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Automotive 750 V, 600 A Dual Side Cooling Half-Bridge Power Module

VE-Trac™ Dual NVG600A75L4DSE2

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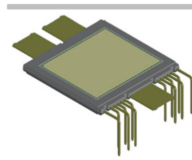
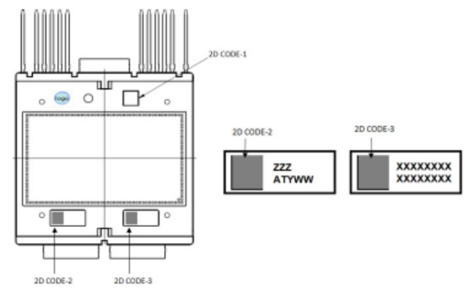
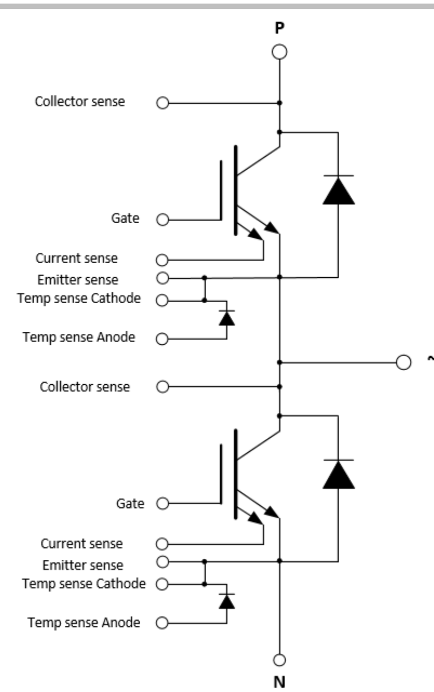


AHPM15−CFA MODULE
CASE MODHQ

MARKING DIAGRAM



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



ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

Product Description

The NVG600A75L4DSE2 is part of a family of power modules with dual side cooling and compact footprints for Hybrid (HEV) and Electric Vehicle (EV) traction inverter application.

The module consists of two narrow mesa Field Stop (FS4) IGBTs in a half−bridge configuration. The chipset utilizes the new narrow mesa IGBT technology in providing high current density and robust short circuit protection with higher blocking voltage to deliver outstanding performance in EV traction applications.

Liquid cooling heatsink reference design, loss models and CAD models are available to support customers in inverter designs.

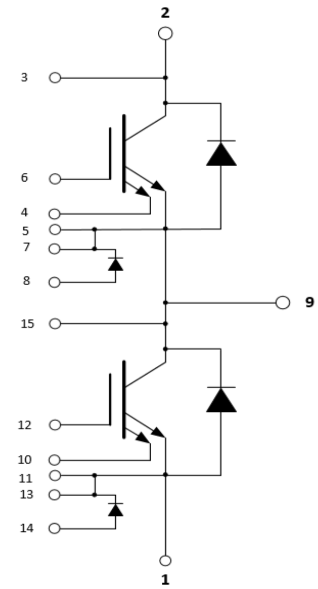
Features

- Dual−Side Cooling
- Integrated Chip Level Temperature and Current Sensor
- $T_{vj\ max}$ = 175°C for Continuous Operation
- Low−Stray Inductance
- Low Conduction and Switching Losses
- Automotive Grade
- 4.2 kV Isolated DBC Substrate
- AEC Qualified and PPAP Capable
- This Device is Pb−Free and is RoHS Compliant

Typical Applications

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

PIN DESCRIPTION

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

MODULE CHARACTERISTICS

Symbol	Parameter			Rating	Unit
T_{vj}	Continuous Operating Junction Temperature Range			−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	−	−	75	g

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

Symbol	Parameter	Rating	Unit
IGBT			
V_{CES}	Collector to Emitter Voltage	750	V
V_{GES}	Gate to Emitter Voltage	±20	V
I_{CN}	Implemented Collector Current	600	A
$I_{C\ nom}$	Continuous DC Collector Current, Tvjmax = 175°C, T_F = 65°C, Ref. Heatsink	500	A
I_{CRM}	Pulsed Collector Current @ VGE = 15 V, tp = 1 ms	1200	A
DIODE			
V_{RRM}	Repetitive Peak Reverse Voltage	750	V
I_{FN}	Implemented Forward Current	600	A
I_F	Continuous Forward Current, Tvjmax = 175°C, T_F = 65°C, Ref. Heatsink	400	A
I_{FRM}	Repetitive Peak Forward Current, t_p = 1 ms	1200	A
I^2t value	V_R = 0 V, t_p = 10 ms, T_{VJ} = 150°C T_{VJ} = 175°C	14000 12000	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.

THERMAL CHARACTERISTICS

Symbol	Parameter	Min.	Typ.	Max.	Unit
IGBT.$R_{th,J-C}$	Effective Rth, Junction to Case	–	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	–	0.146	–	°C/W
Diode.$R_{th,J-C}$	Effective Rth, Junction to Case	–	0.10	0.13	°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	–	0.196	–	°C/W

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

Parameters		Conditions	Min	Typ	Max	unit
V_{CESAT}	Collector to Emitter Saturation Voltage	V_{GE} = 15 V, I_C = 400 A, T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C V_{GE} = 15 V, I_C = 600 A, T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – – – – –	1.23 1.28 1.30 1.39 1.53 1.57	1.35 – – – – –	V
I_{CES}	Collector to Emitter Leakage Current	V_{GE} = 0, V_{CE} = 750 V T_{vj} = 25°C T_{vj} = 175°C	– –	– 8	1 –	mA
I_{GES}	Gate – Emitter Leakage Current	V_{CE} = 0, V_{GE} = ±20 V	–	–	±400	nA
V_{th}	Threshold Voltage	V_{CE} = V_{GE}, I_C = 500 mA	4.5	5.6	6.5	V
Q_G	Total Gate Charge	V_{GE} = −8 to 15 V, V_{CE} = 400 V, I_C = 400 A	–	1.0	–	μC
R_{Gint}	Internal Gate Resistance		–	2	–	Ω
C_{ies}	Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	36	–	nF
C_{oes}	Output Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	0.7	–	nF
C_{res}	Reverse Transfer Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	0.09	–	nF
$T_{d.on}$	Turn On Delay, Inductive Load	I_C = 400 A, V_{CE} = 400 V T_{vj} = 25°C V_{GE} = +15/−8 V T_{vj} = 150°C Rg.on = 3.9 Ω T_{vj} = 175°C	– – –	194 224 228	– – –	ns
T_r	Rise Time, Inductive Load	I_C = 400 A, V_{CE} = 400 V T_{vj} = 25°C V_{GE} = +15/−8 V T_{vj} = 150°C Rg.on = 3.9 Ω T_{vj} = 175°C	– – –	71 89 94	– – –	ns
$T_{d.off}$	Turn Off Delay, Inductive Load	I_C = 400 A, V_{CE} = 400 V T_{vj} = 25°C V_{GE} = +15/−8 V T_{vj} = 150°C Rg.off = 15 Ω T_{vj} = 175°C	– – –	969 1047 1063	– – –	ns
T_f	Fall Time, Inductive Load	I_C = 400 A, V_{CE} = 400 V T_{vj} = 25°C V_{GE} = +15/−8 V T_{vj} = 150°C Rg.off = 15 Ω T_{vj} = 175°C	– – –	123 202 230	– – –	ns
E_{ON}	Turn−On Switching Loss (Including Diode Reverse Recovery Loss)	I_C = 400 A, V_{CE} = 400 V T_{vj} = 25°C V_{GE} = +15/−8 V T_{vj} = 150°C Rg.on = 3.9 Ω T_{vj} = 175°C Ls = 25 nH di/dt (T_{vj} = 25°C) = 4.67 A/ns di/dt (T_{vj} = 175°C) = 3.61 A/ns	– – –	10.09 16.73 18.57	– – –	mJ
E_{OFF}	Turn−Off SwitchingLoss	I_C = 400 A, V_{CE} = 400 V T_{vj} = 25°C V_{GE} = +15/−8 V T_{vj} = 150°C Rg.off = 15 Ω T_{vj} = 175°C Ls = 25 nH dv/dt (T_{vj}=25°C) = 2.82 V/ns dv/dt (T_{vj}=175°C) = 2.08 V/ns	– – –	15.95 25.06 27.30	– – –	mJ
Esc	Minimum Short Circuit Energy Withstand	V_{GE} ≤ 15 V, V_{CE} = 400 V T_{vj} = 25°C T_{vj} = 175°C	– 3.5	3.5 –	– –	J

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

Parameters		Conditions		Min	Typ	Max	unit
V_F	Diode Forward Voltage	V_{GE} = 0 V, I_C = 400 A, V_{GE} = 0 V, I_C = 600 A,	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – – – – –	1.34 1.30 1.29 1.48 1.47 1.46	1.47 – – – –	V
E_{rr}	Reverse Recovery Energy	V_R = 400 V, I_F = 400 A, R_{GON} = 3.9 Ω, −di/dt = 3.61 A/ns (175°C) V_{GE} = −8 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.05 4.93 5.90	– – –	mJ
Q_{RR}	Recovered Charge	V_R = 400 V, I_F = 400 A, R_{GON} = 3.9 Ω, −di/dt = 3.61 A/ns (175°C) V_{GE} = −8 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 150°C	– – –	11.60 25.72 29.28	– – –	μC
Irr	Peak Reverse Recovery Current	V_R = 400 V, I_F = 400 A, R_{GON} = 3.9 Ω, −di/dt = 3.61 A/ns (175°C) V_{GE} = −8 V	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	241 294 304	– – –	A

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

Parameters		Conditions		Min	Typ	Max	unit
T_{sense}	Temperature Sense	I_F = 200 μA,	T_{vj} =25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	2.159 1.300 1.186	– – –	V
I_{sense}	Current Sense	R_{shunt} = 0.62 Ω,	I_C = 1200 A I_C = 600 A I_C = 100 A	– – –	65 39 20	– – –	mV

TYPICAL CHARACTERISTICS

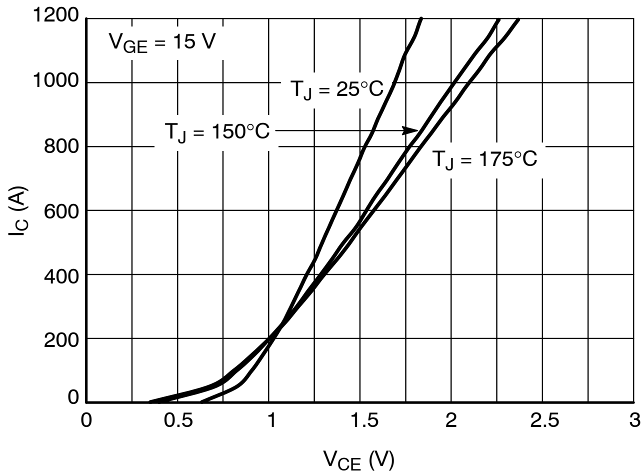


Figure 1. IGBT Output Characteristic

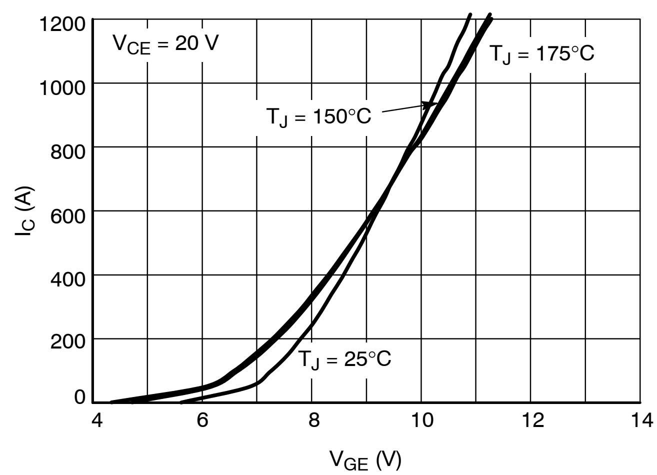


Figure 2. IGBT Transfer Characteristic

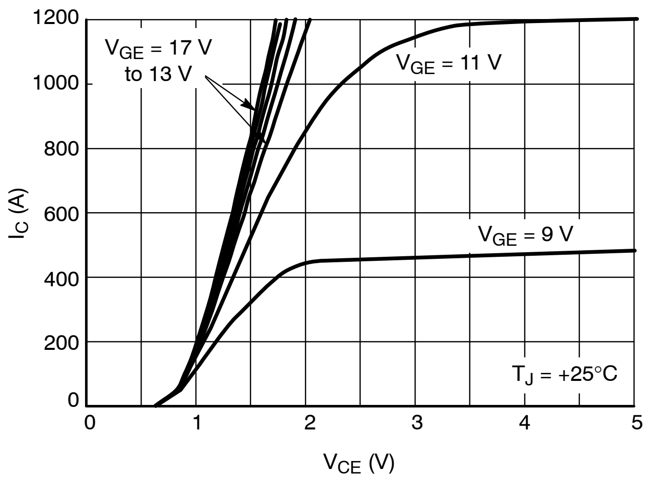


Figure 3. IGBT Output Characteristic, +25°C

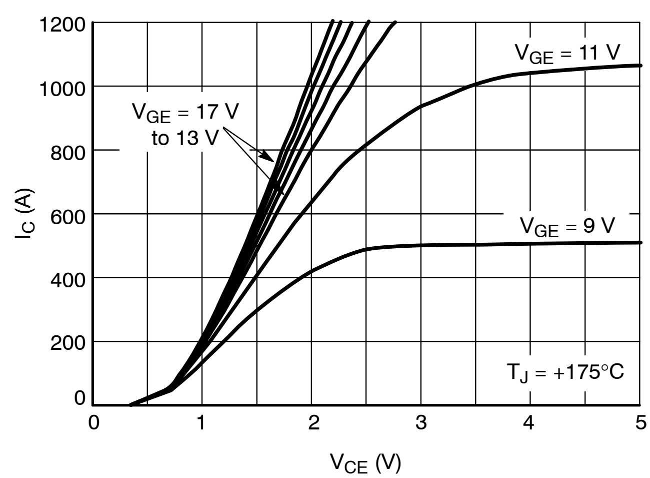


Figure 4. IGBT Output Characteristic, +175°C

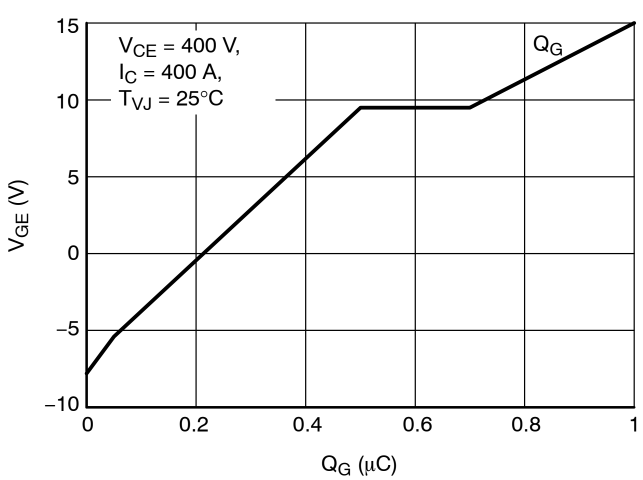


Figure 5. Gate Charge Characteristics

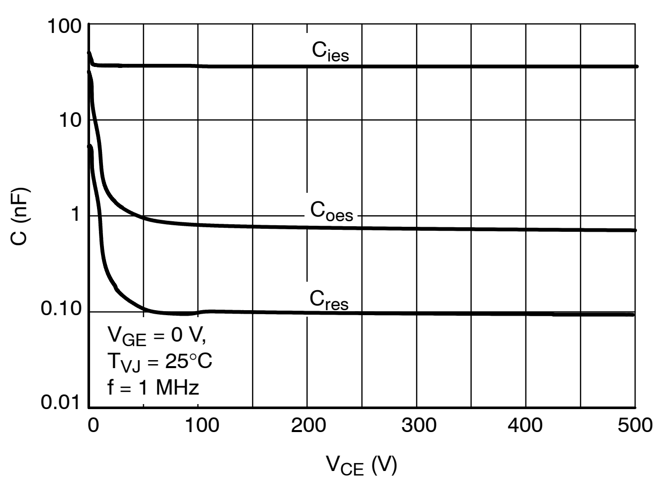


Figure 6. Capacitance Characteristics

TYPICAL CHARACTERISTICS

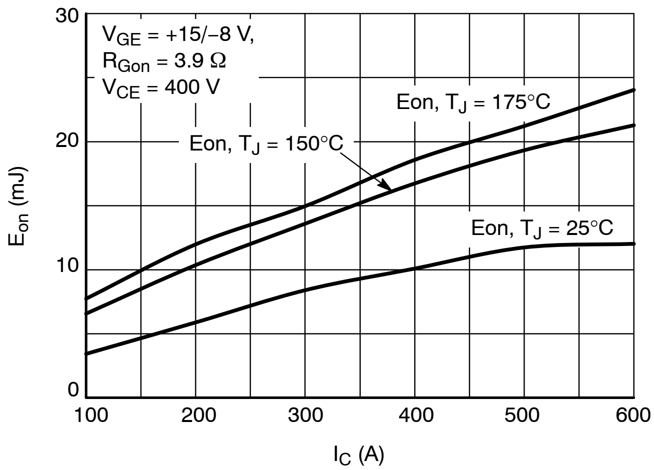


Figure 7. E_{on} vs. I_C

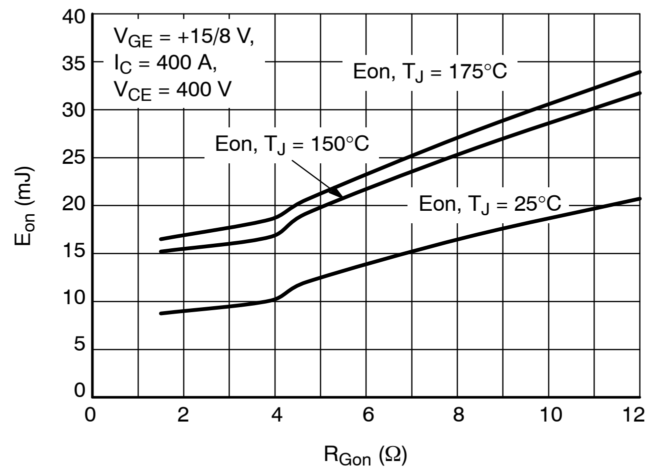


Figure 8. E_{ON} vs. R_{Gon}

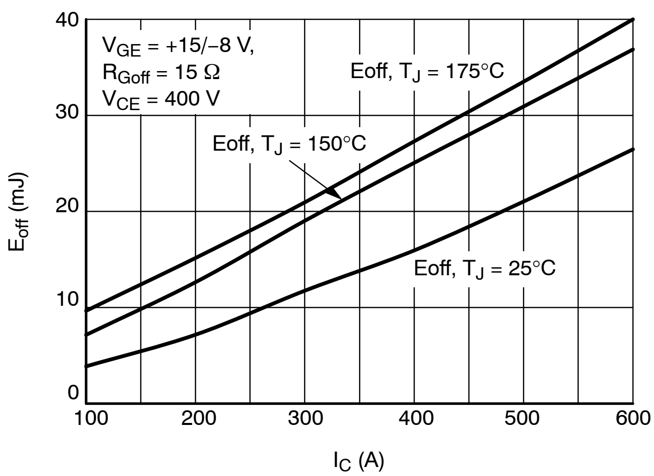


Figure 9. E_{off} vs. I_C

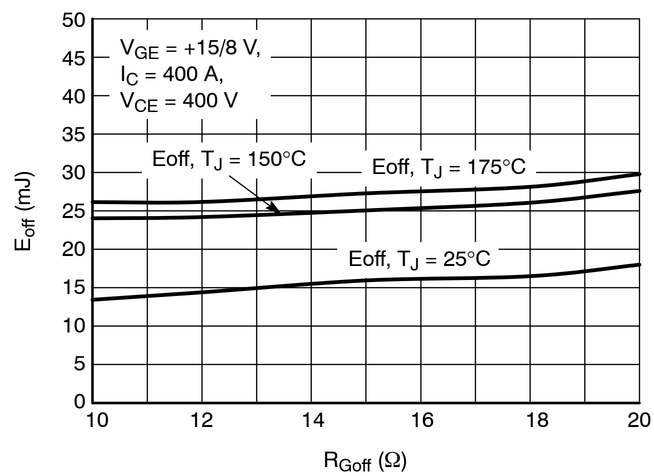


Figure 10. E_{off} vs. R_{Goff}

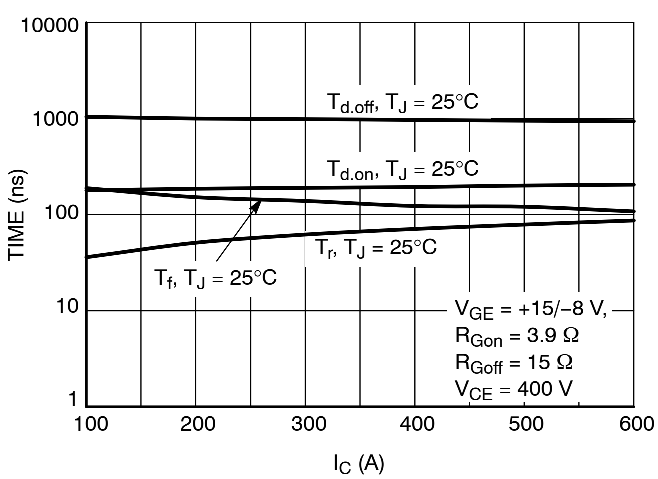


Figure 11. IGBT Switching Times vs. I_C, T_{VJ} = 25°C

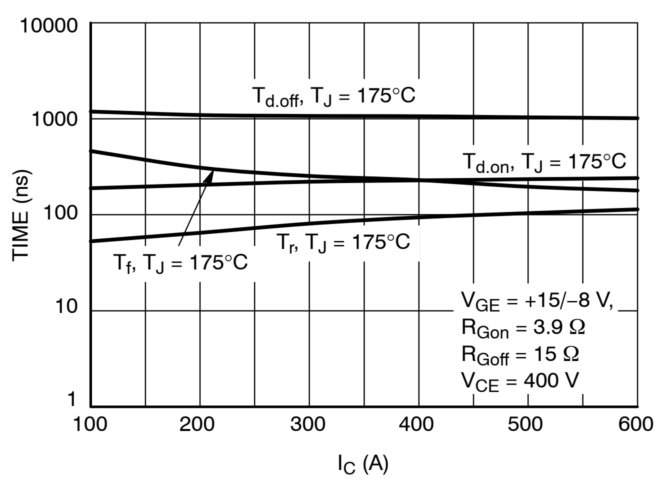


Figure 12. IGBT Switching Times vs. I_C, T_{VJ} = 175°C

TYPICAL CHARACTERISTICS

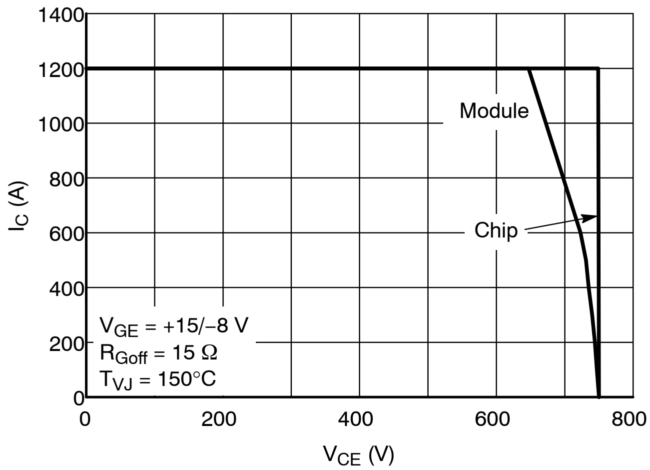


Figure 13. Reverse Bias Safe Operating Area

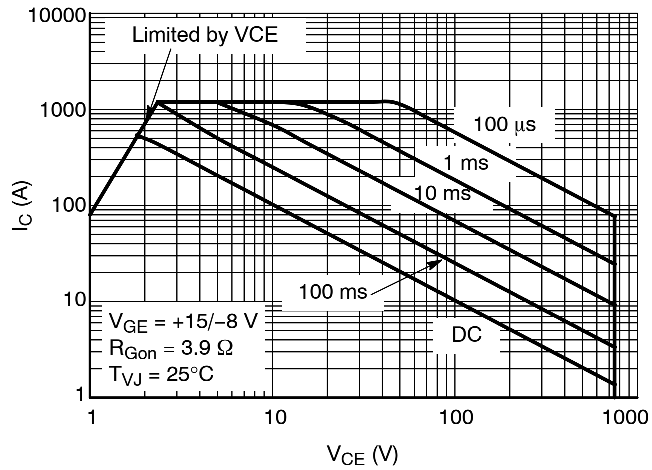


Figure 14. Forward Bias Safe Operating Area

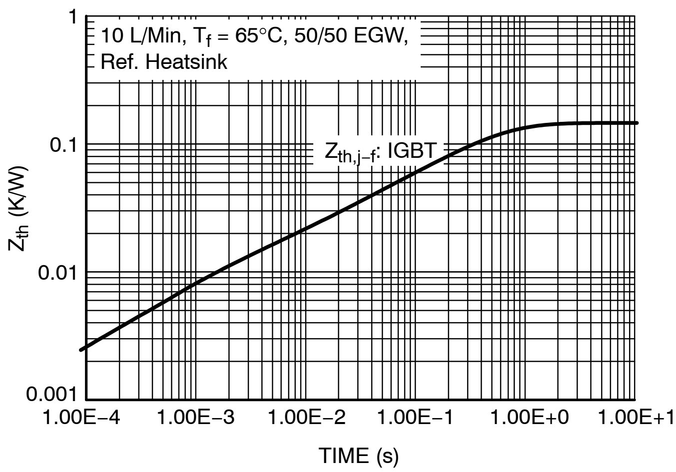


Figure 15. IGBT Transient Thermal Impedance

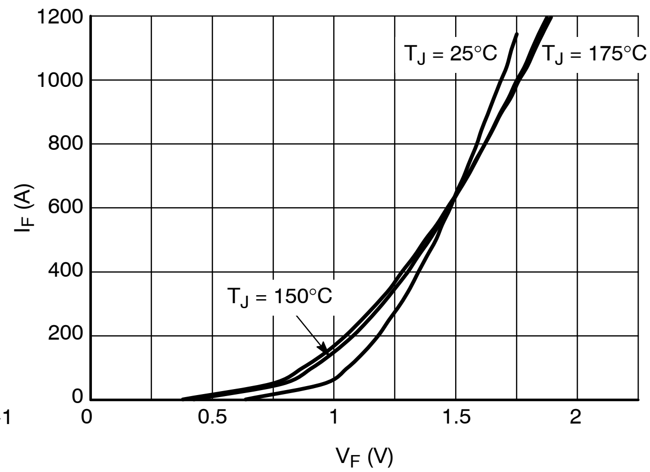


Figure 16. Diode Forward Characteristic

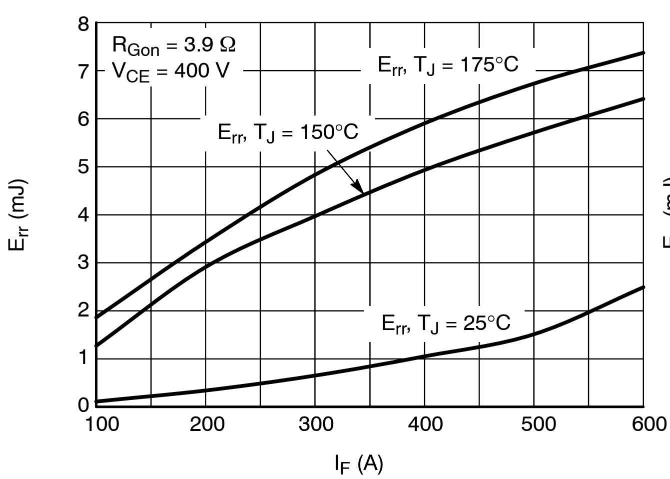


Figure 17. Diode Switching Losses vs. I_F

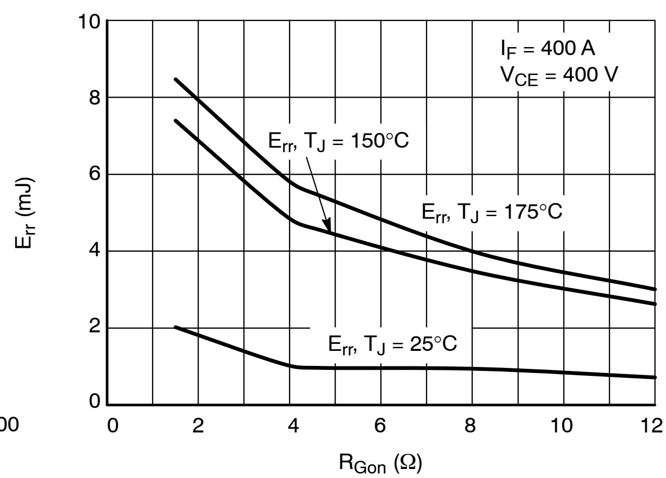


Figure 18. Diode Switching Losses vs. R_{Gon}

TYPICAL CHARACTERISTICS

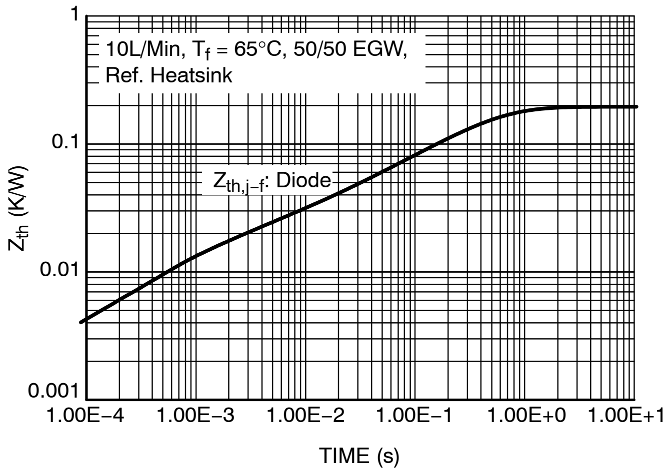


Figure 19. Diode Transient Thermal Impedance

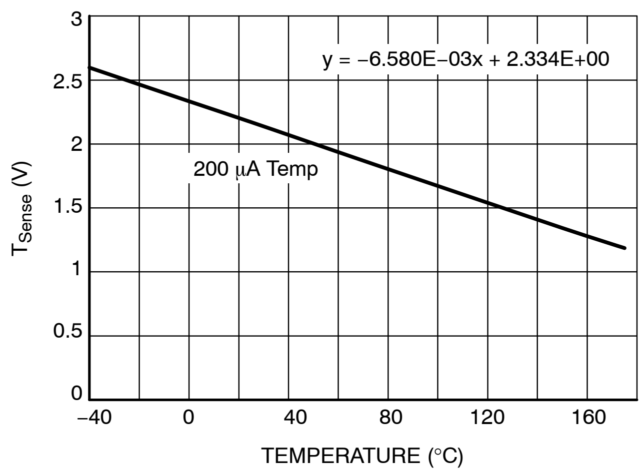


Figure 20. Temperature Sensor Characteristic

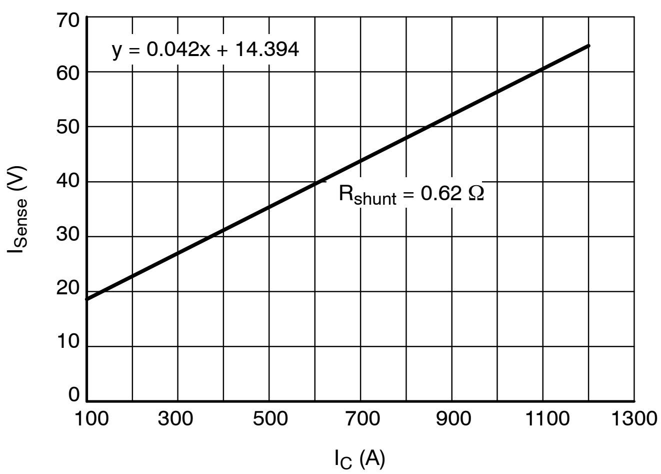


Figure 21. Current Sensor Characteristic

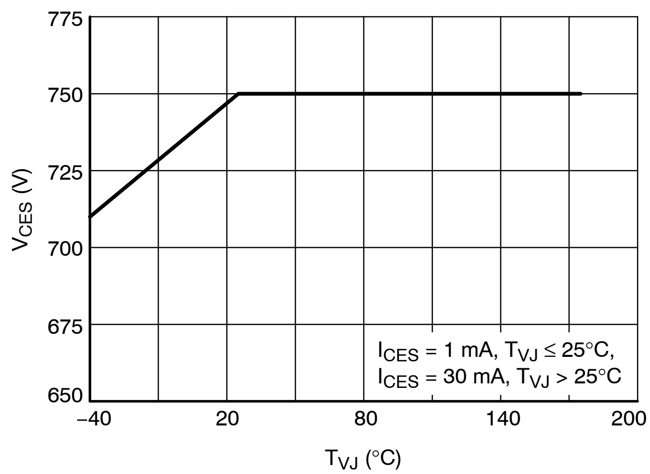


Figure 22. Maximum Allowed V_{CE}

General Note: These are preliminary values measured from a small number of DV units. Values will be updated based on higher quantity of PV measurements.

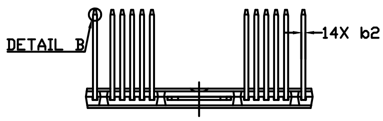
ORDERING INFORMATION

Part Number	Package	Shipping
NVG600A75L4DSE2	AHPM15−CFA Module, Case MODHQ (Pb−Free)	36 Units / 2x Blister Tray

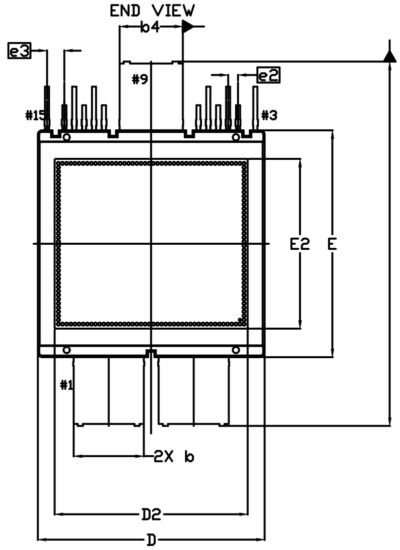
PACKAGE DIMENSIONS

AHPM15−CFA MODULE
CASE MODHQ
ISSUE A

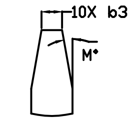
NOTES:
1. DIMENSIONING AND TOLERANCING PER. ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D & E DO NOT INCLUDE MOLD PROTRUSIONS
4. DIMENSIONS b,b2,b4 DO NOT INCLUDE DAMBAR REMAIN.
5. MARKING AREA.
6. ALTERNATE PACKAGE DIMENSIONING OPTION AVAILABLE IN DOC# 08AON34465H



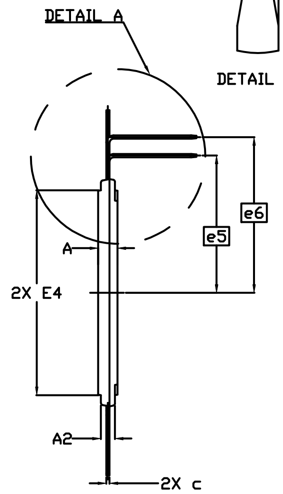
END VIEW



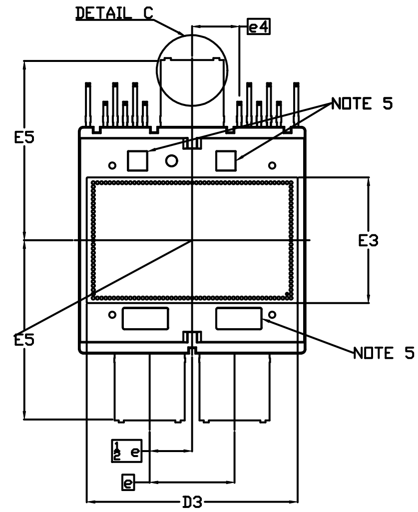
BOTTOM VIEW



DETAIL B

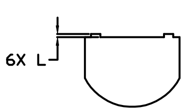


SIDE VIEW

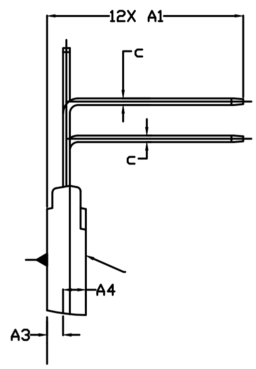


TOP VIEW

END VIEW



DETAIL C



DETAIL A

DIM	MILLIMETERS MIN.	NOM.	MAX.
A	4.65	4.70	4.75
A1	23.10	23.80	24.50
A2	3.20	3.40	3.60
A3		1.95 REF	
A4		2.75 REF	
b	16.90	17.00	17.10
b2	0.90	1.00	1.10
b3		0.50 REF	
b4	15.20	15.30	15.40
c	0.70	0.80	0.90
D	54.80	55.00	55.20
D2	45.80	46.80	47.80
D3	50.50	51.20	51.90

DIM	MILLIMETERS MIN.	NOM.	MAX.
E	54.80	55.00	55.20
E2	40.20	41.20	42.20
E3	29.80	30.50	31.20
E4	49.40	49.60	49.80
E5	43.35	43.70	44.05
e		20.60 BSC	
e2		2.40 BSC	
e3		4.20 BSC	
e4		11.45 BSC	
e5		33.20 BSC	
e6		37.70 BSC	
L		0.50 REF	
M		10° REF	

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Email Requests to: orderlit@onsemi.com

ON Semiconductor Website: www.onsemi.com

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Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative