

TMPIM 650 V 50 A Converter-Inverter-PFCs Module



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Product Preview

NXH50M65L4C2ESG

The NXH50M65L4C2ESG is a transfer-molded power module with advanced substrate containing a converter-inverter-PFC circuit consisting of single phase converter with four 75 A, 1600 V rectifiers, six 50 A, 600 V IGBTs with inverse diodes, 2-Channel interleaved PFC containing two 75 A, 650 V PFC IGBT with inverse diode, two 50 A, 650 V PFC diode, and an NTC thermistor.

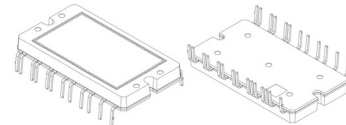
Features

- 2-Channel Interleaved PFC with Wide Switching Frequency
18 kHz ~ 65 kHz
- Low Thermal Resistance Substrate for Low Thermal Resistance
- 6 mm Clearance Distance between Pin to Heatsink
- Compact 73 mm x 40 mm x 8 mm Package
- Solderable Pins
- Thermistor
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

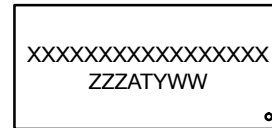
- Industrial Motor Drives
- Servo Drives

This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.



**DIP27 73.2x40.2
CASE 184AA**

MARKING DIAGRAM



XXX = Specific Device Code
ZZZ = Assembly Lot Code
AT = Assembly & Test Location
Y = Year
WW = Work Week

ORDERING INFORMATION

See detailed ordering and shipping information on page 18 of this data sheet.

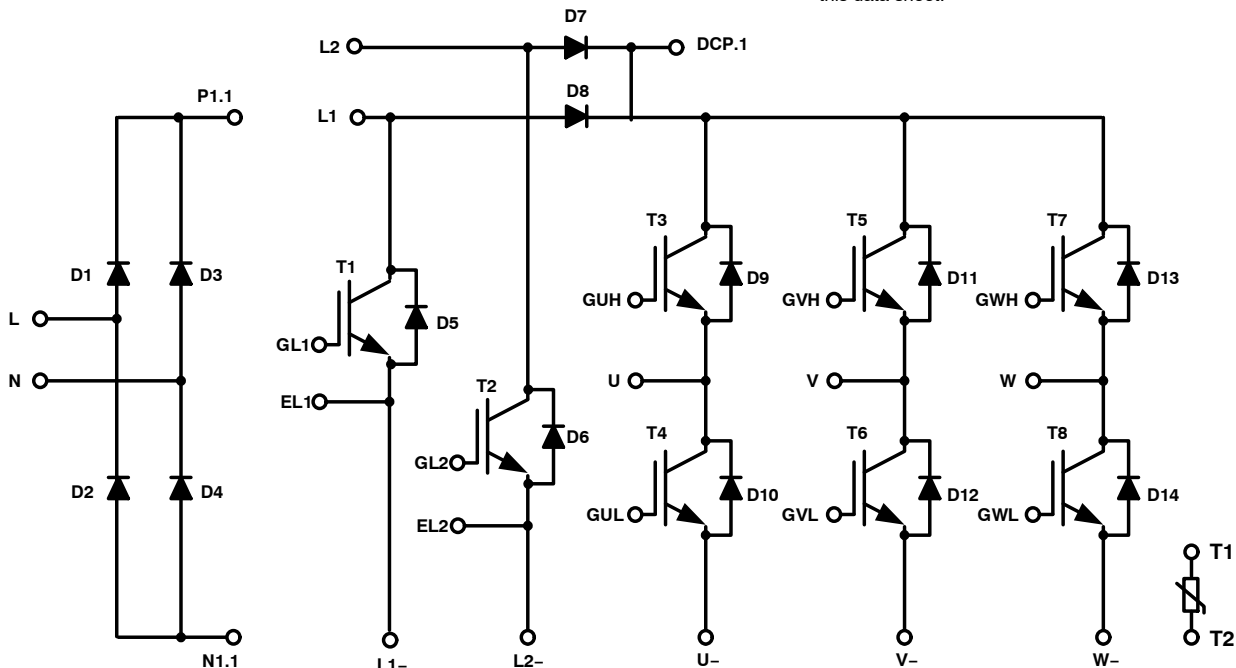


Figure 1. NXH50M65L4C2ESG Schematic Diagram

NXH50M65L4C2ESG

PIN CONFIGURATION TABLE

Pin	Name
1	N1.1
2	-
3	-
4	L1-
5	EL1
6	GL1
7	-
8	L2-
9	EL2
10	GL2
11	-
12	-
13	U-
14	GuL
15	-
16	-
17	V-
18	GvL
19	-
20	-
21	W-
22	GwL
23	-
24	-
25	T1

PIN CONFIGURATION TABLE (continued)

Pin	Name
26	T2
27	Gwh
28	W
29	-
30	-
31	Gvh
32	V
33	-
34	-
35	Guh
36	U
37	-
38	-
39	DCP.1
40	-
44	L1
45	-
46	P1.1
47	-
48	-
49	N
50	-
51	-
52	L

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MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
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INVERTER IGBT (T3 – T8)

Collector–Emitter Voltage	V_{CES}	650	V
Gate–Emitter Voltage	V_{GE}	± 20	V
Continuous Collector Current @ $T_c = 80^\circ\text{C}$ ($T_{V_{Jmax}} = 175^\circ\text{C}$)	I_C	50	A
Pulsed Collector Current	I_{Cpulse}	150	A

INVERTER INVERSE DIODE (D9 – D14)

Peak Repetitive Reverse Voltage	V_{RRM}	600	V
Continuous Forward Current @ $T_c = 80^\circ\text{C}$ ($T_{V_{Jmax}} = 175^\circ\text{C}$)	I_F	30	A
Repetitive Peak Forward Current	I_{FRM}	90	A

PFC IGBT (T1, T2)

Collector–Emitter Voltage	V_{CES}	650	V
Gate–Emitter Voltage	V_{GE}	± 20	V
Continuous Collector Current @ $T_c = 80^\circ\text{C}$ ($T_{V_{Jmax}} = 175^\circ\text{C}$)	I_C	75	A
Pulsed Collector Current	I_{Cpulse}	225	A

PFC INVERSE DIODE (D5, D6)

Peak Repetitive Reverse Voltage	V_{RRM}	650	V
Continuous Forward Current @ $T_c = 80^\circ\text{C}$ ($T_{V_{Jmax}} = 175^\circ\text{C}$)	I_F	15	A
Repetitive Peak Forward Current	I_{FRM}	45	A

PFC DIODE (D7, D8)

Peak Repetitive Reverse Voltage	V_{RRM}	650	V
Continuous Forward Current @ $T_c = 80^\circ\text{C}$ ($T_{V_{Jmax}} = 175^\circ\text{C}$)	I_F	50	A
Repetitive Peak Forward Current	I_{FRM}	150	A

CONVERTER DIODE (D1 – D4)

Peak Repetitive Reverse Voltage	V_{RRM}	1600	V
Continuous Forward Current @ $T_c = 80^\circ\text{C}$ ($T_{V_{Jmax}} = 150^\circ\text{C}$)	I_F	75	A
Repetitive Peak Forward Current	I_{FRM}	225	A
I^2t Value (10 ms Single Half–sine Wave) @ 150°C	I^2t	1200	A^2s
Surge Current (10 ms sin 180°) @ 25°C	IFSM	635	A

THERMAL PROPERTIES

Storage Temperature Range	T_{stg}	–40 to 125	$^\circ\text{C}$
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INSULATION PROPERTIES

Isolation Test Voltage, $t = 1$ s, 50 Hz	V_{is}	3000	V_{RMS}
Internal Isolation		HPS	
Creepage Distance		6.0	mm
Clearance Distance		6.0	mm
Comperative Tracking Index	CTI	>400	

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 ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.

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

Parameter	Test Condition	Symbol	Min	Typ	Max	Unit	
INVERTER IGBT CHARACTERISTICS (T3 – T8)							
Collector–Emitter Cutoff Current	V _{GE} = 0 V, V _{CE} = 600 V	I _{CES}	–	–	250	μA	
Collector–Emitter Saturation Voltage	V _{GE} = 15 V, I _C = 50 A, T _J = 25°C	V _{CE(sat)}	–	1.6	2	V	
	V _{GE} = 15 V, I _C = 50 A, T _J = 150°C		–	1.8	–		
Gate–Emitter Threshold Voltage	V _{GE} = V _{CE} , I _C = 50 mA	V _{GE(TH)}	3.8	4.7	5.7	V	
Gate Leakage Current	V _{GE} = 20 V, V _{CE} = 0 V	I _{GES}	–	–	400	nA	
Turn-on Delay Time	T _J = 25°C V _{CE} = 350 V, I _C = 21 A V _{GE} = +15 V / –8 V, R _G = 25 Ω	t _{d(on)}	–	41	–	ns	
Rise Time		t _r	–	24	–		
Turn-off Delay Time		t _{d(off)}	–	184	–		
Fall Time		t _f	–	78	–		
Turn-on Switching Loss per Pulse		E _{on}	–	270	–		μJ
Turn off Switching Loss per Pulse		E _{off}	–	450	–		
Turn-on Delay Time	T _J = 125 °C V _{CE} = 350 V, I _C = 21 A V _{GE} = +15 V / –8 V, R _G = 25 Ω	t _{d(on)}	–	52.8	–	ns	
Rise Time		t _r	–	25.2	–		
Turn-off Delay Time		t _{d(off)}	–	232	–		
Fall Time		t _f	–	140.2	–		
Turn-on Switching Loss per Pulse		E _{on}	–	390	–		μJ
Turn off Switching Loss per Pulse		E _{off}	–	710	–		
Input Capacitance	V _{CE} = 20 V, V _{GE} = 0 V, f = 1 MHz	C _{ies}	–	2608	–	pF	
Output Capacitance		C _{oes}	–	77	–		
Reverse Transfer Capacitance		C _{res}	–	21	–		
Total Gate Charge	V _{CE} = 480 V, I _C = 50 A, V _{GE} = –15 V~+15 V	Q _g	–	122	–	nC	
Temperature under switching conditions		T _{vj op}	–40		150	°C	
Thermal Resistance – Chip–to–Case		R _{thJC}	–	0.41	–	°C/W	
Thermal Resistance – Chip–to–Heatsink	Thermal grease, Thickness ≈ 3mil, λ = 2.8 W/mK	R _{thJH}	–	0.81	–	°C/W	

INVERTER INVERSE DIODE CHARACTERISTICS (D9 – D14)

Diode Forward Voltage	I _F = 30 A, T _J = 25°C	V _F	–	1.9	2.7	V
	I _F = 30 A, T _J = 150°C		–	1.6	–	
Reverse Recovery Time	T _J = 25 °C V _{CE} = 350 V, I _C = 21 A V _{GE} = +18 V / –8 V, R _G = 25 Ω	t _{rr}	–	34	–	ns
Reverse Recovery Charge		Q _{rr}	–	210	–	nC
Peak Reverse Recovery Current		I _{RRM}	–	11	–	A
Reverse Recovery Energy		E _{rr}	–	37	–	μJ
Reverse Recovery Time	T _J = 125 °C V _{CE} = 350 V, I _C = 21 A V _{GE} = +15 V / –8 V, R _G = 25 Ω	t _{rr}	–	46	–	ns
Reverse Recovery Charge		Q _{rr}	–	472	–	nC
Peak Reverse Recovery Current		I _{RRM}	–	16	–	A
Reverse Recovery Energy		E _{rr}	–	82	–	μJ
Temperature under Switching Conditions		T _{vj op}	–40		150	°C
Thermal Resistance – Chip–to–Case		R _{thJC}	–	0.7	–	°C/W
Thermal Resistance – Chip–to–Heatsink	Thermal grease, Thickness ≈ 3 mil, λ = 2.8 W/mK	R _{thJH}	–	1.0	–	°C/W

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

Parameter	Test Condition	Symbol	Min	Typ	Max	Unit	
PFC IGBT CHARACTERISTICS (T1, T2)							
Collector–Emitter Cutoff Current	V _{GE} = 0 V, V _{CE} = 650 V	I _{CES}	–	–	250	μA	
Collector–Emitter Saturation Voltage	V _{GE} = 15 V, I _C = 75 A, T _J = 25°C	V _{CE(sat)}	–	1.4	2.2	V	
	V _{GE} = 15 V, I _C = 75 A, T _J = 150°C		–	1.6	–		
Gate–Emitter Threshold Voltage	V _{GE} = V _{CE} , I _C = 75 mA	V _{GE(TH)}	3.8	4.5	5.7	V	
Gate Leakage Current	V _{GE} = 20 V, V _{CE} = 0 V	I _{GES}	–	–	400	nA	
Turn–on Delay Time	T _J = 25°C V _{CE} = 400 V, I _C = 24 A V _{GE} = +15 V / –8 V, R _G = 10 Ω	t _{d(on)}	–	47	–	ns	
Rise Time		t _r	–	12	–		
Turn–off Delay Time		t _{d(off)}	–	190	–		
Fall Time		t _f	–	8	–		
Turn–on Switching Loss per Pulse		E _{on}	–	240	–		μJ
Turn off Switching Loss per Pulse		E _{off}	–	250	–		
Turn–on Delay Time	T _J = 125 °C V _{CE} = 400 V, I _C = 24 A V _{GE} = +15 V / –8 V, R _G = 10 Ω	t _{d(on)}	–	45	–	ns	
Rise Time		t _r	–	14	–		
Turn–off Delay Time		t _{d(off)}	–	218	–		
Fall Time		t _f	–	25	–		
Turn–on Switching Loss per Pulse		E _{on}	–	390	–		μJ
Turn off Switching Loss per Pulse		E _{off}	–	350	–		
Input Capacitance	V _{CE} = 20 V, V _{GE} = 0 V, f = 10 kHz	C _{ies}	–	4877	–	pF	
Output Capacitance		C _{oes}	–	77	–		
Reverse Transfer Capacitance		C _{res}	–	21	–		
Total Gate Charge	V _{CE} = 480 V, I _C = 75 A, V _{GE} = 0 V~+15 V	Q _g	–	151	–	nC	
Temperature under Switching Conditions		T _{vj op}	–40		150	°C	
Thermal Resistance – Chip–to–Case		R _{thJC}	–	0.46	–	°C/W	
Thermal Resistance – Chip–to–Heatsink	Thermal grease, Thickness ≈ 3 mil, λ = 2.8 W/mK	R _{thJH}	–	0.81	–	°C/W	

PFC IGBT INVERSE DIODE CHARACTERISTICS (D5, D6)

Rectifier Forward Voltage	I _F = 15 A, T _J = 25°C	V _F	–	1.9	2.4	V
	I _F = 15 A, T _J = 150°C		–	1.8	–	
Temperature under Switching Conditions		T _{vj op}	–40		150	°C
Thermal Resistance – Chip–to–Case		R _{thJC}	–	2.04	–	°C/W
Thermal Resistance – Chip–to–Heatsink	Thermal grease, Thickness ≈ 3 mil, λ = 2.8 W/mK	R _{thJH}	–	2.4	–	°C/W

PFC DIODE CHARACTERISTICS (D7, D8)

Rectifier Reverse Leakage Current	V _R = 650 V	I _R	–	–	200	μA
Rectifier Forward Voltage	I _F = 50 A, T _J = 25°C	V _F	–	2.1	2.8	V
	I _F = 50 A, T _J = 150°C		–	1.7	–	
Reverse Recovery Time	T _J = 25 °C V _{CE} = 400 V, I _C = 24 A V _{GE} = +15 V / –8 V, R _G = 10 Ω	t _{rr}	–	24	–	ns
Reverse Recovery Charge		Q _{rr}	–	456	–	nC
Peak Reverse Recovery Current		I _{RRM}	–	32	–	A
Reverse Recovery Energy		E _{rr}	–	109	–	μJ

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

Parameter	Test Condition	Symbol	Min	Typ	Max	Unit
PFC DIODE CHARACTERISTICS (D7, D8)						
Reverse Recovery Time	T _J = 125 °C V _{CE} = 400 V, I _C = 24 A V _{GE} = +15 V / -8 V, R _G = 10 Ω	t _{rr}		36		ns
Reverse Recovery Charge		Q _{rr}	–	902	–	nC
Peak Reverse Recovery Current		I _{RRM}	–	42	–	A
Reverse Recovery Energy		E _{rr}	–	209	–	μJ
Temperature under Switching Conditions		T _{vj op}	-40		150	°C
Thermal Resistance – Chip-to-Case		R _{thJC}	–	0.58	–	°C/W
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness ≈ 3 mil, λ = 2.8 W/mK	R _{thJH}	–	0.87	–	°C/W

CONVERTER DIODE CHARACTERISTICS (D1-D4)

Rectifier Reverse Leakage Current	V _R = 1600 V	I _R	–	–	200	μA
Rectifier Forward Voltage	I _F = 75 A, T _J = 25°C	V _F	–	1.3	1.7	V
	I _F = 75 A, T _J = 150°C		–	1.4	–	
Temperature under Switching Conditions		T _{vj op}	-40		150	°C
Thermal Resistance – Chip-to-Case		R _{thJC}	–	0.36	–	°C/W
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness ≈ 3 mil, λ = 2.8 W/mK	R _{thJH}	–	0.64	–	°C/W

THERMISTOR CHARACTERISTICS

Nominal Resistance	T = 25°C	R ₂₅	–	5	–	kΩ
Nominal Resistance	T = 100°C	R ₁₀₀	–	493.3	–	Ω
Deviation of R25		ΔR/R	-5	–	5	%
Power Dissipation		P _D	–	20	–	mW
Power Dissipation Constant			–	1.4	–	mW/K
B-value	B (25/50), tolerance ±2%		–	3375	–	K
B-value	B (25/100), tolerance ±2%		–	3455	–	K

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.

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TYPICAL CHARACTERISTICS – T3 – T8 INVERTER IGBT & D9–D14 INVERSE DIODE

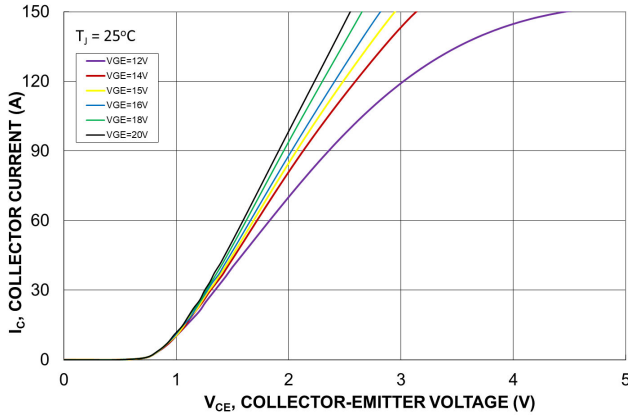


Figure 2. IGBT Typical Output Characteristics

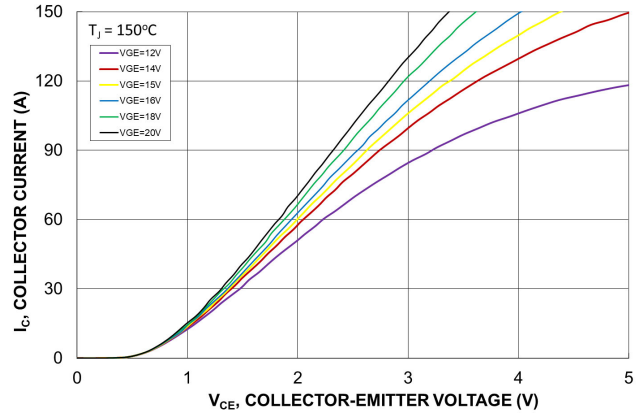


Figure 3. IGBT Typical Output Characteristics

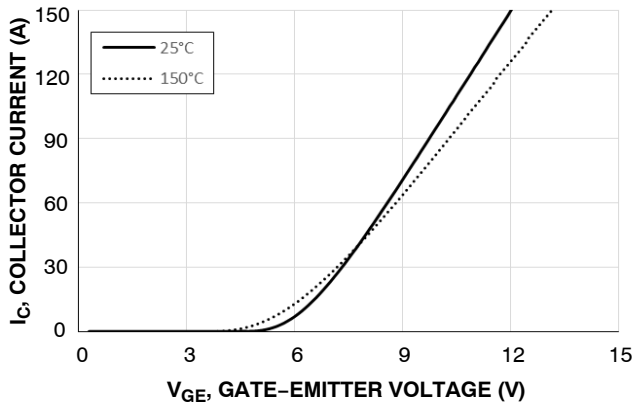


Figure 4. Typical Transfer Characteristics

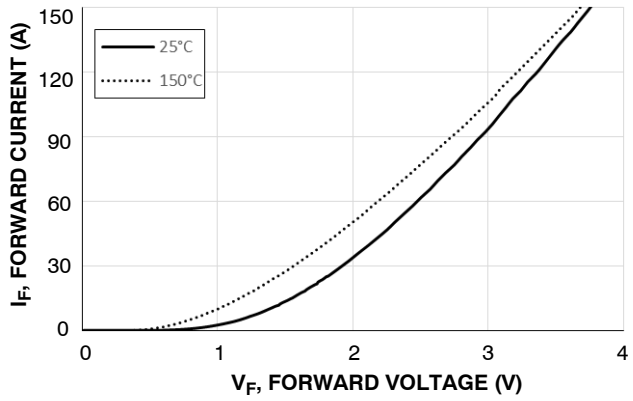


Figure 5. Diode Typical Forward Characteristics

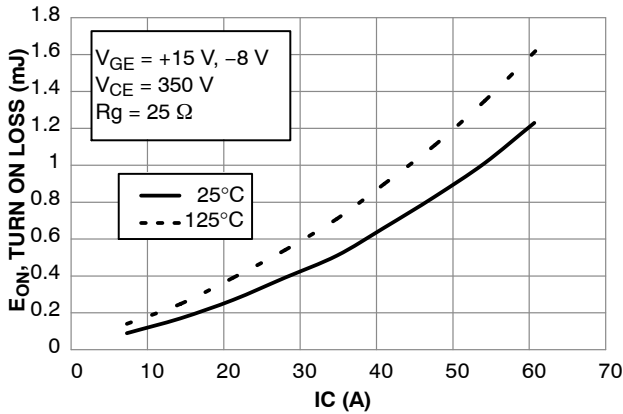


Figure 6. Typical Turn ON Loss vs. IC

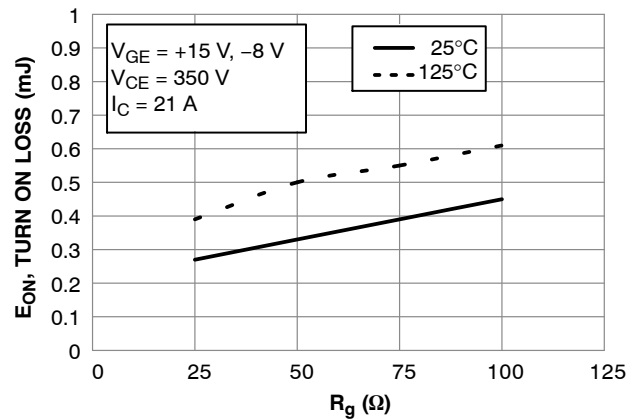


Figure 7. Typical Turn ON Loss vs. Rg

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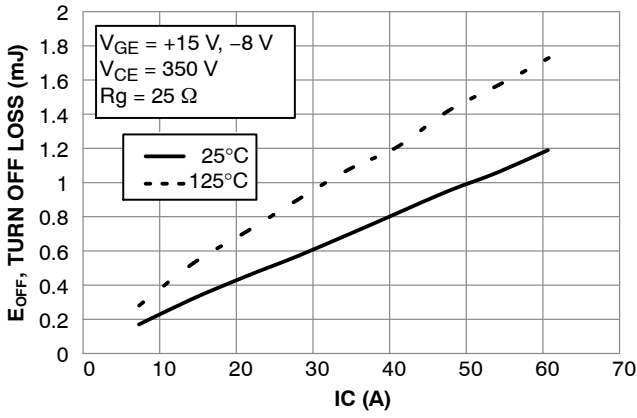


Figure 8. Typical Turn OFF Loss vs. IC

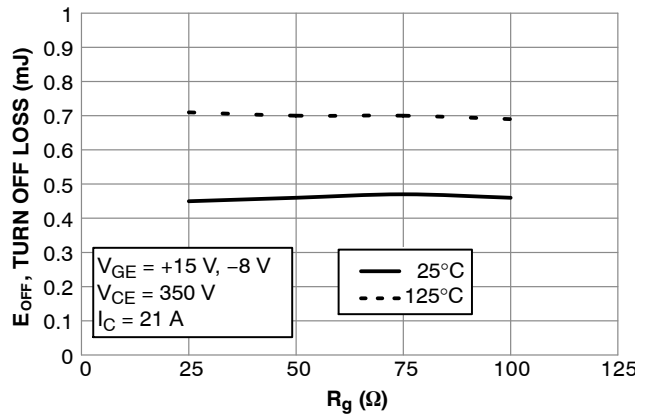


Figure 9. Typical Turn OFF Loss vs. Rg

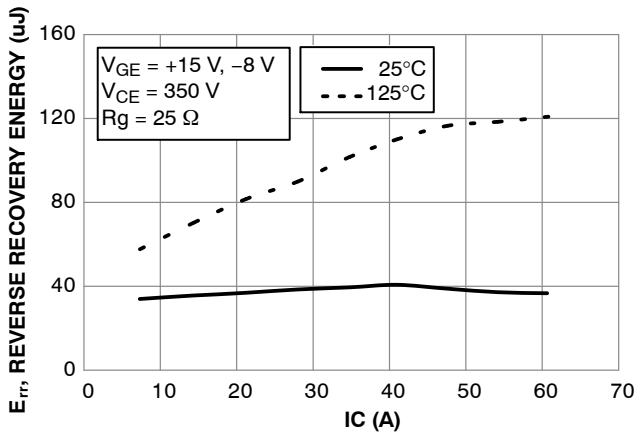


Figure 10. Typical Reverse Recovery Energy Loss vs. IC

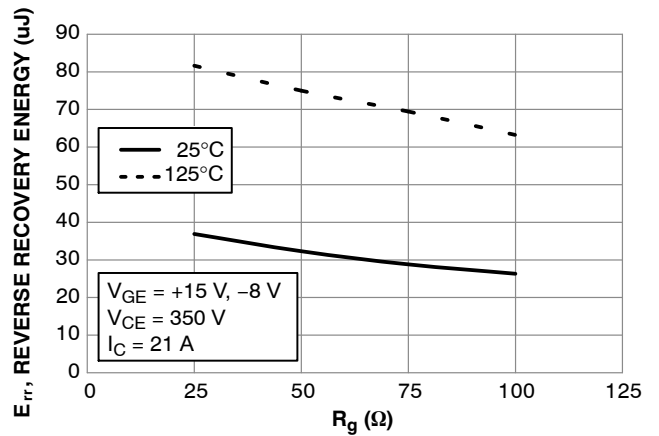


Figure 11. Typical Reverse Recovery Energy Loss vs. Rg

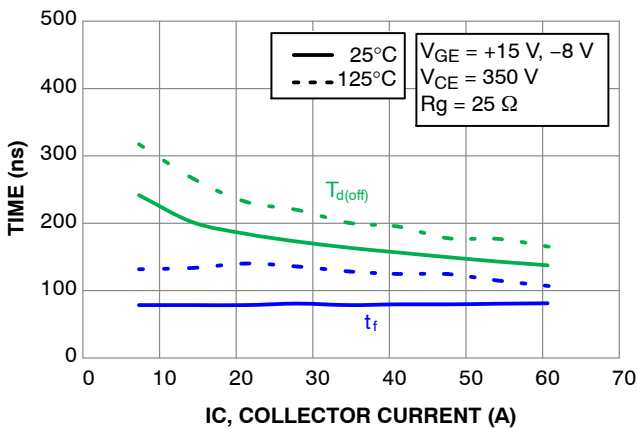


Figure 12. Typical Turn-Off Switching Time vs. IC

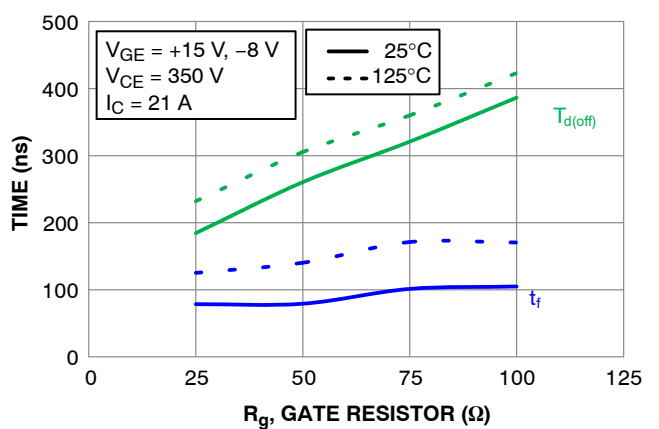


Figure 13. Typical Turn-Off Switching Time vs. Rg

NXH50M65L4C2ESG

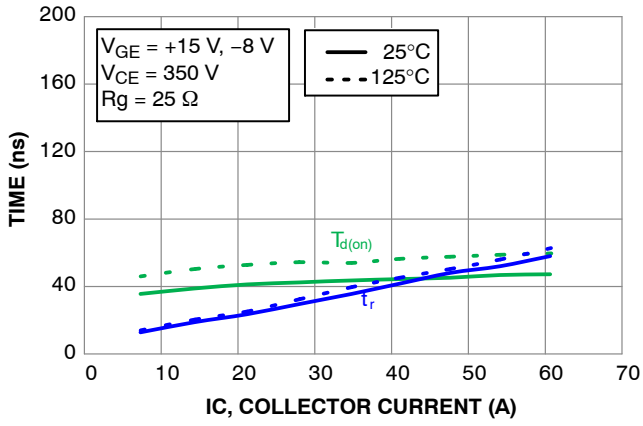


Figure 14. Typical Turn-On Switching Time vs. IC

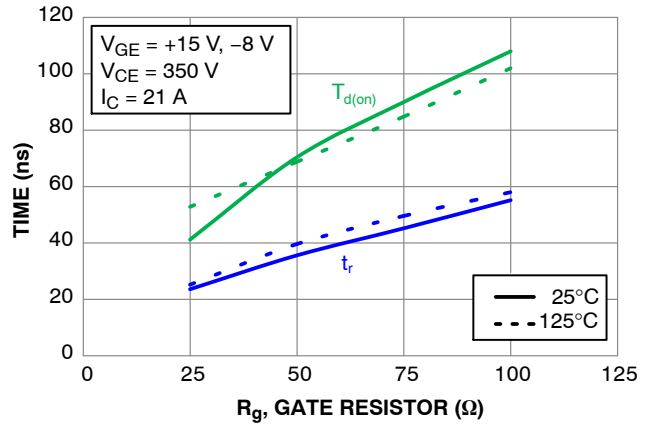


Figure 15. Typical Turn-Off Switching Time vs. Rg

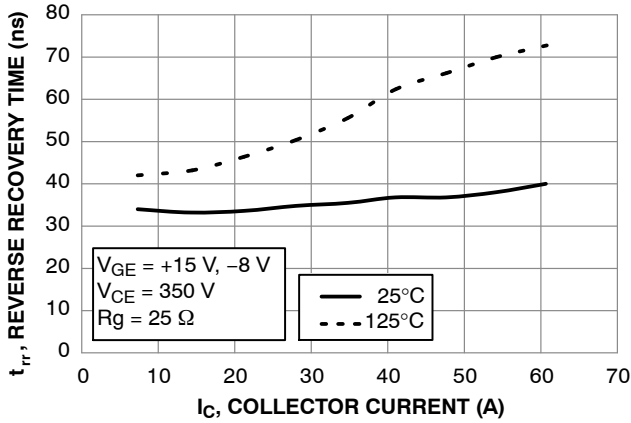


Figure 16. Typical Reverse Recovery Time vs. IC

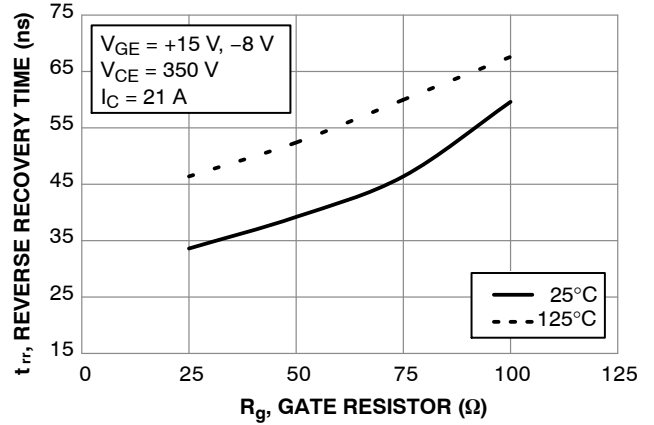


Figure 17. Typical Reverse Recovery Time vs. Rg

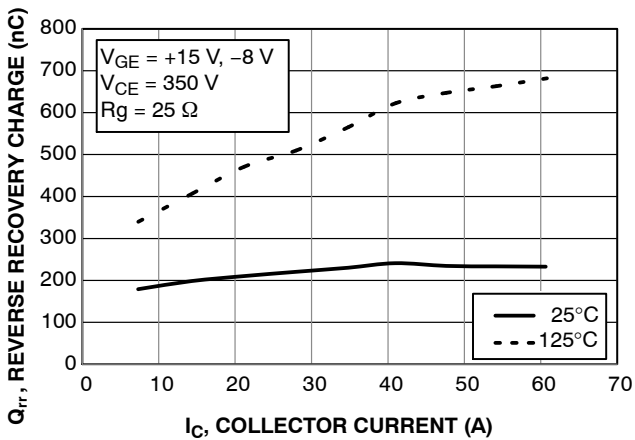


Figure 18. Typical Reverse Recovery Charge vs. IC

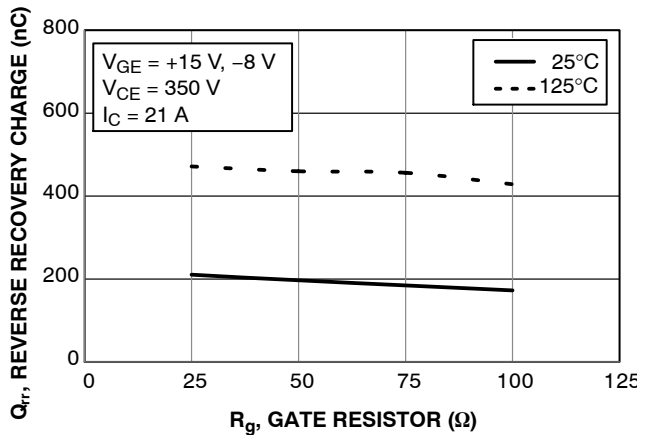


Figure 19. Typical Reverse Recovery Charge vs. Rg

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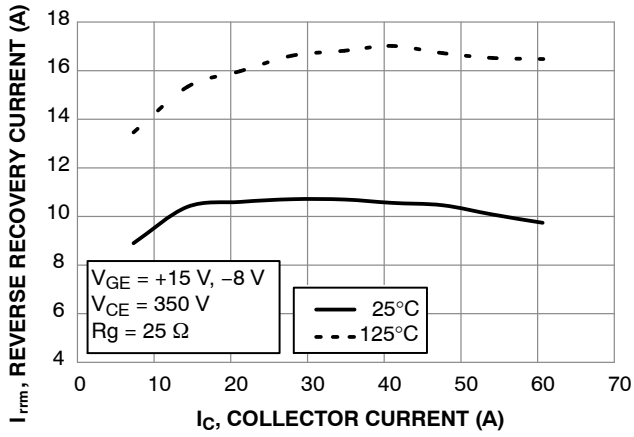


Figure 20. Typical Reverse Recovery Peak Current vs. I_C

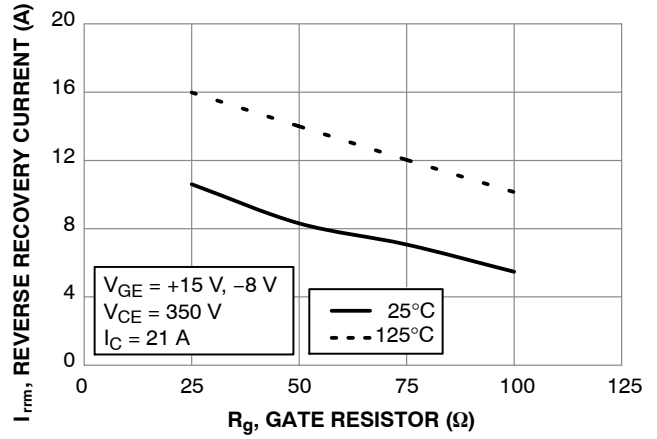


Figure 21. Typical Reverse Recovery Peak Current vs. R_g

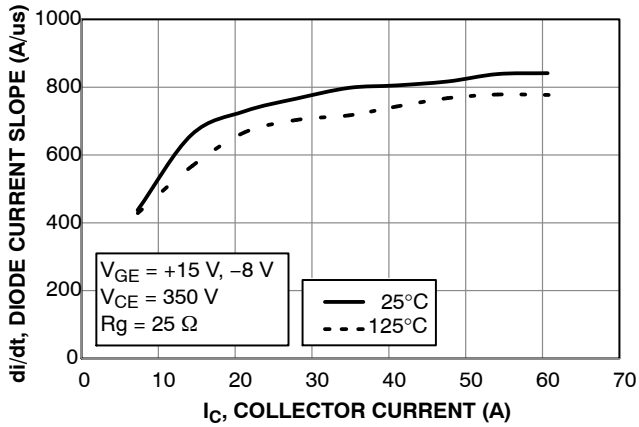


Figure 22. Typical di/dt Current Slope vs. I_C

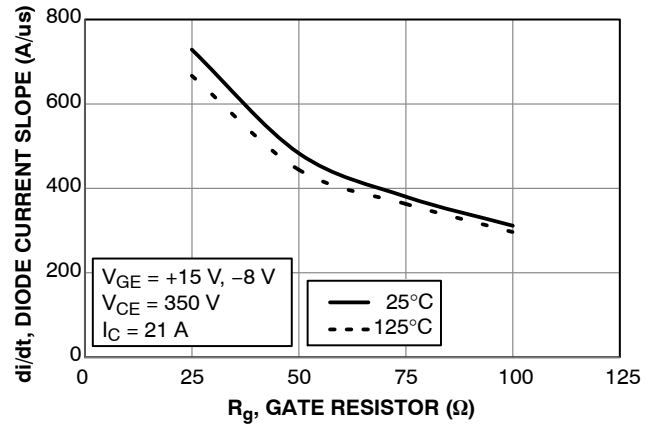


Figure 23. Typical di/dt Current Slope vs. R_g

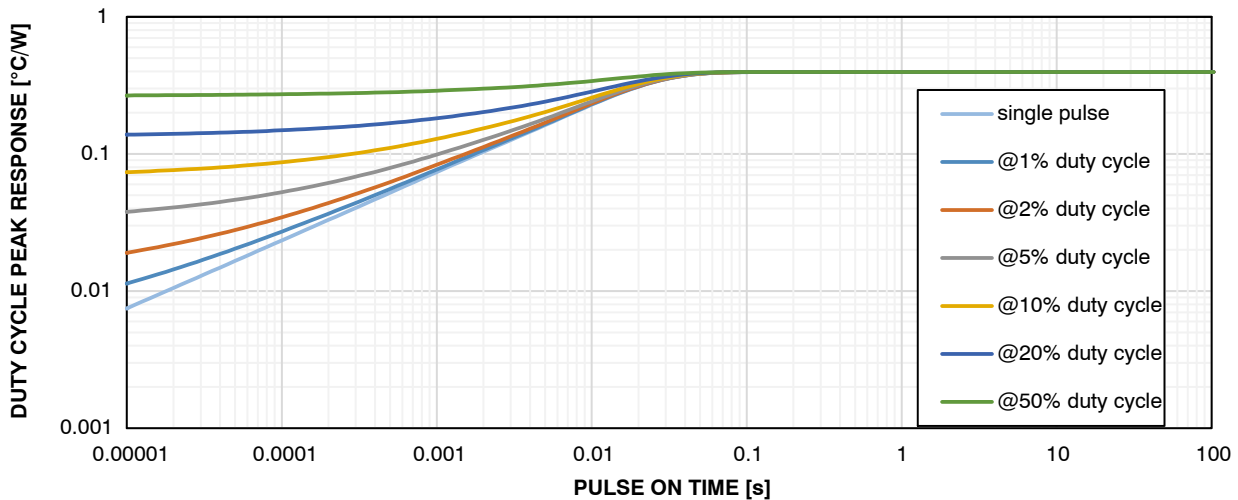


Figure 24. IGBT Junction-to-Case Transient Thermal Impedance

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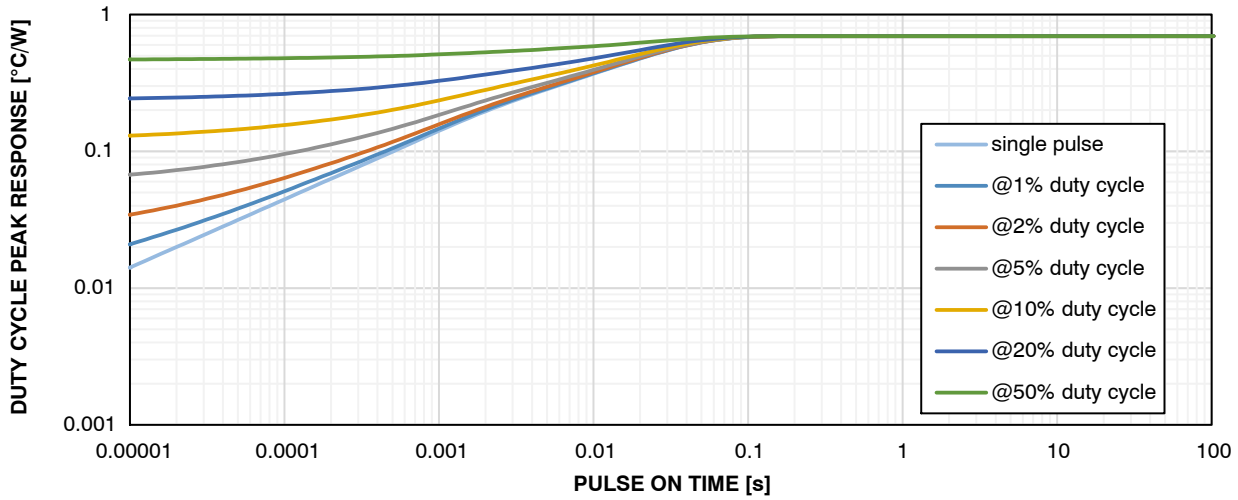


Figure 25. Diode Junction-to-Case Transient Thermal Impedance

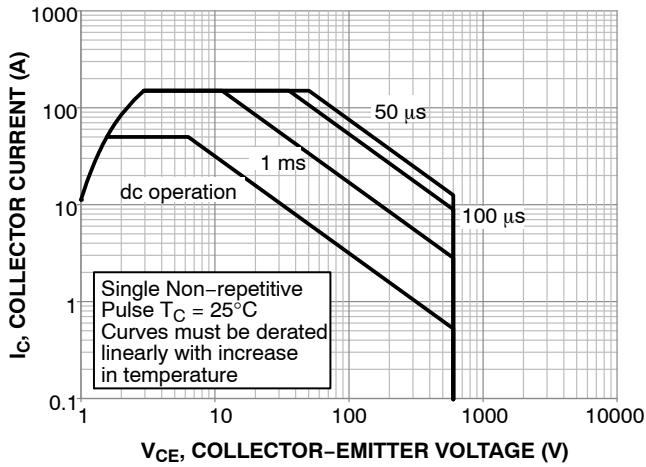


Figure 26. IGBT FBSOA

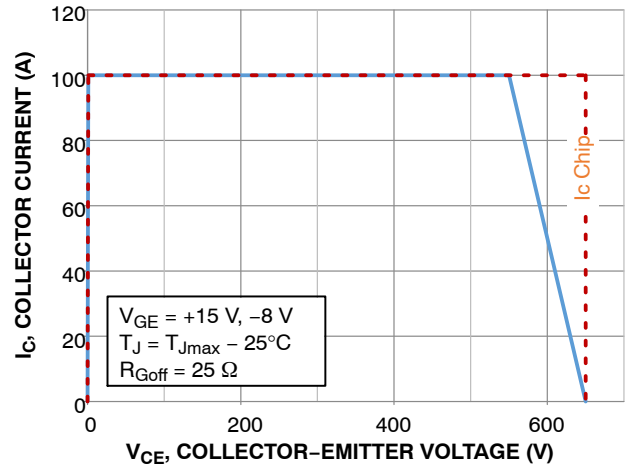


Figure 27. IGBT RBSOA

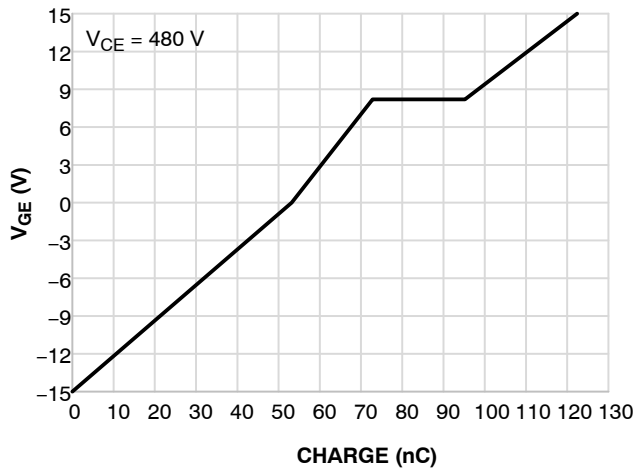


Figure 28. IGBT Gate Voltage vs. Gate Charge

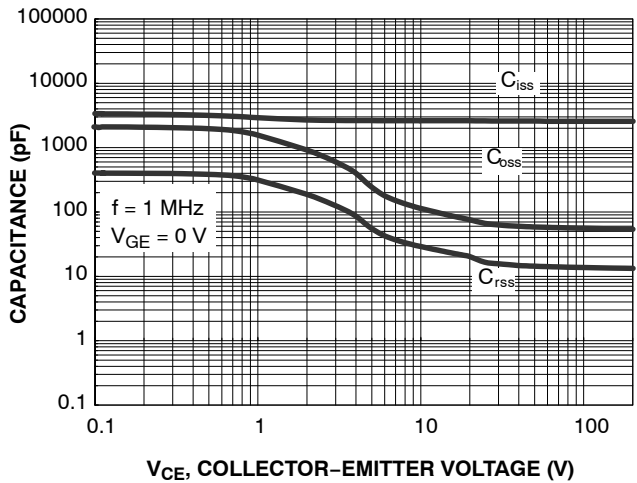


Figure 29. IGBT Capacitance vs. Collector-Emitter Voltage

NXH50M65L4C2ESG

TYPICAL CHARACTERISTICS – T1 – T2 PFC IGBT & D5 – D6 INVERSE DIODE

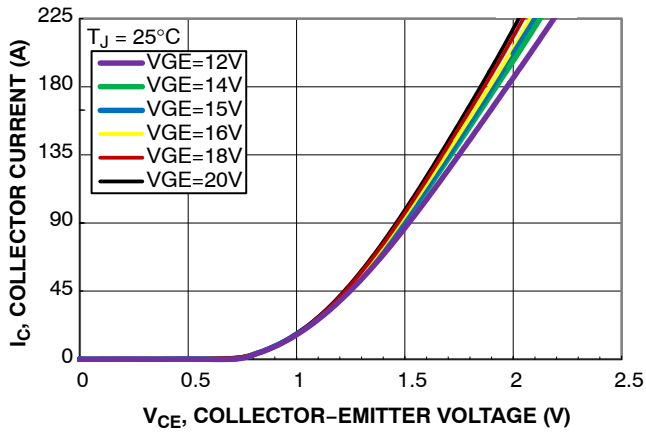


Figure 30. IGBT Typical Output Characteristic

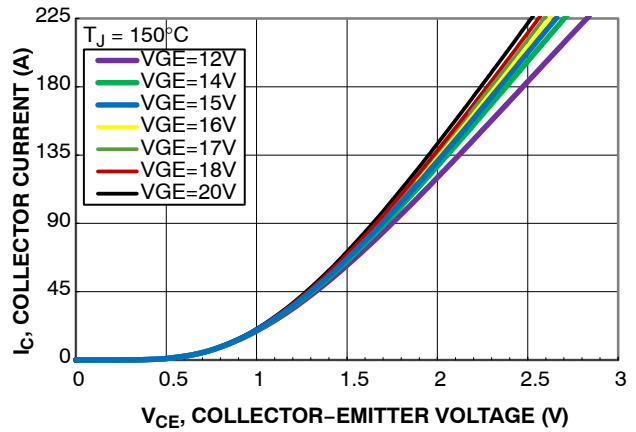


Figure 31. IGBT Typical Output Characteristic

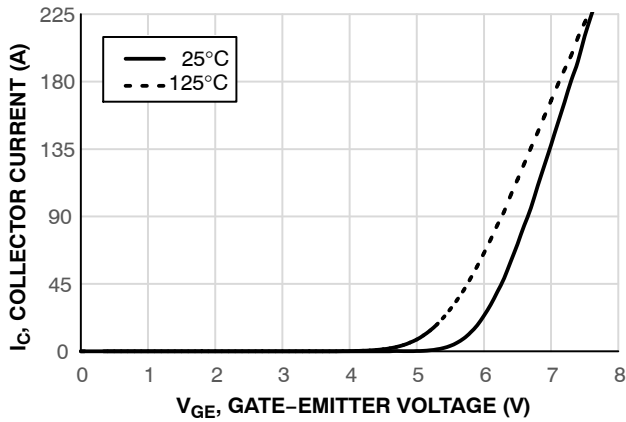


Figure 32. IGBT Typical Transfer Characteristic

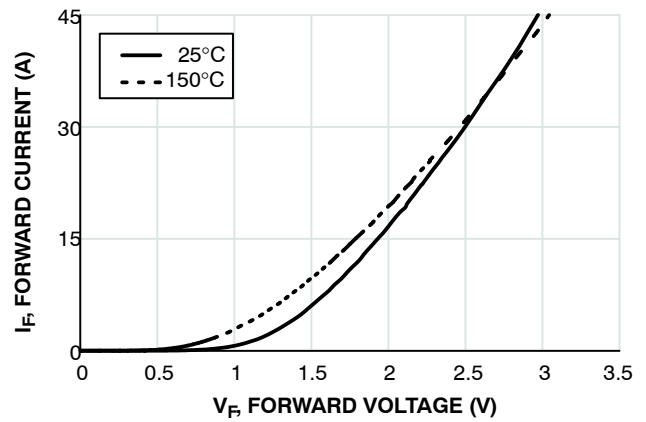


Figure 33. Diode Typical Forward Characteristic

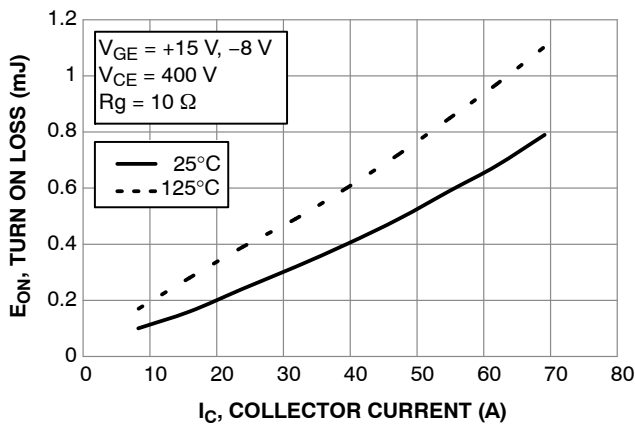


Figure 34. Typical Turn ON Loss vs. IC

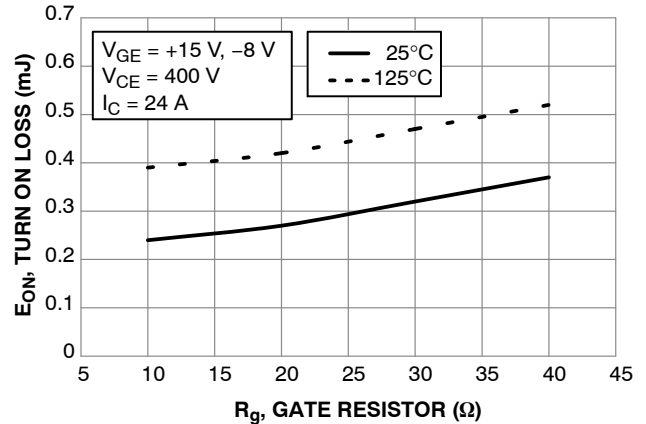


Figure 35. Typical Turn ON Loss vs. Rg

NXH50M65L4C2ESG

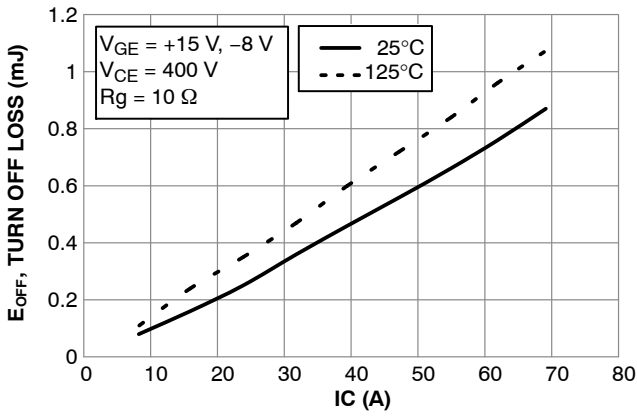


Figure 36. Typical Turn OFF Loss vs. IC

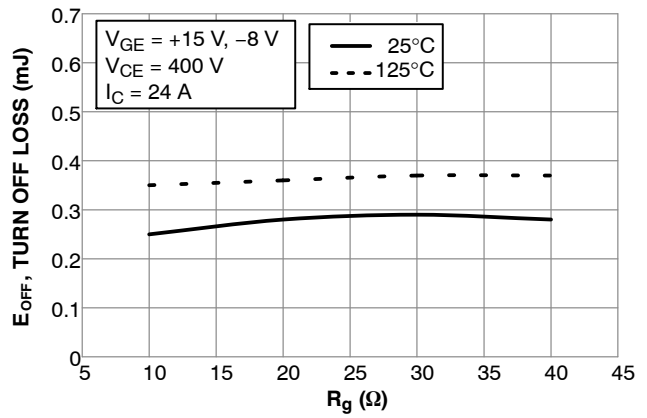


Figure 37. Typical Turn OFF Loss vs. Rg

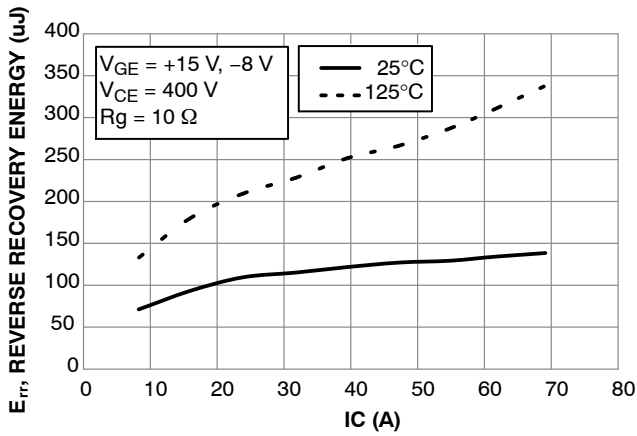


Figure 38. Typical Reverse Recovery Energy Loss vs. IC

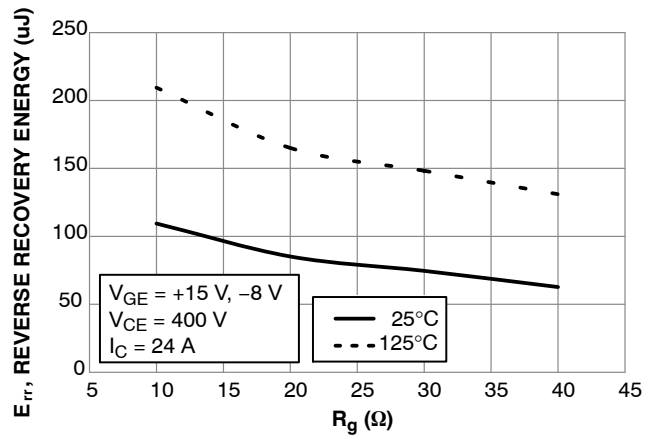


Figure 39. Typical Reverse Recovery Energy Loss vs. Rg

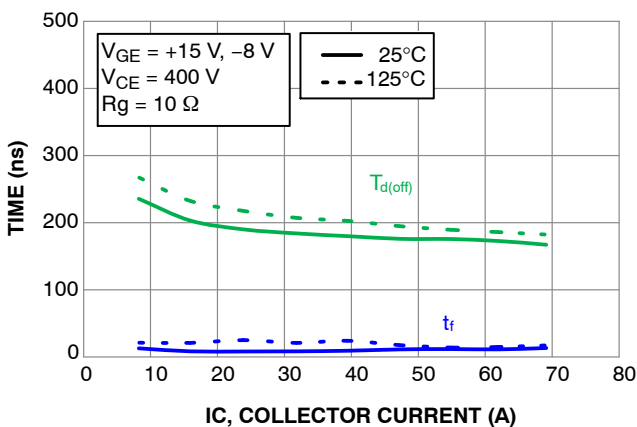


Figure 40. Typical Turn-Off Switching Time vs. IC

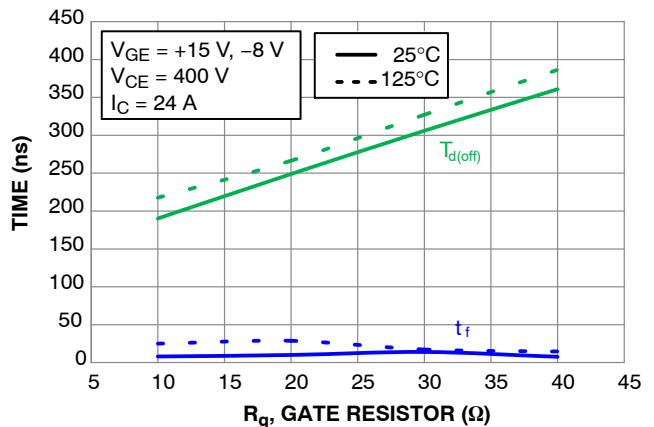


Figure 41. Typical Turn-Off Switching Time vs. Rg

NXH50M65L4C2ESG

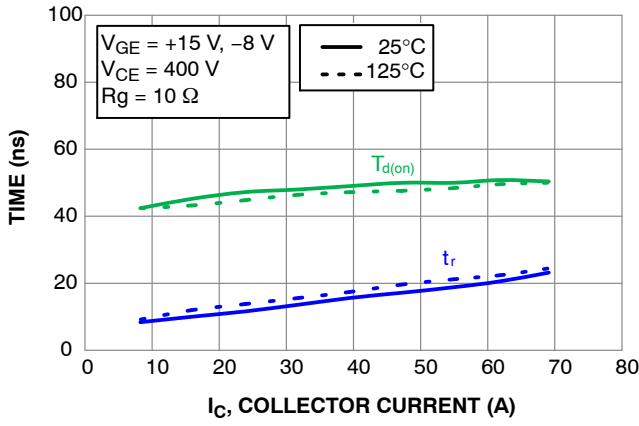


Figure 42. Typical Turn-On Switching Time vs. IC

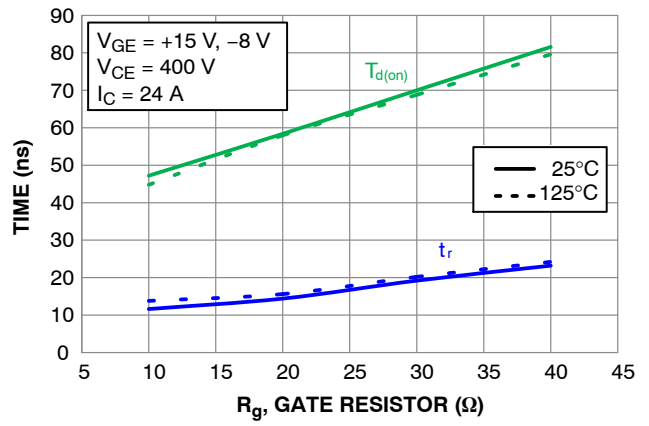


Figure 43. Typical Turn-Off Switching Time vs. Rg

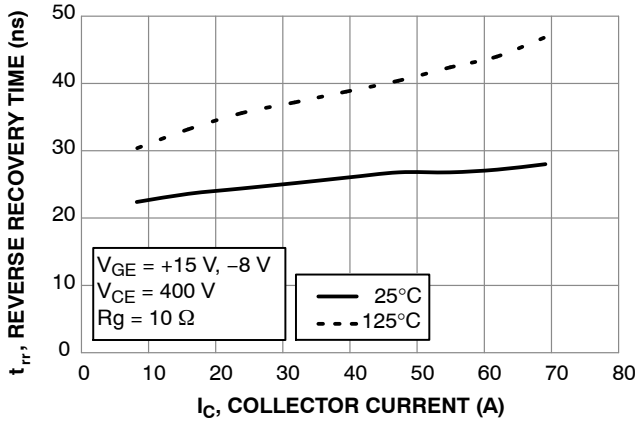


Figure 44. Typical Reverse Recovery Time vs. IC

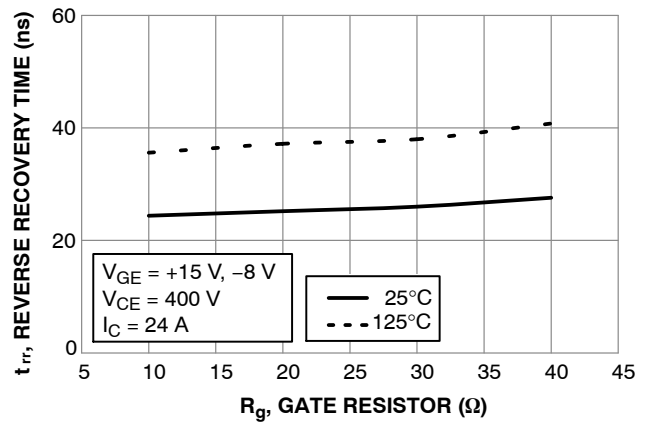


Figure 45. Typical Reverse Recovery Time vs. Rg

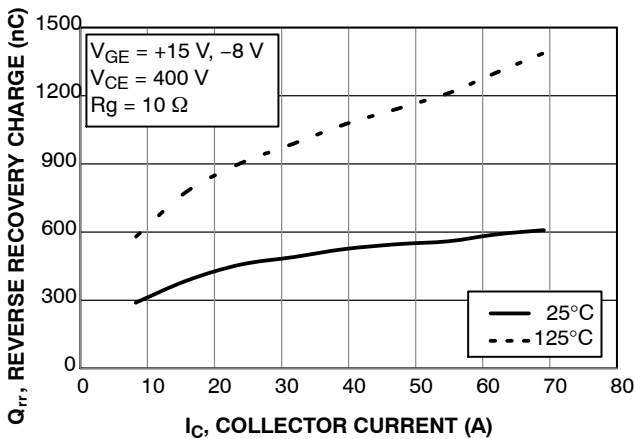


Figure 46. Typical Reverse Recovery Charge vs. IC

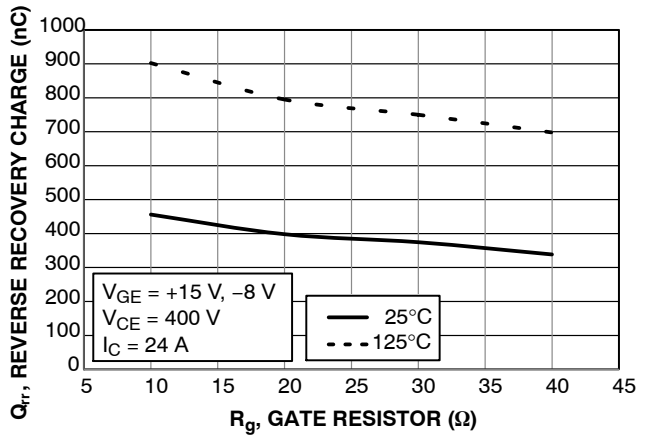


Figure 47. Typical Reverse Recovery Charge vs. Rg

NXH50M65L4C2ESG

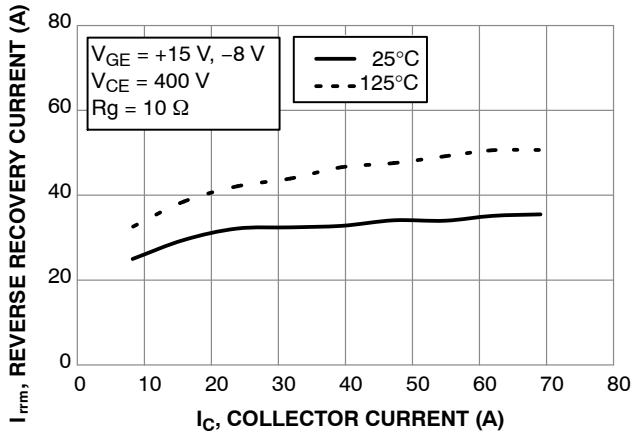


Figure 48. Typical Reverse Recovery Peak Current vs. I_C

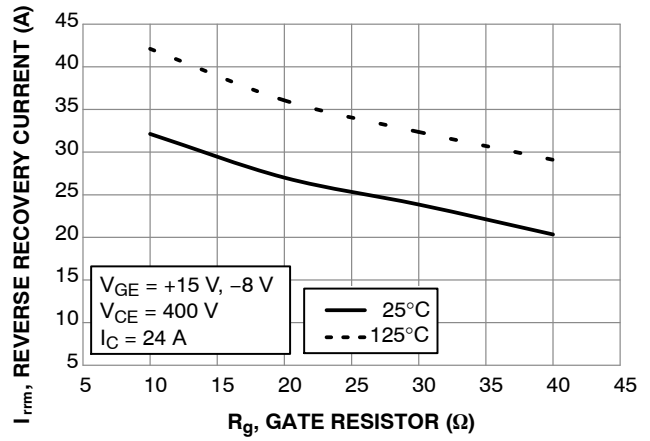


Figure 49. Typical Reverse Recovery Peak Current vs. R_g

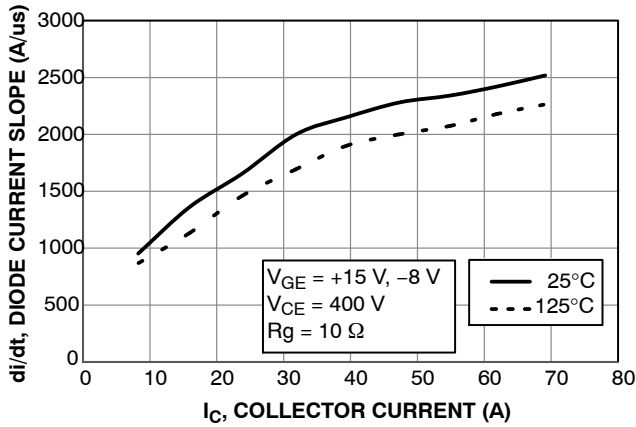


Figure 50. Typical di/dt Current Slope vs. I_C

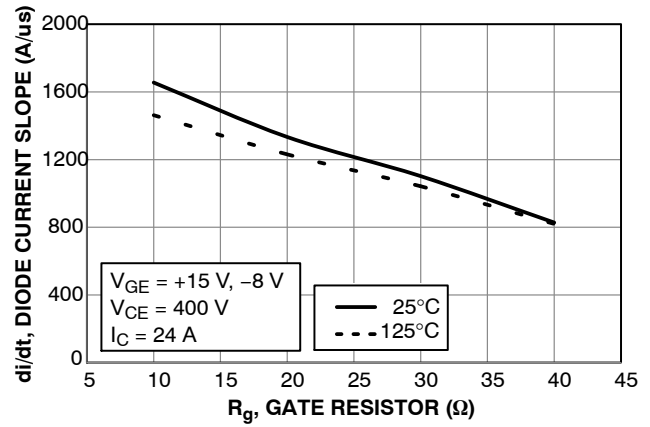


Figure 51. Typical di/dt Current Slope vs. R_g

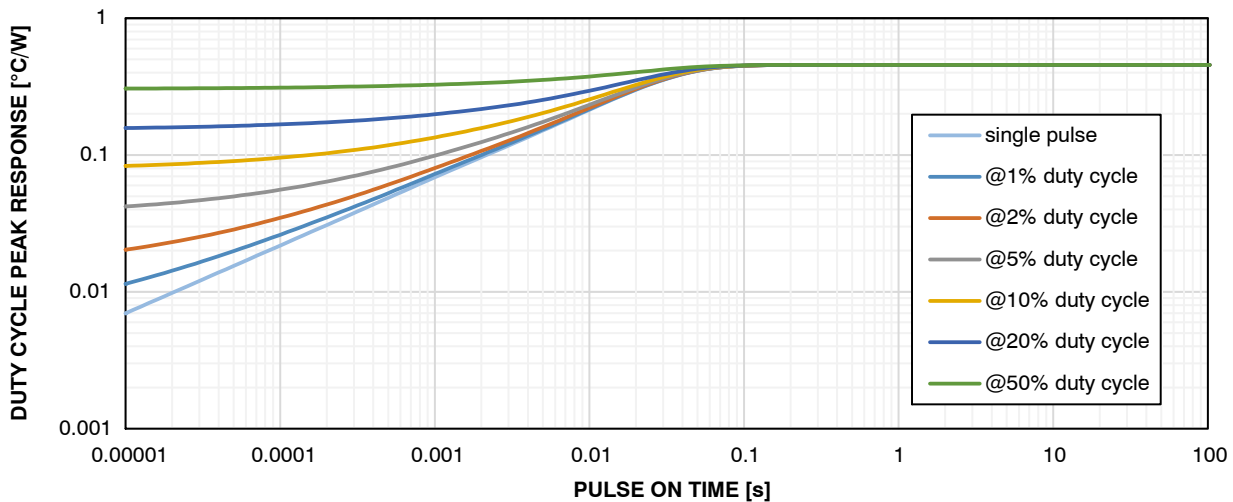


Figure 52. IGBT Junction-to-Case Transient Thermal Impedance

NXH50M65L4C2ESG

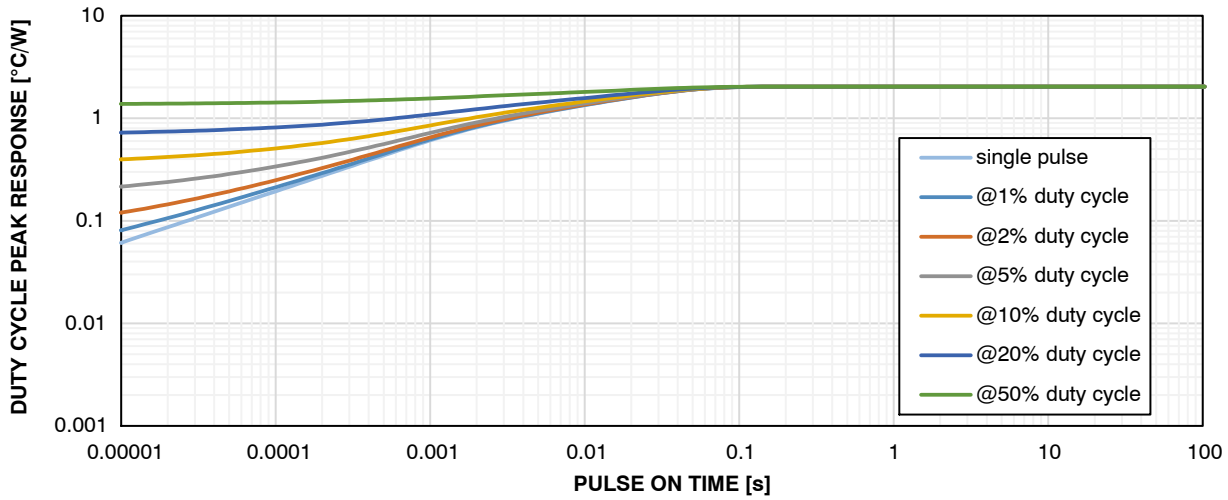


Figure 53. Diode Junction-to-Case Transient Thermal Impedance

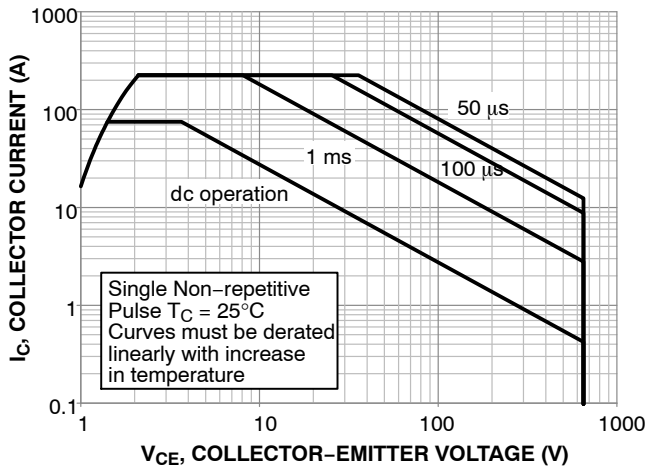


Figure 54. IGBT FBSOA

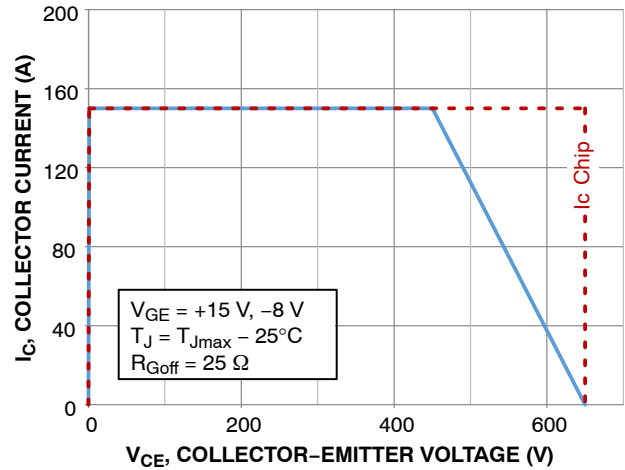


Figure 55. IGBT RBSOA

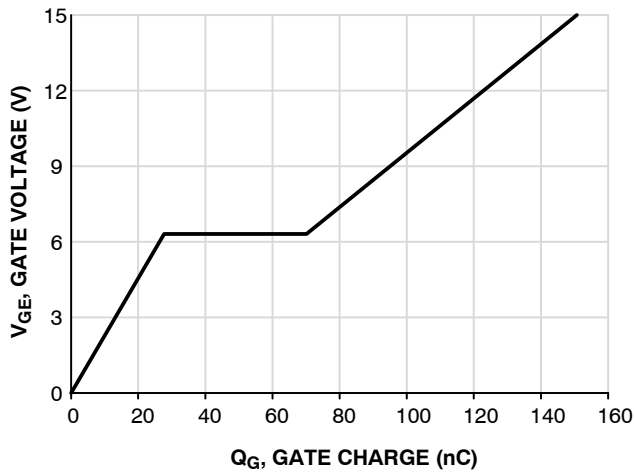


Figure 56. IGBT Gate Voltage vs. Gate Charge

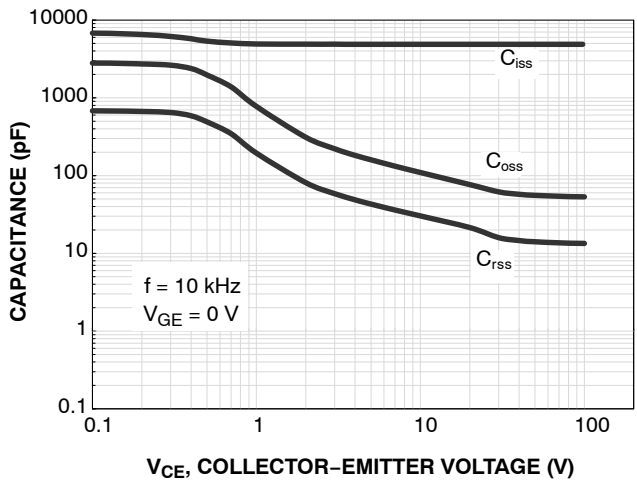


Figure 57. IGBT Capacitance vs. Collector-Emitter Voltage

NXH50M65L4C2ESG

TYPICAL CHARACTERISTICS – D7, D8 PFC DIODE & D1 – D4 CONVERTER DIODE

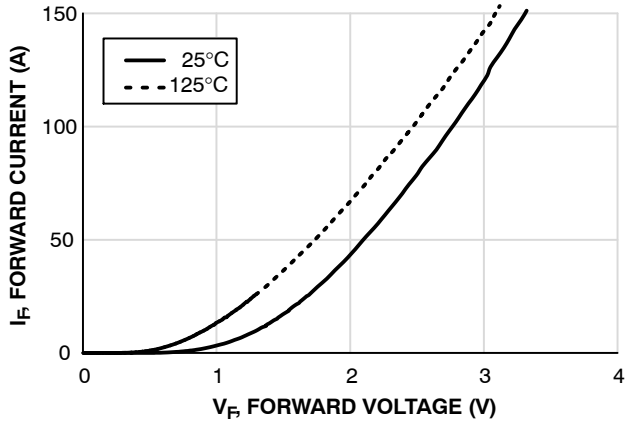


Figure 58. PFC Diode Forward Characteristics

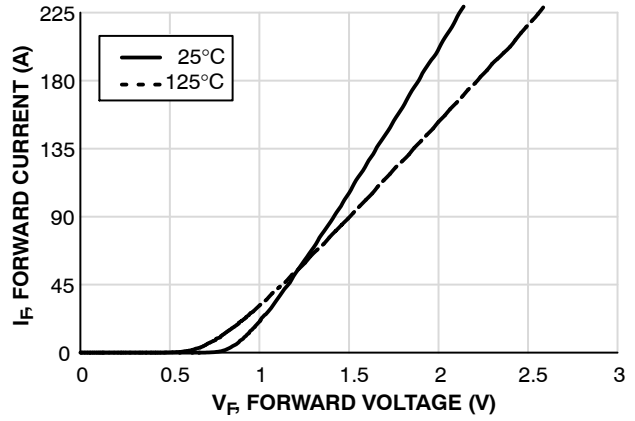


Figure 59. Converter Diode Forward Characteristics

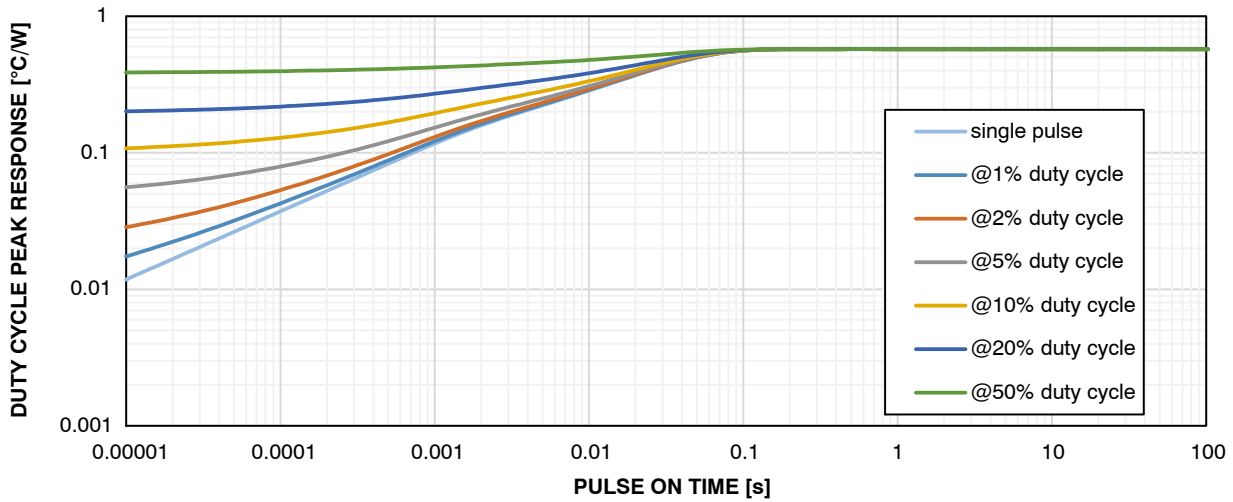


Figure 60. PFC Diode Junction-to-Case Transient Thermal Impedance

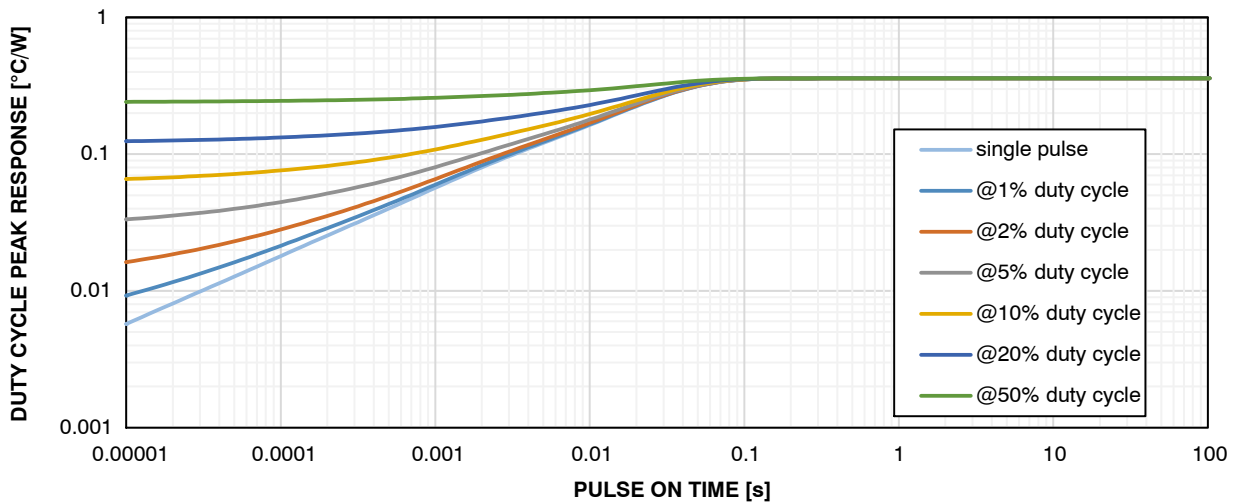


Figure 61. Converter Diode Junction-to-Case Transient Thermal Impedance

NXH50M65L4C2ESG

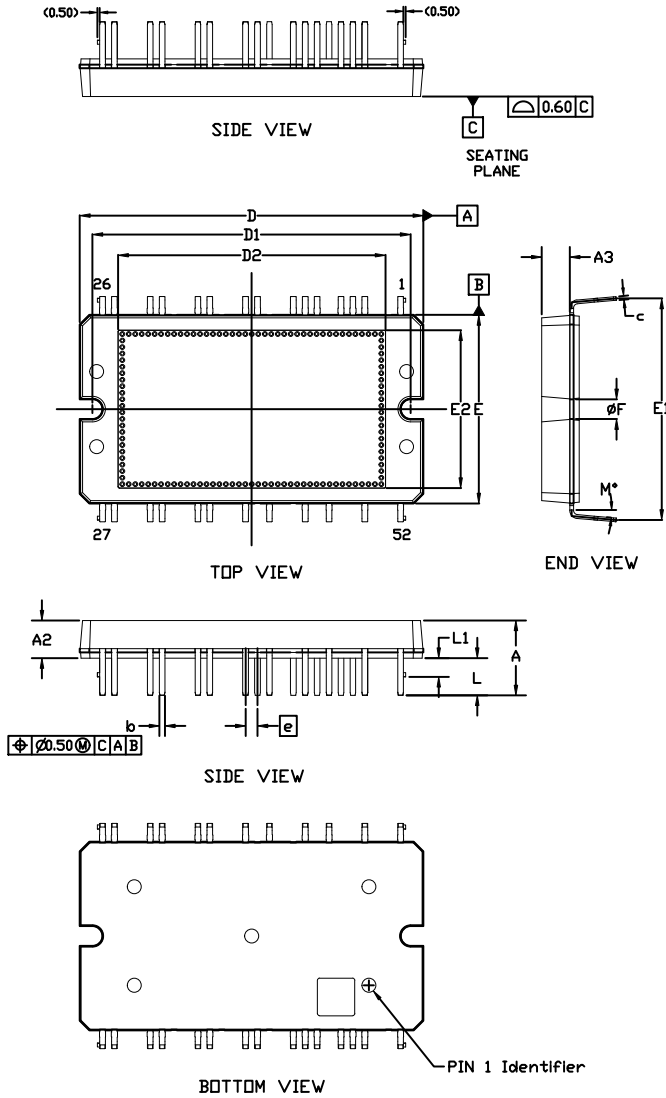
ORDERING INFORMATION

Device Order Number	Specific Device Marking	Package Type	Shipping
NXH50M65L4C2ESG	NXH50M65L4C2ESG	DIP27 73.2x40.2 (Pb-Free)	6 Units / Tube

NXH50M65L4C2ESG

PACKAGE DIMENSIONS

DIP27 73.2x40.2
CASE 184AA
ISSUE A



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
4. DIMENSIONS b AND c APPLY TO PLATED LEADS
5. POSITION OF THE LEADS IS DETERMINED AT THE ROOT OF THE LEAD WHERE IT EXITS THE PACKAGE BODY
6. MISSING PINS ARE 2,3,7,11,12,15,16,19,20,23,24,29, 30,33,34,37,38,40,42,43,45,47,48,50,51

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	15.50	16.00	16.50
A2	7.80	8.00	8.20
A3	6.00 REF		
b	1.10	1.20	1.30
c	0.70	0.80	0.90
D	72.70	73.20	73.70
D1	67.30	67.80	68.30
D2	57.30 REF		
E	39.70	40.20	40.70
E1	46.70	47.20	47.70
E2	33.87 REF		
e	2.54 BSC		
F	4.00	4.20	4.40
L	8.00 REF		
L1	3.50	4.00	4.50
M	4°	5°	6°

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