

Silicon Carbide (SiC) Module – EliteSiC Power Module for OBC, 80 mohm, 1200 V, 20 A, Vienna Rectifier, in APM32 Series NVXK2KR80WDT

Features

- DIP Silicon Carbide Vienna Rectifier Power Module for On-board Charger (OBC) for xEV Applications
- Creepage and Clearance per IEC60664-1, IEC 60950-1
- Compact Design for Low Total Module Resistance
- Module Serialization for Full Traceability
- Lead Free, ROHS and UL94V-0 Compliant
- Automotive Qualified per AEC-Q101 and AQC324

Typical Applications

- Vienna PFC for On-Board Charger in xEV Applications

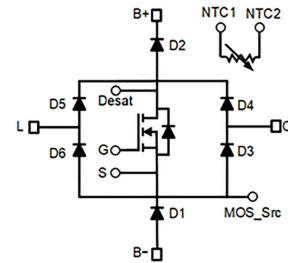
MAXIMUM RATINGS MOSFET (T_J = 25°C unless otherwise noted)

Parameter	Symbol	Value	Unit
Drain-to-Source Voltage	V _{DSS}	1200	V
Gate-to-Source Voltage	V _{GS}	+25/-15	V
Recommended Operation Values of Gate-to-Source Voltage, T _J ≤ 175°C	V _{GSop}	+20/-5	V
Continuous Drain Current (Notes 1, 2)	I _D	20	A
Power Dissipation (Note 1)			
Pulsed Drain Current (Note 3)	I _{DM}	110	A
Single Pulse Surge Drain Current Capability	I _{DSC}	266	A
Operating Junction and Storage Temperature	T _J , T _{stg}	-55 to 175	°C
Source Current (Body Diode)	I _S	18	A
Single Pulse Drain-to-Source Avalanche Energy (Note 4)	E _{AS}	180	mJ

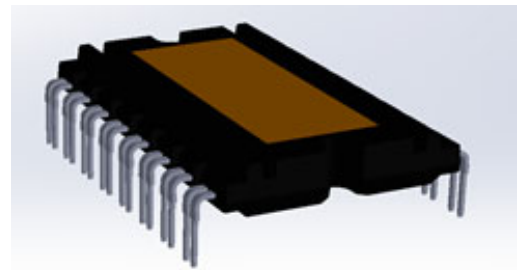
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Particular conditions specified determine thermal resistance values shown. Infinite heatsink with T_C = 100°C for R_{θJC}. For R_{ψJS} assembled to 3 mm thick aluminum heatsink with infinite cooling bottom surface at 85°C, through 80 μm thick TIM with 3 W/mK thermal conductivity.
2. Qualified per ECPE Guideline AQC 324.
3. Repetitive rating limited by maximum junction temperature and transconductance.
4. E_{AS} based on initial T_J = 25°C, L = 1 mH, I_{AS} = 19 A, V_{DD} = 120 V, V_{GS} = 18 V.

V _{(BR)DSS}	R _{DS(on)} Max	I _D Max
1200 V	116 mΩ @ 20 V	20 A



SiC MOSFET Vienna Rectifier Module



APM32

ORDERING INFORMATION

Device	Package	Shipping
NVXK2KR80WDT	APM32 (Pb-Free)	10 ea / Tube

NVXK2KR80WDT

THERMAL CHARACTERISTICS SiC MOSFET (Note 1)

Parameter	Symbol	Typ	Max	Unit
Thermal Resistance Junction-to-Case (Note 1)	$R_{\theta JC}$ (MOS)	1.41	1.84	$^{\circ}\text{C}/\text{W}$
Thermal Resistance Junction-to-Sink (Note 1)	$R_{\psi JS}$ (MOS)	1.84	2.26	$^{\circ}\text{C}/\text{W}$

THERMAL CHARACTERISTICS DIODES (Note 1)

Parameter	Symbol	Value	Unit
SiC Diode (D1-D2) Thermal Resistance Junction-to-Case (Note 1)	$R_{\theta JC}$ (SiC Diode)	1.97	$^{\circ}\text{C}/\text{W}$
SiC Diode (D1-D2) Thermal Resistance Junction-to-Sink (Note 1)	$R_{\psi JS}$ (SiC Diode)	2.51	$^{\circ}\text{C}/\text{W}$
SiC Diode (D3-D6) Thermal Resistance Junction-to-Case (Note 1)	$R_{\theta JC}$ (Si Diode)	1.61	$^{\circ}\text{C}/\text{W}$
SiC Diode (D3-D6) Thermal Resistance Junction-to-Sink (Note 1)	$R_{\psi JS}$ (Si Diode)	2.54	$^{\circ}\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS SiC MOSFET ($T_J = 25^{\circ}\text{C}$ unless otherwise stated)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	1200			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS} / T_J$	$I_D = 1\text{ mA}$, referenced to 25°C		500		$\text{mV}/^{\circ}\text{C}$
Zero Gate Voltage Drain Current	I_{DSS}	$V_{GS} = 0\text{ V}$ $V_{DS} = 1200\text{ V}$	$T_J = 25^{\circ}\text{C}$		100	μA
			$T_J = 175^{\circ}\text{C}$		1	mA
Gate-to-Source Leakage Current	I_{GSS}	$V_{GS} = +25/-15\text{ V}, V_{DS} = 0\text{ V}$			± 1	μA

ON CHARACTERISTICS (Note 5)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 10\text{ mA}$	1.8	3	4.3	V
Recommended Gate Voltage	V_{GOP}		-5		+20	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 20\text{ V}, I_D = 20\text{ A}, T_J = 25^{\circ}\text{C}$		80	116	$\text{m}\Omega$
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 20\text{ V}, I_D = 20\text{ A}, T_J = 175^{\circ}\text{C}$		150		$\text{m}\Omega$
Forward Transconductance	g_{FS}	$V_{DS} = 20\text{ V}, I_D = 20\text{ A}$		11		S

CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	C_{ISS}	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$		1154		pF
Output Capacitance	C_{OSS}			79		
Reverse Transfer Capacitance	C_{RSS}			7.9		
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V}, I_D = 20\text{ A}$		56		nC
Threshold Gate Charge	$Q_{G(TH)}$			10		
Gate-to-Source Charge	Q_{GS}			18		
Gate-to-Drain Charge	Q_{GD}			11		
Gate-Resistance	R_G	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		1.2		Ω

INDUCTIVE SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -5 / 20\text{ V}, V_{DS} = 800\text{ V},$ $I_D = 20\text{ A}, R_G = 4.7\ \Omega,$ Inductive load		12		ns	
Rise Time	t_r			12			
Turn-Off Delay Time	$t_{d(OFF)}$			21			
Fall Time	t_f			9			
Turn-On Switching Loss	E_{ON}			135			μJ
Turn-Off Switching Loss	E_{OFF}			46			μJ
Total Switching Loss	E_{tot}			181			μJ

NVXK2KR80WDT

ELECTRICAL CHARACTERISTICS SiC MOSFET ($T_J = 25^\circ\text{C}$ unless otherwise stated) (continued)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
DRAIN-SOURCE DIODE CHARACTERISTICS						
Continuous Drain-Source Diode Forward Current (Notes 1, 2)	I_{SD}	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$			18	A
Pulsed Drain-Source Diode Forward Current (Note 3)	I_{SDM}	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$			110	A
Forward Diode Voltage	V_{SD}	$V_{GS} = -5\text{ V}, I_{SD} = 10\text{ A}, T_J = 25^\circ\text{C}$		3.9		V
Reverse Recovery Time	t_{RR}	$V_{GS} = -5\text{ V}, dI_S/dt = 1000\text{ A}/\mu\text{s}, I_{SD} = 20\text{ A}$		16.2		ns
Peak Reverse Recovery Current	I_{RRM}			7.6		A
Reverse Recovery Energy	E_{REC}			4.1		μJ
Reverse Recovery Charge	Q_{RR}			61.6		nC

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.

5. Pulse test: pulse width $\leq 300\ \mu\text{s}$, duty ratio $\leq 2\%$.

MAXIMUM RATINGS SiC DIODE (D1-D2) ($T_J = 25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Value	Unit
Peak Repetitive Reverse Voltage	V_{RRM}	1200	V
Single Pulse Avalanche Energy (Note 6)	E_{AS}	210	mJ
Continuous Rectified Forward Current @ $T_C < 150^\circ\text{C}$	I_F	17	A
Continuous Rectified Forward Current @ $T_C < 75^\circ\text{C}$		33	
Non-Replicative Peak Forward Surge Current	$I_{F, Max}$	$T_C = 25^\circ\text{C}, 10\ \mu\text{s}$	394
		$T_C = 150^\circ\text{C}, 10\ \mu\text{s}$	161
Non-Replicative Forward Surge Current (pk)	$I_{F, SM}$	78	A
Repetitive Forward Surge Current (pk)	$I_{F, RM}$	70	A
Power Dissipation	P_{TOT}	$T_C = 25^\circ\text{C}$	76
		$T_C = 150^\circ\text{C}$	13
Operating and Storage Temperature Range	T_J, T_{STG}	-55 to +175	$^\circ\text{C}$

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.

6. E_{AS} of 210 mJ is based on starting $T_J = 25^\circ\text{C}$, $L = 0.5\text{ mH}$, $I_{AS} = 29\text{ A}$, $V = 50\text{ V}$.

ELECTRICAL CHARACTERISTICS SiC DIODE (D1-D2) ($T_J = 25^\circ\text{C}$ unless otherwise stated)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Forward Voltage	V_F	$I_F = 20\text{ A}, T_J = 25^\circ\text{C}$		1.45	1.75	V
		$I_F = 20\text{ A}, T_J = 125^\circ\text{C}$		1.70		
		$I_F = 20\text{ A}, T_J = 175^\circ\text{C}$		2.00		
Reverse Current	I_R	$V_R = 1200\text{ V}, T_J = 25^\circ\text{C}$			200	μA
		$V_R = 1200\text{ V}, T_J = 125^\circ\text{C}$			300	
		$V_R = 1200\text{ V}, T_J = 175^\circ\text{C}$			400	
Total Capacitive Charge	Q_C	$V = 800\text{ V}$		120		nC
Total Capacitance	C	$V_R = 1\text{ V}, f = 100\text{ kHz}$		1220		pF
		$V_R = 400\text{ V}, f = 100\text{ kHz}$		111		
		$V_R = 800\text{ V}, f = 100\text{ kHz}$		88		

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.

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS Si DIODE (D3-D6)

Maximum ratings and electrical characteristics are found in Vishay Data Sheet VS207DM..CCB, Document Number 93888, Revision: 04-Aug-13. Refer herein for thermal performance only (Figure 22 & [Thermal Characteristics Table](#), p. 2).

NVXK2KR80WDT

TYPICAL CHARACTERISTICS SIC MOSFET

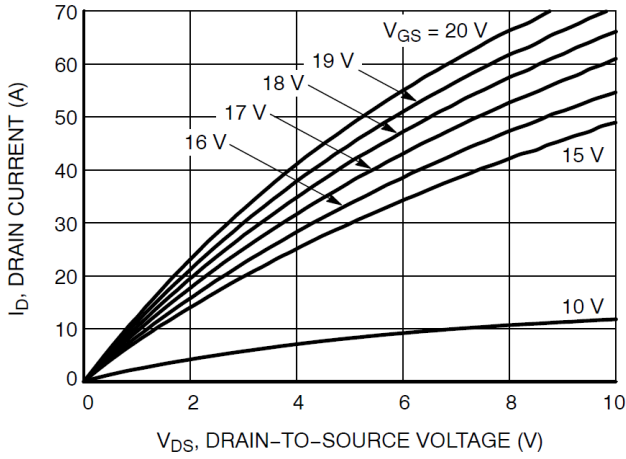


Figure 1. On-Region Characteristics

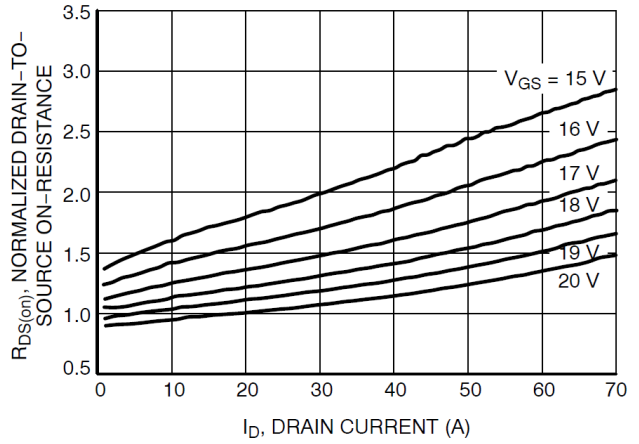


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

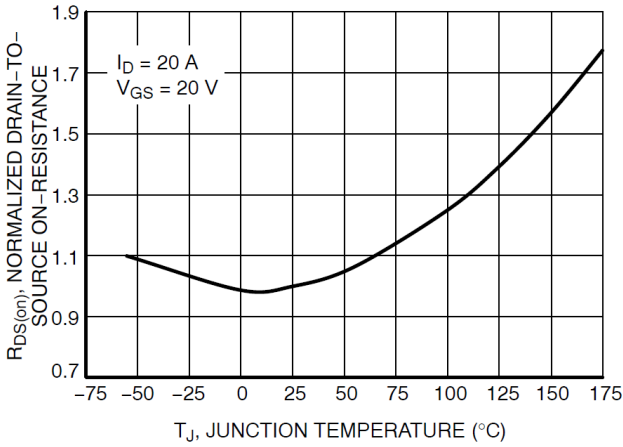


Figure 3. On-Resistance Variation with Temperature

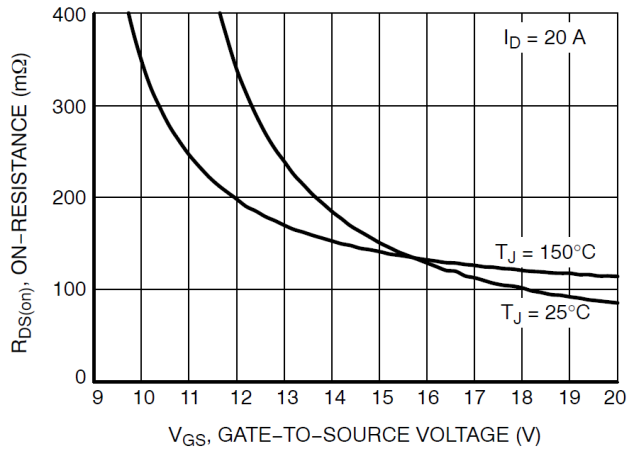


Figure 4. On-Resistance vs. Gate-to-Source Voltage

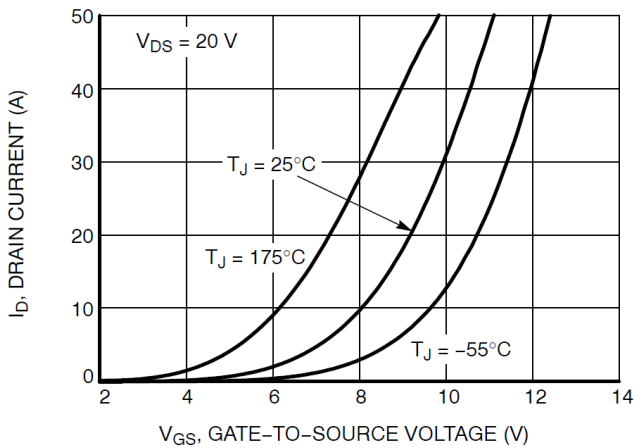


Figure 5. Transfer Characteristics

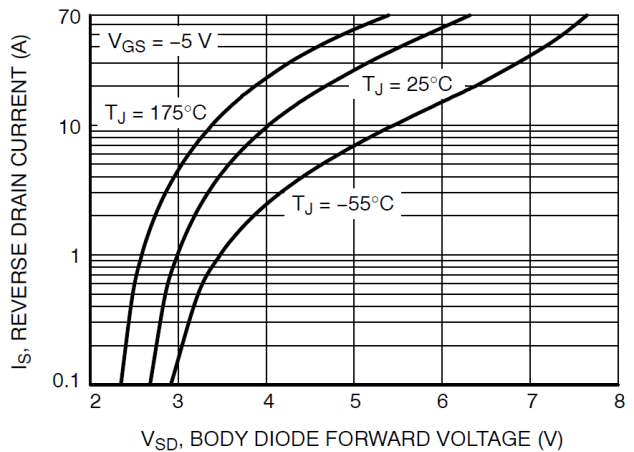


Figure 6. Diode Forward Voltage vs. Current

NVXK2KR80WDT

TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)

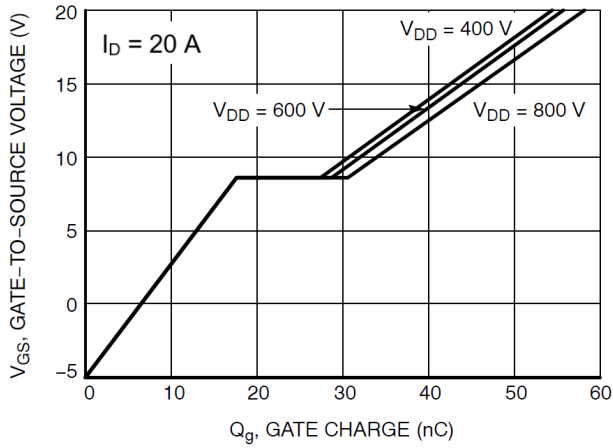


Figure 7. Gate-to-Source Voltage vs. Total Charge

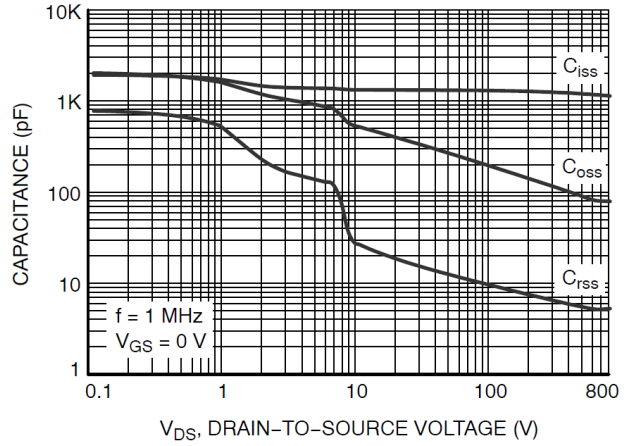


Figure 8. Capacitance vs. Drain-to-Source Voltage

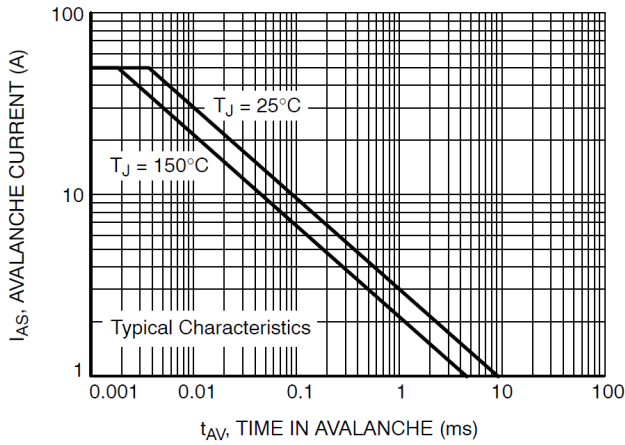


Figure 9. Unclamped Inductive Switching Capability

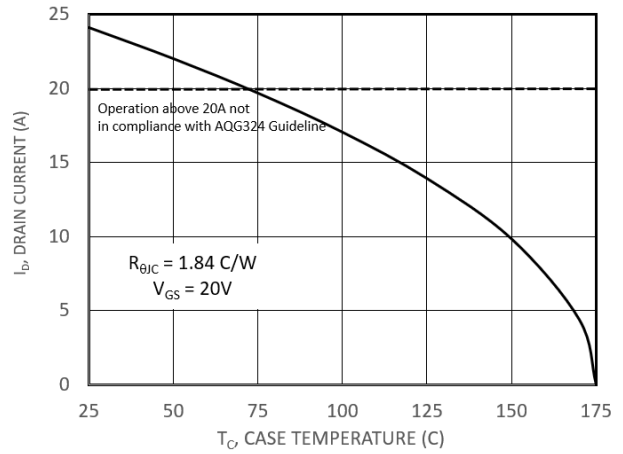


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

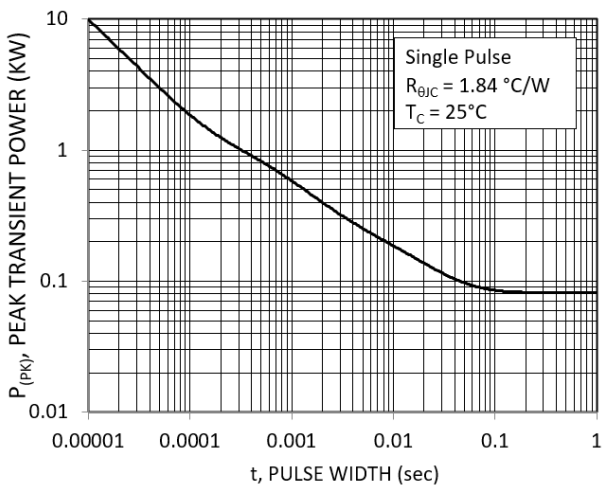


Figure 11. Single Pulse Maximum Power Dissipation

NVXK2KR80WDT

TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)

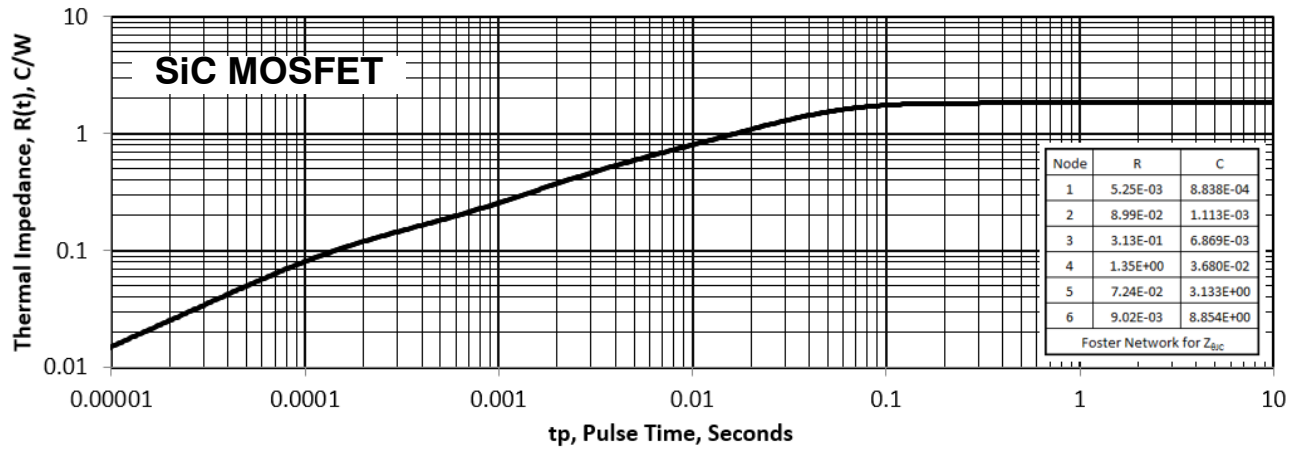


Figure 12. Thermal Response

NVXK2KR80WDT

TYPICAL CHARACTERISTICS SIC DIODE

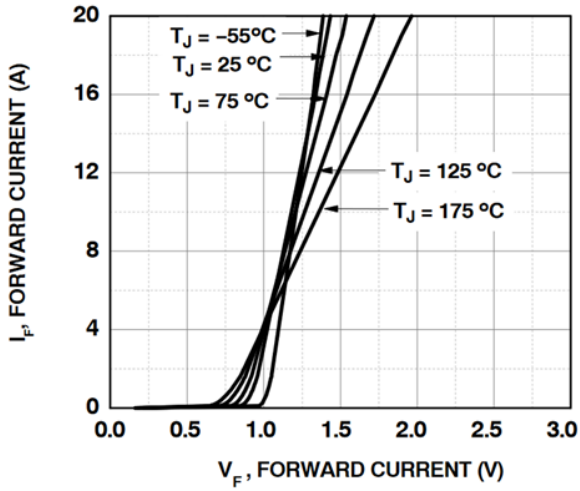


Figure 13. Forward Characteristics

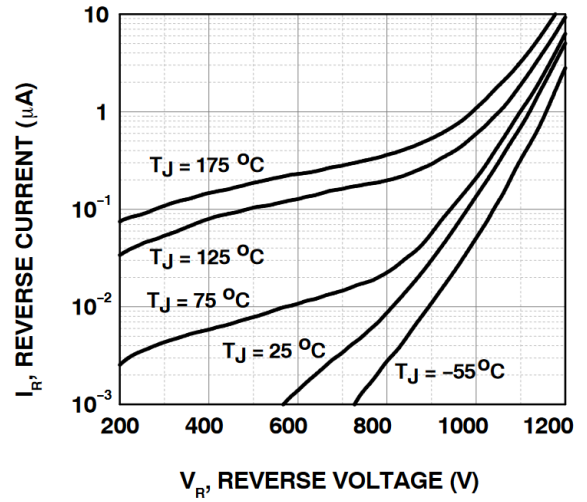


Figure 14. Reverse Characteristics

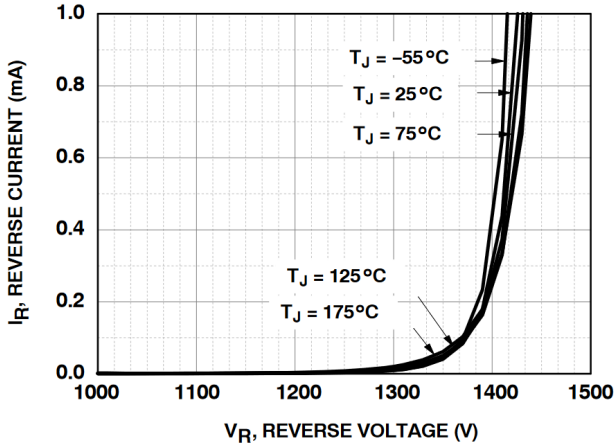


Figure 15. Reverse Characteristics

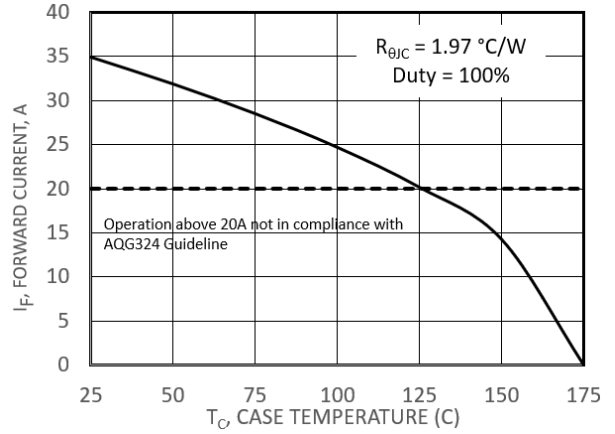


Figure 16. Current Derating

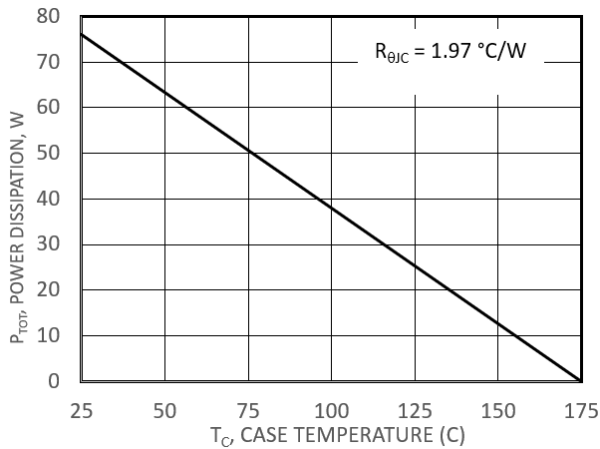


Figure 17. Power Derating

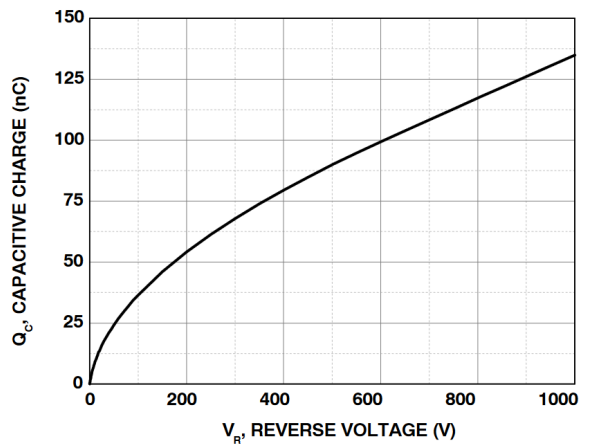


Figure 18. Capacitive Charge vs. Reverse Voltage

NVXK2KR80WDT

TYPICAL CHARACTERISTICS SIC DIODE (CONTINUED)

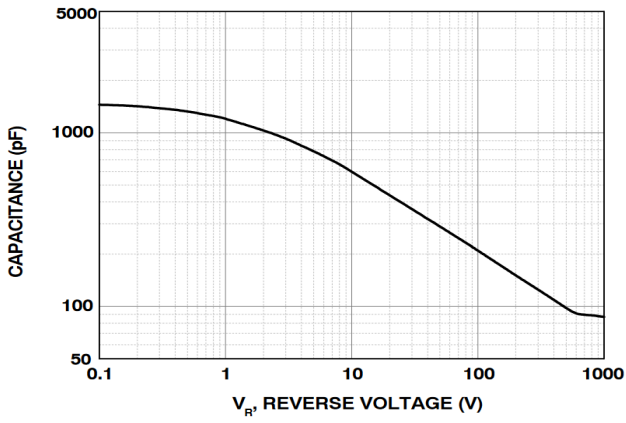


Figure 19. Capacitance vs. Reverse Voltage

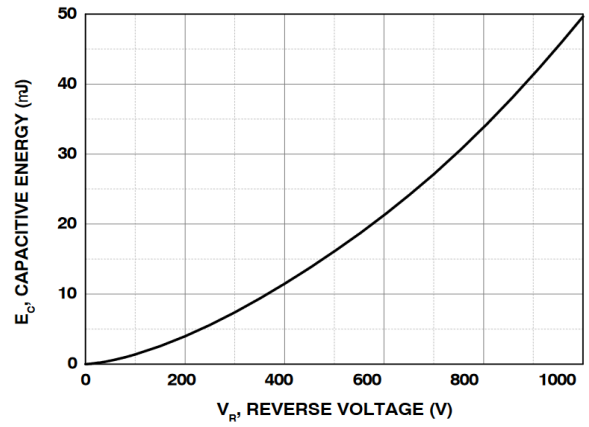


Figure 20. Capacitance Stored Energy

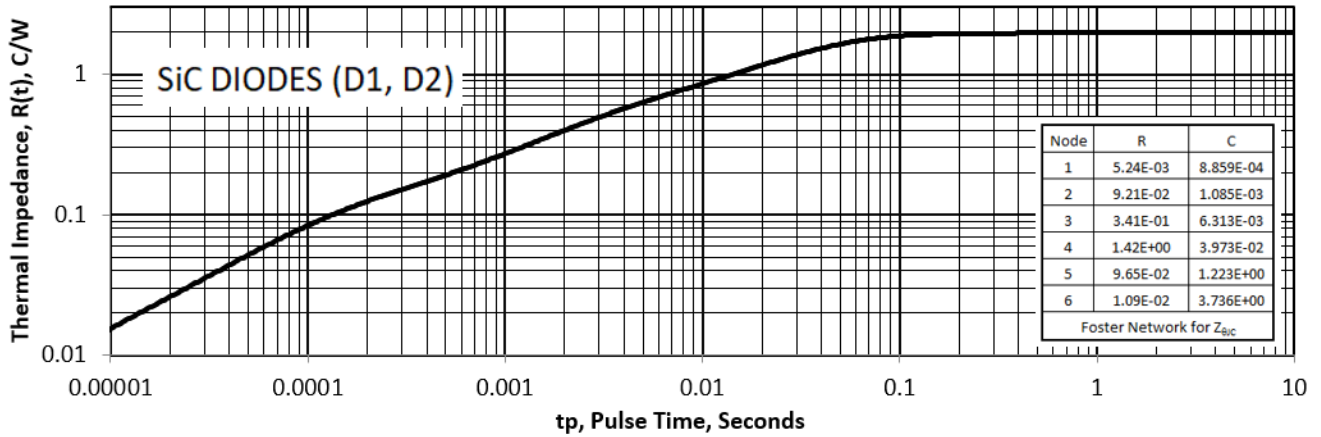


Figure 21. Junction-to-Case Transient Thermal Response Curve – SiC Diode

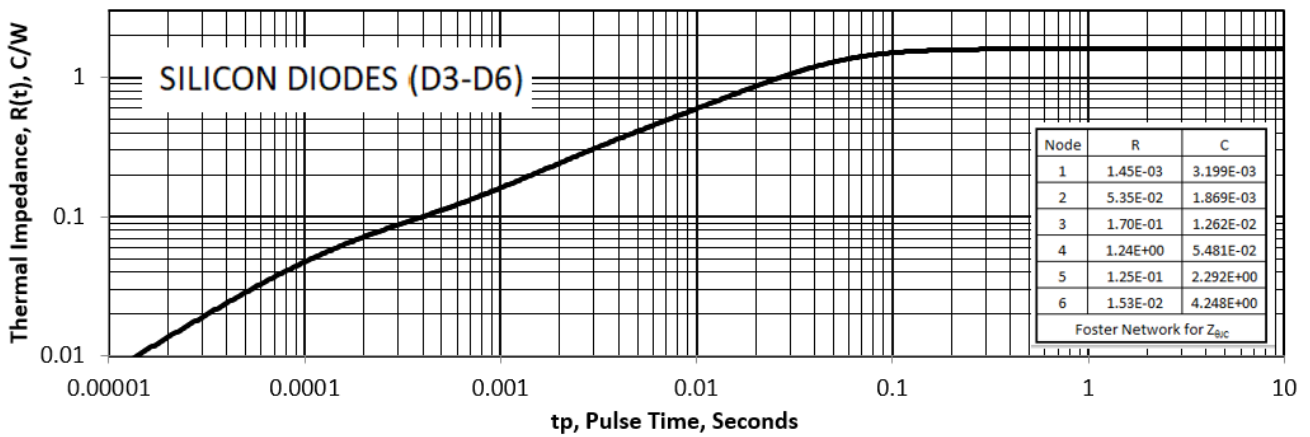
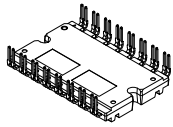


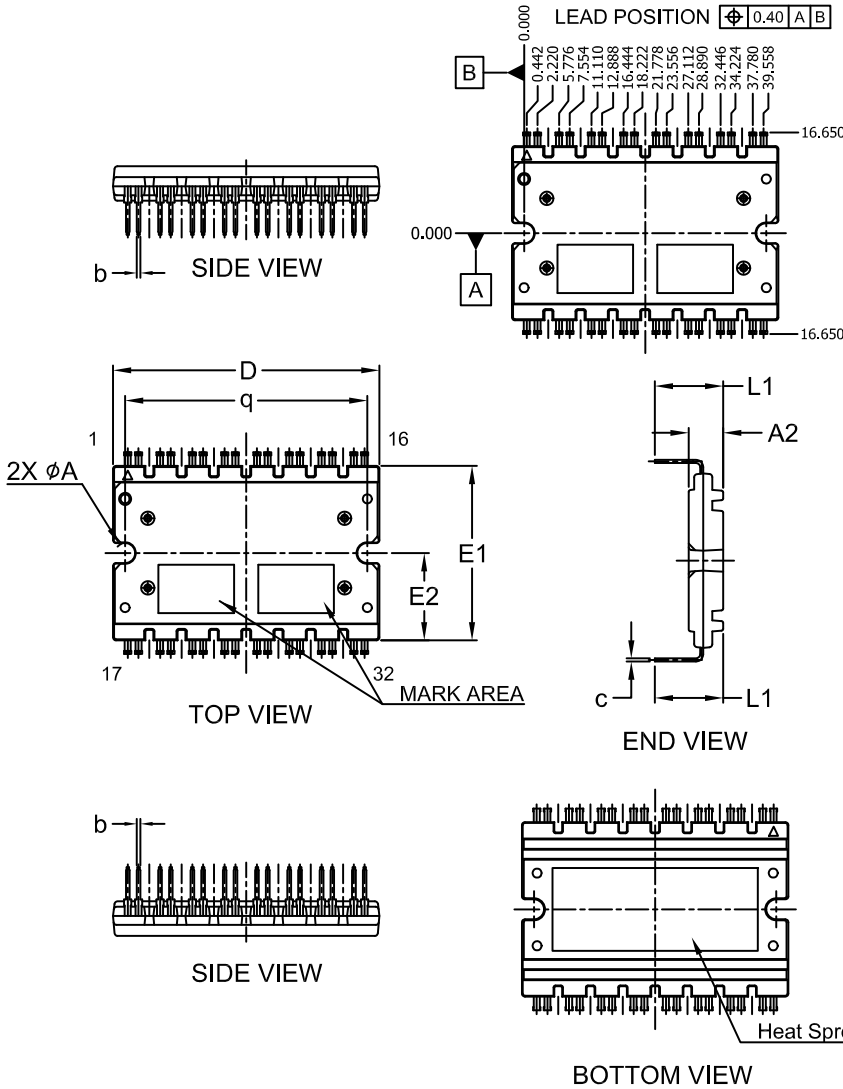
Figure 22. Junction-to-Case Transient Thermal Response Curve – Silicon Diode

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



APM32 AUTOMOTIVE MODULE CASE MODHL ISSUE B

DATE 05 APR 2022

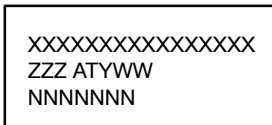


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A2	5.60	5.70	5.80
b	0.50	0.60	0.70
c	0.45	0.50	0.60
D	43.80	44.00	44.20
E1	28.60	28.80	29.00
E2	14.25	14.40	14.55
L1	11.00	11.30	11.60
q	39.85	40.00	40.15
φA	3.20	3.30	3.40

GENERIC MARKING DIAGRAM*



- XXXX = Specific Device Code
- ZZZ = Lot ID
- AT = Assembly & Test Location
- Y = Year
- W = Work Week
- NNN = Serial Number

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "μ", may or may not be present. Some products may not follow the Generic Marking.

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