

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 μ 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} | 650 | V |
| Collector current @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$ | I_C | 30 15 | A |
| Pulsed collector current, T_{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_{pulse} limited by $T_{J\text{max}}$ | I_{FM} | 120 | A |
| Gate-emitter voltage | V_{GE} | ± 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 | μs |
| 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 | $^\circ\text{C}$ |

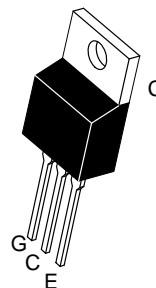
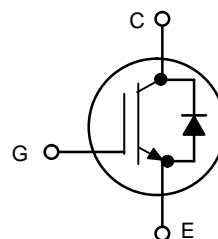
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.



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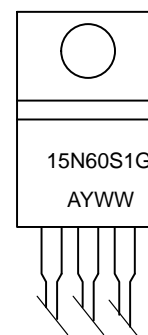
www.onsemi.com

15 A, 650 V
 $V_{CE\text{sat}} = 1.5\text{ V}$



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 | $R_{\theta JC}$ | 0.5 | $^{\circ}\text{C}/\text{W}$ |
| Thermal resistance junction to case, for Diode | $R_{\theta JC}$ | 2.3 | $^{\circ}\text{C}/\text{W}$ |
| 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 |
|-----------|-----------------|--------|-----|-----|-----|------|
|-----------|-----------------|--------|-----|-----|-----|------|

STATIC CHARACTERISTIC

| | | | | | | |
|---|---|---------------|-------------|-------------|-------------|---------------|
| Collector-emitter breakdown voltage, gate-emitter short-circuited | $V_{GE} = 0\text{ V}, I_C = 500\ \mu\text{A}$ $V_{GE} = 0\text{ V}, I_C = 500\ \mu\text{A}, T_J = -40^{\circ}\text{C}$ | $V_{(BR)CES}$ | 650 - | 720 660 | - - | 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 | $V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$ $V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_J = 150^{\circ}\text{C}$ | I_{CES} | - - | 10 - | - 200 | μA |
| 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 | | | $T_J = 150^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 15\text{ A}$ $R_g = 22\ \Omega$ $V_{GE} = 0\text{ V} / 15\text{ V}$ | $t_{d(on)}$ | - | 65 | - | ns |
| Rise time | | | | t_r | - | 28 | - | |
| Turn-off delay time | | | | $t_{d(off)}$ | - | 180 | - | |
| Fall time | t_f | - | | 260 | - | | | |
| Turn-on switching loss | $T_J = 150^{\circ}\text{C}$ $V_{CC} = 400\text{ V}, I_C = 15\text{ A}$ $R_g = 22\ \Omega$ $V_{GE} = 0\text{ V} / 15\text{ V}$ | 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 |
|-----------------|---|-------|--------|--------------|-----------|---|

NGTB15N60S1EG

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

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|-----------------------------|---|-----------|-----|------|-----|------|
| DIODE CHARACTERISTIC | | | | | | |
| 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 |

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

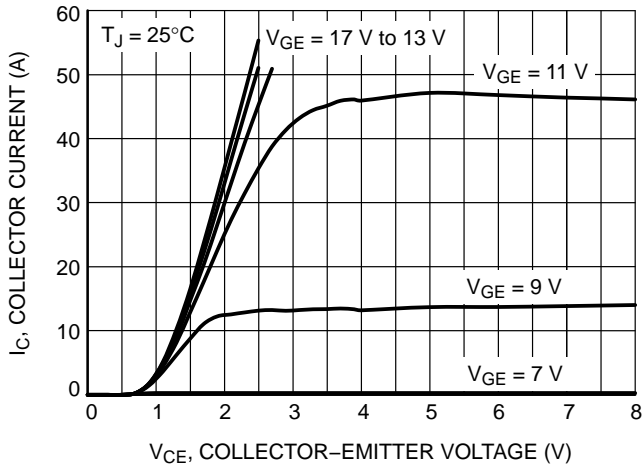


Figure 1. Output Characteristics

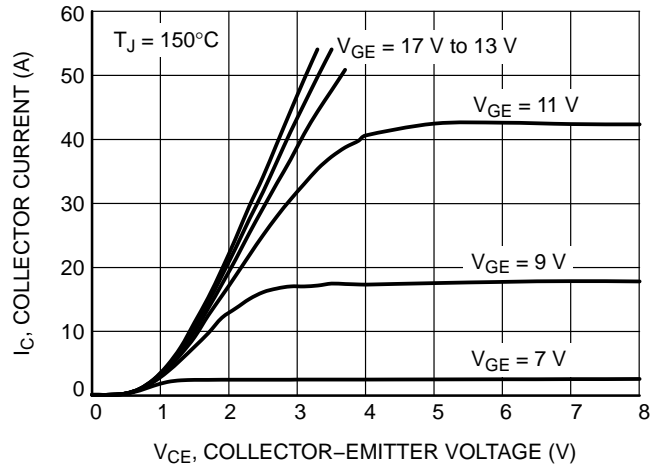


Figure 2. Output Characteristics

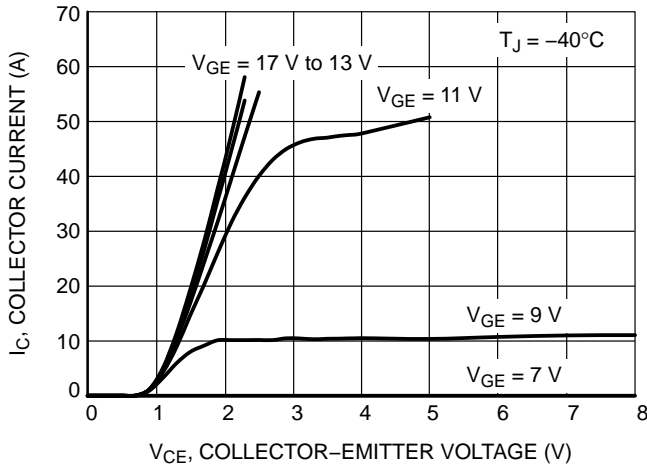


Figure 3. Output Characteristics

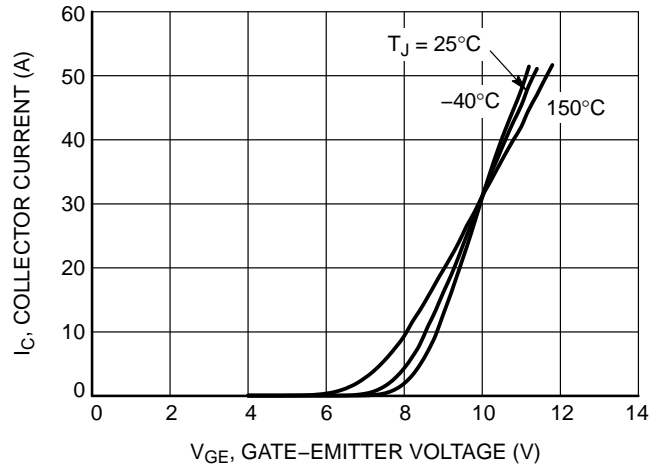


Figure 4. Typical Transfer Characteristics

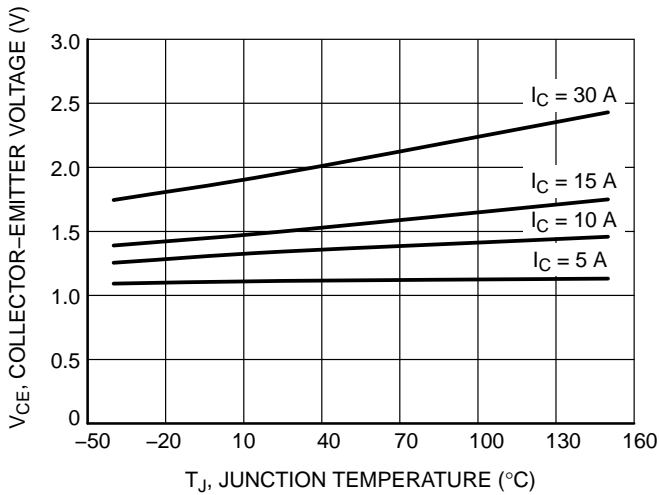


Figure 5. $V_{CE(sat)}$ vs. T_J

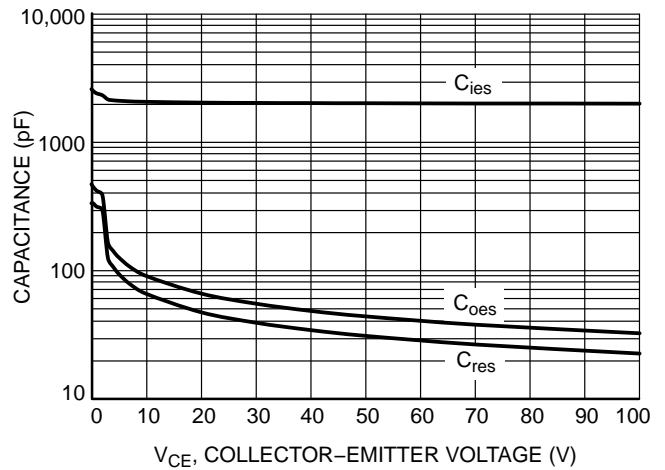


Figure 6. Typical Capacitance

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TYPICAL CHARACTERISTICS

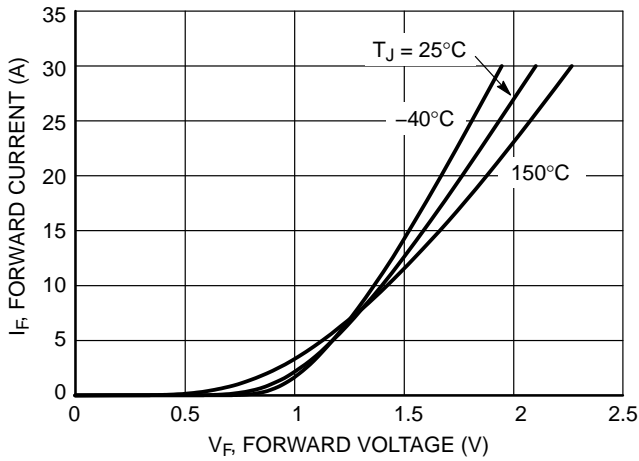


Figure 7. Diode Forward Characteristics

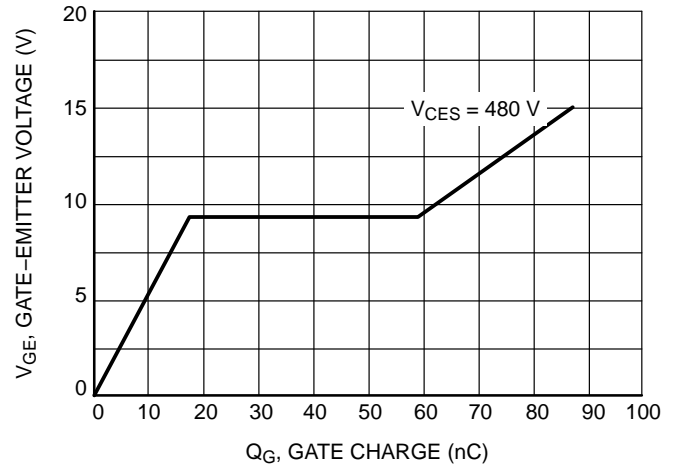


Figure 8. Typical Gate Charge

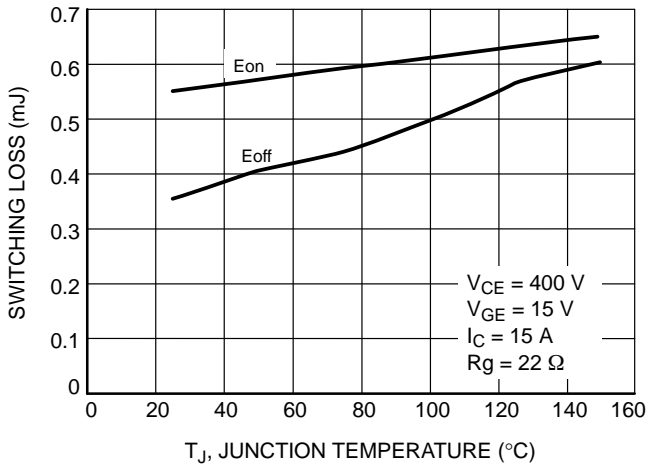


Figure 9. Switching Loss vs. Temperature

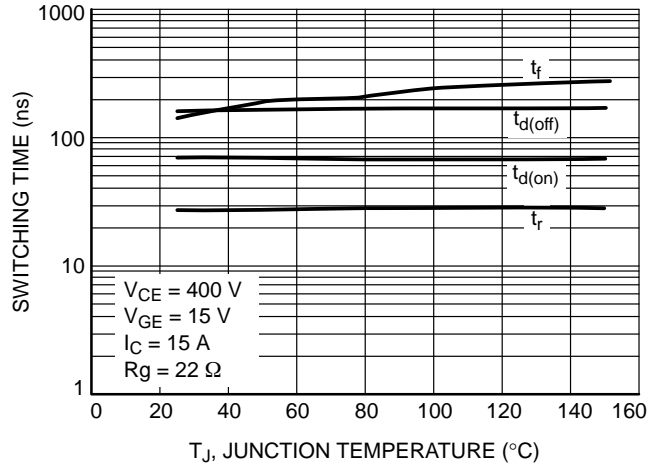


Figure 10. Switching Time vs. Temperature

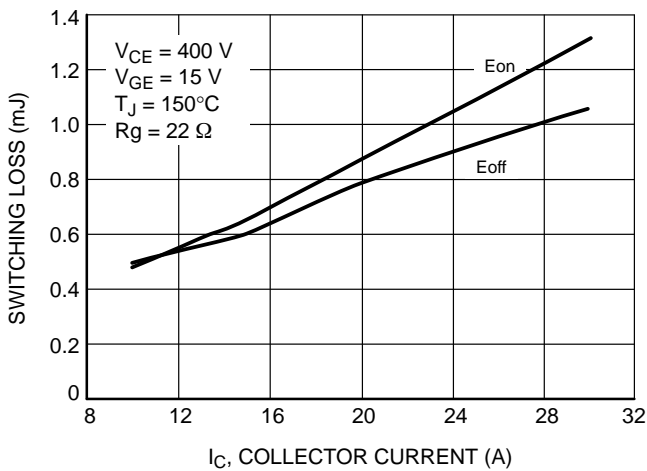


Figure 11. Switching Loss vs. I_C

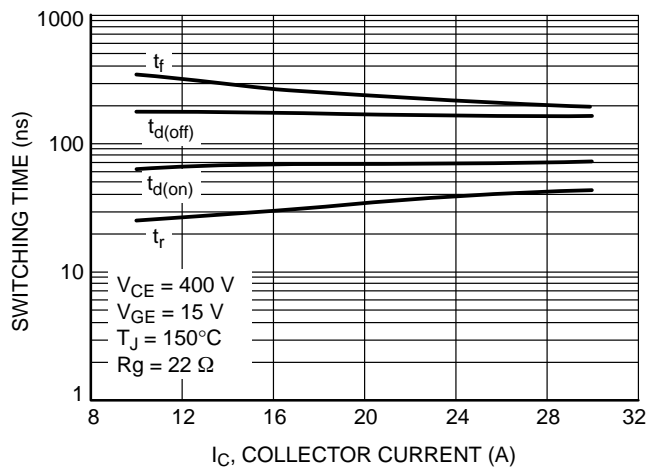


Figure 12. Switching Time vs. I_C

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TYPICAL CHARACTERISTICS

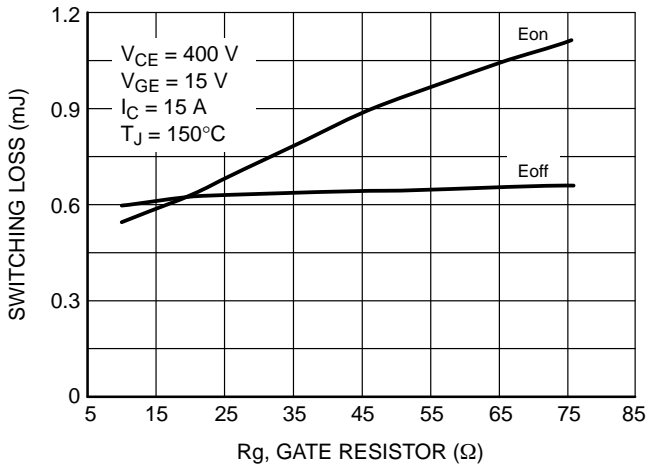


Figure 13. Switching Time vs. Rg

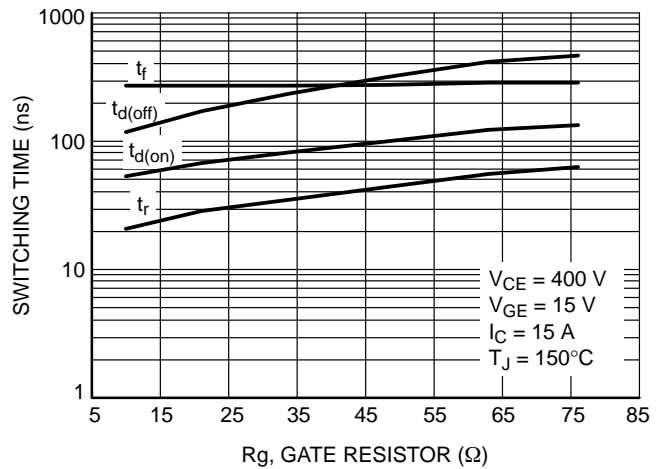


Figure 14. Switching Time vs. Rg

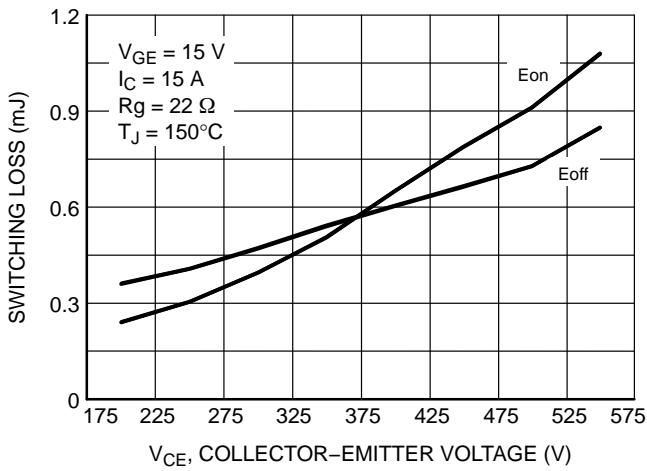


Figure 15. Switching Loss vs. V_{CE}

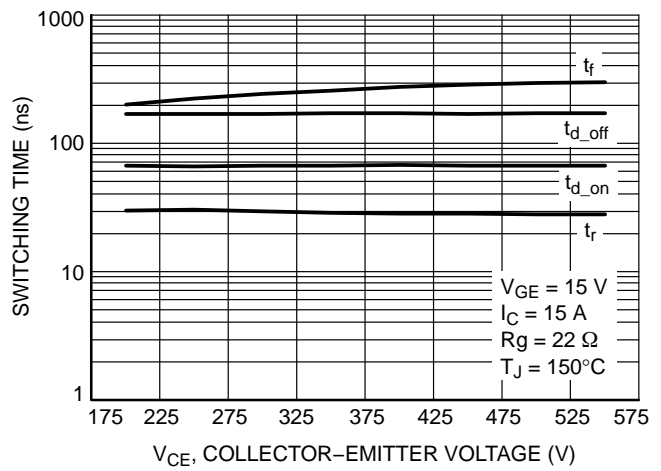


Figure 16. Switching Time vs. V_{CE}

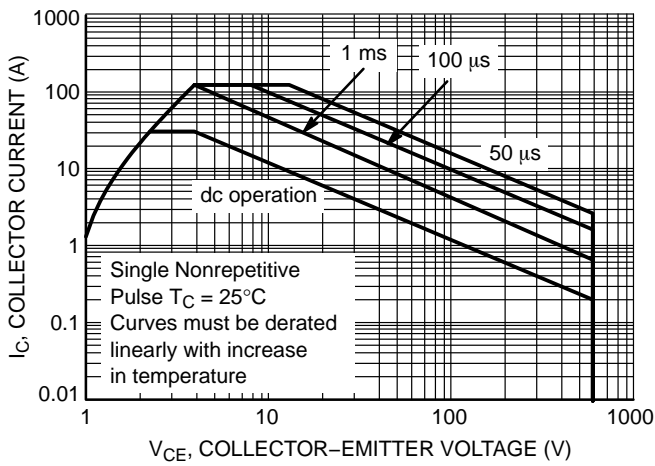


Figure 17. Safe Operating Area

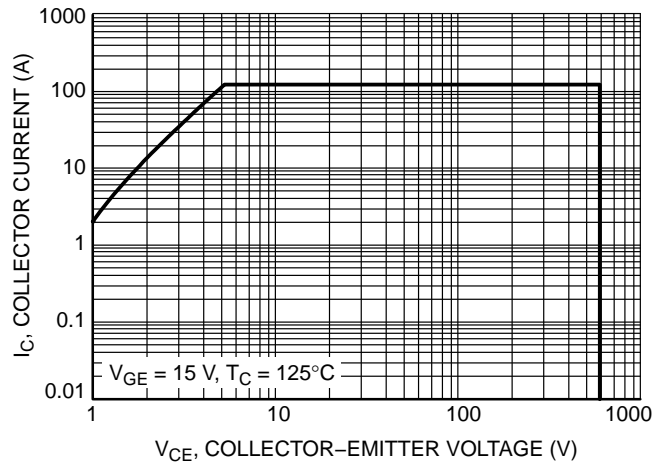


Figure 18. Reverse Bias Safe Operating Area

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TYPICAL CHARACTERISTICS

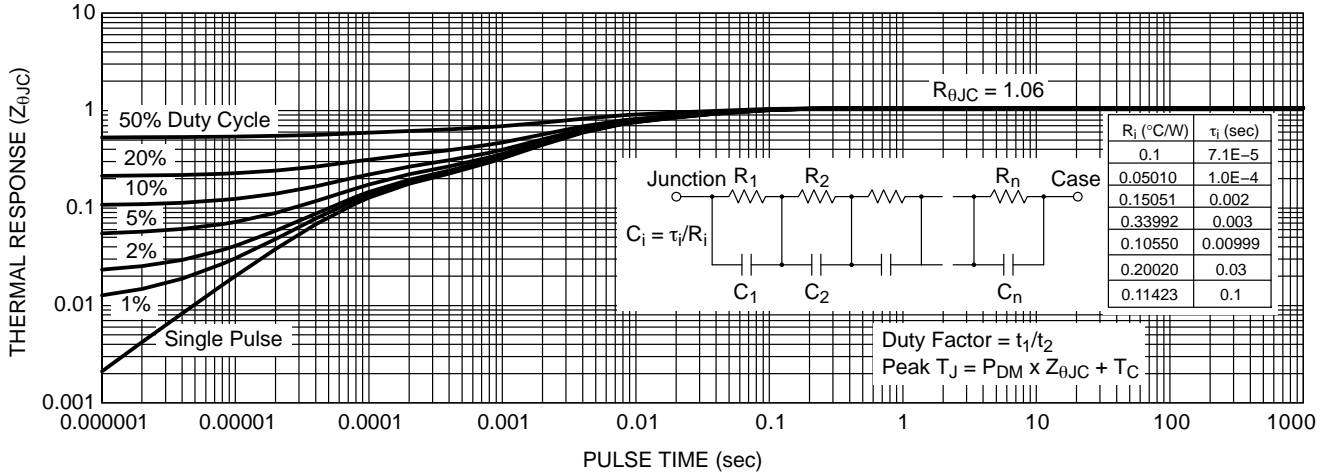


Figure 19. IGBT Transient Thermal Impedance

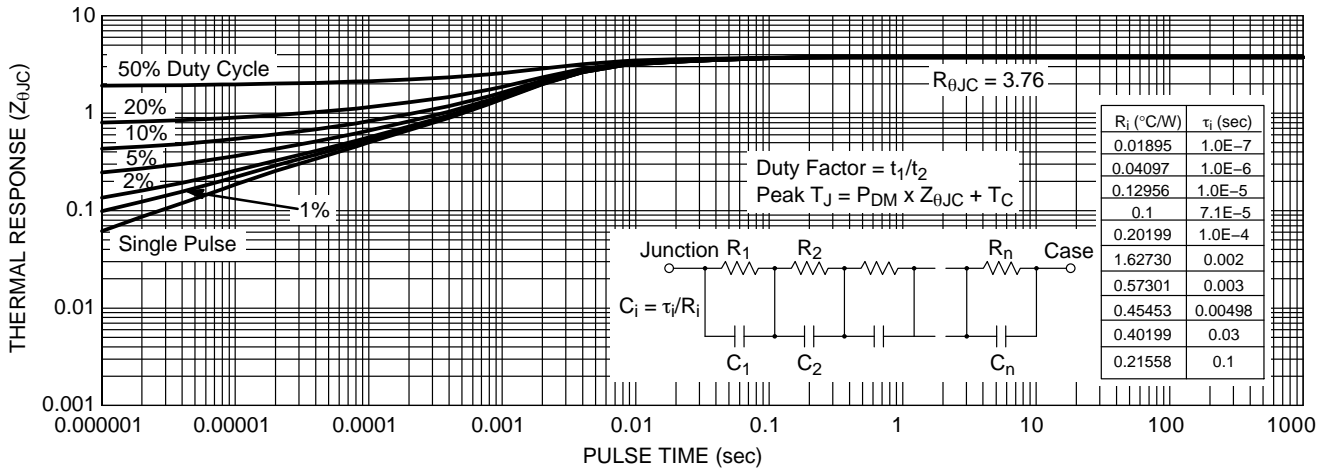


Figure 20. Diode Transient Thermal Impedance

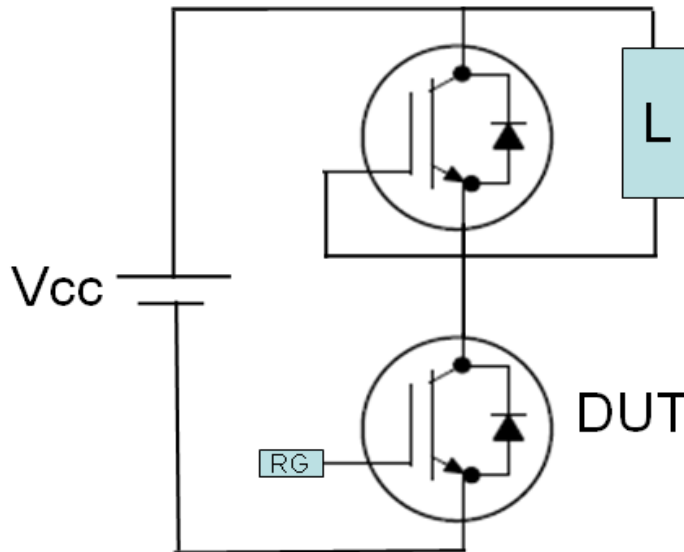


Figure 21. Test Circuit for Switching Characteristics

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Figure 22. Definition of Turn On Waveform

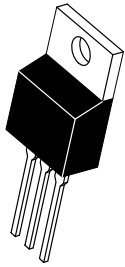


Figure 23. Definition of Turn Off Waveform

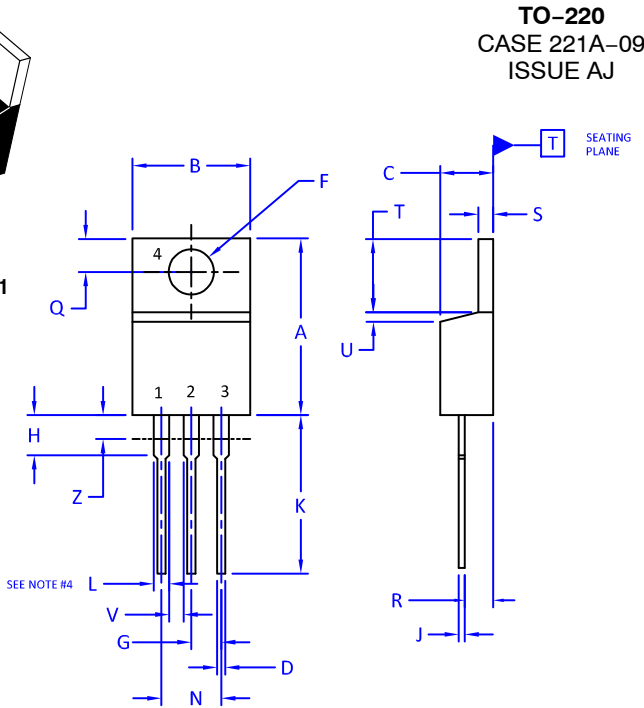
MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

ON Semiconductor®



SCALE 1:1



TO-220
CASE 221A-09
ISSUE AJ

DATE 05 NOV 2019

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 2009.
2. CONTROLLING DIMENSION: INCHES
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.
4. MAX WIDTH FOR F102 DEVICE = 1.35MM

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.570 | 0.620 | 14.48 | 15.75 |
| B | 0.380 | 0.415 | 9.66 | 10.53 |
| C | 0.160 | 0.190 | 4.07 | 4.83 |
| D | 0.025 | 0.038 | 0.64 | 0.96 |
| F | 0.142 | 0.161 | 3.60 | 4.09 |
| G | 0.095 | 0.105 | 2.42 | 2.66 |
| H | 0.110 | 0.161 | 2.80 | 4.10 |
| J | 0.014 | 0.024 | 0.36 | 0.61 |
| 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 | 1.41 |
| 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 1:

- PIN 1. BASE
- 2. COLLECTOR
- 3. EMITTER
- 4. COLLECTOR

STYLE 2:

- PIN 1. BASE
- 2. EMITTER
- 3. COLLECTOR
- 4. EMITTER

STYLE 3:

- PIN 1. CATHODE
- 2. ANODE
- 3. GATE
- 4. ANODE

STYLE 4:

- PIN 1. MAIN TERMINAL 1
- 2. MAIN TERMINAL 2
- 3. GATE
- 4. MAIN TERMINAL 2

STYLE 5:

- PIN 1. GATE
- 2. DRAIN
- 3. SOURCE
- 4. DRAIN

STYLE 6:

- PIN 1. ANODE
- 2. CATHODE
- 3. ANODE
- 4. CATHODE

STYLE 7:

- PIN 1. CATHODE
- 2. ANODE
- 3. CATHODE
- 4. ANODE

STYLE 8:

- PIN 1. CATHODE
- 2. ANODE
- 3. EXTERNAL TRIP/DELAY
- 4. ANODE

STYLE 9:

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

STYLE 10:

- PIN 1. GATE
- 2. SOURCE
- 3. DRAIN
- 4. SOURCE

STYLE 11:

- PIN 1. DRAIN
- 2. SOURCE
- 3. GATE
- 4. SOURCE

STYLE 12:

- PIN 1. MAIN TERMINAL 1
- 2. MAIN TERMINAL 2
- 3. GATE
- 4. NOT CONNECTED

| | | |
|-------------------------|--------------------|--|
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| DESCRIPTION: | TO-220 | PAGE 1 OF 1 |

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