

# NGD8201N, NGD8201AN

## Ignition IGBT

### 20 A, 400 V, N-Channel DPAK

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
- DPAK Package Offers Smaller Footprint for Increased Board Space
- 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

#### 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<br>( $t \leq 2$ 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 $25^\circ\text{C}$ | $P_D$          | 125<br>0.83 | W<br>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.

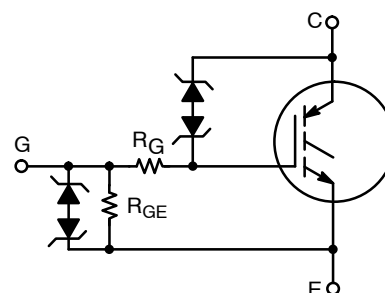


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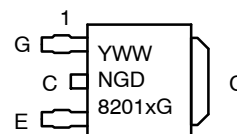
**20 A, 400 V**

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



**DPAK**  
**CASE 369C**  
**STYLE 7**

#### MARKING DIAGRAM



Y = Year  
WW = Work Week  
NGD8201x = Device Code  
x = N or A  
G = Pb-Free Package

#### ORDERING INFORMATION

| Device       | Package           | Shipping†          |
|--------------|-------------------|--------------------|
| NGD8201NT4G  | DPAK<br>(Pb-Free) | 2500 / Tape & Reel |
| NGD8201ANT4G | DPAK<br>(Pb-Free) | 2500 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# NGD8201N, NGD8201AN

## 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                                              | $R_{\theta JC}$ | 1.2 | $^{\circ}C/W$ |
| Thermal Resistance, Junction-to-Ambient (Note 1)                                  | $R_{\theta JA}$ | 95  | $^{\circ}C/W$ |
| Maximum Temperature for Soldering Purposes, 1/8" from case for 5 seconds (Note 2) | $T_L$           | 275 | $^{\circ}C$   |

- When surface mounted to an FR4 board using the minimum recommended pad size (76x76x1.6mm board size, 60 sqmm 1 oz. Copper).
- For further details, see Soldering and Mounting Techniques Reference Manual: SOLDERM/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       | $I_{CES}$     | $V_{GE} = 0\text{ V}$ , $V_{CE} = 15\text{ V}$     | $T_J = 25^{\circ}C$                    |       | 0.1   | 1.0  | $\mu A$    |
|                                           |               |                                                    | $T_J = 175^{\circ}C$                   | 0.5   | 1.5   | 10   |            |
|                                           |               | $V_{CE} = 200\text{ V}$ ,<br>$V_{GE} = 0\text{ V}$ | $T_J = 175^{\circ}C$                   | 1.0   | 25    | 100* | $\mu A$    |
|                                           |               |                                                    | $T_J = -40^{\circ}C$                   | 0.4   | 0.8   | 5.0  |            |
| 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 | $I_{CES(R)}$  | $V_{CE} = -24\text{ V} -$<br>NGD8201N              | $T_J = 25^{\circ}C$                    | 0.05  | 0.1   | 1.0  | mA         |
|                                           |               |                                                    | $T_J = 175^{\circ}C$                   | 1.0   | 5.0   | 10   |            |
|                                           |               |                                                    | $T_J = -40^{\circ}C$                   | 0.005 | 0.01  | 0.1  |            |
|                                           |               | $V_{CE} = -24\text{ V} -$<br>NGD8201AN             | $T_J = 25^{\circ}C$                    | 0.05  | 0.2   | 1.0  |            |
|                                           |               |                                                    | $T_J = 175^{\circ}C$                   | 1.0   | 8.5   | 25   |            |
|                                           |               |                                                    | $T_J = -40^{\circ}C$                   | 0.005 | 0.025 | 0.2  |            |
| 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                             | $R_G$         |                                                    | $T_J = -40^{\circ}C$ 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 3)

|                                              |              |                                           |                      |     |     |      |                 |
|----------------------------------------------|--------------|-------------------------------------------|----------------------|-----|-----|------|-----------------|
| Gate Threshold Voltage                       | $V_{GE(th)}$ | $I_C = 1.0\text{ mA}$ , $V_{GE} = V_{CE}$ | $T_J = 25^{\circ}C$  | 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.

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

# NGD8201N, NGD8201AN

## ELECTRICAL CHARACTERISTICS

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

### ON CHARACTERISTICS (Note 3)

|                                 |              |                                                                  |                           |      |      |      |      |
|---------------------------------|--------------|------------------------------------------------------------------|---------------------------|------|------|------|------|
| Collector-to-Emitter On-Voltage | $V_{CE(on)}$ | $I_C = 6.5 \text{ A}, V_{GE} = 3.7 \text{ V} - \text{NGD8201N}$  | $T_J = 25^\circ\text{C}$  | 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  | 1.4  |      |
|                                 |              | $I_C = 6.5 \text{ A}, V_{GE} = 3.7 \text{ V} - \text{NGD8201AN}$ | $T_J = 25^\circ\text{C}$  | 0.85 | 1.03 | 1.35 |      |
|                                 |              |                                                                  | $T_J = 175^\circ\text{C}$ | 0.7  | 0.9  | 1.15 |      |
|                                 |              |                                                                  | $T_J = -40^\circ\text{C}$ | 0.9  | 1.11 | 1.4  |      |
|                                 |              | $I_C = 9.0 \text{ A}, V_{GE} = 3.9 \text{ V} - \text{NGD8201N}$  | $T_J = 25^\circ\text{C}$  | 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  |      |
|                                 |              | $I_C = 9.0 \text{ A}, V_{GE} = 3.9 \text{ V} - \text{NGD8201AN}$ | $T_J = 25^\circ\text{C}$  | 0.9  | 1.11 | 1.45 |      |
|                                 |              |                                                                  | $T_J = 175^\circ\text{C}$ | 0.8  | 1.01 | 1.25 |      |
|                                 |              |                                                                  | $T_J = -40^\circ\text{C}$ | 1.0  | 1.18 | 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* |      |
|                                 |              | $I_C = 20 \text{ A}, V_{GE} = 4.5 \text{ V} - \text{NGD8201N}$   | $T_J = 25^\circ\text{C}$  | 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  |      |
|                                 |              | $I_C = 20 \text{ A}, V_{GE} = 4.5 \text{ V} - \text{NGD8201AN}$  | $T_J = 25^\circ\text{C}$  | 1.1  | 1.4  | 1.9  |      |
|                                 |              |                                                                  | $T_J = 175^\circ\text{C}$ | 1.2  | 1.5  | 1.8  |      |
|                                 |              |                                                                  | $T_J = -40^\circ\text{C}$ | 1.3  | 1.42 | 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   |    |

\*Maximum Value of Characteristic across Temperature Range.

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

# NGD8201N, NGD8201AN

## ELECTRICAL CHARACTERISTICS

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

### SWITCHING CHARACTERISTICS

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

TYPICAL ELECTRICAL CHARACTERISTICS

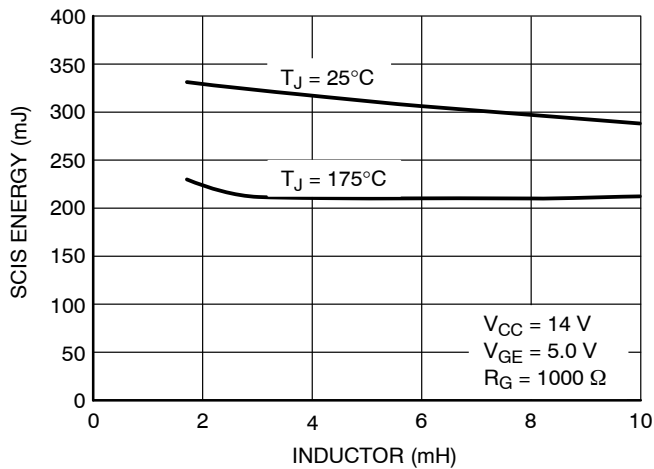


Figure 1. Self Clamped Inductive Switching

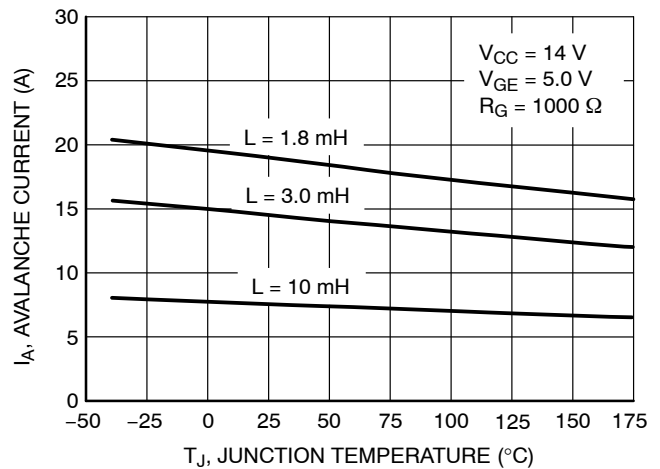


Figure 2. Open Secondary Avalanche Current vs. Temperature

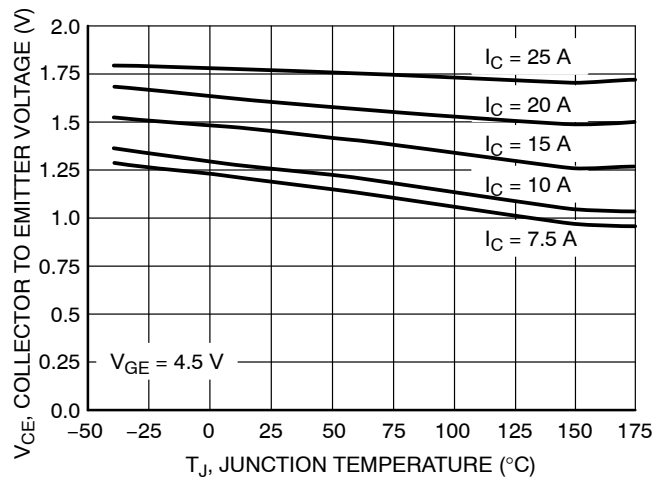


Figure 3. Collector-to-Emitter Voltage vs. Junction Temperature

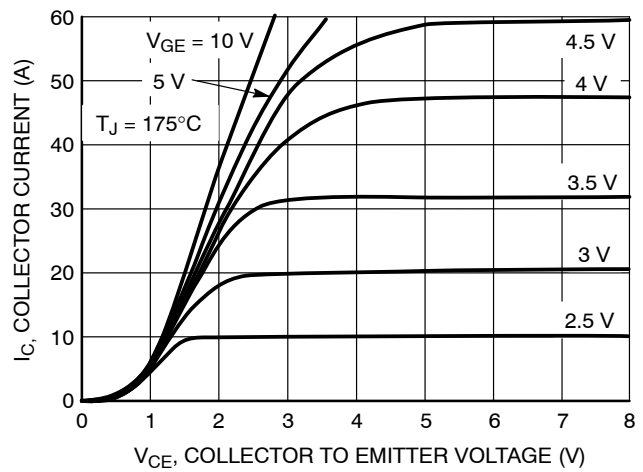


Figure 4. Collector Current vs. Collector-to-Emitter Voltage

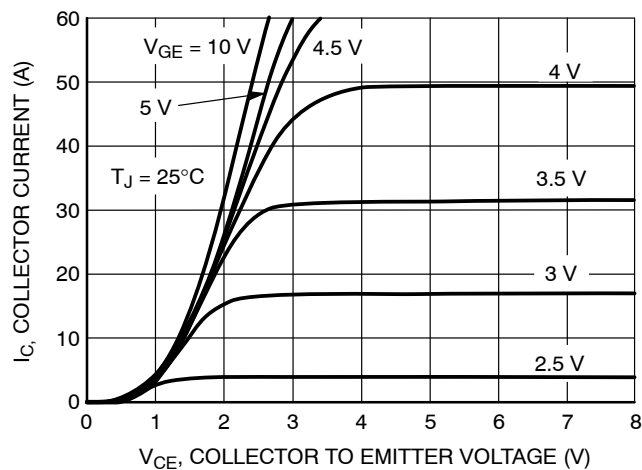


Figure 5. Collector Current vs. Collector-to-Emitter Voltage

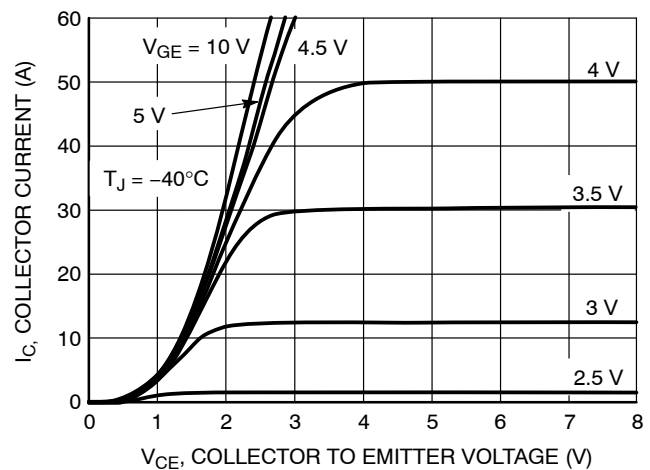


Figure 6. Collector Current vs. Collector-to-Emitter Voltage

TYPICAL ELECTRICAL CHARACTERISTICS

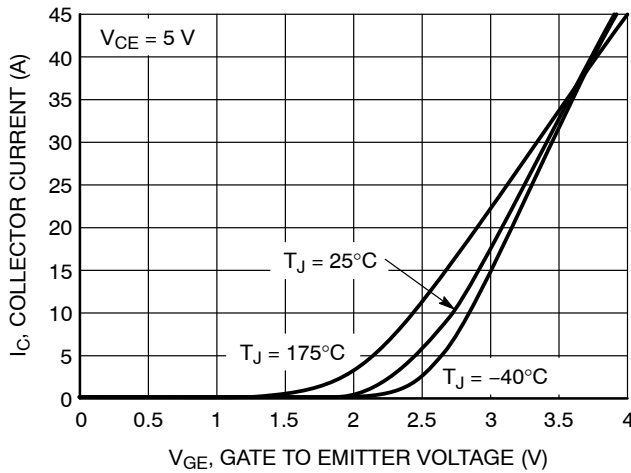


Figure 7. Transfer Characteristics

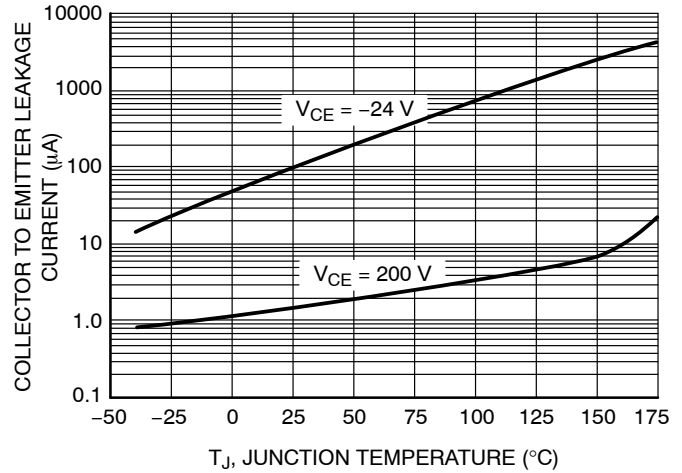


Figure 8. Collector-to-Emitter Leakage Current vs. Temperature

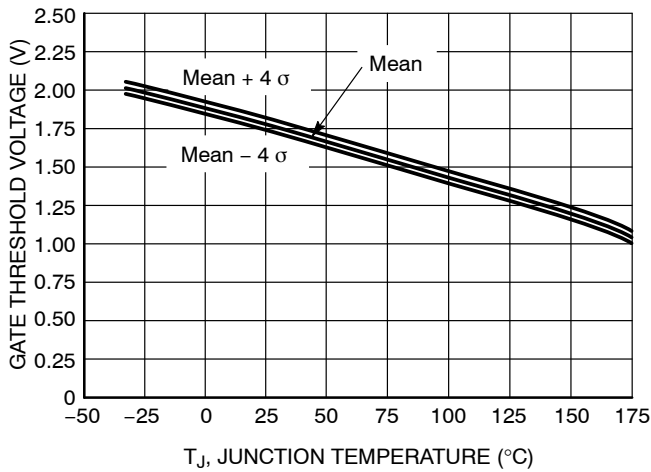


Figure 9. Gate Threshold Voltage vs. Temperature

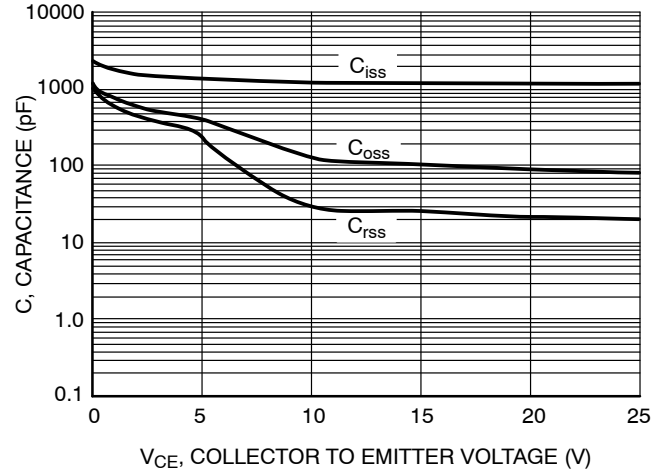


Figure 10. Capacitance vs. Collector-to-Emitter Voltage

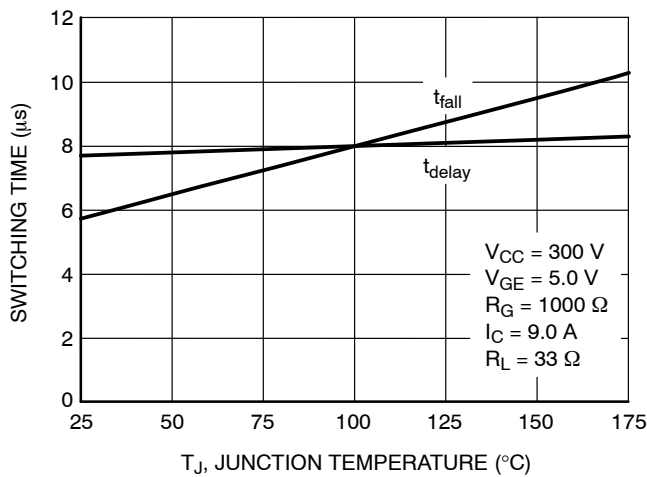


Figure 11. Resistive Switching Fall Time vs. Temperature

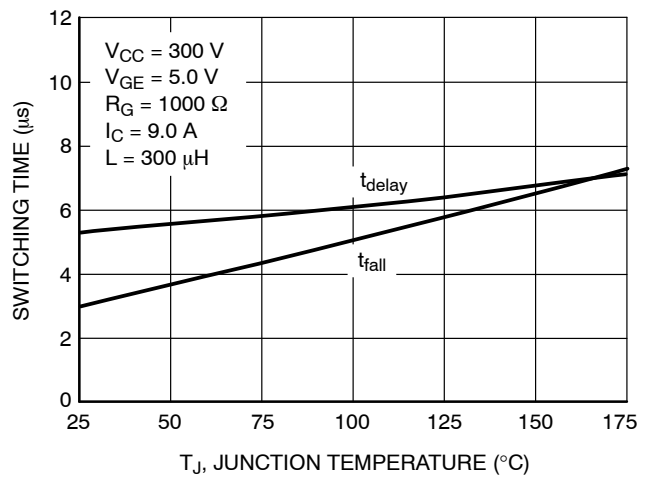
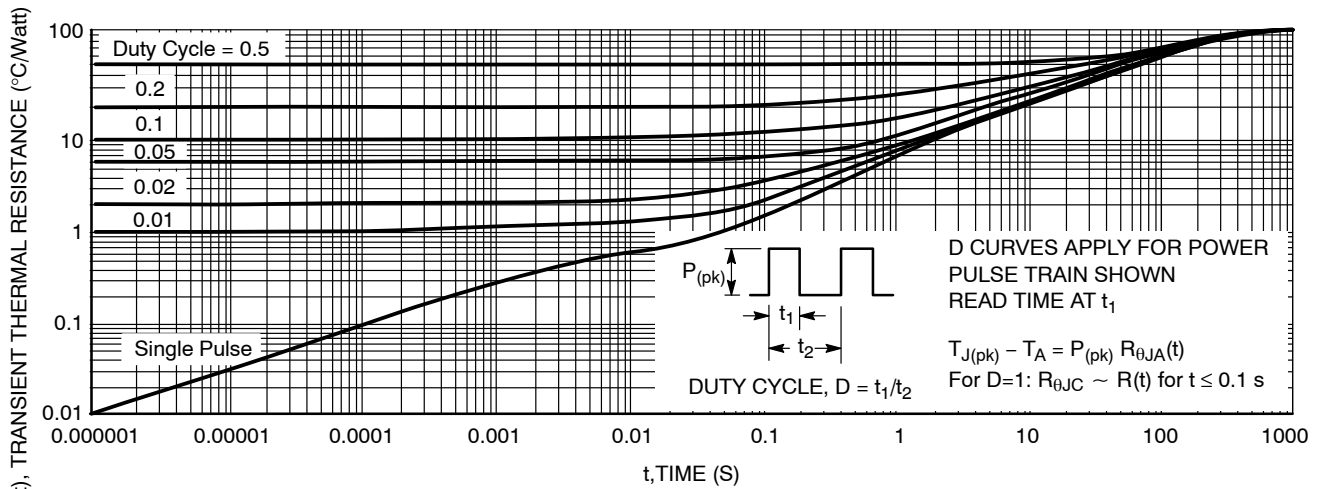
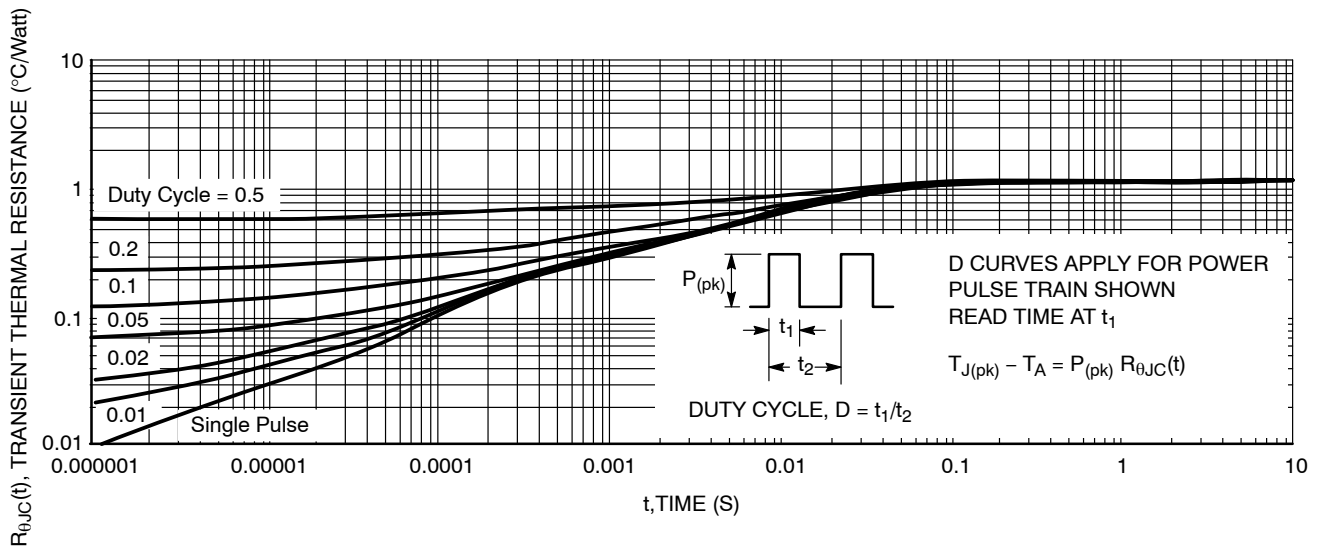


Figure 12. Inductive Switching Fall Time vs. Temperature

# NGD8201N, NGD8201AN



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

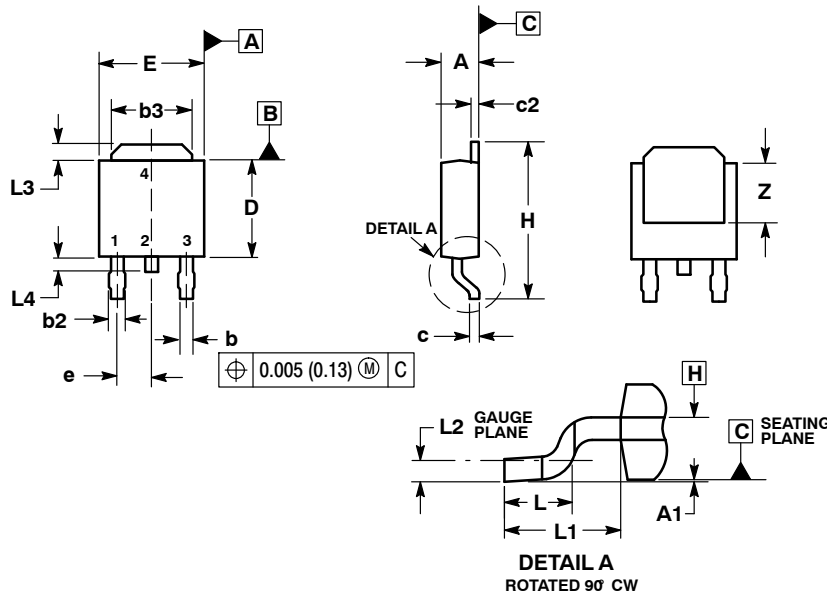


**Figure 14. Best Case Transient Thermal Resistance  
(Non-normalized Junction-to-Case Mounted on Cold Plate)**

# NGD8201N, NGD8201AN

## PACKAGE DIMENSIONS

### DPAK CASE 369C ISSUE D

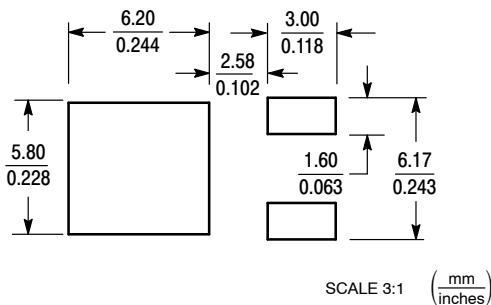


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.086     | 0.094 | 2.18        | 2.38  |
| A1  | 0.000     | 0.005 | 0.00        | 0.13  |
| b   | 0.025     | 0.035 | 0.63        | 0.89  |
| b2  | 0.030     | 0.045 | 0.76        | 1.14  |
| b3  | 0.180     | 0.215 | 4.57        | 5.46  |
| c   | 0.018     | 0.024 | 0.46        | 0.61  |
| c2  | 0.018     | 0.024 | 0.46        | 0.61  |
| D   | 0.235     | 0.245 | 5.97        | 6.22  |
| E   | 0.250     | 0.265 | 6.35        | 6.73  |
| e   | 0.090 BSC |       | 2.29 BSC    |       |
| H   | 0.370     | 0.410 | 9.40        | 10.41 |
| L   | 0.055     | 0.070 | 1.40        | 1.78  |
| L1  | 0.108 REF |       | 2.74 REF    |       |
| L2  | 0.020 BSC |       | 0.51 BSC    |       |
| L3  | 0.035     | 0.050 | 0.89        | 1.27  |
| L4  | 0.040     |       | 1.01        |       |
| Z   | 0.155     | ---   | 3.93        | ---   |

### SOLDERING FOOTPRINT\*



#### STYLE 7:

- PIN 1. GATE
- COLLECTOR
- EMITTER
- COLLECTOR

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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