



**THE DATASHEET OF  
NGB8206N**



# NGB8206N, NGB8206AN

## Ignition IGBT

### 20 A, 350 V, N-Channel D<sup>2</sup>PAK

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
- These are Pb-Free Devices

#### Applications

- Ignition Systems

#### MAXIMUM RATINGS (T<sub>J</sub> = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V <sub>CES</sub>	390	V
Collector-Gate Voltage	V <sub>CER</sub>	390	V
Gate-Emitter Voltage	V <sub>GE</sub>	±15	V
Collector Current-Continuous @ T <sub>C</sub> = 25°C - Pulsed	I <sub>C</sub>	20 50	A <sub>DC</sub> A <sub>AC</sub>
Continuous Gate Current	I <sub>G</sub>	1.0	mA
Transient Gate Current (t ≤ 2 ms, f ≤ 100 Hz)	I <sub>G</sub>	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 <sub>C</sub> = 25°C Derate above 25°C	P <sub>D</sub>	150 1.0	W W/°C
Operating & Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-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.

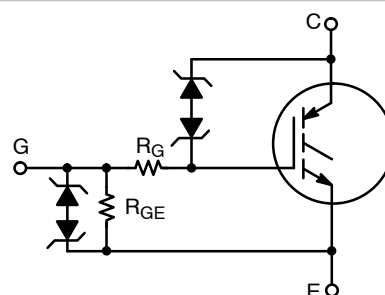


**ON Semiconductor®**

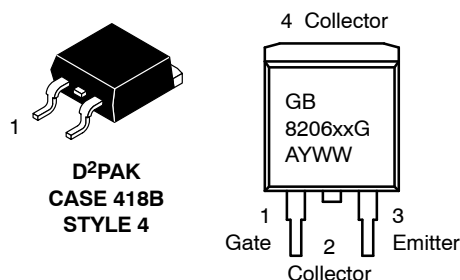
<http://onsemi.com>

**20 AMPS, 350 VOLTS**

**V<sub>CE(on)</sub> = 1.3 V @  
I<sub>C</sub> = 10 A, V<sub>GE</sub> ≥ 4.5 V**



#### MARKING DIAGRAM



GB8206xx = Device Code  
xx = N or AN  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

# NGB8206N, NGB8206AN

## 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 $V_{CC} = 50\text{ V}$ , $V_{GE} = 5.0\text{ V}$ , Pk $I_L = 16.7\text{ A}$ , $L = 1.8\text{ mH}$ , $R_g = 1\text{ k}\Omega$ Starting $T_J = 25^{\circ}C$ $V_{CC} = 50\text{ V}$ , $V_{GE} = 5.0\text{ V}$ , Pk $I_L = 14.9\text{ A}$ , $L = 1.8\text{ mH}$ , $R_g = 1\text{ k}\Omega$ Starting $T_J = 150^{\circ}C$ $V_{CC} = 50\text{ V}$ , $V_{GE} = 5.0\text{ V}$ , Pk $I_L = 14.1\text{ A}$ , $L = 1.8\text{ mH}$ , $R_g = 1\text{ k}\Omega$ Starting $T_J = 175^{\circ}C$	$E_{AS}$	250 200 180	mJ
Reverse Avalanche Energy $V_{CC} = 100\text{ V}$ , $V_{GE} = 20\text{ V}$ , 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 (Note 1)	$R_{\theta JA}$	62.5	$^{\circ}C/W$
Maximum Temperature for Soldering Purposes, 0.125 in 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.
- For further details, see Soldering and Mounting Techniques Reference Manual: SOLDERRM/D.

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions	Temperature	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Collector-Emitter Clamp Voltage	$BV_{CES}$	$I_C = 2.0\text{ mA}$	$T_J = -40^{\circ}C$ to $175^{\circ}C$	325	350	375	V
		$I_C = 10\text{ mA}$	$T_J = -40^{\circ}C$ to $175^{\circ}C$	340	365	390	
Zero Gate Voltage Collector Current	$I_{CES}$	$V_{CE} = 15\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_J = 25^{\circ}C$		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*	
		$V_{CE} = 175\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_J = -40^{\circ}C$	0.4	0.8	5.0	
			$T_J = 25^{\circ}C$	30	35	39	V
			$T_J = 175^{\circ}C$	35	39	45*	
Reverse Collector-Emitter Clamp Voltage	$BV_{CES(R)}$	$I_C = -75\text{ mA}$ – NGB8206	$T_J = -40^{\circ}C$	30	33	37	
			$T_J = 25^{\circ}C$	30	35	39	
			$T_J = 175^{\circ}C$	32	37	42	
		$I_C = -75\text{ mA}$ – NGB8206A	$T_J = -40^{\circ}C$	29	32	37	
			$T_J = 25^{\circ}C$	0.05	0.25	0.5	mA
			$T_J = 175^{\circ}C$	1.0	12.5	25	
Reverse Collector-Emitter Leakage Current	$I_{CES(R)}$	$V_{CE} = -24\text{ V}$ – NGB8206	$T_J = -40^{\circ}C$	0.005	0.03	0.25	
			$T_J = 25^{\circ}C$	0.05	0.25	1.0	
			$T_J = 175^{\circ}C$	1.0	12.5	25	
		$V_{CE} = -24\text{ V}$ – NGB8206A	$T_J = -40^{\circ}C$	0.005	0.03	0.25	
			$T_J = 25^{\circ}C$	12	12.5	14	V
			$T_J = 175^{\circ}C$	200	300	350*	
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	
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*	

\*Maximum Value of Characteristic across Temperature Range.

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

# NGB8206N, NGB8206AN

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions	Temperature	Min	Typ	Max	Unit
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### ON CHARACTERISTICS (Note 3)

Threshold Temperature Coefficient (Negative)				3.8	4.6	6.0	mV/°C
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
			$T_J = 175^\circ\text{C}$	0.70	0.95	1.15	
			$T_J = -40^\circ\text{C}$	1.0	1.30	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	1.50	
		$I_C = 7.5 \text{ A}, V_{GE} = 4.5 \text{ V}$	$T_J = 25^\circ\text{C}$	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*	
		$I_C = 10 \text{ A}, V_{GE} = 4.5 \text{ V}$ NGB8206	$T_J = 25^\circ\text{C}$	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*	
		$I_C = 10 \text{ A}, V_{GE} = 4.5 \text{ V}$ NGB8206A	$T_J = 25^\circ\text{C}$	0.9	1.2	1.6	
			$T_J = 175^\circ\text{C}$	0.8	1.05	1.4	
			$T_J = -40^\circ\text{C}$	1.0	1.2	1.7*	
		$I_C = 15 \text{ A}, V_{GE} = 4.5 \text{ V}$ NGB8206	$T_J = 25^\circ\text{C}$	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*	
		$I_C = 15 \text{ A}, V_{GE} = 4.5 \text{ V}$ NGB8206A	$T_J = 25^\circ\text{C}$	1.0	1.3	1.7	
			$T_J = 175^\circ\text{C}$	1.0	1.3	1.55	
			$T_J = -40^\circ\text{C}$	1.1	1.35	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 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  $\leq 2\%$ .

# NGB8206N, NGB8206AN

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Test Conditions	Temperature	Min	Typ	Max	Unit
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### SWITCHING CHARACTERISTICS

Turn-Off Delay Time (Resistive)	$t_{d(off)}$	$V_{CC} = 300\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, R_L = 33\text{ }\Omega$ $V_{GE} = 5\text{ V}$	$T_J = 25^\circ\text{C}$	6.0	8.0	10	$\mu\text{Sec}$
			$T_J = 175^\circ\text{C}$	6.0	8.0	10	
Fall Time (Resistive)	$t_f$	$V_{CC} = 300\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, R_L = 33\text{ }\Omega$ $V_{GE} = 5\text{ V}$	$T_J = 25^\circ\text{C}$	4.0	6.0	8.0	
			$T_J = 175^\circ\text{C}$	8.0	10.5	14	
Turn-Off Delay Time (Inductive)	$t_{d(off)}$	$V_{CC} = 300\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, L = 300\text{ }\mu\text{H}$ $V_{GE} = 5\text{ V}$	$T_J = 25^\circ\text{C}$	3.0	5.0	7.0	
			$T_J = 175^\circ\text{C}$	5.0	7.0	9.0	
Fall Time (Inductive)	$t_f$	$V_{CC} = 300\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, L = 300\text{ }\mu\text{H}$ $V_{GE} = 5\text{ V}$	$T_J = 25^\circ\text{C}$	1.5	3.0	4.5	
			$T_J = 175^\circ\text{C}$	5.0	7.0	10	
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 14\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, R_L = 1.5\text{ }\Omega$ $V_{GE} = 5\text{ V}$	$T_J = 25^\circ\text{C}$	1.0	1.5	2.0	
			$T_J = 175^\circ\text{C}$	1.0	1.5	2.0	
Rise Time	$t_r$	$V_{CC} = 14\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, R_L = 1.5\text{ }\Omega$ $V_{GE} = 5\text{ V}$	$T_J = 25^\circ\text{C}$	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  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

# NGB8206N, NGB8206AN

## TYPICAL ELECTRICAL CHARACTERISTICS

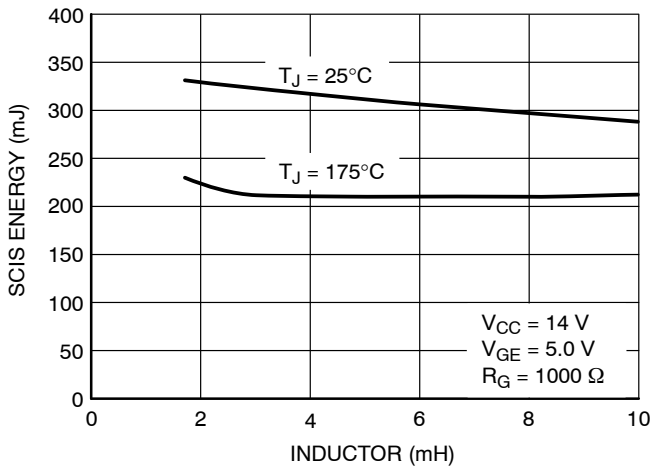


Figure 1. Self Clamped Inductive Switching

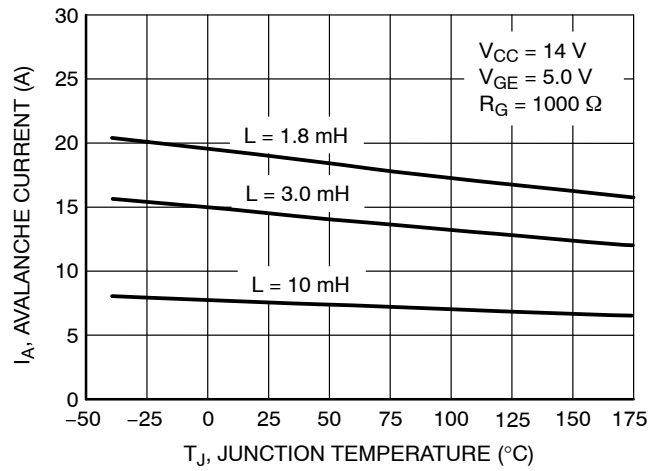


Figure 2. Open Secondary Avalanche Current vs. Temperature

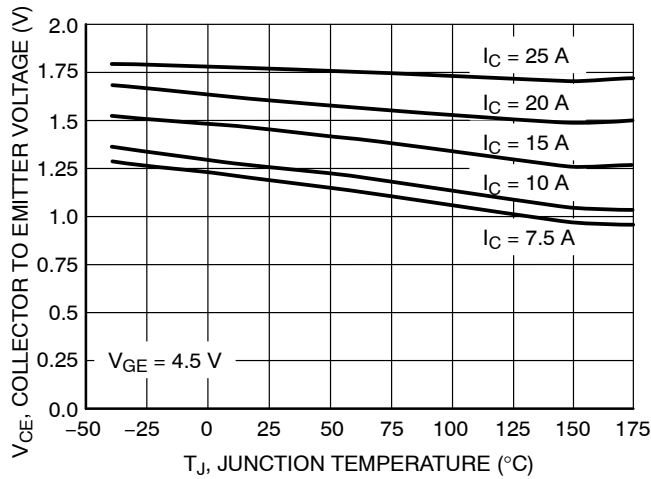


Figure 3. Collector-to-Emitter Voltage vs. Junction Temperature

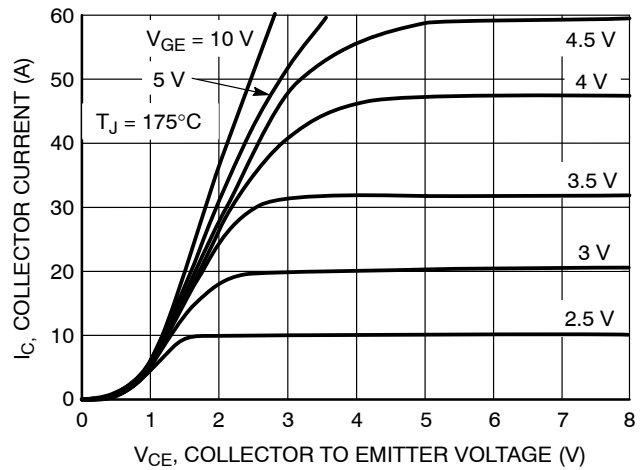


Figure 4. Collector Current vs. Collector-to-Emitter Voltage

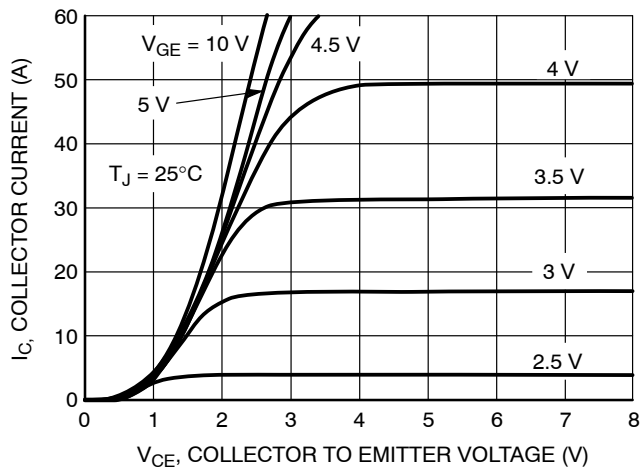


Figure 5. Collector Current vs. Collector-to-Emitter Voltage

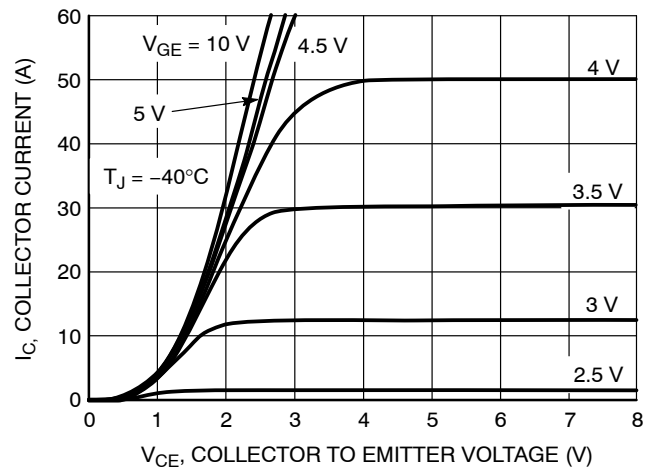


Figure 6. Collector Current vs. Collector-to-Emitter Voltage

TYPICAL ELECTRICAL CHARACTERISTICS

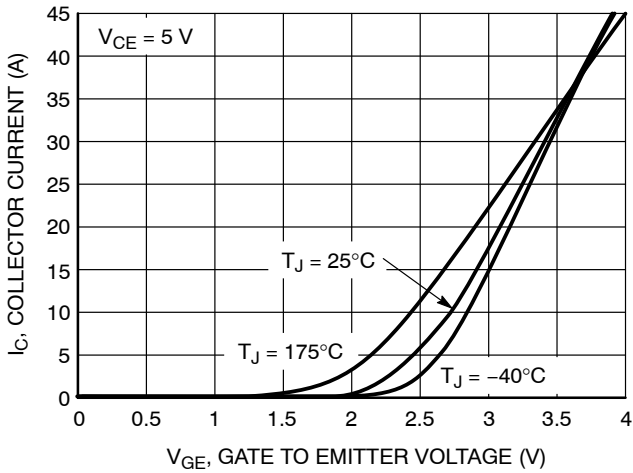


Figure 7. Transfer Characteristics

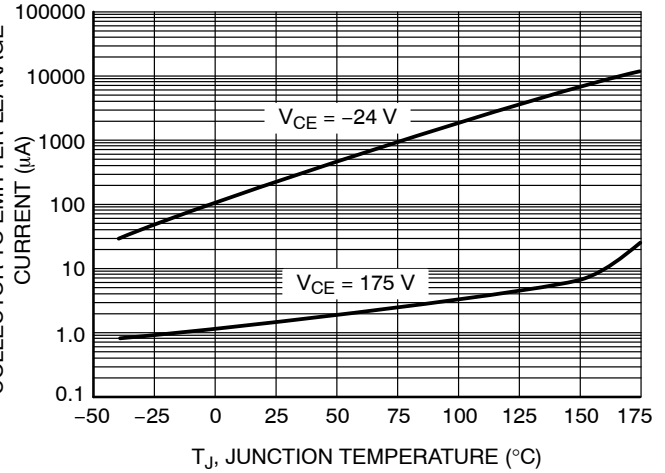


Figure 8. Collector-to-Emitter Leakage Current vs. Temperature

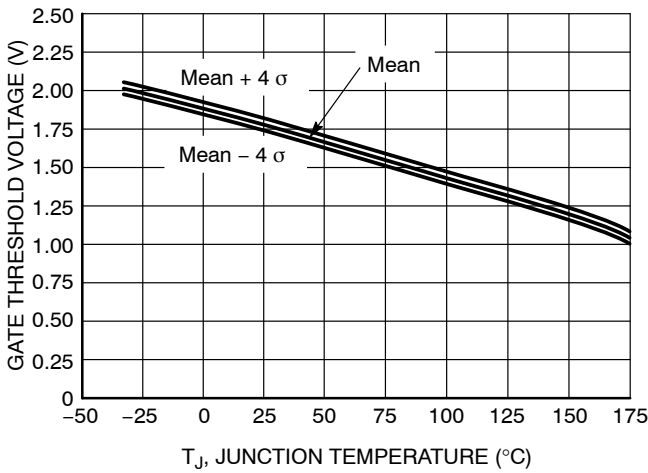


Figure 9. Gate Threshold Voltage vs. Temperature

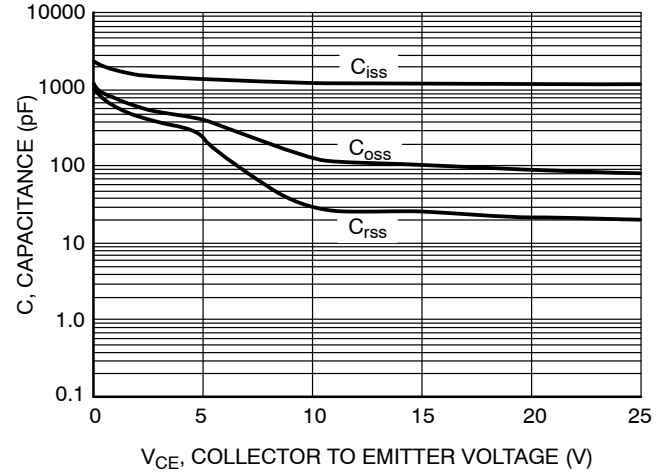


Figure 10. Capacitance vs. Collector-to-Emitter Voltage

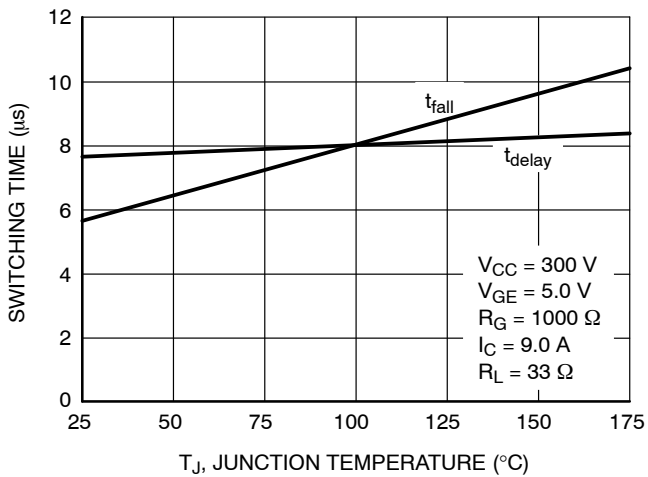


Figure 11. Resistive Switching Fall Time vs. Temperature

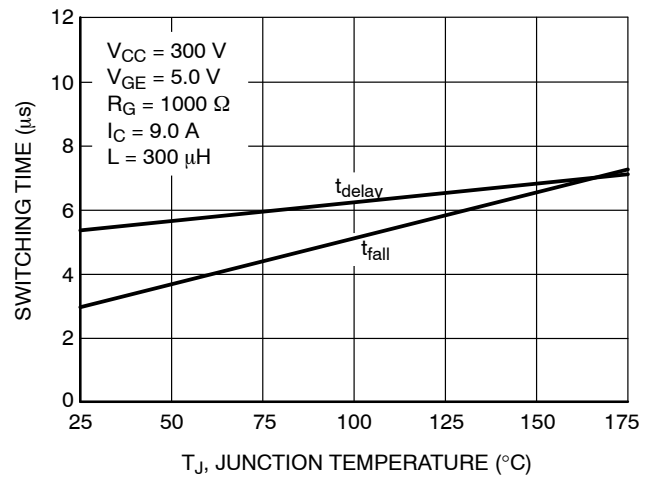
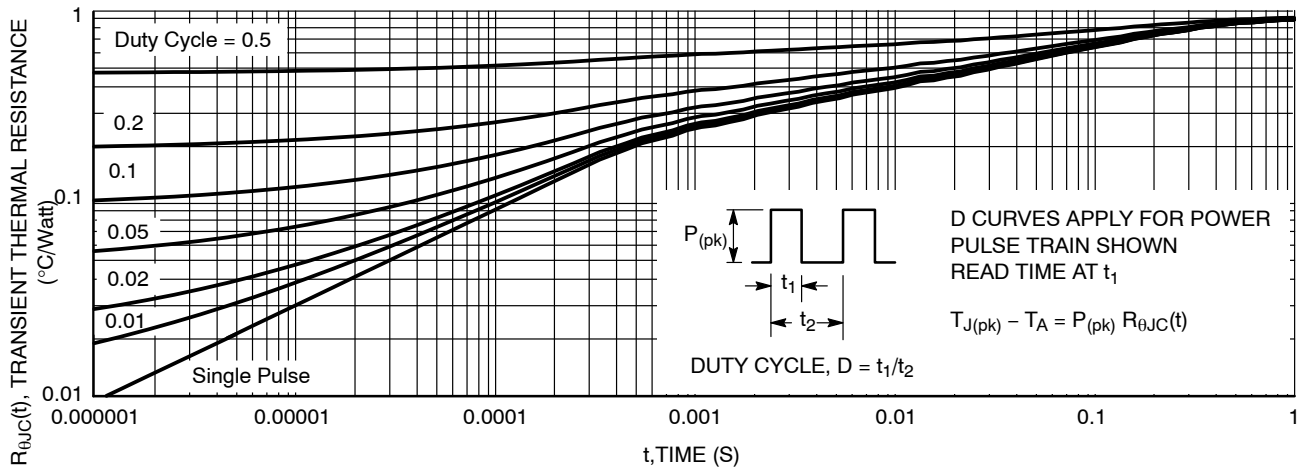


Figure 12. Inductive Switching Fall Time vs. Temperature

# NGB8206N, NGB8206AN



**Figure 13. Best Case Transient Thermal Resistance  
(Non-normalized Junction-to-Case Mounted on Cold Plate)**

## ORDERING INFORMATION

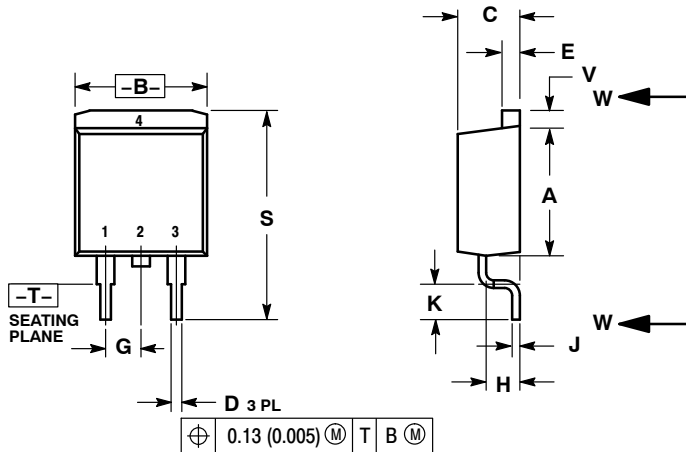
Device	Package	Shipping†
NGB8206NG	D <sup>2</sup> PAK (Pb-Free)	50 Units / Rail
NGB8206NT4G	D <sup>2</sup> PAK (Pb-Free)	800 / Tape & Reel
NGB8206ANT4G	D <sup>2</sup> PAK (Pb-Free)	800 / Tape & Reel
NGB8206ANTF4G	D <sup>2</sup> PAK (Pb-Free)	700 / Tape & Reel
NGB8206ANSL3G	D <sup>2</sup> PAK (Pb-Free)	50 Units / Rail

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

# NGB8206N, NGB8206AN

## PACKAGE DIMENSIONS

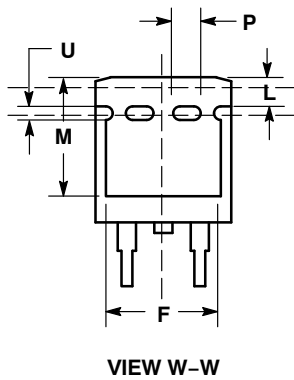
D<sup>2</sup>PAK 3  
CASE 418B-04  
ISSUE K



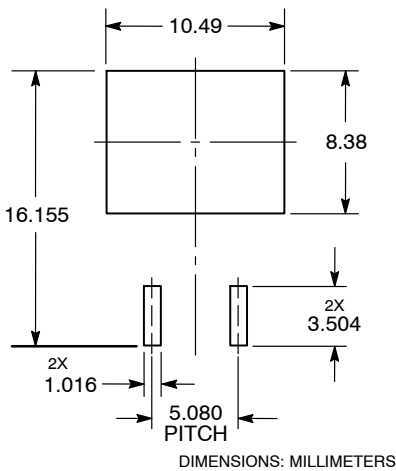
**NOTES:**

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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.340	0.380	8.65	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



### SOLDERING FOOTPRINT\*



**STYLE 4:**

- PIN 1. GATE
2. COLLECTOR
3. EMITTER
4. 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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- ✓ Cost Control Management
- ✓ Shortage Management
- ✓ Alternative Solution
- ✓ Excess Inventory Management