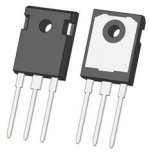
# Silicon Carbide (SiC) Cascode JFET - EliteSiC, Power N-Channel, TO247-3, 650 V, 80 mohm

# UJ3C065080K3S



TO247-3 15.90x20.96x5.03, 5.44P
CASE 340AK

## Description

This SiC FET device is based on a 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 super-junction 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.

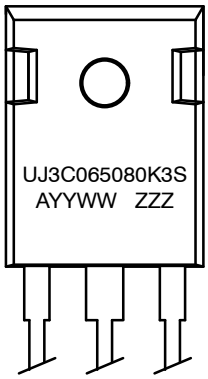
## Features

- Typical On-resistance $R_{DS(on),typ}$: 80 mΩ
- Maximum Operating Temperature of 175 °C
- Excellent Reverse Recovery
- Low Gate Charge
- Low Intrinsic Capacitance
- ESD Protected: HBM Class 2
- This Device is Pb-Free, Halogen Free and is RoHS Compliant

## Typical Applications

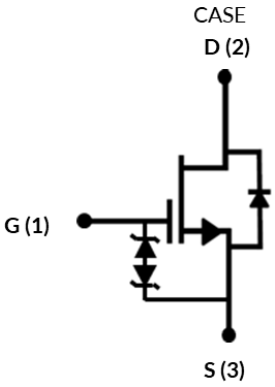
- EV Charging
- PV Inverters
- Switch Mode Power Supplies
- Power Factor Correction Modules
- Motor Drives
- Induction Heating

## MARKING DIAGRAM




| | |
|---|---|
| UJ3C065080K3S | = Specific Device Code |
| A | = Assembly Location |
| YY | = Year |
| WW | = Work Week |
| ZZZ | = Lot ID |

## PIN CONNECTIONS




## ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

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## MAXIMUM RATINGS

| Parameter | Symbol | Test Conditions | Value | Unit |
|---|---|---|---|---|
| Drain-source Voltage | $V_{DS}$ | | 650 | V |
| Gate-source Voltage | $V_{GS}$ | DC | −25 to +25 | V |
| Continuous Drain Current (Note 1) | $I_D$ | $T_C$ = 25 °C | 31 | A |
| | | $T_C$ = 100 °C | 23 | A |
| Pulsed Drain Current (Note 2) | $I_{DM}$ | $T_C$ = 25 °C | 65 | A |
| Single Pulsed Avalanche Energy (Note 3) | $E_{AS}$ | L = 15 mH, $I_{AS}$ = 2.1 A | 33 | mJ |
| Power Dissipation | $P_{tot}$ | $T_C$ = 25 °C | 190 | W |
| Maximum Junction Temperature | $T_{J,max}$ | | 175 | °C |
| Operating and Storage Temperature | $T_J$, $T_{STG}$ | | −55 to 175 | °C |
| Max. Lead Temperature for Soldering, 1/8" from Case for 5 Seconds | $T_L$ | | 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

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | | – | 0.61 | 0.79 | °C/W |

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

| Parameter | Symbol | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **TYPICAL PERFORMANCE – STATIC** | | | | | | | |
| Drain-source Breakdown Voltage | $BV_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA | | 650 | – | – | V |
| Total Drain Leakage Current | $I_{DSS}$ | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V, $T_J$ = 25 °C | | – | 6 | 100 | μA |
| | | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V, $T_J$ = 175°C | | – | 40 | – | |
| Total Gate Leakage Current | $I_{GSS}$ | $V_{DS}$ = 0 V, $T_J$ = 25 °C, $V_{GS}$ = −20 V/ +20 V | | – | 6 | ±20 | μA |
| Drain-source On-resistance | $R_{DS(on)}$ | $V_{GS}$ = 12 V, $I_D$ = 20 A | $T_J$ = 25 °C | – | 80 | 100 | mΩ |
| | | | $T_J$ = 125 °C | – | 111 | – | |
| | | | $T_J$ = 175 °C | – | 141 | – | |
| Gate Threshold Voltage | $V_{G(th)}$ | $V_{DS}$ = 5 V, $I_D$ = 10 mA | | 4 | 5 | 6 | V |
| Gate Resistance | $R_G$ | f = 1 MHz, open drain | | – | 4.5 | – | Ω |
| **TYPICAL PERFORMANCE – REVERSE DIODE** | | | | | | | |
| Diode Continuous Forward Current (Note 4) | $I_S$ | $T_C$ = 25 °C | | – | – | 31 | A |
| Diode Pulse Current (Note 5) | $I_{S,pulse}$ | $T_C$ = 25 °C | | – | – | 65 | A |
| Forward Voltage | $V_{FSD}$ | $V_{GS}$ = 0 V, $I_S$ = 10 A, $T_J$ = 25 °C | | – | 1.5 | 2 | V |
| | | $V_{GS}$ = 0 V, $I_S$ = 10 A, $T_J$ = 175 °C | | – | 1.75 | – | |
| Reverse Recovery Charge | $Q_{rr}$ | $V_{DS}$ = 400 V, $I_S$ = 20 A, $V_{GS}$ = 0 V, $R_{G_EXT}$ = 20 Ω, di/dt = 1600 A/μs, $T_J$ = 150 °C | | – | 111 | – | nC |
| Reverse Recovery Time | $t_{rr}$ | | | – | 16 | – | ns |



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

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **TYPICAL PERFORMANCE – DYNAMIC** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = 100 V, $V_{GS}$ = 0 V, f = 100 kHz | – | 1500 | – | pF |
| Output Capacitance | $C_{oss}$ | | – | 104 | – | |
| Reverse Transfer Capacitance | $C_{rss}$ | | – | 2.6 | – | |
| Effective Output Capacitance, Energy Related | $C_{oss(er)}$ | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | – | 77 | – | pF |
| Effective Output Capacitance, Time Related | $C_{oss(tr)}$ | | – | 176 | – | pF |
| $C_{oss}$ Stored Energy | $E_{oss}$ | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | – | 6.2 | – | μJ |
| Total Gate Charge | $Q_G$ | $V_{DS}$ = 400 V, $I_D$ = 20 A, $V_{GS}$ = −5 V to 15 V | – | 51 | – | nC |
| Gate-drain Charge | $Q_{GD}$ | | – | 11 | – | |
| Gate-source Charge | $Q_{GS}$ | | – | 19 | – | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DS}$ = 400 V, $I_D$ = 20 A, Gate Driver = −5 V to +15 V, Turn-on $R_{G,EXT}$ = 1 Ω, Turn-off $R_{G,EXT}$ = 20 Ω, Inductive Load, FWD: UJ3D06510TS, $T_J$ = 150 °C | – | 18 | – | ns |
| Rise Time | $t_r$ | | – | 13 | – | |
| Turn-off Delay Time | $t_{d(off)}$ | | – | 59 | – | |
| Fall Time | $t_f$ | | – | 11 | – | |
| Turn-on Energy | $E_{ON}$ | | – | 85 | – | μJ |
| Turn-off Energy | $E_{OFF}$ | | – | 62 | – | |
| Total Switching Energy | $E_{TOTAL}$ | | – | 147 | – | |

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. Limited by $T_{J,max}$.
5. Pulse width $t_p$ limited by $T_{J,max}$.



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## TYPICAL PERFORMANCE DIAGRAMS

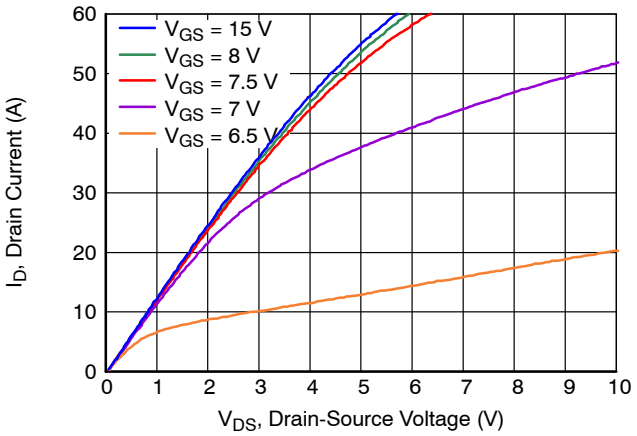


**Figure 1. Typical Output Characteristics at $T_J$ = −55 °C, $t_p$ < 250 μs**

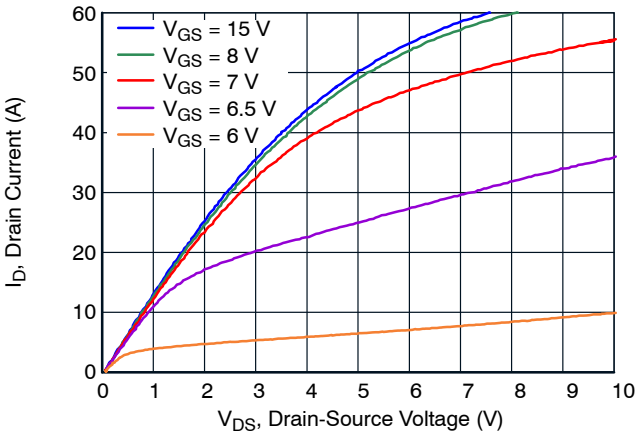


**Figure 2. Typical Output Characteristics at $T_J$ = 25 °C, $t_p$ < 250 μs**

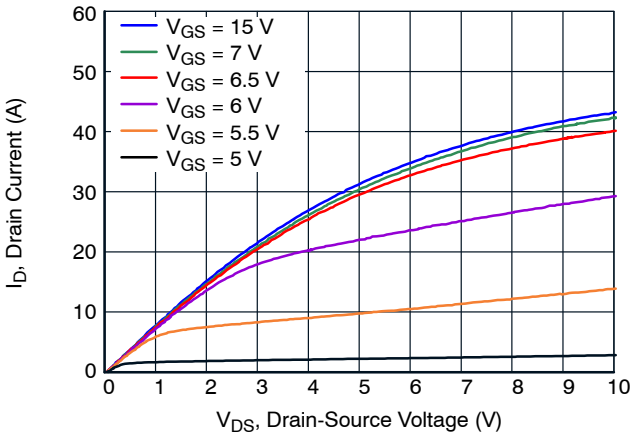


**Figure 3. Typical Output Characteristics at $T_J$ = 175 °C, $t_p$ < 250 μs**

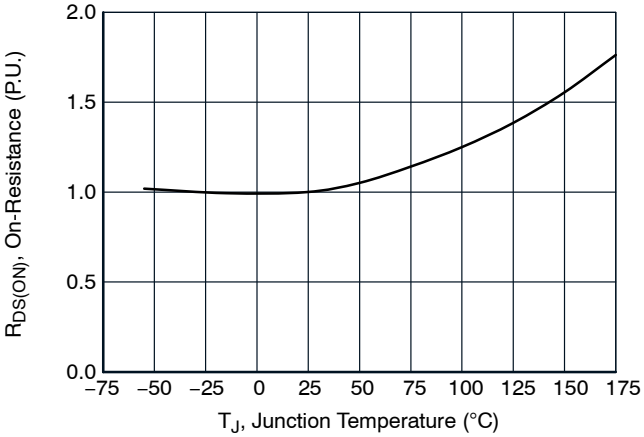


**Figure 4. Normalized On-Resistance vs. Temperature at $V_{GS}$ = 12 V and $I_D$ = 20 A**

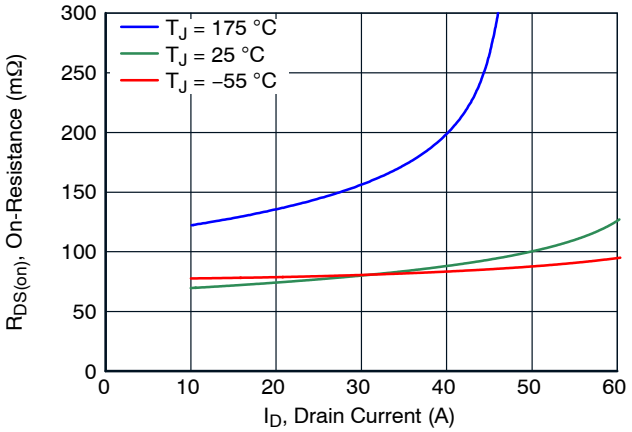


**Figure 5. Typical Drain-Source On-Resistances at $V_{GS}$ = 12 V**

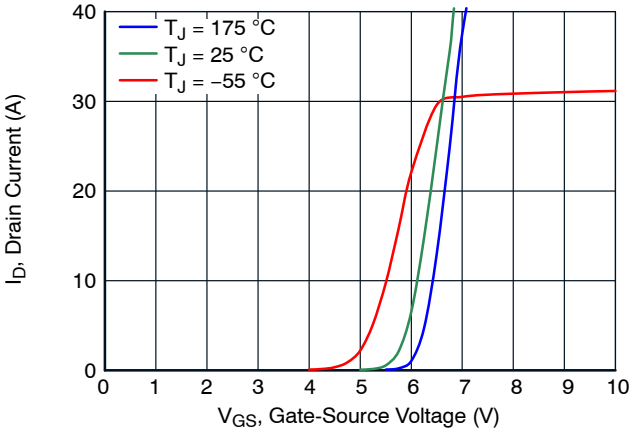


**Figure 6. Typical Transfer Characteristics at $V_{DS}$ = 5 V**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

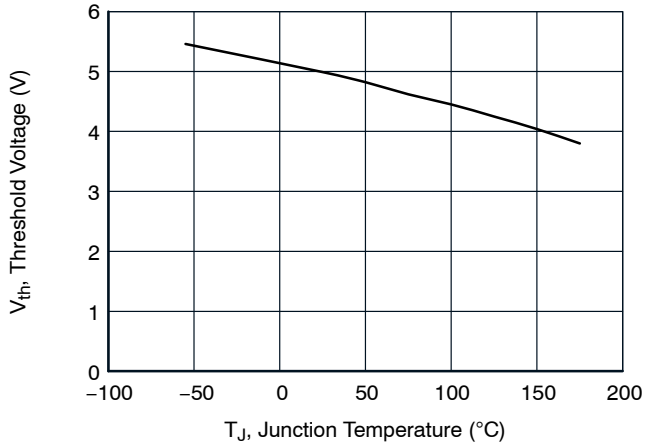


**Figure 7. Threshold Voltage vs. Junction Temperature at $V_{DS}$ = 5 V and $I_D$ = 10 mA**

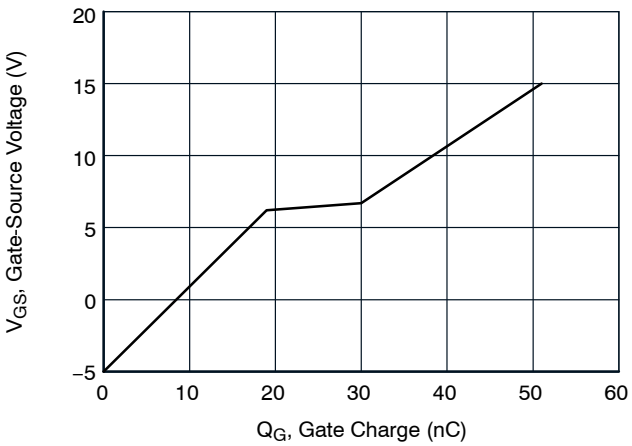


**Figure 8. Typical Gate Charge at $V_{DS}$ = 400 V and $I_D$ = 20 A**

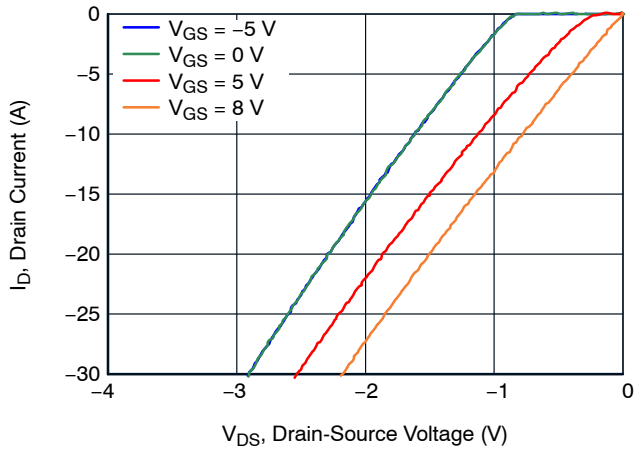


**Figure 9. 3rd Quadrant Characteristics at $T_J$ = −55 °C**

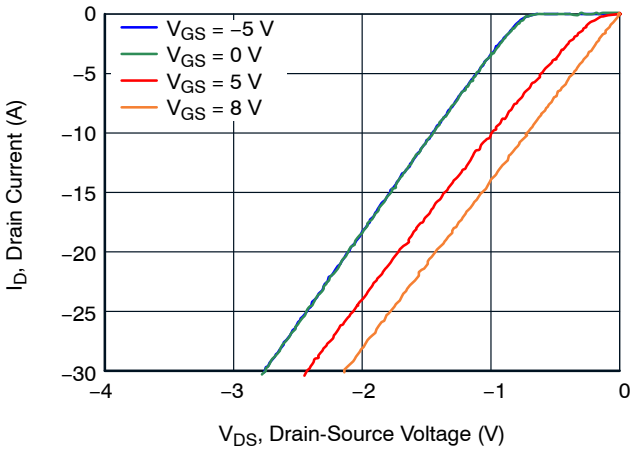


**Figure 10. 3rd Quadrant Characteristics at $T_J$ = 25 °C**

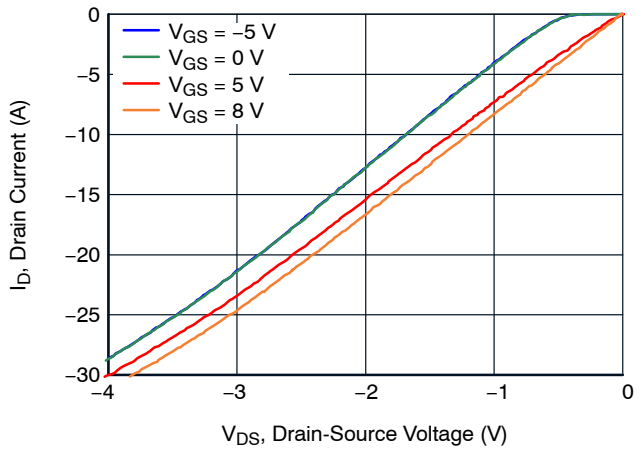


**Figure 11. 3rd Quadrant Characteristics at $T_J$ = 175 °C**

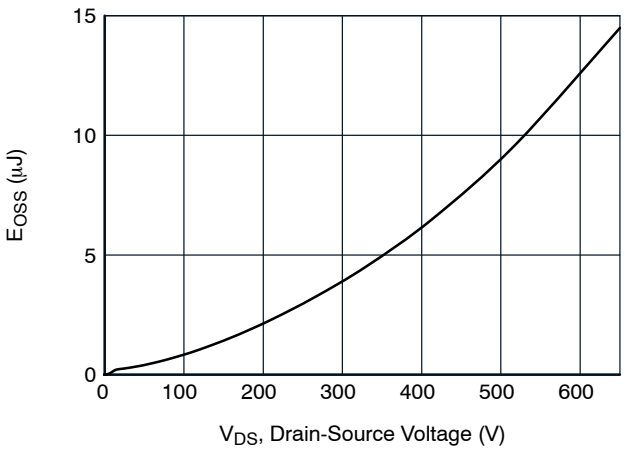


**Figure 12. Typical Stored Energy in $C_{OSS}$ at $V_{GS}$ = 0 V**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

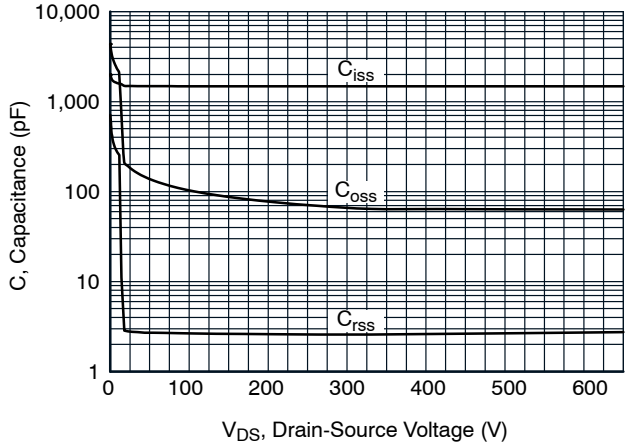


**Figure 13. Typical Capacitances at f = 100 kHz and $V_{GS}$ = 0 V**

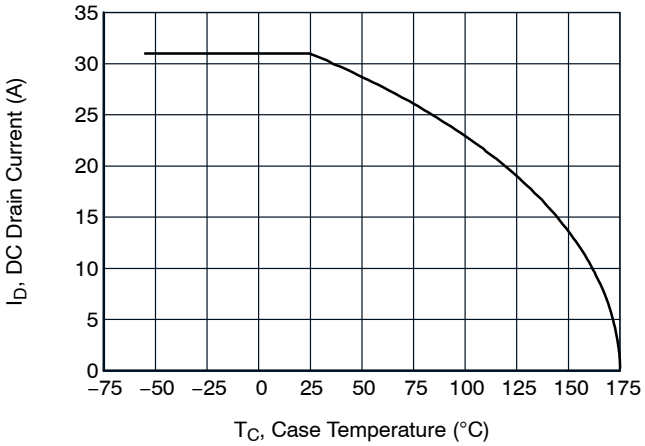


**Figure 14. DC Drain Current Derating**

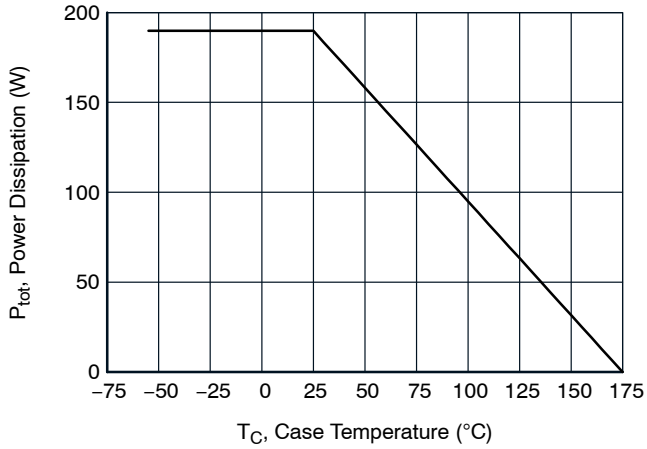


**Figure 15. Total Power Dissipation**

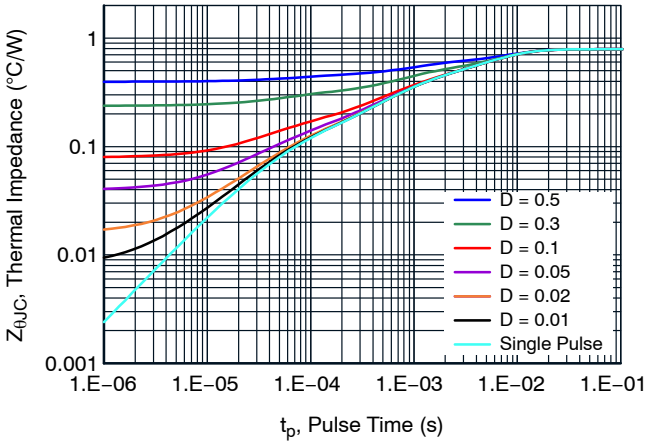


**Figure 16. Maximum Transient Thermal Impedance**

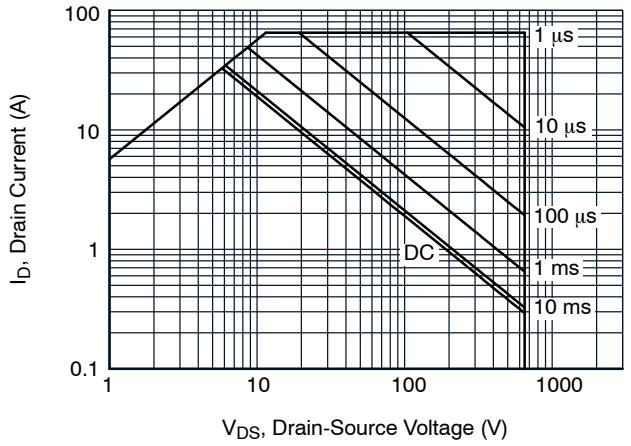


**Figure 17. Safe Operation Area at $T_C$ = 25 °C, D = 0, Parameter $t_p$**

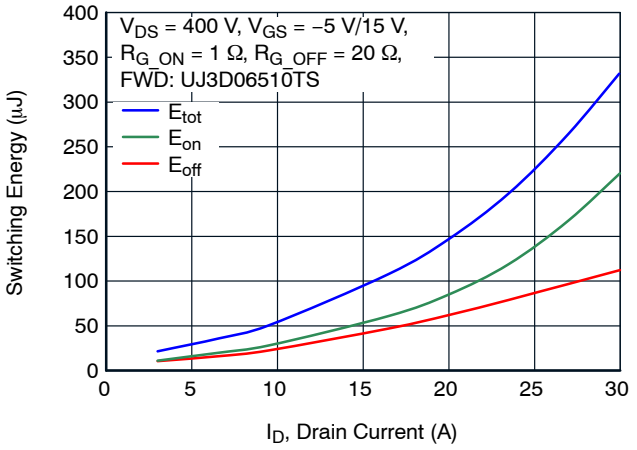


**Figure 18. Clamped Inductive Switching Energy vs. Drain Current at $T_J$ = 150 °C**



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## TYPICAL PERFORMANCE DIAGRAMS (continued)

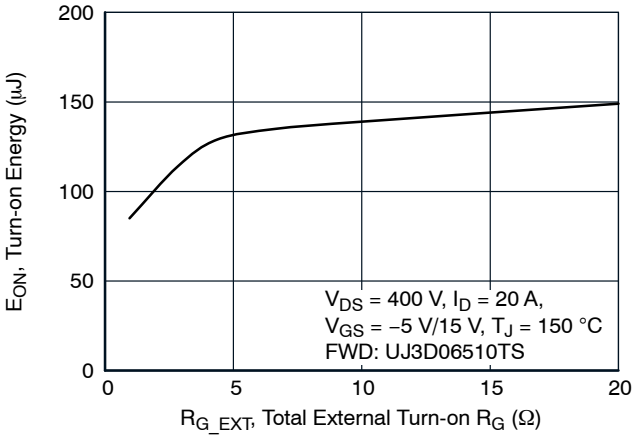


**Figure 19. Clamped Inductive Switching Turn-on Energy vs. $R_{G,EXT_ON}$**

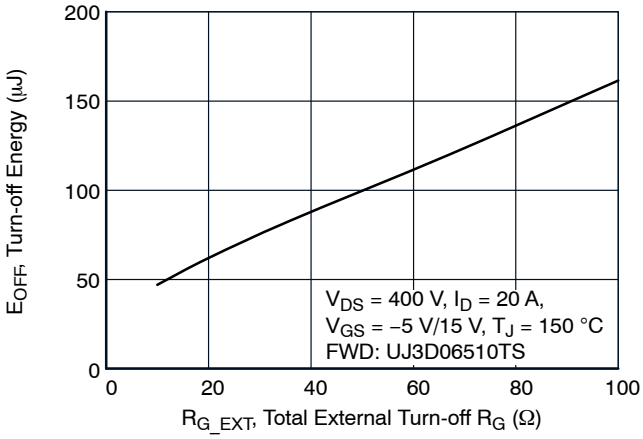


**Figure 20. Clamped Inductive Switching Turn-on Energy vs. $R_{G,EXT_OFF}$**

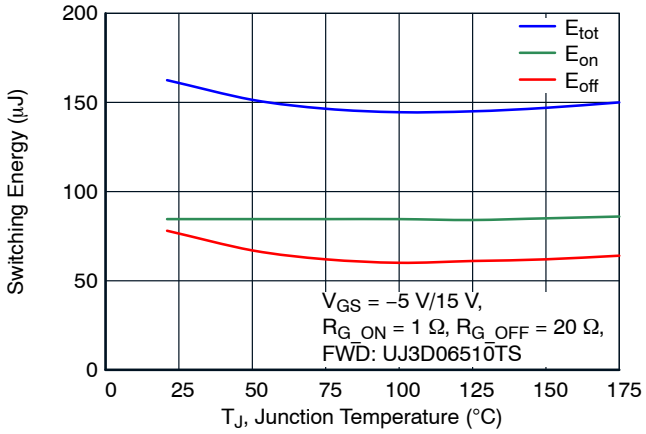


**Figure 21. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS}$ = 400 V and $I_D$ = 20 A**



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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.

### ORDERING INFORMATION

| Part Number | Marking | Package | Shipping |
|---|---|---|---|
| UJ3C065080K3S | UJ3C065080K3S | TO247-3 15.90x20.96x5.03, 5.44P (Pb-Free, Halogen Free) | 600 / Tube |



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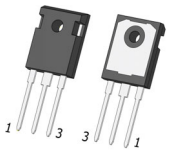
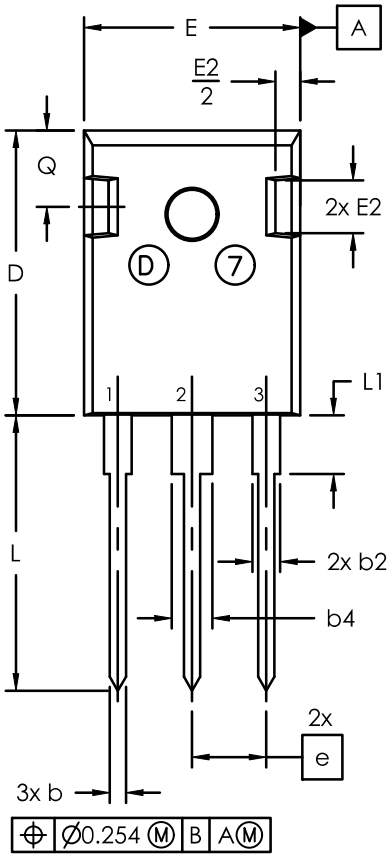
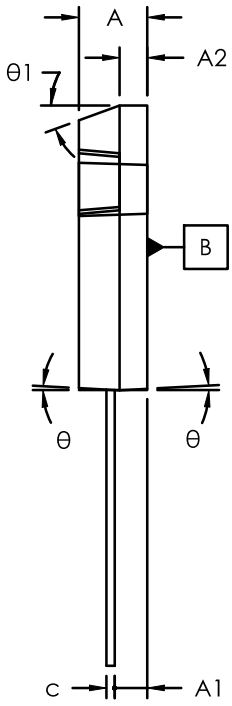
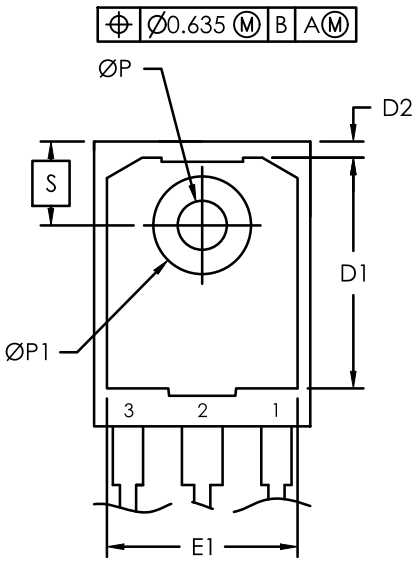


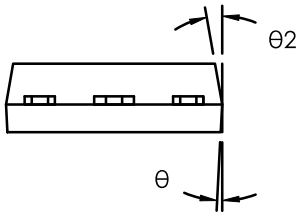
**TO247−3 15.90x20.96x5.03, 5.44P**
CASE 340AK
ISSUE B

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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