

Automotive 1200 V, 450 A Dual Side Cooling Half-Bridge Power Module VE-Trac™ Dual NVG450A120L5DSC



AHPM15-CEA
CASE 100DD

Product Description

The NVG450A120L5DSC is a member of the VE-Trac Dual power module family with dual side cooling and compact footprints for Hybrid (HEV) and Electric Vehicle (EV) traction inverter application.

The module consists of two latest 1200 V Ultra Field Stop (UFS) IGBTs in a half-bridge configuration. The chipset utilizes the proven Trench Ultra Field Stop IGBT technology in providing high current density while offering robust short circuit protection and increased blocking voltage. Additionally, UFS IGBT and copacked soft diode deliver a low power loss operation and soft switching simultaneously, which helps to improve overall system efficiency in HEV/EV traction applications.

Features

- Dual-Side Cooling
- Integrated Chip Level Temperature & Current Sensor
- $T_{vj\ max} = 175^{\circ}C$
- Low Stray Inductance
- Low Conduction and Switching Losses
- Automotive Grade
- 4.2 kV Isolated DBC Substrate
- This is a Pb-Free Device

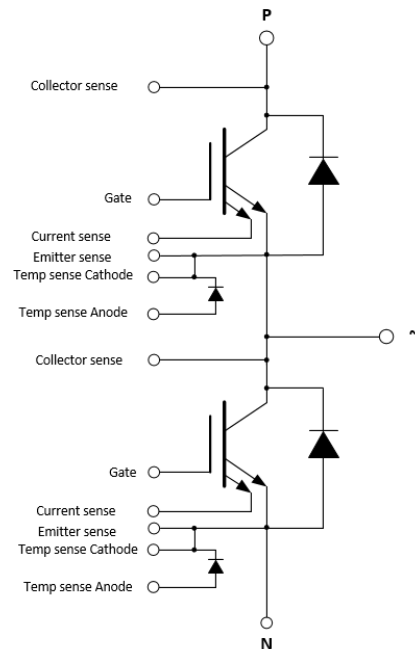
Typical Applications

- Hybrid and Electric Vehicle Traction Inverter
- High Power DC-DC Converter

MARKING DIAGRAM



ZZZ = Assembly Lot Code
AT = Assembly & Test Site Code
Y = Year
WW = Work Week
XXXX = Specific Device Code
NNN = Serial Number



ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

VE-Trac™ Dual NVG450A120L5DSC

PIN DESCRIPTION

| Pin No. | Pin | Description | Pin Arrangement |
|---------|--------------------------|------------------------------------|-----------------|
| 1 | N | Low Side Emitter | |
| 2 | P | High Side Collector | |
| 3 | H/S COLLECTOR SENSE | High Side Collector Sense | |
| 4 | H/S CURRENT SENSE | High Side Current Sense | |
| 5 | H/S EMITTER SENSE | High Side Emitter Sense | |
| 6 | H/S GATE | High Side Gate | |
| 7 | H/S TEMP SENSE (CATHODE) | High Side Temp sense Diode Cathode | |
| 8 | H/S TEMP SENSE (ANODE) | High Side Temp sense Diode Anode | |
| 9 | ~ | Phase Output | |
| 10 | L/S CURRENT SENSE | Low Side Current Sense | |
| 11 | L/S EMITTER SENSE | Low Side Emitter Sense | |
| 12 | L/S GATE | Low Side Gate | |
| 13 | L/S TEMP SENSE (CATHODE) | Low Side Temp sense Diode Cathode | |
| 14 | L/S TEMP SENSE (ANODE) | Low Side Temp sense Diode Anode | |
| 15 | L/S COLLECTOR SENSE | Low Side Collector Sense | |

DBC Substrate

Al₂O₃ isolated substrate, basic isolation, and copper on both sides

Lead frame

Copper, with tin electro-plating

Flammability Information

All Power Module packaging materials meet UL flammability rating class 94V-0

MODULE CHARACTERISTICS

| Symbol | Parameter | Rating | Unit | | |
|----------------------|--|-------------|-------------|-------------|----|
| T _{vj} | Continuous Operating Junction Temperature Range | -40 to 150 | °C | | |
| T _{vj,op} | Continuous Operating Junction Temperature Under Switching Conditions | -40 to 175 | °C | | |
| T _{STG} | Storage Temperature Range | -40 to 125 | °C | | |
| V _{ISO} | Isolation Voltage, DC, t = 1 s | 4200 | V | | |
| Creepage | Terminal to Heatsink Terminal to Terminal | 6.0 | mm | | |
| Clearance | Terminal to Heatsink Terminal to Terminal | 3.2 | mm | | |
| CTI | Comparative Tracking Index | >600 | | | |
| | | Min. | Typ. | Max. | |
| L _{sCE} | Stray Inductance | - | - | 8 | nH |
| R _{CC'+EE'} | Module Lead Resistance, Terminals - Chip | - | - | 0.15 | mΩ |
| G | Module Weight | - | - | 72 | g |
| M | M4 Screws for Module Terminals | - | - | 2.2 | Nm |

VE-Trac™ Dual NVG450A120L5DSC

ABSOLUTE MAXIMUM RATINGS (T_{Vj} = 25°C, unless otherwise specified)

| Symbol | Parameter | Rating | Unit |
|----------------------------|---|--------------|------|
| IGBT | | | |
| V _{CES} | Collector to Emitter Voltage | 1200 | V |
| V _{GES} | Gate to Emitter Voltage | -15/+20 | V |
| V _{GES transient} | Gate to Emitter Voltage, Limits under switching conditions | ±20 | V |
| I _{CN} | Implemented Collector Current | 450 | A |
| I _{C nom} | Continuous DC Collector Current, T _{vjmax} = 175°C, T _F = 65°C, Ref. Heatsink | 410 (Note 1) | A |
| I _{CRM} | Pulsed Collector Current @ V _{GE} = 15 V, t _p = 1 ms | 900 | A |

DIODE

| | | | |
|------------------------|--|----------------|------------------|
| V _{RRM} | Repetitive Peak Reverse Voltage | 1200 | V |
| I _{FN} | Implemented Forward Current | 450 | A |
| I _F | Continuous Forward Current, T _{vjmax} = 175°C, T _F = 65°C, Ref. Heatsink | 360 (Note 1) | A |
| I _{FRM} | Repetitive Peak Forward Current, t _p = 1 ms | 900 | A |
| I ² t value | V _R = 0 V, t _p = 10 ms, T _{VJ} = 150°C T _{VJ} = 175°C | 14400 12960 | A ² s |

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. Verified by characterization, not test.

THERMAL CHARACTERISTICS (Verified by characterization, not test)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---------------------------|--|------|------|------|------|
| IGBT.R _{th,J-C} | Effective R _{th} , Junction to Case (Note 2) | - | 0.06 | 0.08 | °C/W |
| IGBT.R _{th,J-F} | Effective R _{th} , Junction to Fluid, λ _{TIM} = 6 W/m-K, F = 660 N 10 L/min, 65°C, 50/50 EGW, Ref. Heatsink | - | 0.15 | - | °C/W |
| Diode.R _{th,J-C} | Effective R _{th} , Junction to Case (Note 2) | - | 0.08 | 0.10 | °C/W |
| Diode.R _{th,J-F} | Effective R _{th} , Junction to Fluid, λ _{TIM} = 6 W/m-K, F = 660 N 10 L/min, 65°C, 50/50 EGW, Ref. Heatsink | - | 0.21 | - | °C/W |

2. For the measurement point of case temperature (T_c), DBC discoloration, picker circle print is allowed, please refer to the VE-Trac Dual assembly guide for additional details about acceptable DBC surface finish.

VE-Trac™ Dual NVG450A120L5DSC

CHARACTERISTICS OF IGBT ($T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

| Parameters | | Conditions | Min | Typ | Max | unit | |
|-------------|--|---|--------------------------------|------|-----------|---------------|----|
| V_{CESAT} | Collector to Emitter Saturation Voltage (Terminal) | $V_{GE} = 15\text{ V}, I_C = 300\text{ A},$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 1.38 | 1.6 | V |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 1.50 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 1.53 | - | |
| | | $V_{GE} = 15\text{ V}, I_C = 450\text{ A},$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 1.59 | - | |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 1.82 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 1.87 | - | |
| I_{CES} | Collector to Emitter Leakage Current | $V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$ | $T_{vj} = 25^{\circ}\text{C}$ | - | - | 1 | mA |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 7 | - | |
| I_{GES} | Gate – Emitter Leakage Current | $V_{CE} = 0\text{ V}, V_{GE} = +20\text{ V}/-15\text{ V}$ | - | - | ± 400 | nA | |
| V_{th} | Threshold Voltage | $V_{CE} = V_{GE}, I_C = 500\text{ mA}$ | 5.8 | 6.8 | 7.6 | V | |
| Q_G | Total Gate Charge | $V_{GE} = -8\text{ to }15\text{ V}, V_{CE} = 600\text{ V}$ | - | 1.45 | - | μC | |
| R_{Gint} | Internal Gate Resistance | | - | 0 | - | Ω | |
| C_{ies} | Input Capacitance | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$ | - | 61 | - | nF | |
| C_{oes} | Output Capacitance | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$ | - | 1.5 | - | nF | |
| C_{res} | Reverse Transfer Capacitance | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$ | - | 0.7 | - | nF | |
| $T_{d,on}$ | Turn On Delay, Inductive Load | $I_C = 300\text{ A}, V_{CE} = 600\text{ V}$ $V_{GE} = +15/-8\text{ V}$ $R_{g,on} = 3\ \Omega$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 128 | - | ns |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 121 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 118 | - | |
| T_r | Rise Time, Inductive Load | $I_C = 300\text{ A}, V_{CE} = 600\text{ V}$ $V_{GE} = +15/-8\text{ V}$ $R_{g,on} = 3\ \Omega$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 59 | - | ns |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 66 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 68 | - | |
| $T_{d,off}$ | Turn Off Delay, Inductive Load | $I_C = 300\text{ A}, V_{CE} = 600\text{ V}$ $V_{GE} = +15/-8\text{ V}$ $R_{g,off} = 5\ \Omega$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 1070 | - | ns |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 1132 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 1157 | - | |
| T_f | Fall Time, Inductive Load | $I_C = 300\text{ A}, V_{CE} = 600\text{ V}$ $V_{GE} = +15/-8\text{ V}$ $R_{g,off} = 5\ \Omega$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 103 | - | ns |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 250 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 281 | - | |
| E_{ON} | Turn-On Switching Loss (Including Diode Reverse Recovery Loss) | $I_C = 300\text{ A}, V_{CE} = 600\text{ V}$ $V_{GE} = +15/-8\text{ V}$ $R_{g,on} = 3\ \Omega$ $L_s = 25\text{ nH}$ $di/dt (T_{vj}=25^{\circ}\text{C}) = 4.06\text{ A/ns}$ $di/dt (T_{vj}=175^{\circ}\text{C}) = 3.95\text{ A/ns}$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 18 | - | mJ |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 28 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 30 | - | |
| | | | | - | | - | |
| E_{OFF} | Turn-Off Switching Loss | $I_C = 300\text{ A}, V_{CE} = 600\text{ V}$ $V_{GE} = +15/-8\text{ V}$ $R_{g,off} = 5\ \Omega$ $L_s = 25\text{ nH}$ $dv/dt (T_{vj}=25^{\circ}\text{C}) = 4.15\text{ V/ns}$ $dv/dt (T_{vj}=175^{\circ}\text{C}) = 3.21\text{ V/ns}$ | $T_{vj} = 25^{\circ}\text{C}$ | - | 19 | - | mJ |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | - | 34 | - | |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | - | 37 | - | |
| | | | | - | | - | |
| Esc | Minimum Short Circuit Energy Withstand | $V_{GE} = 15\text{ V}, V_{CC} = 600\text{ V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$ | $T_{vj} = 25^{\circ}\text{C}$ | 16 | - | - | J |
| | | | $T_{vj} = 175^{\circ}\text{C}$ | 8.8 | - | - | |

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CHARACTERISTICS OF INVERSE DIODE (T_{vj} = 25°C, unless otherwise specified)

| Parameters | | Conditions | Min | Typ | Max | unit | |
|-----------------|----------------------------------|--|-------------------------|-----|------|------|----|
| V _F | Diode Forward Voltage (Terminal) | V _{GE} = 0 V, I _C = 300 A, | T _{vj} = 25°C | – | 1.58 | 1.82 | V |
| | | | T _{vj} = 150°C | – | 1.56 | – | |
| | | | T _{vj} = 175°C | – | 1.54 | – | |
| | | V _{GE} = 0 V, I _C = 450 A, | T _{vj} = 25°C | – | 1.80 | – | |
| | | | T _{vj} = 150°C | – | 1.81 | – | |
| | | | T _{vj} = 175°C | – | 1.78 | – | |
| E _{rr} | Reverse Recovery Energy | V _R = 600 V, I _F = 300 A, R _{GON} = 3 Ω, –di/dt = 3.95 A/ns (175°C) V _{GE} = –8 V | T _{vj} = 25°C | – | 10 | – | mJ |
| | | | T _{vj} = 150°C | – | 22 | – | |
| | | | T _{vj} = 175°C | – | 24 | – | |
| | | | | – | – | – | |
| Q _{RR} | Recovered Charge | V _R = 600 V, I _F = 300 A, R _{GON} = 3 Ω, –di/dt = 3.95 A/ns (175°C) V _{GE} = –8 V | T _{vj} = 25°C | – | 25 | – | μC |
| | | | T _{vj} = 150°C | – | 53 | – | |
| | | | T _{vj} = 175°C | – | 59 | – | |
| | | | | – | – | – | |
| I _{rr} | Peak Reverse Recovery Current | V _R = 600 V, I _F = 300 A, R _{GON} = 3 Ω, –di/dt = 3.95 A/ns (175°C) V _{GE} = –8 V | T _{vj} = 25°C | – | 250 | – | A |
| | | | T _{vj} = 150°C | – | 332 | – | |
| | | | T _{vj} = 175°C | – | 343 | – | |
| | | | | – | – | – | |

SENSOR CHARACTERISTICS (T_{vj} = 25°C, unless otherwise specified)

| Parameters | | Conditions | Min | Typ | Max | unit | | |
|--------------------|-------------------|----------------------------|-------------------------|----------|------|----------|----|---|
| T _{sense} | Temperature Sense | I _F = 250 μA, | T _{vj} = –40°C | – | 3.40 | – | V | |
| | | | T _{vj} = 25°C | 2.95 | 3.01 | 3.086 | | |
| | | | | (Note 3) | – | (Note 3) | | – |
| | | | T _{vj} = 150°C | – | 2.27 | – | | |
| I _{sense} | Current Sense | R _{shunt} = 10 Ω, | I _C = 600 A | – | 392 | – | mV | |
| | | | I _C = 300 A | – | 254 | – | | |
| | | | I _C = 200 A | – | 209 | – | | |
| | | R _{shunt} = 20 Ω, | I _C = 600 A | – | 566 | – | | |
| | | | I _C = 300 A | – | 377 | – | | |
| | | | I _C = 200 A | – | 314 | – | | |

3. Measured at final test.

VE-Trac™ Dual NVG450A120L5DSC

TYPICAL CHARACTERISTICS

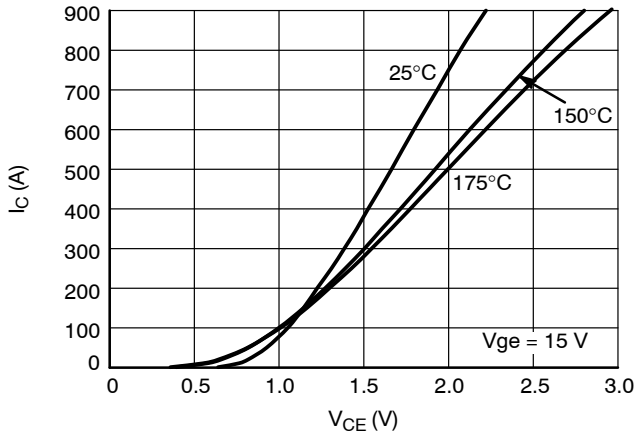


Figure 1. IGBT Output Characteristic

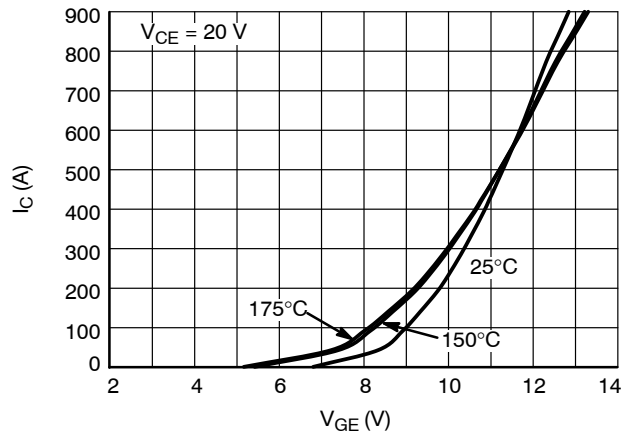


Figure 2. IGBT Transfer Characteristic

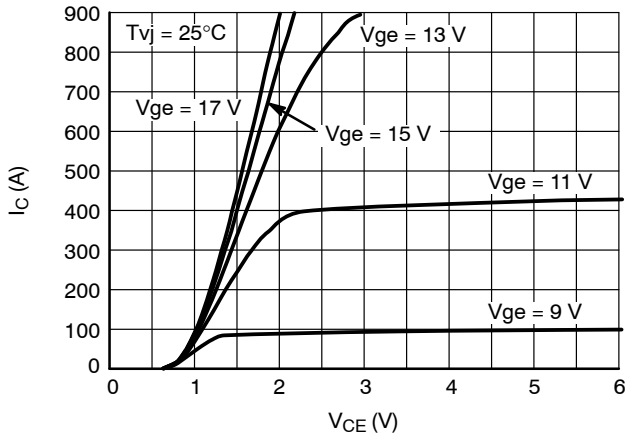


Figure 3. IGBT Output Characteristic

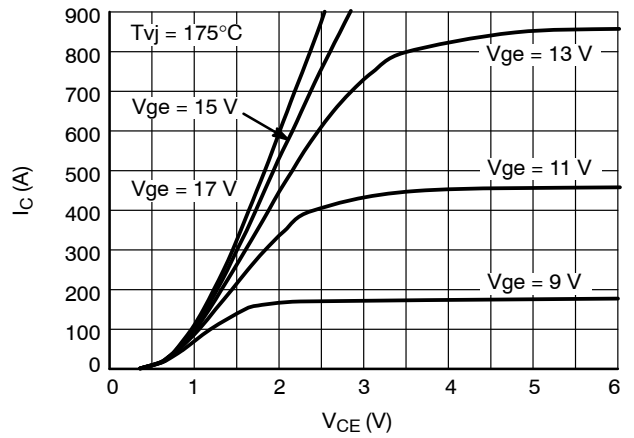


Figure 4. IGBT Output Characteristic

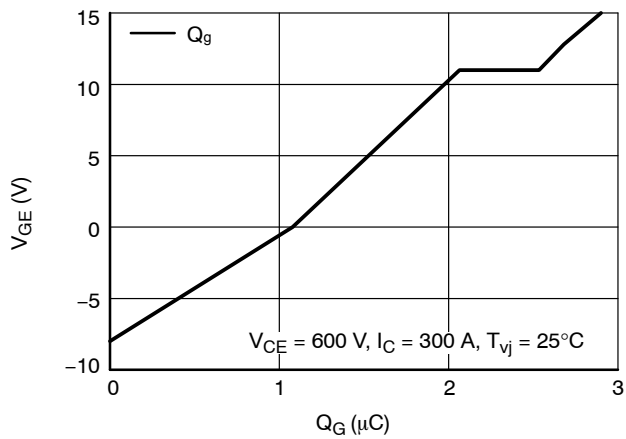


Figure 5. Gate Charge Characteristic

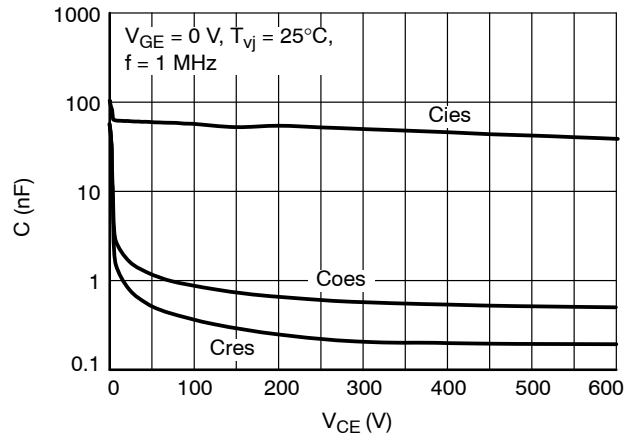


Figure 6. Capacitance Characteristic

VE-Trac™ Dual NVG450A120L5DSC

TYPICAL CHARACTERISTICS

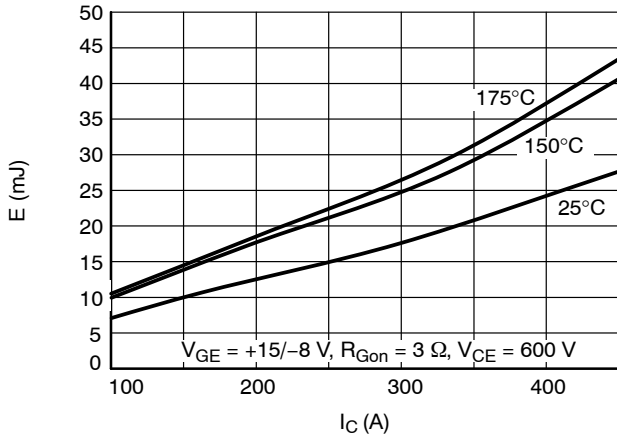


Figure 7. IGBT Turn-on Losses vs. I_C

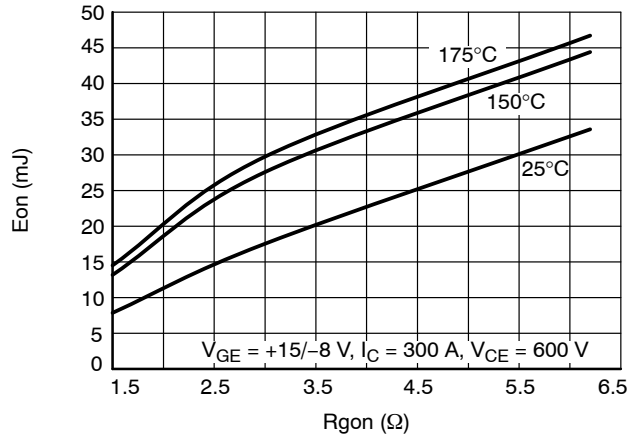


Figure 8. IGBT Turn-on Losses vs. R_{gon}

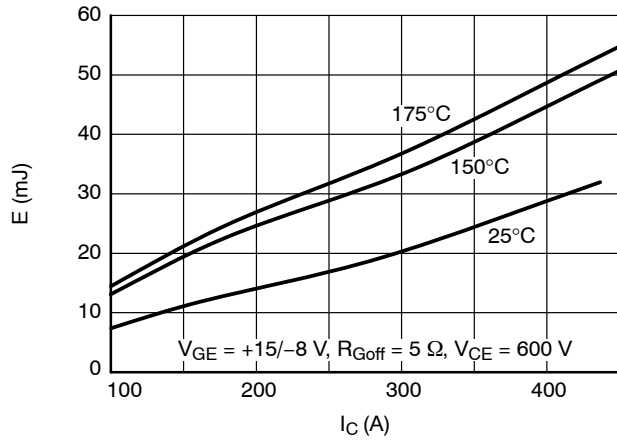


Figure 9. IGBT Turn-off Losses vs. I_C

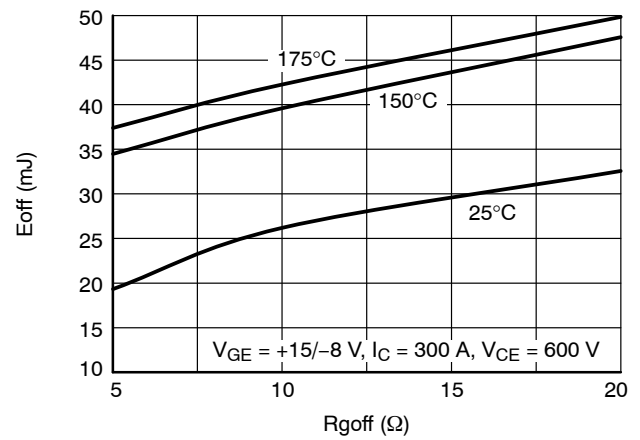


Figure 10. IGBT Turn-off Losses vs. R_{goff}

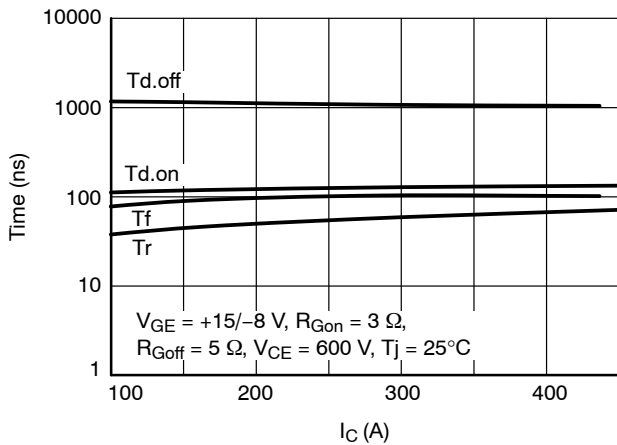


Figure 11. IGBT Switching Times vs. I_C , $T_{vi} = 25^\circ\text{C}$

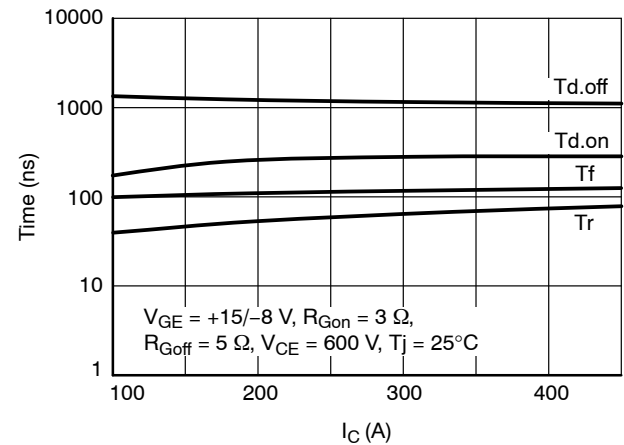


Figure 12. IGBT Switching Times vs. I_C , $T_{vi} = 175^\circ\text{C}$

VE-Trac™ Dual NVG450A120L5DSC

TYPICAL CHARACTERISTICS

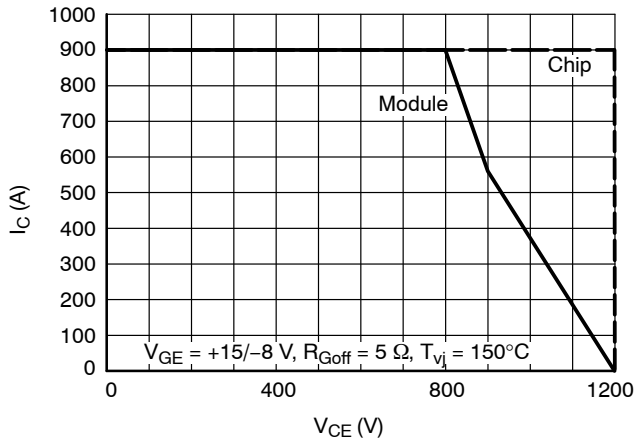


Figure 13. Reverse Bias Safe Operating Area

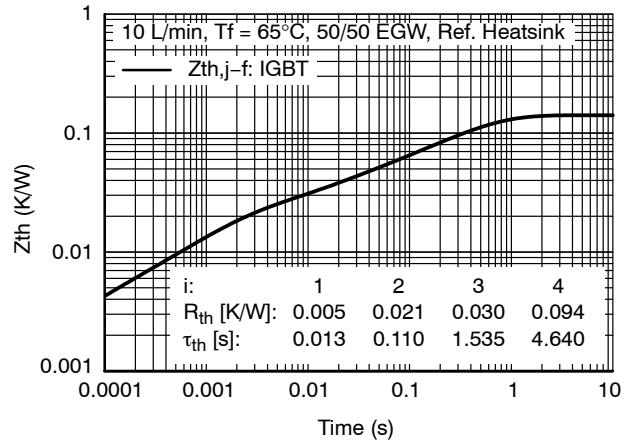


Figure 14. IGBT Transient Thermal Impedance

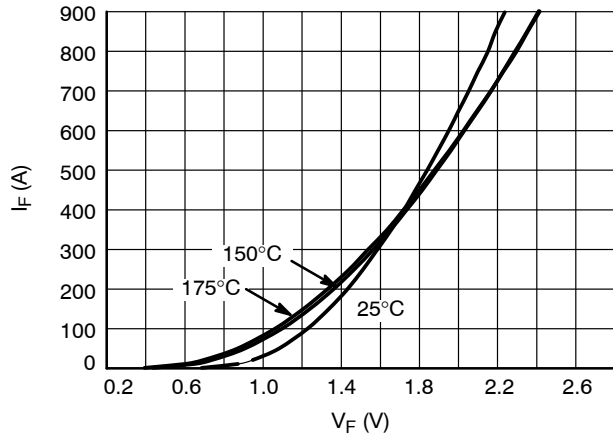


Figure 15. Diode Forward Characteristics

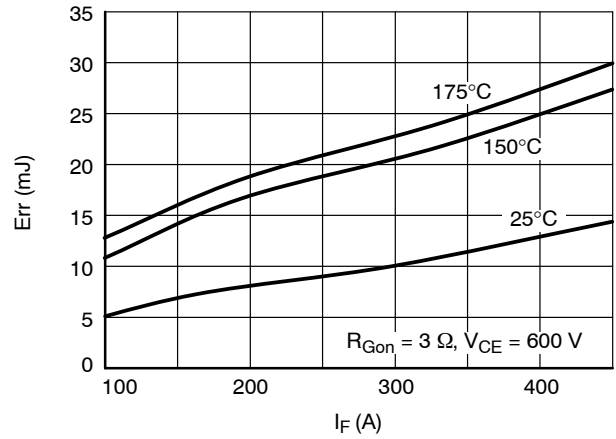


Figure 16. Diode Switching Losses vs. I_F

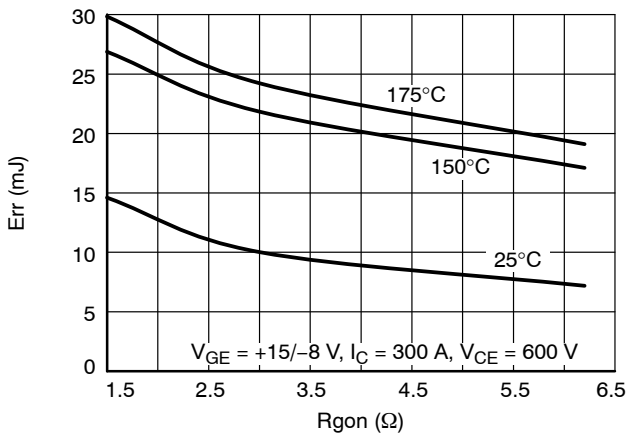


Figure 17. Diode Reverse Recovery Losses vs. R_{gon}

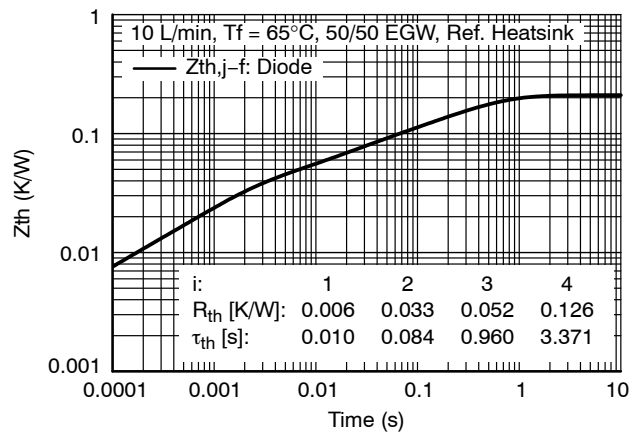


Figure 18. Diode Transient Thermal Impedance

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TYPICAL CHARACTERISTICS

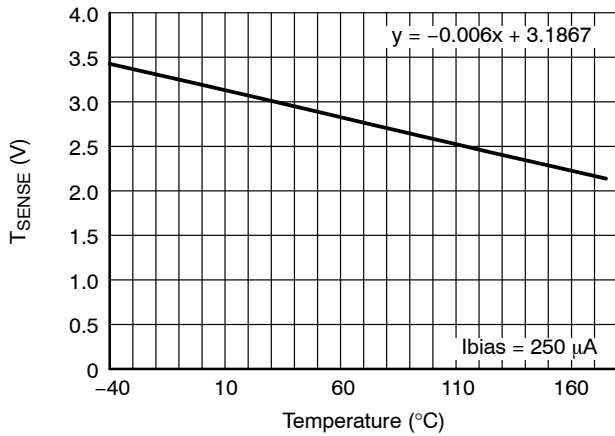


Figure 19. Temperature Sensor Characteristics

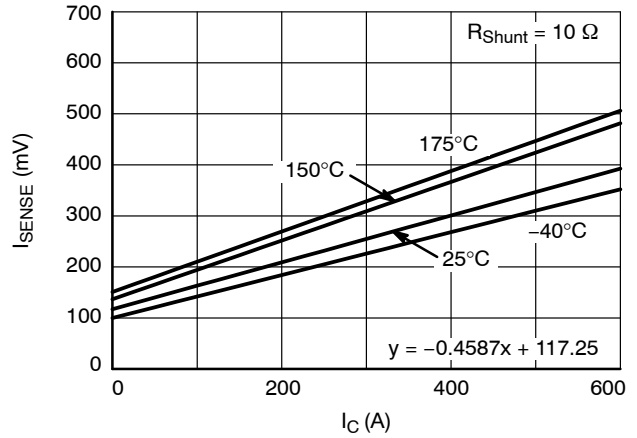


Figure 20. Current Sensor Characteristics

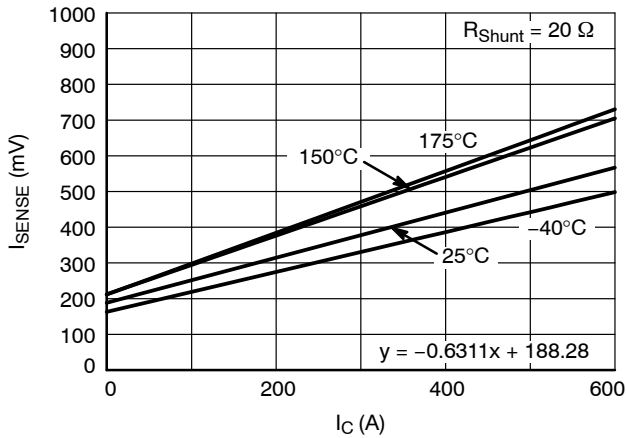
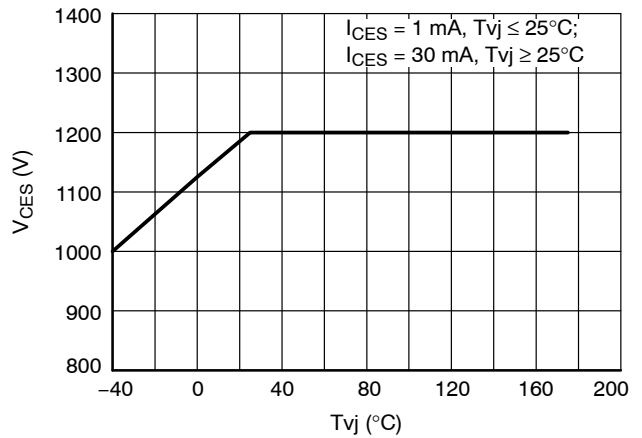


Figure 21. Current Sensor Characteristics



Verified by characterization/design, not by test.

Figure 22. Maximum Allowed V_{ce}

ORDERING INFORMATION

| Device | Device Marking | Package | Shipping |
|-----------------|----------------|-------------------------|---------------|
| NVG450A120L5DSC | N412DSC | AHPM15-CEA (Pb-Free) | 6 Unit / Tube |

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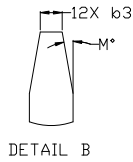
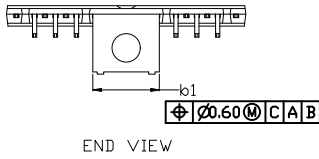
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®



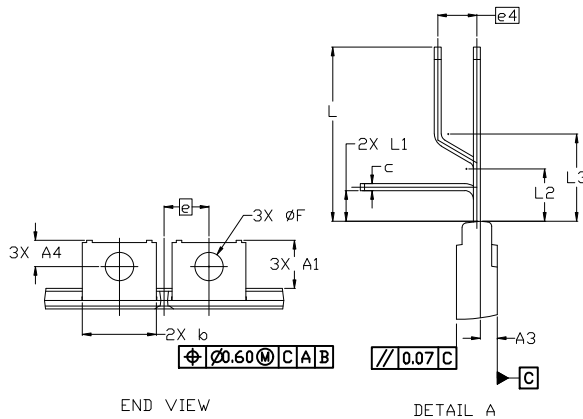
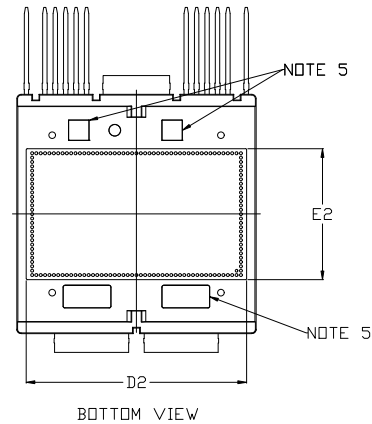
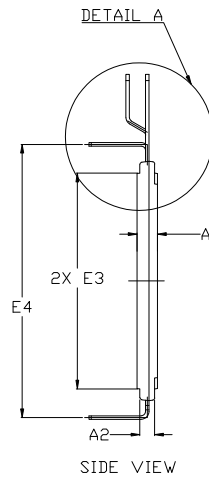
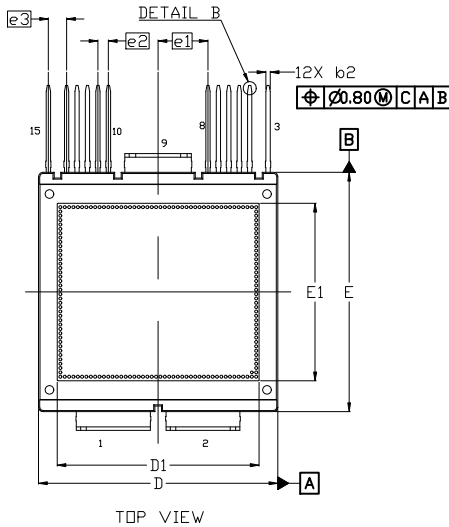
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DATE 09 OCT 2019



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D & E DO NOT INCLUDE MOLD PROTRUSIONS
4. DIMENSIONS b, b1, b2 DO NOT INCLUDE DAMBAR REMAIN.
5. MARKING AREA.



| DIM | MILLIMETERS | | |
|-----|-------------|-------|-------|
| | MIN. | NDM. | MAX. |
| A | 4.65 | 4.70 | 4.75 |
| A1 | 10.75 | 11.05 | 11.35 |
| A2 | 3.20 | 3.40 | 3.60 |
| A3 | 1.60 | 1.95 | 2.30 |
| A4 | 5.70 | 6.00 | 6.30 |
| b | 16.90 | 17.00 | 17.10 |
| b1 | 15.20 | 15.30 | 15.40 |
| b2 | 0.90 | 1.00 | 1.10 |
| b3 | 0.50 REF | | |
| c | 0.70 | 0.80 | 0.90 |
| D | 54.80 | 55.00 | 55.20 |
| D1 | 46.10 | 46.40 | 46.70 |
| D2 | 50.40 | 50.70 | 51.00 |

| DIM | MILLIMETERS | | |
|-----|-------------|-------|-------|
| | MIN. | NDM. | MAX. |
| E | 54.80 | 55.00 | 55.20 |
| E1 | 40.50 | 40.80 | 41.10 |
| E2 | 29.80 | 30.10 | 30.40 |
| E3 | 49.40 | 49.60 | 49.80 |
| E4 | 61.60 | 62.00 | 62.40 |
| e | 10.30 BSC | | |
| e1 | 11.45 BSC | | |
| e2 | 2.40 BSC | | |
| e3 | 4.20 BSC | | |
| F | 6.45 | 6.50 | 6.55 |
| L | 19.60 | 20.00 | 20.40 |
| L1 | 3.10 | 3.50 | 3.90 |
| L2 | 5.70 | 6.00 | 6.30 |
| L3 | 9.70 | 10.00 | 10.30 |
| M | 10° REF | | |

GENERIC MARKING DIAGRAM*



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