

# NGTB50N60FWG

## IGBT

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

### Features

- Optimized for Very Low  $V_{CEsat}$
- Low Switching Loss Reduces System Power Dissipation
- Soft Fast Reverse Recovery Diode
- 5  $\mu$ s Short-Circuit Capability
- These are Pb-Free Devices

### Typical Applications

- Solar Inverters
- Uninterruptible Power Supplies (UPS)
- Motor Drives

### ABSOLUTE MAXIMUM RATINGS

| Rating                                                                                                              | Symbol    | Value                | Unit             |
|---------------------------------------------------------------------------------------------------------------------|-----------|----------------------|------------------|
| Collector-emitter voltage                                                                                           | $V_{CES}$ | 600                  | V                |
| Collector current<br>@ $T_c = 25^\circ\text{C}$<br>@ $T_c = 100^\circ\text{C}$                                      | $I_C$     | 100<br>50            | A                |
| Pulsed collector current, $T_{pulse}$ limited by $T_{Jmax}$                                                         | $I_{CM}$  | 200                  | A                |
| Diode Forward Current<br>@ $T_c = 25^\circ\text{C}$<br>@ $T_c = 100^\circ\text{C}$                                  | $I_F$     | 100<br>50            | A                |
| Diode Pulsed Current $T_{pulse}$ limited by $T_{Jmax}$                                                              | $I_{FM}$  | 200                  | A                |
| Short-circuit withstand time<br>$V_{GE} = 15\text{ V}$ , $V_{CE} = 300\text{ V}$ ,<br>$T_J \leq +150^\circ\text{C}$ | $t_{SC}$  | 5                    | $\mu$ s          |
| Gate-emitter voltage<br>Transient Gate-Emitter Voltage                                                              | $V_{GE}$  | $\pm 20$<br>$\pm 30$ | V                |
| Power Dissipation<br>@ $T_c = 25^\circ\text{C}$<br>@ $T_c = 100^\circ\text{C}$                                      | $P_D$     | 223<br>89            | W                |
| 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.



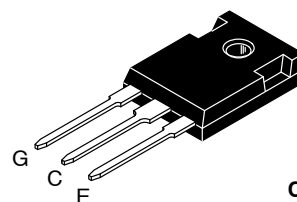
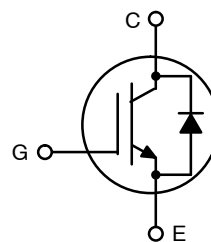
ON Semiconductor®

<http://onsemi.com>

50 A, 600 V

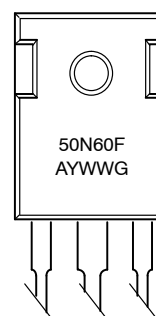
$V_{CEsat} = 1.45\text{ V}$

$E_{OFF} = 1.20\text{ mJ}$



TO-247  
CASE 340L  
STYLE 4

### MARKING DIAGRAM



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

### ORDERING INFORMATION

| Device       | Package             | Shipping        |
|--------------|---------------------|-----------------|
| NGTB50N60FWG | TO-247<br>(Pb-Free) | 30 Units / Rail |

# NGTB50N60FWG

## THERMAL CHARACTERISTICS

| Rating                                         | Symbol          | Value | Unit                 |
|------------------------------------------------|-----------------|-------|----------------------|
| Thermal resistance junction-to-case, for IGBT  | $R_{\theta JC}$ | 0.56  | $^{\circ}\text{C/W}$ |
| Thermal resistance junction-to-case, for Diode | $R_{\theta JC}$ | 0.74  | $^{\circ}\text{C/W}$ |
| Thermal resistance junction-to-ambient         | $R_{\theta JA}$ | 40    | $^{\circ}\text{C/W}$ |

## 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 | $V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$                                                                     | $V_{(BR)CES}$ | 600       | –           | –        | V  |
| Collector-emitter saturation voltage                              | $V_{GE} = 15\text{ V}, I_C = 50\text{ A}$<br>$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 150^{\circ}\text{C}$       | $V_{CEsat}$   | 1.25<br>– | 1.45<br>1.7 | 1.7<br>– | V  |
| Gate-emitter threshold voltage                                    | $V_{GE} = V_{CE}, I_C = 350\text{ }\mu\text{A}$                                                                         | $V_{GE(th)}$  | 4.5       | 5.5         | 6.5      | V  |
| Collector-emitter cut-off current, gate-emitter short-circuited   | $V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$<br>$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 150^{\circ}\text{C}$ | $I_{CES}$     | –<br>–    | –<br>–      | 0.5<br>2 | 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            | $V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$    | $C_{ies}$ | – | 7300 | – | pF |
| Output capacitance           |                                                                  | $C_{oes}$ | – | 275  | – |    |
| Reverse transfer capacitance |                                                                  | $C_{res}$ | – | 170  | – |    |
| Gate charge total            | $V_{CE} = 480\text{ V}, I_C = 50\text{ A}, V_{GE} = 15\text{ V}$ | $Q_g$     | – | 310  | – | nC |
| Gate to emitter charge       |                                                                  | $Q_{ge}$  | – | 60   | – |    |
| Gate to collector charge     |                                                                  | $Q_{gc}$  | – | 150  | – |    |

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |                                                                                                                                            |              |   |     |   |    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------|---|-----|---|----|
| Turn-on delay time      | $T_J = 25^{\circ}\text{C}$<br>$V_{CC} = 400\text{ V}, I_C = 50\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$  | $t_{d(on)}$  | – | 117 | – | ns |
| Rise time               |                                                                                                                                            | $t_r$        | – | 43  | – |    |
| Turn-off delay time     |                                                                                                                                            | $t_{d(off)}$ | – | 285 | – |    |
| Fall time               |                                                                                                                                            | $t_f$        | – | 105 | – |    |
| Turn-on switching loss  |                                                                                                                                            | $E_{on}$     | – | 1.1 | – | mJ |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    | – | 1.2 | – |    |
| Total switching loss    |                                                                                                                                            | $E_{ts}$     | – | 2.3 | – |    |
| Turn-on delay time      | $T_J = 150^{\circ}\text{C}$<br>$V_{CC} = 400\text{ V}, I_C = 50\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$ | $t_{d(on)}$  | – | 112 | – | ns |
| Rise time               |                                                                                                                                            | $t_r$        | – | 45  | – |    |
| Turn-off delay time     |                                                                                                                                            | $t_{d(off)}$ | – | 300 | – |    |
| Fall time               |                                                                                                                                            | $t_f$        | – | 214 | – |    |
| Turn-on switching loss  |                                                                                                                                            | $E_{on}$     | – | 1.4 | – | mJ |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    | – | 2.0 | – |    |
| Total switching loss    |                                                                                                                                            | $E_{ts}$     | – | 3.4 | – |    |

# NGTB50N60FWG

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

| Parameter                   | Test Conditions                                                                                               | Symbol    | Min      | Typ         | Max      | Unit          |
|-----------------------------|---------------------------------------------------------------------------------------------------------------|-----------|----------|-------------|----------|---------------|
| <b>DIODE CHARACTERISTIC</b> |                                                                                                               |           |          |             |          |               |
| Forward voltage             | $V_{GE} = 0\text{ V}, I_F = 50\text{ A}$<br>$V_{GE} = 0\text{ V}, I_F = 50\text{ A}, T_J = 150^\circ\text{C}$ | $V_F$     | 1.4<br>– | 1.95<br>2.1 | 2.5<br>– | V             |
| Reverse recovery time       | $T_J = 25^\circ\text{C}$<br>$I_F = 50\text{ A}, V_R = 200\text{ V}$<br>$di_F/dt = 200\text{ A}/\mu\text{s}$   | $t_{rr}$  | –        | 77          | –        | ns            |
| Reverse recovery charge     |                                                                                                               | $Q_{rr}$  | –        | 0.4         | –        | $\mu\text{C}$ |
| Reverse recovery current    |                                                                                                               | $I_{rrm}$ | –        | 8           | –        | A             |

TYPICAL CHARACTERISTICS

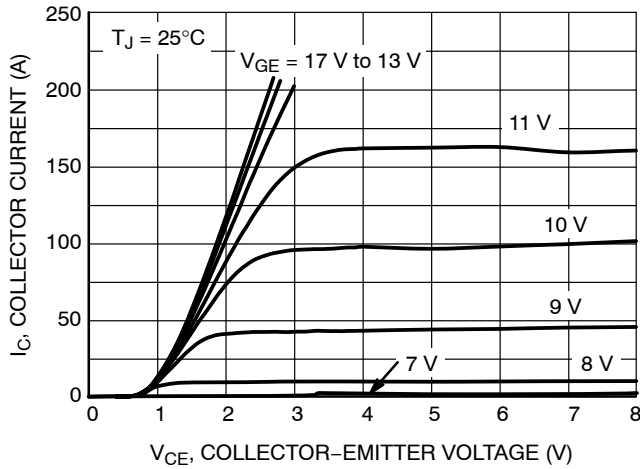


Figure 1. Output Characteristics

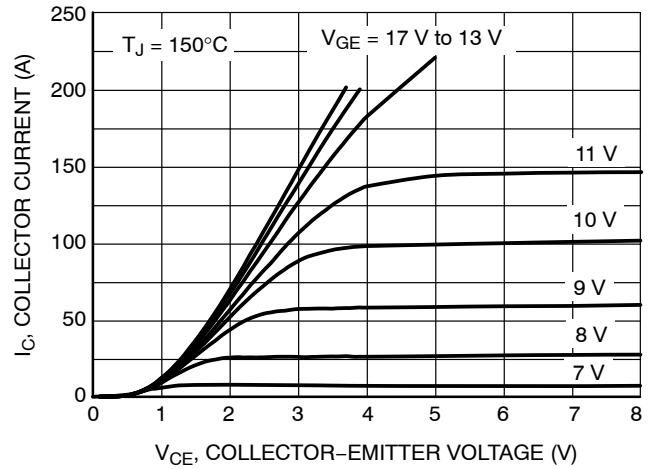


Figure 2. Output Characteristics

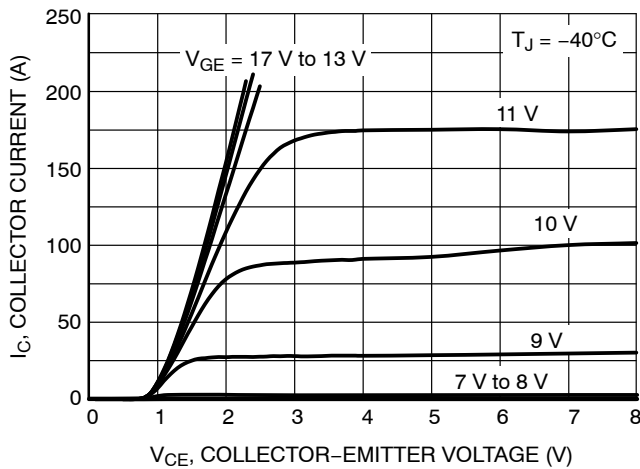


Figure 3. Output Characteristics

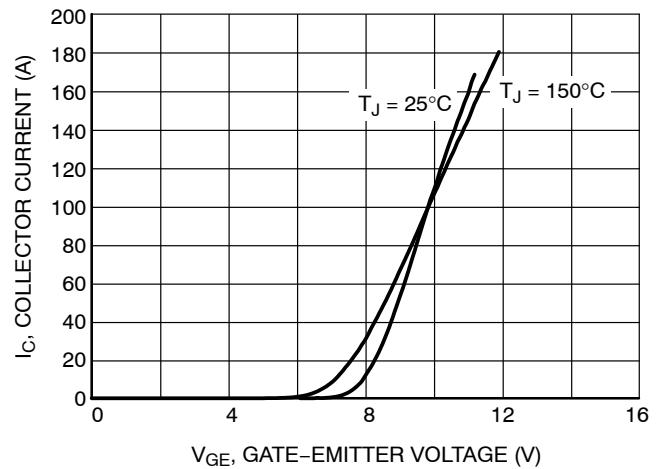


Figure 4. Typical Transfer Characteristics

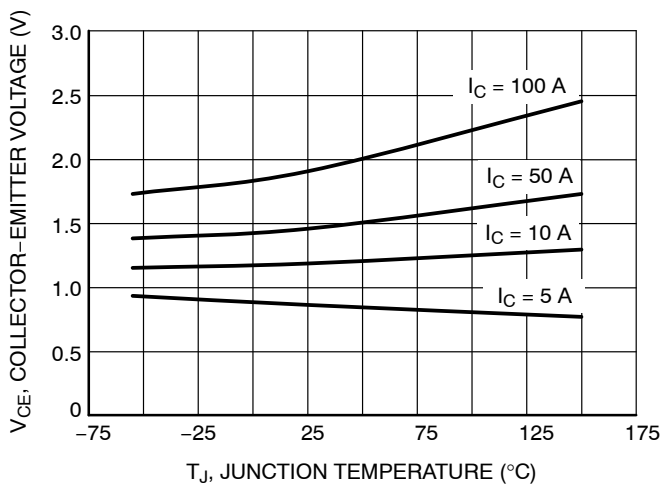


Figure 5.  $V_{CE(sat)}$  vs.  $T_J$

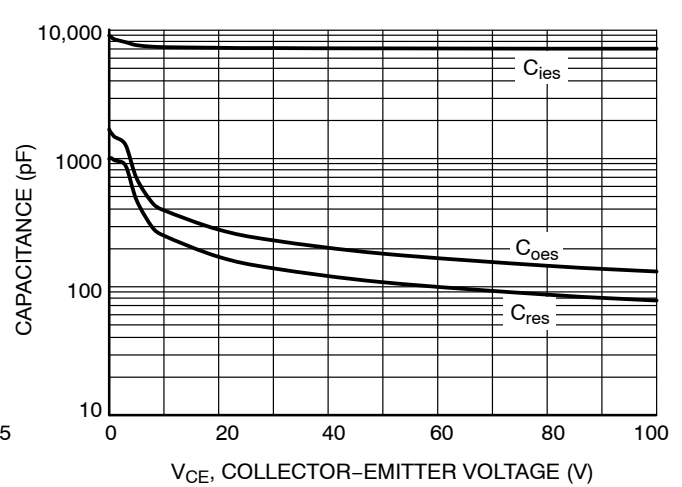


Figure 6. Typical Capacitance

TYPICAL CHARACTERISTICS

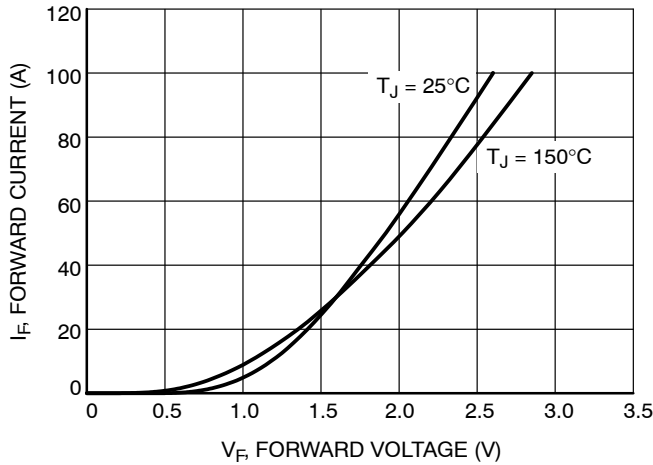


Figure 7. Diode Forward Characteristics

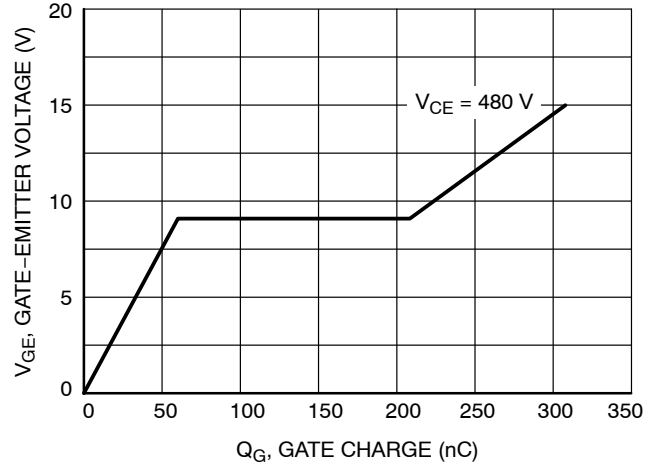


Figure 8. Typical Gate Charge

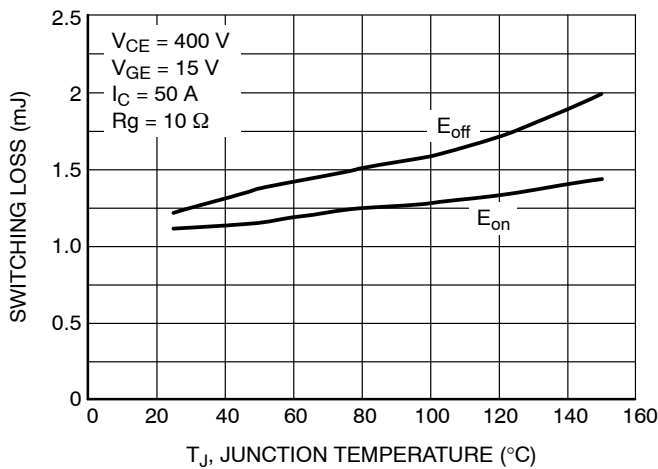


Figure 9. Switching Loss vs. Temperature

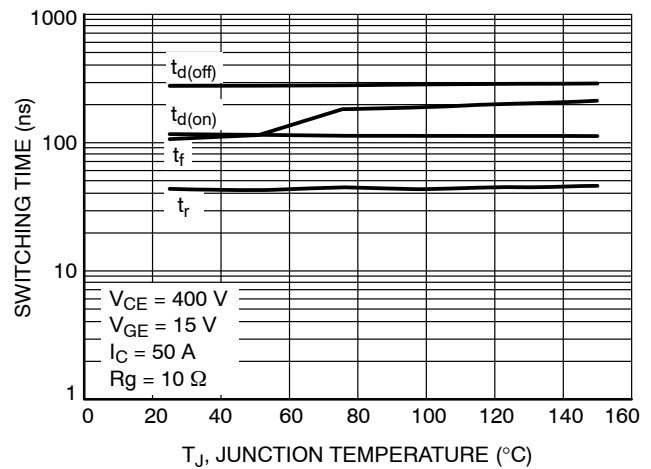


Figure 10. Switching Time vs. Temperature

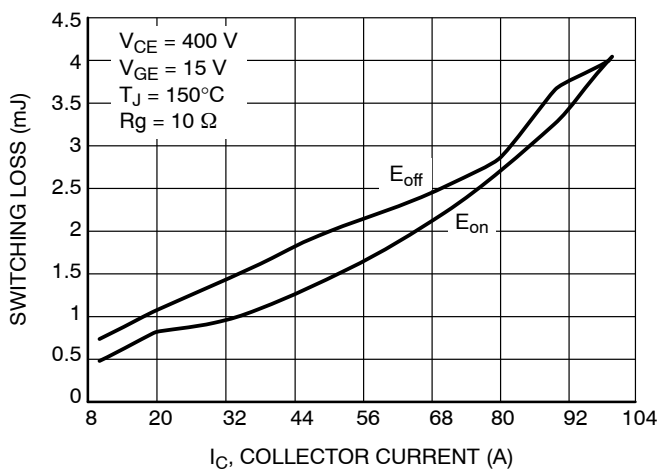


Figure 11. Switching Loss vs.  $I_C$

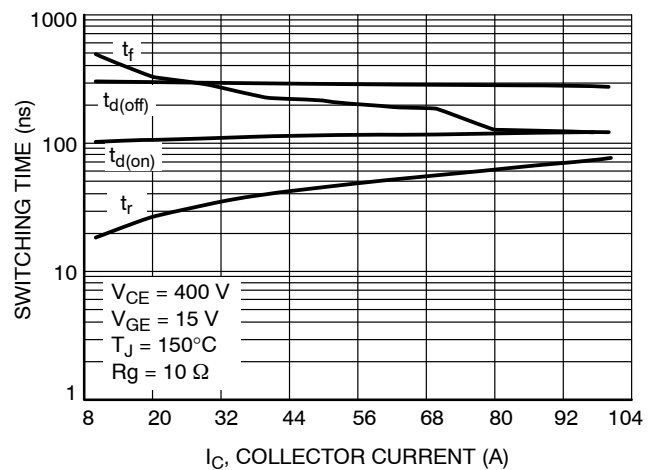


Figure 12. Switching Time vs.  $I_C$

TYPICAL CHARACTERISTICS

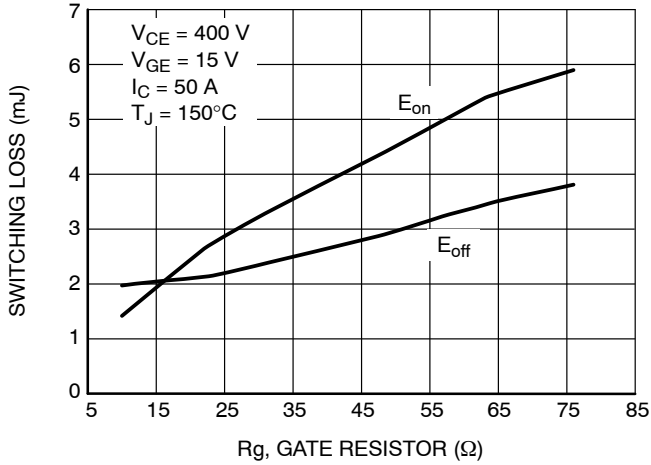


Figure 13. Switching Loss vs. Rg

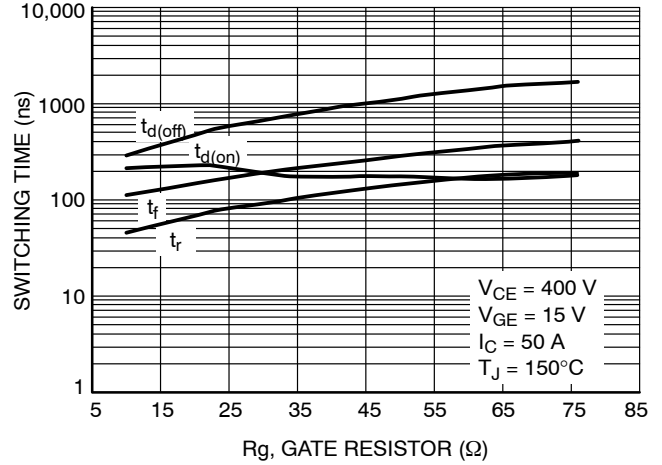


Figure 14. Switching Time vs. Rg

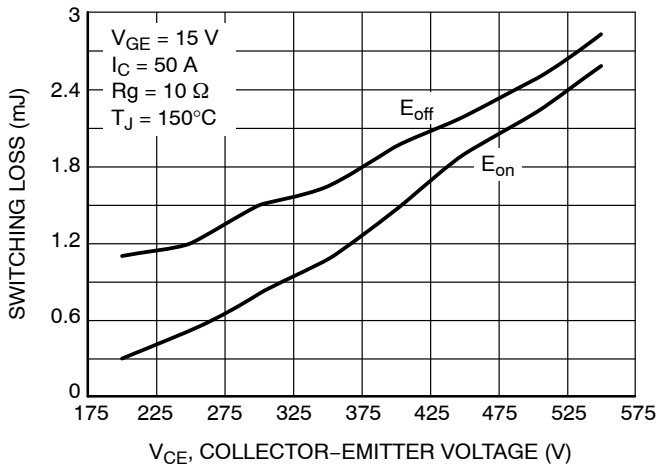


Figure 15. Switching Loss vs.  $V_{CE}$

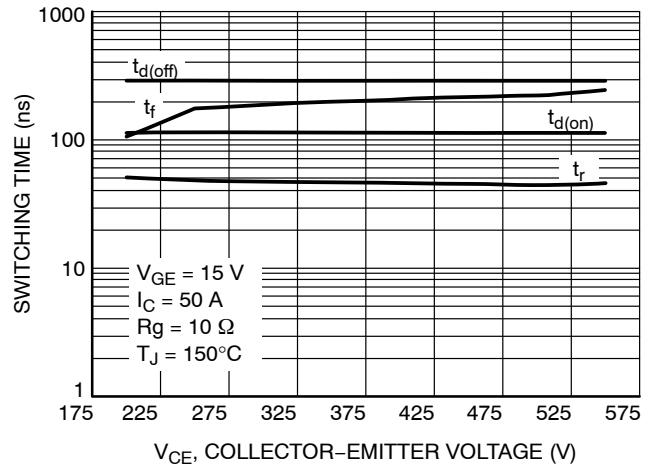


Figure 16. Switching Time vs.  $V_{CE}$

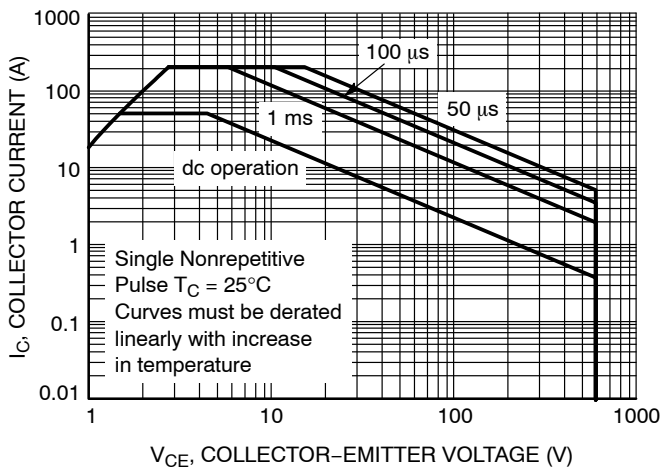


Figure 17. Safe Operating Area

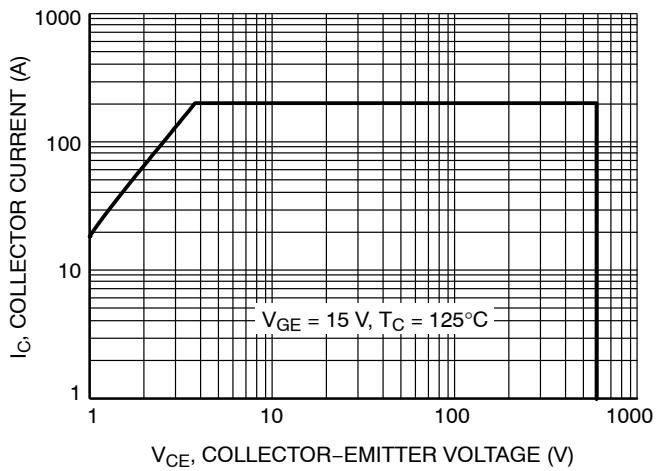


Figure 18. Reverse Bias Safe Operating Area

# NGTB50N60FWG

## TYPICAL CHARACTERISTICS

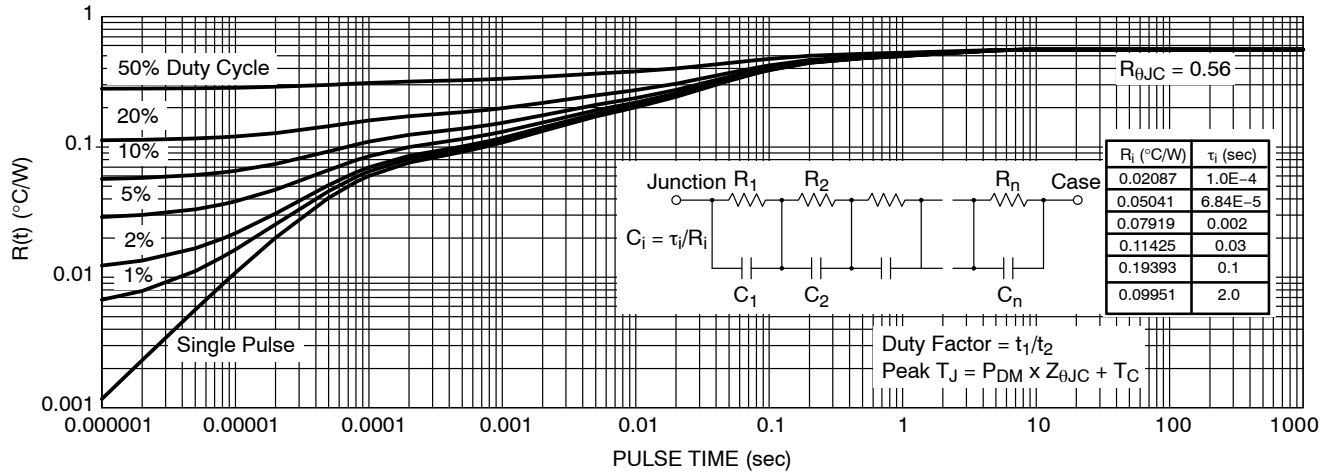


Figure 19. IGBT Transient Thermal Impedance

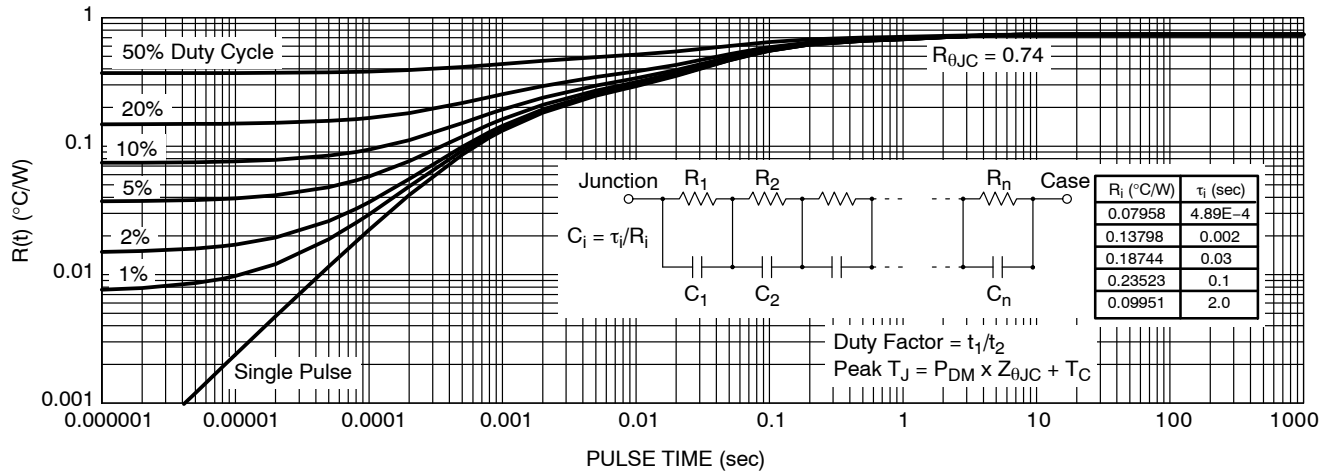


Figure 20. Diode Transient Thermal Impedance

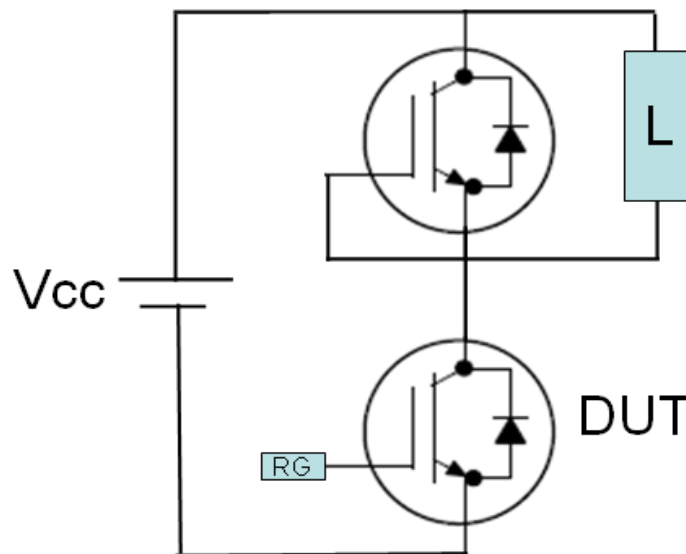


Figure 21. Test Circuit for Switching Characteristics

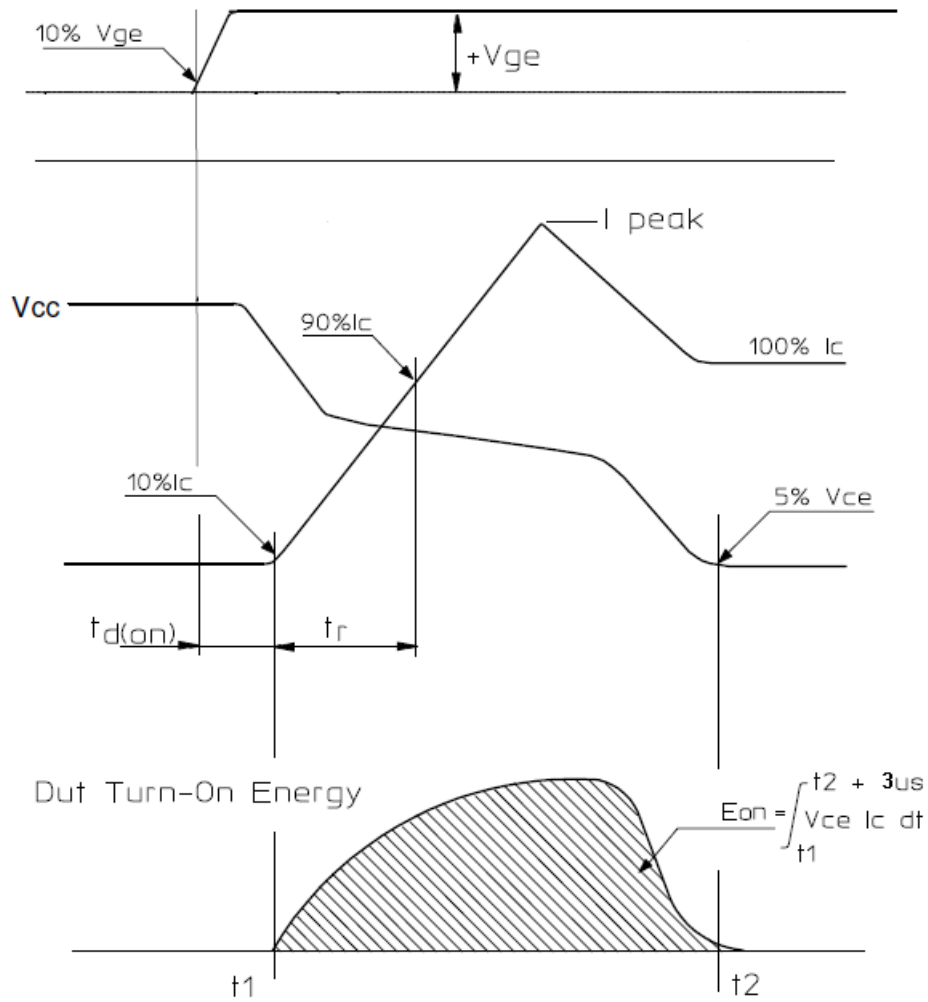


Figure 22. Definition of Turn On Waveform



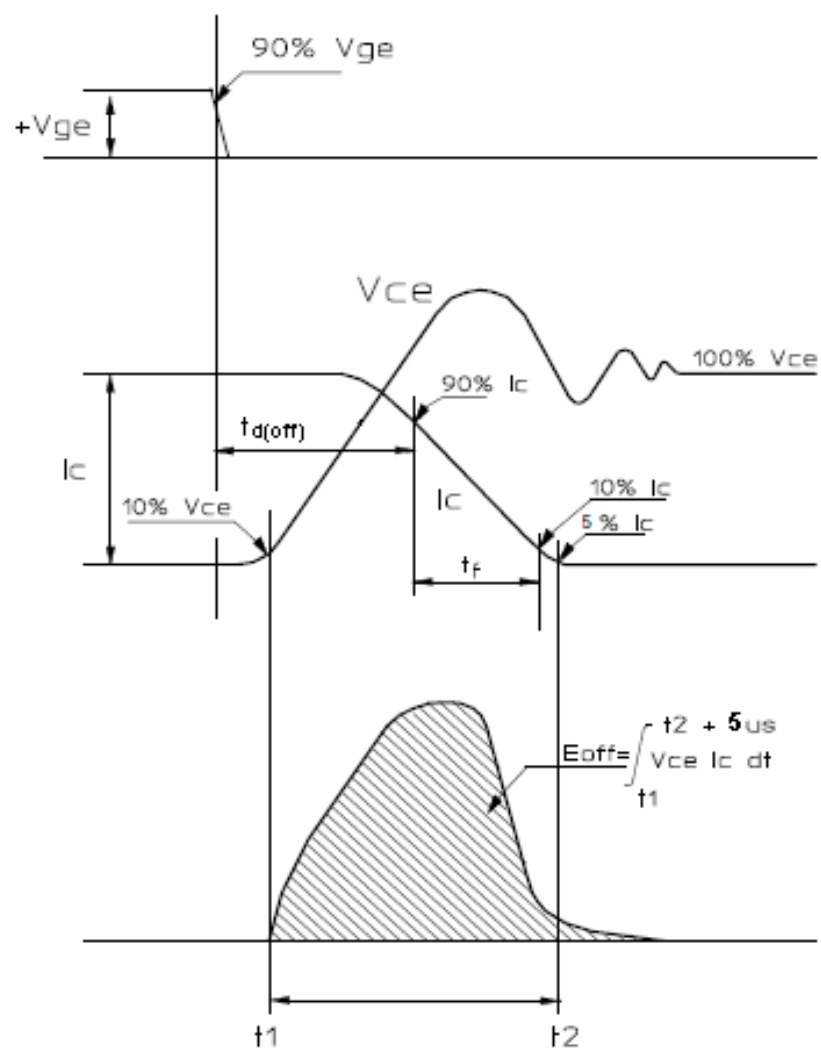
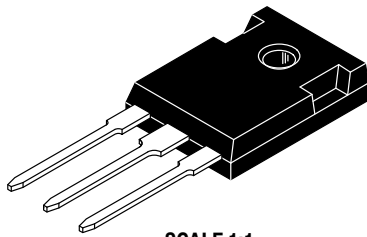


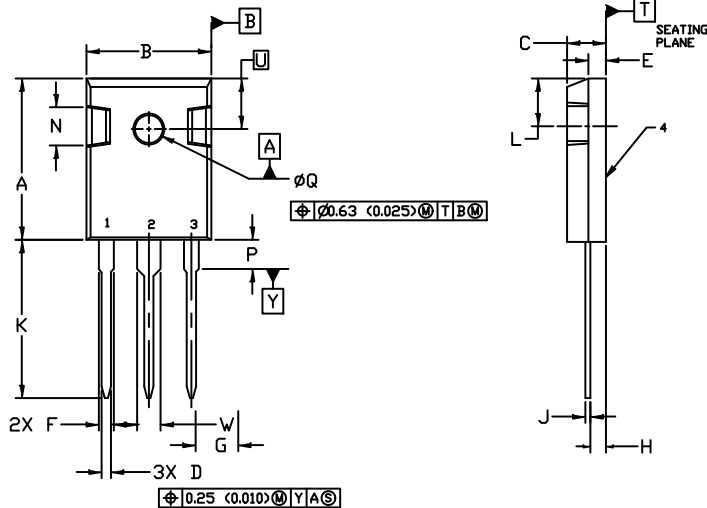
Figure 23. Definition of Turn Off Waveform



TO-247  
CASE 340L  
ISSUE G

DATE 06 OCT 2021

SCALE 1:1

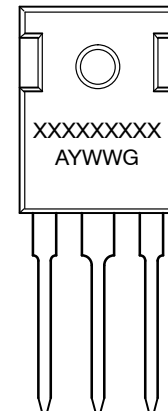


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER

|     | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
| DIM | MIN.        | MAX.  | MIN.      | MAX.  |
| A   | 20.32       | 21.08 | 0.800     | 0.830 |
| B   | 15.75       | 16.26 | 0.620     | 0.640 |
| C   | 4.70        | 5.30  | 0.185     | 0.209 |
| D   | 1.00        | 1.40  | 0.040     | 0.055 |
| E   | 1.90        | 2.60  | 0.075     | 0.102 |
| F   | 1.65        | 2.13  | 0.065     | 0.084 |
| G   | 5.45 BSC    |       | 0.215 BSC |       |
| H   | 1.50        | 2.49  | 0.059     | 0.098 |
| J   | 0.40        | 0.80  | 0.016     | 0.031 |
| K   | 19.81       | 20.83 | 0.780     | 0.820 |
| L   | 5.40        | 6.20  | 0.212     | 0.244 |
| N   | 4.32        | 5.49  | 0.170     | 0.216 |
| P   | ----        | 4.50  | ----      | 0.177 |
| Q   | 3.55        | 3.65  | 0.140     | 0.144 |
| U   | 6.15 BSC    |       | 0.242 BSC |       |
| W   | 2.87        | 3.12  | 0.113     | 0.123 |

GENERIC  
MARKING DIAGRAM\*



- STYLE 1:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN
- STYLE 2:  
PIN 1. ANODE  
2. CATHODE (S)  
3. ANODE 2  
4. CATHODE (S)
- STYLE 3:  
PIN 1. BASE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR
- STYLE 4:  
PIN 1. GATE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR
- STYLE 5:  
PIN 1. CATHODE  
2. ANODE  
3. GATE  
4. ANODE
- STYLE 6:  
PIN 1. MAIN TERMINAL 1  
2. MAIN TERMINAL 2  
3. GATE  
4. MAIN TERMINAL 2

XXXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

\*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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