Automotive 750 V, 800 A Dual Side Cooling Half-Bridge Power Module

VE-Trac™ Dual NVG800A75L4DSB

ON Semiconductor®

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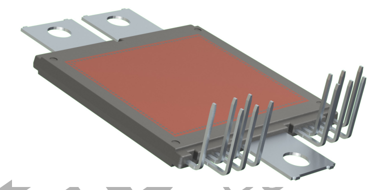
Product Description

The NVG800A75L4DSB 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.



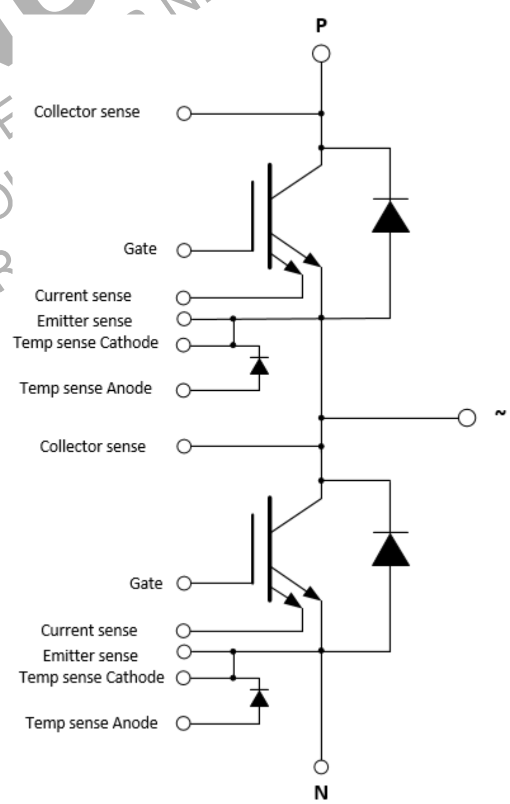
AHPM15−CEC
CASE 100DV

Features

- Dual−Side Cooling
- Integrated Chip Level Temperature and Current Sensor
- $T_{vj\ max}$ = 175°C for Continuous Operation
- Ultra−low Stray Inductance
- Low V_{CESAT} and Switching Losses
- Automotive Grade FS4 IGBT & Soft Diode Chip Technologies
- 4.2 kV Isolated DBC Substrate
- This Device is RoHS Compliant

Typical Applications

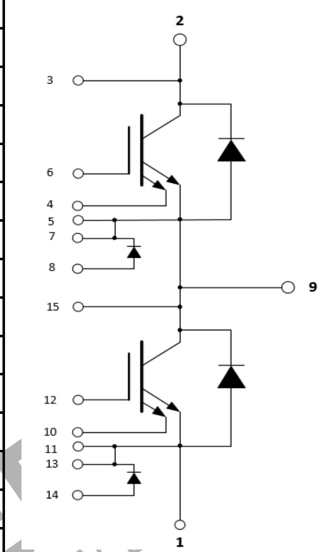
- Hybrid and Electric Vehicle Traction Inverter
- High Power DC−DC Converter



ORDERING INFORMATION

See detailed ordering and shipping information on page 11 of this data sheet.

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	

Materials

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 Terminal			6.0	mm
Clearance	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
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	750	V
V_{GES}	Gate to Emitter Voltage	±20	V
I_{CN}	Implemented Collector Current	800	A
$I_{C\ nom}$	Continuous DC Collector Current, Tv_{Jmax} = 175°C, T_F = 65°C, Ref. Heatsink	550 (Note 1)	A
I_{CRM}	Pulsed Collector Current @ V_{GE} = 15 V, t_p = 1 ms	1600	A
DIODE			
V_{RRM}	Repetitive Peak Reverse Voltage	750	V
I_{FN}	Implemented Forward Current	800	A
I_F	Continuous Forward Current, Tv_{Jmax} = 175°C, T_F = 65°C, Ref. Heatsink	420 (Note 1)	A
I_{FRM}	Repetitive Peak Forward Current, t_p = 1 ms	1600	A
I^2t value	V_R = 0 V, t_p = 10 ms, Tv_J = 150°C T_{VJ} = 175°C	20000 18000	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 by test.

THERMAL CHARACTERISTICS (Verified by characterization, not by test.)

Symbol	Parameter	Min	Typ	Max	Unit
IGBT.$R_{th,J-C}$	Effective Rth, Junction to Case (Note 2)		0.05	0.07	°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		0.14		°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 = 600 A, Tv_J = 25°C Tv_J = 150°C Tv_J = 175°C V_{GE} = 15 V, I_C = 800 A, Tv_J = 25°C Tv_J = 150°C Tv_J = 175°C	– – – – – –	1.30 1.42 1.45 1.44 1.64 1.68	1.55 – – – – –	V
I_{CES}	Collector to Emitter Leakage Current	V_{GE} = 0, V_{CE} = 750 V Tv_J = 25°C Tv_J = 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	4.6	5.5	6.2	V
Q_G	Total Gate Charge	$V_{GE=}$ −8 to 15 V, V_{CE} = 400 V	–	2.2	–	μC
R_{Gint}	Internal Gate Resistance		–	2	–	Ω
C_{ies}	Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	48	–	nF
C_{oes}	Output Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	1.37	–	nF
C_{res}	Reverse Transfer Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz	–	0.15	–	nF
$T_{d.on}$	Turn On Delay, Inductive Load	I_C = 600 A, V_{CE} = 400 V Tv_J = 25°C V_{GE} = +15/−8 V Tv_J = 150°C Rg.on = 4.7 Ω Tv_J = 175°C	– – –	253 282 287	– – –	ns
T_r	Rise Time, Inductive Load	I_C = 600 A, V_{CE} = 400 V Tv_J = 25°C V_{GE} = +15/−8 V Tv_J = 150°C Rg.on = 4.7 Ω Tv_J = 175°C	– – –	94 112 117	– – –	ns
$T_{d.off}$	Turn Off Delay, Inductive Load	I_C = 600 A, V_{CE} = 400 V Tv_J = 25°C V_{GE} = +15/−8 V Tv_J = 150°C Rg.off = 15 Ω Tv_J = 175°C	– – –	760 790 800	– – –	ns
T_f	Fall Time, Inductive Load	$I_{C=}$ 600 A, V_{CE} = 400 V Tv_J = 25°C V_{GE} = +15/−8 V Tv_J = 150°C Rg.off = 15 Ω Tv_J = 175°C	– – –	95 140 153	– – –	ns
E_{ON}	Turn−On Switching Loss (including diode reverse recovery loss)	I_C = 600 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, Ls = 20 nH, Rg.on = 4,7 Ω di/dt (Tv_J = 25°C) = 5.13 A/ns di/dt (Tv_J = 175°C) = 4.11 A/ns Tv_J = 25°C Tv_J = 150°C Tv_J = 175°C	 – – –	 21.30 32.55 33.66	 – – –	mJ
E_{OFF}	Turn−Off Switching Loss	I_C = 600 A, V_{CE} = 400 V, V_{GE}= +15/−8 V, Ls = 20 nH, Rg.off = 15 Ω dv/dt (Tv_J = 25°C) = 2.81 V/ns dv/dt (Tv_J = 175°C) = 2.11 V/ns Tv_J = 25°C Tv_J = 150°C Tv_J = 175°C	 – – –	 22.62 31.77 33.60	 – – –	mJ
E_{SC}	Minimum Short Circuit Energy Withstand	V_{GE} = 15 V, V_{CC} = 400 V Tv_J = 25°C Tv_J = 175°C	 5 7.5	 – –	 – –	J

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 = 600 A,	T_{VJ} = 25°C	–	1.50	1.70	V
			T_{VJ} = 150°C	–	1.46	–	
			T_{VJ} = 175°C	–	1.44	–	
		V_{GE} = 0 V, I_C = 800 A,	T_{VJ} = 25°C	–	1.73	–	
			T_{VJ} = 150°C	–	1.69	–	
			T_{VJ} = 175°C	–	1.68	–	
E_{rr}	Reverse Recovery Energy	I_F = 600 A, V_R = 400 V, V_{GE} = −8 V, Rg.on = 4.7 Ω, −di/dt = 3.12 A/ns (175°C)					mJ
			T_{VJ} = 25°C	–	3.58	–	
			T_{VJ} = 150°C	–	11.71	–	
			T_{VJ} = 175°C	–	12.33	–	
Q_{RR}	Recovered Charge	I_F = 600 A, V_R = 400 V, V_{GE} = −8 V, Rg.on = 4.7 Ω, −di/dt = 3.12 A/ns (175°C)					μC
			T_{VJ} = 25°C	–	16.36	–	
			T_{VJ} = 150°C	–	47.65	–	
			T_{VJ} = 175°C	–	49.78	–	
Irr	Peak Reverse Recovery Current	I_F = 600 A, V_R = 400 V, V_{GE} = −8 V, Rg.on = 4.7 Ω, −di/dt = 3.12 A/ns (175°C)					A
			T_{VJ} = 25°C	–	220	–	
			T_{VJ} = 150°C	–	350	–	
			T_{VJ} = 175°C	–	360	–	

SENSOR CHARACTERISTICS (T_{VJ} = 25°C, Unless Otherwise Specified)

Parameters		Conditions		Min	Typ	Max	Unit
T_{sense}	Temperature Sense	I_F = 1 mA,	T_{VJ} = −40°C	–	2.96	–	V
			T_{VJ} = 25°C	2.46 (Note 3)	2.54	2.60 (Note 3)	
			T_{VJ} = 150°C	–	1.76	–	
			T_{VJ} = 175°C	–	1.61	–	
I_{sense}	Current Sense	R_{shunt} = 5 Ω	I_C = 1600 A	–	379	–	mV
			I_C = 800 A	–	200	–	
			I_C = 100 A	–	43.0	–	
		R_{shunt} = 20 Ω	I_C = 1600 A	–	644	–	
			I_C = 800 A	–	351	–	
			I_C = 100 A	–	94.0	–	

3. Measured at chip level

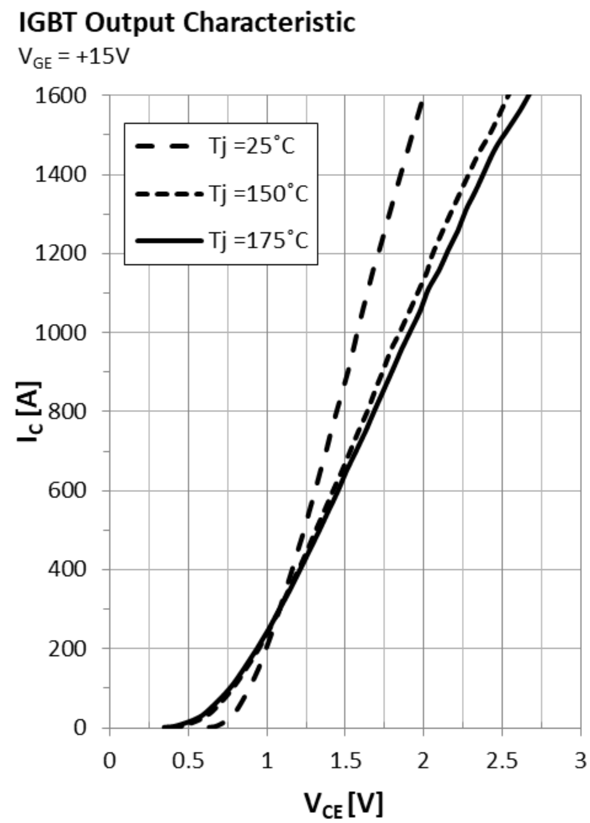


Figure 1. IGBT Output Characteristic

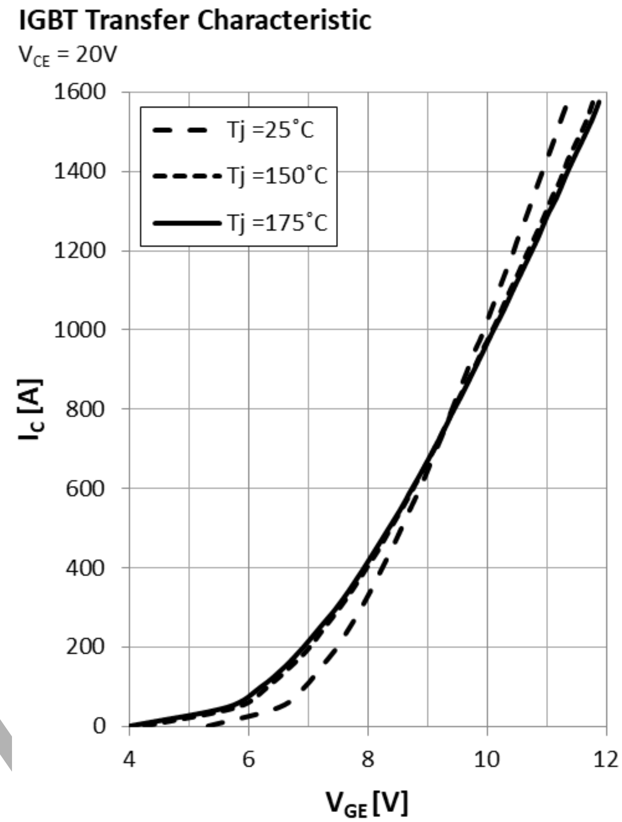


Figure 2. IGBT Transfer Characteristic

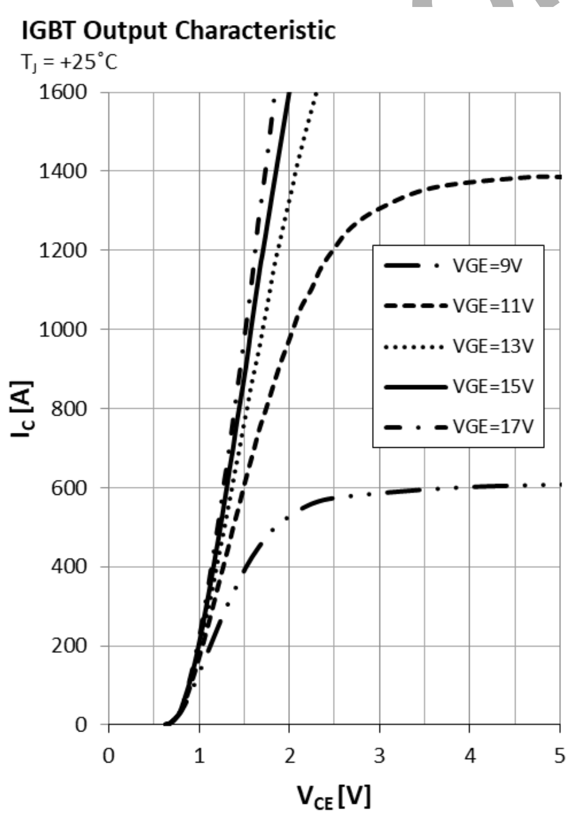


Figure 3. IGBT Output Characteristic

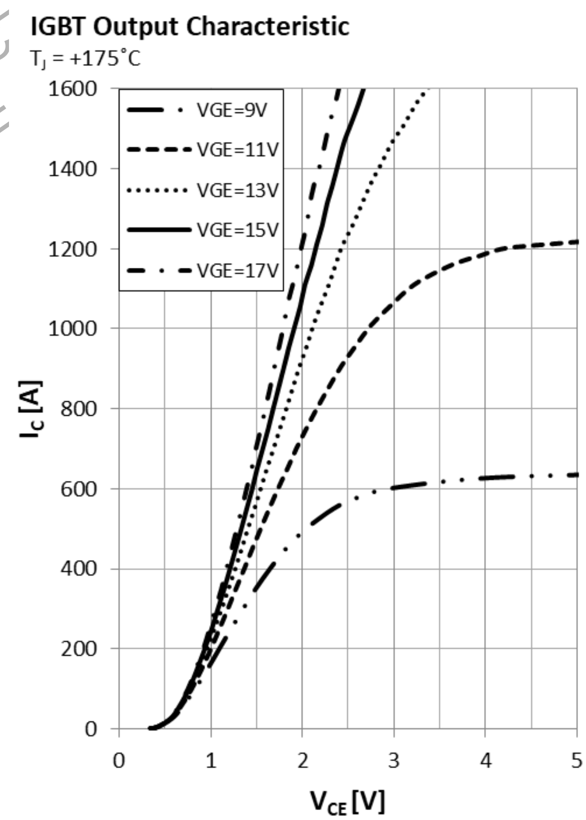


Figure 4. IGBT Output Characteristic

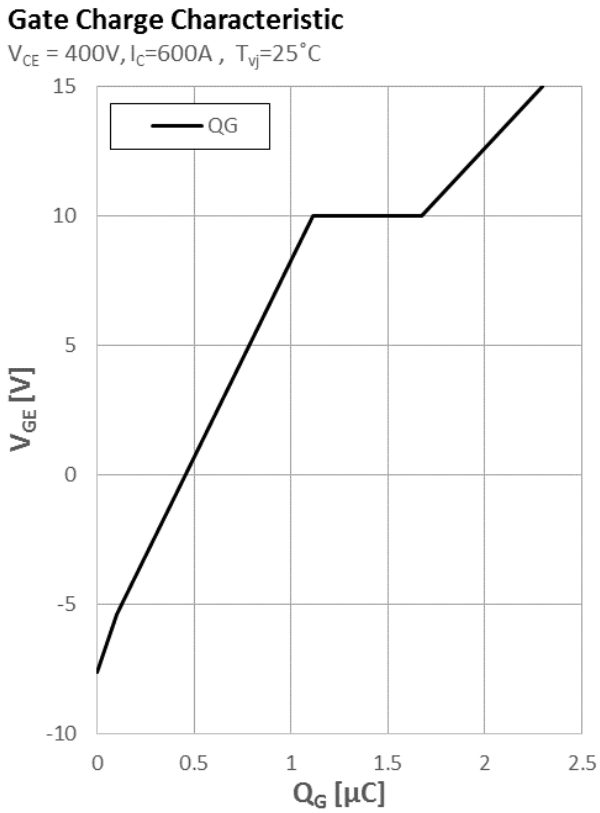


Figure 5. Gate Charge Characteristic

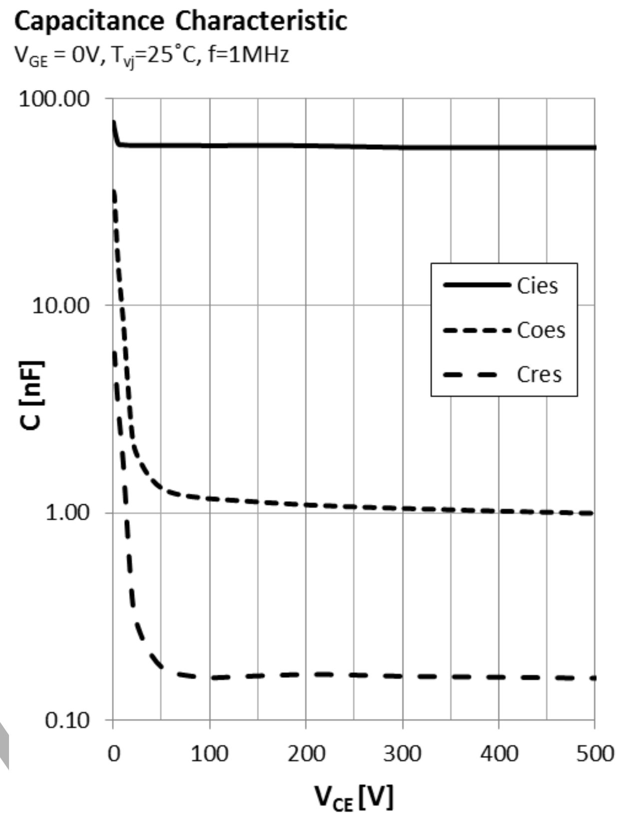


Figure 6. Capacitance Characteristic

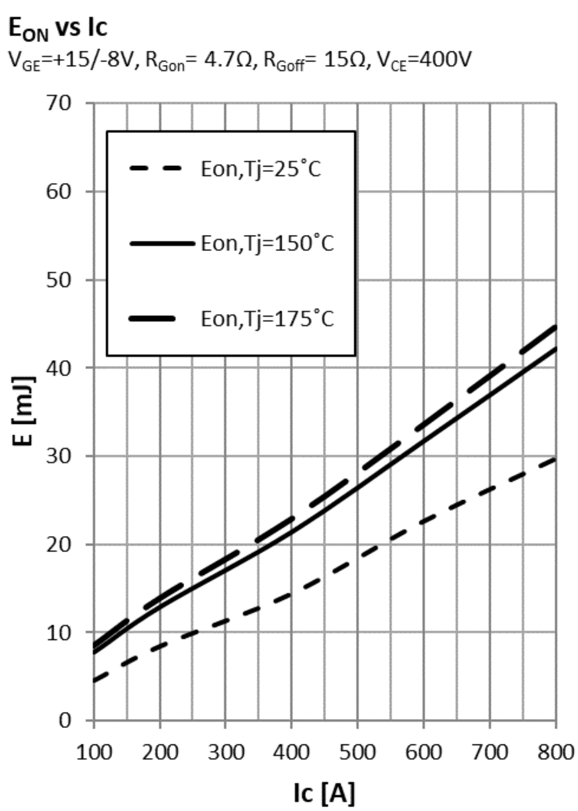


Figure 7. E_{ON} vs. Ic

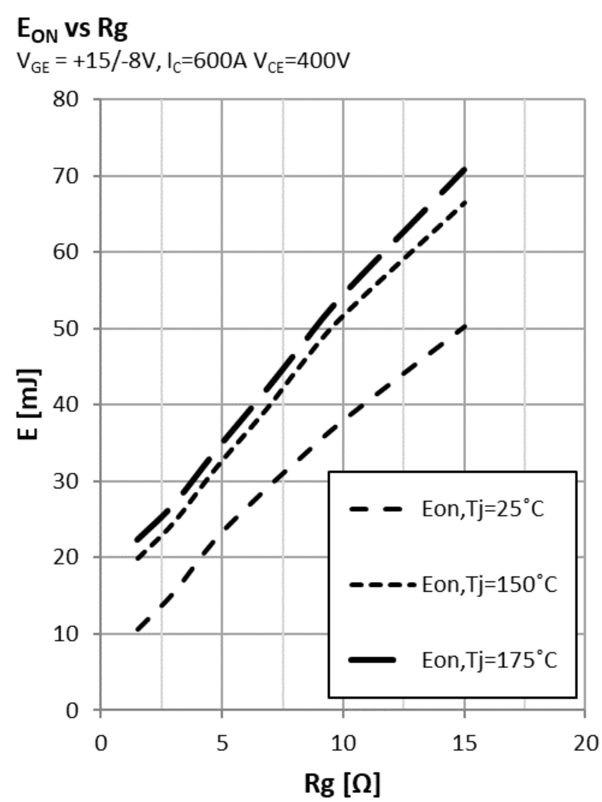


Figure 8. E_{ON} vs. Rg

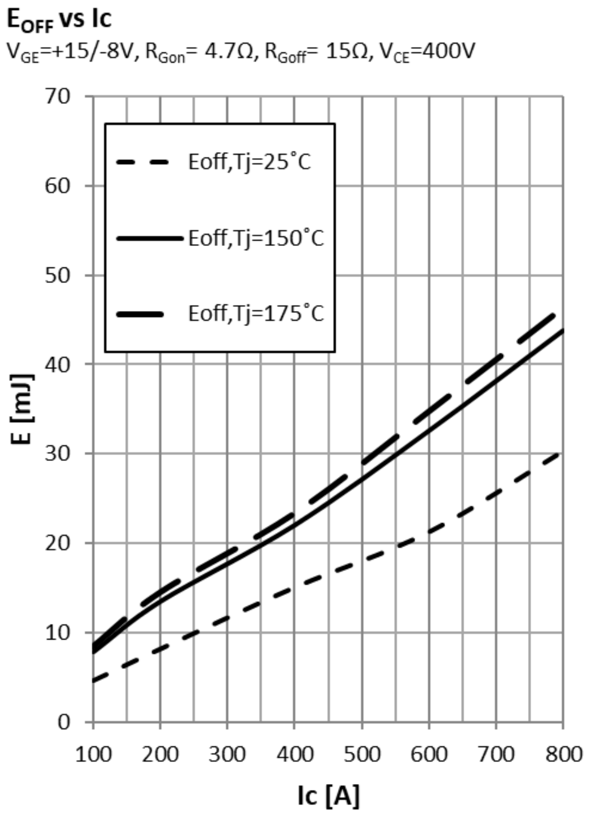


Figure 9. E_{OFF} vs. Ic

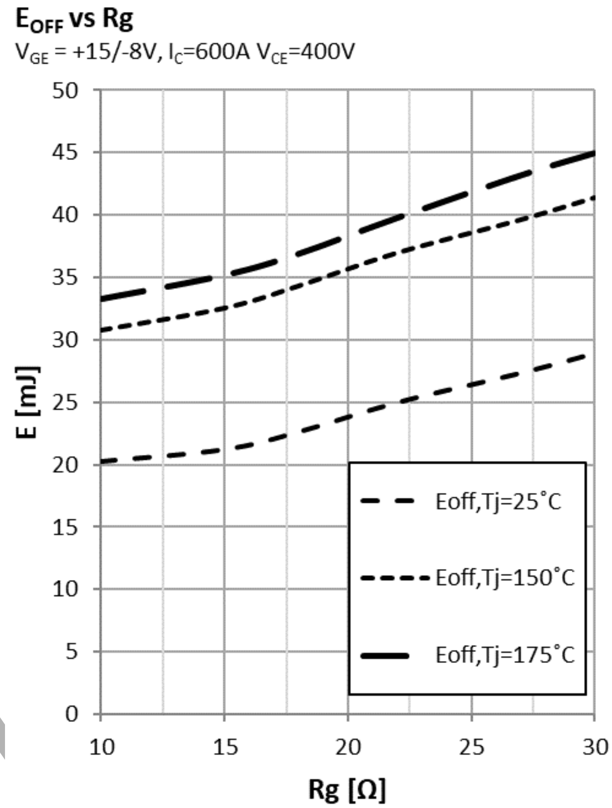


Figure 10. E_{OFF} vs. Rg

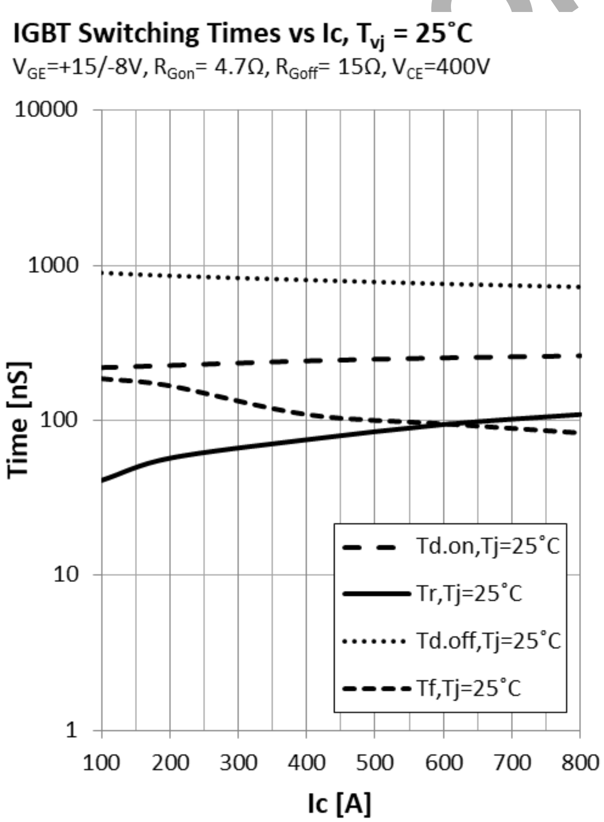


Figure 11. IGBT Switching Times vs Ic, T_{VJ} = 25°C

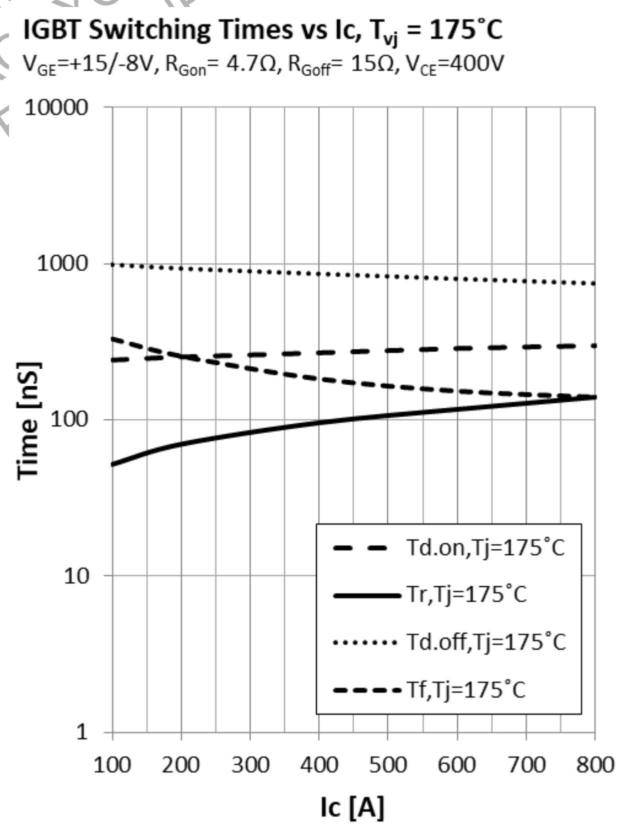


Figure 12. IGBT Switching Times vs Ic, T_{VJ} = 175°C

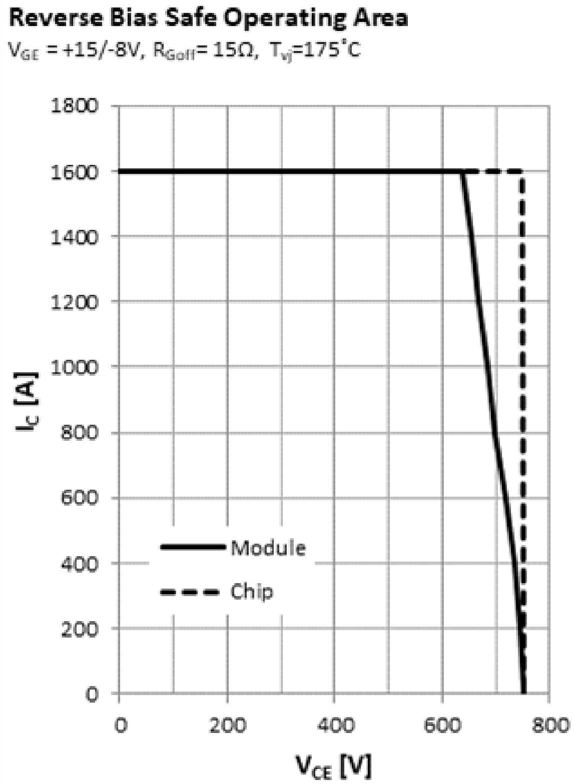


Figure 13. Reverse Bias Safe Operating Area

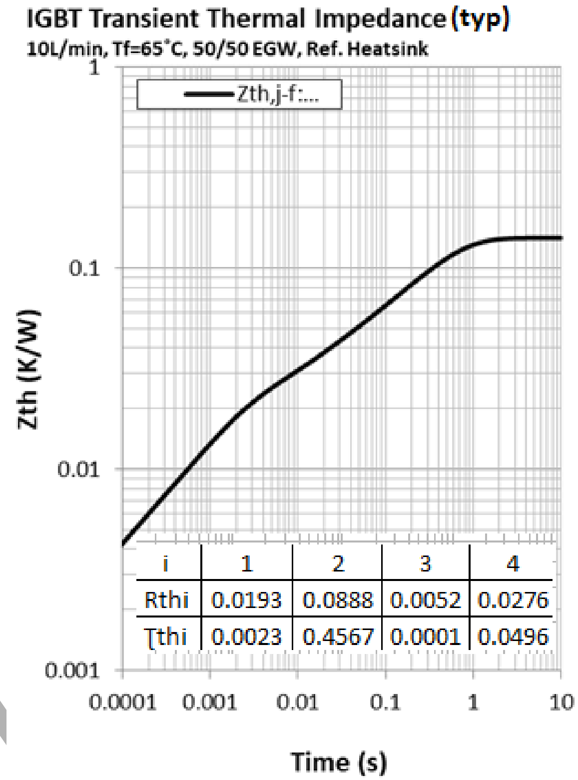


Figure 14. IGBT Transient Thermal Impedance

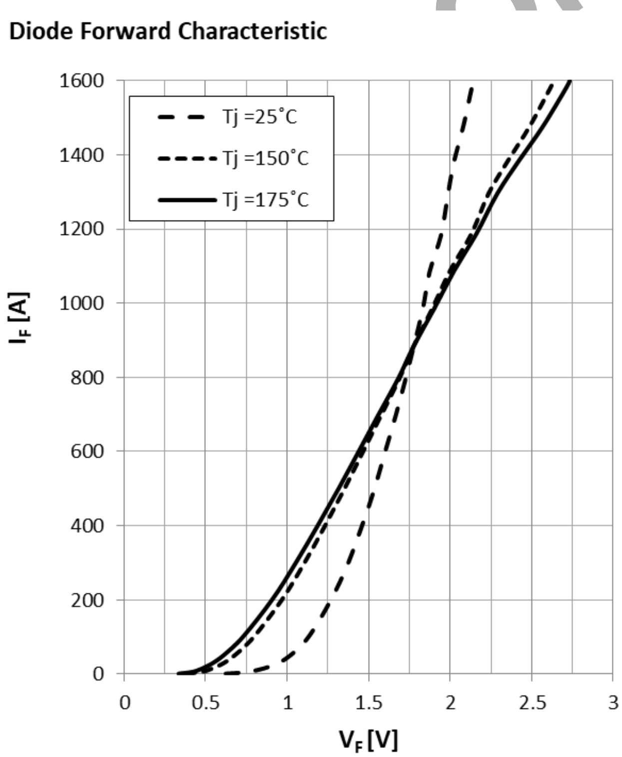


Figure 15. Diode Forward Characteristic

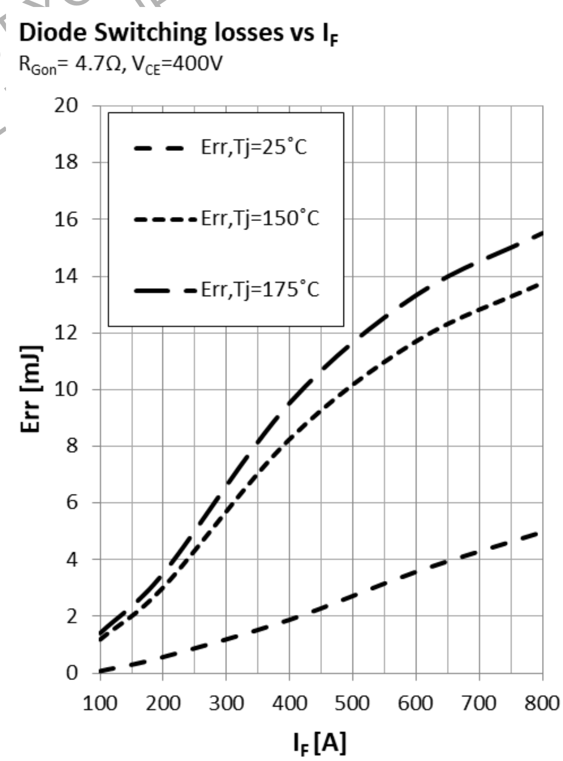


Figure 16. Diode Switching Losses vs. I_F

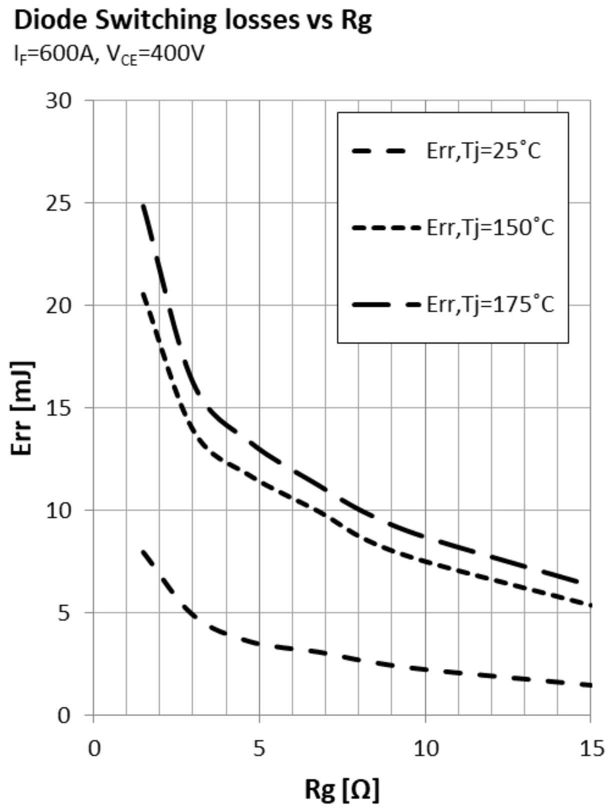
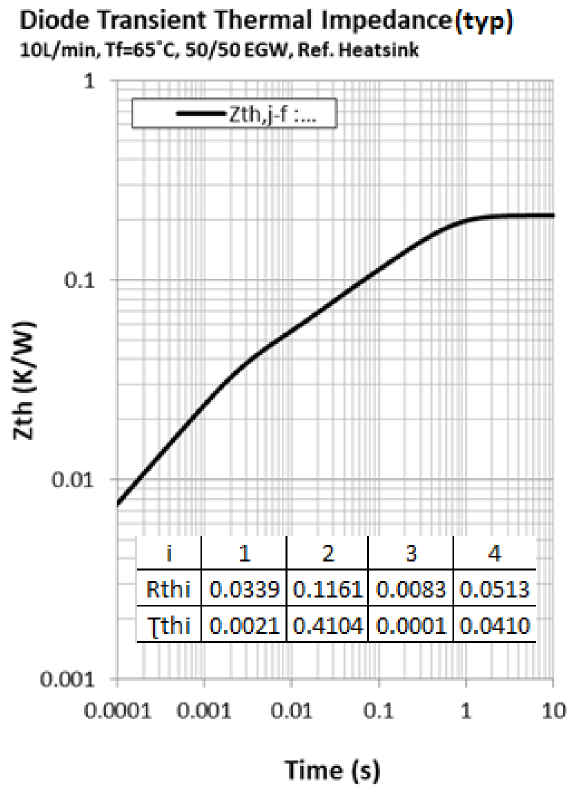


Figure 17. Diode Switching Losses vs. Rg



i	1	2	3	4
Rthi	0.0339	0.1161	0.0083	0.0513
Tthi	0.0021	0.4104	0.0001	0.0410

Figure 18. Diode Transient Thermal Impedance

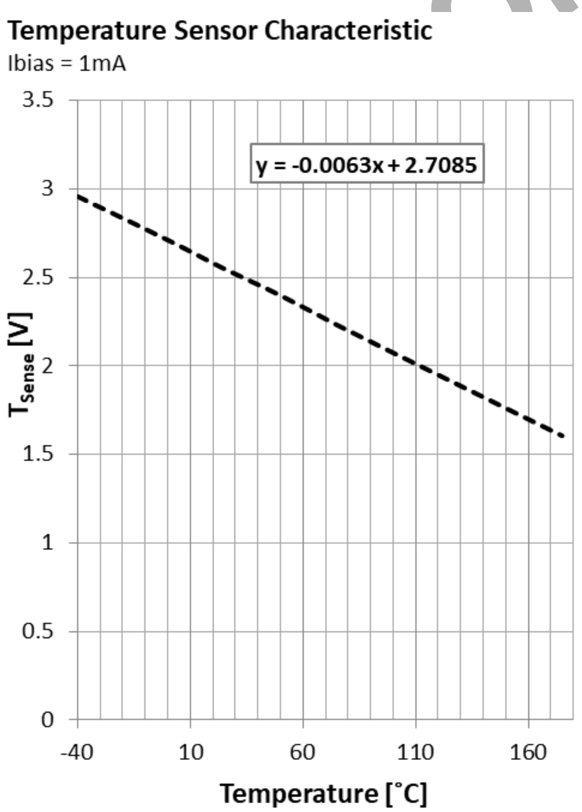


Figure 19. Temperature Sensor Characteristic

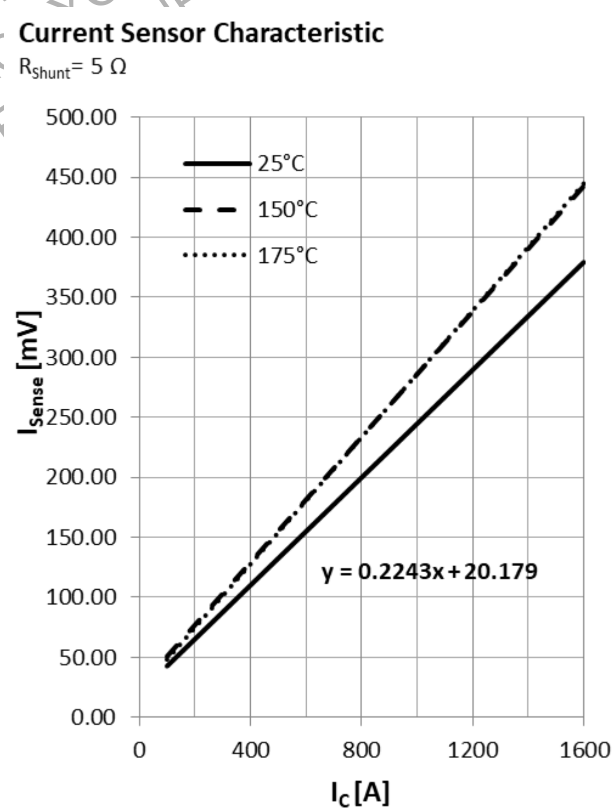


Figure 20. Current Sensor Characteristic

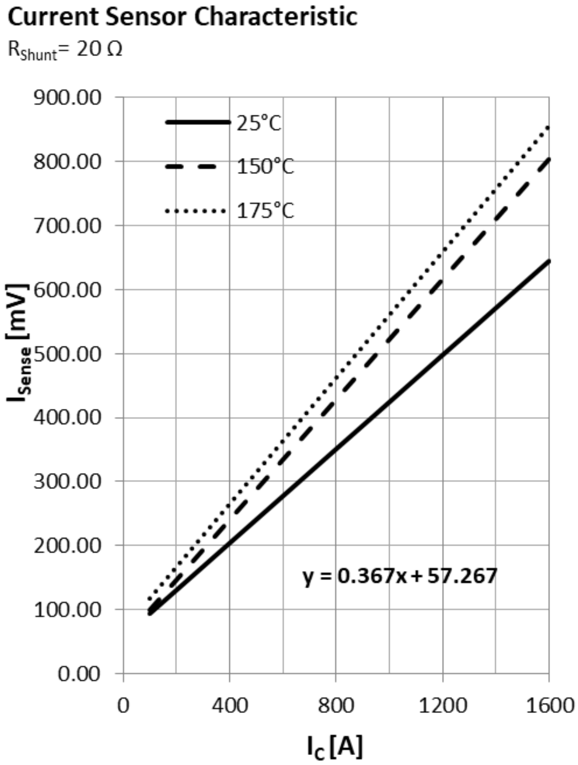


Figure 21. Current Sensor Characteristic

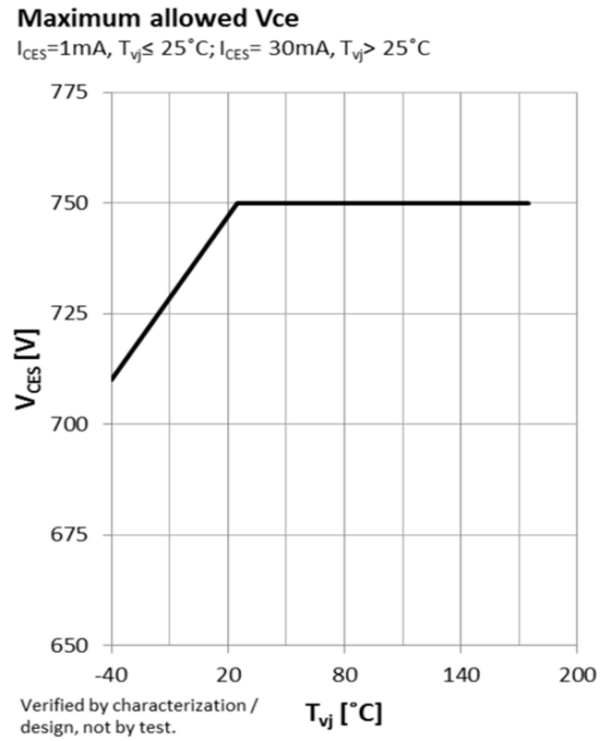
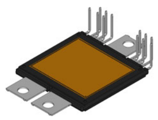


Figure 22. Maximum Allowed V_{CE}

ORDERING INFORMATION

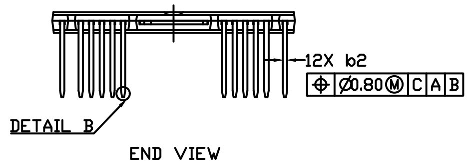
Part Number	Device Marking	Package	Shipping
NVG800A75L4DSB	N875DSB	AHPM15−CEC	6 Units / Tube

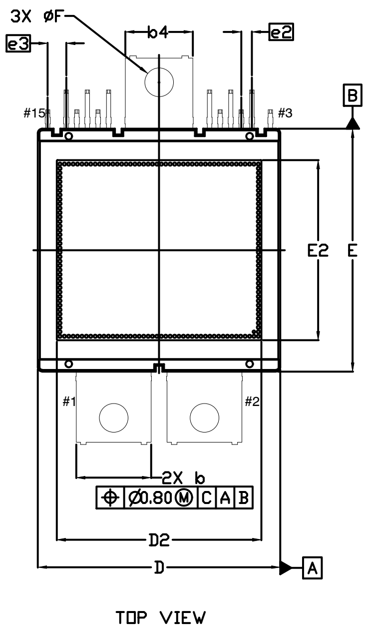


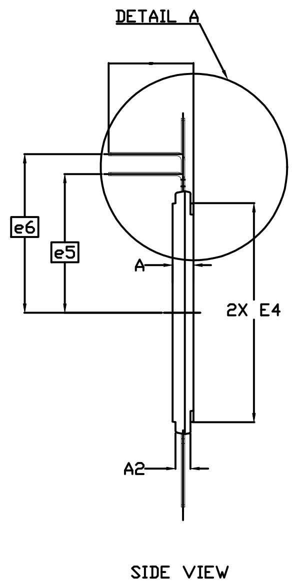
AHPM15−CEC
CASE 100DV
ISSUE A

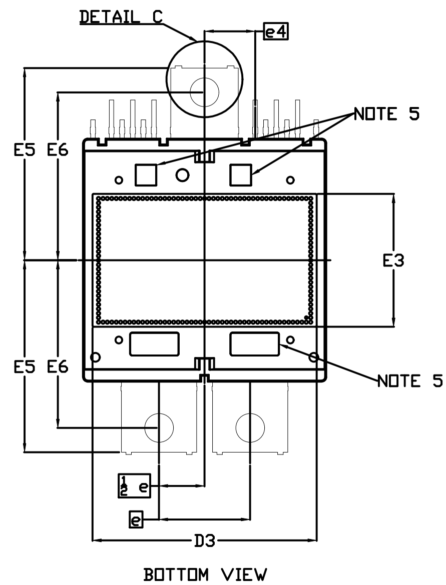
DATE 03 OCT 2022

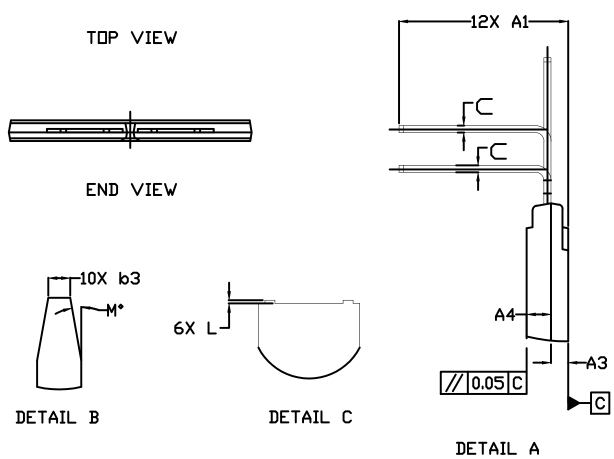
NOTES:
1. DIMENSIONING AND TOLERANCING PER. ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D & E DO NOT INCLUDE MOLD PROTRUSIONS
4. DIMENSIONS b, b2 DO NOT INCLUDE DAMBAR REMAIN.
5. MARKING AREA.











DIM	MILLIMETERS MIN.	NOM.	MAX.
A	4.65	4.70	4.75
A1	18.82	19.17	19.52
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	46.20	46.50	46.80
D3	50.70	51.00	51.30
E	54.80	55.00	55.20

DIM	MILLIMETERS MIN.	NOM.	MAX.
E2	40.50	40.80	41.10
E3	29.80	30.10	30.40
E4	49.40	49.60	49.80
E5	43.35	43.70	44.05
E6	37.70	38.00	38.30
e		20.60 BSC	
e2		2.40 BSC	
e3		4.20 BSC	
e4		11.45 BSC	
e5		31.40 BSC	
e6		35.90 BSC	
F	6.45	6.50	6.55
L		0.50 REF	
M		10° REF	

GENERIC MARKING DIAGRAM*

ZZZ = Assembly Lot Code
AT = Assembly & Test Site Code
YWW = Year and Work Week Code
XXXXX = Specific Device Code
NNNNN = 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−CEC	PAGE 1 OF 1

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