

# SiC Power MOSFET Module

## 1200 V, 40 mΩ, 31 A 3-Phase Bridge Power Module NVXK2VR40WDT2

### Features

- DIP Silicon Carbide 3-Phase Bridge Power Module for On-board Charger (OBC) for xEV Applications
- Creepage and Clearance per IEC 60664-1, 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

- PFC for On-Board Charger in xEV Applications

### MAXIMUM RATINGS (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			
Continuous Drain Current (Note 1)	T <sub>C</sub> = 25°C	I <sub>D</sub>	31 A
		P <sub>D</sub>	102 W
Power Dissipation (Note 1)			
Pulsed Drain Current (Note 2)	T <sub>C</sub> = 25°C t <sub>p</sub> = 100 μs	I <sub>DM</sub>	170 A
Single Pulse Surge Drain Current Capability	T <sub>C</sub> = 25°C, t <sub>p</sub> = 10 μs, R <sub>G</sub> = 4.7 Ω	I <sub>DSC</sub>	403 A
Operating Junction Temperature	T <sub>J</sub>	-55 to 175	°C
Storage Temperature	T <sub>stg</sub>	-40 to 125	°C
Source Current (Body Diode)	I <sub>S</sub>	27	A
Single Pulse Drain-to-Source Avalanche Energy (Note 3)	E <sub>AS</sub>	338	mJ

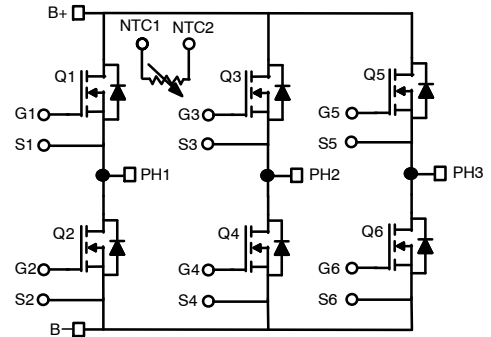
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL CHARACTERISTICS (Note 1)

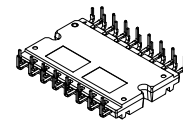
Parameter	Symbol	Typ	Max	Unit
Thermal Resistance Junction-to-Case (Note 1)	R <sub>θJC</sub>	1.13	1.47	°C/W
Thermal Resistance Junction-to-Sink (Note 1)	R <sub>ψJS</sub>	1.59	1.93	°C/W

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 38 μm thick TIM with 6.5 W/mK thermal conductivity.
2. Repetitive rating limited by maximum junction temperature and transconductance.
3. E<sub>AS</sub> based on initial T<sub>J</sub> = 25°C, L = 1 mH, I<sub>AS</sub> = 26 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	59 mΩ @ 20 V	31 A



SiC MOSFET 3-Phase Bridge Module

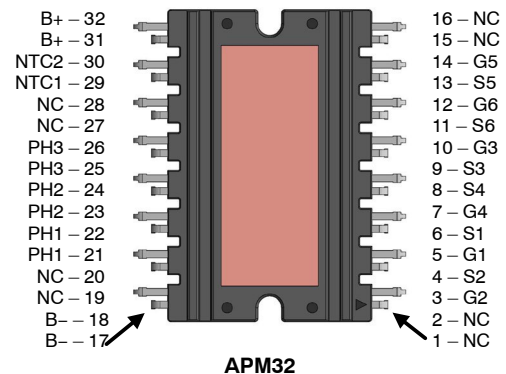


APM32  
44.00x28.80x5.70  
CASE MODHM

### MARKING DIAGRAM

NVXK2VR40WDT2  
ZZZ ATYWW  
NNNNNNN

NVXK2VR40WDT2 = Specific Device Code  
ZZZ = Lot Number  
AT = Assembly Site & Test Location  
Y = Year  
W = Work Week  
NNN = Serial Number



### ORDERING INFORMATION

Device	Package	Shipping
NVXK2VR40WDT2	APM32 (Pb-Free)	10 ea / Tube

# NVXK2VR40WDT2

## PIN DESCRIPTION

Pin No.	Pin Name	Description
1, 2, 15, 16, 19, 20, 27, 28	NC	Not Connected
3	G2	Q2 Gate
4	S2	Q2 Source
5	G1	Q1 Gate
6	S1	Q1 Source
7	G4	Q4 Gate
8	S4	Q4 Source
9	S3	Q3 Source
10	G3	Q3 Gate
11	S6	Q6 Source
12	G6	Q6 Gate
13	S5	Q5 Source
14	G5	Q5 Gate
17, 18	B-	Negative Power Terminal
21, 22	PH1	Phase 1 Output
23, 24	PH2	Phase 2 Output
25, 26	PH3	Phase 3 Output
29	NTC1	NTC Pin1
30	NTC2	NTC Pin2
31, 32	B+	Positive Power Terminal

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise stated)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	V <sub>(BR)DSS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA	1200	-	-	V	
Drain-to-Source Breakdown Voltage Temperature Coefficient	B <sub>(BR)DSS</sub> /T <sub>J</sub>	I <sub>D</sub> = 1 mA, referenced to 25°C	-	450	-	mV/°C	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 1200 V	T <sub>J</sub> = 25°C	-	-	100	μA
			T <sub>J</sub> = 175°C	-	-	1	mA
Gate-to-Source Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> = +25/-15 V, V <sub>DS</sub> = 0 V	-	-	±1	μA	

### ON CHARACTERISTICS (Note 4)

Gate Threshold Voltage	V <sub>GS(TH)</sub>	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 10 mA	1.8	3	4.3	V
Recommended Gate Voltage	V <sub>GOP</sub>		-5	-	+20	V
Drain-to-Source On Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 20 V, I <sub>D</sub> = 35 A, T <sub>J</sub> = 25°C	-	40	59	mΩ
		V <sub>GS</sub> = 20 V, I <sub>D</sub> = 35 A, T <sub>J</sub> = 175°C	-	71	-	mΩ
Forward Transconductance	g <sub>FS</sub>	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 35 A	-	20	-	S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	C <sub>ISS</sub>	V <sub>GS</sub> = 0 V, f = 1 MHz, V <sub>DS</sub> = 800 V	-	1789	-	pF
Output Capacitance	C <sub>OSS</sub>		-	139	-	
Reverse Transfer Capacitance	C <sub>RSS</sub>		-	12.5	-	

# NVXK2VR40WDT2

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>CHARGES, CAPACITANCES &amp; GATE RESISTANCE</b>						
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V}, I_D = 47\text{ A}$	-	106	-	nC
Threshold Gate Charge	$Q_{G(TH)}$		-	18	-	
Gate-to-Source Charge	$Q_{GS}$		-	34	-	
Gate-to-Drain Charge	$Q_{GD}$		-	26	-	
Gate-Resistance	$R_G$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	-	2	-	$\Omega$

### INDUCTIVE SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 47\text{ A}, R_G = 4.7\ \Omega,$ Inductive load	-	17	-	ns
Rise Time	$t_r$		-	20	-	
Turn-Off Delay Time	$t_{d(OFF)}$		-	30	-	
Fall Time	$t_f$		-	9	-	
Turn-On Switching Loss	$E_{ON}$		-	366	-	$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		-	200	-	$\mu\text{J}$
Total Switching Loss	$E_{tot}$	-	566	-	$\mu\text{J}$	

### DRAIN-SOURCE DIODE CHARACTERISTICS

Continuous Drain-Source Diode Forward Current (Note 1)	$I_{SD}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$	-	-	27	A
Pulsed Drain-Source Diode Forward Current (Note 2)	$I_{SDM}$	$V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$	-	-	170	A
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -5\text{ V}, I_{SD} = 17.5\text{ A}, T_J = 25^\circ\text{C}$	-	3.7	-	V
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -5\text{ V}, di_S/dt = 1000\text{ A}/\mu\text{s}, I_{SD} = 17.5\text{ A}$	-	24	-	ns
Peak Reverse Recovery Current	$I_{RRM}$		-	10.4	-	A
Charge Time	$t_a$		-	12.4	-	ns
Discharge Time	$t_b$		-	11.6	-	ns
Reverse Recovery Charge	$Q_{RR}$		-	125	-	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.

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

### COMPONENTS

Component	Description	Type	Quantity	Specification
NTC	10 k $\Omega$ , $\pm 3\%$ Case Size 0603	Discrete	1	B Constants $B_{25/50} = 3590$ $B_{25/85} = 3635$ $B_{25/100} = 3650 \pm 3\%$

# NVXK2VR40WDT2

## TYPICAL CHARACTERISTICS

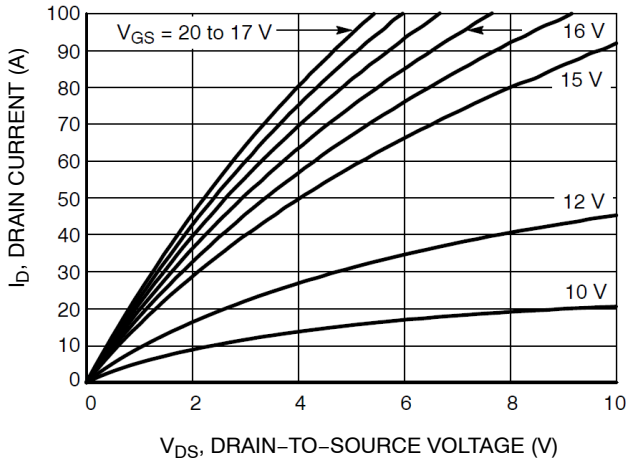


Figure 1. On-Region Characteristics

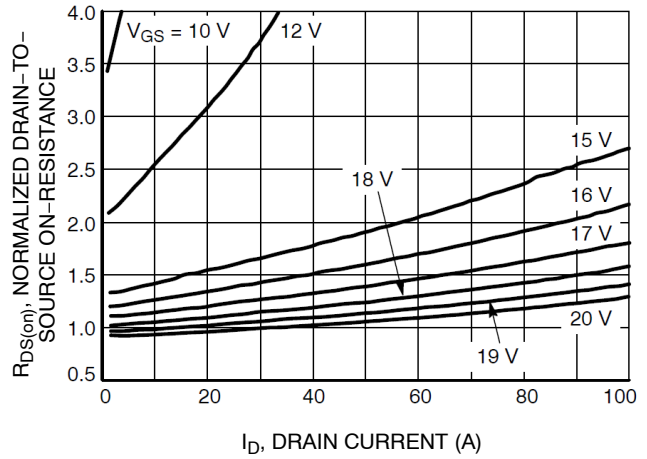


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

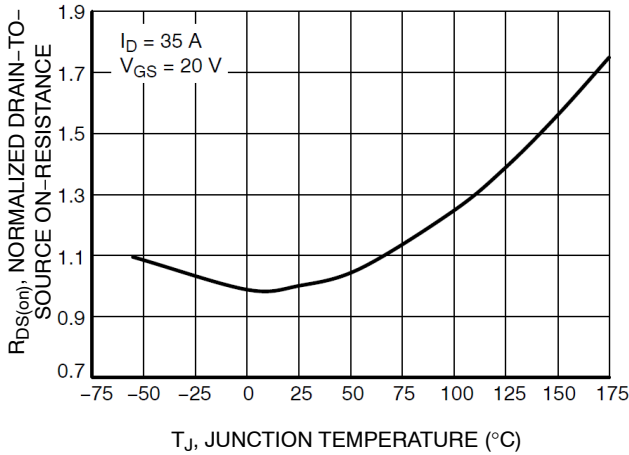


Figure 3. On-Resistance Variation with Temperature

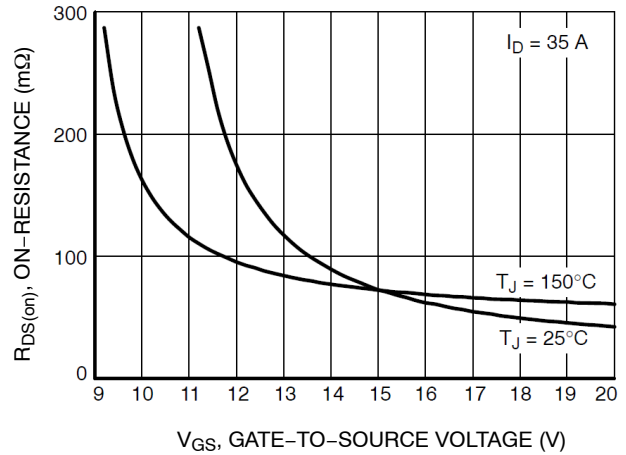


Figure 4. On-Resistance vs. Gate-to-Source Voltage

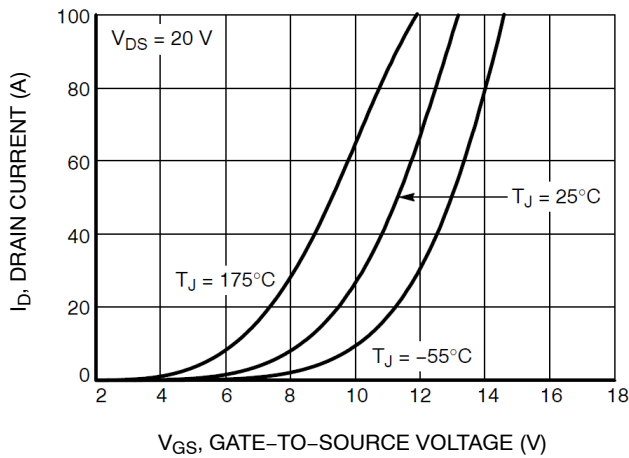


Figure 5. Transfer Characteristics

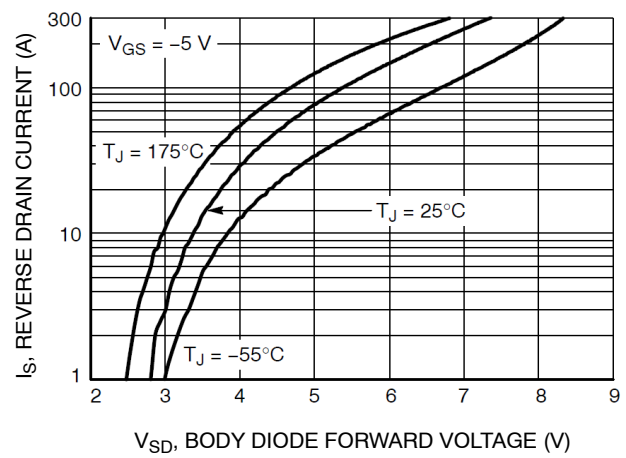


Figure 6. Diode Forward Voltage vs. Current

# NVXK2VR40WDT2

## TYPICAL CHARACTERISTICS (continued)

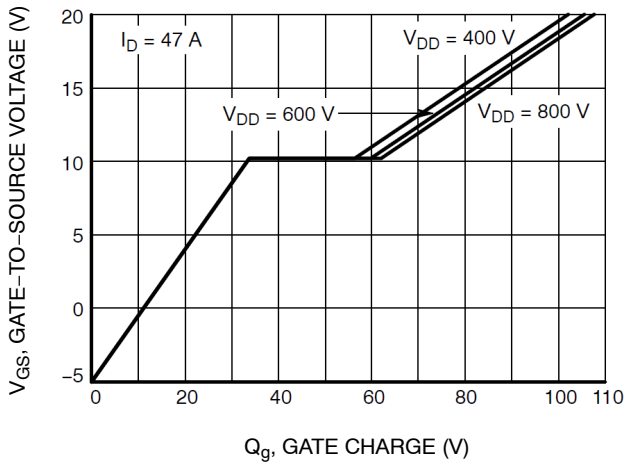


Figure 7. Gate-to-Source Voltage vs. Total Charge

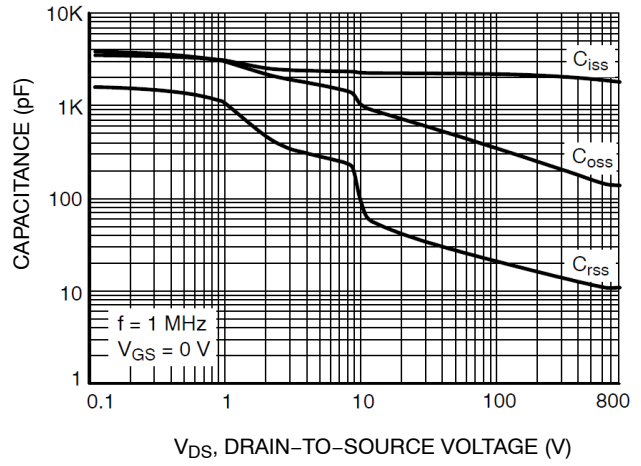


Figure 8. Capacitance vs. Drain-to-Source Voltage

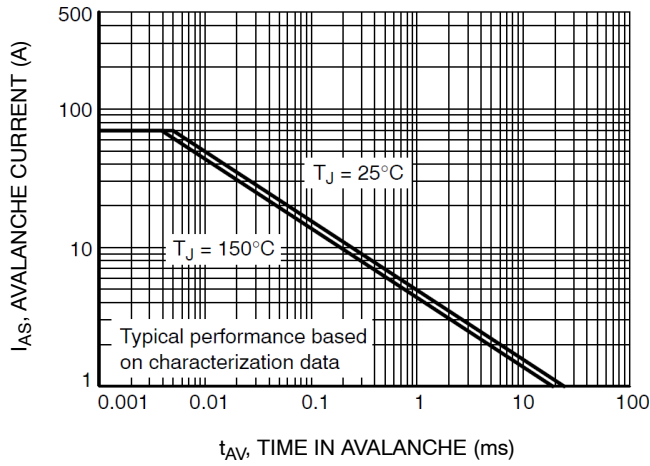


Figure 9. Unclamped Inductive Switching Capability

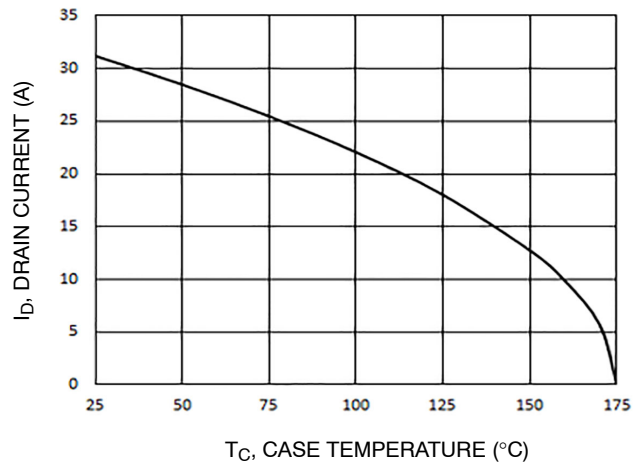


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

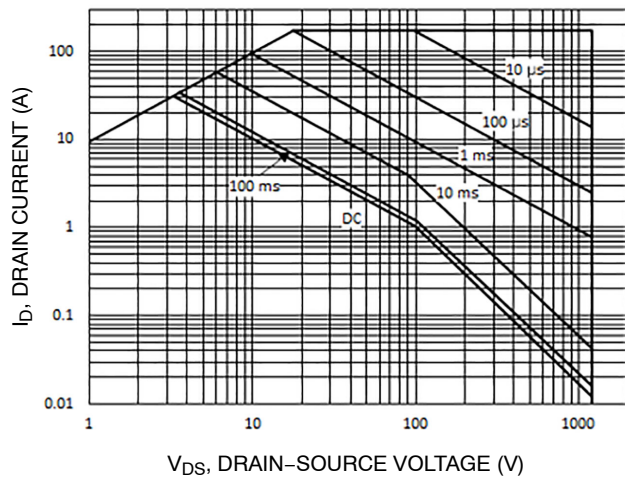


Figure 11. Safe Operating Area

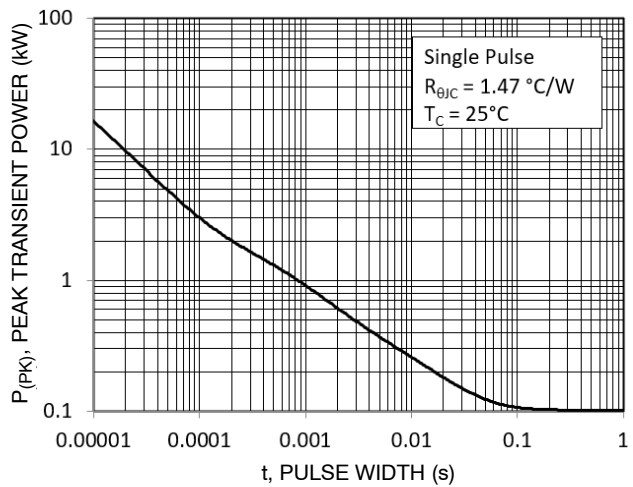


Figure 12. Single Pulse Maximum Power Dissipation

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## TYPICAL CHARACTERISTICS (continued)

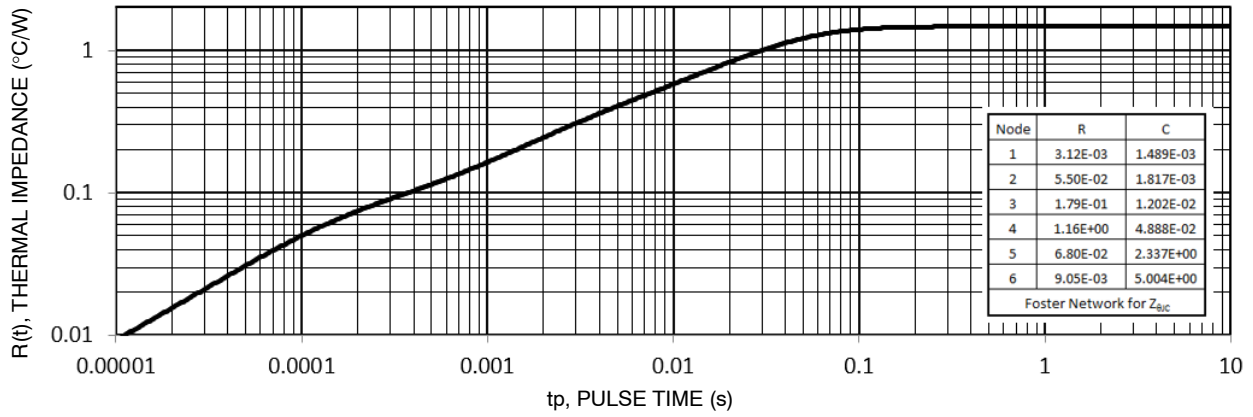
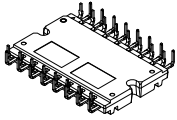
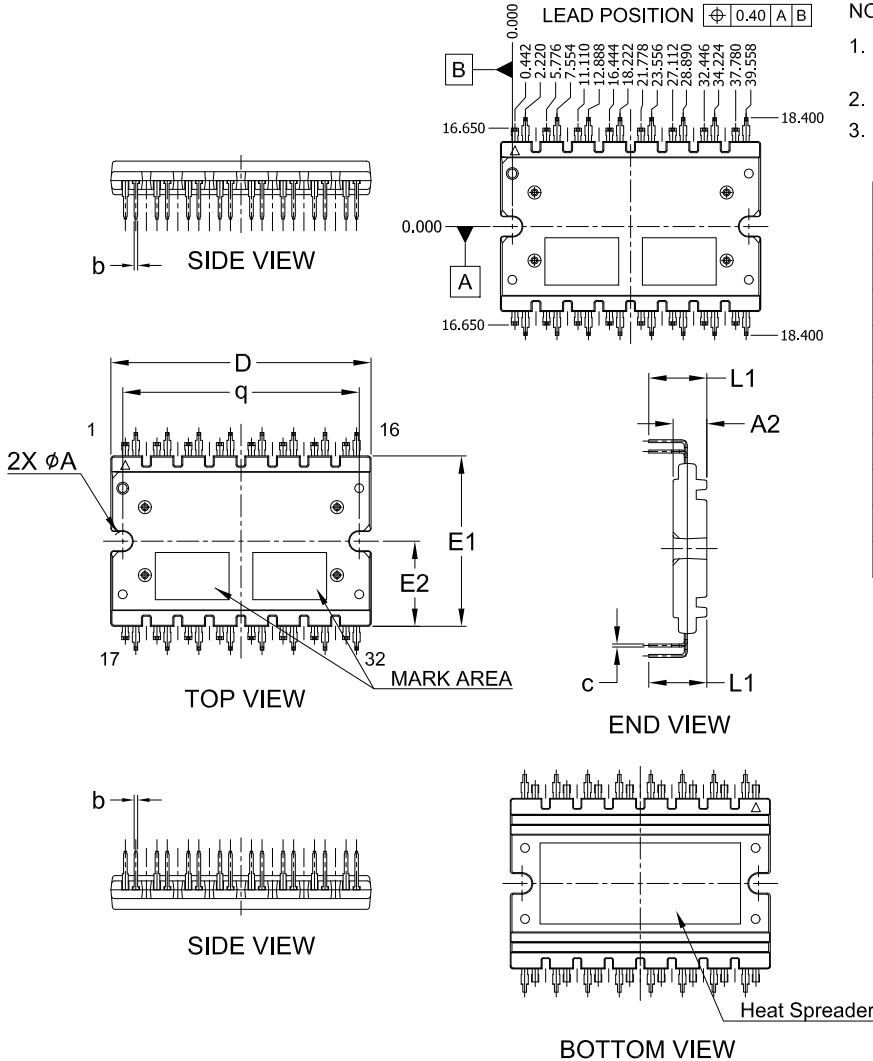


Figure 13. Thermal Response



**APM32 44.00x28.80x5.70  
CASE MODHM  
ISSUE A**

DATE 01 AUG 2023

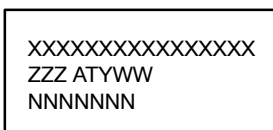


**NOTES:**

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	9.50	9.80	10.10
q	39.85	40.00	40.15
$\phi A$	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 "•", may or may not be present. Some products may not follow the Generic Marking.

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