onsemi

<u>Si/SiC Hybrid Module</u> – EliteSiC, I-Type NPC 1000 V, 350 A IGBT, 1200 V, 100 A SiC Diode, Q2 Package

NXH350N100H4Q2F2

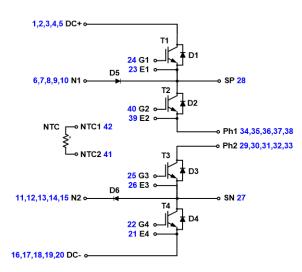
This high-density, integrated power module combines high-performance IGBTs with rugged anti-parallel diodes.

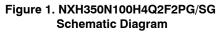
Features

- Extremely Efficient Trench with Field Stop Technology
- Low Switching Loss Reduces System Power Dissipation
- Module Design Offers High Power Density
- Low Inductive Layout
- Low Package Height
- These Devices are Pb–Free, Halogen Free/BFR Free and are RoHS Compliant

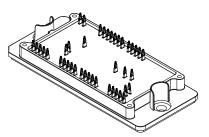
Typical Applications

- Solar Inverters
- Uninterruptable Power Supplies Systems

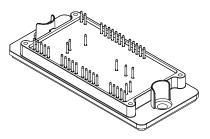








Q2PACK INPC PRESS FIT PINS CASE 180BH



Q2PACK INPC SOLDER PINS CASE 180BS

MARKING DIAGRAM



AT = Assembly & Test Site Code

YYWW = Year and Work Week Code

PIN CONNECTIONS

See details pin connections on page 2 of this data sheet.

ORDERING INFORMATION

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

PIN CONNECTIONS

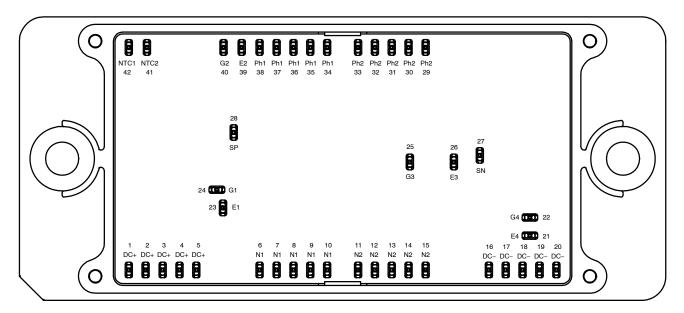


Figure 2. Pin Connections

ABSOLUTE MAXIMUM RATINGS ($T_J = 25^{\circ}C$ unless otherwise noted)

Rating	Symbol	Value	Unit
OUTER IGBT (T1, T4)	•		•
Collector-Emitter Voltage	V _{CES}	1000	V
Gate-Emitter Voltage Positive transient gate-emitter voltage (T _{pulse} = 5 μs, D < 0.10)	V _{GE}	±20 30	V
Continuous Collector Current @ T _C = 80°C	Ι _C	303	А
Pulsed Peak Collector Current @ $T_C = 80^{\circ}C (T_J = 150^{\circ}C)$	I _{C(Pulse)}	909	А
Maximum Power Dissipation ($T_J = 150^{\circ}C$)	P _{tot}	592	W
Minimum Operating Junction Temperature	T _{JMIN}	-40	°C
Maximum Operating Junction Temperature	T _{JMAX}	175	°C
INNER IGBT (T2, T3)			
Collector-Emitter Voltage	V _{CES}	1000	V
Gate-Emitter Voltage Positive transient gate-emitter voltage (T_{pulse} = 5 µs, D < 0.10)	V _{GE}	±20 30	V
Continuous Collector Current @ $T_C = 80^{\circ}C$	Ι _C	329	А
Pulsed Peak Collector Current @ $T_C = 80^{\circ}C (T_J = 150^{\circ}C)$	I _{C(Pulse)}	987	А
Maximum Power Dissipation (T _J = 175°C)	P _{tot}	532	W
Minimum Operating Junction Temperature	T _{JMIN}	-40	°C
Maximum Operating Junction Temperature	T _{JMAX}	175	°C
IGBT INVERSE DIODE (D1, D2, D3, D4)			
Peak Repetitive Reverse Voltage	V _{RRM}	1000	V
Continuous Forward Current @ $T_C = 80^{\circ}C$	l _F	133	А
Repetitive Peak Forward Current (T _J = 175°C)	I _{FRM}	399	А
Maximum Power Dissipation (T _J = 175°C)	P _{tot}	276	W

ABSOLUTE MAXIMUM RATINGS (T,I = 25°C unless otherwise noted) (continued)

Rating	Symbol	Value	Unit
IGBT INVERSE DIODE (D1, D2, D3, D4)			
Minimum Operating Junction Temperature	T _{JMIN}	-40	°C
Maximum Operating Junction Temperature	T _{JMAX}	175	°C
NEUTRAL POINT DIODE (D5, D6)			
Peak Repetitive Reverse Voltage	V _{RRM}	1200	V
Continuous Forward Current @ $T_C = 80^{\circ}C$	l _F	98	А
Repetitive Peak Forward Current (T _J = 175°C)	I _{FRM}	294	А
Maximum Power Dissipation ($T_J = 175^{\circ}C$)	P _{tot}	239	W
Minimum Operating Junction Temperature	T _{JMIN}	-40	°C
Maximum Operating Junction Temperature	T _{JMAX}	175	°C
THERMAL PROPERTIES			
Operating Temperature under Switching Condition	T _{VJOP}	-40 to +150	°C
Storage Temperature Range	T _{stg}	-40 to +125	°C
INSULATION PROPERTIES			
Isolation Test Voltage, t = 2 s, 50 Hz (Note 2)	V _{is}	4000	V _{RMS}
Creepage Distance		12.7	mm
Comparative Tracking Index	CTI	> 600	

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. Refer to <u>ELECTRICAL CHARACTERISTICS</u> and/or APPLICATION INFORMATION for Safe Operating parameters.

2. 4000 VAC_{RMS} for 1 second duration is equivalent to 3333 VAC_{RMS} for 1 minute duration.

ELECTRICAL CHARACTERISTICS (T_J = 25° C unless otherwise specified)

Characteristic	Test Conditions	Symbol	Min	Тур	Мах	Unit
OUTER IGBT (T1, T4) CHARACTER	RISTICS					
Collector-Emitter Cutoff Current	$V_{GE} = 0 \text{ V}, \text{ V}_{CE} = 1000 \text{ V}$	I _{CES}	_	_	1000	μA
Collector-Emitter Saturation Voltage	V_{GE} = 15 V, I _C = 375 A, T _J = 25°C	V _{CE(sat)}	—	1.63	1.80	V
	V_{GE} = 15 V, I _C = 375 A, T _J = 150°C		_	1.92	-	
Gate-Emitter Threshold Voltage	$V_{GE} = V_{CE}, I_C = 375 \text{ mA}$	V _{GE(TH)}	4.1	4.84	5.7	V
Gate Leakage Current	V_{GE} = ±20 V, V_{CE} = 0 V	I _{GES}	-	-	±2000	nA
Turn-on Delay Time	$T_J = 25$ °C V _{CE} = 600 V, I _C = 170 A V _{GE} = -8 V, 15 V, R _G = 5 Ω	t _{d(on)}	-	86	-	ns
Rise Time		t _r	—	30	-	
Turn-off Delay Time		t _{d(off)}	-	312	-	
Fall Time		t _f	-	32	-	
Turn-on Switching Loss per Pulse		E _{on}	—	2376	-	μJ
Turn-off Switching Loss per Pulse		E _{off}	—	5437	-	
Turn-on Delay Time	$T_{\rm J} = 125^{\circ}C$	t _{d(on)}	-	79	-	ns
Rise Time	V _{CE} = 600 V, I _C = 170 A V _{GE} = -8 V, 15 V, R _G = 5 Ω	t _r	—	35	-	
Turn-off Delay Time		t _{d(off)}	-	357	-	
Fall Time		t _f	—	73	-	
Turn-on Switching Loss per Pulse		Eon	_	4568	_	μJ
Turn-off Switching Loss per Pulse		E _{off}	_	7421	-	

ELECTRICAL CHARACTERISTICS (T_J = 25° C unless otherwise specified) (continued)

Characteristic	Test Conditions	Symbol	Min	Тур	Max	Unit
OUTER IGBT (T1, T4) CHARACTER	RISTICS					
Input Capacitance	V_{CE} = 20 V, V_{GE} = 0 V, f = 1 MHz	C _{ies}	_	24146	-	pF
Output Capacitance	1	C _{oes}	-	1027	-	
Reverse Transfer Capacitance		C _{res}	-	106	_	
Total Gate Charge	V_{CE} = 600 V, I _C = 375 A, V _{GE} = 15 V	Qg	-	680	_	nC
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness = 2.1 Mil ±2%	R _{thJH}	_	0.22	-	K/W
Thermal Resistance - Chip-to-Case	λ = 2.9 W/mK	R _{thJC}	-	0.12	_	K/W
NEUTRAL POINT DIODE (D5, D6) (CHARACTERISTICS					
Diode Forward Voltage	$I_F = 100 \text{ A}, \text{ T}_J = 25^{\circ}\text{C}$	V _F	-	1.50	1.85	V
	I _F = 100 A, T _J = 150°C		-	2.07	_	
Reverse Recovery Time	T _J = 25°C	t _{rr}	-	19	—	ns
Reverse Recovery Charge	V _{CE} = 600 V, I _C = 170 A V _{GE} = –8 V, 15 V, R _G = 5 Ω	Q _{rr}	-	229	—	μC
Peak Reverse Recovery Current		I _{RRM}	-	19	—	А
Peak Rate of Fall of Recovery Current		di/dt	—	6053	-	A/μs
Reverse Recovery Energy		E _{rr}	-	164	—	μJ
Reverse Recovery Time	T _J = 125°C	t _{rr}	-	34	—	ns
Reverse Recovery Charge	V _{CE} = 600 V, I _C = 120 A V _{GF} = -8 V, 15 V, R _G = 5 Ω	Q _{rr}	-	359	—	μC
Peak Reverse Recovery Current		I _{RRM}	-	17	—	А
Peak Rate of Fall of Recovery Current		di/dt	_	4621	-	A/μs
Reverse Recovery Energy		E _{rr}	-	211	—	μJ
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness = 2.1 Mil ±2%	R _{thJH}	_	0.42	-	K/W
Thermal Resistance - Chip-to-Case	λ = 2.9 W/mK	R _{thJC}	-	0.29	_	K/W
INNER IGBT (T2, T3) CHARACTER	ISTICS					
Collector-Emitter Cutoff Current	V _{GE} = 0 V, V _{CE} = 1000 V	I _{CES}	-	-	500	μA
Collector-Emitter Saturation Voltage	V_{GE} = 15 V, I _C = 300 A, T _J = 25°C	V _{CE(sat)}	-	1.27	1.50	V
	V_{GE} = 15 V, I _C = 300 A, T _J = 150°C		-	1.34	_	
Gate-Emitter Threshold Voltage	$V_{GE} = V_{CE}$, $I_C = 300 \text{ mA}$	V _{GE(TH)}	4.1	4.96	5.7	V
Gate Leakage Current	V_{GE} = ±20 V, V_{CE} = 0 V	I _{GES}	1	-	±1600	nA
Turn-on Delay Time	$T_{\rm J} = 25^{\circ}{\rm C}$	t _{d(on)}	-	69.5	-	ns
Rise Time	V _{CE} = 600 V, I _C = 170 A V _{GE} = –8 V, 15 V, R _G = 5 Ω	t _r	-	31	_	
Turn-off Delay Time		t _{d(off)}	_	422.5		
Fall Time		t _f	_	51.5	-	
Turn-on Switching Loss per Pulse		Eon	_	3705	_	μJ
Turn-off Switching Loss per Pulse		E _{off}	_	12590		
Turn-on Delay Time	$T_{\rm J} = 125^{\circ}C$	t _{d(on)}	_	66	-	ns
Rise Time	V _{CE} = 600 V, I _C = 170 A V _{GE} = –8 V, 15 V, R _G = 5 Ω	t _r	_	30.5	—	
Turn-off Delay Time		t _{d(off)}	-	508.5	_	
Fall Time		t _f	_	64	-	
Turn-on Switching Loss per Pulse		E _{on}	_	5777	_	μJ
Turn-off Switching Loss per Pulse	1	E _{off}	_	18390	_	

ELECTRICAL CHARACTERISTICS ($T_J = 25^{\circ}C$ unless otherwise specified) (continued)

Characteristic	Test Conditions	Symbol	Min	Тур	Max	Unit
INNER IGBT (T2, T3) CHARACTERISTICS						
Input Capacitance	V_{CE} = 20 V, V_{GE} = 0 V, f = 1 MHz	C _{ies}	_	25260	_	pF
Output Capacitance		C _{oes}	-	1009	-	
Reverse Transfer Capacitance		C _{res}	-	118	-	
Total Gate Charge	V_{CE} = 600 V, I_C = 300 A, V_{GE} = 15 V	Qg	-	720	-	nC
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness = 2.1 Mil ±2%	R _{thJH}	-	0.24	-	K/W
Thermal Resistance – Chip-to-Case	$\lambda = 2.9 \text{ W/mK}$	R _{thJC}	-	0.13	—	K/W

IGBT INVERSE DIODE (D1, D2, D3, D4) CHARACTERISTICS

Diode Forward Voltage	$I_F = 150 \text{ A}, T_J = 25^{\circ}\text{C}$	V _F	-	2.06	2.44	V
	I _F = 150 A, T _J = 150°C		-	1.77	-	
Reverse Recovery Time	T _J = 25°C	t _{rr}	-	96	_	ns
Reverse Recovery Charge	V _{CE} = 600 V, I _C = 170 A V _{GE} = –8 V, 15 V, R _G = 5 Ω	Q _{rr}	-	5094	_	μC
Peak Reverse Recovery Current		I _{RRM}	-	124	-	А
Peak Rate of Fall of Recovery Current		di/dt	—	4571	_	A/μs
Reverse Recovery Energy		Err	-	2069	-	μJ
Reverse Recovery Time	T _J = 125°C	t _{rr}	-	192	_	ns
Reverse Recovery Charge	V _{CE} = 600 V, I _C = 170 A V _{GE} = –8 V, 15 V, R _G = 5 Ω	Q _{rr}	-	11900	_	μC
Peak Reverse Recovery Current		I _{RRM}	-	148	-	А
Peak Rate of Fall of Recovery Current		di/dt	_	4167	_	A/μs
Reverse Recovery Energy		E _{rr}	_	4665	_	μJ
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness = 2.1 Mil $\pm 2\%$ λ = 2.9 W/mK	R _{thJH}	-	0.39	_	K/W
Thermal Resistance - Chip-to-Case		R _{thJC}	-	0.25	_	K/W

THERMISTOR CHARACTERISTICS

Nominal Resistance	T = 25°C	R ₂₅	—	22	—	kΩ
Nominal Resistance	T = 100°C	R ₁₀₀	-	1.486	-	kΩ
Deviation of R25		$\Delta R/R$	-5	_	5	%
Power Dissipation		PD	-	200	-	mW
Power Dissipation Constant			-	2	-	mW/K
B-value	B(25/50), tolerance ±3%		-	3950	-	К
B-value	B(25/100), tolerance ±3%		_	3998	_	К

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.

ORDERING INFORMATION

Part Number	Marking	Package	Shipping
NXH350N100H4Q2F2PG PRESS FIT PINS	NXH350N100H4Q2F2PG	Q2PACK (Pb-free/Halide-free)	12 Units / Blister Tray
NXH350N100H4Q2F2SG SOLDER PINS	NXH350N100H4Q2F2SG	Q2PACK (Pb-free/Halide-free)	12 Units / Blister Tray

TYPICAL CHARACTERISTICS – OUTER IGBT, INNER IGBT

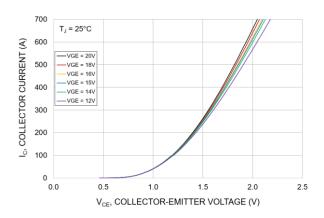


Figure 3. Typical Output Characteristics – Outer IGBT

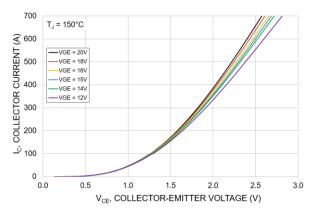


Figure 4. Typical Output Characteristics – Outer IGBT

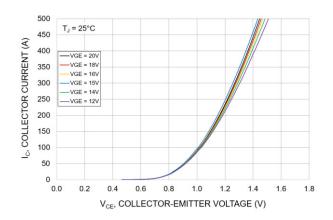


Figure 5. Typical Output Characteristics – Inner IGBT

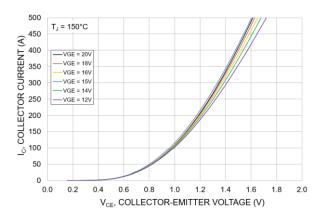


Figure 6. Typical Output Characteristics – Inner IGBT

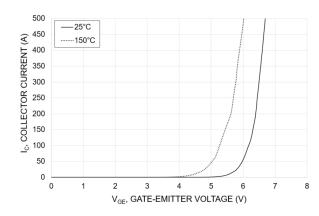
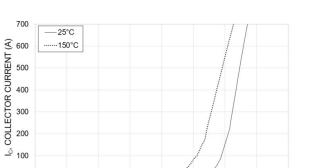


Figure 8. Transfer Characteristics – Inner IGBT



4

V_{GE}, GATE-EMITTER VOLTAGE (V)

5

6

7

8

Figure 7. Transfer Characteristics – Outer IGBT

3

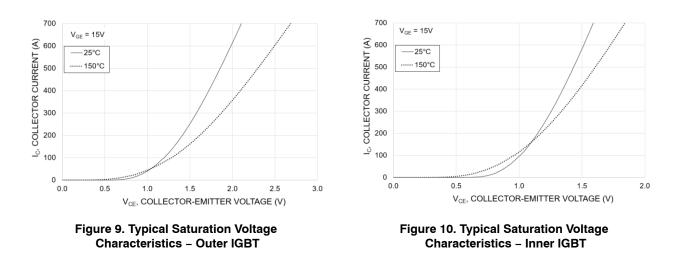
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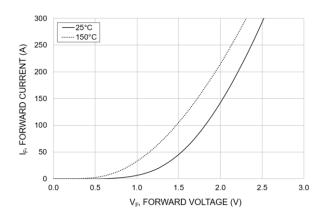
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1

TYPICAL CHARACTERISTICS – OUTER IGBT, INNER IGBT, IGBT INVERSE DIODE AND NEUTRAL POINT DIODE







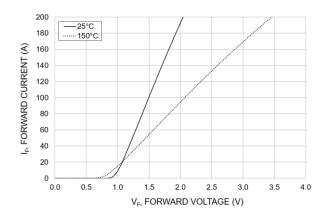


Figure 12. Buck Diode Forward Characteristics

TYPICAL SWITCHING CHARACTERISTICS – OUTER IGBT

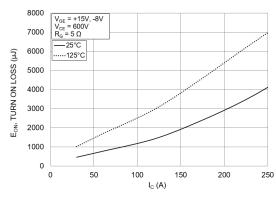


Figure 13. Typical Turn On Loss vs. IC

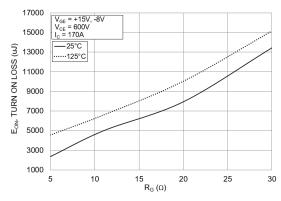


Figure 15. Typical Turn On Loss vs. R_G

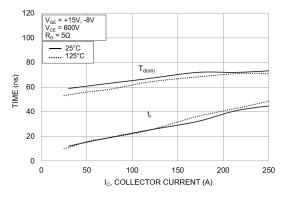


Figure 17. Typical Turn On Switching Time vs. IC

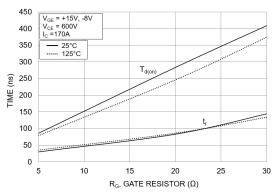


Figure 19. Typical Turn On Switching Time vs. R_G

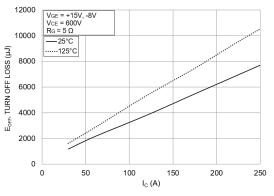


Figure 14. Typical Turn Off Loss vs. IC

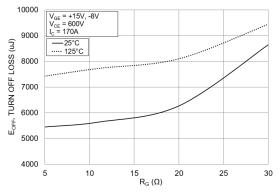


Figure 16. Typical Turn Off Loss vs. R_G

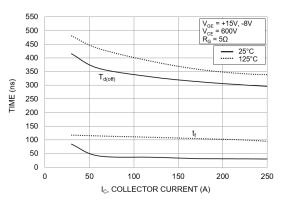


Figure 18. Typical Turn Off Switching Time vs. $\rm I_{C}$

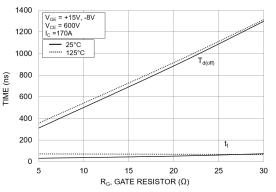


Figure 20. Typical Turn On Switching Time vs. R_G

TYPICAL SWITCHING CHARACTERISTICS – INNER IGBT

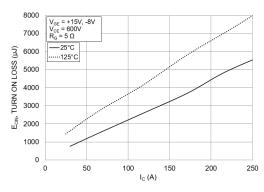


Figure 21. Typical Turn On Loss vs. I_C

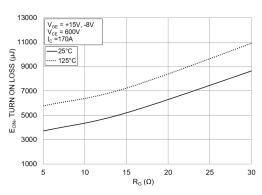


Figure 23. Typical Turn On Loss vs. R_G

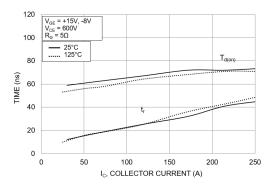


Figure 25. Typical Turn On Switching Time vs. I_C

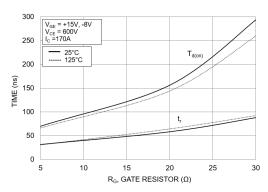


Figure 27. Typical Turn On Switching Time vs. $\rm R_{G}$

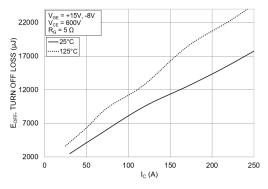


Figure 22. Typical Turn Off Loss vs. $\rm I_C$

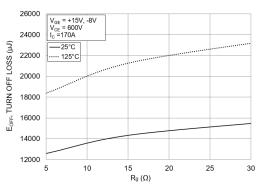


Figure 24. Typical Turn Off Loss vs. $\rm R_{G}$

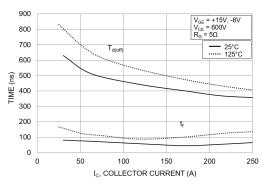


Figure 26. Typical Turn Off Switching Time vs. I_C

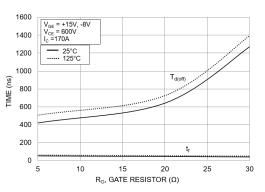
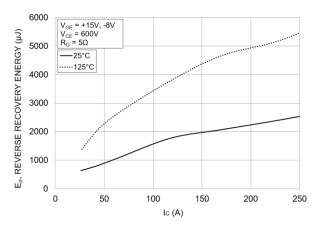
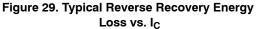


Figure 28. Typical Turn On Switching Time vs. ${\rm R}_{\rm G}$

TYPICAL SWITCHING CHARACTERISTICS – INVERSE DIODE

5000





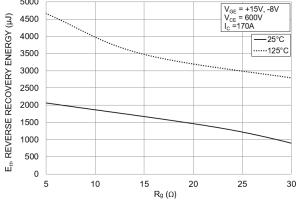


Figure 30. Typical Reverse Recovery Energy Loss vs. R_G

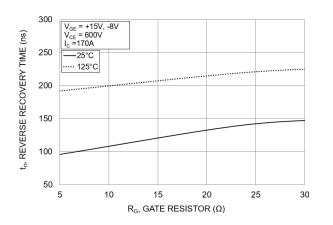


Figure 31. Typical Reverse Recovery Time vs. R_G

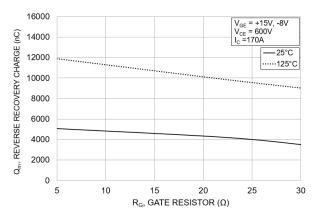
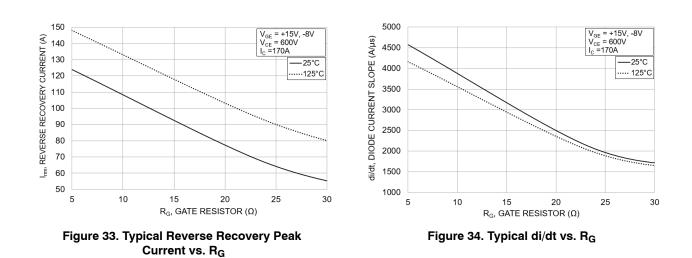


Figure 32. Typical Reverse Recovery Charge vs. R_G



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TYPICAL SWITCHING CHARACTERISTICS – NEUTRAL POINT DIODE

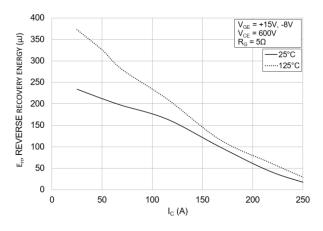


Figure 35. Typical Reverse Recovery Energy Loss vs. I_C

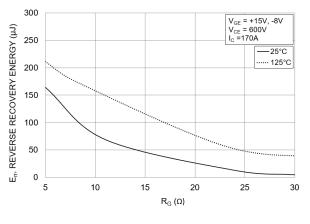


Figure 36. Typical Reverse Recovery Energy Loss vs. R_G

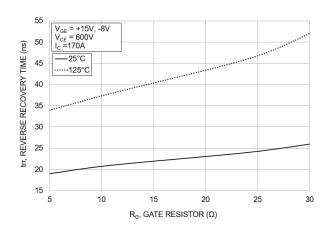


Figure 37. Typical Reverse Recovery Time vs. R_G

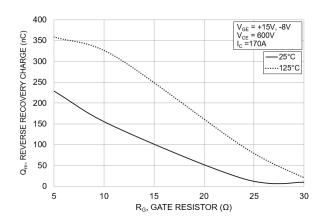
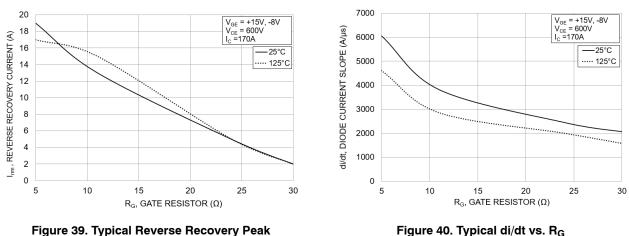


Figure 38. Typical Reverse Recovery Charge vs. R_G



Current vs. R_G

Figure 40. Typical di/dt vs. R_G

TRANSIENT THERMAL IMPEDANCE

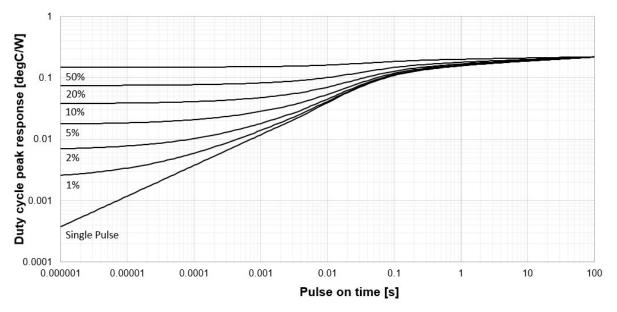
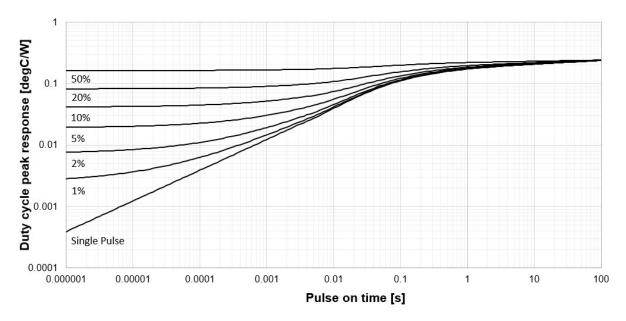


Figure 41. Transient Thermal Impedance – Outer IGBT





TRANSIENT THERMAL IMPEDANCE (CONTINUED)

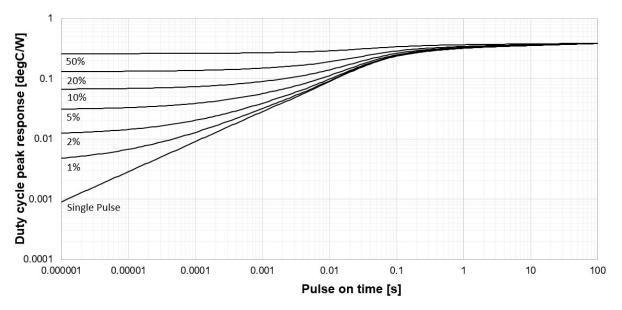


Figure 43. Transient Thermal Impedance – Inverse Diode

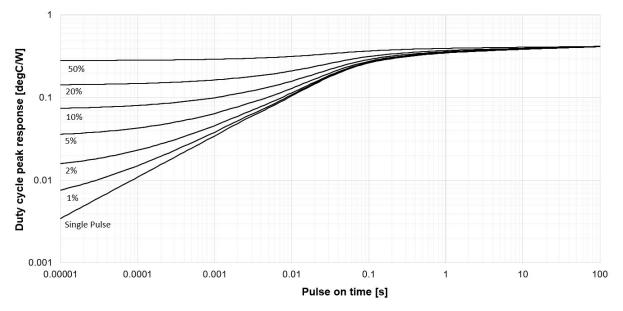


Figure 44. Transient Thermal Impedance – Neutral Point Diode

SAFE OPERATING AREA

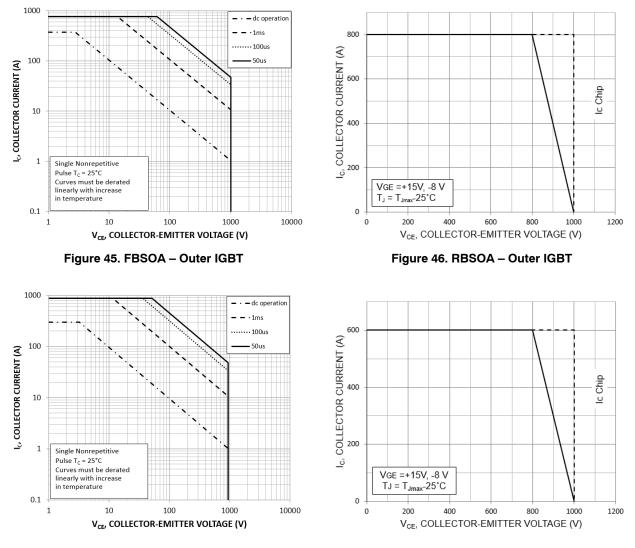
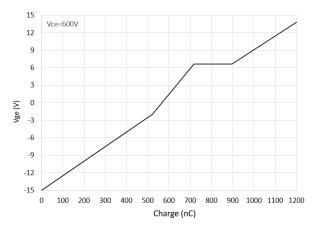




Figure 48. RBSOA – Inner IGBT

GATE CHARGE AND CAPACITANCE





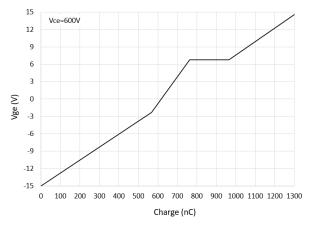


Figure 50. Gate Voltage vs. Gate Charge – Inner IGBT

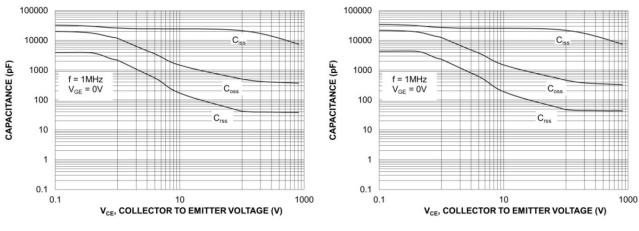
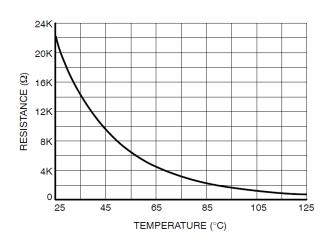


Figure 51. Capacitance Charge – Outer IGBT

Figure 52. Capacitance Charge – Inner IGBT

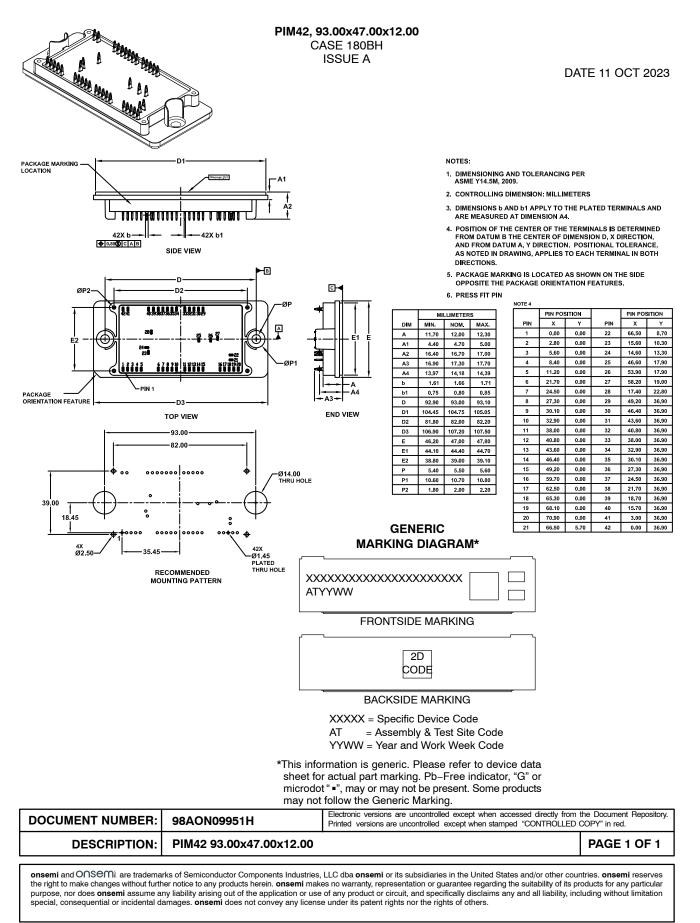


TYPICAL CHARCTERISTICS – THERMISTOR

Figure 53. Thermistor Characteristics

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ONSEM¹.



MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

PIM42, 93.00x47.00x12.00 CASE 180BS ISSUE A DATE 12 OCT 2023 NOTES: PACKAGE MARKING 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009. LOCATION Warpage ±0.3 A1 2. CONTROLLING DIMENSION: MILLIMETERS 3. DIMENSIONS b AND b1 APPLY TO THE PLATED TERMINALS AND ARE MEASURED AT DIMENSION A4. A2 4. POSITION OF THE CENTER OF THE TERMINALS IS DETERMINED FROM DATUM B THE CENTER OF DIMENSION D. X DIRECTION. AND FROM DATUM A. Y DIRECTION. POSITIONAL TOLERANCE. AS NOTED IN DRAWING, APPLIES TO EACH TERMINAL IN BOTH 42X b DIRECTIONS 0.80**S** A B 5. PACKAGE MARKING IS LOCATED AS SHOWN ON THE SIDE SIDE VIEW OPPOSITE THE PACKAGE ORIENTATION FEATURES. -в 6. SOLDER PIN MILLIMETERS ØP2 D2 DIM MIN. NOM. MAX. ØР Α 11.70 12.00 12,30 ö 0 0 4241 40 39 38 37 36 35 34 333231 3029 A1 4.70 5.00 4.40 16,40 A2 16.70 17.00 Α 280 16,80 17,20 17.60 A3 26 27 25 + E2 0.95 1.00 1.05 b 24 o 230 92.90 93.00 93.10 D ØP1 D1 104.45 104.75 105.05 6 7 8 9 10 11 12 13 14 15 161718192 D2 81,80 82,00 82,20 D3 106.90 107.20 107.50 Δ - PIN 1 46.20 47.00 47.80 Е A3 E1 44.10 44.40 44.70 D3 PACKAGE E2 38.80 39.00 39.10 END VIEW TOP VIEW **ORIENTATION FEATURE** 5.40 5,60 Р 5,50 NOTE 4 **P1** 10.60 10.70 10.80 PIN POSITION PIN POSITION P2 1,80 2,00 2,20 PIN Х Υ PIN Х Y 0.00 0.00 22 66.50 8.70 GENERIC 1 2.80 0.00 23 15.60 10.30 **MARKING DIAGRAM*** 2 3 5,60 0.00 24 14.60 13.30 4 8,40 0.00 25 46.60 17.90 5 11.20 0.00 26 53.90 17.90 ATYYWW 6 21.70 0.00 27 58.20 19.00 7 24.50 0.00 17.40 22.80 28 FRONTSIDE MARKING 8 27.30 0.00 29 49.20 36.90 9 30.10 0.00 30 46.40 36.90 10 32.90 0.00 31 43.60 36.90 2D 0.00 40.80 11 38.00 32 36.90 CODE 12 40.80 0.00 33 38.00 36,90 13 43.60 0.00 34 32.90 36,90 **BACKSIDE MARKING** 14 46.40 0.00 35 30.10 36.90 15 49,20 0,00 36 27.30 36.90 XXXXX = Specific Device Code = Assembly & Test Site Code 16 59.70 0.00 37 24.50 36.90 AT YYWW = Year and Work Week Code 17 62.50 0.00 38 21.70 36.90 18 65.30 39 18.70 36.90 0.00 *This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or 19 68.10 0.00 40 15.70 36.90 20 70.90 0.00 41 3.00 36.90 microdot "•", may or may not be present. Some products may not follow the Generic Marking. 21 66.50 5.70 42 0.00 36.90 Electronic versions are uncontrolled except when accessed directly from the Document Repository. DOCUMENT NUMBER: 98AON15232H Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. **DESCRIPTION:** PIM42 93.00x47.00x12.00 PAGE 1 OF 1 onsemi and ONSEMI are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular

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