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Automotive 750 V, 660 A Single Side Direct Cooling 6-Pack Power Module

VE-Trac™ Direct Module NVH660S75L4SPFC

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Product Description

The NVH660S75L4SPFC is a power module from the VE−Trac™ Direct family of highly integrated power modules with industry standard footprints for Hybrid (HEV) and Electric Vehicle (EV) traction inverter application.

The module integrates six Field Stop 4 (FS4) 750 V Narrow Mesa IGBTs in a 6−pack configuration, which excels in providing high current density, while offering robust short circuit protection and increased blocking voltage. Additionally, FS4 750 V Narrow Mesa IGBTs show low power losses during lighter loads, which helps to improve overall system efficiency in automotive applications.

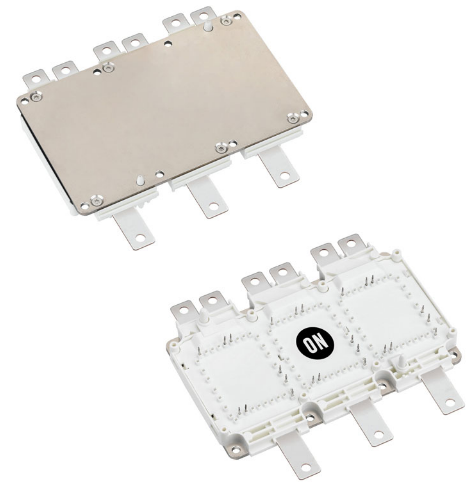
For assembly ease and reliability, a new generation of press−fit pins are integrated into the power module signal terminals. In addition, the power module has longer power terminals to easily integrate an external current sensor.

Features

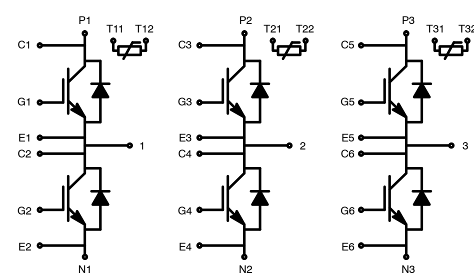
- Direct or Indirect Cooling w/ Flat Base Heatsink
- Ultra−low Stray Inductance
- T_{jmax} = 175°C Continuous Operation
- Low V_{CESAT} and Switching Losses
- Automotive Grade FS4 750 V Narrow Mesa IGBT
- Fast Recovery Diode Chip Technologies
- 4.2 kV Isolated DBC Substrate
- Easy to Integrate 6−pack Topology
- This Device is Pb−Free and is RoHS Compliant

Typical Applications

- Hybrid and Electric Vehicle Traction Inverter
- High Power Converters



SSDC33, 154.50x92.0 (SPFC)
CASE 183AF



ORDERING INFORMATION

See detailed ordering and shipping information on page 5 of this data sheet.

Pin Description

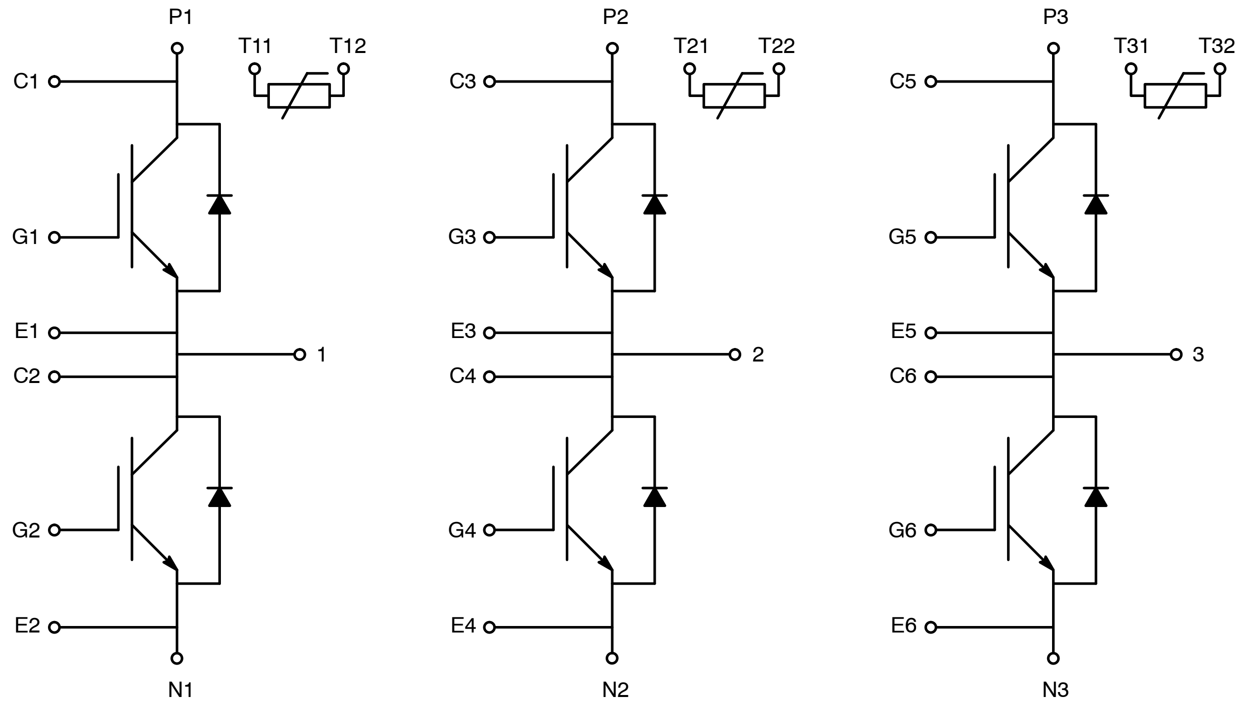


Figure 1. Pin Description

PIN FUNCTION DESCRIPTION

Pin #	Pin Function Description
P1, P2, P3	Positive Power Terminals
N1, N2, N3	Negative Power Terminals
1	Phase 1 Output
2	Phase 2 Output
3	Phase 3 Output
G1−G6	IGBT Gate
E1−E6	IGBT Gate Return
C1−C6	Desat Detect/Collector Sense
T11, T12	Phase 1 Temperature Sensor Output
T21, T22	Phase 2 Temperature Sensor Output
T31, T32	Phase 3 Temperature Sensor Output

Materials

DBC Substrate: Al_2O_3 isolated substrate, basic isolation, and copper on both sides
Terminals: Copper + Tin electro−plating
Signal Leads: Copper + Tin plating
Flat Base plate: Copper + Ni plating

Flammability Information

The module frame meets UL94V−0 flammability rating.

MODULE CHARACTERISTICS (T_{vj} = 25°C, Unless Otherwise Specified)

Symbol	Parameter		Rating	Unit
T_{vj}	Operating Junction Temperature		−40 to 175	°C
T_{STG}	Storage Temperature		−40 to 125	°C
V_{ISO}	Isolation Voltage (DC, 0 Hz, 1 s)		4200	V
L_{sCE}	Stray Inductance		8	nH
RCC'+EE'	Module Lead Resistance, Terminals − Chip		0.75	mΩ
G	Module Weight		580	g
CTI	Comparative Tracking Index		>200	−
d_{creep}	Creepage:	Terminal to Heatsink Terminal to Terminal	9.0 9.0	mm
d_{clear}	Clearance:	Terminal to Heatsink Terminal to Terminal	4.5 4.5	mm

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		660	A
$I_{C\ nom}$	Continuous DC Collector Current, T_{vj} = 175°C, T_F = 65°C, Ref. Heatsink		450 (Note 1)	A
I_{CRM}	Pulsed Collector Current @ V_{GE} = 15 V, t_p = 1 ms		1320	A
P_{tot}	Total Power Dissipation T_{vj} = 175°C, T_F = 65°C, Ref. Heatsink		733	W
DIODE				
V_{RRM}	Repetitive Peak Reverse Voltage		750	V
I_{FN}	Implemented Forward Current		660	A
I_F	Continuous Forward Current, T_{vj} = 175°C, T_F = 65°C, Ref. Heatsink		300 (Note 1)	A
I_{FRM}	Repetitive Peak Forward Current, t_p = 1 ms		1320	A
I^2t value	Surge Current Capability, t_p = 10 ms,	T_{vj} = 150°C T_{vj} = 175°C	19000 16000	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/design, not by test.

CHARACTERISTICS OF IGBT (T_{vj} = 25°C, Unless Otherwise Specified)

Symbol	Parameters	Conditions		Min	Typ	Max	Unit
V_{CESAT}	Collector to Emitter Saturation Voltage (Terminal)	V_{GE} = 15 V, I_C = 450 A	T_{vj} = 25°C	–	1.19	1.44	V
	Collector to Emitter Saturation Voltage (Chip)	V_{GE} = 15 V, I_C = 450 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.16 1.20 1.21	1.41 – –	
		V_{GE} = 15 V, I_C = 660 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.29 1.40 1.43	– – –	
I_{CES}	Collector to Emitter Leakage Current	V_{GE} = 0, V_{CE} = 750 V	T_{vj} = 25°C T_{vj} = 150°C	– –	– 2.0	500 –	μA mA
I_{GES}	Gate – Emitter Leakage Current	V_{CE} = 0, V_{GE} = ±20 V		–	–	±300	nA
V_{th}	Threshold Voltage	V_{CE} = V_{GE}, I_C = 90 mA		4.8	5.7	6.6	V
Q_G	Total Gate Charge	V_{GE} = −8 to 15 V, V_{CE} = 400 V		–	1.9	–	μC
R_{Gint}	Internal Gate Resistance			–	1.7	–	Ω
C_{ies}	Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz		–	63	–	nF
C_{oes}	Output Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz		–	1.8	–	nF
C_{res}	Reverse Transfer Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1 MHz		–	0.2	–	nF
$T_{d.on}$	Turn On Delay, Inductive Load	I_C = 450 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, Rg.on = 4 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	308 304 294	– – –	ns
T_r	Rise Time, Inductive Load	I_C = 450 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, Rg.on = 4 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	114 133 124	– – –	ns
$T_{d.off}$	Turn Off Delay, Inductive Load	I_C = 450 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, Rg.off = 12 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1432 1579 1536	– – –	ns
T_f	Fall Time, Inductive Load	I_C = 450 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, Rg.off = 12 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	169 256 246	– – –	ns
E_{ON}	Turn−On Switching Loss (Including Diode Reverse Recovery Loss)	I_C = 450 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, Ls = 22 nH, Rg.on = 4 Ω	di/dt = 3.2 A/nS, T_{vj} = 25°C di/dt = 2.7 A/nS, T_{vj} = 150°C di/dt = 2.9 A/nS, T_{vj} = 175°C	– – –	16 25 27	– – –	mJ
E_{OFF}	Turn−Off Switching Loss	I_C = 450 A, V_{CE} = 400 V, V_{GE}= +15/−8 V, Ls = 22 nH, Rg.off = 12 Ω	dv/dt = 2.3 V/nS, T_{vj} = 25°C dv/dt = 1.6 V/nS, T_{vj} = 150°C dv/dt = 1.5 V/nS, T_{vj} = 175°C	– – –	22 33 35	– – –	mJ
E_{SC}	Minimum Short Circuit Energy Withstand	V_{GE} = 15 V, V_{CC} = 400 V	T_{vj} = 25°C T_{vj} = 175°C	8 4	– –	– –	J

CHARACTERISTICS OF INVERSE DIODE (T_{vj} = 25°C, Unless Otherwise Specified)

Symbol	Parameters	Conditions		Min	Typ	Max	Unit
V_F	Diode Forward Voltage (Terminal)	I_F = 450 A	T_{vj} = 25°C	–	1.51	1.76	V
	Diode Forward Voltage (Chip)	I_F = 450 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.45 1.33 1.30	1.70 – –	
		I_F = 660 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.58 1.52 1.50	– – –	
E_{rr}	Reverse Recovery Energy	I_F = 450 A, V_F = 400 V, V_{GE} = +15/−8 V, Rg.on = 4 Ω	di/dt = 3.5 A/nS, T_{vj} = 25°C di/dt = 3.0 A/nS, T_{vj} = 150°C di/dt = 2.9 A/nS, T_{vj} = 175°C	– – –	2 7 9	– – –	mJ
Q_{rr}	Recovered Charge	I_F = 450 A, V_F = 400 V, V_{GE} = −8 V, Rg.on = 4 Ω	di/dt = 3.5 A/nS, T_{vj} = 25°C di/dt = 3.0 A/nS, T_{vj} = 150°C di/dt = 2.9 A/nS, T_{vj} = 175°C	– – –	7 26 33	– – –	μC
I_{rr}	Peak Reverse Recovery Current	I_F = 450 A, V_F = 400 V, V_{GE} = −8 V, Rg.on = 4 Ω	di/dt = 3.5 A/nS, T_{vj} = 25°C di/dt = 3.0 A/nS, T_{vj} = 150°C di/dt = 2.9 A/nS, T_{vj} = 175°C	– – –	120 227 264	– – –	A

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

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
R_{25} (Note 3)	Rated Resistance	T_C = 25°C	–	5147	–	Ω
ΔR/R	Deviation of R105	T_C = 105°C, R_{105} = 472 Ω	5	–	5	%
P_{25}	Power Dissipation	T_C = 25°C	–	–	32	mW
$B_{25/55}$	B−Value	$R = R_{25} \exp [B_{25/55} (1/T−1/298)]$	–	3340	–	K
$B_{25/85}$	B−Value	$R = R_{25} \exp [B_{25/85} (1/T−1/298)]$	–	3360	–	K
$B_{25/105}$	B−Value	$R = R_{25} \exp [B_{25/105} (1/T−1/298)]$	–	3364	–	K

2. Measured value at terminals.

THERMAL CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Unit
IGBT.$R_{th,J−C}$	Rth, Junction to Case	–	0.074	0.085	°C/W
IGBT.$R_{th,J−F}$	Rth, Junction to Fluid, 10 L/min, 65°C, 50/50 EGW, Ref. Coolinig Jacket	–	0.15		°C/W
Diode.$R_{th,J−C}$	Rth, Junction to Case	–	0.13	0.15	°C/W
Diode.$R_{th,J−F}$	Rth, Junction to Fluid, 10 L/min, 65°C, 50/50 EGW, Ref. Coolinig Jacket	–	0.23		°C/W

ORDERING INFORMATION

Part Number	Package	Shipping
NVH660S75L4SPFC	SSDC33, 154.50x92.0 (SPFC) (Pb−Free)	4 Units / Tray

TYPICAL CHARACTERISTICS

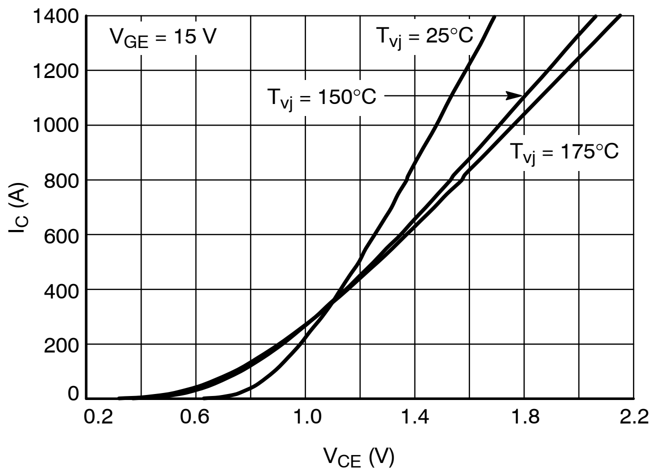


Figure 2. IGBT Output Characteristic

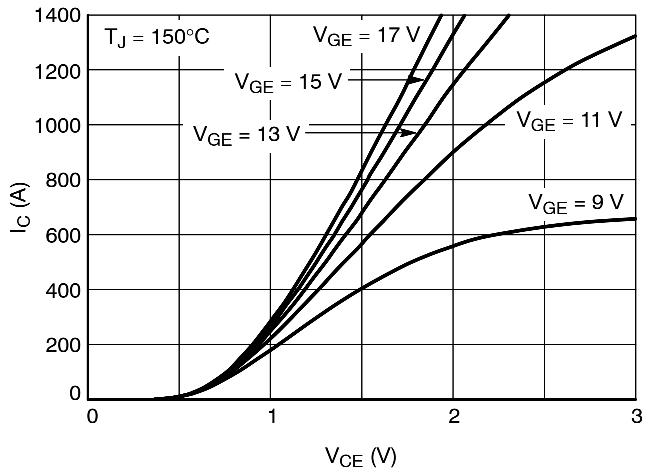


Figure 3. IGBT Output Characteristic

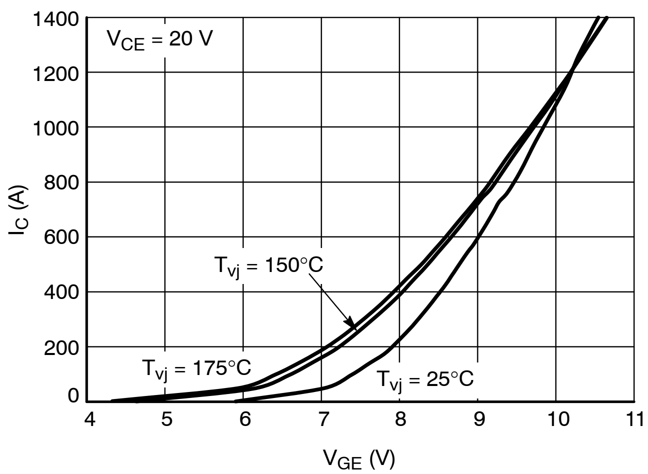


Figure 4. IGBT Transfer Characteristic

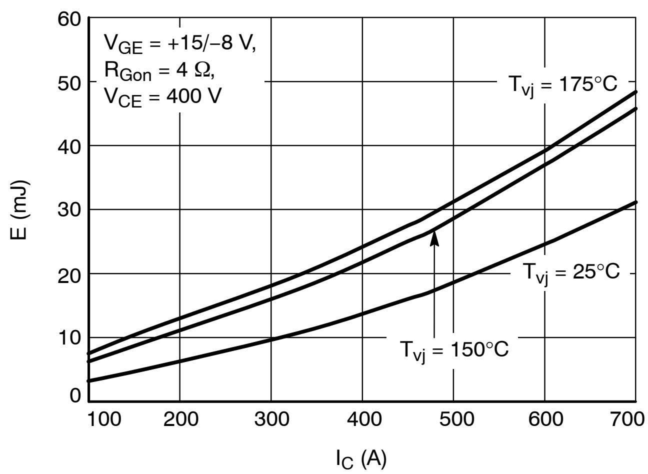


Figure 5. IGBT Turn−on Losses vs. I_C

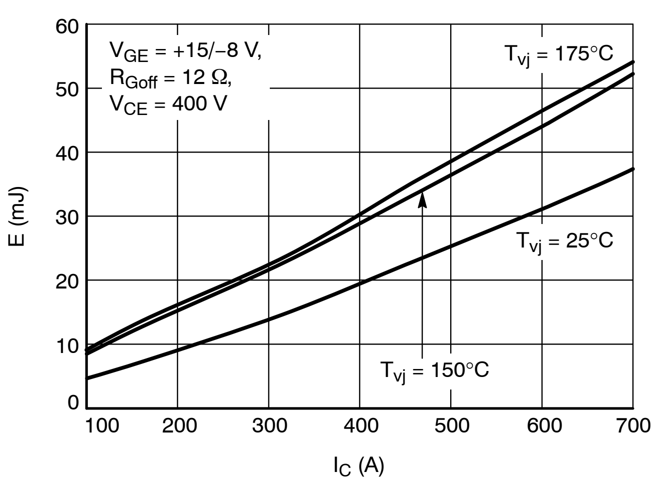


Figure 6. IGBT Turn−off Losses vs. I_C

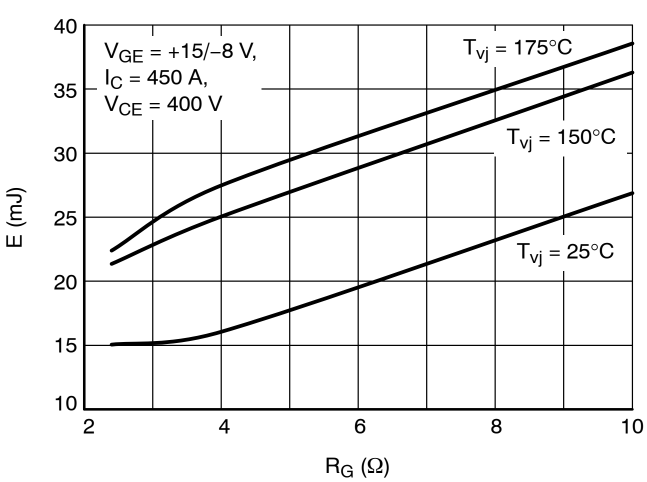


Figure 7. E_{ON} vs. R_G

TYPICAL CHARACTERISTICS

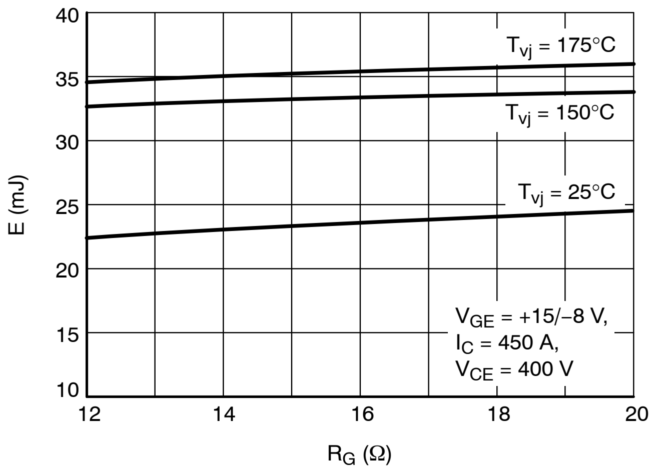


Figure 8. E_{OFF} vs. R_G

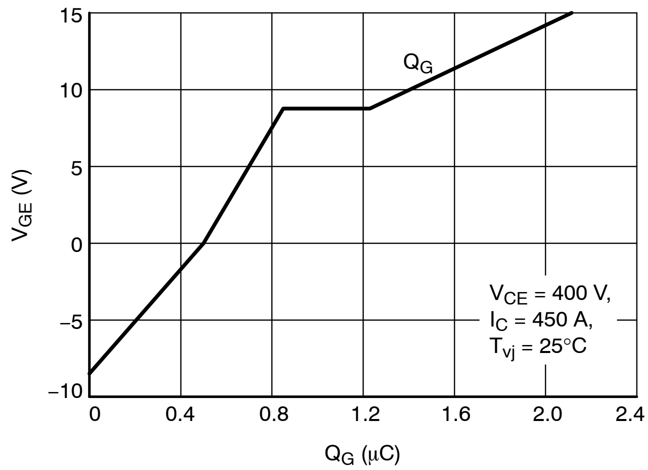


Figure 9. Gate Charge Characteristic

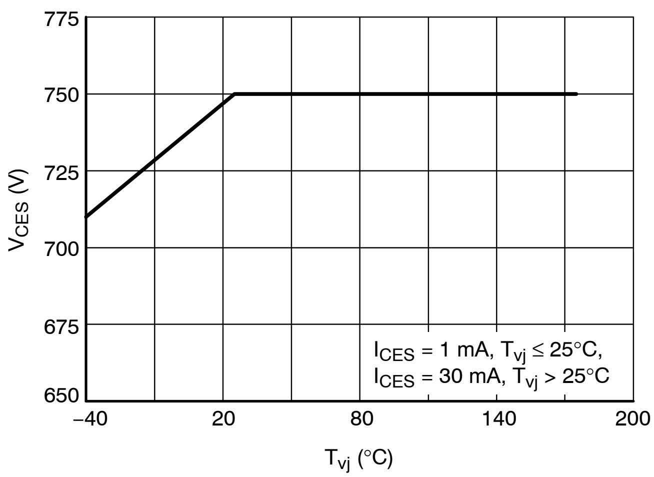


Figure 10. Maximum Allowed V_{CE}

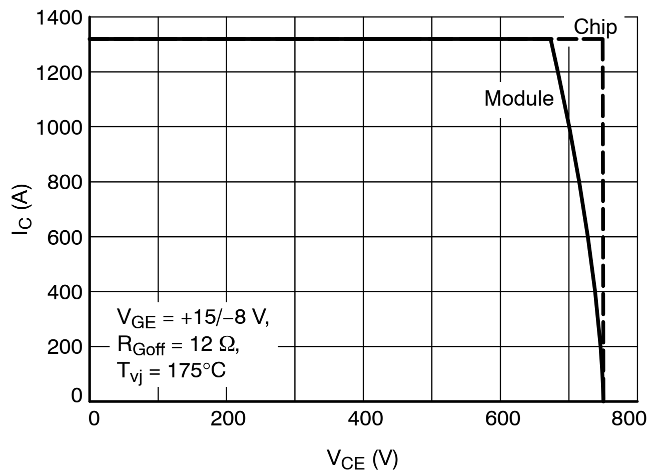


Figure 11. Reverse Bias Safe Operating Area

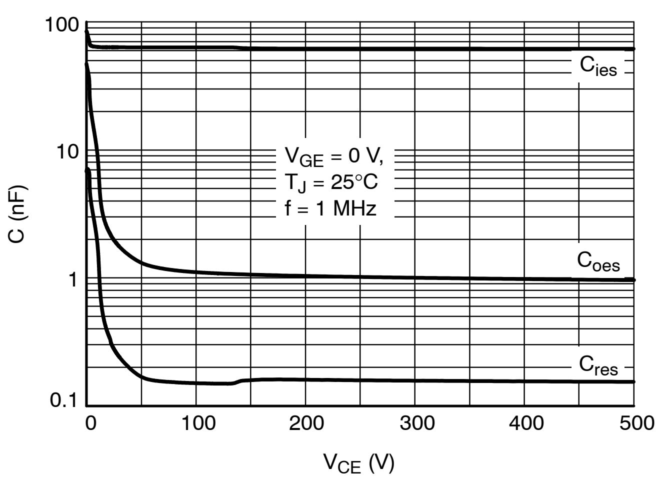


Figure 12. Capacitance Characteristic

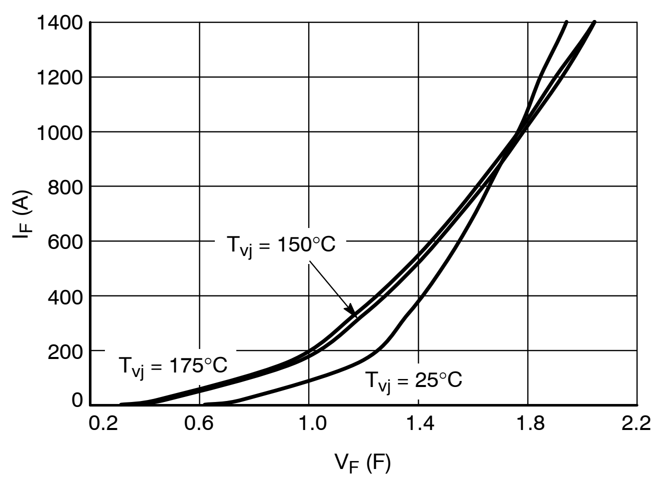


Figure 13. Diode Forward Characteristic

TYPICAL CHARACTERISTICS

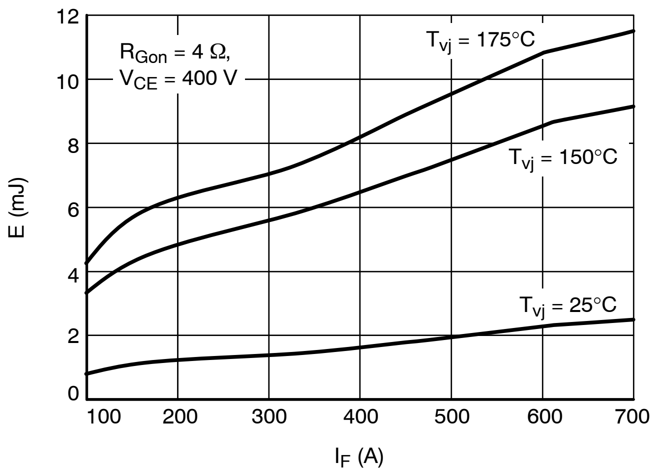


Figure 14. Diode Switching Losses vs. I_F

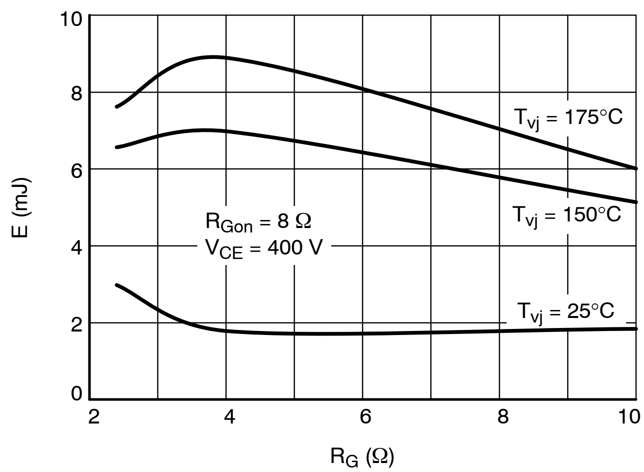
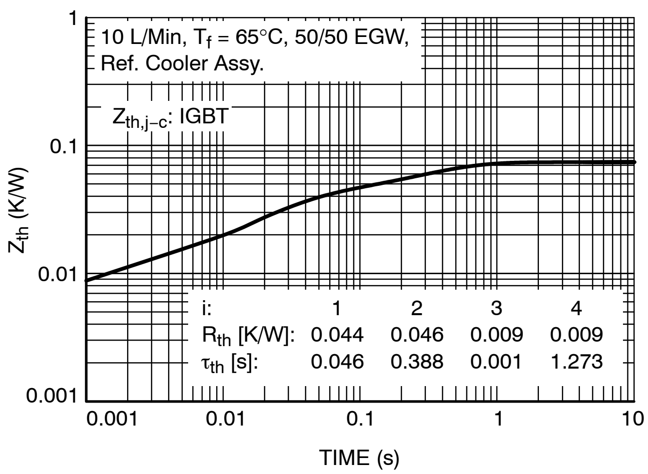
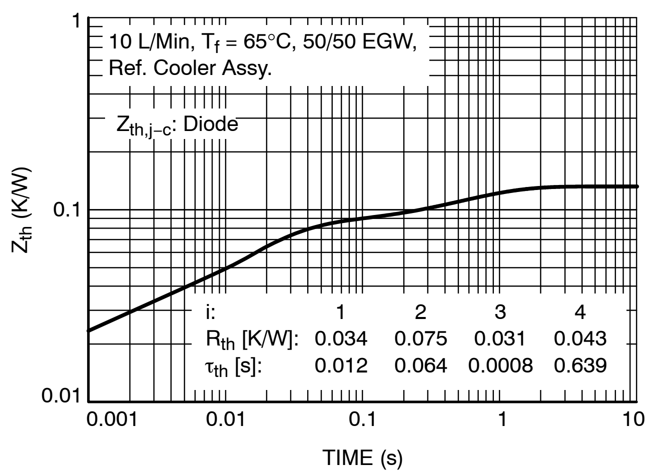


Figure 15. Diode Switching Losses vs. R_G



i:	1	2	3	4
R_{th} [K/W]:	0.044	0.046	0.009	0.009
τ_{th} [s]:	0.046	0.388	0.001	1.273

Figure 16. IGBT Transient Thermal Impedance (Typ.)



i:	1	2	3	4
R_{th} [K/W]:	0.034	0.075	0.031	0.043
τ_{th} [s]:	0.012	0.064	0.0008	0.639

Figure 17. Diode Transient Thermal Impedance (Typ.)

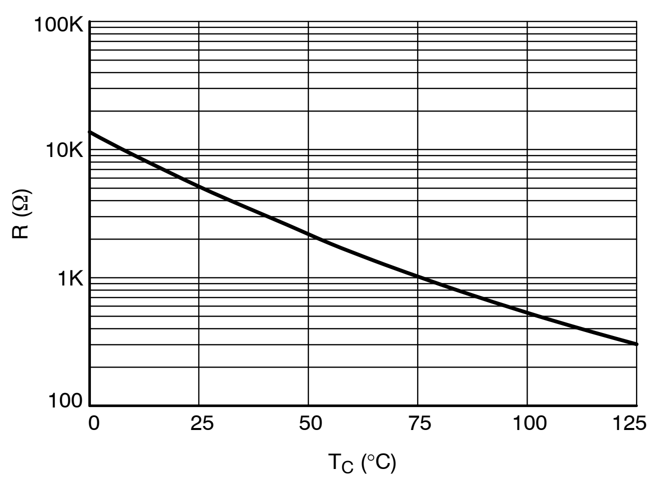
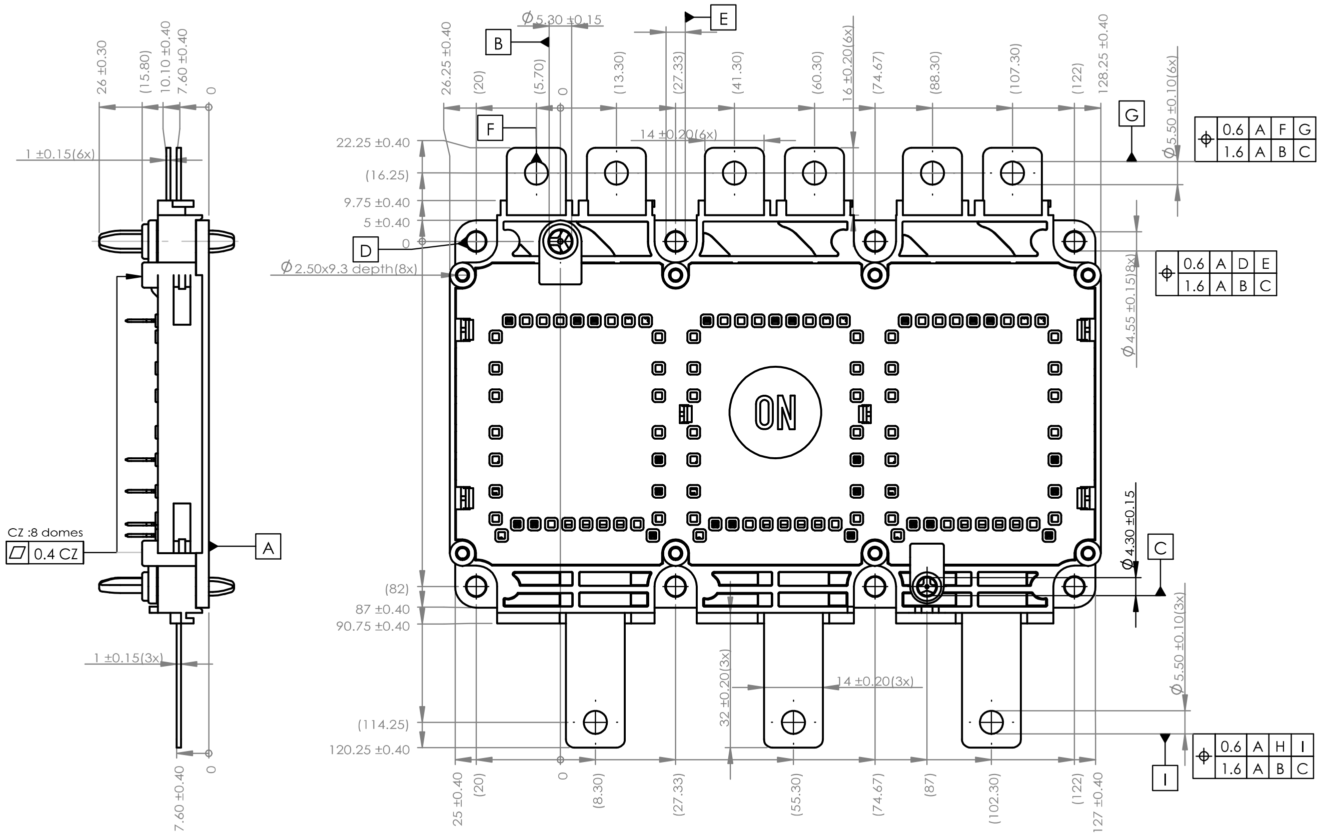


Figure 18. NTC Thermistor − Temperature Characteristic (Typical)

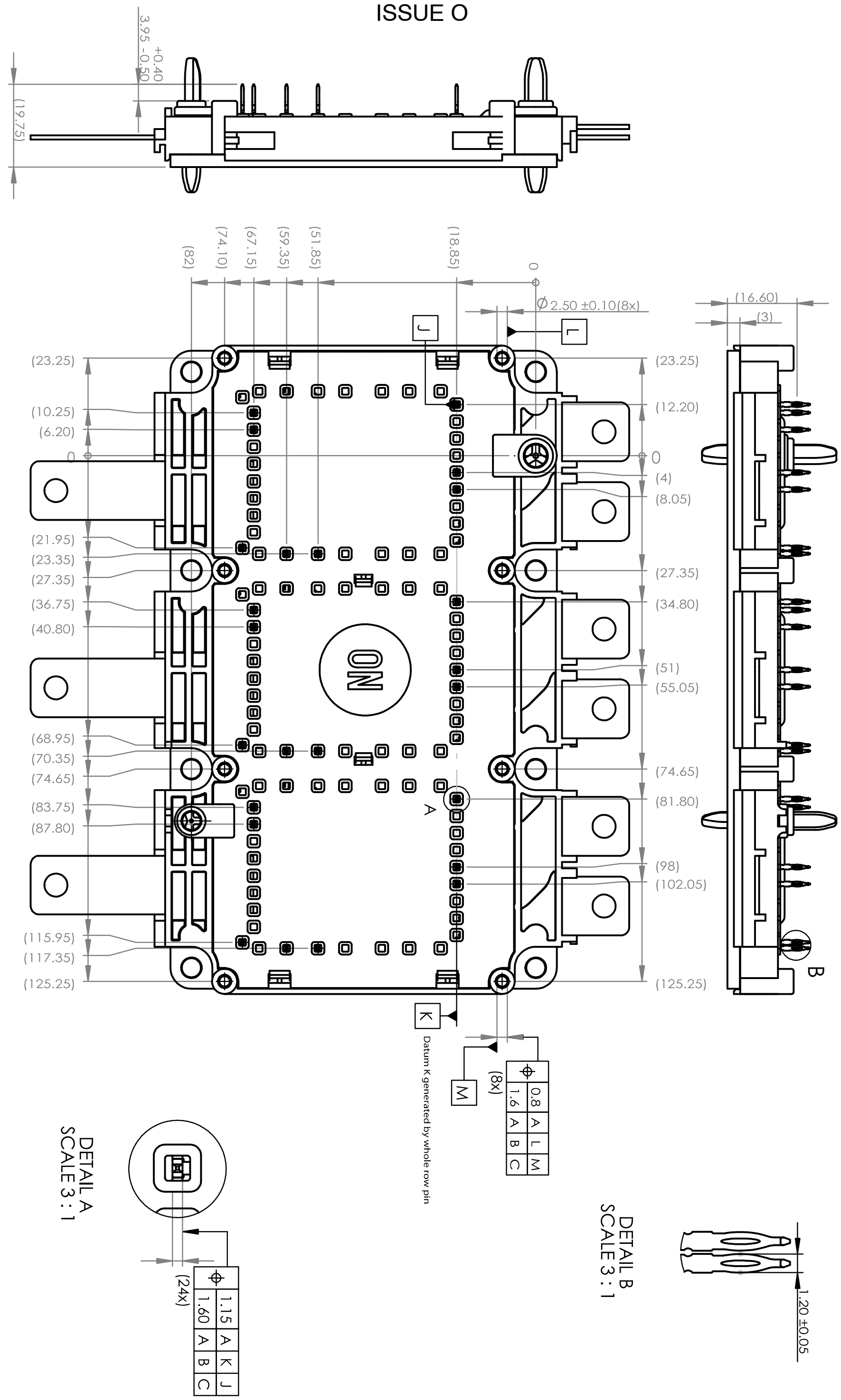
PACKAGE DIMENSIONS

SSDC33, 154.50x92.0
CASE 183AF
ISSUE O



PACKAGE DIMENSIONS

SSDC33, 154.50x92.0
CASE 183AF
ISSUE O



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