Automotive 750 V, 950 A Single Side Direct Cooling 6-Pack Power Module

VE-Tract™ Direct Module

NVH950S75L4SPB

Product Description

The NVH950S75L4SPB 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.

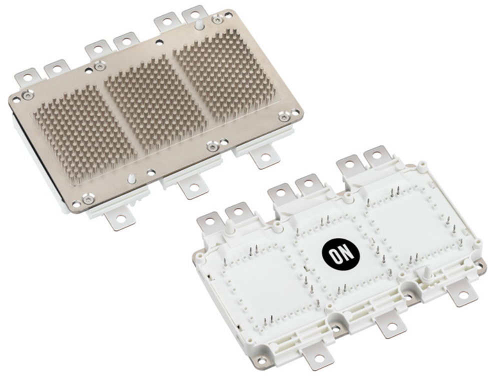
For assembly ease and reliability, a new generation of press−fit pins are integrated into the power module signal terminals. In addition, the power module has an optimized pin−fin heatsink in the baseplate.

Features

- Direct Cooling w/ Integrated Pin−fin Heatsink
- Ultra−low Stray Inductance
- T_{vjmax} = 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

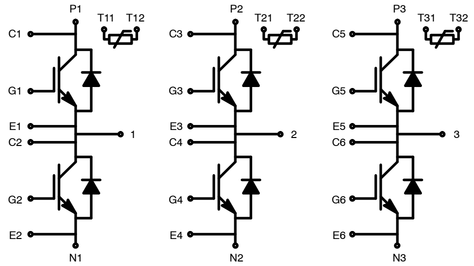


SSDC33, 154.50x92.0 (SPB)
CASE 183AB

MARKING DIAGRAM

XXXXXXXXXXXXXXXXXXXXX
ATYYWW

XXXXX = Specific Device Code
AT = Assembly & Test Site Code
YYWW = Year and Work Week Code



ORDERING INFORMATION

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

December, 2022 − Rev. 6

Pin Description

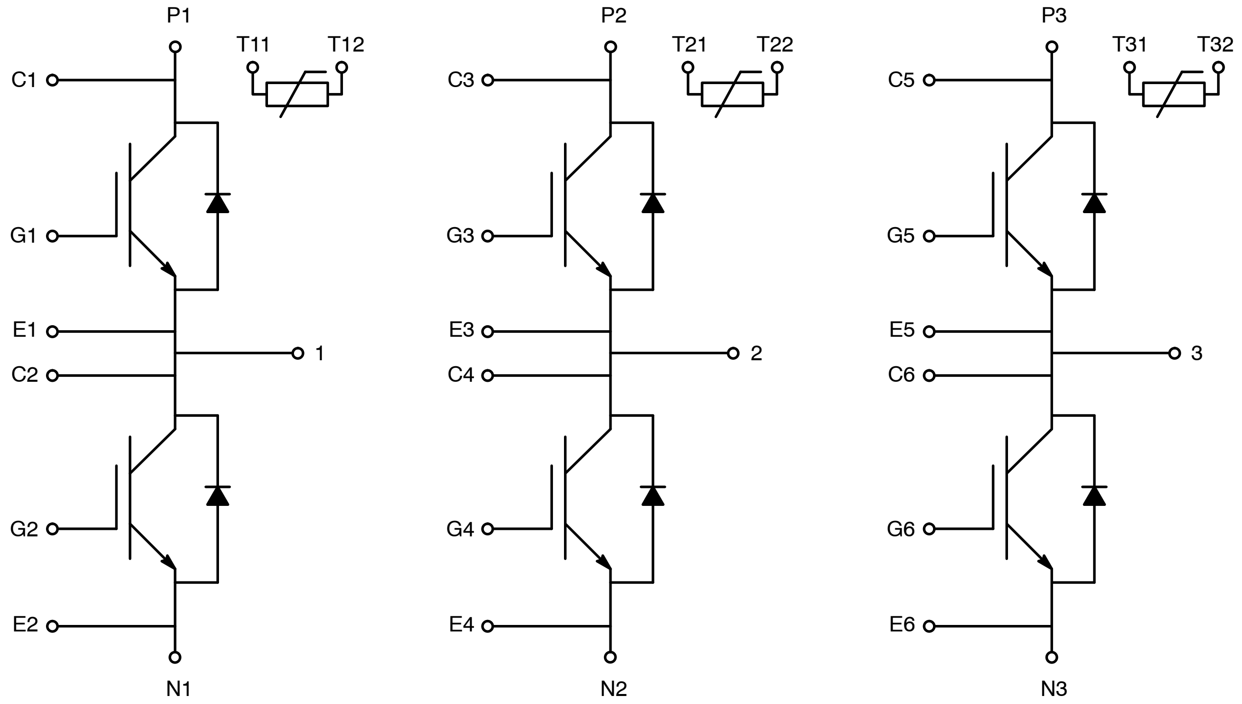


Figure 1. Pin Description

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: SiN isolated substrate, basic isolation, and copper on both sides
Terminals: Copper + Tin electro−plating
Signal Leads: Copper + Tin plating
Pin−fin 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		700	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

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
Δp	Pressure Drop in Cooling Circuit	10 L/min, 65°C, 50/50 EGW	−	95	−	mbar
P (Note 1)	Maximum Pressure in Cooling Loop (relative)	$T_{Baseplate} < 40°C$ $T_{Baseplate} > 40°C$	− −	− −	2.5 2.0	bar

1. EPDM rubber 50 durometer ‘O’ ring used.

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		950	A
$I_{C\ nom}$	Continuous DC Collector Current, T_{vj} = 175°C, T_F = 65°C, Ref. Heatsink		750 (Note 2)	A
I_{CRM}	Pulsed Collector Current @ V_{GE} = 15 V, t_p = 1 ms		1900	A
P_{tot}	Total Power Dissipation T_{vj} = 175°C, T_F = 65°C, Ref. Heatsink		1300	W
Diode				
V_{RRM}	Repetitive Peak Reverse Voltage		750	V
I_{FN}	Implemented Forward Current		950	A
I_F	Continuous Forward Current, T_{vj} = 175°C, T_F = 65°C, Ref. Heatsink		500 (Note 2)	A
I_{FRM}	Repetitive Peak Forward Current, t_p = 1 ms		1900	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.

2. 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 = 600 A	T_{vj} = 25°C	–	1.30	1.55	V
	Collector to Emitter Saturation Voltage (Chip)	V_{GE} = 15 V, I_C = 600 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.25 1.37 1.40	1.50 – –	
		V_{GE} = 15 V, I_C = 950 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.47 1.71 1.77	– – –	
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		–	2.3	–	µC
R_{Gint}	Internal Gate Resistance			–	1.7	–	Ω
C_{ies}	Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 100 kHz		–	60	–	nF
C_{oes}	Output Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 100 kHz		–	1.90	–	nF
C_{res}	Reverse Transfer Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 100 kHz		–	0.2	–	nF
$T_{d.on}$	Turn On Delay, Inductive Load	I_C = 600 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, $R_{g.on}$ = 4 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	315 320 322	– – –	ns
T_r	Rise Time, Inductive Load	I_C = 600 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, $R_{g.on}$ = 4 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	108 127 132	– – –	ns
$T_{d.off}$	Turn Off Delay, Inductive Load	I_C = 600 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, $R_{g.off}$ = 12 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1063 1196 1203	– – –	ns
T_f	Fall Time, Inductive Load	I_C = 600 A, V_{CE} = 400 V, V_{GE} = +15/−8 V, $R_{g.off}$ = 12 Ω	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	85 144 151	– – –	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, L_s = 22 nH, $R_{g.on}$ = 4 Ω	di/dt = 4.5 A/ns, T_{vj} = 25°C di/dt = 3.9 A/ns, T_{vj} = 150°C di/dt = 3.6 A/ns, T_{vj} = 175°C	– – –	26 36 38	– – –	mJ
E_{OFF}	Turn Off Switching Loss	I_C = 600 A, V_{CE} = 400 V, V_{GE}= +15/−8 V, L_s = 22 nH, $R_{g.off}$ = 12 Ω	dv/dt = 2.7 V/ns, T_{vj} = 25°C dv/dt = 1.9 V/ns, T_{vj} = 150°C dv/dt = 1.9 V/ns, T_{vj} = 175°C	– – –	33 46 50	– – –	mJ
E_{SC}	Minimum Short Circuit Energy Withstand	V_{GE} = 15 V, V_{CC} = 400 V	T_{vj} = 25°C T_{vj} = 175°C	9 4.5	– –	– –	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 = 600 A	T_{vj} = 25°C	–	1.70	1.95	V
	Diode Forward Voltage (Chip)	I_F = 600 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.60 1.55 1.50	1.85 – –	
		I_F = 950 A	T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	– – –	1.73 1.75 1.74	– – –	
E_{rr}	Reverse Recovery Energy	I_F = 600 A, V_R = 400 V, V_{GE} = −8 V, Rg.on = 4 Ω	di/dt = 4.5 A/nS, T_{vj} = 25°C di/dt = 3.9 A/nS, T_{vj} = 150°C di/dt = 3.6 A/nS, T_{vj} = 175°C	– – –	3 9 11	– – –	mJ
Q_{rr}	Recovered Charge	I_F = 600 A, V_R = 400 V, V_{GE} = −8 V, Rg.on = 4 Ω	di/dt = 4.5 A/nS, T_{vj} = 25°C di/dt = 3.9 A/nS, T_{vj} = 150°C di/dt = 3.6 A/nS, T_{vj} = 175°C	– – –	9 32 39	– – –	μC
I_{rr}	Peak Reverse Recovery Current	I_F = 600 A, V_R = 400 V, V_{GE} = −8 V, Rg.on = 4 Ω	di/dt = 4.5 A/nS, T_{vj} = 25°C di/dt = 3.9 A/nS, T_{vj} = 150°C di/dt = 3.6 A/nS, T_{vj} = 175°C	– – –	133 246 282	– – –	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	–	5	–	kΩ
ΔR/R	Deviation of R100	T_C = 100°C, R_{100} = 493 Ω	5	–	5	%
P_{25}	Power Dissipation	T_C = 25°C	–	–	20	mW
$B_{25/50}$	B−Value	R = R_{25} exp [$B_{25/50}$ (1/T−1/298)]	–	3375	–	K
$B_{25/80}$	B−Value	R = R_{25} exp [$B_{25/80}$ (1/T−1/298)]	–	3411	–	K
$B_{25/100}$	B−Value	R = R_{25} exp [$B_{25/100}$ (1/T−1/298)]	–	3433	–	K

THERMAL CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Unit
IGBT.$R_{th,J-F}$	Rth, Junction to Fluid, 10 L/min, 65°C, 50/50 EGW	–	0.083	0.10	°C/W
Diode.$R_{th,J-F}$	Rth, Junction to Fluid, 10 L/min, 65°C, 50/50 EGW	–	0.13	0.16	°C/W

ORDERING INFORMATION

Part Number	Package	Shipping
NVH950S75L4SPB	SSDC33, 154.50x92.0 (SPB) (Pb−Free)	4 Units / Tray

TYPICAL CHARACTERISTICS

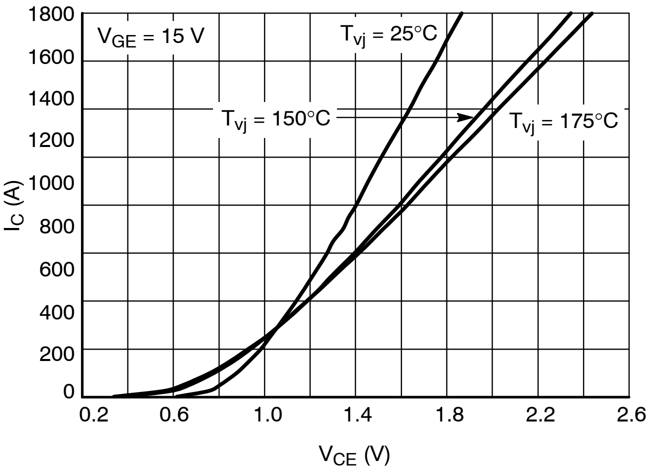


Figure 2. IGBT Output Characteristic

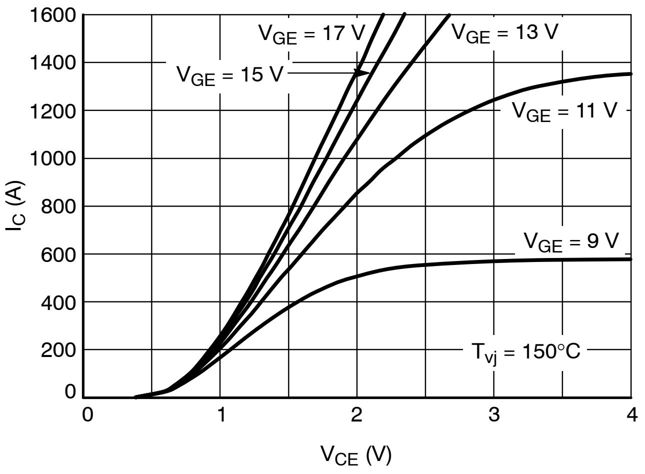


Figure 3. IGBT Output Characteristic

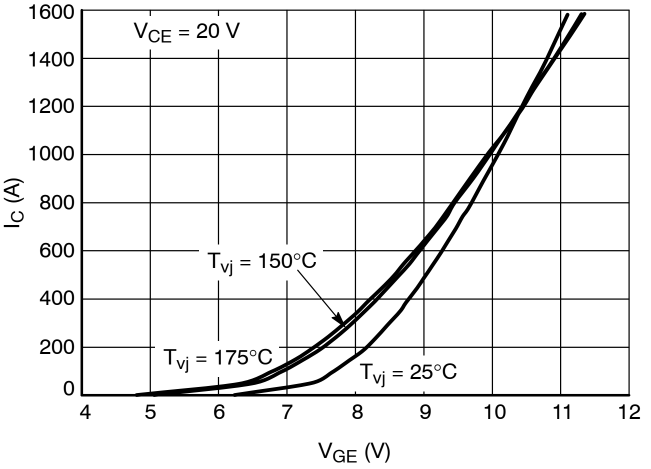


Figure 4. IGBT Transfer Characteristic

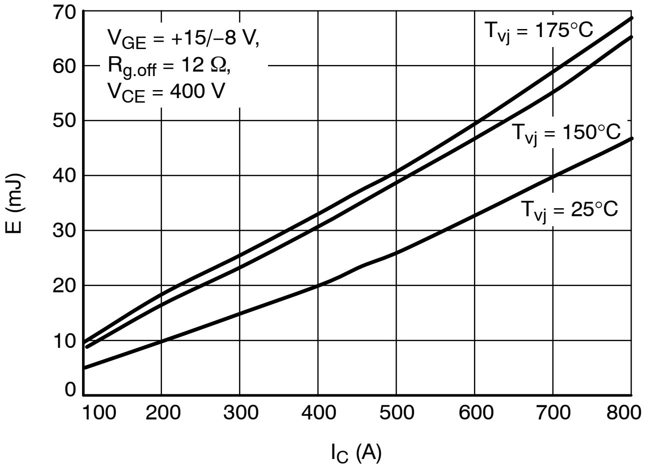


Figure 5. IGBT Turn−off Losses vs. I_C

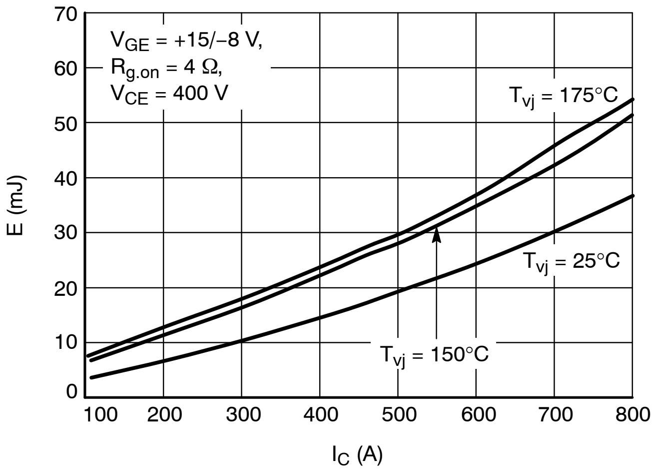


Figure 6. IGBT Turn−on Losses vs. I_C

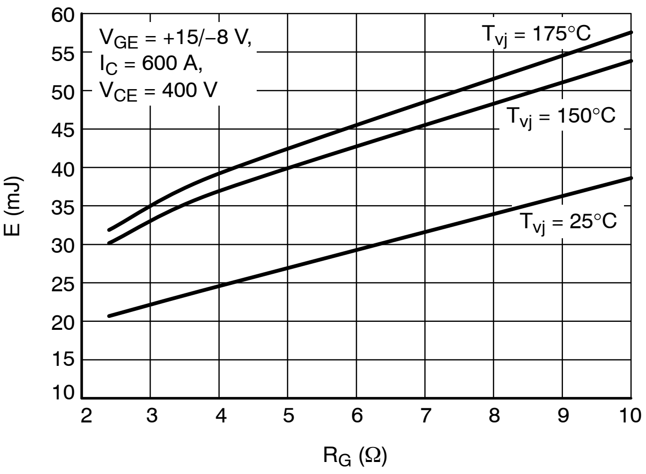


Figure 7. E_{ON} vs. R_G

TYPICAL CHARACTERISTICS

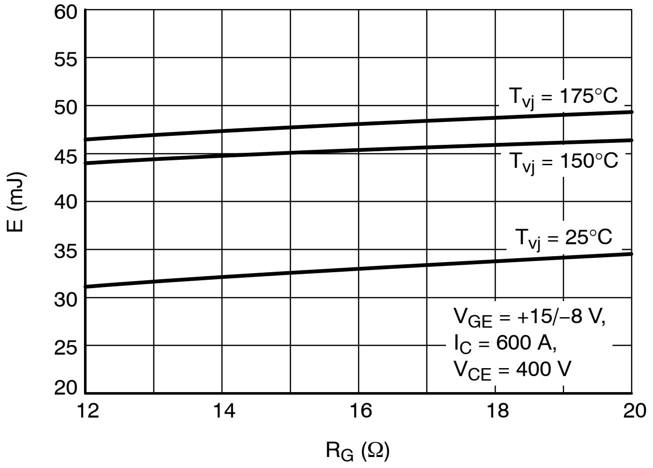


Figure 8. E_{OFF} vs. R_G

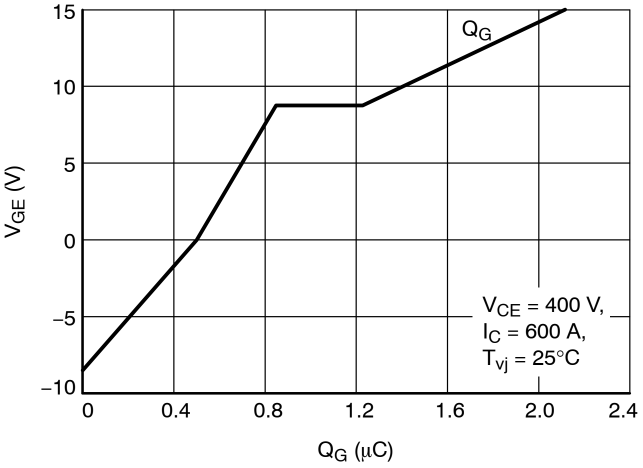


Figure 9. Gate Charge Characteristic

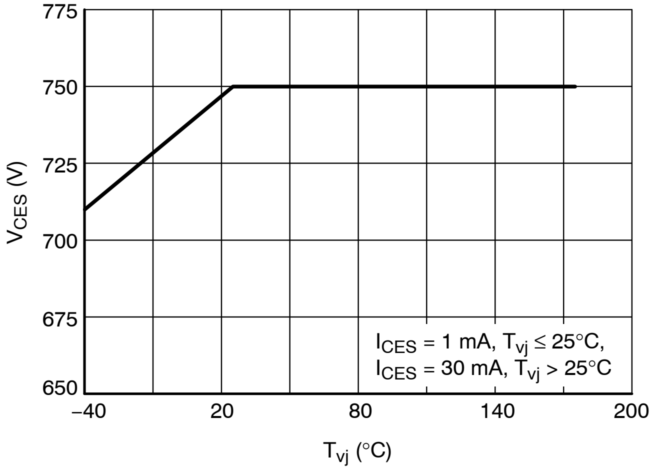


Figure 10. Maximum Allowed V_{CE}

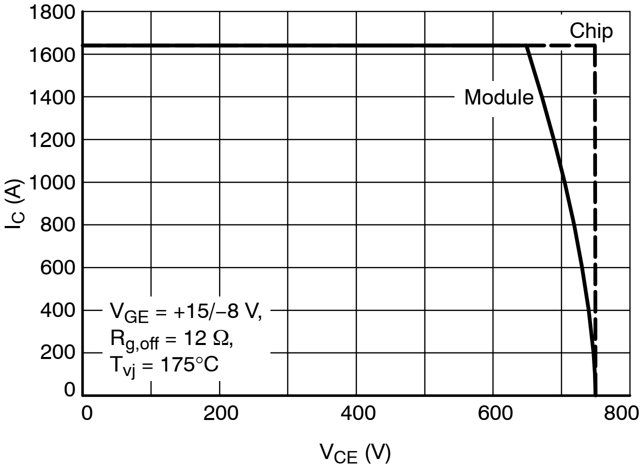


Figure 11. Reverse Bias Safe Operating Area

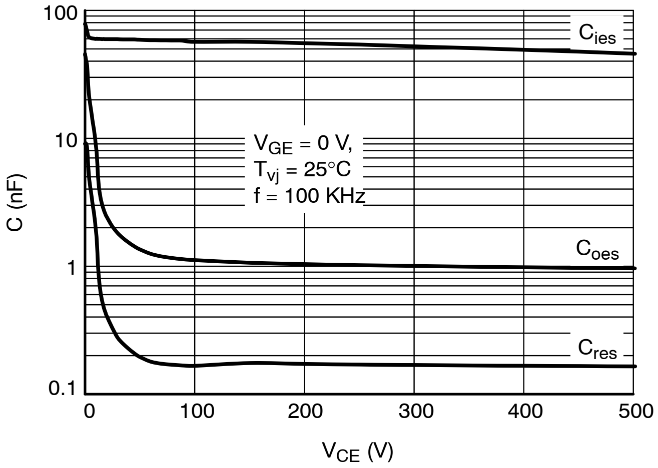


Figure 12. Capacitance Characteristic

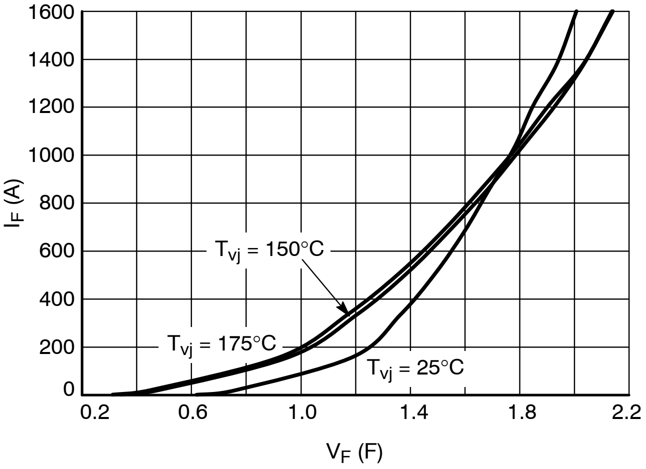


Figure 13. Diode Forward Characteristic

TYPICAL CHARACTERISTICS

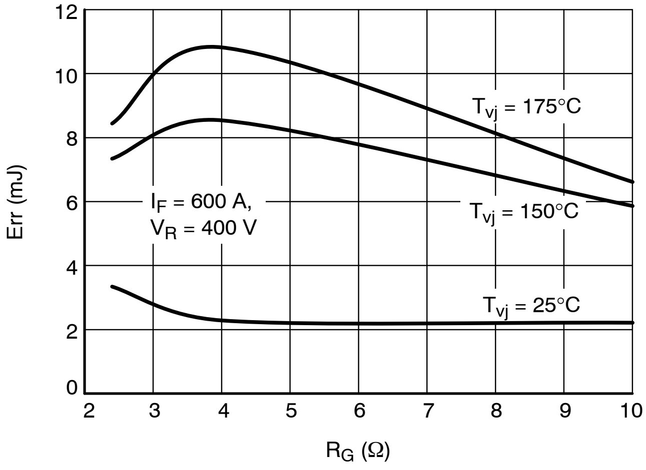


Figure 14. Diode Switching Losses vs. R_G

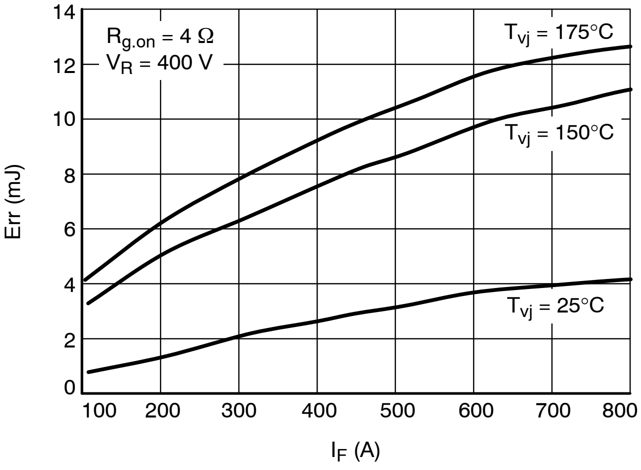
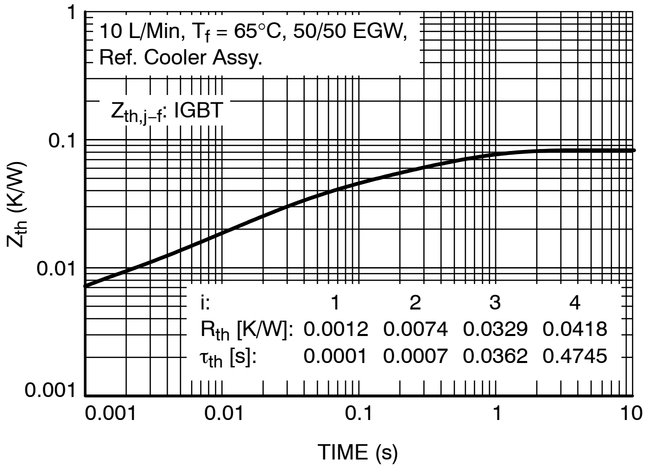
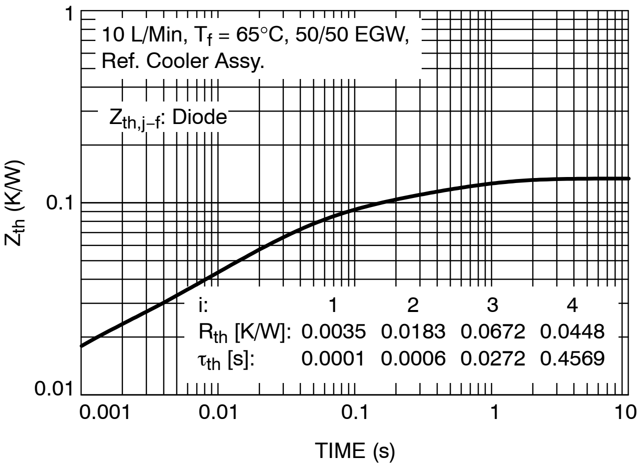


Figure 15. Diode Switching Losses vs. I_F



i:	1	2	3	4
R_{th} [K/W]:	0.0012	0.0074	0.0329	0.0418
τ_{th} [s]:	0.0001	0.0007	0.0362	0.4745

Figure 16. IGBT Transient Thermal Impedance (Typ.)



i:	1	2	3	4
R_{th} [K/W]:	0.0035	0.0183	0.0672	0.0448
τ_{th} [s]:	0.0001	0.0006	0.0272	0.4569

Figure 17. Diode Transient Thermal Impedance (Typ.)

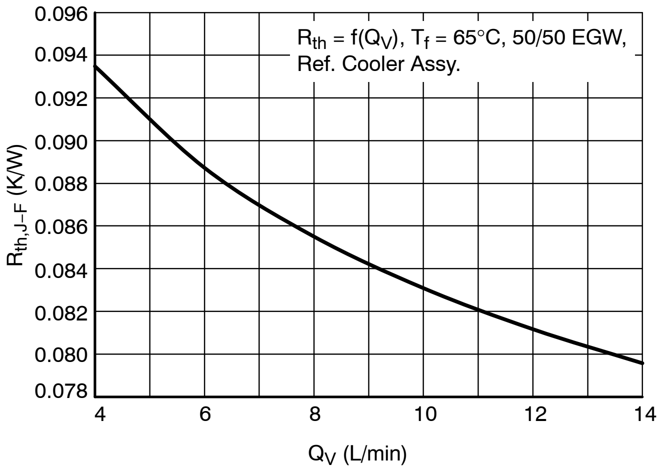


Figure 18. IGBT, Thermal Resistance (Typ.)

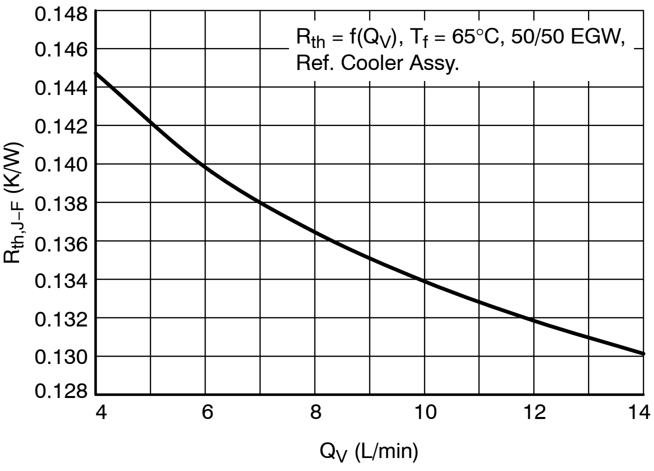


Figure 19. Diode, Thermal Resistance (Typ.)

TYPICAL CHARACTERISTICS

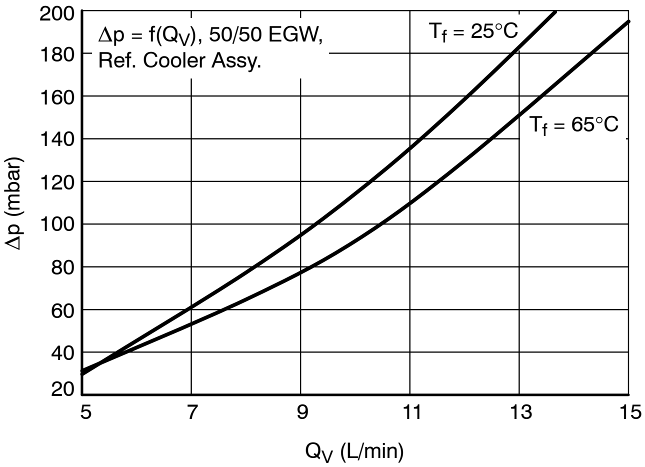


Figure 20. Pressure Drop in Cooling Circuit

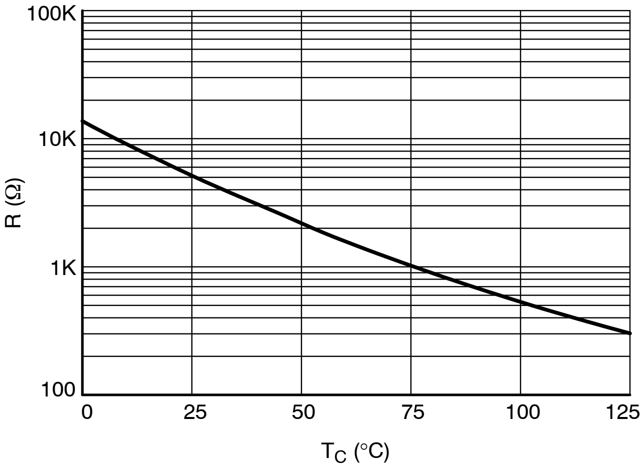


Figure 21. NTC Thermistor − Temperature Characteristic (Typ.)

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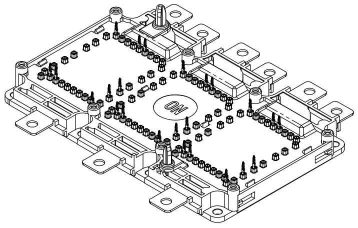
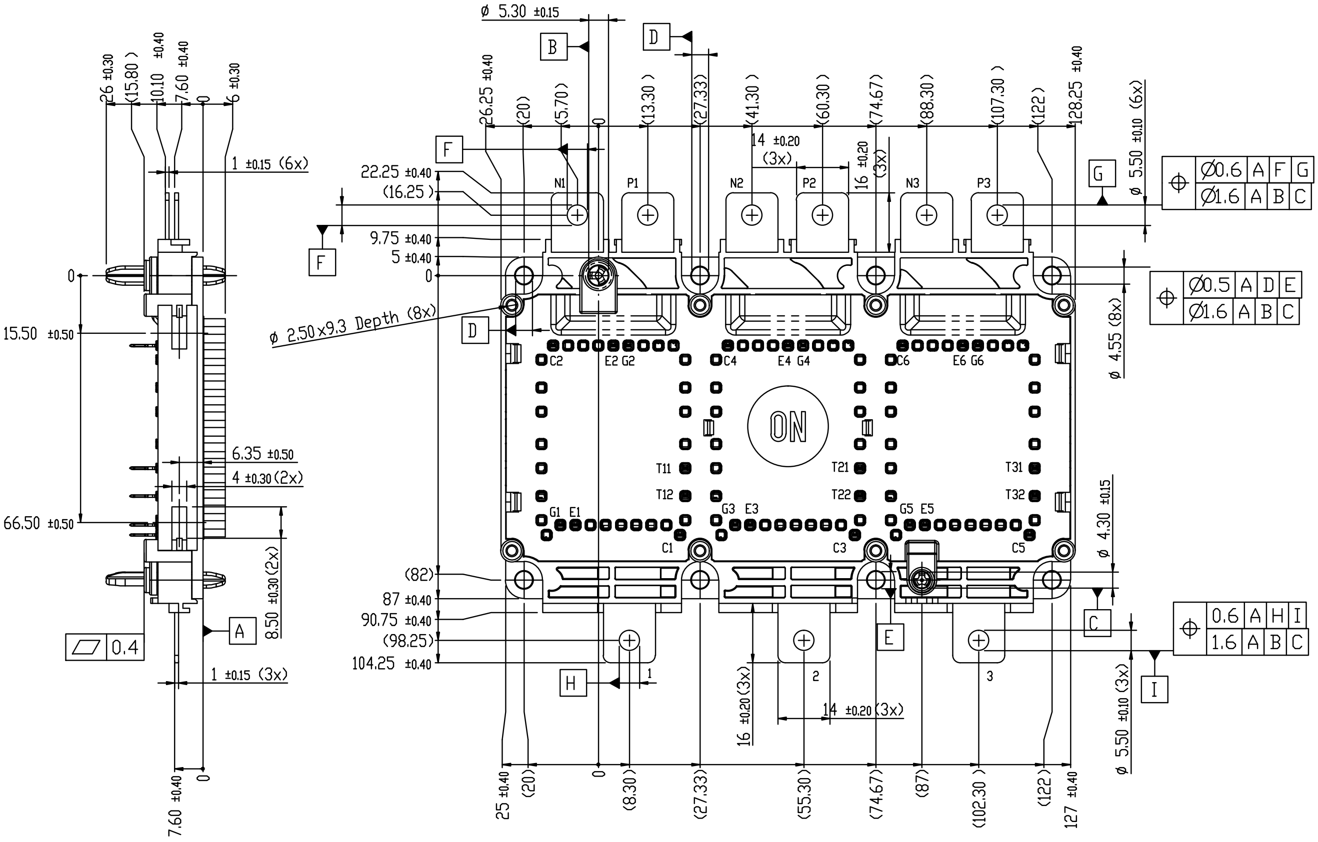


SSDC33, 154.50x92.0 (SPB)
CASE 183AB
ISSUE A

DATE 05 DEC 2019



GENERIC
MARKING DIAGRAM*

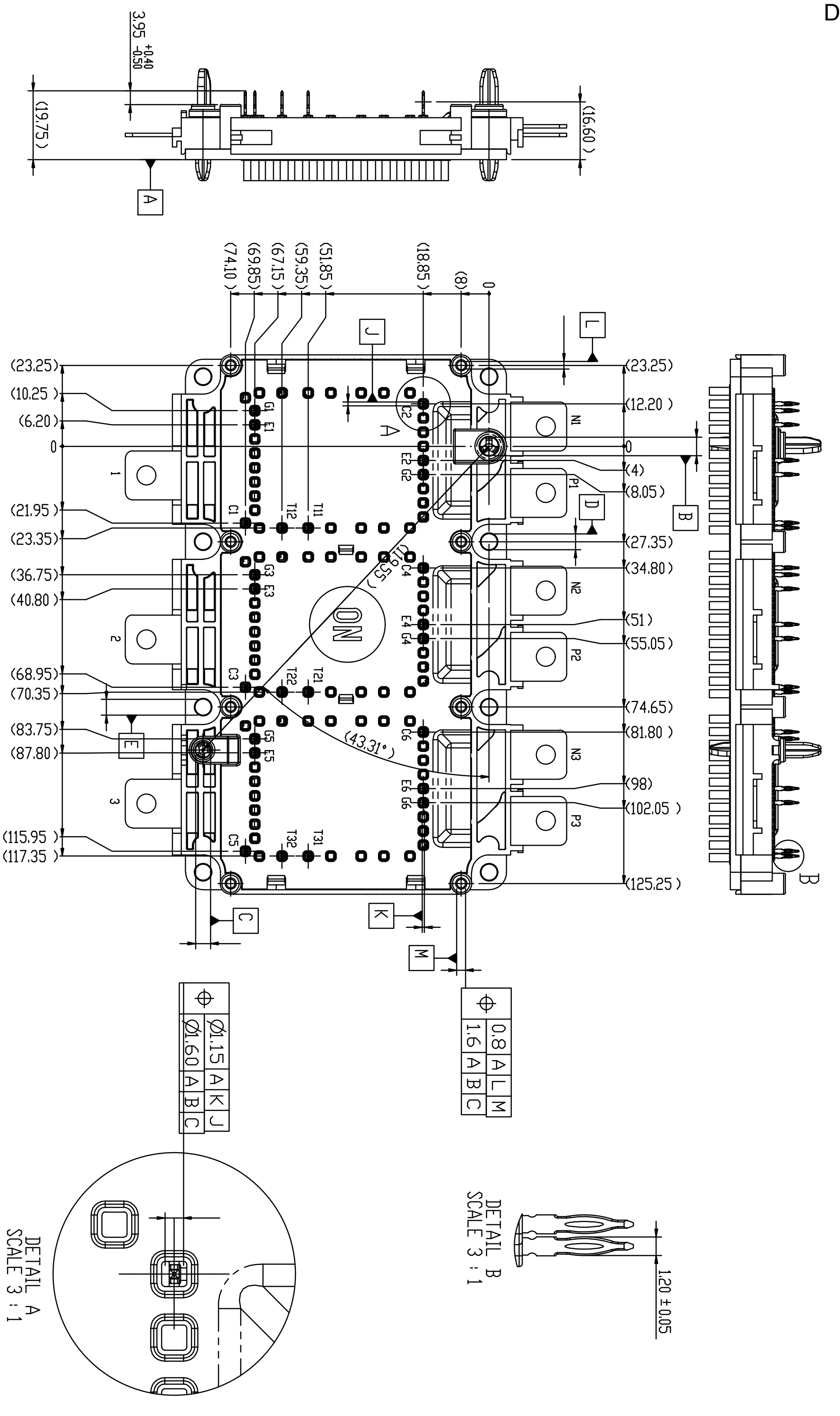
XXXXXXXXXXXXXXXXXXXXXXG
ATYYWW

XXXXX = Specific Device Code
G = Pb−Free Package
AT = Assembly & Test Site Code
YYWW= Year and Work Week 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.

SSDC33, 154.50x92.0 (SPB)
CASE 183AB
ISSUE A

DATE 05 DEC 2019



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