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Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

# NGTB40N60L2WG

# IGBT

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.

### Features

- Extremely Efficient Trench with Field Stop Technology
- $T_{Jmax}$ = 175°C
- Soft Fast Reverse Recovery Diode
- Optimized for Low $V_{CEsat}$
- 5 μs Short−Circuit Capability
- This is a Pb−Free Device

### Typical Applications

- Motor Drive Inverters
- Industrial Switching
- Welding

### 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>80<br>40 | A |
| Diode Forward Current<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_F$ | <br>80<br>40 | A |
| Diode Pulsed Current<br>$T_{PULSE}$ Limited by $T_J$ Max | $I_{FM}$ | 160 | A |
| Pulsed collector current, $T_{pulse}$ limited by $T_{Jmax}$ | $I_{CM}$ | 160 | A |
| Short−circuit withstand time<br>$V_{GE}$ = 15 V, $V_{CE}$ = 400 V,<br>$T_J \le$ +150°C | $t_{SC}$ | 5 | μs |
| Gate−emitter voltage | $V_{GE}$ | ±20 | V |
| Transient gate−emitter voltage ($T_{PULSE}$ = 5 μs, D < 0.10) | | ±30 | V |
| Power Dissipation<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $P_D$ | <br>417<br>208 | W |
| Operating junction temperature range | $T_J$ | −55 to +175 | °C |
| Storage temperature range | $T_{stg}$ | −55 to +175 | °C |
| Lead temperature for soldering, 1/8” from case for 5 seconds | $T_{SLD}$ | 260 | °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.

**ON Semiconductor®**

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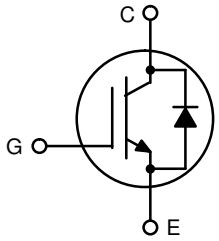
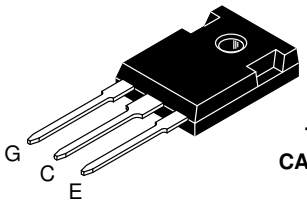
**40 A, 600 V**
**$V_{CEsat}$ = 1.65 V**
**$E_{OFF}$ = 0.28 mJ**




**TO−247**
**CASE 340AL**

### MARKING DIAGRAM


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

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| NGTB40N60L2WG | TO−247<br>(Pb−Free) | 30 Units / Rail |

## THERMAL CHARACTERISTICS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance junction−to−case, for IGBT | $R_{\theta JC}$ | 0.36 | °C/W |
| Thermal resistance junction−to−case, for Diode | $R_{\theta JC}$ | 1.00 | °C/W |
| Thermal resistance junction−to−ambient | $R_{\theta JA}$ | 40 | °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, $I_C$ = 40 A<br>$V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 175°C | $V_{CEsat}$ | –<br>– | 1.65<br>1.90 | 1.90<br>– | V |
| Gate−emitter threshold voltage | $V_{GE}$ = $V_{CE}$, $I_C$ = 350 μA | $V_{GE(th)}$ | 4.5 | 5.8 | 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, $T_J$ = 175°C | $I_{CES}$ | –<br>– | –<br>5.0 | 0.5<br>– | mA |
| Gate leakage current, collector−emitter short−circuited | $V_{GE}$ = 20 V , $V_{CE}$ = 0 V | $I_{GES}$ | – | – | 200 | nA |
| **DYNAMIC CHARACTERISTIC** | | | | | | |
| Input capacitance | $V_{CE}$ = 20 V, $V_{GE}$ = 0 V, f = 1 MHz | $C_{ies}$ | – | 5286 | – | pF |
| Output capacitance | | $C_{oes}$ | – | 213 | – | |
| Reverse transfer capacitance | | $C_{res}$ | – | 147 | – | |
| Gate charge total | $V_{CE}$ = 480 V, $I_C$ = 40 A, $V_{GE}$ = 15 V | $Q_g$ | – | 228 | – | nC |
| Gate to emitter charge | | $Q_{ge}$ | – | 50 | – | |
| Gate to collector charge | | $Q_{gc}$ | – | 115 | – | |
| **SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_J$ = 25°C<br>$V_{CC}$ = 400 V, $I_C$ = 40 A<br>$R_g$ = 10 Ω<br>$V_{GE}$ = 0 V/ 15 V | $t_{d(on)}$ | – | 98 | – | ns |
| Rise time | | $t_r$ | – | 42 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 213 | – | |
| Fall time | | $t_f$ | – | 60 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 1.17 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.28 | – | |
| Total switching loss | | $E_{ts}$ | – | 1.45 | – | |
| Turn−on delay time | $T_J$ = 150°C<br>$V_{CC}$ = 400 V, $I_C$ = 40 A<br>$R_g$ = 10 Ω<br>$V_{GE}$ = 0 V/ 15 V | $t_{d(on)}$ | – | 98 | – | ns |
| Rise time | | $t_r$ | – | 44 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 220 | – | |
| Fall time | | $t_f$ | – | 88 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 1.45 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.68 | – | |
| Total switching loss | | $E_{ts}$ | – | 2.13 | – | |
| **DIODE CHARACTERISTIC** | | | | | | |
| Forward voltage | $V_{GE}$ = 0 V, $I_F$ = 40 A<br>$V_{GE}$ = 0 V, $I_F$ = 40 A, $T_J$ = 175°C | $V_F$ | –<br>– | 2.40<br>2.58 | 3.00<br>– | V |
| Reverse recovery time | $T_J$ = 25°C<br>$I_F$ = 40 A, $V_R$ = 200 V<br>$di_F/dt$ = 200 A/μs | $t_{rr}$ | – | 73 | – | ns |
| Reverse recovery charge | | $Q_{rr}$ | – | 282 | – | nC |
| Reverse recovery current | | $I_{rrm}$ | – | 6.7 | – | A |
| Reverse recovery time | $T_J$ = 175°C<br>$I_F$ = 40 A, $V_R$ = 200 V<br>$di_F/dt$ = 200 A/μs | $t_{rr}$ | – | 160 | – | ns |
| Reverse recovery charge | | $Q_{rr}$ | – | 912 | – | nC |
| Reverse recovery current | | $I_{rrm}$ | – | 8.6 | – | 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.

## TYPICAL CHARACTERISTICS

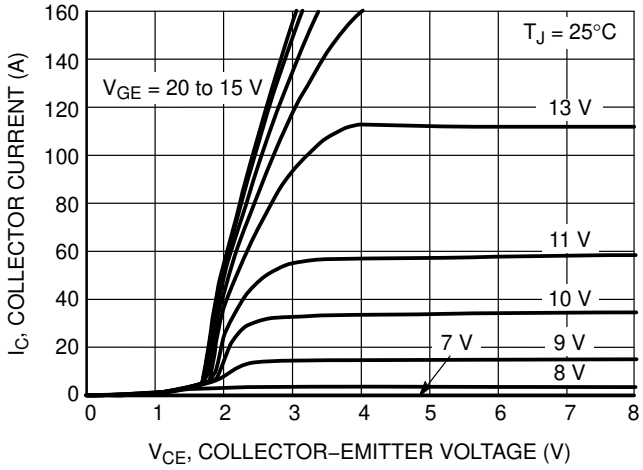



**Figure 1. Output Characteristics**

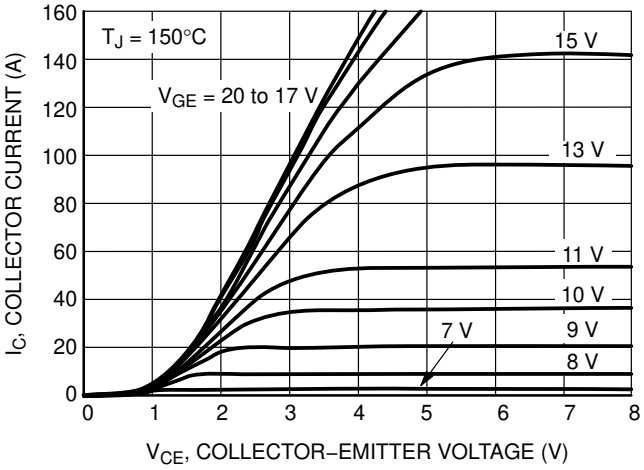



**Figure 2. Output Characteristics**

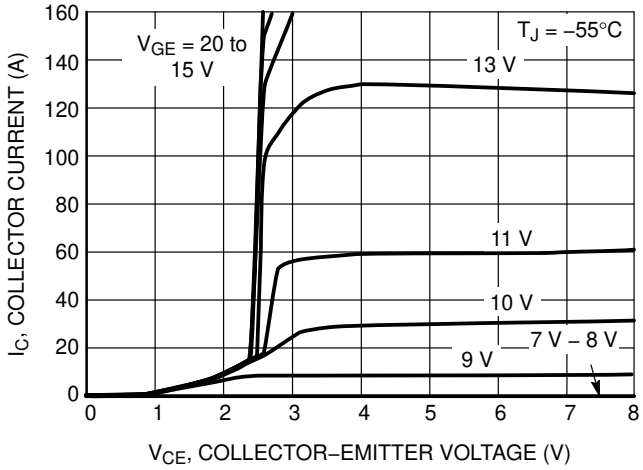



**Figure 3. Output Characteristics**

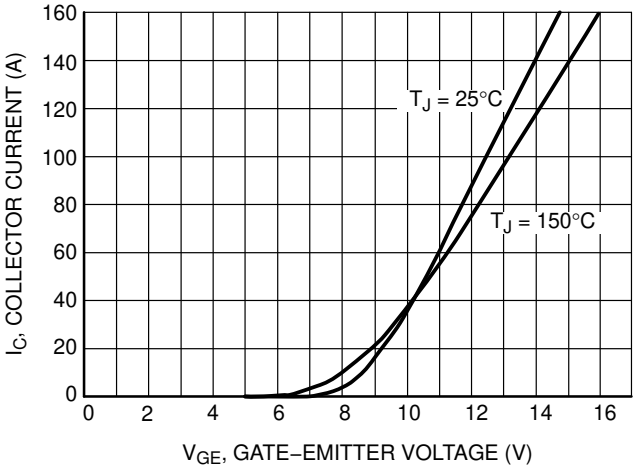



**Figure 4. Typical Transfer Characteristics**

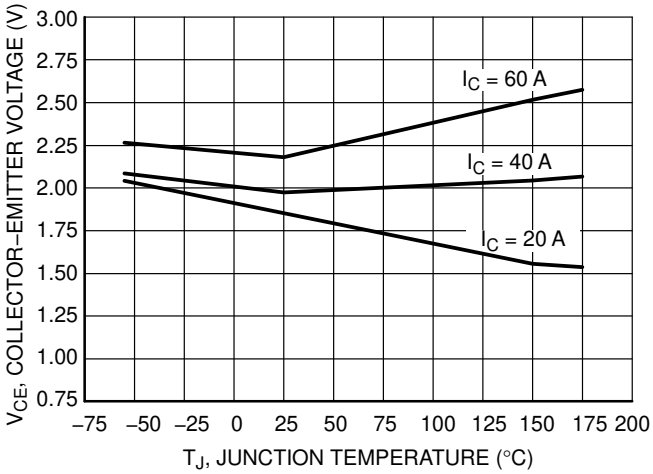



**Figure 5. $V_{CE(sat)}$ vs. $T_J$**

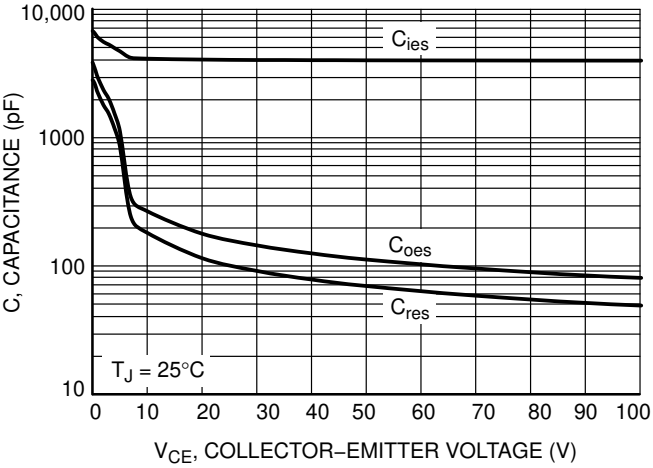



**Figure 6. Typical Capacitance**

## TYPICAL CHARACTERISTICS

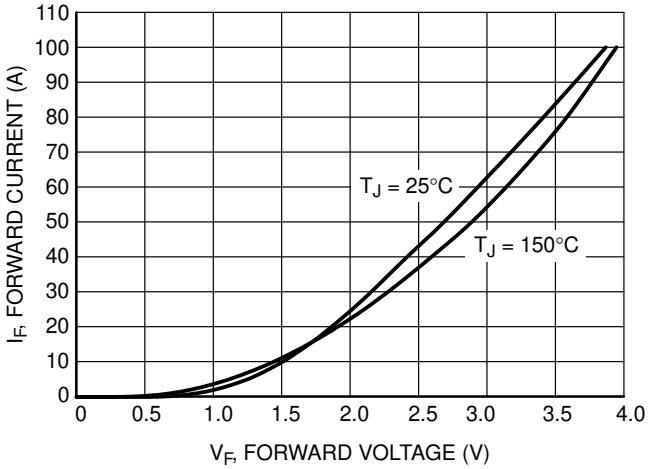



**Figure 7. Diode Forward Characteristics**

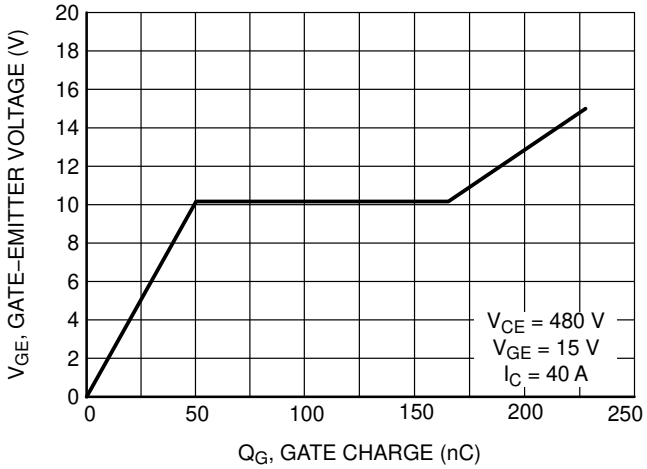



**Figure 8. Typical Gate Charge**

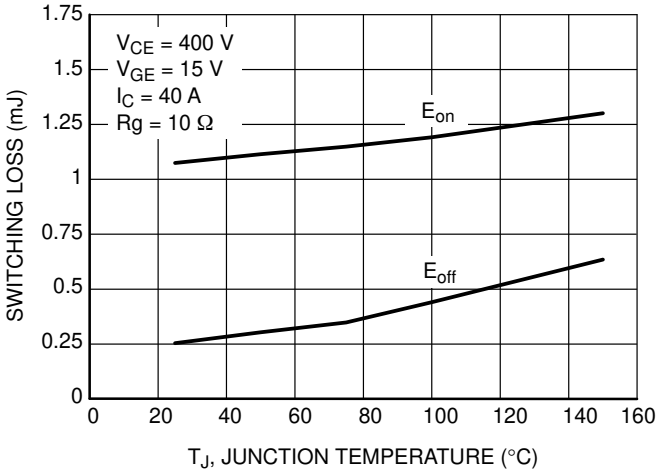



**Figure 9. Switching Loss vs. Temperature**

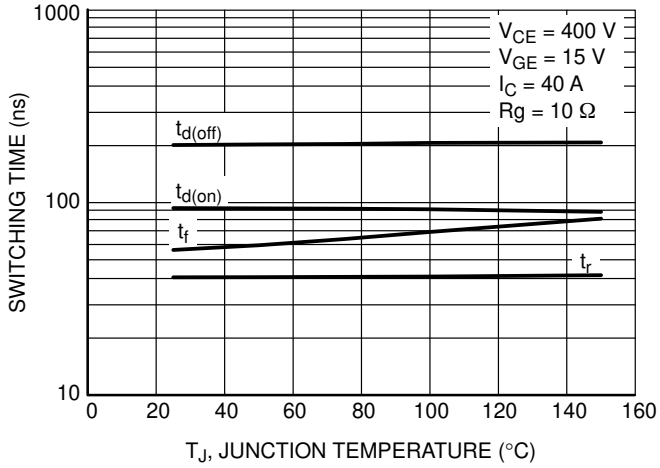



**Figure 10. Switching Time vs. Temperature**

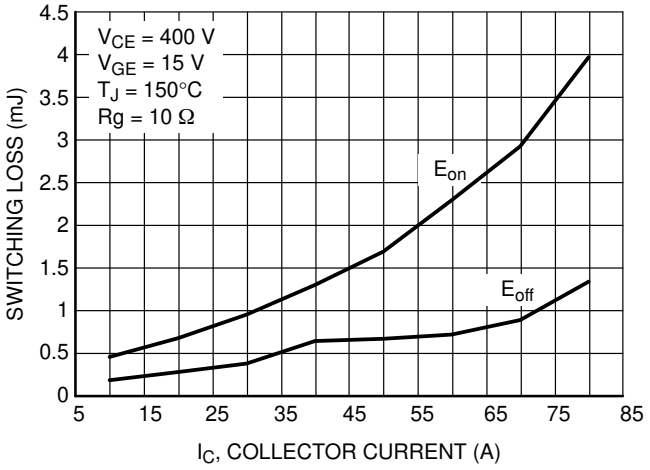



**Figure 11. Switching Loss vs. $I_C$**

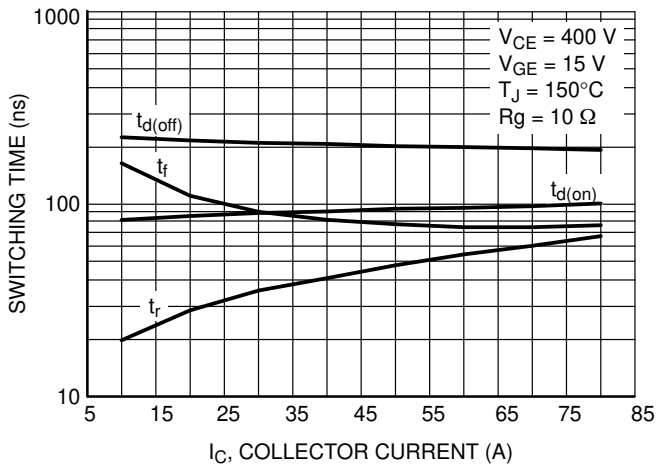



**Figure 12. Switching Time vs. $I_C$**

## TYPICAL CHARACTERISTICS

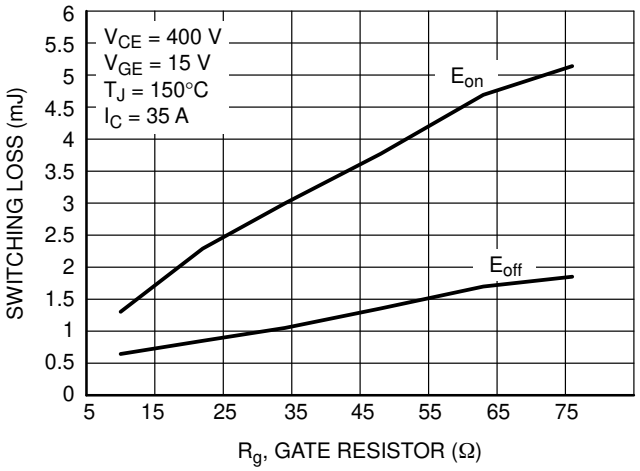



**Figure 13. Switching Loss vs. $R_g$**

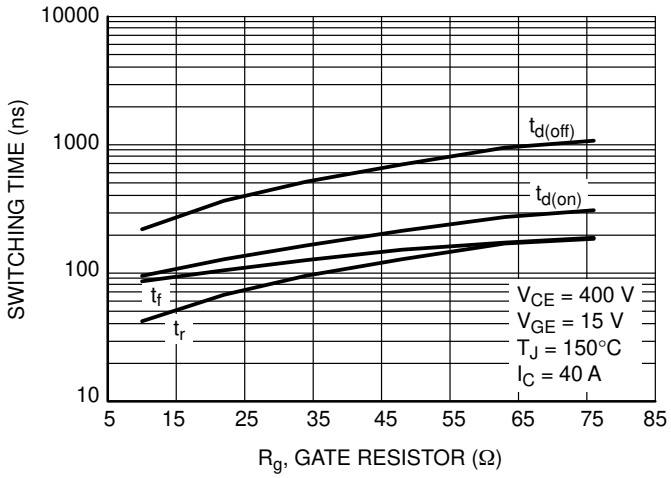



**Figure 14. Switching Time vs. $R_g$**

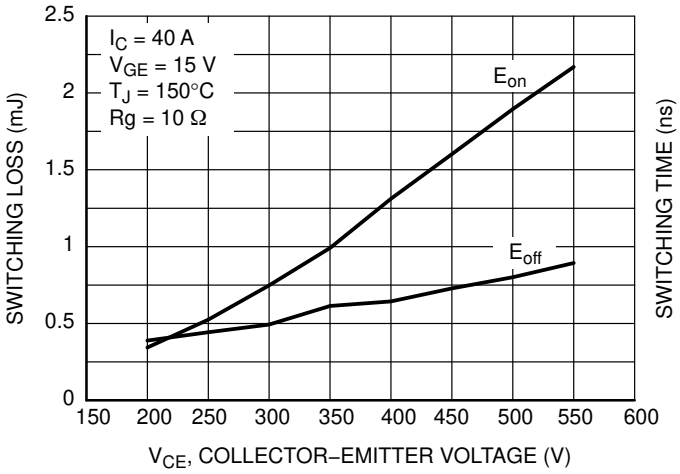



**Figure 15. Switching Loss vs. $V_{CE}$**

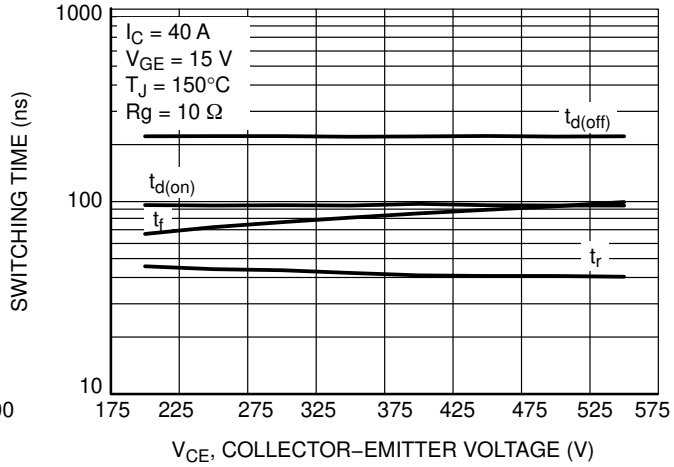



**Figure 16. Switching Time vs. $V_{CE}$**

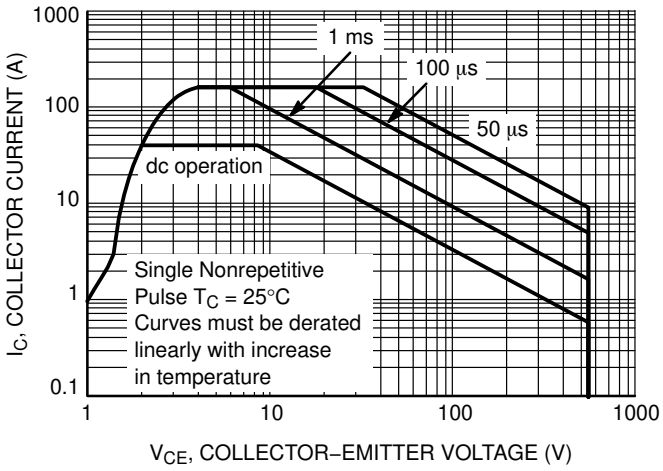



**Figure 17. Safe Operating Area**

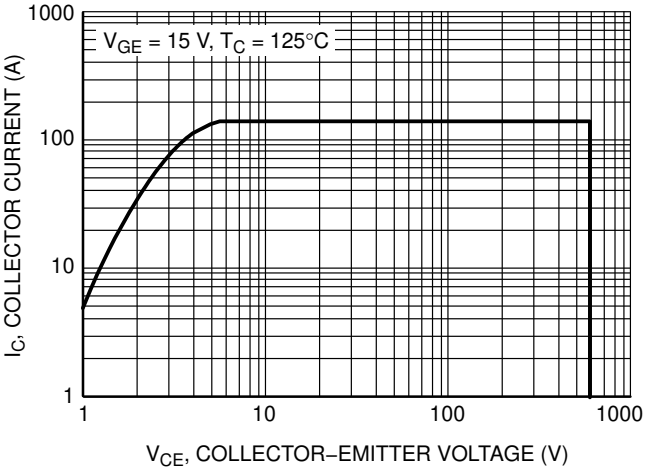



**Figure 18. Reverse Bias Safe Operating Area**

## TYPICAL CHARACTERISTICS

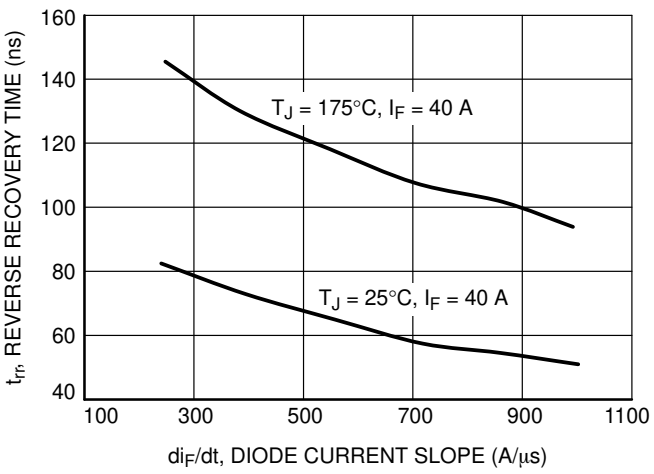



**Figure 19. $t_{rr}$ vs. $di_F/dt$ ($V_R$ = 400 V)**

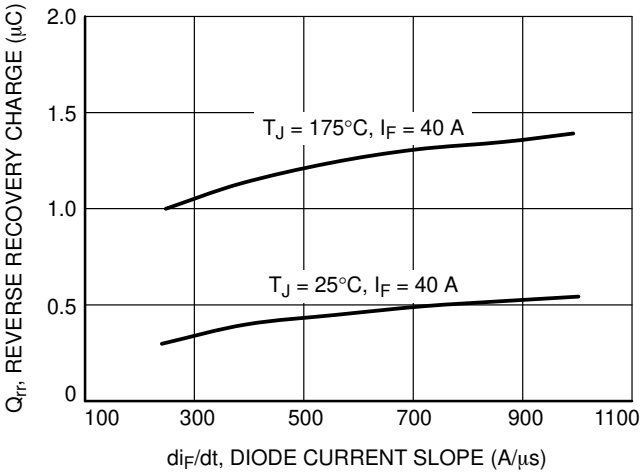



**Figure 20. $Q_{rr}$ vs. $di_F/dt$ ($V_R$ = 400 V)**

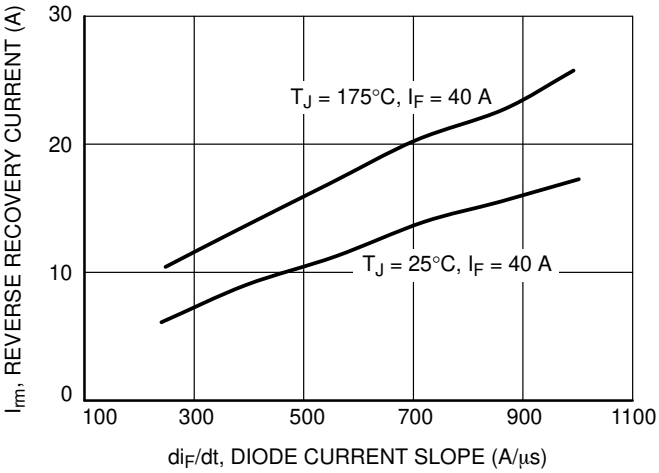



**Figure 21. $I_{rm}$ vs. $di_F/dt$ ($V_R$ = 400 V)**

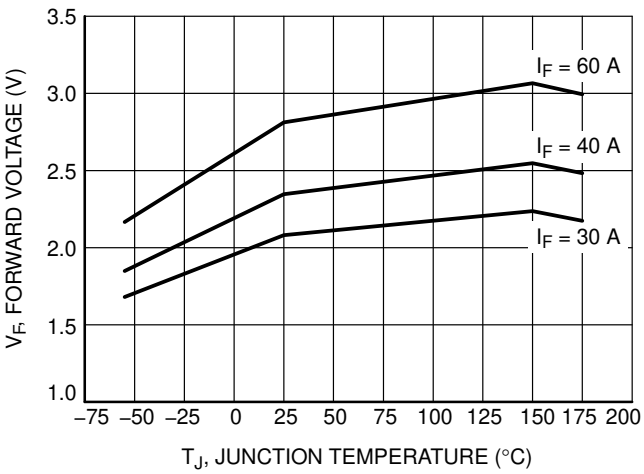



**Figure 22. $V_F$ vs. $T_J$**

## TYPICAL CHARACTERISTICS

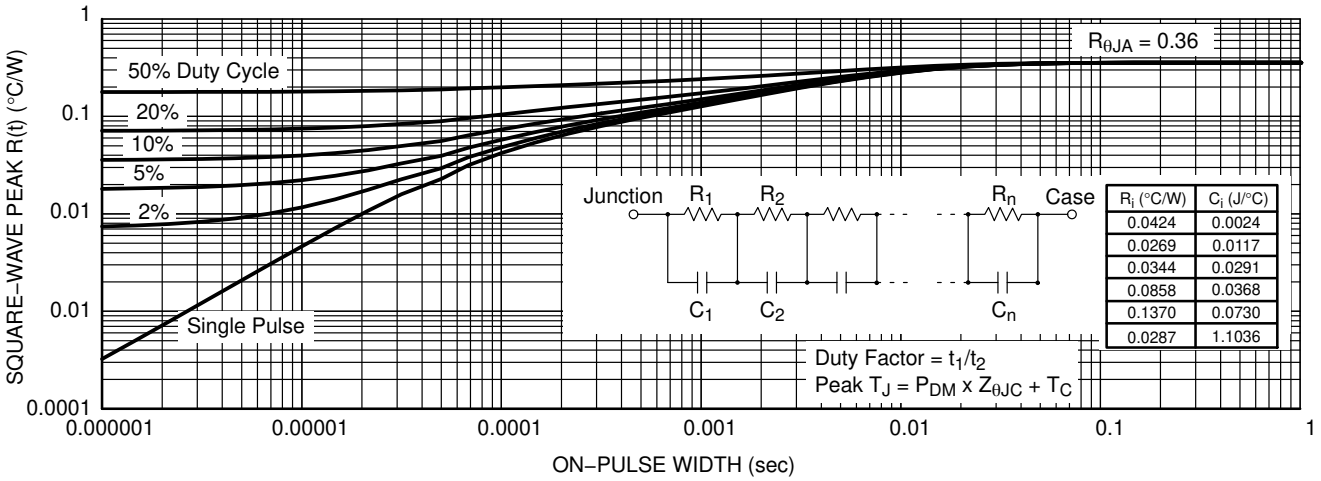



**Figure 23. IGBT Die Self−heating Square−wave Duty Cycle Transient Thermal Response**

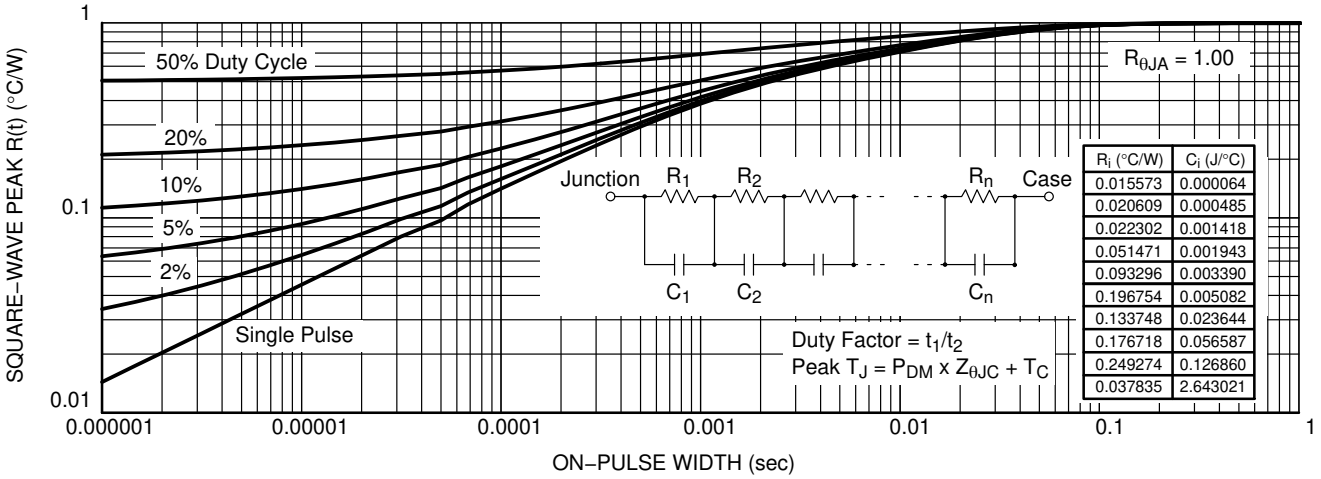
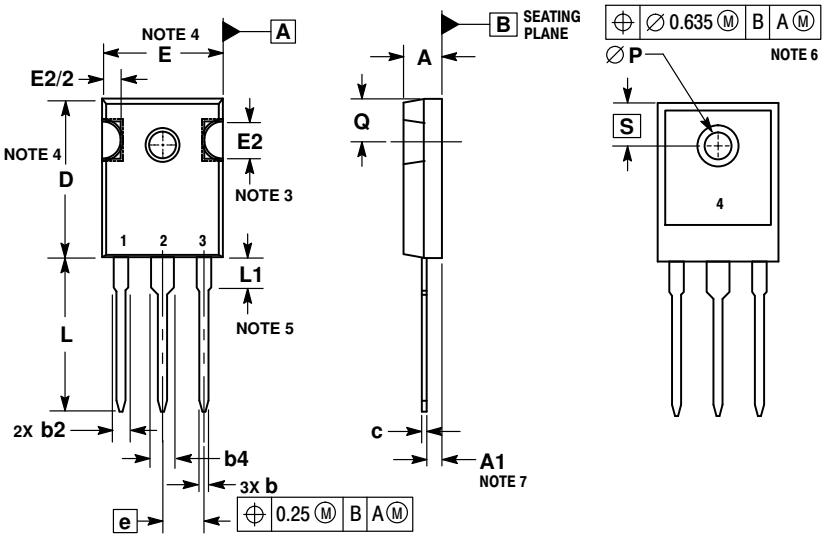



**Figure 24. Diode Die Self−heating Square−wave Duty Cycle Transient Thermal Response**

# NGTB40N60L2WG

## 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. ∅P 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.

| | MILLIMETERS | |
|---|---|---|
| DIM | 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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