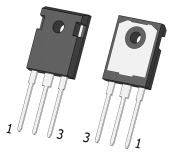
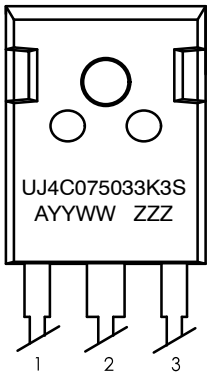
# Silicon Carbide (SiC) Cascode JFET – EliteSiC, Power N-Channel, TO247-3, 750 V, 33 mohm

# UJ4C075033K3S



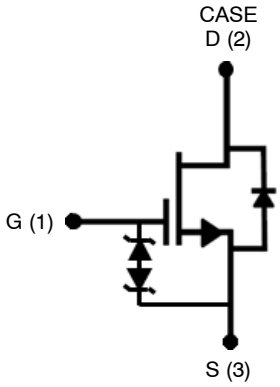
TO247-3
CASE 340AK

## MARKING DIAGRAM




| | |
|---|---|
| UJ4C075033K3S | = Specific Device Number |
| A | = Assembly Location |
| YY | = Year |
| WW | = Work Week |
| ZZZ | = Lot ID |

## PIN CONNECTIONS




## ORDERING INFORMATION

See detailed ordering and shipping information on page 11 of this data sheet.

### Description

The UJ4C075033K3S is a 750 V, 33 mΩ G4 SiC FET. It is based on unique 'cascode' circuit configuration, in which a normally-on SiC JFET is co-packaged with a Si MOSFET to produce a normally-off SiC FET device. The device's standard gate-drive characteristics allows for a true "drop-in replacement" to Si IGBTs, Si FETs, SiC MOSFETs or Si superjunction devices. Available in the TO247-3 package, this device exhibits ultra-low gate charge and exceptional reverse recovery characteristics, making it ideal for switching inductive loads and any application requiring standard gate drive.

### Features

- On-Resistance $R_{DS(on)}$ : 33 mΩ (typ)
- Operating Temperature: 175 °C (max)
- Excellent Reverse Recovery: Qrr = 71 nC
- Low Body Diode $V_{FSD}$: 1.26 V
- Low Gate Charge: $Q_G$ = 37.8nC
- Threshold Voltage $V_{G(th)}$: 4.8 V (typ) Allowing 0 to 15 V Drive
- Low Intrinsic Capacitance
- ESD Protected: HBM Class 2 and CDM Class C3
- This Device is Pb-Free, Halogen Free and is RoHS Compliant

### Typical Applications

- EV Charging
- PV Inverters
- Switch Mode Power Supplies
- Power Factor Correction Modules
- Motor Drives
- Induction Heating

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## MAXIMUM RATINGS

| Symbol | Parameter | Test Conditions | Value | Unit |
|---|---|---|---|---|
| $V_{DS}$ | Drain-Source Voltage | | 750 | V |
| $V_{GS}$ | Gate-Source Voltage | DC | −20 to +20 | V |
| | | AC (f > 1 Hz) | −25 to +25 | V |
| $I_D$ | Continuous Drain Current (Note 1) | $T_C$ = 25 °C | 47 | A |
| | | $T_C$ = 100 °C | 35 | A |
| $I_{DM}$ | Pulsed Drain Current (Note 2) | $T_C$ = 25 °C | 140 | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy (Note 3) | L = 15 mH, $I_{AS}$ = 2.4 A | 43 | mJ |
| dv/dt | SiC FET dv/dt Ruggedness | $V_{DS}$ ≤ 500 V | 200 | V/ns |
| $P_{tot}$ | Power Dissipation | $T_C$ = 25 °C | 242 | W |
| $T_{J,max}$ | Maximum Junction Temperature | | 175 | °C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature | | −55 to 175 | °C |
| $T_L$ | Max. Lead Temperature for Soldering, 1/8” from Case for 5 Seconds | | 250 | °C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Limited by $T_{J,max}$.
2. Pulse width $t_p$ limited by $T_{J,max}$.
3. Starting $T_J$ = 25 °C.

## THERMAL CHARACTERISTICS

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | | – | 0.48 | 0.62 | °C/W |

## ELECTRICAL CHARACTERISTICS ($T_J$ = +25 °C unless otherwise specified)

| Symbol | Parameter | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **TYPICAL PERFORMANCE – STATIC** | | | | | | | |
| $BV_{DS}$ | Drain-Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA | | 750 | – | – | V |
| $I_{DSS}$ | Total Drain Leakage Current | $V_{DS}$ = 750 V, $V_{GS}$ = 0 V, $T_J$ = 25 °C | | – | 2 | 20 | μA |
| | | $V_{DS}$ = 750 V, $V_{GS}$ = 0 V, $T_J$ = 175 °C | | – | 20 | – | |
| $I_{GSS}$ | Total Gate Leakage Current | $V_{DS}$ = 0 V , $T_J$ = 25 °C<br>$V_{GS}$ = −20 V / +20 V | | – | 6 | ±20 | μA |
| $R_{DS(on)}$ | Drain-Source On-resistance | $V_{GS}$ = 12 V, $I_D$ = 30 A | $T_J$ = 25 °C | – | 33 | 41 | mΩ |
| | | | $T_J$ = 125 °C | – | 57 | – | |
| | | | $T_J$ = 175 °C | – | 75 | – | |
| $V_{G(th)}$ | Gate Threshold Voltage | $V_{DS}$ = 5 V, $I_D$ = 10 mA | | 4 | 4.8 | 6 | V |
| $R_G$ | Gate Resistance | f = 1 MHz, open drain | | – | 4.5 | – | Ω |
| **TYPICAL PERFORMANCE – REVERSE DIODE** | | | | | | | |
| $I_S$ | Diode Continuous Forward Current (Note 1) | $T_C$ = 25 °C | | – | – | 47 | A |
| $I_{S,pulse}$ | Diode Pulse Current (Note 2) | $T_C$ = 25 °C | | – | – | 140 | A |
| $V_{FSD}$ | Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 15 A, $T_J$ = 25 °C | | – | 1.26 | 1.42 | V |
| | | $V_{GS}$ = 0 V, $I_S$ = 15 A, $T_J$ = 175 °C | | – | 1.59 | – | |
| $Q_{rr}$ | Reverse Recovery Charge | $V_R$ = 400 V, $I_S$ = 30 A, $V_{GS}$ = 0 V, $R_{G_EXT}$ = 5 Ω, di/dt = 1600 A/μs, $T_J$ = 25 °C | | – | 71 | – | nC |
| $t_{rr}$ | Reverse Recovery Time | | | – | 11.5 | – | ns |



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**ELECTRICAL CHARACTERISTICS** ($T_J$ = +25 °C unless otherwise specified) (continued)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **TYPICAL PERFORMANCE – REVERSE DIODE(CONTINUED)** | | | | | | |
| $Q_{rr}$ | Reverse Recovery Charge | $V_R$ = 400 V, $I_S$ = 30 A, $V_{GS}$ = 0 V, $R_{G_EXT}$ = 5 Ω, di/dt = 1600 A/μs, $T_J$ = 150 °C | – | 79 | – | nC |
| $t_{rr}$ | Reverse Recovery Time | | – | 12 | – | ns |
| **TYPICAL PERFORMANCE – DYNAMIC** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, f = 100 kHz | – | 1400 | – | pF |
| $C_{oss}$ | Output Capacitance | | – | 68 | – | |
| $C_{rss}$ | Reverse Transfer Capacitance | | – | 2.5 | – | |
| $C_{oss(er)}$ | Effective Output Capacitance, Energy Related | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | – | 83 | – | pF |
| $C_{oss(tr)}$ | Effective Output Capacitance, Time Related | | – | 162 | – | pF |
| $E_{oss}$ | $C_{OSS}$ Stored Energy | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | – | 6.6 | – | μJ |
| $Q_G$ | Total Gate Charge | $V_{DS}$ = 400 V, $I_D$ = 30 A, $V_{GS}$ = 0 V to 15 V | – | 37.8 | – | nC |
| $Q_{GD}$ | Gate-Drain Charge | | – | 8 | – | |
| $Q_{GS}$ | Gate-Source Charge | | – | 11.8 | – | |
| $t_{d(on)}$ | Turn-on Delay Time | Notes 4 and 5 $V_{DS}$ = 400 V, $I_D$ = 30 A, Gate Driver = 0 V, to +15 V, Turn-on $R_{G,EXT}$ = 1 Ω, Turn-off $R_{G,EXT}$ = 5 Ω, Inductive Load, FWD: same device with $V_{GS}$ = 0 V and $R_G$ = 5 Ω, RC snubber: $R_S$ = 15 Ω and $C_S$ = 100 pF, $T_J$ = 25 °C | – | 14 | – | ns |
| $t_r$ | Rise Time | | – | 32 | – | |
| $t_{d(off)}$ | Turn-off Delay Time | | – | 19 | – | |
| $t_f$ | Fall Time | | – | 9 | – | |
| $E_{ON}$ | Turn-on Energy Including $R_S$ Energy | | – | 253 | – | μJ |
| $E_{OFF}$ | Turn-off Energy Including $R_S$ Energy | | – | 52 | – | |
| $E_{TOTAL}$ | Total Switching Energy | | – | 305 | – | |
| $E_{RS_ON}$ | Snubber $R_S$ Energy During Turn-on | | – | 2.9 | – | |
| $E_{RS_OFF}$ | Snubber $R_S$ Energy During Turn-off | | – | 5.5 | – | |
| $t_{d(on)}$ | Turn-on Delay Time | Notes 4 and 5 $V_{DS}$ = 400 V, $I_D$ = 30 A, Gate Driver = 0 V, to +15 V, Turn-on $R_{G,EXT}$ = 1 Ω, Turn-off $R_{G,EXT}$ = 5 Ω, Inductive Load, FWD: same device with $V_{GS}$ = 0 V and $R_G$ = 5 Ω, RC snubber: $R_S$ = 15 Ω and $C_S$ = 100 pF, $T_J$ = 150 °C | – | 12 | – | ns |
| $t_r$ | Rise Time | | – | 35 | – | |
| $t_{d(off)}$ | Turn-off Delay Time | | – | 23 | – | |
| $t_f$ | Fall Time | | – | 10 | – | |
| $E_{ON}$ | Turn-on Energy Including $R_S$ Energy | | – | 273 | – | μJ |
| $E_{OFF}$ | Turn-off Energy Including $R_S$ Energy | | – | 68 | – | |
| $E_{TOTAL}$ | Total Switching Energy | | – | 341 | – | |
| $E_{RS_ON}$ | Snubber $R_S$ Energy During Turn-on | | – | 3 | – | |
| $E_{RS_OFF}$ | Snubber $R_S$ Energy During Turn-off | | – | 5 | – | |
| $t_{d(on)}$ | Turn-on Delay Time | Notes 6 $V_{DS}$ = 400 V, $I_D$ = 30 A, Gate Driver = 0 V, to +15 V, Turn-on $R_{G,EXT}$ = 1 Ω, Turn-off $R_{G,EXT}$ = 5 Ω, Inductive Load, FWD: UJ3D06520TS RC snubber: $R_S$ = 15 Ω and $C_S$ = 100 pF, $T_J$ = 25 °C | – | 11 | – | ns |
| $t_r$ | Rise Time | | – | 31 | – | |
| $t_{d(off)}$ | Turn-off Delay Time | | – | 13 | – | |
| $t_f$ | Fall Time | | – | 9 | – | |
| $E_{ON}$ | Turn-on Energy Including $R_S$ Energy | | – | 225 | – | μJ |
| $E_{OFF}$ | Turn-off Energy Including $R_S$ Energy | | – | 49 | – | |
| $E_{TOTAL}$ | Total Switching Energy | | – | 274 | – | |
| $E_{RS_ON}$ | Snubber $R_S$ Energy During Turn-on | | – | 2.6 | – | |
| $E_{RS_OFF}$ | Snubber $R_S$ Energy During Turn-off | | – | 7 | – | |



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**ELECTRICAL CHARACTERISTICS** ($T_J$ = +25 °C unless otherwise specified) (continued)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **TYPICAL PERFORMANCE – DYNAMIC** | | | | | | |
| $t_{d(on)}$ | Turn-on Delay Time | Notes 6<br>$V_{DS}$ = 400 V, $I_D$ = 30 A,<br>Gate Driver = 0 V, to +15 V,<br>Turn-on $R_{G,EXT}$ = 1 Ω,<br>Turn-off $R_{G,EXT}$ = 5 Ω,<br>Inductive Load,<br>FWD: UJ3D06520TS<br>RC snubber: $R_S$ = 15 Ω and<br>$C_S$ = 100 pF, $T_J$ = 150 °C | – | 15 | – | ns |
| $t_r$ | Rise Time | | – | 31 | – | |
| $t_{d(off)}$ | Turn-off Delay Time | | – | 19 | – | |
| $t_f$ | Fall Time | | – | 10 | – | |
| $E_{ON}$ | Turn-on Energy Including $R_S$ Energy | | – | 265 | – | μJ |
| $E_{OFF}$ | Turn-off Energy Including $R_S$ Energy | | – | 81 | – | |
| $E_{TOTAL}$ | Total Switching Energy | | – | 346 | – | |
| $E_{RS_ON}$ | Snubber $R_S$ Energy During Turn-on | | – | 2 | – | |
| $E_{RS_OFF}$ | Snubber $R_S$ Energy During Turn-off | | – | 5 | – | |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Measured with the switching test circuit in Figure 35.
5. In this datasheet, all the switching energies (turn-on energy, turn-off energy and total energy) presented in the tables and Figures include the device RC snubber energy losses.
6. Measured with the switching test circuit in Figure 36.



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## TYPICAL PERFORMANCE DIAGRAMS

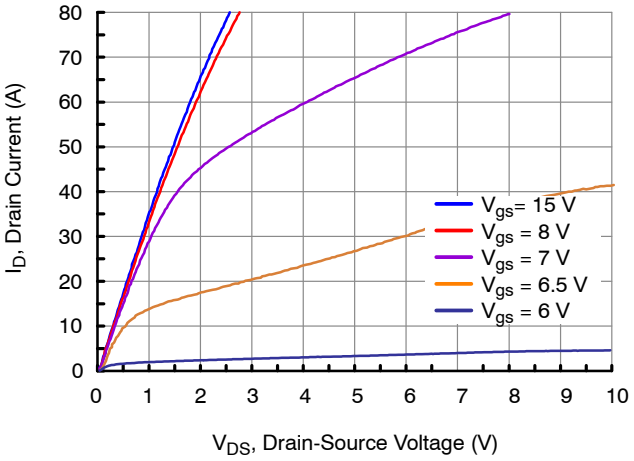


**Figure 1. Typical Output Characteristics at $T_J$ = −55 °C, $t_p$ < 250 μs**

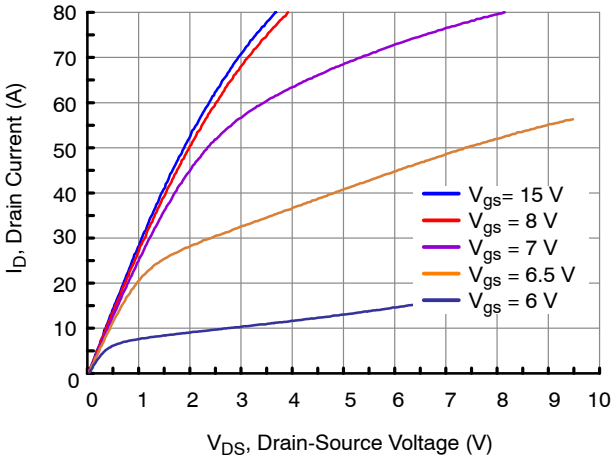


**Figure 2. Typical Output Characteristics at $T_J$ = 25 °C, $t_p$ < 250 μs**

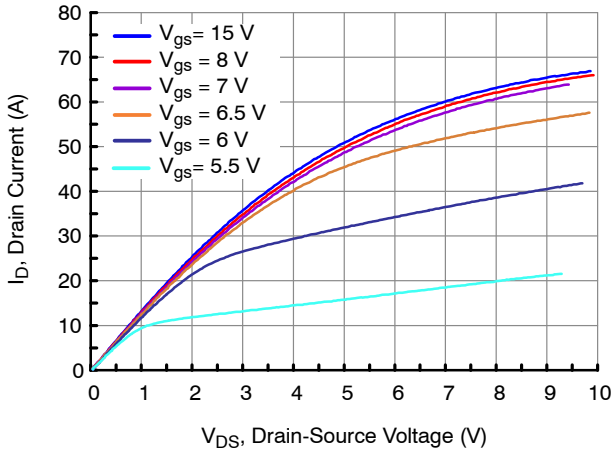


**Figure 3. Typical Output Characteristics at $T_J$ = 175 °C, $t_p$ < 250 μs**

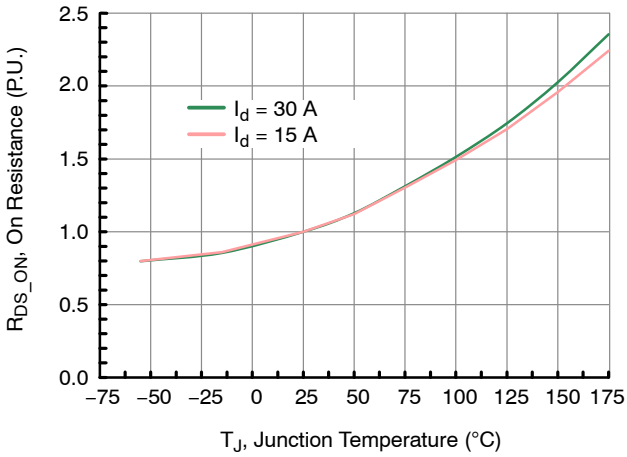


**Figure 4. Normalized On-Resistance vs. Temperature at $V_{GS}$ = 12 V**

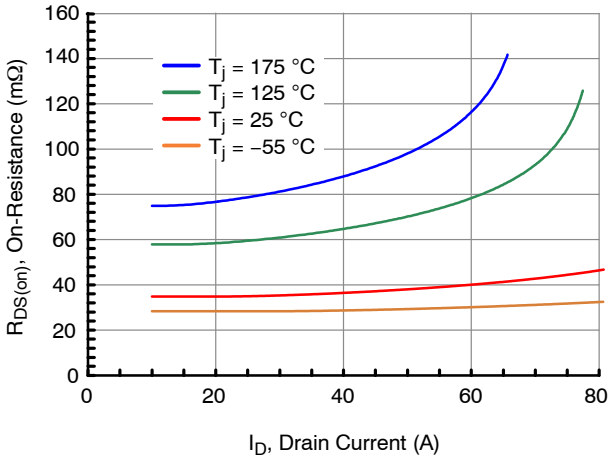


**Figure 5. Typical Drain-Source On-Resistances at $V_{GS}$ = 12 V**

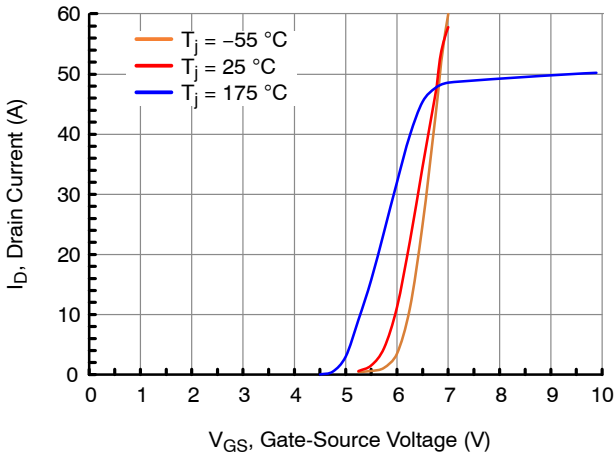


**Figure 6. Typical Transfer Characteristics at $V_{DS}$ = 5 V**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

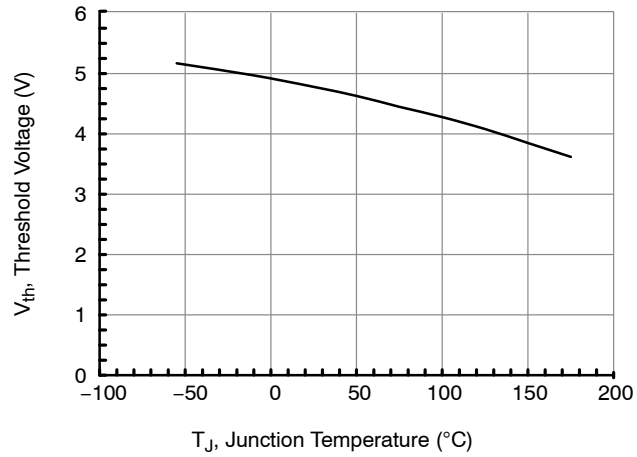


**Figure 7. Threshold Voltage vs. Junction Temperature at $V_{DS}$ = 5 V and $I_D$ = 10 mA**

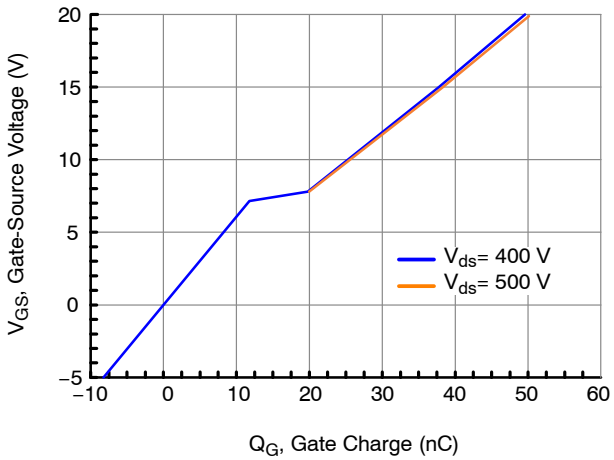


**Figure 8. Typical Gate Charge at $I_D$ = 30 A**

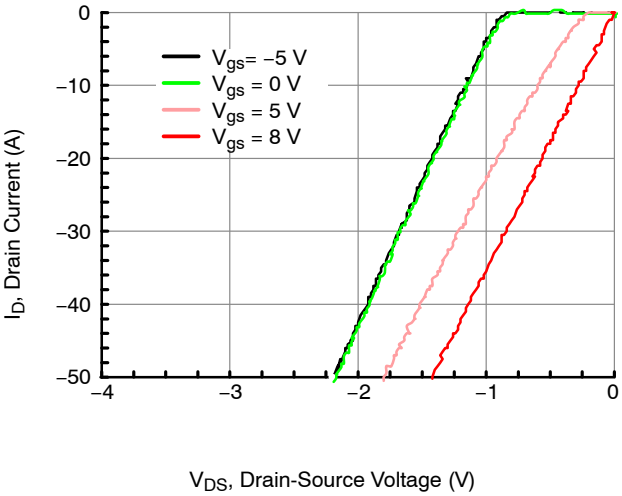


**Figure 9. 3rd Quadrant Characteristics at $T_J$ = −55 °C**

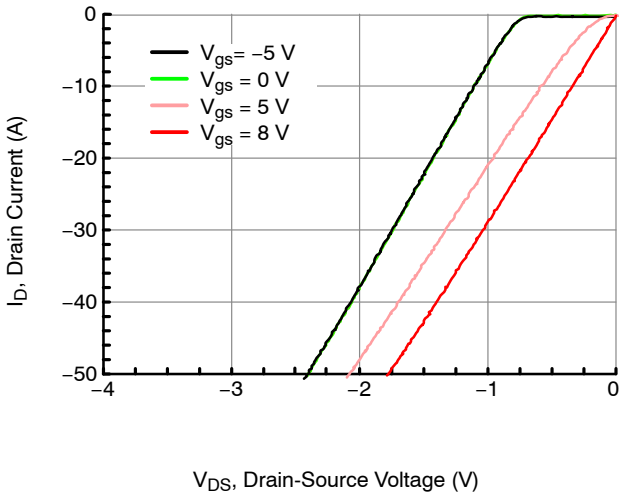


**Figure 10. 3rd Quadrant Characteristics at $T_J$ = 25 °C**

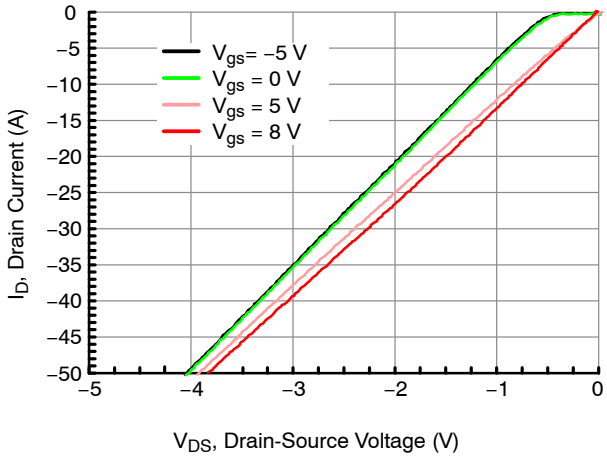


**Figure 11. 3rd Quadrant Characteristics at $T_J$ = 175 °C**

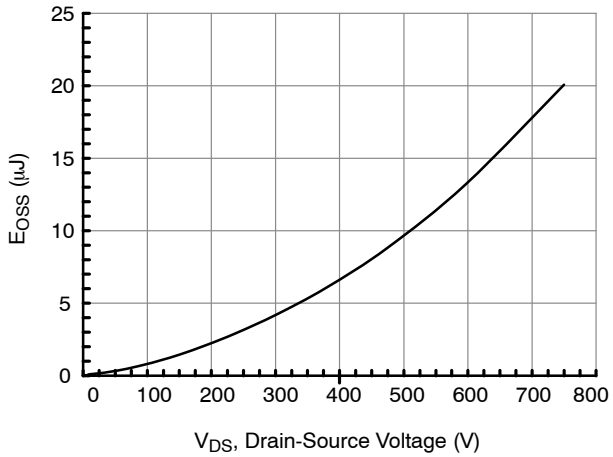


**Figure 12. Typical Stored Energy in $C_{OSS}$ at $V_{GS}$ = 0 V**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

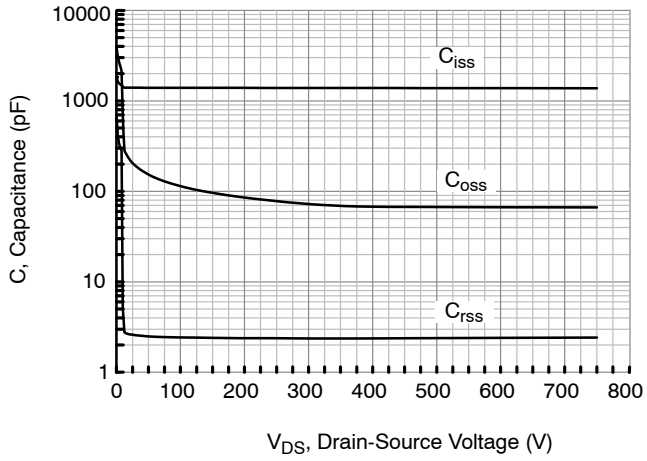


**Figure 13. Typical Capacitances at f = 100 kHz and $V_{GS}$ = 0 V**

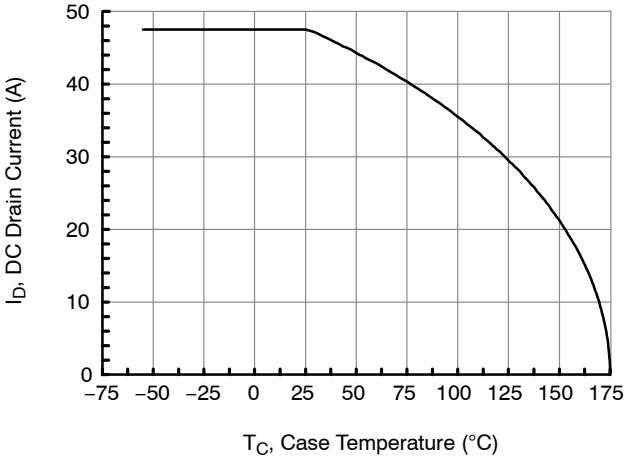


**Figure 14. DC Drain Current Derating**

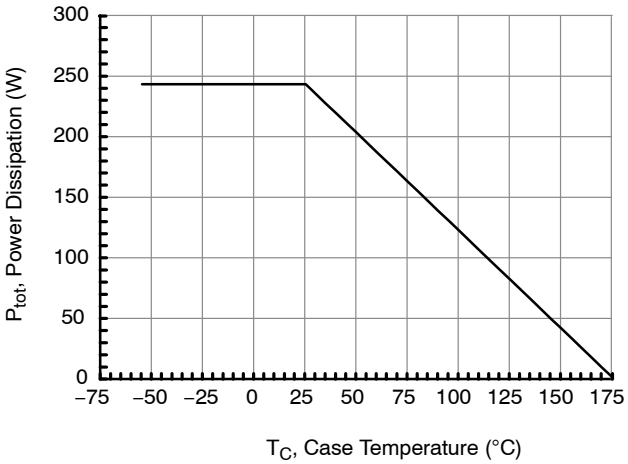


**Figure 15. Total Power Dissipation**

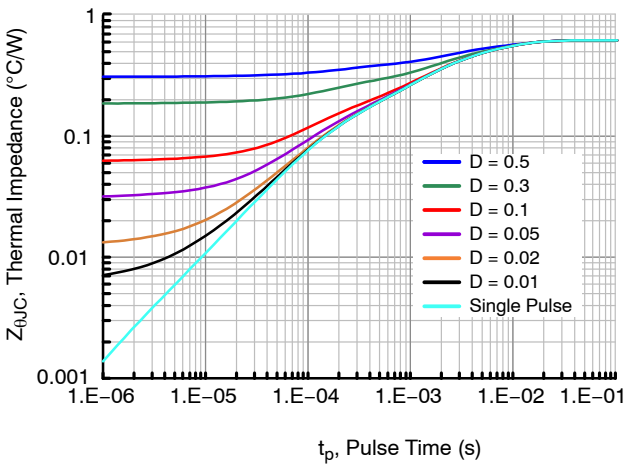


**Figure 16. Maximum Transient Thermal Impedance**

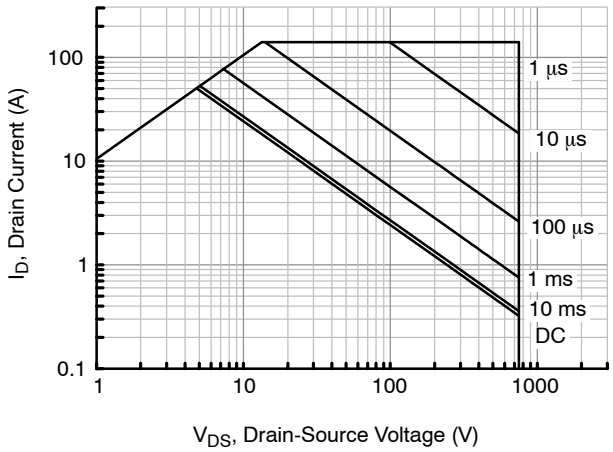


**Figure 17. Safe Operation Area at $T_C$ = 25 °C, D = 0, Parameter $t_p$**

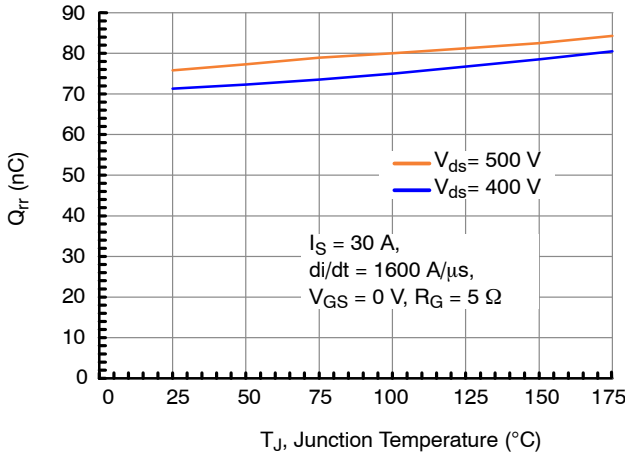


**Figure 18. Reverse Recovery Charge $Q_{rr}$ vs. Junction Temperature**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

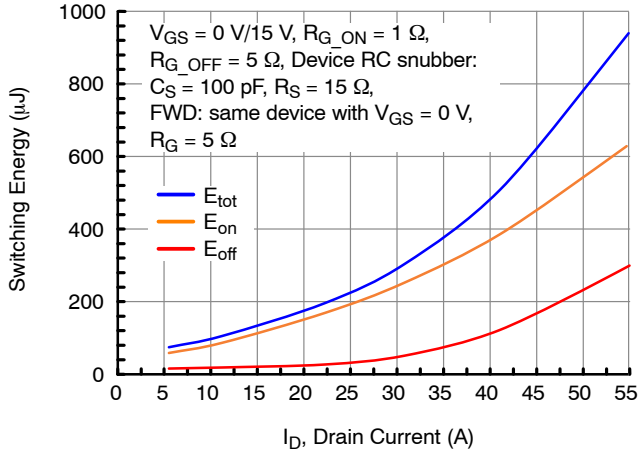


**Figure 19. Clamped Inductive Switching Energy vs. Drain Current at $V_{DS}$ = 400 V and $T_J$ = 25 °C**

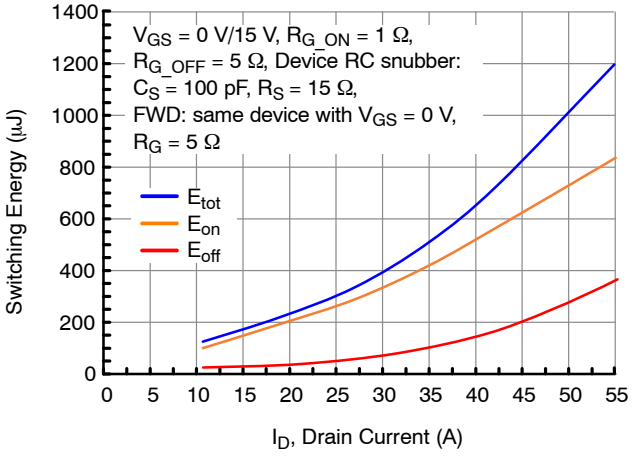


**Figure 20. Clamped Inductive Switching Energy vs.Drain Current at $V_{DS}$ = 500 V, and $T_J$ = 25 °C**

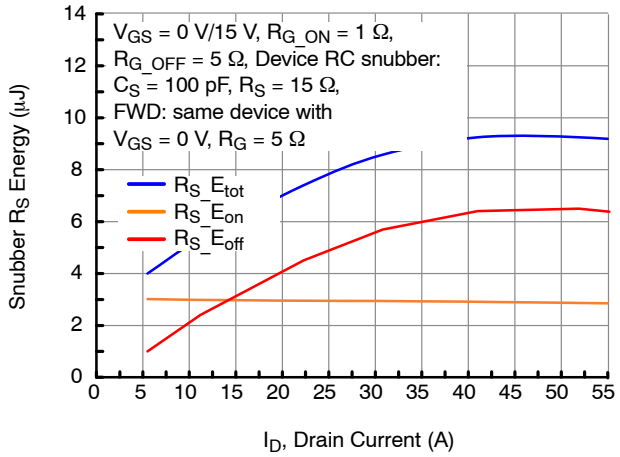


**Figure 21. RC Snubber Energy Loss vs. Drain Current at $V_{DS}$ = 400 V and $T_J$ = 25 °C**

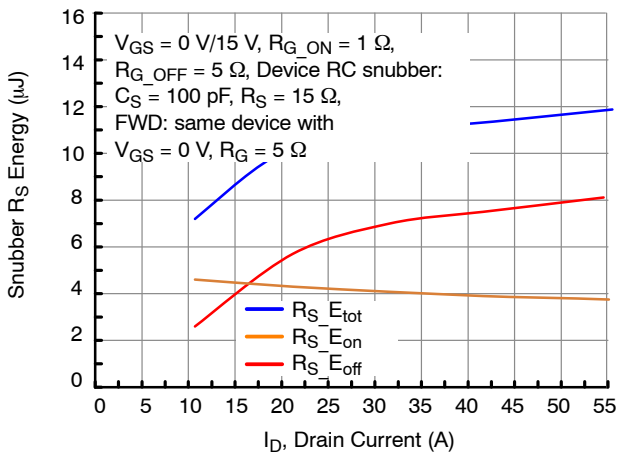


**Figure 22. RC Snubber Energy Losses vs. Drain Current at $V_{DS}$ = 500 V and $T_J$ = 25 °C**

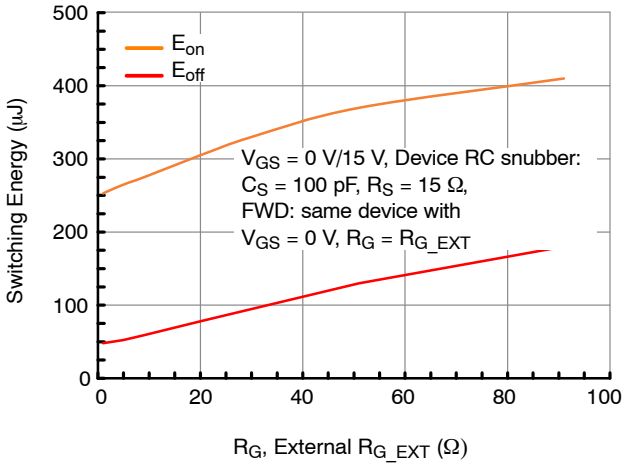


**Figure 23. Clamped Inductive Switching Energies vs. $R_{G_EXT}$ at $V_{DS}$ = 400 V, $I_D$ = 30 A and $T_J$ = 25 °C**

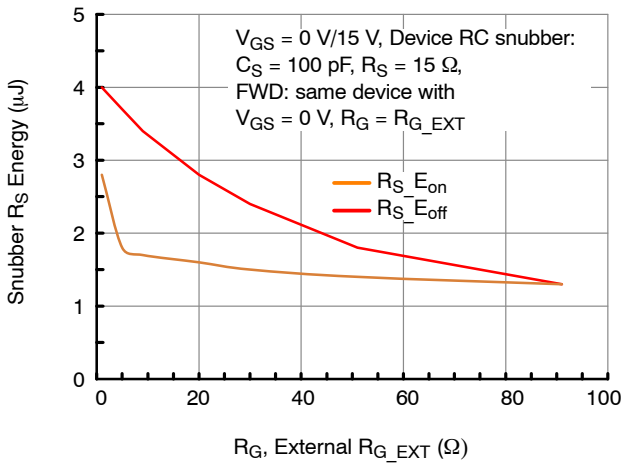


**Figure 24. RC Snubber Energy Losses vs. $R_{G_EXT}$ at $V_{DS}$ = 400 V, $I_D$ = 30 A and $T_J$ = 25 °C**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

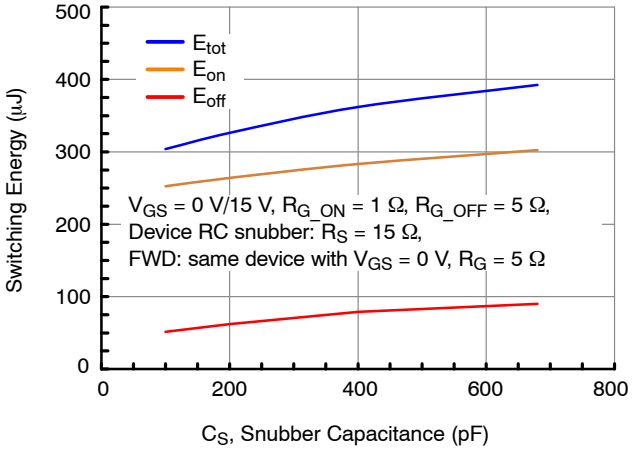


**Figure 25. Clamped Inductive Switching Energies vs. Snubber Capacitance $C_S$ at $V_{DS}$ = 400 V, $I_D$ = 30 A and $T_J$ = 25 °C**

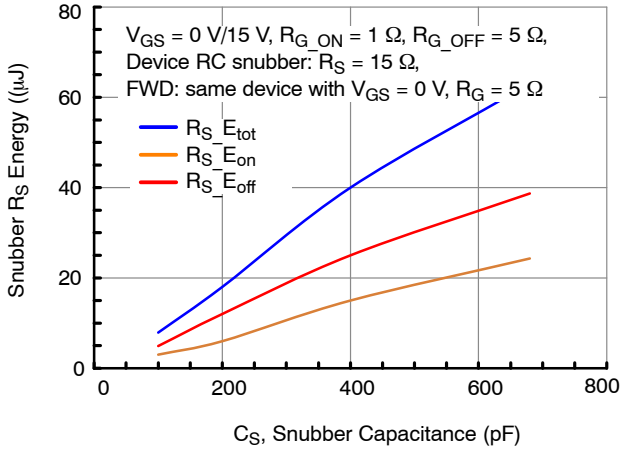


**Figure 26. RC Snubber Energy Losses vs. Snubber Capacitance $C_S$ at $V_{DS}$ = 400 V, $I_D$ = 30 A and $T_J$ = 25 °C**

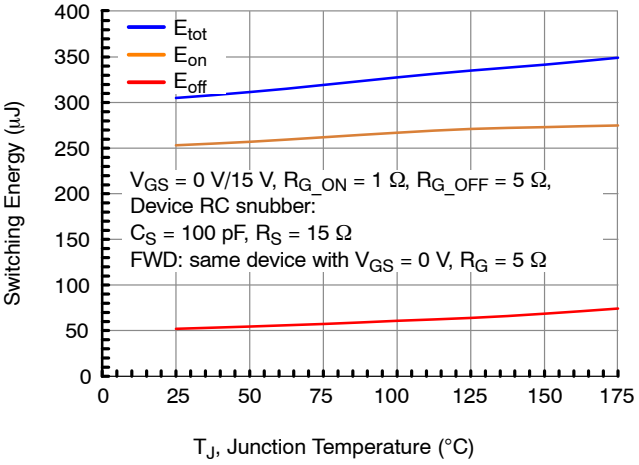


**Figure 27. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS}$ = 400 V and $I_D$ = 30 A**

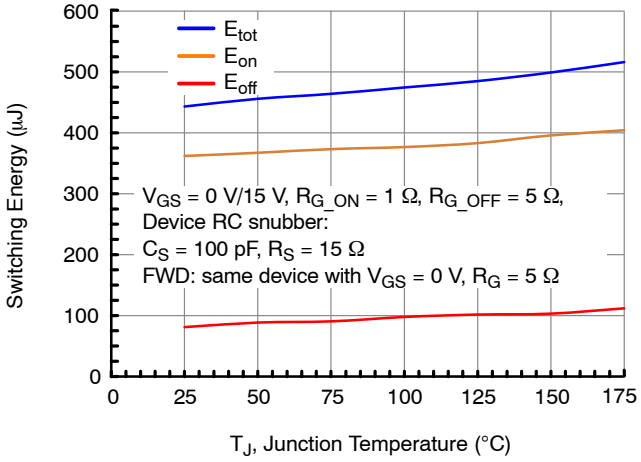


**Figure 28. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS}$ = 500 V, $I_D$ = 30 A**

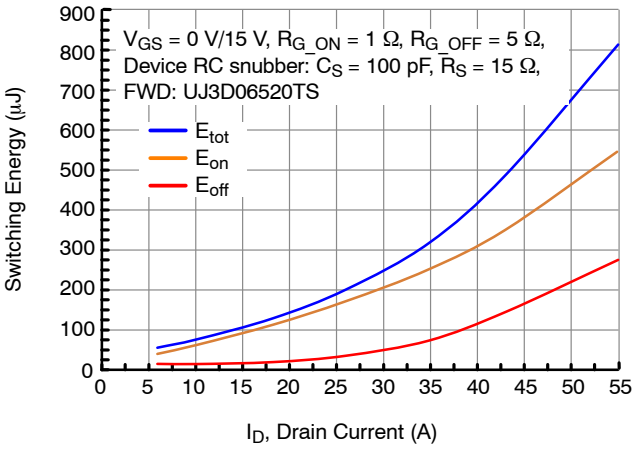


**Figure 29. Clamped Inductive Switching Energy vs. Drain Current at $V_{DS}$ = 400 V and $T_J$ = 25 °C**

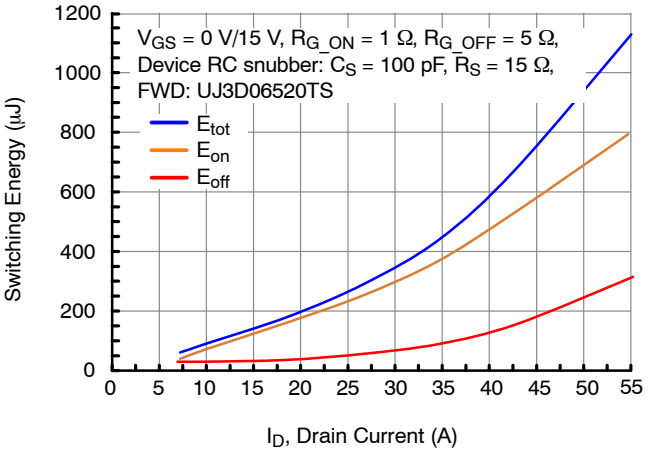


**Figure 30. Clamped Inductive Switching Energy vs. Drain Current at $V_{DS}$ = 500 V and $T_J$ = 25 °C**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

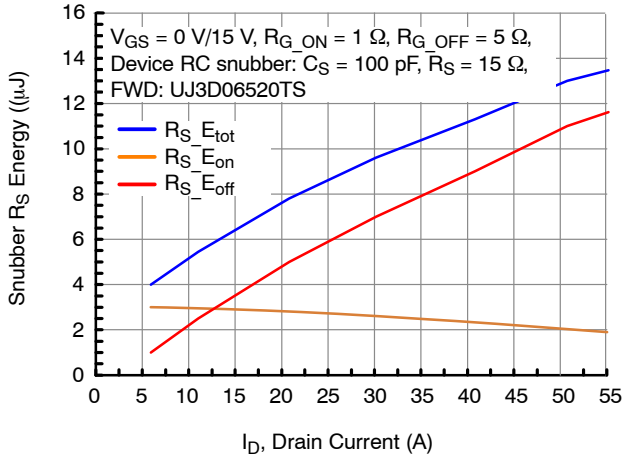


**Figure 31. RC Snubber Energy Losses vs. Drain Current at $V_{DS}$ = 400 V and $T_J$ = 25 °C**

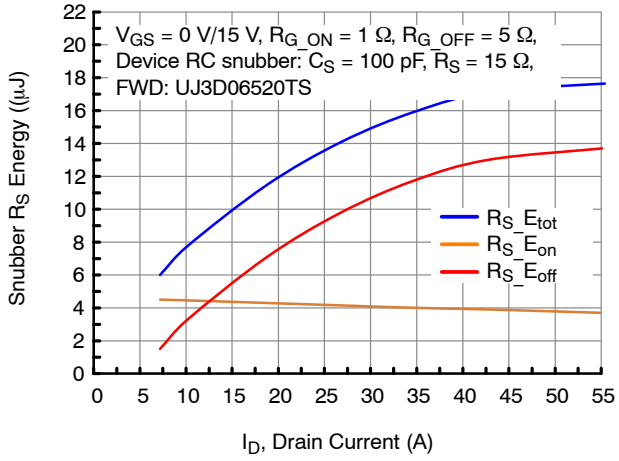


**Figure 32. RC Snubber Energy Losses vs. Drain Current at $V_{DS}$ = 500 V and $T_J$ = 25 °C**

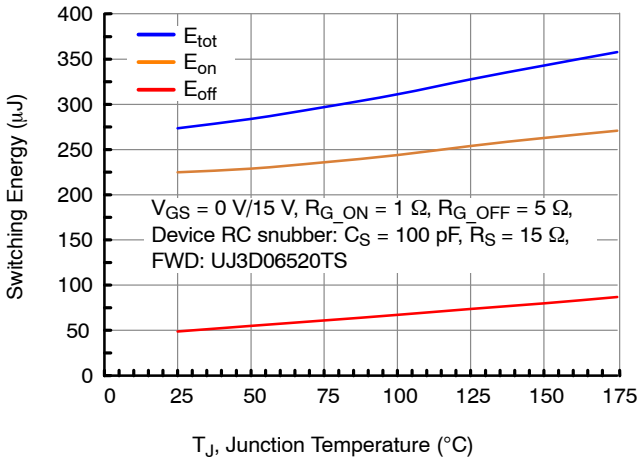


**Figure 33. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS}$ = 400 V and $I_D$ = 30 A**

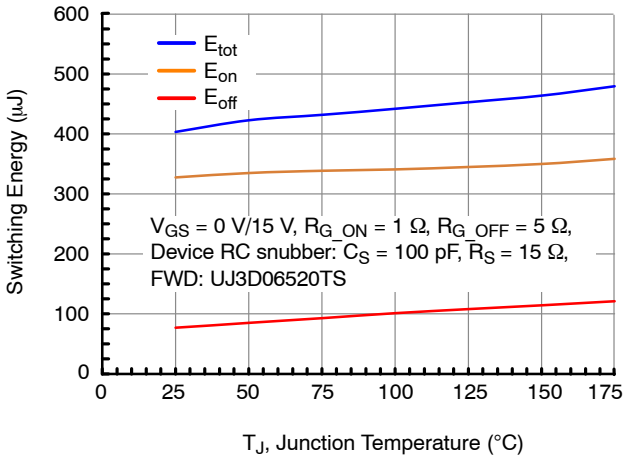


**Figure 34. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS}$ = 500 V and $I_D$ = 30 A**

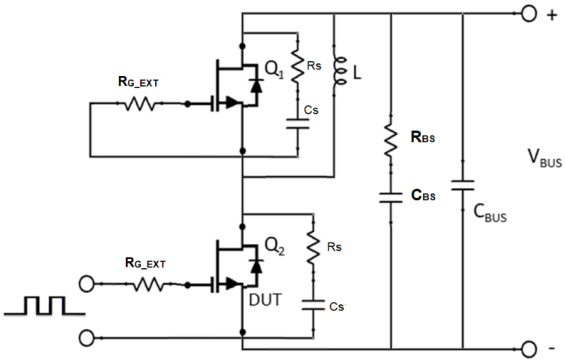


**Figure 35. Schematic of the Half-Bridge Mode Switching Test Circuit. Note, a Bus RC Snubber ($R_{BS}$ = 2.5 Ω, $C_{BS}$ =100 nF) is Used to Reduce the Power Loop High Frequency Oscillations.**

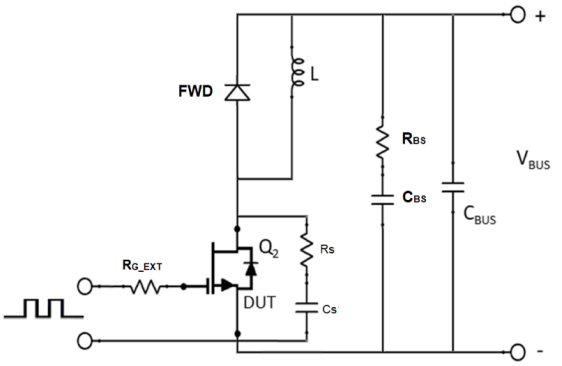


**Figure 36. Schematic of the Chopper Mode Switching Test Circuit. Note, a Bus RC Snubber ($R_{BS}$ = 2.5 Ω, $C_{BS}$ =100 nF) is Used to Reduce the Power Loop High Frequency Oscillations.**



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## APPLICATIONS INFORMATION

SiC FETs are enhancement-mode power switches formed by a high-voltage SiC depletion-mode JFET and a low-voltage silicon MOSFET connected in series. The silicon MOSFET serves as the control unit while the SiC JFET provides high voltage blocking in the off state. This combination of devices in a single package provides compatibility with standard gate drivers and offers superior performance in terms of low on-resistance ($R_{DS(on)}$), output capacitance ($C_{oss}$), gate charge ($Q_G$), and reverse recovery charge ($Q_{rr}$) leading to low conduction and switching losses. The SiC FETs also provide excellent reverse conduction capability eliminating the need for an external anti-parallel diode.

Like other high performance power switches, proper PCB layout design to minimize circuit parasitics is strongly recommended due to the high dv/dt and di/dt rates. An external gate resistor is recommended when the FET is working in the diode mode in order to achieve the optimum reverse recovery performance. For more information on SiC FET operation, see www.onsemi.com.

A snubber circuit with a small $R_{(G)}$, or gate resistor, provides better EMI suppression with higher efficiency compared to using a high $R_{(G)}$ value. There is no extra gate delay time when using the snubber circuitry, and a small $R_{(G)}$ will better control both the turn-off $V_{(DS)}$ peak spike and ringing duration, while a high $R_{(G)}$ will damp the peak spike but result in a longer delay time. In addition, the total switching loss when using a snubber circuit is less than using high $R_{(G)}$, while greatly reducing $E_{(OFF)}$ from mid-to-full load range with only a small increase in $E_{(ON)}$. Efficiency will therefore improve with higher load current. For more information on how a snubber circuit will improve overall system performance, visit the **onsemi** website at www.onsemi.com.

### ORDERING INFORMATION

| Part Number | Marking | Package | Shipping |
|---|---|---|---|
| UJ4C075033K3S | UJ4C075033K3S | TO247-3<br>(Pb-Free, Halogen Free) | 600 Units / Tube |



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## REVISION HISTORY

| Revision | Description of Changes | Date |
|---|---|---|
| C | Acquired the original Qorvo JFET Division Data Sheet and updated the main document title to comply with onsemi standards for SiC products. | 1/15/2025 |
| 3 | Converted the Data Sheet to **onsemi** format. | 6/2/2025 |



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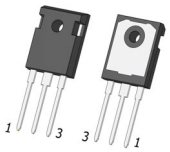
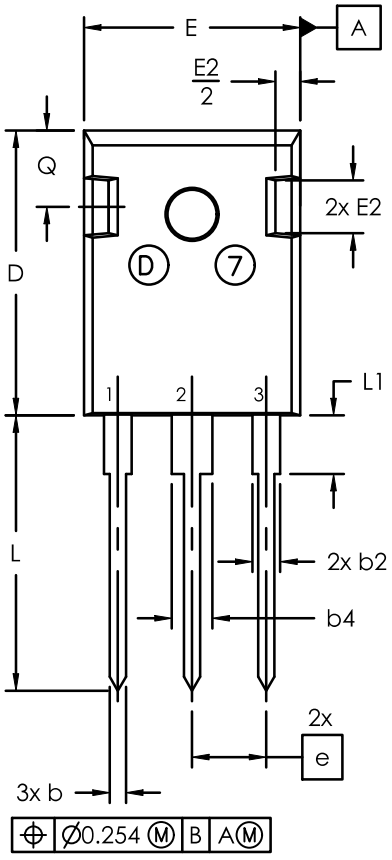
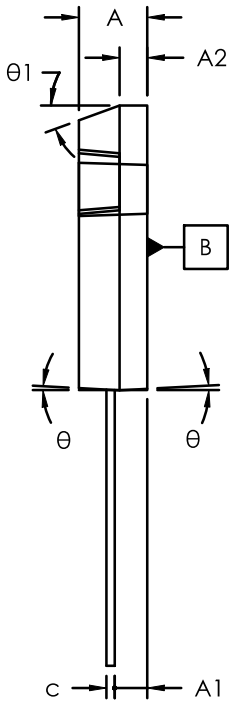
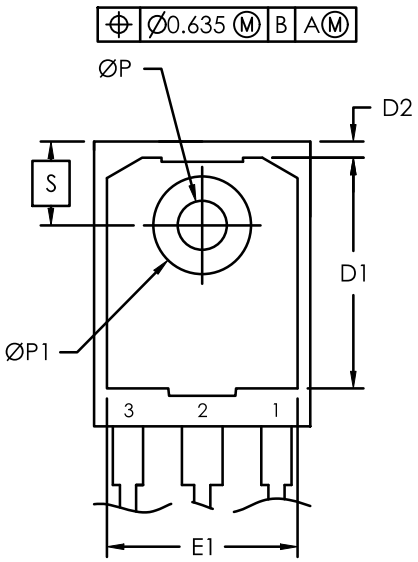


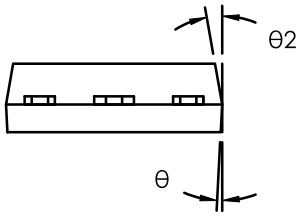
**TO247−3 15.90x20.96x5.03, 5.44P**
CASE 340AK
ISSUE B

DATE 14 APR 2025




| SYM | millimeters | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.70 | 5.03 | 5.31 |
| A1 | 2.21 | 2.40 | 2.59 |
| A2 | 1.50 | 2.03 | 2.49 |
| b | 0.99 | 1.20 | 1.40 |
| b2 | 1.65 | 2.03 | 2.39 |
| b4 | 2.59 | 3.00 | 3.43 |
| c | 0.38 | 0.60 | 0.89 |
| D | 20.70 | 20.96 | 21.46 |
| D1 | 13.08 | — | — |
| D2 | 0.51 | 1.19 | 1.35 |
| E | 15.49 | 15.90 | 16.26 |
| e | 5.44 BSC | | |
| E1 | 13.00 | 13.30 | 13.60 |
| E2 | 3.43 | 3.89 | 5.20 |
| L | 19.62 | 20.27 | 20.32 |
| L1 | — | — | 4.50 |
| ØP | 3.40 | 3.60 | 3.80 |
| ØP1 | 7.06 | 7.19 | 7.39 |
| Q | 5.38 | 5.62 | 6.20 |
| S | 6.15 BSC | | |
| θ | 3° | | |
| θ1 | 20° | | |
| θ2 | 10° | | |

NOTE:
1. Dimensioning and tolerancing as per ASME Y14.5 - 2018
2. Controlling dimension : millimeters
3. Package Outline in compliance with JEDEC standard var. AD.
4. Dimensions D & E does not include mold flash.
5. ØP to have max draft angle of 1.7° to the top with max. hole diameter of 3.91mm.

| | | | |
|---|---|---|---|
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| **DESCRIPTION:** | **TO247−3 15.90x20.96x5.03, 5.44P** | | **PAGE 1 OF 1** |

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