

# NGTB15N60S1EG

## IGBT - Short-Circuit Rated

This Insulated Gate Bipolar Transistor (IGBT) features a robust and cost effective Non-Punch Through (NPT) Trench construction, and provides superior performance in demanding switching applications. Offering both low on state voltage and minimal switching loss, the IGBT is well suited for motor drive control and other hard switching applications. Incorporated into the device is a rugged co-packaged reverse recovery diode with a low forward voltage.

### Features

- Low Saturation Voltage Resulting in Low Conduction Loss
- Low Switching Loss in Higher Frequency Applications
- Soft Fast Reverse Recovery Diode
- 5  $\mu$ s Short Circuit Capability
- Excellent Current versus Package Size Performance Density
- This is a Pb-Free Device

### Typical Applications

- White Goods Appliance Motor Control
- General Purpose Inverter
- AC and DC Motor Control

### ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-emitter voltage	$V_{CES}$	600	V
Collector current @ $T_c = 25^\circ\text{C}$ @ $T_c = 100^\circ\text{C}$	$I_c$	30 15	A
Pulsed collector current, $T_{\text{pulse}}$ limited by $T_{J\text{max}}$	$I_{CM}$	120	A
Diode forward current @ $T_c = 25^\circ\text{C}$ @ $T_c = 100^\circ\text{C}$	$I_F$	30 15	A
Diode pulsed current, $T_{\text{pulse}}$ limited by $T_{J\text{max}}$	$I_{FM}$	120	A
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Power dissipation @ $T_c = 25^\circ\text{C}$ @ $T_c = 100^\circ\text{C}$	$P_D$	117 47	W
Short circuit withstand time $V_{GE} = 15\text{ V}$ , $V_{CE} = 400\text{ V}$ , $T_J \leq +150^\circ\text{C}$	$t_{SC}$	5	$\mu\text{s}$
Operating junction temperature range	$T_J$	-55 to +150	$^\circ\text{C}$
Storage temperature range	$T_{stg}$	-55 to +150	$^\circ\text{C}$
Lead temperature for soldering, 1/8" from case for 5 seconds	$T_{SLD}$	260	$^\circ\text{C}$

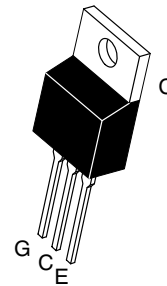
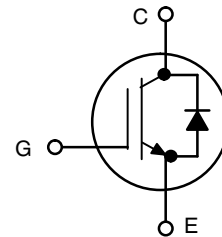
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.



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15 A, 600 V  
 $V_{CEsat} = 1.5\text{ V}$



TO-220  
CASE 221A  
STYLE 9

### MARKING DIAGRAM



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

### ORDERING INFORMATION

Device	Package	Shipping
NGTB15N60S1EG	TO-220 (Pb-Free)	50 Units / Rail

# NGTB15N60S1EG

## THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal resistance junction to case, for IGBT	$R_{\theta JC}$	1.06	$^{\circ}\text{C}/\text{W}$
Thermal resistance junction to case, for Diode	$R_{\theta JC}$	3.76	$^{\circ}\text{C}/\text{W}$
Thermal resistance junction to ambient	$R_{\theta JA}$	60	$^{\circ}\text{C}/\text{W}$

## 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	$V_{GE} = 15\text{ V}, I_C = 15\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 15\text{ A}, T_J = 150^{\circ}\text{C}$	$V_{CEsat}$	1.3 1.55	1.5 1.75	1.7 1.95	V
Gate-emitter threshold voltage	$V_{GE} = V_{CE}, I_C = 250\ \mu\text{A}$	$V_{GE(th)}$	4.5	5.5	6.5	V
Collector-emitter cut-off current, gate-emitter short-circuited	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$ $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 150^{\circ}\text{C}$	$I_{CES}$	-	10	-	$\mu\text{A}$
Gate leakage current, collector-emitter short-circuited	$V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$	$I_{GES}$	-	-	100	nA
Forward Transconductance	$V_{CE} = 20\text{ V}, I_C = 15\text{ A}$	$g_{fs}$	-	10.1	-	S

### DYNAMIC CHARACTERISTIC

Input capacitance	$V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	$C_{ies}$	-	1950	-	pF
Output capacitance		$C_{oes}$	-	70	-	
Reverse transfer capacitance		$C_{res}$	-	42	-	
Gate charge total	$V_{CE} = 480\text{ V}, I_C = 15\text{ A}, V_{GE} = 15\text{ V}$	$Q_g$	-	88	-	nC
Gate to emitter charge		$Q_{ge}$	-	16	-	
Gate to collector charge		$Q_{gc}$	-	42	-	

### SWITCHING CHARACTERISTIC , INDUCTIVE LOAD

Turn-on delay time	$T_J = 25^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 15\text{ A}$ $R_g = 22\ \Omega$ $V_{GE} = 0\text{ V} / 15\text{ V}$	$t_{d(on)}$	-	65	-	ns	
Rise time		$t_r$	-	28	-		
Turn-off delay time		$t_{d(off)}$	-	170	-		
Fall time		$t_f$	-	140	-		
Turn-on switching loss		$T_J = 150^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 15\text{ A}$ $R_g = 22\ \Omega$ $V_{GE} = 0\text{ V} / 15\text{ V}$	$E_{on}$	-	0.550	-	mJ
Turn-off switching loss			$E_{off}$	-	0.350	-	
Total switching loss			$E_{ts}$	-	0.900	-	
Turn-on delay time			$t_{d(on)}$	-	65	-	
Rise time	$t_r$	-	28	-			
Turn-off delay time	$t_{d(off)}$	-	180	-			
Fall time	$t_f$	-	260	-			
Turn-on switching loss	$T_J = 150^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 15\text{ A}$ $R_g = 22\ \Omega$ $V_{GE} = 0\text{ V} / 15\text{ V}$	$E_{on}$	-	0.650	-	mJ	
Turn-off switching loss		$E_{off}$	-	0.600	-		
Total switching loss		$E_{ts}$	-	1.250	-		

### DIODE CHARACTERISTIC

Forward voltage	$V_{GE} = 0\text{ V}, I_F = 15\text{ A}$ $V_{GE} = 0\text{ V}, I_F = 15\text{ A}, T_J = 150^{\circ}\text{C}$	$V_F$	-	1.65 1.75	1.85 -	V
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## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
<b>DIODE CHARACTERISTIC</b>						
Reverse recovery time	$T_J = 25^\circ\text{C}$ $I_F = 15\text{ A}, V_R = 200\text{ V}$ $di_F/dt = 200\text{ A}/\mu\text{s}$	$t_{rr}$	-	270	-	ns
Reverse recovery charge		$Q_{rr}$	-	350	-	nc
Reverse recovery current		$I_{rrm}$	-	5	-	A
Reverse recovery time	$T_J = 125^\circ\text{C}$ $I_F = 15\text{ A}, V_R = 200\text{ V}$ $di_F/dt = 200\text{ A}/\mu\text{s}$	$t_{rr}$	-	350	-	ns
Reverse recovery charge		$Q_{rr}$	-	1000	-	nc
Reverse recovery current		$I_{rrm}$	-	7.5	-	A

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## TYPICAL CHARACTERISTICS

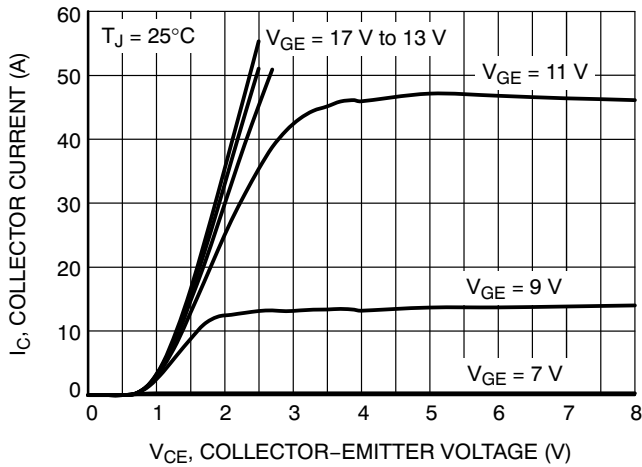


Figure 1. Output Characteristics

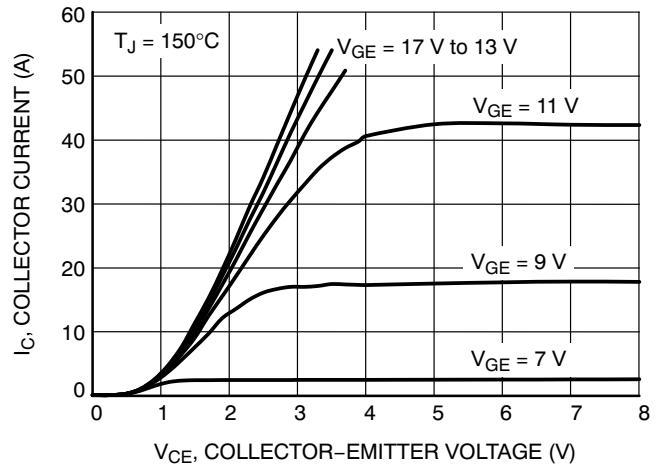


Figure 2. Output Characteristics

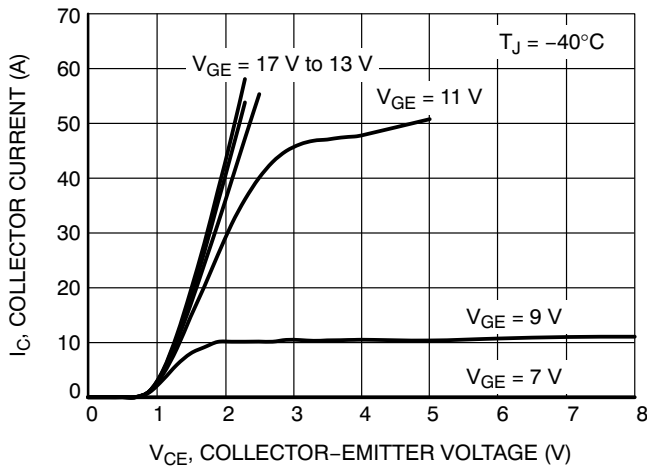


Figure 3. Output Characteristics

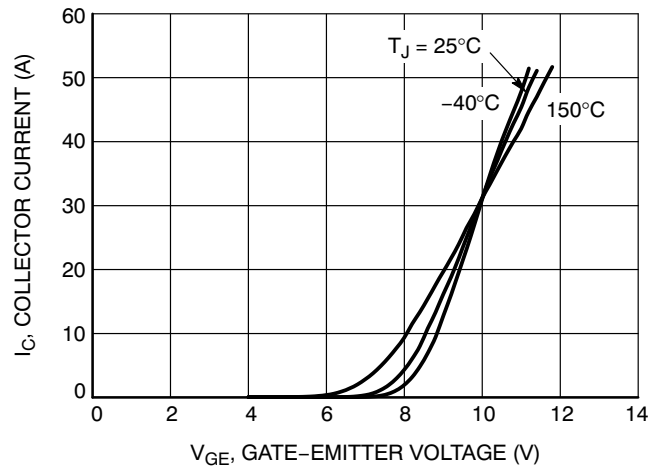


Figure 4. Typical Transfer Characteristics

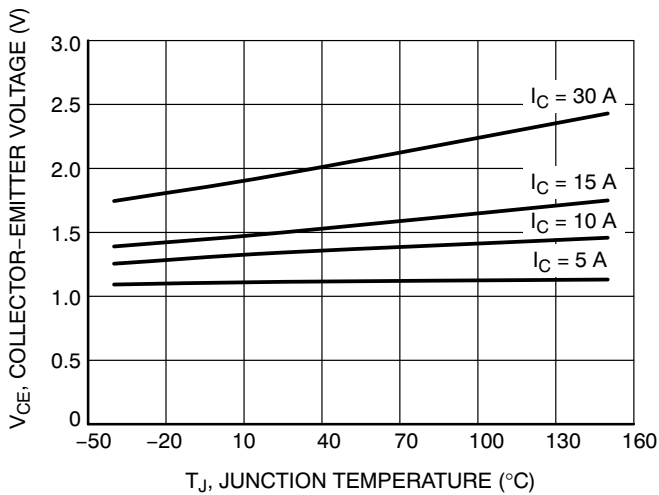


Figure 5.  $V_{CE(sat)}$  vs.  $T_J$

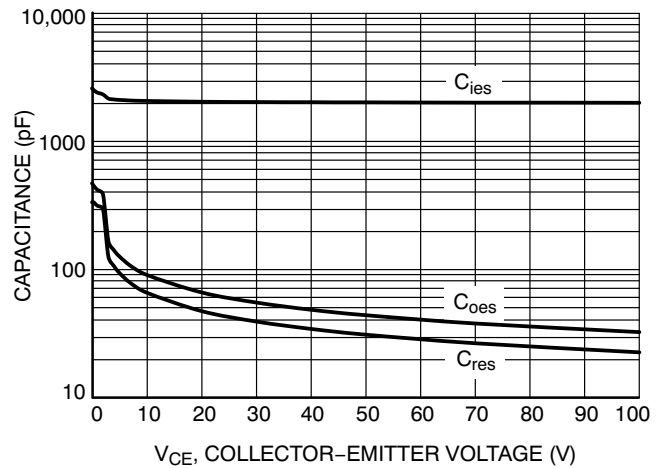


Figure 6. Typical Capacitance

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## TYPICAL CHARACTERISTICS

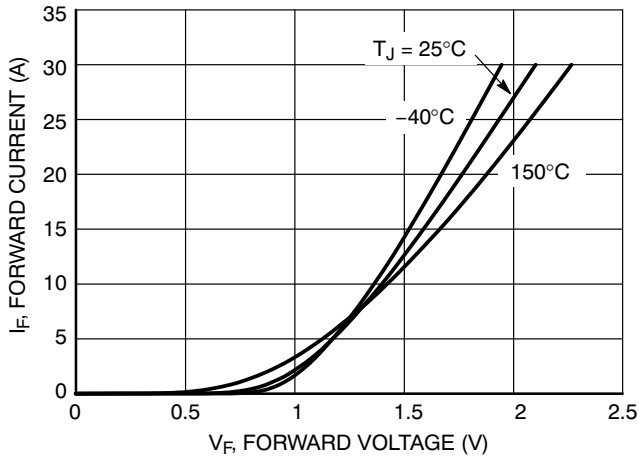


Figure 7. Diode Forward Characteristics

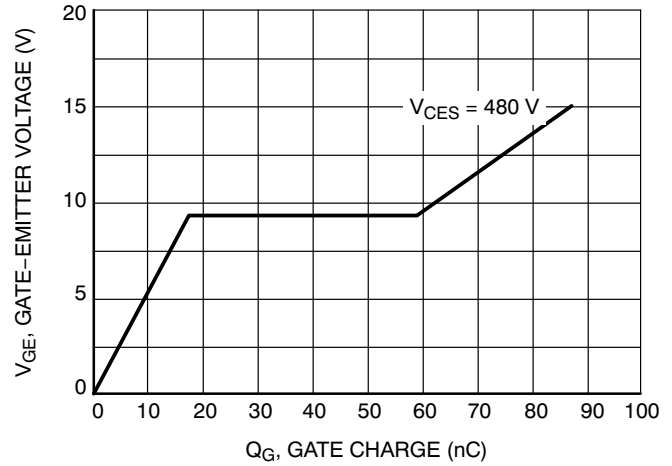


Figure 8. Typical Gate Charge

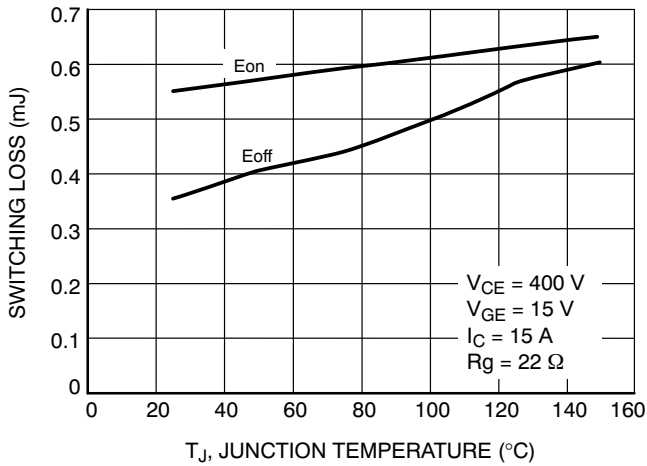


Figure 9. Switching Loss vs. Temperature

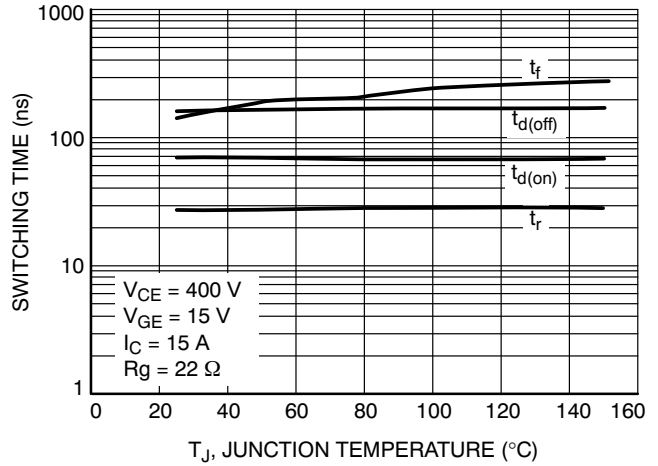


Figure 10. Switching Time vs. Temperature

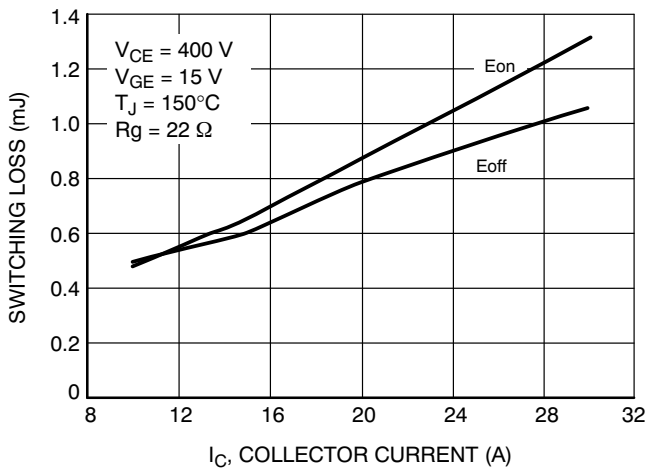


Figure 11. Switching Loss vs.  $I_C$

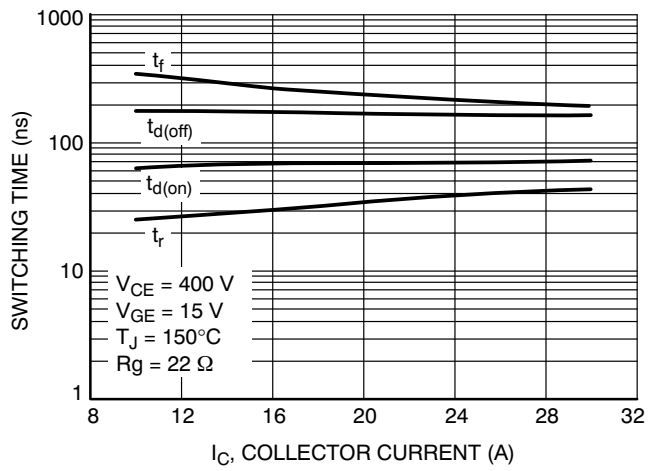


Figure 12. Switching Time vs.  $I_C$

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## TYPICAL CHARACTERISTICS

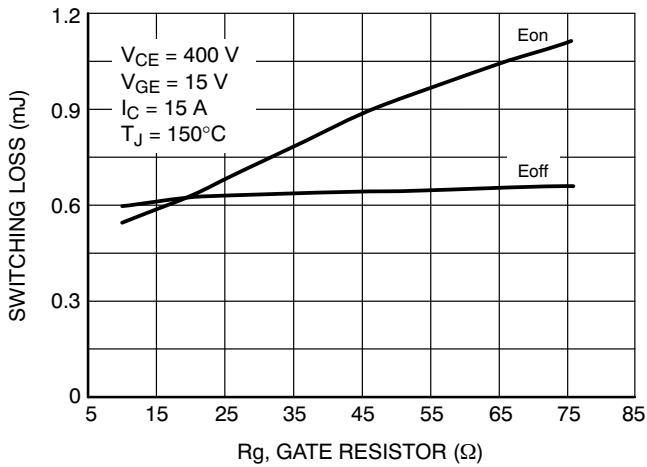


Figure 13. Switching Time vs. Rg

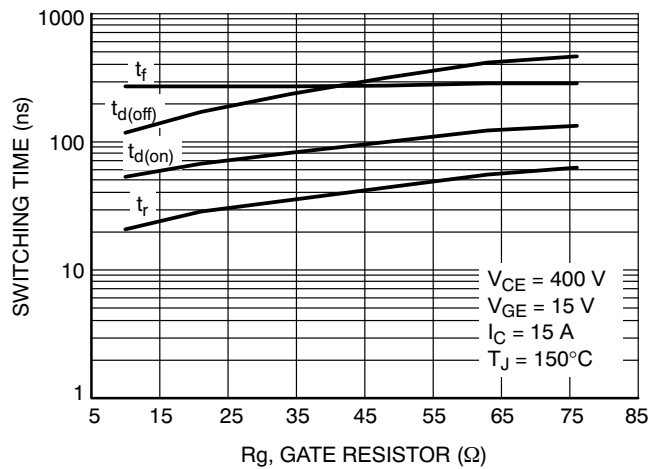


Figure 14. Switching Time vs. Rg

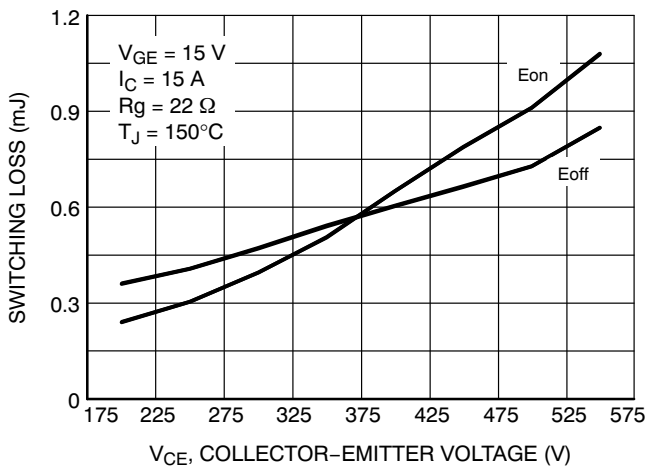


Figure 15. Switching Loss vs. VCE

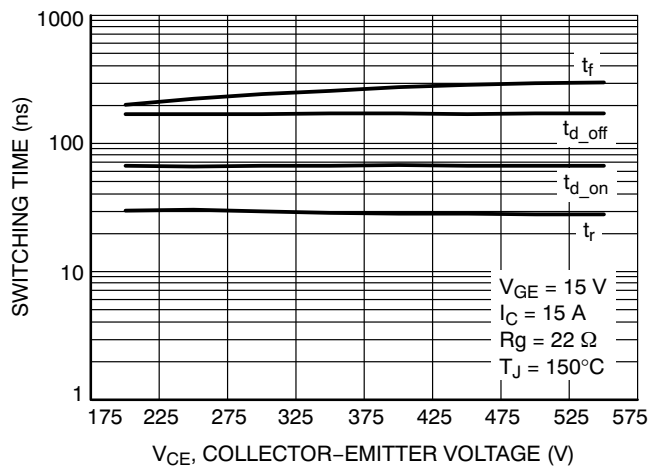


Figure 16. Switching Time vs. VCE

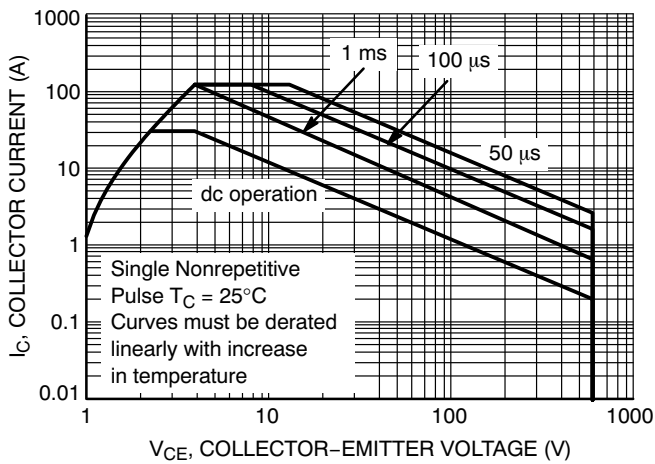


Figure 17. Safe Operating Area

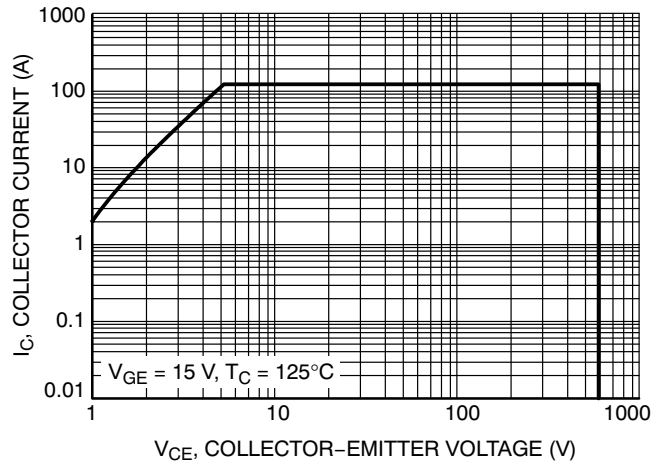


Figure 18. Reverse Bias Safe Operating Area

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## TYPICAL CHARACTERISTICS

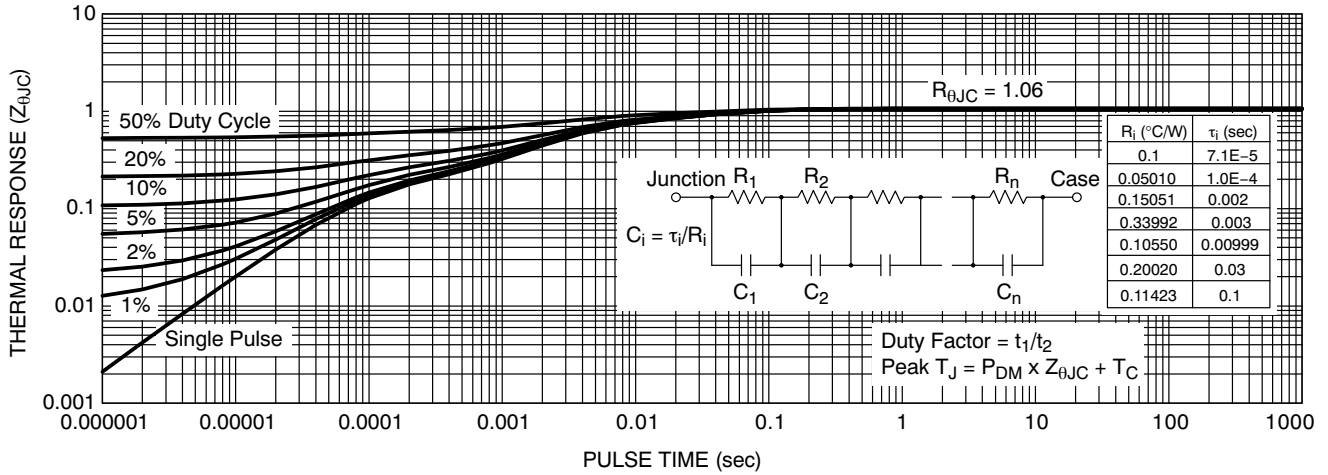


Figure 19. IGBT Transient Thermal Impedance

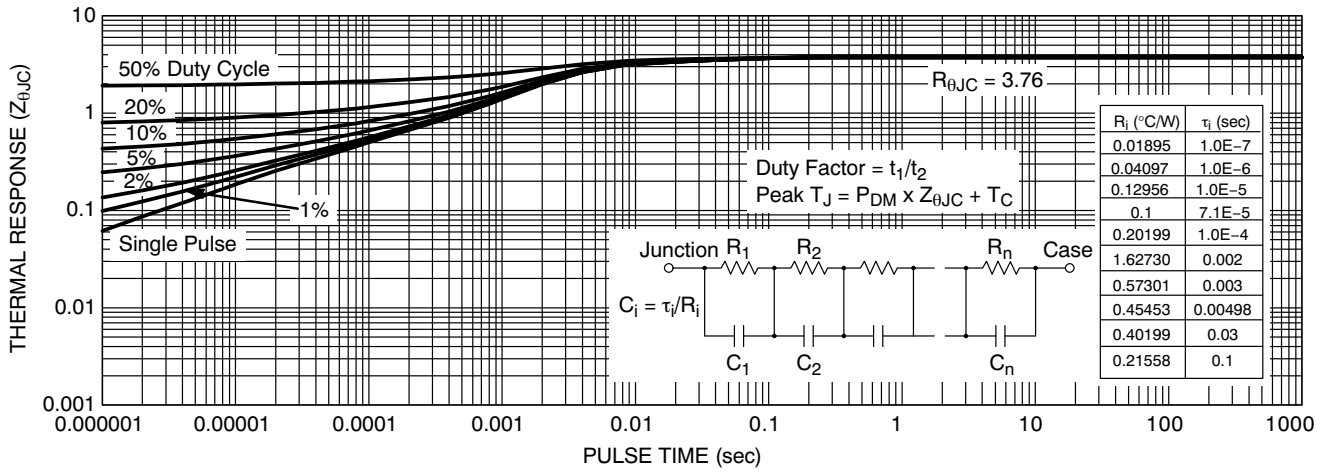


Figure 20. Diode Transient Thermal Impedance

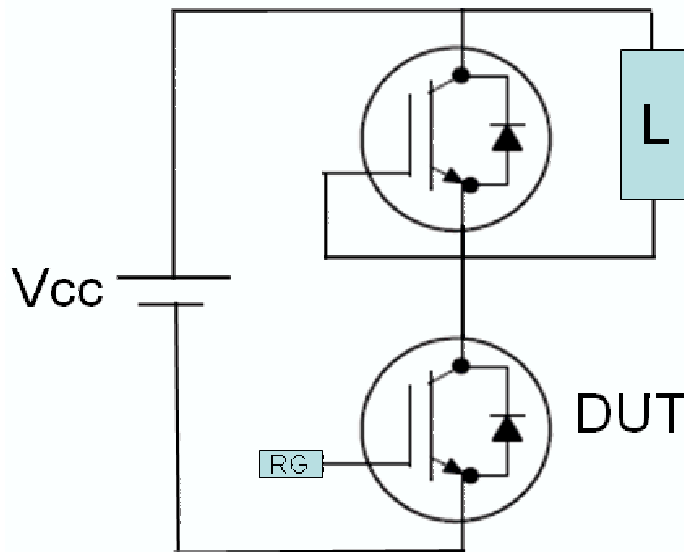


Figure 21. Test Circuit for Switching Characteristics

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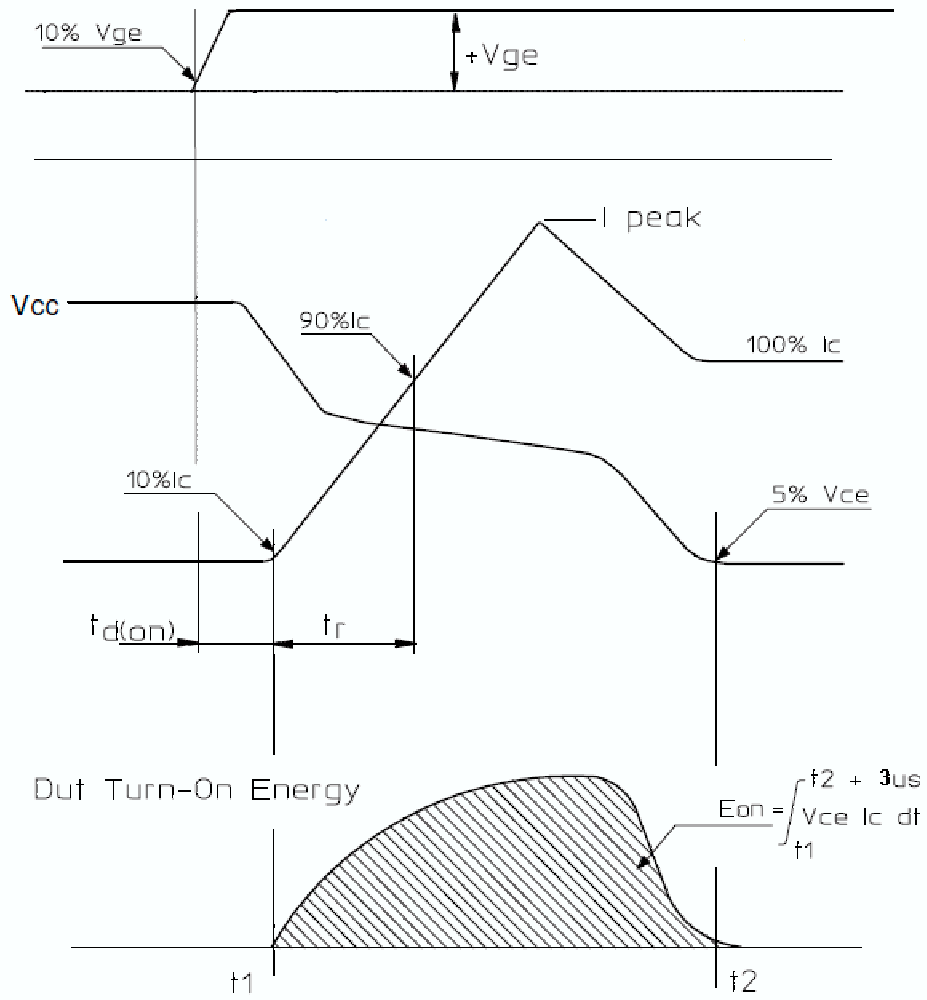


Figure 22. Definition of Turn On Waveform



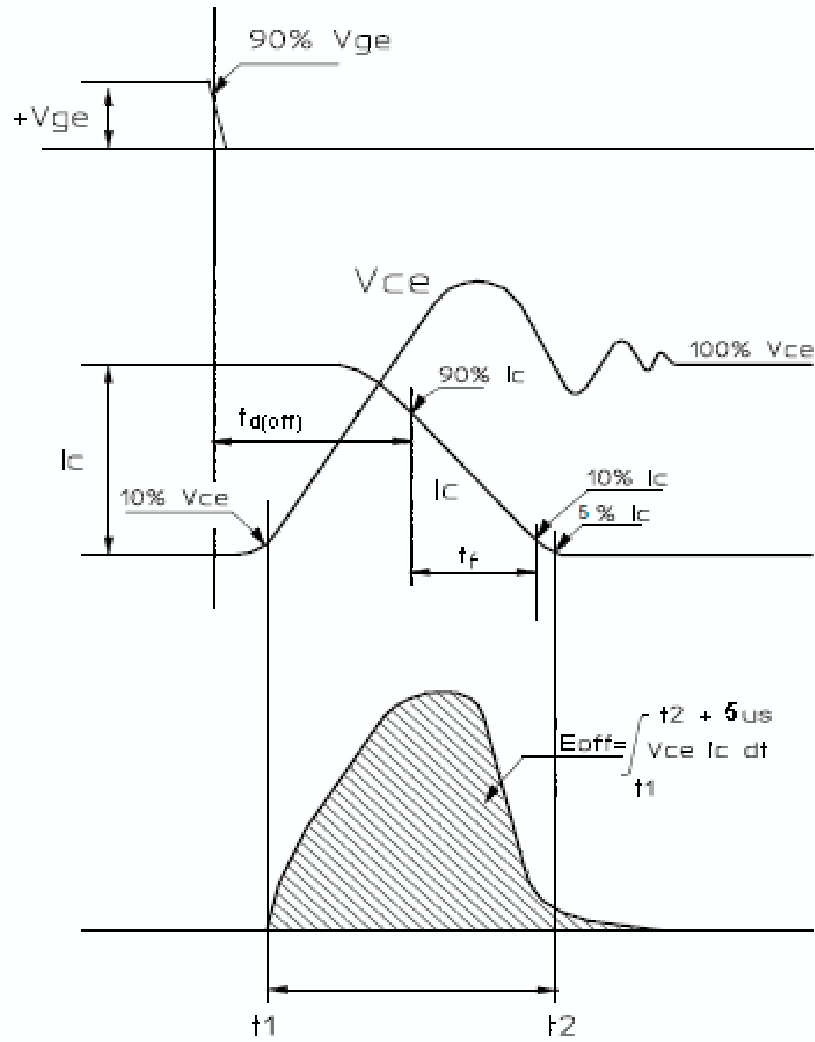
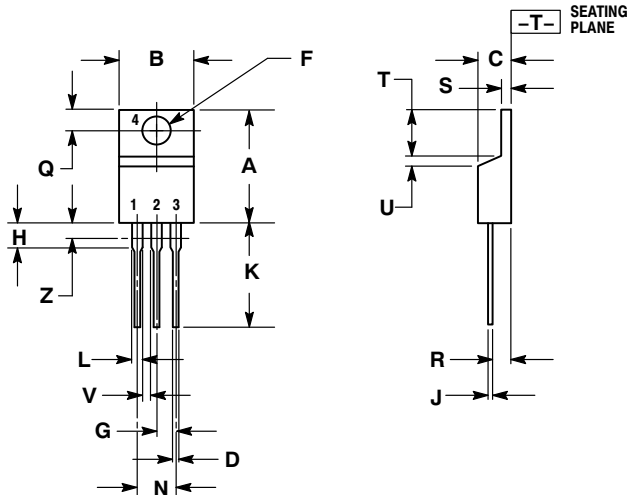


Figure 23. Definition of Turn Off Waveform

# NGTB15N60S1EG

## PACKAGE DIMENSIONS

TO-220  
CASE 221A-09  
ISSUE AG



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.036	0.64	0.91
F	0.142	0.161	3.61	4.09
G	0.095	0.105	2.42	2.66
H	0.110	0.161	2.80	4.10
J	0.014	0.025	0.36	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	---	1.15	---
Z	---	0.080	---	2.04

STYLE 9:

- PIN 1: GATE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

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