

Automotive Power MOSFET Module

NXV10V125DT1

Features

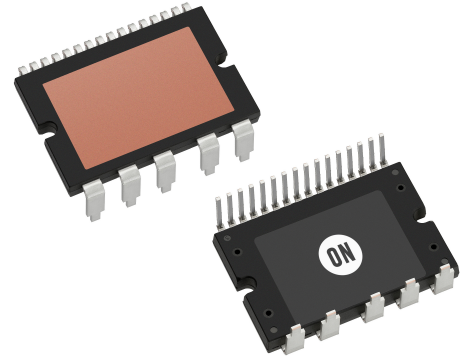
- 3 Phase MOSFET Module
- Electrically Isolated DBC Substrate for Low Thermal Resistance
- Temperature Sensing
- Compact Design for Low Total Module Resistance
- Module Serialization for Full Traceability
- AQG324 Qualified and PPAP Capable
- Pb-free, RoHS and UL94V-0 Compliant

Typical Applications

- 48 V E-Compressor and Other 48 V Auxiliaries

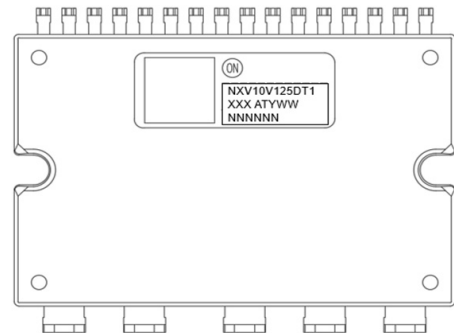
Benefits

- Enable Design of Small, Efficient and Reliable System for Reduced Vehicle Fuel Consumption and CO₂ Emission
- Simplified Vehicle Assembly
- Enable Low Thermal Resistance to Junction-to-Heat Sink by Direct Mounting via Thermal Interface Material between Module Case and Heat Sink



APM21-CGA
CASE MODBQ

MARKING DIAGRAM



NXV10V125DT1 = Specific Device Code
 XXX = Lot ID
 AT = Assembly & Test Location
 Y = Year
 WW = Work Week
 NNN = Serial Number

ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

NXV10V125DT1

ORDERING INFORMATION

| Device | Package | Packing Method | Shipping |
|--------------|-----------|----------------|----------------|
| NXV10V125DT1 | APM21-CGA | Tube | 44 Units / Box |

Pin Configuration

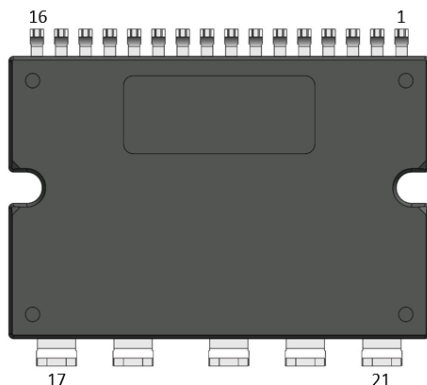


Figure 1. Pin Configuration

PIN DESCRIPTION

| Pin Number | Pin Name | Description |
|------------|------------|--|
| 1 | NTC+ | NTC Thermistor Terminal 1 |
| 2 | NTC- | NTC Thermistor Terminal 2 |
| 3 | Sense Q6 | Source of Q6 |
| 4 | G3 | Gate of Q3, high side Phase W MOSFET |
| 5 | Sense Q3 | Source of Q3 |
| 6 | G6 | Gate of Q6, low side Phase W MOSFET |
| 7 | Sense Q5 | Source of Q5 |
| 8 | G2 | Gate of Q2, high side Phase V MOSFET |
| 9 | Sense Q2 | Source of Q2 |
| 10 | G5 | Gate of Q5, low side Phase V MOSFET |
| 11 | G4 | Gate of Q4, low side Phase U MOSFET |
| 12 | Sense Q4 | Source of Q4 |
| 13 | Sense Q1 | Source of Q1 |
| 14 | G1 | Gate of Q1, high side Phase U MOSFET |
| 15 | Vbat Sense | Common pins for Sense of Vbat |
| 16 | Vbat Sense | Common pins for Sense of Vbat, one of pin 15 or 16 can be used for Sense of Vbat |
| 17 | B+ | Battery voltage power lead |
| 18 | GND | Battery return power lead |
| 19 | U | Phase U (Phase 1) |
| 20 | V | Phase V (Phase 2) |
| 21 | W | Phase W (Phase 3) |

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Block Diagram



Figure 2. Schematic

Flammability Information

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

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. Base of the leads, at the interface with the package body should not be exposed to more than 200°C during mounting on the PCB, this to prevent the remelt of the solder joints.

ABSOLUTE MAXIMUM RATINGS (T_J = 25°C unless otherwise specified)

| Symbol | Parameter | Value | Unit |
|---------------------|--|------------|------|
| V _{DS} | Drain-to-Source Voltage | 100 | V |
| V _{GS} | Gate-to-Source Voltage | ±20 | V |
| E _{AS} | Single Pulse Avalanche Energy (I _{PK} = 50 A) | 587 | mJ |
| T _{J(max)} | Maximum Junction Temperature | 175 | °C |
| T _{STG} | Storage Temperature Range | -40 to 125 | °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.

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THERMAL CHARACTERISTICS

| Symbol | Parameter | Min | Typ | Max | Unit |
|-----------------|---|-----|------|------|------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case (Note 1) | - | 0.63 | 0.85 | °C/W |

1. Test method compliant with MIL-STD-883-1012.1

ISOLATION VOLTAGE

| Symbol | Parameter | Min | Typ | Max | Unit |
|--------|---|-----|-----|-----|---------|
| - | Leakage @Isolation Voltage, $V_{AC} = 3$ kV, 1 second | - | - | 250 | μ A |

ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$; unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------------|--|---|-----|---|-----------|------------|
| B_{VDSS} | Drain-to-Source Breakdown Voltage | $I_D = 250 \mu\text{A}$, $V_{GS} = 0$ V | 100 | - | - | V |
| I_{DSS} | Drain-to-Source Leakage Current | $V_{GS} = 0$ V, $V_{DS} = 100$ V | - | - | 5 | μ A |
| I_{GSS} | Gate-to-Source Leakage Current | $V_{GS} = \pm 20$ V | - | - | ± 100 | nA |
| $V_{GS(TH)}$ | Gate-to-Source Threshold Voltage | $V_{GS} = V_{DS}$, $I_D = 250 \mu\text{A}$ | 2.0 | - | 4.5 | V |
| $R_{DS(ON)}$ Q1 | MOSFET $R_{DS(ON)}$ for Q1-Q6 (Notes 2, 3) | $I_D = 80$ A, $V_{GS} = 12$ V | - | 1.43 | 1.92 | m Ω |
| $R_{DS(ON)}$ Q2 | | | - | 1.53 | 2.05 | m Ω |
| $R_{DS(ON)}$ Q3 | | | - | 1.64 | 2.20 | m Ω |
| $R_{DS(ON)}$ Q4 | | | - | 1.34 | 1.80 | m Ω |
| $R_{DS(ON)}$ Q5 | | | - | 1.36 | 1.82 | m Ω |
| $R_{DS(ON)}$ Q6 | | | - | 1.37 | 1.83 | m Ω |
| $R_{DS(ON)}$ Q4 | | | | $I_D = 80$ A, $V_{GS} = 12$ V, $T_J = 175^\circ\text{C}$ (Note 4) | - | - |
| $R_{DS(ON)}$ Q1 | Module $R_{DS(ON)}$ for Q1-Q6 (Note 3) | $I_D = 80$ A, $V_{GS} = 12$ V | - | 2.40 | 3.20 | m Ω |
| $R_{DS(ON)}$ Q2 | | | - | 2.48 | 3.30 | m Ω |
| $R_{DS(ON)}$ Q3 | | | - | 2.62 | 3.50 | m Ω |
| $R_{DS(ON)}$ Q4 | | | - | 1.97 | 2.62 | m Ω |
| $R_{DS(ON)}$ Q5 | | | - | 2.13 | 2.84 | m Ω |
| $R_{DS(ON)}$ Q6 | | | - | 2.34 | 3.12 | m Ω |
| V_{SD} | $V_{GS} = 0$ V, $I_S = 80$ A | $V_{GS} = 0$ V, $I_S = 80$ A | - | - | 1.25 | V |

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.

- All bare die have the same size and on resistance, However, on resistance values of each FETs could be different in the data sheet because of different access path inside the module. The value of Q4 is the rating of $R_{DS(ON)}$ of MOSFET of this module and be used for the power loss calculation because their values are close to the actual MOSFET $R_{DS(ON)}$ sensing by Kelvin pin.
- Module R_{dson} means total resistance of the measurement path between Power terminals, referring to the resistance measurement methods table.
- The maximum value is specified by design at $T_J = 175^\circ\text{C}$. Product is not tested to this condition in production.

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RESISTANCE MEASUREMENT METHODS

| FETs | + Force Pin# | - Force Pin# | + Sense Pin# | - Sense Pin# |
|------------------------|--------------|--------------|--------------|--------------|
| MOSFET $R_{DS(ON)}$ Q1 | B+ | Phase 1 | Vbat | Sense Q1 |
| MOSFET $R_{DS(ON)}$ Q2 | B+ | Phase 2 | Vbat | Sense Q2 |
| MOSFET $R_{DS(ON)}$ Q3 | B+ | Phase 3 | Vbat | Sense Q3 |
| MOSFET $R_{DS(ON)}$ Q4 | Phase 1 | GND | Sense Q1 | Sense Q4 |
| MOSFET $R_{DS(ON)}$ Q5 | Phase 2 | GND | Sense Q2 | Sense Q5 |
| MOSFET $R_{DS(ON)}$ Q6 | Phase 3 | GND | Sense Q3 | Sense Q6 |
| Module $R_{DS(ON)}$ Q1 | B+ | Phase 1 | B+ | Phase 1 |
| Module $R_{DS(ON)}$ Q2 | B+ | Phase 2 | B+ | Phase 2 |
| Module $R_{DS(ON)}$ Q3 | B+ | Phase 3 | B+ | Phase 3 |
| Module $R_{DS(ON)}$ Q4 | Phase 1 | GND | Phase 1 | GND |
| Module $R_{DS(ON)}$ Q5 | Phase 2 | GND | Phase 2 | GND |
| Module $R_{DS(ON)}$ Q6 | Phase 3 | GND | Phase 3 | GND |

ELECTRICAL CHARACTERISTICS ($T_J = 25^\circ\text{C}$; unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|-----------|------------|-----|-----|-----|------|
|--------|-----------|------------|-----|-----|-----|------|

DYNAMIC CHARACTERISTICS

| | | | | | | |
|--------------|---------------------------------------|--|---|------|---|----------|
| C_{iss} | Input Capacitance (Note 5) | $V_{DS} = 50\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$ | - | 6970 | - | pF |
| C_{oss} | Output Capacitance (Note 5) | | - | 3950 | - | pF |
| C_{rss} | Reverse Transfer Capacitance (Note 5) | | - | 29 | - | pF |
| R_g | Gate Resistance | $f = 1\text{ MHz}$ | - | 0.4 | - | Ω |
| $Q_{g(tot)}$ | Total Gate Charge | $V_{GS} = 0\text{ to }10\text{ V},$ $V_{DD} = 80\text{ V}, I_D = 80\text{ A}$ | - | 101 | - | nC |
| Q_{gs} | Gate to Source Gate Charge | | - | 34 | - | nC |
| Q_{gd} | Gate to Drain "Miller" Charge | | - | 19 | - | nC |

SWITCHING CHARACTERISTICS

| | | | | | | |
|--------------|---------------------|---|---|----|---|----|
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD} = 50\text{ V}, I_D = 80\text{ A},$ $V_{GS} = 10\text{ V}, R_{GEN} = 6\text{ }\Omega$ | - | 46 | - | ns |
| t_r | Rise Time | | - | 26 | - | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 52 | - | ns |
| t_f | Fall Time | | - | 15 | - | ns |

5. Reference typical characteristics of discrete FDBL86062-F085.

COMPONENTS

| Components | Specification | Quantity | Size |
|----------------|--|----------|----------------|
| MOSFET | 100 V, bare die used in FDBL86062_F085 | 6 | 6.60 x 3.68 mm |
| RESISTOR | 2.2 Ω | 1 | 2.0 x 1.25 mm |
| CAPACITOR | 100 V, 0.047 μF | 2 | 1.6 x 0.8 mm |
| NTC Thermistor | 100 k Ω | 1 | 1.6 x 0.8 mm |

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TYPICAL CHARACTERISTICS

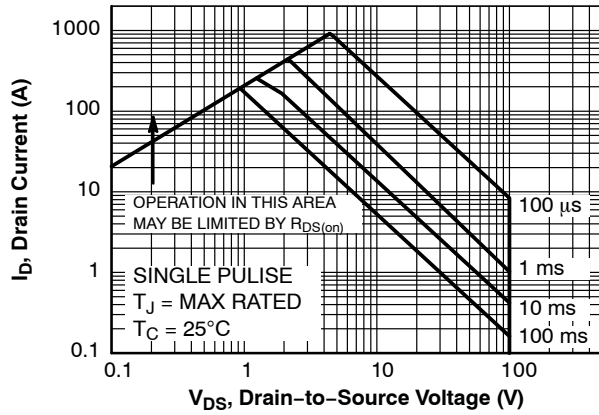


Figure 3. Safe Operation Area

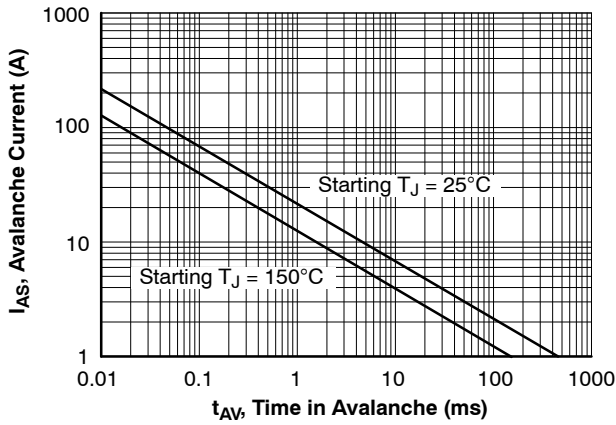


Figure 4. Unclamped Inductive Switching Capability

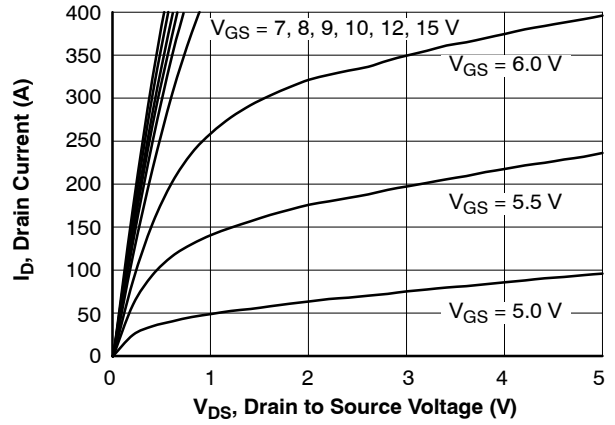


Figure 5. Saturation Characteristics

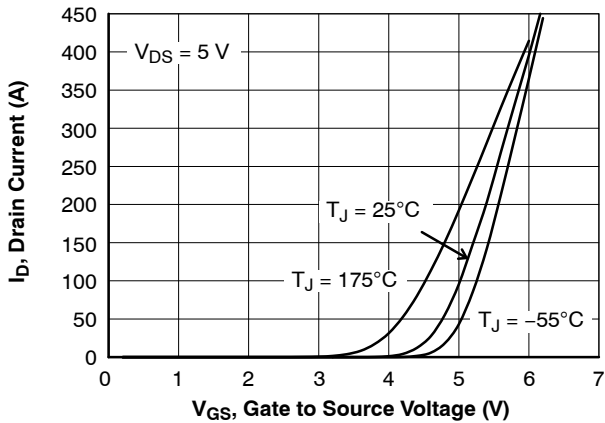


Figure 6. Transfer Characteristics

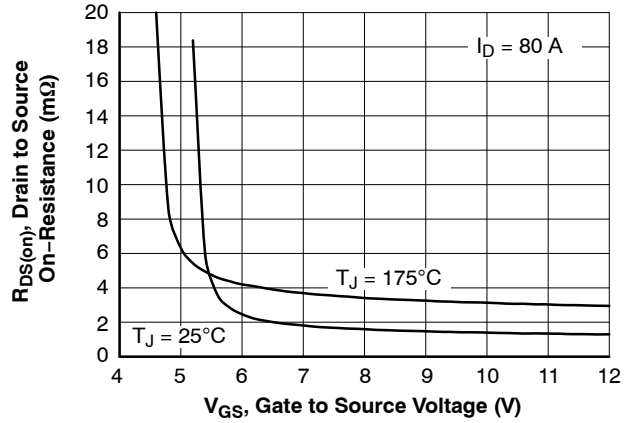


Figure 7. $R_{DS(on)}$ vs. Gate Voltage

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TYPICAL CHARACTERISTICS (continued)

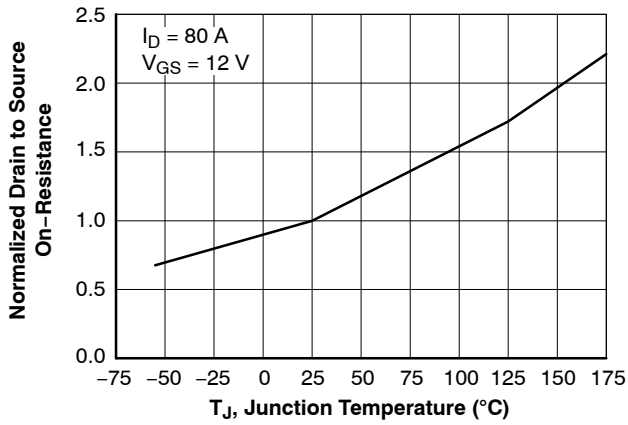


Figure 8. Normalized $R_{DS(on)}$ vs. Junction Temperature

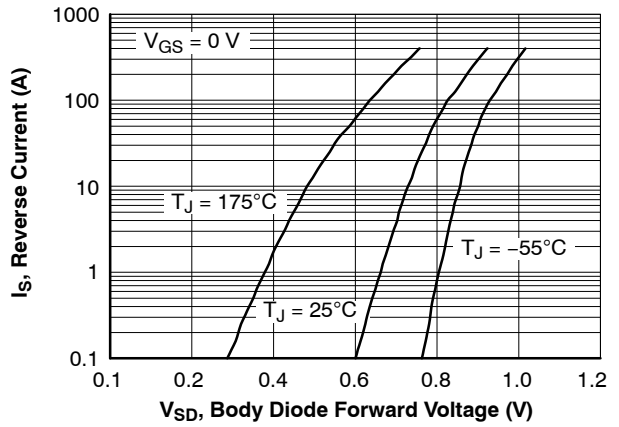


Figure 9. Forward Diode Characteristics

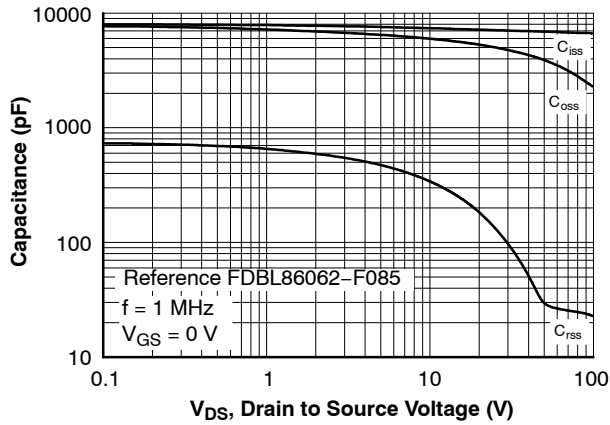


Figure 10. Capacitance vs. Drain to Source Voltage

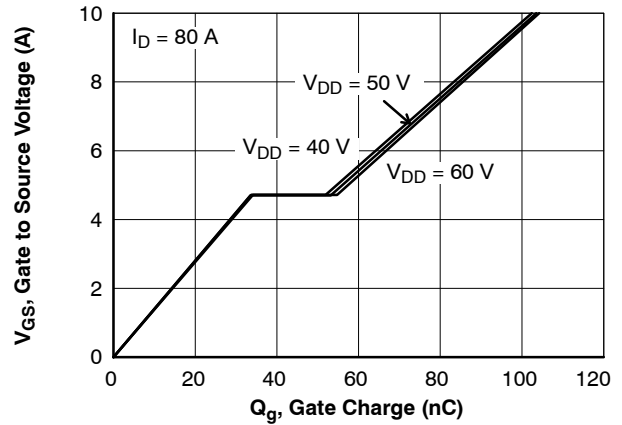


Figure 11. Gate Charge vs. Gate to Source Voltage

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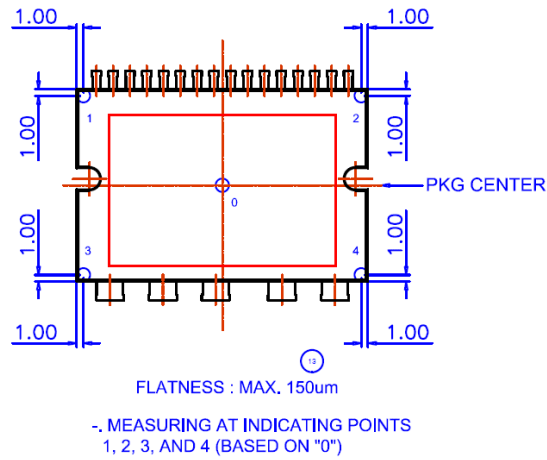


Figure 12. Flatness Measurement Position

MECHANICAL CHARACTERISTICS AND RATINGS

| Parameter | Test Conditions | Min | Typ | Max | Unit |
|-----------------|--|-----|------|--------------|------|
| Device Flatness | Refer to Figure 12 | 0 | - | 150 | μm |
| Mounting Torque | Mounting screw: M3, recommended 0.7 Nm | 0.4 | - | 1.4 (Note 6) | Nm |
| Weight | | - | 21.2 | - | g |

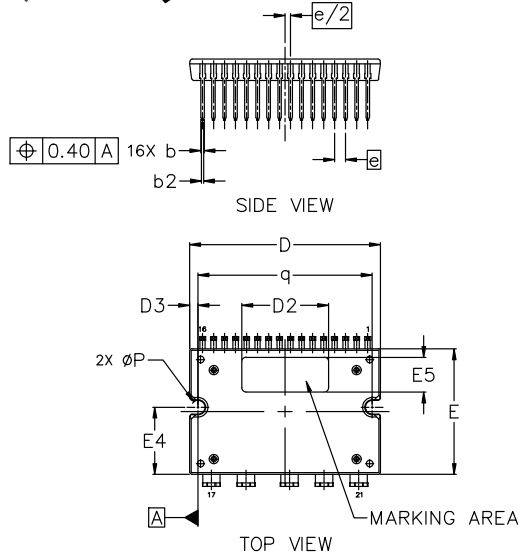
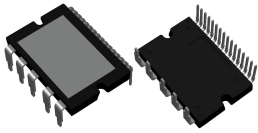
6. Max Torque rating can be different by the type of screw, such as the screw head diameter, use or without use of Washer. In case of special screw mounting method is applied, contact to **onsemi** for the proper information of mounding condition.

NXV10V125DT1

PACKAGE DIMENSIONS

APM21 44.00x29.00x5.00, 8.00P
CASE MODBQ
ISSUE A

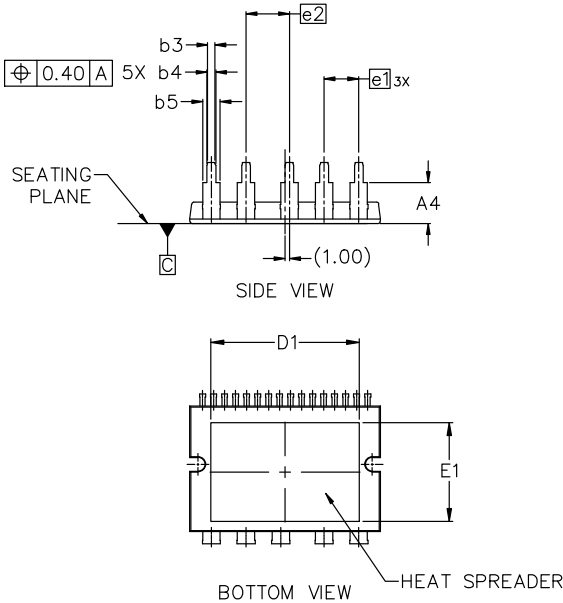
DATE 31 MAY 2024



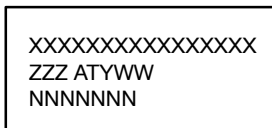
NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5-2018.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.

| DIM | MILLIMETERS | | |
|-----|-------------|-------|-------|
| | MIN. | NOM. | MAX. |
| A | 13.85 | 14.15 | 14.45 |
| A2 | 4.90 | 5.00 | 5.10 |
| A3 | 9.15 REF. | | |
| A4 | 9.20 | 9.50 | 9.80 |
| b | 0.70 | 0.80 | 0.90 |
| b2 | 0.30 | 0.50 | 0.70 |
| b3 | 1.50 | 1.70 | 1.90 |
| b4 | 1.90 | 2.00 | 2.10 |
| b5 | 3.90 | 4.00 | 4.10 |
| c | 0.75 | 0.80 | 0.90 |
| D | 43.90 | 44.00 | 44.10 |
| D1 | 34.00 | 34.30 | 34.60 |
| D2 | 17.70 | 20.00 | 20.30 |
| D3 | 1.80 | 1.90 | 2.00 |
| E | 28.90 | 29.00 | 29.10 |
| E1 | 22.50 | 22.80 | 23.10 |
| E2 | 17.90 | 18.30 | 18.70 |
| E3 | 15.90 | 16.30 | 16.70 |
| E4 | 15.40 | 15.50 | 15.60 |
| E5 | 7.70 | 8.00 | 8.30 |
| e | 2.54 BSC | | |
| e1 | 8.00 BSC | | |
| e2 | 10.00 BSC | | |
| øP | 3.10 | 3.20 | 3.30 |
| q | 4.10 | 4.20 | 4.30 |



GENERIC MARKING DIAGRAM*



XXXX = Specific Device Code
 ZZZ = Lot ID
 AT = Assembly & Test Location
 Y = Year
 WW = Work Week
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*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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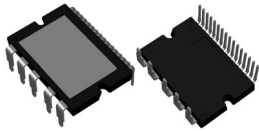
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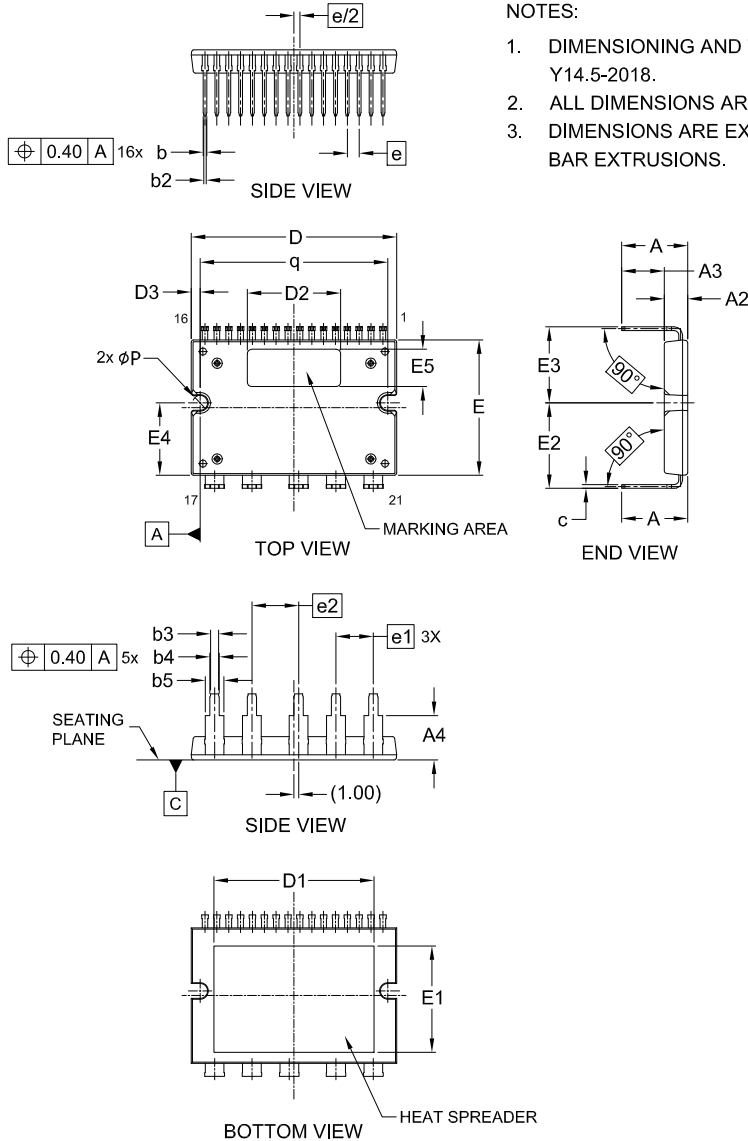


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CASE MODBQ
ISSUE B

DATE 12 NOV 2024

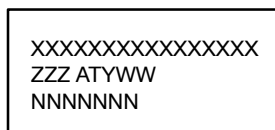


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| D2 | 19.70 | 20.00 | 20.30 |
| D3 | 1.80 | 1.90 | 2.00 |
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| E2 | 17.90 | 18.30 | 18.70 |
| E3 | 15.90 | 16.30 | 16.70 |
| E4 | 15.40 | 15.50 | 15.60 |
| E5 | 7.70 | 8.00 | 8.30 |
| e | 2.54 BASIC | | |
| e1 | 8.00 BASIC | | |
| e2 | 10.00 BASIC | | |
| φP | 3.10 | 3.20 | 3.30 |
| q | 40.10 | 40.20 | 40.30 |

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