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# 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

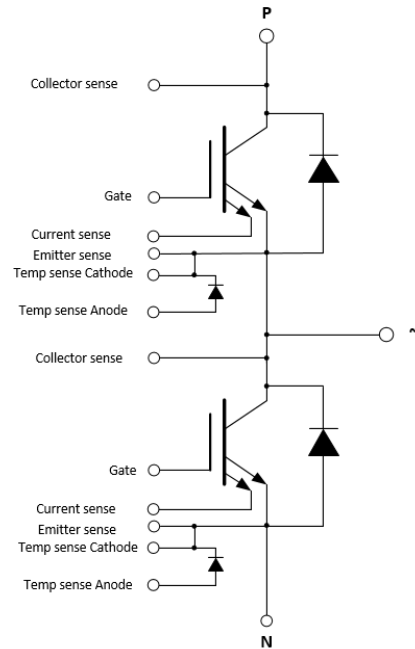
## Typical Applications

- 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

Al<sub>2</sub>O<sub>3</sub> 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 <sub>vj</sub>	Continuous Operating Junction Temperature Range	-40 to 150	°C		
T <sub>vj,op</sub>	Continuous Operating Junction Temperature Under Switching Conditions	-40 to 175	°C		
T <sub>STG</sub>	Storage Temperature Range	-40 to 125	°C		
V <sub>ISO</sub>	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			
		<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
L <sub>sCE</sub>	Stray Inductance	-	-	8	nH
R <sub>CC'+EE'</sub>	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 ( $T_{Vj} = 25^{\circ}\text{C}$ , unless otherwise specified)

Symbol	Parameter	Rating	Unit
<b>IGBT</b>			
$V_{CES}$	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	$\pm 20$	V
$I_{CN}$	Implemented Collector Current	450	A
$I_{C\ nom}$	Continuous DC Collector Current, $T_{vjmax} = 175^{\circ}\text{C}$ , $T_F = 65^{\circ}\text{C}$ , Ref. Heatsink	410 (Note 1)	A
$I_{CRM}$	Pulsed Collector Current @ $V_{GE} = 15\text{ V}$ , $t_p = 1\text{ ms}$	900	A

## DIODE

$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_{FN}$	Implemented Forward Current	450	A
$I_F$	Continuous Forward Current, $T_{vjmax} = 175^{\circ}\text{C}$ , $T_F = 65^{\circ}\text{C}$ , Ref. Heatsink	360 (Note 1)	A
$I_{FRM}$	Repetitive Peak Forward Current, $t_p = 1\text{ ms}$	900	A
$I^2t$ value	$V_R = 0\text{ V}$ , $t_p = 10\text{ ms}$ , $T_{Vj} = 150^{\circ}\text{C}$ $T_{Vj} = 175^{\circ}\text{C}$	14400 12960	$\text{A}^2\text{s}$

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	$^{\circ}\text{C}/\text{W}$
IGBT. $R_{th,J-F}$	Effective $R_{th}$ , Junction to Fluid, $\lambda_{TIM} = 6\text{ W/m-K}$ , $F = 660\text{ N}$ 10 L/min, $65^{\circ}\text{C}$ , 50/50 EGW, Ref. Heatsink	-	0.15	-	$^{\circ}\text{C}/\text{W}$
Diode. $R_{th,J-C}$	Effective $R_{th}$ , Junction to Case (Note 2)	-	0.08	0.10	$^{\circ}\text{C}/\text{W}$
Diode. $R_{th,J-F}$	Effective $R_{th}$ , Junction to Fluid, $\lambda_{TIM} = 6\text{ W/m-K}$ , $F = 660\text{ N}$ 10 L/min, $65^{\circ}\text{C}$ , 50/50 EGW, Ref. Heatsink	-	0.21	-	$^{\circ}\text{C}/\text{W}$

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	$V_{CE} = 0\text{ V}, V_{GE} = +20\text{ V}/-15\text{ V}$	-	-	$\pm 400$	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	-	$\mu\text{C}$	
$R_{Gint}$	Internal Gate Resistance		-	0	-	$\Omega$	
$C_{ies}$	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	$V_{GE} = 15\text{ V}, V_{CC} = 600\text{ V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	16	-	-	J	
			8.8	-	-		

# VE-Trac™ Dual NVG450A120L5DSC

## CHARACTERISTICS OF INVERSE DIODE (T<sub>vj</sub> = 25°C, unless otherwise specified)

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

## SENSOR CHARACTERISTICS (T<sub>vj</sub> = 25°C, unless otherwise specified)

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

3. Measured at final test.

# VE-Trac™ Dual NVG450A120L5DSC

## TYPICAL CHARACTERISTICS

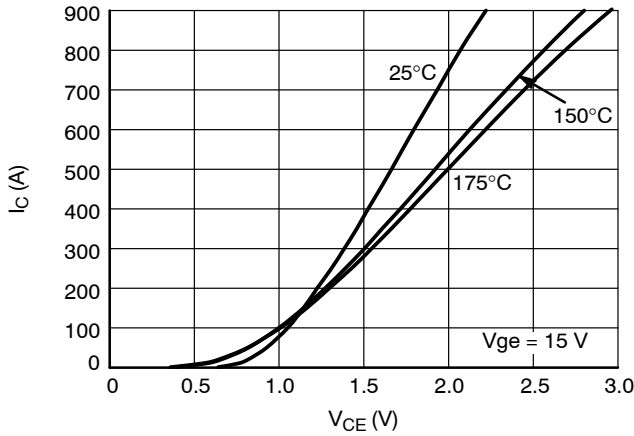


Figure 1. IGBT Output Characteristic

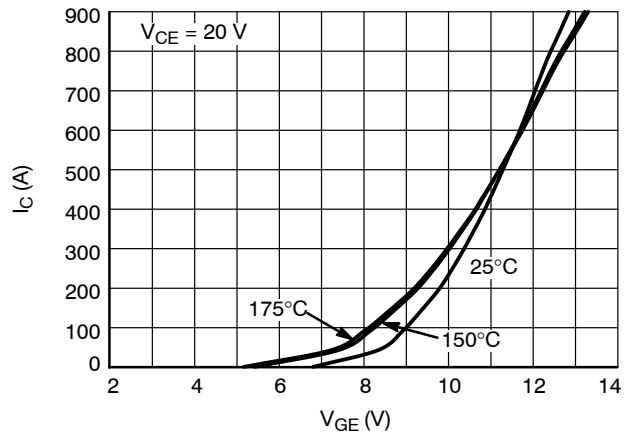


Figure 2. IGBT Transfer Characteristic

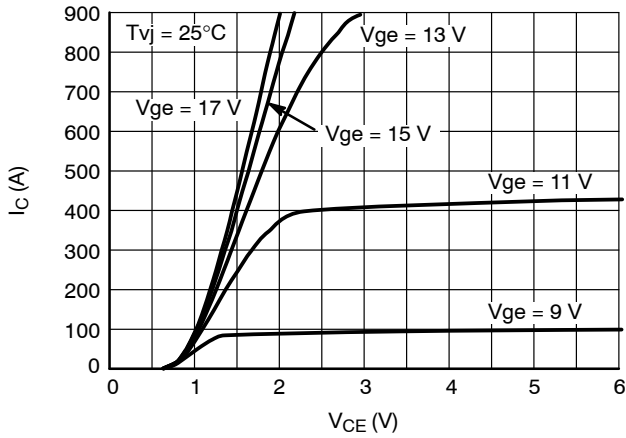


Figure 3. IGBT Output Characteristic

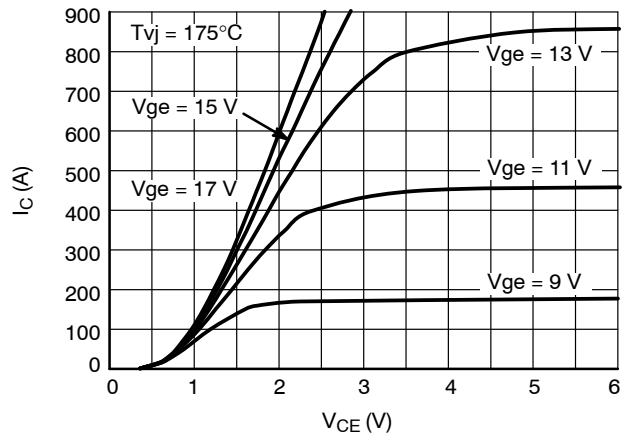


Figure 4. IGBT Output Characteristic

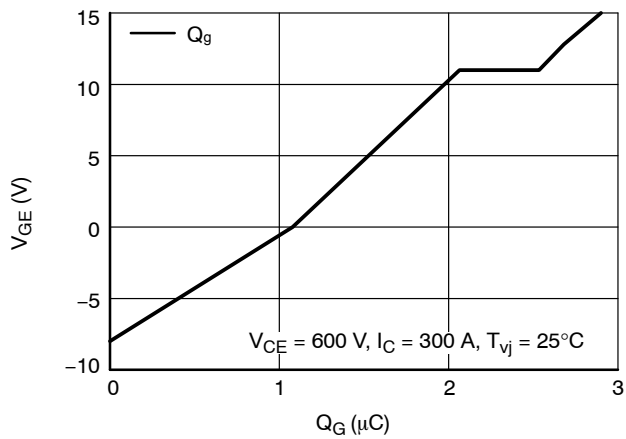


Figure 5. Gate Charge Characteristic

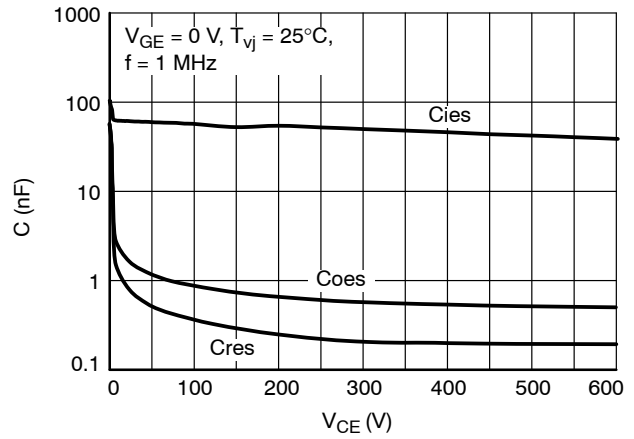


Figure 6. Capacitance Characteristic

# VE-Trac™ Dual NVG450A120L5DSC

## TYPICAL CHARACTERISTICS

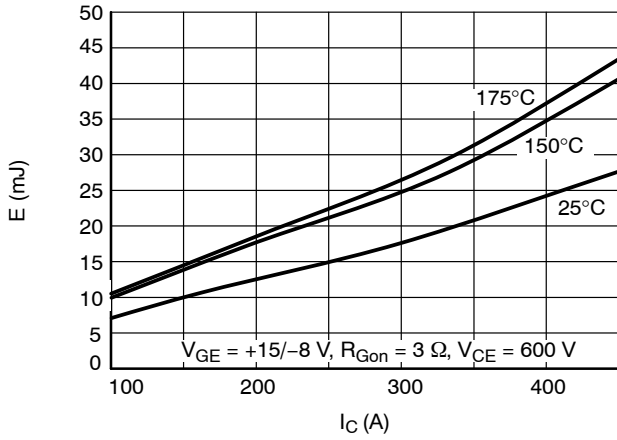


Figure 7. IGBT Turn-on Losses vs.  $I_C$

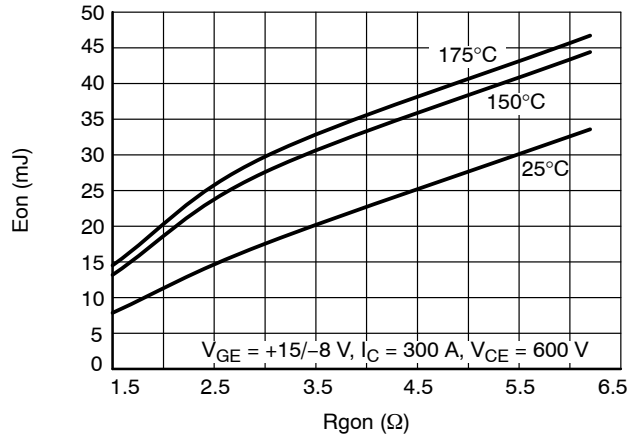


Figure 8. IGBT Turn-on Losses vs.  $R_{gon}$

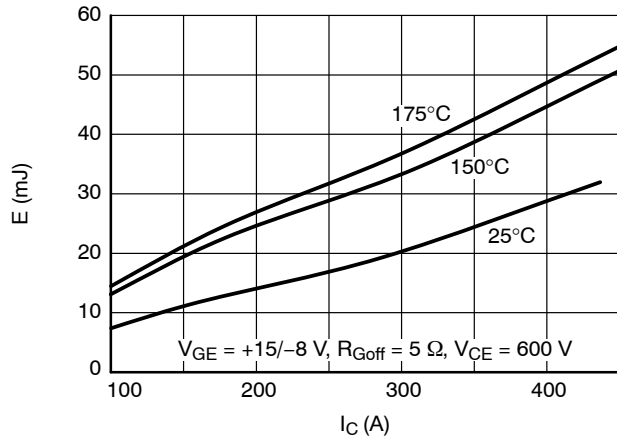


Figure 9. IGBT Turn-off Losses vs.  $I_C$

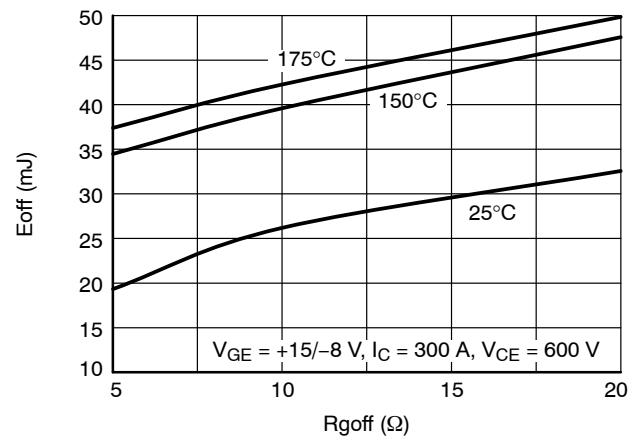


Figure 10. IGBT Turn-off Losses vs.  $R_{goff}$

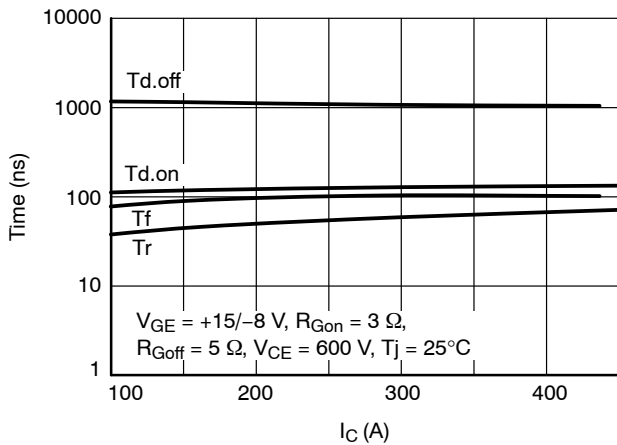


Figure 11. IGBT Switching Times vs.  $I_C$ ,  $T_{vj} = 25^\circ\text{C}$

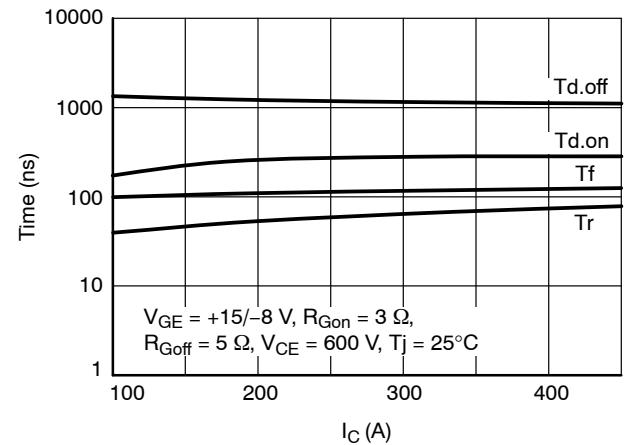


Figure 12. IGBT Switching Times vs.  $I_C$ ,  $T_{vj} = 175^\circ\text{C}$



# VE-Trac™ Dual NVG450A120L5DSC

## TYPICAL CHARACTERISTICS

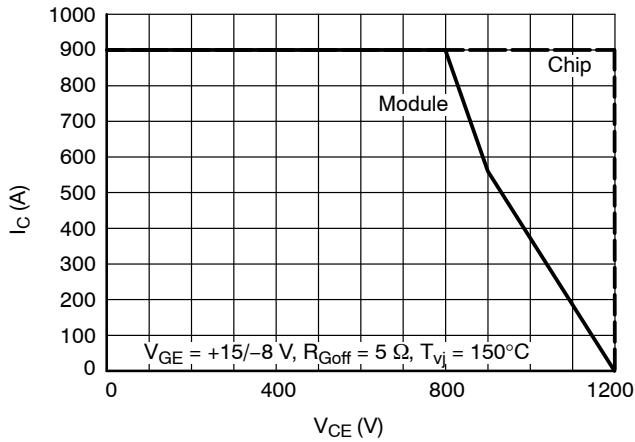


Figure 13. Reverse Bias Safe Operating Area

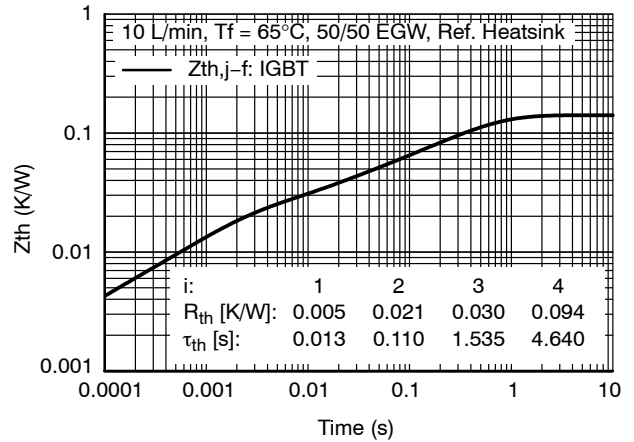


Figure 14. IGBT Transient Thermal Impedance

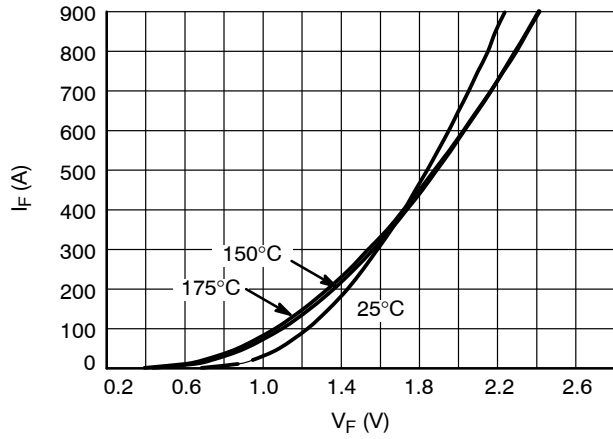


Figure 15. Diode Forward Characteristics

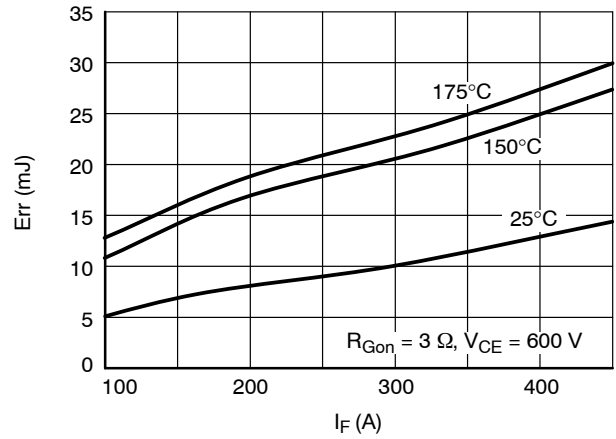


Figure 16. Diode Switching Losses vs.  $I_F$

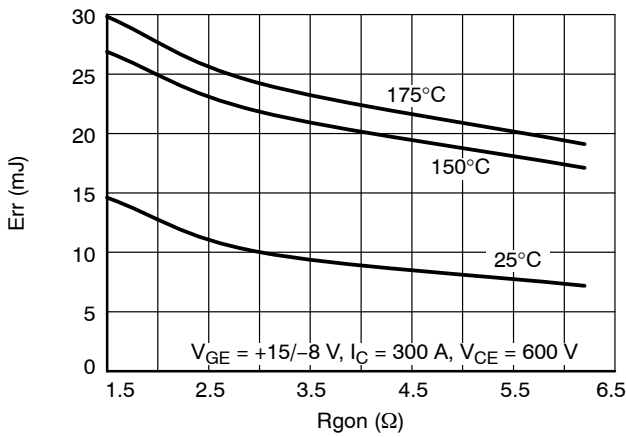


Figure 17. Diode Reverse Recovery Losses vs.  $R_{gon}$

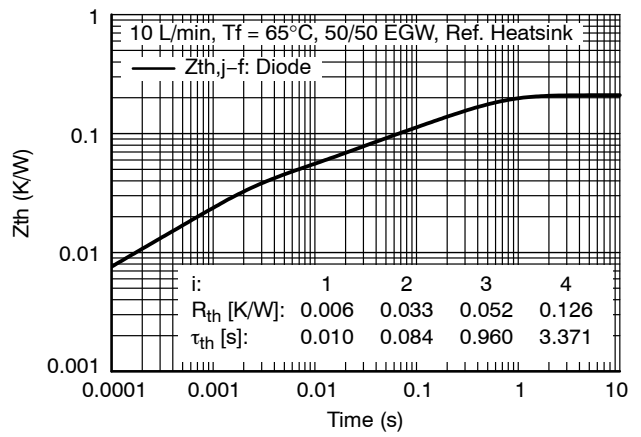


Figure 18. Diode Transient Thermal Impedance

# VE-Trac™ Dual NVG450A120L5DSC

## TYPICAL CHARACTERISTICS

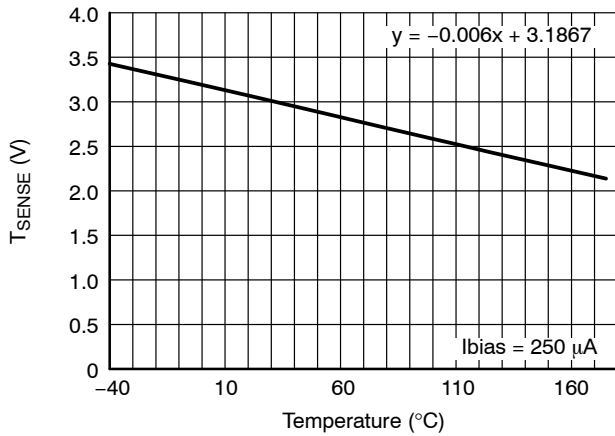


Figure 19. Temperature Sensor Characteristics

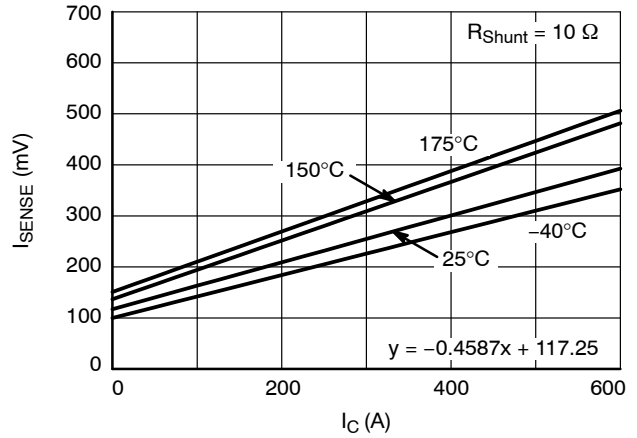


Figure 20. Current Sensor Characteristics

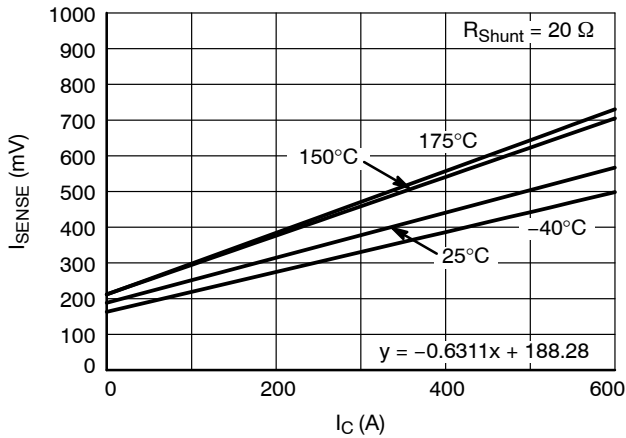
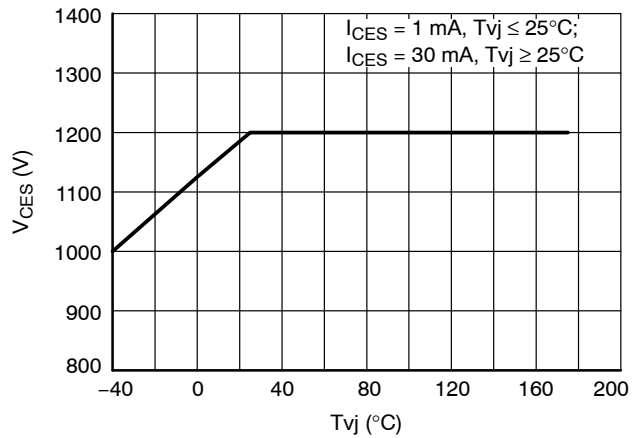


Figure 21. Current Sensor Characteristics



Verified by characterization/design, not by test.

Figure 22. Maximum Allowed  $V_{ce}$

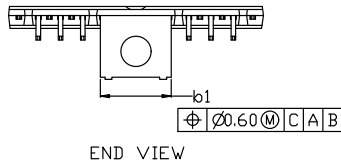
### ORDERING INFORMATION

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

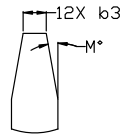


AHPM15-CEA  
CASE 100DD  
ISSUE B

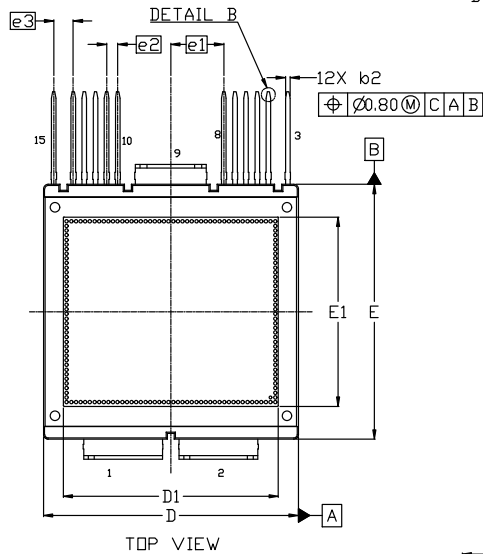
DATE 28 SEP 2022



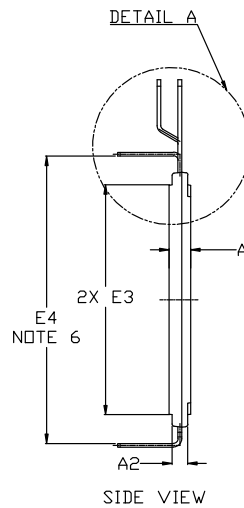
END VIEW



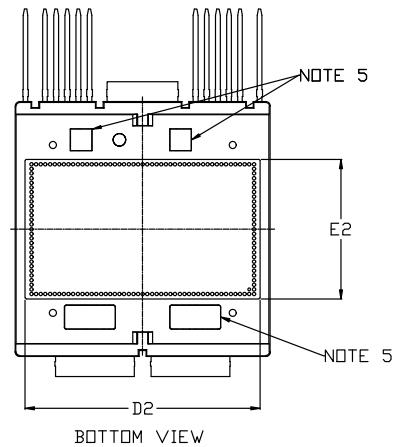
DETAIL B



TOP VIEW



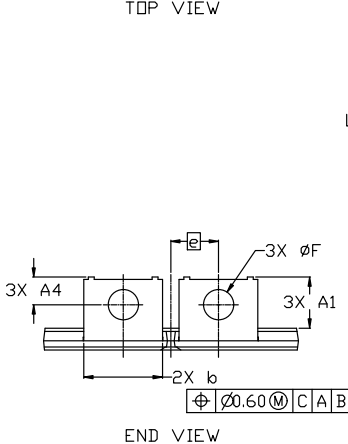
SIDE VIEW



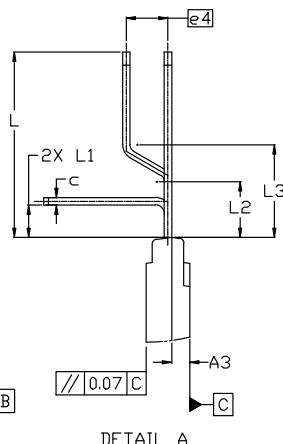
BOTTOM VIEW

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.



END VIEW



DETAIL A

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\*



- 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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