

# 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

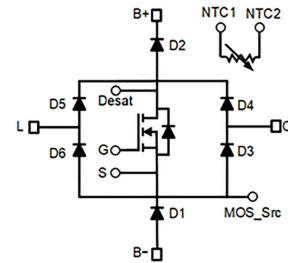
## MAXIMUM RATINGS MOSFET (T<sub>J</sub> = 25°C unless otherwise noted)

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

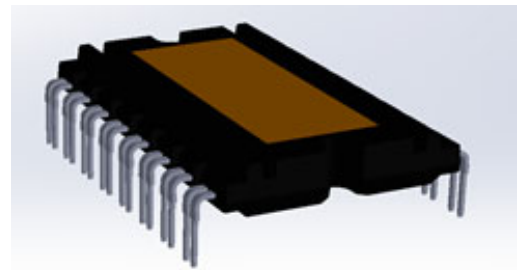
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Particular conditions specified determine thermal resistance values shown. Infinite heatsink with T<sub>C</sub> = 100°C for R<sub>θJC</sub>. For R<sub>ψJS</sub> 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<sub>AS</sub> based on initial T<sub>J</sub> = 25°C, L = 1 mH, I<sub>AS</sub> = 19 A, V<sub>DD</sub> = 120 V, V<sub>GS</sub> = 18 V.

V <sub>(BR)DSS</sub>	R <sub>DS(on) Max</sub>	I <sub>D Max</sub>
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	°C/W
Thermal Resistance Junction-to-Sink (Note 1)	$R_{\psi JS}$ (MOS)	1.84	2.26	°C/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	°C/W
SiC Diode (D1-D2) Thermal Resistance Junction-to-Sink (Note 1)	$R_{\psi JS}$ (SiC Diode)	2.51	°C/W
SiC Diode (D3-D6) Thermal Resistance Junction-to-Case (Note 1)	$R_{\theta JC}$ (Si Diode)	1.61	°C/W
SiC Diode (D3-D6) Thermal Resistance Junction-to-Sink (Note 1)	$R_{\psi JS}$ (Si Diode)	2.54	°C/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 $25^\circ\text{C}$		500		mV/°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	$\mu\text{A}$
			$T_J = 175^\circ\text{C}$		1	mA
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = +25/-15\text{ V}, V_{DS} = 0\text{ V}$			$\pm 1$	$\mu\text{A}$

### 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	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		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		

### INDUCTIVE SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V},$ $I_D = 20\text{ A}, R_G = 4.7\text{ }\Omega,$ 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				$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		46				$\mu\text{J}$
Total Switching Loss	$E_{tot}$		181				$\mu\text{J}$

# NVXK2KR80WDT

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>DRAIN-SOURCE DIODE CHARACTERISTICS</b>						
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		$\mu\text{J}$
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	$\mu\text{A}$
		$V_R = 1200\text{ V}, T_J = 125^\circ\text{C}$			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

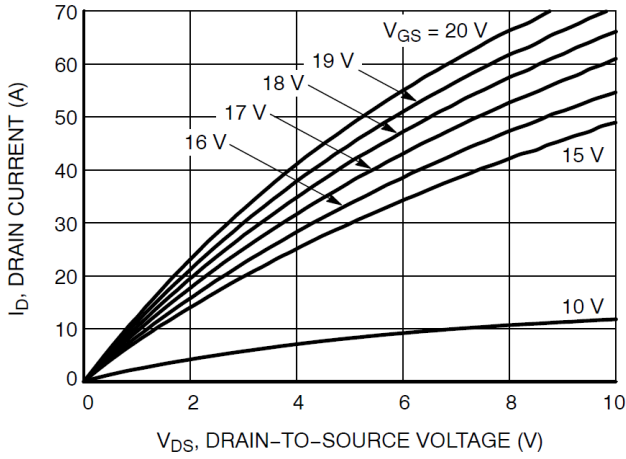


Figure 1. On-Region Characteristics

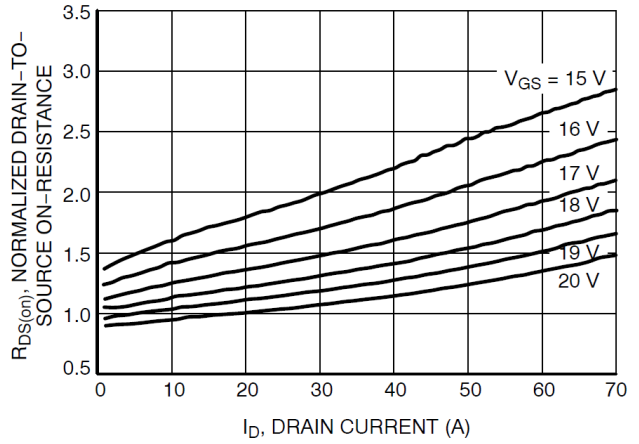


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

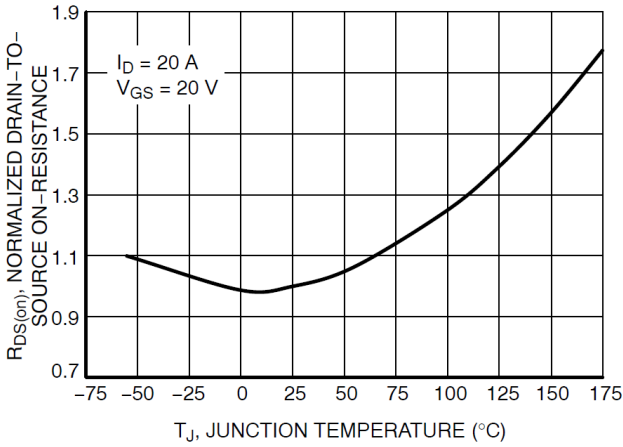


Figure 3. On-Resistance Variation with Temperature

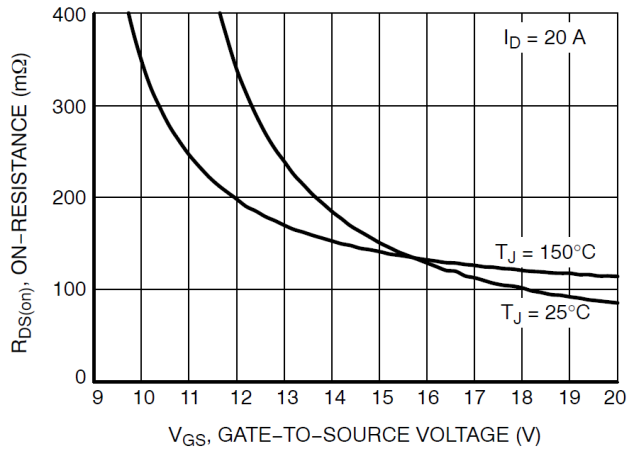


Figure 4. On-Resistance vs. Gate-to-Source Voltage

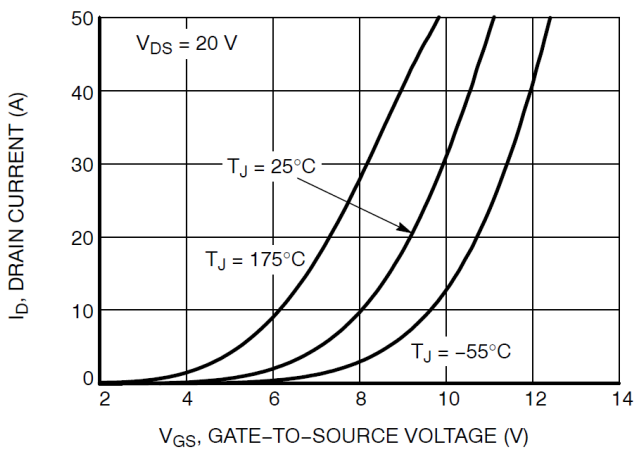


Figure 5. Transfer Characteristics

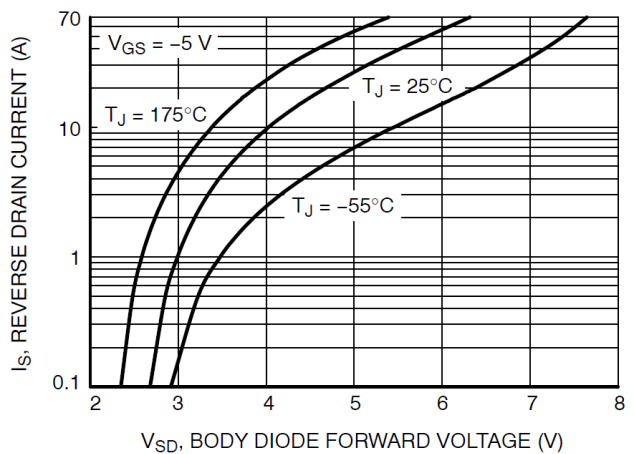


Figure 6. Diode Forward Voltage vs. Current

# NVXK2KR80WDT

## TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)

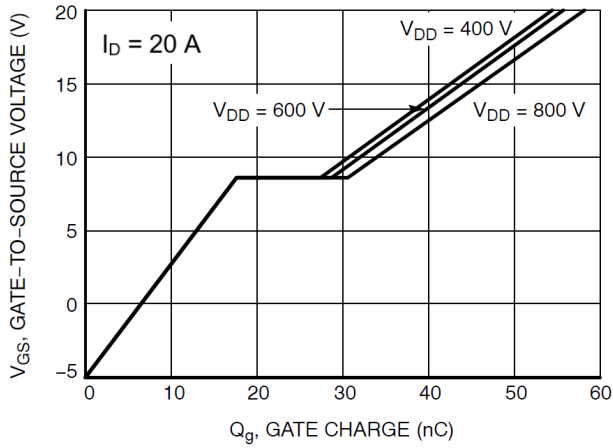


Figure 7. Gate-to-Source Voltage vs. Total Charge

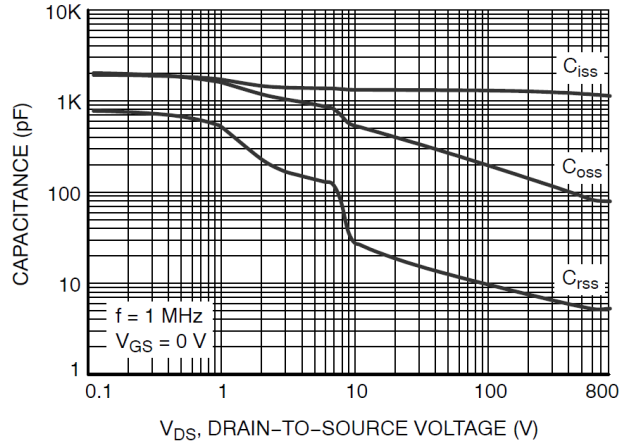


Figure 8. Capacitance vs. Drain-to-Source Voltage

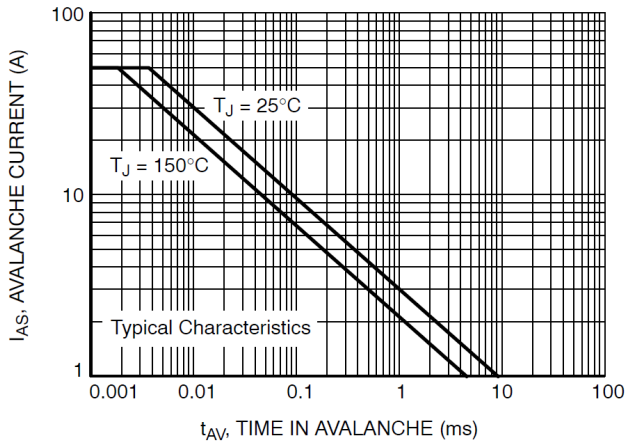


Figure 9. Unclamped Inductive Switching Capability

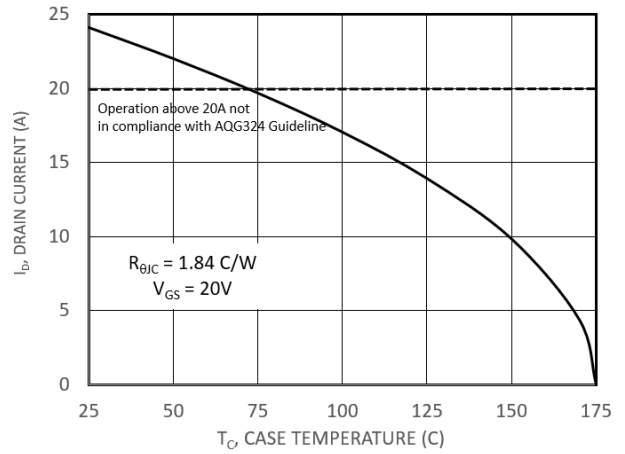


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

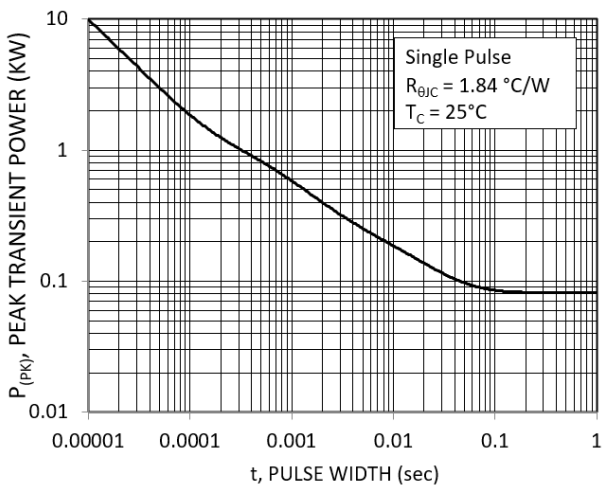


Figure 11. Single Pulse Maximum Power Dissipation

# NVXK2KR80WDT

## TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)

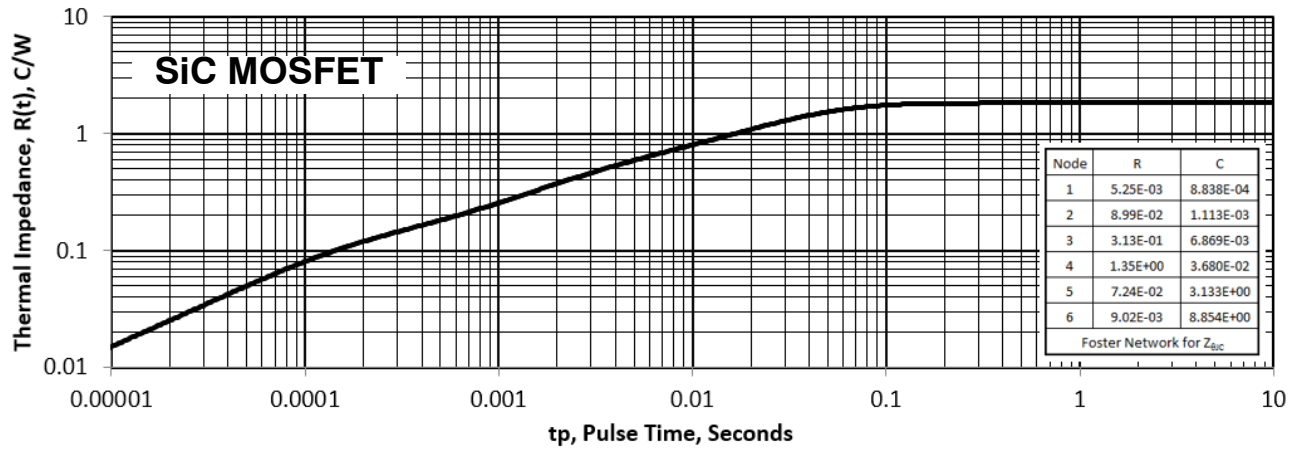


Figure 12. Thermal Response

# NVXK2KR80WDT

## TYPICAL CHARACTERISTICS SIC DIODE

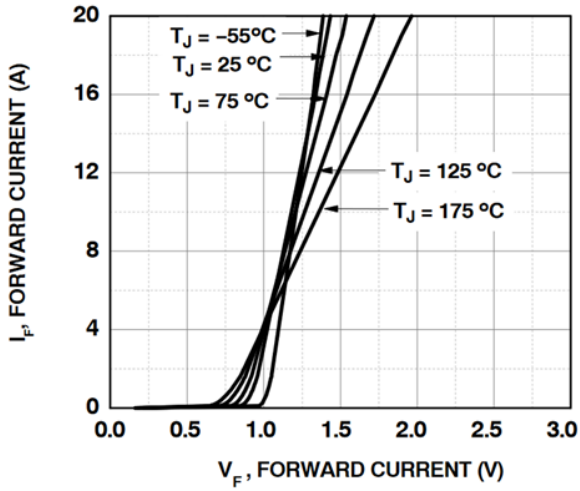


Figure 13. Forward Characteristics

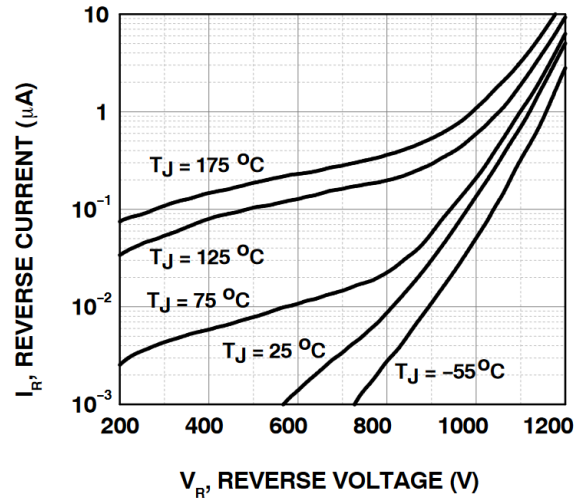


Figure 14. Reverse Characteristics

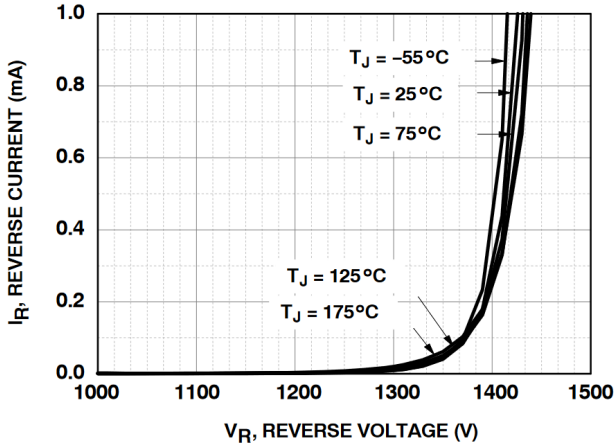


Figure 15. Reverse Characteristics

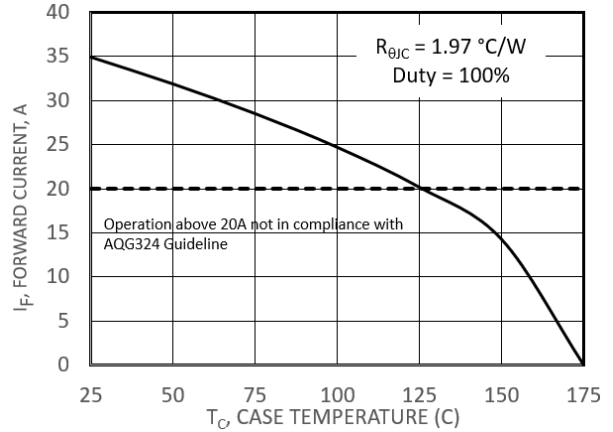


Figure 16. Current Derating

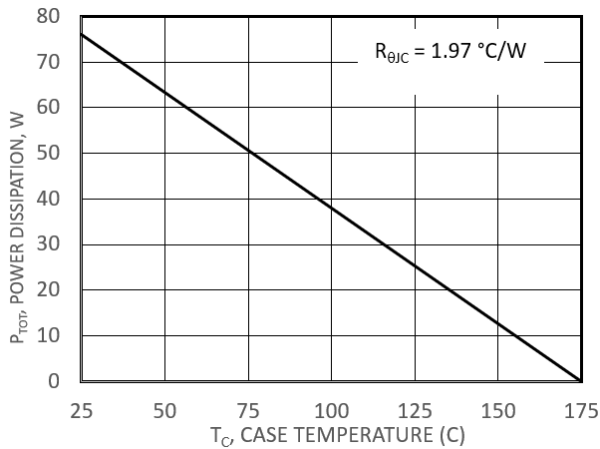


Figure 17. Power Derating

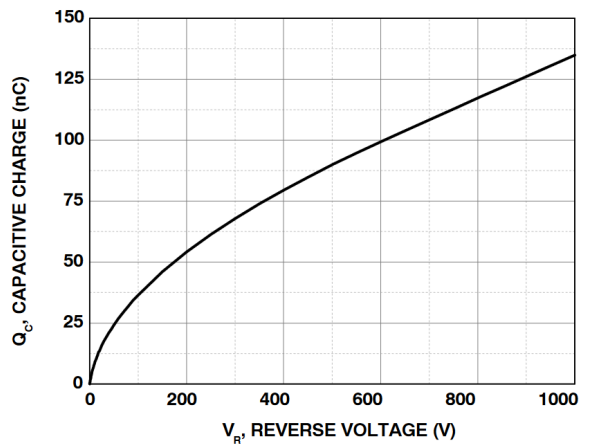


Figure 18. Capacitive Charge vs. Reverse Voltage

# NVXK2KR80WDT

## TYPICAL CHARACTERISTICS SIC DIODE (CONTINUED)

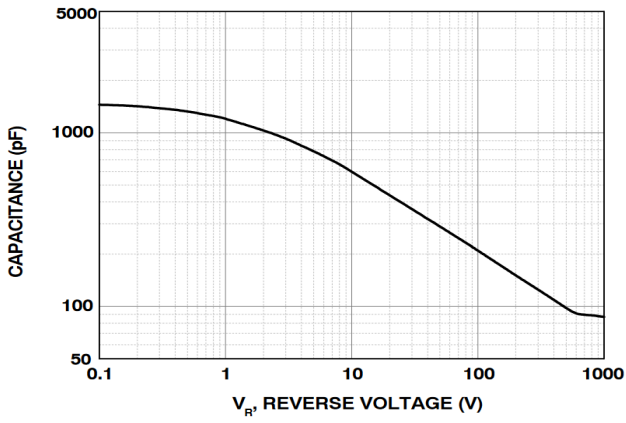


Figure 19. Capacitance vs. Reverse Voltage

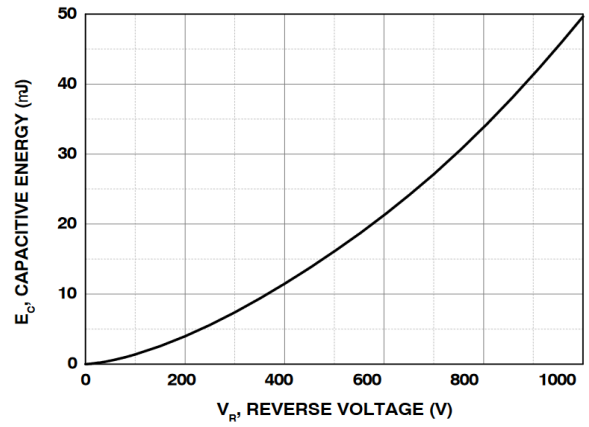


Figure 20. Capacitance Stored Energy

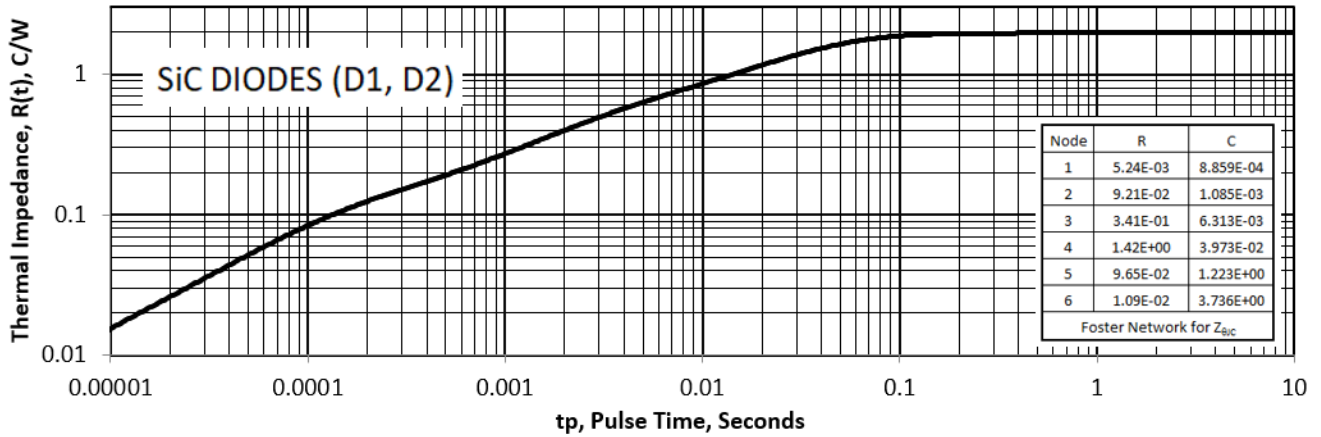


Figure 21. Junction-to-Case Transient Thermal Response Curve – SiC Diode

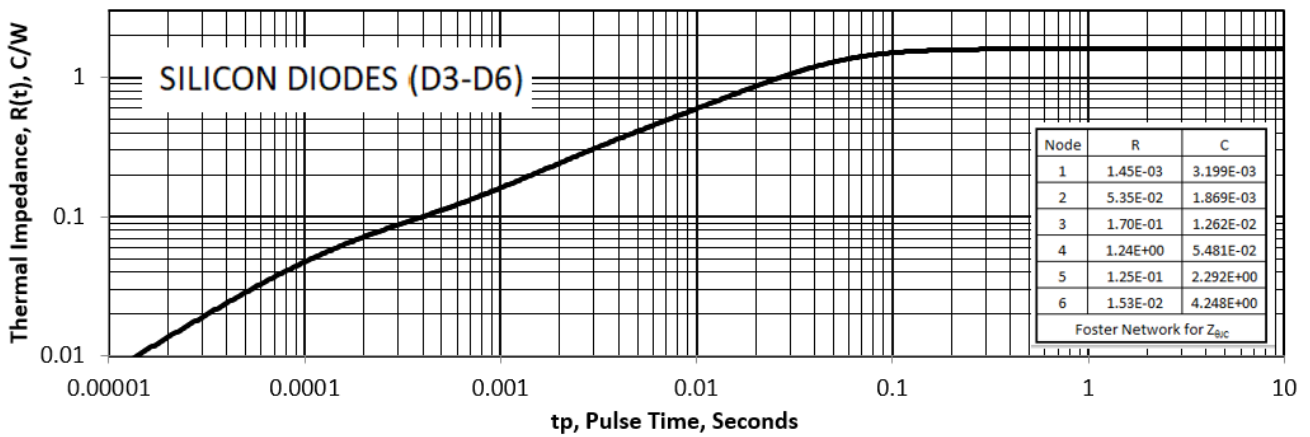
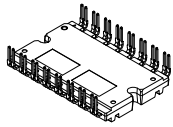


Figure 22. Junction-to-Case Transient Thermal Response Curve – Silicon Diode

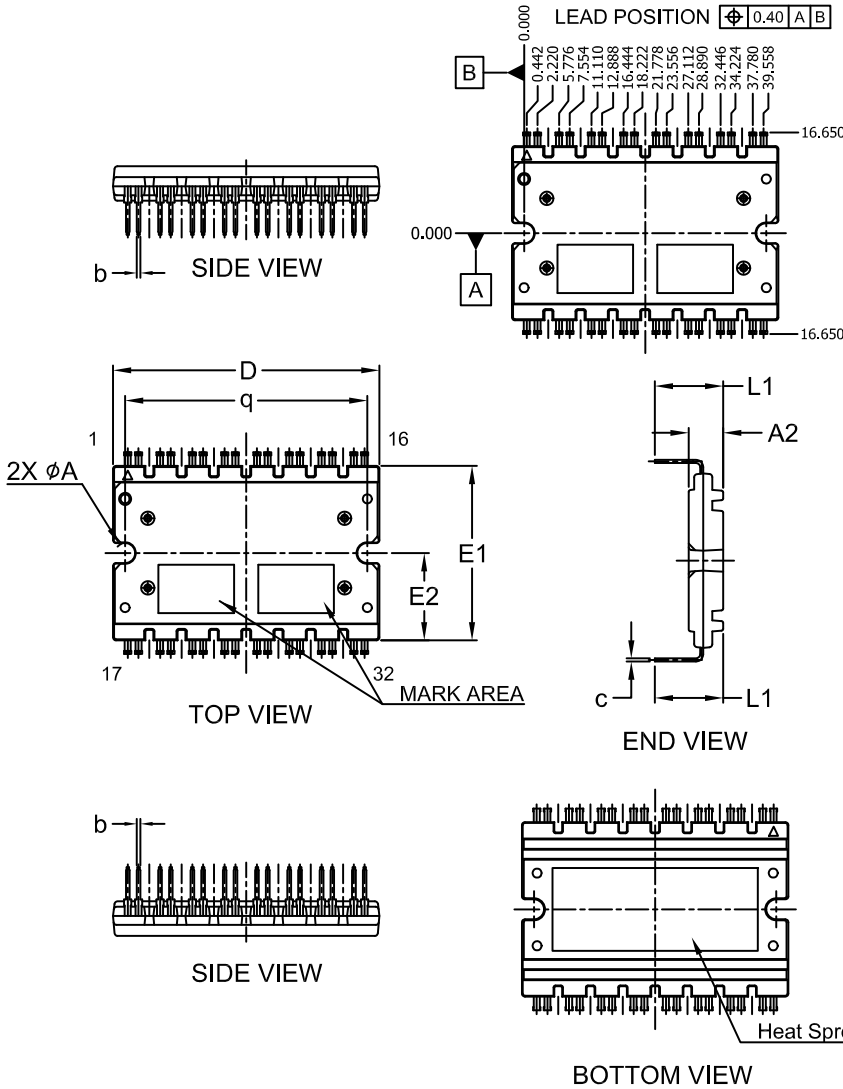


# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



## APM32 AUTOMOTIVE MODULE CASE MODHL ISSUE B

DATE 05 APR 2022

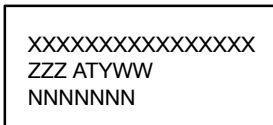


NOTES:

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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<b>DESCRIPTION:</b>	<b>APM32 AUTOMOTIVE MODULE</b>	<b>PAGE 1 OF 1</b>

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