

# NGTB40N60L2WG

## IGBT

This Insulated Gate Bipolar Transistor (IGBT) features a robust and cost effective Field Stop (FS) Trench construction, and provides superior performance in demanding switching applications, offering both low on state voltage and minimal switching loss.

### Features

- Extremely Efficient Trench with Field Stop Technology
- $T_{Jmax} = 175^{\circ}C$
- Soft Fast Reverse Recovery Diode
- Optimized for Low  $V_{CEsat}$
- 5  $\mu s$  Short-Circuit Capability
- This is a Pb-Free Device

### Typical Applications

- Motor Drive Inverters
- Industrial Switching
- Welding

### ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-emitter voltage	$V_{CES}$	600	V
Collector current @ $T_c = 25^{\circ}C$ @ $T_c = 100^{\circ}C$	$I_c$	80 40	A
Diode Forward Current @ $T_c = 25^{\circ}C$ @ $T_c = 100^{\circ}C$	$I_F$	80 40	A
Diode Pulsed Current $T_{PULSE}$ Limited by $T_J$ Max	$I_{FM}$	160	A
Pulsed collector current, $T_{pulse}$ limited by $T_{Jmax}$	$I_{CM}$	160	A
Short-circuit withstand time $V_{GE} = 15 V$ , $V_{CE} = 400 V$ , $T_J \leq +150^{\circ}C$	$t_{SC}$	5	$\mu s$
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Transient gate-emitter voltage ( $T_{PULSE} = 5 \mu s$ , $D < 0.10$ )		$\pm 30$	V
Power Dissipation @ $T_c = 25^{\circ}C$ @ $T_c = 100^{\circ}C$	$P_D$	417 208	W
Operating junction temperature range	$T_J$	-55 to +175	$^{\circ}C$
Storage temperature range	$T_{stg}$	-55 to +175	$^{\circ}C$
Lead temperature for soldering, 1/8" from case for 5 seconds	$T_{SLD}$	260	$^{\circ}C$

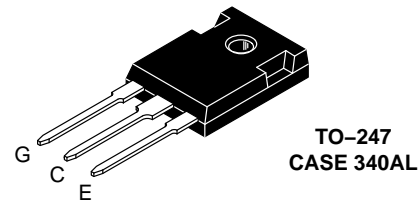
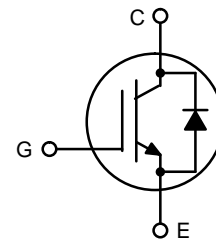
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.



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**40 A, 600 V**  
 **$V_{CEsat} = 1.65 V$**   
 **$E_{OFF} = 0.28 mJ$**



### MARKING DIAGRAM



A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

Device	Package	Shipping
NGTB40N60L2WG	TO-247 (Pb-Free)	30 Units / Rail

# NGTB40N60L2WG

## THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal resistance junction-to-case, for IGBT	$R_{\theta JC}$	0.36	$^{\circ}\text{C}/\text{W}$
Thermal resistance junction-to-case, for Diode	$R_{\theta JC}$	1.00	$^{\circ}\text{C}/\text{W}$
Thermal resistance junction-to-ambient	$R_{\theta JA}$	40	$^{\circ}\text{C}/\text{W}$

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

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
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### STATIC CHARACTERISTIC

Collector-emitter breakdown voltage, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, I_C = 500\ \mu\text{A}$	$V_{(BR)CES}$	600	-	-	V
Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175^{\circ}\text{C}$	$V_{CEsat}$	-	1.65 1.90	1.90 -	V
Gate-emitter threshold voltage	$V_{GE} = V_{CE}, I_C = 350\ \mu\text{A}$	$V_{GE(th)}$	4.5	5.8	6.5	V
Collector-emitter cut-off current, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$ $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 175^{\circ}\text{C}$	$I_{CES}$	-	- 5.0	0.5 -	mA
Gate leakage current, collector-emitter short-circuited	$V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$	$I_{GES}$	-	-	200	nA

### DYNAMIC CHARACTERISTIC

Input capacitance	$V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	$C_{ies}$	-	5286	-	pF
Output capacitance		$C_{oes}$	-	213	-	
Reverse transfer capacitance		$C_{res}$	-	147	-	
Gate charge total	$V_{CE} = 480\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V}$	$Q_g$	-	228	-	nC
Gate to emitter charge		$Q_{ge}$	-	50	-	
Gate to collector charge		$Q_{gc}$	-	115	-	

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

Turn-on delay time	$T_J = 25^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 40\text{ A}$ $R_g = 10\ \Omega$ $V_{GE} = 0\text{ V}/15\text{ V}$	$t_{d(on)}$	-	98	-	ns
Rise time		$t_r$	-	42	-	
Turn-off delay time		$t_{d(off)}$	-	213	-	
Fall time		$t_f$	-	60	-	
Turn-on switching loss		$E_{on}$	-	1.17	-	mJ
Turn-off switching loss		$E_{off}$	-	0.28	-	
Total switching loss		$E_{ts}$	-	1.45	-	
Turn-on delay time	$T_J = 150^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 40\text{ A}$ $R_g = 10\ \Omega$ $V_{GE} = 0\text{ V}/15\text{ V}$	$t_{d(on)}$	-	98	-	ns
Rise time		$t_r$	-	44	-	
Turn-off delay time		$t_{d(off)}$	-	220	-	
Fall time		$t_f$	-	88	-	
Turn-on switching loss		$E_{on}$	-	1.45	-	mJ
Turn-off switching loss		$E_{off}$	-	0.68	-	
Total switching loss		$E_{ts}$	-	2.13	-	

### DIODE CHARACTERISTIC

Forward voltage	$V_{GE} = 0\text{ V}, I_F = 40\text{ A}$ $V_{GE} = 0\text{ V}, I_F = 40\text{ A}, T_J = 175^{\circ}\text{C}$	$V_F$	-	2.40 2.58	3.00 -	V
Reverse recovery time	$T_J = 25^{\circ}\text{C}$ $I_F = 40\text{ A}, V_R = 200\text{ V}$ $di_F/dt = 200\text{ A}/\mu\text{s}$	$t_{rr}$	-	73	-	ns
Reverse recovery charge		$Q_{rr}$	-	282	-	nC
Reverse recovery current		$I_{rrm}$	-	6.7	-	A
Reverse recovery time	$T_J = 175^{\circ}\text{C}$ $I_F = 40\text{ A}, V_R = 200\text{ V}$ $di_F/dt = 200\text{ A}/\mu\text{s}$	$t_{rr}$	-	160	-	ns
Reverse recovery charge		$Q_{rr}$	-	912	-	nC
Reverse recovery current		$I_{rrm}$	-	8.6	-	A

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.

# NGTB40N60L2WG

## TYPICAL CHARACTERISTICS

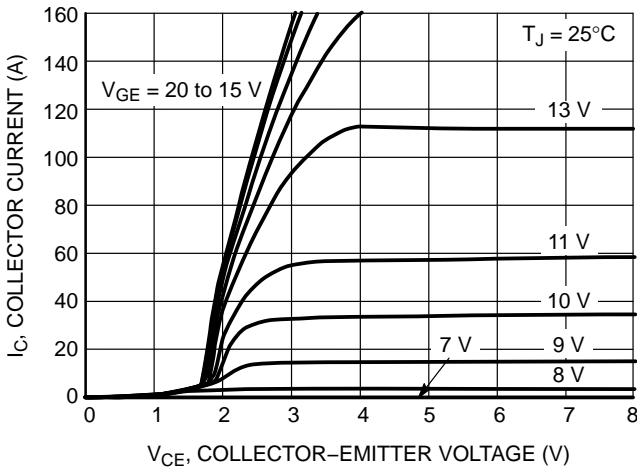


Figure 1. Output Characteristics

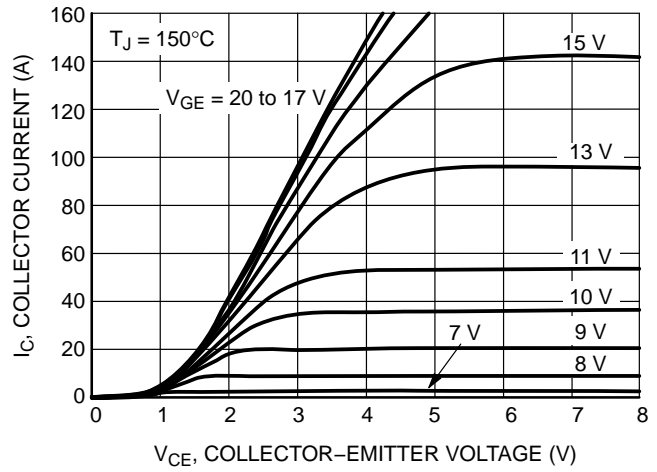


Figure 2. Output Characteristics

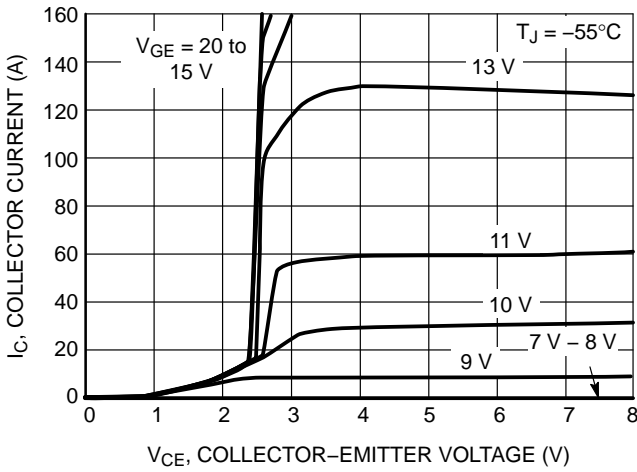


Figure 3. Output Characteristics

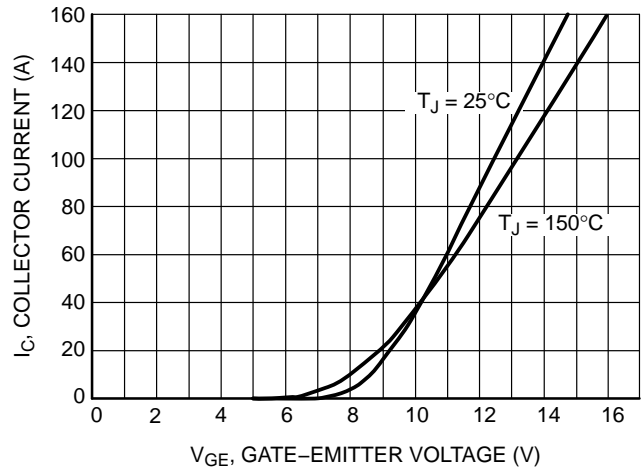


Figure 4. Typical Transfer Characteristics

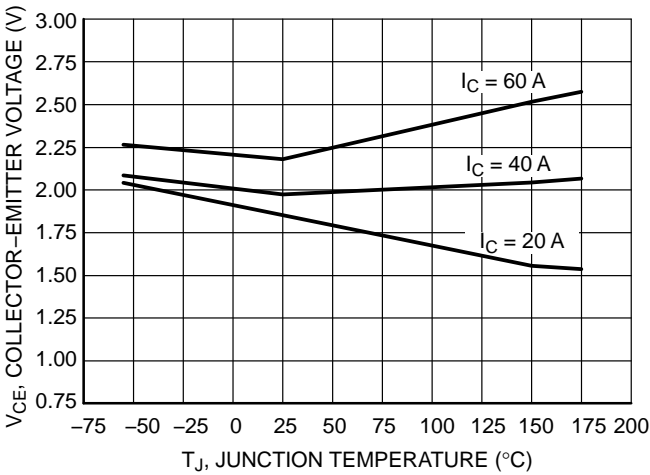


Figure 5.  $V_{CE(sat)}$  vs.  $T_J$

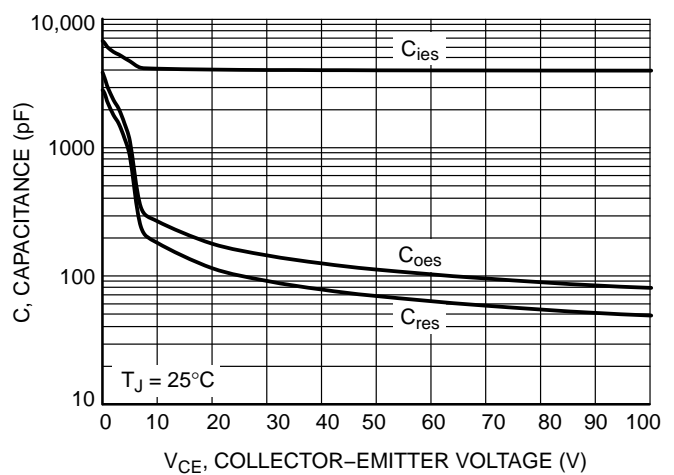


Figure 6. Typical Capacitance

# NGTB40N60L2WG

## TYPICAL CHARACTERISTICS

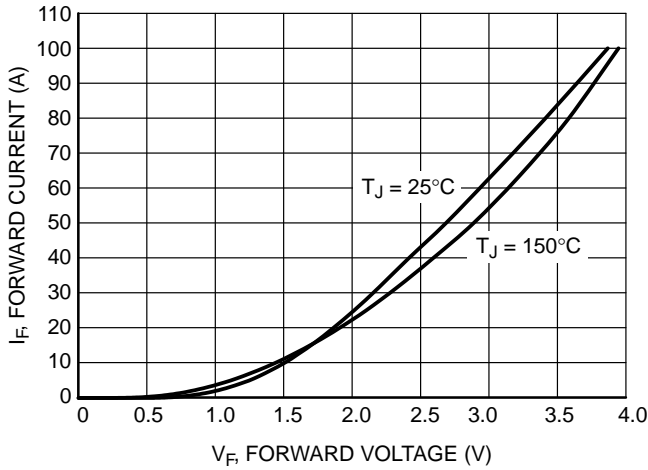


Figure 7. Diode Forward Characteristics

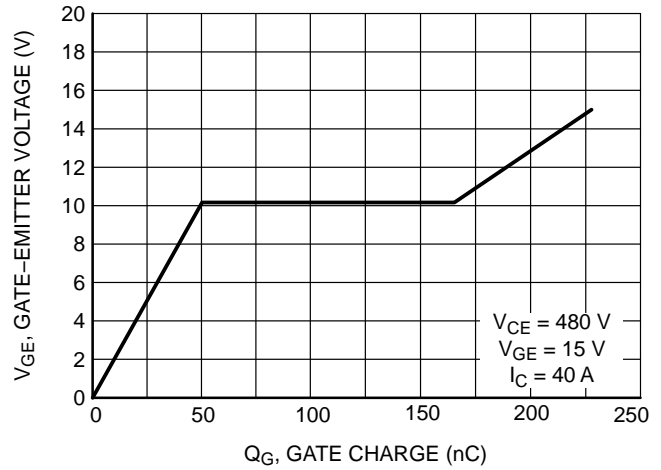


Figure 8. Typical Gate Charge

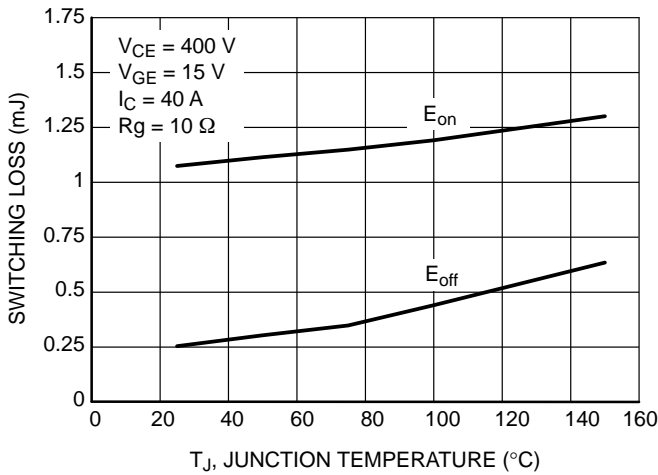


Figure 9. Switching Loss vs. Temperature

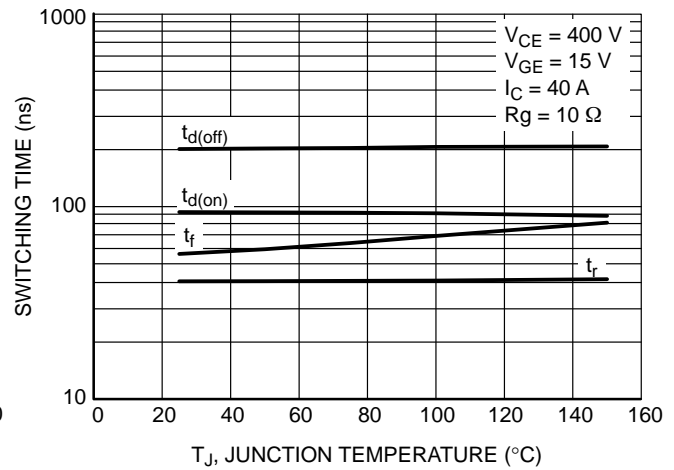


Figure 10. Switching Time vs. Temperature

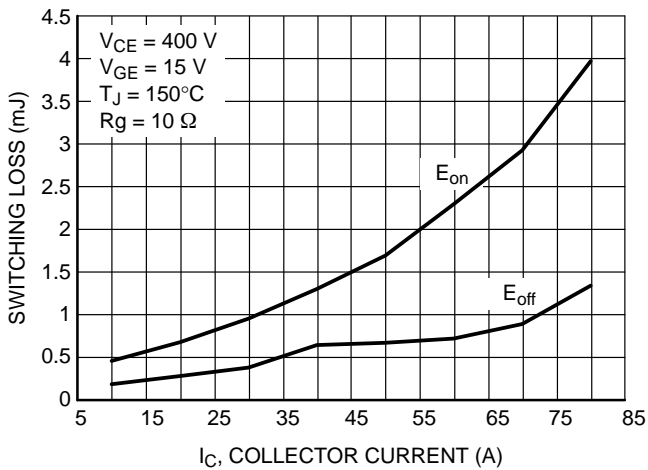


Figure 11. Switching Loss vs.  $I_C$

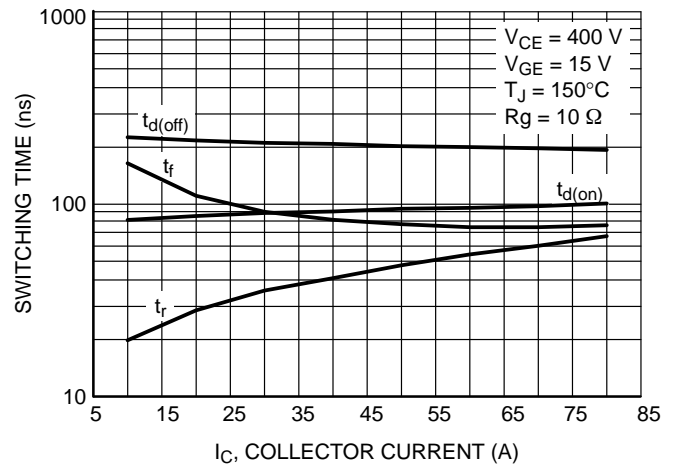


Figure 12. Switching Time vs.  $I_C$

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## TYPICAL CHARACTERISTICS

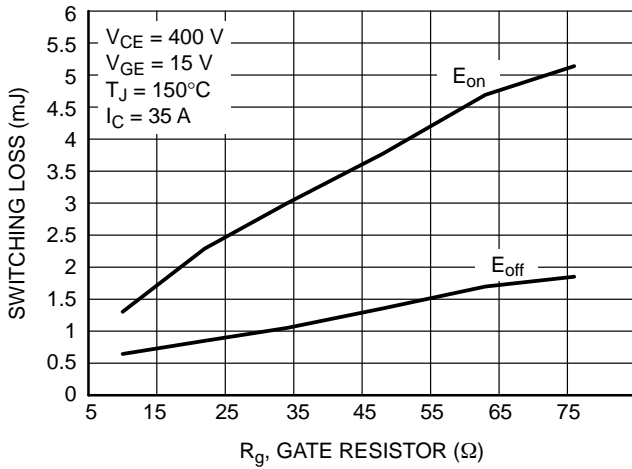


Figure 13. Switching Loss vs.  $R_g$

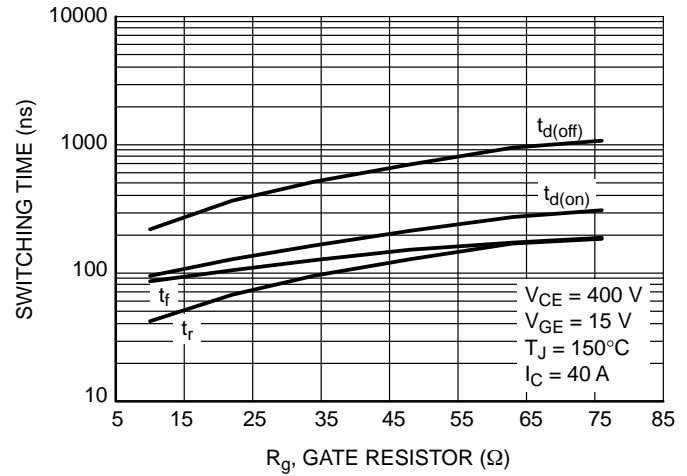


Figure 14. Switching Time vs.  $R_g$

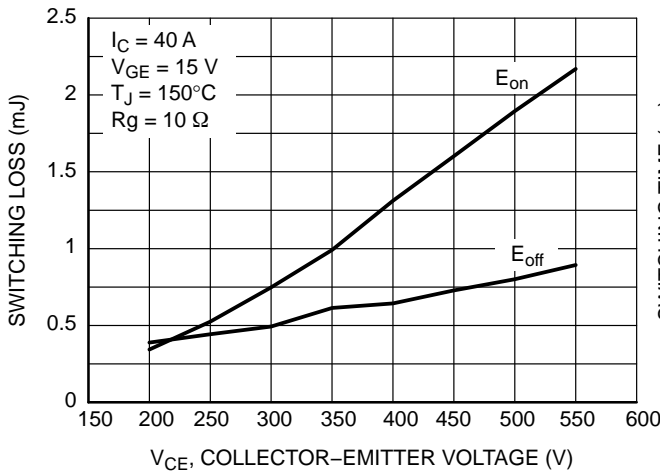


Figure 15. Switching Loss vs.  $V_{CE}$

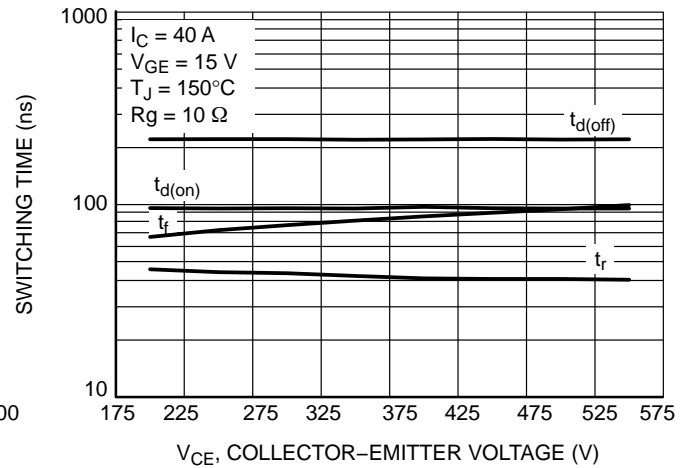


Figure 16. Switching Time vs.  $V_{CE}$

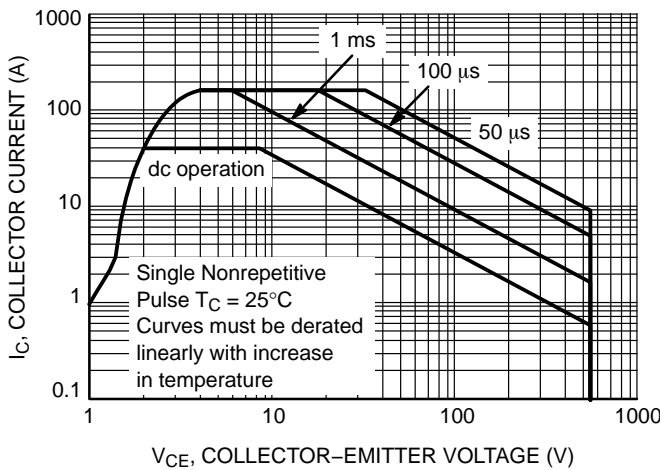


Figure 17. Safe Operating Area

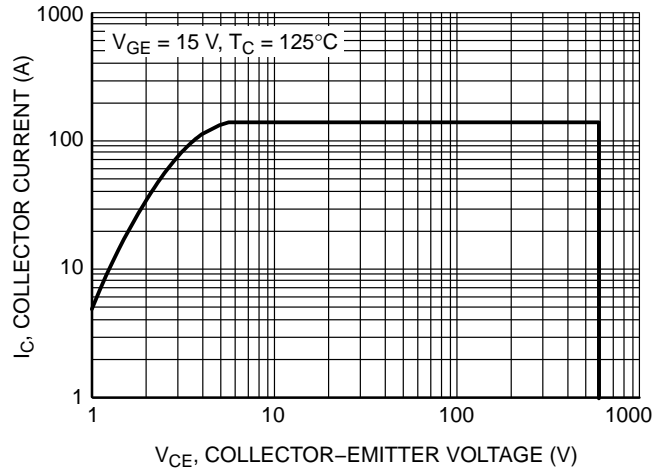


Figure 18. Reverse Bias Safe Operating Area

# NGTB40N60L2WG

## TYPICAL CHARACTERISTICS

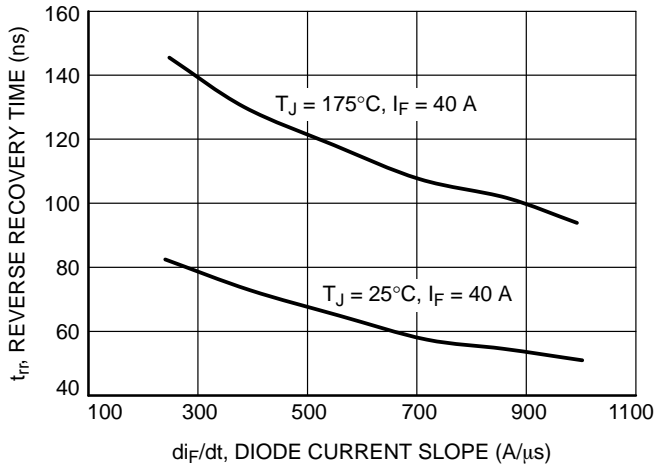


Figure 19.  $t_{rr}$  vs.  $di_F/dt$   
( $V_R = 400\text{ V}$ )

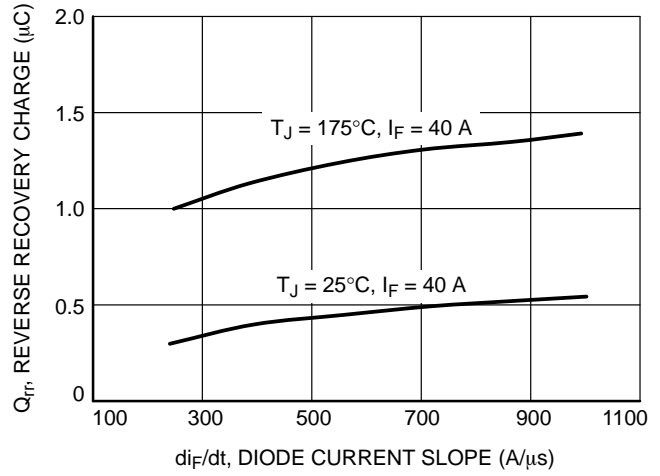


Figure 20.  $Q_{rr}$  vs.  $di_F/dt$   
( $V_R = 400\text{ V}$ )

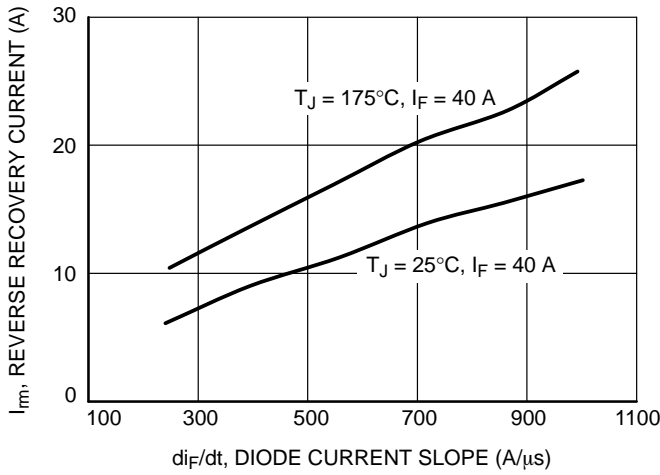


Figure 21.  $I_{rm}$  vs.  $di_F/dt$   
( $V_R = 400\text{ V}$ )

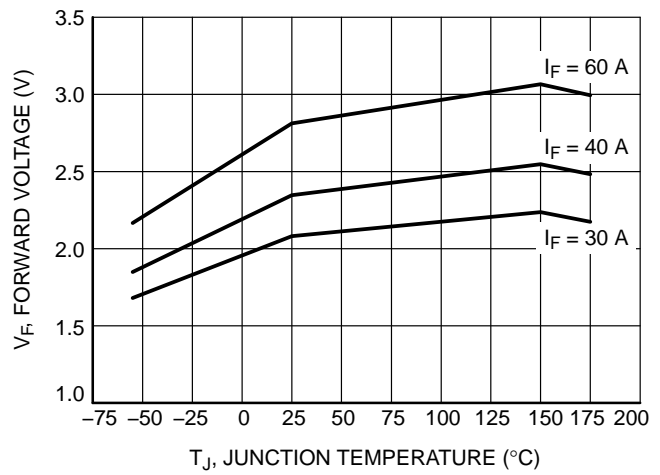


Figure 22.  $V_F$  vs.  $T_J$

# NGTB40N60L2WG

## TYPICAL CHARACTERISTICS

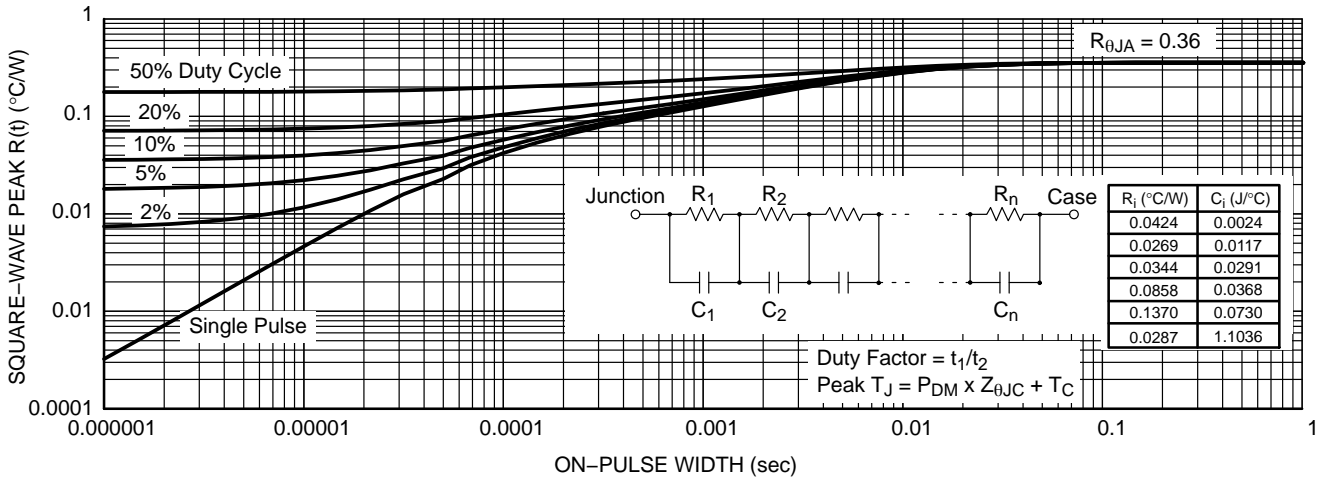


Figure 23. IGBT Die Self-heating Square-wave Duty Cycle Transient Thermal Response

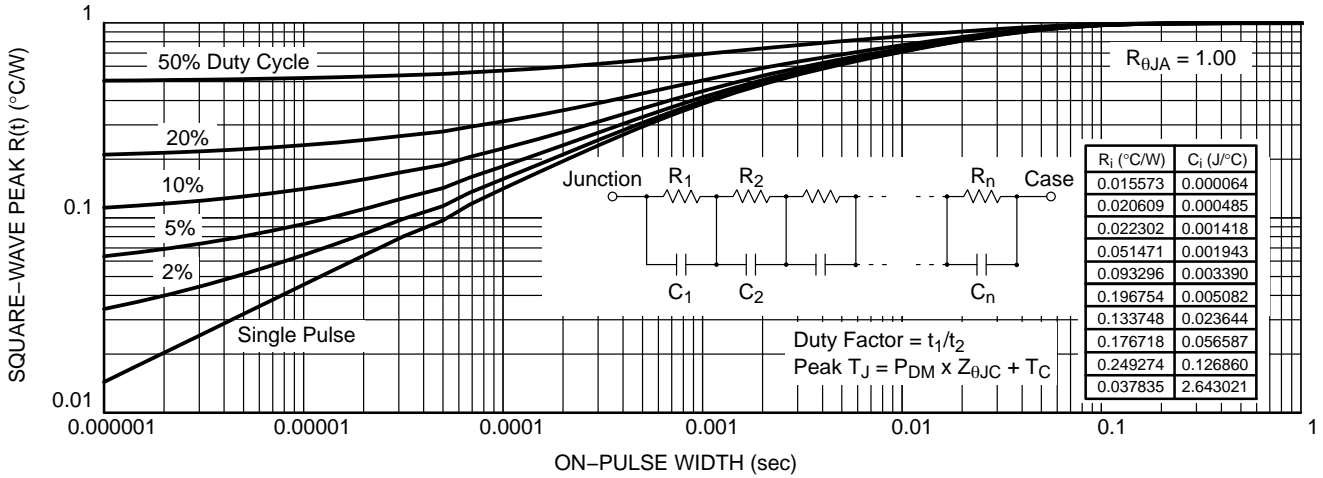
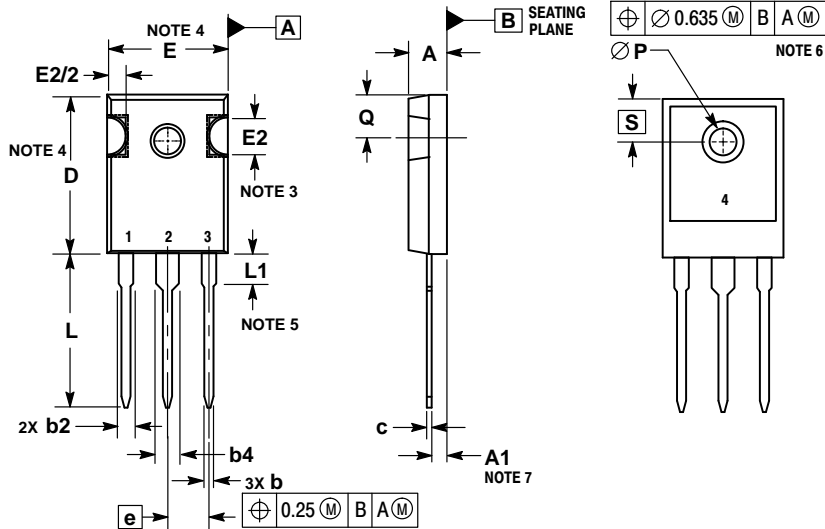


Figure 24. Diode Die Self-heating Square-wave Duty Cycle Transient Thermal Response

# NGTB40N60L2WG

## PACKAGE DIMENSIONS

### TO-247 CASE 340AL ISSUE A



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. SLOT REQUIRED, NOTCH MAY BE ROUNDED.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.13 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREME OF THE PLASTIC BODY.
5. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.
6.  $\varnothing P$  SHALL HAVE A MAXIMUM DRAFT ANGLE OF 1.5° TO THE TOP OF THE PART WITH A MAXIMUM DIAMETER OF 3.91.
7. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.

DIM	MILLIMETERS	
	MIN	MAX
A	4.70	5.30
A1	2.20	2.60
b	1.00	1.40
b2	1.65	2.35
b4	2.60	3.40
c	0.40	0.80
D	20.30	21.40
E	15.50	16.25
E2	4.32	5.49
e	5.45 BSC	
L	19.80	20.80
L1	3.50	4.50
P	3.55	3.65
Q	5.40	6.20
S	6.15 BSC	

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