

# Silicon Carbide (SiC) Module – EliteSiC Power Module for OBC, 40 mohm, 1200 V, 55 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

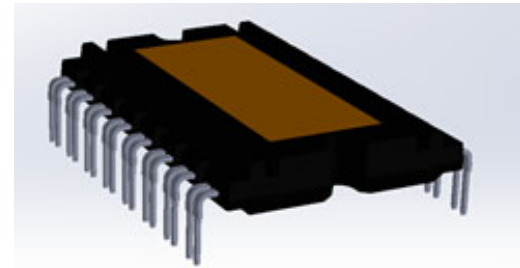
## MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter                                                                            | Symbol     | Value      | Unit             |
|--------------------------------------------------------------------------------------|------------|------------|------------------|
| Drain-to-Source Voltage                                                              | $V_{DS}$   | 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 (Note 1)                                                    | $I_D$      | 55         | A                |
| Power Dissipation (Note 1)                                                           | $P_D$      | 319        | W                |
| Pulsed Drain Current (Note 2)                                                        | $I_{DM}$   | 170        | A                |
| Single Pulse Surge Drain Current Capability                                          | $I_{DSC}$  | 495        | A                |
| Operating Junction Temperature                                                       | $T_J$      | -55 to 175 | $^\circ\text{C}$ |
| Storage Temperature                                                                  | $T_{stg}$  | -40 to 125 | $^\circ\text{C}$ |
| Source Current (Body Diode)                                                          | $I_S$      | 55         | A                |
| Single Pulse Drain-to-Source Avalanche Energy (Note 3)                               | $E_{AS}$   | 338        | mJ               |

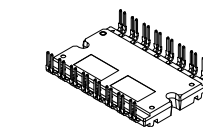
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Particular conditions specified determine thermal resistance values shown. Infinite heatsink with  $T_C = 100^\circ\text{C}$  for  $R_{\theta JC}$ . For  $R_{\theta JS}$  assembled to 3 mm thick aluminum heatsink with infinite cooling bottom surface at  $85^\circ\text{C}$ , through 38  $\mu\text{m}$  thick TIM with 6.5 W/mK thermal conductivity.
2. Repetitive rating limited by maximum junction temperature and transconductance.
3.  $E_{AS}$  based on initial  $T_J = 25^\circ\text{C}$ ,  $L = 1\text{ mH}$ ,  $I_{AS} = 26\text{ A}$ ,  $V_{DD} = 120\text{ V}$ ,  $V_{GS} = 18\text{ V}$ .

| $V_{(BR)DSS}$ | $R_{DS(on)} \text{ Max}$ | $I_D \text{ Max}$ |
|---------------|--------------------------|-------------------|
| 1200 V        | 59 m $\Omega$ @ 20 V     | 55 A              |



APM32


APM32  
AUTOMOTIVE MODULE  
CASE MODHL

## MARKING DIAGRAM

NVXK2TR40WXT  
ZZZ ATYWW  
NNNNNNN

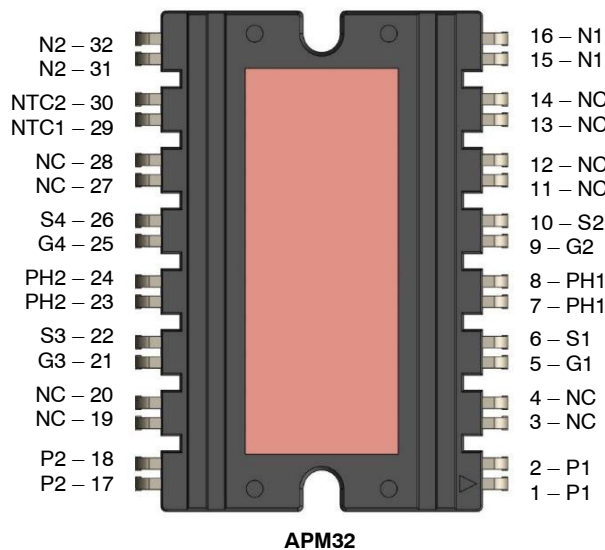
NVXK2TR40WXT = Specific Device Code  
ZZZ = Lot ID  
AT = Assembly Site & Test Location  
Y = Year  
W = Work Week  
NNN = Serial Number

## ORDERING INFORMATION

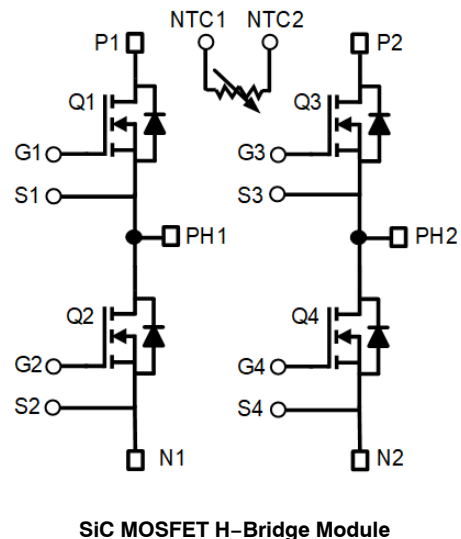
| Device       | Package            | Shipping     |
|--------------|--------------------|--------------|
| NVXK2TR40WXT | APM32<br>(Pb-Free) | 10 ea / Tube |

# 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 | °C/W |
| Thermal Resistance Junction-to-Sink (Note 1) | $R_{\theta JS}$ | 0.84 | 0.95 | °C/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 |         | mV/°C         |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$           | $V_{GS} = 0\text{ V}$<br>$V_{DS} = 1200\text{ V}$      |      |     | 100     | $\mu\text{A}$ |
|                                                           |                     | $T_J = 25^\circ\text{C}$<br>$T_J = 175^\circ\text{C}$  |      |     | 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 4)

|                               |              |                                                                    |     |    |     |            |
|-------------------------------|--------------|--------------------------------------------------------------------|-----|----|-----|------------|
| 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  | 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 |     | m $\Omega$ |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 20\text{ V}, I_D = 35\text{ A}$                          |     | 20 |     | S          |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                              |              |                                                                          |  |      |  |          |
|------------------------------|--------------|--------------------------------------------------------------------------|--|------|--|----------|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz},$<br>$V_{DS} = 800\text{ V}$      |  | 1789 |  | pF       |
| Output Capacitance           | $C_{OSS}$    |                                                                          |  | 139  |  |          |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                          |  | 12.5 |  |          |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V},$<br>$I_D = 47\text{ A}$ |  | 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      | $t_{d(ON)}$  | $V_{GS} = -5 / 20\text{ V}, V_{DS} = 800\text{ V},$<br>$I_D = 47\text{ A}, R_G = 4.7\text{ }\Omega,$<br>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) | $I_{SD}$  | $V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$                              |  |     | 55  | 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                                  | $V_{SD}$  | $V_{GS} = -5\text{ V}, I_{SD} = 17.5\text{ A},$<br>$T_J = 25^\circ\text{C}$ |  | 3.7 |     | V |

# NVXK2TR40WXT

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

| Parameter                                 | Symbol    | Test Conditions                                                                              | Min | Typ  | Max | Unit |
|-------------------------------------------|-----------|----------------------------------------------------------------------------------------------|-----|------|-----|------|
| <b>DRAIN-SOURCE DIODE CHARACTERISTICS</b> |           |                                                                                              |     |      |     |      |
| Reverse Recovery Time                     | $t_{RR}$  | $V_{GS} = -5\text{ V}$ , $dI_S/dt = 1000\text{ A}/\mu\text{s}$ ,<br>$I_{SD} = 17.5\text{ A}$ |     | 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  $\leq 300\text{ }\mu\text{s}$ , duty ratio  $\leq 2\%$ .

## NTC THERMISTOR

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

TYPICAL CHARACTERISTICS

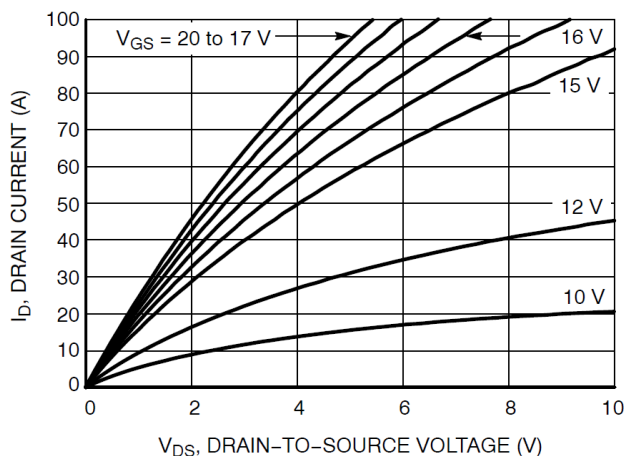


Figure 1. On-Region Characteristics

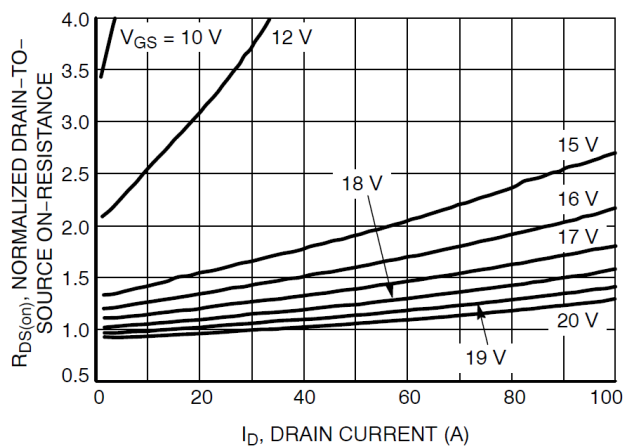


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

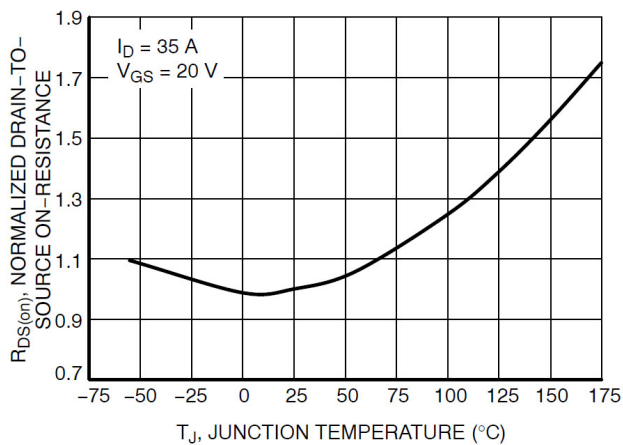


Figure 3. On-Resistance Variation with Temperature

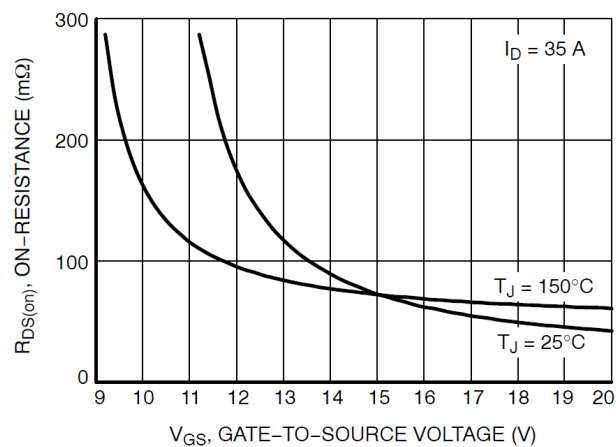


Figure 4. On-Resistance vs. Gate-to-Source Voltage

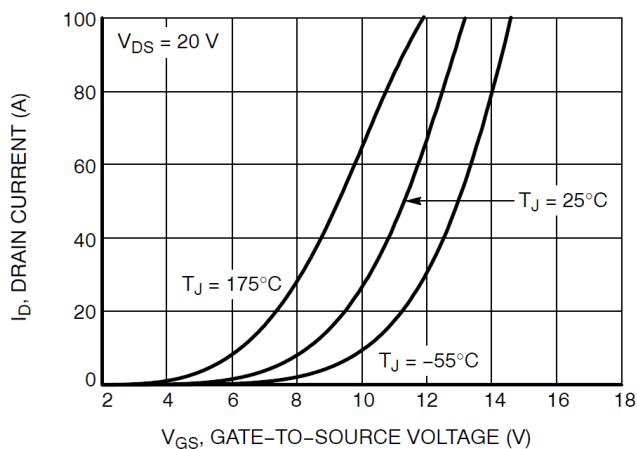


Figure 5. Transfer Characteristics

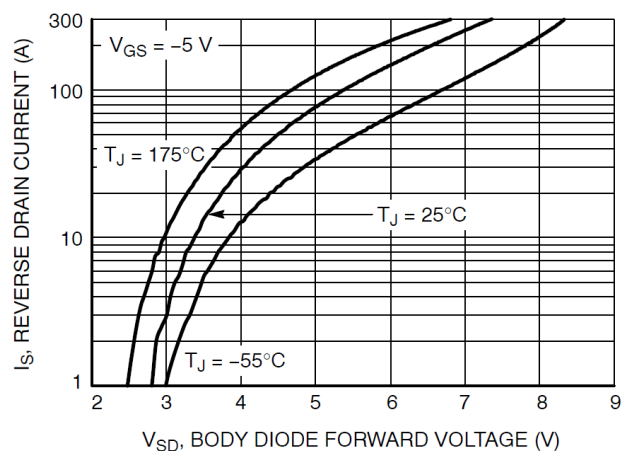


Figure 6. Diode Forward Voltage vs. Current

# NVXK2TR40WXT

## TYPICAL CHARACTERISTICS (CONTINUED)

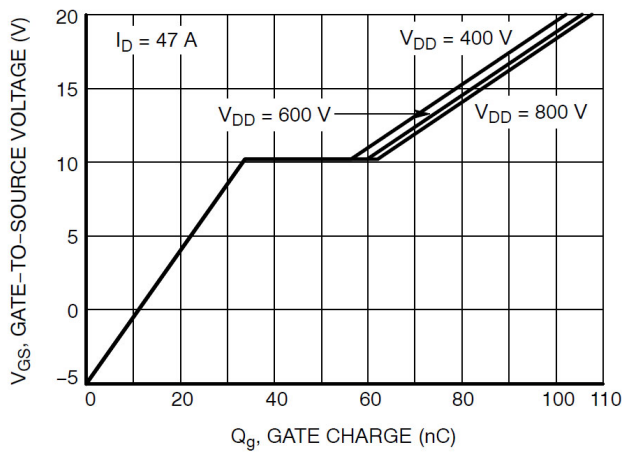


Figure 7. Gate-to-Source Voltage vs. Total Charge

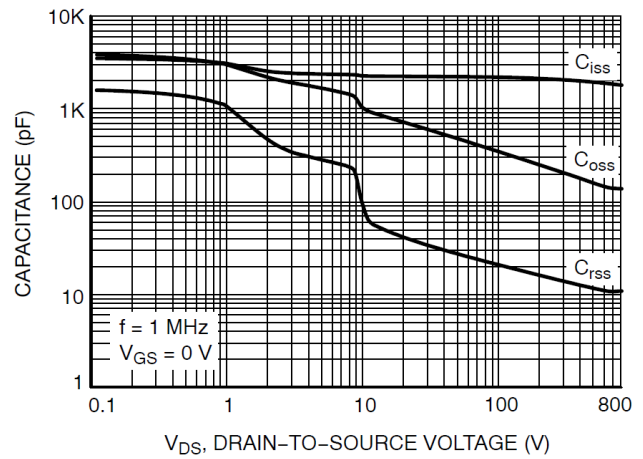


Figure 8. Capacitance vs. Drain-to-Source Voltage

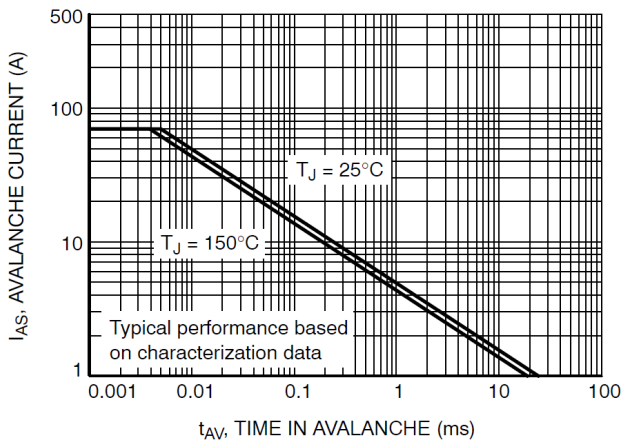


Figure 9. Unclamped Inductive Switching Capability

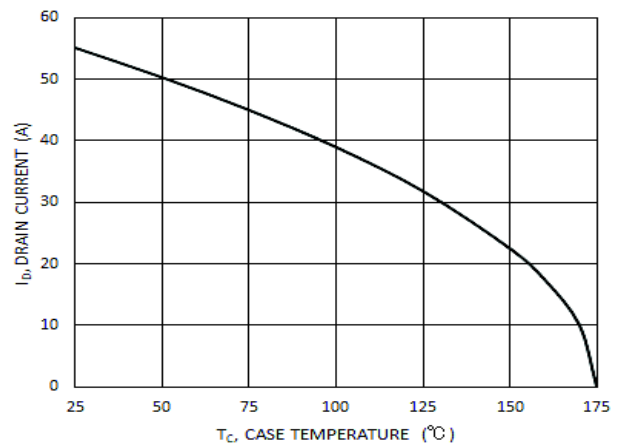


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

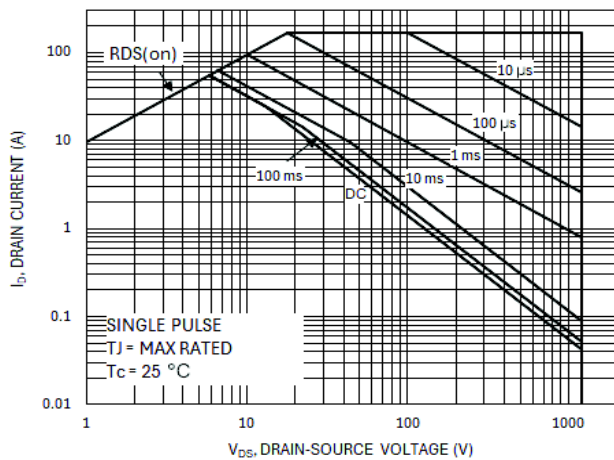


Figure 11. Safe Operating Area

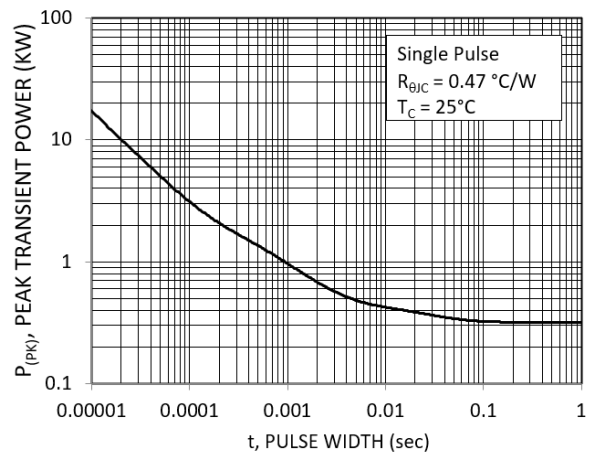


Figure 12. Single Pulse Maximum Power Dissipation

# NVXK2TR40WXT

## TYPICAL CHARACTERISTICS (CONTINUED)

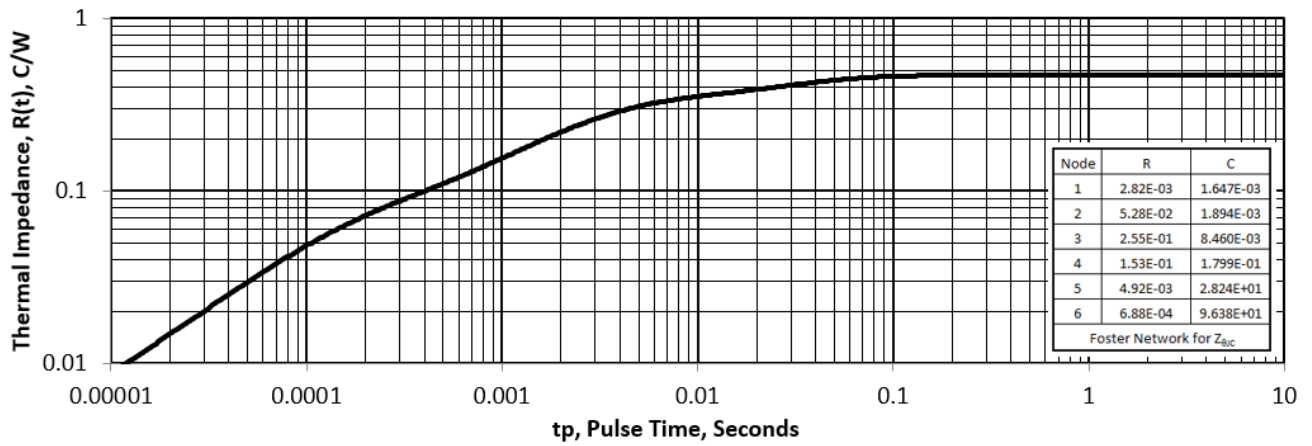
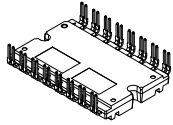
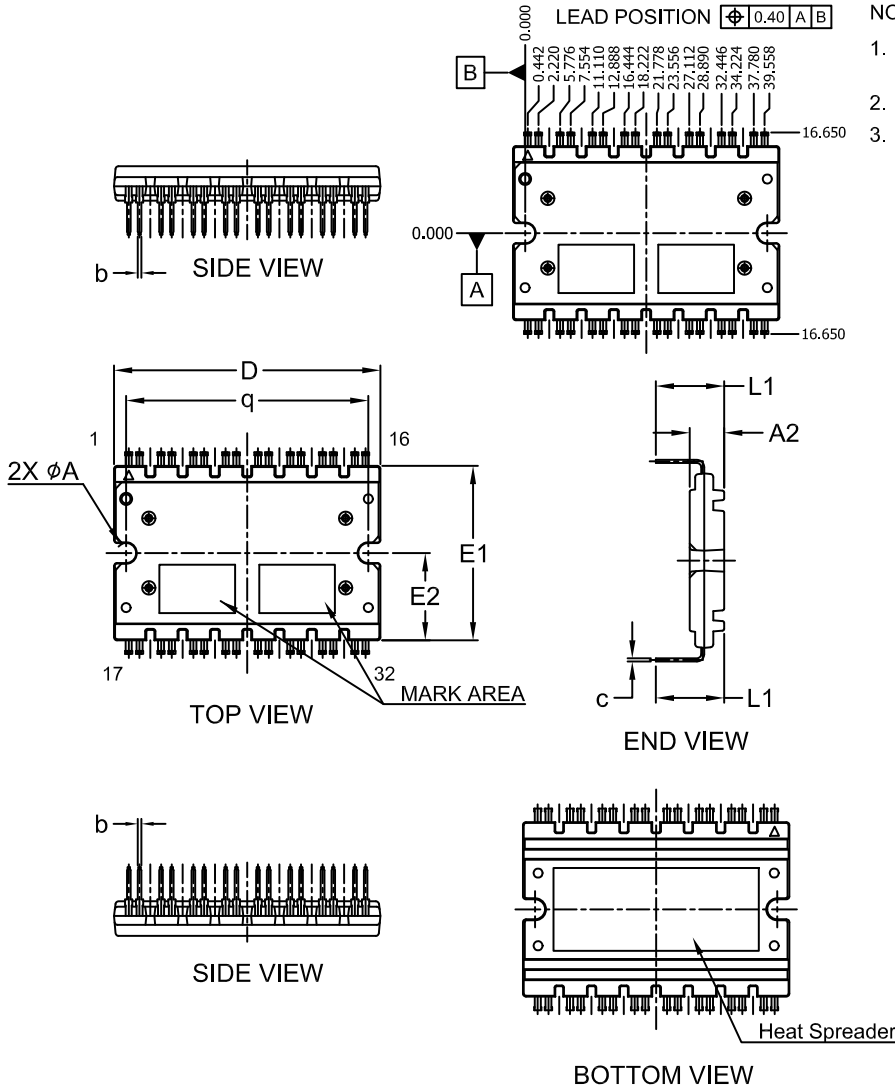


Figure 13. Thermal Response



**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\***

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.

|                         |                                |                                                                                                                                                                                  |
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