

# NGTB40N135IHRWG

## IGBT with Monolithic Free Wheeling Diode

This Insulated Gate Bipolar Transistor (IGBT) features a robust and cost effective Field Stop (FS) 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 resonant or soft switching applications.

### Features

- Extremely Efficient Trench with Fieldstop Technology
- 1350 V Breakdown Voltage
- Optimized for Low Losses in IH Cooker Application
- Reliable and Cost Effective Single Die Solution
- These are Pb-Free Devices

### Typical Applications

- Inductive Heating
- Consumer Appliances
- Soft Switching

### ABSOLUTE MAXIMUM RATINGS

| Rating                                                                                                                     | Symbol           | Value                | Unit             |
|----------------------------------------------------------------------------------------------------------------------------|------------------|----------------------|------------------|
| Collector-emitter voltage                                                                                                  | $V_{CES}$        | 1350                 | 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, $T_{\text{pulse}}$ limited by $T_{J\text{max}}$ , 10 $\mu\text{s}$ Pulse, $V_{GE} = 15\text{ V}$ | $I_{CM}$         | 120                  | 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, $T_{\text{pulse}}$ limited by $T_{J\text{max}}$ , 10 $\mu\text{s}$ Pulse, $V_{GE} = 0\text{ V}$      | $I_{FM}$         | 120                  | A                |
| Gate-emitter voltage<br>Transient Gate-emitter Voltage<br>( $T_{\text{pulse}} = 5\text{ }\mu\text{s}$ , $D < 0.10$ )       | $V_{GE}$         | $\pm 20$<br>$\pm 25$ | V                |
| Power Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$                                             | $P_D$            | 394<br>197           | W                |
| Operating junction temperature range                                                                                       | $T_J$            | $-40$ to $+175$      | $^\circ\text{C}$ |
| Storage temperature range                                                                                                  | $T_{\text{stg}}$ | $-55$ to $+175$      | $^\circ\text{C}$ |
| Lead temperature for soldering, 1/8" from case for 5 seconds                                                               | $T_{\text{SLD}}$ | 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.



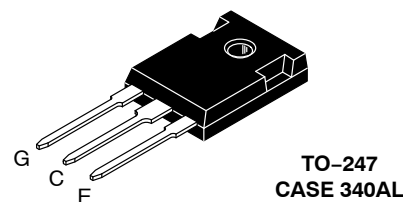
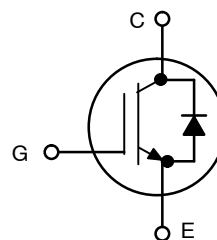
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40 A, 1350 V

$V_{CEsat} = 2.40\text{ V}$

$E_{off} = 1.30\text{ mJ}$



### MARKING DIAGRAM



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

### ORDERING INFORMATION

| Device          | Package          | Shipping        |
|-----------------|------------------|-----------------|
| NGTB40N135IHRWG | TO-247 (Pb-Free) | 30 Units / Rail |

# NGTB40N135IHRWG

## THERMAL CHARACTERISTICS

| Rating                                 | Symbol          | Value | Unit                 |
|----------------------------------------|-----------------|-------|----------------------|
| Thermal resistance junction-to-case    | $R_{\theta JC}$ | 0.385 | $^{\circ}\text{C/W}$ |
| 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 | $V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$                                                                       | $V_{(BR)CES}$ | 1350   | –            | –          | 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>– | 2.40<br>2.80 | 2.70<br>–  | V  |
| Gate-emitter threshold voltage                                    | $V_{GE} = V_{CE}, I_C = 250\text{ }\mu\text{A}$                                                                           | $V_{GE(th)}$  | 4.5    | 5.5          | 6.5        | V  |
| Collector-emitter cut-off current, gate-emitter short-circuited   | $V_{GE} = 0\text{ V}, V_{CE} = 1350\text{ V}$<br>$V_{GE} = 0\text{ V}, V_{CE} = 1350\text{ V}, T_J = 175^{\circ}\text{C}$ | $I_{CES}$     | –<br>– | –<br>–       | 0.5<br>2.0 | 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            | $V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$    | $C_{ies}$ | – | 5290 | – | pF |
| Output capacitance           |                                                                  | $C_{oes}$ | – | 124  | – |    |
| Reverse transfer capacitance |                                                                  | $C_{res}$ | – | 100  | – |    |
| Gate charge total            | $V_{CE} = 600\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V}$ | $Q_g$     | – | 234  | – | nC |
| Gate to emitter charge       |                                                                  | $Q_{ge}$  | – | 39   | – |    |
| Gate to collector charge     |                                                                  | $Q_{gc}$  | – | 105  | – |    |

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |                                                                                                                                            |              |   |      |   |    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------|---|------|---|----|
| Turn-off delay time     | $T_J = 25^{\circ}\text{C}$<br>$V_{CC} = 600\text{ V}, I_C = 40\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$  | $t_{d(off)}$ | – | 250  | – | ns |
| Fall time               |                                                                                                                                            | $t_f$        | – | 130  | – |    |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    | – | 1.30 | – | mJ |
| Turn-off delay time     | $T_J = 150^{\circ}\text{C}$<br>$V_{CC} = 600\text{ V}, I_C = 40\text{ A}$<br>$R_g = 10\text{ }\Omega$<br>$V_{GE} = 0\text{ V}/15\text{ V}$ | $t_{d(off)}$ | – | 260  | – | ns |
| Fall time               |                                                                                                                                            | $t_f$        | – | 190  | – |    |
| Turn-off switching loss |                                                                                                                                            | $E_{off}$    | – | 2.60 | – | 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>– | 2.30<br>3.70 | 2.70<br>– | V |
|-----------------|-----------------------------------------------------------------------------------------------------------------|-------|--------|--------------|-----------|---|

TYPICAL CHARACTERISTICS

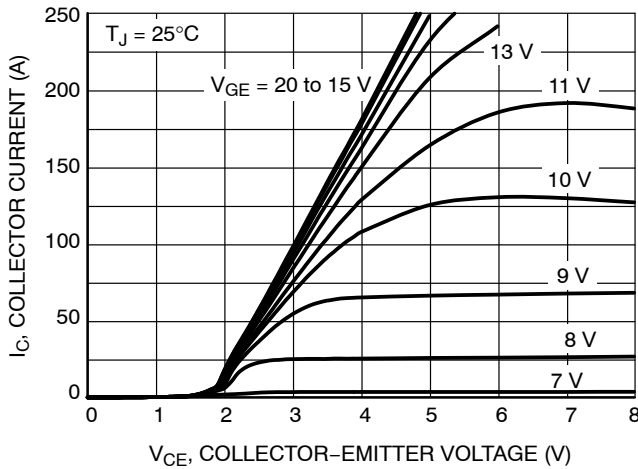


Figure 1. Output Characteristics

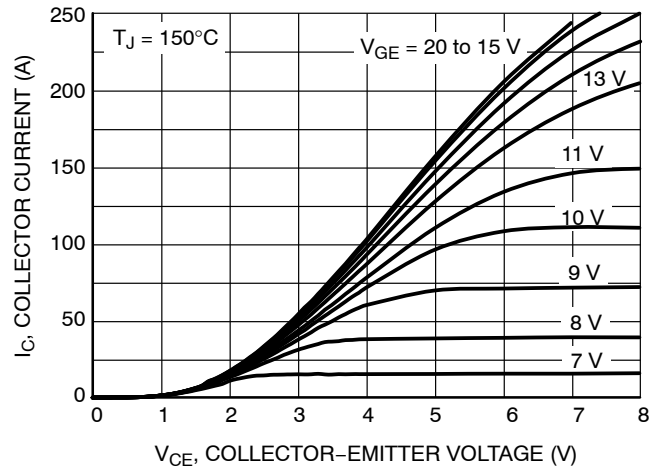


Figure 2. Output Characteristics

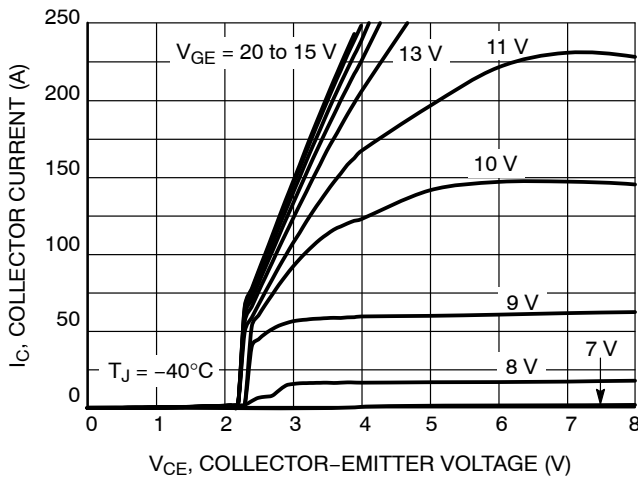


Figure 3. Output Characteristics

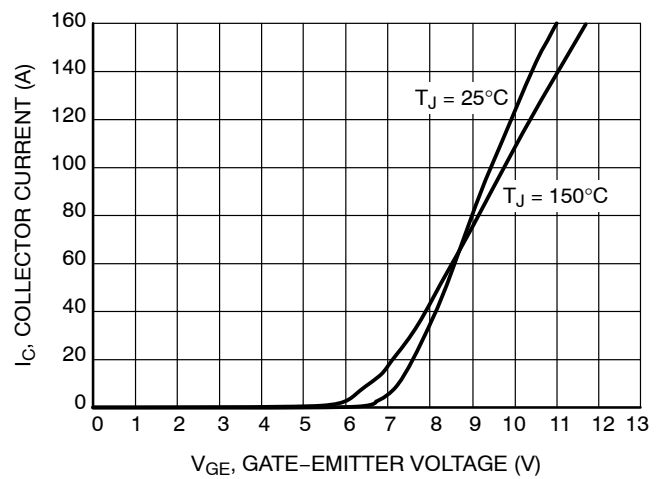


Figure 4. Typical Transfer Characteristics

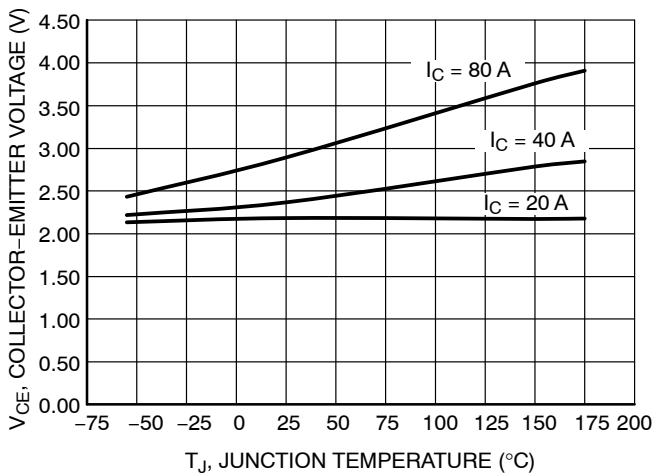


Figure 5.  $V_{CE(sat)}$  vs.  $T_J$

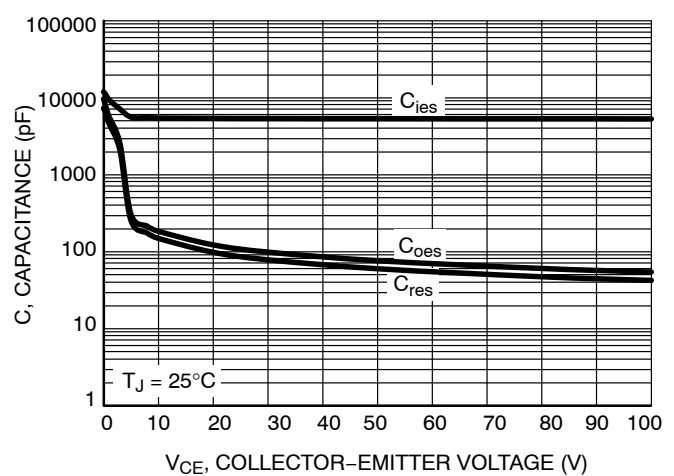


Figure 6. Typical Capacitance

TYPICAL CHARACTERISTICS

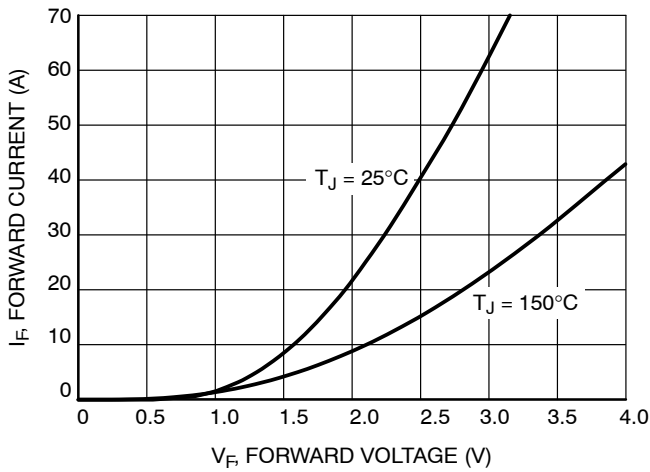


Figure 7. Diode Forward Characteristics

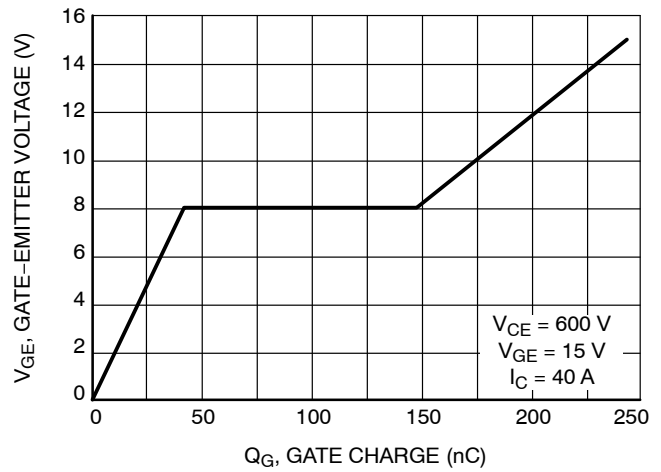


Figure 8. Typical Gate Charge

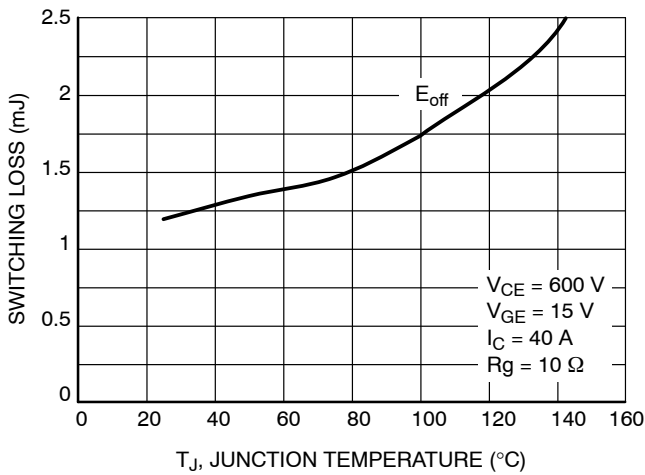


Figure 9. Switching Loss vs. Temperature

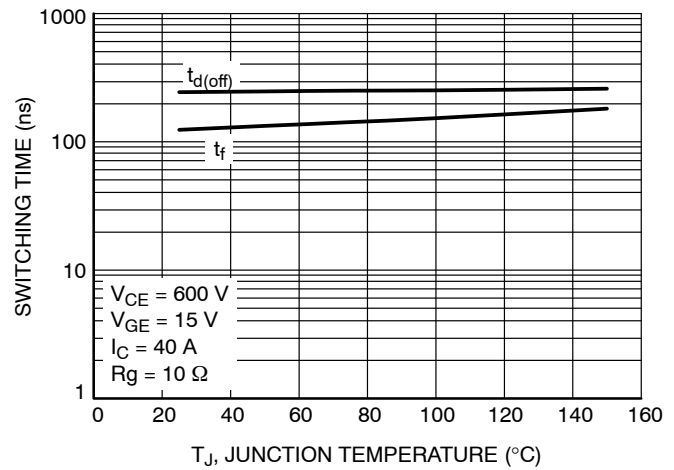


Figure 10. Switching Time vs. Temperature

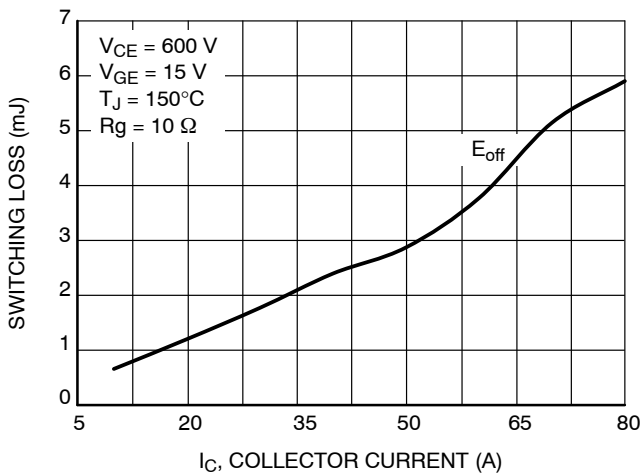


Figure 11. Switching Loss vs.  $I_C$

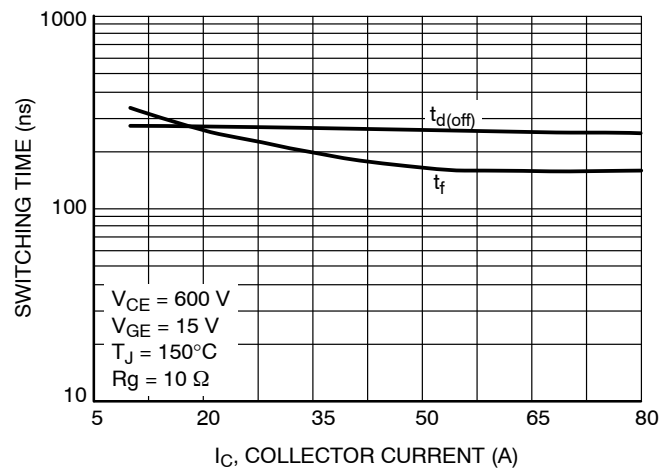


Figure 12. Switching Time vs.  $I_C$

TYPICAL CHARACTERISTICS

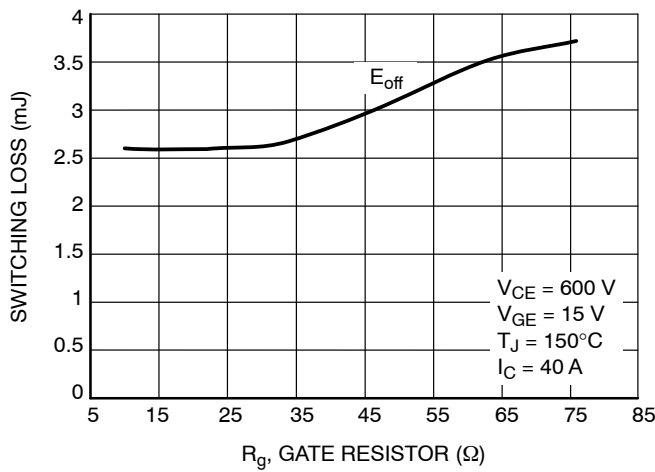


Figure 13. Switching Loss vs.  $R_g$

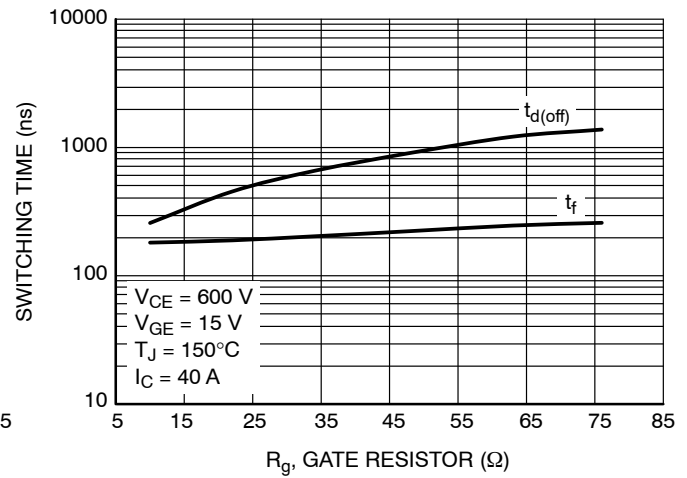


Figure 14. Switching Time vs.  $R_g$

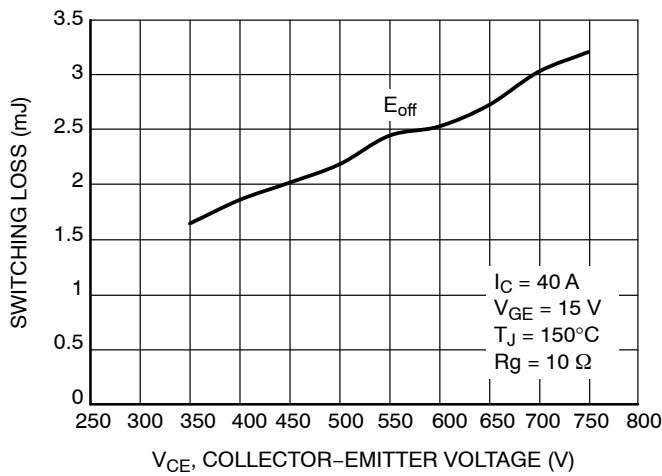


Figure 15. Switching Loss vs.  $V_{CE}$

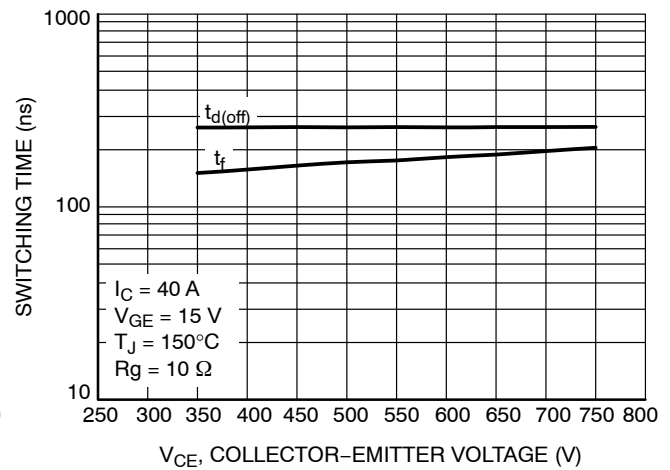


Figure 16. Switching Time vs.  $V_{CE}$

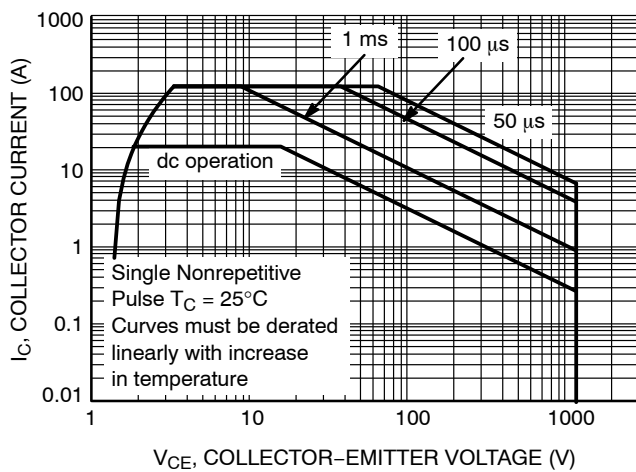


Figure 17. Safe Operating Area

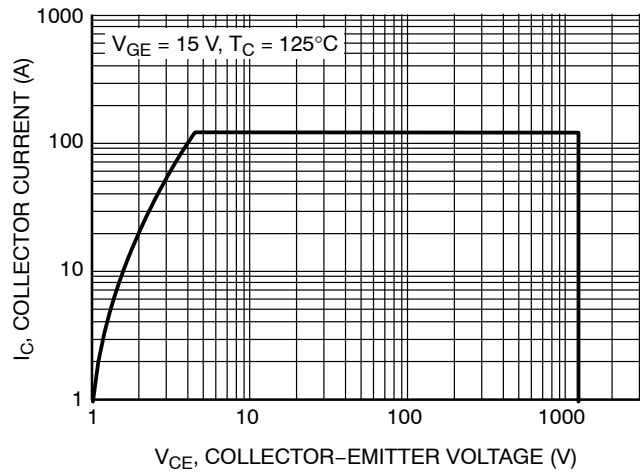


Figure 18. Reverse Bias Safe Operating Area

# NGTB40N135IHRWG

## TYPICAL CHARACTERISTICS

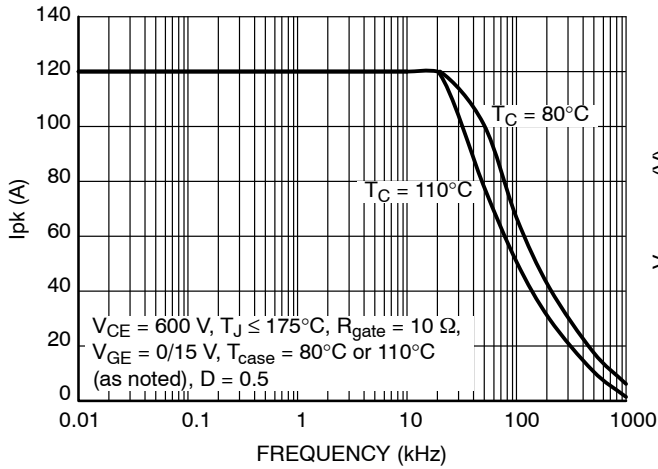


Figure 19. Collector Current vs. Switching Frequency

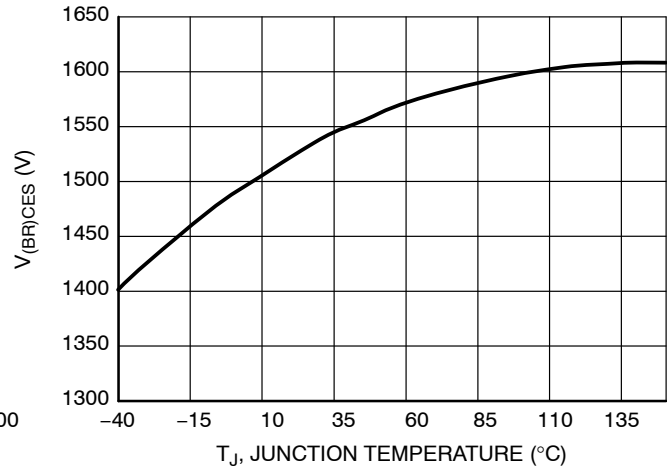


Figure 20. Typical  $V_{(BR)CES}$  vs. Temperature

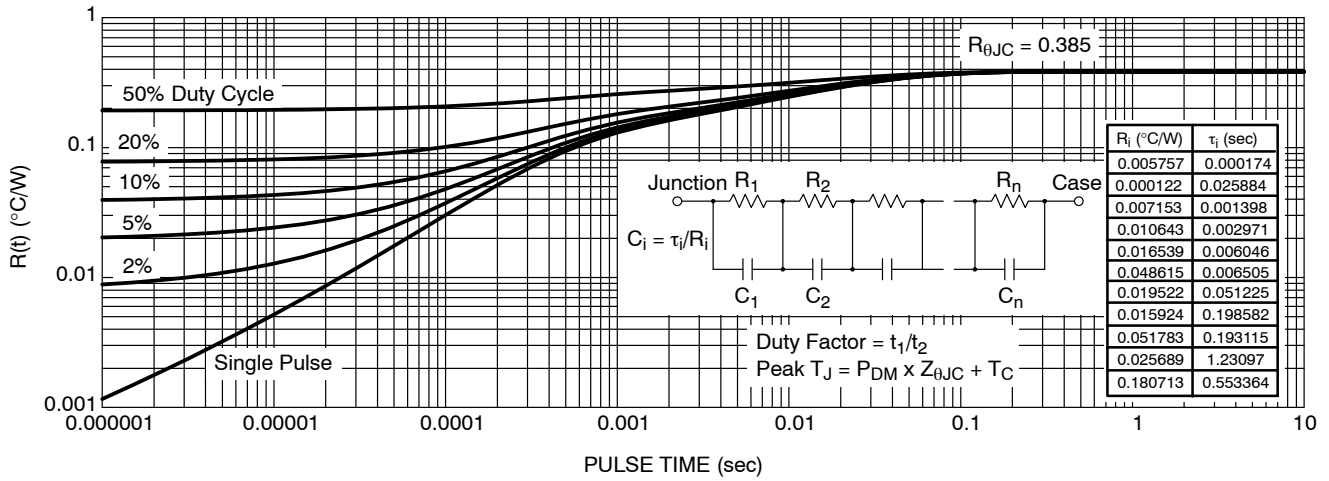


Figure 21. IGBT Transient Thermal Impedance



Figure 22. Test Circuit for Switching Characteristics



Figure 23. Definition of Turn On Waveform

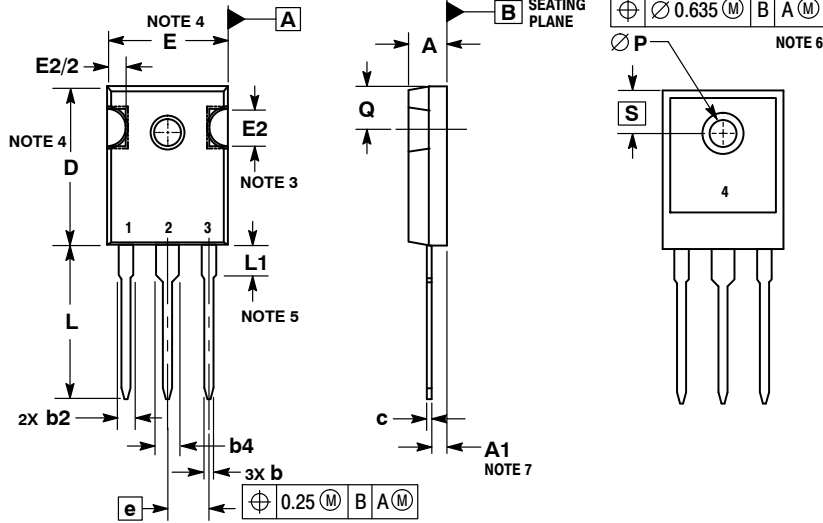


Figure 24. Definition of Turn Off Waveform

# NGTB40N135IHRWG

## PACKAGE DIMENSIONS

### TO-247 CASE 340AL ISSUE A



#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. SLOT REQUIRED, NOTCH MAY BE ROUNDED.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.13 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREME OF THE PLASTIC BODY.
5. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.
6. ØP SHALL HAVE A MAXIMUM DRAFT ANGLE OF 1.5° TO THE TOP OF THE PART WITH A MAXIMUM DIAMETER OF 3.91.
7. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.

| DIM | MILLIMETERS |       |
|-----|-------------|-------|
|     | MIN         | MAX   |
| A   | 4.70        | 5.30  |
| A1  | 2.20        | 2.60  |
| b   | 1.00        | 1.40  |
| b2  | 1.65        | 2.35  |
| b4  | 2.60        | 3.40  |
| c   | 0.40        | 0.80  |
| D   | 20.30       | 21.40 |
| E   | 15.50       | 16.25 |
| E2  | 4.32        | 5.49  |
| e   | 5.45 BSC    |       |
| L   | 19.80       | 20.80 |
| L1  | 3.50        | 4.50  |
| P   | 3.55        | 3.65  |
| Q   | 5.40        | 6.20  |
| S   | 6.15 BSC    |       |

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