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.

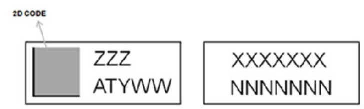
Features

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

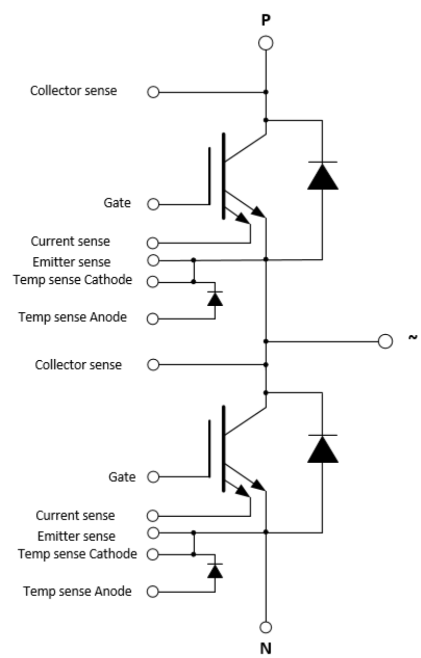
Typical Applications

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

MARKING DIAGRAM



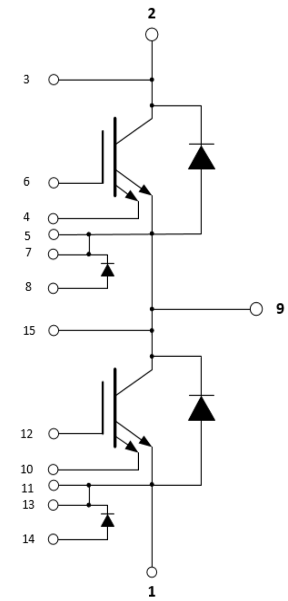
ZZZ = Assembly Lot Code
AT = Assembly & Test Site Code
Y = Year
WW = Work Week
XXXX = Specific Device Code
NNN = Serial Number



ORDERING INFORMATION

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

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

Al_2O_3 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, AC, f = 50 Hz, 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

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, Tvjmax = 175°C, T_F = 65°C, Ref. Heatsink	410 (Note 1)	A
I_{CRM}	Pulsed Collector Current @ VGE = 15 V, tp = 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, Tvjmax = 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^2t value	V_R = 0 V, t_p = 10 ms, Tv_J = 150°C T_{VJ} = 175°C	14400 12960	A^2s

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 Rth, Junction to Case (Note 2)	–	0.06	0.08	°C/W
IGBT.$R_{th,J-F}$	Effective Rth, 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 Rth, Junction to Case (Note 2)	–	0.08	0.10	°C/W
Diode.$R_{th,J-F}$	Effective Rth, 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 (Tc), DBC discoloration, picker circle print is allowed, please refer to the VE−Trac Dual assembly guide for additional details about acceptable DBC surface finish.

CHARACTERISTICS OF IGBT (Tvj = 25°C, unless otherwise specified)

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

CHARACTERISTICS OF INVERSE DIODE (Tvj = 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 T_{vj} = 150°C T_{vj} = 175°C	– – –	1.58 1.56 1.54	1.82 – –	V
		V_{GE} = 0 V, I_C = 450 A,	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.80 1.81 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 T_{vj} = 150°C T_{vj} = 175°C	– – –	10 22 24	– – –	mJ
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 T_{vj} = 150°C T_{vj} = 175°C	– – –	25 53 59	– – –	μC
Irr	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 T_{vj} = 150°C T_{vj} = 175°C	– – –	250 332 343	– – –	A

SENSOR CHARACTERISTICS (Tvj = 25°C, unless otherwise specified)

Parameters		Conditions		Min	Typ	Max	unit
T_{sense}	Temperature Sense	I_F = 250 μA,	T_{vj} = −40°C T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– 2.95 (Note 3) – –	3.40 3.01 2.27 2.08	– 3.086 (Note 3) – –	V
I_{sense}	Current Sense	R_{shunt} = 10 Ω,	I_C = 600 A I_C = 300 A I_C = 200 A	– – –	392 254 209	– – –	mV
		R_{shunt} = 20 Ω,	I_C = 600 A I_C = 300 A I_C = 200 A	– – –	566 377 314	– – –	

3. Measured at final test.

TYPICAL CHARACTERISTICS

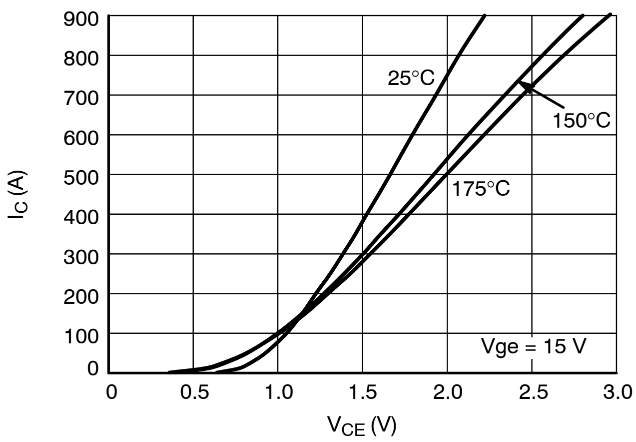


Figure 1. IGBT Output Characteristic

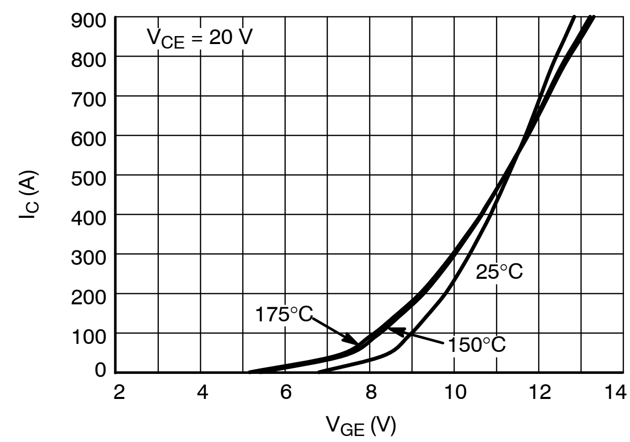


Figure 2. IGBT Transfer Characteristic

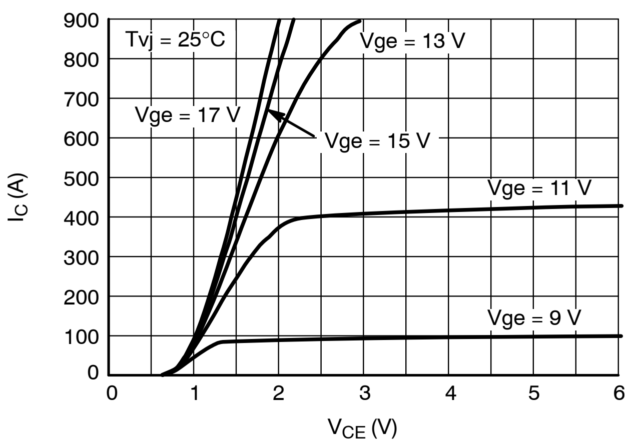


Figure 3. IGBT Output Characteristic

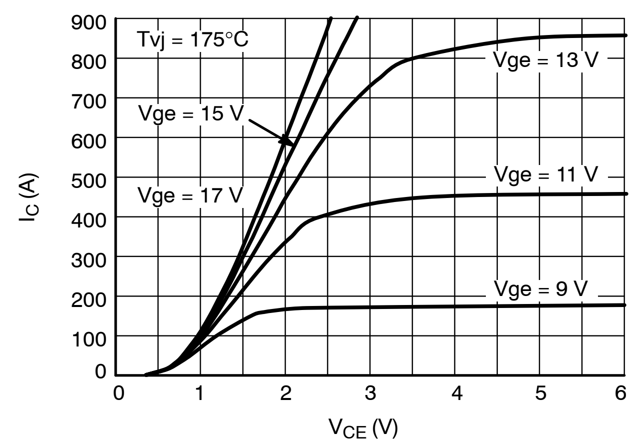


Figure 4. IGBT Output Characteristic

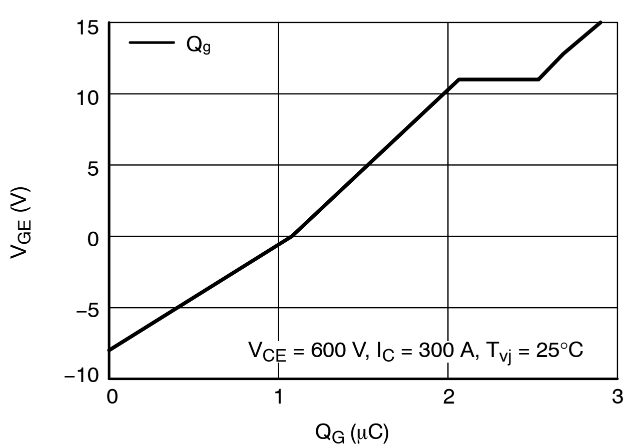


Figure 5. Gate Charge Characteristic

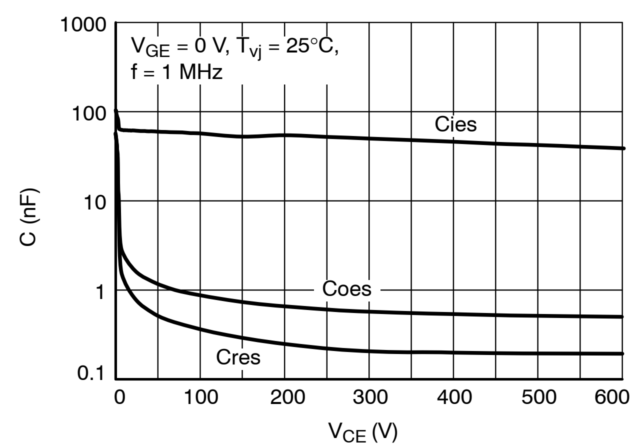


Figure 6. Capacitance Characteristic

TYPICAL CHARACTERISTICS

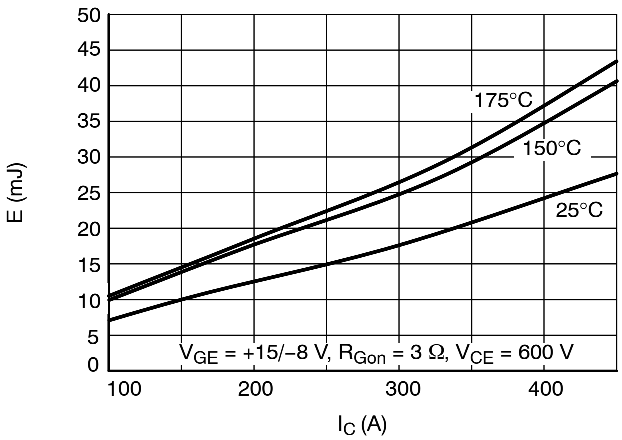


Figure 7. IGBT Turn−on Losses vs. I_C

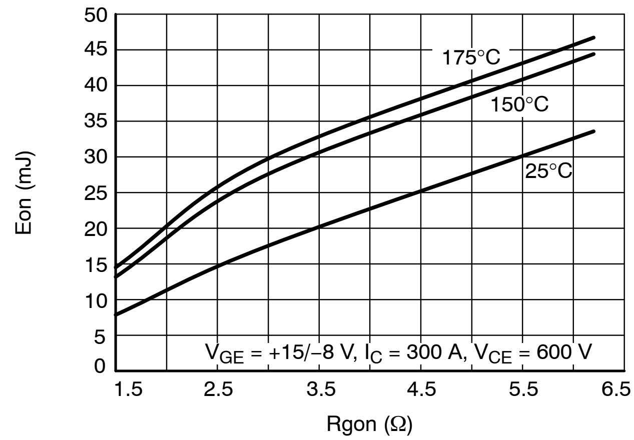


Figure 8. IGBT Turn−on Losses vs. Rgon

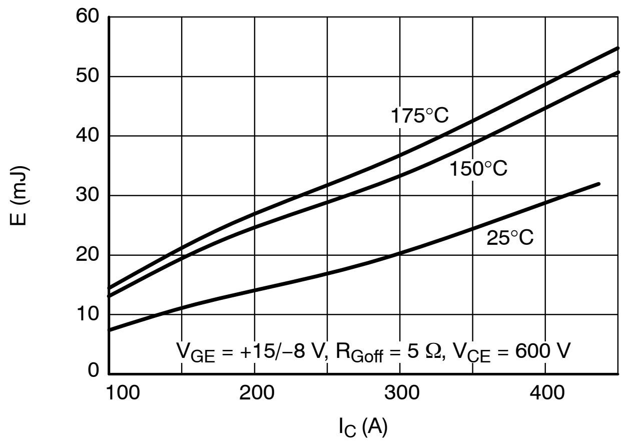


Figure 9. IGBT Turn−off Losses vs. I_C

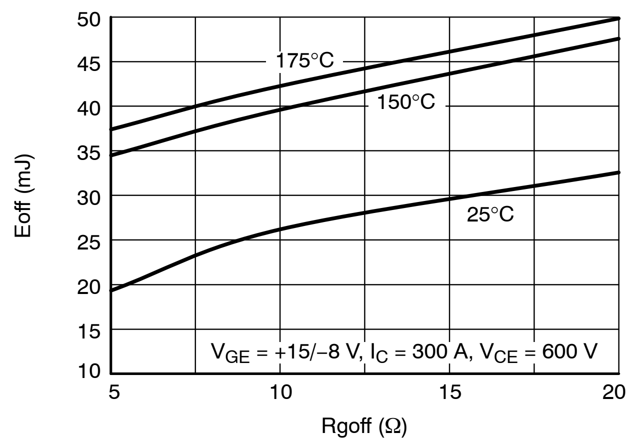


Figure 10. IGBT Turn−off Losses vs. Rgoff

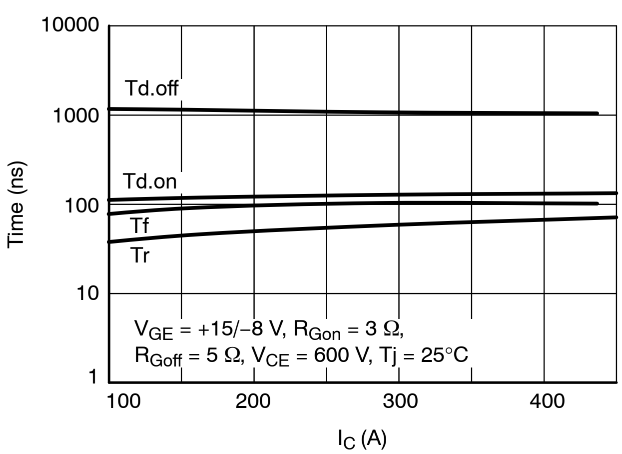


Figure 11. IGBT Switching Times vs. I_C, T_{vj} = 25°C

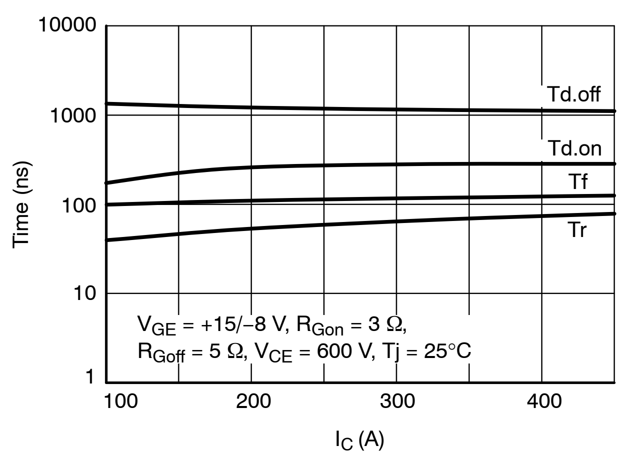


Figure 12. IGBT Switching Times vs. I_C, T_{vj} = 175°C

TYPICAL CHARACTERISTICS

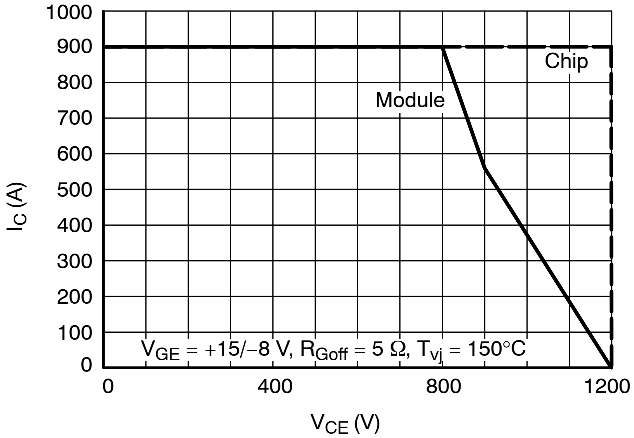


Figure 13. Reverse Bias Safe Operating Area

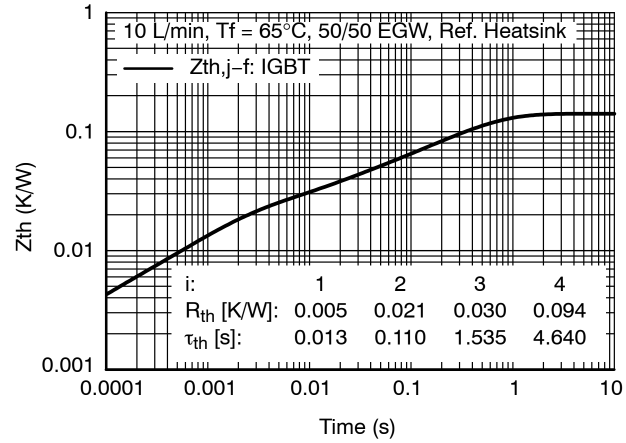


Figure 14. IGBT Transient Thermal Impedance

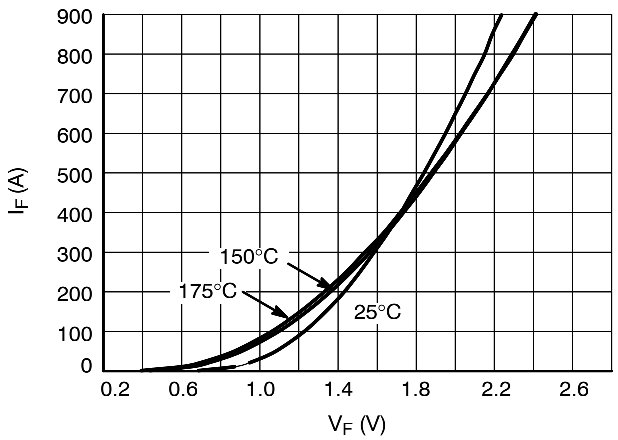


Figure 15. Diode Forward Characteristics

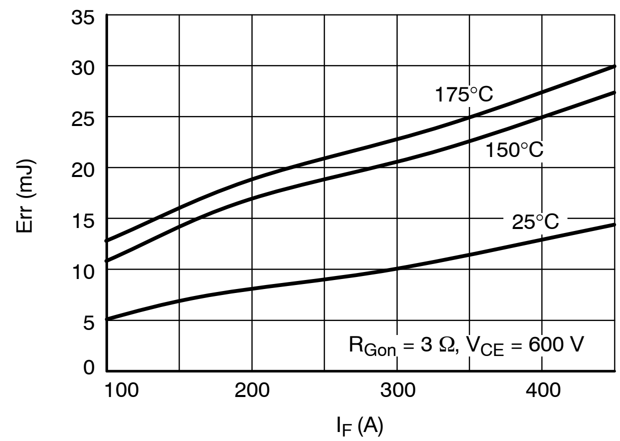


Figure 16. Diode Switching Losses vs. I_F

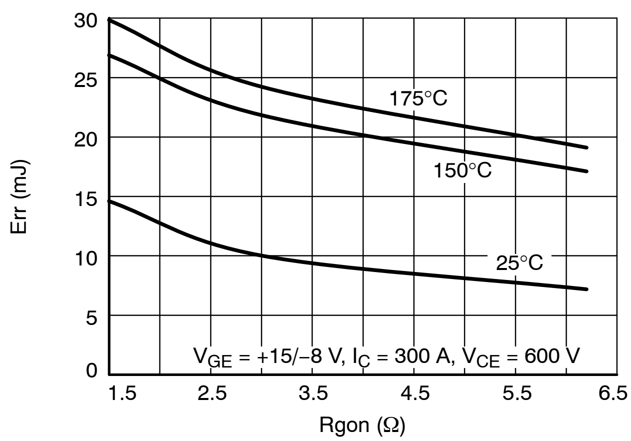


Figure 17. Diode Reverse Recovery Losses vs. Rgon

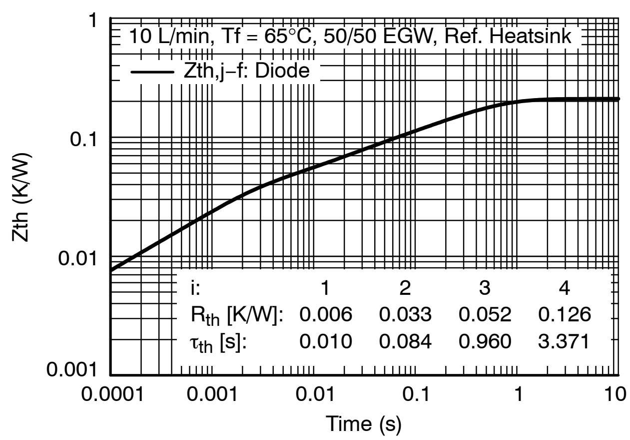


Figure 18. Diode Transient Thermal Impedance

TYPICAL CHARACTERISTICS

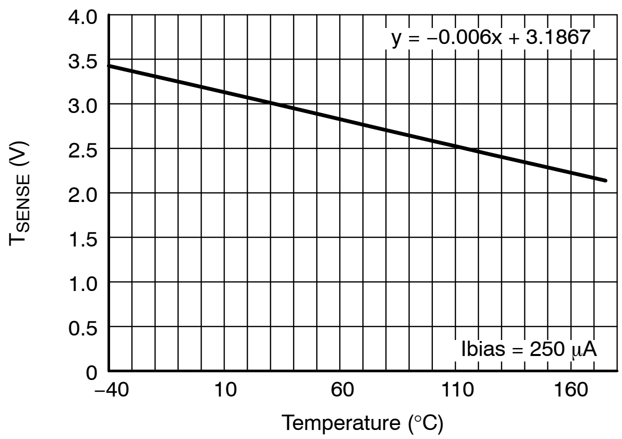


Figure 19. Temperature Sensor Characteristics

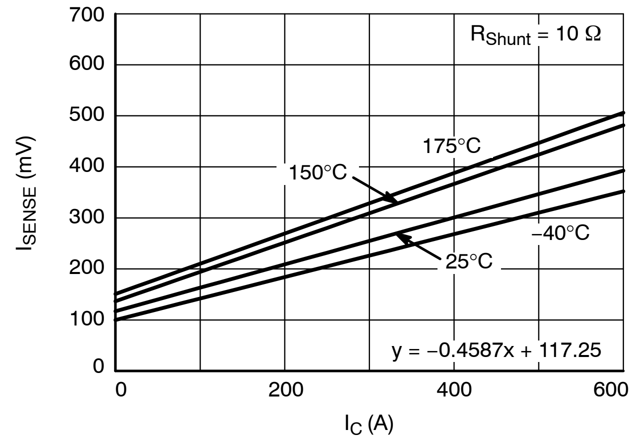


Figure 20. Current Sensor Characteristics

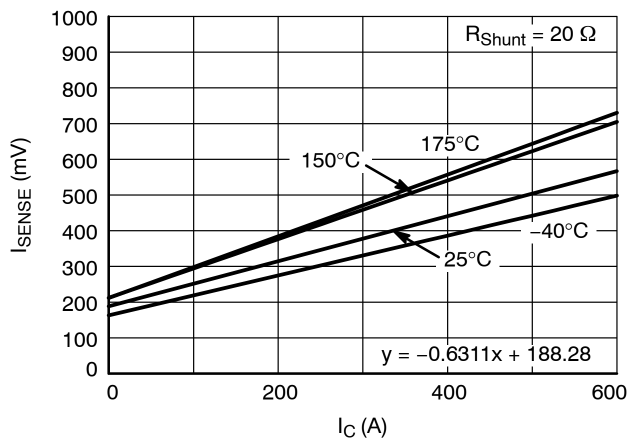
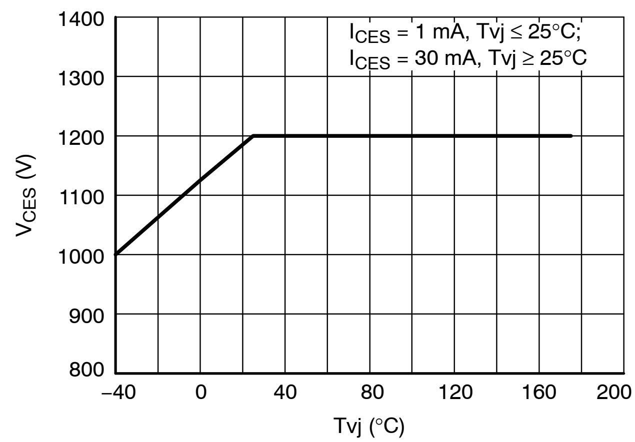


Figure 21. Current Sensor Characteristics



Verified by characterization/design,not by test.

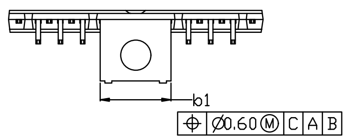
Figure 22. Maximum Allowed Vce

ORDERING INFORMATION

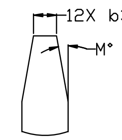
Device	Device Marking	Package	Shipping
NVG450A120L5DSC	N412DSC	AHPM15−CEA (Pb−Free)	6 Unit / Tube

AHPM15−CEA
CASE 100DD
ISSUE B

DATE 28 SEP 2022

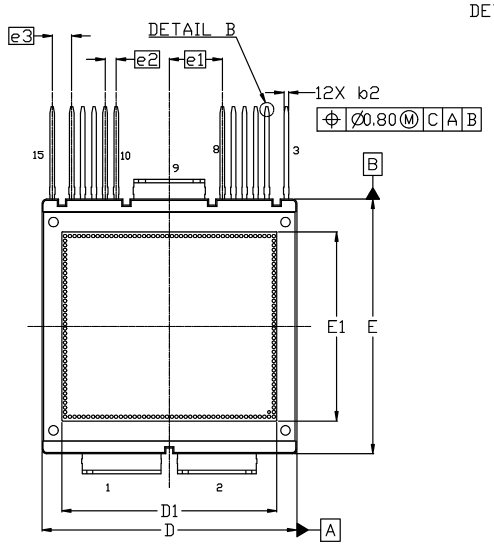


END VIEW

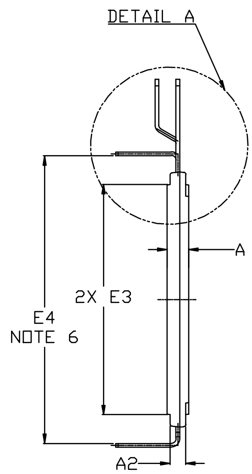


DETAIL B

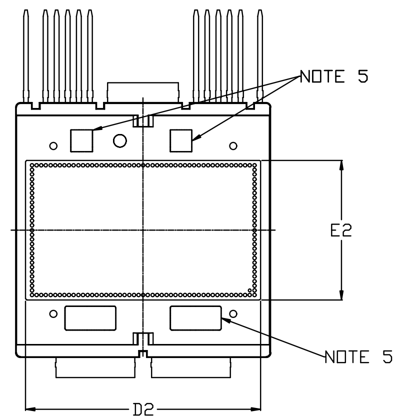
NOTES:
1. DIMENSIONING AND TOLERANCING PER. ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D & E DO NOT INCLUDE MOLD PROTRUSIONS
4. DIMENSIONS b,b1,b2 DO NOT INCLUDE DAMBAR REMAIN.
5. MARKING AREA.
6. E4 IS FROM INNER LEAD TIP TO INNER LEAD TIP DISTANCE.



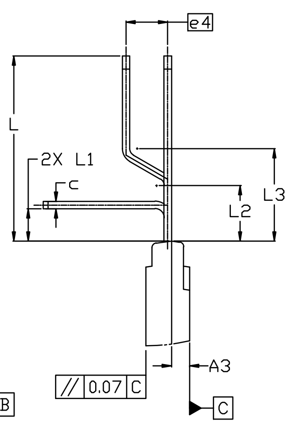
TOP VIEW



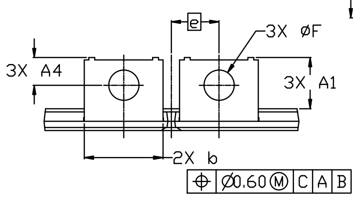
SIDE VIEW



BOTTOM VIEW



DETAIL A

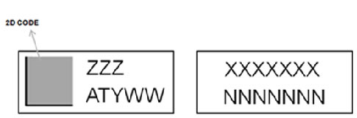


END VIEW

DIM	MILLIMETERS MIN.	NOM.	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	46.20	46.50	46.80
D2	50.70	51.00	51.30

DIM	MILLIMETERS MIN.	NOM.	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	61.75	62.00	62.25
e		10.30 BSC	
e1		11.45 BSC	
e2		2.40 BSC	
e3		4.20 BSC	
e4		4.50 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*



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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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DESCRIPTION:	AHPM15−CEA	PAGE 1 OF 1

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