

# NGP8203N

## Ignition IGBT

### 20 A, 400 V, N-Channel TO-220

This Logic Level Insulated Gate Bipolar Transistor (IGBT) features monolithic circuitry integrating ESD and Overvoltage 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
- Optional Gate Resistor ( $R_G$ ) and Gate-Emitter Resistor ( $R_{GE}$ )

#### Applications

- Ignition Systems

#### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Rating  | Symbol         | Value       | Unit                               |
|---|----------------|-------------|------------------------------------|
| Collector-Emitter Voltage   | $V_{CES}$      | 440         | V                                  |
| Collector-Gate Voltage  | $V_{CER}$      | 440         | V                                  |
| Gate-Emitter Voltage  | $V_{GE}$       | $\pm 15$    | V                                  |
| Collector Current-Continuous<br>@ $T_C = 25^\circ\text{C}$ - Pulsed                   | $I_C$          | 20<br>50    | $A_{DC}$<br>$A_{AC}$               |
| Continuous Gate Current   | $I_G$          | 1.0         | mA                                 |
| Transient Gate Current ( $t \leq 2$ ms, $f \leq 100$ Hz)                              | $I_G$          | 20          | mA                                 |
| ESD (Charged-Device Model)  | ESD            | 2.0         | kV                                 |
| ESD (Human Body Model)<br>$R = 1500 \Omega$ , $C = 100$ pF                            | ESD            | 8.0         | kV                                 |
| ESD (Machine Model) $R = 0 \Omega$ , $C = 200$ pF                                     | ESD            | 500         | V                                  |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 150<br>1.0  | Watts<br>$\text{W}/^\circ\text{C}$ |
| Operating & Storage Temperature Range   | $T_J, T_{stg}$ | -55 to +175 | $^\circ\text{C}$                   |

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.



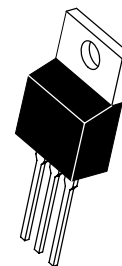
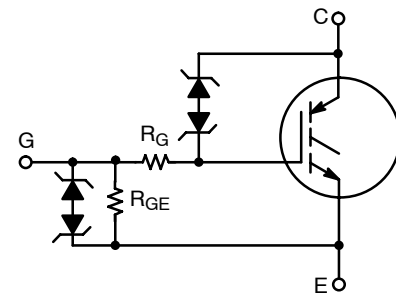
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<http://onsemi.com>

**20 AMPS**

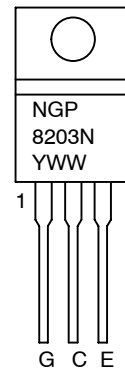
**400 VOLTS**

$V_{CE(on)} = 1.3 \text{ V @}$   
 $I_C = 10 \text{ A, } V_{GE} \geq 4.5 \text{ V}$



**TO-220  
CASE 221A  
STYLE 9**

#### MARKING DIAGRAM



NGP8203N = Device Code  
Y = Year  
WW = Work Week

#### ORDERING INFORMATION

| Device   | Package | Shipping        |
|----------|---------|-----------------|
| NGP8203N | TO-220  | 50 Units / Rail |

# NGP8203N

## UNCLAMPED COLLECTOR-TO-EMITTER AVALANCHE CHARACTERISTICS ( $-55^{\circ} \leq T_J \leq 175^{\circ}C$ )

| Characteristic  | Symbol      | Value             | Unit |
|---|-------------|-------------------|------|
| Single Pulse Collector-to-Emitter Avalanche Energy<br>$V_{CC} = 50\text{ V}$ , $V_{GE} = 5.0\text{ V}$ , Pk $I_L = 16.7\text{ A}$ , $R_G = 1000\ \Omega$ , $L = 1.8\text{ mH}$ , Starting $T_J = 25^{\circ}C$<br>$V_{CC} = 50\text{ V}$ , $V_{GE} = 5.0\text{ V}$ , Pk $I_L = 14.9\text{ A}$ , $R_G = 1000\ \Omega$ , $L = 1.8\text{ mH}$ , Starting $T_J = 150^{\circ}C$<br>$V_{CC} = 50\text{ V}$ , $V_{GE} = 5.0\text{ V}$ , Pk $I_L = 14.1\text{ A}$ , $R_G = 1000\ \Omega$ , $L = 1.8\text{ mH}$ , Starting $T_J = 175^{\circ}C$ | $E_{AS}$    | 250<br>200<br>180 | mJ   |
| Reverse Avalanche Energy<br>$V_{CC} = 100\text{ V}$ , $V_{GE} = 20\text{ V}$ , Pk $I_L = 25.8\text{ A}$ , $L = 6.0\text{ mH}$ , Starting $T_J = 25^{\circ}C$  | $E_{AS(R)}$ | 2000              | mJ   |

## THERMAL CHARACTERISTICS

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

1. For further details, see Soldering and Mounting Techniques Reference Manual: SOLDERRM/D.

## ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Test Conditions | Temperature | Min | Typ | Max | Unit |
|----------------|--------|-----------------|-------------|-----|-----|-----|------|
|----------------|--------|-----------------|-------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|   |               |   |  |       |      |      |            |
|---|---------------|---|--|-------|------|------|------------|
| Collector-Emitter Clamp Voltage           | $BV_{CES}$    | $I_C = 2.0\text{ mA}$                             | $T_J = -40^{\circ}C$ to $175^{\circ}C$ | 370   | 395  | 420  | V          |
|   |               | $I_C = 10\text{ mA}$                              | $T_J = -40^{\circ}C$ to $175^{\circ}C$ | 390   | 415  | 440  |            |
| Zero Gate Voltage Collector Current       | $I_{CES}$     | $V_{GE} = 0\text{ V}$ ,<br>$V_{CE} = 15\text{ V}$ | $T_J = 25^{\circ}C$                    |       | 0.1  | 1.0  | $\mu A$    |
|   |               |   | $T_J = 25^{\circ}C$                    | 0.5   | 1.5  | 10   |            |
|   |               |   | $T_J = 175^{\circ}C$                   | 1.0   | 25   | 100* |            |
| Reverse Collector-Emitter Clamp Voltage   | $BV_{CES(R)}$ | $I_C = -75\text{ mA}$                             | $T_J = 25^{\circ}C$                    | 30    | 35   | 39   | V          |
|   |               |   | $T_J = 175^{\circ}C$                   | 35    | 39   | 45*  |            |
|   |               |   | $T_J = -40^{\circ}C$                   | 30    | 33   | 37   |            |
| Reverse Collector-Emitter Leakage Current | $I_{CES(R)}$  | $V_{CE} = -24\text{ V}$                           | $T_J = 25^{\circ}C$                    | 0.05  | 0.1  | 0.5  | mA         |
|   |               |   | $T_J = 175^{\circ}C$                   | 1.0   | 5.0  | 10*  |            |
|   |               |   | $T_J = -40^{\circ}C$                   | 0.005 | 0.01 | 0.1  |            |
| Gate-Emitter Clamp Voltage                | $BV_{GES}$    | $I_G = \pm 5.0\text{ mA}$                         | $T_J = -40^{\circ}C$ to $175^{\circ}C$ | 12    | 12.5 | 14   | V          |
| Gate-Emitter Leakage Current              | $I_{GES}$     | $V_{GE} = \pm 5.0\text{ V}$                       | $T_J = -40^{\circ}C$ to $175^{\circ}C$ | 200   | 300  | 350* | $\mu A$    |
| Gate Resistor (Optional)                  | $R_G$         |   | $T_J = -40^{\circ}C$ to $175^{\circ}C$ |       | 70   |      | $\Omega$   |
| Gate-Emitter Resistor                     | $R_{GE}$      |   | $T_J = -40^{\circ}C$ to $175^{\circ}C$ | 14.25 | 16   | 25   | k $\Omega$ |

### ON CHARACTERISTICS (Note 2)

|  |              |  |                      |     |     |      |                 |
|--|--------------|--|----------------------|-----|-----|------|-----------------|
| Gate Threshold Voltage                       | $V_{GE(th)}$ | $I_C = 1.0\text{ mA}$ ,<br>$V_{GE} = V_{CE}$ | $T_J = 25^{\circ}C$  | 1.5 | 1.8 | 2.1  | V               |
|  |              |  | $T_J = 175^{\circ}C$ | 0.7 | 1.0 | 1.3  |                 |
|  |              |  | $T_J = -40^{\circ}C$ | 1.7 | 2.0 | 2.3* |                 |
| Threshold Temperature Coefficient (Negative) |              |  |                      | 4.0 | 4.6 | 5.2  | mV/ $^{\circ}C$ |

\*Maximum Value of Characteristic across Temperature Range.

2. Pulse Test: Pulse Width  $\leq 300\ \mu S$ , Duty Cycle  $\leq 2\%$ .

# NGP8203N

## ELECTRICAL CHARACTERISTICS

| Characteristic                               | Symbol                    | Test Conditions                               | Temperature               | Min  | Typ  | Max  | Unit |
|--|---------------------------|---|---------------------------|------|------|------|------|
| <b>ON CHARACTERISTICS</b> (Note 3)           |                           |   |                           |      |      |      |      |
| Collector-to-Emitter On-Voltage              | $V_{CE(on)}$              | $I_C = 6.5 \text{ A}, V_{GE} = 3.7 \text{ V}$ | $T_J = 25^\circ\text{C}$  | 0.95 | 1.15 | 1.35 | V    |
|  |                           |   | $T_J = 175^\circ\text{C}$ | 0.7  | 0.95 | 1.15 |      |
|  |                           |   | $T_J = -40^\circ\text{C}$ | 1.0  | 1.3  | 1.40 |      |
|  |                           | $I_C = 9.0 \text{ A}, V_{GE} = 3.9 \text{ V}$ | $T_J = 25^\circ\text{C}$  | 0.95 | 1.25 | 1.45 |      |
|  |                           |   | $T_J = 175^\circ\text{C}$ | 0.8  | 1.05 | 1.25 |      |
|  |                           |   | $T_J = -40^\circ\text{C}$ | 1.1  | 1.4  | 1.5  |      |
|  |                           | $I_C = 7.5 \text{ A}, V_{GE} = 4.5 \text{ V}$ | $T_J = 25^\circ\text{C}$  | 0.85 | 1.15 | 1.4  |      |
|  |                           |   | $T_J = 175^\circ\text{C}$ | 0.7  | 0.95 | 1.2  |      |
|  |                           |   | $T_J = -40^\circ\text{C}$ | 1.0  | 1.3  | 1.6* |      |
|  |                           | $I_C = 10 \text{ A}, V_{GE} = 4.5 \text{ V}$  | $T_J = 25^\circ\text{C}$  | 1.0  | 1.3  | 1.6  |      |
|  |                           |   | $T_J = 175^\circ\text{C}$ | 0.8  | 1.05 | 1.4  |      |
|  |                           |   | $T_J = -40^\circ\text{C}$ | 1.1  | 1.4  | 1.7* |      |
|  |                           | $I_C = 15 \text{ A}, V_{GE} = 4.5 \text{ V}$  | $T_J = 25^\circ\text{C}$  | 1.15 | 1.45 | 1.7  |      |
|  |                           |   | $T_J = 175^\circ\text{C}$ | 1.0  | 1.3  | 1.55 |      |
|  |                           |   | $T_J = -40^\circ\text{C}$ | 1.25 | 1.55 | 1.8* |      |
| $I_C = 20 \text{ A}, V_{GE} = 4.5 \text{ V}$ | $T_J = 25^\circ\text{C}$  | 1.3   | 1.6                       | 1.9  |      |      |      |
|  | $T_J = 175^\circ\text{C}$ | 1.2   | 1.5                       | 1.8  |      |      |      |
|  | $T_J = -40^\circ\text{C}$ | 1.4   | 1.75                      | 2.0* |      |      |      |
| Forward Transconductance                     | gfs                       | $I_C = 6.0 \text{ A}, V_{CE} = 5.0 \text{ V}$ | $T_J = 25^\circ\text{C}$  | 10   | 18   | 25   | Mhos |

## DYNAMIC CHARACTERISTICS

|                      |           |   |                          |      |      |      |    |
|----------------------|-----------|---|--------------------------|------|------|------|----|
| Input Capacitance    | $C_{ISS}$ | $f = 10 \text{ kHz}, V_{CE} = 25 \text{ V}$ | $T_J = 25^\circ\text{C}$ | 1100 | 1300 | 1500 | pF |
| Output Capacitance   | $C_{OSS}$ |   |                          | 70   | 80   | 90   |    |
| Transfer Capacitance | $C_{RSS}$ |   |                          | 18   | 20   | 22   |    |

## SWITCHING CHARACTERISTICS

|                                 |              |   |                           |     |      |     |                 |
|---------------------------------|--------------|---|---------------------------|-----|------|-----|-----------------|
| Turn-Off Delay Time (Resistive) | $t_{d(off)}$ | $V_{CC} = 300 \text{ V}, I_C = 9.0 \text{ A}, R_G = 1.0 \text{ k}\Omega, R_L = 33 \Omega, V_{GE} = 5.0 \text{ V}$     | $T_J = 25^\circ\text{C}$  | 6.0 | 8.0  | 10  | $\mu\text{Sec}$ |
| Fall Time (Resistive)           | $t_f$        |   | $T_J = 175^\circ\text{C}$ | 6.0 | 8.0  | 10  |                 |
|                                 |              |   | $T_J = 25^\circ\text{C}$  | 4.0 | 6.0  | 8.0 |                 |
| Turn-Off Delay Time (Inductive) | $t_{d(off)}$ |   | $T_J = 175^\circ\text{C}$ | 8.0 | 10.5 | 14  |                 |
|                                 |              | $T_J = 25^\circ\text{C}$  | 3.0                       | 5.0 | 7.0  |     |                 |
| Fall Time (Inductive)           | $t_f$        | $V_{CC} = 300 \text{ V}, I_C = 9.0 \text{ A}, R_G = 1.0 \text{ k}\Omega, L = 300 \mu\text{H}, V_{GE} = 5.0 \text{ V}$ | $T_J = 175^\circ\text{C}$ | 5.0 | 7.0  | 9.0 |                 |
|                                 |              |   | $T_J = 25^\circ\text{C}$  | 1.5 | 3.0  | 4.5 |                 |
| Turn-On Delay Time              | $t_{d(on)}$  |   | $T_J = 175^\circ\text{C}$ | 5.0 | 7.0  | 10  |                 |
|                                 |              |   | $T_J = 25^\circ\text{C}$  | 1.0 | 1.5  | 2.0 |                 |
| Rise Time                       | $t_r$        | $V_{CC} = 14 \text{ V}, I_C = 9.0 \text{ A}, R_G = 1.0 \text{ k}\Omega, R_L = 1.5 \Omega, V_{GE} = 5.0 \text{ V}$     | $T_J = 175^\circ\text{C}$ | 1.0 | 1.5  | 2.0 |                 |
|                                 |              |   | $T_J = 25^\circ\text{C}$  | 1.0 | 1.5  | 2.0 |                 |
|                                 |              |   | $T_J = 25^\circ\text{C}$  | 4.0 | 6.0  | 8.0 |                 |
| $T_J = 175^\circ\text{C}$       | 3.0          |   | 5.0                       | 7.0 |      |     |                 |

\*Maximum Value of Characteristic across Temperature Range.

3. Pulse Test: Pulse Width  $\leq 300 \mu\text{S}$ , Duty Cycle  $\leq 2\%$ .

TYPICAL ELECTRICAL CHARACTERISTICS

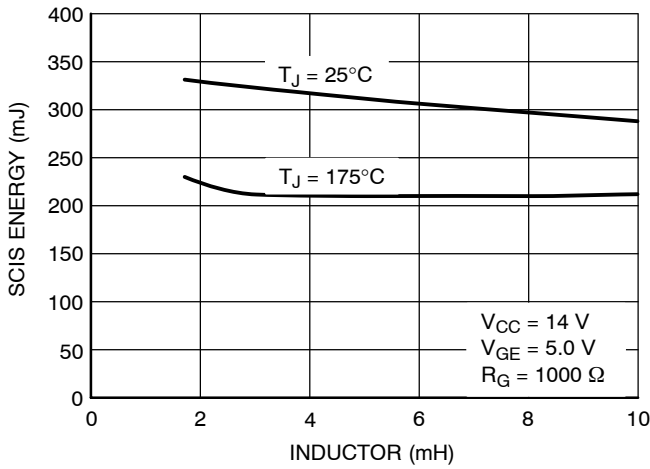


Figure 1. Self Clamped Inductive Switching

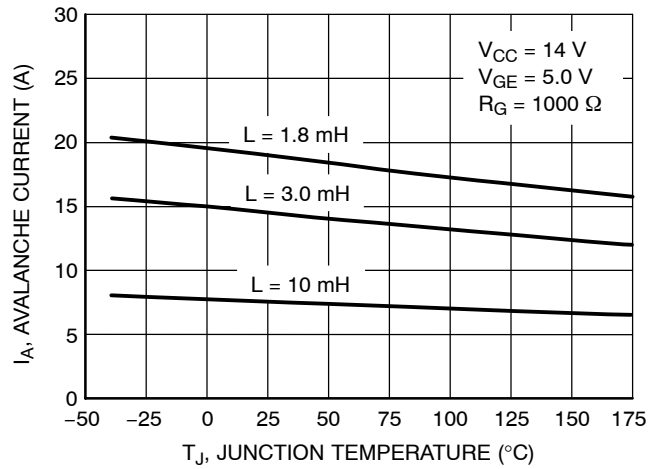


Figure 2. Open Secondary Avalanche Current vs. Temperature

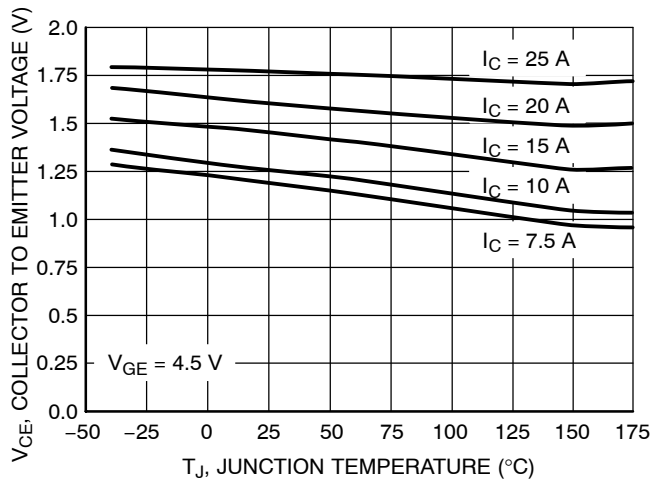


Figure 3. Collector-to-Emitter Voltage vs. Junction Temperature

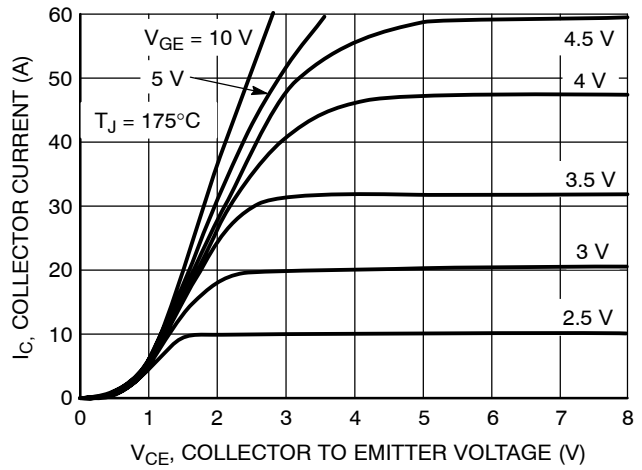


Figure 4. Collector Current vs. Collector-to-Emitter Voltage

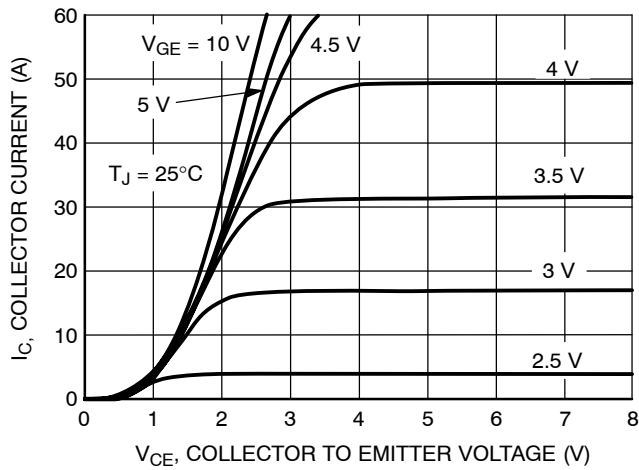


Figure 5. Collector Current vs. Collector-to-Emitter Voltage

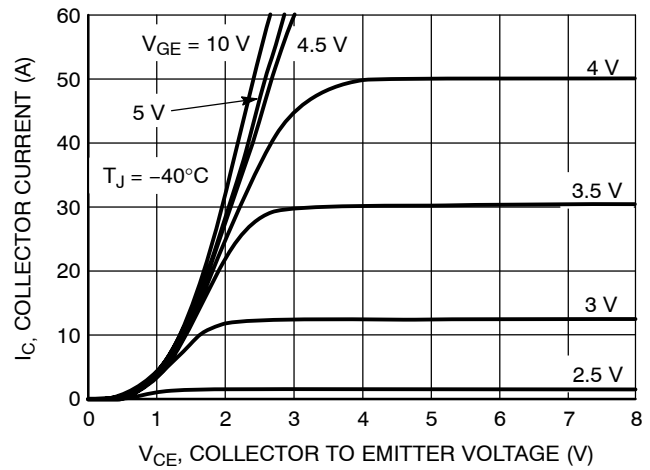


Figure 6. Collector Current vs. Collector-to-Emitter Voltage

TYPICAL ELECTRICAL CHARACTERISTICS

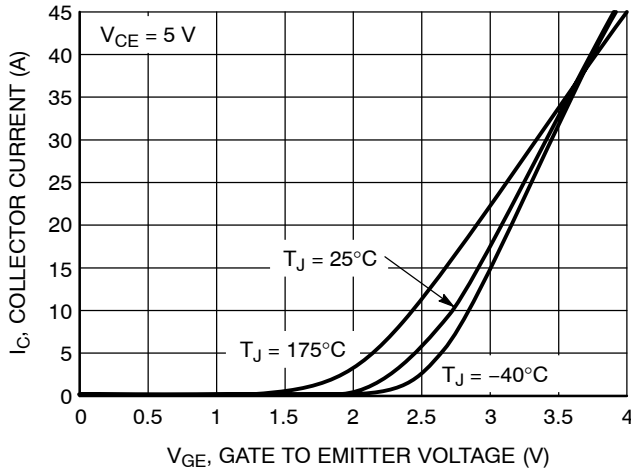


Figure 7. Transfer Characteristics

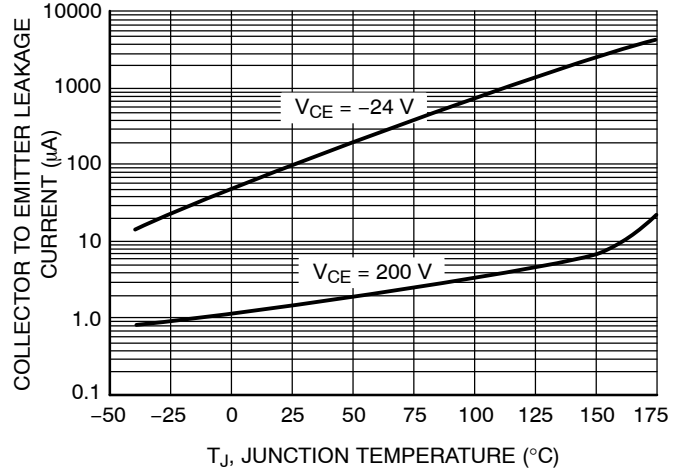


Figure 8. Collector-to-Emitter Leakage Current vs. Temperature

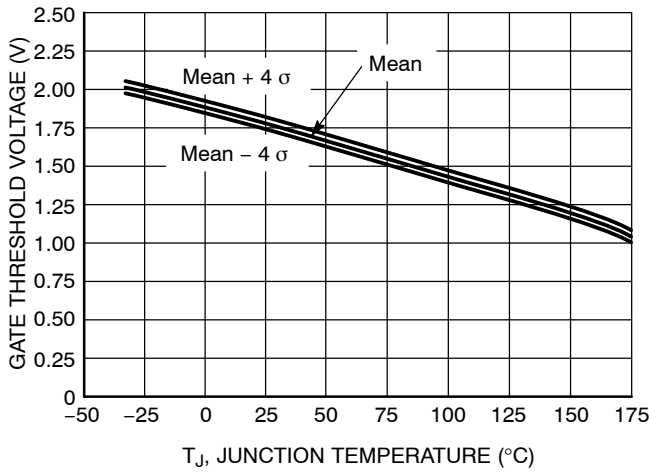


Figure 9. Gate Threshold Voltage vs. Temperature

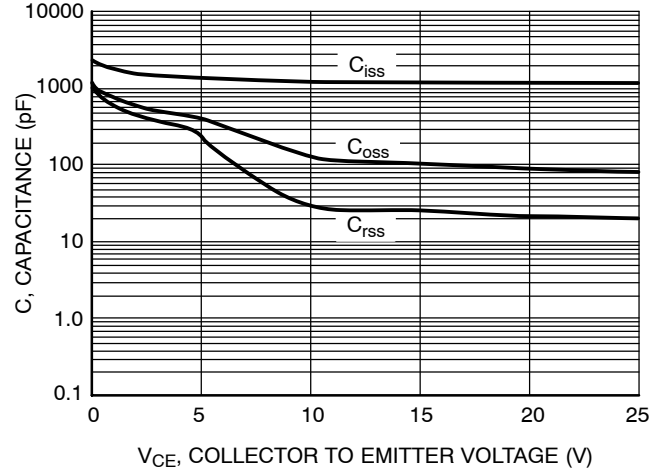


Figure 10. Capacitance vs. Collector-to-Emitter Voltage

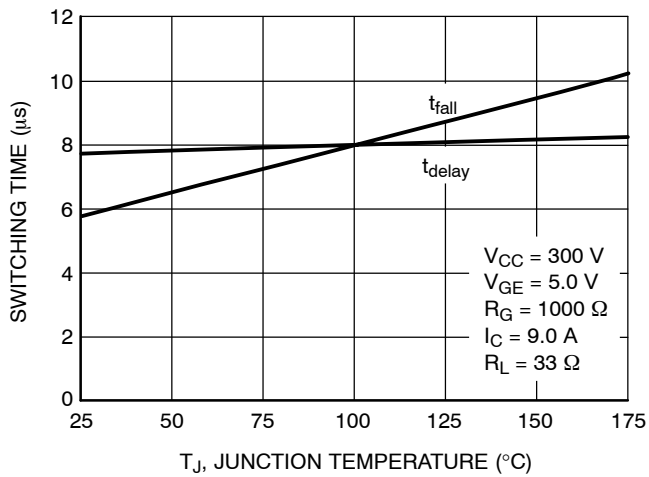


Figure 11. Resistive Switching Fall Time vs. Temperature

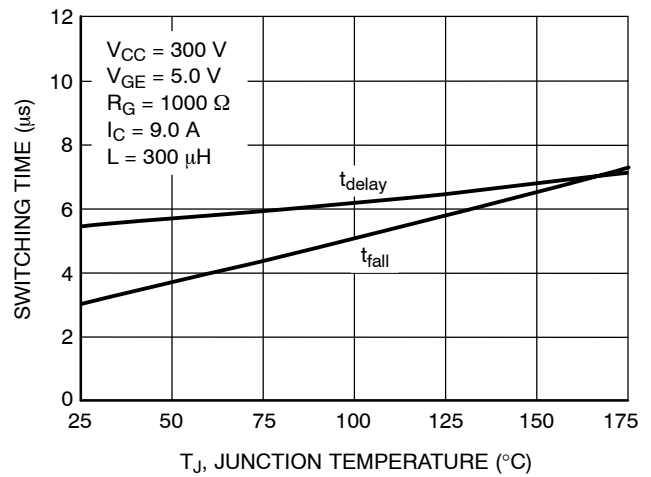
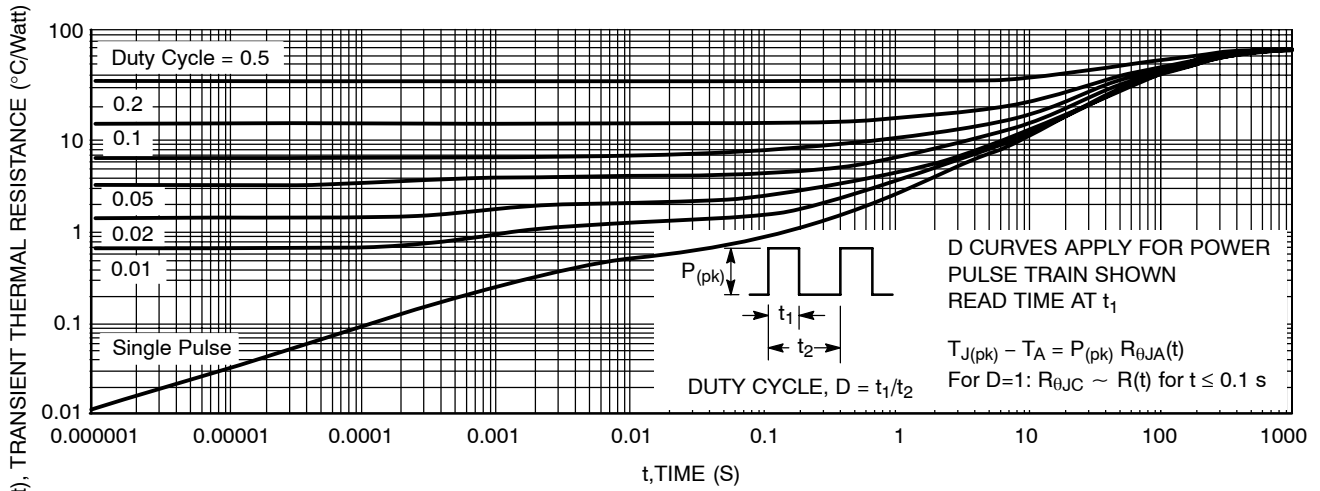
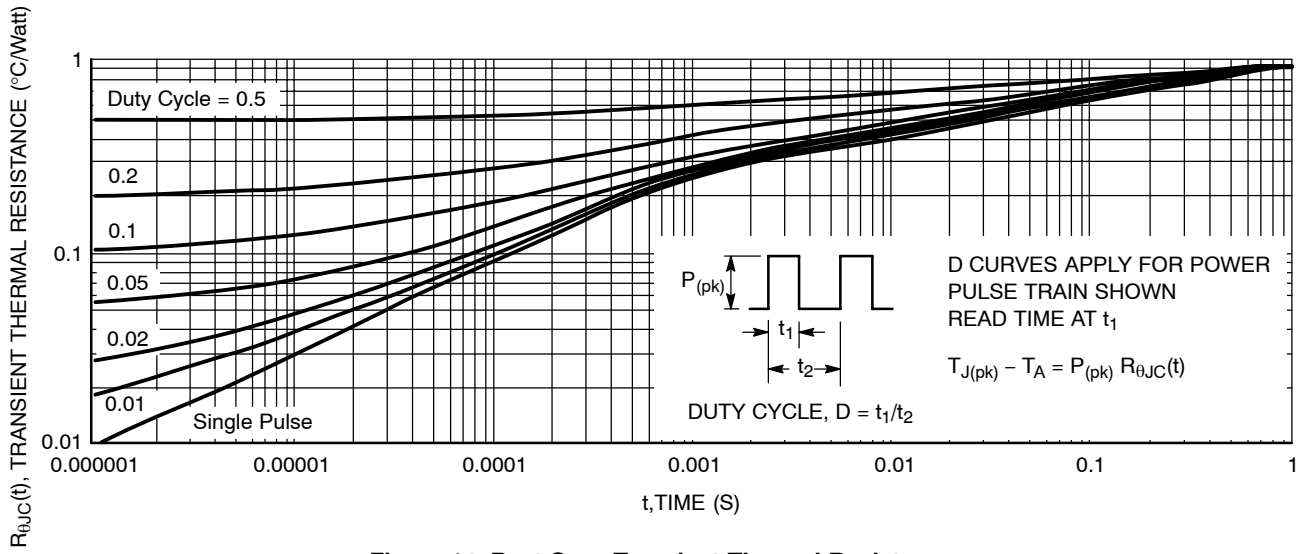


Figure 12. Inductive Switching Fall Time vs. Temperature

# NGP8203N



**Figure 13. Transient Thermal Resistance (Non-normalized Junction-to-Ambient)**

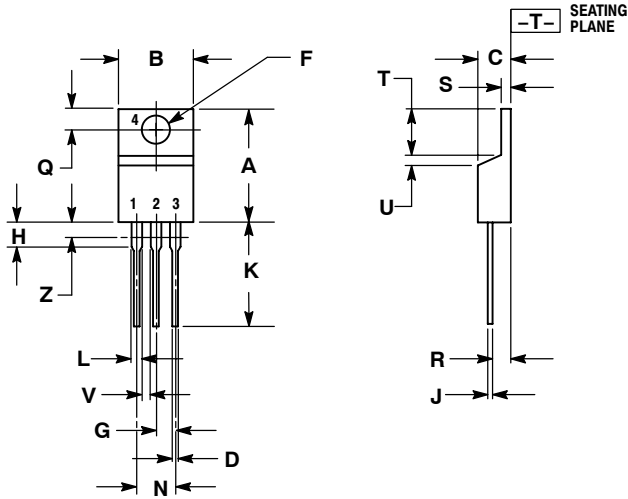


**Figure 14. Best Case Transient Thermal Resistance (Non-normalized Junction-to-Case Mounted on Cold Plate)**

# NGP8203N

## PACKAGE DIMENSIONS

TO-220  
CASE 221A-09  
ISSUE AD



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.570  | 0.620 | 14.48       | 15.75 |
| B   | 0.380  | 0.405 | 9.66        | 10.28 |
| C   | 0.160  | 0.190 | 4.07        | 4.82  |
| D   | 0.025  | 0.035 | 0.64        | 0.88  |
| F   | 0.142  | 0.147 | 3.61        | 3.73  |
| G   | 0.095  | 0.105 | 2.42        | 2.66  |
| H   | 0.110  | 0.155 | 2.80        | 3.93  |
| J   | 0.018  | 0.025 | 0.46        | 0.64  |
| K   | 0.500  | 0.562 | 12.70       | 14.27 |
| L   | 0.045  | 0.060 | 1.15        | 1.52  |
| N   | 0.190  | 0.210 | 4.83        | 5.33  |
| Q   | 0.100  | 0.120 | 2.54        | 3.04  |
| R   | 0.080  | 0.110 | 2.04        | 2.79  |
| S   | 0.045  | 0.055 | 1.15        | 1.39  |
| T   | 0.235  | 0.255 | 5.97        | 6.47  |
| U   | 0.000  | 0.050 | 0.00        | 1.27  |
| V   | 0.045  | ---   | 1.15        | ---   |
| Z   | ---    | 0.080 | ---         | 2.04  |

STYLE 9:

- PIN 1: GATE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

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