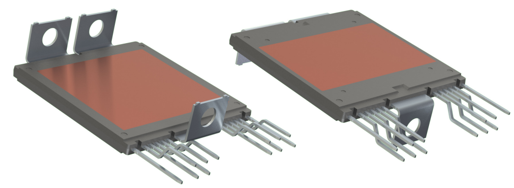
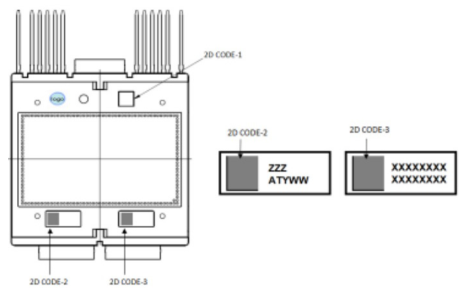
Automotive 750 V, 600 A Dual Side Cooling Half-Bridge Power Module

VE-Trac™ Dual Gen II NVG600A75L4DSC2

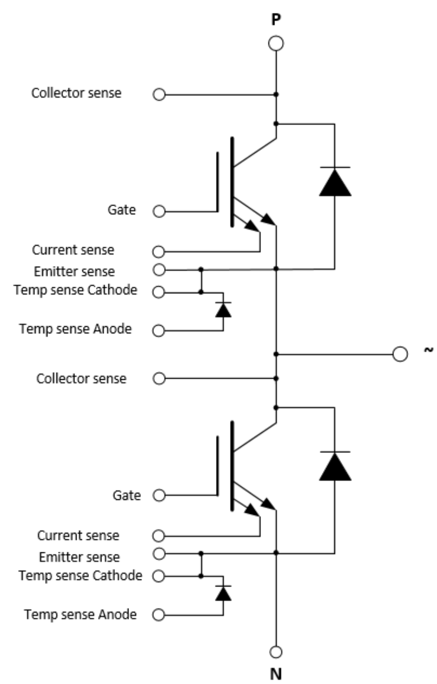


AHPM15−CEA
CASE MODHS

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.

Product Description

The NVG600A75L4DSC2 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

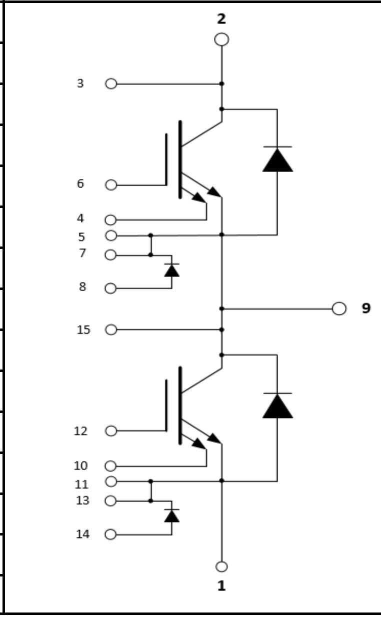
- Dual−Side Cooling
- Integrated Chip Level Temperature and Current Sensor
- $T_{vj\ max}$ = 175°C for Continuous Operation
- Low−Stray Inductance
- Low Conduction and Switching Losses
- Automotive Grade
- 4.2 kV Isolated DBC Substrate
- AEC Qualified and PPAP Capable
- This Device is Pb−Free and is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

Typical Applications

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

July, 2022 − Rev. 1
Publication Order Number:
NVG600A75L4DSC2/D

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	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_{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

1. Verified by design / not by test.

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	– – –	1.23 1.28 1.30	1.35 – –	V
		V_{GE} = 15 V, I_C = 600 A,	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.39 1.53 1.57	– – –	
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 V_{GE} = +15/–8 V Rg.on = 3.9 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	194 224 228	– – –	ns
T_r	Rise Time, Inductive Load	I_C = 400 A, V_{CE} = 400 V V_{GE} = +15/–8 V Rg.on = 3.9 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	71 89 94	– – –	ns
$T_{d.off}$	Turn Off Delay, Inductive Load	I_C = 400 A, V_{CE} = 400 V V_{GE} = +15/–8 V Rg.off = 15 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	969 1047 1063	– – –	ns
T_f	Fall Time, Inductive Load	I_C = 400 A, V_{CE} = 400 V V_{GE} = +15/–8 V Rg.off = 15 Ω	T_{vj} = 25°C T_{vj} = 150°C 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 V_{GE} = +15/–8 V Rg.on = 3.9 Ω Ls = 25 nH di/dt (T_{vj} = 25°C) = 4.67 A/ns di/dt (T_{vj} = 175°C) = 3.61 A/ns	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	10.09 16.73 18.57	– – –	mJ
E_{OFF}	Turn−Off SwitchingLoss	I_C = 400 A, V_{CE} = 400 V V_{GE} = +15/–8 V Rg.off = 15 Ω Ls = 25 nH dv/dt (T_{vj}=25°C) = 2.82 V/ns dv/dt (T_{vj}=175°C) = 2.08 V/ns	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	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

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.

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,	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.34 1.30 1.29	1.47 – –	V
		V_{GE} = 0 V, I_C = 600 A,	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.48 1.47 1.46	 – –	
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 = 1 mA,	T_{vj} =25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	2.5 1.7 1.5	– – –	V
I_{sense}	Current Sense	R_{shunt} = 10 Ω,	I_C = 1200 A I_C = 600 A I_C = 100 A	– – –	416 223 50	– – –	mV

ORDERING INFORMATION

Part Number	Package	Shipping
NVG600A75L4DSC2	AHPM15−CEA Module Case MODHS (Pb−Free)	18 Units / 3x Tub

TYPICAL CHARACTERISTICS

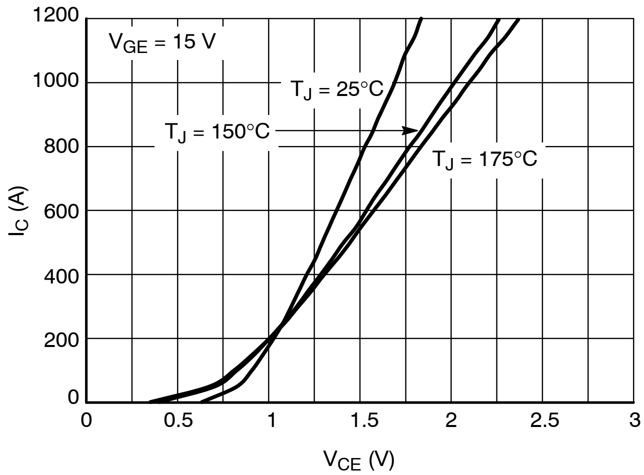


Figure 1. IGBT Output Characteristic

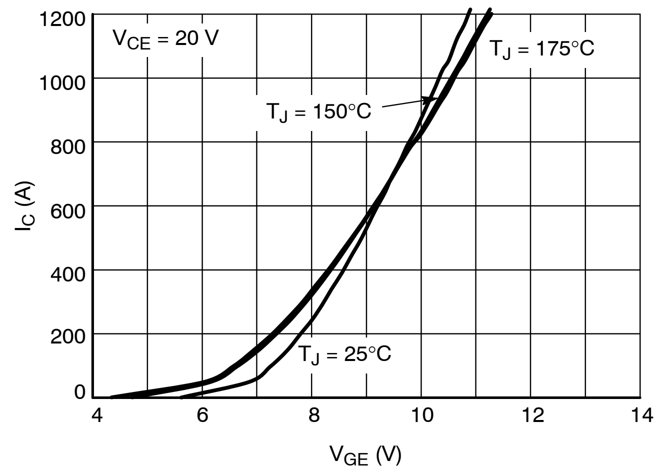


Figure 2. IGBT Transfer Characteristic

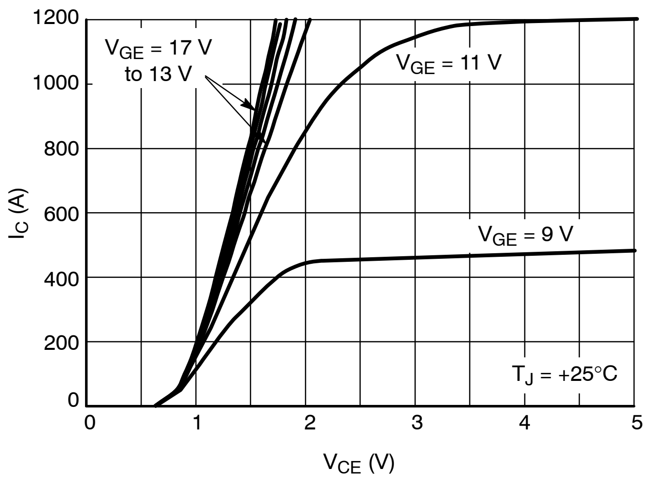


Figure 3. IGBT Output Characteristic, +25°C

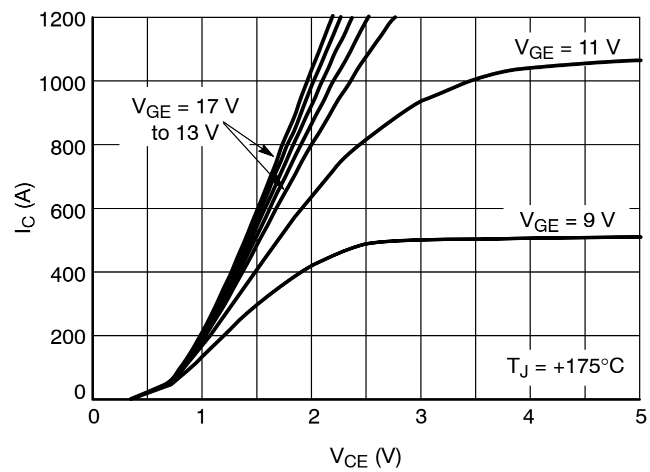


Figure 4. IGBT Output Characteristic, +175°C

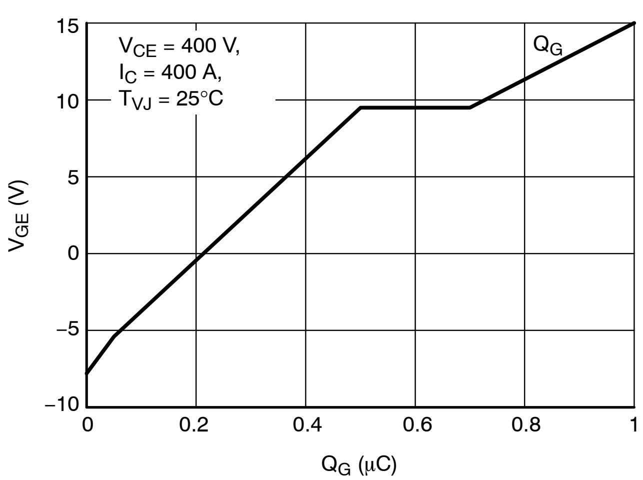


Figure 5. Gate Charge Characteristics

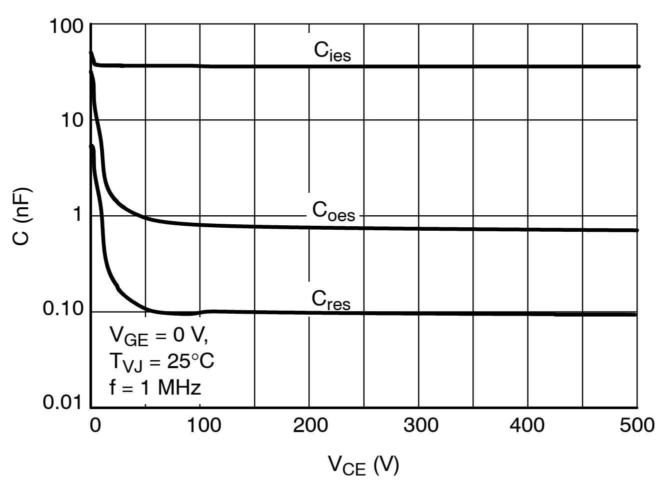


Figure 6. Capacitance Characteristics

TYPICAL CHARACTERISTICS

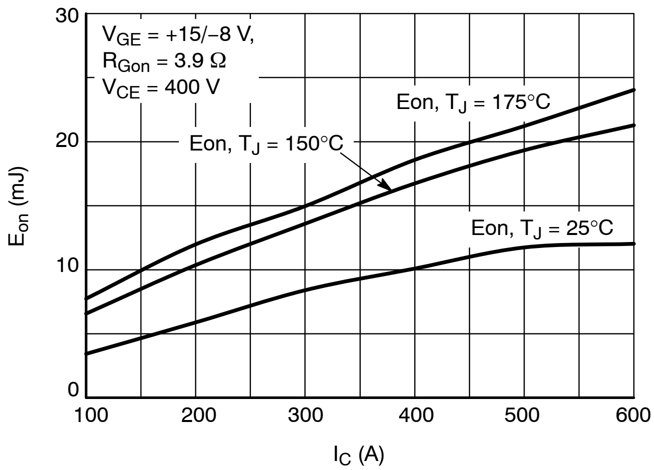


Figure 7. E_{on} vs. I_C

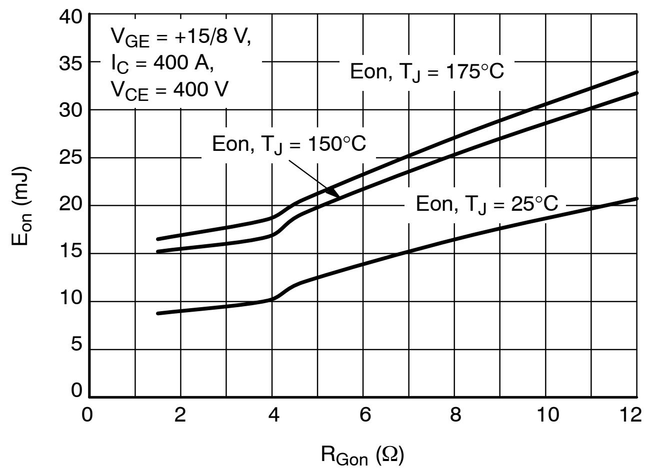


Figure 8. E_{ON} vs. R_{Gon}

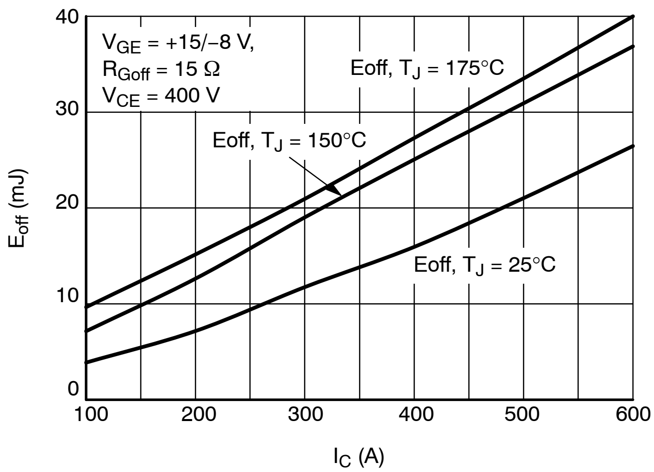


Figure 9. E_{off} vs. I_C

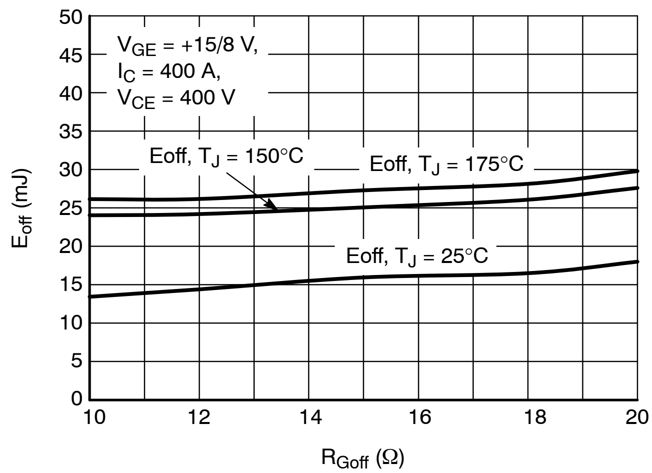


Figure 10. E_{off} vs. R_{Goff}

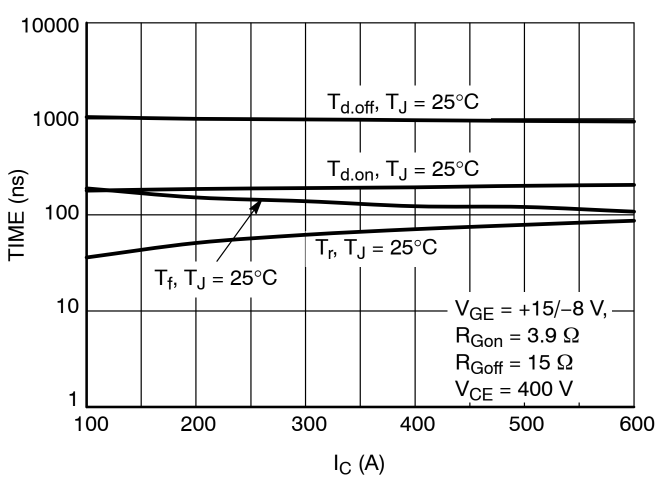


Figure 11. IGBT Switching Times vs. I_C, T_{VJ} = 25°C

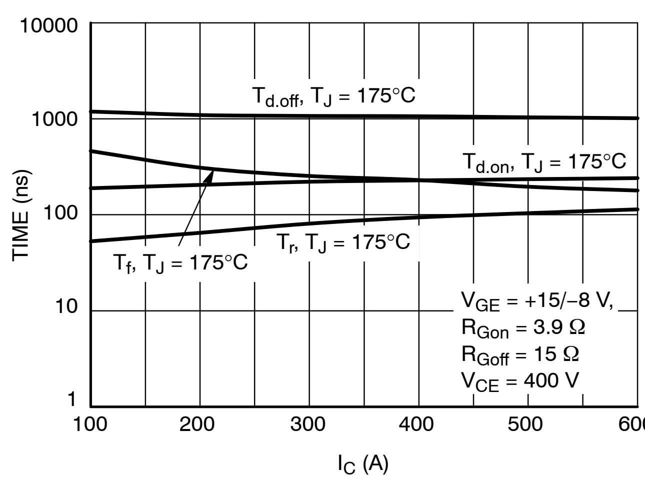


Figure 12. IGBT Switching Times vs. I_C, T_{VJ} = 175°C

TYPICAL CHARACTERISTICS

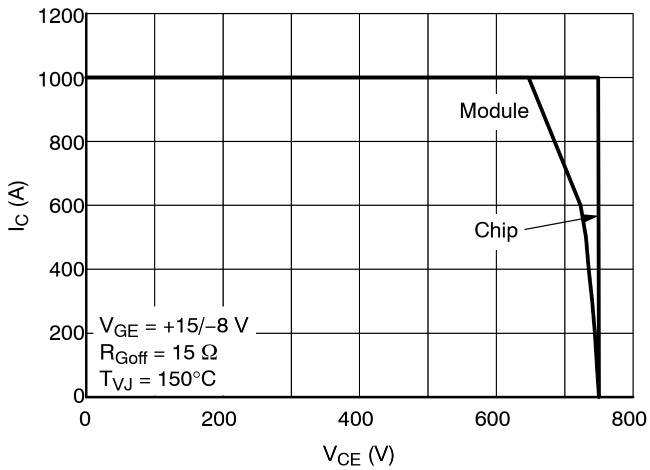


Figure 13. Reverse Bias Safe Operating Area

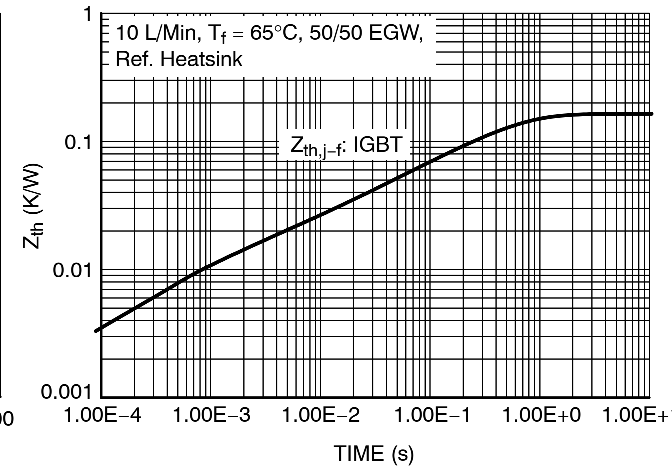


Figure 14. IGBT Transient Thermal Impedance

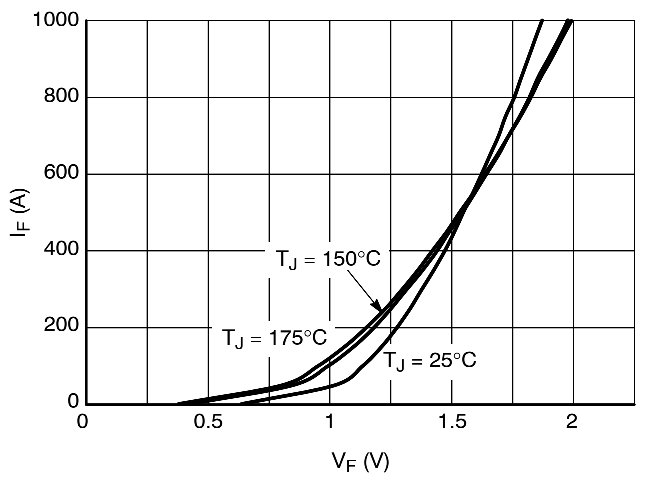


Figure 15. Diode Forward Characteristic

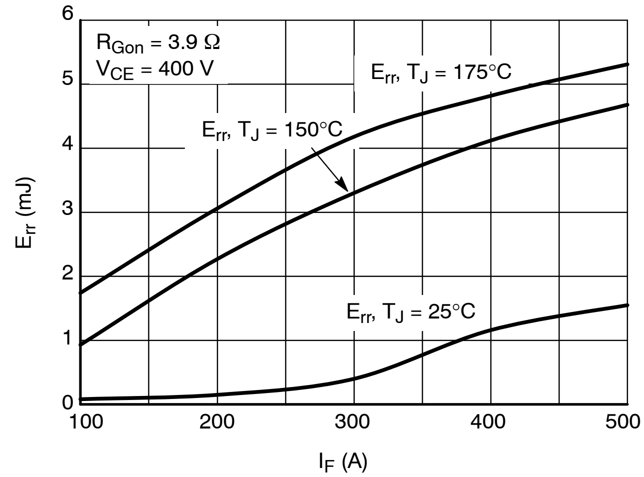


Figure 16. Diode Switching Losses vs. I_F

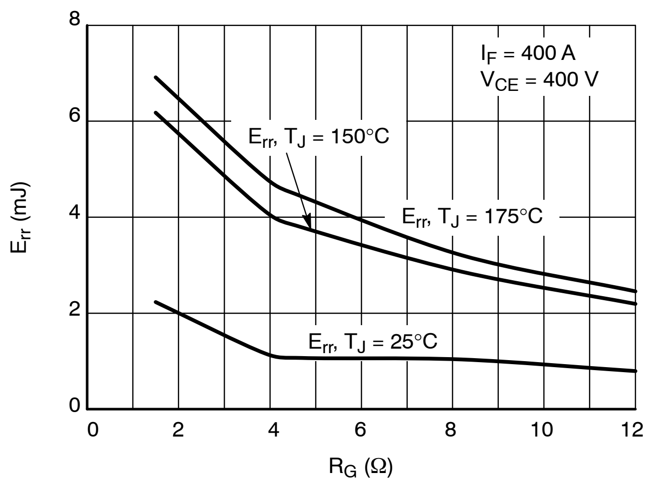


Figure 17. Diode Switching Losses vs. R_{Gon}

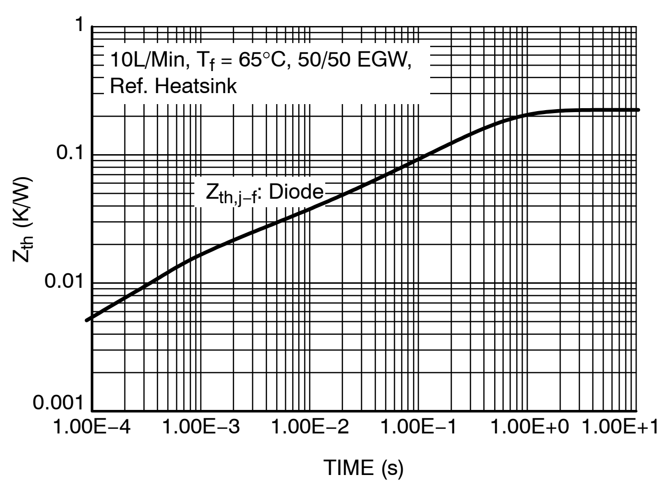


Figure 18. Diode Transient Thermal Impedance

TYPICAL CHARACTERISTICS

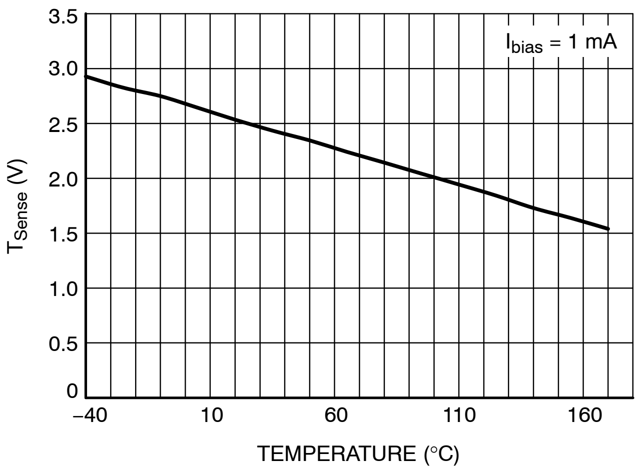


Figure 19. Temperature Sensor Characteristic

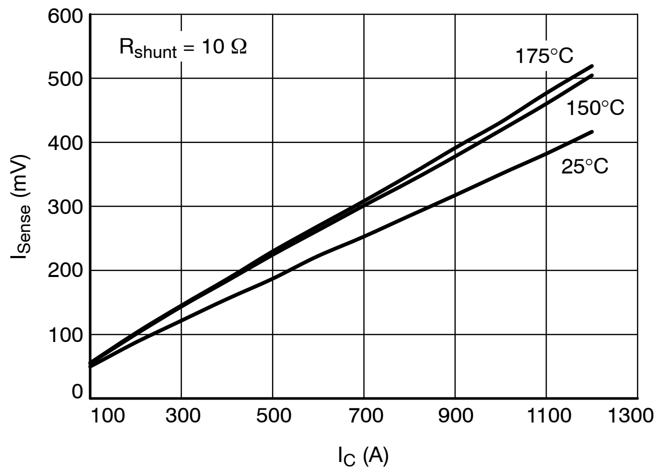


Figure 20. Current Sensor Characteristic

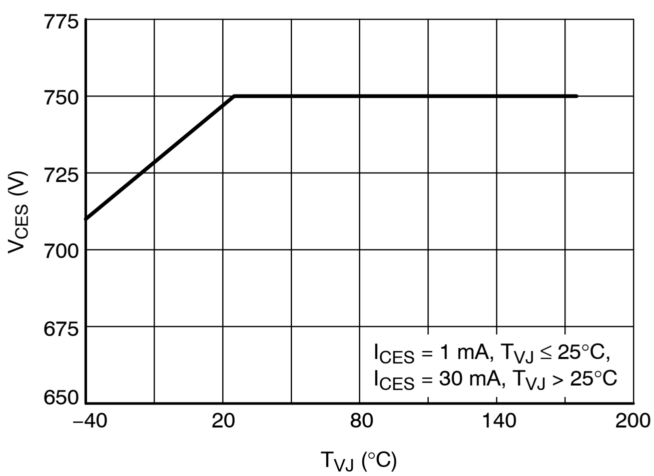


Figure 21. Maximum Allowed V_{CE}

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.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
Technical Library: www.onsemi.com/design/resources/technical−documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support
For additional information, please contact your local Sales Representative at www.onsemi.com/support/sales