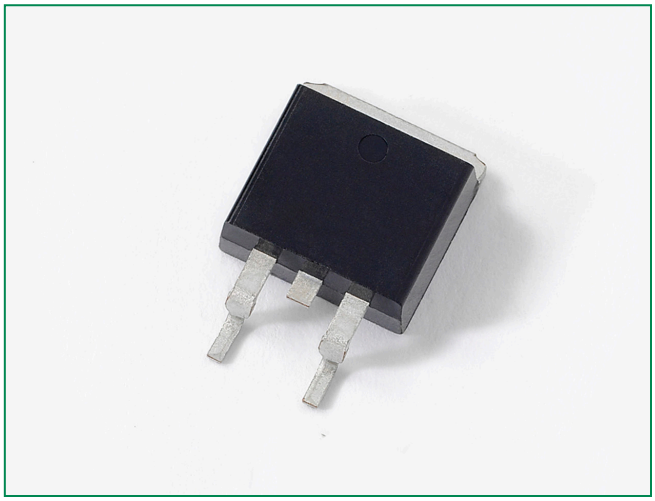
# NGB8206AN - 20 A, 350 V, N-Channel Ignition IGBT, D²PAK



20 Amps, 350 Volts
$V_{CE}(on) \leq 1.3$ V @
$I_C = 10A$, $V_{GE} \geq 4.5$ V

## Maximum Ratings ($T_J$ = 25°C unless otherwise noted)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector−Emitter Voltage | $V_{CES}$ | 390 | V |
| Collector−Gate Voltage | $V_{CER}$ | 390 | V |
| Gate−Emitter Voltage | $V_{GE}$ | ±15 | V |
| Collector Current−Continuous @ $T_C$ = 25°C − Pulsed | $I_C$ | 20<br>50 | $A_{DC}$<br>$A_{AC}$ |
| Continuous Gate Current | $I_G$ | 1.0 | mA |
| Transient Gate Current (t ≤ 2 ms, f ≤ 100 Hz) | $I_G$ | 20 | mA |
| ESD (Charged−Device Model) | ESD | 2.0 | kV |
| ESD (Human Body Model) R = 1500 Ω, C = 100 pF | ESD | 8.0 | kV |
| ESD (Machine Model) R = 0 Ω, C = 200 pF | ESD | 500 | V |
| Total Power Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 150<br>1.0 | Watts<br>W/°C |
| Operating and Storage Temperature Range | $T_J$, $T_{stg}$ | −55 to +175 | °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.

## Description

This Logic Level Insulated Gate Bipolar Transistor (IGBT) features monolithic circuitry integrating ESD and Over−Voltage clamped protection for use in inductive coil drivers applications. Primary uses include Ignition, Direct Fuel Injection, or wherever high voltage and high current switching is required.

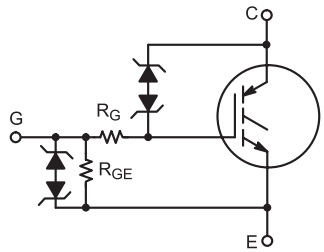
## Features

- Ideal for Coil−on−Plug and Driver−on−Coil Applications
- Gate−Emitter ESD Protection
- Temperature Compensated Gate−Collector Voltage Clamp Limits Stress Applied to Load
- Integrated ESD Diode Protection
- Low Threshold Voltage for Interfacing Power Loads to Logic or Microprocessor Devices
- Low Saturation Voltage
- High Pulsed Current Capability
- These are Pb−Free Devices

## Applications

- Ignition Systems

## Functional Diagram




## Additional Information

Datasheet | Resources | Samples

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## Unclamped Collector–To–Emitter Avalanche Characteristics (–55° ≤ $T_J$ ≤ 175°C)

| | Symbol | Value | Unit |
|---|---|---|---|
| Single Pulse Collector–to–Emitter Avalanche Energy | | | |
| $V_{CC}$ = 50 V, $V_{GE}$ = 5.0 V, $P_k$ $I_L$ = 16.7 A, $R_G$ = 1000 Ω, L = 1.8 mH, Starting $T_J$ = 25°C | $E_{AS}$ | 250 | mJ |
| $V_{CC}$ = 50 V, $V_{GE}$ = 5.0 V, $P_k$ $I_L$ = 14.9 A, $R_G$ = 1000 Ω, L = 1.8 mH, Starting $T_J$ = 150°C | | 200 | |
| $V_{CC}$ = 50 V, $V_{GE}$ = 5.0 V, $P_k$ $I_L$ = 14.1 A, $R_G$ = 1000 Ω, L = 1.8 mH, Starting $T_J$ = 175°C | | 180 | |
| Reverse Avalanche Energy | | | |
| $V_{CC}$ = 100 V, $V_{GE}$ = 20 V, $P_k$ $I_L$ = 25.8 A, L = 6.0 mH, Starting $T_J$ = 25°C | $E_{AS(R)}$ | 2000 | mJ |

1. When surface mounted to an FR4 board using the minimum recommended pad size.

## Thermal Characteristics

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 1.0 | °C/W |
| Thermal Resistance, Junction to Ambient (Note 1) | $R_{\theta JA}$ | 62.5 | °C/W |
| Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds | $T_L$ | 275 | °C |

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## Electrical Characteristics - OFF

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Collector–Emitter Clamp Voltage | $BV_{CES}$ | $I_C$ = 2.0 mA | $T_J$ = –40°C to 150°C | 325 | 350 | 375 | V |
| | | $I_C$ = 10 mA | $T_J$ = –40°C to 150°C | 340 | 365 | 390 | |
| Zero Gate Voltage Collector Current | $I_{CES}$ | $V_{CE}$ = 15 V, $V_{GE}$ = 0 V, | $T_J$ = 25°C | – | 0.1 | 1.0 | μA |
| | | $V_{CE}$ = 175V $V_{GE}$ = 0 V | $T_J$ = 25°C | 0.5 | 1.5 | 10 | |
| | | | $T_J$ = 175°C | 1.0 | 25 | 100* | |
| | | | $T_J$ = -40°C | 0.4 | 0.8 | 5.0 | |
| Reverse Collector–Emitter Clamp Voltage | $BV_{CES(R)}$ | $I_C$ = –75 mA | $T_J$ = 25°C | 30 | 35 | 39 | V |
| | | | $T_J$ = 175°C | 32 | 37 | 42 | |
| | | | $T_J$ = –40°C | 29 | 32 | 37 | |
| Reverse Collector–Emitter Leakage Current | $I_{CES(R)}$ | $V_{CE}$ = –24 V | $T_J$ = 25°C | 0.05 | 0.25 | 1.0 | mA |
| | | | $T_J$ = 175°C | 1.0 | 12.5 | 25 | |
| | | | $T_J$ = –40°C | 0.005 | 0.03 | 0.25 | |
| Gate–Emitter Clamp Voltage | $BV_{GES}$ | $I_G$ = ±5.0 mA | $T_J$ = –40°C to 175°C | 12 | 12.5 | 14 | V |
| Gate–Emitter Leakage Current | $I_{GES}$ | $V_{GE}$ = ±5.0 V | $T_J$ = –40°C to 175°C | 200 | 300 | 350* | μA |
| Gate Resistor | $R_G$ | - | $T_J$ = –40°C to 175°C | - | - | - | Ω |
| Gate Emitter Resistor | $R_{GE}$ | - | $T_J$ = –40°C to 175°C | 14.25 | 16 | 25 | kΩ |

## Electrical Characteristics - ON (Note 3)

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Gate Threshold Voltage | $V_{GE(th)}$ | $I_C$ = 1.0 mA, $V_{GE}$ = $V_{CE}$ | $T_J$ = 25°C | 1.5 | 1.8 | 2.1 | V |
| | | | $T_J$ = 175°C | 0.7 | 1.0 | 1.3 | |
| | | | $T_J$ = –40°C | 1.7 | 2.0 | 2.3* | |
| Threshold Temperature Coefficient (Negative) | – | – | – | 3.8 | 4.6 | 6.0 | mV/°C |

*Maximum Value of Characteristic across Temperature Range.

3. Pulse Test: Pulse Width ≤ 300 μS, Duty Cycle ≤ 2%.

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## Electrical Characteristics - ON (Note 4)

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Collector–to–Emitter On–Voltage | $V_{CE\ (on)}$ | $I_C$ = 6.5 A, $V_{GE}$ = 3.7 V | $T_J$ = 25°C | 0.95 | 1.15 | 1.35 | V |
| | | | $T_J$ = 175°C | 0.70 | 0.95 | 1.15 | |
| | | | $T_J$ = −40°C | 1.0 | 1.30 | 1.40 | |
| | | $I_C$ = 9.0 A, $V_{GE}$ = 3.9 V | $T_J$ = 25°C | 0.95 | 1.25 | 1.45 | |
| | | | $T_J$ = 175°C | 0.8 | 1.05 | 1.25 | |
| | | | $T_J$ = −40°C | 1.1 | 1.4 | 1.50 | |
| | | $I_C$ = 7.5 A, $V_{GE}$ = 4.5 V | $T_J$ = 25°C | 0.85 | 1.15 | 1.4 | |
| | | | $T_J$ = 175°C | 0.7 | 0.95 | 1.2 | |
| | | | $T_J$ = −40°C | 1.0 | 1.3 | 1.6* | |
| | | $I_C$ = 10 A, $V_{GE}$ = 4.5 V | $T_J$ = 25°C | 0.9 | 1.2 | 1.6 | |
| | | | $T_J$ = 175°C | 0.8 | 1.05 | 1.4 | |
| | | | $T_J$ = −40°C | 1.0 | 1.2 | 1.7* | |
| | | $I_C$ = 15 A, $V_{GE}$ = 4.5 V | $T_J$ = 25°C | 1.0 | 1.3 | 1.7 | |
| | | | $T_J$ = 175°C | 1.0 | 1.3 | 1.55 | |
| | | | $T_J$ = −40°C | 1.1 | 1.35 | 1.8* | |
| | | $I_C$ = 20 A, $V_{GE}$ = 4.5 V | $T_J$ = 25°C | 1.3 | 1.6 | 1.9 | |
| | | | $T_J$ = 175°C | 1.2 | 1.5 | 1.8 | |
| | | | $T_J$ = −40°C | 1.4 | 1.75 | 2.0* | |
| Forward Transconductance | gfs | $V_{CE}$ = 5.0 V, $I_C$ = 6.0 A | $T_J$ = 25°C | 10 | 18 | 25 | Mhos |

*Maximum Value of Characteristic across Temperature Range.

3. Pulse Test: Pulse Width ≤ 300 μS, Duty Cycle ≤ 2%.

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## Dynamic Characteristics

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Input Capacitance | $C_{ISS}$ | $V_{CE}$ = 25 V<br>f = 10 kHz | $T_J$ = 25°C | 1100 | 1300 | 1500 | pF |
| Output Capacitance | $C_{OSS}$ | | | 70 | 80 | 90 | |
| Transfer Capacitance | $C_{RSS}$ | | | 18 | 20 | 22 | |

## Switching Characteristics

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| Turn–Off Delay Time (Resistive) | $t_{d\ (off)}$ | $V_{CC}$ = 300 V,<br>$I_C$ = 9 A<br>$R_G$ = 1.0 kΩ,<br>$R_L$ = 33 Ω,<br>$V_{GE}$ = 5.0 V | $T_J$ = 25°C | 6.0 | 8.0 | 10 | µSec |
| | | | $T_J$ = 175°C | 6.0 | 8.0 | 10 | |
| Fall Time (Resistive) | $t_f$ | | $T_J$ = 25°C | 4.0 | 6.0 | 8.0 | |
| | | | $T_J$ = 175°C | 8.0 | 10.5 | 14 | |
| Turn–Off Delay Time (Inductive) | $t_{d\ (off)}$ | $V_{CC}$ = 300 V,<br>$I_C$ = 9 A<br>$R_G$ = 1.0 kΩ,<br>L = 300 µH,<br>$V_{GE}$ = 5.0 V | $T_J$ = 25°C | 3.0 | 5.0 | 7.0 | |
| | | | $T_J$ = 175°C | 5.0 | 7.0 | 9.0 | |
| Fall Time (Inductive) | $t_f$ | | $T_J$ = 25°C | 1.5 | 3.0 | 4.5 | |
| | | | $T_J$ = 175°C | 5.0 | 7.0 | 10 | |
| Turn–On Delay Time | $t_{d\ (on)}$ | $V_{CC}$ = 14 V,<br>$I_C$ = 9.0 A<br>$R_G$ = 1.0 kΩ,<br>$R_L$ = 1.5 Ω,<br>$V_{GE}$ = 5.0 V | $T_J$ = 25°C | 1.0 | 1.5 | 2.0 | |
| | | | $T_J$ = 175°C | 1.0 | 1.5 | 2.0 | |
| Rise Time | $t_r$ | | $T_J$ = 25°C | 4.0 | 6.0 | 8.0 | |
| | | | $T_J$ = 175°C | 3.0 | 5.0 | 7.0 | |

2. Pulse Test: Pulse Width ≤ 300 µS, Duty Cycle ≤ 2%.

*Maximum Value of Characteristic across Temperature Range.

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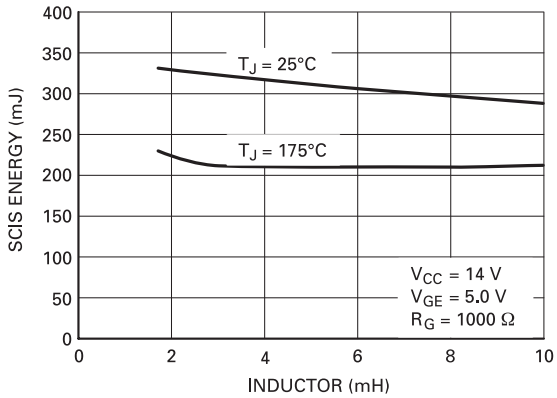
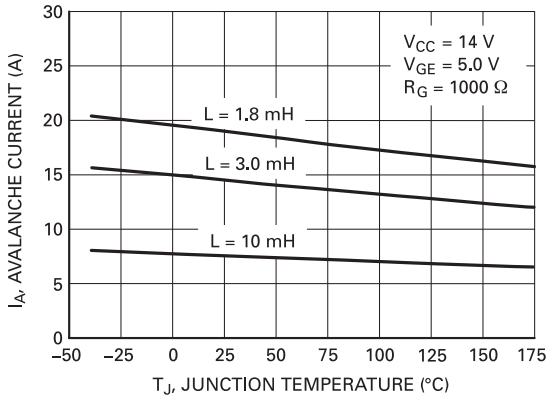
## Ratings and Characteristic Curves

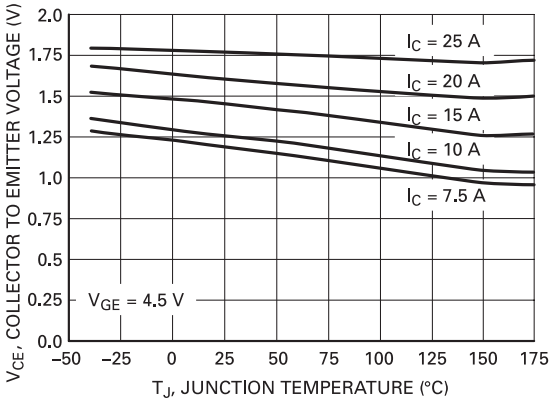
### Figure 1. Self Clamped Inductive Switching



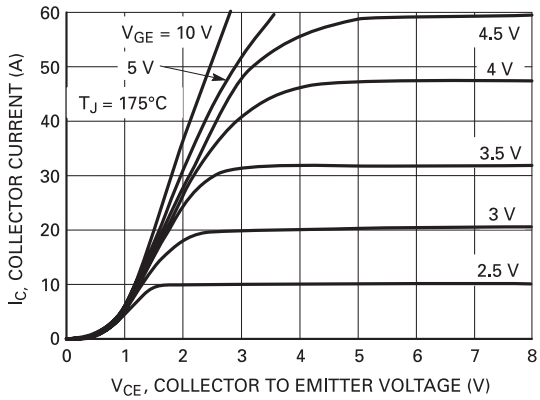

### Figure 2. Open Secondary Avalanche Current vs. Temperature



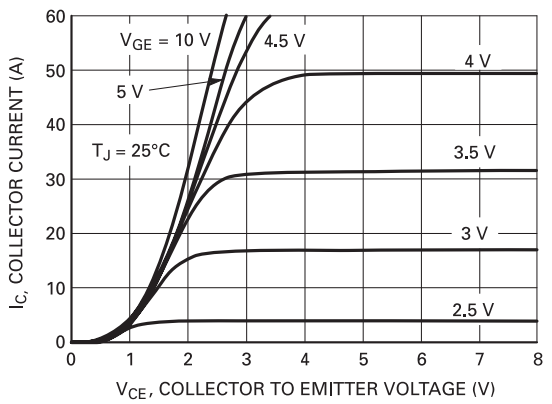

### Figure 3. Collector–to–Emitter Voltage vs. Junction Temperature



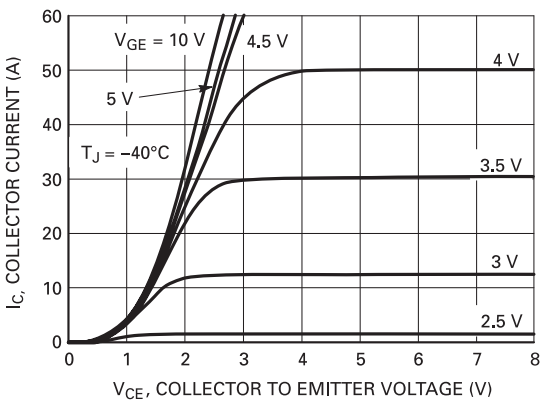

### Figure 4. Collector Current vs. Collector–to–Emitter Voltage




### Figure 5. Collector Current vs. Collector–to–Emitter Voltage




### Figure 6. Collector Current vs. Collector–to–Emitter Voltage

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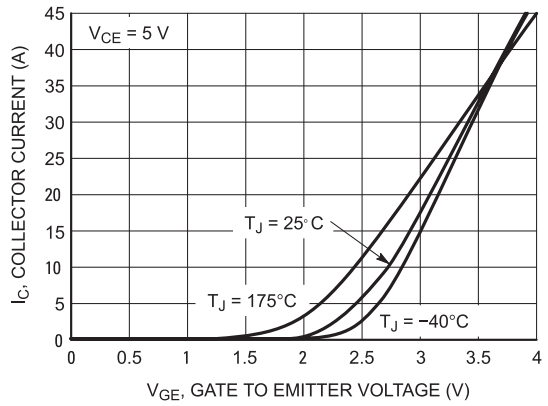
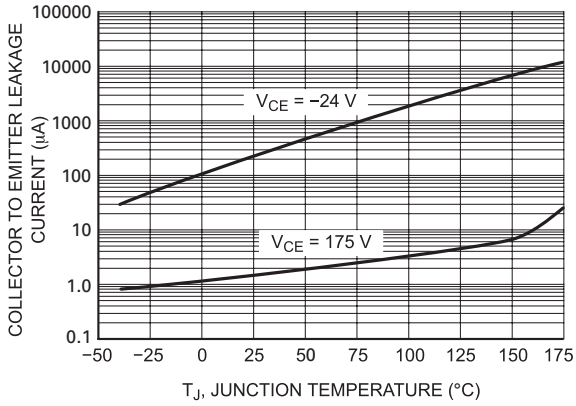
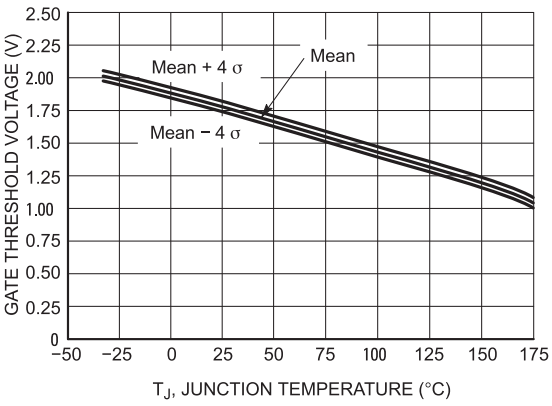
## Figure 7. Transfer Characteristics



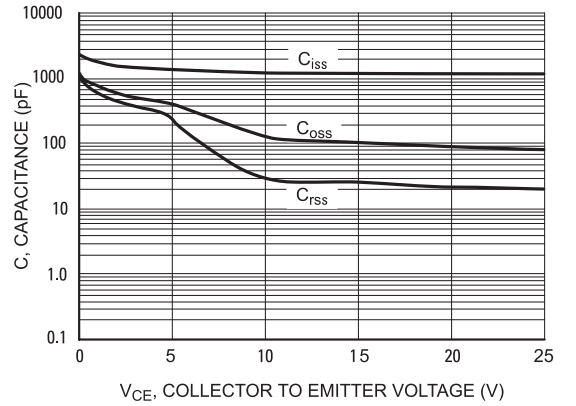

## Figure 8. Collector–to–Emitter Leakage Current vs. Temperature



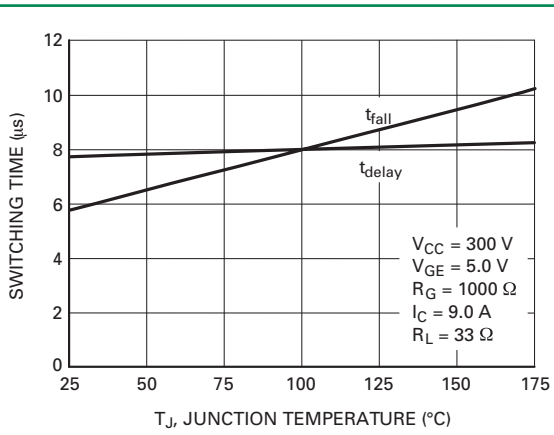

## Figure 9. Gate Threshold Voltage vs. Temperature




## Figure 10. Capacitance vs. Collector–to–Emitter Voltage




## Figure 11. Resistive Switching Fall Time vs. Temperature




## Figure 12. Inductive Switching Fall Time vs. Temperature

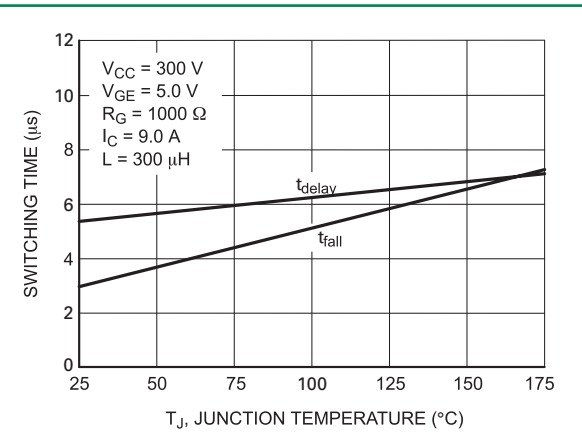



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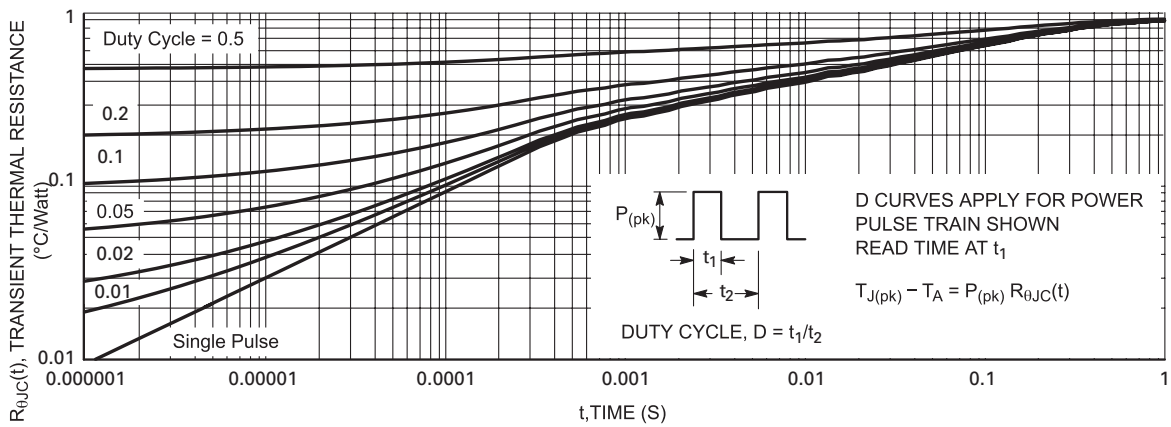
**Figure 13. Minimum Pad Transient Thermal Resistance (Non–normalized Junction–to–Ambient)**

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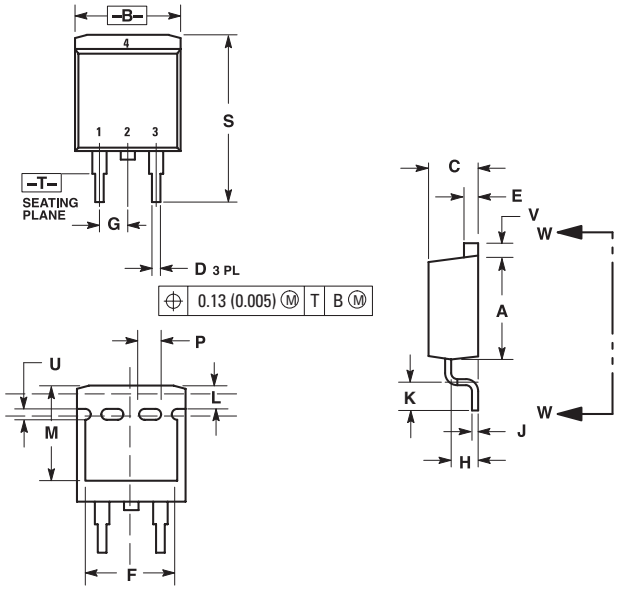
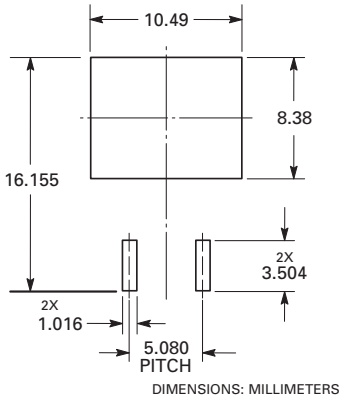
## Dimensions



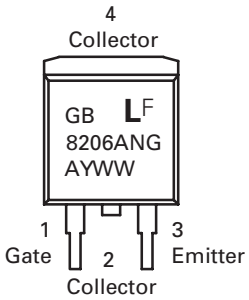

| Dim | Inches | | Millimeters | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.340 | 0.380 | 8.64 | 9.65 |
| B | 0.380 | 0.405 | 9.65 | 10.29 |
| C | 0.160 | 0.190 | 4.06 | 4.83 |
| D | 0.020 | 0.035 | 0.51 | 0.89 |
| E | 0.045 | 0.055 | 1.14 | 1.40 |
| F | 0.310 | 0.350 | 7.87 | 8.89 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.080 | 0.110 | 2.03 | 2.79 |
| J | 0.018 | 0.025 | 0.46 | 0.64 |
| K | 0.090 | 0.110 | 2.29 | 2.79 |
| L | 0.052 | 0.072 | 1.32 | 1.83 |
| M | 0.280 | 0.320 | 7.11 | 8.13 |
| N | 0.197 REF | | 5.00 REF | |
| P | 0.079 REF | | 2.00 REF | |
| R | 0.039 REF | | 0.99 REF | |
| S | 0.575 | 0.625 | 14.60 | 15.88 |
| V | 0.045 | 0.055 | 1.14 | 1.40 |

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 418B–01 THRU 418B–03 OBSOLETE, NEW STANDARD 418B–04.

## Soldering Footprint




## Part Marking System




GB8206AN = Device Code

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

## ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| NGB8206ANT4G | $D^2$PAK (Pb–Free) | 800 / Tape & Reel |
| NGB8206ANTF4G | | 700 / Tape & Reel |
| NGB8206ANSL3G | | 50 Units / Rail |

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