# Single Phase Inverter Automotive Power MOSFET Module
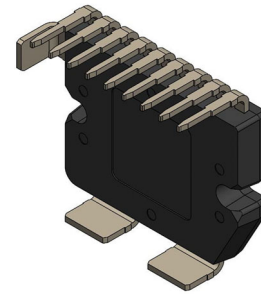
# NXV08A170DB2

## Features
- Half Bridge Inverter for Variable Speed Motor Drive
- Current Sensing and Temperature Sensing
- Electrically Isolated DBC Substrate for Low Thermal Resistance
- Compact Design for Low Total Module Resistance
- Module Serialization for Full Traceability
- C Snubber for Low EMI
- AQG324 Qualified
- PPAP Capable
- This Device is Pb−free, RoHS and UL94−V0 Compliant

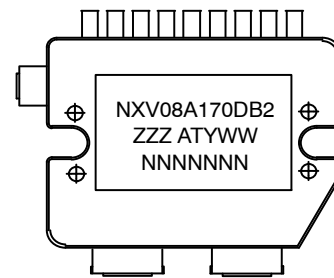## Applications
- 48 V Motor Control

## Benefits
- Enable Design of Small, Efficient and Reliable System for Reduced Vehicle Fuel Consumption and $CO_2$ Emission
- Enable Low Thermal Resistance
- Simplified Vehicle Assembly

**APM12−CBA
CASE MODBG**

**MARKING DIAGRAM**



NXV08A170DB2
ZZZ ATYWW
NNNNNNN

| NXV08A170DB2 | = Specific Device Code |
| ZZZ | = Lot ID |
| AT | = Assembly & Test Location |
| Y | = Year |
| WW | = Work Week |
| NNN | = Serial Number |

## ORDERING INFORMATION

# NXV08A170DB2
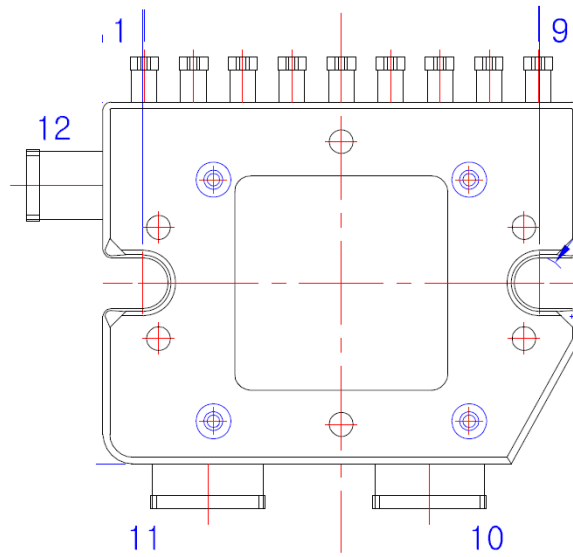


**Figure 1. Pin Configuration**

## PIN DESCRIPTION

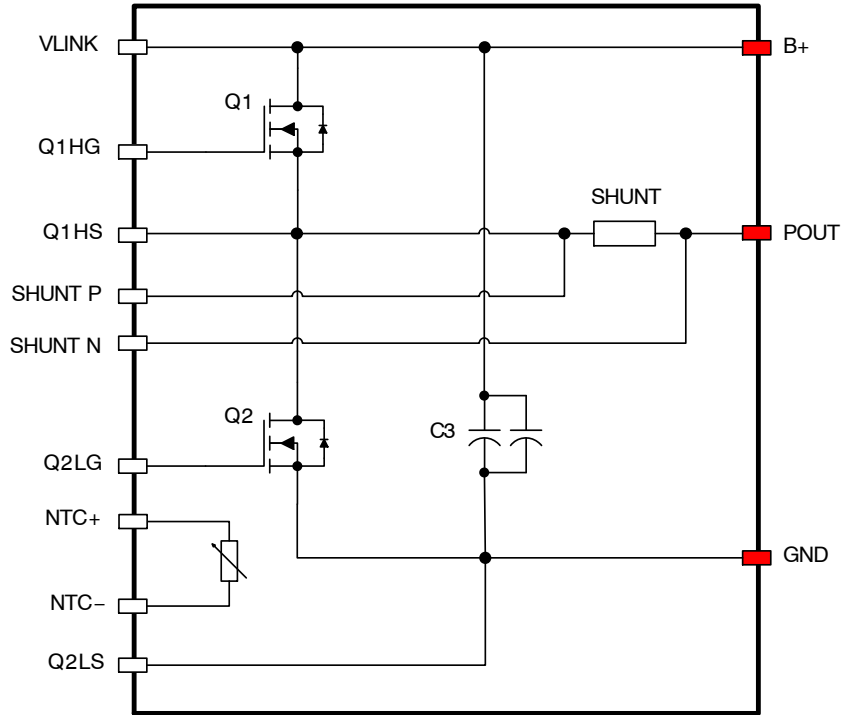| Pin Number | Pin Name | Pin Description |
|------------|----------|-----------------|
| 1 | Q2LG | Low side MOSFET (Q2) Gate |
| 2 | Q2LS | Low side MOSFET (Q2) source sense |
| 3 | NTC+ | Thermistor 1 |
| 4 | NTC− | Thermistor 2 |
| 5 | Shunt N | Shunt N |
| 6 | Shunt P | Shunt P |
| 7 | Q1HS | High side MOSFET (Q1) source sense |
| 8 | VLINK | B+ Sense |
| 9 | Q1HG | High side MOSFET (Q1) Gate |
| 10 | B+ | B+ connection |
| 11 | GND | GND connection |
| 12 | POUT | Phase connection |

# NXV08A170DB2

**Block Diagram**



**Figure 2. Schematic**

**Flammability Information**

All materials present in the power module meet UL flammability rating class 94V−0.

**Compliance to RoHS Directives**

The power module is 100% lead free and RoHS compliant 2000/53/C directive.

**Solder**

Solder used is a lead free SnAgCu alloy.

**ABSOLUTE MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain to Source Voltage | 80 | V |
| $V_{GS}$ | Gate to Source Voltage | ±20 | V |
| $I_D$ | Drain Current Continuous (Note 1) | 200 | A |
| $E_{AS}$ | Single Pulse Avalanche Energy (Note 2) | 685 | mJ |
| $T_{J(max)}$ | Maximum Junction Temperature | 175 | °C |
| $T_{STG}$ | Storage Temperature Range | −40 ~ +125 | °C |
| $V_{ISO}$ | Isolation Voltage | 2000 | Vrms |

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. Defined by design, not subject to production testing. The value is the result of the calculation, Min (package limit max current, Silicon limit max current) where the silicon limit current is calculated based on the maximum value which is not to exceed $T_J$ = 175°C on maximum thermal limitation and on resistance.
2. Starting $T_J$ = 25°C, L = 0.47 mH, $I_{AS}$ = 54 A, $V_{DD}$ = 80 V during inductor charging and $V_{DD}$ = 0 V during time in avalanche.

## THERMAL CHARACTERISTICS

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction−to−Case (Note 3) | – | – | 0.82 | K/W |

3. Test method compliant with MIL−STD−883−1012.1, case temperature measured below the package at the chip center. Cosmetic oxidation and discolor on the DBC surface is allowed.

## ELECTRICAL CHARACTERISTICS ($T_J$ = 25°C unless otherwise noted)

| Parameters | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Drain−to−Source Breakdown Voltage | $I_D$ = 250 μA, $V_{GS}$ = 0 V | $B_{VDSS}$ | 80 | – | – | V |
| Drain−to−Source Leakage Current | $V_{DS}$ = 80 V, $V_{GS}$ = 0 V | $I_{DSS}$ | – | – | 1 | μA |
| Gate−to−Source Leakage Current | $V_{GS}$ = ±20 V | $I_{GSS}$ | – | – | ±100 | nA |
| Gate−to−Source Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 250 μA | $V_{GS(th)}$ | 2.0 | – | 4.0 | V |
| Body Diode Forward Voltage of MOSFET | $I_{SD}$ = 80 A, $V_{GS}$ = 0 V | $V_{SD}$ | – | 0.8 | 1.2 | V |
| Drain−to−Source On Resistance, Q1 | $I_D$ = 80 A, $V_{GS}$ = 10 V (Note 4) | $R_{DS(ON)Q1}$ | – | 0.66 | 0.99 | mΩ |
| Drain−to−Source On Resistance, Q2 | | $R_{DS(ON)Q2}$ | – | 0.90 | 1.35 | mΩ |
| Drain−to−Source On Resistance, Module Level Q1 | | $R_{DS(ON) \text{ Module Q1}}$ | – | 1.75 | 2.40 | mΩ |
| Drain−to−Source On Resistance, Module Level Q2 | | $R_{DS(ON) \text{ Module Q2}}$ | – | 1.75 | 2.40 | mΩ |

4. All bare die MOSFETs have same die size and same level of $R_{DS(ON)}$ value. However the different $R_{DS(ON)}$ values listed in the datasheet are due to the different access points available inside the module for $R_{DS(ON)}$ measurement. Q1 (High side FET) has shorter $R_{DS(ON)}$ measurement path in the layout, in this reason, $R_{DS(ON)}$ value of Q1 can be used for simple power loss calculation.

**Resistance Measurements Methods**

### MOSFET MEASUREMENTS

| | + Force | − Force | + Sense | − Sense | | + Force | − Force | + Sense | − Sense |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | B+ | Phase | Vlink | Q1 Sorce | Q2 | Phase | GND | Q1 Source | Q2 Source |
| PIN# | 9 | 11 | 8 | 5 | PIN# | 11 | 10 | 5 | 2 |

### MODULE PATH MEASUREMENTS

| | + Force | − Force | + Sense | − Sense | | + Force | − Force | + Sense | − Sense |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | B+ | Phase | B+ | Phase | Q2 | Phase | GND | Phase | GND |
| PIN# | 9 | 11 | 9 | 11 | PIN# | 11 | 10 | 11 | 10 |

### CURRENT SENSE RESISTOR

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $R_{SHUNT}$ | Current Sense Resistor, Id = 80 A (Note 5) | 0.293 | 0.304 | 0.317 | mΩ |

5. Except resistance value, all the other characteristic is guaranteed by supplier.

## COMPONENTS

| Component | Specification | Quantity | Type |
|---|---|---|---|
| MOSFET | 80 V Bare die reference discrete part, FDBL86361_F085 | 2 | Bare Die |
| Current Sense Resistor | 0.3 mΩ | 1 | Discrete |
| Capacitor | DC 100 V, 68000 pF | 2 | Discrete |
| NTC | 10 kΩ | 1 | Discrete |

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Parameter | Symbol | Test Condition | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = 40 V, $V_{GS}$ = 0 V, f = 1 MHz | | – | 14000 | – | pF |
| Output Capacitance | $C_{oss}$ | | | – | 9450 | – | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | | | – | 100 | – | pF |
| Gate Resistance | $R_g$ | f = 1 MHz | | – | 2.9 | – | Ω |
| Total Gate Charge | $Q_{g(tot)}$ | $V_{GS}$ = 0 V to 10 V | $V_{DD}$ = 64 V, $I_D$ = 80 A | – | 195 | – | nC |
| Threshold Gate Charge | $Q_{g(th)}$ | $V_{GS}$ = 0 V to 2.7 V | | – | 35 | – | nC |
| Gate to Source Gate Charge | $Q_{gs}$ | $V_{DD}$ = 64 V, $I_D$ = 80 A | | – | 66 | – | nC |
| Gate to Drain "Miller" Charge | $Q_{gd}$ | | | – | 45 | – | nC |
| **ON CHARACTERISTICS** | | | | | | | |
| Turn–On Time | $t_{on}$ | $V_{DD}$ = 48 V, $I_D$ = 80 A $V_{GS}$ = 10 V, $R_{GEN}$ = 6 Ω (Note 6) | | – | 250 | – | ns |
| Turn–On Delay Time | $t_{d(on)}$ | | | – | 65 | – | ns |
| Turn–On Rise Time | $t_r$ | | | – | 184 | – | ns |
| Turn–Off Delay Time | $t_{d(off)}$ | | | – | 153 | – | ns |
| Turn–Off Fall Time | $t_f$ | | | – | 123 | – | ns |
| Turn–Off Time | $t_{off}$ | | | – | 276 | – | ns |
| **BODY DIODE CHARACTERISTICS** | | | | | | | |
| Reverse Recovery Time | $T_{rr}$ | $V_{SD}$ = 64 V, $I_{SD}$ = 125 A, dI/dt = 100 A/μs | | – | 112 | – | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | | – | 208 | – | 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.
6. By characterization, the measurement is limited by test set up.

# NXV08A170DB2

## TYPICAL CHARACTERISTICS
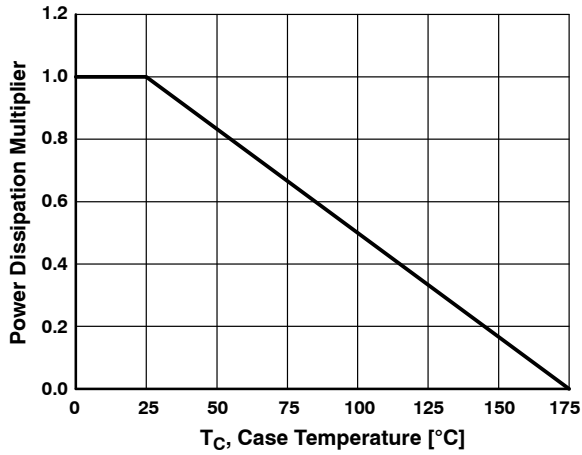
Figure 3. Normalized Power Dissipation
vs. Case Temperature
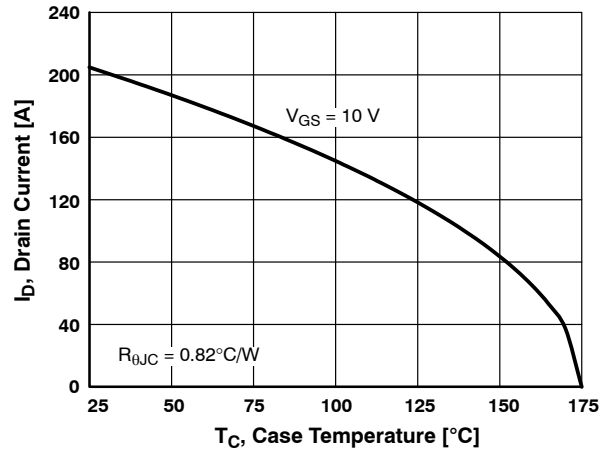
Figure 4. Maximum Continuous Drain
Current vs. Case Temperature
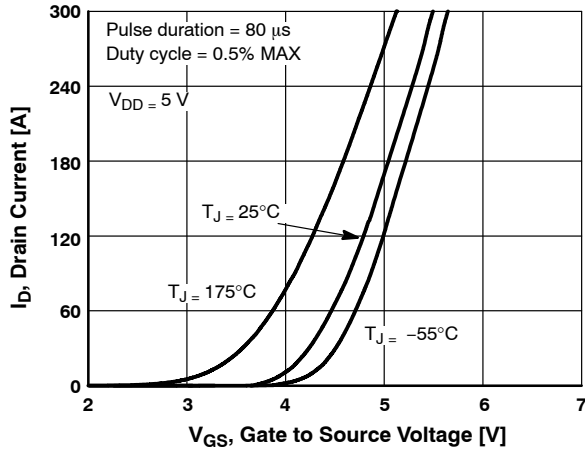
Figure 5. Transfer Characteristics
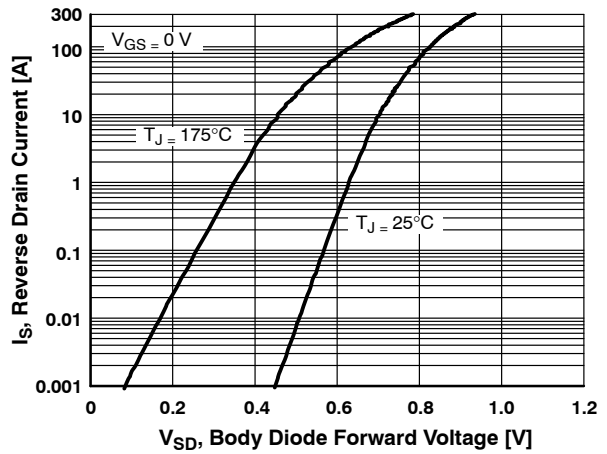
Figure 6. Forward Diode Characteristics
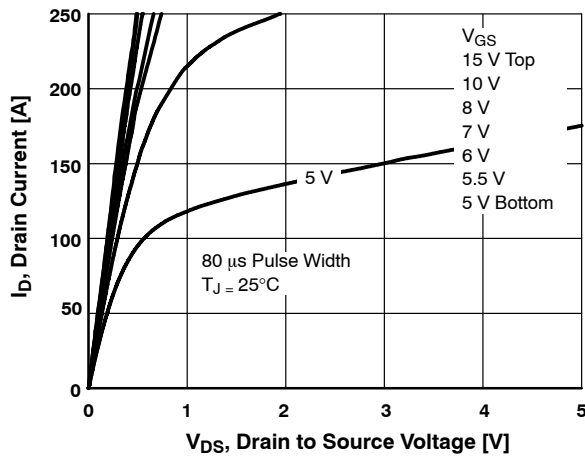
Figure 7. Saturation Characteristics (25°C)
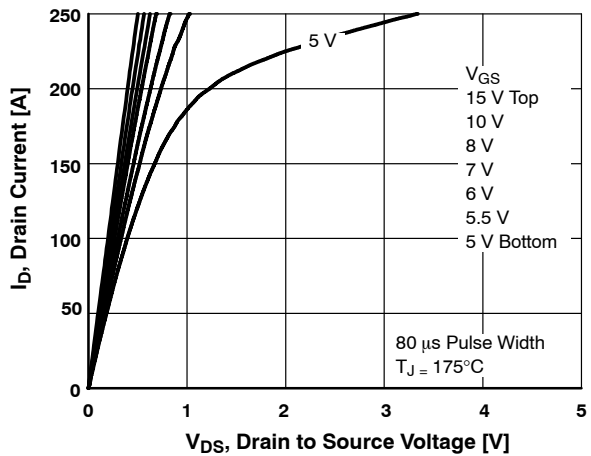
Figure 8. Saturation Characteristics (175°C)

**TYPICAL CHARACTERISTICS** (continued)
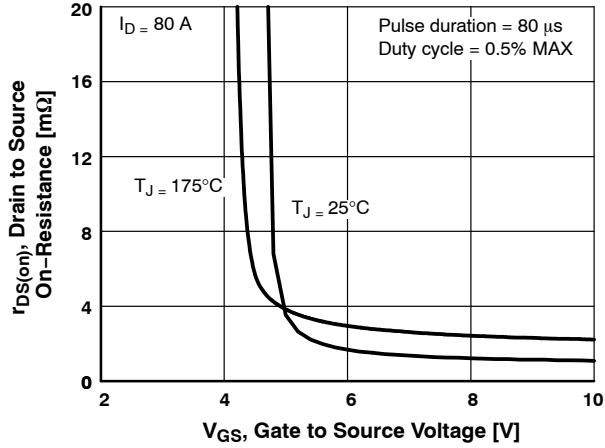
**Figure 9. R$_{DSON}$ vs. Gate Voltage**
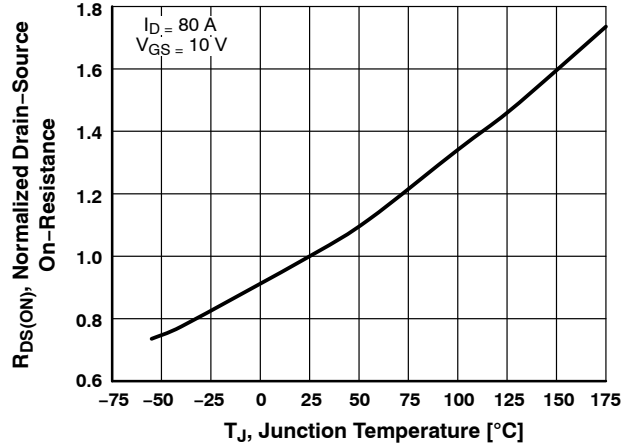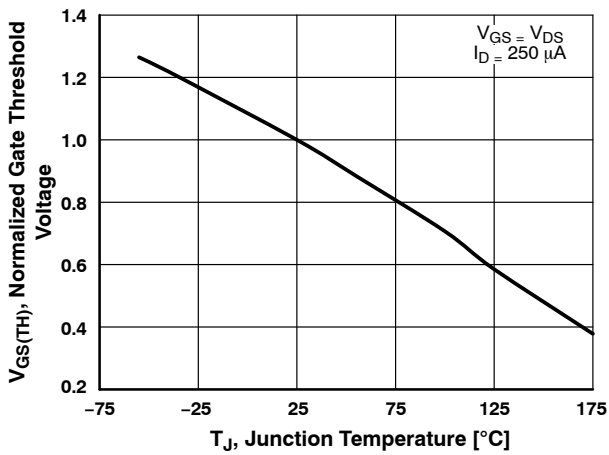
**Figure 10. Normalized R$_{DSON}$ vs. Junction Temperature**

**Figure 11. Normalized V$_{GS(TH)}$ vs. Temperature**
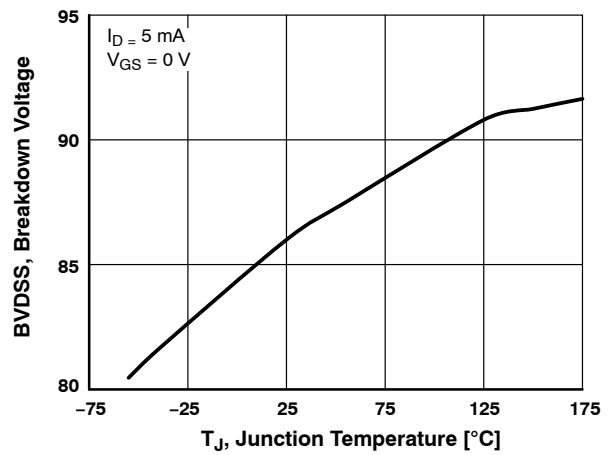
**Figure 12. Breakdown Voltage vs. Temperature**
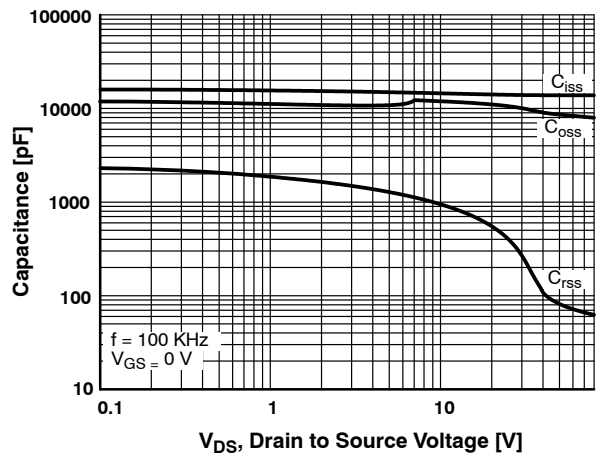
**Figure 13. Capacitance Variation**
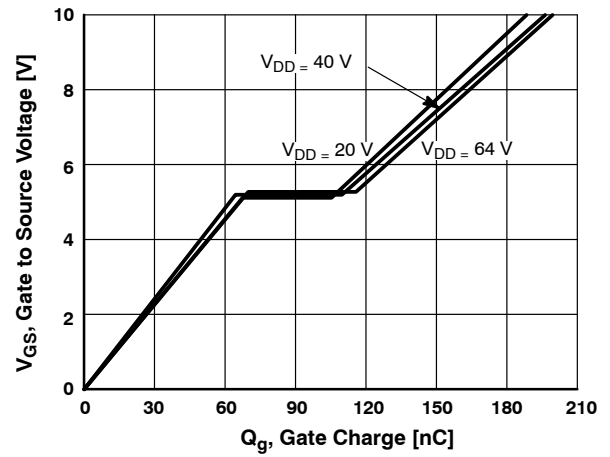
**Figure 14. Gate Charge**

## TYPICAL CHARACTERISTICS (continued)



Refer to **onsemi** Application Notes AN7514 and AN7515.
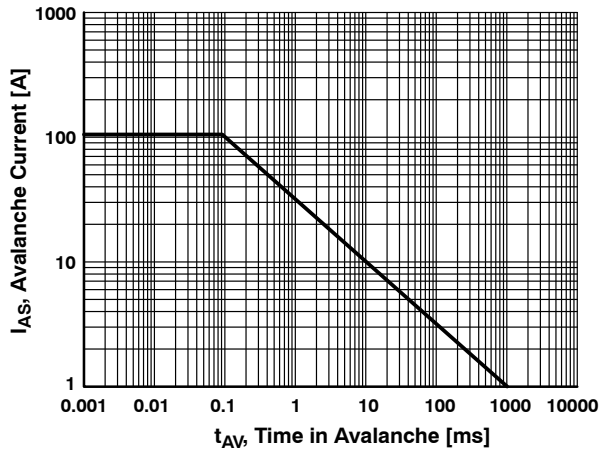
**Figure 15. Unclamped Inductive Switching Capability**
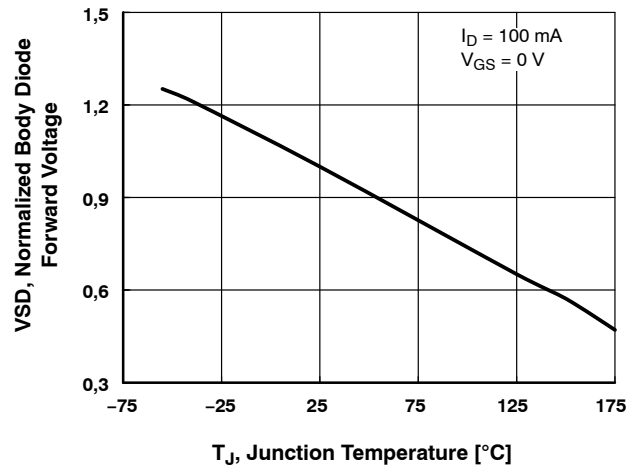


**Figure 16. Forward Diode Characteristic**
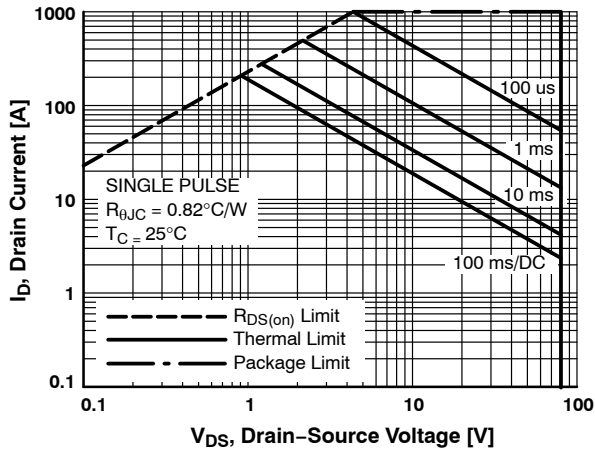


**Figure 17. Safe Operation Area**
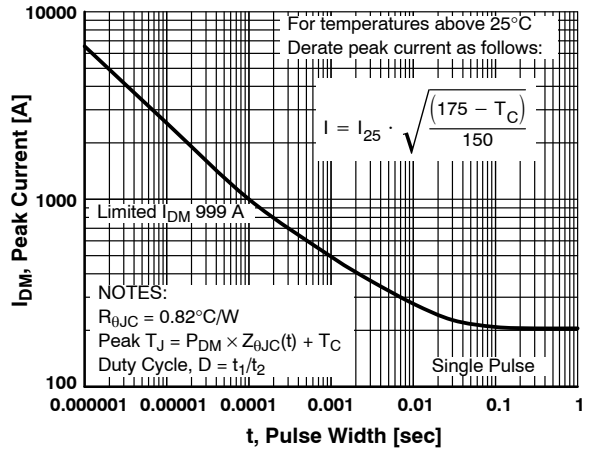


**Figure 18. Peak Current Capability**

**TYPICAL CHARACTERISTICS** (continued)
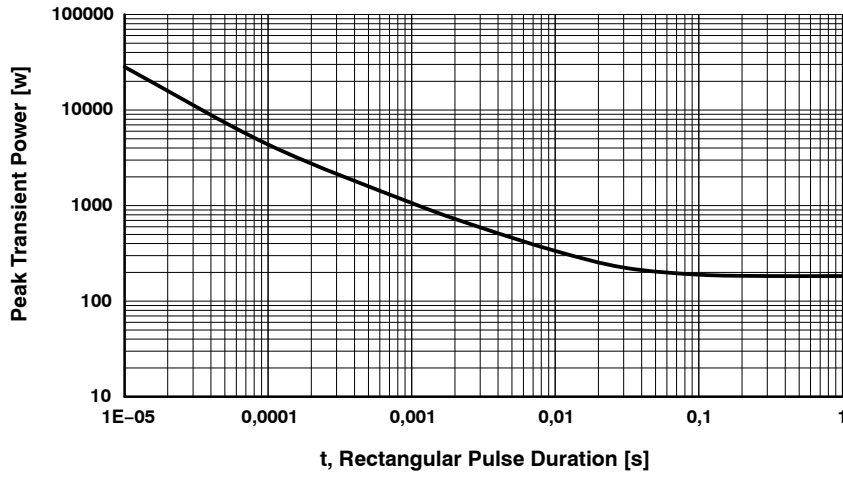
**Figure 19. Peak Power Capability**

NOTES:
$Z_{\theta JC}(t) = r(t) \times R_{\theta JC}$
$R_{\theta JC} = 0.82°C/W$
Peak $T_J = P_{DM} \times Z_{\theta JC}(t) + T_C$
Duty Cycle, $D = t_1/t_2$
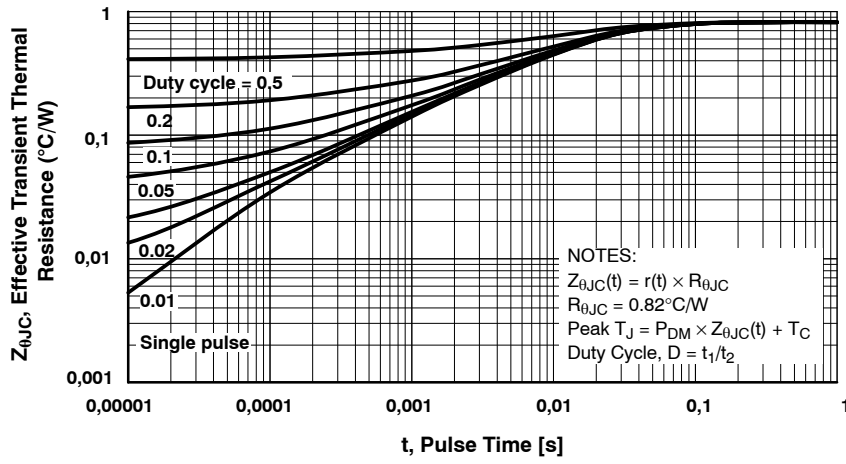
**Figure 20. Maximum Transient Thermal Impedance**

## PACKAGE DIMENSIONS
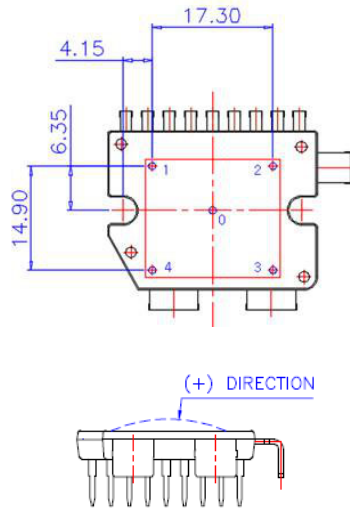


1. WARPAGE SPEC: 0 ~ 100um
2. WARPAGE MEASUREMENT
   1) OPTICAL HEIGHT MEASUREMENT ZERO POINT IN PACKAGE CENTER
   2) WARPAGE IN MAX HEIGHT OF POINT 1,2,3,4

**Figure 21. Flatness Measurement Position**

## MECHANICAL CHARACTERISTICS AND RATINGS

| Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Device Flatness | Refer to the package dimensions | 0 | – | 100 | um |
| Mounting Torque | Mounting screw – M3, Recommended 0.7 N–m | 0.6 | – | 1.4 | N–m |
| Weight | | – | 10 | – | g |
| Compression Test | Maximum load, test speed: 0.5 mm/min (Note 7) | – | – | 22 | kN |

7. Guaranteed by experiment, valid only in confirmed condition.

## PACKAGE MARKING AND ORDERING INFORMATION

| Device | Part Number | Package | Pb–Free and RoHS Compliant | Packing Method |
|---|---|---|---|---|
| NXV08A170DB2 | NXV08A170DB2 | APM12–CBA | Yes | Tray |
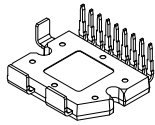
**APM12−SERIES AUTOMOTIVE MODULE**
CASE MODBG
ISSUE B

DATE 16 DEC 2021

LEAD POSITION ⊕ 0.40 A B
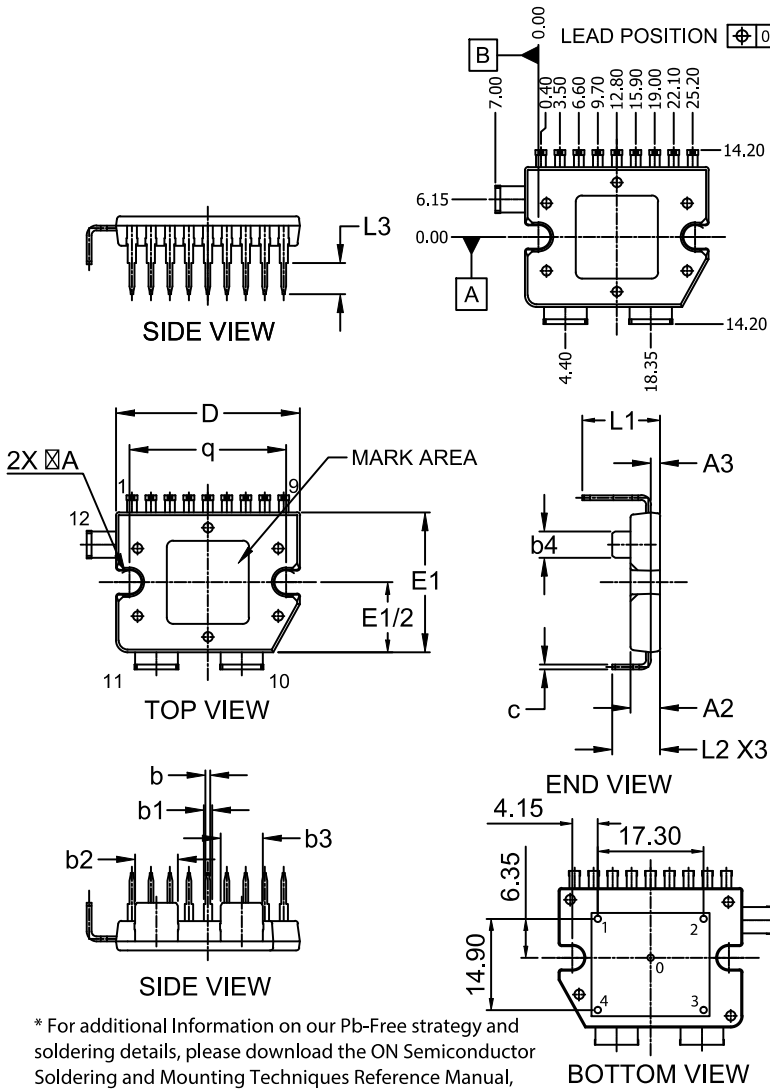
NOTES:

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.

SIDE VIEW

TOP VIEW

END VIEW

SIDE VIEW

BOTTOM VIEW

2X ⍁A

MARK AREA

* WARPAGE(POINT 1,2,3,4 BASED ON 0)
: 0~100um

| DIM | MILLIMETERS | | |
|-----|------|------|------|
|     | MIN. | NOM. | MAX. |
| ⍁A  | 3.70 | 3.80 | 3.90 |
| A2  | 4.60 | 4.80 | 5.00 |
| A3  | 1.30 | 1.50 | 1.70 |
| b   | 0.70 | 0.80 | 0.90 |
| b1  | 1.25 | 1.35 | 1.45 |
| b2  | 6.80 | 7.00 | 7.20 |
| b3  | 6.70 | 6.90 | 7.10 |
| b4  | 4.10 | 4.30 | 4.50 |
| c   | 0.75 | 0.80 | 0.85 |
| D   | 29.80 | 30.00 | 30.20 |
| E1  | 22.60 | 22.80 | 23.00 |
| L1  | 12.40 | 12.70 | 13.00 |
| L2  | 7.50 | 7.80 | 8.10 |
| L3  | 4.90 | 5.10 | 5.30 |
| q   | 25.50 | 25.60 | 25.70 |

* For additional Information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDER RM/D.

### GENERIC MARKING DIAGRAM*

XXXXXXXXXXXXXXXX
ZZZ ATYWW
NNNNNNN
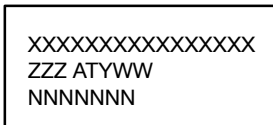
XXXX = Specific Device Code
ZZZ = Lot ID
AT = Assembly & Test Location
Y = Year
WW = Work Week
NNN = Serial Number

*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: | 98AON34474H | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. | |
|---|---|---|---|
| DESCRIPTION: | APM12−SERIES AUTOMOTIVE MODULE | | PAGE 1 OF 1 |

## 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

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