# S4001

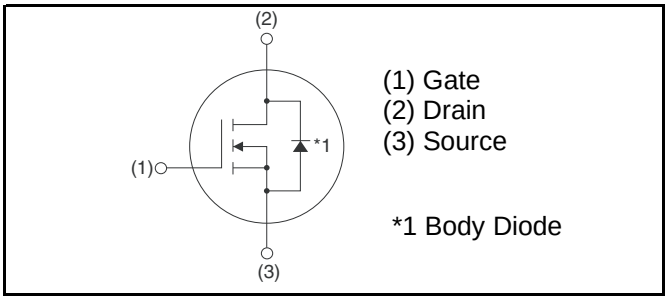
**N-channel SiC power MOSFET bare die** Datasheet

| | |
|---|---|
| $V_{DSS}$ | 650V |
| $R_{DS(on)}$ (Typ.) | 30mΩ |
| $I_D$ | 70A*1 |

## ●Features

1) Low on-resistance
2) Fast switching speed
3) Fast reverse recovery
4) Easy to parallel
5) Simple to drive

## ●Inner circuit




## ●Application

・Solar inverters
・DC/DC converters
・Switch mode power supplies
・Induction heating
・Motor drives

## ●Absolute maximum ratings ($T_a$ = 25°C)

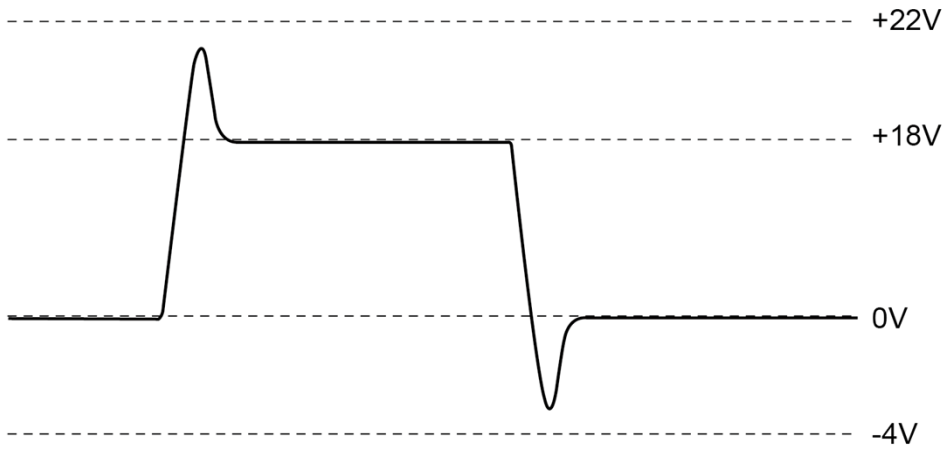
| Parameter | | Symbol | Value | Unit |
|---|---|---|---|---|
| Drain - Source voltage | | $V_{DSS}$ | 650 | V |
| Continuous drain current | $T_c$ = 25°C | $I_D$ *1 | 70 | A |
| Pulsed drain current | | $I_{D,pulse}$ *2 | 175 | A |
| Gate - Source voltage | | $V_{GSS}$ | −4 to 22 | V |
| Gate-Source Surge Voltage | | $V_{GSS_surge}$ | −4 to 22 | V |
| Recommended Drive Voltage | | $V_{GS_op}$ | 0 / 18 | V |
| Junction temperature | | $T_j$ | 175 | °C |
| Range of storage temperature | | $T_{stg}$ | −55 to +175 | °C |


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## ●Electrical characteristics ($T_a$ = 25°C)

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Drain - Source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0V, $I_D$ = 1mA | 650 | - | - | V |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$ = 650V, $V_{GS}$ = 0V<br>$T_j$ = 25°C<br>$T_j$ = 150°C | -<br>- | 1<br>2 | 10<br>- | μA |
| Gate - Source leakage current | $I_{GSS+}$ | $V_{GS}$ = +22V, $V_{DS}$ = 0V | - | - | 100 | nA |
| Gate - Source leakage current | $I_{GSS-}$ | $V_{GS}$ = −4V, $V_{DS}$ = 0V | - | - | −100 | nA |
| Gate threshold voltage | $V_{GS\ (th)}$ | $V_{DS}$ = 10V, $I_D$ = 13.3mA | 2.7 | - | 5.6 | V |
| Static drain - source on - state resistance | $R_{DS(on)}$ *3 | $V_{GS}$ = 18V, $I_D$ = 27A<br>$T_j$ = 25°C<br>$T_j$ = 125°C | -<br>- | 30<br>39.6 | 37.5<br>- | mΩ |
| Gate input resistance | $R_G$ | f = 1MHz, open drain | - | 7 | - | Ω |

## ●Example of acceptable Vgs waveform





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## ●Electrical characteristics ($T_a$ = 25°C)

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Transconductance | $g_{fs}$ *3 | $V_{DS}$ = 10V, $I_D$ = 27A | - | 9.4 | - | S |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0V | - | 1526 | - | pF |
| Output capacitance | $C_{oss}$ | $V_{DS}$ = 500V | - | 89 | - | |
| Reverse transfer capacitance | $C_{rss}$ | f = 1MHz | - | 42 | - | |
| Effective output capacitance, energy related | $C_{o(er)}$ | $V_{GS}$ = 0V<br>$V_{DS}$ = 0V to 300V | - | 230 | - | pF |
| Turn - on delay time | $t_{d(on)}$ *3 | $V_{DD}$ = 300V, $I_D$ = 18A | - | 22 | - | ns |
| Rise time | $t_r$ *3 | $V_{GS}$ = 18V/0V | - | 41 | - | |
| Turn - off delay time | $t_{d(off)}$ *3 | $R_L$ = 17Ω | - | 48 | - | |
| Fall time | $t_f$ *3 | $R_G$ = 0Ω | - | 27 | - | |
| Turn - on switching loss | $E_{on}$ *3 | $V_{DD}$ = 300V, $I_D$=27A<br>$V_{GS}$ = 18V/0V<br>$R_G$ = 0Ω L=250μH<br>*$E_{on}$ includes diode reverse recovery | - | 168 | - | μJ |
| Turn - off switching loss | $E_{off}$ *3 | | - | 112 | - | |

## ●Gate Charge characteristics ($T_a$ = 25°C)

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Total gate charge | $Q_g$ *3 | $V_{DD}$ = 300V | - | 104 | - | nC |
| Gate - Source charge | $Q_{gs}$ *3 | $I_D$ = 27A | - | 25 | - | |
| Gate - Drain charge | $Q_{gd}$ *3 | $V_{GS}$ = 18V | - | 42 | - | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD}$ = 300V, $I_D$ = 27A | - | 9.6 | - | V |

*1 For $T_j$=175°C and thermal dissiparion to ambience of 165W or more.
Limited only by maximum temperature allowed.

*2 PW ≤ 10μs, Duty cycle ≤ 1%

*3 Pulsed


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●**Body diode electrical characteristics** (Source-Drain) ($T_a$ = 25°C)

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Inverse diode continuous, forward current | $I_S$ *1 | $T_c$ = 25°C | - | - | 70 | A |
| Inverse diode direct current, pulsed | $I_{SM}$ *2 | | - | - | 175 | A |
| Forward voltage | $V_{SD}$ *3 | $V_{GS}$ = 0V, $I_S$ = 27A | - | 3.2 | - | V |
| Reverse recovery time | $t_{rr}$ *3 | $I_F$ = 27A, $V_R$ = 300V di/dt = 1100A/μs | - | 26 | - | ns |
| Reverse recovery charge | $Q_{rr}$ *3 | | - | 130 | - | nC |
| Peak reverse recovery current | $I_{rrm}$ *3 | | - | 10 | - | A |


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## ●Electrical characteristic curves

Fig.1 Typical Output Characteristics(I)

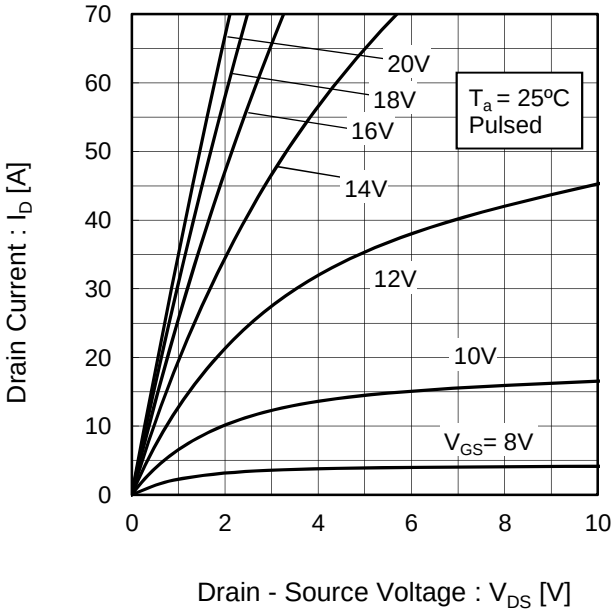



Fig.2 Typical Output Characteristics(II)

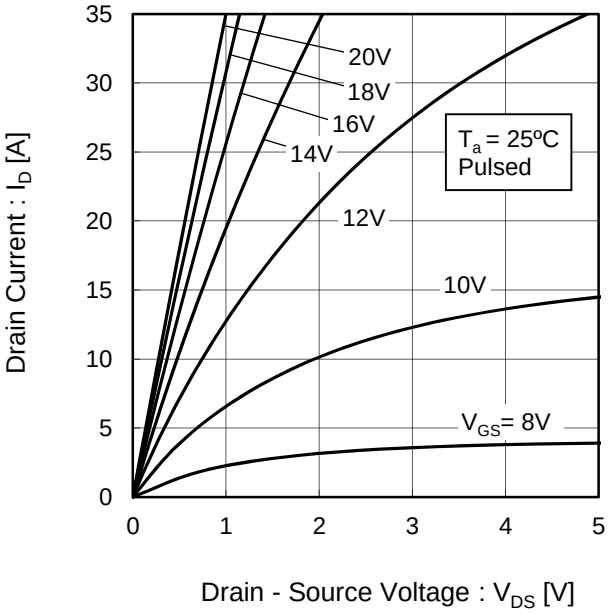



Fig.3 $T_j$ = 150ºC Typical Output Characteristics(I)

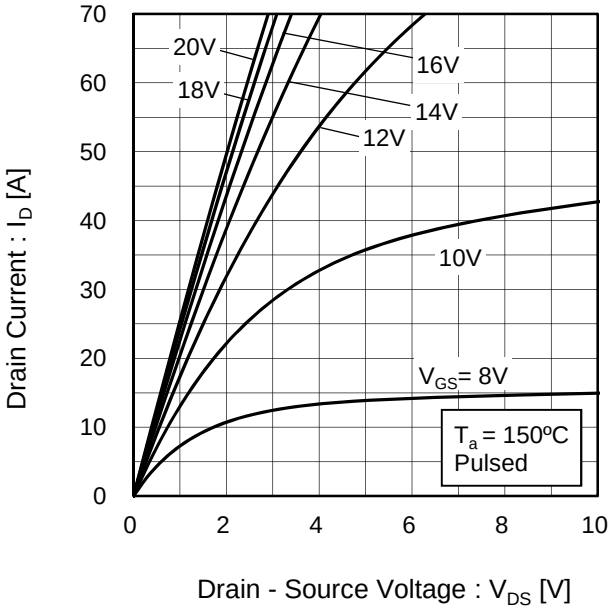
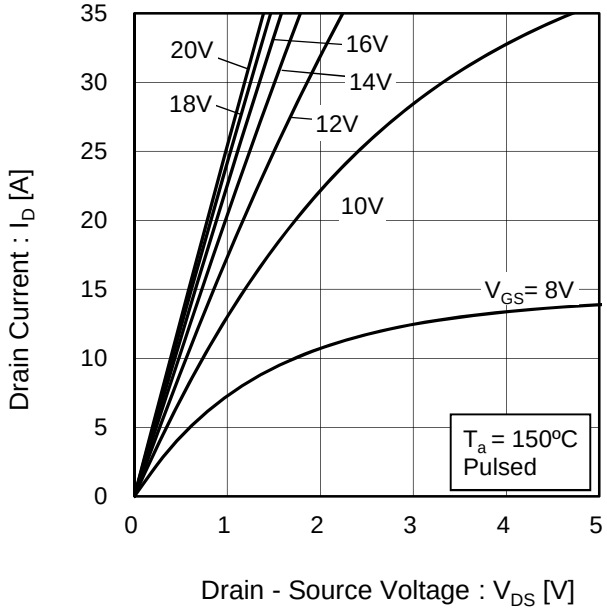



Fig.4 $T_j$ = 150ºC Typical Output Characteristics(II)





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## ●Electrical characteristic curves

Fig.5 Typical Transfer Characteristics (I)

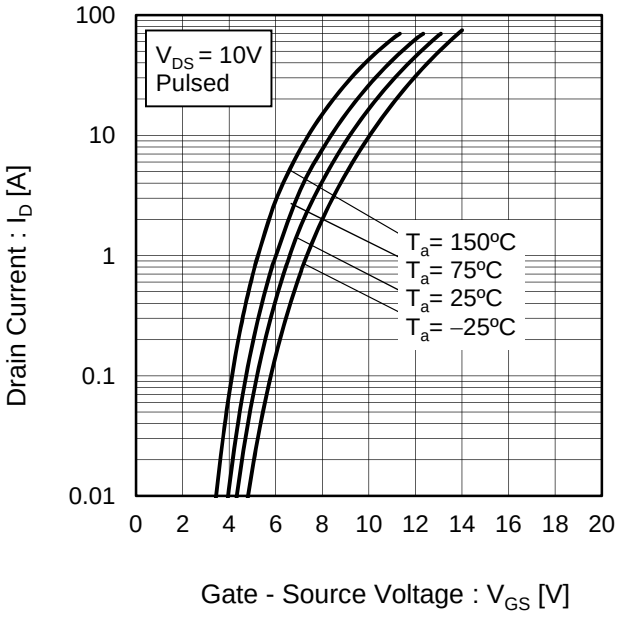



Fig.6 Typical Transfer Characteristics (II)

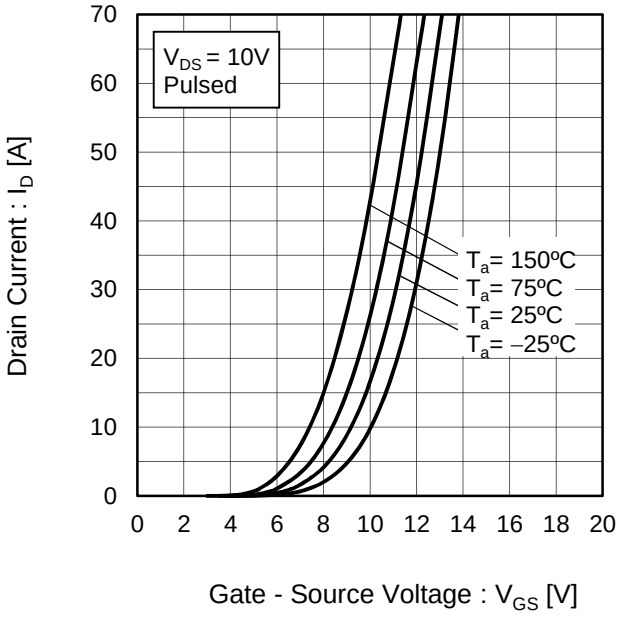



Fig.7 Gate Threshold Voltage vs. Junction Temperature

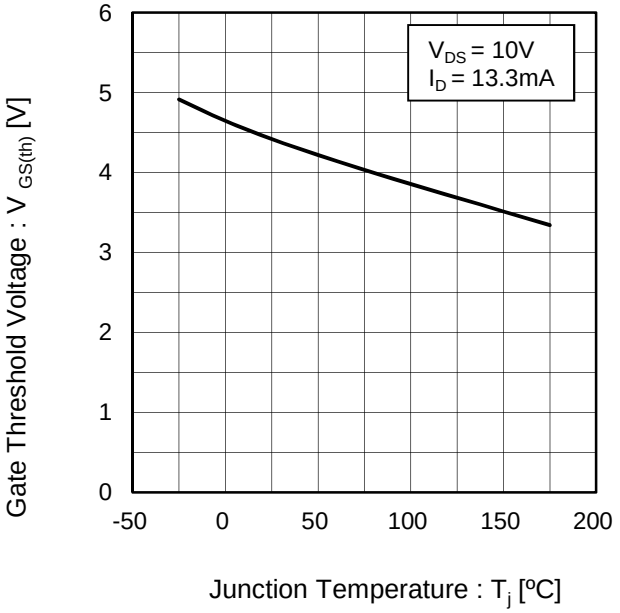
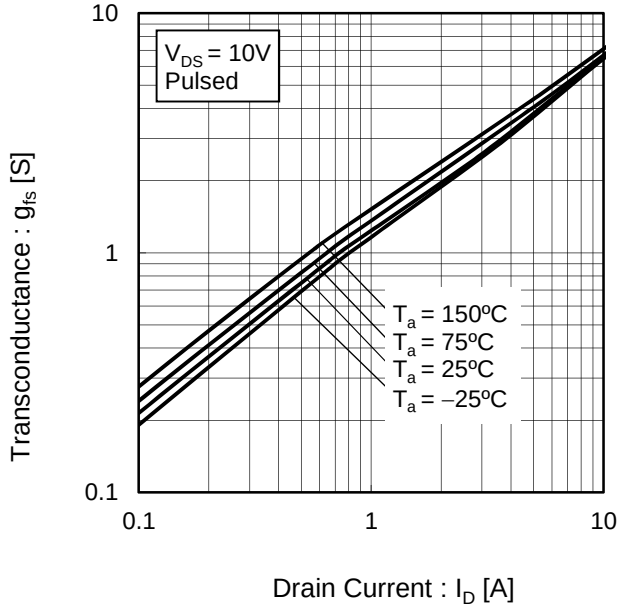



Fig.8 Transconductance vs. Drain Current





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## ●Electrical characteristic curves

Fig.9 Static Drain - Source On - State Resistance vs. Gate - Source Voltage

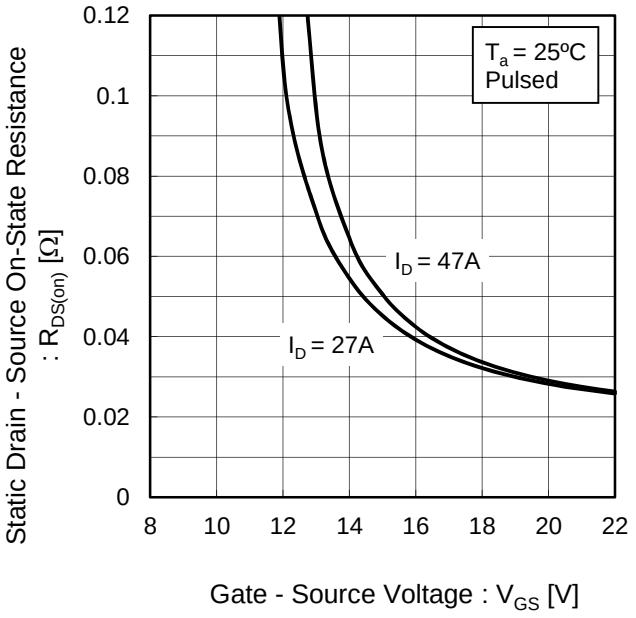



Fig.10 Static Drain - Source On - State Resistance vs. Junction Temperature

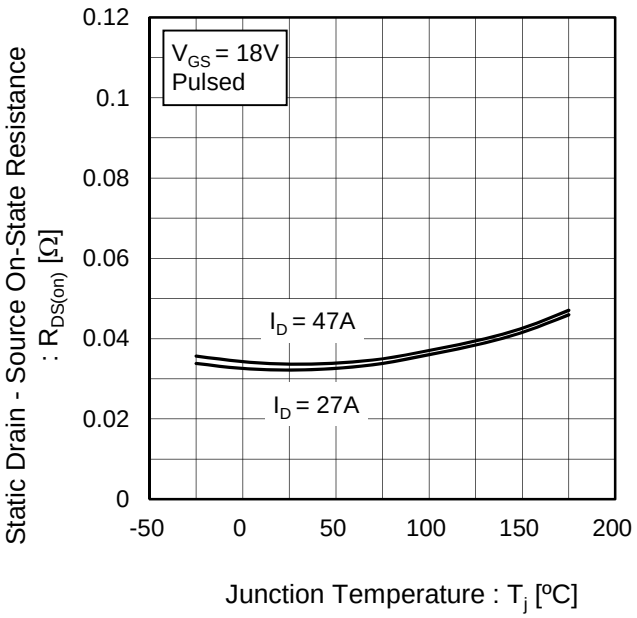
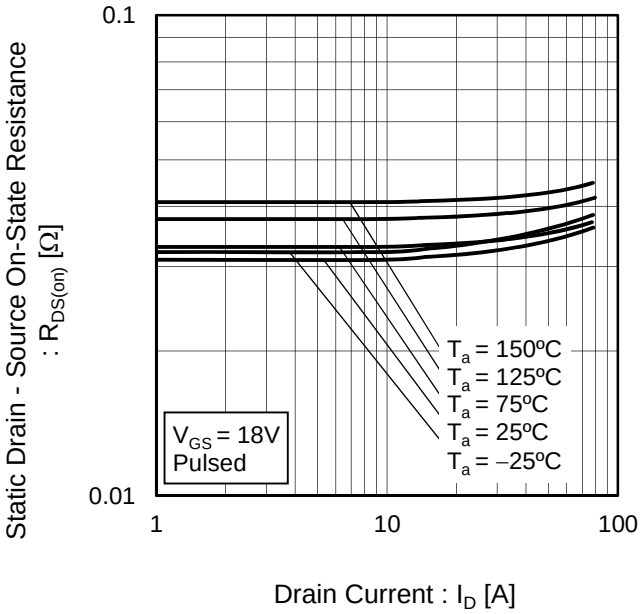



Fig.11 Static Drain - Source On - State Resistance vs. Drain Current





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## ●Electrical characteristic curves

Fig.12 Typical Capacitance vs. Drain - Source Voltage

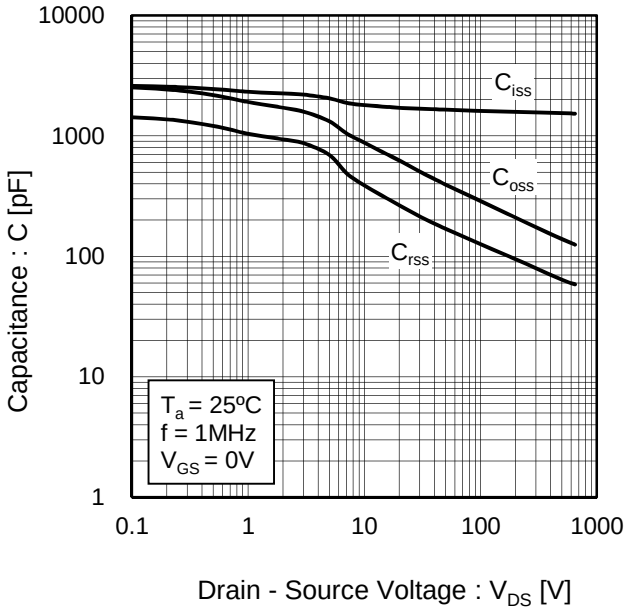



Fig.13 Coss Stored Energy

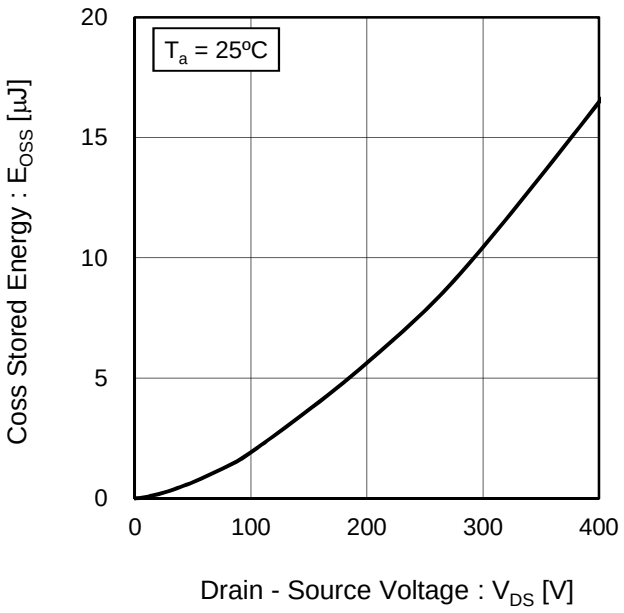



Fig.14 Switching Characteristics

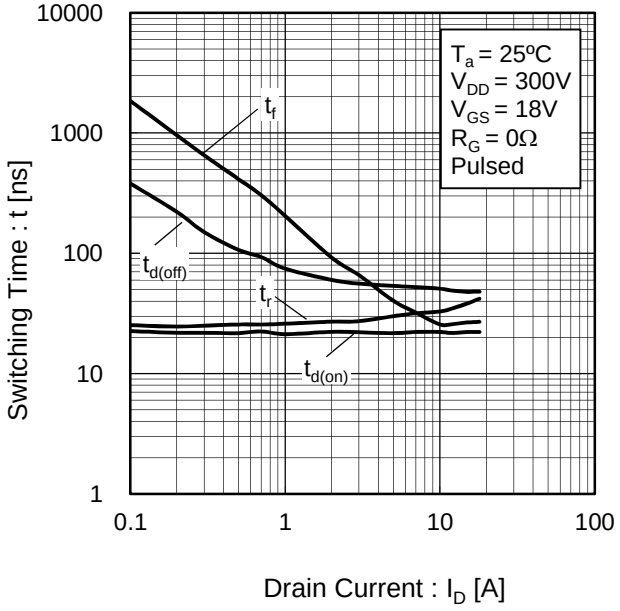
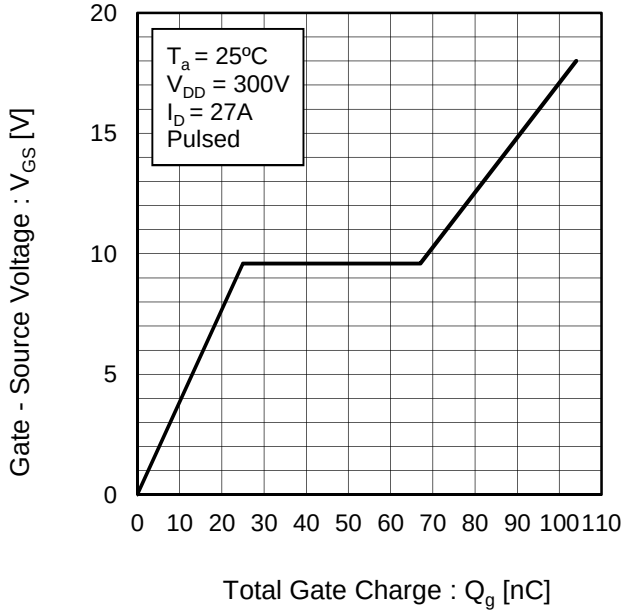



Fig.15 Dynamic Input Characteristics





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## ●Electrical characteristic curves

Fig.16 Typical Switching Loss vs. Drain - Source Voltage

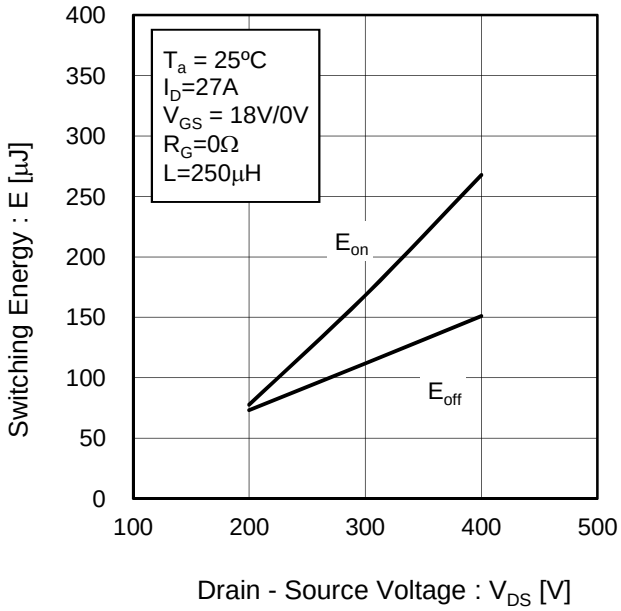



Fig.17 Typical Switching Loss vs. Drain Current

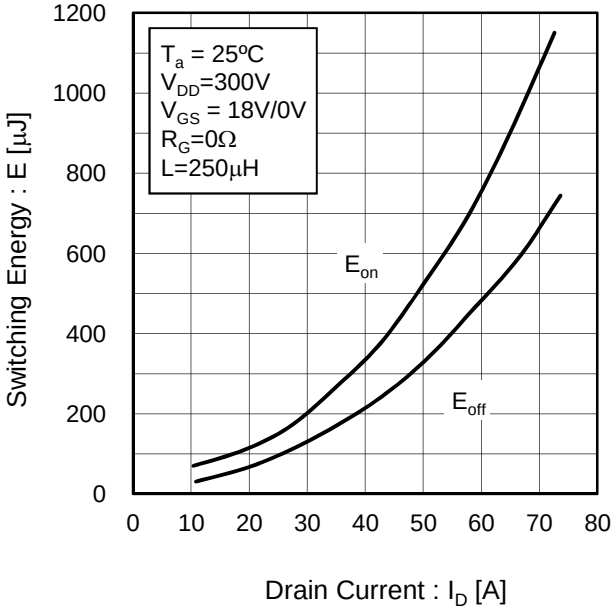
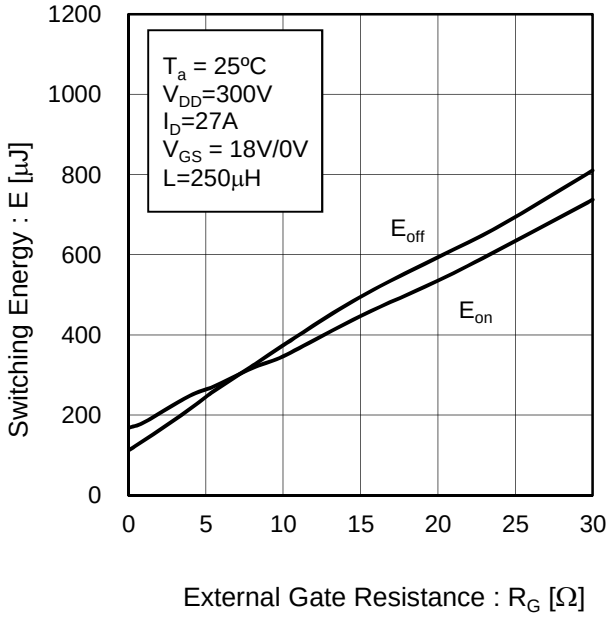



Fig.18 Typical Switching Loss vs. External Gate Resistance





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## ●Electrical characteristic curves

Fig.19 Inverse Diode Forward Current vs. Source - Drain Voltage

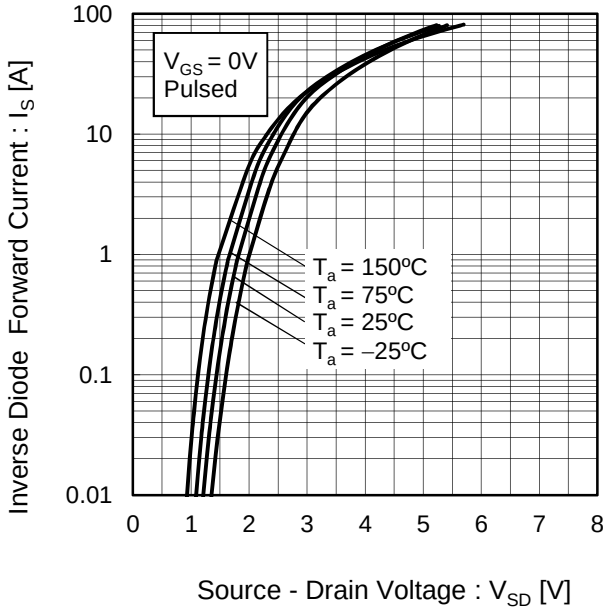
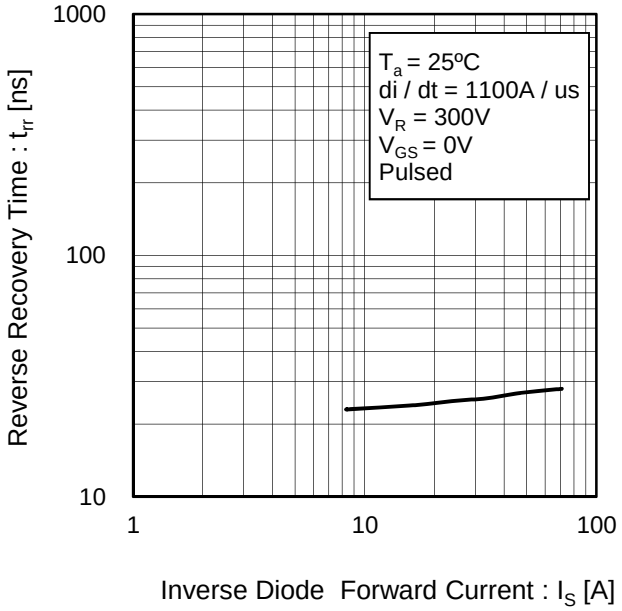



Fig.20 Reverse Recovery Time vs.Inverse Diode Forward Current





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## ●Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

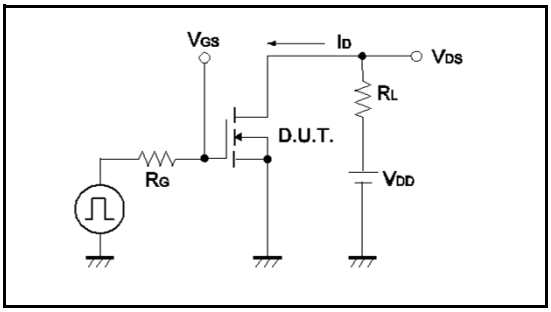



Fig.1-2 Switching Waveforms

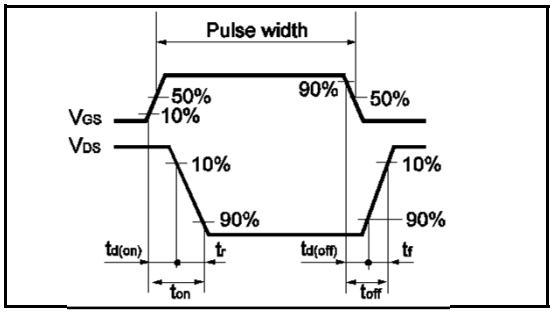



Fig.2-1 Gate Charge Measurement Circuit

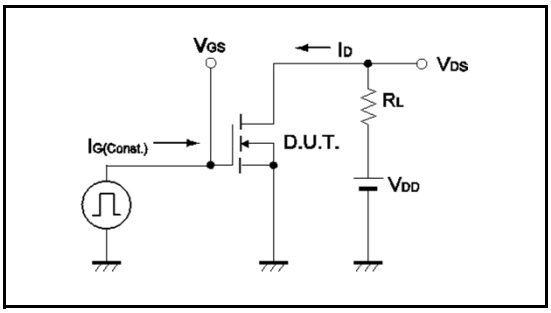



Fig.2-2 Gate Charge Waveform

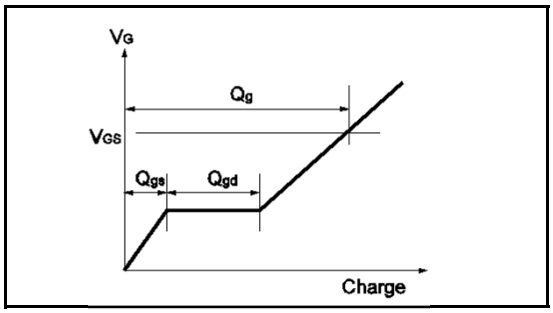



Fig.3-1 Switching Energy Measurement Circuit

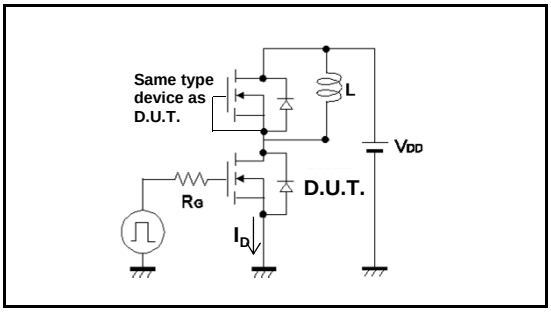



Fig.3-2 Switching Waveforms

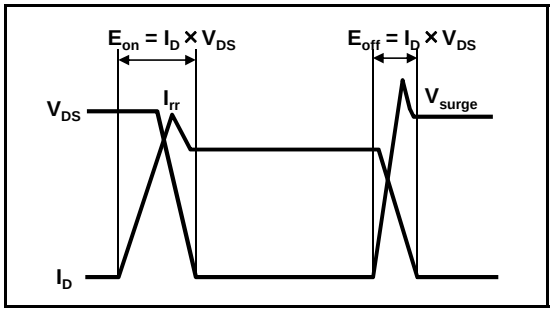



Fig.4-1 Reverse Recovery Time Measurement Circuit

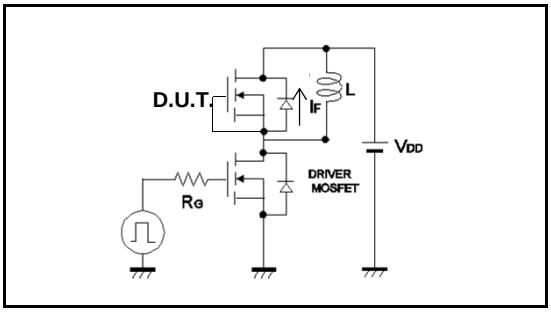
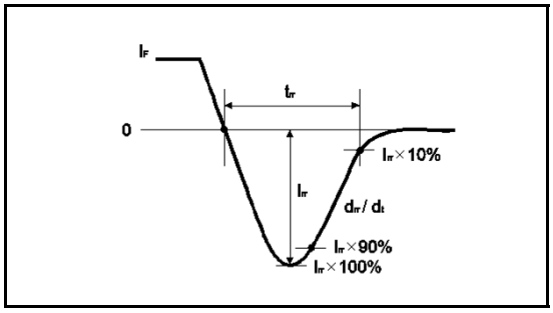



Fig.4-2 Reverse Recovery Waveform





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S4001 - Web Page

| | |
|---|---|
| Part Number | S4001 |
| Package | |
| Unit Quantity | |
| Minimum Package Quantity | |
| Packing Type | |
| Constitution Materials List | inquiry |
| RoHS | Yes |