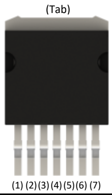
# SCT4090KWAHR

**Automotive Grade N-channel SiC power MOSFET** Datasheet

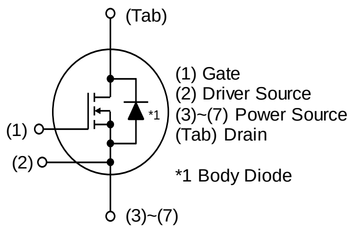
| | |
|---|---|
| $V_{DSS}$ | 1200V |
| $R_{DS(on)}$ (Typ.) | 90mΩ |
| $I_D$ *1 | 17A |
| $P_D$ | 71W |

## ●Outline

TO-263-7LA




## ●Inner circuit




Please note Driver Source and Power Source are not exchangeable. Their exchange might lead to malfunction.

## ● Features

1) Qualified to AEC-Q101

2) Low on-resistance

3) Fast switching speed

4) Fast reverse recovery

5) Easy to parallel

6) Simple to drive

7) Pb-free lead plating ; RoHS compliant

8) Wide creepage distance = min.4.7 mm

## ● Application

・Automobile

・Switch mode power supplies

## ●Packaging specifications

| | | |
|---|---|---|
| Type | Packing | Embossed tape |
| | Reel size (mm) | 330 |
| | Tape width (mm) | 24 |
| | Basic ordering unit (pcs) | 1000 |
| | Taping code | TL |
| | Marking | SCT4090KWA |

## ●Absolute maximum ratings ($T_{vj}$ = 25°C unless otherwise specified)

| Parameter | | | Symbol | Value | Unit |
|---|---|---|---|---|---|
| Drain - source voltage | | | $V_{DSS}$ | 1200 | V |
| Continuous drain and source current | $V_{GS} = V_{GS\_on}$ | $T_c$ = 25°C | $I_D$, $I_S$ *1 | 17 | A |
| | | $T_c$ = 100°C | | 12 | A |
| Pulsed drain current | $V_{GS} = V_{GS\_on}$ | $T_c$ = 25°C | $I_{D,pulse}$ *2 | 45 | A |
| Body diode pulsed forward current | | $T_c$ = 25°C $V_{GS}$ = 0 V | $I_{S,pulse}$ *1,*3 | 17 | A |
| Body diode surge forward current | | | $I_{S,pulse}$ *1,*4 | 45 | A |
| Gate - source voltage (DC) | | | $V_{GSS\_DC}$ | -4 to +21 | V |
| Gate - source surge voltage ($t_{surge}$ < 300ns) | | | $V_{GSS\_surge}$ *5 | -4 to +23 | V |
| Recommended turn-on gate - source drive voltage | | | $V_{GS\_on}$ *6 | +15 to +18 | V |
| Recommended turn-off gate - source drive voltage | | | $V_{GS\_off}$ | 0 | V |
| Virtual junction temperature | | | $T_{vj}$ | 175 | °C |
| Range of storage temperature | | | $T_{stg}$ | -40 to +175 | °C |

## ●Electrical characteristics ($T_{vj}$ = 25°C unless otherwise specified)

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Drain - Source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 3.7mA<br>$T_{vj}$ = 25°C | 1200 | - | - | V |
| Zero Gate voltage Drain current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DS}$ =1200V<br>$T_{vj}$ = 25°C<br>$T_{vj}$ = 150°C | -<br>- | 1<br>10 | 80<br>- | μA |
| Gate - Source leakage current | $I_{GSS+}$ | $V_{GS}$ = +21V , $V_{DS}$ = 0V | - | - | 100 | nA |
| Gate - Source leakage current | $I_{GSS-}$ | $V_{GS}$ = -4V , $V_{DS}$ = 0V | - | - | -100 | nA |
| Gate threshold voltage | $V_{GS(th)}$ *7 | $V_{DS}$ = 10V, $I_D$ = 4.44mA | 2.8 | - | 4.8 | V |
| Static Drain - Source on - state resistance | $R_{DS(on)}$ *8 | $V_{GS}$ = 18V, $I_D$ = 8.3A<br>$T_{vj}$ = 25°C<br>$T_{vj}$ = 150°C | -<br>- | 90<br>180 | 117<br>- | mΩ |
| Gate input resistance | $R_G$ | f = 1MHz, open drain | - | 4 | - | Ω |

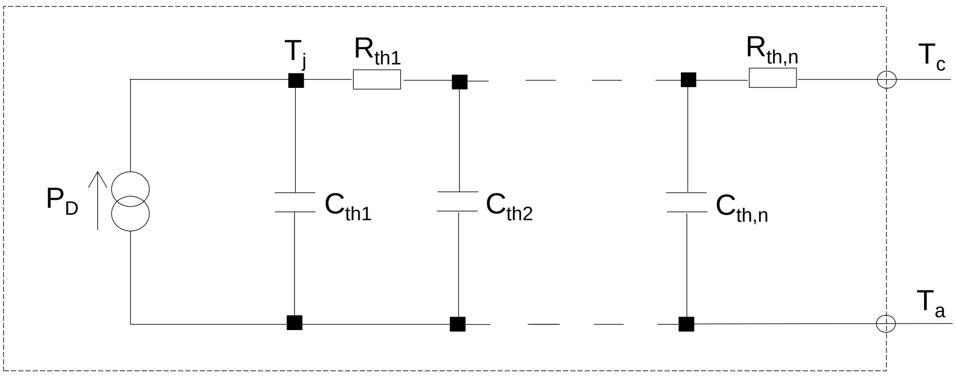
## ●Thermal resistance

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| Thermal resistance, junction - case | $R_{thJC}$ *9 | - | 1.6 | 2.1 | K/W |

## ●Typical Transient Thermal Characteristics

| Symbol | Value | Unit |
|---|---|---|
| $R_{th1}$ | $3.0 \times 10^{-1}$ | K/W |
| $R_{th2}$ | $5.8 \times 10^{-1}$ | K/W |
| $R_{th3}$ | $7.2 \times 10^{-1}$ | K/W |

| Symbol | Value | Unit |
|---|---|---|
| $C_{th1}$ | $2.4 \times 10^{-4}$ | Ws/K |
| $C_{th2}$ | $1.0 \times 10^{-3}$ | Ws/K |
| $C_{th3}$ | $2.7 \times 10^{-3}$ | Ws/K |



● **Electrical characteristics** ($T_{vj}$ = 25°C unless otherwise specified)

| Parameter | | Symbol | Conditions | Values Min. | Values Typ. | Values Max. | Unit |
|---|---|---|---|---|---|---|---|
| Transconductance | | $g_{fs}$ *8 | $V_{DS}$ = 10V, $I_D$ = 8.3A | - | 4.1 | - | S |
| Input capacitance | | $C_{iss}$ | $V_{GS}$ = 0V<br>$V_{DS}$ = 800V<br>f = 1MHz | - | 1026 | - | pF |
| Output capacitance | | $C_{oss}$ | | - | 35 | - | |
| Reverse transfer capacitance | | $C_{rss}$ | | - | 3 | - | |
| Effective output capacitance, energy related | | $C_{o(er)}$ | $V_{GS}$ = 0V<br>$V_{DS}$ = 0V to 800V | - | 44 | - | pF |
| Total Gate charge | | $Q_g$ *8 | $V_{DS}$ = 800V<br>$I_D$ = 8.3A<br>$V_{GS}$ = 18V<br>See Fig. 1-1, 1-2. | - | 48 | - | nC |
| Gate - Source charge | | $Q_{gs}$ *8 | | - | 11 | - | |
| Gate - Drain charge | | $Q_{gd}$ *8 | | - | 16 | - | |
| Turn - on delay time | | $t_{d(on)}$ *8 | $V_{DS}$ = 800V<br>$I_D$ = 8.3A<br>$V_{GS}$ = +18V / 0V<br>$R_G$ = 0Ω, L = 250μH<br>$E_{on}$ includes diode reverse recovery<br>$L_σ$ = 50nH, $C_σ$ = 10pF<br>See Fig. 2-1, 2-2, 2-3. | - | 4.4 | - | ns |
| Rise time | | $t_r$ *8 | | - | 9.8 | - | |
| Turn - off delay time | | $t_{d(off)}$ *8 | | - | 19 | - | |
| Fall time | | $t_f$ *8 | | - | 16 | - | |
| Turn - on switching loss | | $E_{on}$ *8 | | - | 100 | - | μJ |
| Turn - off switching loss | | $E_{off}$ *8 | | - | 9 | - | |
| Short-circuit withstand time | $V_{GS(on)}$ = +15V | $t_{sc}$ *10 | $V_{DS}$ ≦ 800V<br>$V_{DS,peak}$ ≦ 1200V<br>$T_{vj(start)}$ = 25°C<br>$R_G$ = 2.2Ω | - | 4.5 | - | μs |
| | $V_{GS(on)}$ = +18V | | | - | 4.0 | - | μs |

●**Body diode electrical characteristics** (Source-Drain) ($T_{vj}$ = 25°C unless otherwise specified)

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Forward voltage | $V_{SD}$ *8 | $V_{GS}$ = 0V, $I_S$ = 8.3A | - | 3.3 | - | V |
| Reverse recovery time | $t_{rr}$ *8 | $I_F$ = 8.3A<br>$V_R$ = 800V<br>di/dt = 3000A/μs<br>$L_σ$ = 50nH, $C_σ$ = 10pF<br>See Fig. 3-1, 3-2. | - | 8.5 | - | ns |
| Reverse recovery charge | $Q_{rr}$ *8 | | - | 90 | - | nC |
| Peak reverse recovery current | $I_{rrm}$ *8 | | - | 21 | - | A |

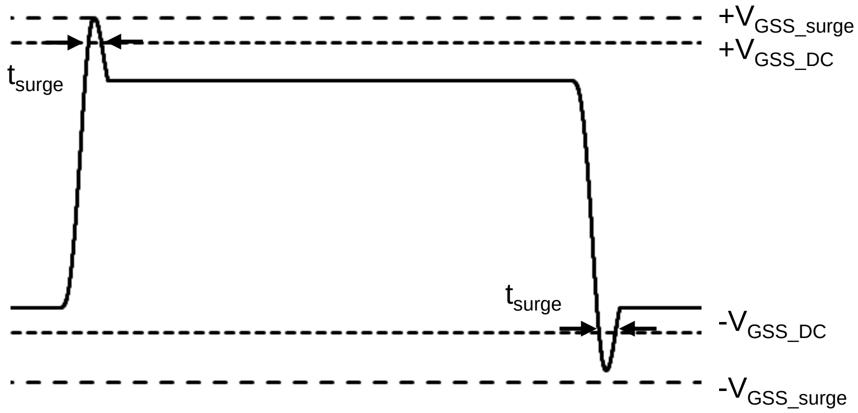
*1 Limited by maximum $T_{vj}$ and for Max. $R_{thJC}$.

*2 Pulse width and duty cycle are limited by $T_{vj,max}$.

*3 Only for body-diode, Repetitive pulse, PW ≤ 1.5μs, Duty cycle ≤ 5%

*4 When used as a protective function, PW ≤ 10μs

*5 Example of acceptable $V_{GS}$ waveform




*6 Please be advised not to use SiC-MOSFETs with $V_{GS}$ below 10V as doing so may cause thermal runaway.

*7 Tested after applying $V_{GS}$ = 21V for 100ms.

*8 Pulsed

*9 Measured conformable to JESD51-14.

See the application note "rthjc_measurement_and_usage_an-e.pdf". Link

URL: https://fscdn.rohm.com/en/products/databook/applinote/discrete/common/rthjc_measurement_and_usage_an-e.pdf

*10 The value is based on TO-247 package. Single Pulsed.

## ●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

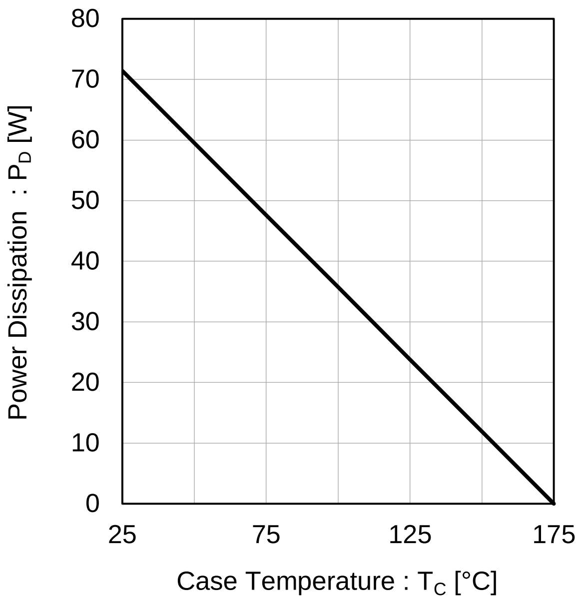



Fig.2 Maximum Safe Operating Area

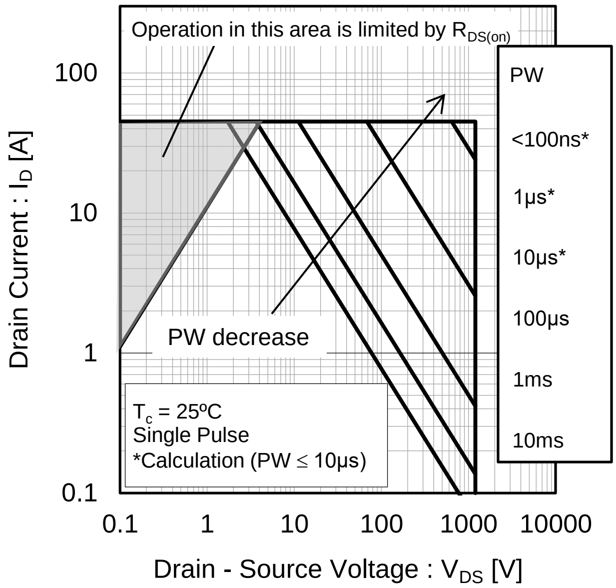
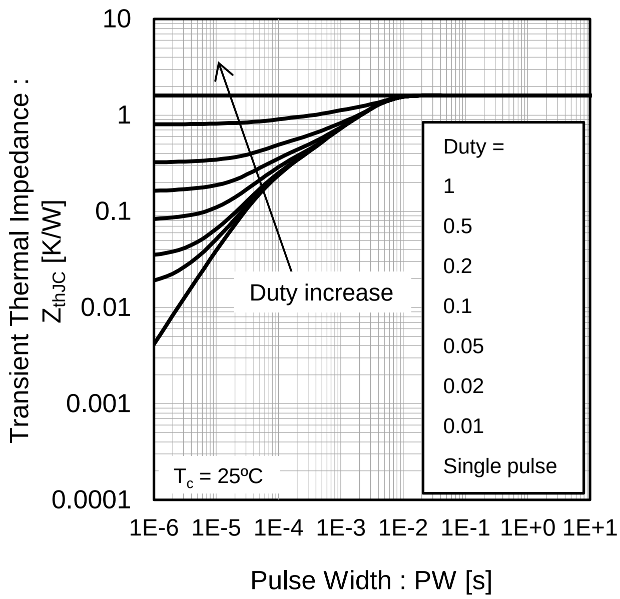



Fig.3 Typical Transient Thermal Impedance vs. Pulse Width



## ●Electrical characteristic curves

Fig.4 $T_{vj}$ = 25ºC Typical Output Characteristics

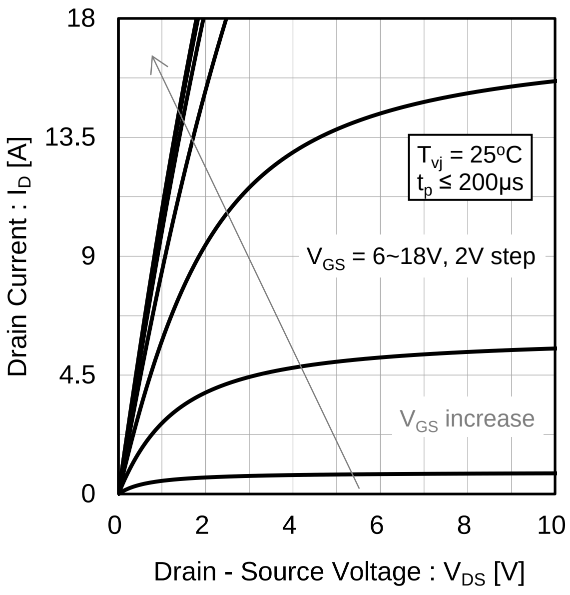
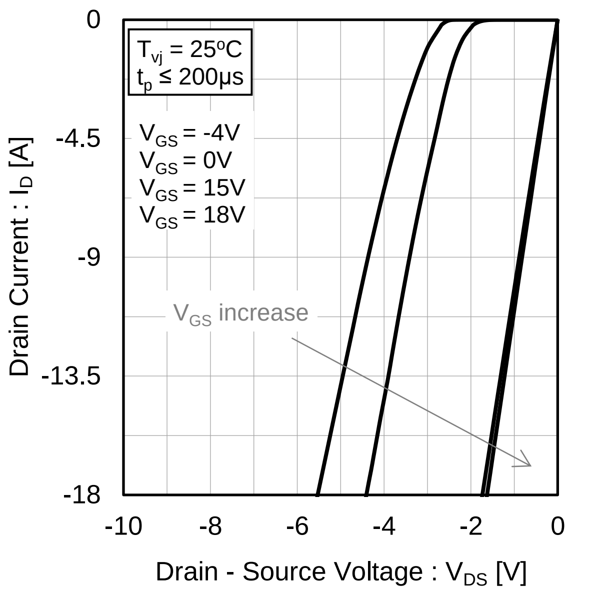



Fig.5 $T_{vj}$ = 25ºC 3rd Quadrant Characteristics



## ●Electrical characteristic curves

Fig.6 $T_{vj}$ = 150ºC Typical Output Characteristics

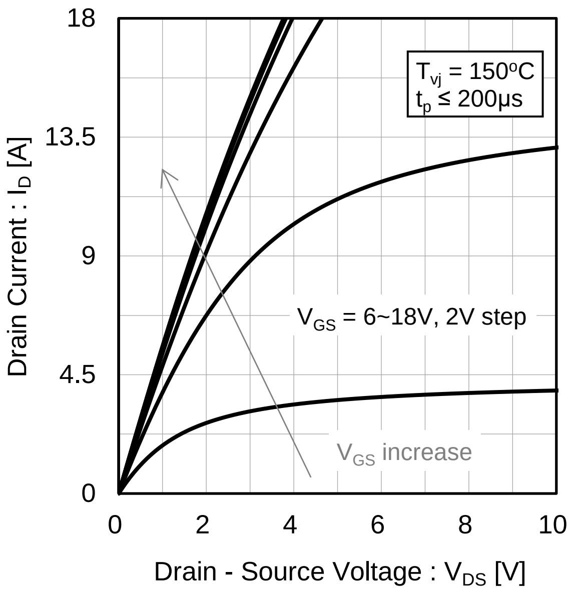



Fig.7 $T_{vj}$ = 150ºC 3rd Quadrant Characteristics

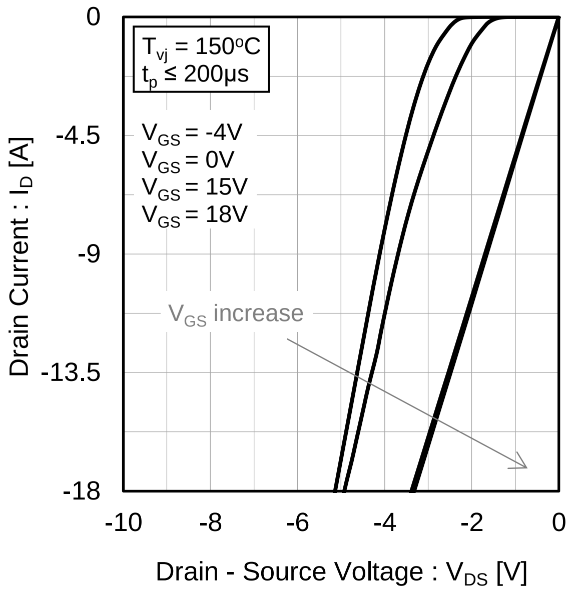
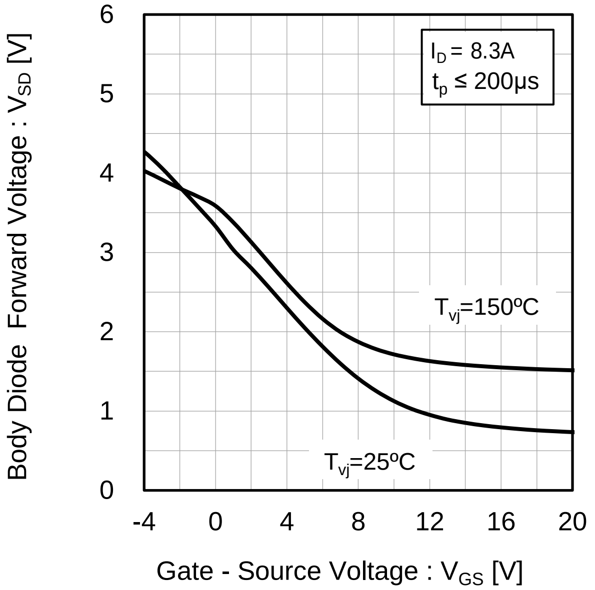



Fig.8 Body Diode Forward Voltage vs. Gate - Source Voltage



## ●Electrical characteristic curves

Fig.9 Typical Transfer Characteristics (I)

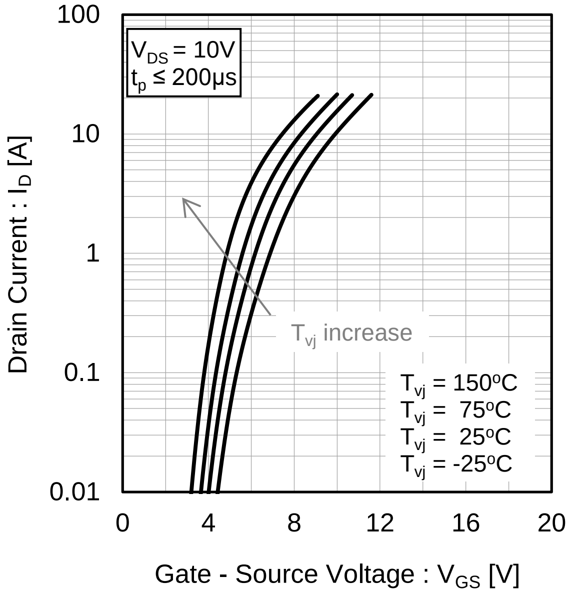



Fig.10 Typical Transfer Characteristics (II)

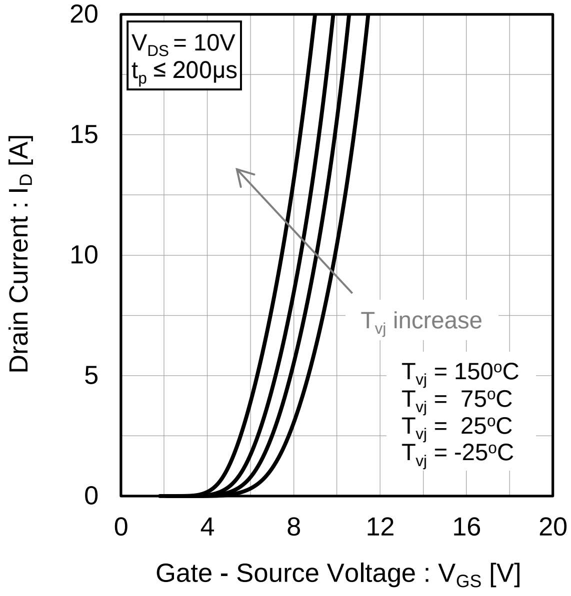



Fig.11 Gate Threshold Voltage vs. Virtual Junction Temperature

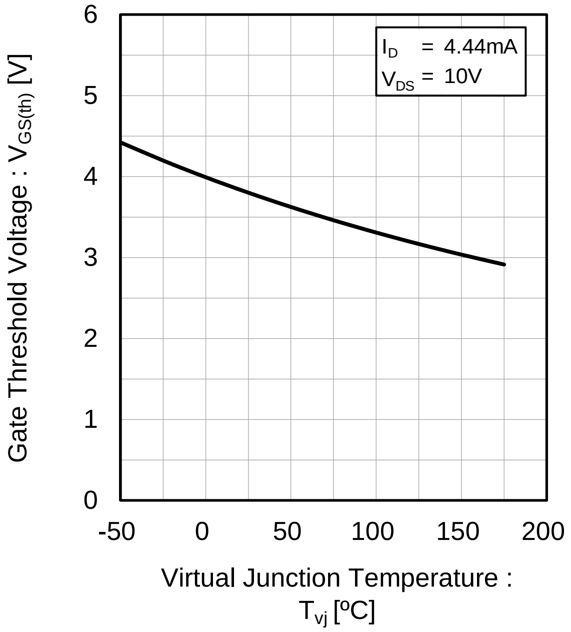
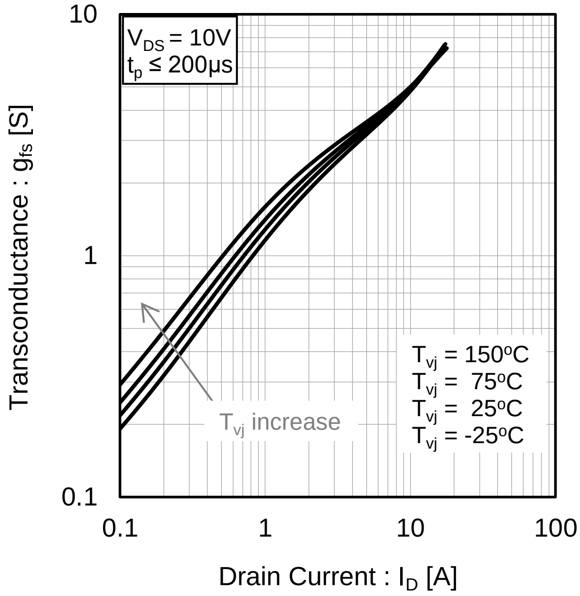



Fig.12 Transconductance vs. Drain Current



## ●Electrical characteristic curves

Fig.13 Static Drain - Source On - State Resistance vs. Gate - Source Voltage

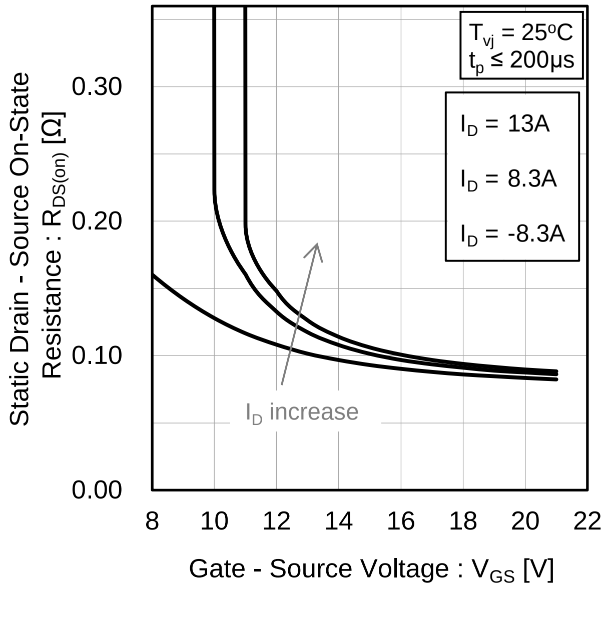



Fig.14 Static Drain - Source On - State Resistance vs. Virtual Junction Temperature

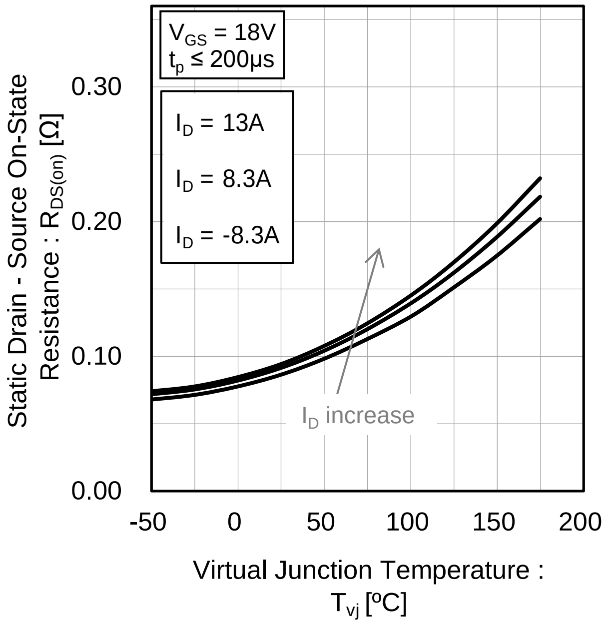



Fig.15 Static Drain - Source On - State Resistance vs. Drain Current

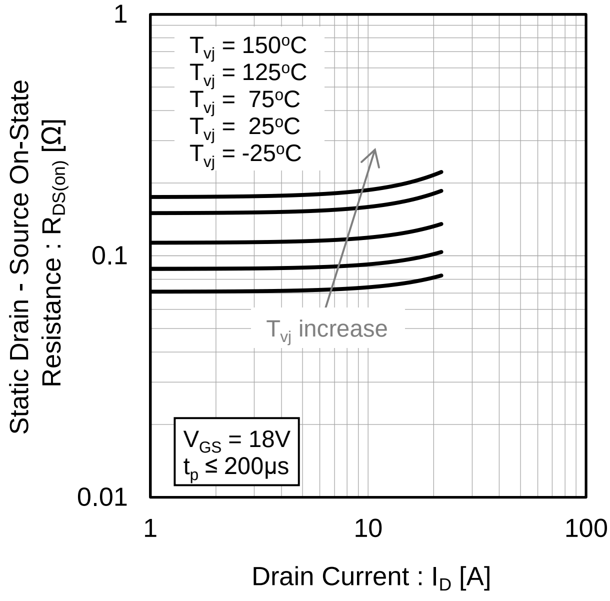
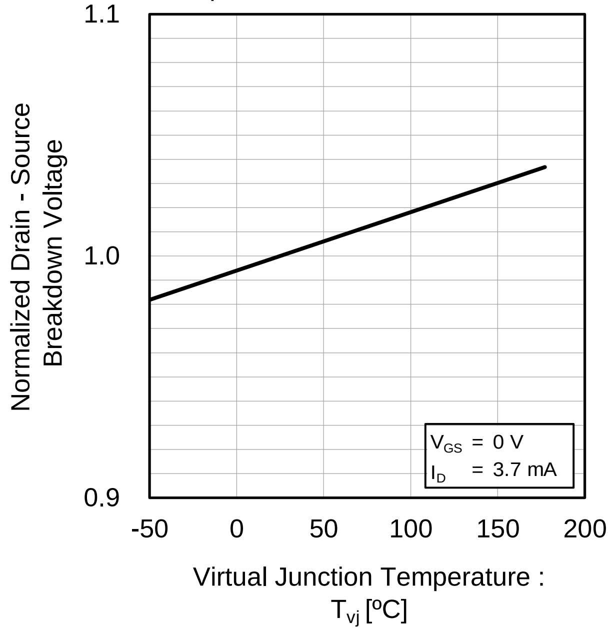



Fig.16 Normalized Drain - Source Breakdown Voltage vs. Virtual Junction Temperature



## ●Electrical characteristic curves

Fig.17 Typical Capacitance vs. Drain - Source Voltage

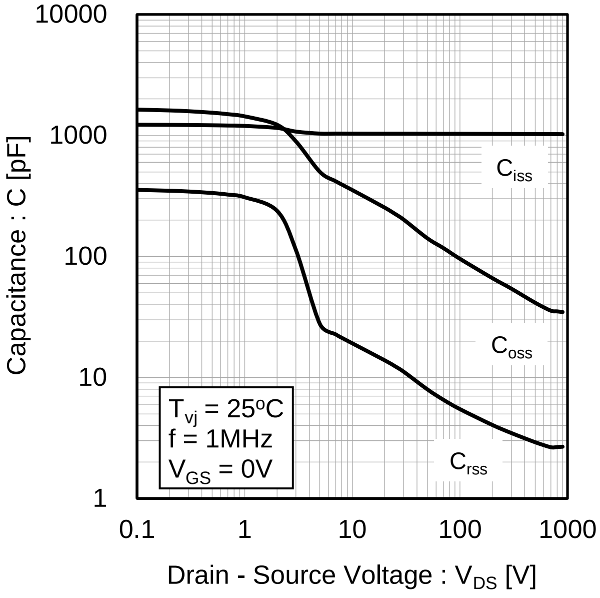



Fig.18 $C_{oss}$ Stored Energy vs. Drain - Source Voltage

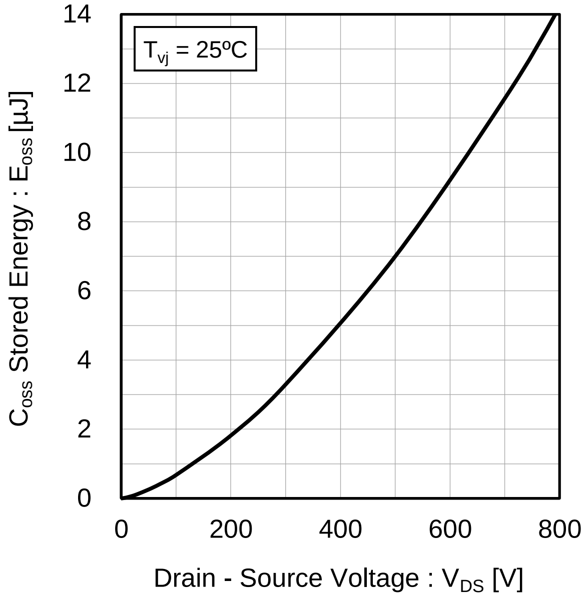
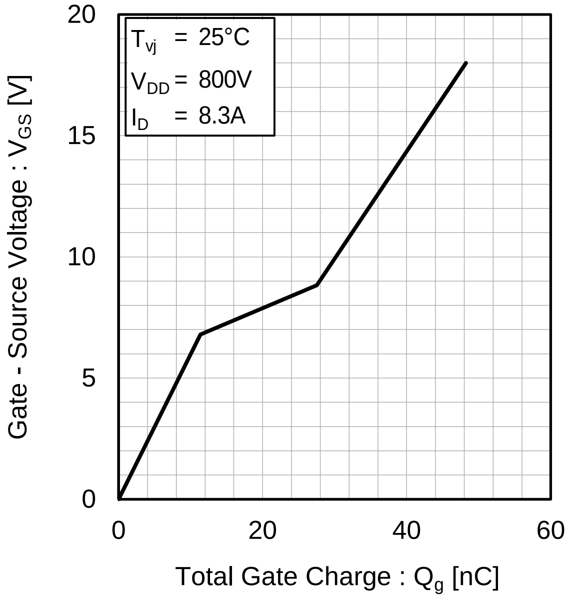



Fig.19 Dynamic Input Characteristics



## ●Electrical characteristic curves

Fig.20 Typical Switching Time
vs. External Gate Resistance

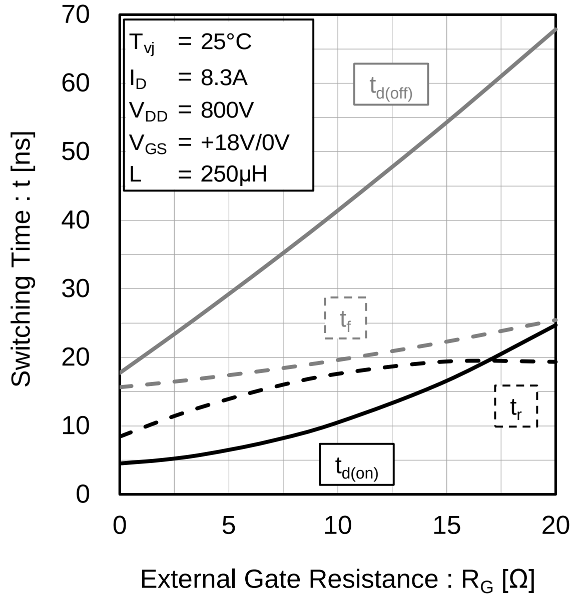



Fig.21 Typical Switching Loss
vs. Drain - Source Voltage

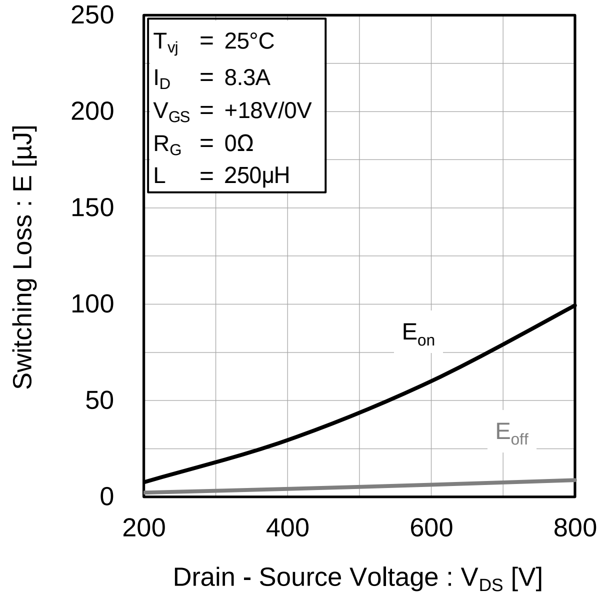



Fig.22 Typical Switching Loss
vs. Drain Current

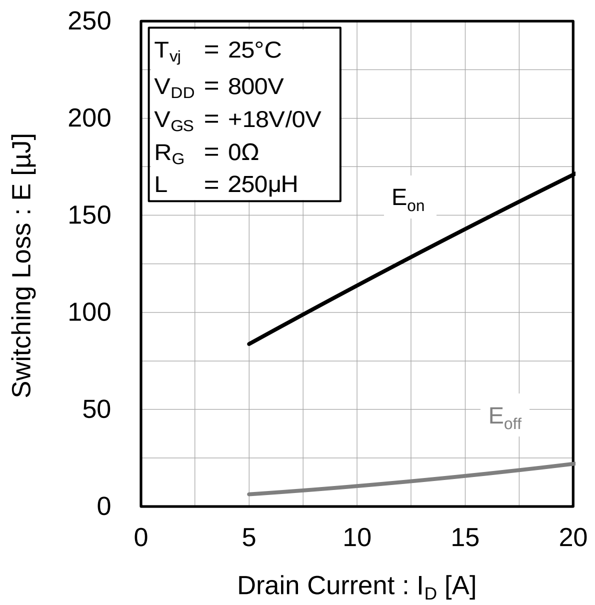
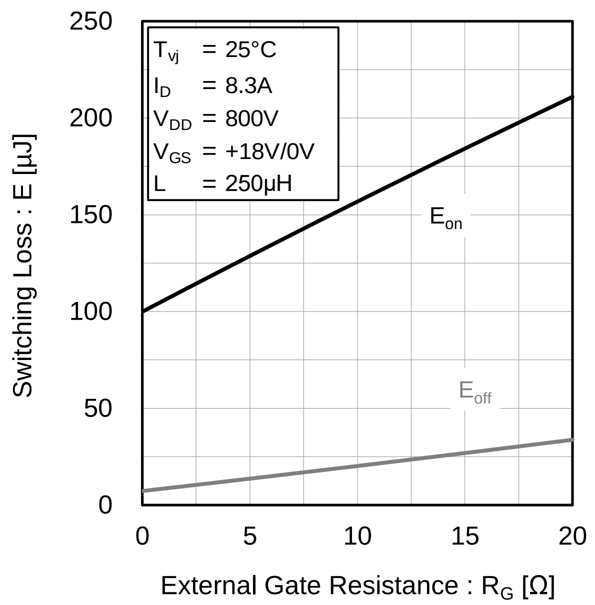



Fig.23 Typical Switching Loss
vs. External Gate Resistance



## ●Measurement circuits and waveforms

Fig.1-1 Gate Charge Measurement Circuit

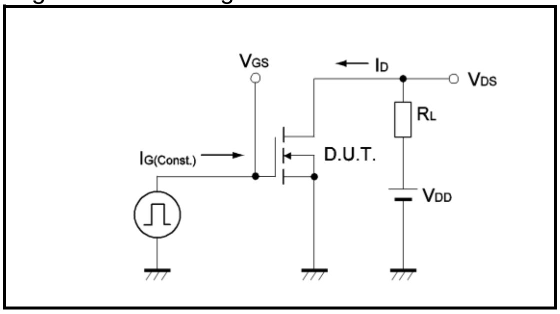



Fig.1-2 Gate Charge Waveform

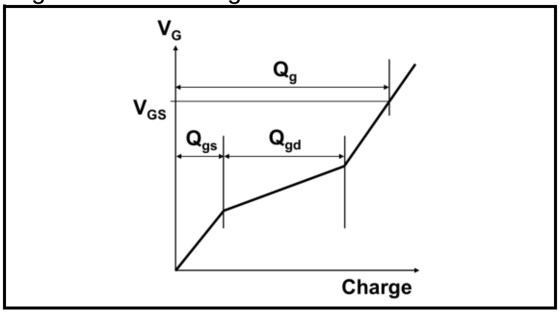



Fig.2-1 Switching Characteristics Measurement Circuit

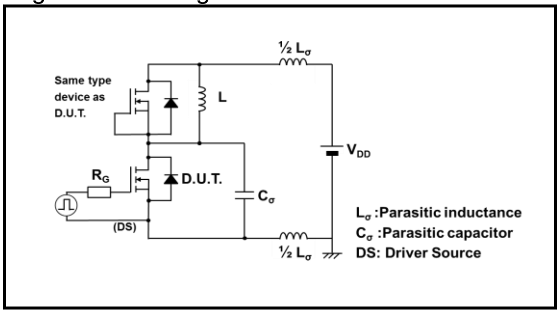



Fig.2-2 Waveforms for Switching Time

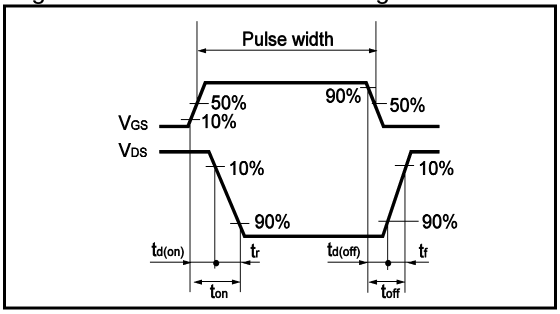



Fig.2-3 Waveforms for Switching Energy Loss

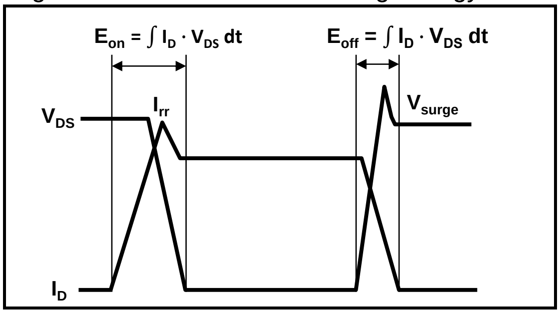



Fig.3-1 Reverse Recovery Time Measurement Circuit

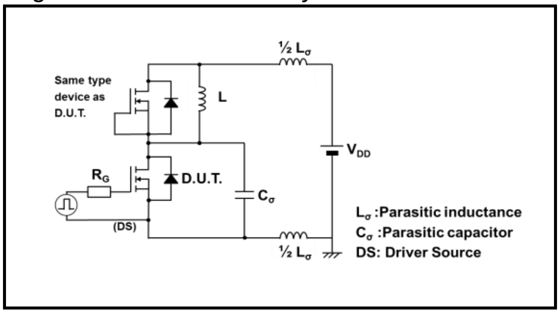
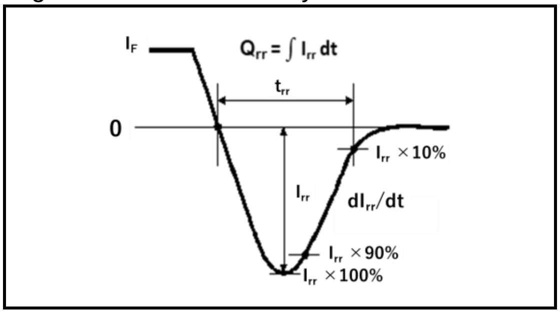
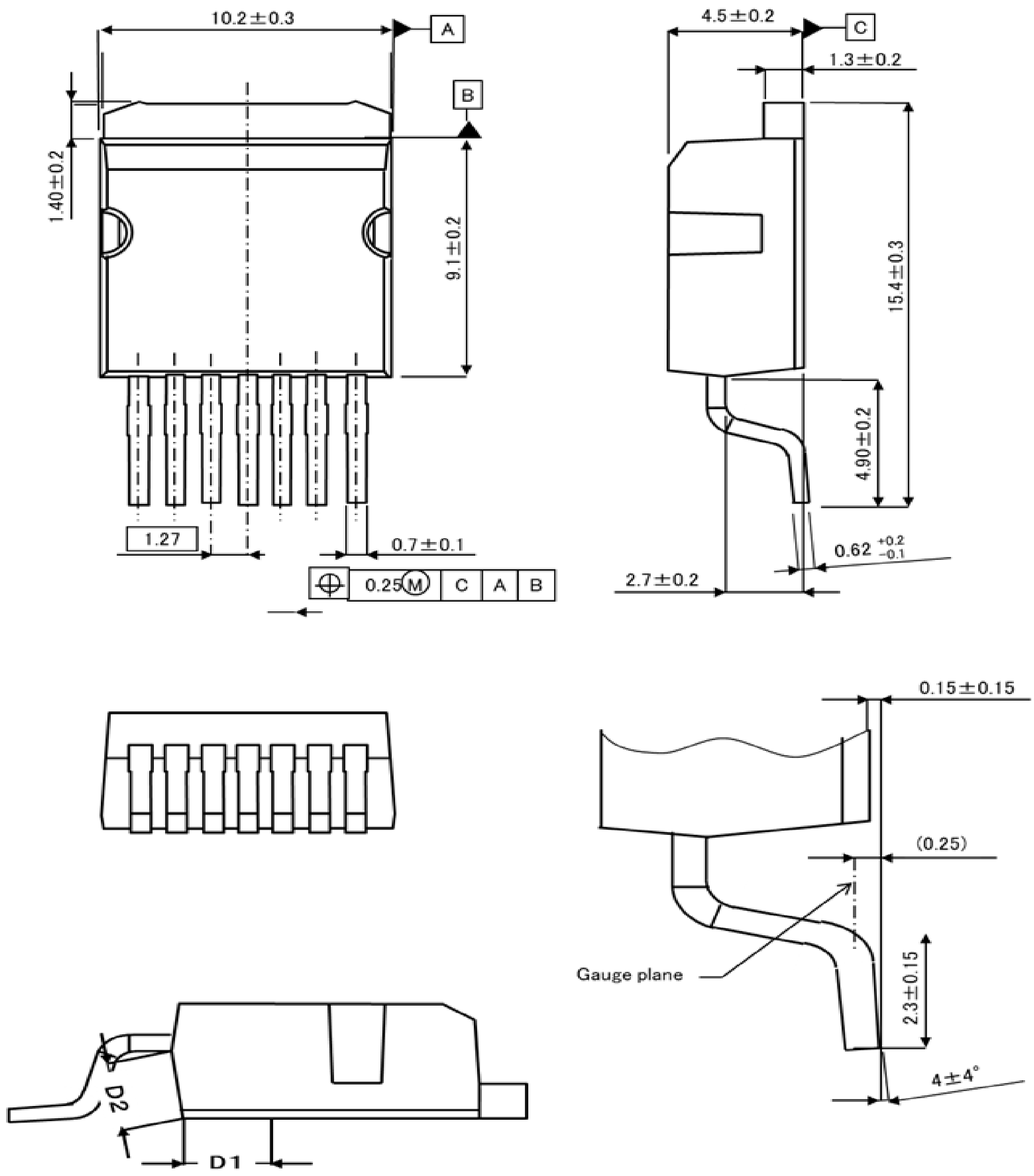



Fig.3-2 Reverse Recovery Waveform

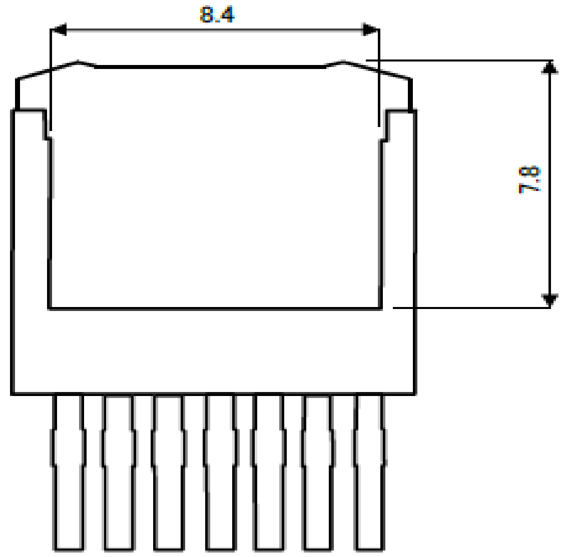


## ●Package Dimensions

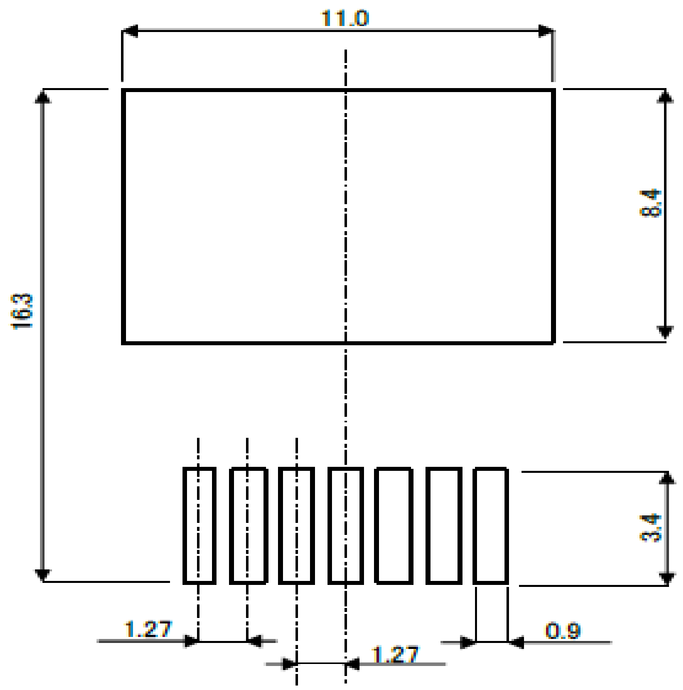



Minimum Creepage Distance = 4.7mm (D1+D2)

Unit: mm

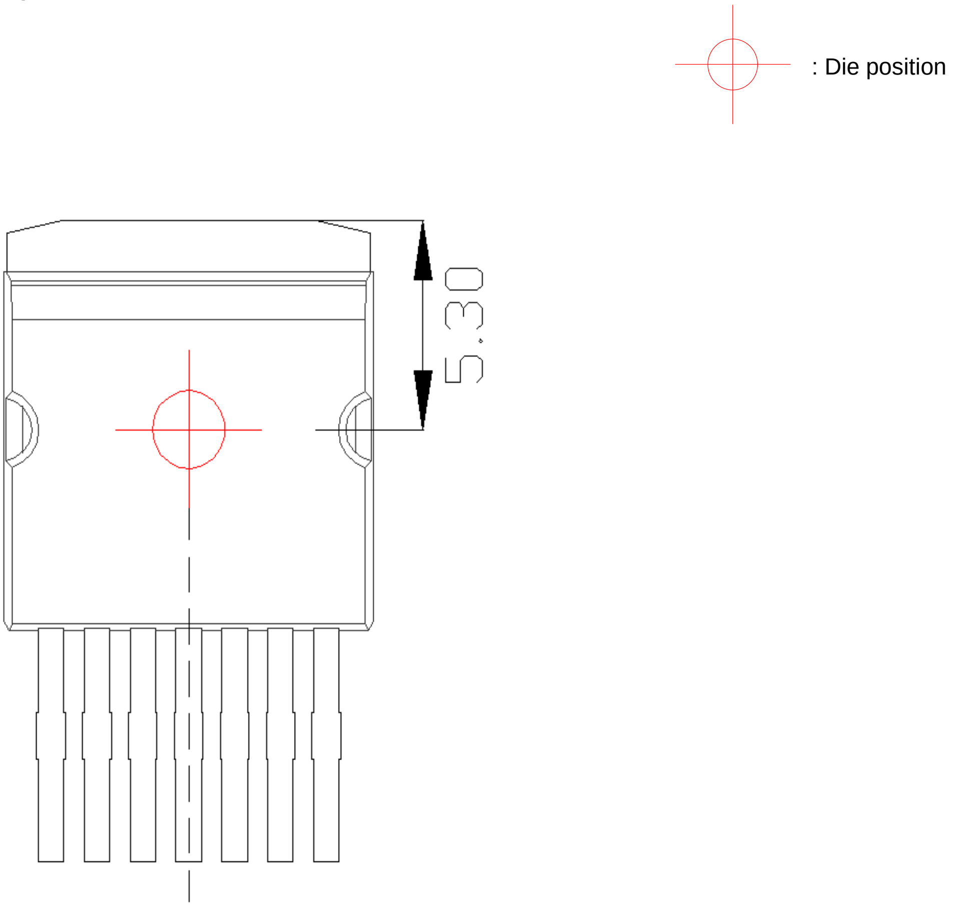



RECOMMENDED FOOTPRINT DIMENSIONS




Unit: mm

## ●Die Bonding Layout




・Front view of the packaging.

・Dimensions are design values.

・If the heat sink is to be installed, it should be in contact with the die bonding point.

Unit: mm

## Notes

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3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.
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