

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

VE-Tract[™] Direct Module

NVH950S75L4SPC

Product Description

The NVH950S75L4SPC is a power module from the VE-Tract[™] 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.

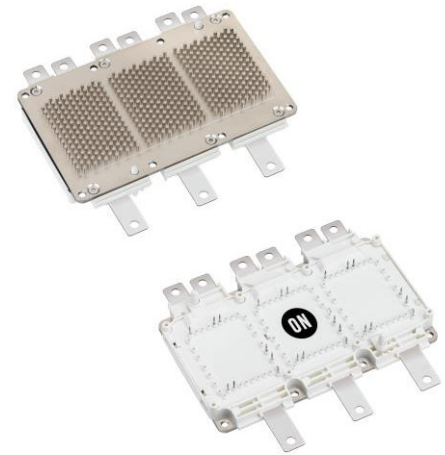
For assembly ease and reliability, a new generation of press-fit pins are integrated into the power module signal terminals. In addition, the power module has an optimized pin-fin heatsink in the baseplate and longer power terminals to easily integrate an external current sensor.

Features

- Direct Cooling w/ Integrated Pin-fin Heatsink
- Ultra-low Stray Inductance
- $T_{vjmax} = 175^{\circ}\text{C}$ 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

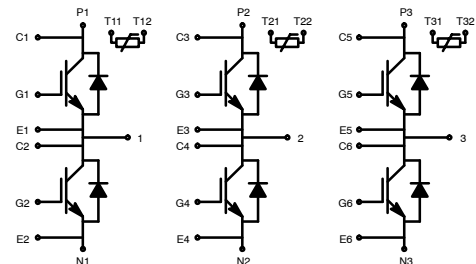


**SSDC33, 154.50x92.0 (SPC)
CASE 183AC**

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.

NVH950S75L4SPC

Pin Description

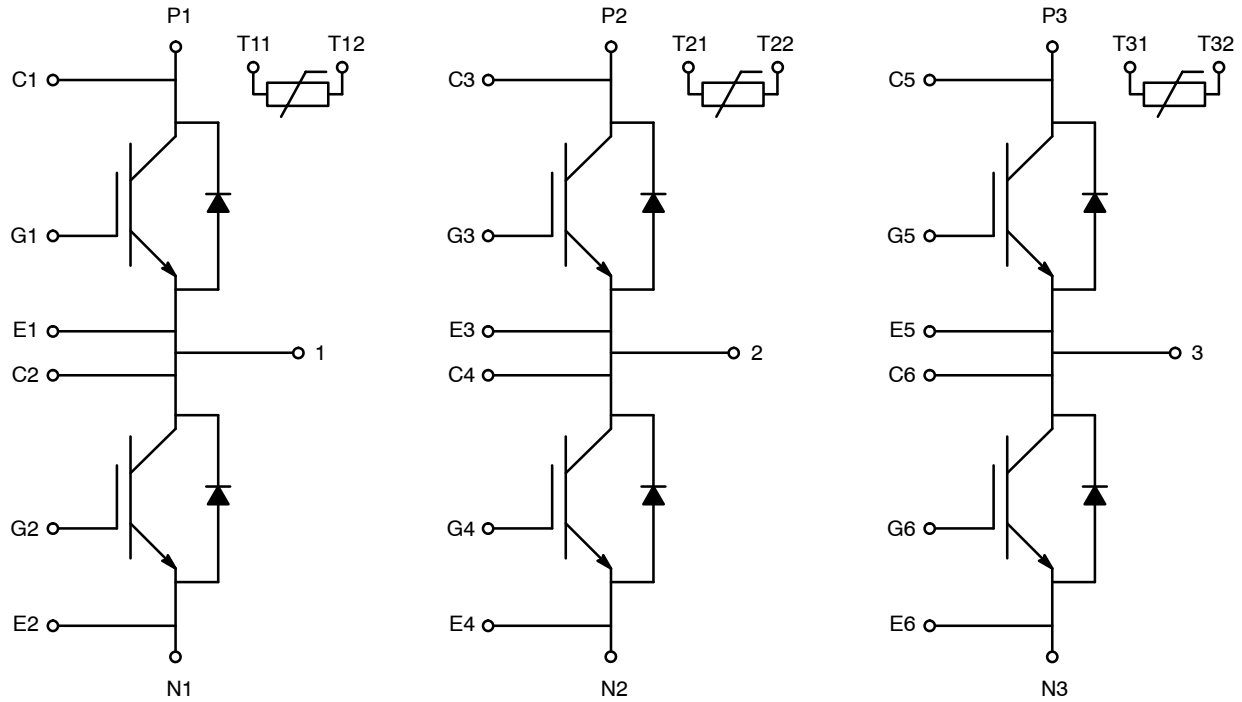


Figure 1. Pin Description

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.

NVH950S75L4SPC

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
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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	1325	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 ² t value	Surge Current Capability, t _p = 10 mS, T _{vj} = 150°C T _{vj} = 175°C	19000 16000	A²s

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.

NVH950S75L4SPC

CHARACTERISTICS OF IGBT ($T_{vj} = 25^{\circ}\text{C}$, Unless Otherwise Specified)

Symbol	Parameters	Conditions		Min	Typ	Max	Unit
V_{CESAT}	Collector to Emitter Saturation Voltage (Terminal)	$V_{GE} = 15\text{ V}$, $I_C = 600\text{ A}$	$T_{vj} = 25^{\circ}\text{C}$	–	1.30	1.55	V
	Collector to Emitter Saturation Voltage (Chip)	$V_{GE} = 15\text{ V}$, $I_C = 600\text{ A}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	– – –	1.25 1.37 1.40	1.50 – –	
			$V_{GE} = 15\text{ V}$, $I_C = 950\text{ A}$	– – –	1.47 1.71 1.77	– – –	
I_{CES}	Collector to Emitter Leakage Current	$V_{GE} = 0$, $V_{CE} = 750\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	– –	– 2.0	500 –	μA mA
I_{GES}	Gate – Emitter Leakage Current	$V_{CE} = 0$, $V_{GE} = \pm 20\text{ V}$		–	–	± 300	nA
V_{th}	Threshold Voltage	$V_{CE} = V_{GE}$, $I_C = 90\text{ mA}$		4.8	5.7	6.6	V
Q_G	Total Gate Charge	$V_{GE} = -8\text{ to }15\text{ V}$, $V_{CE} = 400\text{ V}$		–	2.3	–	μC
R_{Gint}	Internal Gate Resistance			–	1.7	–	Ω
C_{ies}	Input Capacitance	$V_{CE} = 30\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 100\text{ kHz}$		–	60	–	nF
C_{oes}	Output Capacitance	$V_{CE} = 30\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 100\text{ kHz}$		–	1.90	–	nF
C_{res}	Reverse Transfer Capacitance	$V_{CE} = 30\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 100\text{ kHz}$		–	0.2	–	nF
$T_{d,on}$	Turn On Delay, Inductive Load	$I_C = 600\text{ A}$, $V_{CE} = 400\text{ V}$, $V_{GE} = +15/-8\text{ V}$, $R_{g,on} = 4\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	– – –	315 320 322	– – –	nS
T_r	Rise Time, Inductive Load	$I_C = 600\text{ A}$, $V_{CE} = 400\text{ V}$, $V_{GE} = +15/-8\text{ V}$, $R_{g,on} = 4\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	– – –	108 127 132	– – –	nS
$T_{d,off}$	Turn Off Delay, Inductive Load	$I_C = 600\text{ A}$, $V_{CE} = 400\text{ V}$, $V_{GE} = +15/-8\text{ V}$, $R_{g,off} = 12\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	– – –	1063 1196 1203	– – –	nS
T_f	Fall Time, Inductive Load	$I_C = 600\text{ A}$, $V_{CE} = 400\text{ V}$, $V_{GE} = +15/-8\text{ V}$, $R_{g,off} = 12\text{ }\Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	– – –	85 144 151	– – –	nS
E_{ON}	Turn-On Switching Loss (Including Diode Reverse Recovery Loss)	$I_C = 600\text{ A}$, $V_{CE} = 400\text{ V}$, $V_{GE} = +15/-8\text{ V}$, $L_s = 22\text{ nH}$, $R_{g,on} = 4\text{ }\Omega$	$di/dt = 4.6\text{ A/nS}$, $T_{vj} = 25^{\circ}\text{C}$ $di/dt = 3.9\text{ A/nS}$, $T_{vj} = 150^{\circ}\text{C}$ $di/dt = 3.6\text{ A/nS}$, $T_{vj} = 175^{\circ}\text{C}$	– – –	26 36 38	– – –	mJ
E_{OFF}	Turn-Off Switching Loss	$I_C = 600\text{ A}$, $V_{CE} = 400\text{ V}$, $V_{GE} = +15/-8\text{ V}$, $L_s = 22\text{ nH}$, $R_{g,off} = 12\text{ }\Omega$	$dv/dt = 2.7\text{ V/nS}$, $T_{vj} = 25^{\circ}\text{C}$ $dv/dt = 1.9\text{ V/nS}$, $T_{vj} = 150^{\circ}\text{C}$ $dv/dt = 1.9\text{ V/nS}$, $T_{vj} = 175^{\circ}\text{C}$	– – –	33 46 50	– – –	mJ
E_{SC}	Minimum Short Circuit Energy Withstand	$V_{GE} = 15\text{ V}$, $V_{CC} = 400\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	9 4.5	–	–	J

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CHARACTERISTICS OF INVERSE DIODE ($T_{vj} = 25^{\circ}\text{C}$, Unless Otherwise Specified)

Symbol	Parameters	Conditions		Min	Typ	Max	Unit
V_F	Diode Forward Voltage (Terminal)	$I_F = 600\text{ A}$	$T_{vj} = 25^{\circ}\text{C}$	–	1.70	1.95	V
	Diode Forward Voltage (Chip)	$I_F = 600\text{ A}$	$T_{vj} = 25^{\circ}\text{C}$	–	1.60	1.85	
			$T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	– –	1.55 1.50	– –	
		$I_F = 950\text{ A}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	– – –	1.73 1.75 1.74	– – –	
E_{rr}	Reverse Recovery Energy	$I_F = 600\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = -8\text{ V}$, $R_{g.on} = 4\ \Omega$	$di/dt = 3.5\text{ A/nS}$, $T_{vj} = 25^{\circ}\text{C}$ $di/dt = 3.0\text{ A/nS}$, $T_{vj} = 150^{\circ}\text{C}$ $di/dt = 2.9\text{ A/nS}$, $T_{vj} = 175^{\circ}\text{C}$	– – –	3 9 11	– – –	mJ
Q_{RR}	Recovered Charge	$I_F = 600\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = -8\text{ V}$, $R_{g.on} = 4\ \Omega$	$di/dt = 3.5\text{ A/nS}$, $T_{vj} = 25^{\circ}\text{C}$ $di/dt = 3.0\text{ A/nS}$, $T_{vj} = 150^{\circ}\text{C}$ $di/dt = 2.9\text{ A/nS}$, $T_{vj} = 175^{\circ}\text{C}$	– – –	9 32 39	– – –	μC
I_{rr}	Peak Reverse Recovery Current	$I_F = 600\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = -8\text{ V}$, $R_{g.on} = 4\ \Omega$	$di/dt = 3.5\text{ A/nS}$, $T_{vj} = 25^{\circ}\text{C}$ $di/dt = 3.0\text{ A/nS}$, $T_{vj} = 150^{\circ}\text{C}$ $di/dt = 2.9\text{ A/nS}$, $T_{vj} = 175^{\circ}\text{C}$	– – –	133 246 282	– – –	A

NTC SENSOR CHARACTERISTICS ($T_{vj} = 25^{\circ}\text{C}$, Unless Otherwise Specified)

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
R_{25} (Note 3)	Rated Resistance	$T_C = 25^{\circ}\text{C}$	–	5	–	$\text{k}\Omega$
$\Delta R/R$	Deviation of R_{100}	$T_C = 100^{\circ}\text{C}$, $R_{100} = 493\ \Omega$	5	–	5	%
P_{25}	Power Dissipation	$T_C = 25^{\circ}\text{C}$	–	–	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	$R = R_{25} \exp [B_{25/80} (1/T - 1/298)]$	–	3360	–	K
$B_{25/100}$	B-Value	$R = R_{25} \exp [B_{25/100} (1/T - 1/298)]$	–	3364	–	K

THERMAL CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Unit
$IGBT.R_{th,J-F}$	R_{th} , Junction to Fluid, 10 L/min, 65°C , 50/50 EGW	–	0.083	0.10	$^{\circ}\text{C/W}$
$Diode.R_{th,J-F}$	R_{th} , Junction to Fluid, 10 L/min, 65°C , 50/50 EGW	–	0.134	0.16	$^{\circ}\text{C/W}$

ORDERING INFORMATION

Part Number	Package	Shipping
NVH950S75L4SPC	SSDC33, 154.50x92.0 (SPC) (Pb-Free)	4 Units / Tray

TYPICAL CHARACTERISTICS

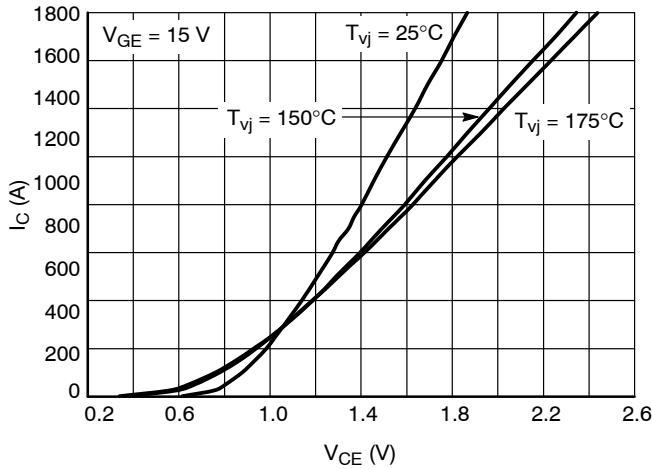


Figure 2. IGBT Output Characteristic

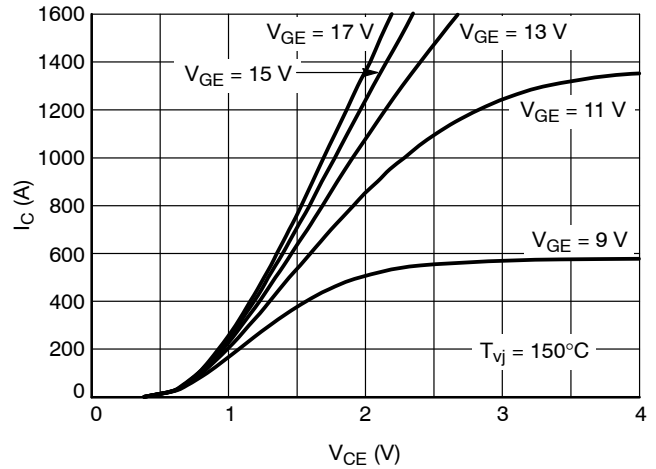


Figure 3. IGBT Output Characteristic

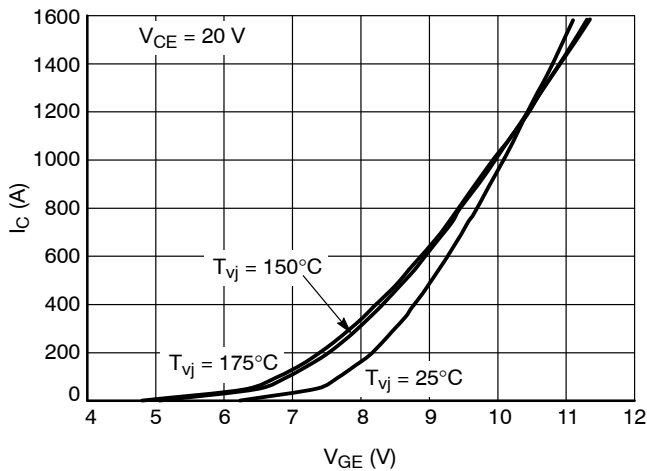


Figure 4. IGBT Transfer Characteristic

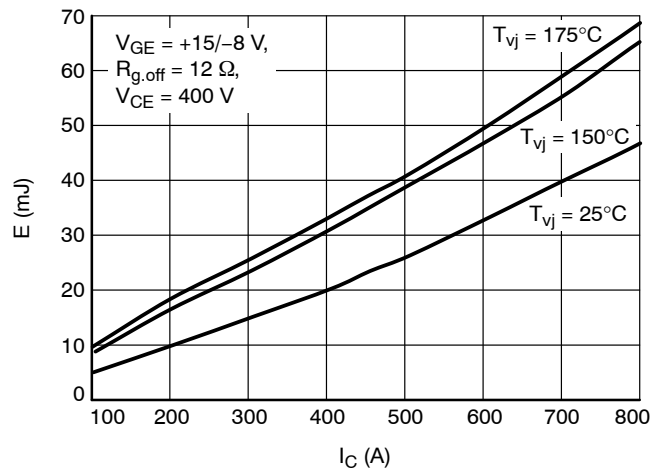


Figure 5. IGBT Turn-off Losses vs. I_C

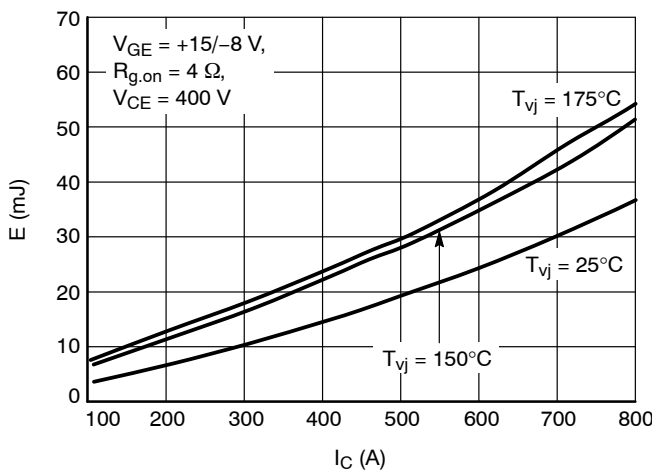


Figure 6. IGBT Turn-on Losses vs. I_C

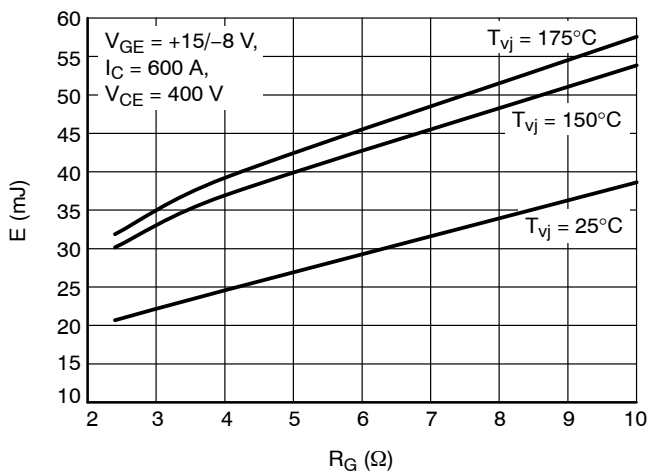


Figure 7. E_{ON} vs. R_G

TYPICAL CHARACTERISTICS

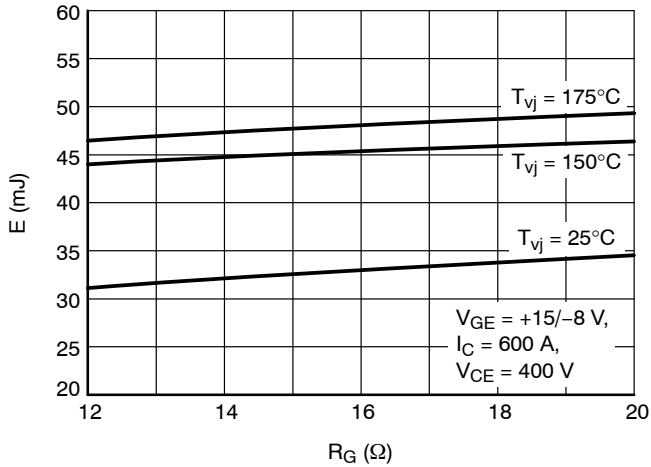


Figure 8. E_{OFF} vs. R_G

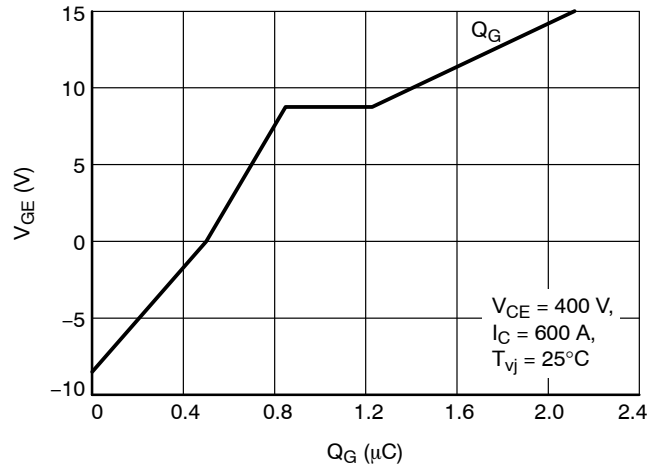


Figure 9. Gate Charge Characteristic

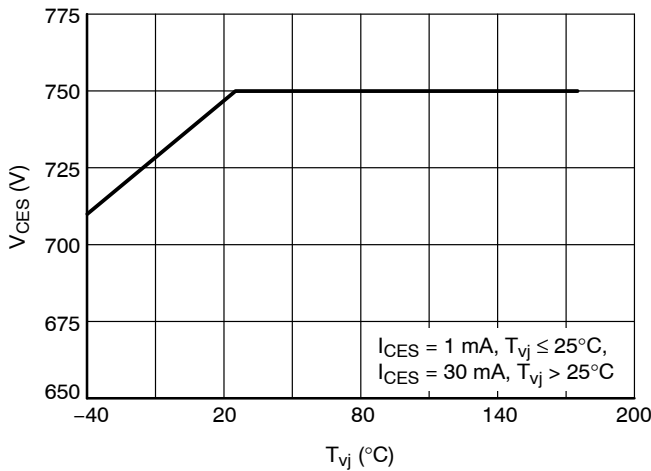


Figure 10. Maximum Allowed V_{CE}

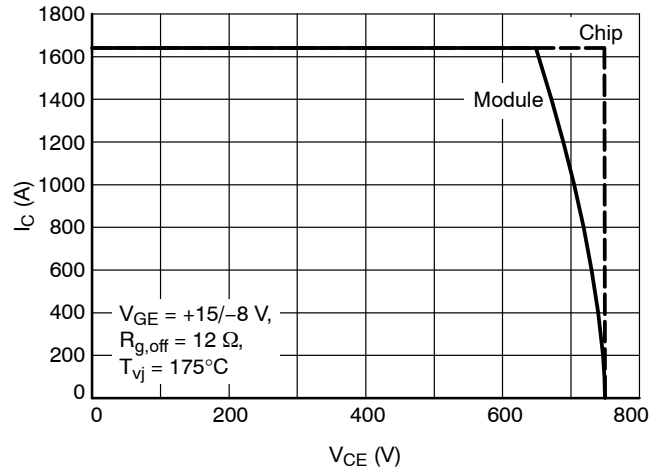


Figure 11. Reverse Bias Safe Operating Area

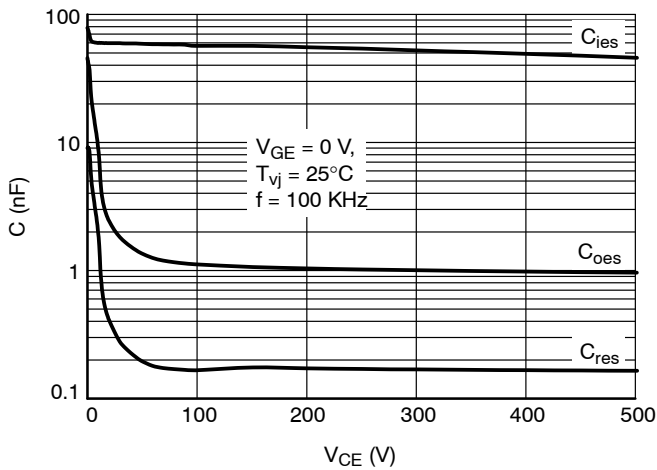


Figure 12. Capacitance Characteristic

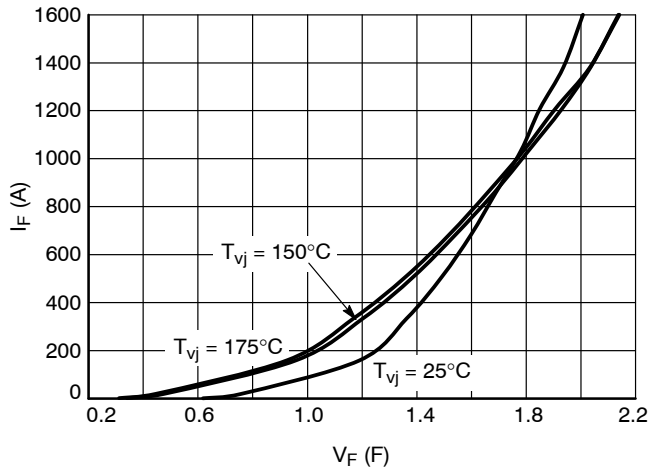


Figure 13. Diode Forward Characteristic

TYPICAL CHARACTERISTICS

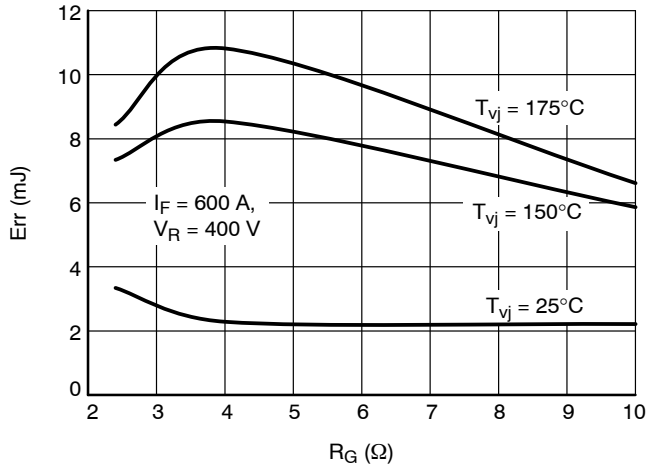


Figure 14. Diode Switching Losses vs. R_G

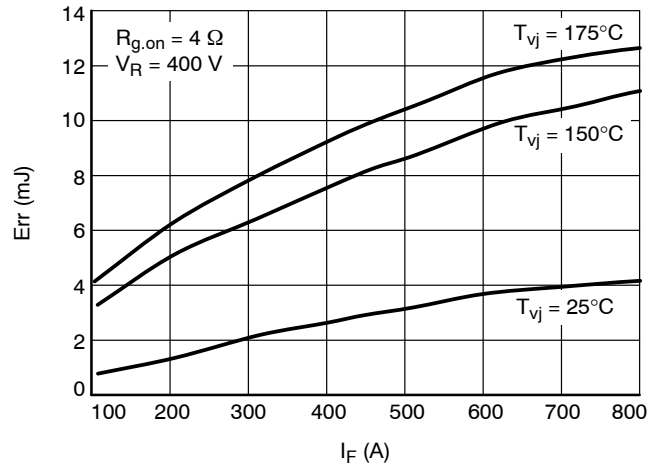


Figure 15. Diode Switching Losses vs. I_F

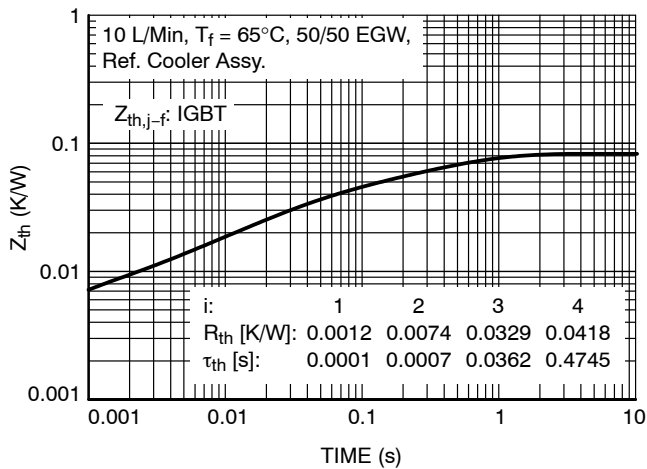


Figure 16. IGBT Transient Thermal Impedance (Typ.)

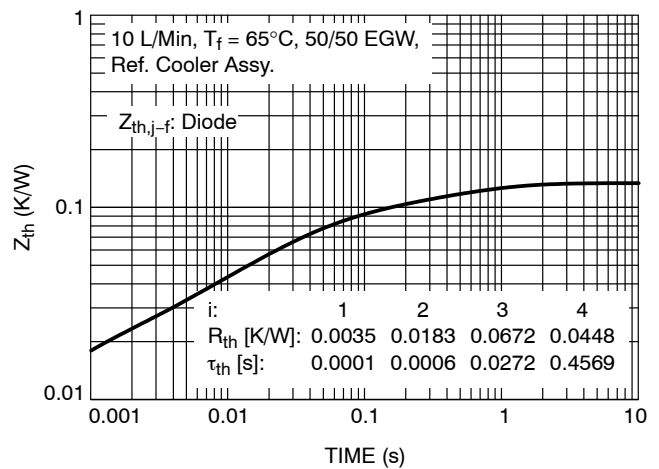


Figure 17. Diode Transient Thermal Impedance (Typ.)

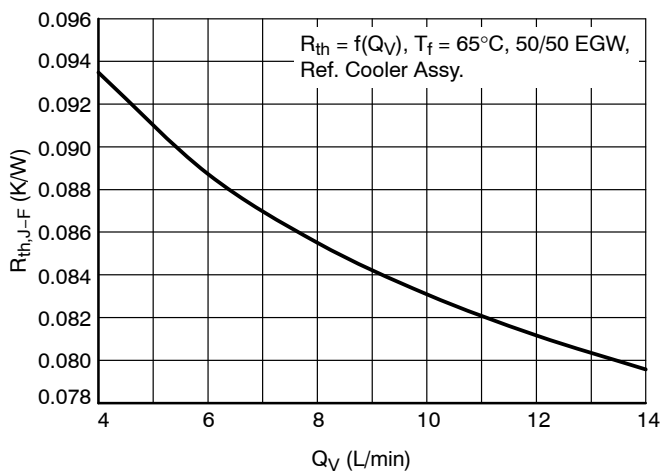


Figure 18. IGBT, Thermal Resistance (Typ.)

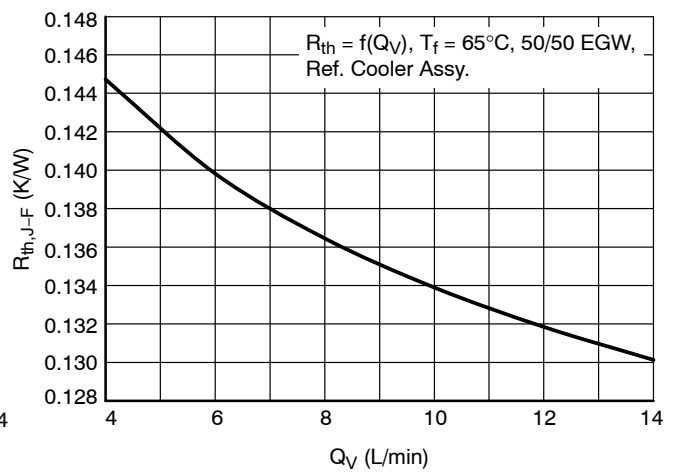


Figure 19. Diode, Thermal Resistance (Typ.)

TYPICAL CHARACTERISTICS

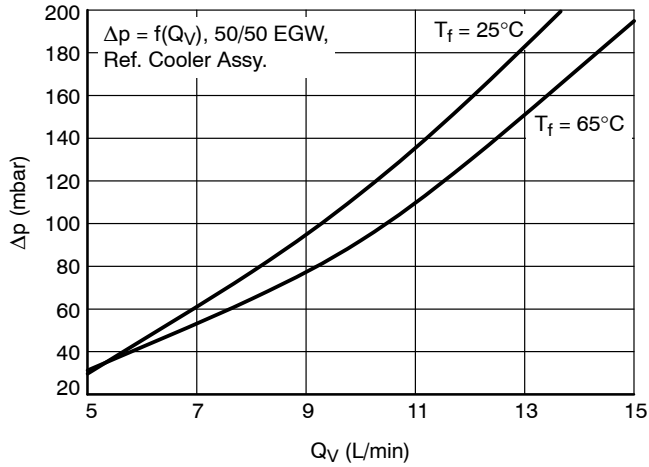


Figure 20. Pressure Drop in Cooling Circuit

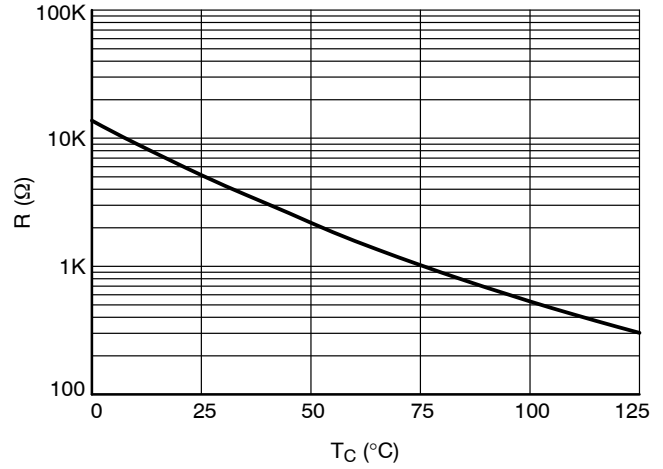
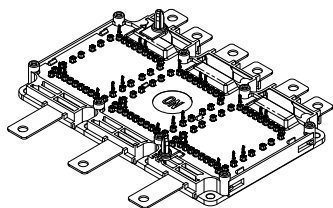
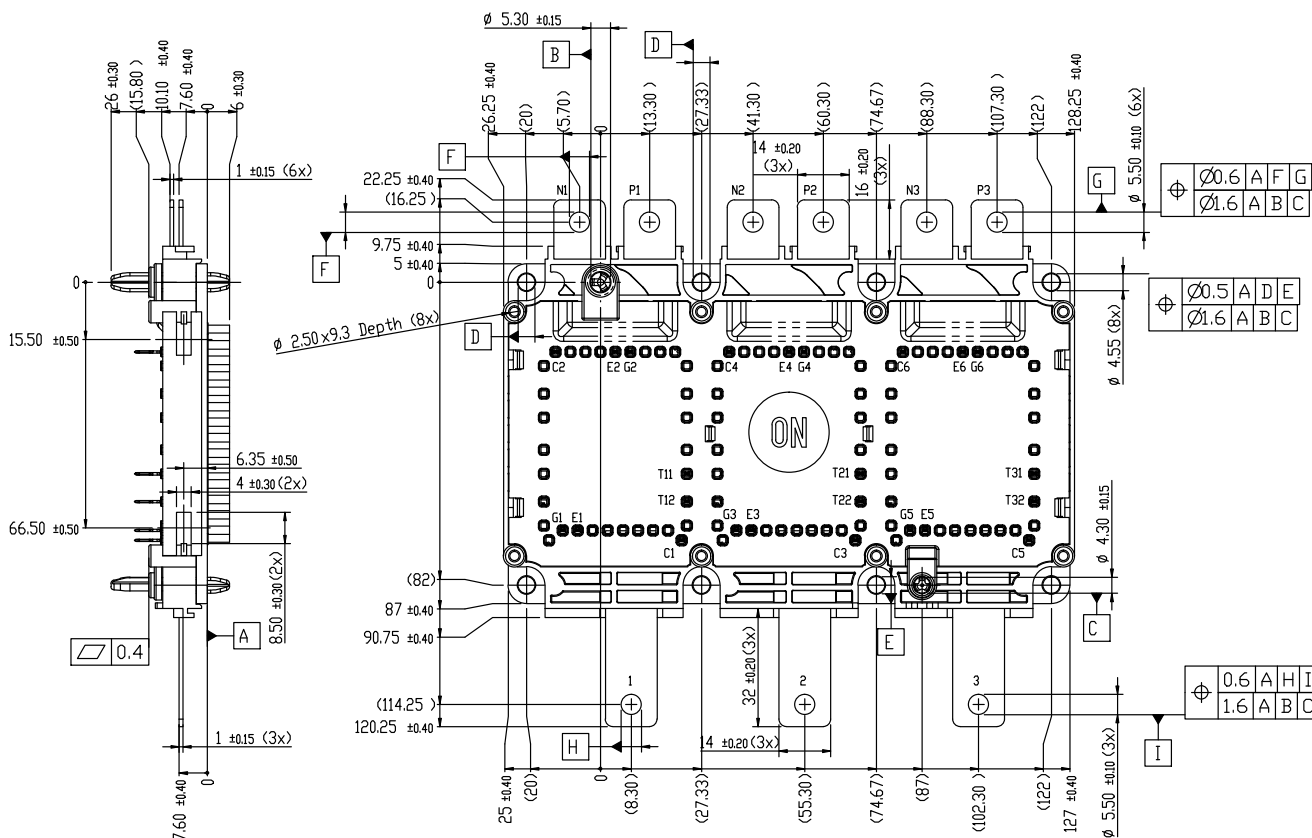


Figure 21. NTC Thermistor – Temperature Characteristic (Typical)



SSDC33, 154.50x92.0 (SPC)
CASE 183AC
ISSUE A

DATE 11 DEC 2019



GENERIC
MARKING DIAGRAM*

XXXXXXXXXXXXXXXXXXXXG
ATYYWW

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

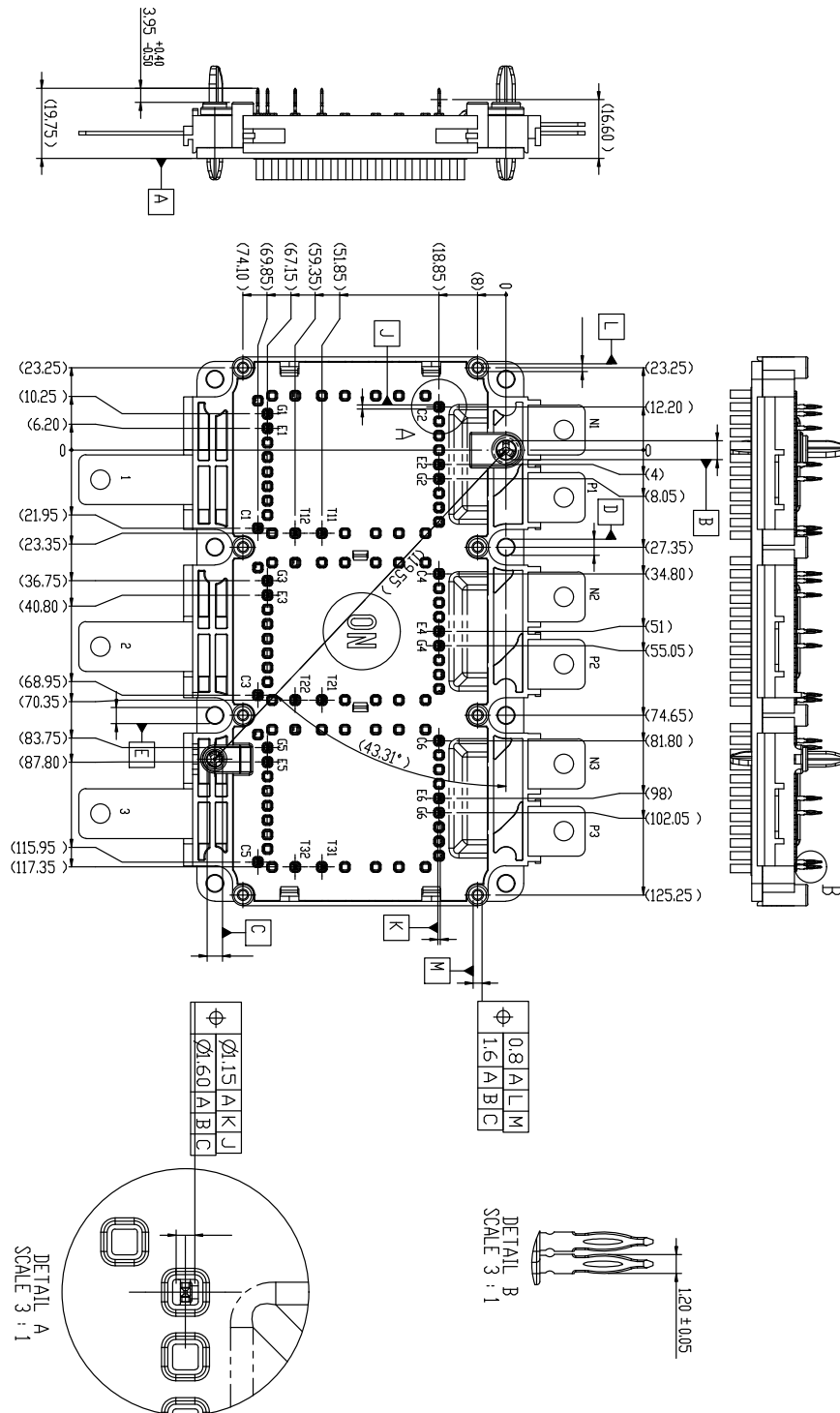
*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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SSDC33, 154.50x92.0 (SPC)
CASE 183AC
ISSUE A

DATE 11 DEC 2019



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ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

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