

# NGTB40N65IHRTG

## IGBT with Monolithic Reverse Conducting Diode

This Insulated Gate Bipolar Transistor (IGBT) features robust and cost effective Field Stop (FS2) trench construction with a monolithic RC Diode. It provides a cost effective Solution for applications where diode losses are minimal. The IGBT is optimized for low conduction losses (low  $V_{CEsat}$ ) and is well suited for resonant or soft switching applications.

### Features

- Extremely Efficient Trench with Fieldstop Technology
- Low Conduction Design for Soft Switching Application
- Reduced Power Dissipation in Inducting Heating Application
- Reliable and Cost Effective Single Die Solution
- This is a Pb-Free Device

### Typical Applications

- Inductive Heating
- Air Conditioning PFC
- Welding

### ABSOLUTE MAXIMUM RATINGS

| Rating                                                                                                       | Symbol    | Value       | Unit             |
|--------------------------------------------------------------------------------------------------------------|-----------|-------------|------------------|
| Collector-emitter voltage                                                                                    | $V_{CES}$ | 650         | V                |
| Collector current<br>@ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$                               | $I_C$     | 80<br>40    | A                |
| Pulsed collector current, $T_{pulse}$ limited by $T_{Jmax}$ , 10 $\mu\text{s}$ pulse, $V_{GE} = 15\text{ V}$ | $I_{CM}$  | 160         | A                |
| Diode forward current<br>@ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$                           | $I_F$     | 80<br>40    | A                |
| Diode pulsed current, $T_{pulse}$ limited by $T_{Jmax}$ , 10 $\mu\text{s}$ pulse, $V_{GE} = 0\text{ V}$      | $I_{FM}$  | 160         | A                |
| Power Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$                               | $P_D$     | 405<br>202  | W                |
| Operating junction temperature range                                                                         | $T_J$     | -40 to +175 | $^\circ\text{C}$ |
| Storage temperature range                                                                                    | $T_{stg}$ | -55 to +175 | $^\circ\text{C}$ |
| 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.



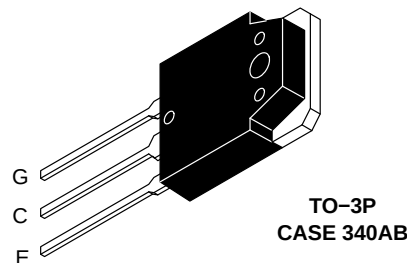
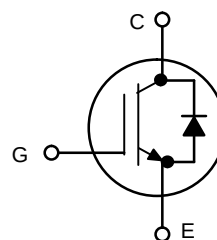
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40 A, 650 V

$V_{CEsat} = 1.55\text{ V}$

$E_{off} = 0.42\text{ mJ}$



### MARKING DIAGRAM



40N65H = Specific Device Code  
G = Pb-Free Package  
A = Assembly Location  
Y = Year  
WW = Work Week

### ORDERING INFORMATION

| Device         | Package            | Shipping        |
|----------------|--------------------|-----------------|
| NGTB40N65IHRTG | TO-3P<br>(Pb-Free) | 30 Units / Rail |

# NGTB40N65IHRTG

## THERMAL CHARACTERISTICS

| Rating                                 | Symbol          | Value | Unit                 |
|----------------------------------------|-----------------|-------|----------------------|
| Thermal resistance junction-to-case    | $R_{\theta JC}$ | 0.37  | $^{\circ}\text{C/W}$ |
| 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 | $V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$                                                                      | $V_{(BR)CES}$ | 650    | –            | –        | V  |
| Collector-emitter saturation voltage                              | $V_{GE} = 15\text{ V}, I_C = 40\text{ A}$<br>$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175^{\circ}\text{C}$        | $V_{CEsat}$   | –<br>– | 1.55<br>1.95 | 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   | $V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$<br>$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 175^{\circ}\text{C}$ | $I_{CES}$     | –<br>– | –<br>1.0     | 0.3<br>– | mA |
| Gate leakage current, collector-emitter short-circuited           | $V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$                                                                              | $I_{GES}$     | –      | –            | 100      | nA |

### DYNAMIC CHARACTERISTIC

|                              |                                                                  |           |   |      |   |    |
|------------------------------|------------------------------------------------------------------|-----------|---|------|---|----|
| Input capacitance            | $V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$    | $C_{ies}$ | – | 4628 | – | pF |
| Output capacitance           |                                                                  | $C_{oes}$ | – | 148  | – |    |
| Reverse transfer capacitance |                                                                  | $C_{res}$ | – | 126  | – |    |
| Gate charge total            | $V_{CE} = 400\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V}$ | $Q_g$     | – | 190  | – | nC |
| Gate to emitter charge       |                                                                  | $Q_{ge}$  | – | 38   | – |    |
| Gate to collector charge     |                                                                  | $Q_{gc}$  | – | 90   | – |    |

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |                                                                                                                                            |              |   |      |   |    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------|---|------|---|----|
| Turn-off delay time     | $T_J = 25^{\circ}\text{C}$<br>$V_{CC} = 400\text{ V}, I_C = 40\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$  | $t_{d(off)}$ | – | 197  | – | ns |
| Fall time               |                                                                                                                                            | $t_f$        | – | 74   | – |    |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    | – | 0.42 | – | mJ |
| Turn-off delay time     | $T_J = 175^{\circ}\text{C}$<br>$V_{CC} = 400\text{ V}, I_C = 40\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$ | $t_{d(off)}$ | – | 210  | – | ns |
| Fall time               |                                                                                                                                            | $t_f$        | – | 106  | – |    |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    | – | 0.7  | – | mJ |

### DIODE CHARACTERISTIC

|                 |                                                                                                                 |       |        |              |           |   |
|-----------------|-----------------------------------------------------------------------------------------------------------------|-------|--------|--------------|-----------|---|
| Forward voltage | $V_{GE} = 0\text{ V}, I_F = 40\text{ A}$<br>$V_{GE} = 0\text{ V}, I_F = 40\text{ A}, T_J = 175^{\circ}\text{C}$ | $V_F$ | –<br>– | 1.50<br>1.70 | 1.80<br>– | V |
|-----------------|-----------------------------------------------------------------------------------------------------------------|-------|--------|--------------|-----------|---|

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.

# NGTB40N65IHRTG

## TYPICAL CHARACTERISTICS

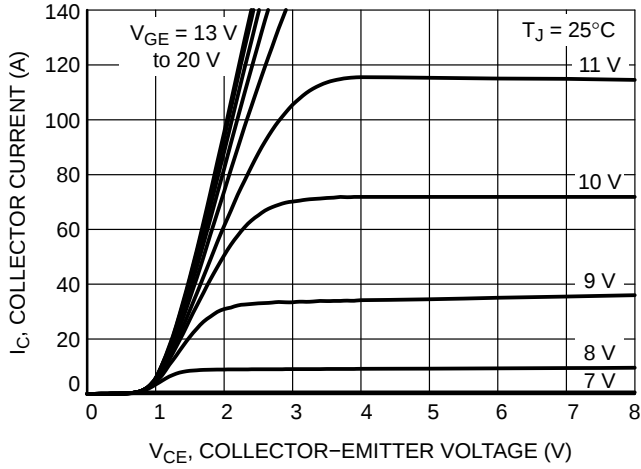


Figure 1. Output Characteristics

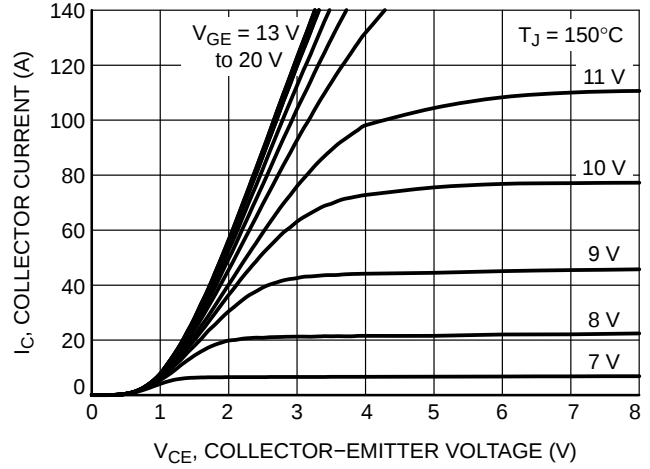


Figure 2. Output Characteristics

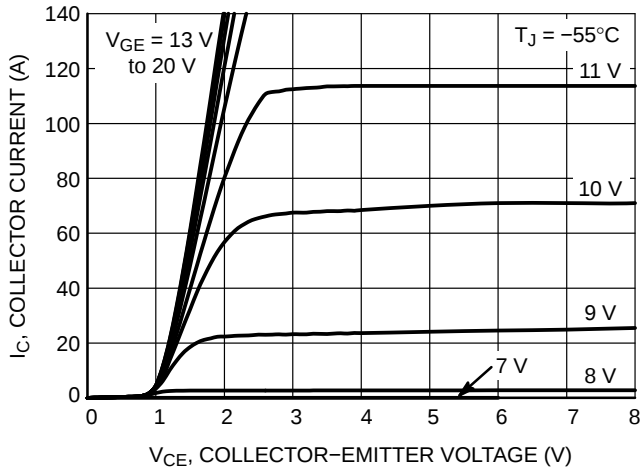


Figure 3. Output Characteristics

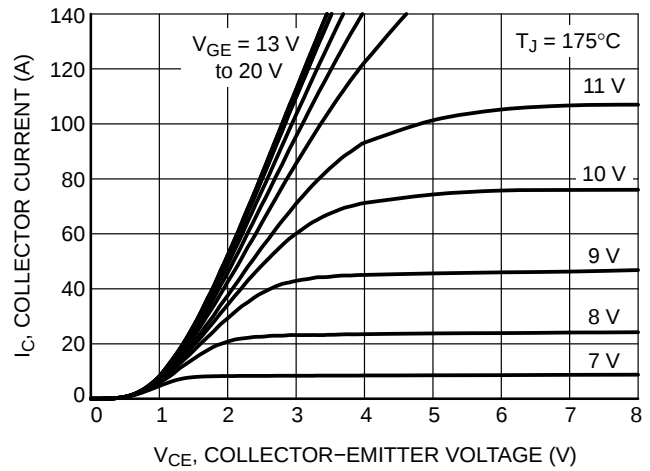


Figure 4. Output Characteristics

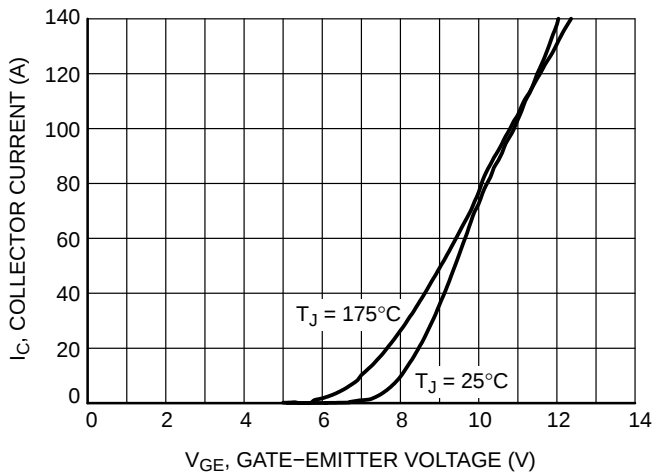


Figure 5. Typical Transfer Characteristics

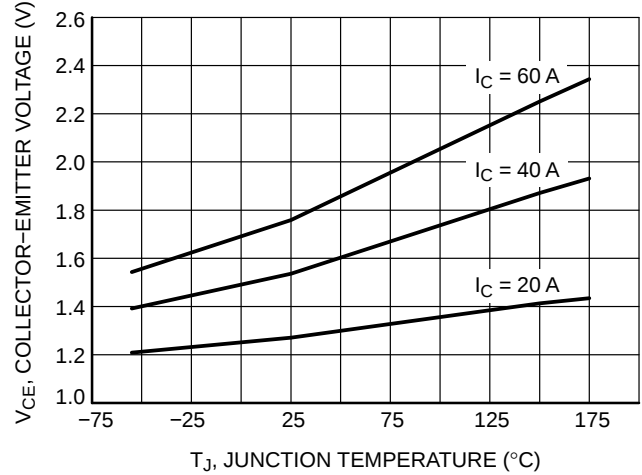


Figure 6.  $V_{CE(sat)}$  vs.  $T_J$

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## TYPICAL CHARACTERISTICS

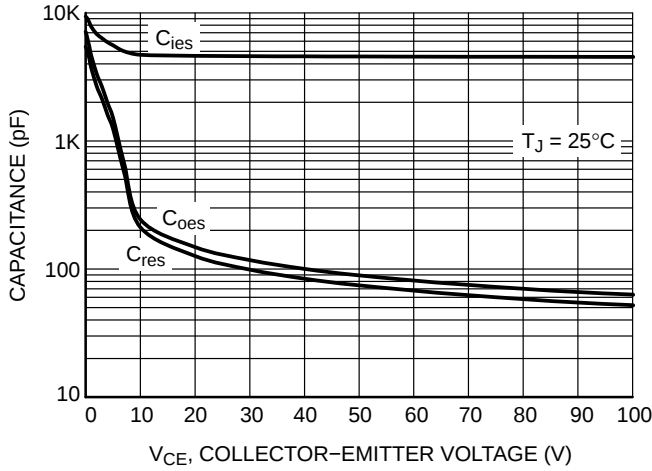


Figure 7. Typical Capacitance

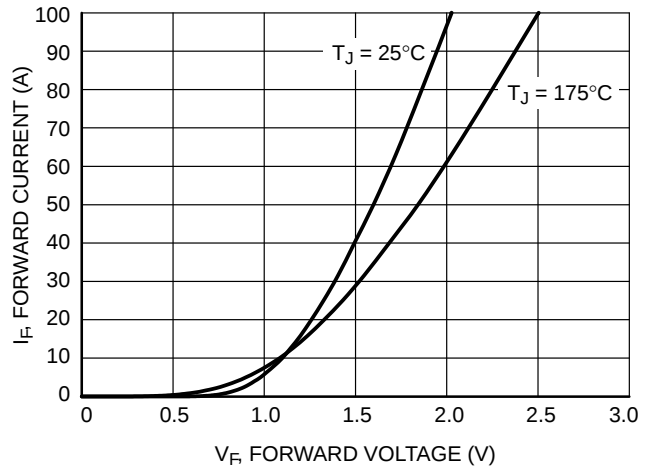


Figure 8. Diode Forward Characteristics

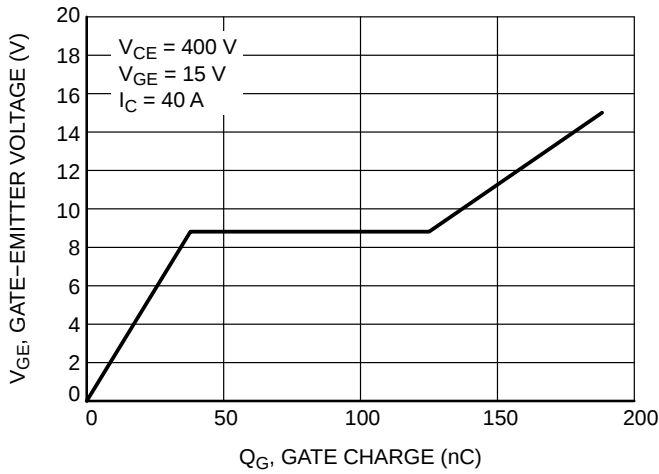


Figure 9. Typical Gate Charge

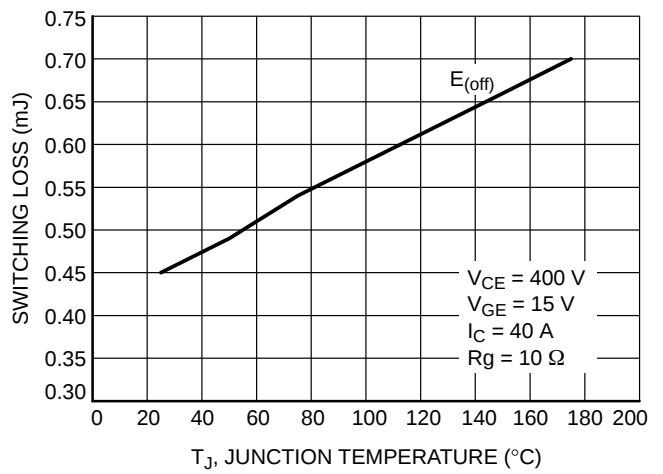


Figure 10. Switching Loss vs. Temperature

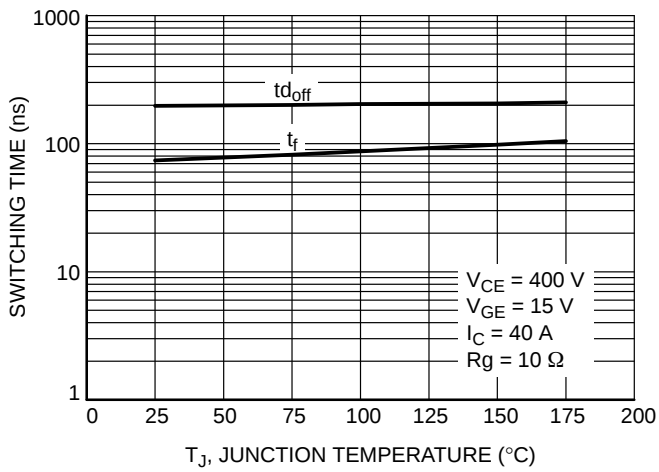


Figure 11. Switching Time vs. Temperature

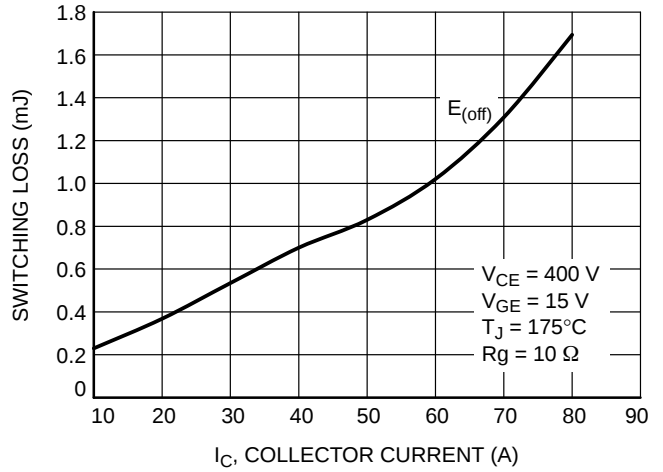


Figure 12. Switching Loss vs.  $I_C$

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## TYPICAL CHARACTERISTICS

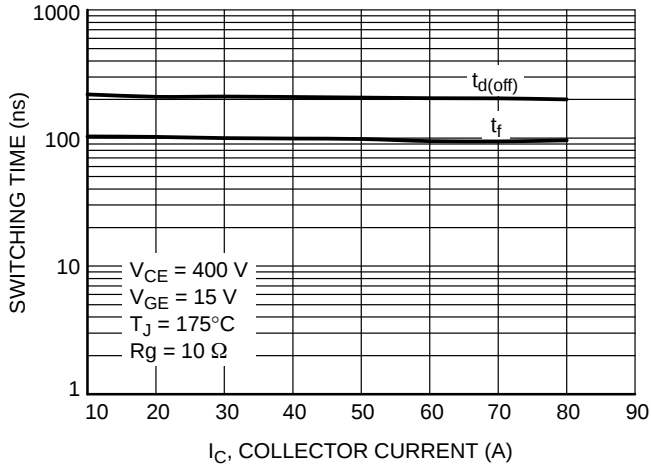


Figure 13. Switching Time vs.  $I_C$

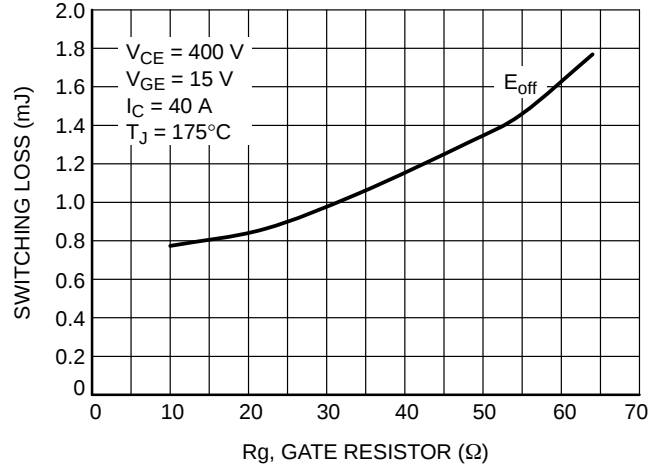


Figure 14. Switching Loss vs.  $R_g$

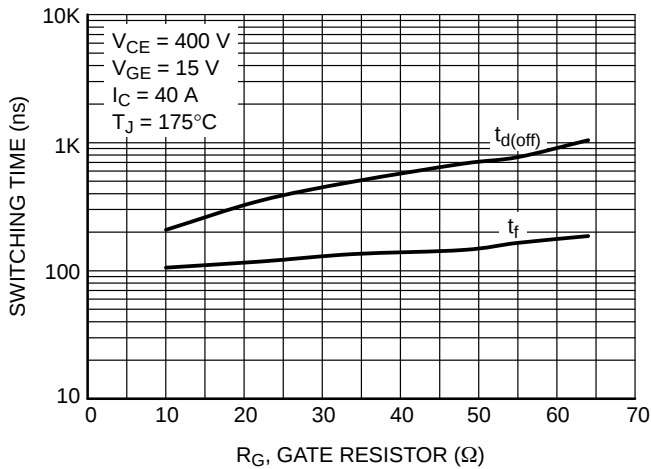


Figure 15. Switching Time vs.  $R_g$

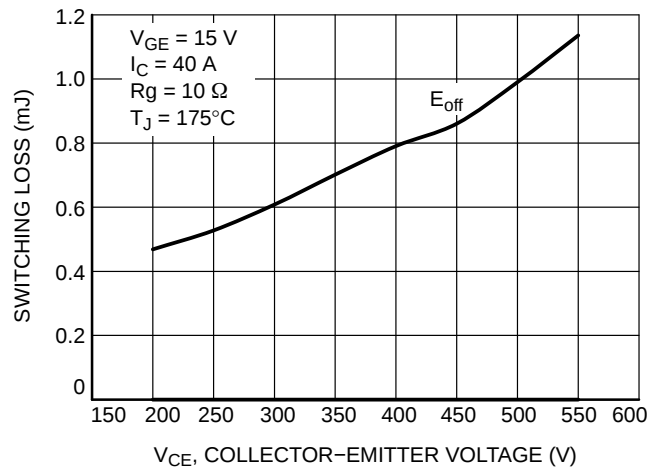


Figure 16. Switching Loss vs.  $V_{CE}$

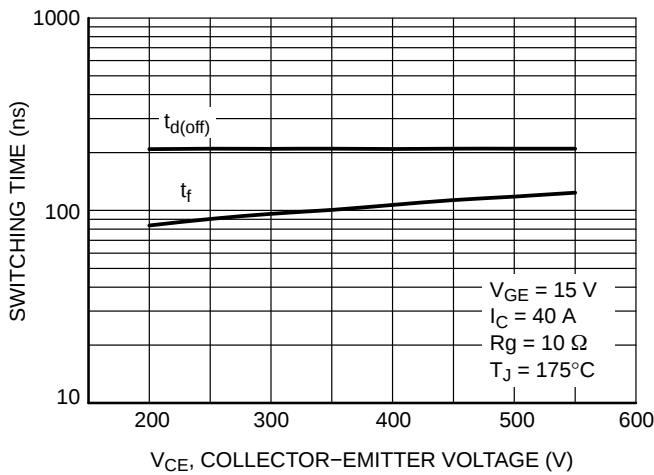


Figure 17. Switching Time vs.  $V_{CE}$

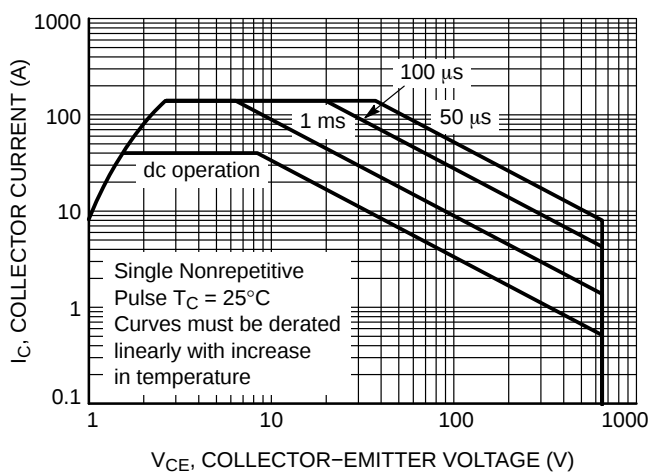


Figure 18. Safe Operating Area

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## TYPICAL CHARACTERISTICS

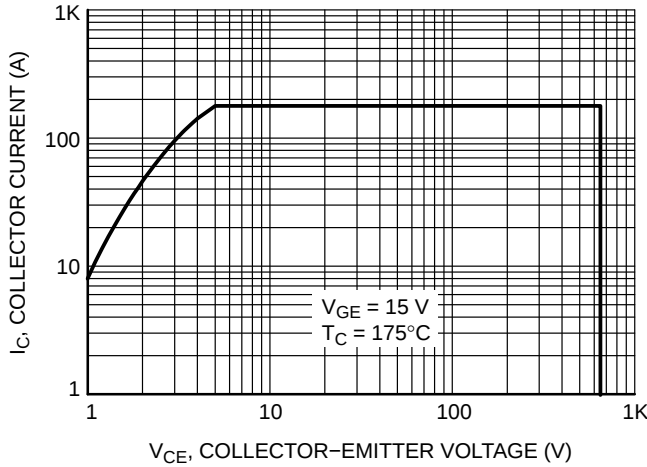


Figure 19. Reverse Bias Safe Operating Area

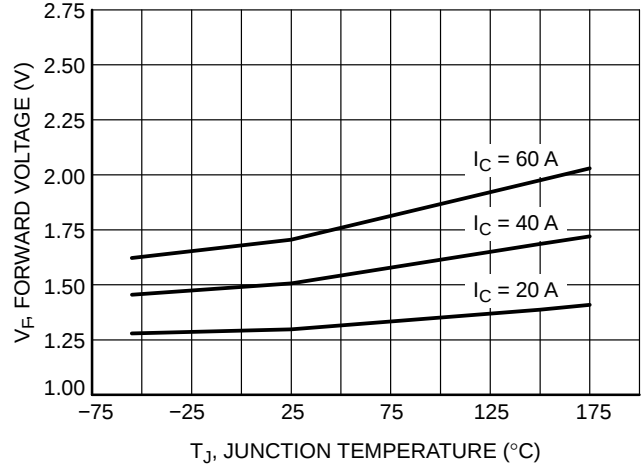


Figure 20. Forward Voltage vs. Junction Temperature

## NGTB40N65IHRTG IGBT die self-heating square-wave duty cycle transient thermal response

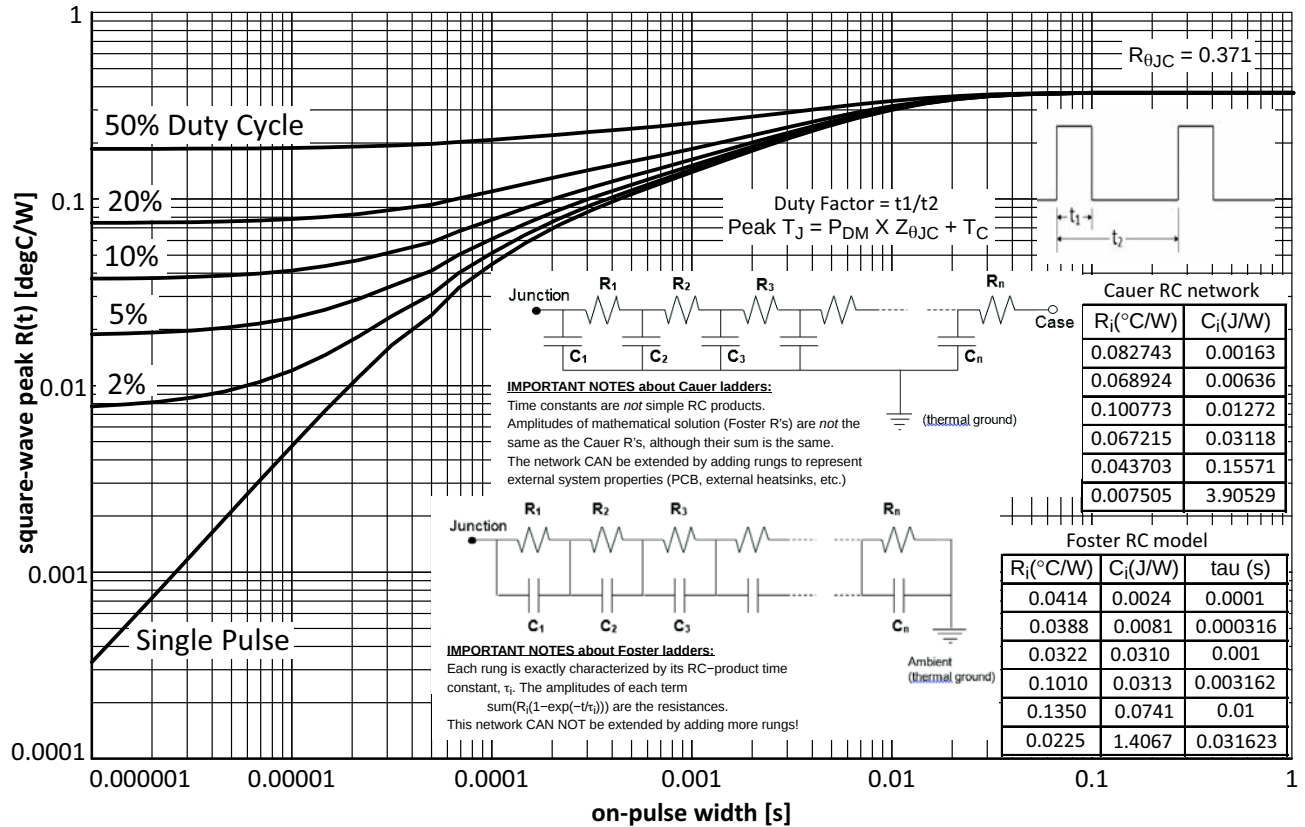


Figure 21. IGBT Transient Thermal Impedance

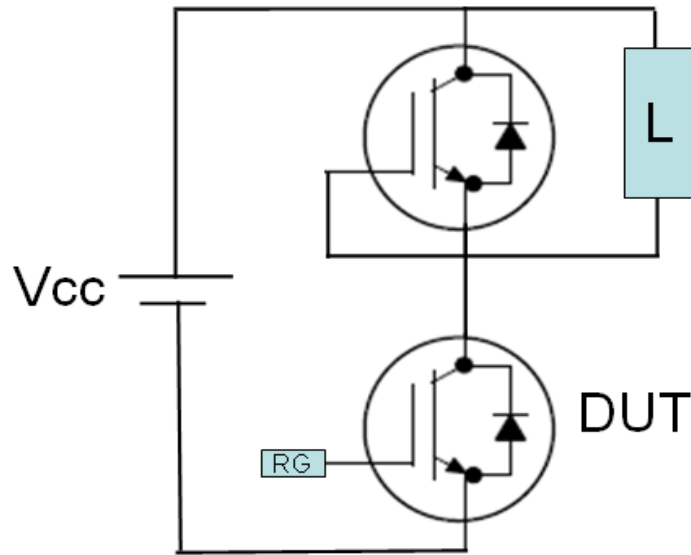


Figure 22. Test Circuit for Switching Characteristics

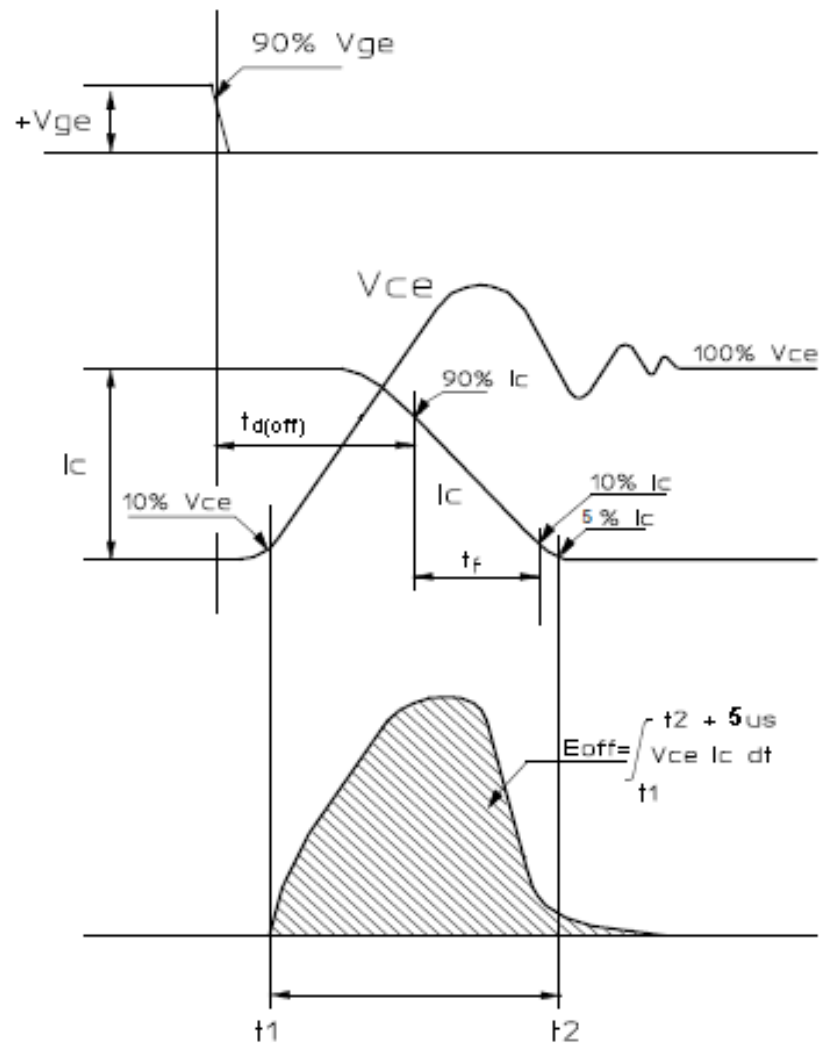
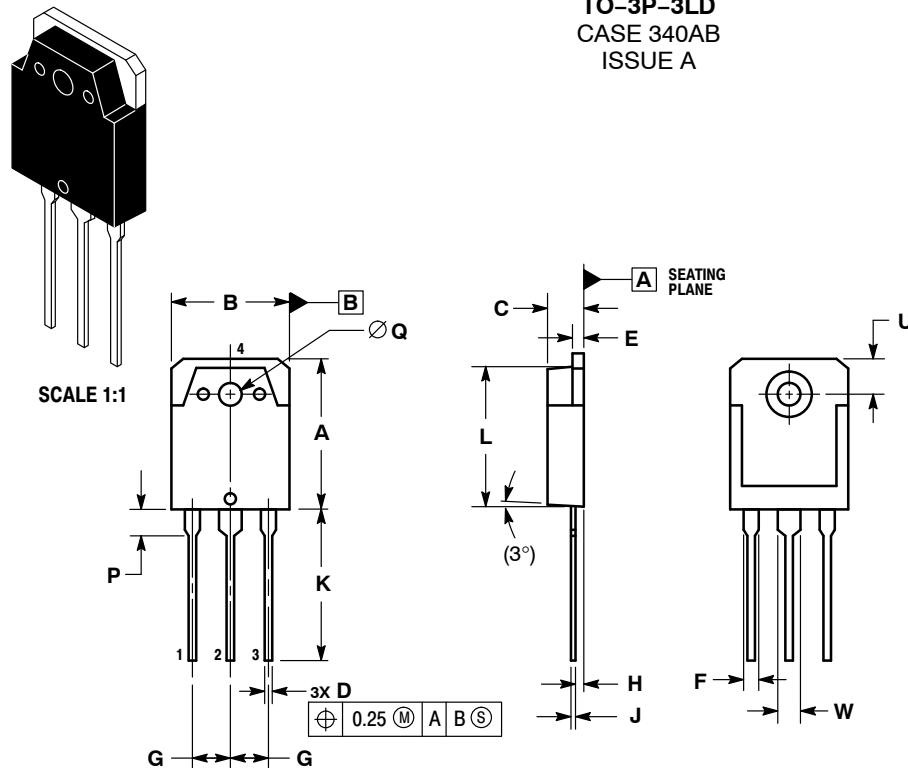


Figure 23. Definition of Turn Off Waveform

TO-3P-3LD  
CASE 340AB  
ISSUE A

DATE 30 OCT 2007

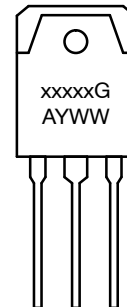


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM THE TERMINAL TIP.
4. DIMENSION A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN         | NOM   | MAX   |
| A   | 19.70       | 19.90 | 20.10 |
| B   | 15.40       | 15.60 | 15.80 |
| C   | 4.60        | 4.80  | 5.00  |
| D   | 0.80        | 1.00  | 1.20  |
| E   | 1.45        | 1.50  | 1.65  |
| F   | 1.80        | 2.00  | 2.20  |
| G   | 5.45 BSC    |       |       |
| H   | 1.20        | 1.40  | 1.60  |
| J   | 0.55        | 0.60  | 0.75  |
| K   | 19.80       | 20.00 | 20.20 |
| L   | 18.50       | 18.70 | 18.90 |
| P   | 3.30        | 3.50  | 3.70  |
| Q   | 3.10        | 3.20  | 3.50  |
| U   | 5.00 REF    |       |       |
| W   | 2.80        | 3.00  | 3.20  |

GENERIC MARKING  
DIAGRAM\*



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

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G", may or not be present.

|                  |             |                                                                                                                                                                                     |
|------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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