

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

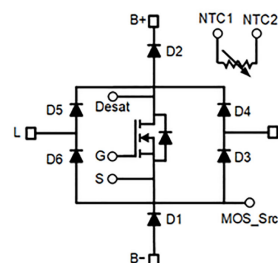
MAXIMUM RATINGS MOSFET ($T_J = 25^\circ\text{C}$ unless otherwise noted)

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, $T_J \leq 175^\circ\text{C}$		V_{GSop}	+20/-5	V
Continuous Drain Current (Notes1, 2)	$T_C = 25^\circ\text{C}$	I_D	20	A
Power Dissipation (Note 1)		P_D	82	W
Pulsed Drain Current (Note 3)	$T_C = 25^\circ\text{C}$	I_{DM}	110	A
Single Pulse Surge Drain Current Capability	$T_C = 25^\circ\text{C}$, $t_p = 10 \mu\text{s}$, $R_G = 4.7 \Omega$	I_{DSC}	266	A
Operating Junction and Storage Temperature		T_J, T_{stg}	-55 to 175	$^\circ\text{C}$
Source Current (Body Diode)		I_S	18	A
Single Pulse Drain-to-Source Avalanche Energy (Note 4)		E_{AS}	180	mJ

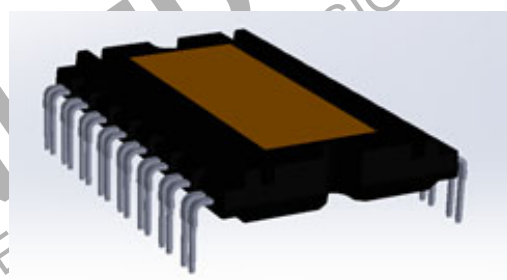
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Particular conditions specified determine thermal resistance values shown. Infinite heatsink with $T_C = 100^\circ\text{C}$ for $R_{\theta JC}$. For $R_{\psi JS}$ 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 AQG 324.
3. Repetitive rating limited by maximum junction temperature and transconductance.
4. E_{AS} based on initial $T_J = 25^\circ\text{C}$, $L = 1\text{ mH}$, $I_{AS} = 19\text{ A}$, $V_{DD} = 120\text{ V}$, $V_{GS} = 18\text{ V}$.

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	°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
-----------	--------	-----------------	-----	-----	-----	------

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		mV/°C
Zero Gate Voltage Drain Current	I_{DSS}	$V_{GS} = 0\text{ V}$ $V_{DS} = 1200\text{ V}$			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_{GSP}		-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 Ω
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 Ω
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	$t_{d(ON)}$	$V_{GS} = -5 / 20\text{ V}, V_{DS} = 800\text{ V},$ $I_D = 20\text{ A}, R_G = 4.7\text{ }\Omega,$ 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		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 $\leq 300\text{ }\mu\text{s}$, 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-Repetitive Peak Forward Surge Current	$T_C = 25^\circ\text{C}, 10\text{ }\mu\text{s}$	$I_{F, \text{Max}}$	A
		394	
	$T_C = 150^\circ\text{C}, 10\text{ }\mu\text{s}$	161	
Non-Repetitive Forward Surge Current (pk)	Half-Sine Pulse, $t_p = 8.3\text{ ms}$	$I_{F, \text{SM}}$	A
Repetitive Forward Surge Current (pk)	Half-Sine Pulse, $t_p = 8.3\text{ ms}$	$I_{F, \text{RM}}$	A
Power Dissipation	$T_C = 25^\circ\text{C}$	P_{TOT}	W
	$T_C = 150^\circ\text{C}$	P_{TOT}	
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).

TYPICAL CHARACTERISTICS SIC MOSFET

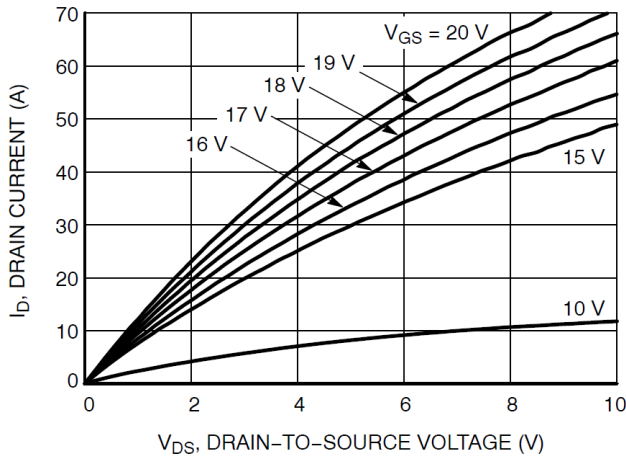


Figure 1. On-Region Characteristics

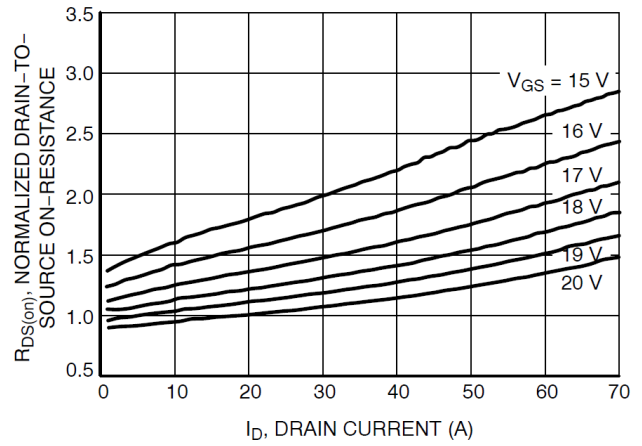


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

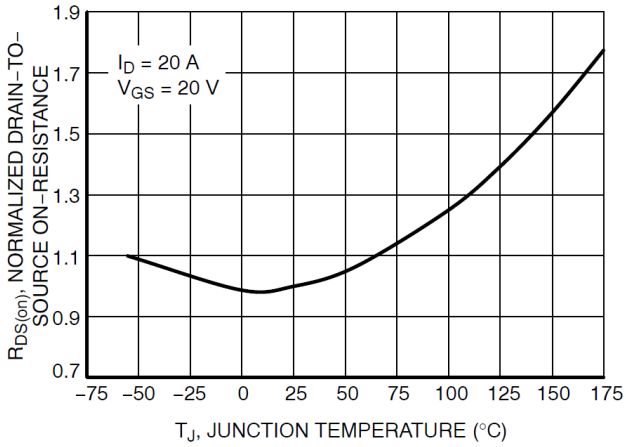


Figure 3. On-Resistance Variation with Temperature

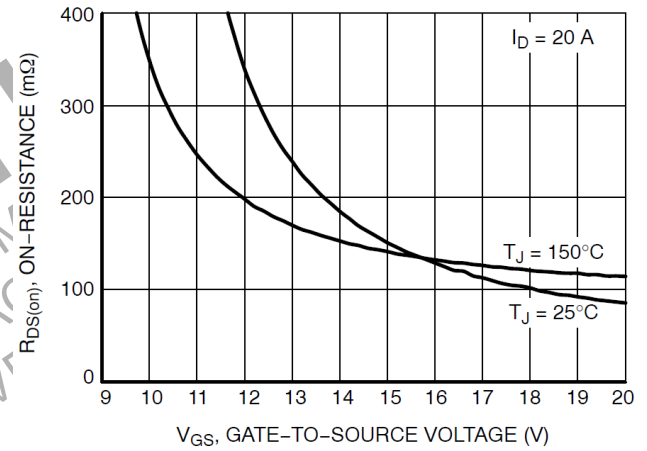


Figure 4. On-Resistance vs. Gate-to-Source Voltage

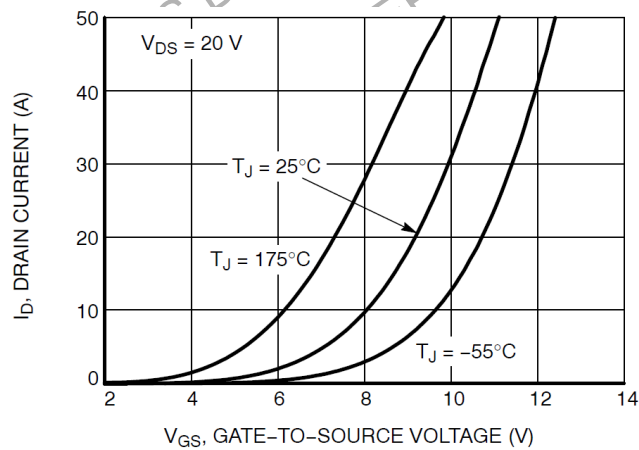


Figure 5. Transfer Characteristics

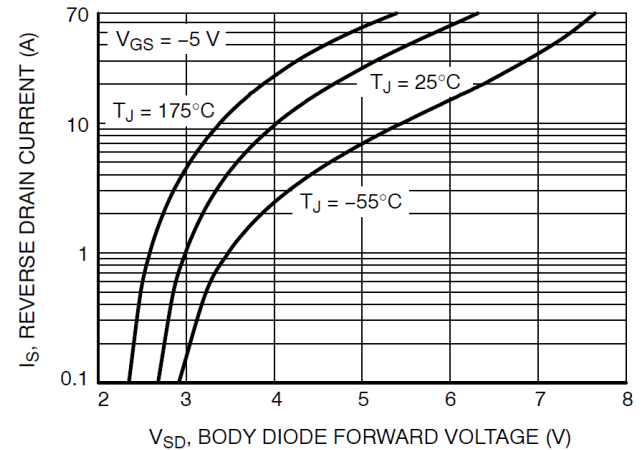


Figure 6. Diode Forward Voltage vs. Current

TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)

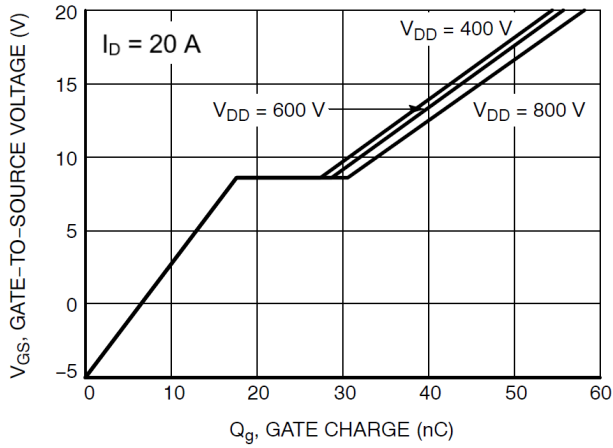


Figure 7. Gate-to-Source Voltage vs. Total Charge

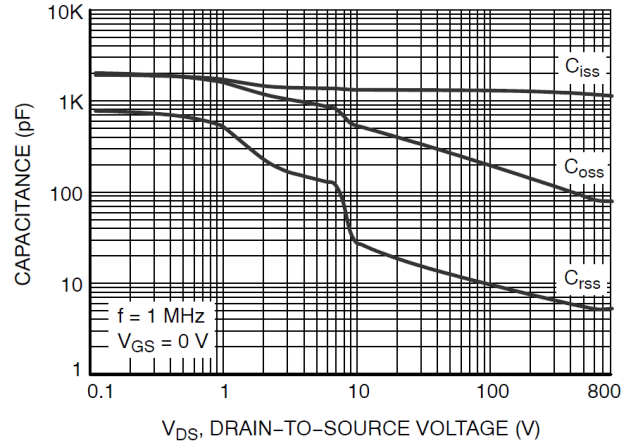


Figure 8. Capacitance vs. Drain-to-Source Voltage

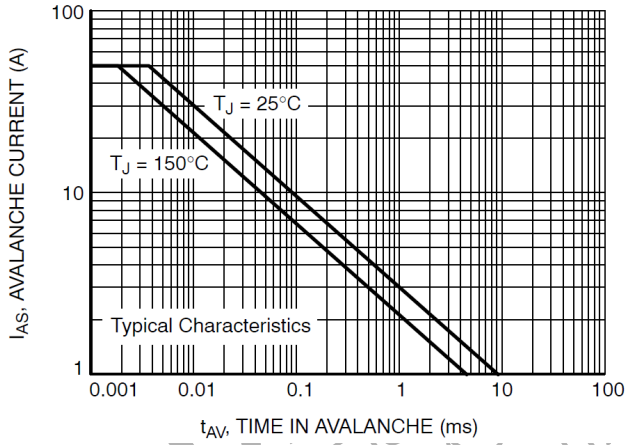


Figure 9. Unclamped Inductive Switching Capability

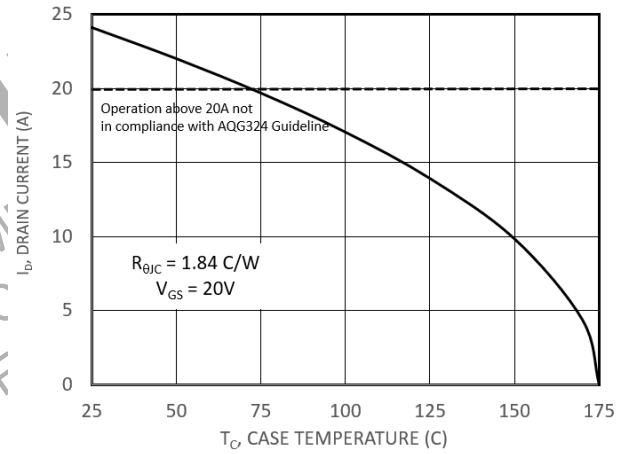


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

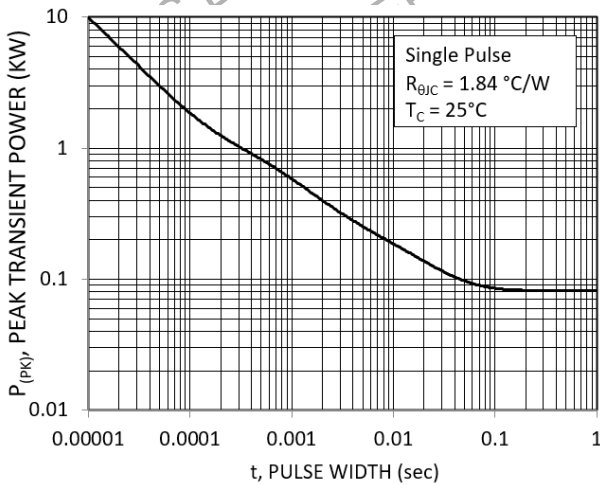


Figure 11. Single Pulse Maximum Power Dissipation

NVXK2KR80WDT

TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)

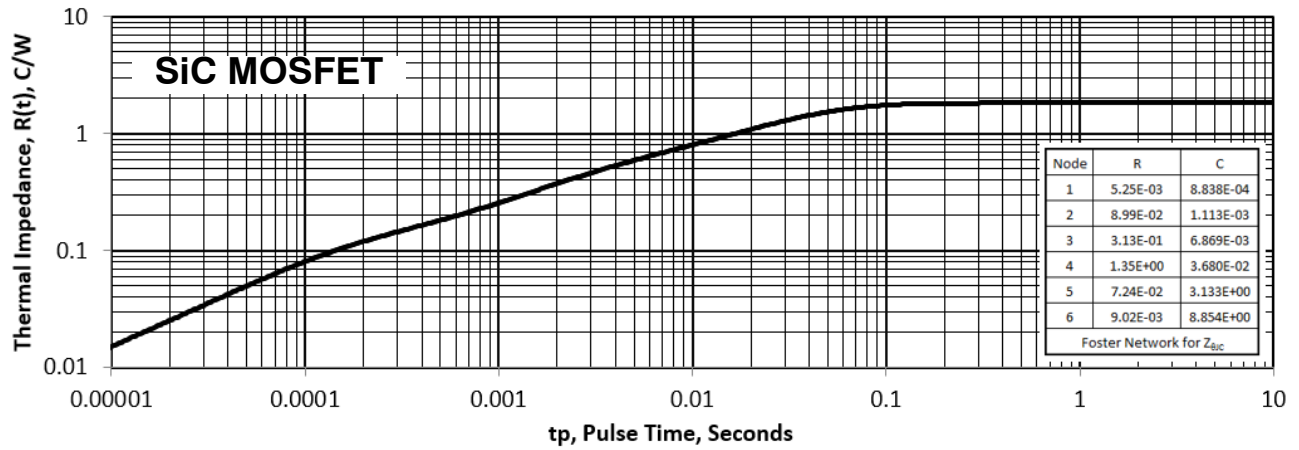


Figure 12. Thermal Response

DISCONTINUED
 THIS DEVICE IS NOT RECOMMENDED FOR NEW DESIGN
 PLEASE CONTACT YOUR onsemi
 REPRESENTATIVE FOR INFORMATION

TYPICAL CHARACTERISTICS SIC DIODE

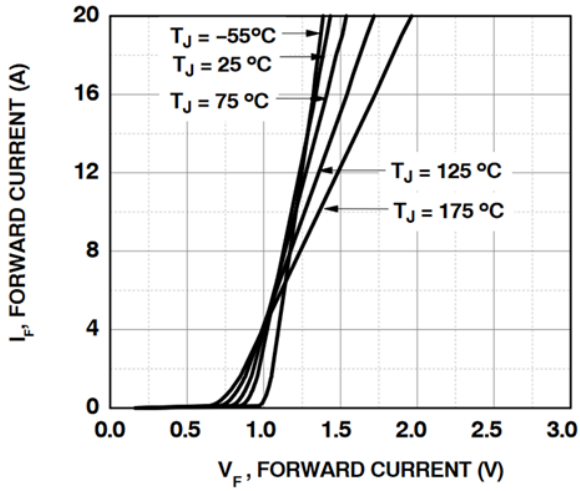


Figure 13. Forward Characteristics

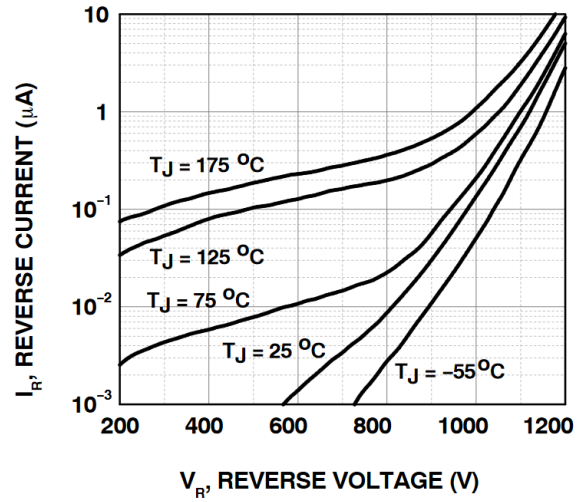


Figure 14. Reverse Characteristics

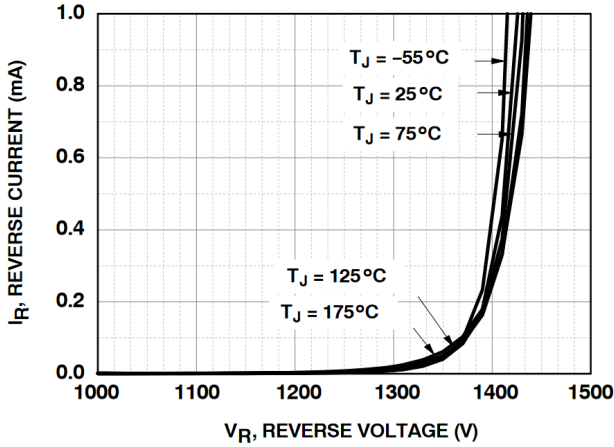


Figure 15. Reverse Characteristics

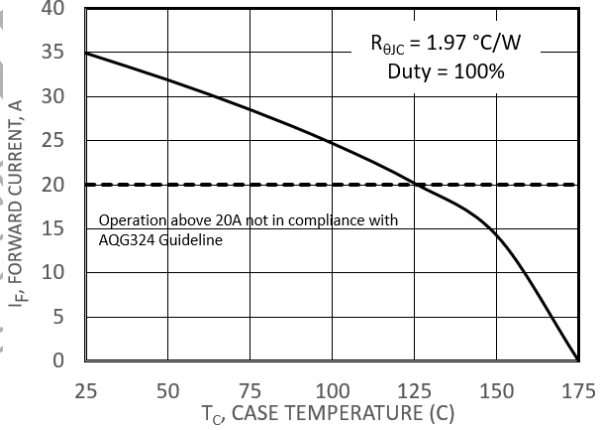


Figure 16. Current Derating

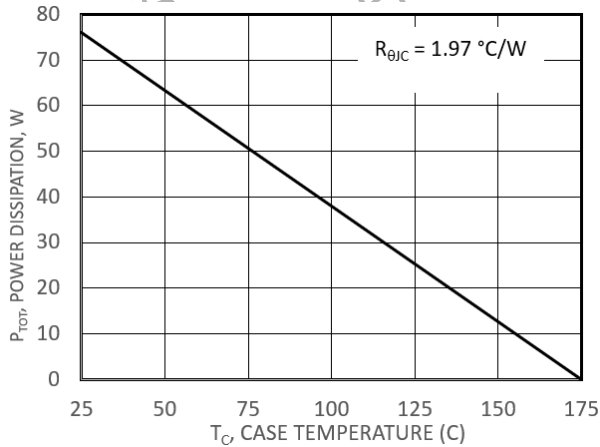


Figure 17. Power Derating

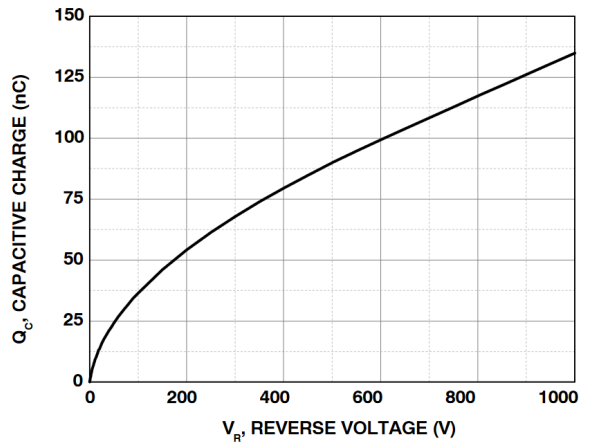


Figure 18. Capacitive Charge vs. Reverse Voltage

TYPICAL CHARACTERISTICS SIC DIODE (CONTINUED)

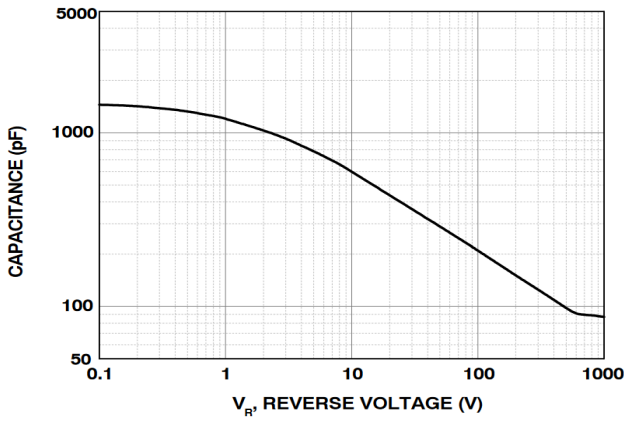


Figure 19. Capacitance vs. Reverse Voltage

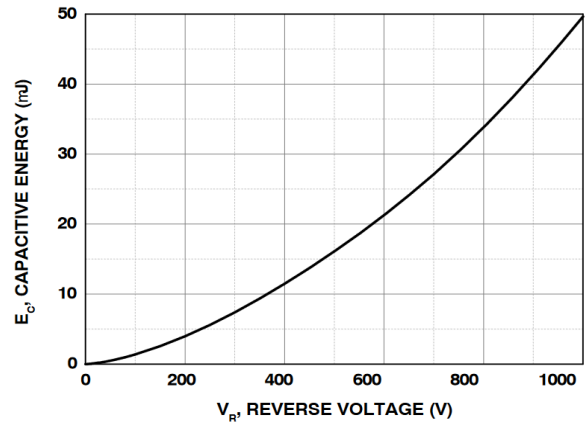


Figure 20. Capacitance Stored Energy

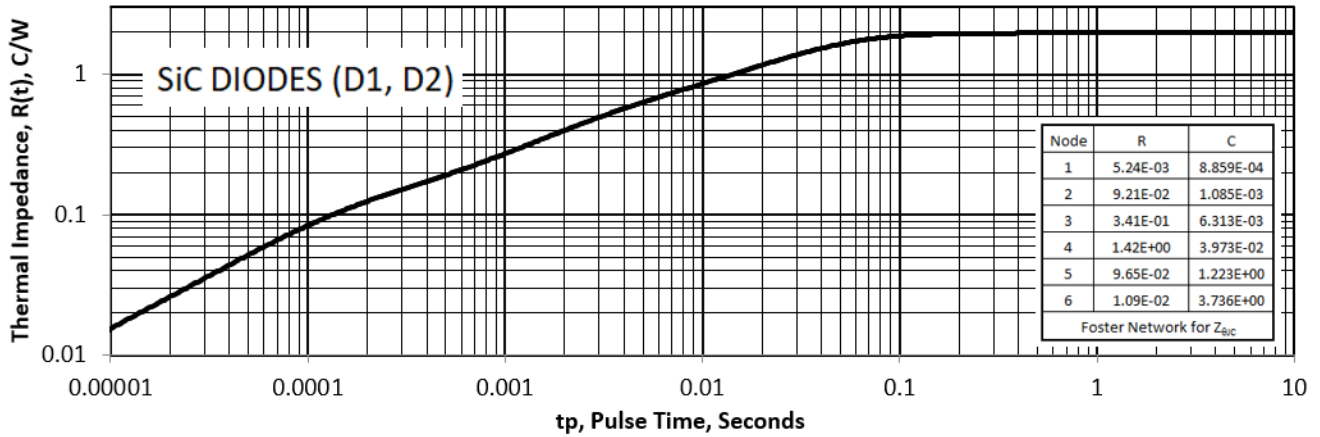


Figure 21. Junction-to-Case Transient Thermal Response Curve – SiC Diode

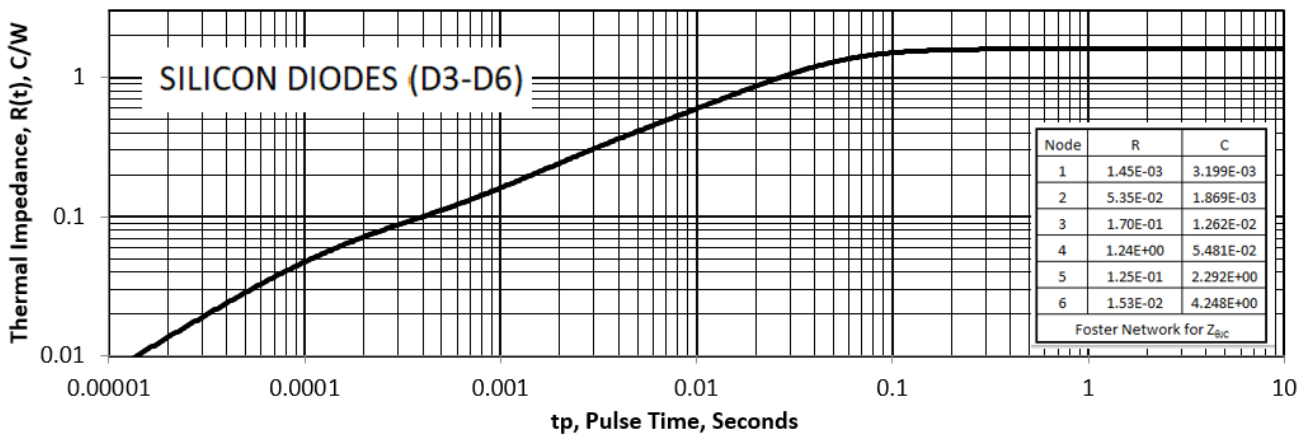
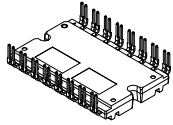
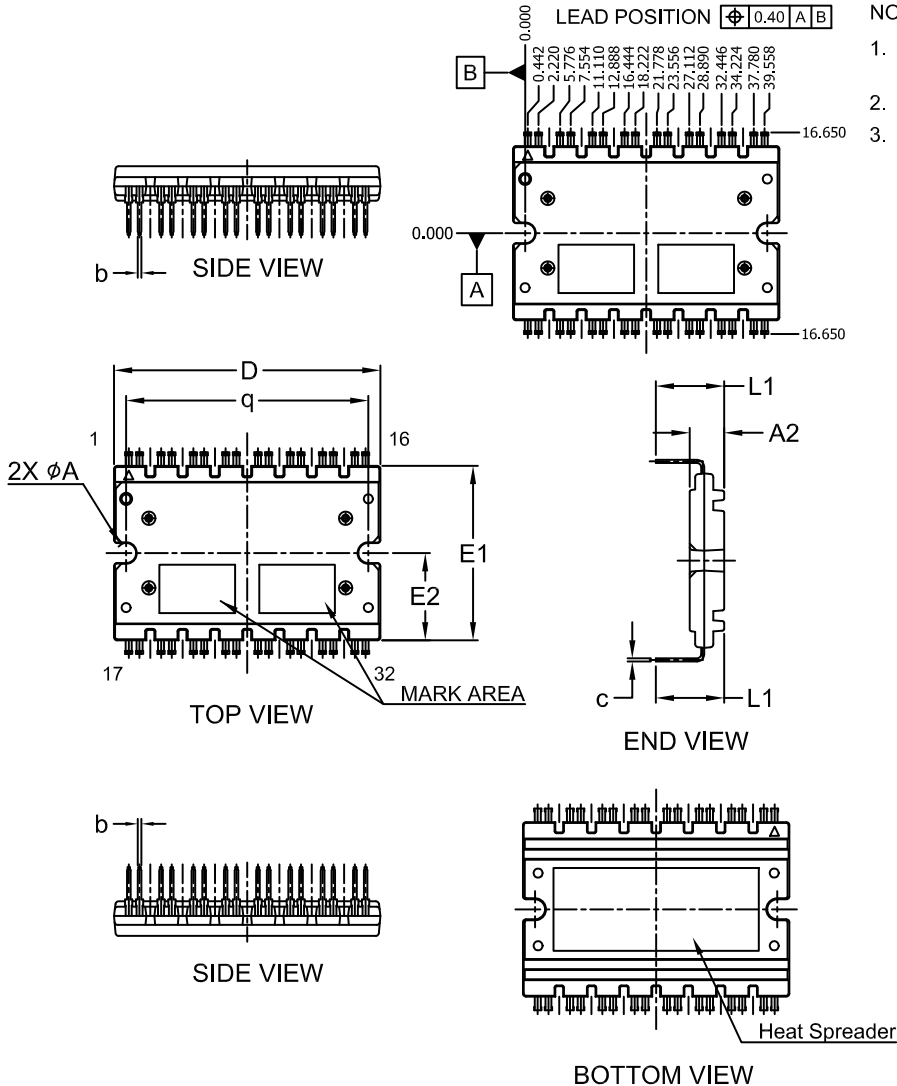


Figure 22. Junction-to-Case Transient Thermal Response Curve – Silicon Diode



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
ØA	3.20	3.30	3.40

GENERIC
MARKING DIAGRAM*

XXXXXXXXXXXXXXXXXX
ZZZ ATYWW
NNNNNNN

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 "•", may or may not be present. Some products may not follow the Generic Marking.

DOCUMENT NUMBER:	98AON29478H	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	APM32 AUTOMOTIVE MODULE	PAGE 1 OF 1

onsemi and onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at
www.onsemi.com/support/sales