## 1200V Silicon Carbide Power MOSFET

## Features

- Revolutionary semiconductor material Silicon Carbide
- High blocking voltage with low on-resistance
- High speed switching with very low switching losses
- High speed and high robust intrinsic body diode
- Optimized package with separate driver source pin

## Product Summary

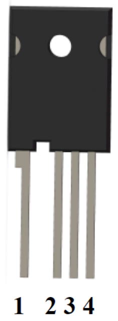
Green

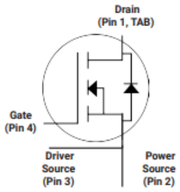
| BVDSS | RDSON | ID |
|---|---|---|
| 1200V | 15mΩ | 166A |

## Applications

- Motor Drives
- EV Battery Charges
- Solar energy system
- UPS
- Industrial motor control

## TO247-4L Pin Configuration





## Maximum Ratings For MOSFET ($T_{VJ}$= 25˚C unless otherwise specified)

| Symbol | Parameter | Value | Unit | Testing Conditions |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | 1200 | V | |
| $I_D$ | Continuous DC Drain Current for $R_{th(j-c,typ.)}$, Limited by $T_{VJ(max)}$ | 166 | A | $T_C$ = 25 ℃ |
| | | 117 | | $T_C$ = 100℃ |
| $I_{DM}$ | Peak Drain Current, tp Limited by $T_{VJ(max)}$ | 318 | A | $T_C$ = 25 ℃ |
| $V_{GS, max}$ | Gate-Source Max Voltage | -10/22 | V | |
| $V_{GS, op}$ | Gate-Source Operate Voltage | -5/18 | V | |
| $E_{AS}$ | Single Pulse Avalanche Energy | 1056 | mJ | L=0.5mH, $I_{AS}$=65 A, $V_{DD}$=50V, $V_{GS}$=18V |
| $P_{tot}$ | Power Dissipation for $R_{th(j-c,typ.)}$ | 789 | W | $T_C$ = 25℃ |

## Package Values

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Testing Conditions |
|---|---|---|---|---|---|---|
| $R_{th(j-c)}$ | MOSFET/Body Diode Junction-Case Thermal Resistance | | 0.19 | 0.23 | K/W | |
| $T_{VJ}$, $T_{STG}$ | Operating Junction and Storage Temperature | -55 | | 175 | ℃ | |
| $T_{SOLD}$ | Soldering Temperature, Wave Soldering only Allowed at Leads 1.6mm from Case for 10s | | 260 | | ℃ | |
| M | M3 screw, Maximum of mounting processes: 3 | | 1 | | Nm | |

## MOSFET Characteristics ($T_{VJ}$= 25˚C unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Testing Conditions | |
|---|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | 1200 | | | V | $I_D$ = 100 μA | |
| $V_{GS(th)}$ | Gate Threshold Voltage | 2 | 2.9 | 4.5 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 21mA | $T_{VJ}$ = 25 ℃ |
| | | | 2.0 | | | | $T_{VJ}$ = 175 ℃ |
| $I_{DSS}$ | Drain-Source Leakage Current | | 0.1 | 20 | μA | $V_{GS}$ = 0 V, $V_{DS}$ = 1200 V | $T_{VJ}$ = 25 ℃ |
| | | | 0.5 | | | | $T_{VJ}$ = 175 ℃ |
| $I_{GSS}$ | Gate-Source Leakage Current | | | 250 | nA | $V_{GS}$ = 22 V, $V_{DS}$ = 0 V | $T_{VJ}$ = 25 ℃ |
| $I_{SGS}$ | Source-Gate Leakage Current | | | 250 | nA | $V_{GS}$ = -10 V, $V_{DS}$ = 0 V | $T_{VJ}$ = 25 ℃ |
| $R_{DS(on)}$ | Drain-Source On-State Resistance | | 13.5 | | mΩ | $V_{GS}$ = 18 V, $I_D$ = 75 A | $T_{VJ}$ = 25 ℃ |
| | | | 23.5 | | | | $T_{VJ}$ = 175 ℃ |
| $g_{fs}$ | Transconductance | | 41 | | S | $V_{DS}$ = 10 V, $I_D$ = 75 A | |
| $R_{G(int)}$ | Internal Gate Resistance | | 1.6 | | Ω | f = 1MHz, $V_{AC}$ = 25 mV | |
| $C_{iss}$ | Input Capacitance | | 5527 | | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 800 V, f = 1MHz | |
| $C_{oss}$ | Output Capacitance | | 235 | | pF | | |
| $C_{rss}$ | Reverse Transfer Capacitance | | 10 | | pF | | |
| $Q_{GS}$ | Gate to Source Charge | | 73 | | nC | $V_{GS}$ = -5 V / +18 V, $V_{DD}$ = 800 V, $I_D$ = 75 A | |
| $Q_{GD}$ | Gate to Drain Charge | | 24 | | nC | | |
| $Q_G$ | Total Gate Charge | | 245 | | nC | | |

## Dynamic MOSFET Characteristics ($T_{VJ}$= 25˚C unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Testing Conditions | |
|---|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn–On Delay Time | | 17.0 | | ns | $V_{GS}$ = -5 V / +18 V,<br>L=100uH<br>$V_{DD}$ = 800 V, $I_D$ = 75 A,<br>$R_{G(on)}$ = 2.2 Ω, $R_{G(off)}$ = 2.2 Ω | $T_{VJ}$ = 25 ℃ |
| | | | 16.1 | | | | $T_{VJ}$ = 175 ℃ |
| $t_r$ | Rise Time | | 19.5 | | ns | | $T_{VJ}$ = 25 ℃ |
| | | | 21.0 | | | | $T_{VJ}$ = 175 ℃ |
| $t_{d(off)}$ | Turn–Off Delay Time | | 46.2 | | ns | | $T_{VJ}$ = 25 ℃ |
| | | | 53.2 | | | | $T_{VJ}$ = 175 ℃ |
| $t_f$ | Fall Time | | 12.8 | | ns | | $T_{VJ}$ = 25 ℃ |
| | | | 16.0 | | | | $T_{VJ}$ = 175 ℃ |
| $E_{on}$ | Turn–On Switching Loss | | 645 | | μJ | | $T_{VJ}$ = 25 ℃ |
| | | | 718 | | | | $T_{VJ}$ = 175 ℃ |
| $E_{off}$ | Turn–Off Switching Loss | | 300 | | μJ | | $T_{VJ}$ = 25 ℃ |
| | | | 389 | | | | $T_{VJ}$ = 175 ℃ |
| $E_{tot}$ | Total Switching Energy | | 945 | | μJ | | $T_{VJ}$ = 25 ℃ |
| | | | 1107 | | | | $T_{VJ}$ = 175 ℃ |

Note: $E_{on}$/$E_{off}$ result is with body diode.

## Maximum Ratings For Body Diode ($T_{VJ}$= 25˚C unless otherwise specified)

| Symbol | Parameter | Value | Unit | Testing Conditions |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | 1200 | V | |
| $I_S$ | Continuous DC Source Current, Limited by $T_{VJ(max)}$ | 138 | A | $T_C$ = 25 ℃ |
| | | 81 | | $T_C$ = 100 ℃ |
| $I_{SM}$ | Peak Reverse Drain Current, tp Limited by $T_{VJ(max)}$ | 318 | | $T_C$ = 25 ℃ |

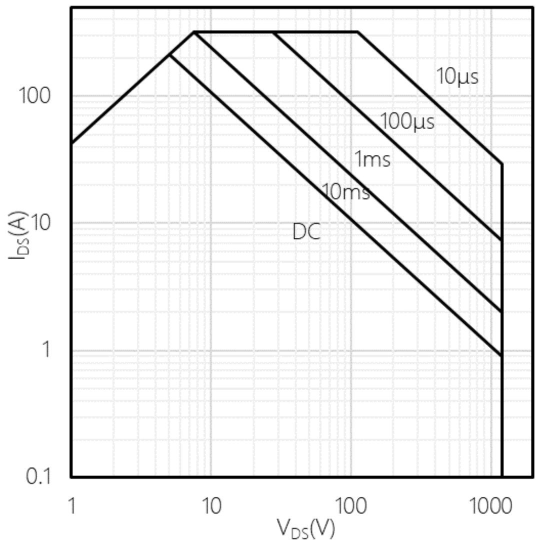
## **Body Diode Characteristics** ($T_{VJ}$= 25˚C unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Testing Conditions | |
|---|---|---|---|---|---|---|---|
| $V_{SD}$ | Body Diode Forward Voltage | | 4.7 | | V | $V_{GS}$ = -5 V, $I_{SD}$ = 75 A | $T_{VJ}$ = 25 ℃ |
| | | | 4.0 | | | | $T_{VJ}$ = 175 ℃ |
| $I_{rrm}$ | Peak Reverse Recovery Current | | 52 | | A | $V_{DS}$ = 800 V, $V_{GS}$ = -5 V, $I_{SD}$ =75A, di/dt = 3970 A / μs | $T_{VJ}$ = 25 ℃ |
| | | | 71 | | | | $T_{VJ}$ = 175 ℃ |
| $Q_{rr}$ | Reverse Recovery Charge | | 587 | | nC | | $T_{VJ}$ = 25 ℃ |
| | | | 1723 | | | | $T_{VJ}$ = 175 ℃ |
| $t_{rr}$ | Reverse Recovery Time | | 21 | | ns | | $T_{VJ}$ = 25 ℃ |
| | | | 39 | | | | $T_{VJ}$ = 175 ℃ |
| $E_{rr}$ | Reverse Recovery Energy | | 77 | | μJ | | $T_{VJ}$ = 25 ℃ |
| | | | 405 | | | | $T_{VJ}$ = 175 ℃ |

## Typical Performances

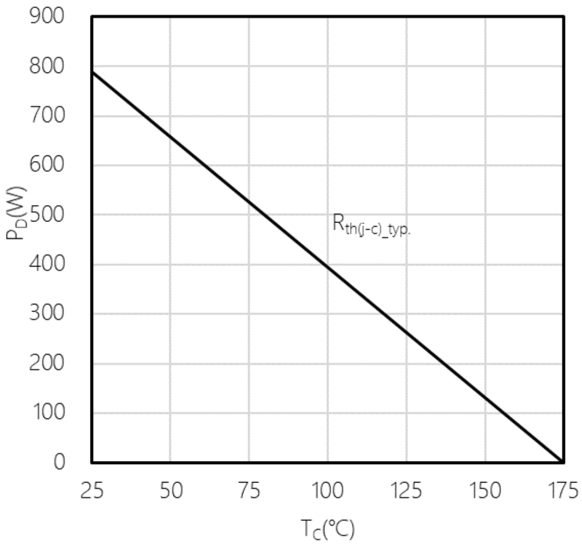
**Safe operating area (SOA)**

$R_{th(j-c)}$ =0.23 °C/W, Single Pulse, $T_{VJ}$ = 25°C



**Power dissipation as a function of case temperature limited by bond wire**

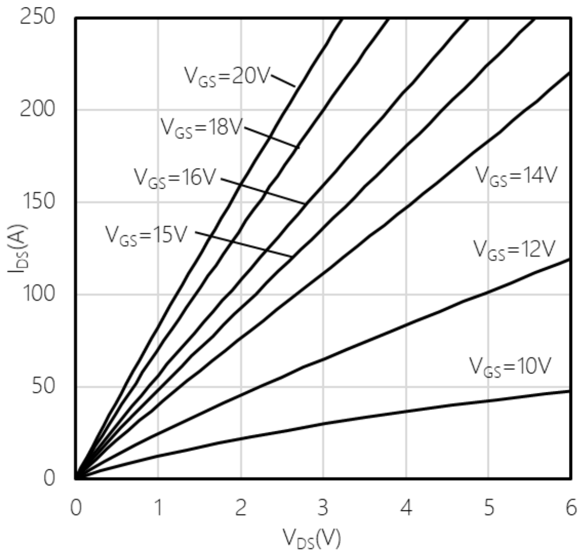
$P_D$ = f($T_C$)



**Typical output characteristic, $V_{GS}$ as parameter**

$I_{DS}$= f($V_{DS}$)

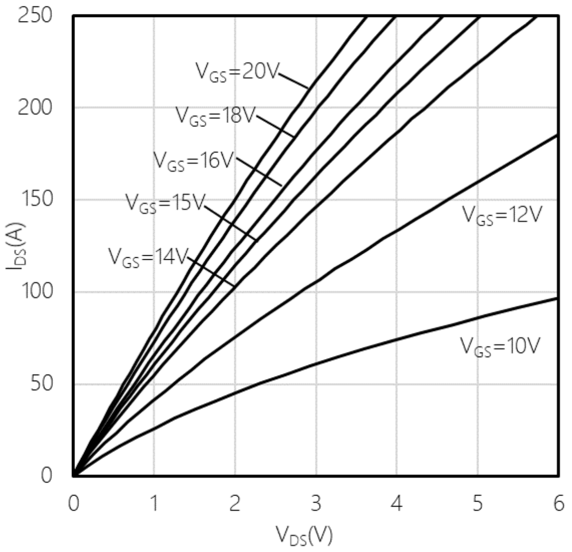
$T_{VJ}$ = -55 ℃



**Typical output characteristic, $V_{GS}$ as parameter**

$I_{DS}$ = f($V_{DS}$)

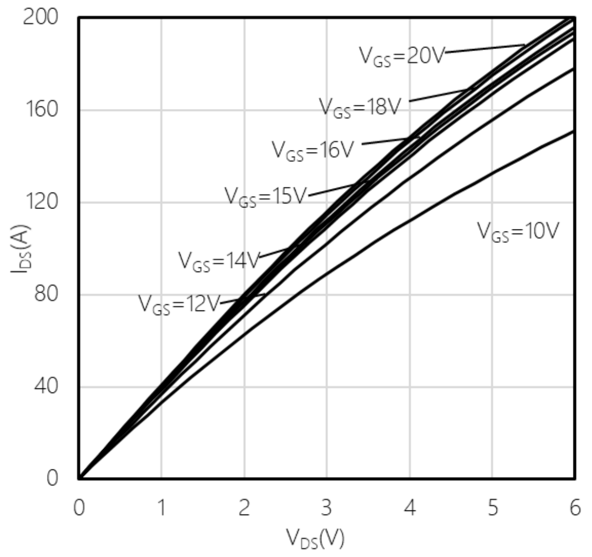
$T_{VJ}$ = 25 ℃



**Typical output characteristic, $V_{GS}$ as parameter**

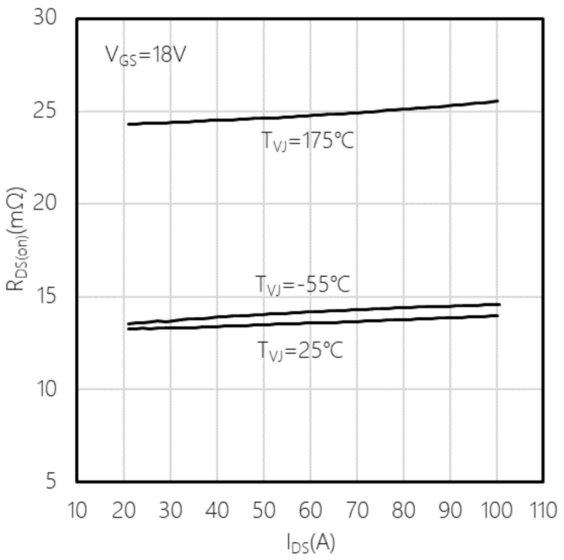
$I_{DS}$ = f($V_{DS}$)

$T_{VJ}$ = 175℃



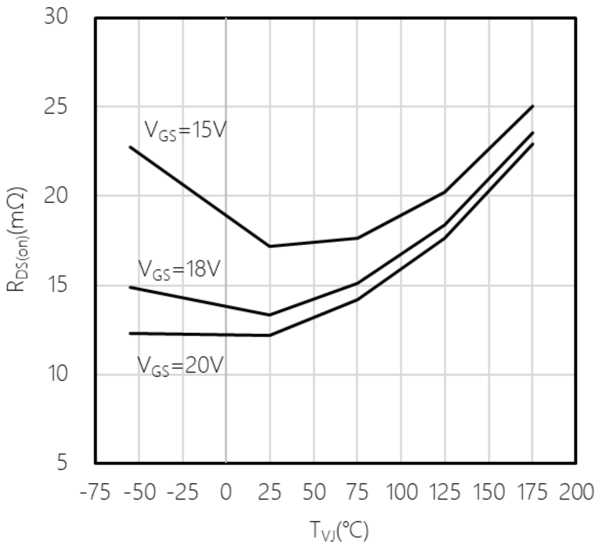
**Typical on-state resistance as a function of drain current**

$R_{DS(on)}$ = f($I_{DS}$), $V_{GS}$ = 18V



**Typical on-state resistance as a function of temperature**

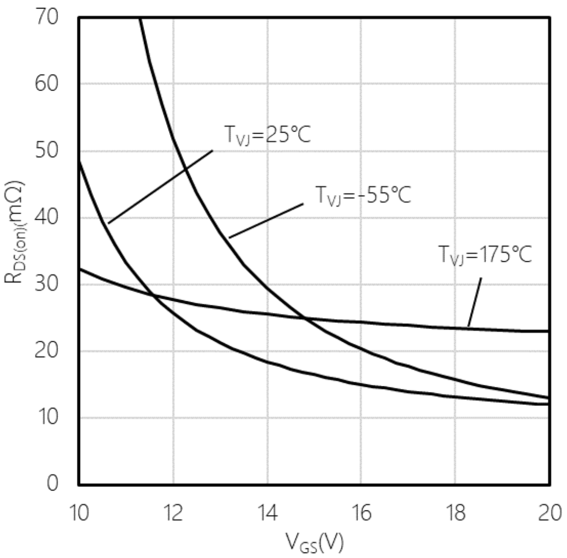
$R_{DS(on)}$ = f($T_{VJ}$), $I_{DS}$ =75A



**Typical on-state resistance as a function of $V_{GS}$**

$R_{DS(on)}$ = f($V_{GS}$)

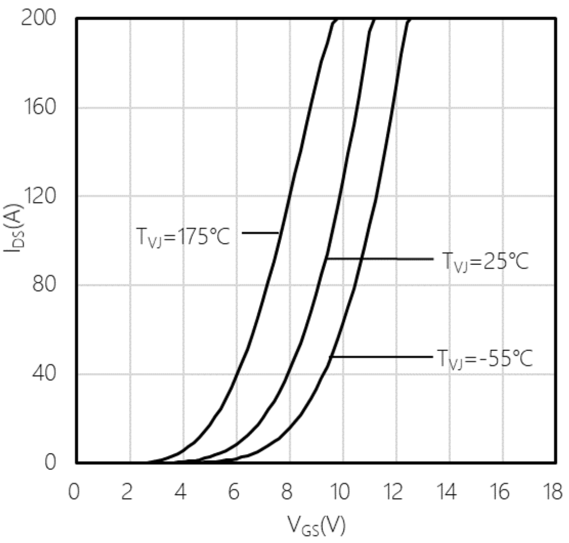
$I_{DS}$ =75A



**Typical transfer characteristic**

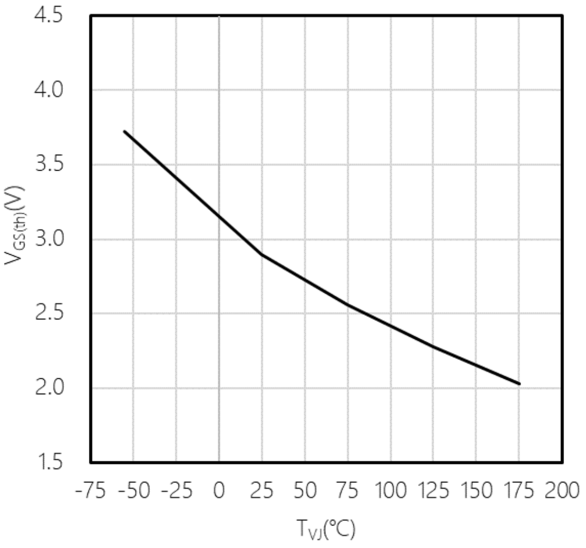
$I_{DS} = f(V_{GS})$

$V_{DS} = 10\ V$



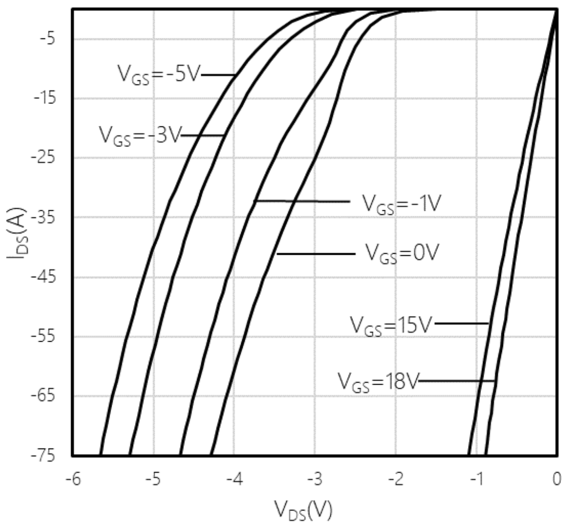
**Typical gate-source threshold voltage as a function of junction temperature**

$V_{GS(th)} = f(T_{VJ})$, $I_{DS} = 23\ mA$



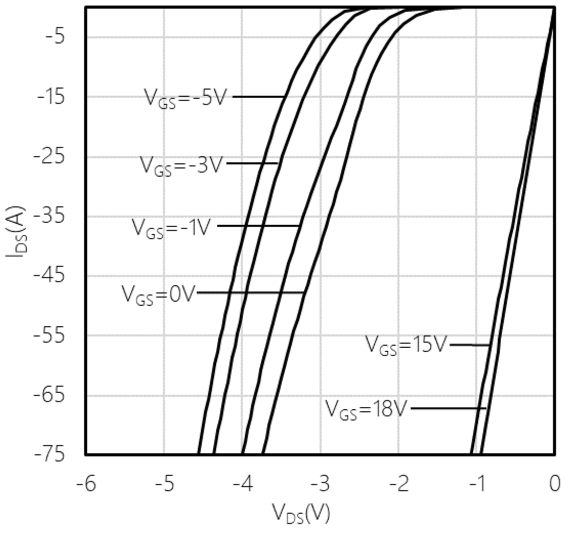
**Typical reverse drain current as function of reverse drain voltage, $V_{GS}$ as parameter**

$I_{DS} = f(V_{DS})$, $T_{VJ} = -55\ °C$



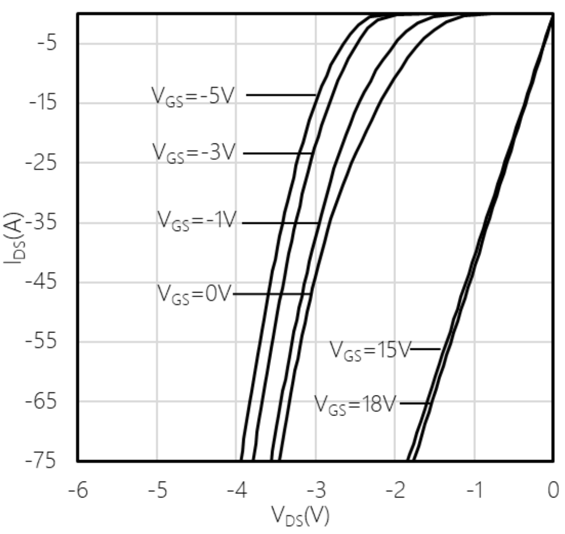
**Typical reverse drain current as function of reverse drain voltage, $V_{GS}$ as parameter**

$I_{DS} = f(V_{DS})$, $T_{VJ} = 25\ °C$



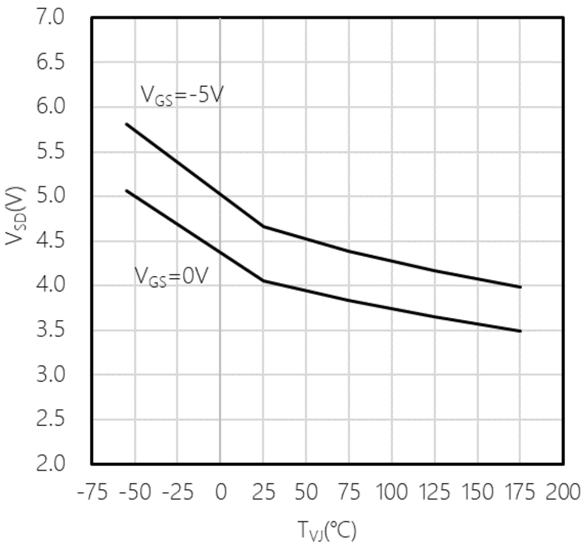
**Typical reverse drain current as function of reverse drain voltage, $V_{GS}$ as parameter**

$I_{DS} = f(V_{DS})$, $T_{VJ}$ = 175 °C



**Typical reverse drain voltage as function of junction temperature**

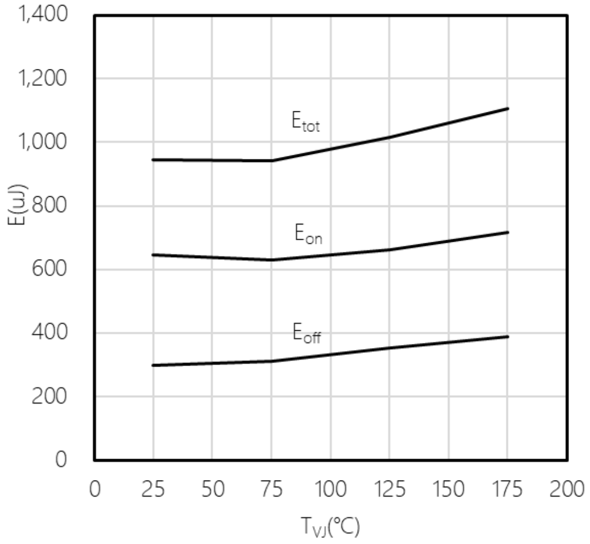
$V_{SD} = f(T_{VJ})$, $I_{SD}$ = 75 A



**Typical switching energy as a function of junction temperature, 2nd device own body diode: $V_{GS}$ = -5 V**

E = $f(T_{VJ})$

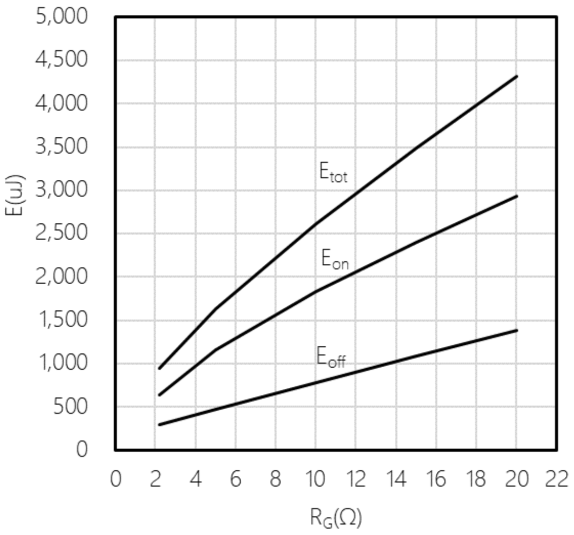
$V_{DS}$ = 800 V, $R_{G(ext)}$ = 2.2 Ω, $V_{GS}$ = -5 V / +18 V, $I_{DS}$ = 75 A



**Typical switching energy losses as a function of gate resistance, 2nd device own body diode: $V_{GS}$ = -5 V**

E = $f(R_{G(ext)})$

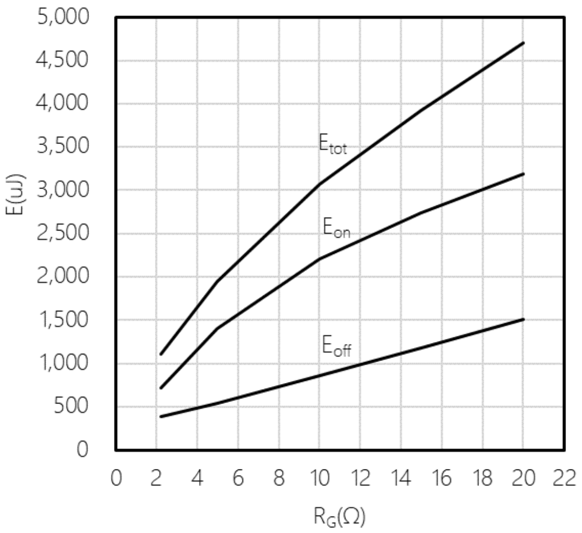
$V_{GS}$ = -5/18 V, $I_{DS}$ = 75 A, $T_{VJ}$ = 25 °C, $V_{DS}$ = 800 V



**Typical switching energy losses as a function of gate resistance, 2nd device own body diode: $V_{GS}$ = -5 V**

E = f($R_{G(ext)}$)

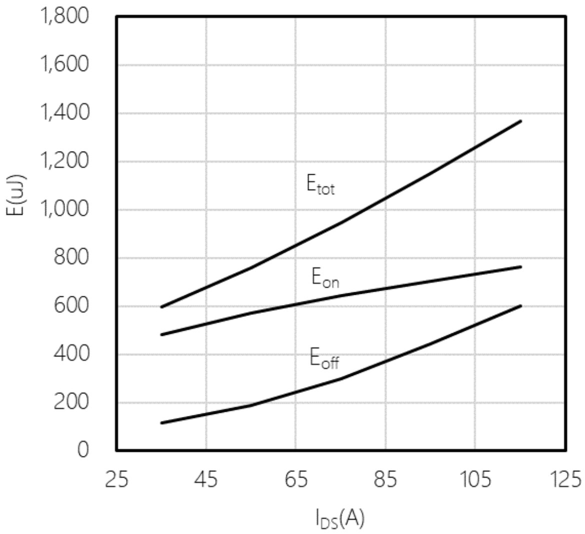
$V_{GS}$ = -5/18 V, $I_{DS}$ = 75 A, $T_{VJ}$ = 175 °C, $V_{DS}$ = 800 V



**Typical switching energy losses as a function of $I_{DS}$, 2nd device own body diode: $V_{GS}$ = -5 V**

E = f($I_{DS}$)

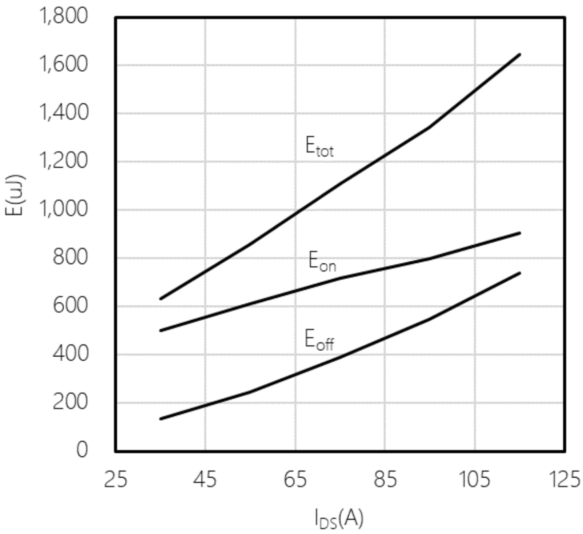
$V_{GS}$ = -5/18 V, $R_{G(ext)}$ = 2.2 Ω, $T_{VJ}$ = 25 °C, $V_{DS}$ = 800 V



**Typical switching energy losses as a function of $I_{DS}$, 2nd device own body diode: $V_{GS}$ = -5 V**

E = f($I_{DS}$)

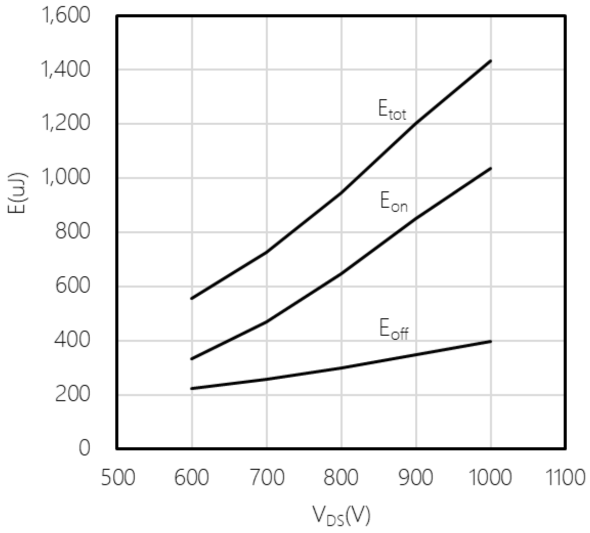
$V_{GS}$ = -5/18 V, $R_{G(ext)}$ = 2.2 Ω, $T_{VJ}$ = 175 °C, $V_{DS}$ = 800 V



**Typical switching energy losses as a function of $V_{DS}$, 2nd device own body diode: $V_{GS}$ = -5 V**

E = f($V_{DS}$)

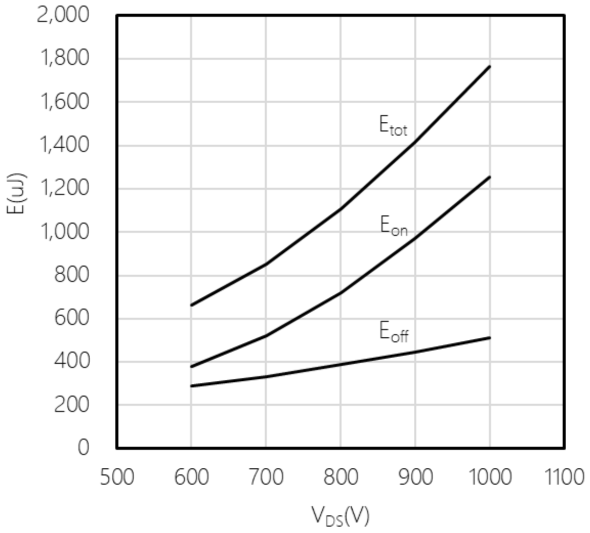
$V_{GS}$ = -5/18 V, $R_{G(ext)}$ = 2.2 Ω, $T_{VJ}$ = 25 °C, $I_{DS}$ = 75 A



**Typical switching energy losses as a function of $V_{DS}$, 2nd device own body diode: $V_{GS}$ = -5 V**

$E = f(V_{DS})$

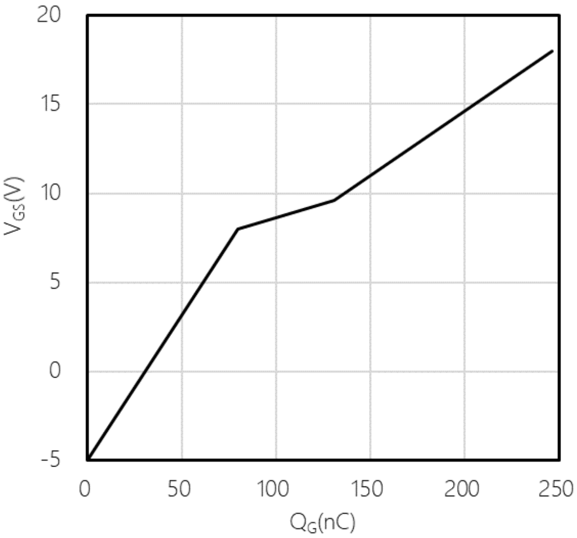
$V_{GS}$ = -5/18 V, $R_{G(ext)}$ = 2.2 Ω, $T_{VJ}$ = 175 °C, $I_{DS}$ = 75 A



**Typical gate charge**

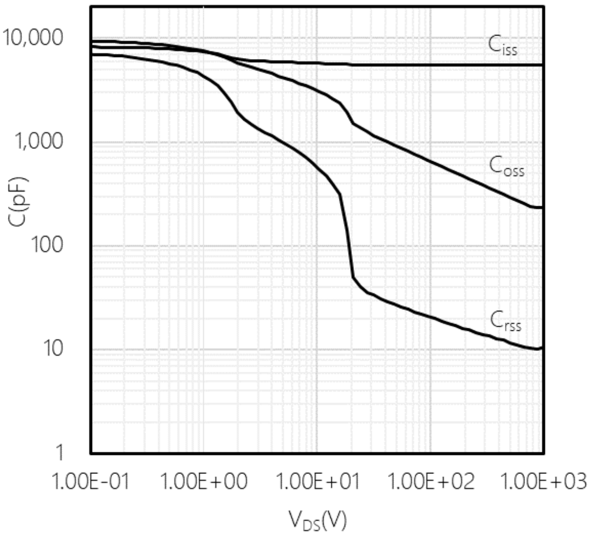
$V_{GS} = f(Q_G)$, $I_{DS}$ = 75A, $V_{DS}$ = 800V

turn-on pulse



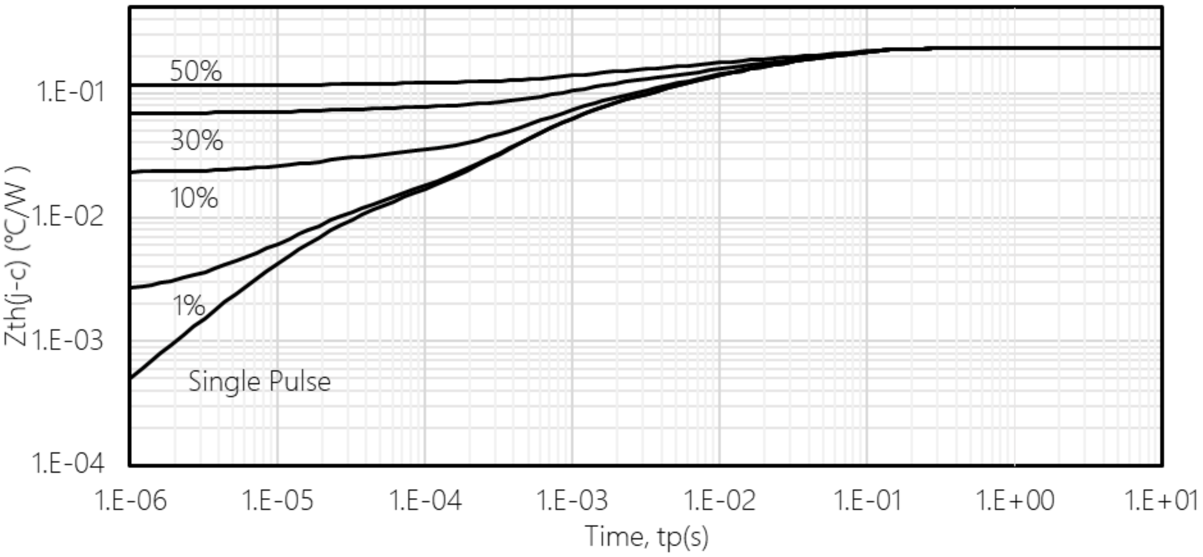
**Typical capacitance as a function of drain-source voltage**

$C = f(V_{DS})$, $V_{GS}$ = 0V, f = 1MHz

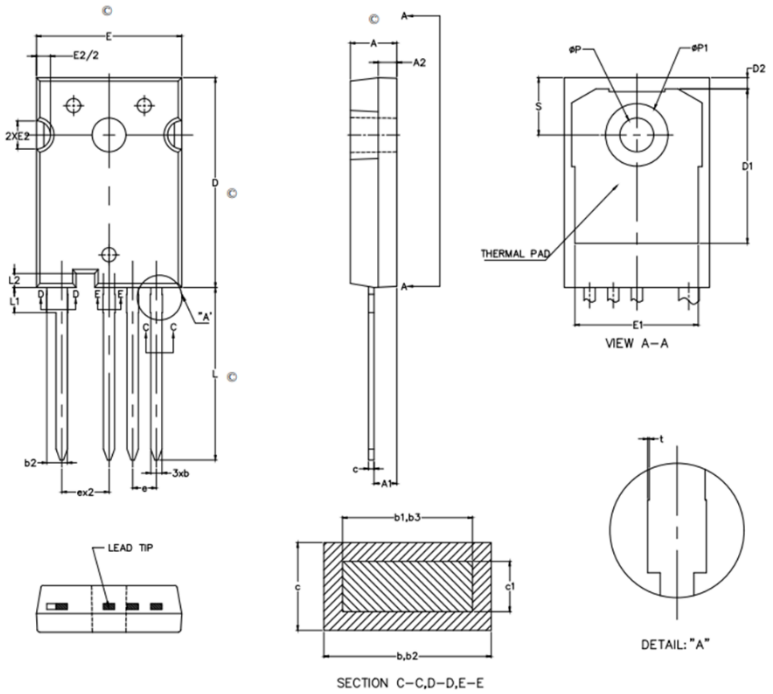


**Transient thermal resistance (MOSFET)**

($Z_{th(j-c,max)}$ = f($t_p$), Parameter D = $t_p$/T



## Package Dimensions



| Symbols | Dimensions | | | |
|---|---|---|---|---|
| | Mm | | Inch | |
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.90 | 5.10 | 0.193 | 0.201 |
| A1 | 2.31 | 2.51 | 0.091 | 0.099 |
| A2 | 1.90 | 2.10 | 0.075 | 0.083 |
| b | 1.16 | 1.26 | 0.046 | 0.050 |
| b1 | 1.15 | 1.22 | 0.045 | 0.048 |
| b2 | 2.16 | 2.26 | 0.085 | 0.089 |
| b3 | 2.15 | 2.22 | 0.085 | 0.087 |
| c | 0.59 | 0.66 | 0.023 | 0.026 |
| c1 | 0.58 | 0.62 | 0.023 | 0.024 |
| D | 22.40 | 22.60 | 0.882 | 0.890 |
| D1 | 16.15 | 16.75 | 0.640 | 0.663 |
| D2 | 1.22 | 1.53 | 0.041 | 0.053 |
| E | 15.75 | 15.90 | 0.620 | 0.626 |
| E1 | 13.26 | —— | 0.552 | —— |
| E2 | 2.90 | 3.10 | 0.114 | 0.122 |
| e | 2.54BSC | | 0.1BSC | |
| L | 18.30 | 18.60 | 0.720 | 0.732 |
| L1 | —— | 2.80 | —— | 0.110 |
| L2 | —— | 1.50 | —— | 0.059 |
| ϕP | 3.50 | 3.70 | 0.138 | 0.146 |
| ϕP1 | —— | 7.40 | —— | 0.291 |
| S | 6.22 | 6.42 | 0.238 | 0.246 |
| t | 0.00 | 0.15 | 0.000 | 0.006 |