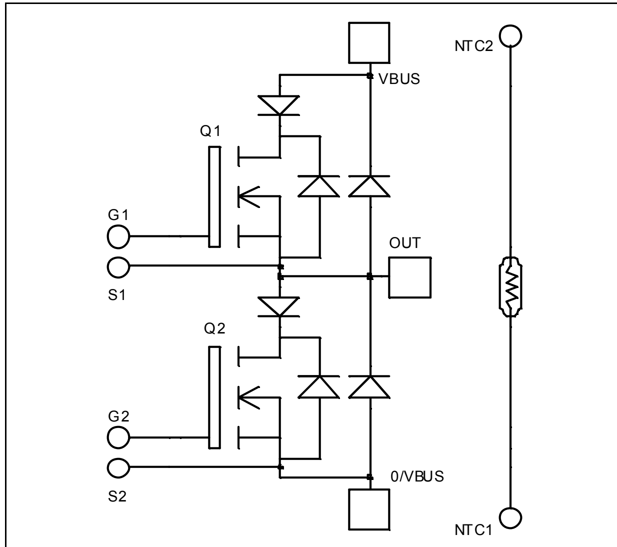
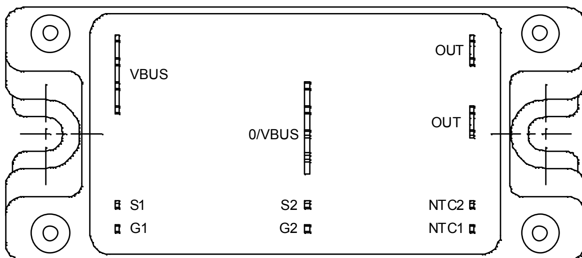
# APTM100A23SCTG

## *Phase leg Series & SiC parallel diodes MOSFET Power Module*

$V_{DSS}$ = 1000V
$R_{DSon}$ = 230mΩ typ @ Tj = 25°C
$I_D$ = 36A @ Tc = 25°C




**Application**

- Motor control
- Switched Mode Power Supplies
- Uninterruptible Power Supplies

**Features**

- ***Power MOS 7® MOSFETs***
  - Low $R_{DSon}$
  - Low input and Miller capacitance
  - Low gate charge
  - Avalanche energy rated
- ***Parallel SiC Schottky Diode***
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature Independent switching behavior
  - Positive temperature coefficient on VF
- Kelvin source for easy drive
- Very low stray inductance
  - Symmetrical design
  - Lead frames for power connections
- Internal thermistor for temperature monitoring
- High level of integration

**Benefits**

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS Compliant

## Absolute maximum ratings

| *Symbol* | *Parameter* | | *Max ratings* | *Unit* |
|---|---|---|---|---|
| $V_{DSS}$ | Drain - Source Breakdown Voltage | | 1000 | V |
| $I_D$ | Continuous Drain Current | $T_c$ = 25°C | 36 | A |
| | | $T_c$ = 80°C | 27 | |
| $I_{DM}$ | Pulsed Drain current | | 144 | |
| $V_{GS}$ | Gate - Source Voltage | | ±30 | V |
| $R_{DSon}$ | Drain - Source ON Resistance | | 270 | mΩ |
| $P_D$ | Maximum Power Dissipation | $T_c$ = 25°C | 694 | W |
| $I_{AR}$ | Avalanche current (repetitive and non repetitive) | | 18 | A |
| $E_{AR}$ | Repetitive Avalanche Energy | | 50 | mJ |
| $E_{AS}$ | Single Pulse Avalanche Energy | | 2500 | |

**CAUTION:** These Devices are sensitive to Electrostatic Discharge. Proper Handing Procedures Should Be Followed. See application note APT0502 on www.microsemi.com

**All ratings @ $T_j = 25°C$ unless otherwise specified**

## Electrical Characteristics

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{GS} = 0V, V_{DS} = 1000V$ | $T_j = 25°C$ | | | 200 | µA |
| | | $V_{GS} = 0V, V_{DS} = 800V$ | $T_j = 125°C$ | | | 1000 | |
| $R_{DS(on)}$ | Drain – Source on Resistance | $V_{GS} = 10V, I_D = 18A$ | | | 230 | 270 | mΩ |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS} = V_{DS}, I_D = 5mA$ | | 3 | | 5 | V |
| $I_{GSS}$ | Gate – Source Leakage Current | $V_{GS} = ±30 V, V_{DS} = 0V$ | | | | ±150 | nA |

## Dynamic Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input Capacitance | $V_{GS} = 0V$<br>$V_{DS} = 25V$<br>f = 1MHz | | 8700 | | pF |
| $C_{oss}$ | Output Capacitance | | | 1430 | | |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 240 | | |
| $Q_g$ | Total gate Charge | $V_{GS} = 10V$<br>$V_{Bus} = 500V$<br>$I_D = 36A$ | | 308 | | nC |
| $Q_{gs}$ | Gate – Source Charge | | | 52 | | |
| $Q_{gd}$ | Gate – Drain Charge | | | 194 | | |
| $T_{d(on)}$ | Turn-on Delay Time | **Inductive switching @ 125°C**<br>$V_{GS} = 15V$<br>$V_{Bus} = 667V$<br>$I_D = 36A$<br>$R_G = 2.5Ω$ | | 10 | | ns |
| $T_r$ | Rise Time | | | 12 | | |
| $T_{d(off)}$ | Turn-off Delay Time | | | 121 | | |
| $T_f$ | Fall Time | | | 35 | | |
| $E_{on}$ | Turn-on Switching Energy | **Inductive switching @ 25°C**<br>$V_{GS} = 15V, V_{Bus} = 667V$<br>$I_D = 36A, R_G = 2.5Ω$ | | 767 | | µJ |
| $E_{off}$ | Turn-off Switching Energy | | | 760 | | |
| $E_{on}$ | Turn-on Switching Energy | **Inductive switching @ 125°C**<br>$V_{GS} = 15V, V_{Bus} = 667V$<br>$I_D = 36A, R_G = 2.5Ω$ | | 1255 | | µJ |
| $E_{off}$ | Turn-off Switching Energy | | | 902 | | |

## Series diode ratings and characteristics

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RRM}$ | Maximum Peak Repetitive Reverse Voltage | | | 200 | | | V |
| $I_{RM}$ | Maximum Reverse Leakage Current | $V_R=200V$ | $T_j = 25°C$ | | | 350 | µA |
| | | | $T_j = 125°C$ | | | 600 | |
| $I_F$ | DC Forward Current | | $T_c = 85°C$ | | 60 | | A |
| $V_F$ | Diode Forward Voltage | $I_F = 60A$ | | | 1.1 | 1.15 | V |
| | | $I_F = 120A$ | | | 1.4 | | |
| | | $I_F = 60A$ | $T_j = 125°C$ | | 0.9 | | |
| $t_{rr}$ | Reverse Recovery Time | $I_F = 60A$<br>$V_R = 133V$<br>di/dt = 400A/µs | $T_j = 25°C$ | | 24 | | ns |
| | | | $T_j = 125°C$ | | 48 | | |
| $Q_{rr}$ | Reverse Recovery Charge | | $T_j = 25°C$ | | 66 | | nC |
| | | | $T_j = 125°C$ | | 300 | | |

## Parallel SiC diode ratings and characteristics

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RRM}$ | Maximum Peak Repetitive Reverse Voltage | | | 1200 | | | V |
| $I_{RM}$ | Maximum Reverse Leakage Current | $V_R$=1200V | $T_j$ = 25°C | | 200 | 800 | µA |
| | | | $T_j$ = 150°C | | 400 | 4000 | |
| $I_F$ | DC Forward Current | | Tc = 125°C | | 20 | | A |
| $V_F$ | Diode Forward Voltage | $I_F$ = 20A | $T_j$ = 25°C | | 1.6 | 1.8 | V |
| | | | $T_j$ = 175°C | | 2.6 | 3.0 | |
| $Q_C$ | Total Capacitive Charge | $I_F$ = 20A, $V_R$ = 600V di/dt =1200A/µs | | | 56 | | nC |
| Q | Total Capacitance | f = 1MHz, $V_R$ = 200V | | | 180 | | pF |
| | | f = 1MHz, $V_R$ = 400V | | | 132 | | |

## Thermal and package characteristics

| Symbol | Characteristic | | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $R_{thJC}$ | Junction to Case Thermal Resistance | | Transistor | | | 0.18 | °C/W |
| | | | Series diode | | | 0.65 | |
| | | | Parallel diode | | | 0.8 | |
| $V_{ISOL}$ | RMS Isolation Voltage, any terminal to case t =1 min, I isol<1mA, 50/60Hz | | | 2500 | | | V |
| $T_J$ | Operating junction temperature range | | | -40 | | 150 | °C |
| $T_{STG}$ | Storage Temperature Range | | | -40 | | 125 | |
| $T_C$ | Operating Case Temperature | | | -40 | | 100 | |
| Torque | Mounting torque | To Heatsink | M5 | 2.5 | | 4.7 | N.m |
| Wt | Package Weight | | | | | 160 | g |

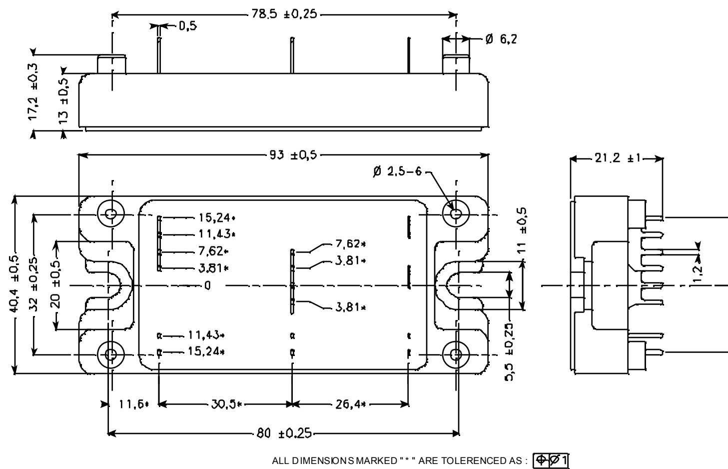
## Temperature sensor NTC (see application note APT0406 on www.microsemi.com for more information).

| Symbol | Characteristic | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $R_{25}$ | Resistance @ 25°C | | 50 | | kΩ |
| $B_{25/85}$ | $T_{25}$ = 298.15 K | | 3952 | | K |

$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

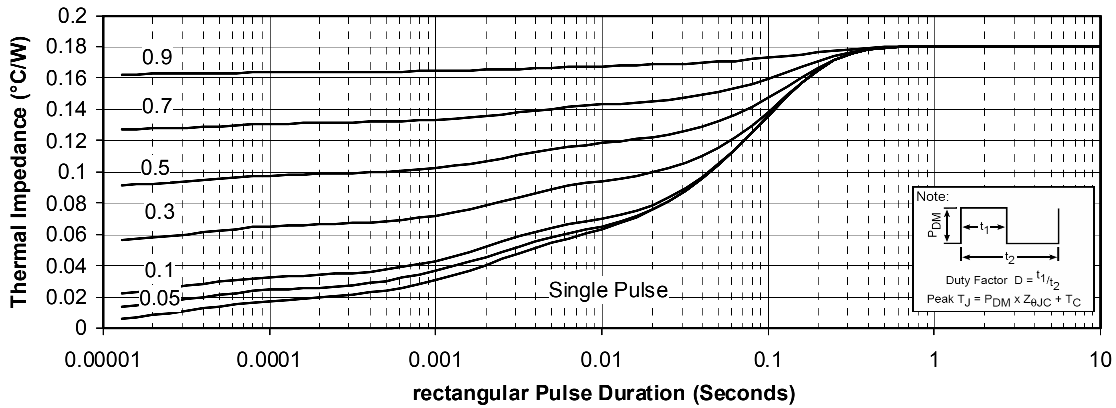
T: Thermistor temperature
$R_T$: Thermistor value at T

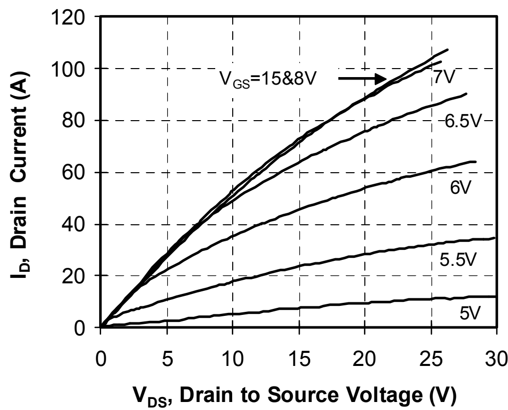
## SP4 Package outline (dimensions in mm)

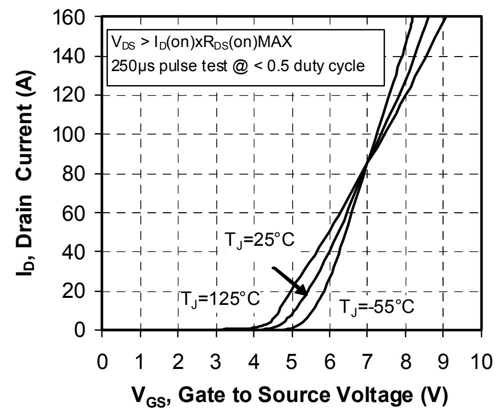


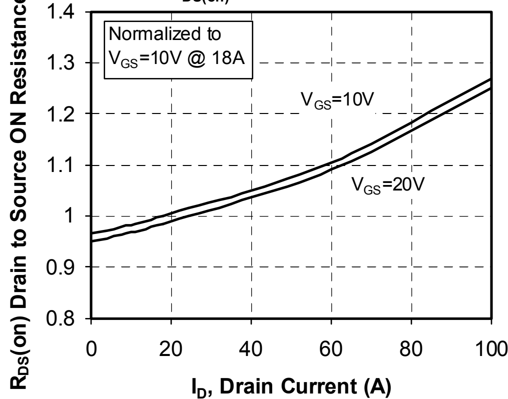

See application note APT0501 - Mounting Instructions for SP4 Power Modules on www.microsemi.com

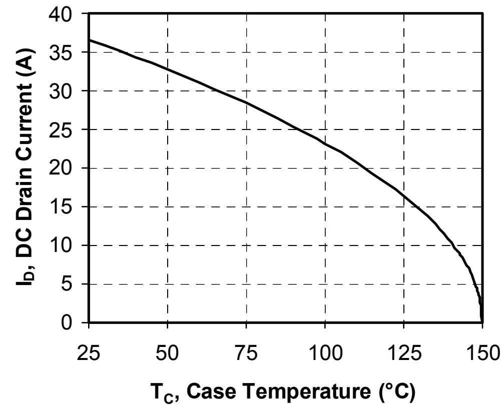
## Typical MOSFET Performance Curve

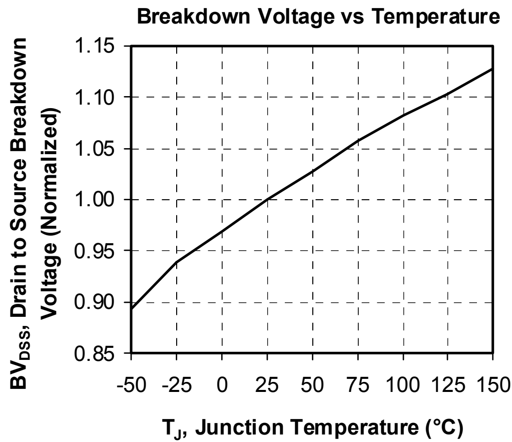


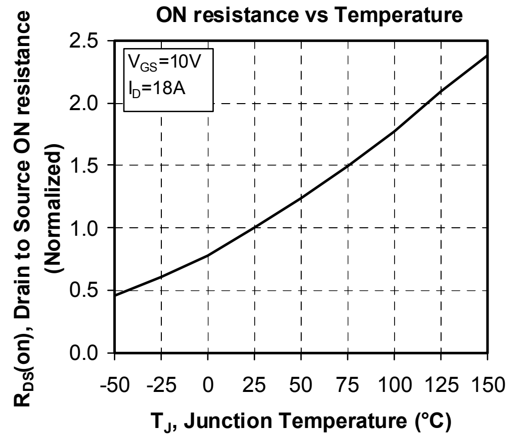



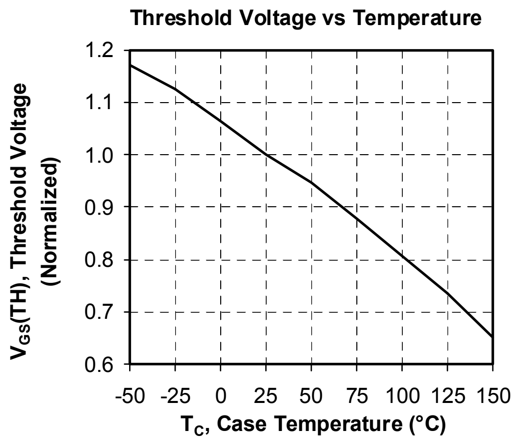



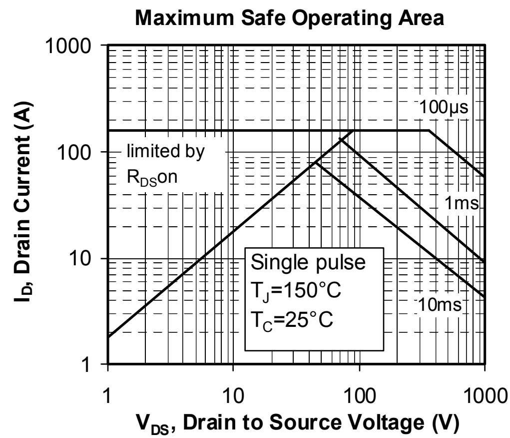



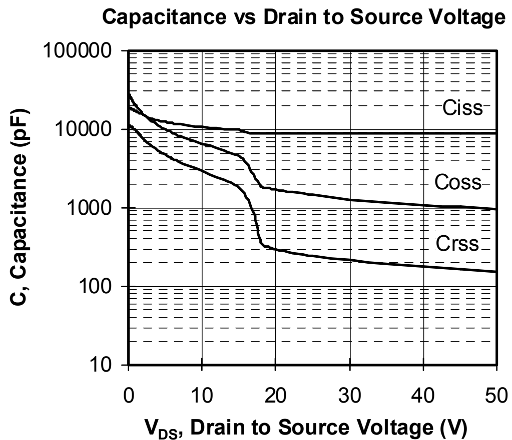



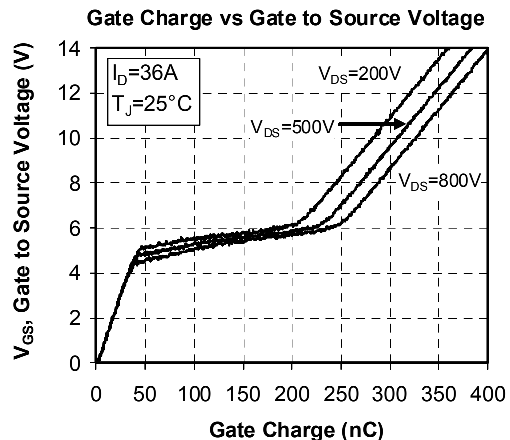

Breakdown Voltage vs Temperature
BVDSS, Drain to Source Breakdown Voltage (Normalized)
TJ, Junction Temperature (°C)

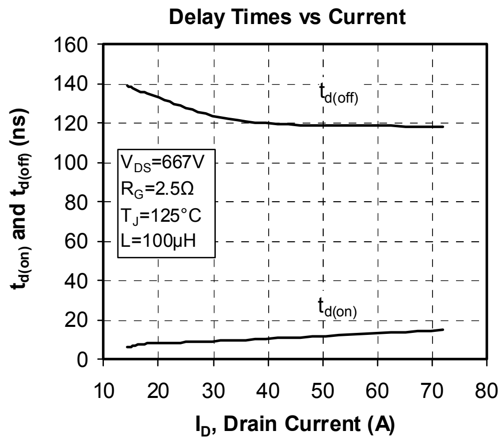

ON resistance vs Temperature
VGS=10V
ID=18A
RDS(on), Drain to Source ON resistance (Normalized)
TJ, Junction Temperature (°C)

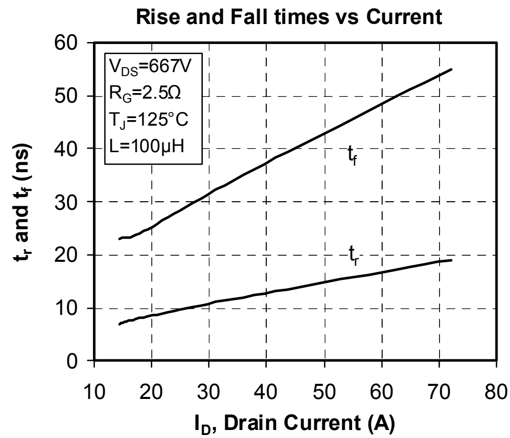

Threshold Voltage vs Temperature
VGS(TH), Threshold Voltage (Normalized)
TC, Case Temperature (°C)

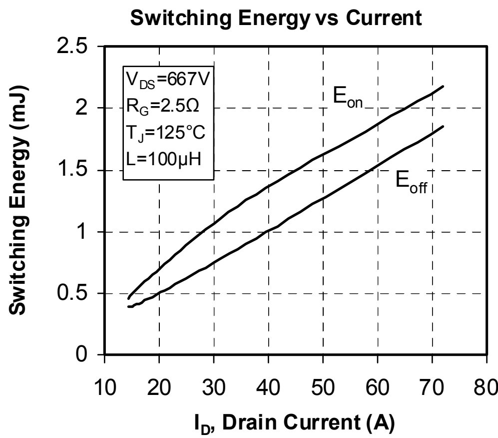

Maximum Safe Operating Area
limited by RDSon
100µs
1ms
10ms
Single pulse
TJ=150°C
TC=25°C
ID, Drain Current (A)
VDS, Drain to Source Voltage (V)

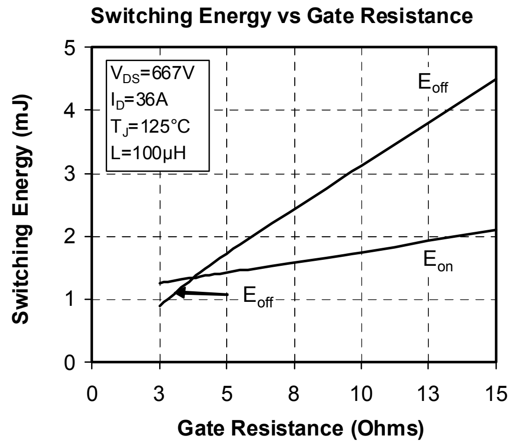

Capacitance vs Drain to Source Voltage
Ciss
Coss
Crss
C, Capacitance (pF)
VDS, Drain to Source Voltage (V)

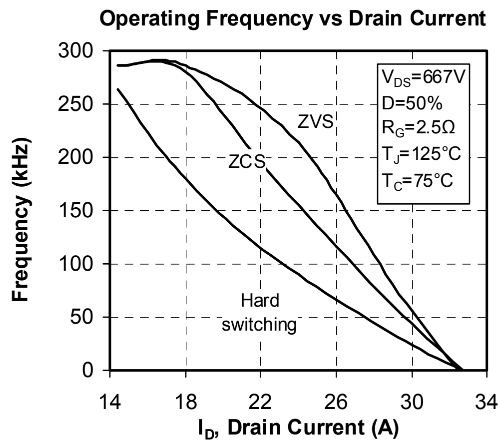

Gate Charge vs Gate to Source Voltage
ID=36A
TJ=25°C
VDS=200V
VDS=500V
VDS=800V
VGS, Gate to Source Voltage (V)
Gate Charge (nC)

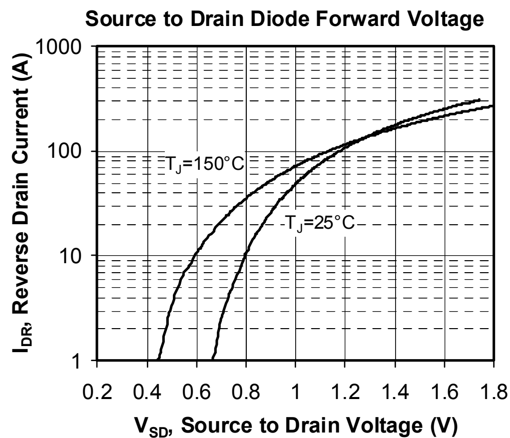

Delay Times vs Current
td(off)
td(on)
VDS=667V
RG=2.5Ω
TJ=125°C
L=100µH
td(on) and td(off) (ns)
ID, Drain Current (A)


Rise and Fall times vs Current
VDS=667V
RG=2.5Ω
TJ=125°C
L=100µH
tf
tr
tr and tf (ns)
ID, Drain Current (A)

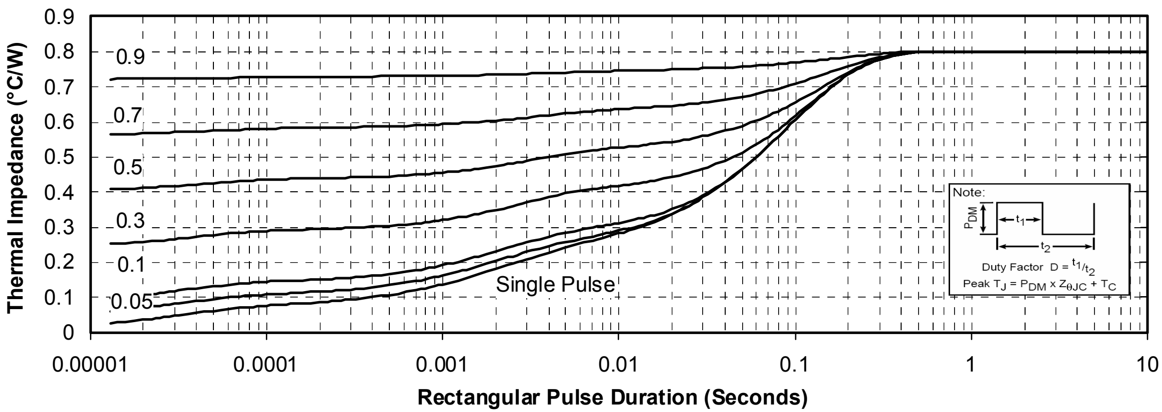

Switching Energy vs Current
VDS=667V
RG=2.5Ω
TJ=125°C
L=100µH
Eon
Eoff
Switching Energy (mJ)
ID, Drain Current (A)

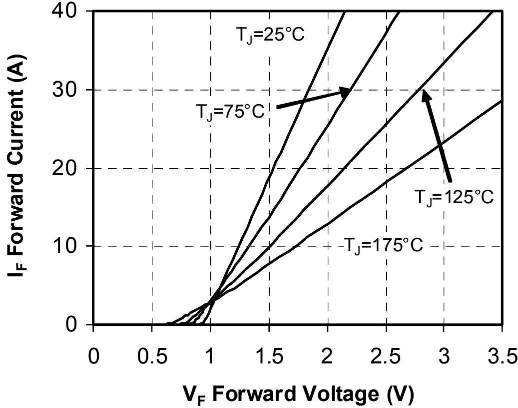

Switching Energy vs Gate Resistance
VDS=667V
ID=36A
TJ=125°C
L=100µH
Eoff
Eon
Eoff
Switching Energy (mJ)
Gate Resistance (Ohms)

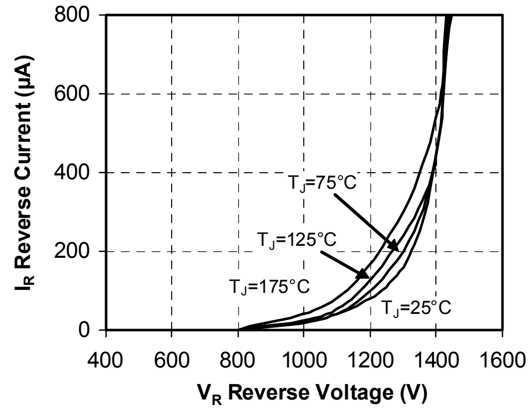

Operating Frequency vs Drain Current
VDS=667V
D=50%
RG=2.5Ω
TJ=125°C
TC=75°C
ZVS
ZCS
Hard
switching
Frequency (kHz)
ID, Drain Current (A)

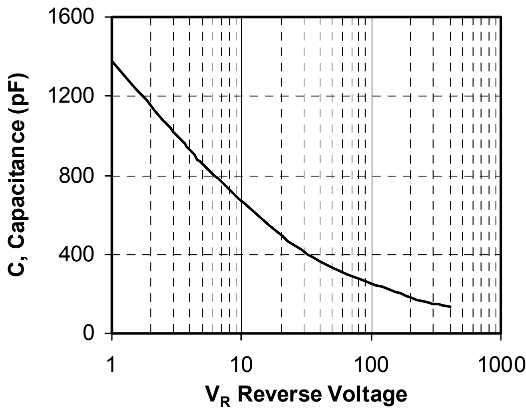

Source to Drain Diode Forward Voltage
TJ=150°C
TJ=25°C
IDR, Reverse Drain Current (A)
VSD, Source to Drain Voltage (V)

## Typical SiC Diode Performance Curve

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