

# Silicon Carbide (SiC) Module – EliteSiC Power Module for OBC, 40 mohm, 1200 V, 27 A, Dual Half-Bridge, in APM32 Series NVXK2TR40WXT

## Features

- DIP Silicon Carbide H-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

- DC-DC and On-Board Charger in xEV Applications

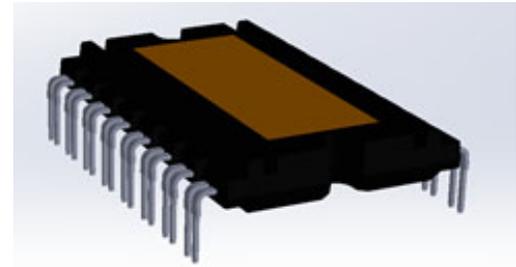
## MAXIMUM RATINGS (T<sub>J</sub> = 25°C unless otherwise noted)

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	V <sub>GSop</sub>	+20/-5	V
Continuous Drain Current (Notes 1, 2)	I <sub>D</sub>	27	A
Power Dissipation (Note 1)			
Pulsed Drain Current (Note 3)	I <sub>DM</sub>	240	A
Single Pulse Surge Drain Current Capability	I <sub>DSC</sub>	495	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) (Note 2)	I <sub>S</sub>	27	A
Single Pulse Drain-to-Source Avalanche Energy (Note 4)	E <sub>AS</sub>	338	mJ

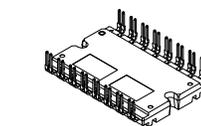
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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. Qualified per ECPE Guideline AQG 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> = 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	27 A



APM32



APM32  
AUTOMOTIVE MODULE  
CASE MODHL

## MARKING DIAGRAM

NVXK2TR40WXT
ZZZ ATYWW
NNNNNNN

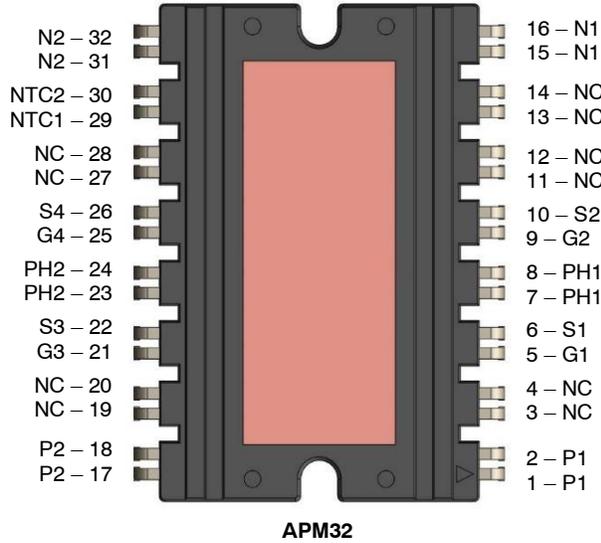
NVXK2TR40WXT = Specific Device Code  
 ZZZ = Lot ID  
 AT = Assembly Site & Test Location  
 Y = Year  
 W = Work Week  
 NNN = Serial Number

## ORDERING INFORMATION

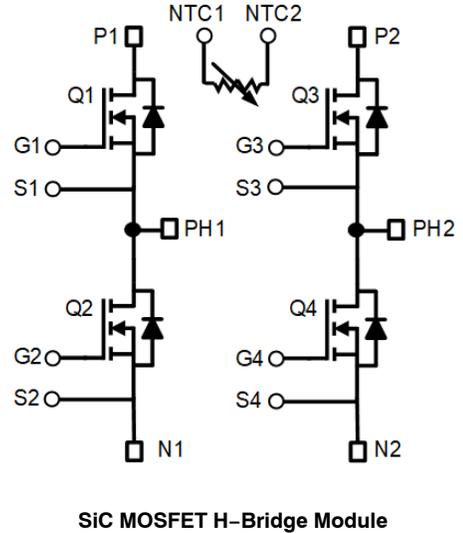
Device	Package	Shipping
NVXK2TR40WXT	APM32 (Pb-Free)	10 ea / Tube

# NVXK2TR40WXT

## PIN CONFIGURATION



## INTERNAL EQUIVALENT CIRCUIT



## PIN DESCRIPTION

Pin	Name	Pin Description
1, 2	P1	Intermediate DC Bus Plus1
5	G1	Q1 Gate
6	S1	Q1 Source
7, 8	PH1	Phase1 Output
9	G2	Q2 Gate
10	S2	Q2 Source
15, 16	N1	Intermediate DC Bus Minus1
17, 18	P2	Intermediate DC Bus Plus2
21	G3	Q3 Gate
22	S3	Q3 Source
23, 24	PH2	Phase2 Output
25	G4	Q4 Gate
26	S4	Q4 Source
29	NTC1	Negative Temperature Coefficient Thermistor Pin1
30	NTC2	Negative Temperature Coefficient Thermistor Pin2
31, 32	N2	Intermediate DC Bus Minus2
3, 4, 11, 12, 13, 14, 19, 20, 27, 28	NC	Not Connected

# NVXK2TR40WXT

## THERMAL CHARACTERISTICS (Note 1)

Parameter	Symbol	Typ	Max	Unit
Thermal Resistance Junction-to-Case (Note 1)	$R_{\theta JC}$	0.37	0.47	$^{\circ}\text{C}/\text{W}$
Thermal Resistance Junction-to-Sink (Note 1)	$R_{\Psi JS}$	0.84	0.95	$^{\circ}\text{C}/\text{W}$

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}\text{C}$ 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 $25^{\circ}\text{C}$		450		$\text{mV}/^{\circ}\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}$ $V_{DS} = 1200\text{ V}$	$T_J = 25^{\circ}\text{C}$		100	$\mu\text{A}$
			$T_J = 175^{\circ}\text{C}$		1	$\text{mA}$
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	$R_{DS(on)}$	$V_{GS} = 20\text{ V}, I_D = 35\text{ A}, T_J = 25^{\circ}\text{C}$		40	59	$\text{m}\Omega$
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 20\text{ V}, I_D = 35\text{ A}, T_J = 175^{\circ}\text{C}$		71		$\text{m}\Omega$
Forward Transconductance	$g_{FS}$	$V_{DS} = 20\text{ V}, I_D = 35\text{ A}$		20		S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz},$ $V_{DS} = 800\text{ V}$		1789		$\text{pF}$
Output Capacitance	$C_{OSS}$			139		
Reverse Transfer Capacitance	$C_{RSS}$			12.5		
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V},$ $I_D = 47\text{ A}$		106		$\text{nC}$
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	

### 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 3)	$I_{SDM}$	$V_{GS} = -5\text{ V}, T_J = 25^{\circ}\text{C}$			240	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

# NVXK2TR40WXT

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>DRAIN-SOURCE DIODE CHARACTERISTICS</b>						
Reverse Recovery Time	t <sub>RR</sub>	V <sub>GS</sub> = -5 V, dI <sub>S</sub> /dt = 1000 A/μs, I <sub>SD</sub> = 17.5 A		24		ns
Peak Reverse Recovery Current	I <sub>RRM</sub>			10.4		A
Charge Time	t <sub>a</sub>			12.4		ns
Discharge Time	t <sub>b</sub>			11.6		ns
Reverse Recovery Charge	Q <sub>RR</sub>			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.

5. Pulse test: pulse width ≤300 μs, duty ratio ≤2%.

## NTC THERMISTOR

Description	Type	Quantity	Specification
10 kΩ, ±3% Case Size 0603	Discrete	1	B Constants B <sub>25/50</sub> : 3590 B <sub>25/85</sub> = 3635 B <sub>25/100</sub> = 3650 ±3%

# NVXK2TR40WXT

## TYPICAL CHARACTERISTICS

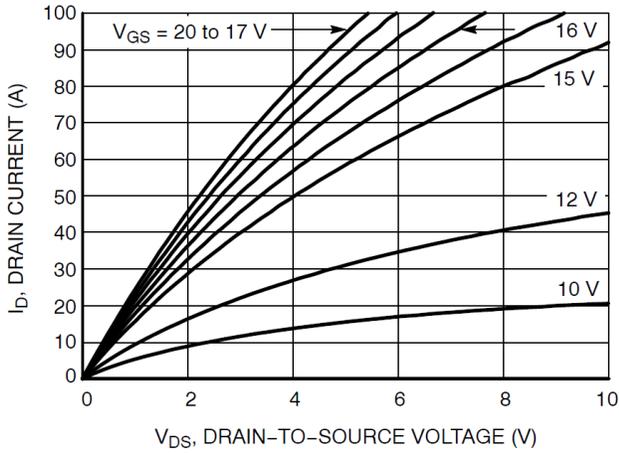


Figure 1. On-Region Characteristics

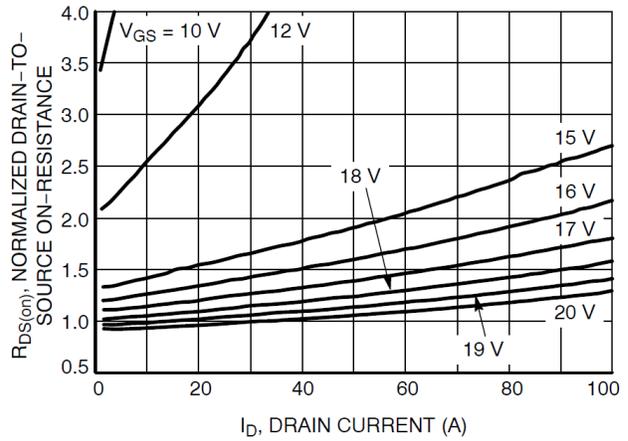


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

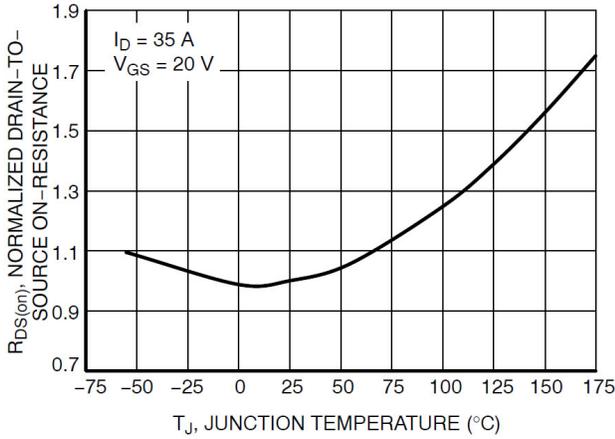


Figure 3. On-Resistance Variation with Temperature

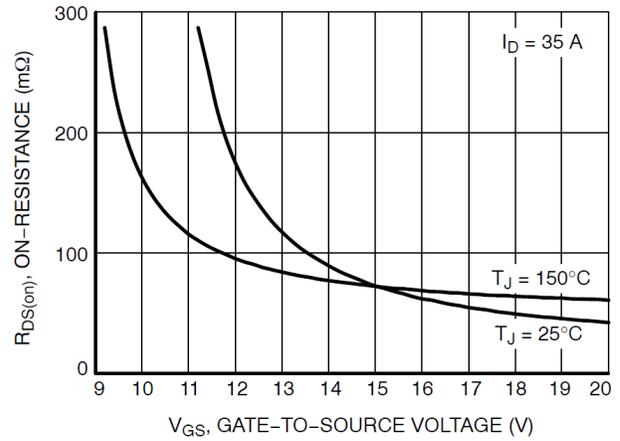


Figure 4. On-Resistance vs. Gate-to-Source Voltage

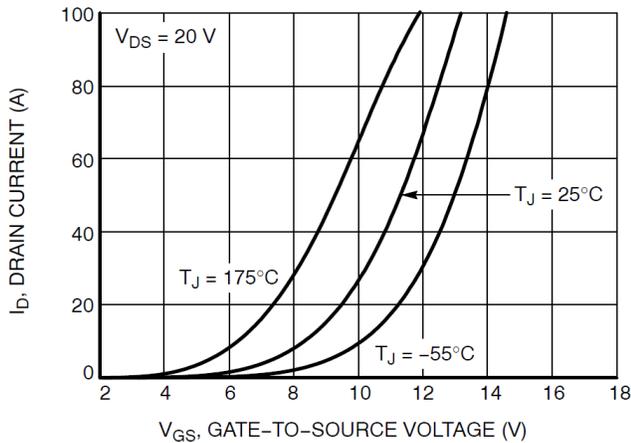


Figure 5. Transfer Characteristics

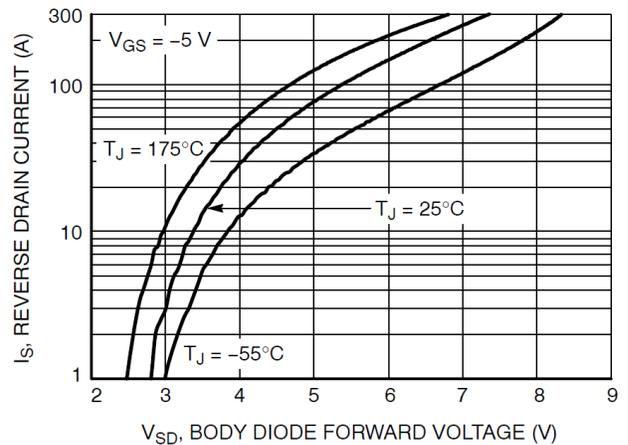


Figure 6. Diode Forward Voltage vs. Current

# NVXK2TR40WXT

## TYPICAL CHARACTERISTICS (CONTINUED)

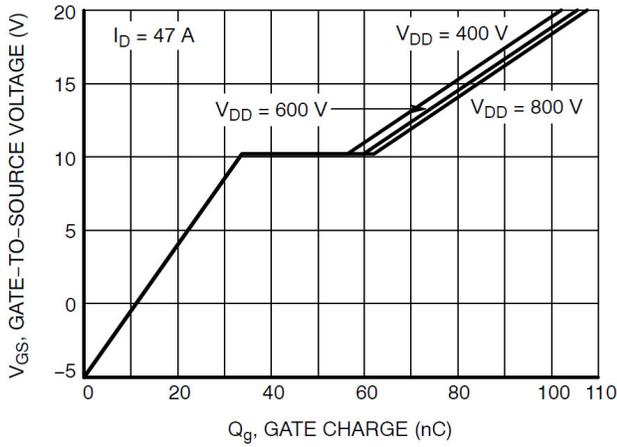


Figure 7. Gate-to-Source Voltage vs. Total Charge

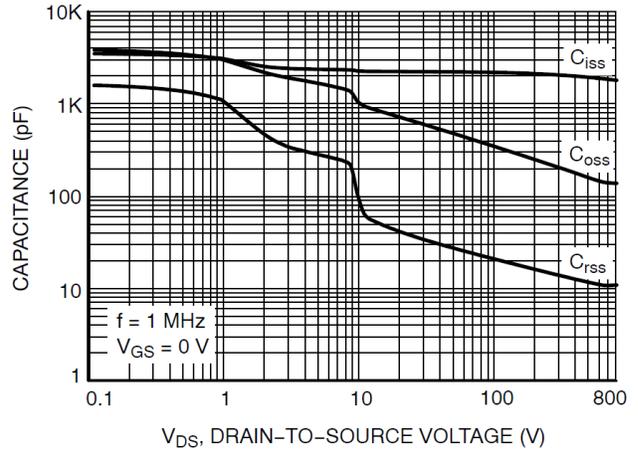


Figure 8. Capacitance vs. Drain-to-Source Voltage

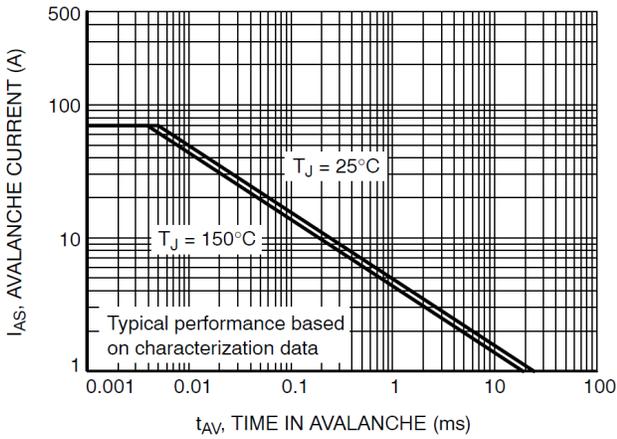


Figure 9. Unclamped Inductive Switching Capability

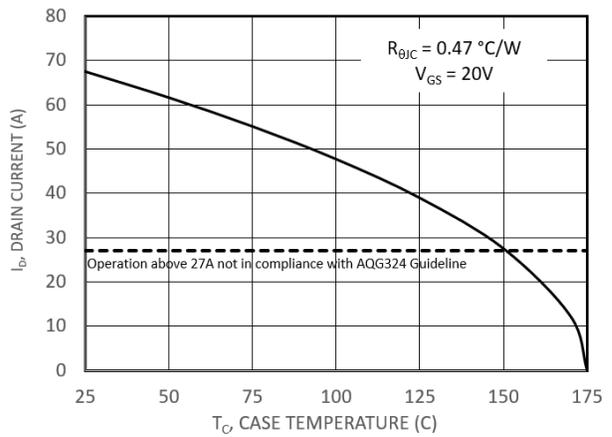


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

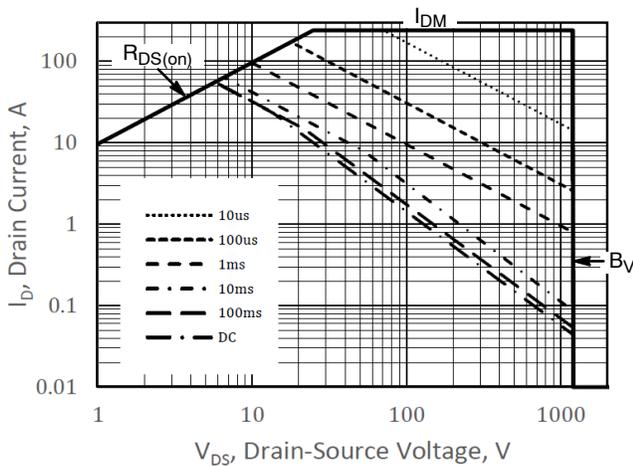


Figure 11. Safe Operating Area

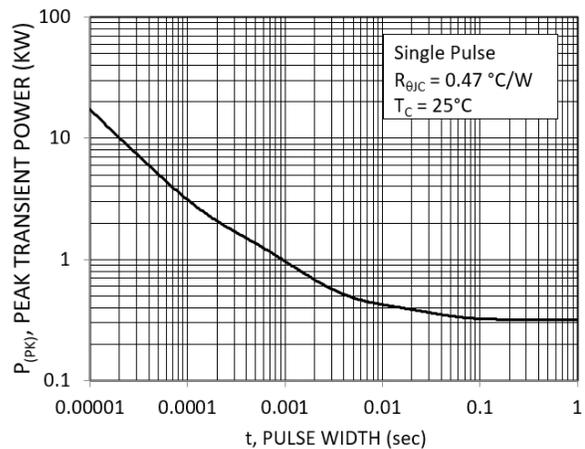


Figure 12. Single Pulse Maximum Power Dissipation

# NVXK2TR40WXT

## TYPICAL CHARACTERISTICS (CONTINUED)

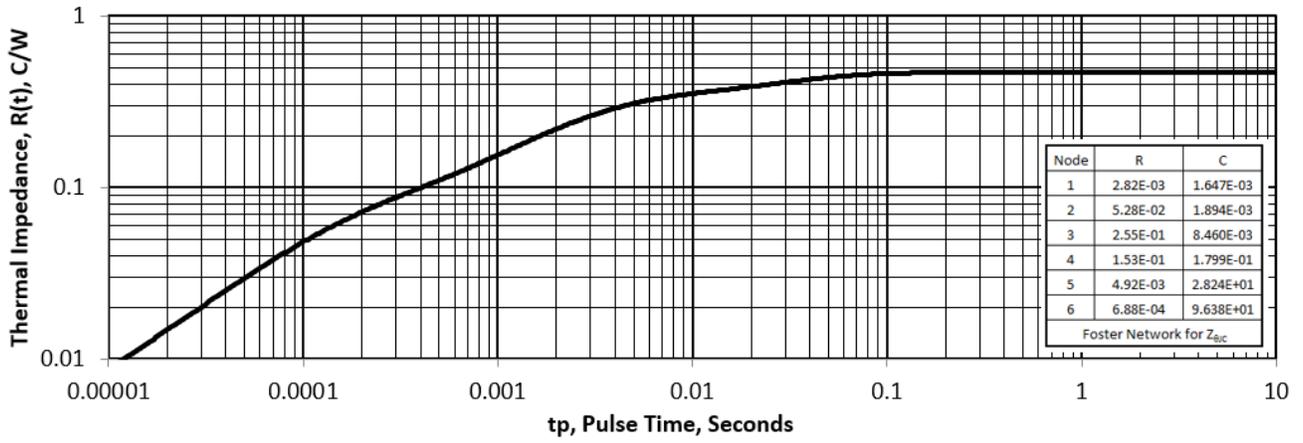
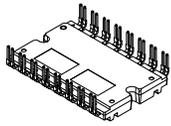


Figure 13. Thermal Response

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

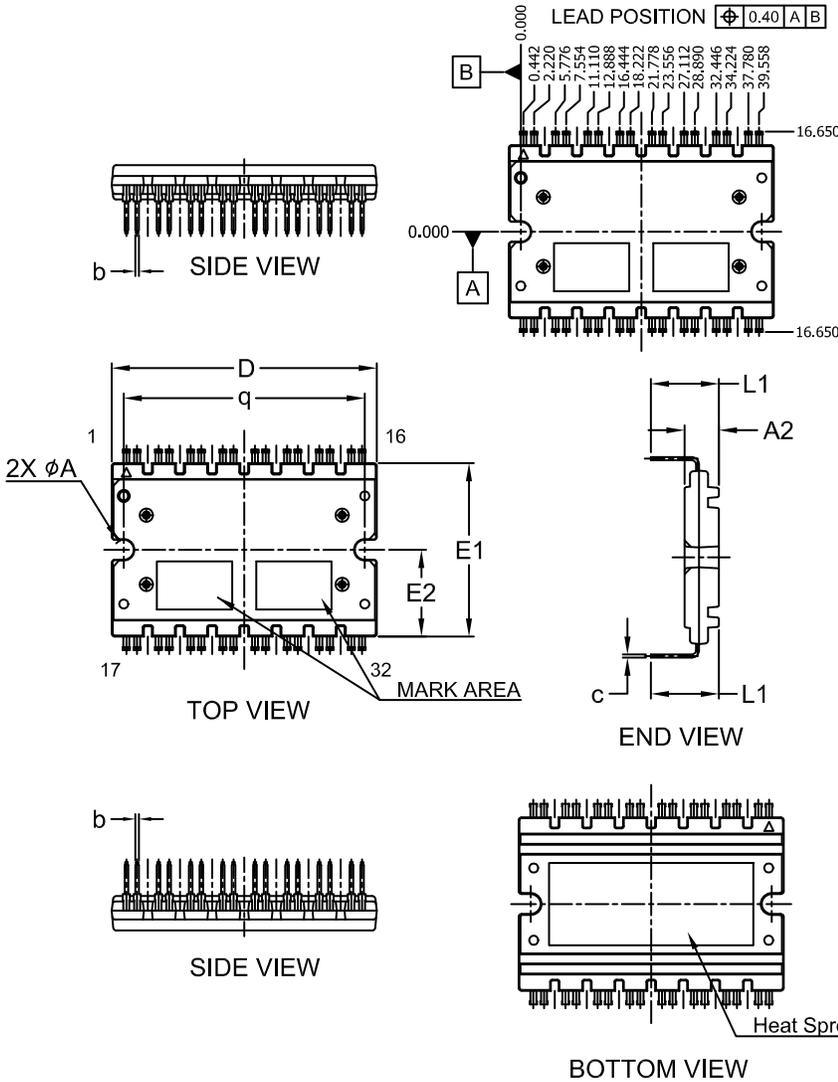


### APM32 AUTOMOTIVE MODULE

#### 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
$\phi A$	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 "u", 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](http://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](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

### ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at [www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)