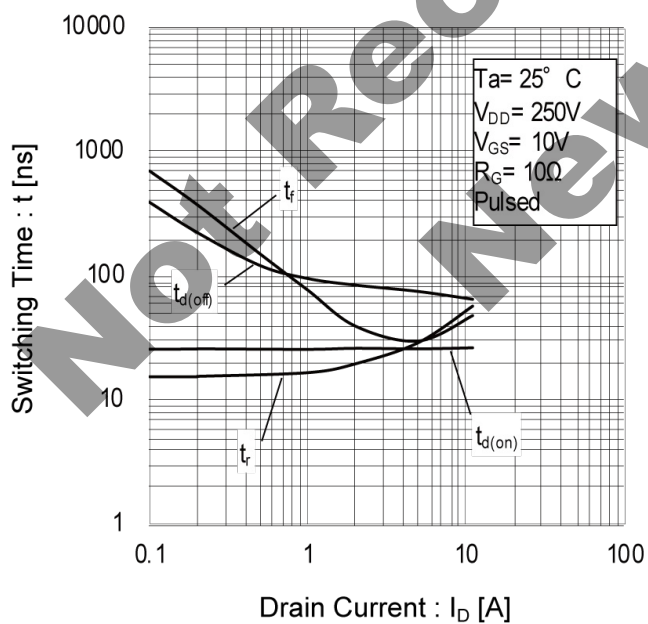
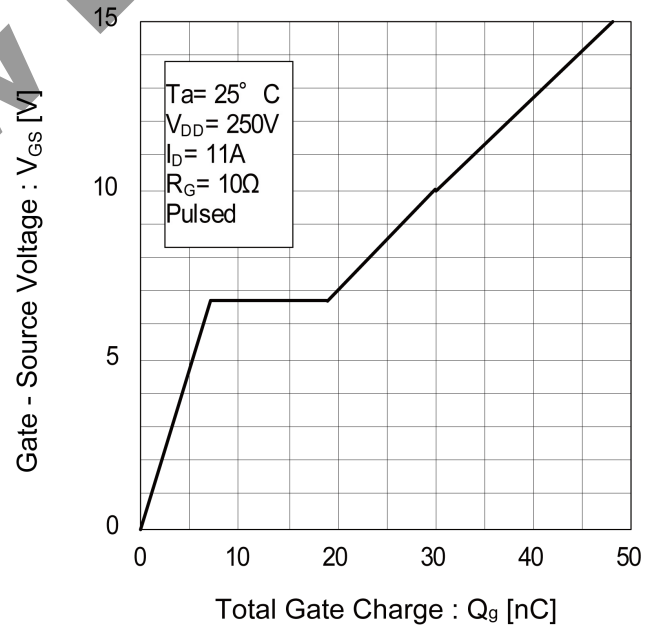


Fig.21 Dynamic Input Characteristics



# ●Electrical characteristic curves

Fig.22 Inverse Diode Forward Current vs.  
Source - Drain Voltage

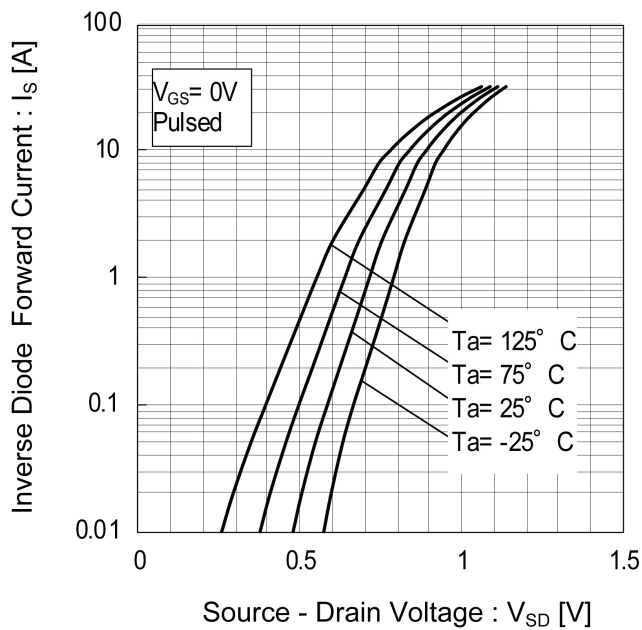
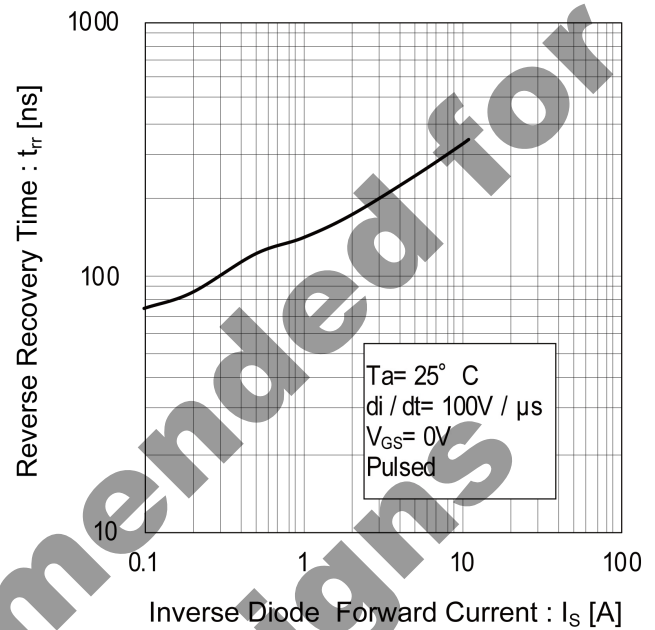


Fig.23 Reverse Recovery Time vs.  
Inverse Diode Forward Current



## ● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

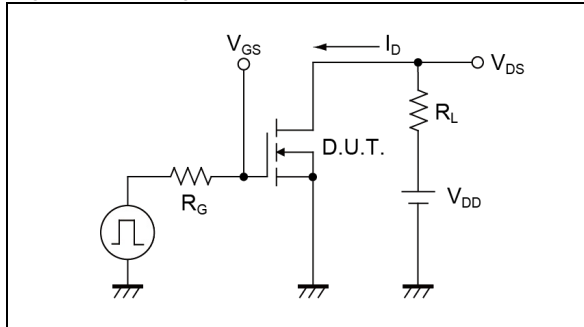


Fig.1-2 Switching Waveforms

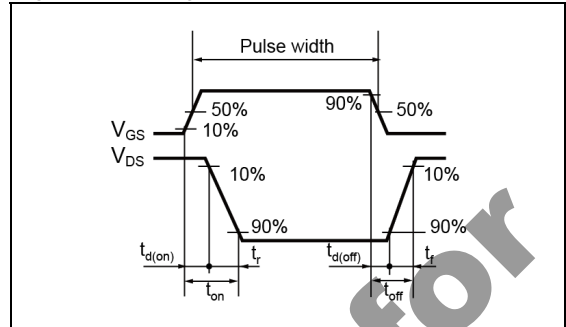


Fig.2-1 Gate Charge Measurement Circuit

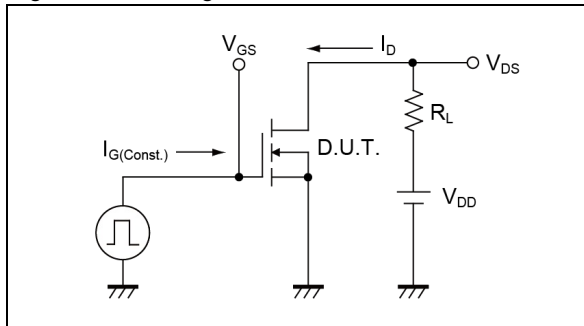


Fig.2-2 Gate Charge Waveform

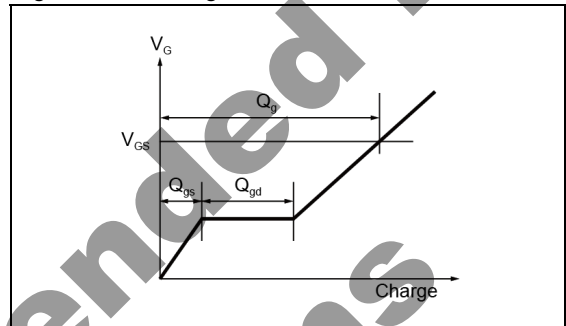


Fig.3-1 Avalanche Measurement Circuit

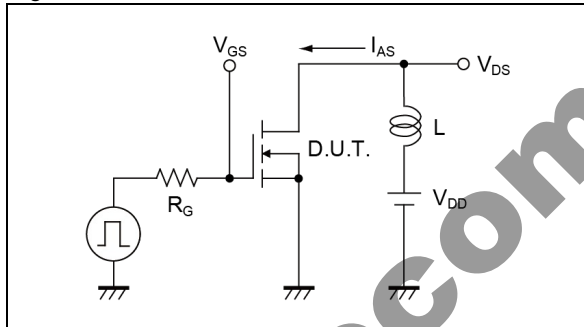


Fig.3-2 Avalanche Waveform

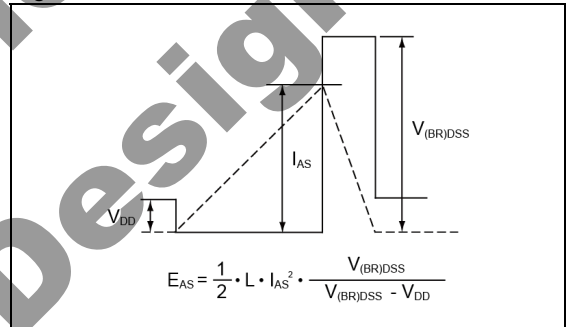


Fig.4-1 dv/dt Measurement Circuit

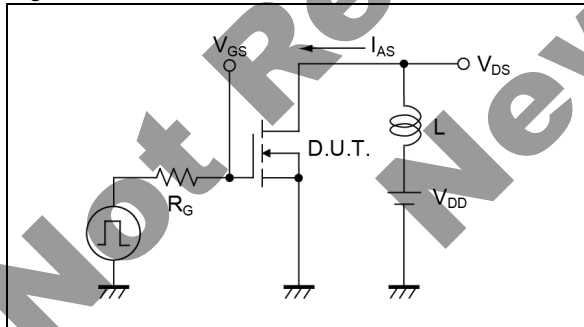


Fig.4-2 dv/dt Waveform

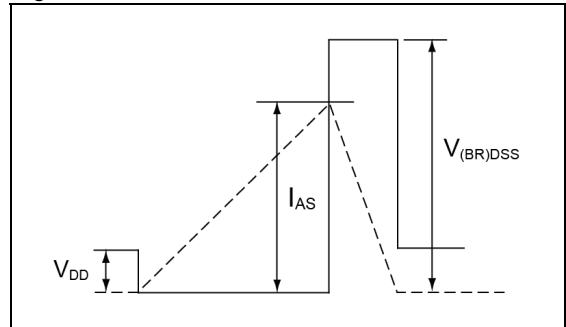


Fig.5-1 di/dt Measurement Circuit

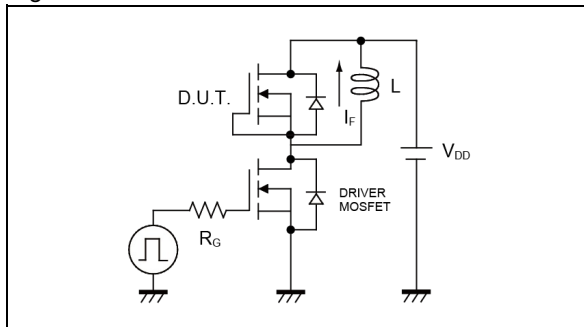
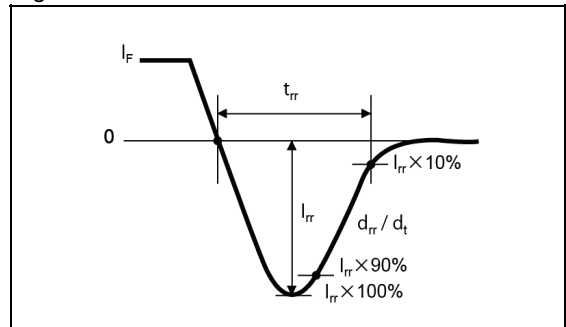
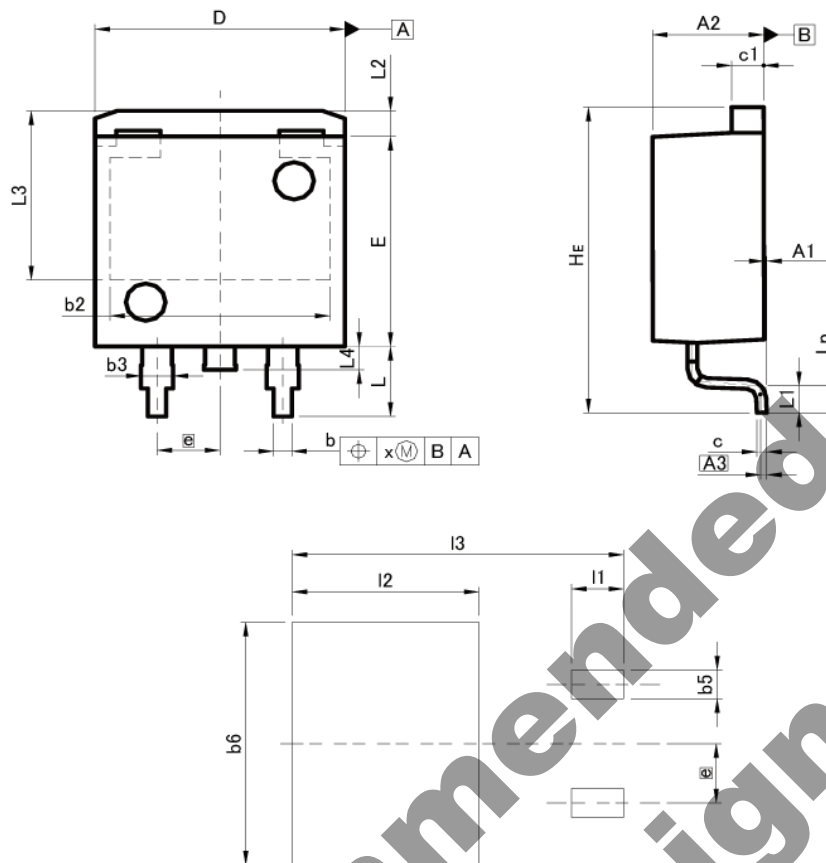


Fig.5-2 di/dt Waveform



●Dimensions

LPTS  
< TO-263 >  
( D2PAK )



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

| DIM | MILIMETERS |       | INCHES |       |
|-----|------------|-------|--------|-------|
|     | MIN        | MAX   | MIN    | MAX   |
| A1  | 0.00       | 0.30  | 0.000  | 0.012 |
| A2  | 4.30       | 4.70  | 0.169  | 0.185 |
| A3  | 0.25       |       | 0.010  |       |
| b   | 0.68       | 0.98  | 0.027  | 0.039 |
| b2  | 8.90       |       | 0.350  |       |
| b3  | 1.14       | 1.44  | 0.045  | 0.057 |
| c   | 0.30       | 0.60  | 0.012  | 0.024 |
| c1  | 1.10       | 1.50  | 0.043  | 0.059 |
| D   | 9.80       | 10.40 | 0.386  | 0.409 |
| E   | 8.80       | 9.20  | 0.346  | 0.362 |
| e   | 2.54       |       | 0.100  |       |
| HE  | 12.80      | 13.40 | 0.504  | 0.528 |
| L   | 2.70       | 3.30  | 0.106  | 0.130 |
| L1  | 0.90       | 1.50  | 0.035  | 0.059 |
| L2  | 1.10       |       | 0.043  |       |
| L3  | 7.25       |       | 0.285  |       |
| L4  | 1.00       |       | 0.039  |       |
| Lp  | 0.90       | 1.50  | 0.035  | 0.059 |
| x   | -          | 0.25  | -      | 0.010 |

| DIM | MILIMETERS |       | INCHES |       |
|-----|------------|-------|--------|-------|
|     | MIN        | MAX   | MIN    | MAX   |
| b5  | -          | 1.23  | -      | 0.049 |
| b6  | -          | 10.40 | -      | 0.409 |
| l1  | -          | 2.10  | -      | 0.083 |
| l2  | -          | 7.55  | -      | 0.297 |
| l3  | -          | 13.40 | -      | 0.528 |

Dimension in mm/inches

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