

# Automotive 750 V, 500 A Dual Side Cooling Half-Bridge Power Module

## VE-Trac<sup>™</sup> Dual Gen II NVG500A75L4DSC2

### Product Description

The NVG500A75L4DSC2 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.

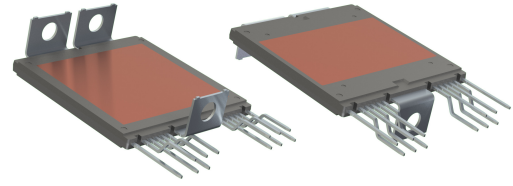
Liquid cooling heatsink reference design, loss models and CAD models are available to support customers in inverter designs.

### Features

- Dual-Side Cooling
- Integrated Chip Level Temperature and Current Sensor
- $T_{vj\ max} = 175^{\circ}\text{C}$  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

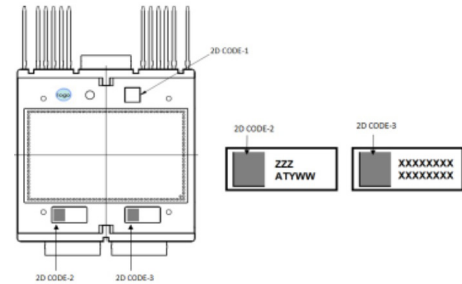
### Typical Applications

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

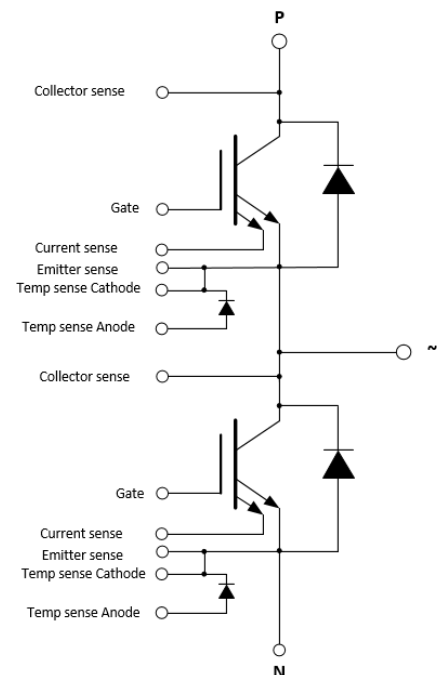


AHPM15-CEA  
CASE MODHS

### 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 5 of this data sheet.

# VE-Trac™ Dual Gen II NVG500A75L4DSC2

## 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<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 materials present in the power module meet UL flammability rating class 94V-0.

## MODULE CHARACTERISTICS

Symbol	Parameter			Rating	Unit
T <sub>vj</sub>	Continuous Operating Junction Temperature Range			−40 to 175	°C
T <sub>STG</sub>	Storage Temperature range			−40 to 125	°C
V <sub>ISO</sub>	Isolation Voltage, DC, t = 1 s			4200	V
Creepage	Minimum : Terminal to Terminal			5.0	mm
Clearance	Minimum: (Note 1) Terminal to Terminal			3.2	mm
CTI	Comparative Tracking Index			>600	
			Min	Typ	Max
L <sub>sCE</sub>	Stray Inductance	–	8	–	nH
R <sub>CC'+EE'</sub>	Module Lead Resistance, Terminals – Chip	–	0.15	–	mΩ
G	Module Weight	–	75	–	g
M	M4 Screws for Module Terminals	–	–	2.2	Nm

1. Verified by design / not by test.

# VE-Trac™ Dual Gen II NVG500A75L4DSC2

## ABSOLUTE MAXIMUM RATINGS (T<sub>VJ</sub> = 25°C, unless otherwise specified)

Symbol	Parameter	Rating	Unit
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### IGBT

V <sub>CES</sub>	Collector to Emitter Voltage	750	V
V <sub>GES</sub>	Gate to Emitter Voltage	±20	V
I <sub>CN</sub>	Implemented Collector Current	500	A
I <sub>C nom</sub>	Continuous DC Collector Current, T <sub>vjmax</sub> = 175°C, T <sub>F</sub> = 65°C, Ref. Heatsink	410	A
I <sub>CRM</sub>	Pulsed Collector Current @ V <sub>GE</sub> = 15 V, t <sub>p</sub> = 1 ms	1000	A

### DIODE

V <sub>RRM</sub>	Repetitive Peak Reverse Voltage	750	V
I <sub>FN</sub>	Implemented Forward Current	500	A
I <sub>F</sub>	Continuous Forward Current, T <sub>vjmax</sub> = 175°C, T <sub>F</sub> = 65°C, Ref. Heatsink	350	A
I <sub>FRM</sub>	Repetitive Peak Forward Current, t <sub>p</sub> = 1 ms	1000	A
I <sup>2</sup> t value	V <sub>R</sub> = 0 V, t <sub>p</sub> = 10 ms, T <sub>VJ</sub> = 150°C T <sub>VJ</sub> = 175°C	10000 9000	A <sup>2</sup> 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.

## THERMAL CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Unit
IGBT.R <sub>th,J-C</sub>	Effective R <sub>th</sub> , Junction to Case	–	0.06	0.08	°C/W
IGBT.R <sub>th,J-F</sub>	Effective R <sub>th</sub> , Junction to Fluid, λ <sub>TIM</sub> = 6 W/m-K, F = 660 N 10 L/min, 65°C, 50/50 EGW, Ref. Heatsink	–	0.164	–	°C/W
Diode.R <sub>th,J-C</sub>	Effective R <sub>th</sub> , Junction to Case	–	0.11	0.14	°C/W
Diode.R <sub>th,J-F</sub>	Effective R <sub>th</sub> , Junction to Fluid, λ <sub>TIM</sub> = 6 W/m-K, F = 660 N 10 L/min, 65°C, 50/50 EGW, Ref. Heatsink	–	0.224	–	°C/W

# VE-Trac™ Dual Gen II NVG500A75L4DSC2

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

Parameters	Conditions	Min	Typ	Max	unit
V <sub>CESAT</sub>	Collector to Emitter Saturation Voltage V <sub>GE</sub> = 15 V, I <sub>C</sub> = 400 A, T <sub>vj</sub> = 25°C T <sub>vj</sub> = 150°C T <sub>vj</sub> = 175°C V <sub>GE</sub> = 15 V, I <sub>C</sub> = 500 A, T <sub>vj</sub> = 25°C T <sub>vj</sub> = 150°C T <sub>vj</sub> = 175°C	– – – – – –	1.32 1.37 1.39 1.39 1.51 1.55	1.45 – – – – –	V
I <sub>CES</sub>	Collector to Emitter Leakage Current V <sub>GE</sub> = 0, V <sub>CE</sub> = 750 V T <sub>vj</sub> = 25°C T <sub>vj</sub> = 175°C	– –	– 8	1 –	mA
I <sub>GES</sub>	Gate – Emitter Leakage Current V <sub>CE</sub> = 0, V <sub>GE</sub> = ±20 V	–	–	±400	nA
V <sub>th</sub>	Threshold Voltage V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 500 mA	4.5	5.6	6.5	V
Q <sub>G</sub>	Total Gate Charge V <sub>GE</sub> = –8 to 15 V, V <sub>CE</sub> = 400 V, I <sub>C</sub> = 400 A	–	0.96	–	μC
R <sub>Gint</sub>	Internal Gate Resistance	–	2	–	Ω
C <sub>ies</sub>	Input Capacitance V <sub>CE</sub> = 30 V, V <sub>GE</sub> = 0 V, f = 1 MHz	–	36	–	nF
C <sub>oes</sub>	Output Capacitance V <sub>CE</sub> = 30 V, V <sub>GE</sub> = 0 V, f = 1 MHz	–	0.7	–	nF
C <sub>res</sub>	Reverse Transfer Capacitance V <sub>CE</sub> = 30 V, V <sub>GE</sub> = 0 V, f = 1 MHz	–	0.09	–	nF
T <sub>d,on</sub>	Turn On Delay, Inductive Load I <sub>C</sub> = 400 A, V <sub>CE</sub> = 400 V T <sub>vj</sub> = 25°C V <sub>GE</sub> = +15/–8 V T <sub>vj</sub> = 150°C R <sub>g,on</sub> = 3.9 Ω T <sub>vj</sub> = 175°C	– – –	168 192 197	– – –	ns
T <sub>r</sub>	Rise Time, Inductive Load I <sub>C</sub> = 400 A, V <sub>CE</sub> = 400 V T <sub>vj</sub> = 25°C V <sub>GE</sub> = +15/–8 V T <sub>vj</sub> = 150°C R <sub>g,on</sub> = 3.9 Ω T <sub>vj</sub> = 175°C	– – –	67 82 86	– – –	ns
T <sub>d,off</sub>	Turn Off Delay, Inductive Load I <sub>C</sub> = 400 A, V <sub>CE</sub> = 400 V T <sub>vj</sub> = 25°C V <sub>GE</sub> = +15/–8 V T <sub>vj</sub> = 150°C R <sub>g,off</sub> = 15 Ω T <sub>vj</sub> = 175°C	– – –	801 872 884	– – –	ns
T <sub>f</sub>	Fall Time, Inductive Load I <sub>C</sub> = 400 A, V <sub>CE</sub> = 400 V T <sub>vj</sub> = 25°C V <sub>GE</sub> = +15/–8 V T <sub>vj</sub> = 150°C R <sub>g,off</sub> = 15 Ω T <sub>vj</sub> = 175°C	– – –	112 165 196	– – –	ns
E <sub>ON</sub>	Turn-On Switching Loss (Including Diode Reverse Recovery Loss) I <sub>C</sub> = 400 A, V <sub>CE</sub> = 400 V T <sub>vj</sub> = 25°C V <sub>GE</sub> = +15/–8 V T <sub>vj</sub> = 150°C R <sub>g,on</sub> = 3.9 Ω T <sub>vj</sub> = 175°C L <sub>s</sub> = 25 nH di/dt (T <sub>vj</sub> = 25°C) = 5.04 A/ns di/dt (T <sub>vj</sub> = 175°C) = 4.15 A/ns	– – – –	10.49 16.20 17.84	– – –	mJ
E <sub>OFF</sub>	Turn-Off Switching Loss I <sub>C</sub> = 400 A, V <sub>CE</sub> = 400 V T <sub>vj</sub> = 25°C V <sub>GE</sub> = +15/–8 V T <sub>vj</sub> = 150°C R <sub>g,off</sub> = 15 Ω T <sub>vj</sub> = 175°C L <sub>s</sub> = 25 nH dv/dt (T <sub>vj</sub> = 25°C) = 3.0 V/ns dv/dt (T <sub>vj</sub> = 175°C) = 2.24 V/ns	– – – –	14.52 23.31 23.88	– – –	mJ
E <sub>sc</sub>	Minimum Short Circuit Energy Withstand V <sub>GE</sub> ≤ 15 V, V <sub>CE</sub> = 400 V T <sub>vj</sub> = 25°C T <sub>vj</sub> = 175°C	– 2.5	2.5 –	– –	J

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.

# VE-Trac™ Dual Gen II NVG500A75L4DSC2

## 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	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 400 A, T <sub>vj</sub> = 25°C	–	1.47	1.62	V
		T <sub>vj</sub> = 150°C	–	1.44	–	
		T <sub>vj</sub> = 175°C	–	1.42	–	
		V <sub>GE</sub> = 0 V, I <sub>C</sub> = 500 A, T <sub>vj</sub> = 25°C	–	1.55	–	
		T <sub>vj</sub> = 150°C	–	1.54	–	
		T <sub>vj</sub> = 175°C	–	1.53	–	
E <sub>rr</sub>	Reverse Recovery Energy	V <sub>R</sub> = 400 V, I <sub>F</sub> = 400 A, T <sub>vj</sub> = 25°C	–	1.16	–	mJ
		R <sub>GON</sub> = 3.9 Ω, T <sub>vj</sub> = 150°C	–	4.12	–	
		–di/dt = 3.61 A/ns (175°C) T <sub>vj</sub> = 175°C	–	4.81	–	
		V <sub>GE</sub> = –8 V	–	–	–	
Q <sub>RR</sub>	Recovered Charge	V <sub>R</sub> = 400 V, I <sub>F</sub> = 400 A, T <sub>vj</sub> = 25°C	–	10.69	–	μC
		R <sub>GON</sub> = 3.9 Ω, T <sub>vj</sub> = 150°C	–	23.14	–	
		–di/dt = 3.61 A/ns (175°C) T <sub>vj</sub> = 150°C	–	25.80	–	
		V <sub>GE</sub> = –8 V	–	–	–	
I <sub>rr</sub>	Peak Reverse Recovery Current	V <sub>R</sub> = 400 V, I <sub>F</sub> = 400 A, T <sub>vj</sub> = 25°C	–	219	–	A
		R <sub>GON</sub> = 3.9 Ω, T <sub>vj</sub> = 150°C	–	272	–	
		–di/dt = 3.61 A/ns (175°C) T <sub>vj</sub> = 175°C	–	276	–	
		V <sub>GE</sub> = –8 V	–	–	–	

## 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> = 1 mA, T <sub>vj</sub> = 25°C	–	2.5	–	V
		T <sub>vj</sub> = 150°C	–	1.7	–	
		T <sub>vj</sub> = 175°C	–	1.5	–	
I <sub>sense</sub>	Current Sense	R <sub>shunt</sub> = 10 Ω, I <sub>C</sub> = 1000 A	–	387	–	mV
		I <sub>C</sub> = 500 A	–	204	–	
		I <sub>C</sub> = 100 A	–	51	–	

## ORDERING INFORMATION

Part Number	Package	Shipping
NVG500A75L4DSC2	AHPM15–CEA Module Case MODHS (Pb–Free)	18 Units / 3x Tube

## TYPICAL CHARACTERISTICS

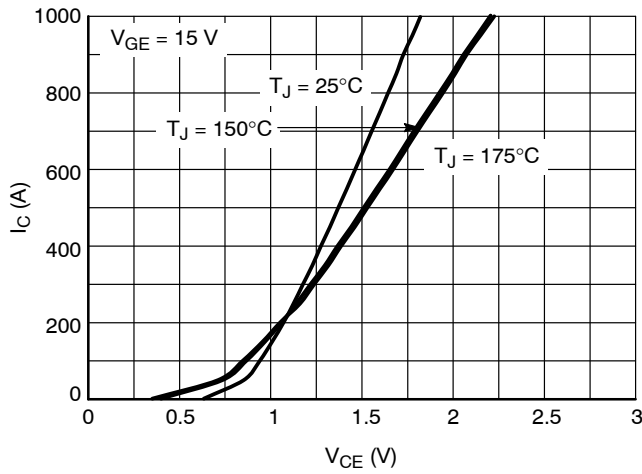


Figure 1. IGBT Output Characteristic

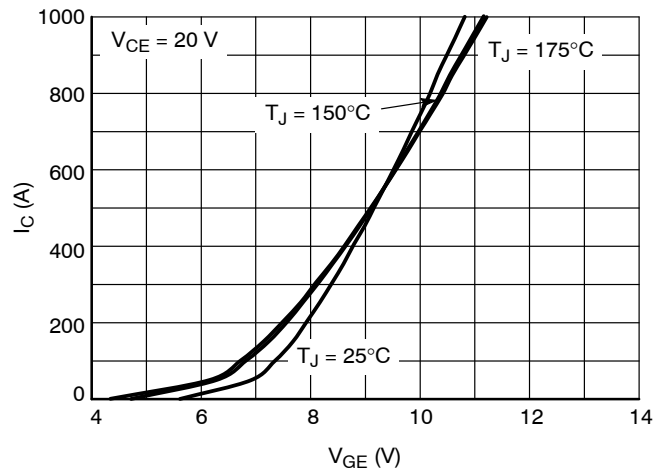


Figure 2. IGBT Transfer Characteristic

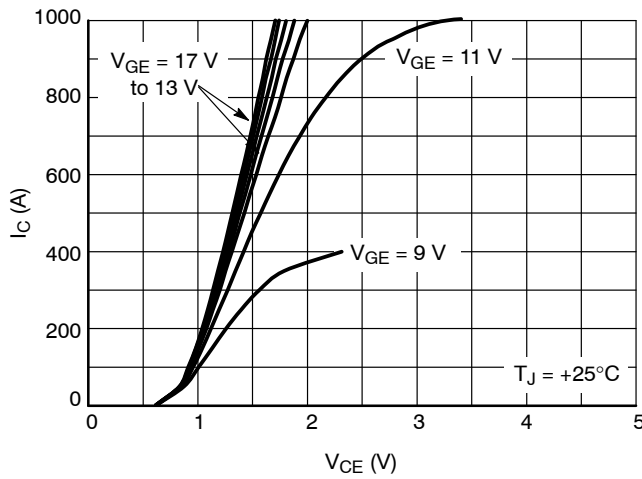


Figure 3. IGBT Output Characteristic, +25°C

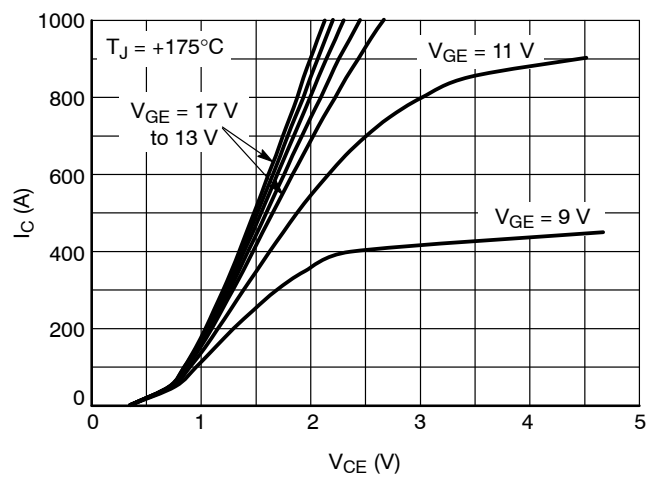


Figure 4. IGBT Output Characteristic, +175°C

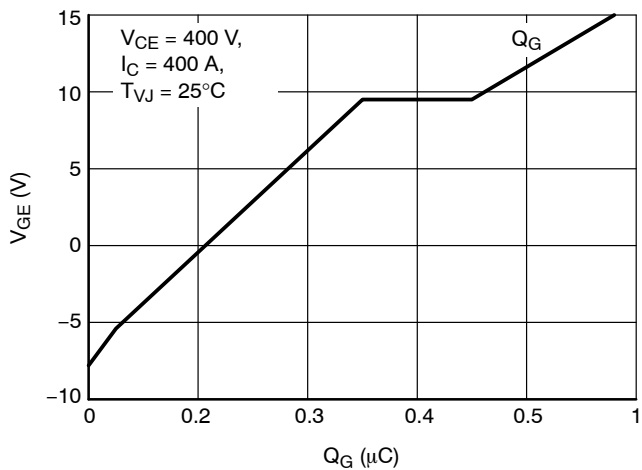


Figure 5. Gate Charge Characteristics

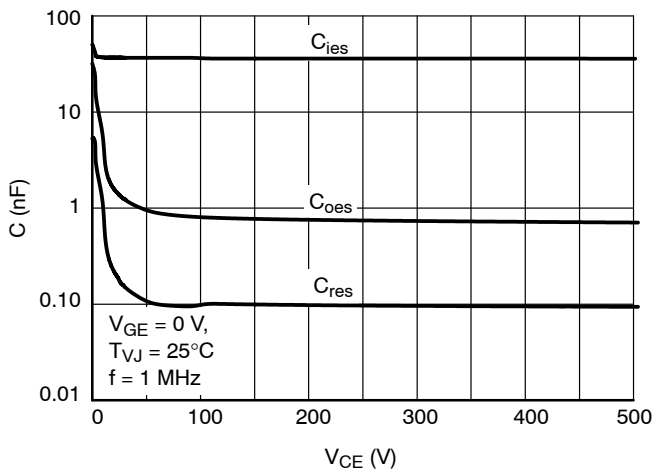


Figure 6. Capacitance Characteristics

## TYPICAL CHARACTERISTICS

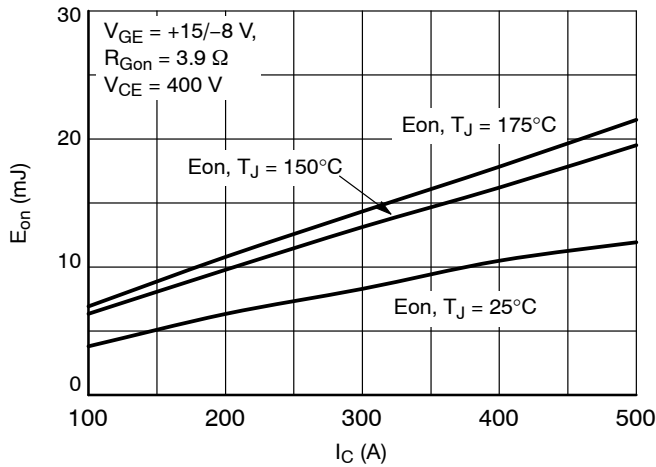


Figure 7.  $E_{on}$  vs.  $I_C$

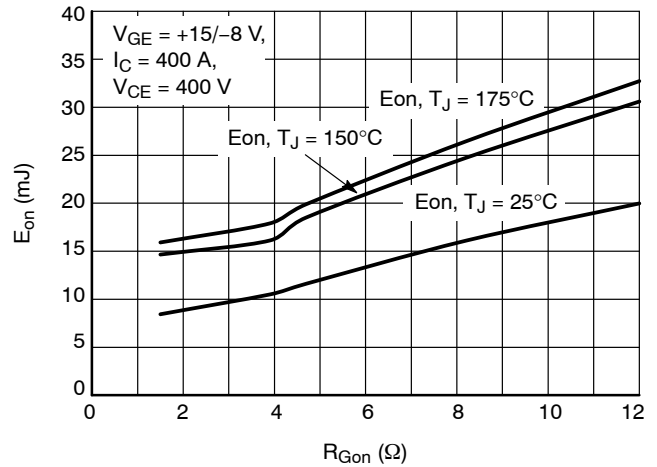


Figure 8.  $E_{on}$  vs.  $R_{Gon}$

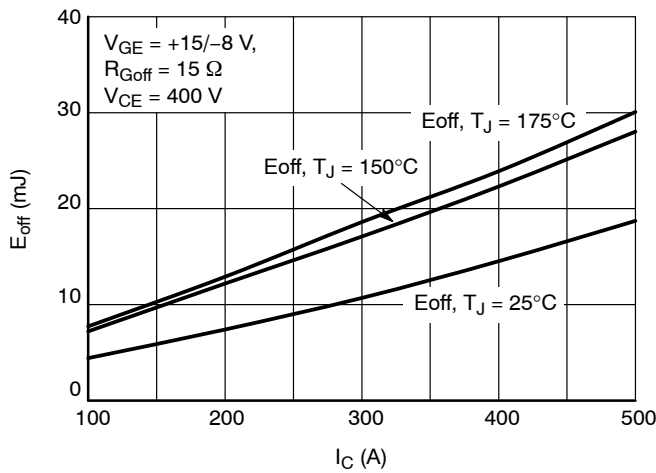


Figure 9.  $E_{off}$  vs.  $I_C$

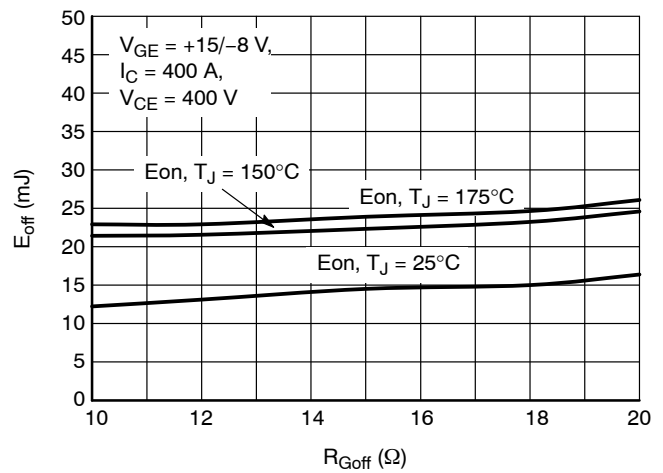


Figure 10.  $E_{off}$  vs.  $R_{Goff}$

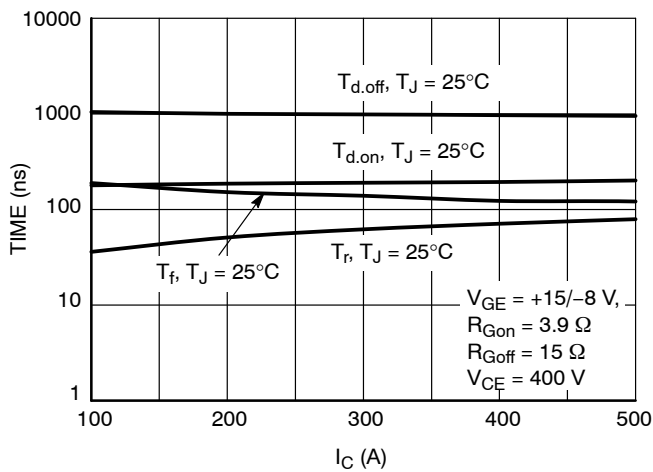


Figure 11. IGBT Switching Times vs.  $I_C$ ,  $T_{J} = 25^\circ\text{C}$

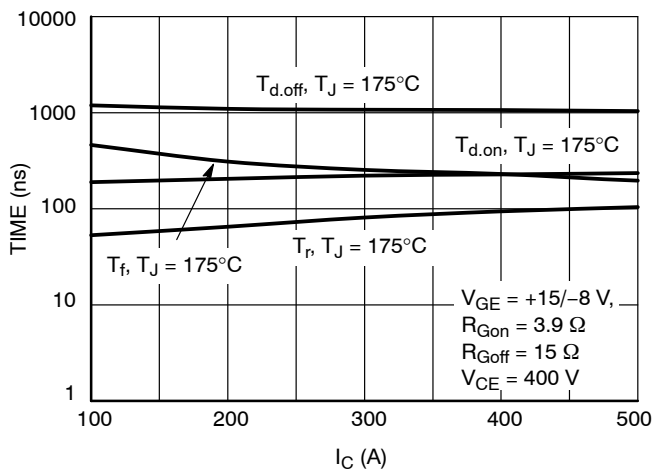


Figure 12. IGBT Switching Times vs.  $I_C$ ,  $T_{J} = 175^\circ\text{C}$

TYPICAL CHARACTERISTICS

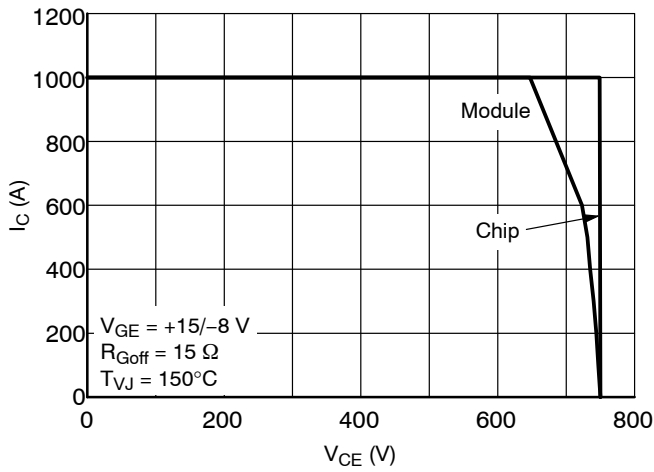


Figure 13. Reverse Bias Safe Operating Area

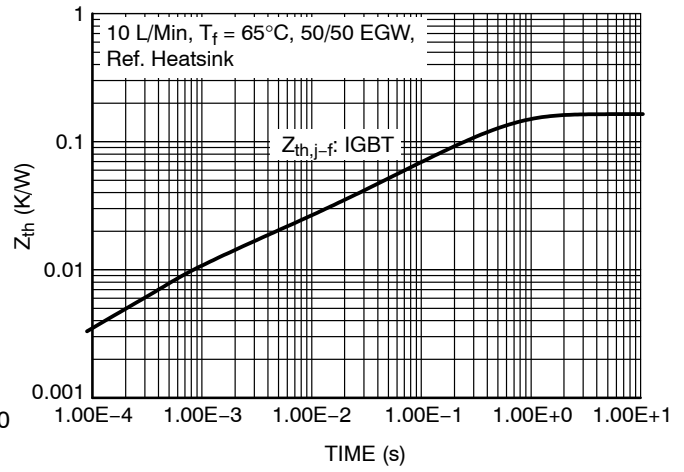


Figure 14. IGBT Transient Thermal Impedance

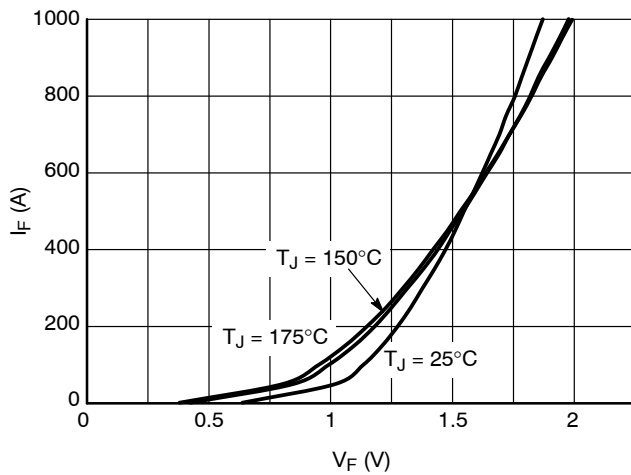


Figure 15. Diode Forward Characteristic

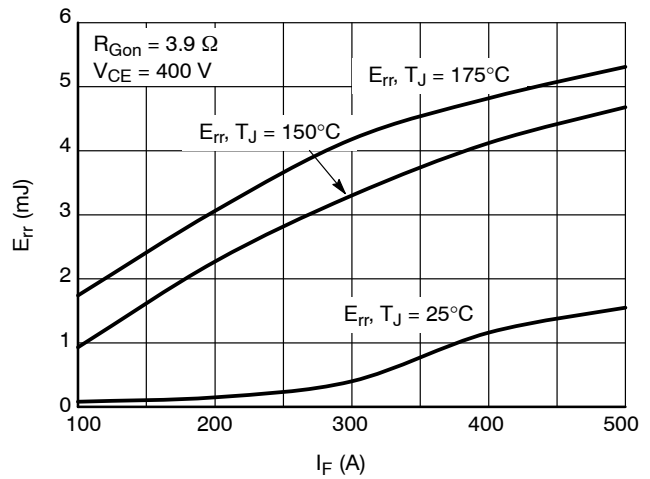


Figure 16. Diode Switching Losses vs.  $I_F$

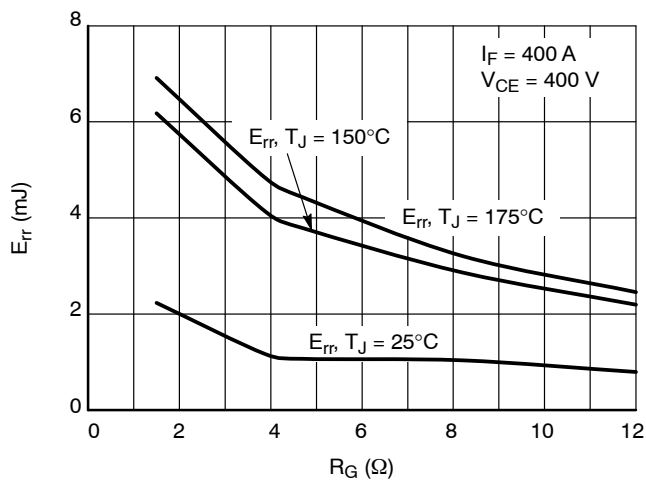


Figure 17. Diode Switching Losses vs.  $R_{Gon}$

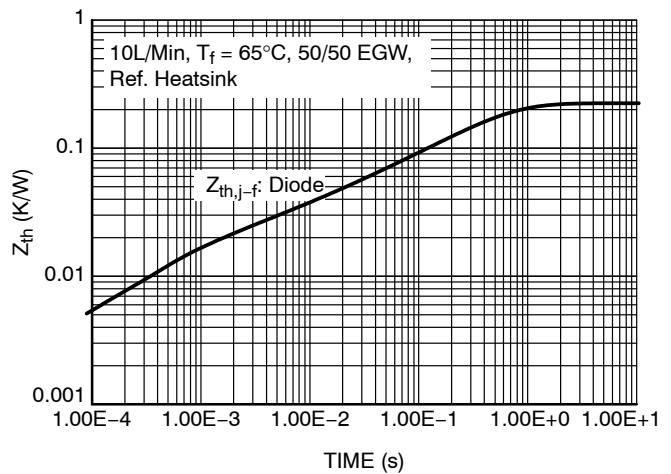


Figure 18. Diode Transient Thermal Impedance

TYPICAL CHARACTERISTICS

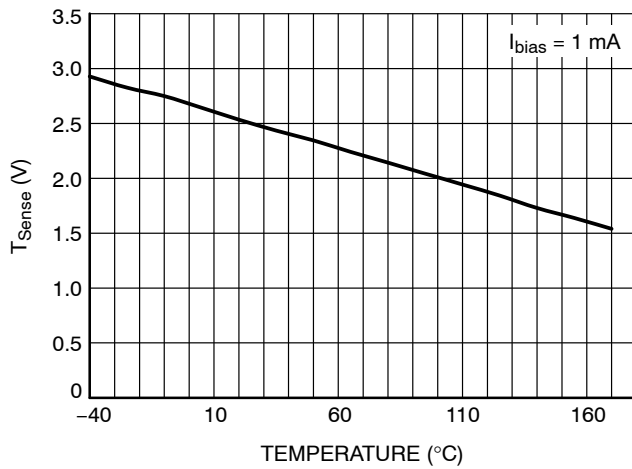


Figure 19. Temperature Sensor Characteristic

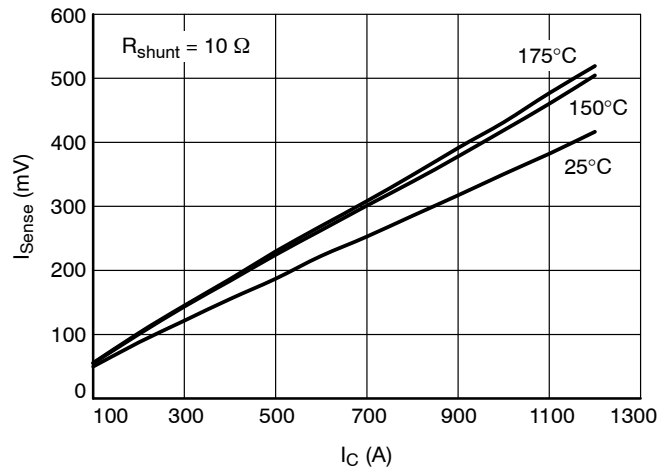


Figure 20. Current Sensor Characteristic

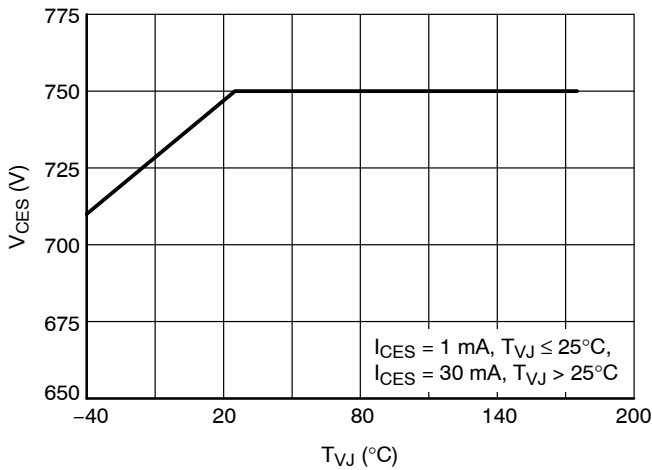
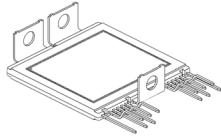
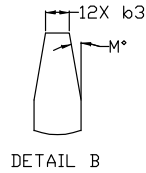
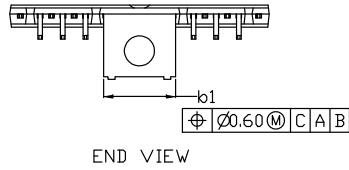


Figure 21. Maximum Allowed V<sub>CE</sub>

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.

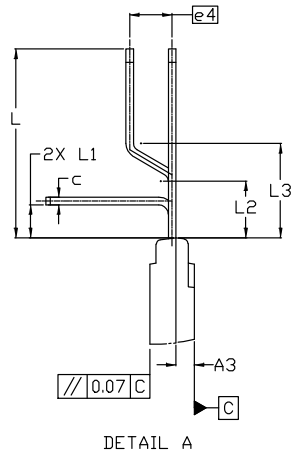
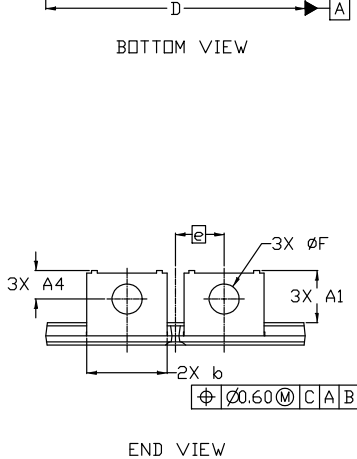
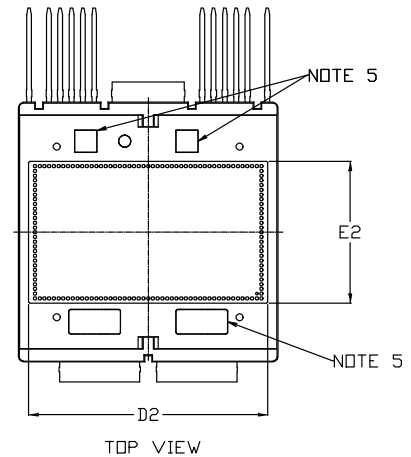
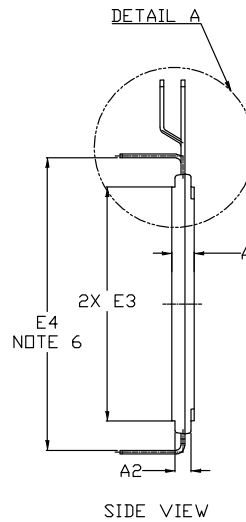
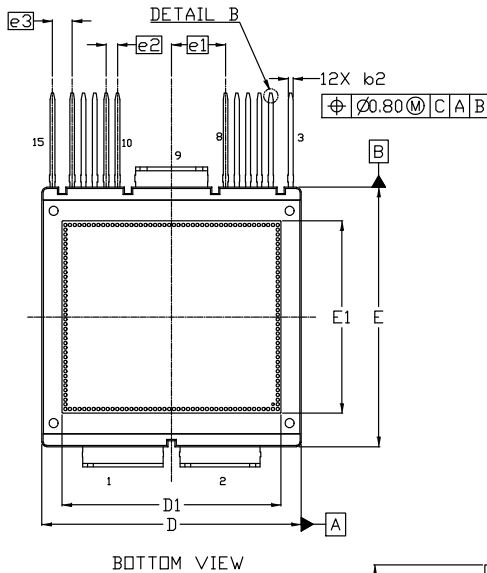

**AHPM15 55x55**  
**CASE MODHS**  
**ISSUE B**

DATE 06 MAY 2022



## 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.



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	45.80	46.80	47.80
D2	50.50	51.20	51.90

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
E	54.80	55.00	55.20
E1	40.20	41.20	42.20
E2	29.80	30.50	31.20
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		
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		

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**DESCRIPTION:** AHPM15 55x55

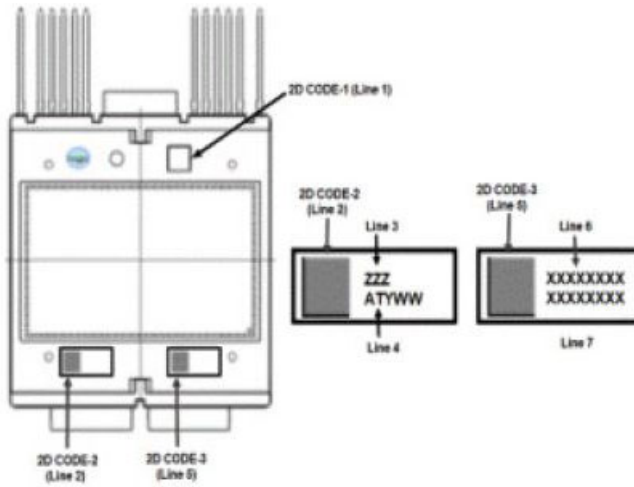
**PAGE 1 OF 2**

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**AHPM15 55x55**  
**CASE MODHS**  
**ISSUE B**

DATE 06 MAY 2022

**GENERIC  
MARKING DIAGRAM\***



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

\*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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<b>DESCRIPTION:</b>	<b>AHPM15 55x55</b>	<b>PAGE 2 OF 2</b>

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