

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}	± 15	V
Collector Current-Continuous @ $T_C = 25^\circ\text{C}$ - Pulsed	I_C	20 50	A_{DC} 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) $R = 1500 \Omega$, $C = 100$ pF	ESD	8.0	kV
ESD (Machine Model) $R = 0 \Omega$, $C = 200$ pF	ESD	500	V
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	125 0.83	W 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.

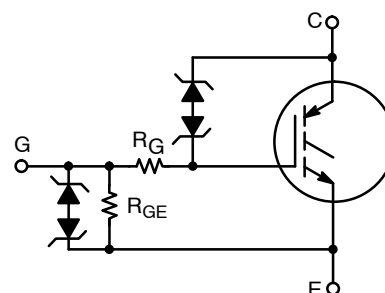


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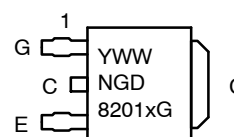
20 A, 400 V

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



**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 (Pb-Free)	2500 / Tape & Reel
NGD8201ANT4G	DPAK (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 $V_{CC} = 50\text{ V}$, $V_{GE} = 5.0\text{ V}$, $Pk\ I_L = 16.7\text{ A}$, $R_G = 1000\ \Omega$, $L = 1.8\text{ mH}$, Starting $T_J = 25^{\circ}C$ $V_{CC} = 50\text{ V}$, $V_{GE} = 5.0\text{ V}$, $Pk\ I_L = 14.9\text{ A}$, $R_G = 1000\ \Omega$, $L = 1.8\text{ mH}$, Starting $T_J = 150^{\circ}C$ $V_{CC} = 50\text{ V}$, $V_{GE} = 5.0\text{ V}$, $Pk\ I_L = 14.1\text{ A}$, $R_G = 1000\ \Omega$, $L = 1.8\text{ mH}$, Starting $T_J = 175^{\circ}C$	E_{AS}	250 200 180	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	$R_{\theta JC}$	1.2	$^{\circ}C/W$
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
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OFF CHARACTERISTICS

Collector-Emitter Clamp Voltage	BV_{CES}	$I_C = 2.0\text{ mA}$	$T_J = -40^{\circ}C$ to $175^{\circ}C$	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	μA
			$T_J = 25^{\circ}C$	0.5	1.5	10	
			$T_J = 175^{\circ}C$	1.0	25	100*	
			$T_J = -40^{\circ}C$	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	$I_{CES(R)}$	$V_{CE} = -24\text{ V}$ – 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	
		$V_{CE} = -24\text{ V}$ – 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*	μA
Gate Resistor	R_G		$T_J = -40^{\circ}C$ to $175^{\circ}C$		70		Ω
Gate-Emitter Resistor	R_{GE}		$T_J = -40^{\circ}C$ to $175^{\circ}C$	14.25	16	25	k Ω

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.

- 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
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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
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SWITCHING CHARACTERISTICS

Turn-Off Delay Time (Resistive)	$t_{d(off)}$	$V_{CC} = 300\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, R_L = 33\ \Omega,$ $V_{GE} = 5.0\text{ V}$	$T_J = 25^\circ\text{C}$	6.0	8.0	10	μSec
			$T_J = 175^\circ\text{C}$	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)	$t_{d(off)}$	$V_{CC} = 300\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega,$ $L = 300\ \mu\text{H}, V_{GE} = 5.0\text{ V}$	$T_J = 25^\circ\text{C}$	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	$t_{d(on)}$		$V_{CC} = 14\text{ V}, I_C = 9.0\text{ A}$ $R_G = 1.0\text{ k}\Omega, R_L = 1.5\ \Omega,$ $V_{GE} = 5.0\text{ V}$	$T_J = 25^\circ\text{C}$	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	

NGD8201N, NGD8201AN

TYPICAL ELECTRICAL CHARACTERISTICS

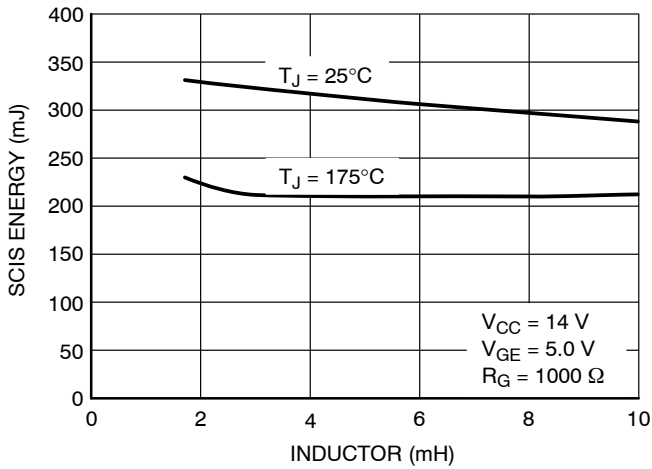


Figure 1. Self Clamped Inductive Switching

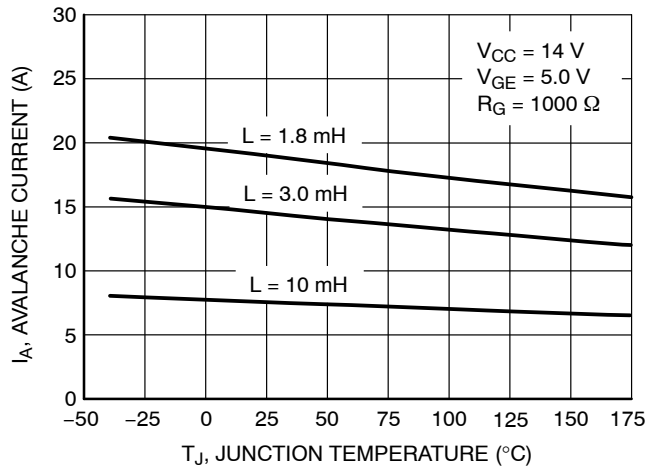


Figure 2. Open Secondary Avalanche Current vs. Temperature

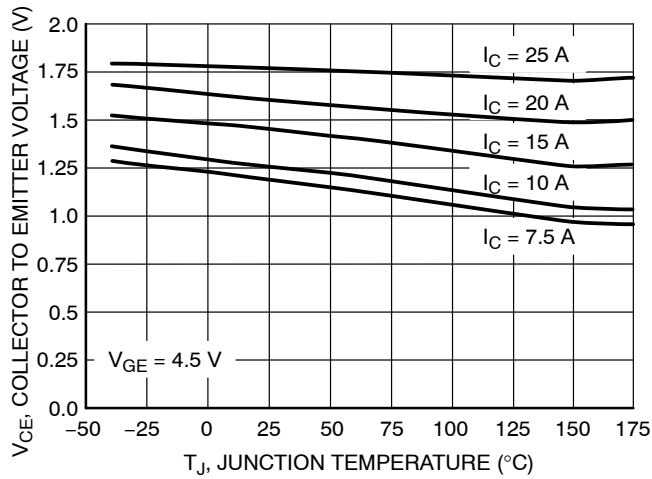


Figure 3. Collector-to-Emitter Voltage vs. Junction Temperature

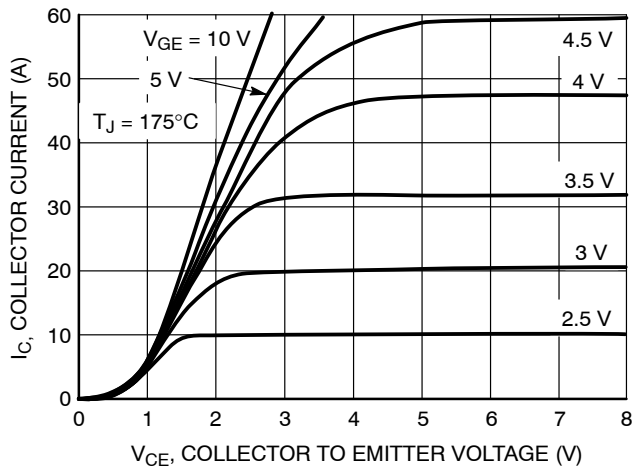


Figure 4. Collector Current vs. Collector-to-Emitter Voltage

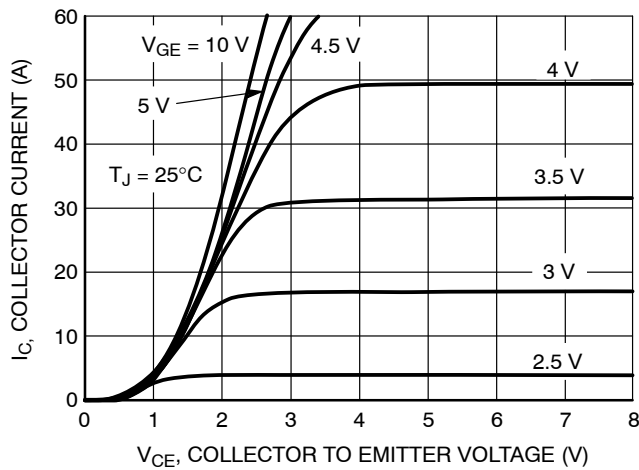


Figure 5. Collector Current vs. Collector-to-Emitter Voltage

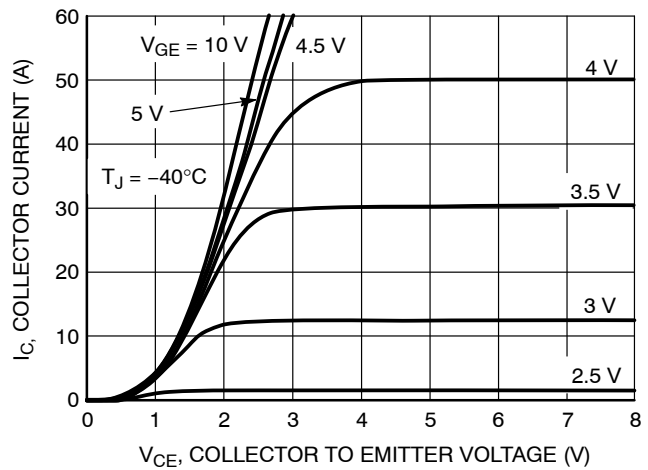


Figure 6. Collector Current vs. Collector-to-Emitter Voltage

TYPICAL ELECTRICAL CHARACTERISTICS

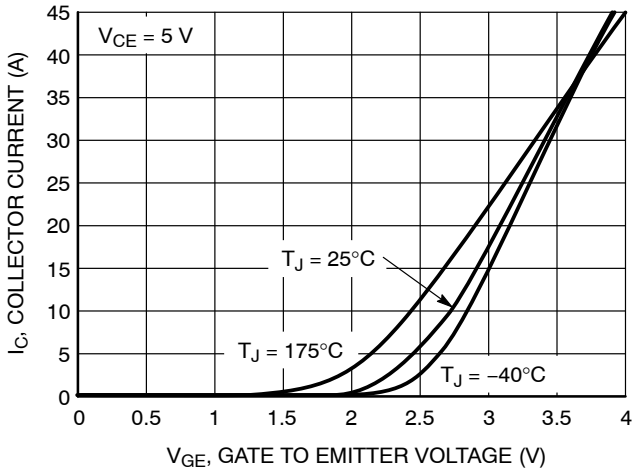


Figure 7. Transfer Characteristics

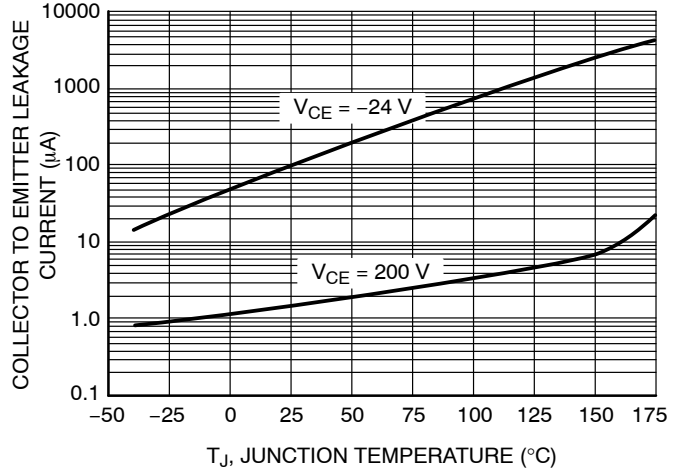


Figure 8. Collector-to-Emitter Leakage Current vs. Temperature

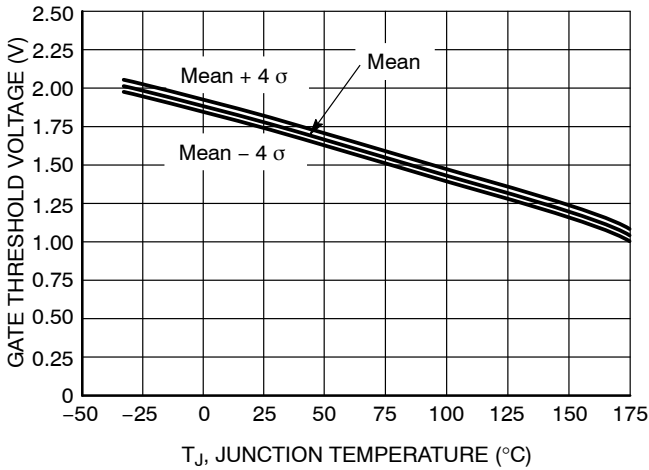


Figure 9. Gate Threshold Voltage vs. Temperature

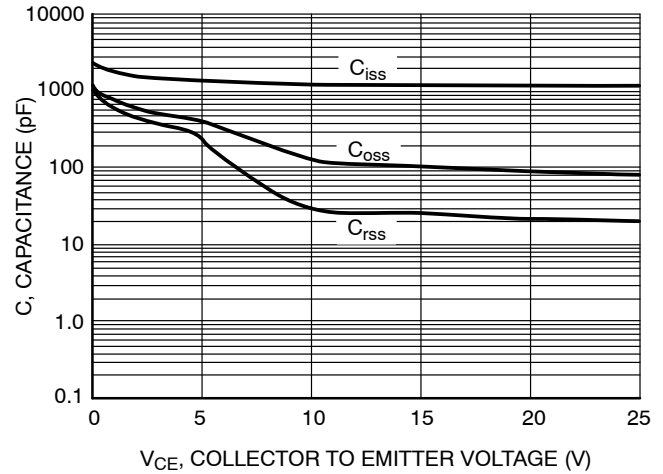


Figure 10. Capacitance vs. Collector-to-Emitter Voltage

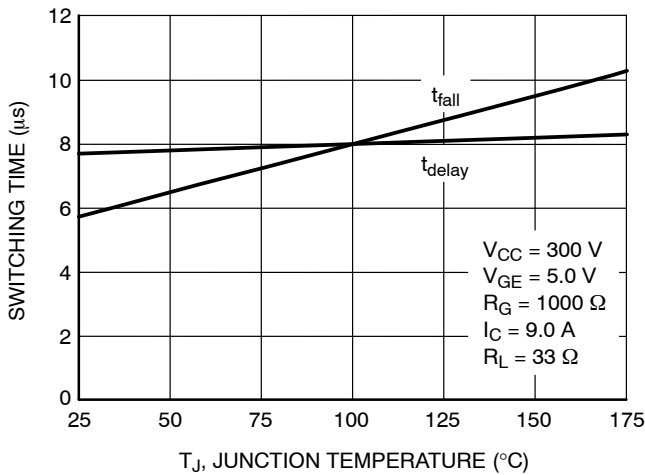


Figure 11. Resistive Switching Fall Time vs. Temperature

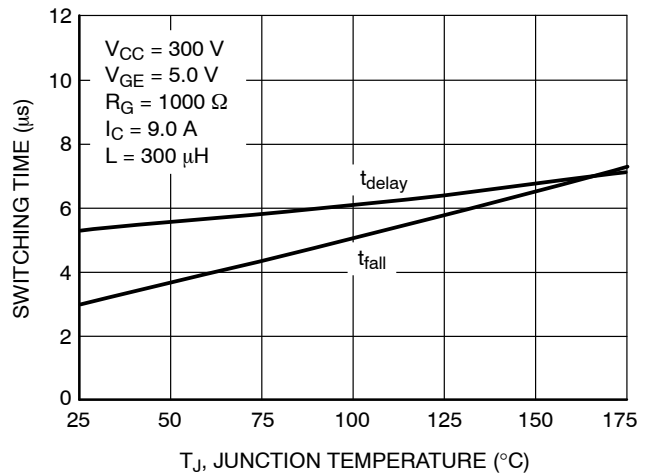


Figure 12. Inductive Switching Fall Time vs. Temperature

NGD8201N, NGD8201AN

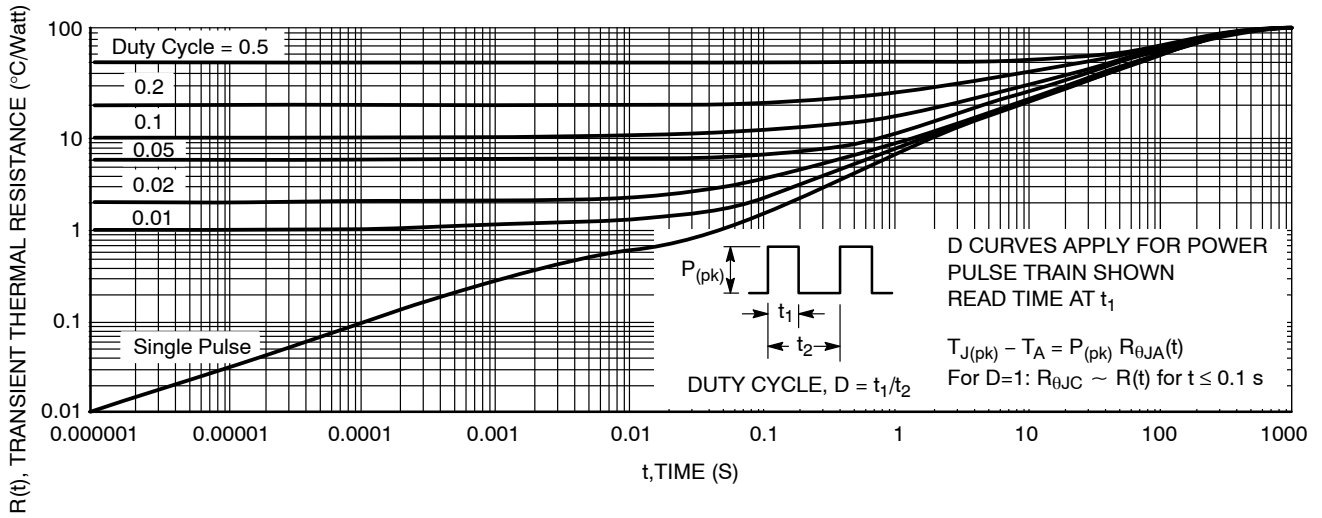


Figure 13. Minimum Pad Transient Thermal Resistance (Non-normalized Junction-to-Ambient)

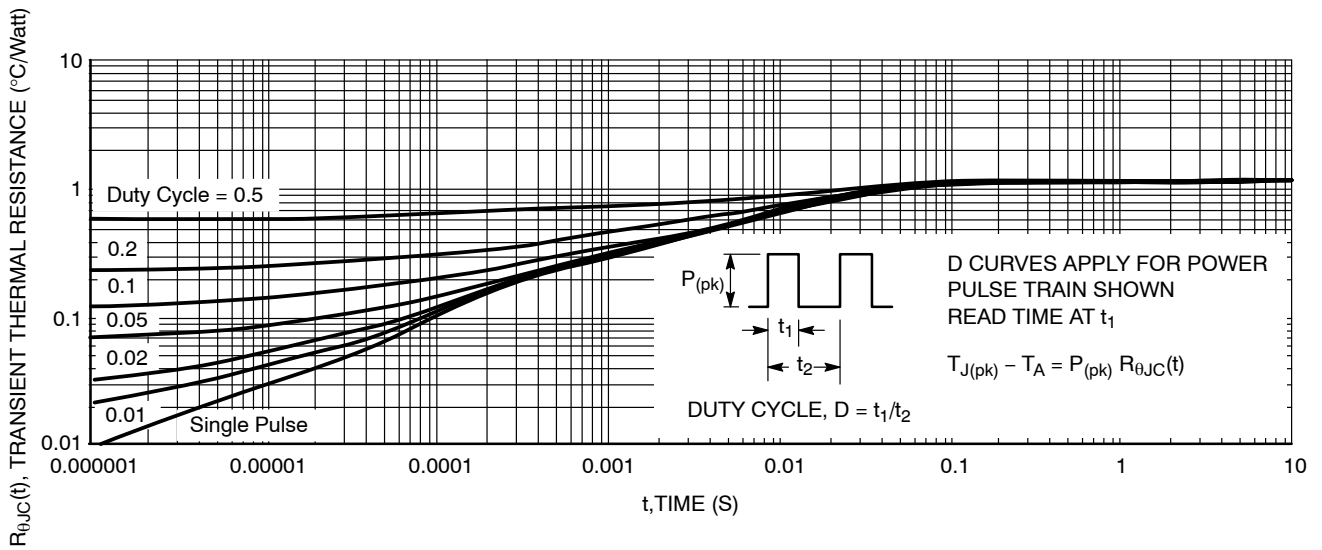
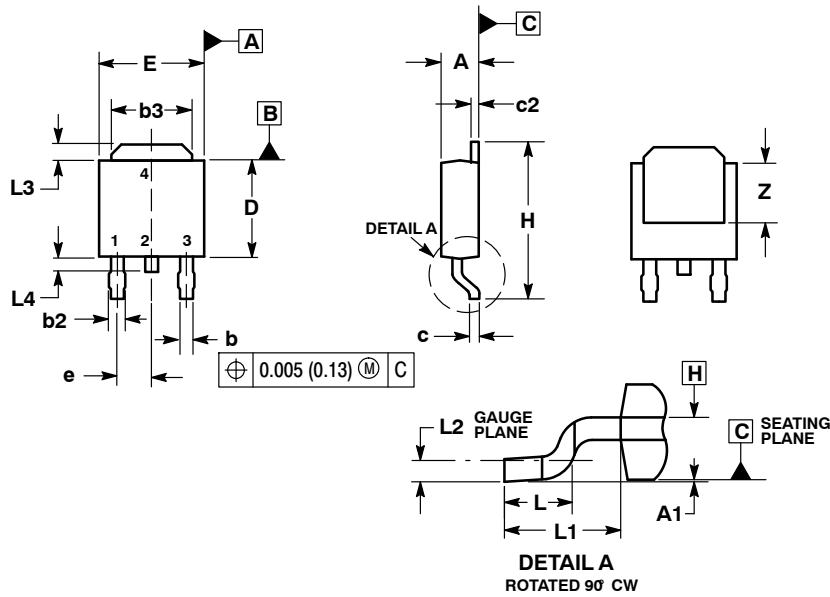


Figure 14. Best Case Transient Thermal Resistance (Non-normalized Junction-to-Case Mounted on Cold Plate)

NGD8201N, NGD8201AN

PACKAGE DIMENSIONS

DPAK CASE 369C ISSUE D



NOTES:

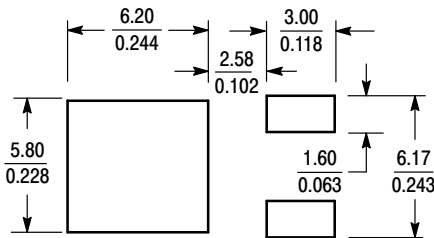
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
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	---

STYLE 7:

1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

SOLDERING FOOTPRINT*



SCALE 3:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

*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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