

# Silicon Carbide (SiC) Cascode JFET – EliteSiC, Power N-Channel, D2PAK-7L, 750 V, 23 mohm

#### **UJ4C075023B7S**

#### **Description**

The UJ4C075023B7S is a 750 V, 23 m $\Omega$  G4 SiC FET. It 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 superjunction devices. Available in the D2PAK-7L 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**

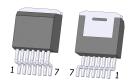
- On-resistance  $R_{DS(on)}$ : 23 m $\Omega$  (Typ)
- Operating Temperature: 175 °C (Max)
- Excellent Reverse Recovery:  $Q_{rr} = 80 \text{ nC}$
- Low Body Diode V<sub>FSD</sub>: 1.23 V
- Low Gate Charge:  $Q_G = 37.8 \text{ nC}$
- Threshold Voltage V<sub>G(th)</sub>: 4.8 V (Typ) Allowing 0 to 15 V Drive
- Low Intrinsic Capacitance
- ESD Protected, HBM Class 2 and CDM Class C3
- D<sup>2</sup>PAK-7L Package For Faster Switching, Clean Gate Waveforms

1

• This Device is Pb-Free, Halogen Free and is RoHS Compliant

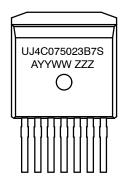
#### **Typical Applications**

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



TO-263-7 10.18x9.08x4.43, 1.27P CASE 418BA

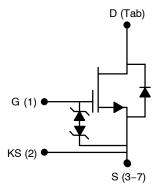
#### MARKING DIAGRAM



UJ4C075023B7S = 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 9 of this data sheet.

#### **MAXIMUM RATINGS**

Parameter	Symbol	Test Conditions	Value	Unit
Drain-Source Voltage	V <sub>DS</sub>		750	V
Gate-Source Voltage	V <sub>GS</sub>	DC	-20 to +20	V
		AC (f > 1 Hz)	-25 to +25	V
Continuous Drain Current (Note 1)	I <sub>D</sub>	T <sub>C</sub> = 25 °C	64	Α
		T <sub>C</sub> = 100 °C	46	Α
Pulsed Drain Current (Note 2)	I <sub>DM</sub>	T <sub>C</sub> = 25 °C	196	Α
Single Pulsed Avalanche Energy (Note 3)	E <sub>AS</sub>	L = 15 mH, I <sub>AS</sub> = 3 A	67	mJ
SiC FET dv/dt Ruggedness	dv/dt	V <sub>DS</sub> ≤ 500V	150	V/ns
Power Dissipation	P <sub>tot</sub>	T <sub>C</sub> = 25 °C	278	W
Maximum Junction Temperature	$T_{J,max}$		175	°C
Operating and Storage Temperature	T <sub>J</sub> , T <sub>STG</sub>		-55 to 175	°C
Reflow Soldering Temperature	T <sub>solder</sub>	Reflow MSL 1	245	°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.

- Limited by T<sub>J,max</sub>
   Pulse width t<sub>p</sub> limited by T<sub>J,max</sub>
   Starting T<sub>J</sub> = 25 °C

#### THERMAL CHARACTERISTICS

Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$		-	0.42	0.54	°C/W

#### **ELECTRICAL CHARACTERISTICS** (T<sub>J</sub> = +25 °C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
TYPICAL PERFORMANCE - STATIC	•		•			
Drain-Source Breakdown Voltage	$BV_{DS}$	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA	750	_	-	V
Total Drain Leakage Current	I <sub>DSS</sub>	$V_{DS}$ = 750 V, $V_{GS}$ = 0 V, $T_{J}$ = 25 °C	-	2	30	μΑ
		$V_{DS} = 750 \text{ V}, V_{GS} = 0 \text{ V}, T_{J} = 175 ^{\circ}\text{C}$	-	15	-	
Total Gate Leakage Current	I <sub>GSS</sub>	$V_{DS} = 0 \text{ V, } T_J = 25 \text{ °C,} $ $V_{GS} = -20 \text{ V / } +20 \text{ V}$	-	6	±20	μΑ
Drain-Source On-resistance	R <sub>DS(on)</sub>	$V_{GS}$ = 12 V, $I_D$ = 40 A, $T_J$ = 25 °C	-	23	29	mΩ
		$V_{GS}$ = 12 V, $I_D$ = 40 A, $T_J$ = 125 °C	-	39	-	
		$V_{GS}$ = 12 V, $I_D$ = 40 A, $T_J$ = 175 °C	-	50	-	
Gate Threshold Voltage	$V_{G(th)}$	V <sub>DS</sub> = 5 V, I <sub>D</sub> = 10 mA	4	4.8	6	V
Gate Resistance	$R_{G}$	f = 1 MHz, open drain	-	4.5	-	Ω
TYPICAL PERFORMANCE - REVERSE DIO	DE					
Diode Continuous Forward Current (Note 1)	I <sub>S</sub>	T <sub>C</sub> = 25 °C	-	_	64	Α
Diode Pulse Current (Note 2)	I <sub>S,pulse</sub>	T <sub>C</sub> = 25 °C	-	_	196	Α
Forward Voltage	$V_{FSD}$	$V_{GS}$ = 0 V, $I_S$ = 20 A, $T_J$ = 25 $^{\circ}$ C	-	1.23	1.39	V
		$V_{GS} = 0 \text{ V}, I_S = 20 \text{ A}, T_J = 175 ^{\circ}\text{C}$	-	1.45	-	
Reverse Recovery Charge	Q <sub>rr</sub>			80	-	nC
Reverse Recovery Time	t <sub>rr</sub>	$R_{G EXT}$ = 50 Ω, di/dt = 1200 A/μs, $T_{J}$ = 25 °C	_	12	-	ns

#### **ELECTRICAL CHARACTERISTICS** (T<sub>J</sub> = +25 °C unless otherwise specified) (continued)

Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
TYPICAL PERFORMANCE - REVERSE DIOD	Ε		_			
Reverse Recovery Charge	Q <sub>rr</sub>	$V_{DS} = 400 \text{ V}, I_S = 40 \text{ A}, V_{GS} = 0 \text{ V},$	-	84	-	nC
Reverse Recovery Time	t <sub>rr</sub>	$R_{G_EXT} = 50 \Omega$ , di/dt = 1200 A/ $\mu$ s, $T_J = 150 ^{\circ}$ C	_	12.8	_	ns
TYPICAL PERFORMANCE – DYNAMIC			.1	<u> </u>	<u>.</u>	
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V,	_	1400	-	pF
Output Capacitance	C <sub>oss</sub>	f = 100 kHz	_	93	_	
Reverse Transfer Capacitance	C <sub>rss</sub>		_	2.5	_	
Effective Output Capacitance, Energy Related	C <sub>oss(er)</sub>	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	_	116	_	pF
Effective Output Capacitance, Time Related	C <sub>oss(tr)</sub>	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	_	232	_	pF
C <sub>OSS</sub> Stored Energy	E <sub>oss</sub>	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V	_	9.3	_	μJ
Total Gate Charge	$Q_{G}$	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 40 A,	_	37.8	_	nC
Gate-drain Charge	$Q_{GD}$	V <sub>GS</sub> = 0 V to 15 V	-	8	-	]
Gate-source Charge	Q <sub>GS</sub>		-	11.8	-	]
Turn-on Delay Time	t <sub>d(on)</sub>	(Note 4)	-	11	_	ns
Rise Time	t <sub>r</sub>	$\begin{split} V_{DS} &= 400 \text{ V, } I_D = 40 \text{ A,} \\ \text{Gate Driver} &= 0 \text{ V to } +15 \text{ V,} \\ \text{Turn-on } R_{G,EXT} &= 1 \Omega, \\ \text{Turn-off } R_{G,EXT} &= 50 \Omega, \\ \text{Inductive Load, FWD: same device} \\ \text{with } V_{GS} &= 0 \text{ V and } R_G = 50 \Omega, \\ T_J &= 25 \text{ °C} \end{split}$	_	23	_	
Turn-off Delay Time	t <sub>d(off)</sub>		_	158	_	
Fall Time	t <sub>f</sub>		_	17	_	
Turn-on Energy	E <sub>ON</sub>		_	219	_	μJ
Turn-off Energy	E <sub>OFF</sub>		_	167	_	
Total Switching Energy	E <sub>TOTAL</sub>		_	386	-	
Turn-on Delay Time	t <sub>d(on)</sub>	(Note 4)	-	11	-	ns
Rise Time	t <sub>r</sub>	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 40 A, Gate Driver =0 V to +15 V,	_	23	-	
Turn-off Delay Time	t <sub>d(off)</sub>	Turn-on $R_{G,EXT}$ = 1 $\Omega$ , Turn-off $R_{G,EXT}$ = 50 $\Omega$ ,	_	160	-	
Fall Time	t <sub>f</sub>	Inductive Load, FWD: same device	-	18.4	-	
Turn-on Energy	E <sub>ON</sub>	with $V_{GS}$ = 0 V and $R_G$ = 50 $\Omega$ , $T_J$ = 150 $^{\circ}$ C	-	238	-	μJ
Turn-off Energy	E <sub>OFF</sub>		-	189	-	
Total Switching Energy	E <sub>TOTAL</sub>		-	427	-	
Turn-on Delay Time	t <sub>d(on)</sub>	(Note 5) and (Note 6)		13	_	ns
Rise Time	t <sub>r</sub>	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 40 A, Gate Driver = 0 V to +15 V,	-	23	-	
Turn-off Delay Time	t <sub>d(off)</sub>	Turn-on $R_{G,EXT}$ = 1 $\Omega$ , Turn-off $R_{G,EXT}$ = 5 $\Omega$ ,	-	44	-	
Fall Time	t <sub>f</sub>	Inductive Load, FWD: Same	-	9.6	-	
Turn-on Energy Including R <sub>S</sub> Energy	E <sub>ON</sub>	Device with $V_{GS} = 0 \text{ V}$ and $R_G = 5 \Omega$ , RC Snubber:	-	231	-	μJ
Turn-off Energy Including R <sub>S</sub> Energy	E <sub>OFF</sub>	$R_S = 10 \Omega$ and $C_S = 200 pF$ , $T_{,l} = 25 ^{\circ}C$	-	53	-	]
Total Switching Energy	E <sub>TOTAL</sub>	<b>1</b>	-	284	-	]
Snubber R <sub>S</sub> Energy During Turn-on	E <sub>RS_ON</sub>		_	8	-	]
Snubber R <sub>S</sub> Energy During Turn-off	E <sub>RS_OFF</sub>	1	_	5	_	]

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

,	-	, , , , , , , , , , , , , , , , , , , ,				
Parameter	Symbol	Test Conditions	Min	Тур	Max	Unit
TYPICAL PERFORMANCE - DYNAMIC	•		-	-	-	
Turn-on Delay Time	t <sub>d(on)</sub>	(Note 5) and (Note 6)	=	12	-	ns
Rise Time	t <sub>r</sub>	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 40 A, Gate Driver = 0 V to +15 V,	_	23	-	ns
Turn-off Delay Time	t <sub>d(off)</sub>	Turn-on $R_{G,EXT}=1~\Omega,$ Turn-off $R_{G,EXT}=5~\Omega,$ Inductive Load, FWD: Same Device with $V_{GS}=0~V$ and $R_{G}=5~\Omega,$ RC Snubber: $R_{S}=10~\Omega$ and $C_{S}=200~pF,$ $T_{J}=150~^{\circ}C$	_	44	-	
Fall Time	t <sub>f</sub>		_	9.6	-	
Turn-on Energy Including R <sub>S</sub> Energy	E <sub>ON</sub>		_	231	-	μJ
Turn-off Energy Including R <sub>S</sub> Energy	E <sub>OFF</sub>		_	53	-	
Total Switching Energy	E <sub>TOTAL</sub>		_	284	-	
Snubber R <sub>S</sub> Energy During Turn-on	E <sub>RS_ON</sub>	1	_	8.3	-	
Snubber R <sub>S</sub> Energy During Turn-off	E <sub>RS OFF</sub>	1	-	6	-	

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 23.

5. Measured with the switching test circuit in Figure 24.

- 6. The switching energies (turn-on energy, turn-off energy and total energy) presented in this table include the device RC snubber energy losses.

#### **TYPICAL PERFORMANCE DIAGRAMS**

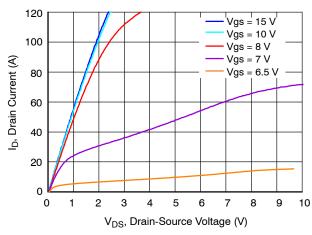


Figure 1. Typical Output Characteristics at  $T_J = -55~^{\circ}\text{C}, \, t_p < 250~\mu\text{s}$ 

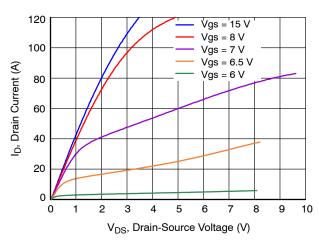


Figure 2. Typical Output Characteristics at  $T_J = 25$  °C,  $t_p < 250~\mu s$ 

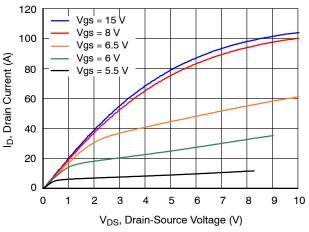


Figure 3. Typical Output Characteristics at  $$T_{J}=175~^{\circ}\text{C},\,t_{p}<250~\mu\text{s}$$ 

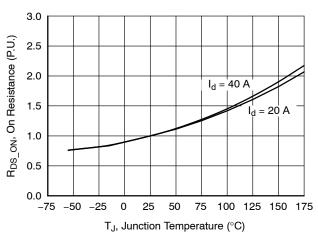


Figure 4. Normalized On-Resistance vs. Temperature at  $V_{GS} = 12 \text{ V}$ 

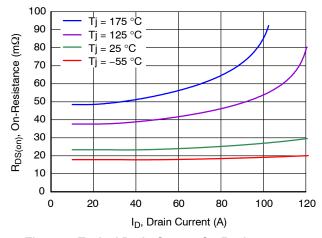


Figure 5. Typical Drain-Source On-Resistances at  $V_{GS}$  = 12 V

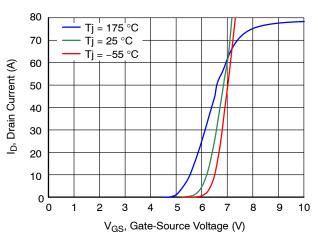


Figure 6. Typical Transfer Characteristics at  $V_{DS} = 5 \text{ V}$ 

#### TYPICAL PERFORMANCE DIAGRAMS (CONTINUED)

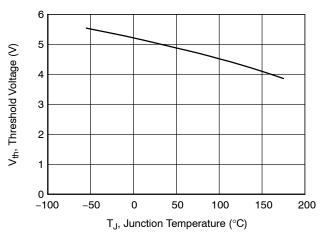


Figure 7. Threshold Voltage vs. Junction Temperature at  $V_{DS}$  = 5 V and  $I_{D}$  = 10 mA

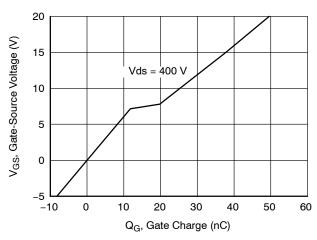


Figure 8. Typical Gate Charge  $I_D = 40 A$ 

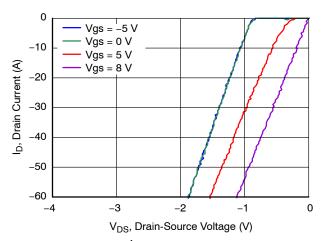


Figure 9.  $3^{rd}$  Quadrant Characteristics at  $T_J = -55$  °C

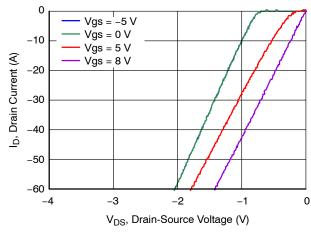


Figure 10.  $3^{rd}$  Quadrant Characteristics at  $T_J = 25$  °C

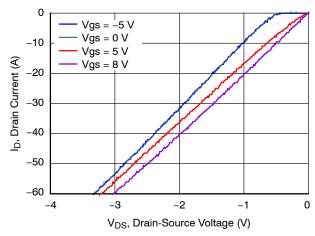


Figure 11.  $3^{rd}$  Quadrant Characteristics at  $T_J = 175$  °C

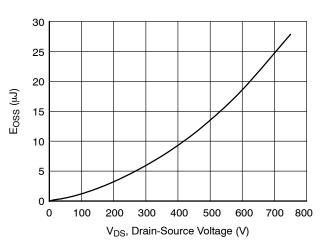


Figure 12. Typical Stored Energy in  $C_{OSS}$  at  $V_{GS} = 0 \text{ V}$ 

#### TYPICAL PERFORMANCE DIAGRAMS (CONTINUED)

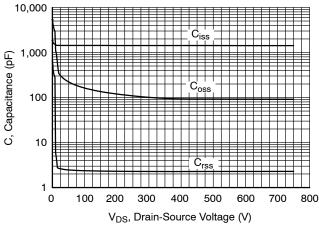


Figure 13. Typical Capacitances at f = 100 kHz and  $V_{GS}$  = 0 V

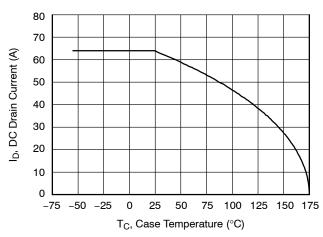


Figure 14. DC Drain Current Derating

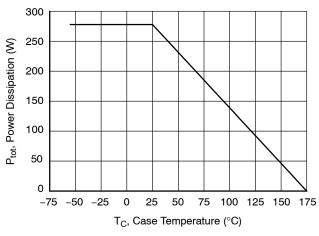


Figure 15. Total Power Dissipation

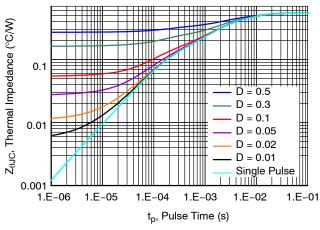


Figure 16. Maximum Transient Thermal Impedance

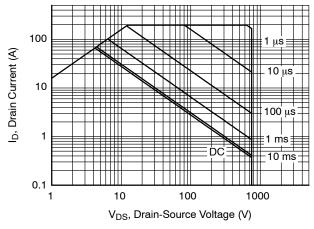


Figure 17. Safe Operation Area at  $T_C$  = 25 °C, D = 0, Parameter  $t_p$ 

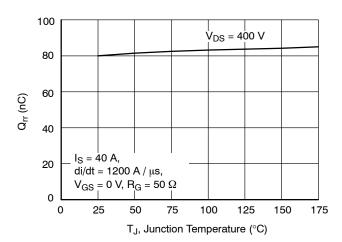


Figure 18. Reverse Recovery Charge Q<sub>rr</sub> vs. Junction Temperature

#### TYPICAL PERFORMANCE DIAGRAMS (CONTINUED)

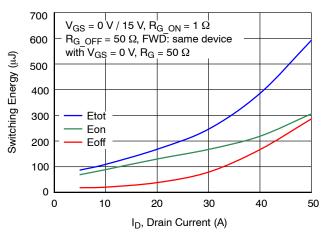


Figure 19. Clamped Inductive Switching Energies vs. Drain Current at  $V_{DS} = 400 \text{ V}$  and  $T_J = 25 \,^{\circ}\text{C}$ 

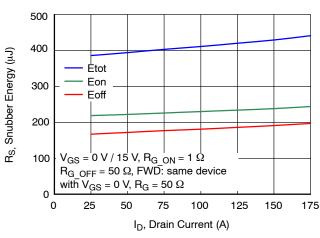


Figure 20. Clamped Inductive Switching Energy vs. Junction Temperature at  $V_{DS} = 400 \text{ V}$  and  $I_D = 40 \text{ A}$ 

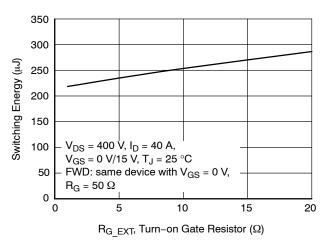


Figure 21. Clamped Inductive Switching Turn-on Energy vs. R<sub>G EXT</sub>, Turn-on Gate Resistor

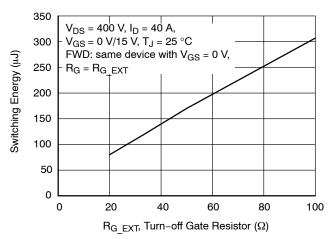


Figure 22. Clamped Inductive Switching Turn-off Energy vs.  $R_{G\ EXT}$ , Turn-off Gate Resistor

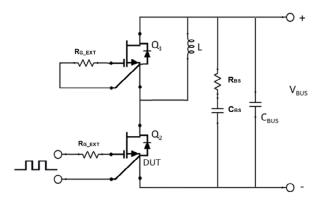


Figure 23. Schematic of the Half-Bridge Mode Switching Test Circuit. Note, a Bus RC Snubber ( $R_{BS} = 2.5~\Omega$ ,  $C_{BS} = 100~nF$ ) is Used to Reduce thePower Loop High Frequency Oscillations.

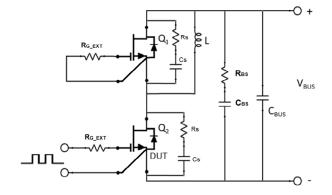


Figure 24. Schematic of the Half-Bridge Mode Switching Test Circuit with Device RC Snubbers (Rs =10  $\Omega$ , Cs = 200 pF) and a Bus RC Snubber (R<sub>BS</sub> = 2.5  $\Omega$ , C<sub>BS</sub> = 100 nF).

#### **APPLICATIONS INFORMATION**

SiC FETs are enhancement-mode power switches formed by a high-voltagee 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 ant-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 <a href="https://www.onsemi.com">www.onsemi.com</a>.

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 <sup>†</sup>
UJ4C075023B7S	UJ4C075023B7S	TO-263-7 10.18x9.08x4.43, 1.27P (Pb-Free, Halogen Free)	800 / Tape and Reel

<sup>†</sup> For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

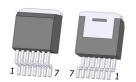
#### **REVISION HISTORY**

Revision	Description of Changes	Date
С	Acquired the original Qorvo JFET Division Data Sheet and updated the main document title to comply with <b>onsemi</b> standards for SiC products.	1/15/2025
3	Converted the Data Sheet to <b>onsem</b> i format.	6/9/2025

E1

**-** E3 •



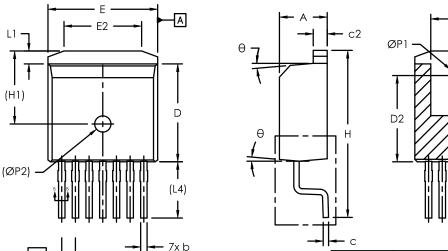


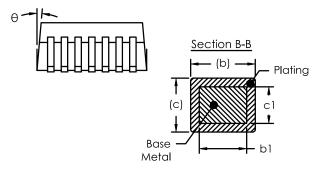
#### TO-263-7 10.18x9.08x4.43, 1.27P CASE 418BA ISSUE B

**DATE 17 APR 2025** 

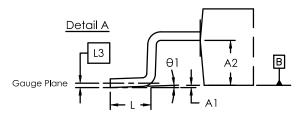
D1

(H3)





**⊕** 0.25mm **M** B A **M** 



#### Notes:

- 1. Dimensioning and Tolerancing as per ASME Y14.5M, 2018.
- 2. Controlling Dimension: Millimeters
- 3. Package body sides exclude mold flash and gate burrs.
- 4. Dimension L is measured on gauge plane.
- 5. Dimension c1 and b1 applies to base metal only.

SYM A A1	Min 4.30 0.00	Nom 4.43	Max		
A1		4.43			
	0.00	I 4.40	4.56		
4.0	0.00	0.13	0.25		
A2	2.45	2.60	2.75		
р	0.50	0.60	0.70		
b1	0.50	-	=		
С	0.40	0.50	0.60		
c1	0.40	-	=		
c2	1.20	1.30	1.40		
О	8.93	9.08	9.23		
D1	5.85	6.00	6.15		
D2	7.90	8.00	8.10		
е	1.27 BSC				
Е	10.08	10.18	10.28		
El	6.82	7.22	7.62		
E2	6.50	7.55	8.60		
E3	3.50	3.60	3.70		
Η	15.00	15.50	16.00		
H1		6.78 REF			
Н3		7.30 REF.			
L	1.90	2.20	2.50		
L1	0.98	1.20	1.42		
L3		0.25 BSC			
L4		5.22 REF			
ØP1	0.65	0.75	0.85		
ØP2		1.50 REF			
θ	5°				
θ1	3°				

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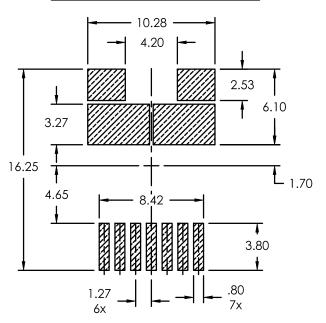
## **TO-263-7 10.18x9.08x4.43, 1.27P**CASE 418BA ISSUE B

**DATE 17 APR 2025** 

#### RECOMMENDED PCB FOOTPRINT

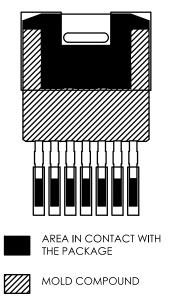
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#### RECOMMENDED STENCIL APERTURE



NOTE: LAND PATTERN AND STENCIL APERTURE DIMENSIONS SERVE ONLY AS AN INITIAL GUIDE. END-USER PCB DESIGN RULES AND TOLERANCES SHOULD ALWAYS PREVAIL.

#### PCB FOOTPRINT with PACKAGE OVERLAY



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