

# Silicon Carbide (SiC) Cascode JFET Module – EliteSiC, Full-Bridge Module, 1200 V, 35 mohm

## UFB25SC12E1BC3N

### Description

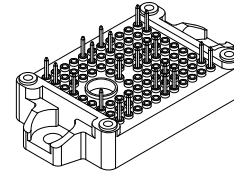
This SiC FET device is based on a unique ‘cascode’ circuit configuration, in which a normally-on SiC JFET is co-packaged with a Si MOSFET to produce a normally-off SiC FET device. The device’s silicon-like gate-drive characteristics allows the use of unipolar gate drives, compatible with Si IGBTs, Si FETs, SiC MOSFETs or Si superjunction devices. Available in the E1B module 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. Advanced Ag sintering die attach technology gives the module superior thermal performance.

### Features

- On-resistance  $R_{DS(on)}$ : 35 m $\Omega$  (Typ)
- Operating Temperature: 150 °C (Max)
- Excellent Reverse Recovery:  $Q_{rr}$  = 244 nC
- Low Body Diode Voltage :  $V_{FSD}$  = 1.4 V
- Low Gate Charge:  $Q_G$  = 42.5 nC
- Threshold Voltage  $V_{G(th)}$ : 5 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

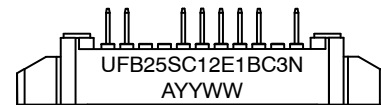
### Typical Applications

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



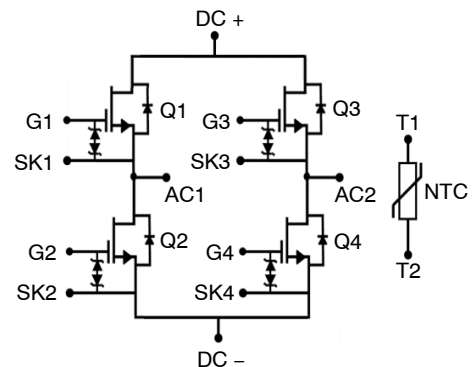
PIM20 33.80x42.50x12.00 E1B  
FULL BRIDGE (SOLDER PIN)  
CASE 180DG

### MARKING DIAGRAM



UFB25SC12E1BC3N = Specific Device Code  
A = Assembly Location  
YY = Year  
WW = Work Week

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

# UFB25SC12E1BC3N

## MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Value	Unit
Drain-source Voltage	$V_{DS}$		1200	V
Gate-source Voltage	$V_{GS}$	DC	-20 to +20	V
		AC ( $f > 1$ Hz)	-25 to +25	
Continuous Drain Current (Note 1)	$I_D$	$T_C = 25\text{ }^{\circ}\text{C}$	36	A
		$T_C = 90\text{ }^{\circ}\text{C}$	25	
Pulsed Drain Current (Note 2)	$I_{DM}$	$T_C = 25\text{ }^{\circ}\text{C}$	175	A
Power Dissipation per Switch	$P_{tot}$	$T_C = 25\text{ }^{\circ}\text{C}$	114	W
Maximum Junction Temperature	$T_{J,max}$		150	$^{\circ}\text{C}$
Operating and Storage Temperature	$T_J, T_{STG}$		-55 to 150	$^{\circ}\text{C}$

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  $T_{J,max}$

## THERMAL CHARACTERISTICS

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Thermal Resistance, Junction-to-Case per Switch	$R_{\theta JC}$		-	0.85	1.1	$^{\circ}\text{C/W}$

## NTC THERMISTOR CHARACTERISTICS

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Rated Resistance	$R_{25}$	$T_{NTC} = 25\text{ }^{\circ}\text{C}$	-	5	-	k $\Omega$
Resistance Value Tolerance	$\Delta R/R$	$T_{NTC} = 25\text{ }^{\circ}\text{C}$	-5	-	5	%
Power Dissipation	$P_{25}$	$T_{NTC} = 25\text{ }^{\circ}\text{C}$	-	-	20	mW
B Constant	$B_{25/50}$	$R_2 = R_{25} \exp [B_{25/50} (1/T_2 - 1/(298.15\text{ K}))]$	-	3375	-	K

## MODULE

Parameter	Symbol	Test Conditions	Value	Unit
Isolation Voltage	$V_{ISOL}$	RMS, $f = 50$ Hz, $t = 1$ min	3	kV
Internal Isolation			$\text{Al}_2\text{O}_3$	
Creepage Distance		Terminal to heatsink	12.7	mm
		Terminal to terminal	6.3	
Clearance Distance		Terminal to heatsink	10	mm
		Terminal to terminal	5	
Stray Inductance Module	$L_{sCE}$		11	nH

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### TYPICAL PERFORMANCE – STATIC

Drain-source Breakdown Voltage	BV <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 4 mA	1200	–	–	V
Total Drain Leakage Current	I <sub>DSS</sub>	V <sub>DS</sub> = 1200 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 25 °C	–	8	150	μA
		V <sub>DS</sub> = 1200 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150 °C	–	35	–	
Total Gate Leakage Current	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, T <sub>J</sub> = 25 °C, V <sub>GS</sub> = –20 V / +20 V	–	6	20	μA
Drain-source On-resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 12 V, I <sub>D</sub> = 25 A, T <sub>J</sub> = 25 °C	–	35	45	mΩ
		V <sub>GS</sub> = 12 V, I <sub>D</sub> = 25 A, T <sub>J</sub> = 125 °C	–	55	–	
		V <sub>GS</sub> = 12 V, I <sub>D</sub> = 25 A, T <sub>J</sub> = 150 °C	–	64	–	
Gate Threshold Voltage	V <sub>G(th)</sub>	V <sub>DS</sub> = 5 V, I <sub>D</sub> = 10 mA	4	5	6	V
Gate Resistance	R <sub>G</sub>	f = 1 MHz, open drain	–	4.5	–	Ω

### TYPICAL PERFORMANCE – REVERSE DIODE

Diode Continuous Forward Current (Note 1)	I <sub>S</sub>	T <sub>C</sub> = 25 °C	–	–	36	A
Diode Pulse Current (Note 2)	I <sub>S,pulse</sub>	T <sub>C</sub> = 25 °C	–	–	175	A
Forward Voltage	V <sub>FSD</sub>	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 20 A, T <sub>J</sub> = 25 °C	–	1.4	2	V
		V <sub>GS</sub> = 0 V, I <sub>S</sub> = 20 A, T <sub>J</sub> = 150 °C	–	1.8	–	
Reverse Recovery Charge	Q <sub>rr</sub>	V <sub>DS</sub> = 800 V, I <sub>S</sub> = 25 A, V <sub>GS</sub> = 0 V, R <sub>G</sub> = 33 Ω, di/dt = 2200 A/μs, T <sub>J</sub> = 25 °C	–	244	–	nC
Reverse Recovery Time	t <sub>rr</sub>		–	29	–	ns
Reverse Recovery Charge	Q <sub>rr</sub>	V <sub>DS</sub> = 800 V, I <sub>S</sub> = 25 A, V <sub>GS</sub> = 0 V, R <sub>G</sub> = 33 Ω, di/dt = 2200 A/μs, T <sub>J</sub> = 150 °C	–	227	–	nC
Reverse Recovery Time	t <sub>rr</sub>		–	28	–	ns

### TYPICAL PERFORMANCE – DYNAMIC

Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> = 800 V, V <sub>GS</sub> = 0 V, f = 100 kHz	–	1450	–	pF
Output Capacitance	C <sub>oss</sub>		–	94	–	
Reverse Transfer Capacitance	C <sub>rss</sub>		–	1.7	–	
Effective Output Capacitance, Energy Related	C <sub>oss(er)</sub>	V <sub>DS</sub> = 0 V to 800 V, V <sub>GS</sub> = 0 V	–	120	–	pF
Effective Output Capacitance, Time Related	C <sub>oss(tr)</sub>		–	265	–	pF
C <sub>oss</sub> Stored Energy	E <sub>oss</sub>	V <sub>DS</sub> = 800 V, V <sub>GS</sub> = 0 V	–	38	–	μJ
Total gate Charge	Q <sub>G</sub>	V <sub>DS</sub> = 800 V, I <sub>D</sub> = 25 A, V <sub>GS</sub> = –5 V to 15 V	–	42.5	–	nC
Gate-drain Charge	Q <sub>GD</sub>		–	9.5	–	
Gate-source Charge	Q <sub>GS</sub>		–	15.5	–	
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DS</sub> = 800 V, I <sub>D</sub> = 25 A, Gate Driver = –5 V to +15 V, R <sub>G ON</sub> = 22 Ω, R <sub>G OFF</sub> = 22 Ω, Inductive Load, FWD: same device with V <sub>GS</sub> = 0 V and R <sub>G</sub> = 22 Ω, T <sub>J</sub> = 25 °C (Notes 3, 4)	–	53	–	ns
Rise Time	t <sub>r</sub>		–	15	–	
Turn-off Delay Time	t <sub>d(off)</sub>		–	54	–	
Fall Time	t <sub>f</sub>		–	11	–	
Turn-on Energy	E <sub>ON</sub>		–	557	–	μJ
Turn-off Energy	E <sub>OFF</sub>		–	44	–	
Total Switching Energy	E <sub>TOTAL</sub>		–	601	–	

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>TYPICAL PERFORMANCE – DYNAMIC</b>						
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DS</sub> = 800 V, I <sub>D</sub> = 25 A, Gate Driver = -5 V to +15 V, R <sub>G_ON</sub> = 22 Ω, R <sub>G_OFF</sub> = 22 Ω, Inductive Load, FWD: same device with V <sub>GS</sub> = 0 V and R <sub>G</sub> = 22 Ω, T <sub>J</sub> = 150 °C (Notes 3, 4)	–	50	–	ns
Rise Time	t <sub>r</sub>		–	12	–	
Turn-off Delay Time	t <sub>d(off)</sub>		–	55	–	
Fall Time	t <sub>f</sub>		–	11	–	
Turn-on Energy	E <sub>ON</sub>		–	516	–	μJ
Turn-off Energy	E <sub>OFF</sub>		–	44	–	
Total Switching Energy	E <sub>TOTAL</sub>		–	560	–	
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DS</sub> = 800 V, I <sub>D</sub> = 25 A, Gate Driver = -5 V to +15 V, Turn-on R <sub>G,EXT</sub> = 15 Ω, Turn-off R <sub>G,EXT</sub> = 10 Ω Inductive Load, FWD: same device with V <sub>GS</sub> = 0 V, and R <sub>G</sub> = 10 Ω, RC snubber: R <sub>S</sub> = 10 Ω, and C <sub>S</sub> = 100 pF, T <sub>J</sub> = 25 °C (Notes 5, 6)	–	52.8	–	ns
Rise Time	t <sub>r</sub>		–	22.4	–	
Turn-off Delay Time	t <sub>d(off)</sub>		–	70	–	
Fall Time	t <sub>f</sub>		–	16.8	–	
Turn-on Energy Including R <sub>S</sub> Energy	E <sub>ON</sub>		–	511	–	μJ
Turn-off Energy Including R <sub>S</sub> Energy	E <sub>OFF</sub>		–	127	–	
Total Switching Energy	E <sub>TOTAL</sub>		–	638	–	
Snubber R <sub>S</sub> Energy During Turn-on	E <sub>RS_ON</sub>		–	3	–	
Snubber R <sub>S</sub> Energy During Turn-off	E <sub>RS_OFF</sub>		–	3	–	
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DS</sub> = 800 V, I <sub>D</sub> = 25 A, Gate Driver = -5 V to +15 V, Turn-on R <sub>G,EXT</sub> = 15 Ω, Turn-off R <sub>G,EXT</sub> = 10 Ω Inductive Load, FWD: same device with V <sub>GS</sub> = 0 V, and R <sub>G</sub> = 10 Ω, RC snubber: R <sub>S</sub> = 10 Ω, and C <sub>S</sub> = 100 pF, T <sub>J</sub> = 150 °C (Notes 5, 6)	–	47.2	–	ns
Rise Time	t <sub>r</sub>		–	26.4	–	
Turn-off Delay Time	t <sub>d(off)</sub>		–	73	–	
Fall Time	t <sub>f</sub>		–	17	–	
Turn-on Energy Including R <sub>S</sub> Energy	E <sub>ON</sub>		–	484	–	μJ
Turn-off Energy Including R <sub>S</sub> Energy	E <sub>OFF</sub>		–	126	–	
Total Switching Energy	E <sub>TOTAL</sub>		–	610	–	
Snubber R <sub>S</sub> Energy During Turn-on	E <sub>RS_ON</sub>		–	2.8	–	
Snubber R <sub>S</sub> Energy During Turn-off	E <sub>RS_OFF</sub>		–	3.2	–	

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.

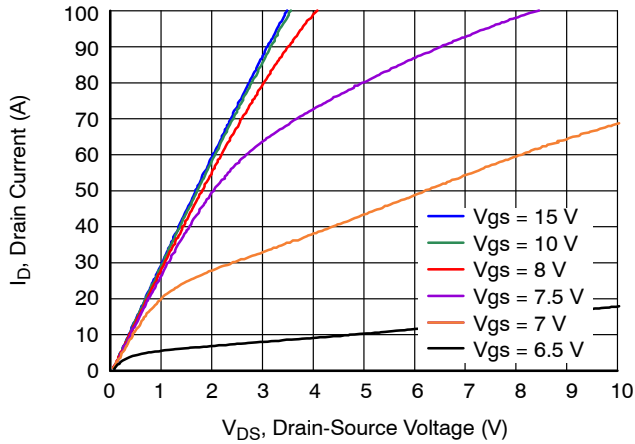
3. Measured with the half-bridge mode switching test circuit in Figure 23.

4. A bus RC snubber (R<sub>BS</sub> = 2.5 Ω, C<sub>BS</sub> = 200 nF) must be applied to reduce the power loop high frequency oscillations.

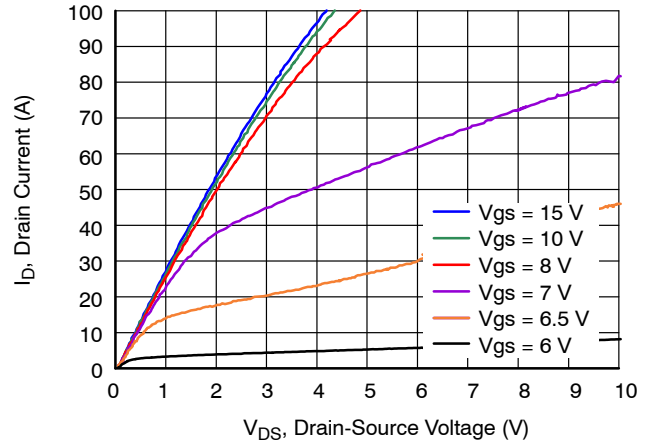
5. Measured with the half-bridge mode switching test circuit in Figure 24.

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

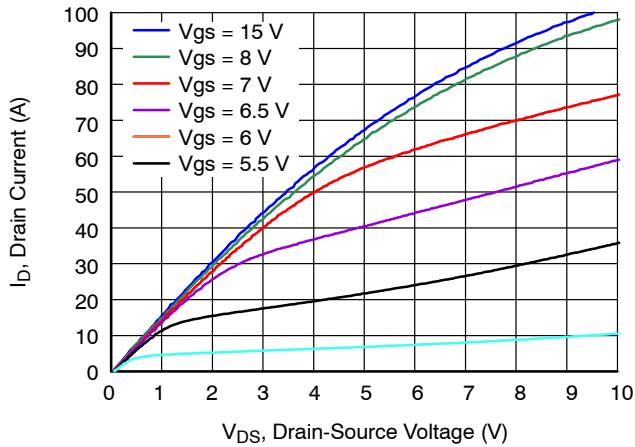
SIC FET TYPICAL PERFORMANCE DIAGRAMS



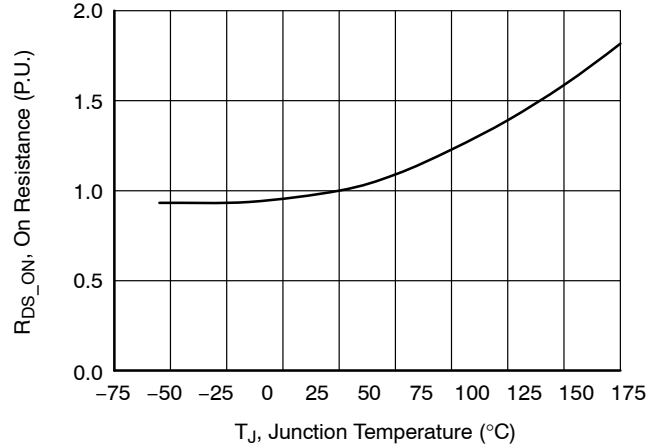
**Figure 1. Typical Output Characteristics**  
at  $T_J = -55\text{ }^{\circ}\text{C}$ ,  $t_p < 250\text{ }\mu\text{s}$



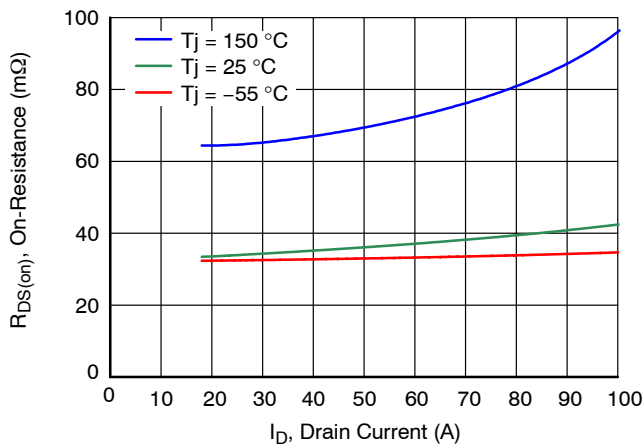
**Figure 2. Typical Output Characteristics**  
at  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $t_p < 250\text{ }\mu\text{s}$



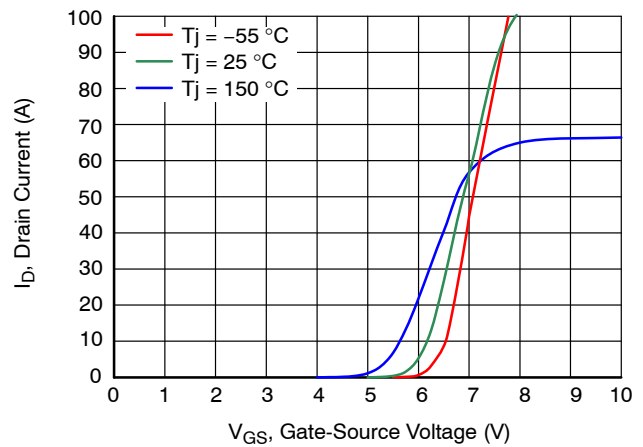
**Figure 3. Typical Output Characteristics**  
at  $T_J = 150\text{ }^{\circ}\text{C}$ ,  $t_p < 250\text{ }\mu\text{s}$



**Figure 4. Normalized On-Resistance**  
vs. Temperature at  $V_{GS} = 12\text{ V}$  and  $I_D = 25\text{ A}$



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



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

SiC FET TYPICAL PERFORMANCE DIAGRAMS (continued)

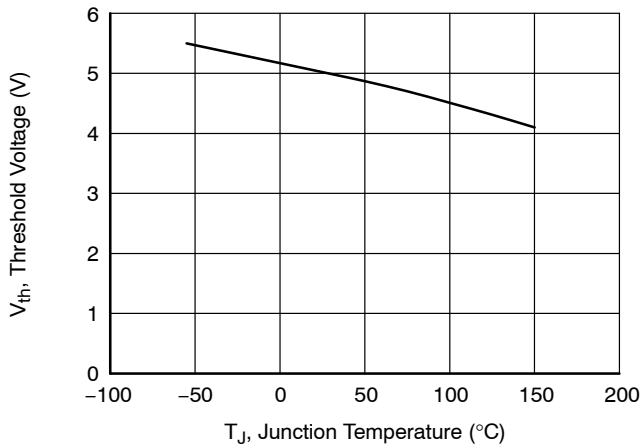


Figure 7. Threshold Voltage vs. Junction Temperature at  $V_{DS} = 5\text{ V}$  and  $I_D = 10\text{ mA}$

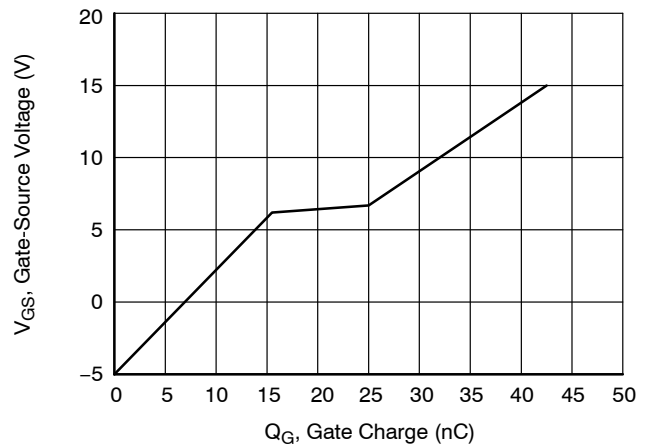


Figure 8. Typical Gate Charge at  $V_{DS} = 800\text{ V}$  and  $I_D = 25\text{ A}$

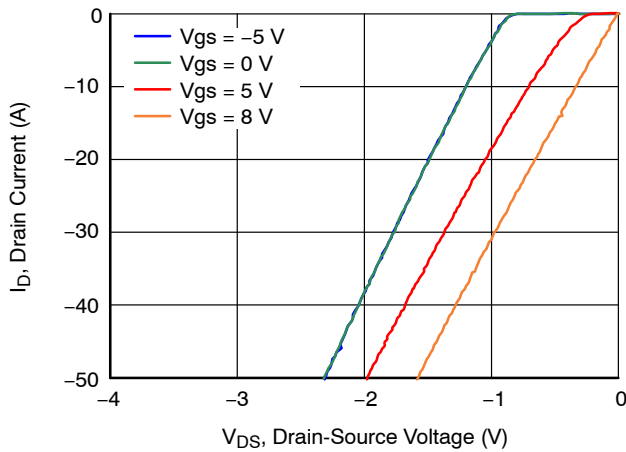


Figure 9. 3<sup>rd</sup> Quadrant Characteristics at  $T_J = -55\text{ °C}$

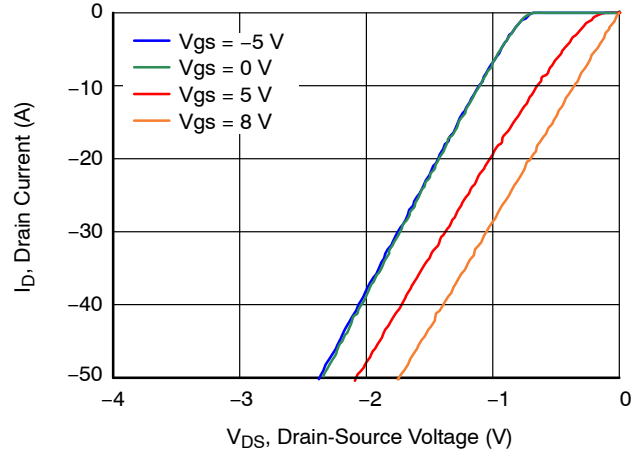


Figure 10. 3<sup>rd</sup> Quadrant Characteristics at  $T_J = 25\text{ °C}$

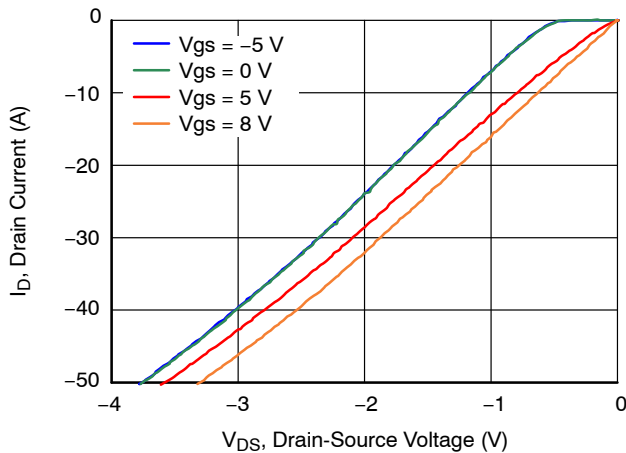


Figure 11. 3<sup>rd</sup> Quadrant Characteristics at  $T_J = 150\text{ °C}$

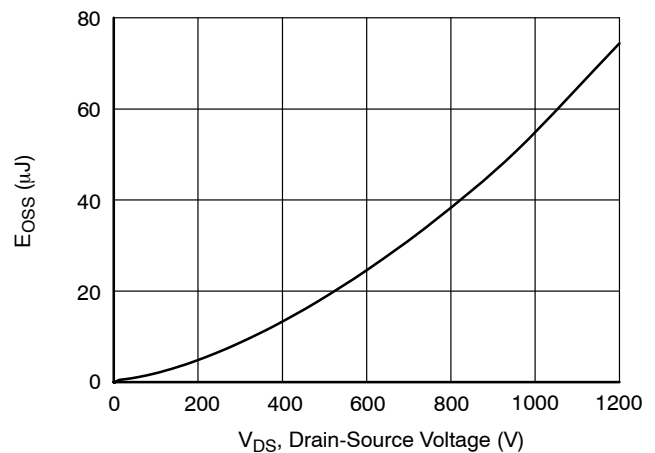
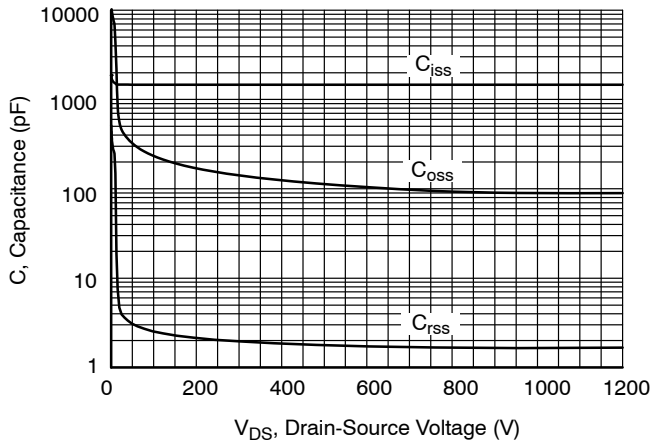


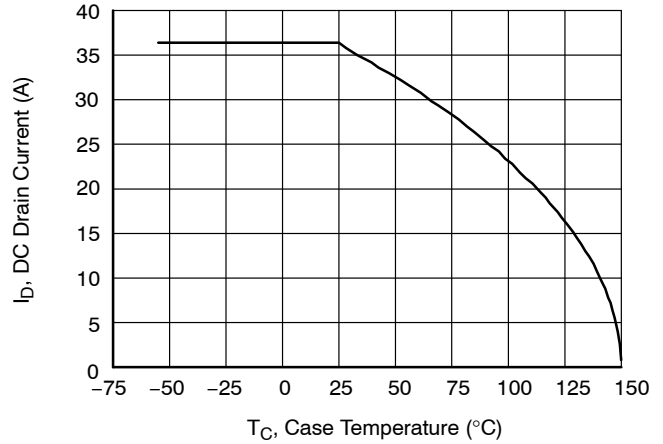
Figure 12. Typical Stored Energy in  $C_{OSS}$  at  $V_{GS} = 0\text{ V}$

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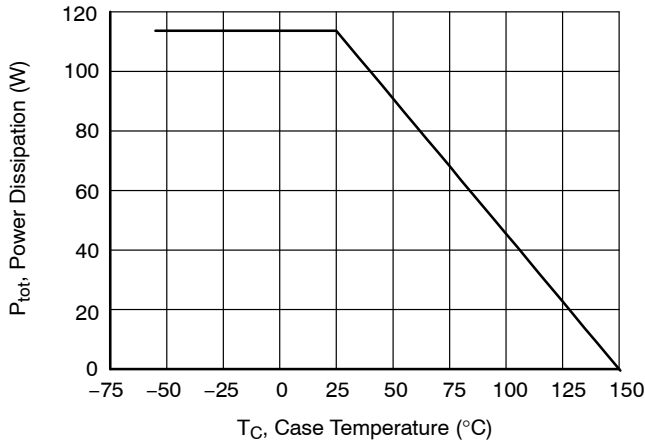
## SiC FET TYPICAL PERFORMANCE DIAGRAMS (continued)



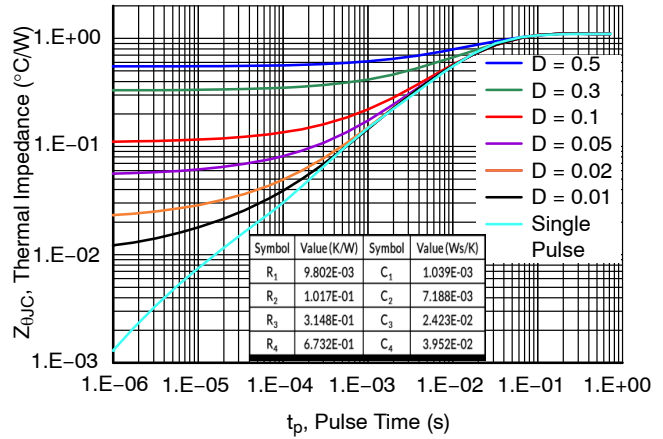
**Figure 13. Typical Capacitances at  $f = 100$  kHz and  $V_{GS} = 0$  V**



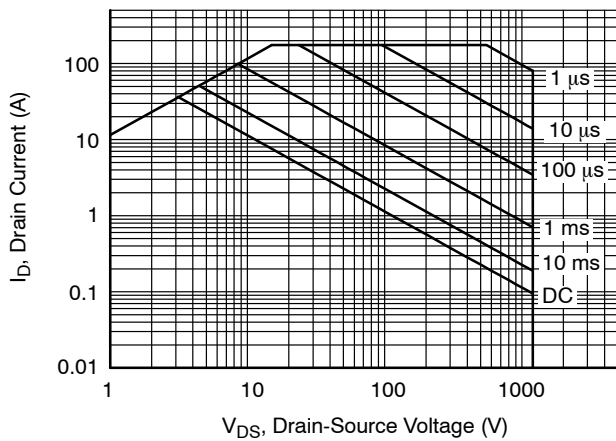
**Figure 14. DC Drain Current Derating**



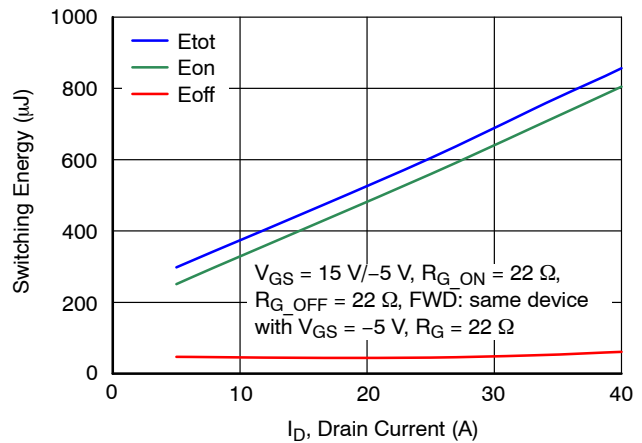
**Figure 15. Total Power Dissipation**



**Figure 16. Maximum Transient Thermal Impedance and Parameters for Thermal Equivalent Circuit (Foster) Model**

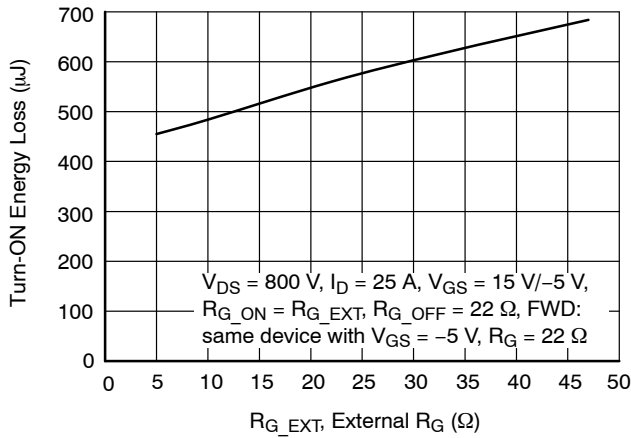


**Figure 17. Safe Operation Area at  $T_C = 25$  °C,  $D = 0$ , Parameter  $t_p$**

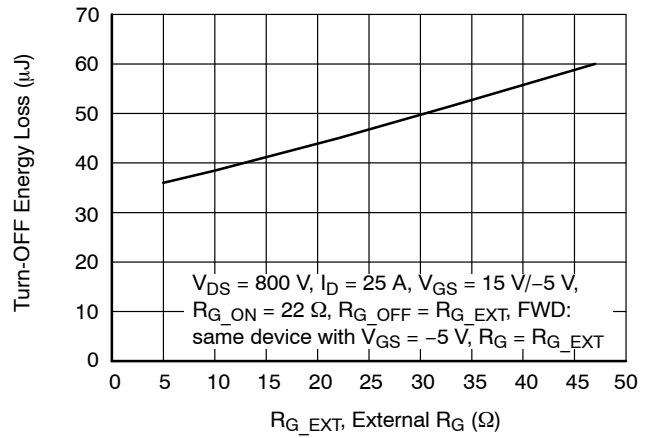


**Figure 18. Clamped Inductive Switching Energy vs. Drain Current at  $V_{DS} = 800$  V and  $T_J = 25$  °C**

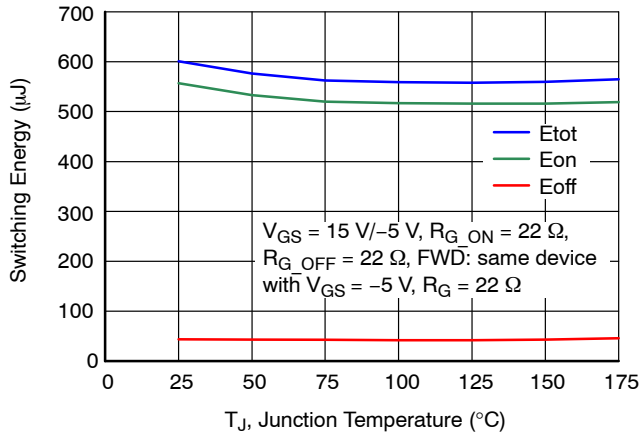
SiC FET TYPICAL PERFORMANCE DIAGRAMS (continued)



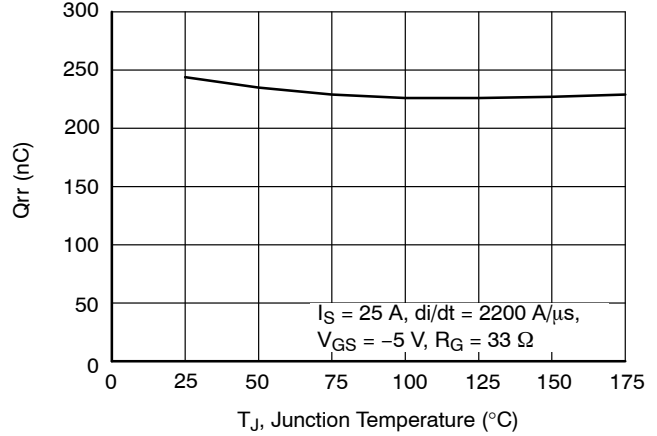
**Figure 19. Clamped Inductive Switching Turn-On Energy vs. Turn-On Gate Resistance  $R_G$  at  $T_J = 25^\circ\text{C}$**



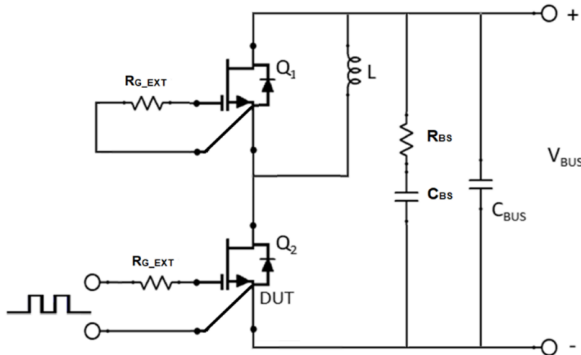
**Figure 20. Clamped Inductive Switching Turn-Off Energy vs. Turn-Off Gate Resistance  $R_G$  at  $T_J = 25^\circ\text{C}$**



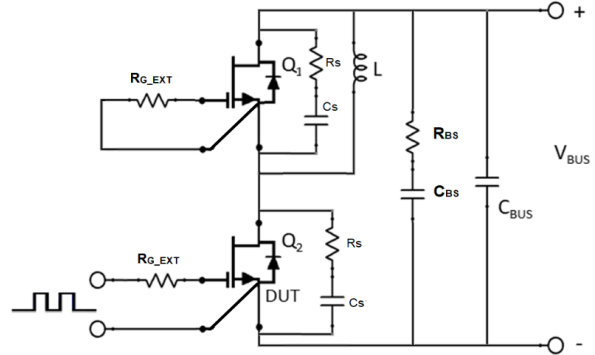
**Figure 21. Clamped Inductive Switching Energy vs. Junction Temperature at  $V_{DS} = 800\text{ V}$  and  $I_D = 25\text{ A}$**



**Figure 22. Reverse Recovery Charge  $Q_{rr}$  vs. Junction Temperature at  $V_{DS} = 800\text{ V}$**



**Figure 23. Schematic of the Half-bridge Mode Switching Test Circuit. Note, a Bus RC Snubber ( $R_{BS} = 2.5\ \Omega$ ,  $C_{BS} = 200\text{ nF}$ ) Must be Applied to Reduce the Power Loop High Frequency Oscillations**



**Figure 24. Schematic of the Half-bridge Mode Switching Test Circuit with Device RC Snubbers ( $R_S = 10\ \Omega$ ,  $C_S = 100\text{ pF}$ ) and a Bus RC Snubber ( $R_{BS} = 2.5\ \Omega$ ,  $C_{BS} = 200\text{ nF}$ )**



## IMPORTANT MOUNTING INFORMATION

This product is recommended for use with solder pin attach and phase change thermal interface materials, and not recommended for implementations using press

fit and application of thermal grease. Please refer to mounting guidelines and user guide documents associated with this product for detailed information.

## 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](http://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](http://www.onsemi.com).

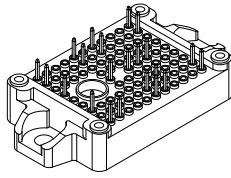
## ORDERING INFORMATION

Part Number	Marking	Package	Shipping
UFB25SC12E1BC3N	UFB25SC12E1BC3N	PIM20 33.80x42.50x12.00 E1B FULL BRIDGE (SOLDER PIN) (Pb-Free, Halogen Free)	24 Units / Tray Blister

## UFB25SC12E1BC3N

### REVISION HISTORY

Revision	Description of Changes	Date
D	Acquired the original Qorvo JFET Division Data Sheet and updated the main document title to comply with <b>onsemi</b> standards for SiC products.	3/19/2025
4	Converted the Data Sheet to <b>onsemi</b> format.	6/4/2025

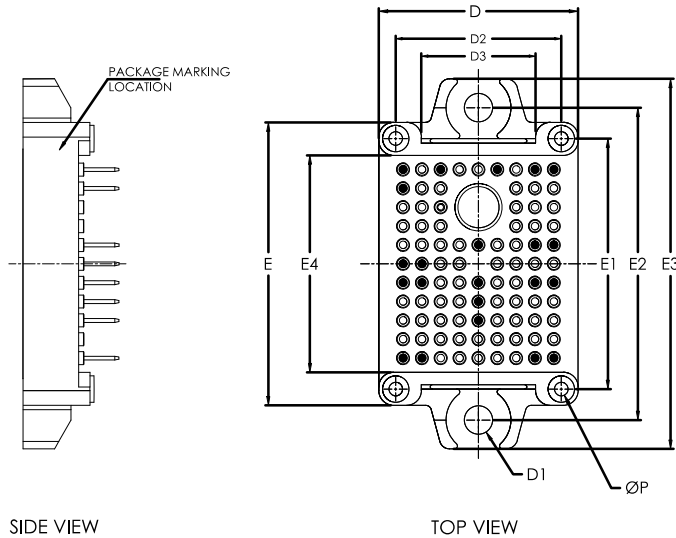


PIM20 33.80x42.50x12.00 E1B FULL BRIDGE (SOLDER PIN)  
CASE 180DG  
ISSUE O

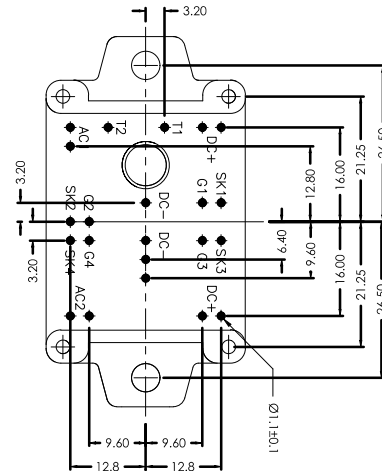
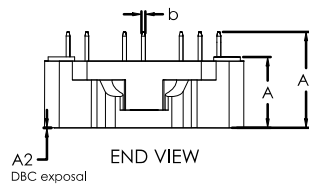
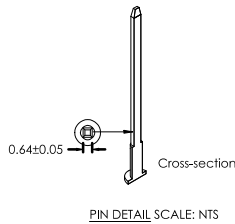
DATE 21 MAR 2025

NOTES:

- 1.CONTROLLING DIMENSION: MILLIMETERS
2. PIN POSITION TOLERANCIS  $\pm 0.40\text{mm}$



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	11.65	12.00	12.35
A1	15.75	16.25	16.75
A2	0.15	0.50	0.85
b	0.59	0.64	0.69
D	33.50	33.80	34.10
D1	Ø4.7	Ø4.8	Ø4.9
D2	27.90	28.10	28.30
D3	19.20	19.40	19.60
E	47.70	48.00	48.30
E1	42.30	42.50	42.70
E2	52.90	53.00	53.10
E3	62.30	62.80	63.30
E4	36.60	36.80	37.00
P	Ø2.2	Ø2.3	Ø2.4



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DESCRIPTION:	PIM20 33.80x42.50x12.00 E1B FULL BRIDGE (SOLDER PIN)	PAGE 1 OF 1

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