# ON Semiconductor

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# NGTB60N60SWG

# 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. The IGBT is well suited for half bridge resonant applications. Incorporated into the device is a soft and fast co−packaged free wheeling diode with a low forward voltage.

### Features

- Low Saturation Voltage using Trench with Fieldstop Technology
- Low Switching Loss Reduces System Power Dissipation
- Low Gate Charge
- Soft, Fast Free Wheeling Diode
- These are Pb−Free Devices

### Typical Applications

- Inverter 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>120<br>60 | A |
| Diode forward current<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_F$ | <br>120<br>60 | A |
| Pulsed collector current, $T_{pulse}$ limited by $T_{Jmax}$ | $I_{CM}$ | 240 | A |
| Diode pulsed current, $T_{pulse}$ limited by $T_{Jmax}$ | $I_{FM}$ | 240 | A |
| Gate−emitter voltage | $V_{GE}$ | ±20 | V |
| Power Dissipation<br>@ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $P_D$ | <br>298<br>119 | W |
| Operating junction temperature range | $T_J$ | −55 to +150 | °C |
| Storage temperature range | $T_{stg}$ | −55 to +150 | °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.

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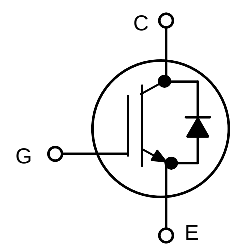
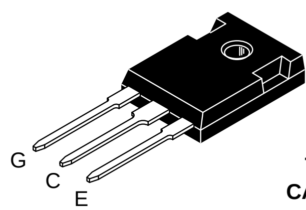
**60 A, 600 V**

**$V_{CEsat}$ = 2.0 V**

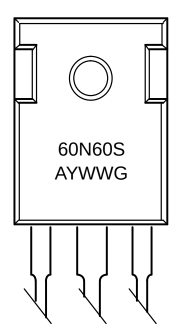
**$E_{off}$ = 0.60 mJ**




**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 |
|---|---|---|
| NGTB60N60SWG | TO−247<br>(Pb−Free) | 30 Units / Rail |





July, 2014 − Rev. 0

Publication Order Number:
NGTB60N60SW/D

## THERMAL CHARACTERISTICS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance junction−to−case, for IGBT | $R_{\theta JC}$ | 0.42 | °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, $I_C$ = 60 A<br>$V_{GE}$ = 15 V, $I_C$ = 60 A, $T_J$ = 150°C | $V_{CEsat}$ | −<br>− | 2.0<br>2.6 | 2.5<br>− | V |
| Gate−emitter threshold voltage | $V_{GE}$ = $V_{CE}$, $I_C$ = 150 μA | $V_{GE(th)}$ | 4.5 | 5.5 | 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, $T_J$ = 150°C | $I_{CES}$ | −<br>− | −<br>− | 0.2<br>2 | 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 | $C_{ies}$ | − | 4112 | − | pF |
| Output capacitance | | $C_{oes}$ | − | 169 | − | |
| Reverse transfer capacitance | | $C_{res}$ | − | 107 | − | |
| Gate charge total | $V_{CE}$ = 480 V, $I_C$ = 60 A, $V_{GE}$ = 15 V | $Q_g$ | | 173 | | nC |
| Gate to emitter charge | | $Q_{ge}$ | | 38 | | |
| Gate to collector charge | | $Q_{gc}$ | | 87 | | |
| **SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_J$ = 25°C<br>$V_{CC}$ = 400 V, $I_C$ = 60 A<br>$R_g$ = 10 Ω<br>$V_{GE}$ = 0 V/ 15 V | $t_{d(on)}$ | | 87 | | ns |
| Rise time | | $t_r$ | | 48 | | |
| Turn−off delay time | | $t_{d(off)}$ | | 180 | | |
| Fall time | | $t_f$ | | 70 | | |
| Turn−off switching loss | | $E_{off}$ | | 0.60 | | mJ |
| Turn−on switching loss | | $E_{on}$ | | 1.41 | | |
| Turn−on delay time | $T_J$ = 150°C<br>$V_{CC}$ = 400 V, $I_C$ = 60 A<br>$R_g$ = 10 Ω<br>$V_{GE}$ = 0 V/ 15 V | $t_{d(on)}$ | | 85 | | ns |
| Rise time | | $t_r$ | | 50 | | |
| Turn−off delay time | | $t_{d(off)}$ | | 186 | | |
| Fall time | | $t_f$ | | 91 | | |
| Turn−off switching loss | | $E_{off}$ | | 1.11 | | mJ |
| Turn−on switching loss | | $E_{on}$ | | 1.77 | | |
| **DIODE CHARACTERISTIC** | | | | | | |
| Forward voltage | $V_{GE}$ = 0 V, $I_F$ = 30 A<br>$V_{GE}$ = 0 V, $I_F$ = 30 A, $T_J$ = 150°C | $V_F$ | | 1.98<br>2.10 | 2.30 | V |
| Reverse recovery time | $T_J$ = 25°C<br>$I_F$ = 30 A, $V_R$ = 200 V<br>$di_F/dt$ = 200 A/μs | $t_{rr}$ | | 76 | | ns |
| Reverse recovery charge | | $Q_{rr}$ | | 291 | | nc |
| Reverse recovery current | | $I_{rrm}$ | | 7 | | 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

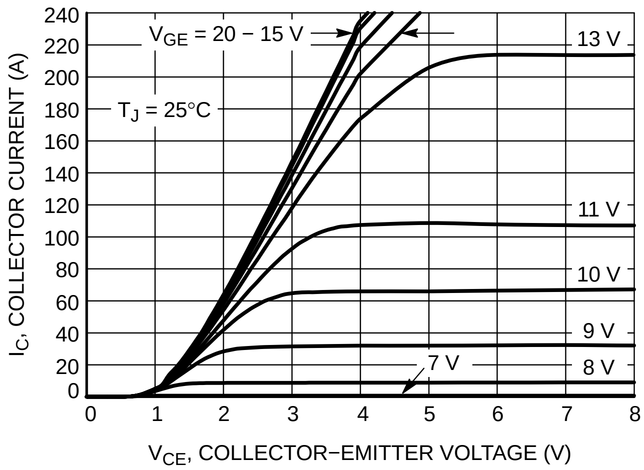



**Figure 1. Output Characteristics**

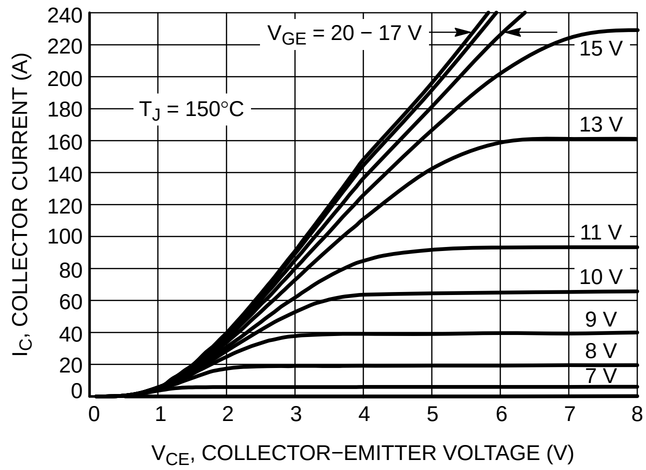



**Figure 2. Output Characteristics**

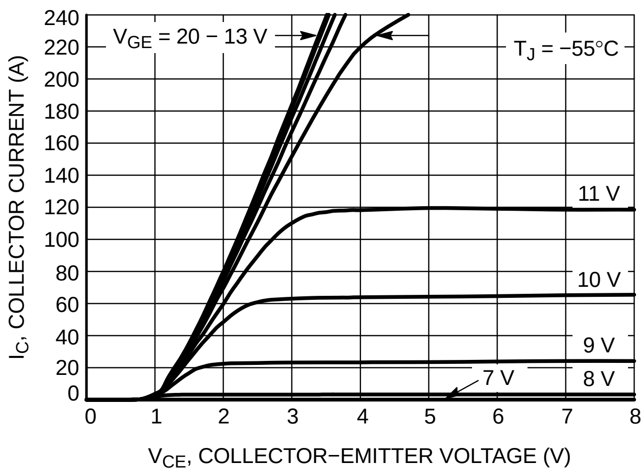



**Figure 3. Output Characteristics**

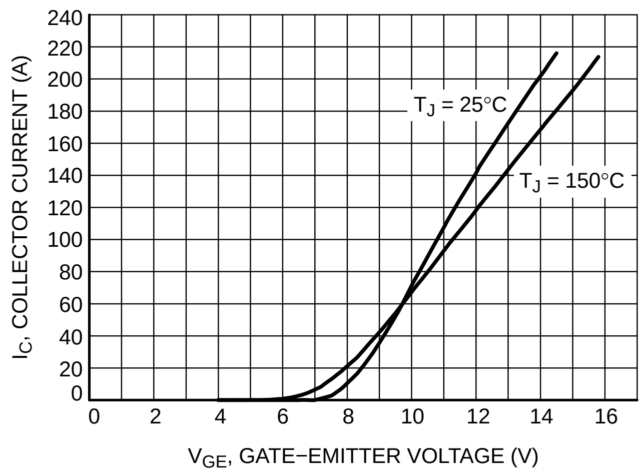



**Figure 4. Typical Transfer Characteristics**

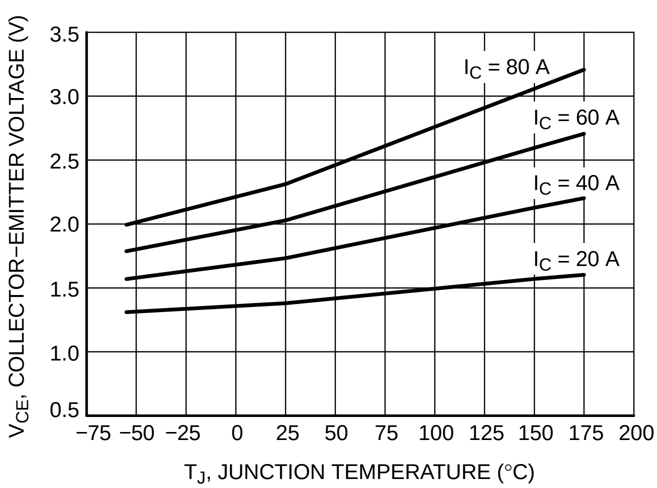



**Figure 5. $V_{CE(sat)}$ vs. $T_J$**

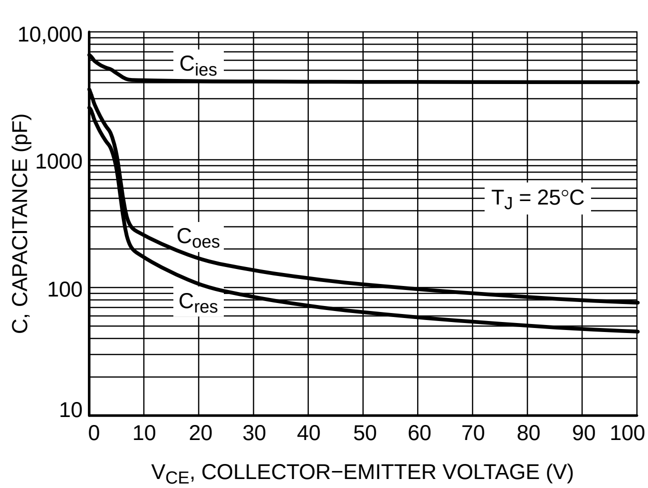



**Figure 6. Typical Capacitance**

## TYPICAL CHARACTERISTICS

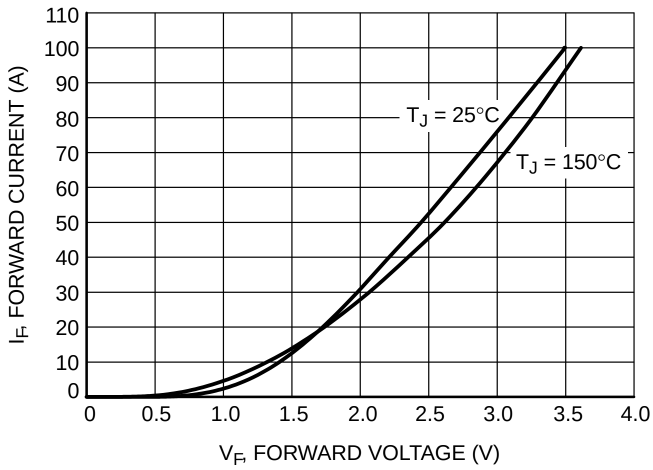



**Figure 7. Diode Forward Characteristics**

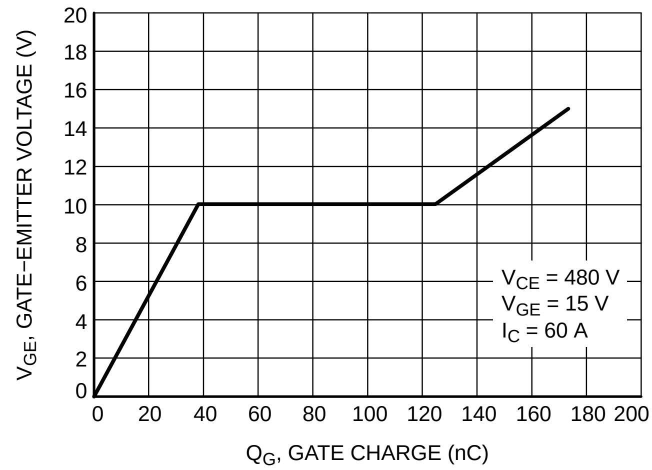



**Figure 8. Typical Gate Charge**

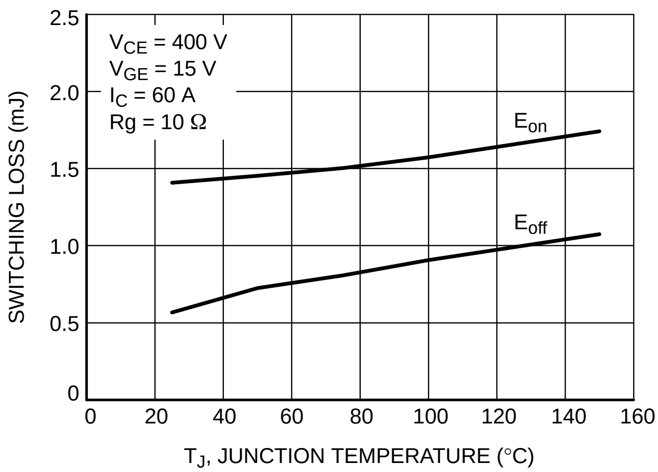



**Figure 9. Switching Loss vs. Temperature**

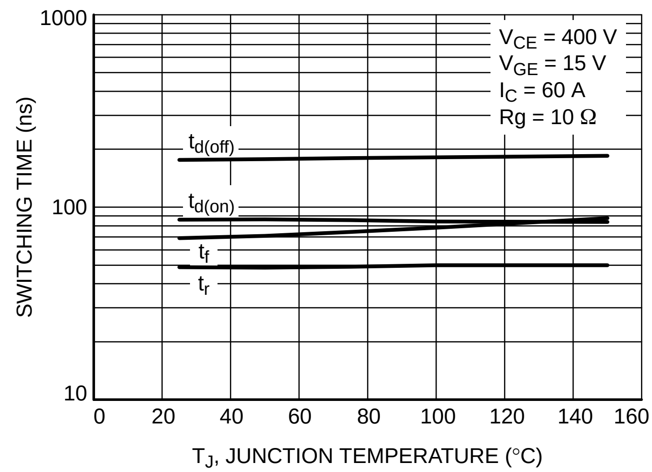



**Figure 10. Switching Time vs. Temperature**

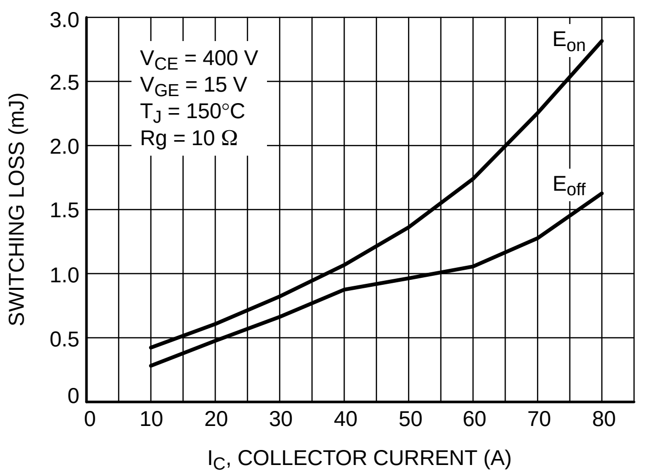



**Figure 11. Switching Loss vs. $I_C$**

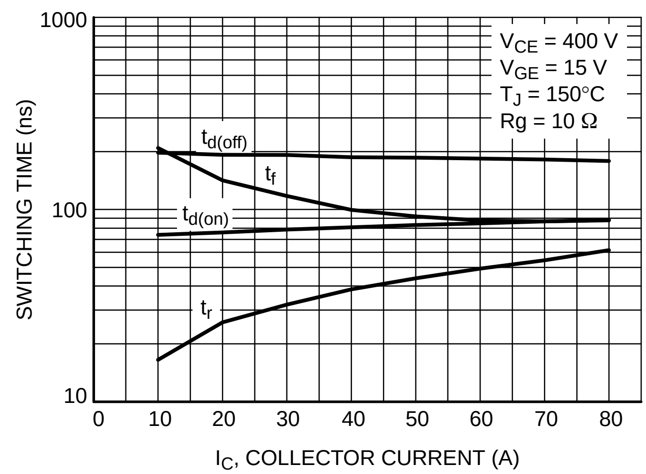



**Figure 12. Switching Time vs. $I_C$**

## TYPICAL CHARACTERISTICS

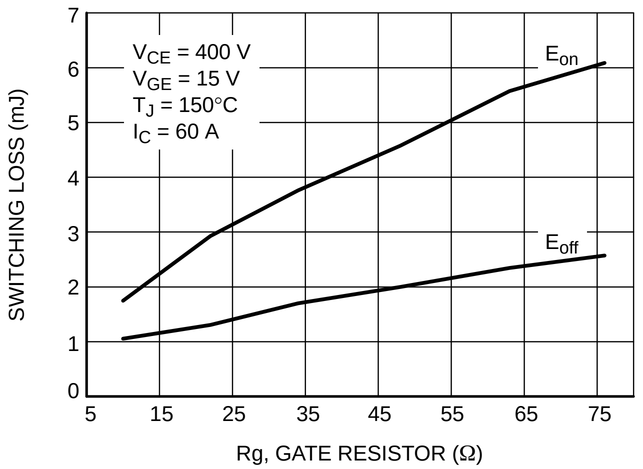



**Figure 13. Switching Loss vs. Rg**

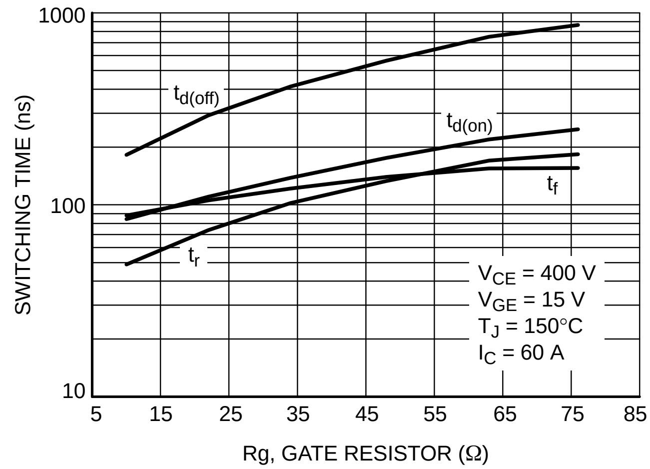



**Figure 14. Switching Time vs. Rg**

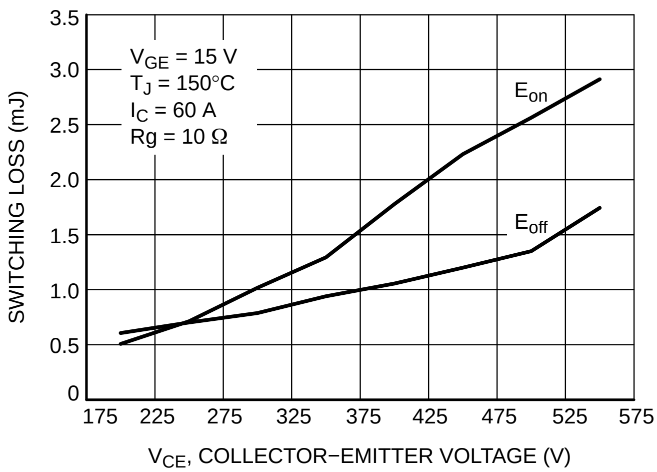



**Figure 15. Switching Loss vs. $V_{CE}$**

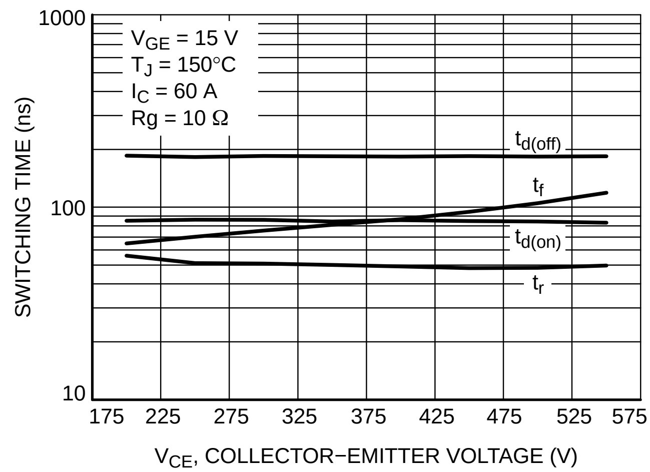



**Figure 16. Switching Time vs. $V_{CE}$**

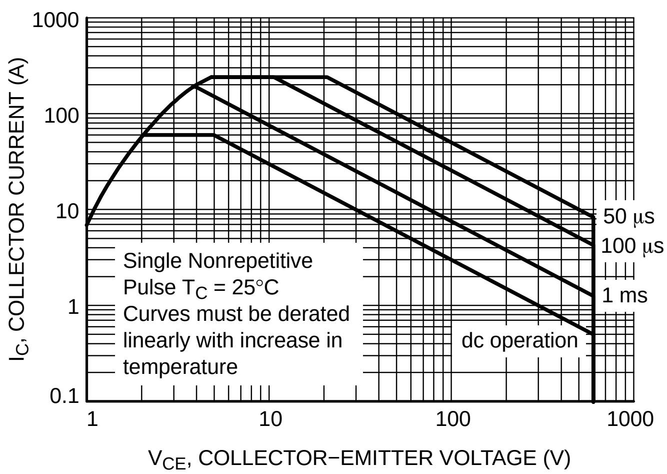



**Figure 17. $I_C$ vs. $V_{CE}$**

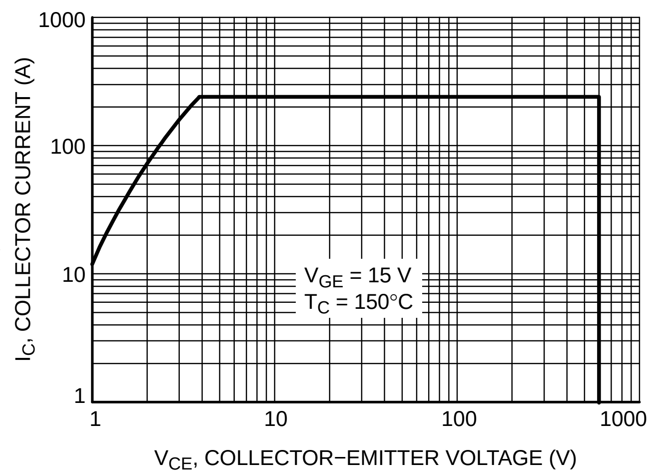
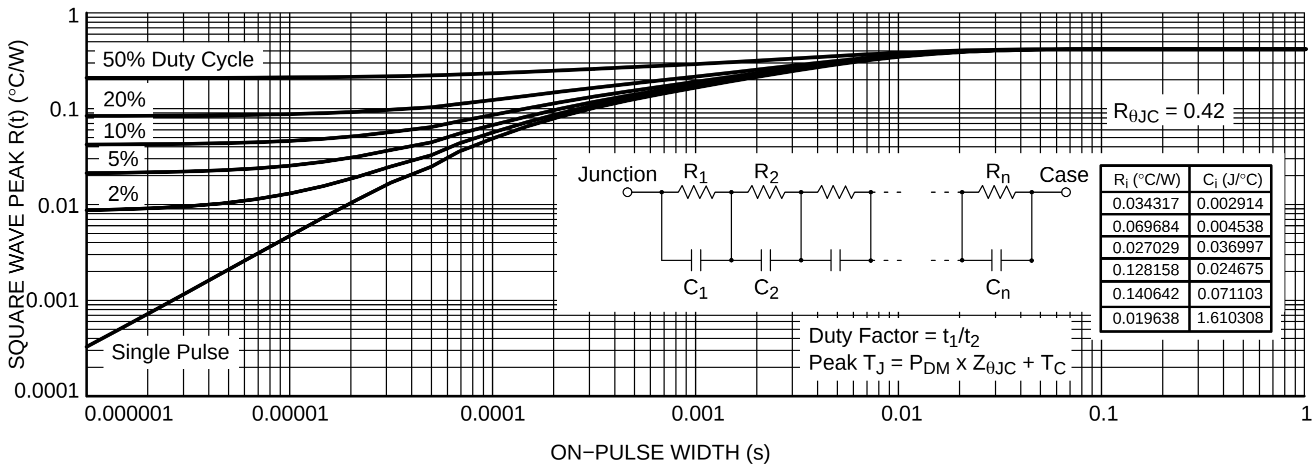


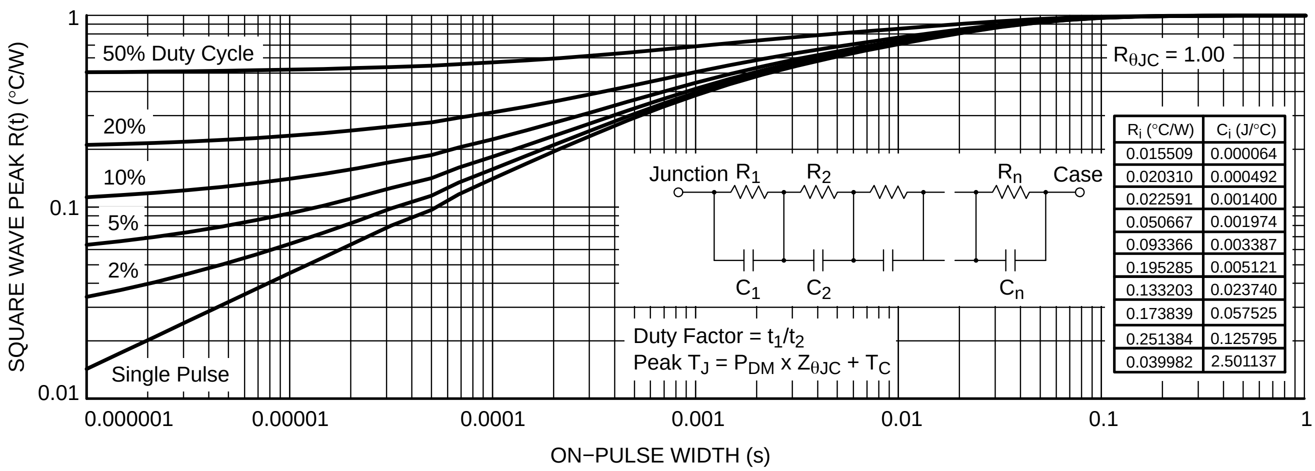

**Figure 18. $I_C$ vs. $V_{CE}$**

## TYPICAL CHARACTERISTICS




| $R_i$ (°C/W) | $C_i$ (J/°C) |
|---|---|
| 0.034317 | 0.002914 |
| 0.069684 | 0.004538 |
| 0.027029 | 0.036997 |
| 0.128158 | 0.024675 |
| 0.140642 | 0.071103 |
| 0.019638 | 1.610308 |

**Figure 19. IGBT Transient Thermal Impedance**




| $R_i$ (°C/W) | $C_i$ (J/°C) |
|---|---|
| 0.015509 | 0.000064 |
| 0.020310 | 0.000492 |
| 0.022591 | 0.001400 |
| 0.050667 | 0.001974 |
| 0.093366 | 0.003387 |
| 0.195285 | 0.005121 |
| 0.133203 | 0.023740 |
| 0.173839 | 0.057525 |
| 0.251384 | 0.125795 |
| 0.039982 | 2.501137 |

**Figure 20. Diode Transient Thermal Impedance**

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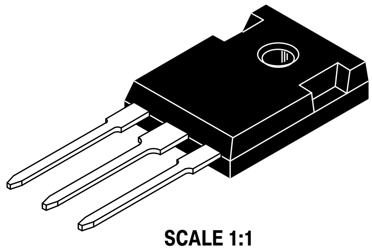
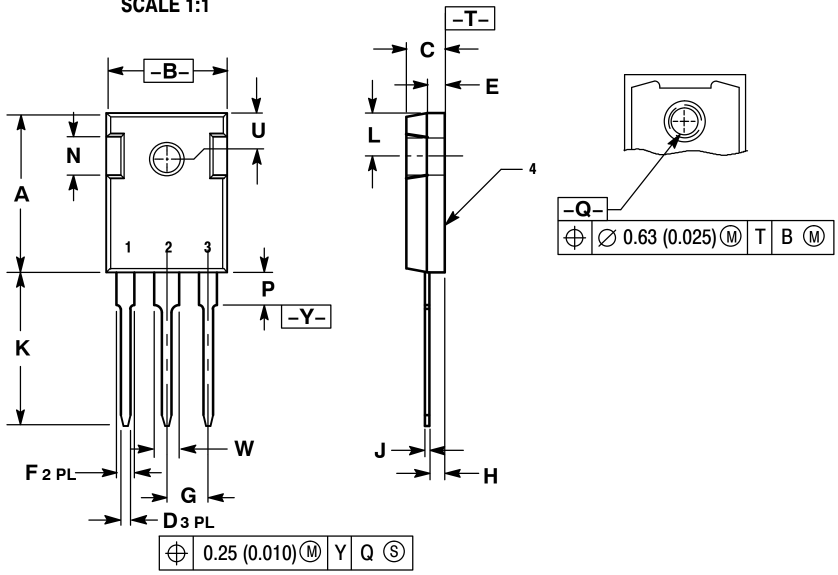


SCALE 1:1

**TO−247**
CASE 340L−02
ISSUE F

DATE 26 OCT 2011




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

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 20.32 | 21.08 | 0.800 | 8.30 |
| 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 |

STYLE 1:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

STYLE 2:
PIN 1. ANODE
2. CATHODE (S)
3. ANODE 2
4. CATHODES (S)

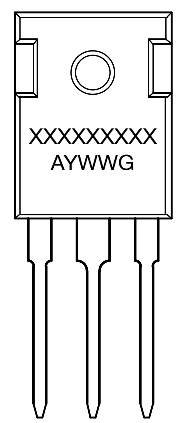
STYLE 3:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

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

**GENERIC MARKING DIAGRAM***




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.

| | | |
|---|---|---|
| **DOCUMENT NUMBER:** | **98ASB15080C** | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red. |
| **STATUS:** | **ON SEMICONDUCTOR STANDARD** | |
| **NEW STANDARD:** | | |
| **DESCRIPTION:** | **TO−247** | **PAGE 1 OF 2** |

| ISSUE | REVISION | DATE |
|---|---|---|
| D | CHANGE OF OWNERSHIP FROM MOTOROLA TO ON SEMICONDUCTOR. DIM A WAS 20.80−21.46/0.819−0.845. DIM K WAS 19.81−20.32/0.780−0.800. UPDATED STYLE 1, ADDED STYLES 2, 3, & 4. REQ. BY L. HAYES. | 25 AUG 2000 |
| E | DIM E MINIMUM WAS 2.20/0.087. DIM K MINIMUM WAS 20.06/0.790. ADDED GENERIC MARKING DIAGRAM. REQ. BY S. ALLEN. | 26 FEB 2010 |
| F | ADDED STYLES 5 AND 6. REQ. BY J. PEREZ. | 26 OCT 2011 |
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