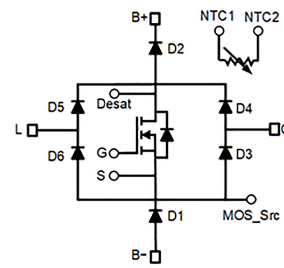
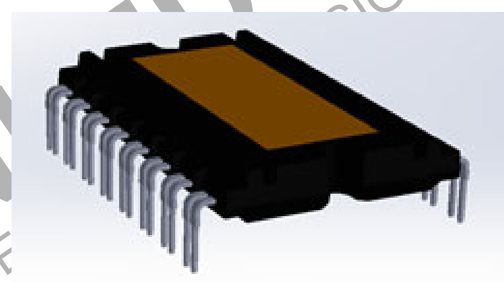
Silicon Carbide (SiC) Module – EliteSiC Power Module for OBC, 80 mohm, 1200 V, 20 A, Vienna Rectifier, in APM32 Series

NVXK2KR80WDT

$V_{(BR)DSS}$	$R_{DS(on)}$ Max	I_D Max
1200 V	116 mΩ @ 20 V	20 A



SiC MOSFET Vienna Rectifier Module



APM32

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 AQG324

Typical Applications

- Vienna PFC for On−Board Charger in xEV Applications

ORDERING INFORMATION

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

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, $T_J \le 175$°C		V_{GSop}	+20/−5	V
Continuous Drain Current (Notes1, 2)	T_C = 25°C	I_D	20	A
Power Dissipation (Note 1)		P_D	82	W
Pulsed Drain Current (Note 3)	T_C = 25°C	I_{DM}	110	A
Single Pulse Surge Drain Current Capability	T_C = 25°C, t_p = 10 μs, R_G = 4.7 Ω	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 $R_{\theta JC}$. 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°C, L = 1 mH, I_{AS} = 19 A, V_{DD} = 120 V, V_{GS} = 18 V.

August, 2024 − Rev. 3
Publication Order Number:
NVXK2KR80WDT/D

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°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 V, I_D = 1 mA	1200			V
Drain−to−Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}$ / T_J	I_D = 1 mA, referenced to 25°C		500		mV/°C
Zero Gate Voltage Drain Current	I_{DSS}	V_{GS} = 0 V, V_{DS} = 1200 V, T_J = 25°C			100	µA
		V_{GS} = 0 V, V_{DS} = 1200 V, T_J = 175°C			1	mA
Gate−to−Source Leakage Current	I_{GSS}	V_{GS} = +25/−15 V, V_{DS} = 0 V			±1	µA
ON CHARACTERISTICS (Note 5)						
Gate Threshold Voltage	$V_{GS(TH)}$	V_{GS} = V_{DS} , I_D = 10 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 V, I_D = 20 A, T_J = 25°C		80	116	mΩ
Drain−to−Source On Resistance	$R_{DS(on)}$	V_{GS} = 20 V, I_D = 20 A, T_J = 175°C		150		mΩ
Forward Transconductance	g_{FS}	V_{DS} = 20 V, I_D = 20 A		11		S
CHARGES, CAPACITANCES & GATE RESISTANCE						
Input Capacitance	C_{ISS}	V_{GS} = 0 V, f = 1 MHz, V_{DS} = 800 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 V, V_{DS} = 600 V, I_D = 20 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 V, f = 1 MHz		1.2		Ω
INDUCTIVE SWITCHING CHARACTERISTICS						
Turn−On Delay Time	$t_{d(ON)}$	V_{GS} = −5 / 20 V, V_{DS} = 800 V, I_D = 20 A, R_G = 4.7 Ω, 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

ELECTRICAL CHARACTERISTICS SiC MOSFET (T_J = 25°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 V, T_J = 25°C			18	A
Pulsed Drain−Source Diode Forward Current (Note 3)	I_{SDM}	V_{GS} = −5 V, T_J = 25°C			110	A
Forward Diode Voltage	V_{SD}	V_{GS} = −5 V, I_{SD} = 10 A, T_J = 25°C		3.9		V
Reverse Recovery Time	t_{RR}	V_{GS} = −5 V, dI_S/dt = 1000 A/µs, I_{SD} = 20 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 ≤300 µs, duty ratio ≤2%.

MAXIMUM RATINGS SiC DIODE (D1−D2) (T_J = 25°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°C		I_F	17	A
Continuous Rectified Forward Current @ T_C < 75°C			33	
Non−Repetitive Peak Forward Surge Current	T_C = 25°C, 10 µs	$I_{F, Max}$	394	A
	T_C = 150°C, 10 µs		161	
Non−Repetitive Forward Surge Current (pk)	Half−Sine Pulse, t_p = 8.3 ms	$I_{F, SM}$	78	A
Repetitive Forward Surge Current (pk)	Half−Sine Pulse, t_p = 8.3 ms	$I_{F, RM}$	70	A
Power Dissipation	T_C = 25°C	P_{TOT}	76	W
	T_C = 150°C	P_{TOT}	13	
Operating and Storage Temperature Range		T_J, T_{STG}	−55 to +175	°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°C, L = 0.5 mH, I_{AS} = 29 A, V = 50 V.

ELECTRICAL CHARACTERISTICS SiC DIODE (D1−D2) (T_J = 25°C unless otherwise stated)

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

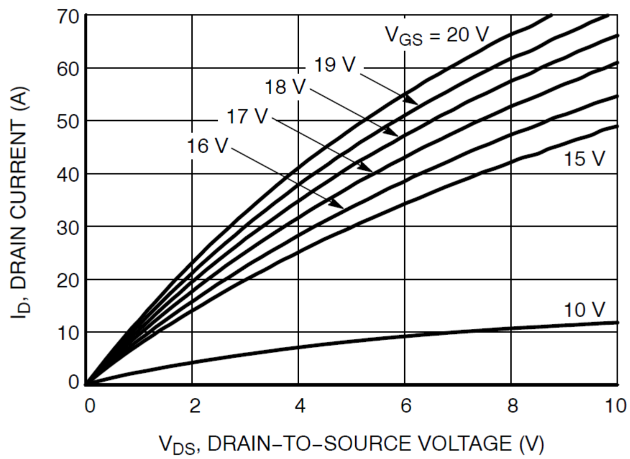


Figure 1. On−Region Characteristics

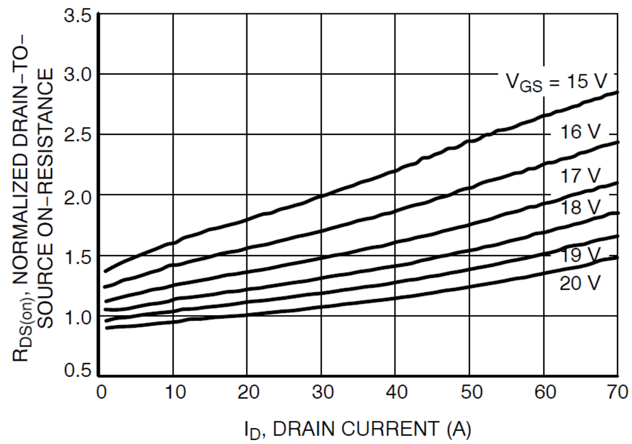


Figure 2. Normalized On−Resistance vs. Drain Current and Gate Voltage

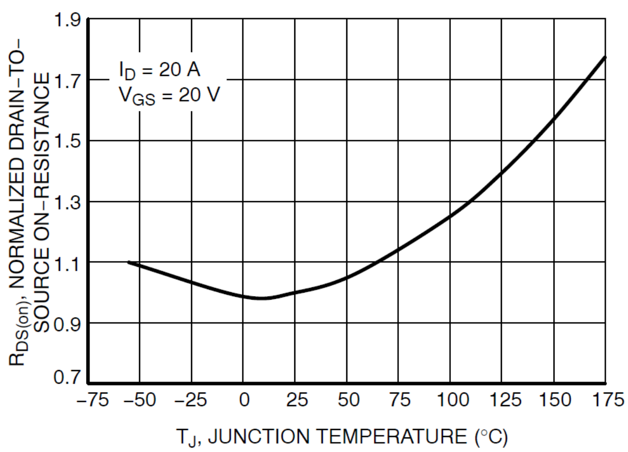


Figure 3. On−Resistance Variation with Temperature

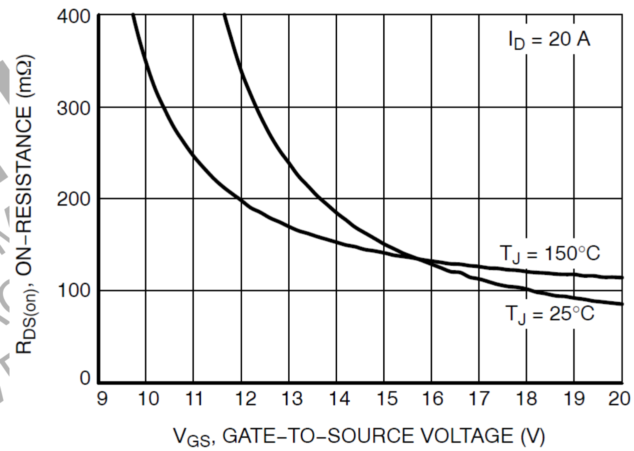


Figure 4. On−Resistance vs. Gate−to−Source Voltage

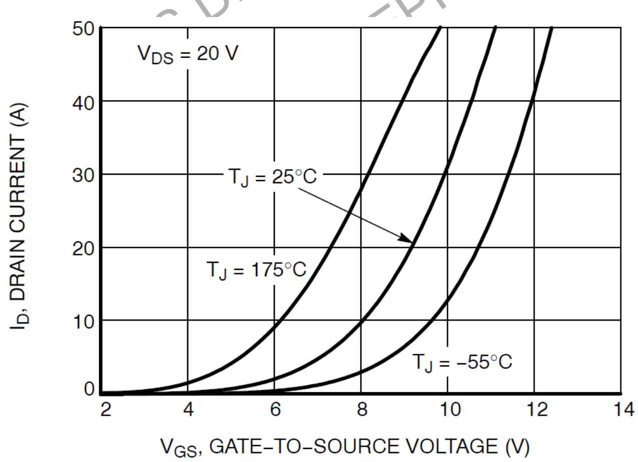


Figure 5. Transfer Characteristics

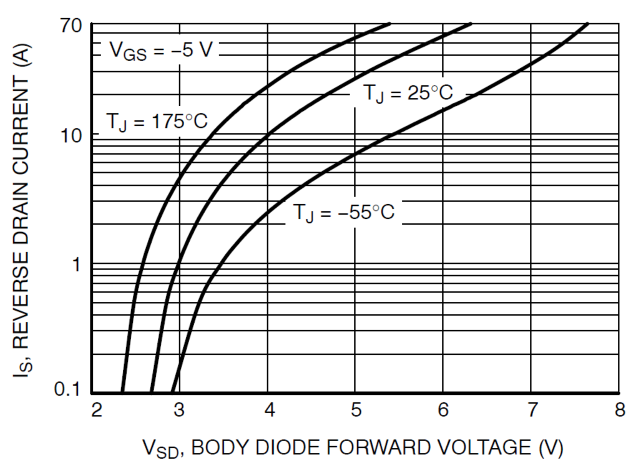


Figure 6. Diode Forward Voltage vs. Current

TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)

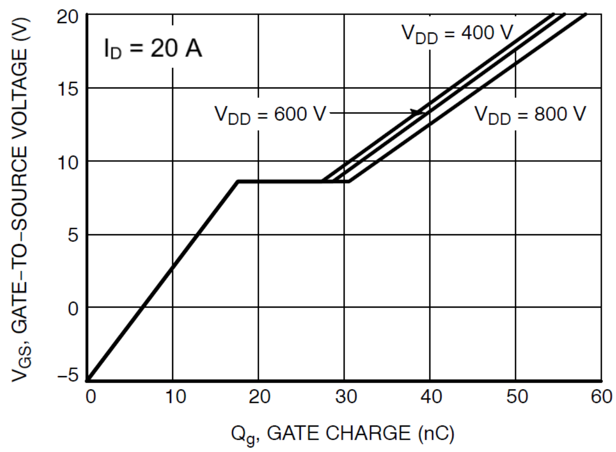


Figure 7. Gate−to−Source Voltage vs. Total Charge

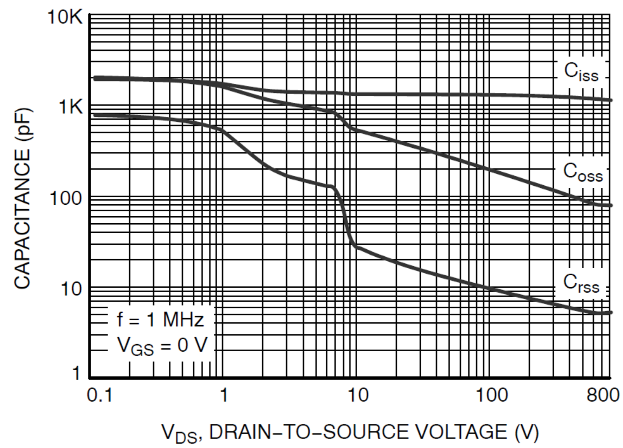


Figure 8. Capacitance vs. Drain−to−Source Voltage

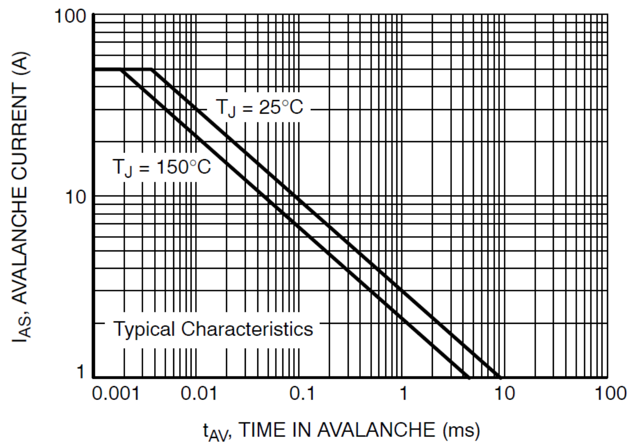


Figure 9. Unclamped Inductive Switching Capability

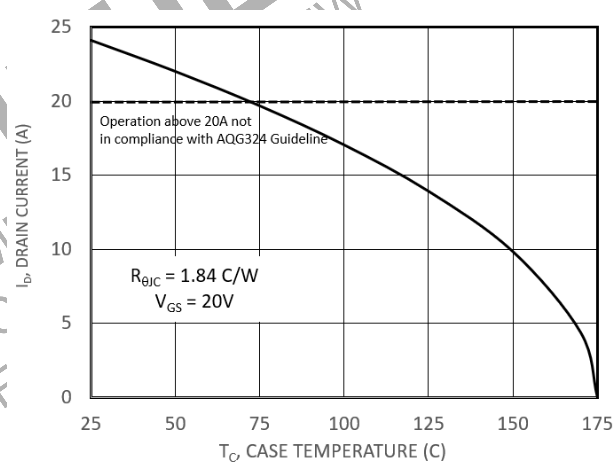


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

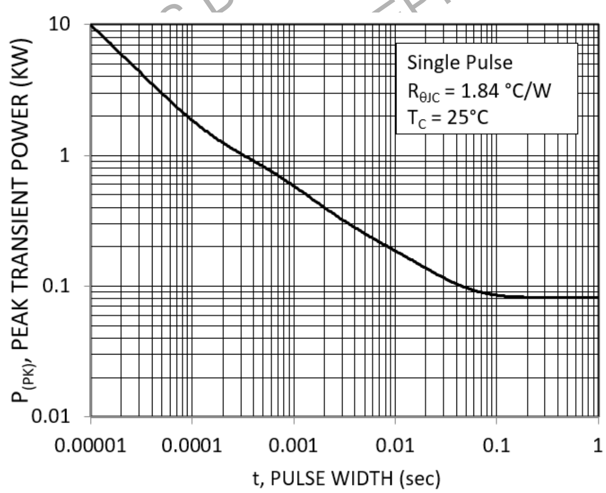
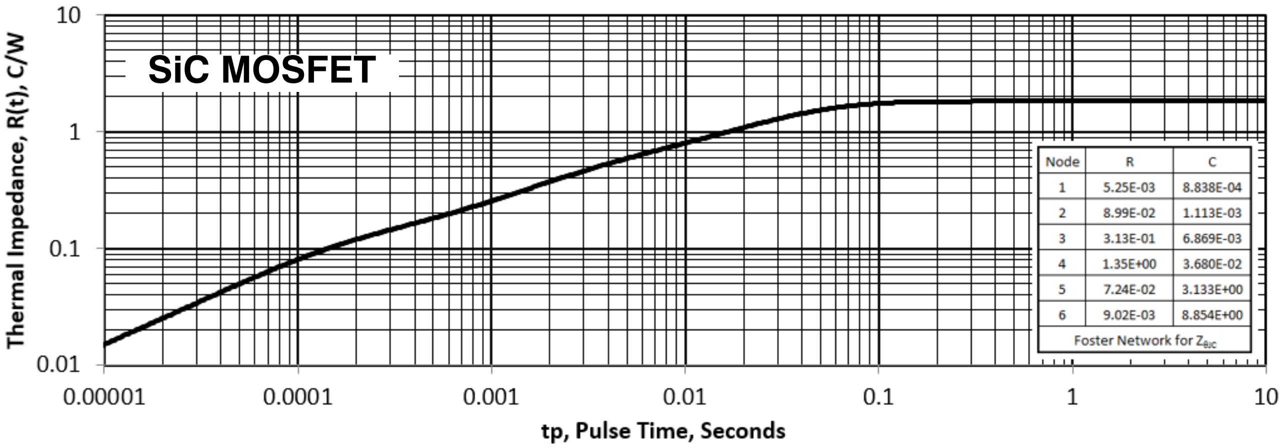


Figure 11. Single Pulse Maximum Power Dissipation

TYPICAL CHARACTERISTICS SIC MOSFET (CONTINUED)



Node	R	C
1	5.25E-03	8.838E-04
2	8.99E-02	1.113E-03
3	3.13E-01	6.869E-03
4	1.35E+00	3.680E-02
5	7.24E-02	3.133E+00
6	9.02E-03	8.854E+00
Foster Network for $Z_{\theta JC}$		

Figure 12. Thermal Response

TYPICAL CHARACTERISTICS SIC DIODE

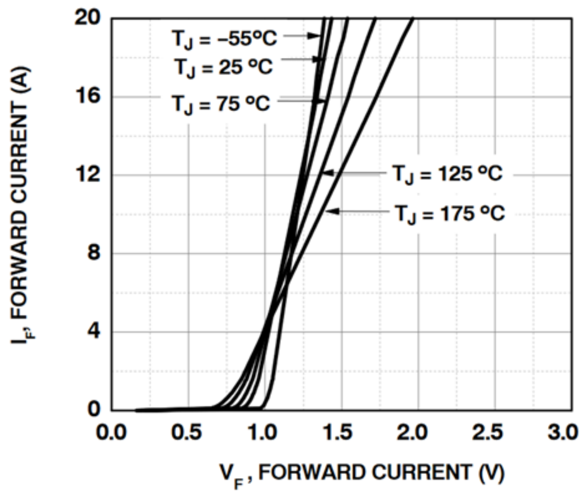


Figure 13. Forward Characteristics

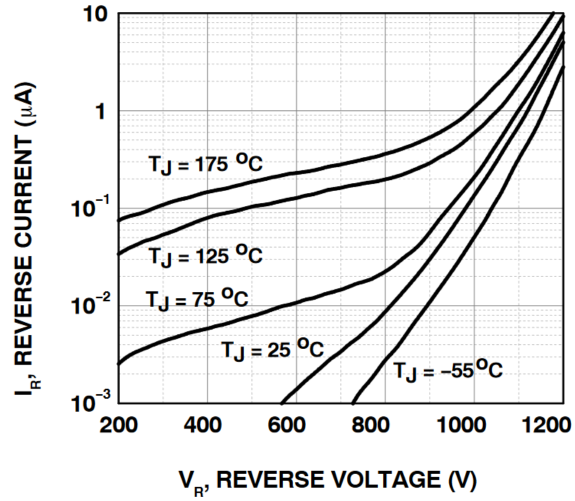


Figure 14. Reverse Characteristics

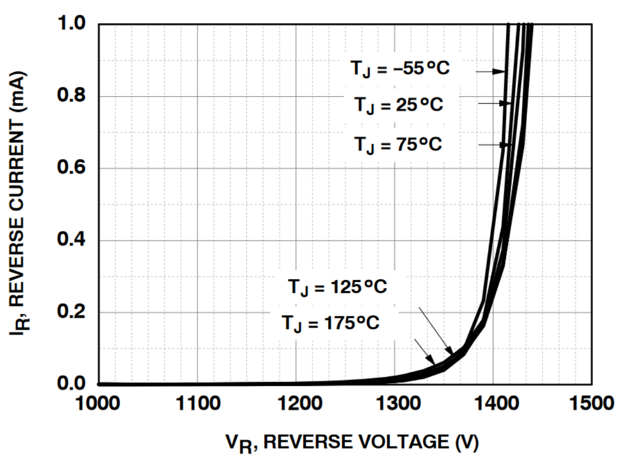


Figure 15. Reverse Characteristics

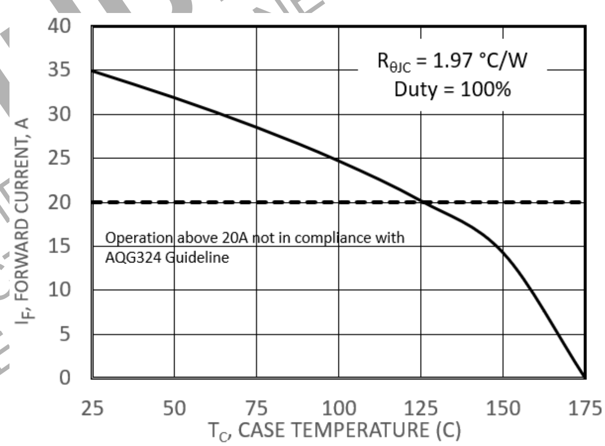


Figure 16. Current Derating

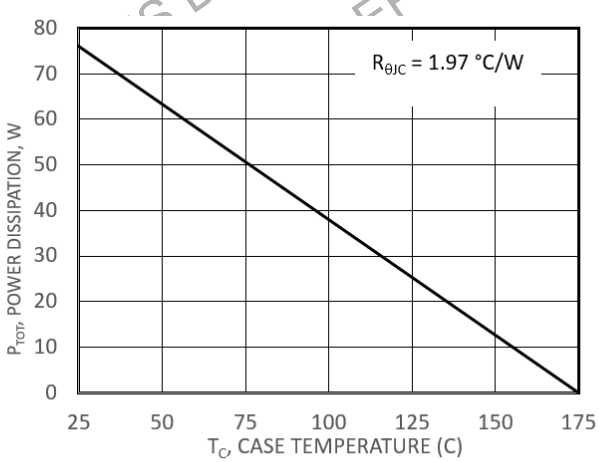


Figure 17. Power Derating

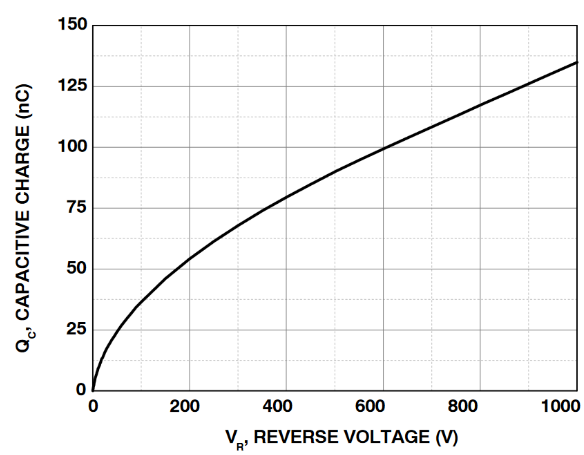


Figure 18. Capacitive Charge vs. Reverse Voltage

TYPICAL CHARACTERISTICS SIC DIODE (CONTINUED)

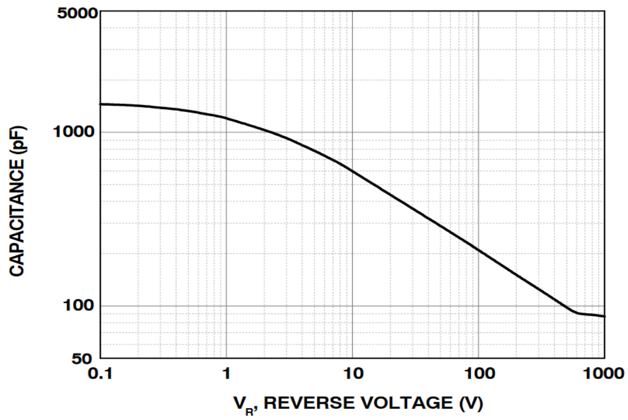


Figure 19. Capacitance vs. Reverse Voltage

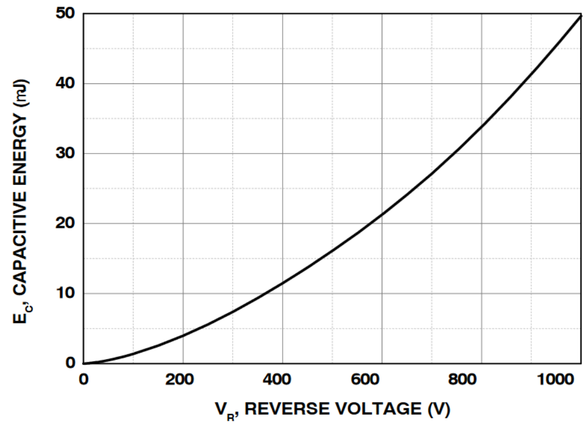


Figure 20. Capacitance Stored Energy

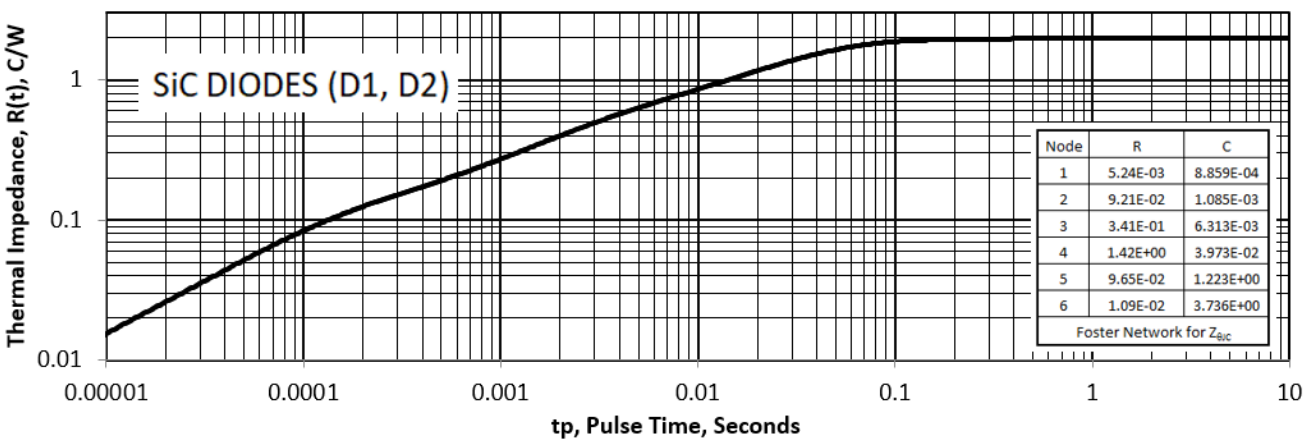


Figure 21. Junction−to−Case Transient Thermal Response Curve − SiC Diode

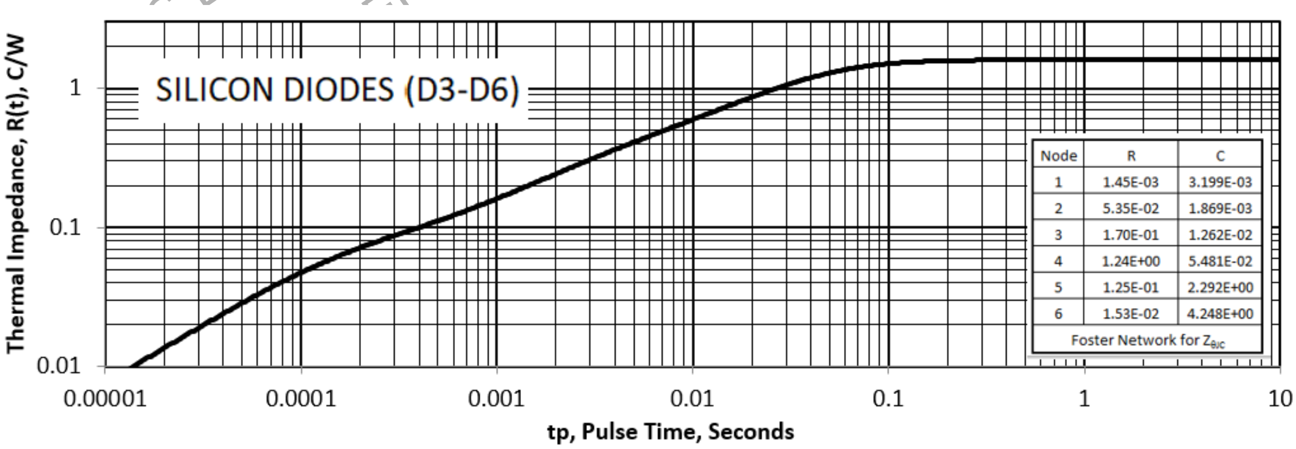
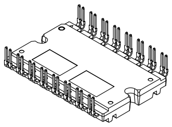


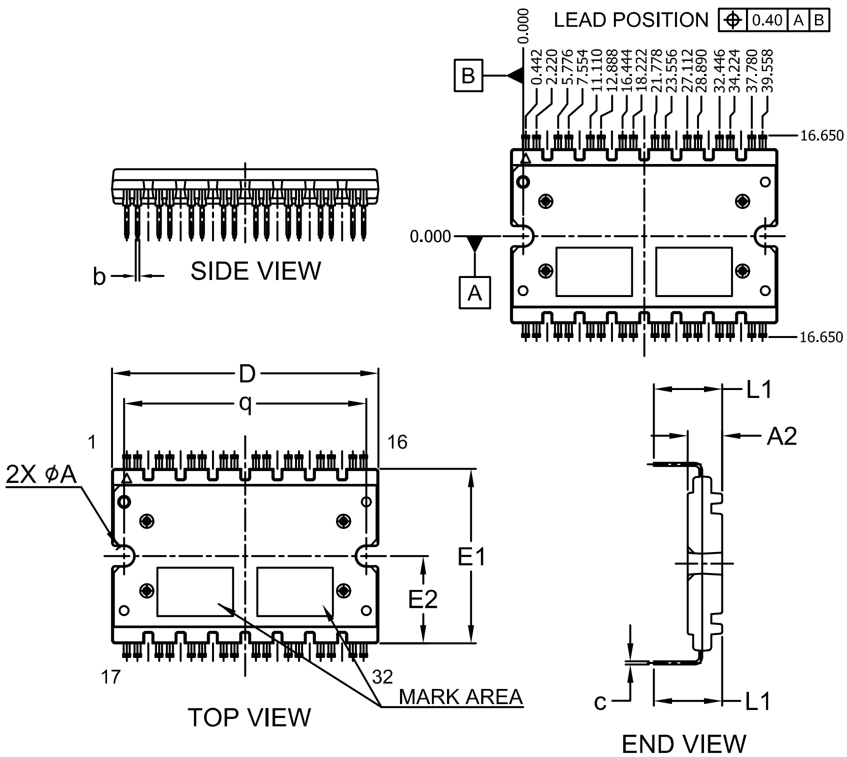
Figure 22. Junction−to−Case Transient Thermal Response Curve − Silicon Diode



APM32 AUTOMOTIVE MODULE

CASE MODHL
ISSUE B

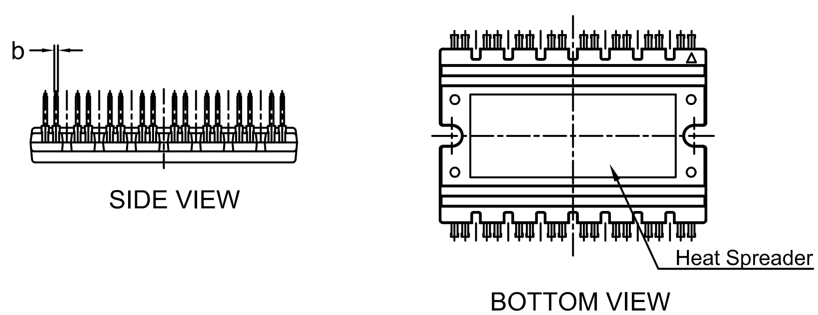
DATE 05 APR 2022



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.

	MILLIMETERS		
DIM	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*

XXXXXXXXXXXXXXXX
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.

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DESCRIPTION:	**APM32 AUTOMOTIVE MODULE**	**PAGE 1 OF 1**

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