

TMPIM 650 V 50 A Converter-Inverter-PFCs Module

Product Preview

NXH50M65L4C2ESG

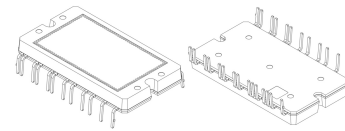
The NXH50M65L4C2ESG is a transfer-molded power module with advanced substrate containing a converter-inverter-PFC circuit consisting of single phase converter with four 75 A, 1600 V rectifiers, six 50 A, 600 V IGBTs with inverse diodes, 2-Channel interleaved PFC containing two 75 A, 650 V PFC IGBT with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

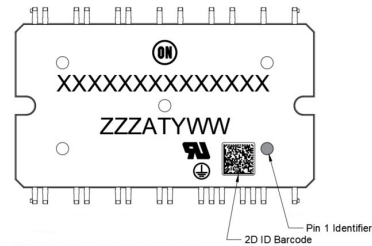
Typical Applications

- Industrial Motor Drives
- Servo Drives



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.

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

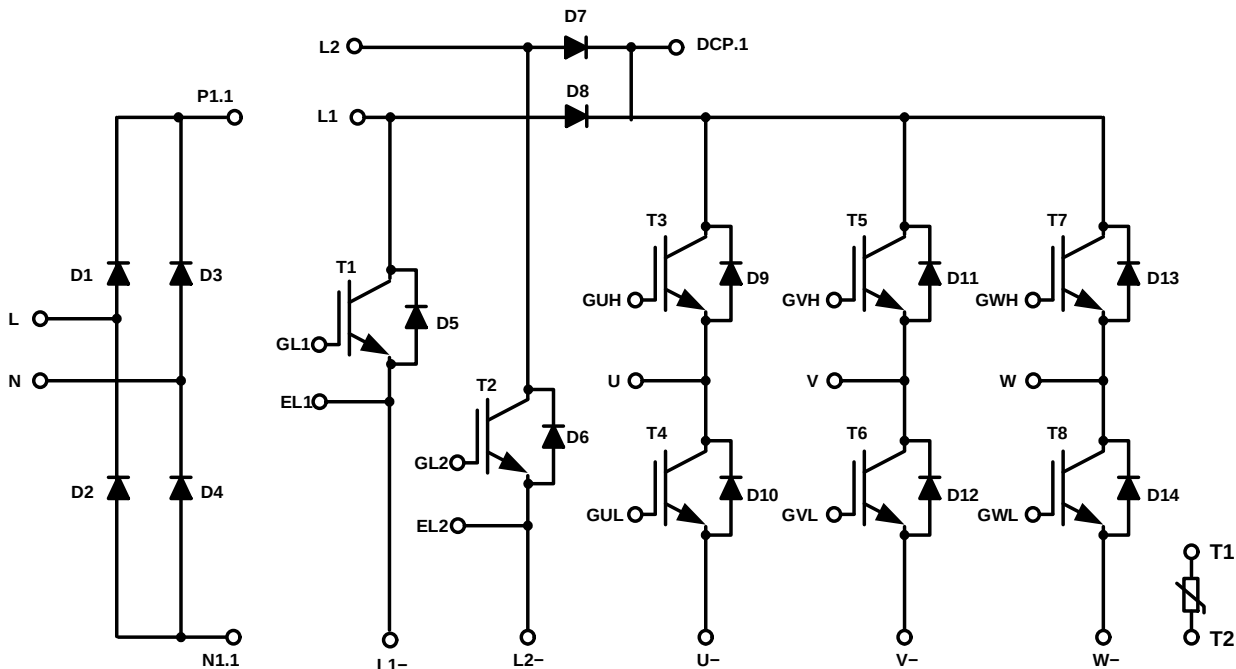


Figure 1. NXH50M65L4C2ESG Schematic Diagram

NXH50M65L4C2ESG

PIN CONFIGURATION TABLE

Pin	Name
1	N1.1
2	L1-
3	EL1
4	GL1
5	L2-
6	EL2
7	GL2
8	U-
9	GuL
10	V-
11	GvL
12	W-
13	GwL
14	T1
15	T2
16	Gwh
17	W
18	Gvh
19	V
20	Guh
21	U
22	DCP.1
23	L2
24	L1
25	P1.1
26	N
27	L

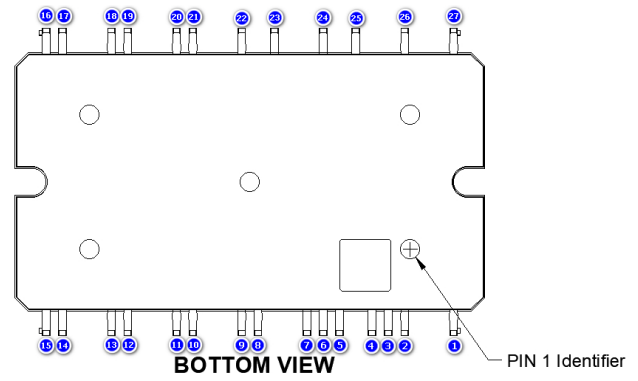


Figure 2. Pin Configuration

NXH50M65L4C2ESG

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 @ $T_c = 80^\circ\text{C}$ ($T_{vjmax} = 175^\circ\text{C}$)	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 @ $T_c = 80^\circ\text{C}$ ($T_{vjmax} = 175^\circ\text{C}$)	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 @ $T_c = 80^\circ\text{C}$ ($T_{vjmax} = 175^\circ\text{C}$)	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 @ $T_c = 80^\circ\text{C}$ ($T_{vjmax} = 175^\circ\text{C}$)	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 @ $T_c = 80^\circ\text{C}$ ($T_{vjmax} = 175^\circ\text{C}$)	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 @ $T_c = 80^\circ\text{C}$ ($T_{vjmax} = 150^\circ\text{C}$)	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	I_{FSM}	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 _{RPM}	–	32	–	A
Reverse Recovery Energy		E _{rr}	–	109	–	μJ

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

Parameter	Test Condition	Symbol	Min	Typ	Max	Unit
PFC DIODE CHARACTERISTICS (D7, D8)						
Reverse Recovery Time	$T_J = 125^\circ\text{C}$ $V_{CE} = 400\text{ V}$, $I_C = 24\text{ A}$ $V_{GE} = +15\text{ V} / -8\text{ V}$, $R_G = 10\ \Omega$	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	$^\circ\text{C}$
Thermal Resistance – Chip-to-Case		R_{thJC}	–	0.58	–	$^\circ\text{C/W}$
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness $\approx 3\text{ mil}$, $\lambda = 2.8\text{ W/mK}$	R_{thJH}	–	0.87	–	$^\circ\text{C/W}$

CONVERTER DIODE CHARACTERISTICS (D1–D4)

Rectifier Reverse Leakage Current	$V_R = 1600\text{ V}$	I_R	–	–	200	μA
Rectifier Forward Voltage	$I_F = 75\text{ A}$, $T_J = 25^\circ\text{C}$	V_F	–	1.3	1.7	V
	$I_F = 75\text{ A}$, $T_J = 150^\circ\text{C}$		–	1.4	–	
Temperature under Switching Conditions		$T_{vj\ op}$	–40		150	$^\circ\text{C}$
Thermal Resistance – Chip-to-Case		R_{thJC}	–	0.36	–	$^\circ\text{C/W}$
Thermal Resistance – Chip-to-Heatsink	Thermal grease, Thickness $\approx 3\text{ mil}$, $\lambda = 2.8\text{ W/mK}$	R_{thJH}	–	0.64	–	$^\circ\text{C/W}$

THERMISTOR CHARACTERISTICS

Nominal Resistance	$T = 25^\circ\text{C}$	R_{25}	–	5	–	$\text{k}\Omega$
Nominal Resistance	$T = 100^\circ\text{C}$	R_{100}	–	493.3	–	Ω
Deviation of R25		$\Delta R/R$	–5	–	5	%
Power Dissipation		P_D	–	20	–	mW
Power Dissipation Constant			–	1.4	–	mW/K
B-value	B (25/50), tolerance $\pm 2\%$		–	3375	–	K
B-value	B (25/100), tolerance $\pm 2\%$		–	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.

NXH50M65L4C2ESG

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

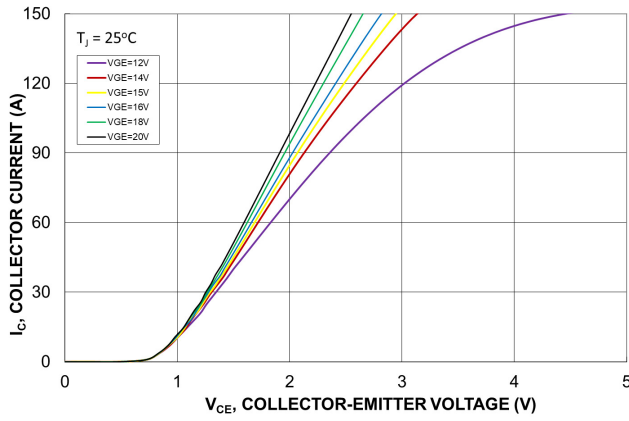


Figure 3. IGBT Typical Output Characteristics

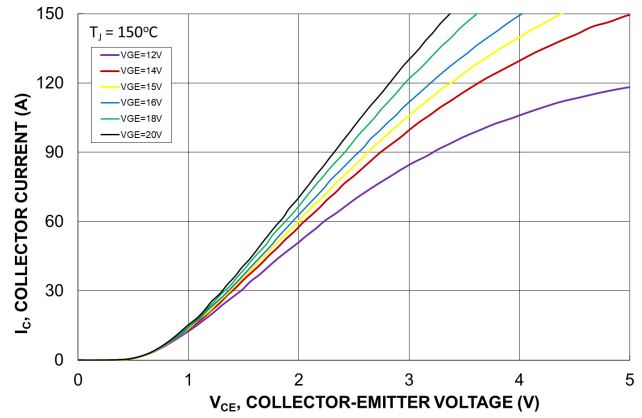


Figure 4. IGBT Typical Output Characteristics

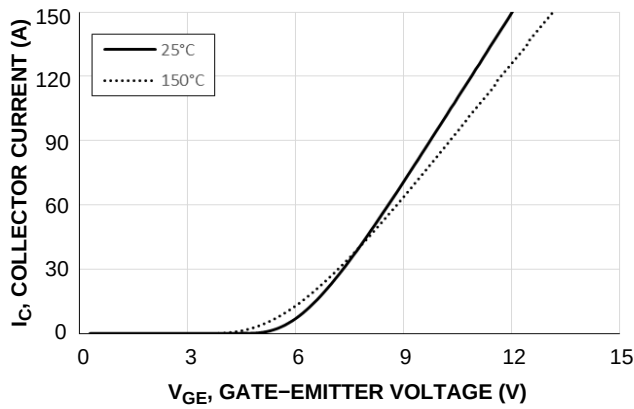


Figure 5. Typical Transfer Characteristics

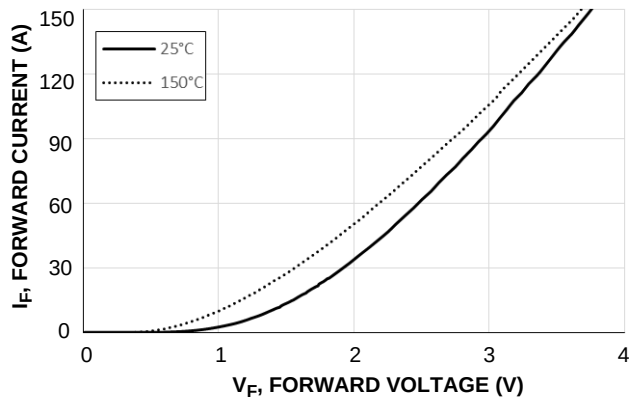


Figure 6. Diode Typical Forward Characteristics

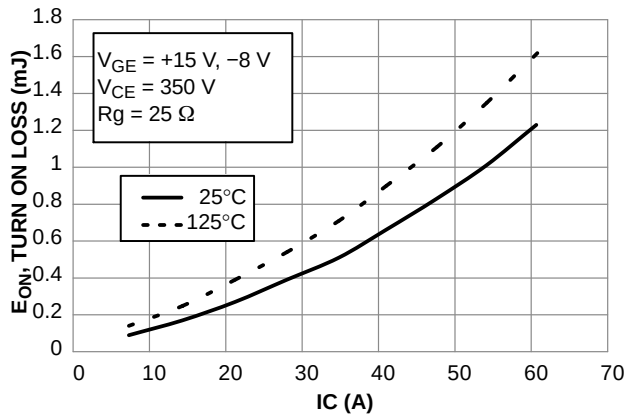


Figure 7. Typical Turn ON Loss vs. IC

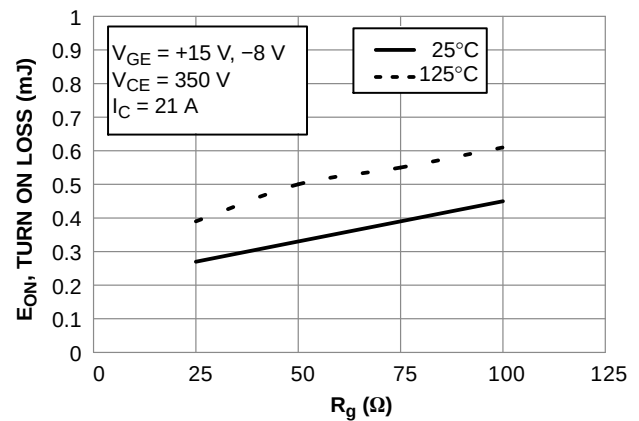


Figure 8. Typical Turn ON Loss vs. Rg

NXH50M65L4C2ESG

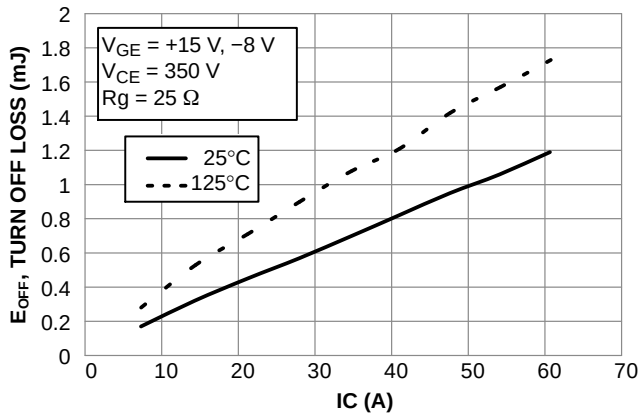


Figure 9. Typical Turn OFF Loss vs. IC

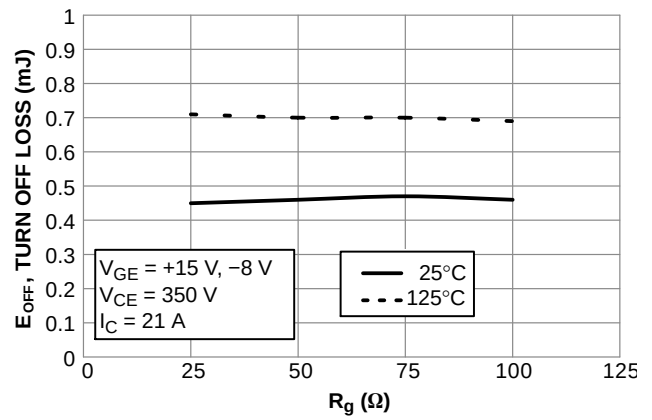


Figure 10. Typical Turn OFF Loss vs. Rg

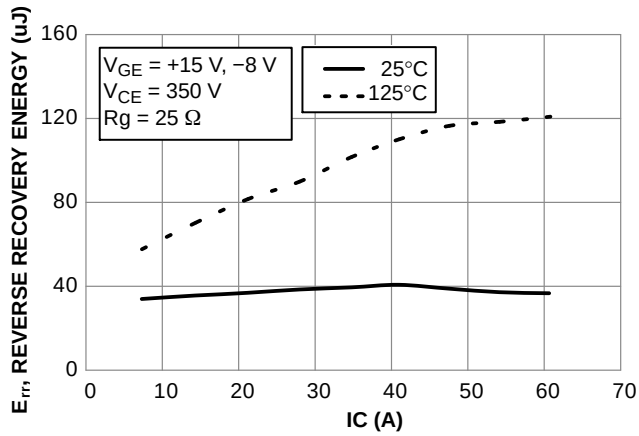


Figure 11. Typical Reverse Recovery Energy Loss vs. IC

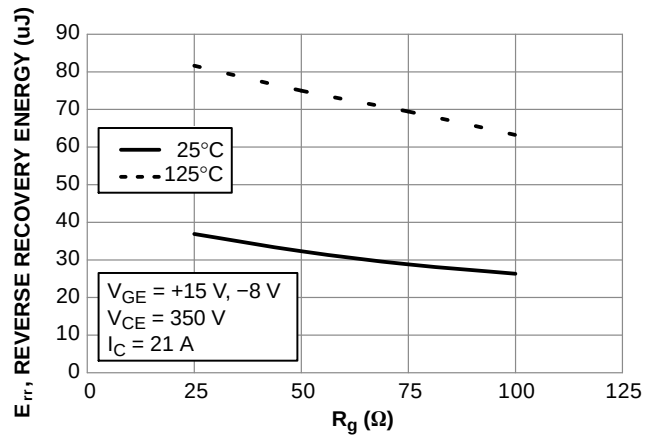


Figure 12. Typical Reverse Recovery Energy Loss vs. Rg

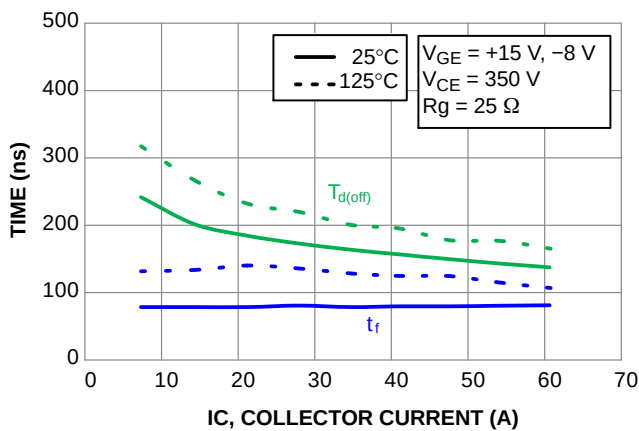


Figure 13. Typical Turn-Off Switching Time vs. IC

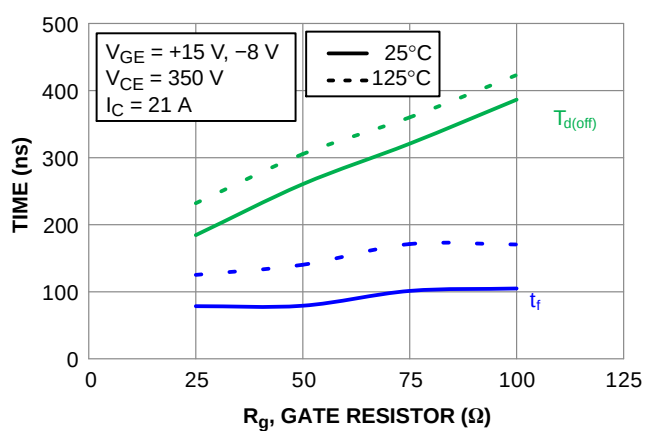


Figure 14. Typical Turn-Off Switching Time vs. Rg

NXH50M65L4C2ESG

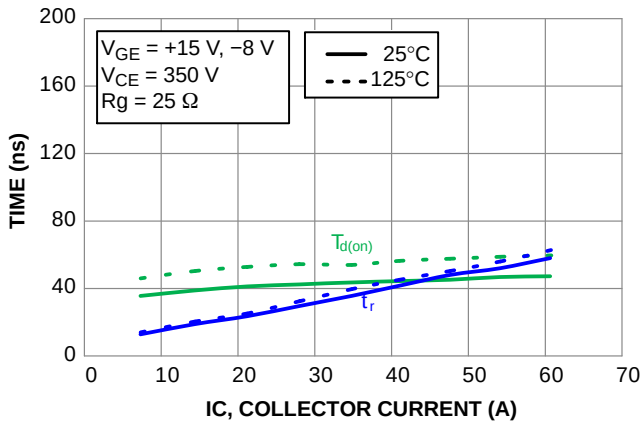


Figure 15. Typical Turn-On Switching Time vs. IC

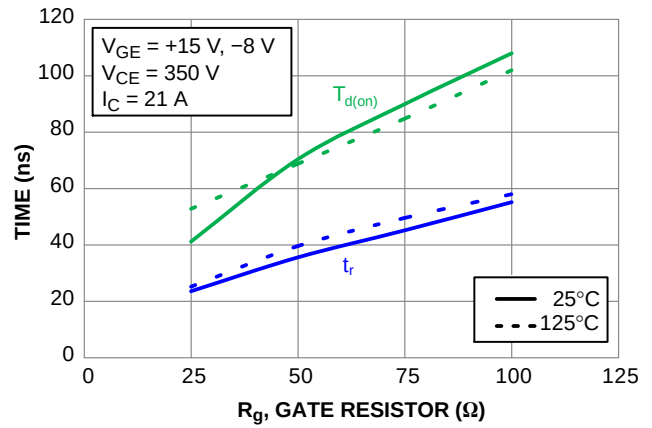


Figure 16. Typical Turn-Off Switching Time vs. Rg

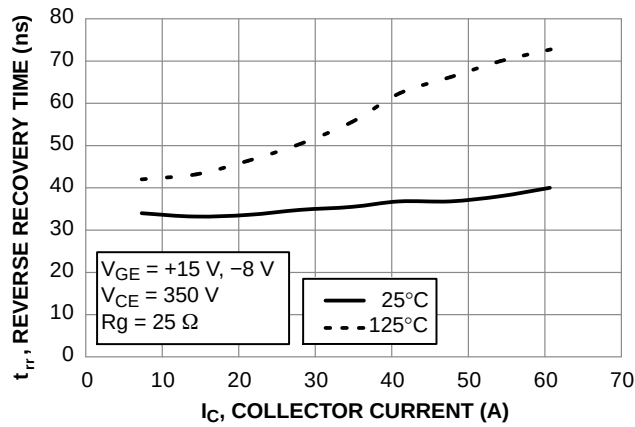


Figure 17. Typical Reverse Recovery Time vs. IC

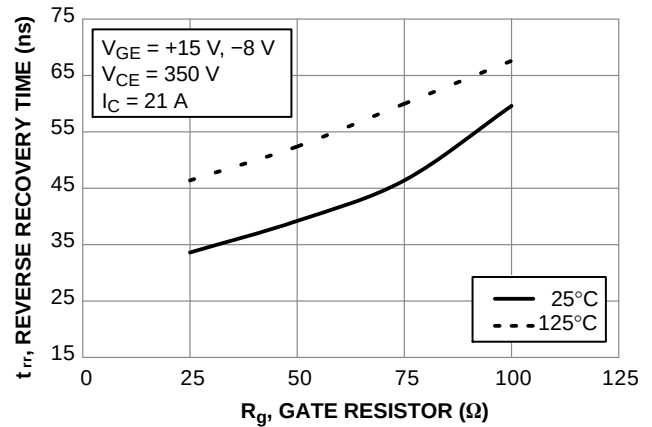


Figure 18. Typical Reverse Recovery Time vs. Rg

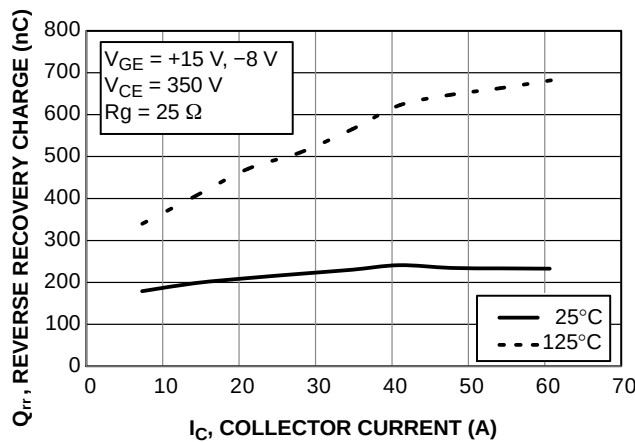


Figure 19. Typical Reverse Recovery Charge vs. IC

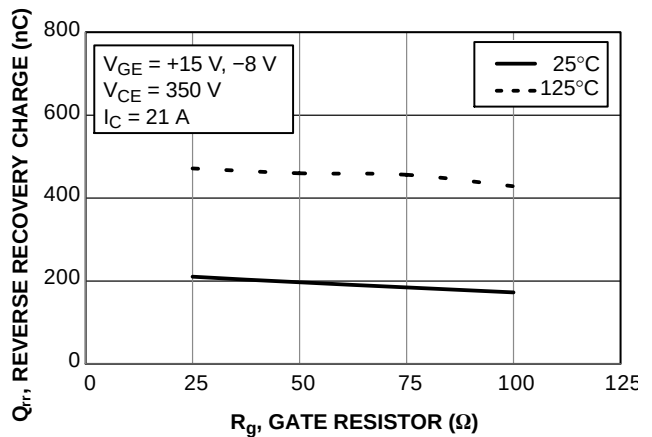


Figure 20. Typical Reverse Recovery Charge vs. Rg

NXH50M65L4C2ESG

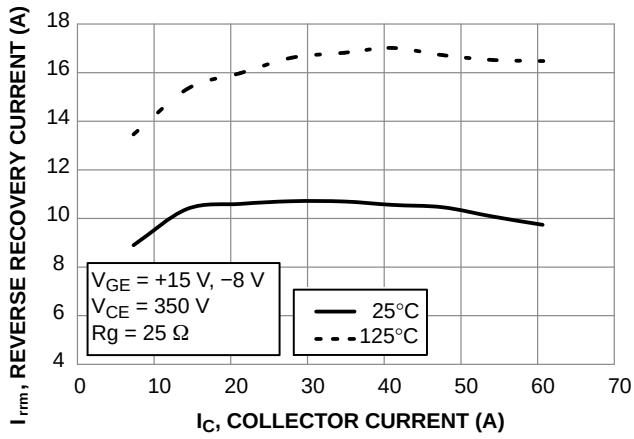


Figure 21. Typical Reverse Recovery Peak Current vs. IC

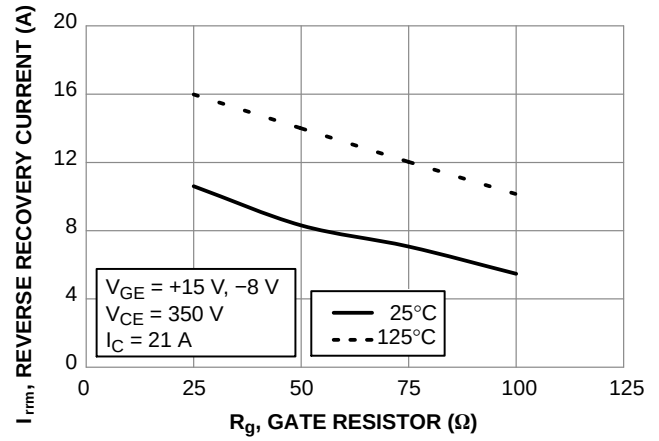


Figure 22. Typical Reverse Recovery Peak Current vs. RG

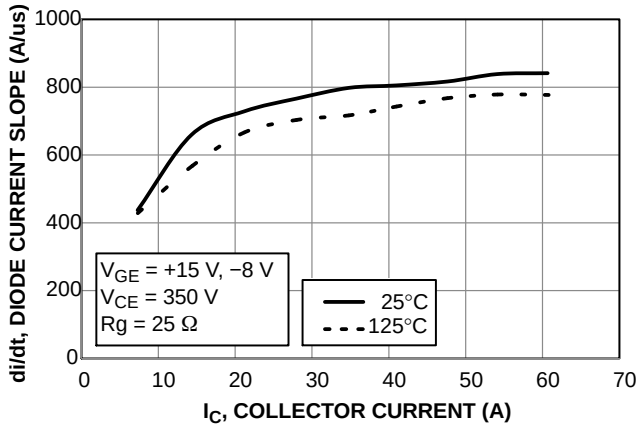


Figure 23. Typical di/dt Current Slope vs. IC

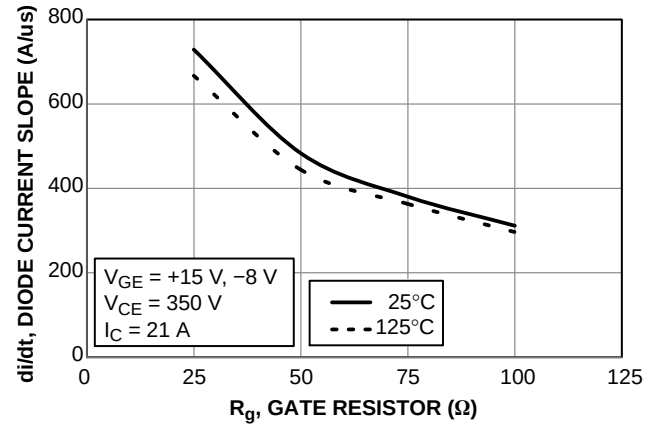


Figure 24. Typical di/dt Current Slope vs. RG

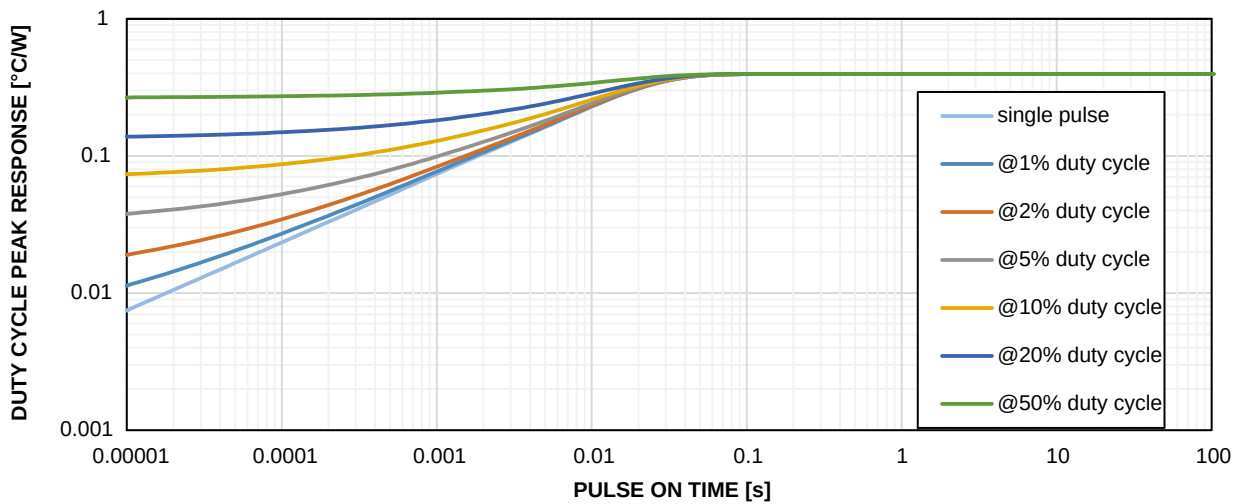


Figure 25. IGBT Junction-to-Case Transient Thermal Impedance

NXH50M65L4C2ESG

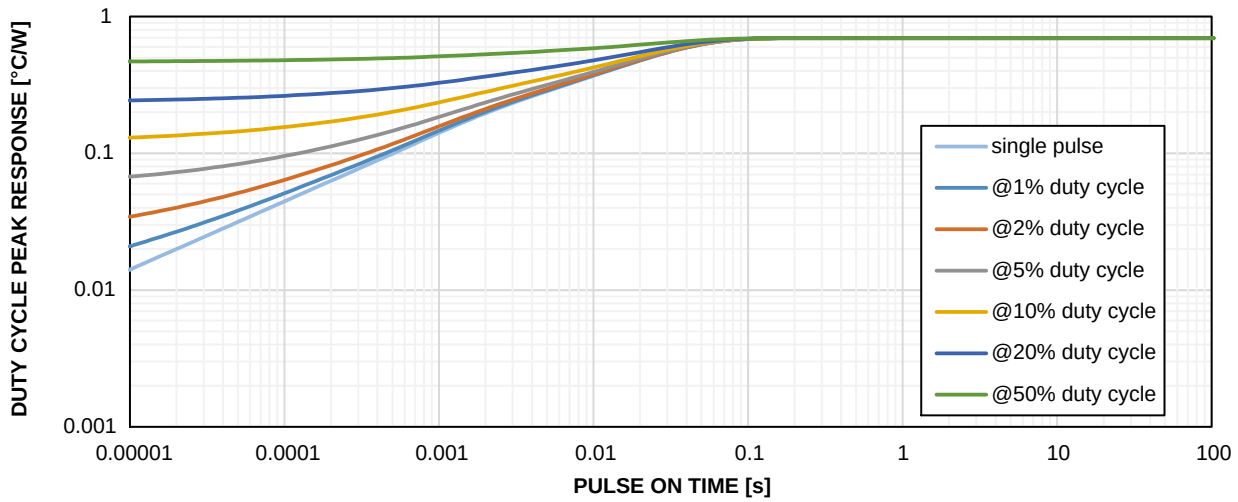


Figure 26. Diode Junction-to-Case Transient Thermal Impedance

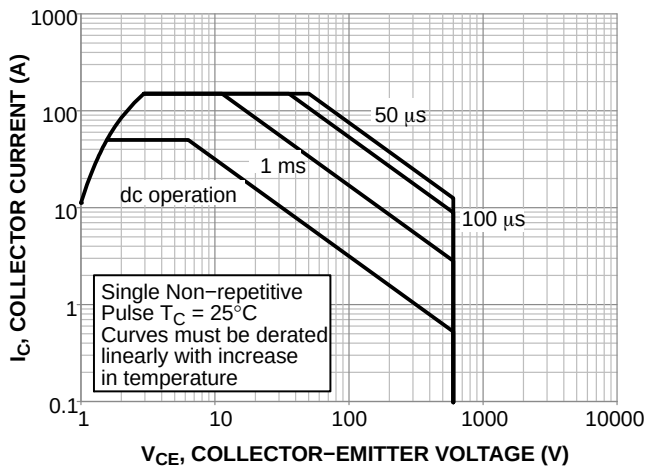


Figure 27. IGBT FBSOA

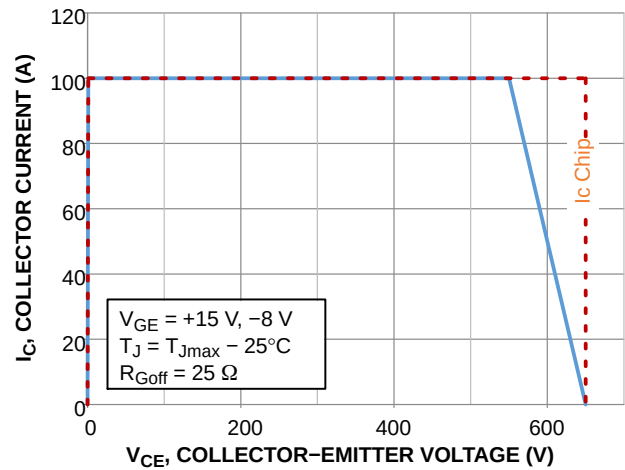


Figure 28. IGBT RBSOA

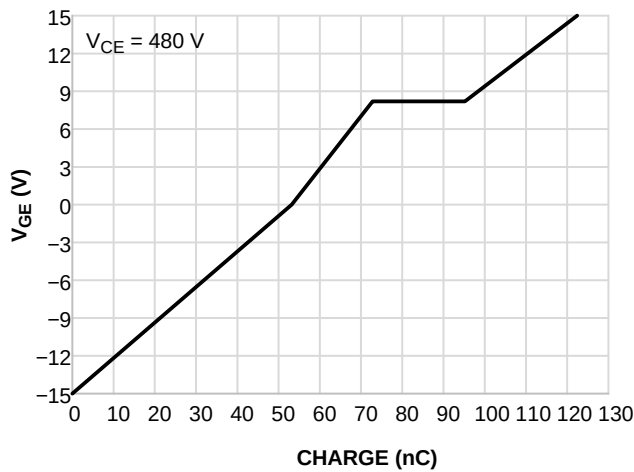


Figure 29. IGBT Gate Voltage vs. Gate Charge

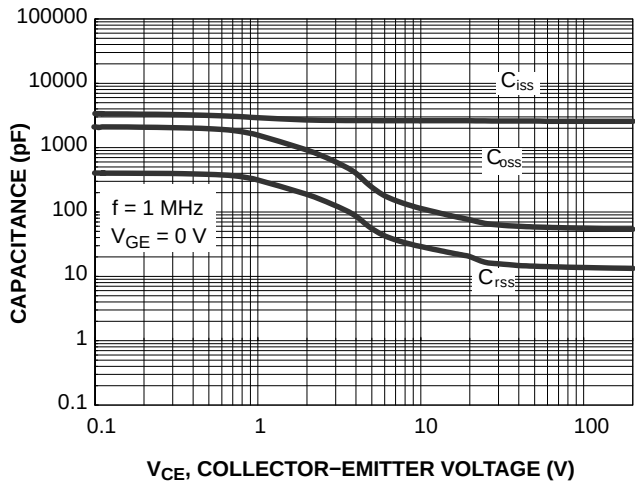


Figure 30. IGBT Capacitance vs. Collector-Emitter Voltage

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

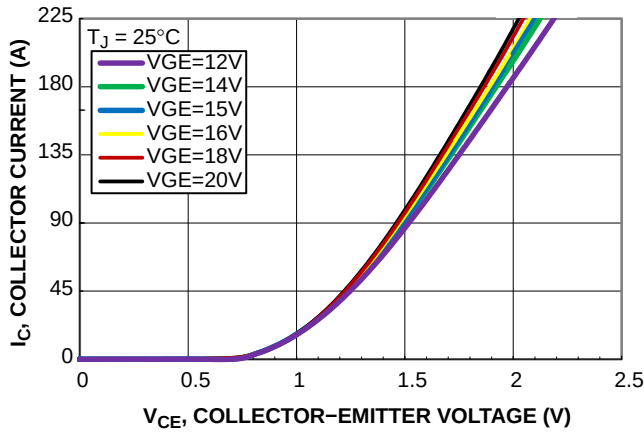


Figure 31. IGBT Typical Output Characteristic

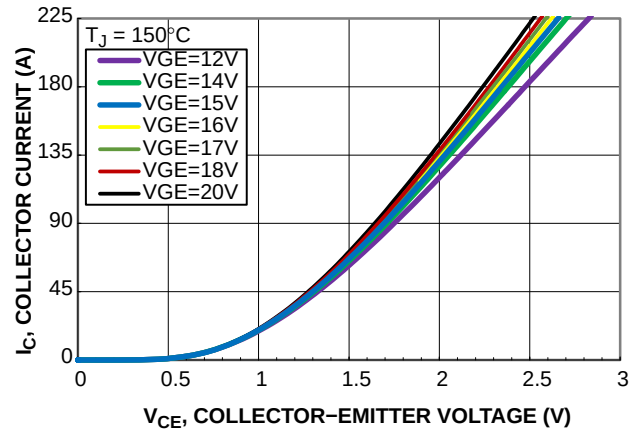


Figure 32. IGBT Typical Output Characteristic

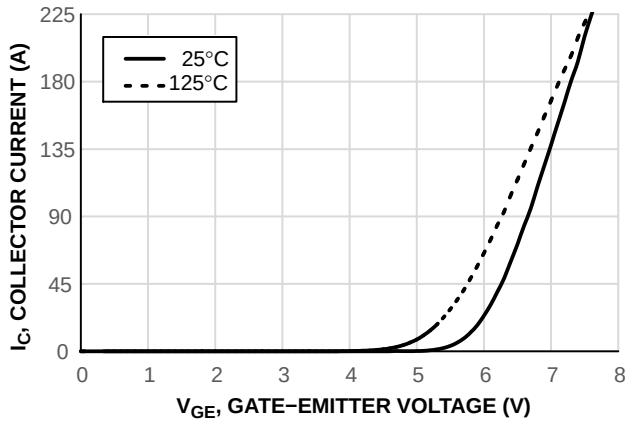


Figure 33. IGBT Typical Transfer Characteristic

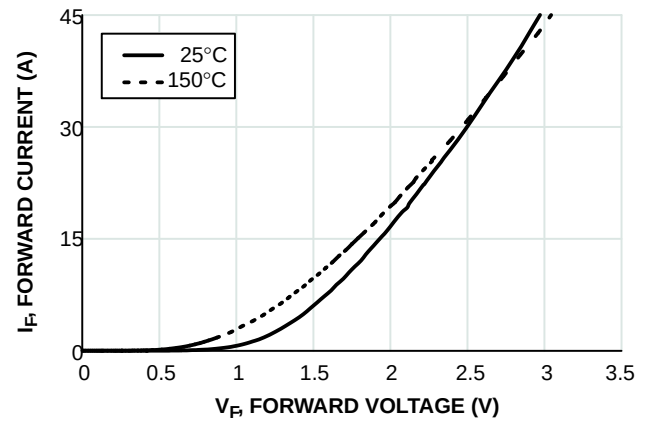


Figure 34. Diode Typical Forward Characteristic

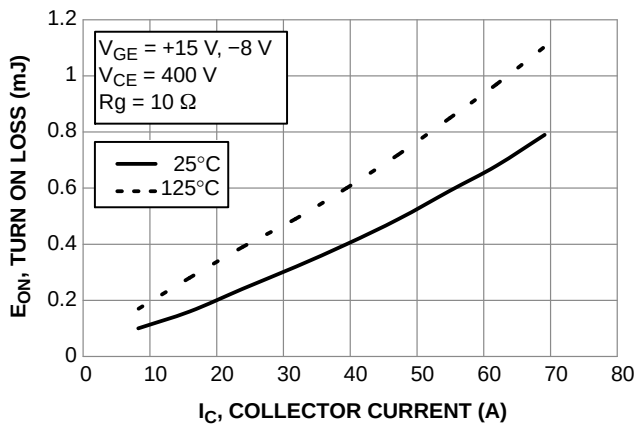


Figure 35. Typical Turn ON Loss vs. IC

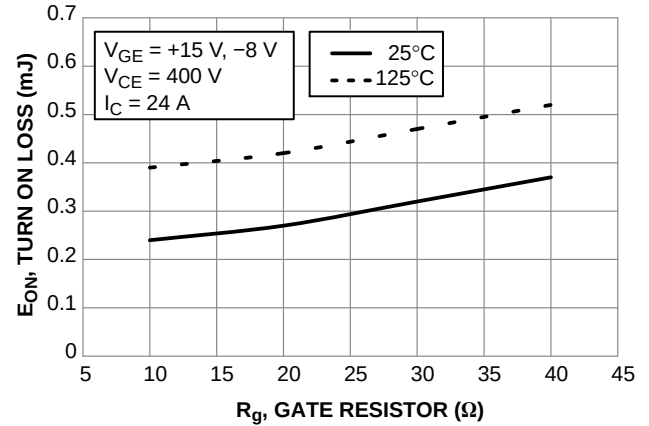


Figure 36. Typical Turn ON Loss vs. Rg

NXH50M65L4C2ESG

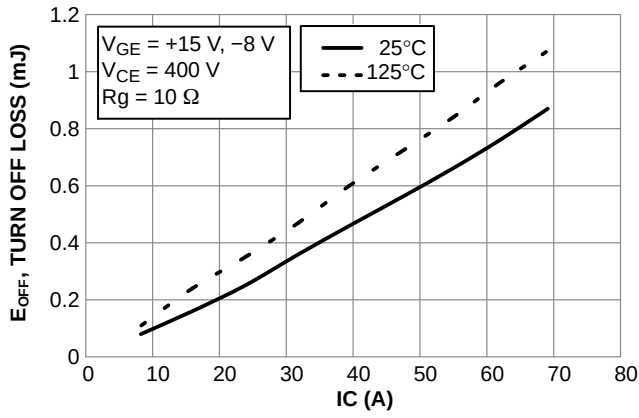


Figure 37. Typical Turn OFF Loss vs. IC

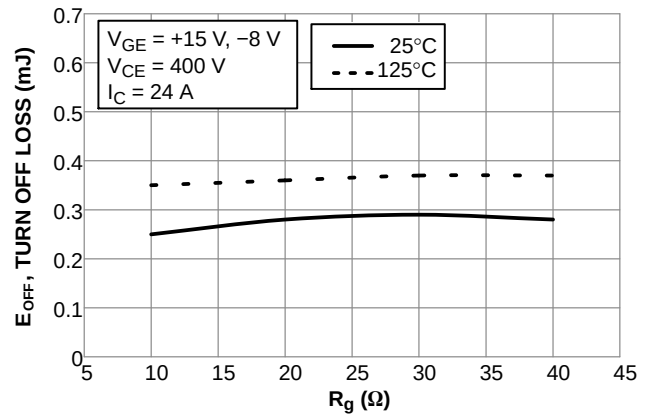


Figure 38. Typical Turn OFF Loss vs. Rg

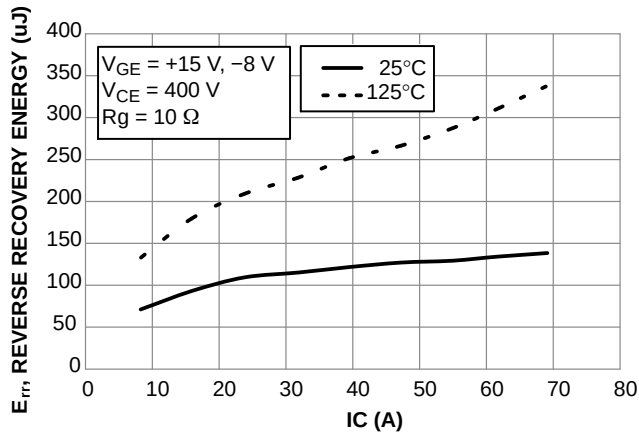


Figure 39. Typical Reverse Recovery Energy Loss vs. IC

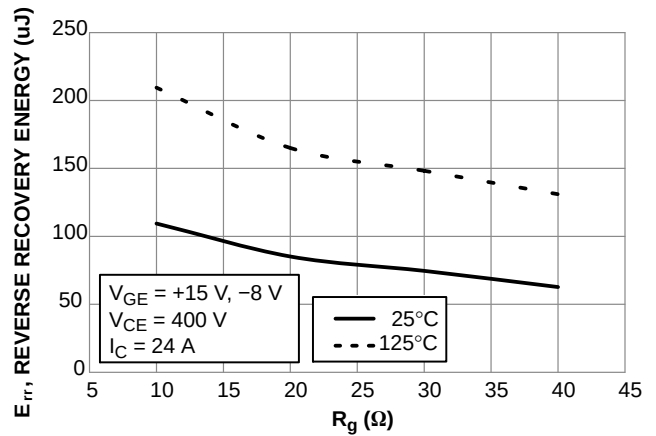


Figure 40. Typical Reverse Recovery Energy Loss vs. Rg

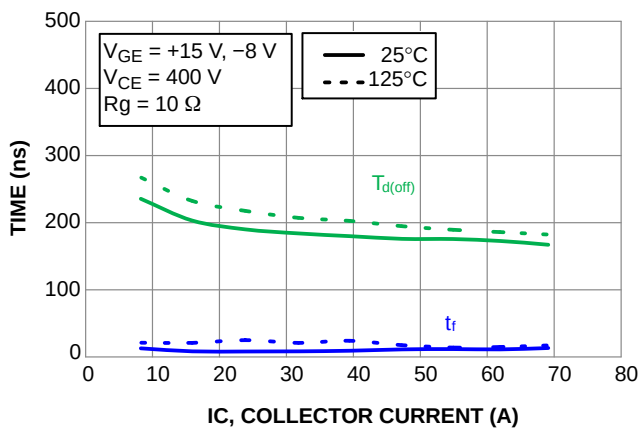


Figure 41. Typical Turn-Off Switching Time vs. IC

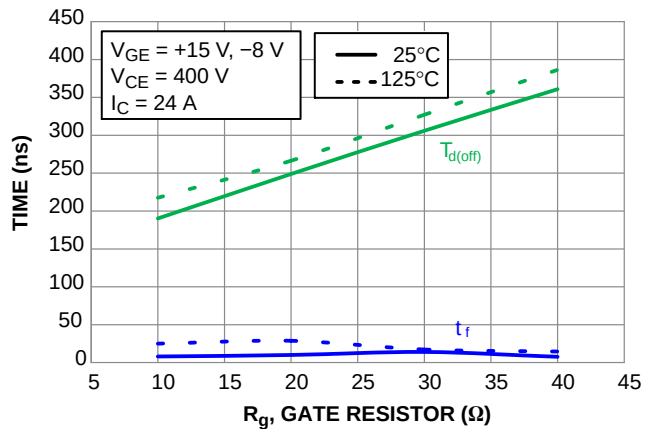


Figure 42. Typical Turn-Off Switching Time vs. Rg

NXH50M65L4C2ESG

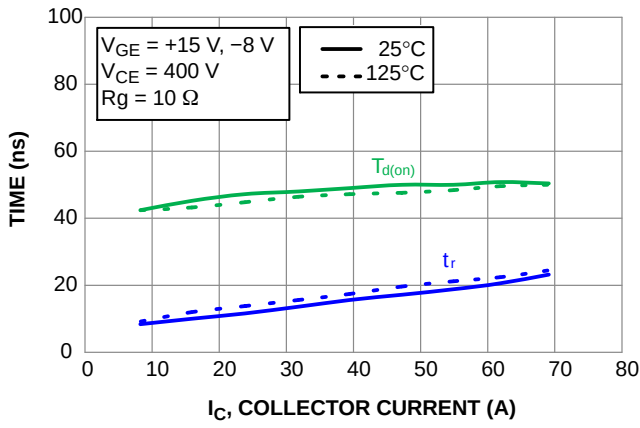


Figure 43. Typical Turn-On Switching Time vs. IC

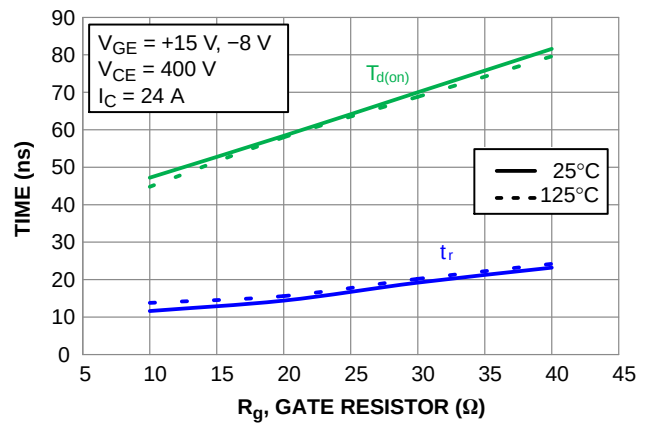


Figure 44. Typical Turn-Off Switching Time vs. Rg

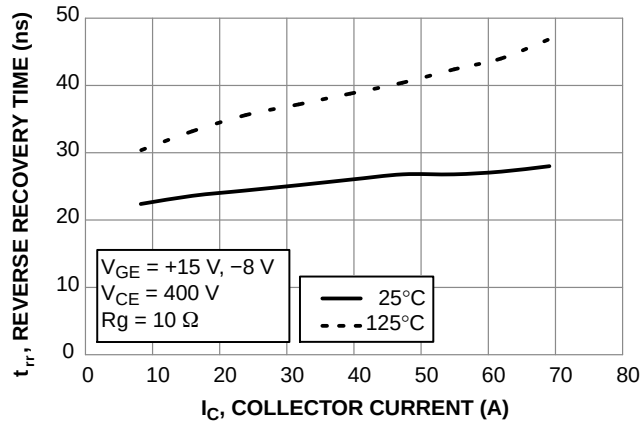


Figure 45. Typical Reverse Recovery Time vs. IC

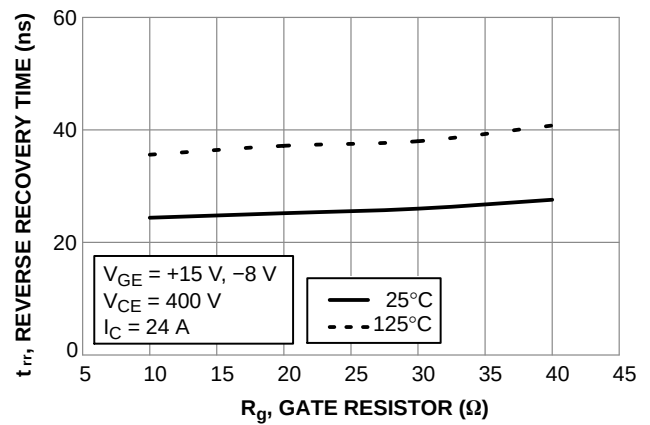


Figure 46. Typical Reverse Recovery Time vs. Rg

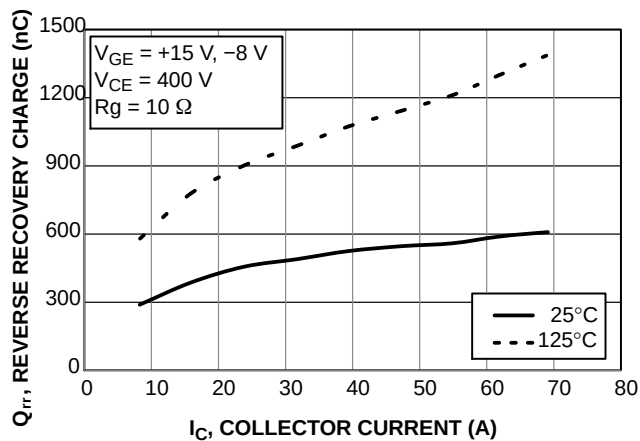


Figure 47. Typical Reverse Recovery Charge vs. IC

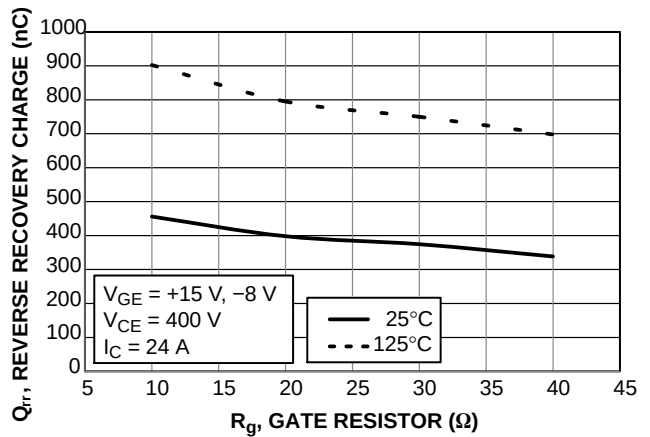


Figure 48. Typical Reverse Recovery Charge vs. Rg

NXH50M65L4C2ESG

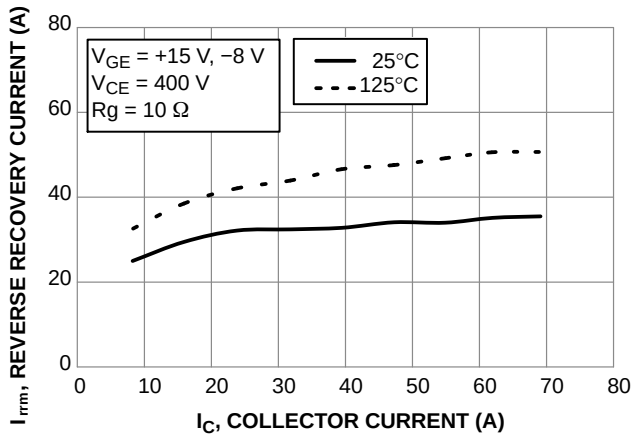


Figure 49. Typical Reverse Recovery Peak Current vs. IC

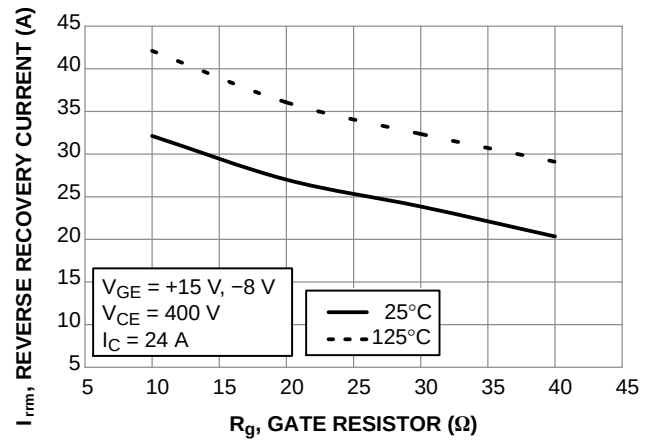


Figure 50. Typical Reverse Recovery Peak Current vs. RG

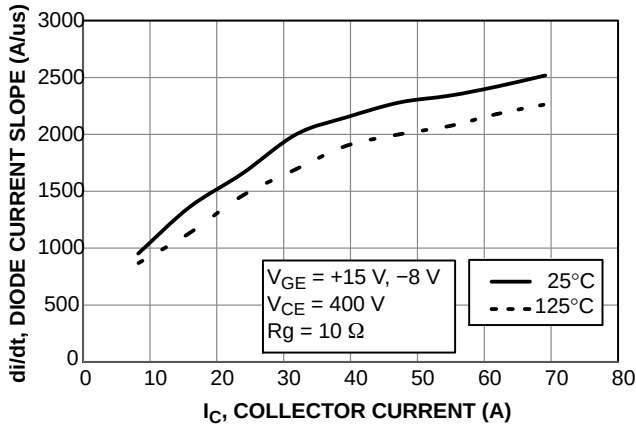


Figure 51. Typical di/dt Current Slope vs. IC

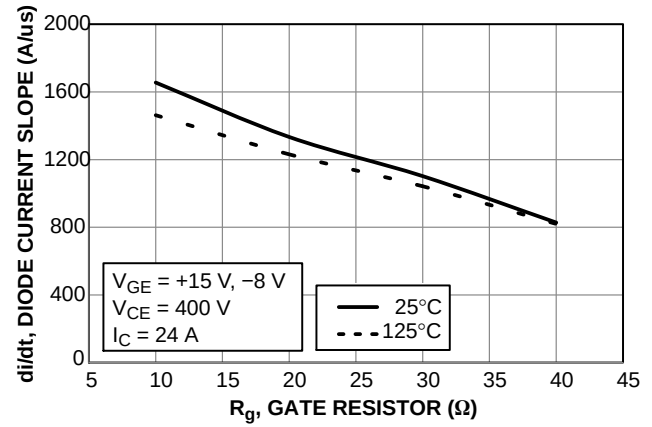


Figure 52. Typical di/dt Current Slope vs. RG

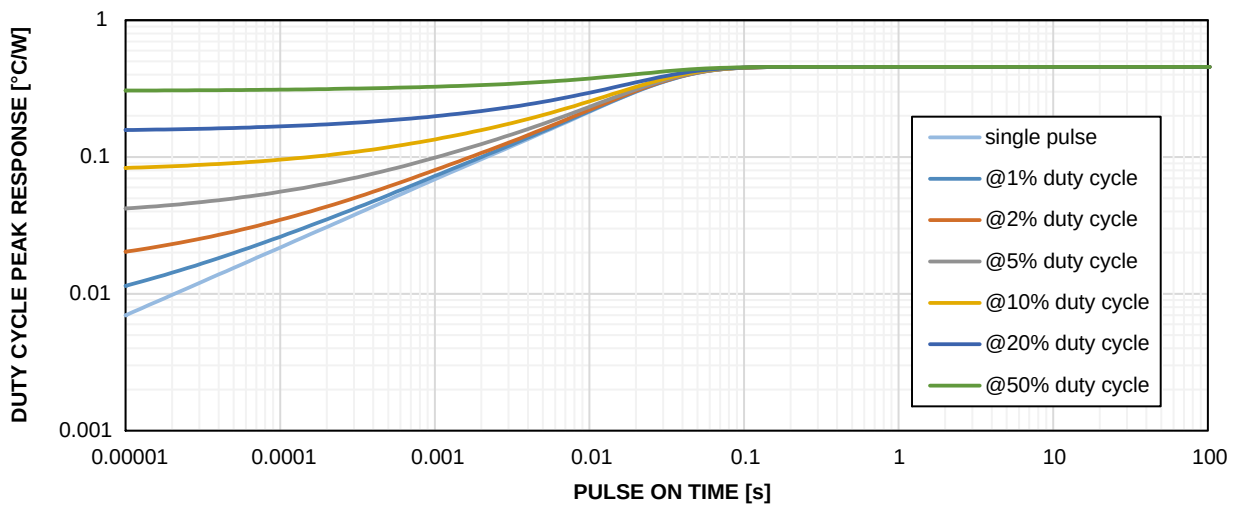


Figure 53. IGBT Junction-to-Case Transient Thermal Impedance

NXH50M65L4C2ESG

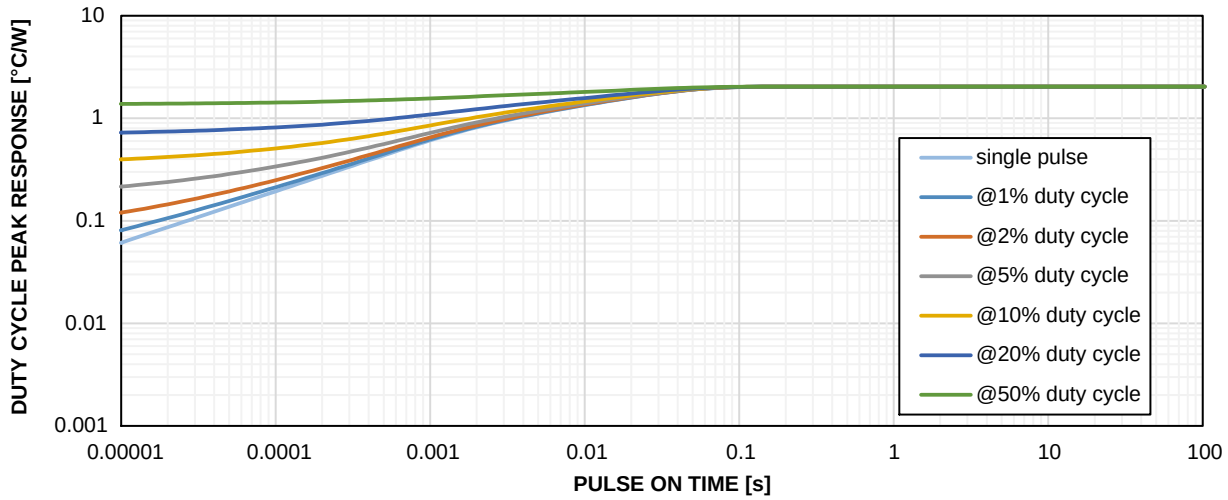


Figure 54. Diode Junction-to-Case Transient Thermal Impedance

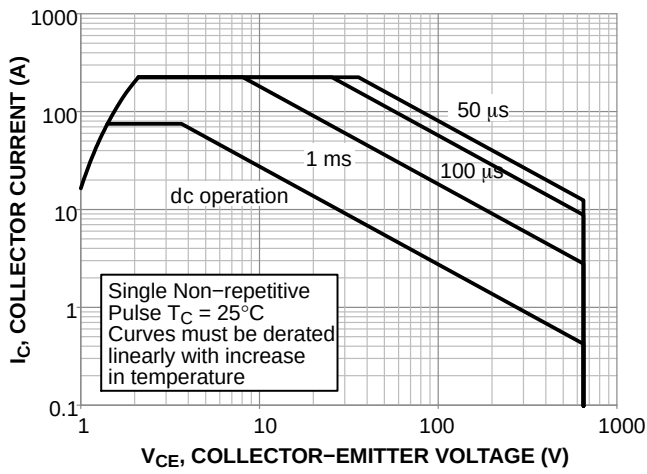


Figure 55. IGBT FBSOA

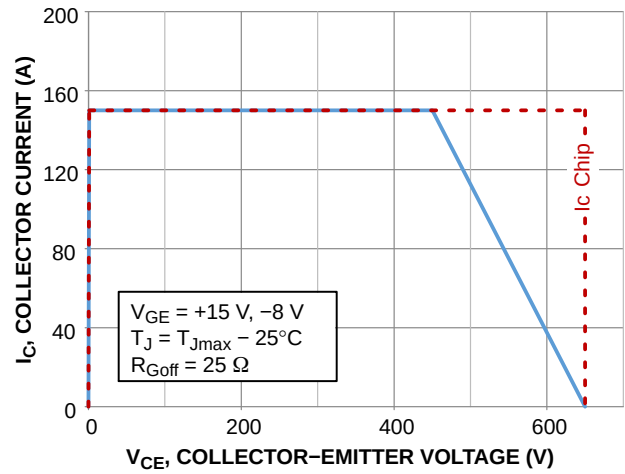


Figure 56. IGBT RBSOA

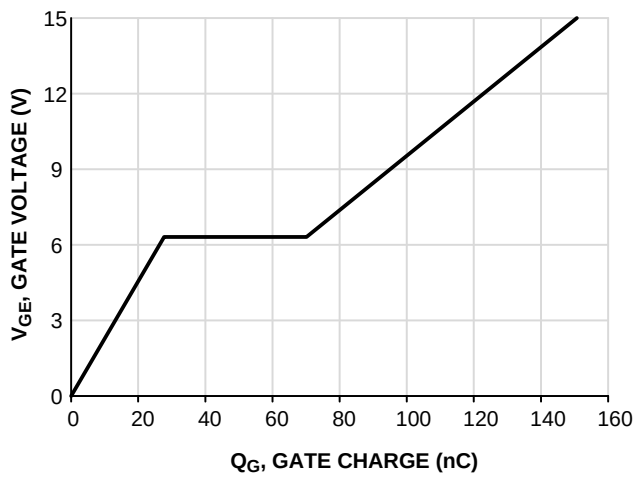


Figure 57. IGBT Gate Voltage vs. Gate Charge

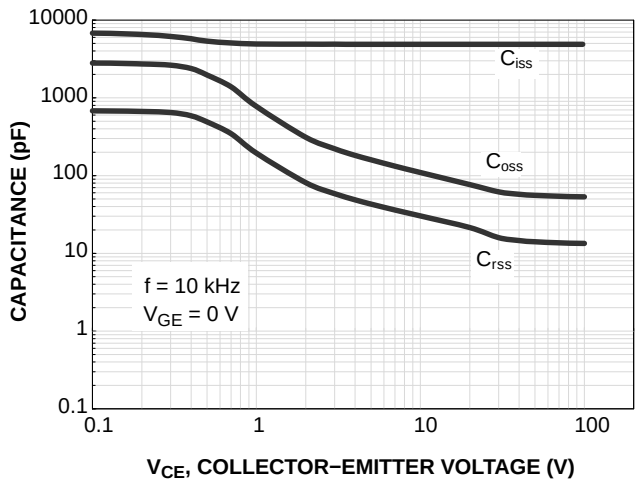


Figure 58. IGBT Capacitance vs. Collector-Emitter Voltage

NXH50M65L4C2ESG

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

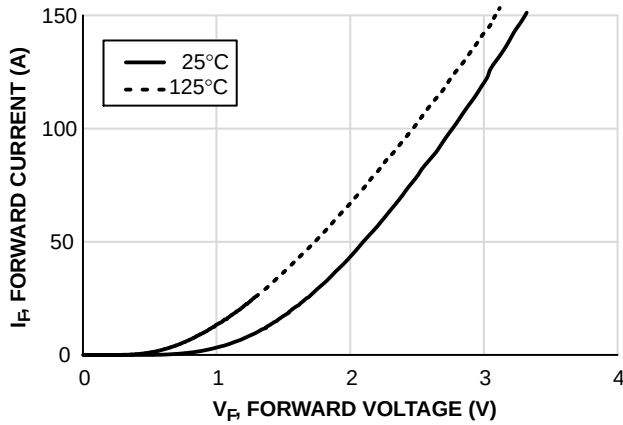


Figure 59. PFC Diode Forward Characteristics

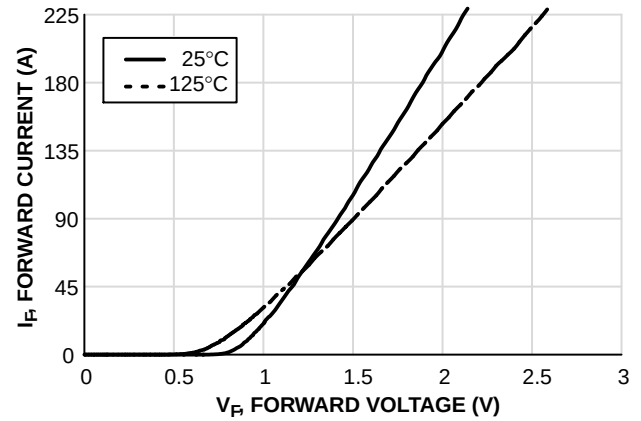


Figure 60. Converter Diode Forward Characteristics

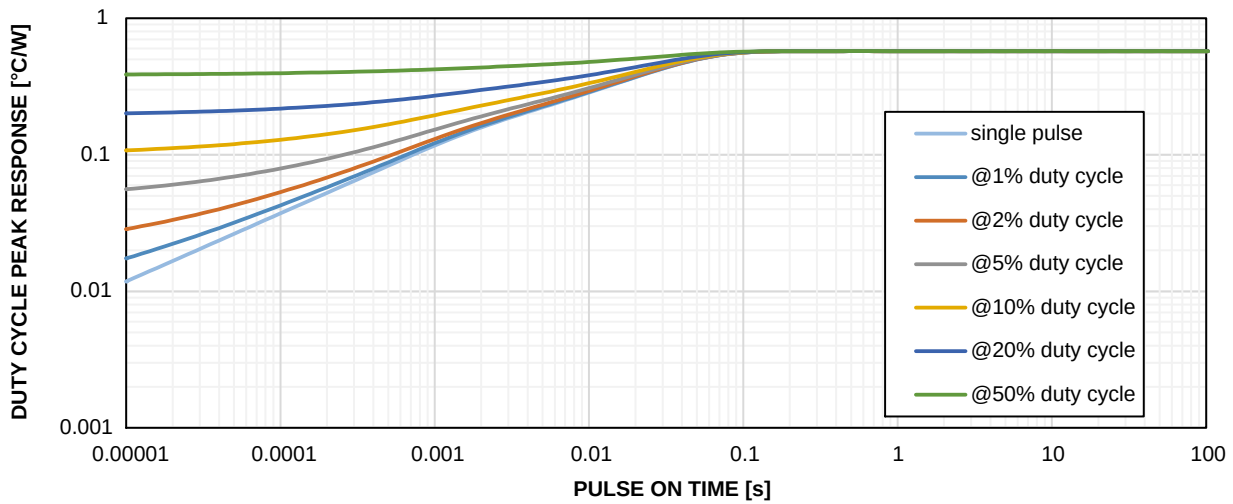


Figure 61. PFC Diode Junction-to-Case Transient Thermal Impedance

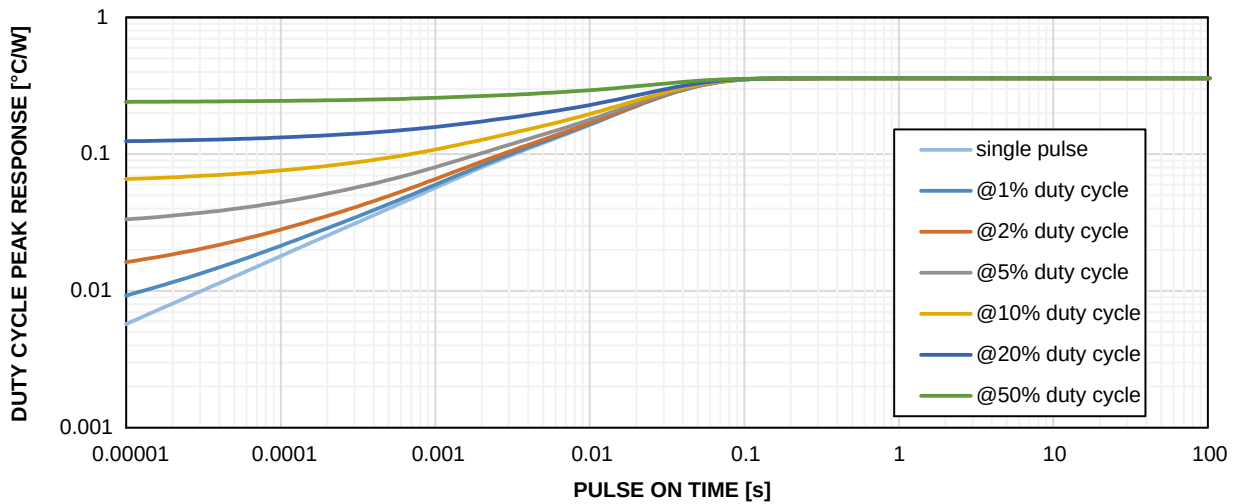


Figure 62. Converter Diode Junction-to-Case Transient Thermal Impedance

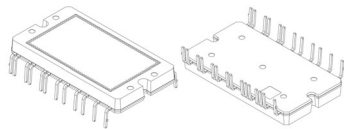
NXH50M65L4C2ESG

ORDERING INFORMATION

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

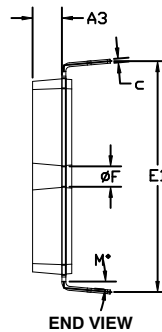
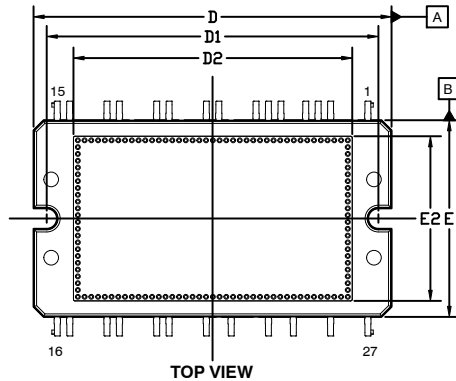
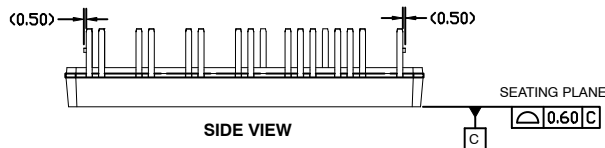
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®

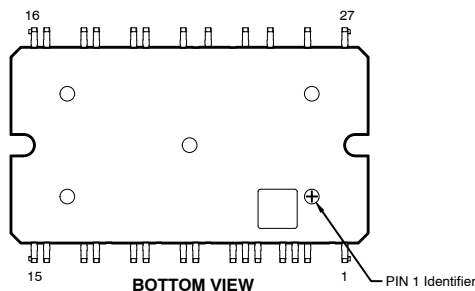
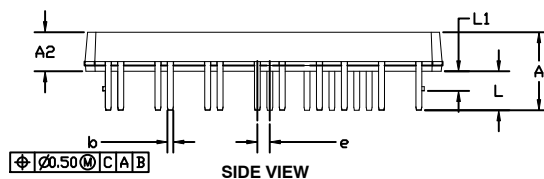


DIP27 73.2x40.2
CASE 184AA
ISSUE B

DATE 15 JUL 2021



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°



NOTES:

1. Dimensioning and tolerancing as per ASME Y14.5M, 2009
2. Controlling Dimension: Millimeters
3. Dimensions are exclusive of Burrs, Mold Flash, and Tiebar 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

GENERIC MARKING DIAGRAM*

XXXXXXXXXXXXXXXXXX
ZZZATYWW



XXX = Specific Device Code
ZZZ = Assembly Lot Code
A = Assembly Site
T = Test Site
Y = Year
WW = Work Week

*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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