fast SiC semiconductor

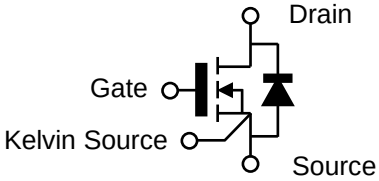
# FF06030A

Product Datasheet

## Silicon Carbide MOSFET

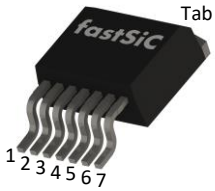
650V, 30mΩ SiC MOSFET – Falcon Series

### Product Information:





TOLL




TO-263-7L

### Features

- Optimized $R_{DS(on)}$ with Rapid Switching Behavior
- Compatible with Standard Gate Drivers
- Clean Kelvin-Source Switching Pin-out
- High Avalanche Endurance Capability
- Optimized for High Power Density Applications
- RoHS Compliant and Halogen Free
- Validated Based on AEC-Q101 Automotive Qualified

| Terminal | Packaging Type | |
|---|---|---|
| | TOLL | TO-263-7L |
| Gate | 1 | 1 |
| Drain | Tab | Tab |
| Source | 3, 4, 5, 6, 7, 8 | 3, 4, 5, 6, 7 |
| Kelvin Source | 2 | 2 |

### Benefits

- Higher System Efficiency
- Increase Parallel Device Convenience
- Enable High Temperature Application
- Allow High Frequency Operation
- Realize Compact and Lightweight Systems
- High Reliability

### Potential Applications

- Switching Mode Power Supply
- PFC & DC/DC Converter
- EV Charging Station
- UPS
- Renewable Energy
- Power Inverter & Motor Driver

### Key Performance Parameters

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DS}$ @$T_{j(max)}$ | 700 | V |
| Recommended Gate-Source Turn-On Voltage | $V_{GS}$ | 15~18 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | 30 | mΩ |
| Continuous Drain Current | $I_D$ | 74 | A |
| Pulse Drain Current | $I_{D,\ pulse}$ | 191 | |
| Power Dissipation | $P_{tot}$ | 268 | W |
| Avalanche Energy | $E_{AS}$ | 1100 | mJ |
| Gate Charge | $Q_G$ | 125 | nC |
| Output Capacitive Charge | $Q_{oss}$ | 102 | |
| Junction & Storage Temperature | $T_j$, $T_{stg}$ | -55 to 175 | °C |

| Part Number | Package | Marking |
|---|---|---|
| FF06030FA | TOLL | FF06030A |
| FF06030J-7A | TO-263-7L | FF06030A |
| -- | -- | -- |

For further information about comparable products, please contact (www.fastsic.com).

## Maximum Ratings: ($T_j$ = 25°C, unless otherwise specified)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | 650 | -- | -- | V | $V_{GS}$=0V, $I_D$=100μA |
| Continuous Drain Current | $I_D$ | -- | -- | 74<br>53 | A | $V_{GS}$=18V, $T_C$=25°C<br>$V_{GS}$=18V, $T_C$=100°C |
| Pulse Drain Current | $I_{D,\ pulse}$ | -- | -- | 191 | | Per Fig. 13 |
| Continuous Body Diode Current | $I_S$ | -- | -- | 49 | | $V_{GS}$=0V, $T_C$=25°C |
| Avalanche Energy, Single Pulse | $E_{AS}$ | -- | -- | 1100 | mJ | $L$=25mH |
| Operate Gate Source Voltage | $V_{GS,\ op}$ | -8~0 | -- | 15~18 | V | Recommended operating values |
| Transient Gate Source Voltage | $V_{GS,\ tran.}$ | -10 | -- | 22 | | Transient operating limit<br>(AC $f$ > 1Hz, pulse width < 100ns) |
| Power Dissipation | $P_{tot}$ | -- | -- | 268 | W | $T_c$=25°C |
| Junction Temperature | $T_j$ | -55 | -- | 175 | °C | -- |
| Storage Temperature | $T_{stg}$ | -55 | -- | 175 | | |
| Soldering Temperature | $T_L$ | -- | -- | 260 | | |

## Electrical Characteristics:

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **DC Characteristics (at $T_j$ = 25°C, unless otherwise specified)** | | | | | | |
| Drain-source Breakdown Voltage | $V_{(BR)DSS}$ | 650<br>-- | --<br>700 | --<br>-- | V | $V_{GS}$=0V, $I_D$=100μA, $T_j$=25°C<br>$V_{GS}$=0V, $I_D$=100μA, $T_j$=175°C |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | --<br>-- | 30<br>43 | 45<br>-- | mΩ | $V_{GS}$=18V, $I_D$=30A, $T_j$=25°C<br>$V_{GS}$=18V, $I_D$=30A, $T_j$=175°C |
| Gate-Source Threshold Voltage | $V_{th}$ | -- | 2.5 | -- | V | $V_{GS}$=$V_{DS}$, $I_D$=40mA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | -- | 2 | 60 | μA | $V_{DS}$=650V, $V_{GS}$=0V, $T_j$=25°C |
| Gate-Source Leakage Current | $I_{GSS}$ | -- | -- | 100 | nA | $V_{GS}$=18V, $V_{DS}$=0V |
| Body Diode Forward Voltage | $V_{SD}$ | --<br>-- | 3.3<br>2.9 | --<br>-- | V | $V_{GS}$=0V, $I_S$=20A, $T_j$=25°C<br>$V_{GS}$=0V, $I_S$=20A, $T_j$=175°C |
| **AC Characteristics (at $T_j$ = 25°C, unless otherwise specified)** | | | | | | |
| Input Capacitance | $C_{iss}$ | -- | 3015 | -- | pF | $V_{DS}$=400V, $V_{GS}$=0V,<br>$f$=250kHz, $V_{AC}$=25mV |
| Output Capacitance | $C_{oss}$ | -- | 199 | -- | | |
| Reverse Capacitance | $C_{rss}$ | -- | 26 | -- | | |
| Effective Output Capacitance, energy related | $C_{o(er)}$[1] | -- | 222 | -- | | |
| Effective Output Capacitance, time related | $C_{o(tr)}$[2] | -- | 279 | -- | | |
| $C_{oss}$ Stored Energy | $E_{oss}$ | -- | 15 | -- | μJ | |
| Output Capacitive Charge | $Q_{oss}$ | -- | 102 | -- | nC | |
| Internal Gate Resistance | $R_{G,\ int.}$ | -- | 2.4 | -- | Ω | $f$=1MHz, $V_{AC}$=25mV |

[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V.
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V.

## Switching Characteristics:

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| **Gate Characteristics** | | | | | | |
| Gate to Source Charge | $Q_{GS}$ | -- | 15 | -- | nC | $V_{DS}$=400V, $V_{GS}$=0V/15V, $I_D$=40A |
| Gate to Drain Charge | $Q_{GD}$ | -- | 72 | -- | | |
| Total Gate Charge | $Q_G$ | -- | 125 | -- | | |
| **Inductive Load** | | | | | | |
| Turn On Delay Time | $t_{d(on)}$ | -- | 57 | -- | ns | $V_{DS}$=400V, $I_D$=28.5A, $V_{GS}$=-3/+15V, $R_{G(ext.)}$= 2.7Ω External SiC Diode as an FWD |
| Rise Time | $t_r$ | -- | 47 | -- | | |
| Turn Off Delay Time | $t_{d(off)}$ | -- | 14 | -- | | |
| Fall Time | $t_f$ | -- | 35 | -- | | |
| Turn On Switching Energy | $E_{on}$ | -- | 324 | -- | µJ | |
| Turn Off Switching Energy | $E_{off}$ | -- | 54 | -- | | |
| **Resistive Load** | | | | | | |
| Turn On Delay Time | $t_{d(on)}$ | -- | 18 | -- | ns | $V_{DS}$=400V, $I_D$=26.7A, $V_{GS}$=-3/+15V, $R_{G\_on,\ ext.}$= 2.7Ω , $R_{G\_off,\ ext.}$= 1Ω $R_L$=15Ω |
| Rise Time | $t_r$ | -- | 25 | -- | | |
| Turn Off Delay Time | $t_{d(off)}$ | -- | 38 | -- | | |
| Fall Time | $t_f$ | -- | 14 | -- | | |
| **Body Diode Characteristics** | | | | | | |
| Reverse Recovery Charge | $Q_{rr}$ | -- | 128 | -- | nC | $V_{GS}$=0V, $I_S$=40A, $V_{DS}$=400V, $di/dt$=300A/µs *$Q_{rr}$ herein excluded the $Q_{oss}$ value. |
| Reverse Recovery Time | $t_{rr}$ | -- | 68 | -- | ns | |
| Peak Reverse Recovery Current | $I_{rrm}$ | -- | 3.5 | -- | A | |

## Thermal Characteristics:

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Thermal Impedance, junction-case | $R_{th\text{-}jc}$ | -- | 0.56 | -- | K/W | -- |
| Thermal Impedance, junction-ambient | $R_{th\text{-}ja}$ | -- | 40 | -- | | Device on PCB, with 6 cm² of cooling area |

## Electrical Characteristics Diagrams

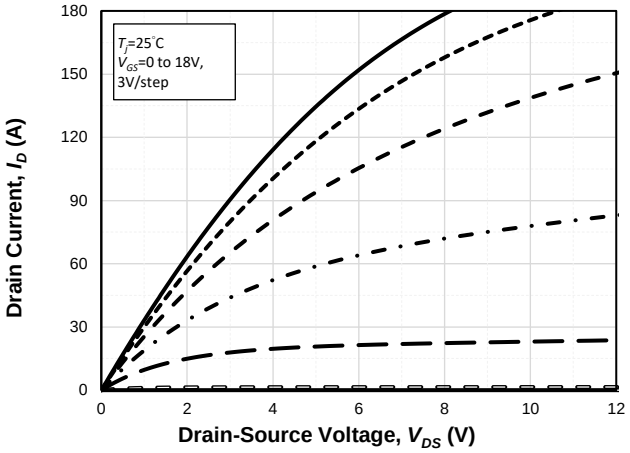



Fig. 1 Typical Output Characteristics at $T_j$=25˚C

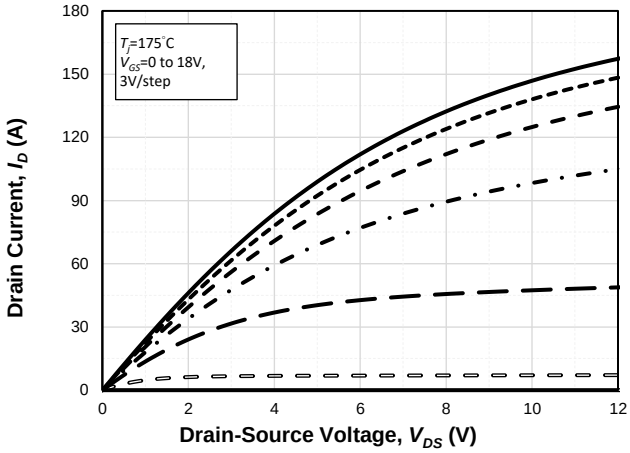



Fig. 2 Typical Output Characteristics at $T_j$=175˚C

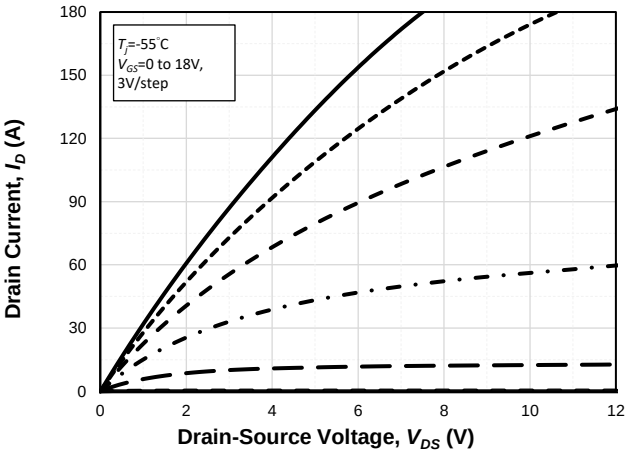



Fig. 3 Typical Output Characteristics at $T_j$=-55˚C

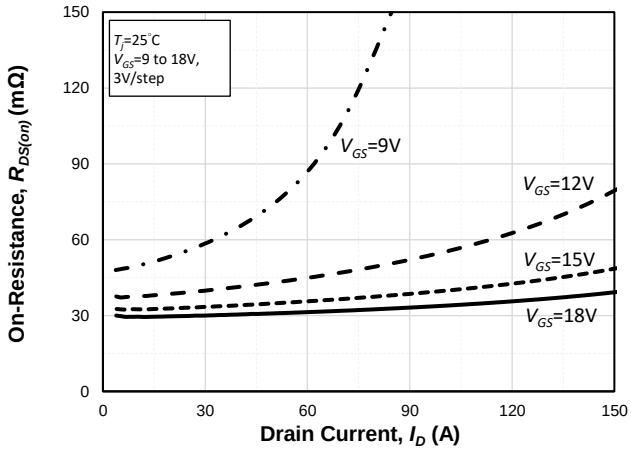



Fig. 4 Typ. $R_{DS(on)}$ vs. $I_D$ with Various $V_{GS}$

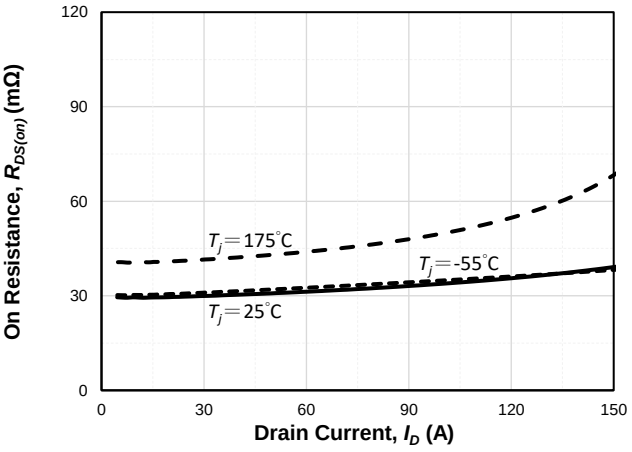



Fig. 5 Typ. $R_{DS(on)}$ vs. $I_D$ with Various $T_j$, $V_{GS}$=18V

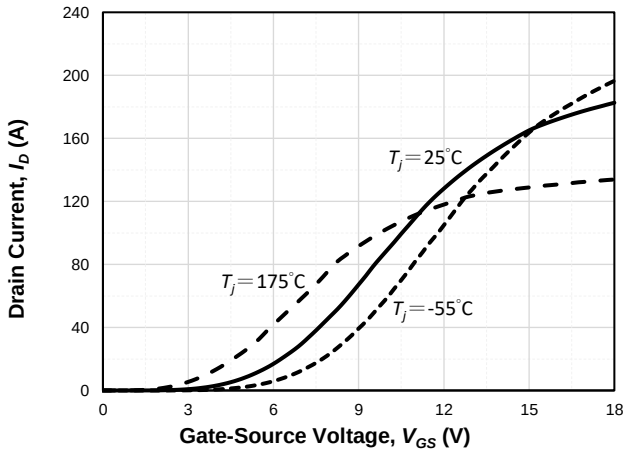



Fig. 6 Typ. $I_D$ vs. $V_{GS}$ with Various $T_j$, $V_{DS}$=10V

## Electrical Characteristics Diagrams

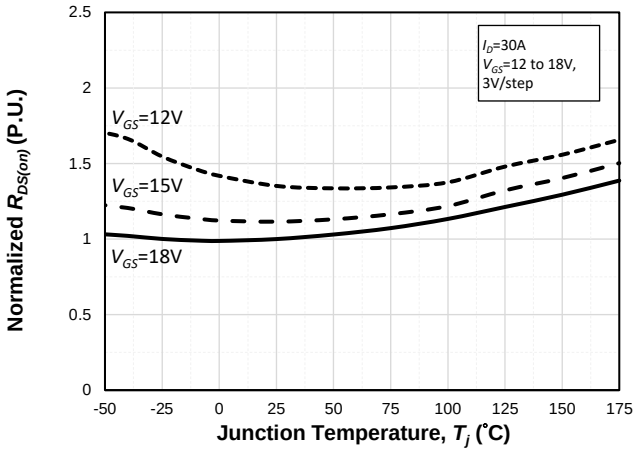



Fig. 7 Normalized $R_{DS(on)}$ vs. $T_j$ with Various $V_{GS}$

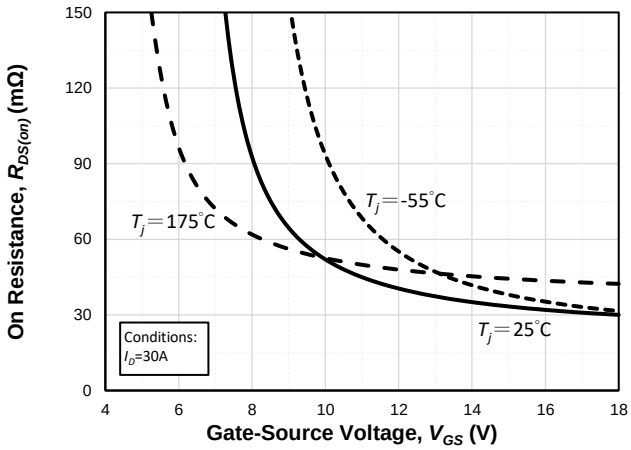



Fig. 8 Typ. $R_{DS(on)}$ vs. $V_{GS}$ with Various $T_j$

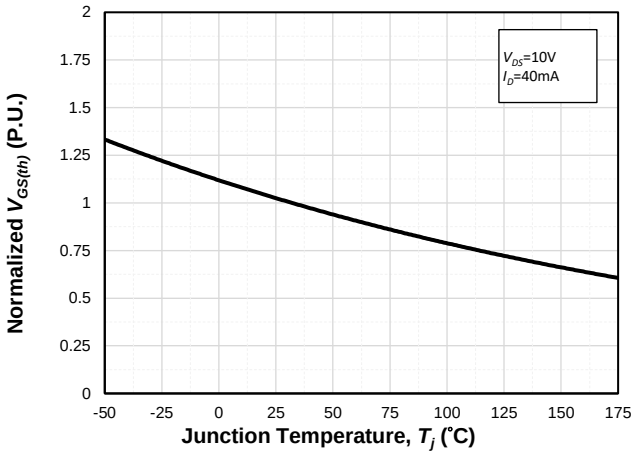



Fig. 9 Normalized $V_{th}$ vs. $T_j$

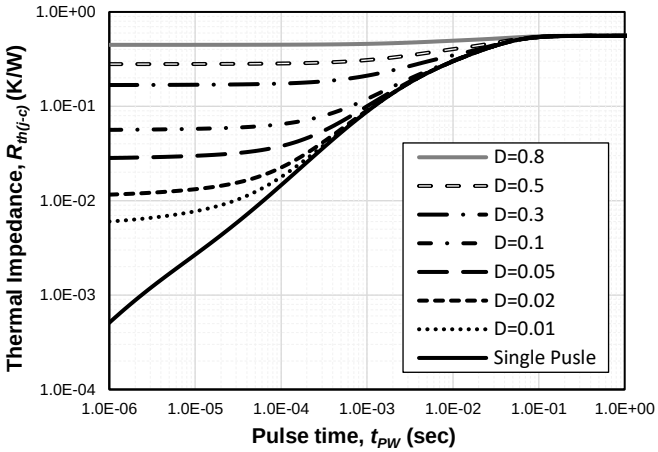



Fig. 10 Typ. Transient Thermal Impedance $R_{th\text{-}jc}$

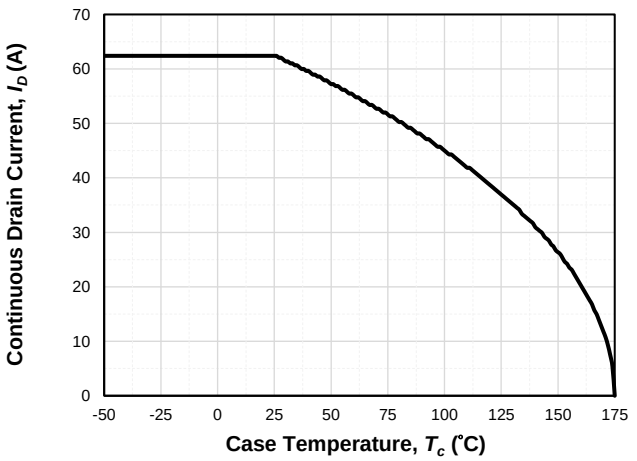



Fig. 11 Continuous $I_D$ De-rating at $V_{GS}$=18V, $T_j$≤175˚C

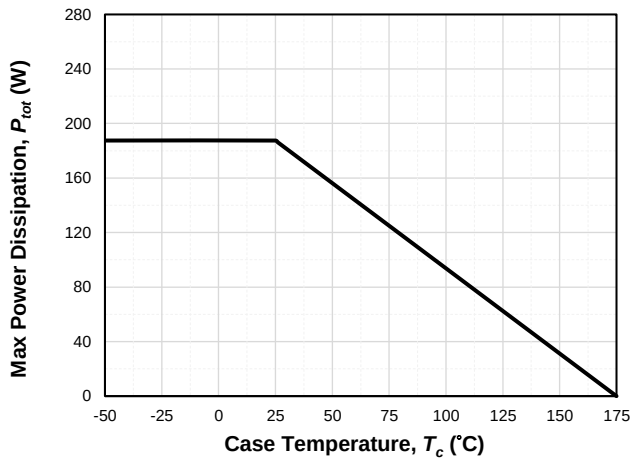



Fig. 12 Power Dissipation at $V_{GS}$=18V, $T_j$≤175˚C

## Electrical Characteristics Diagrams

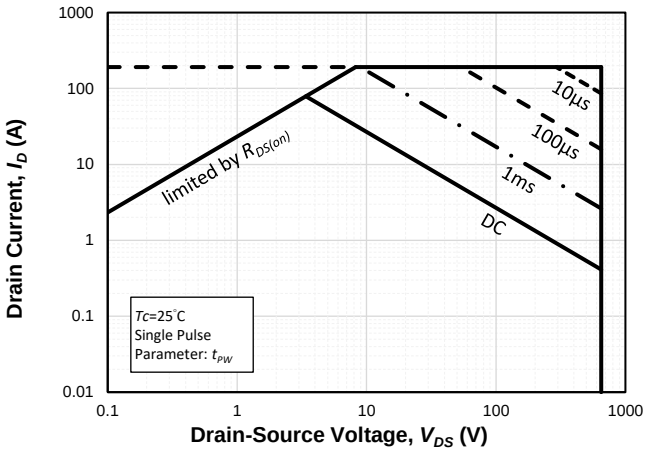



Fig. 13 Safe Operating Area at $T_c$=25˚C

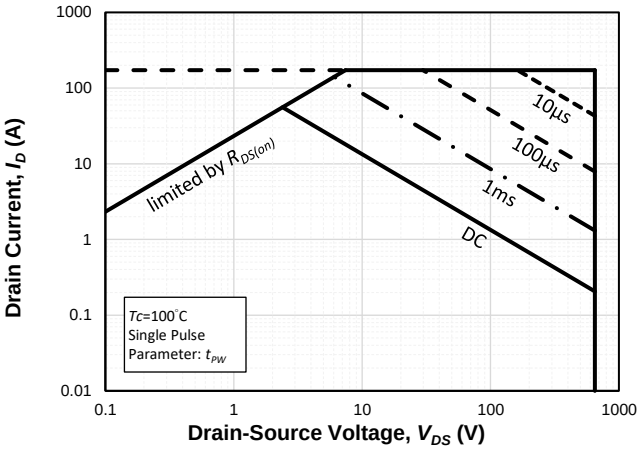



Fig. 14 Safe Operating Area at $T_c$=100˚C

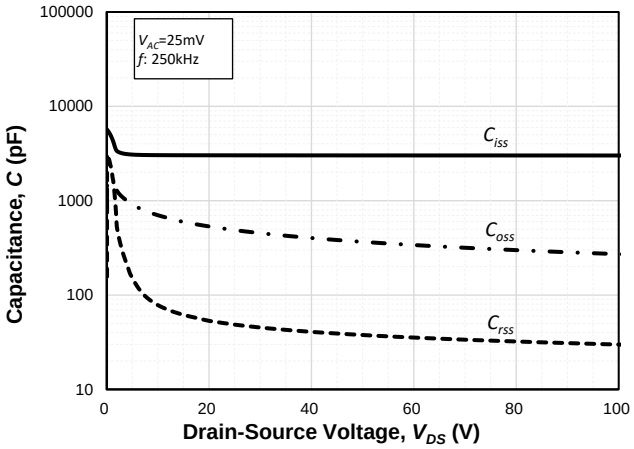



Fig. 15 Typ. Capacitance vs. $V_{DS}$ at $f_{sw}$=250kHz, $V_{DS}$≤100V

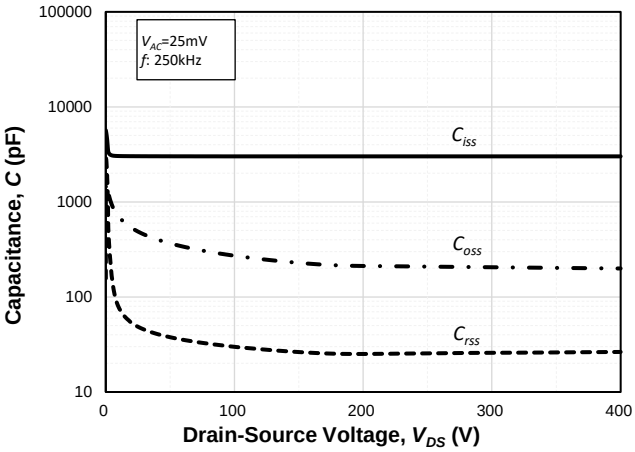



Fig. 16 Typ. Capacitance vs. $V_{DS}$ at $f_{sw}$=250kHz, $V_{DS}$≤400V

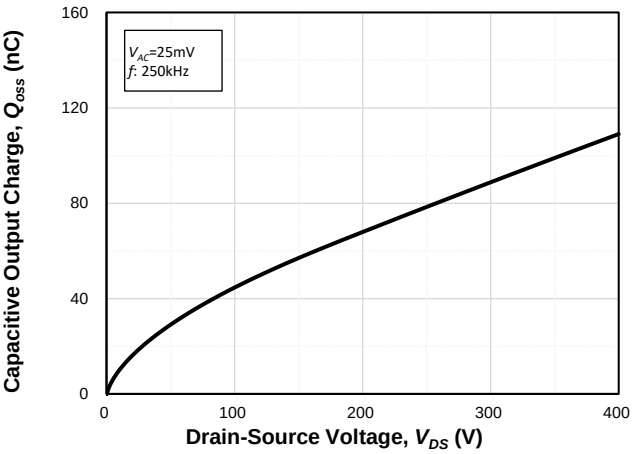



Fig. 17 Typ. Capacitive Output Charge at $f_{sw}$=250kHz

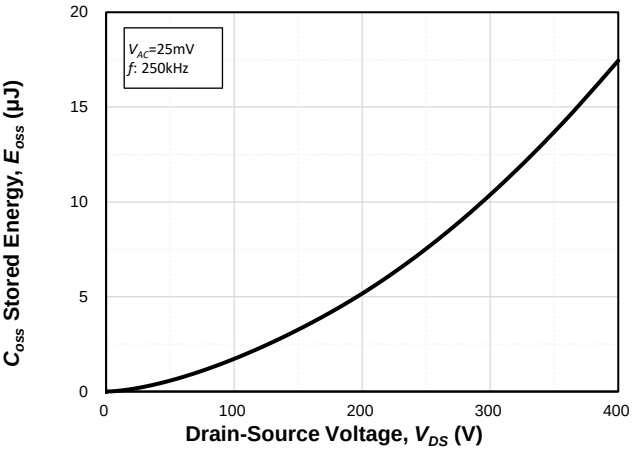



Fig. 18 Typ. $C_{oss}$ Stored Energy at $f_{sw}$=250kHz

## Electrical Characteristics Diagrams

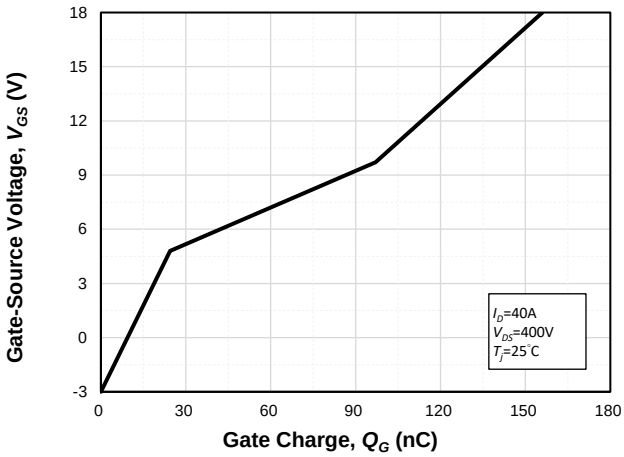



**Fig. 19 Typ. Gate Charge at $V_{DS}$=400V, $I_D$=40A**

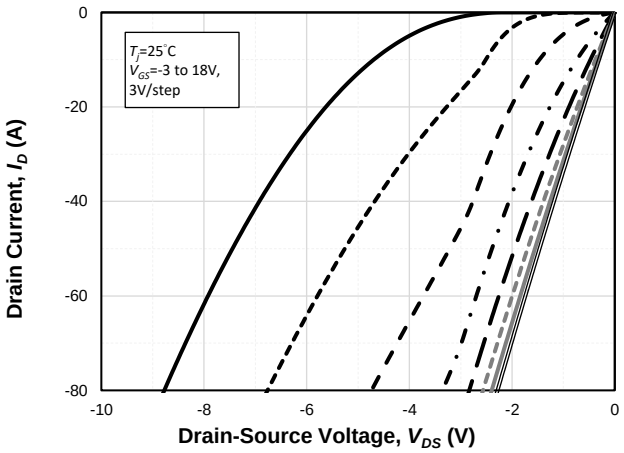



**Fig. 20 Typical Forward Characteristics of Reverse Conduction at $T_j$=25˚C**

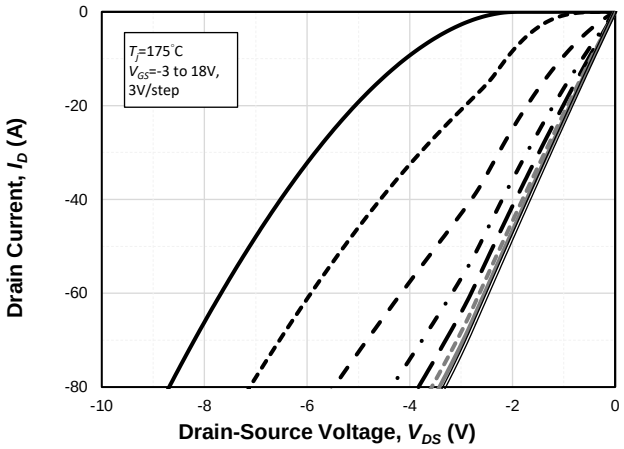



**Fig. 21 Typical Forward Characteristics of Reverse Conduction at $T_j$=175˚C**

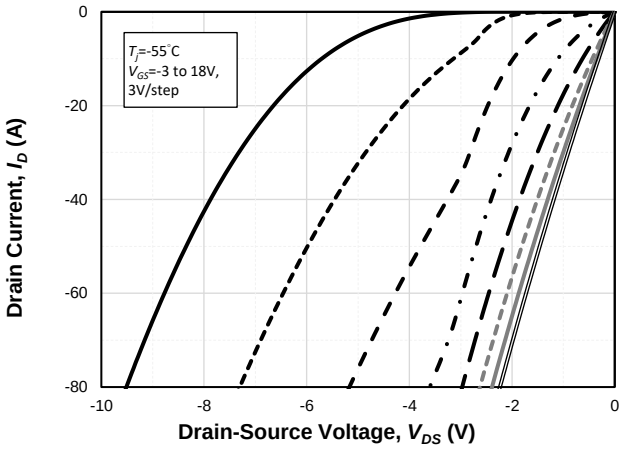



**Fig. 22 Typical Forward Characteristics of Reverse Conduction at $T_j$=-55˚C**

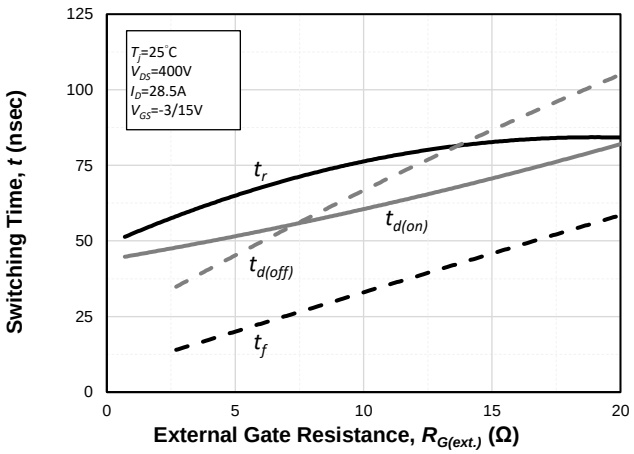



**Fig. 23 Typ. Switching Time vs. $R_{G(ext.)}$**

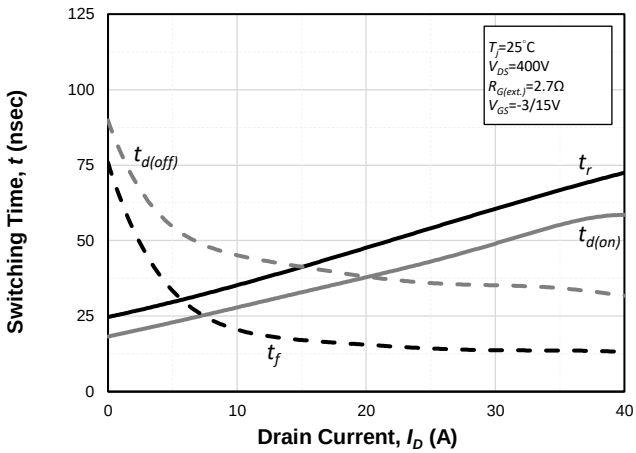



**Fig. 24 Typ. Switching Time vs. $I_D$**

## Electrical Characteristics Diagrams

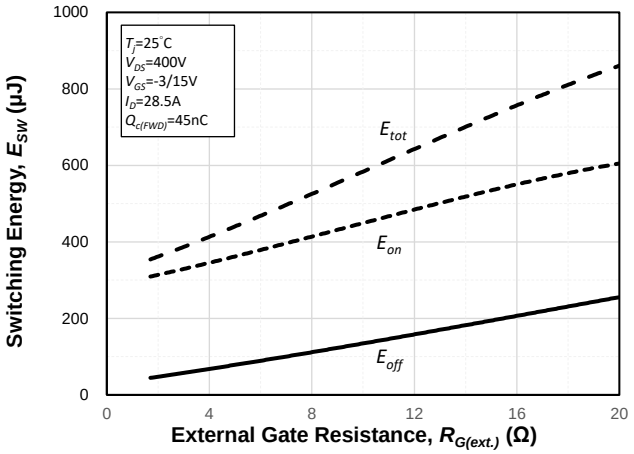



**Fig. 25 Typ. Switching Energy vs. $R_{G(ext.)}$**

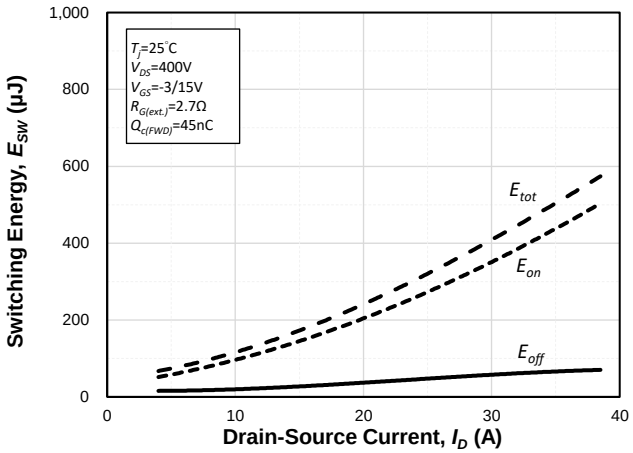
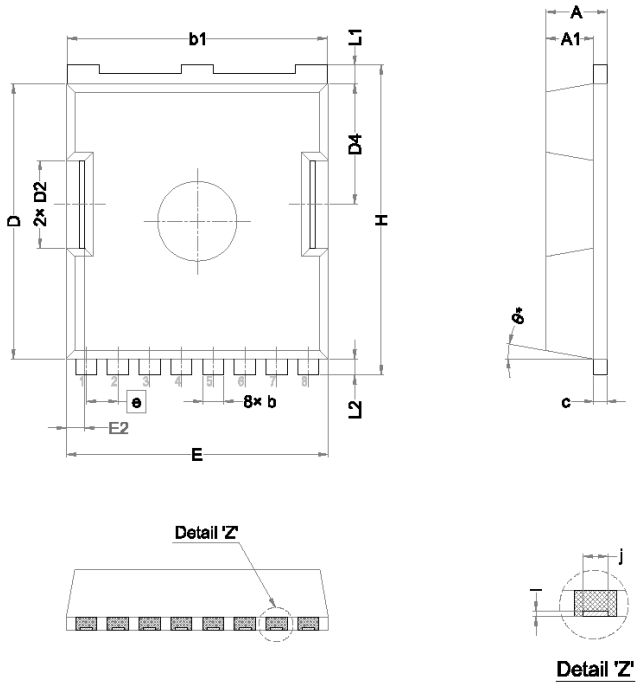
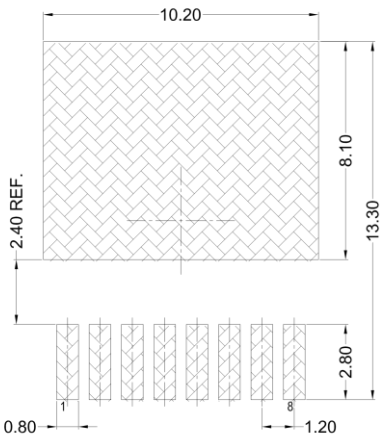



**Fig. 26 Typ. Switching Energy vs. $I_D$**

## Package Outline (TOLL, MO-299B)



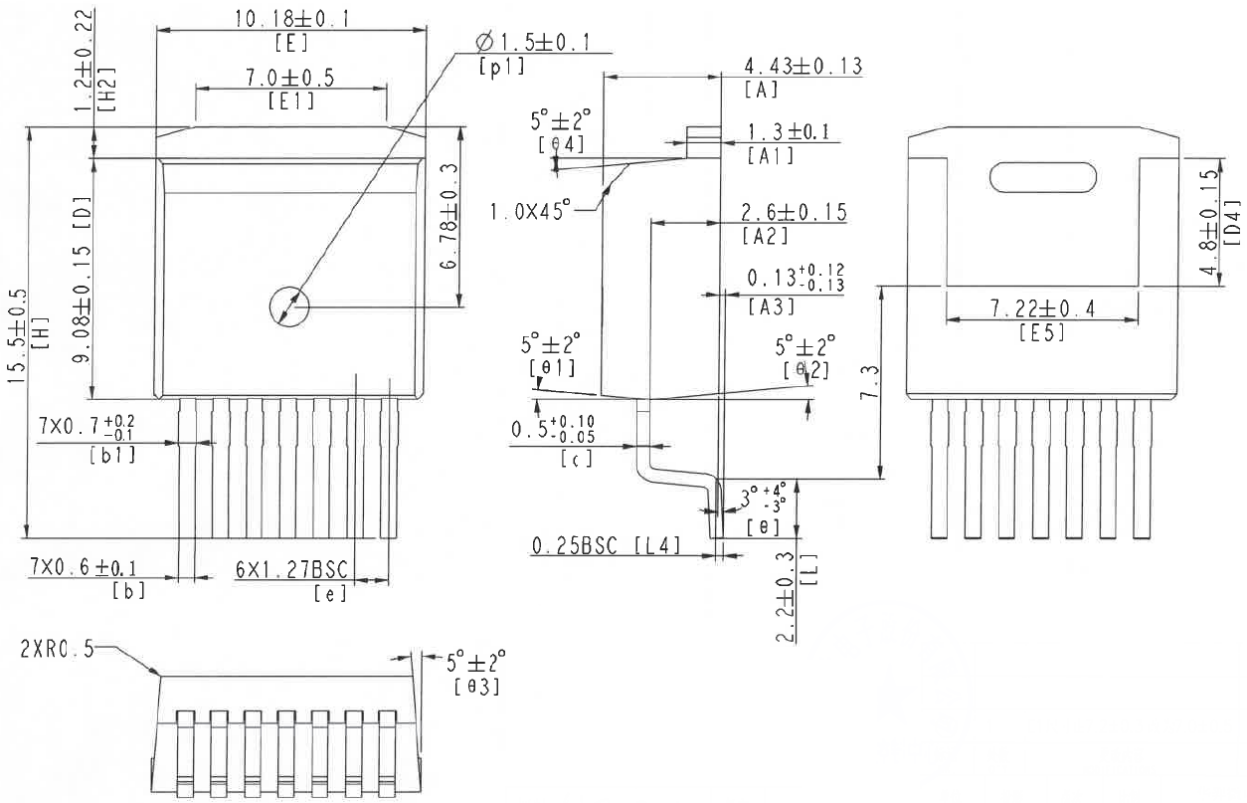

**Land Pattern (Only for reference)**

| Symbol | Dimension (Millimeters) | | |
|---|---|---|---|
| | Min. | Nom. | Max. |
| A | 2.20 | 2.30 | 2.40 |
| A1 | 1.70 | 1.80 | 1.90 |
| b | 0.70 | 0.80 | 0.90 |
| b1 | 9.70 | 9.80 | 9.90 |
| b3 | 1.10 | 1.20 | 1.30 |
| c | 0.40 | 0.50 | 0.60 |
| D | 10.28 | 10.38 | 10.48 |
| D1 | 10.98 | 11.08 | 11.18 |
| D2 | 3.20 | 3.30 | 3.40 |
| D4 | 4.45 | 4.55 | 4.65 |
| E | 9.80 | 9.90 | 10.00 |
| E1 | 8.00 | 8.10 | 8.20 |
| E2 | 0.60 | 0.70 | 0.80 |
| e | | 1.20 BSC. | |
| H | 11.58 | 11.68 | 11.78 |
| H1 | | 6.95 BSC. | |
| H2 | | 5.89 BSC. | |
| i | | 0.10 REF. | |
| j | | 0.46REF. | |
| K | | 2.80 REF. | |
| L | 1.40 | 1.90 | 2.10 |
| L1 | 0.60 | 0.70 | 0.80 |
| L2 | 0.50 | 0.60 | 0.70 |
| L3 | 0.30 | 0.70 | 0.80 |
| N | | 8 | |
| Q | | 6.80 REF. | |
| R | 3.00 | 3.10 | 3.20 |
| θ | | 10° REF. | |

**Note:**

1. Dimensions do not inclusive burrs and mold flash.
2. "*" is for reference.

## Package Outline (TO-263-7L)



## Revision History

| Date | Revision | Changes |
|---|---|---|
| 23.04 | Tentative | 1st issue |
| 23.06 | Preliminary | Update to preliminary version |
| 24.04 | Preliminary | Minor change |
| 24.11 | Preliminary | Update pad layout |
| | | |

## Important Note (Disclaimer)

Fast SiC Semiconductor Inc. (“FSS”) reserves the right to make changes and improvements to this product and the information provided in this document may be subject to change without prior notice. Buyers should contact FSS sales representatives to obtain the latest information on this product before placing order and are solely responsible for the selection and use of this product. In addition, any information given in this document is only intended to show the typical functions that can vary in different applications and shall not be regarded as a guarantee or warranty of conditions or characteristics.

This product is not designed or intended for use for applications in which the failure of the product could lead to personal injury, death or property damage, including but not limited to equipment used in medical systems, traffic communication or control systems, transportations (cars, ships, trains) and aerospace. FSS shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions provided herein.

Published by:
Fast SiC Semiconductor Inc.
Hsinchu, Taiwan