# NGTG15N60S1EG

## 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.

### Features

- Low Saturation Voltage Resulting in Low Conduction Loss
- Low Switching Loss in Higher Frequency Applications
- 5 μs 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<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_C$ | <br>30<br>15 | A |
| Pulsed collector current, $T_{pulse}$ limited by $T_{Jmax}$ | $I_{CM}$ | 120 | A |
| Gate−emitter voltage | $V_{GE}$ | ±20 | V |
| Power dissipation<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $P_D$ | <br>117<br>47 | W |
| Short circuit withstand time<br>$V_{GE}$ = 15 V, $V_{CE}$ = 400 V, $T_J \leq +150°C$ | $t_{SC}$ | 5 | μs |
| Operating junction temperature range | $T_J$ | −55 to +150 | °C |
| Storage temperature range | $T_{stg}$ | −55 to +150 | °C |
| Lead temperature for soldering, 1/8” from case for 5 seconds | $T_{SLD}$ | 260 | °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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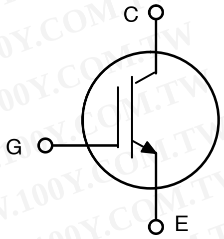
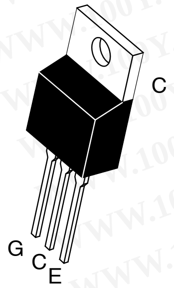
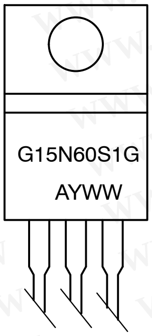
**15 A, 600 V**
**$V_{CEsat}$ = 1.5 V**





**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 |
|---|---|---|
| NGTG15N60S1EG | TO−220<br>(Pb−Free) | 50 Units / Rail |

## THERMAL CHARACTERISTICS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance junction to case, for IGBT | $R_{\theta JC}$ | 1.06 | °C/W |
| Thermal resistance junction to ambient | $R_{\theta JA}$ | 60 | °C/W |

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

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **STATIC CHARACTERISTIC** | | | | | | |
| Collector−emitter breakdown voltage, gate−emitter short−circuited | $V_{GE}$ = 0 V, $I_C$ = 500 μA | $V_{(BR)CES}$ | 600 | – | – | V |
| Collector−emitter saturation voltage | $V_{GE}$ = 15 V , $I_C$ = 15 A<br>$V_{GE}$ = 15 V , $I_C$ = 15 A, $T_J$ = 150°C | $V_{CEsat}$ | 1.3<br>1.55 | 1.5<br>1.75 | 1.7<br>1.95 | V |
| Gate−emitter threshold voltage | $V_{GE}$ = $V_{CE}$ , $I_C$ = 250 μA | $V_{GE(th)}$ | 4.5 | 5.5 | 6.5 | V |
| Collector−emitter cut−off current, gate−emitter short−circuited | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V<br>$V_{GE}$ = 0 V, $V_{CE}$ = 600 V, $T_J$ = 150°C | $I_{CES}$ | –<br>– | 10<br>– | –<br>200 | μA |
| Gate leakage current, collector−emitter short−circuited | $V_{GE}$ = 20 V, $V_{CE}$ = 0 V | $I_{GES}$ | – | – | 100 | nA |
| Forward Transconductance | $V_{CE}$ = 20 V, $I_C$ = 15 A | $g_{fs}$ | – | 10.1 | – | S |
| **DYNAMIC CHARACTERISTIC** | | | | | | |
| Input capacitance | $V_{CE}$ = 20 V, $V_{GE}$ = 0 V, f = 1 MHz | $C_{ies}$ | – | 1950 | – | pF |
| Output capacitance | | $C_{oes}$ | – | 70 | – | |
| Reverse transfer capacitance | | $C_{res}$ | – | 48 | – | |
| Gate charge total | $V_{CE}$ = 480 V, $I_C$ = 15 A, $V_{GE}$ = 15 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°C<br>$V_{CC}$ = 400 V, $I_C$ = 15 A<br>$R_g$ = 22 Ω<br>$V_{GE}$ = 0 V / 15 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 | | $E_{on}$ | – | 0.550 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.350 | – | |
| Total switching loss | | $E_{ts}$ | – | 0.900 | – | |
| Turn−on delay time | $T_J$ = 150°C<br>$V_{CC}$ = 400 V, $I_C$ = 15 A<br>$R_g$ = 22 Ω<br>$V_{GE}$ = 0 V / 15 V* | $t_{d(on)}$ | – | 65 | – | ns |
| Rise time | | $t_r$ | – | 28 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 180 | – | |
| Fall time | | $t_f$ | – | 260 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 0.650 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.600 | – | |
| Total switching loss | | $E_{ts}$ | – | 1.250 | – | |

*Includes diode reverse recovery loss using NGTB15N60S1EG.

## TYPICAL CHARACTERISTICS

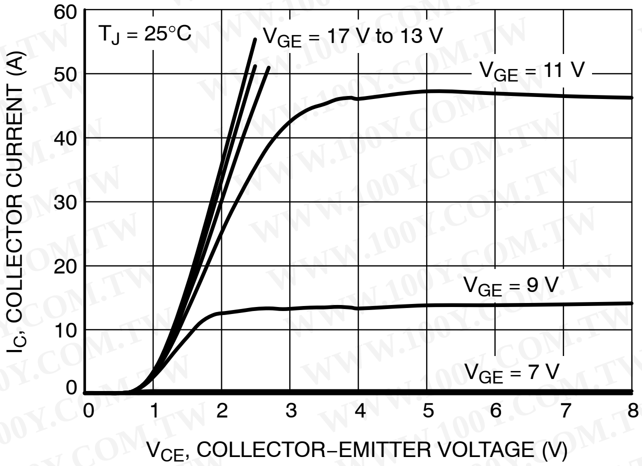


**Figure 1. Output Characteristics**

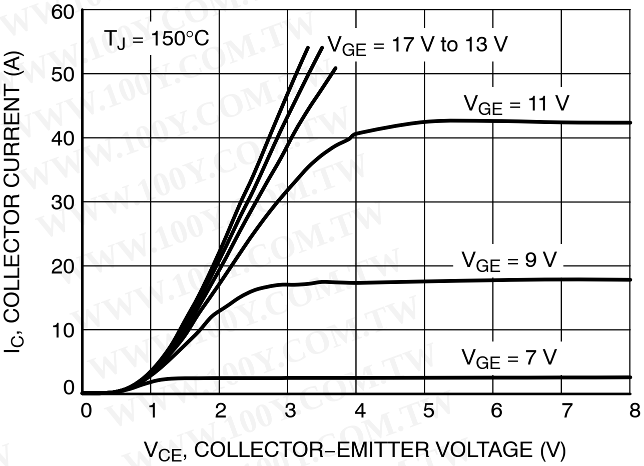


**Figure 2. Output Characteristics**

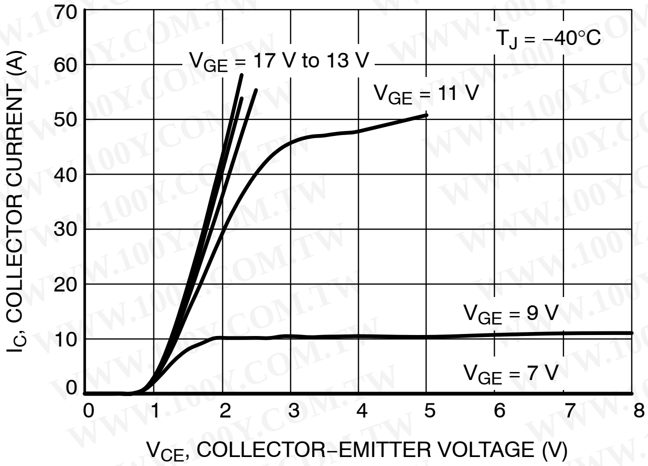


**Figure 3. Output Characteristics**

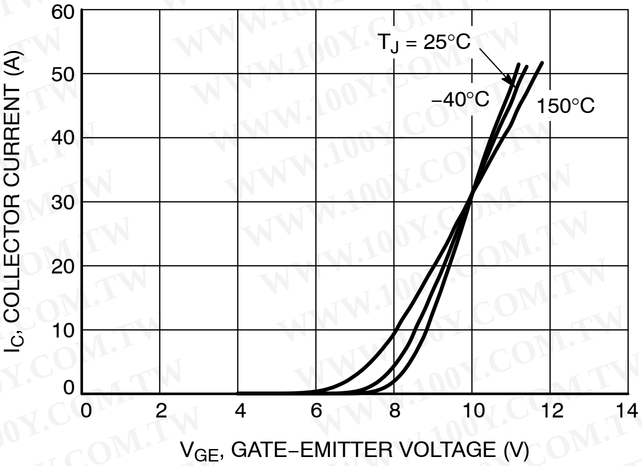


**Figure 4. Typical Transfer Characteristics**

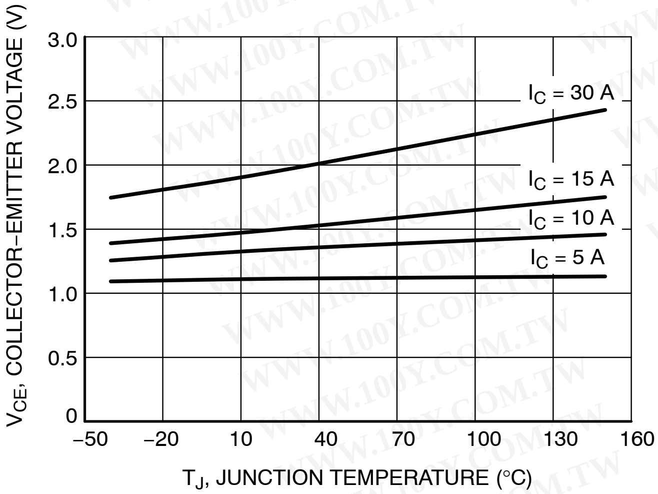


**Figure 5. $V_{CE(sat)}$ vs. $T_J$**

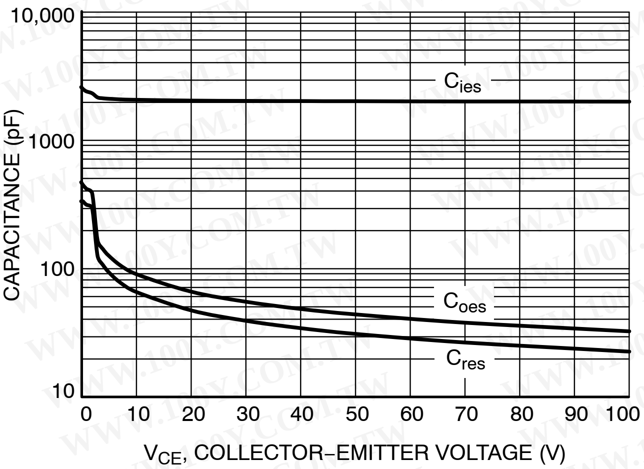


**Figure 6. Typical Capacitance**

## TYPICAL CHARACTERISTICS

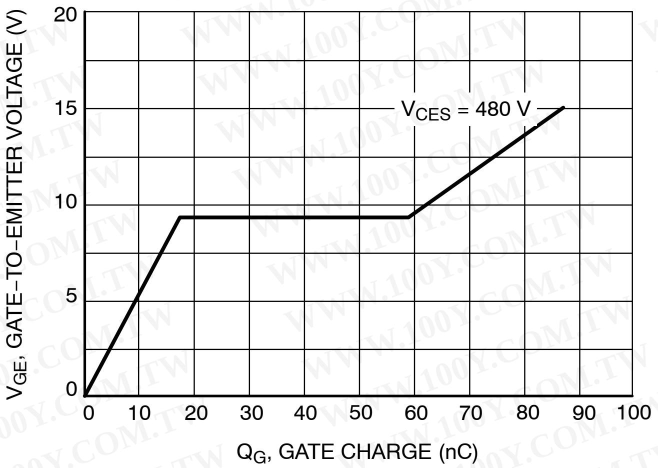


Figure 7. Typical Gate Charge

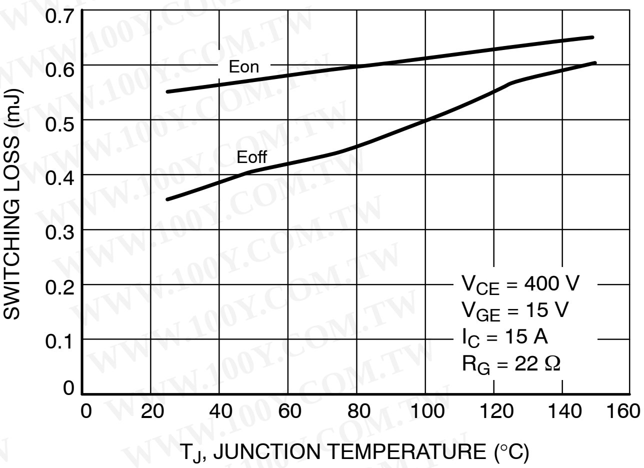


Figure 8. Switching Loss vs. Temperature

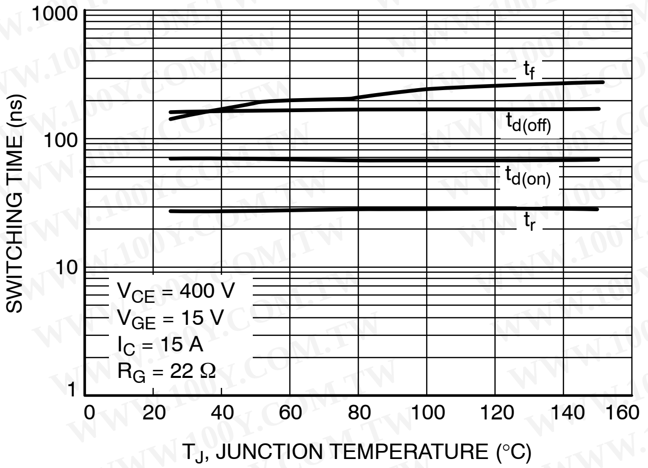


Figure 9. Switching Time vs. Temperature

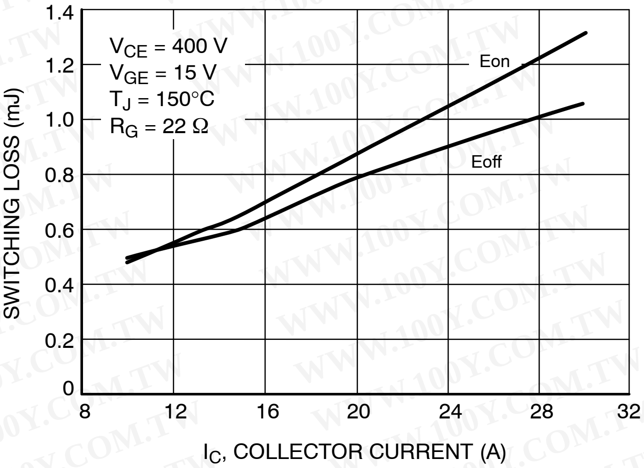


Figure 10. Switching Loss vs. $I_C$

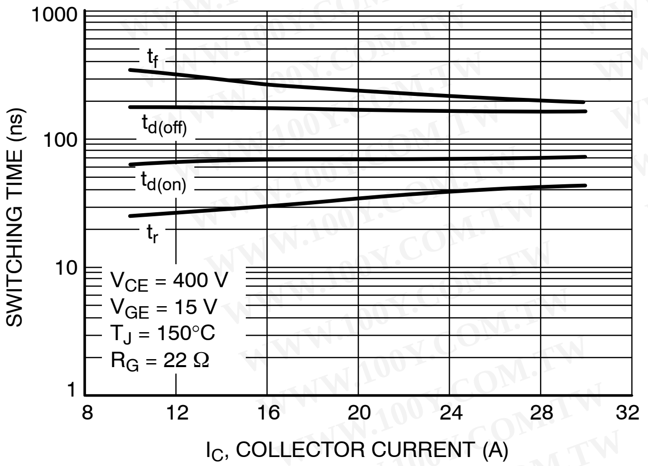


Figure 11. Switching Time vs. $I_C$

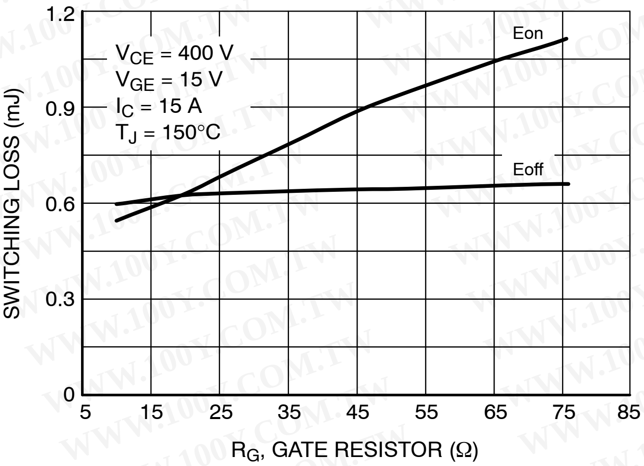


Figure 12. Switching Time vs. $R_G$

## TYPICAL CHARACTERISTICS

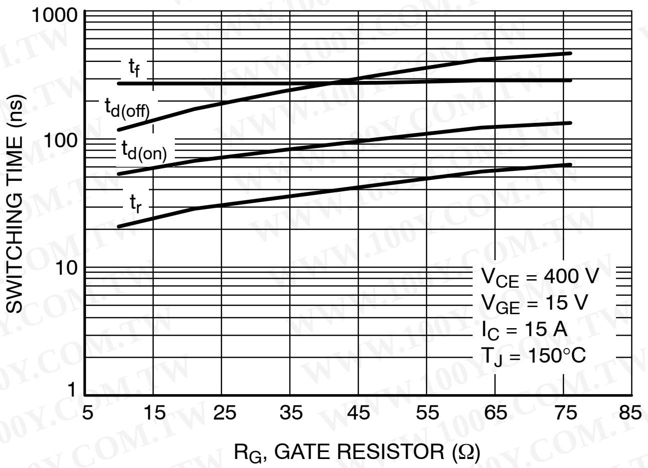


Figure 13. Switching Time vs. $R_G$

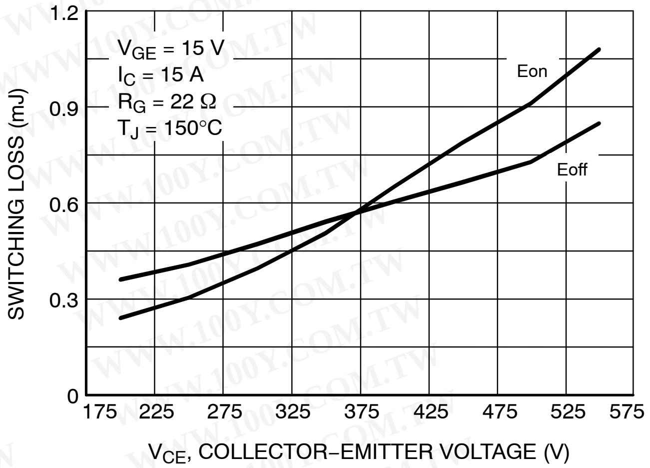


Figure 14. Switching Loss vs. $V_{CE}$

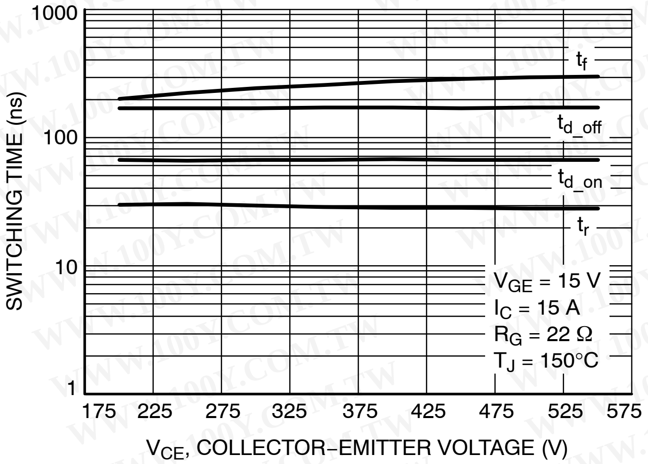


Figure 15. Switching Time vs. $V_{CE}$

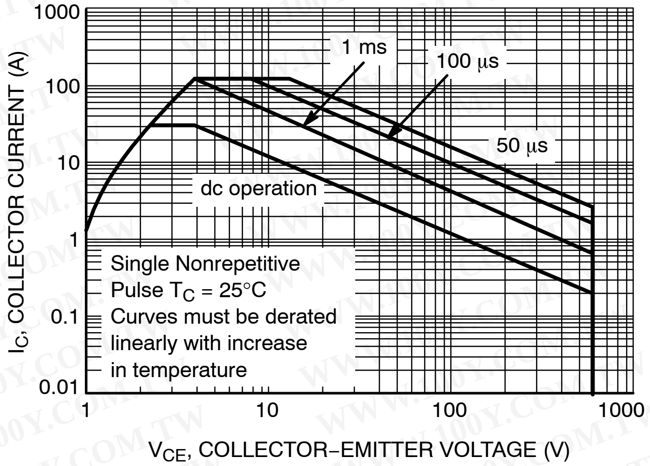


Figure 16. Safe Operating Area

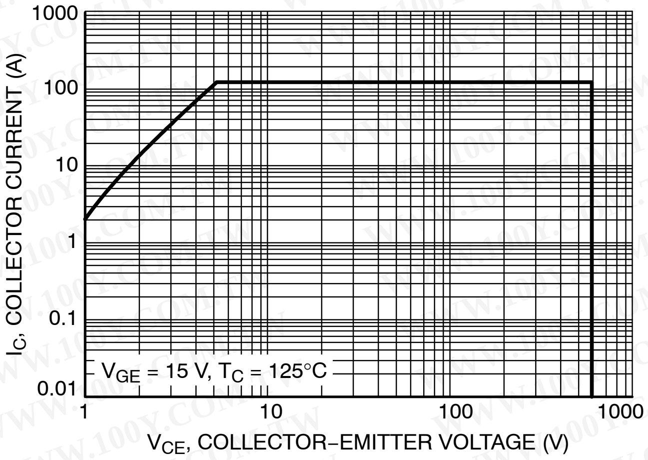
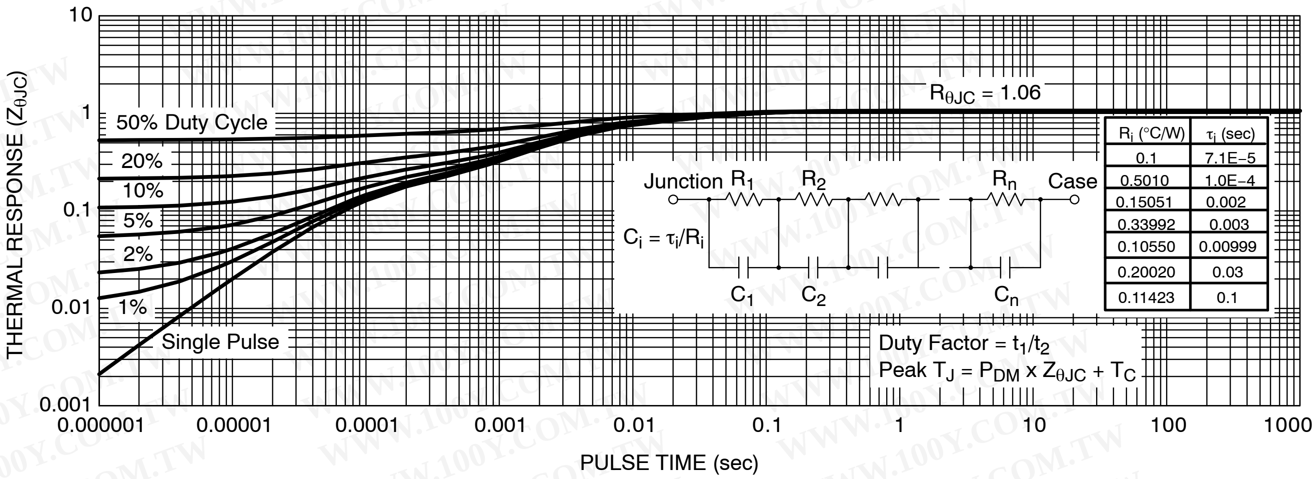


Figure 17. Reverse Bias Safe Operating Area

## TYPICAL CHARACTERISTICS



| $R_i$ (°C/W) | $\tau_i$ (sec) |
|---|---|
| 0.1 | 7.1E−5 |
| 0.5010 | 1.0E−4 |
| 0.15051 | 0.002 |
| 0.33992 | 0.003 |
| 0.10550 | 0.00999 |
| 0.20020 | 0.03 |
| 0.11423 | 0.1 |

**Figure 18. IGBT Transient Thermal Impedance**

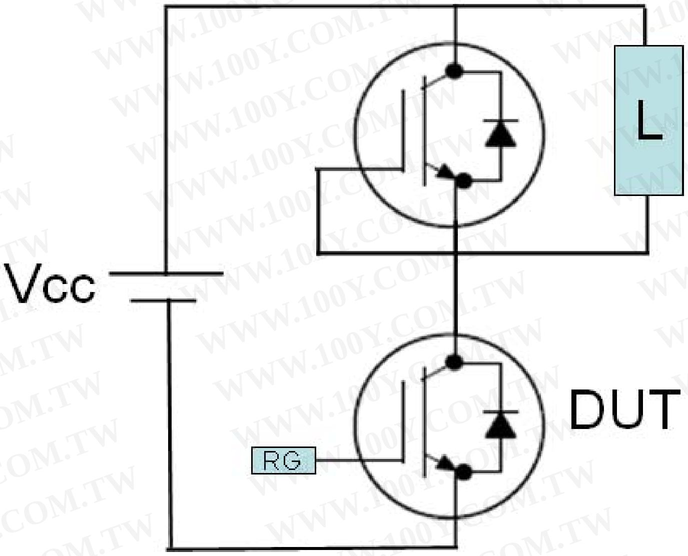


**Figure 19. Test Circuit for Switching Characteristics**

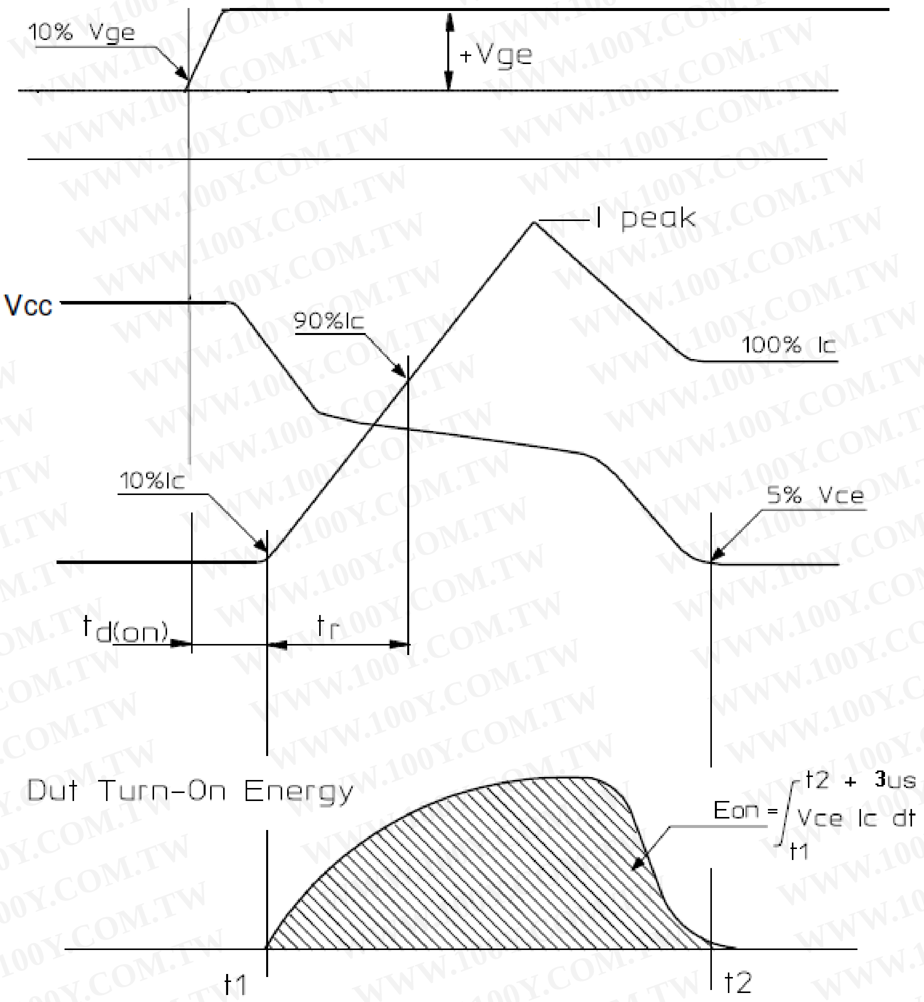


Figure 20. Definition of Turn On Waveform

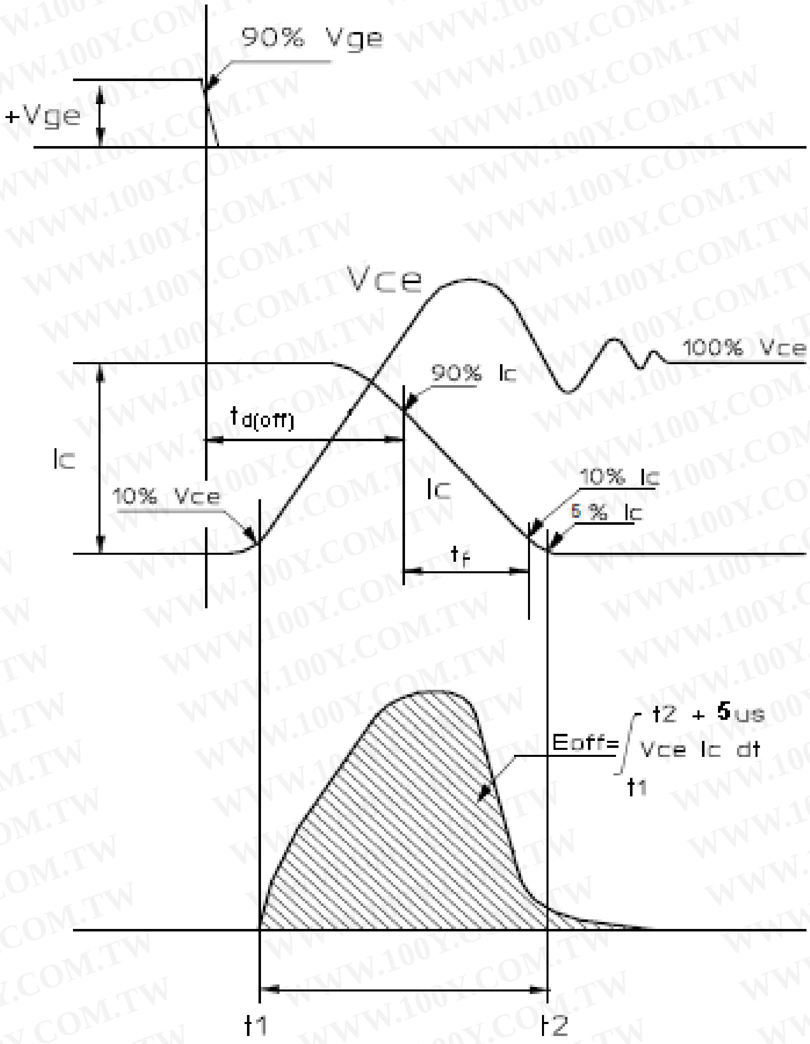


Figure 21. Definition of Turn Off Waveform

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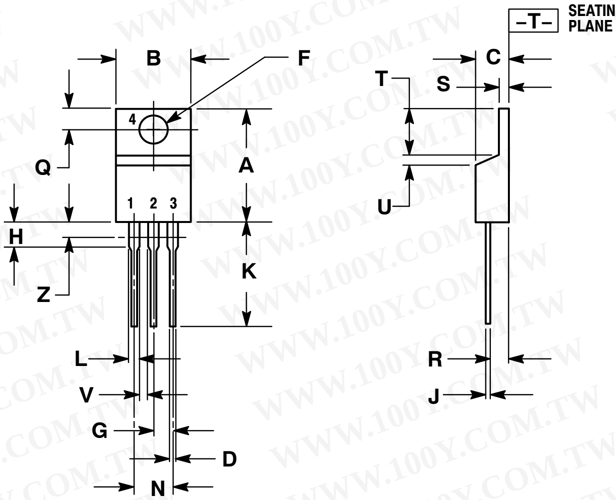
## PACKAGE DIMENSIONS

### 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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