

Silicon Carbide (SiC) Cascode JFET Module - EliteSiC, Full-Bridge Module, 1200 V, 70 mohm UFB15C12E1BC3N

Description

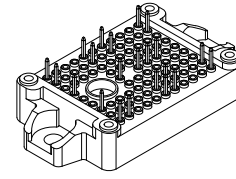
This SiC FET device is based on a unique ‘cascode’ circuit configuration, in which a normally-on SiC JFET is co-packaged with a Si MOSFET to produce a normally-off SiC FET device. The device’s silicon-like gate-drive characteristics allows the use of unipolar gate drives, compatible with Si IGBTs, Si FETs, SiC MOSFETs or Si super-junction devices. Available in the PIM20 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 $R_{DS(on)}$: 70 m Ω (Typ)
- Operating Temperature: 150 °C (Max)
- Excellent Reverse Recovery: Q_{rr} = 140 nC
- Low Body Diode V_{FSD} : 1.4 V
- Low Gate Charge: Q_G = 46 nC
- Threshold Voltage $V_{G(th)}$: 5 V (Typ) Allowing 0 to 15 V Drive
- ESD Protected, HBM Class 2 and CDM Class 3
- 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



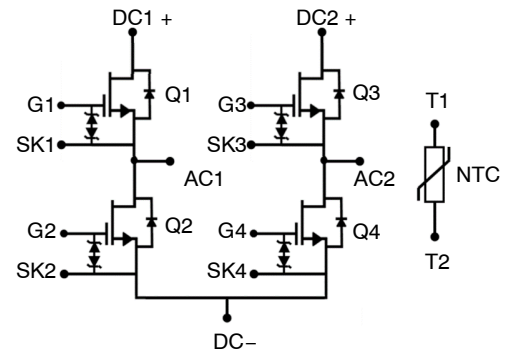
PIM20
CASE 180DG

MARKING DIAGRAM



UFB15C12E1BC3N = Specific Device Code
A = Assembly Location
YY = Year
WW = Work Week

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

UFB15C12E1BC3N

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	$T_C = 25\text{ }^{\circ}\text{C}$	24	A
		$T_C = 105\text{ }^{\circ}\text{C}$	15	A
Pulsed Drain Current (Note 2)	I_{DM}	$T_C = 25\text{ }^{\circ}\text{C}$	80	A
Power Dissipation	P_{tot}	$T_C = 25\text{ }^{\circ}\text{C}$	96	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.

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

THERMAL CHARACTERISTICS

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$		–	1.0	1.3	$^{\circ}\text{C/W}$

NTC THERMAL 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	$\Delta R/R$		-5	–	5	%
Power Dissipation	P_{25}		–	–	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}		–	3	–	kV
Internal Isolation			–	Al_2O_3	–	
Creepage Distance		Terminal to Heatsink	–	12.7	–	mm
		Terminal to Terminal	–	6.3	–	
Clearance Distance		Terminal to Heatsink	–	10	–	
		Terminal to Terminal	–	5	–	
Stray Inductance Module	L_{sCE}		–	11	–	nH

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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	1200	–	–	V
Total Drain Leakage Current	I _{DSS}	V _{DS} = 1200 V, V _{GS} = 0 V, T _J = 25 °C	–	0.5	75	μA
		V _{DS} = 1200 V, V _{GS} = 0 V, T _J = 150 °C	–	2.5	–	
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 = 15 A, T _J = 25 °C	–	70	90	mΩ
		V _{GS} = 12 V, I _D = 15 A, T _J = 125 °C	–	111	–	
		V _{GS} = 12 V, I _D = 15 A, T _J = 150 °C	–	129	–	
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 3)	I _S	T _C = 25 °C	–	–	24	A
Diode Pulse Current (Note 4)	I _{S, pulse}	T _C = 25 °C	–	–	80	A
Forward Voltage	V _{FSD}	V _{GS} = 0 V, I _S = 15 A, T _J = 25 °C	–	1.4	2	V
		V _{GS} = 0 V, I _S = 15 A, T _J = 150 °C	–	1.63	–	
Reverse Recovery Charge	Q _{rr}	V _{DS} = 800 V, I _S = 15 A, V _{GS} = 0 V, R _G = 5 Ω, di/dt = 1200 A/μs, T _J = 25 °C	–	140	–	nC
Reverse Recovery Time	t _{rr}	V _{DS} = 800 V, I _S = 15 A, V _{GS} = 0 V, R _G = 5 Ω, di/dt = 1200 A/μs, T _J = 25 °C	–	35	–	ns
Reverse Recovery Charge	Q _{rr}	V _{DS} = 800 V, I _S = 15 A, V _{GS} = 0 V, R _G = 5 Ω, di/dt = 1200 A/μs, T _J = 150 °C	–	141	–	nC
Reverse Recovery Time	t _{rr}	V _{DS} = 800 V, I _S = 15 A, V _{GS} = 0 V, R _G = 5 Ω, di/dt = 1200 A/μs, T _J = 150 °C	–	35	–	ns

TYPICAL PERFORMANCE – DYNAMIC

Input Capacitance	C _{iss}	V _{DS} = 800 V, V _{GS} = 0 V, f = 100 kHz	–	1445	–	pF
Output Capacitance	C _{oss}		–	55	–	
Reverse Transfer Capacitance	C _{rss}		–	2	–	
Effective Output Capacitance, Energy Related	C _{oss(er)}	V _{DS} = 0 V to 800 V, V _{GS} = 0 V	–	63	–	pF
Effective Output Capacitance, Time Related	C _{oss(tr)}		–	128	–	
C _{oss} Stored Energy	E _{oss}	V _{DS} = 800 V, V _{GS} = 0 V	–	20	–	μJ
Total Gate Charge	Q _G	V _{DS} = 800 V, I _D = 15 A, V _{GS} = –5 V to 15 V	–	46	–	nC
Gate-drain Charge	Q _{GD}		–	7	–	
Gate-source Charge	Q _{GS}		–	19	–	
Turn-on Delay Time	t _{d(on)}	V _{DS} = 800 V, I _D = 15 A, Gate Driver = –5 V to +15 V, R _{G_ON} = 1 Ω, R _{G_OFF} = 20 Ω, Inductive Load, FWD: Same Device with V _{GS} = 0 V and R _G = 20 Ω, T _J = 25 °C (Notes 5, 7)	–	22.4	–	ns
Rise Time	t _r		–	18.4	–	
Turn-off Delay Time	t _{d(off)}		–	65	–	
Fall Time	t _f		–	10.4	–	
Turn-on Energy	E _{ON}		–	396	–	μJ
Turn-off Energy	E _{OFF}		–	42	–	
Total Switching Energy	E _{TOTAL}		–	438	–	

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ELECTRICAL CHARACTERISTICS ($T_J = +25^\circ\text{C}$ unless otherwise specified) (continued)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
TYPICAL PERFORMANCE – DYNAMIC						
Turn-on Delay Time	$t_{d(on)}$	$V_{DS} = 800\text{ V}$, $I_D = 15\text{ A}$, Gate Driver = -5 V to $+15\text{ V}$, $R_{G_ON} = 1\ \Omega$, $R_{G_OFF} = 20\ \Omega$, Inductive Load, FWD: Same Device with $V_{GS} = 0\text{ V}$ and $R_G = 20\ \Omega$, $T_J = 150^\circ\text{C}$ (Notes 5, 7)	–	22	–	ns
Rise Time	t_r		–	16	–	
Turn-off Delay Time	$t_{d(off)}$		–	67	–	
Fall Time	t_f		–	12	–	
Turn-on Energy	E_{ON}		–	381	–	μJ
Turn-off Energy	E_{OFF}		–	41	–	
Total Switching Energy	E_{TOTAL}		–	422	–	
Turn-on Delay Time	$t_{d(on)}$	$V_{DS} = 800\text{ V}$, $I_D = 15\text{ A}$, Gate Driver = -5 V to $+15\text{ V}$, $R_{G_ON} = 1\ \Omega$, $R_{G_OFF} = 1\ \Omega$, Inductive Load, FWD: Same Device with $V_{GS} = 0\text{ V}$ and $R_G = 1\ \Omega$, Snubber: $R_S = 5\ \Omega$ and $C_S = 68\text{ pF}$, $T_J = 25^\circ\text{C}$ (Notes 6, 8)	–	44	–	ns
Rise Time	t_r		–	20	–	
Turn-off Delay Time	$t_{d(off)}$		–	32	–	
Fall Time	t_f		–	17.6	–	
Turn-on Energy Including R_S Energy	E_{ON}		–	474	–	μJ
Turn-off Energy Including R_S Energy	E_{OFF}		–	62	–	
Total Switching Energy	E_{TOTAL}		–	536	–	
Snubber R_S Energy During Turn-on	E_{RS_ON}		–	1	–	
Snubber R_S Energy During Turn-off	E_{RS_OFF}		–	0.7	–	ns
Turn-on Delay Time	$t_{d(on)}$	$V_{DS} = 800\text{ V}$, $I_D = 15\text{ A}$, Gate Driver = -5 V to $+15\text{ V}$, $R_{G_ON} = 1\ \Omega$, $R_{G_OFF} = 1\ \Omega$, Inductive Load, FWD: Same Device with $V_{GS} = 0\text{ V}$ and $R_G = 1\ \Omega$, Snubber: $R_S = 5\ \Omega$ and $C_S = 68\text{ pF}$, $T_J = 150^\circ\text{C}$ (Notes 6, 8)	–	42.4	–	
Rise Time	t_r		–	19.2	–	
Turn-off Delay Time	$t_{d(off)}$		–	32.8	–	
Fall Time	t_f		–	18.4	–	
Turn-on Energy Including R_S Energy	E_{ON}		–	450	–	μJ
Turn-off Energy Including R_S Energy	E_{OFF}		–	64	–	
Total Switching Energy	E_{TOTAL}		–	514	–	
Snubber R_S Energy During Turn-on	E_{RS_ON}		–	0.9	–	
Snubber R_S Energy During Turn-off	E_{RS_OFF}		–	0.9	–	

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. Limited by $T_{J, \max}$.

4. Pulse width t_p limited by $T_{J, \max}$.

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

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

7. 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.

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

TYPICAL PERFORMANCE DIAGRAMS

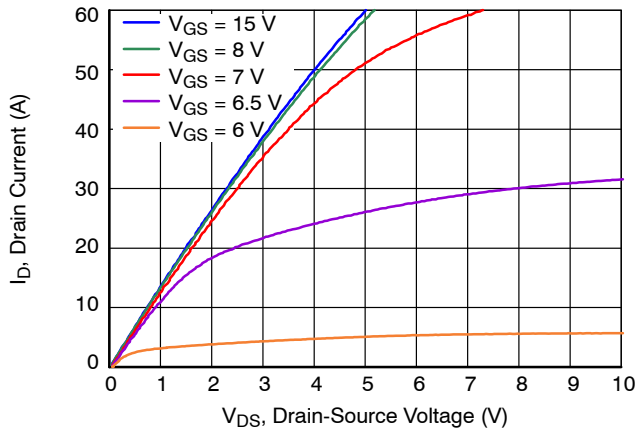


Figure 1. Typical Output Characteristics at $T_J = -55\text{ }^{\circ}\text{C}$, $t_p < 250\text{ }\mu\text{s}$

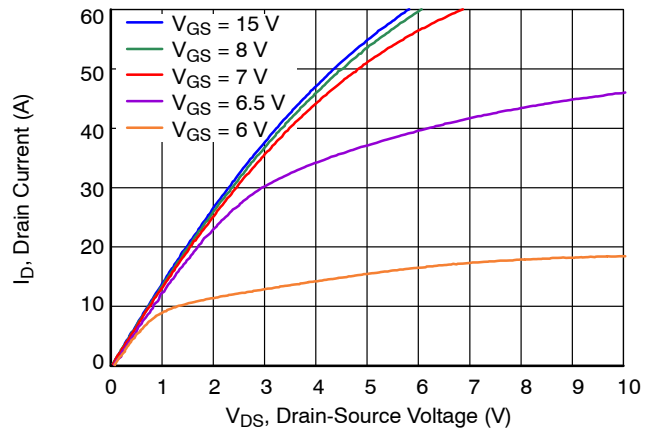


Figure 2. Typical Output Characteristics at $T_J = 25\text{ }^{\circ}\text{C}$, $t_p < 250\text{ }\mu\text{s}$

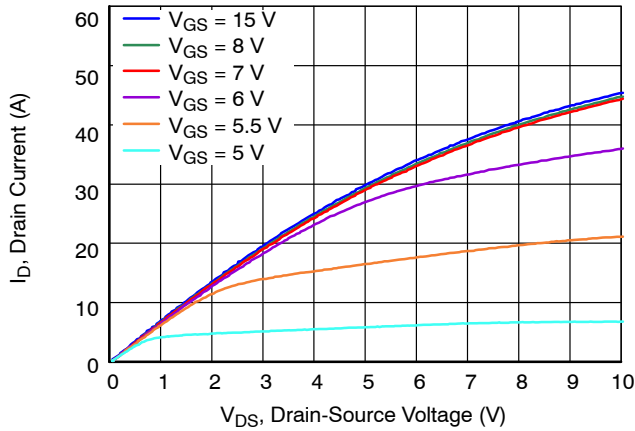


Figure 3. Typical Output Characteristics at $T_J = 175\text{ }^{\circ}\text{C}$, $t_p < 250\text{ }\mu\text{s}$

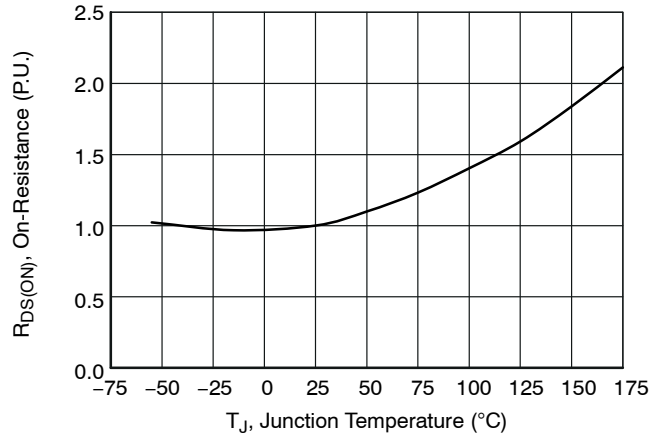


Figure 4. Normalized On-Resistance vs. Temperature at $V_{GS} = 12\text{ V}$ and $I_D = 20\text{ A}$

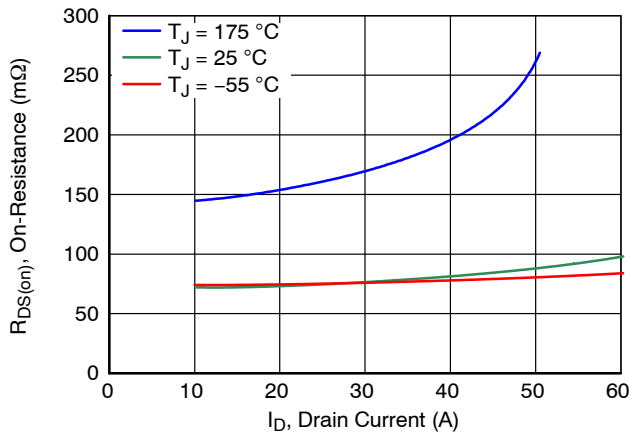


Figure 5. Typical Drain-Source On-Resistances at $V_{GS} = 12\text{ V}$

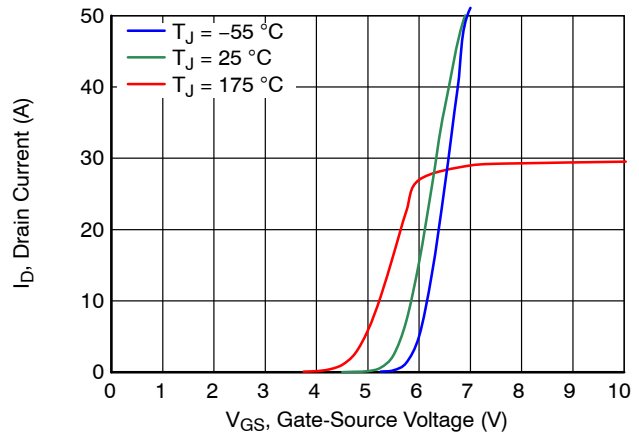


Figure 6. Typical Transfer Characteristics at $V_{DS} = 5\text{ V}$

TYPICAL PERFORMANCE DIAGRAMS (continued)

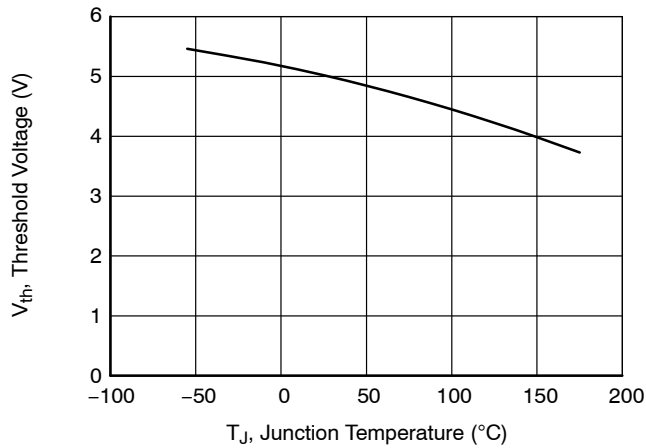


Figure 7. Threshold Voltage vs. Junction Temperature at $V_{DS} = 5 \text{ V}$ and $I_D = 10 \text{ mA}$

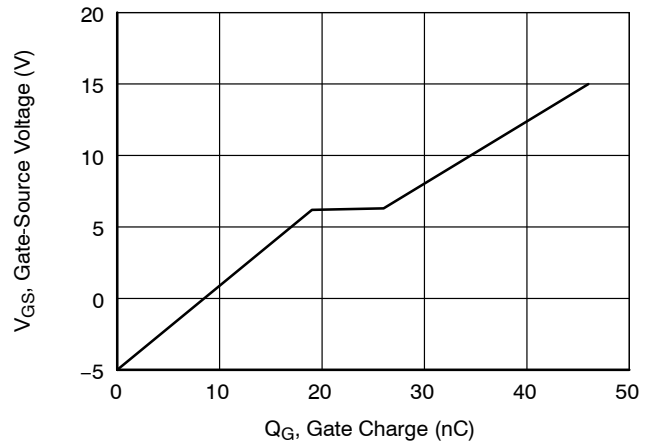


Figure 8. Typical Gate Charge at $V_{DS} = 800 \text{ V}$ and $I_D = 15 \text{ A}$

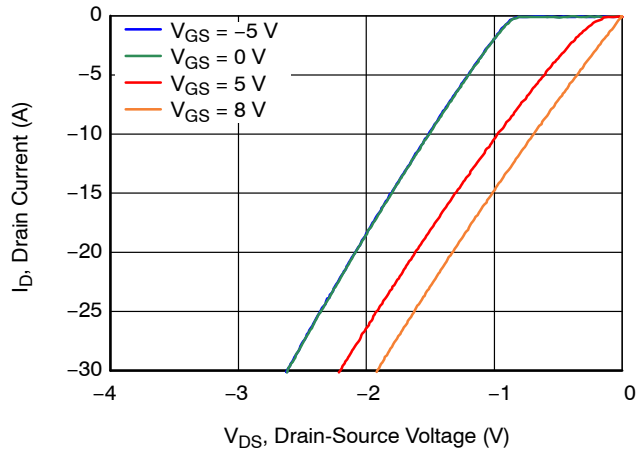


Figure 9. 3rd Quadrant Characteristics at $T_J = -55^\circ\text{C}$

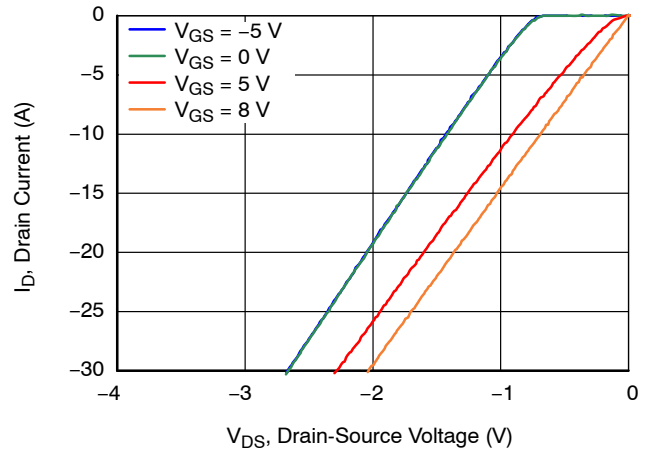


Figure 10. 3rd Quadrant Characteristics at $T_J = 25^\circ\text{C}$

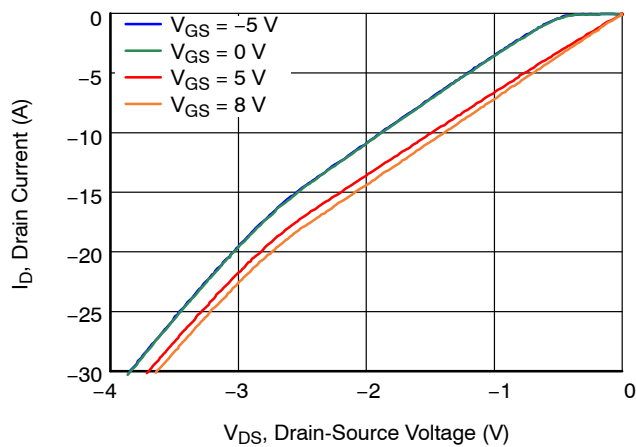


Figure 11. 3rd Quadrant Characteristics at $T_J = 175^\circ\text{C}$

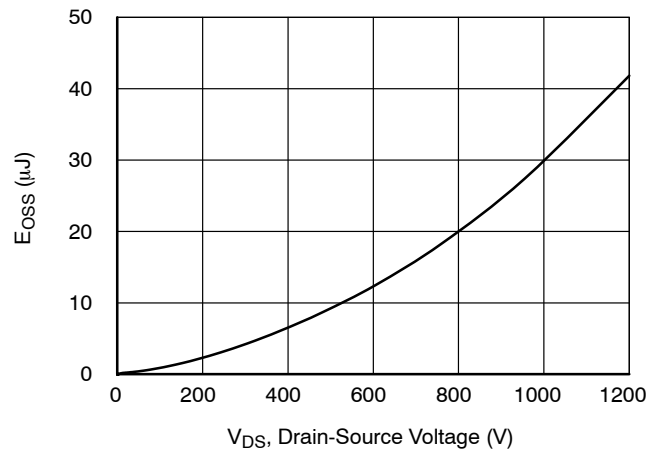


Figure 12. Typical Stored Energy in C_{OSS} at $V_{GS} = 0 \text{ V}$

TYPICAL PERFORMANCE DIAGRAMS (continued)

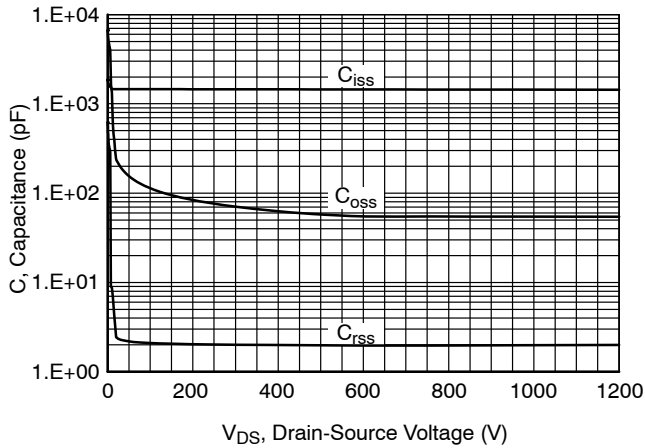


Figure 13. Typical Capacitances at $f = 100 \text{ kHz}$ and $V_{GS} = 0 \text{ V}$

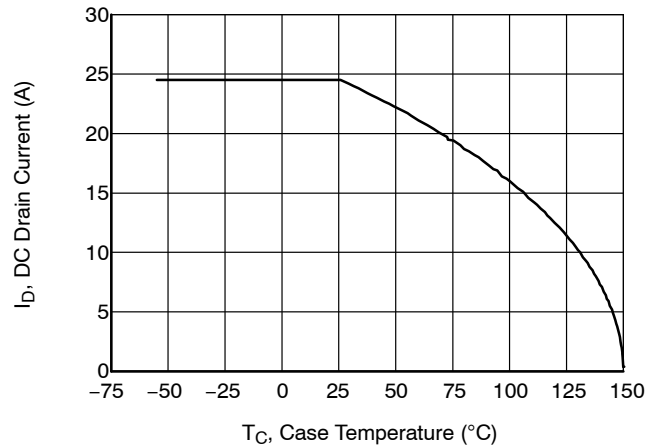


Figure 14. DC Drain Current Derating

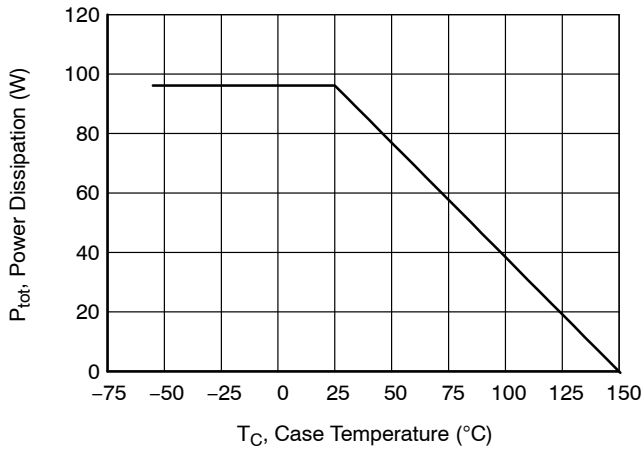


Figure 15. Total Power Dissipation

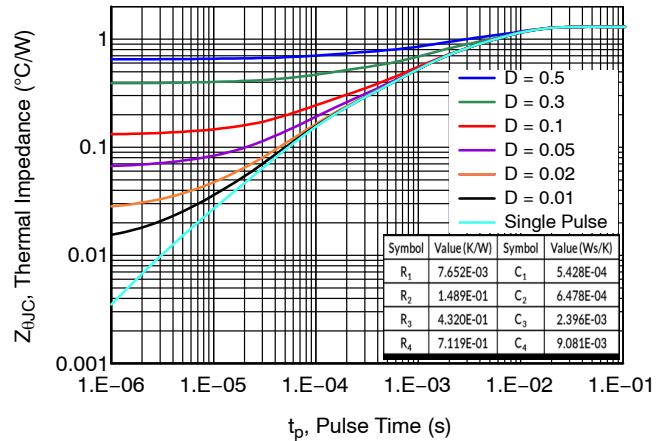


Figure 16. Maximum Transient Thermal Impedance and Parameters for Thermal Equivalent Circuit (Foster) Model

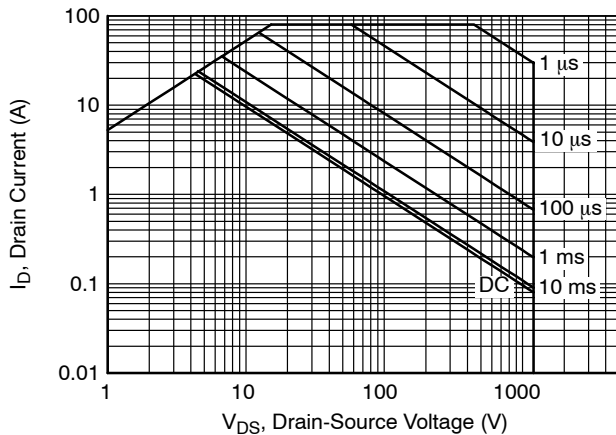


Figure 17. Safe Operation Area at $T_C = 25 \text{ °C}$, $D = 0$, Parameter t_p

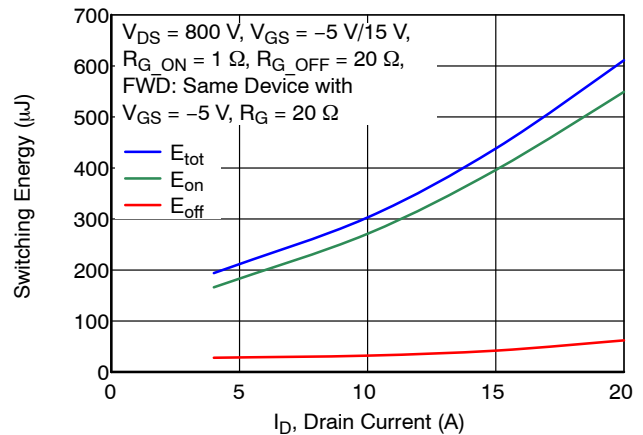


Figure 18. Clamped Inductive Switching Energy vs. Drain Current at $T_J = 25 \text{ °C}$

TYPICAL PERFORMANCE DIAGRAMS (continued)

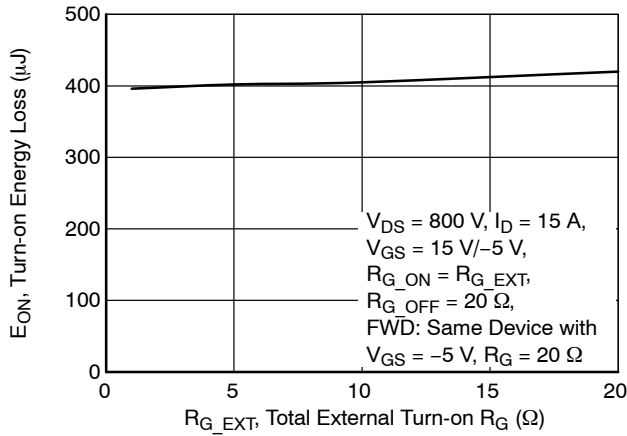


Figure 19. Clamped Inductive Switching Turn-On Energy vs. Turn-on Gate Resistance R_G

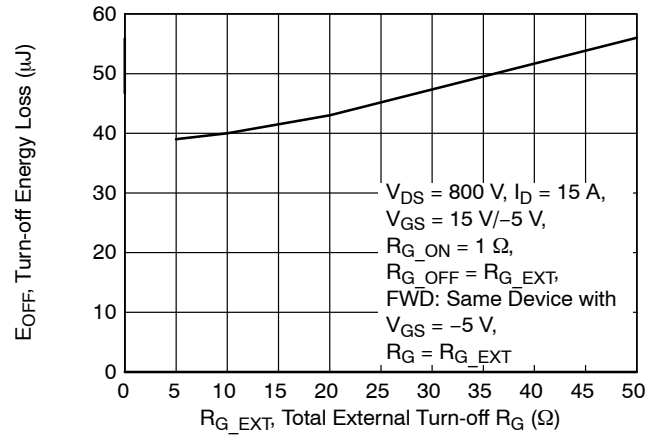


Figure 20. Clamped Inductive Switching Turn-Off Energy vs. Turn-off Gate Resistance R_G

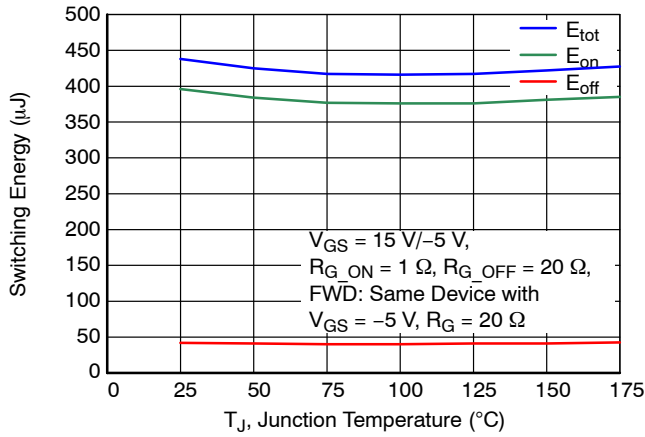


Figure 21. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS} = 800\text{ V}$ and $I_D = 15\text{ A}$

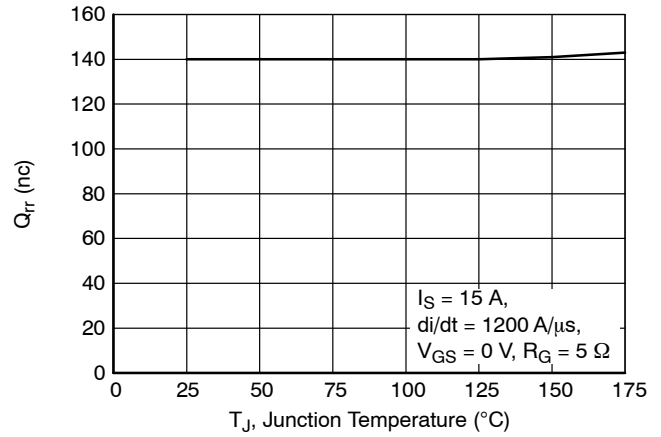


Figure 22. Reverse Recovery Charge Q_{rr} vs. Junction Temperature at $V_{DS} = 800\text{ V}$

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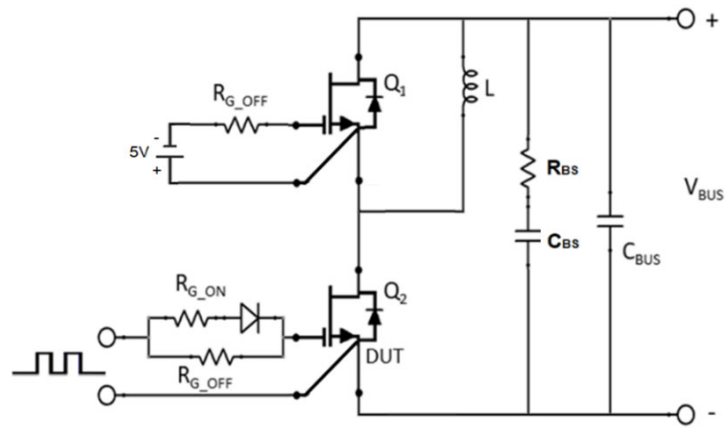


Figure 23. Schematic of the Half-Bridge Mode Switching Test Circuit. Note, a Bus RC Snubber ($R_{BS} = 2.5 \Omega$, $C_{BS} = 200 \text{ nF}$) is Used to Reduce the Power Loop High Frequency Oscillations

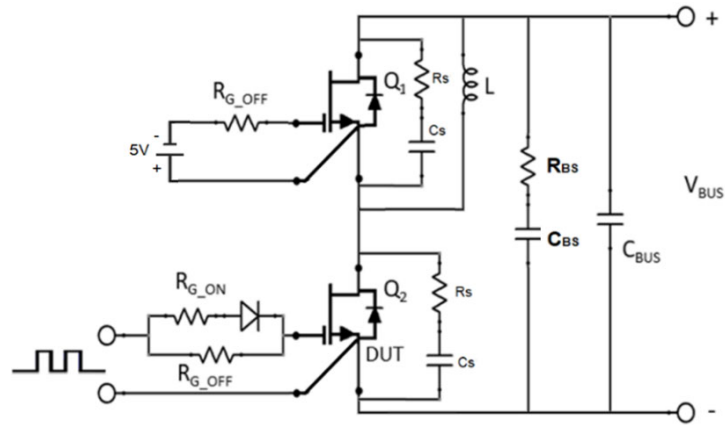


Figure 24. Schematic of the Half-Bridge Mode Switching Test Circuit with Device Snubbers ($R_S = 5 \Omega$, $C_S = 68 \text{ nF}$) and a RC Snubber ($R_{BS} = 2.5 \Omega$, $C_{BS} = 200 \text{ nF}$)

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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.

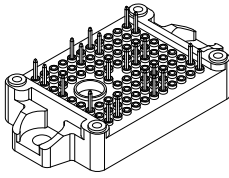
ORDERING INFORMATION

Part Number	Marking	Package	Shipping
UFB15C12E1BC3N	UFB15C12E1BC3N	PIM20 (Pb-Free)	24 Units / Tray

UFB15C12E1BC3N

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 onsemi standards for SiC products.	1/15/2025
5	Converted the Data Sheet to onsemi format.	06/04/2025

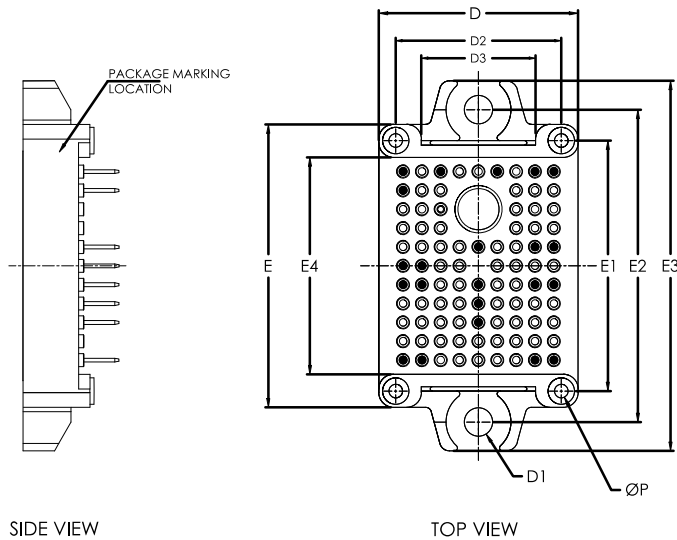


PIM20 33.80x42.50x12.00 E1B FULL BRIDGE (SOLDER PIN)
CASE 180DG
ISSUE O

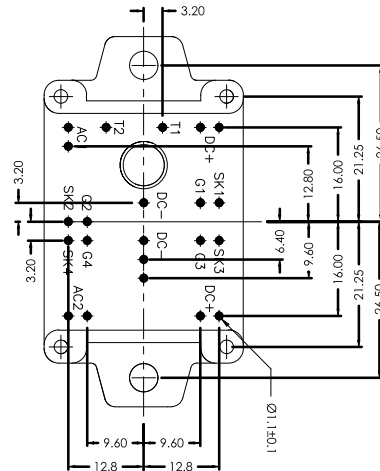
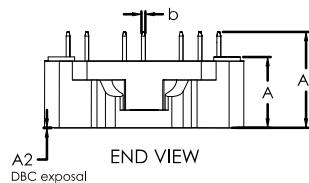
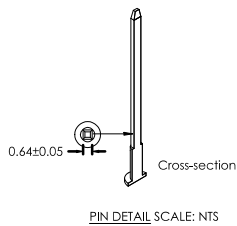
DATE 21 MAR 2025

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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