

NGD15N41ACL, NGB15N41ACL, NGP15N41ACL

Ignition IGBT 15 A, 410 V N-Channel DPAK, D²PAK and TO-220

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 Applications
- DPAK Package Offers Smaller Footprint and Increased Board Space
- Gate-Emitter ESD Protection
- Temperature Compensated Gate-Collector Voltage Clamp Limits Stress Applied to Load
- Integrated ESD Diode Protection
- New Design Increases Unclamped Inductive Switching (UIS) Energy Per Area
- Low Threshold Voltage to Interface 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})
- These are Pb-Free Devices

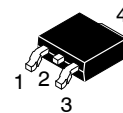
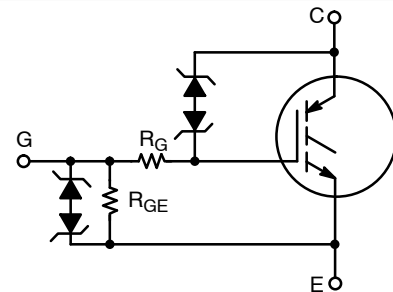
MAXIMUM RATINGS ($T_J = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	440	V_{DC}
Collector-Gate Voltage	V_{CER}	440	V_{DC}
Gate-Emitter Voltage	V_{GE}	15	V_{DC}
Collector Current-Continuous @ $T_C = 25^\circ\text{C}$ - Pulsed	I_C	15 50	A_{DC} A_{AC}
ESD (Human Body Model) $R = 1500 \Omega$, $C = 100 \text{ pF}$	ESD	8.0	kV
ESD (Machine Model) $R = 0 \Omega$, $C = 200 \text{ pF}$	ESD	800	V
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	107 0.71	Watts $\text{W}/^\circ\text{C}$
Operating and Storage Temperature Range	T_J, T_{stg}	-55 to +175	$^\circ\text{C}$

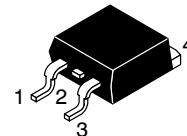
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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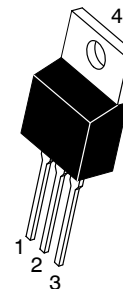
15 AMPS
410 VOLTS
 $V_{CE(on)} \leq 2.1 \text{ V @}$
 $I_C = 10 \text{ A}, V_{GE} \geq 4.5 \text{ V}$



DPAK
CASE 369C
STYLE 2



D²PAK
CASE 418B
STYLE 4



TO-220AB
CASE 221A
STYLE 9

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 8 of this data sheet.

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UNCLAMPED COLLECTOR-TO-EMITTER AVALANCHE CHARACTERISTICS (-55° ≤ T_J ≤ 175°C)

Characteristic	Symbol	Value	Unit
Single Pulse Collector-to-Emitter Avalanche Energy V _{CC} = 50 V, V _{GE} = 5.0 V, Pk I _L = 16.6 A, L = 1.8 mH, Starting T _J = 25°C V _{CC} = 50 V, V _{GE} = 5.0 V, Pk I _L = 15 A, L = 1.8 mH, Starting T _J = 125°C	E _{AS}	250 200	mJ

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case	R _{θJC}	1.4	°C/W
Thermal Resistance, Junction to Ambient	DPAK (Note 1) R _{θJA}	100	
	D ² PAK (Note 1) R _{θJA}	50	
	TO-220 R _{θJA}	62.5	
Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds	T _L	275	°C

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 mA	T _J = -40°C to 150°C	380	410	440	V _{DC}
		I _C = 10 mA	T _J = -40°C to 150°C	380	410	440	
Zero Gate Voltage Collector Current	I _{CES}	V _{CE} = 350 V, V _{GE} = 0 V	T _J = 25°C	-	2.0	20	μA _{DC}
			T _J = 150°C	-	10	40*	
			T _J = -40°C	-	1.0	10	
Reverse Collector-Emitter Leakage Current	I _{ECS}	V _{CE} = -24 V	T _J = 25°C	-	0.7	2.0	mA
			T _J = 150°C	-	12	25*	
			T _J = -40°C	-	0.1	1.0	
Reverse Collector-Emitter Clamp Voltage	BV _{CES(R)}	I _C = -75 mA	T _J = 25°C	27	33	37	V _{DC}
			T _J = 150°C	30	36	40	
			T _J = -40°C	25	31	35	
Gate-Emitter Clamp Voltage	BV _{GES}	I _G = 5.0 mA	T _J = -40°C to 150°C	11	13	15	V _{DC}
Gate-Emitter Leakage Current	I _{GES}	V _{GE} = 10 V	T _J = -40°C to 150°C	384	640	1000	μA _{DC}
Gate Resistor	R _G	-	T _J = -40°C to 150°C	-	70	-	Ω
Gate Emitter Resistor	R _{GE}	-	T _J = -40°C to 150°C	10	16	26	kΩ

ON CHARACTERISTICS (Note 2)

Gate Threshold Voltage	V _{GE(th)}	I _C = 1.0 mA, V _{GE} = V _{CE}	T _J = 25°C	1.1	1.4	1.9	V _{DC}
			T _J = 150°C	0.75	1.0	1.4	
			T _J = -40°C	1.2	1.6	2.1*	
Threshold Temperature Coefficient (Negative)	-	-	-	-	3.4	-	mV/°C

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

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

*Maximum Value of Characteristic across Temperature Range.

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ELECTRICAL CHARACTERISTICS (continued)

Characteristic	Symbol	Test Conditions	Temperature	Min	Typ	Max	Unit
ON CHARACTERISTICS (continued) (Note 3)							
Collector-to-Emitter On-Voltage	$V_{CE(on)}$	$I_C = 6.0 \text{ A}$, $V_{GE} = 4.0 \text{ V}$	$T_J = 25^\circ\text{C}$	1.0	1.6	1.8	V_{DC}
			$T_J = 150^\circ\text{C}$	0.9	1.5	1.8	
			$T_J = -40^\circ\text{C}$	1.1	1.65	1.9*	
		$I_C = 8.0 \text{ A}$, $V_{GE} = 4.0 \text{ V}$	$T_J = 25^\circ\text{C}$	1.3	1.8	2.0*	
			$T_J = 150^\circ\text{C}$	1.2	1.7	1.9	
			$T_J = -40^\circ\text{C}$	1.4	1.8	2.0*	
		$I_C = 10 \text{ A}$, $V_{GE} = 4.0 \text{ V}$	$T_J = 25^\circ\text{C}$	1.4	2.0	2.2	
			$T_J = 150^\circ\text{C}$	1.5	2.0	2.3*	
			$T_J = -40^\circ\text{C}$	1.4	2.0	2.2	
		$I_C = 10 \text{ A}$, $V_{GE} = 4.5 \text{ V}$	$T_J = 25^\circ\text{C}$	1.3	1.9	2.1	
			$T_J = 150^\circ\text{C}$	1.3	1.9	2.1	
			$T_J = -40^\circ\text{C}$	1.4	1.95	2.1*	
Forward Transconductance	gfs	$V_{CE} = 5.0 \text{ V}$, $I_C = 6.0 \text{ A}$	$T_J = -40^\circ\text{C}$ to 150°C	8.0	15	25	Mhos

DYNAMIC CHARACTERISTICS

Input Capacitance	C_{ISS}	$V_{CC} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$ $f = 1.0 \text{ MHz}$	$T_J = -40^\circ\text{C}$ to 150°C	400	650	1000	pF
Output Capacitance	C_{OSS}			30	55	100	
Transfer Capacitance	C_{RSS}			3.0	4.5	8.0	

SWITCHING CHARACTERISTICS

Turn-Off Delay Time (Inductive)	$t_{d(off)}$	$V_{CC} = 300 \text{ V}$, $I_C = 6.5 \text{ A}$ $R_G = 1.0 \text{ k}\Omega$, $L = 300 \mu\text{H}$	$T_J = 25^\circ\text{C}$	-	4.0	10	μSec
			$T_J = 150^\circ\text{C}$	-	4.5	10	
Fall Time (Inductive)	t_f	$V_{CC} = 300 \text{ V}$, $I_C = 6.5 \text{ A}$ $R_G = 1.0 \text{ k}\Omega$, $L = 300 \mu\text{H}$	$T_J = 25^\circ\text{C}$	-	6.0	12	μSec
			$T_J = 150^\circ\text{C}$	-	10	12	
Turn-Off Delay Time (Resistive)	$t_{d(off)}$	$V_{CC} = 300 \text{ V}$, $I_C = 6.5 \text{ A}$ $R_G = 1.0 \text{ k}\Omega$, $R_L = 46 \Omega$	$T_J = 25^\circ\text{C}$	-	3.0	10	μSec
			$T_J = 150^\circ\text{C}$	-	3.5	10	
Fall Time (Resistive)	t_f	$V_{CC} = 300 \text{ V}$, $I_C = 6.5 \text{ A}$ $R_G = 1.0 \text{ k}\Omega$, $R_L = 46 \Omega$	$T_J = 25^\circ\text{C}$	-	8.0	15	μSec
			$T_J = 150^\circ\text{C}$	-	12	15	
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 10 \text{ V}$, $I_C = 6.5 \text{ A}$ $R_G = 1.0 \text{ k}\Omega$, $R_L = 1.5 \Omega$	$T_J = 25^\circ\text{C}$	-	0.7	4.0	μSec
			$T_J = 150^\circ\text{C}$	-	0.7	4.0	
Rise Time	t_r	$V_{CC} = 10 \text{ V}$, $I_C = 6.5 \text{ A}$ $R_G = 1.0 \text{ k}\Omega$, $R_L = 1.5 \Omega$	$T_J = 25^\circ\text{C}$	-	4.0	7.0	μSec
			$T_J = 150^\circ\text{C}$	-	5.0	7.0	

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

*Maximum Value of Characteristic across Temperature Range.

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TYPICAL ELECTRICAL CHARACTERISTICS (unless otherwise noted)

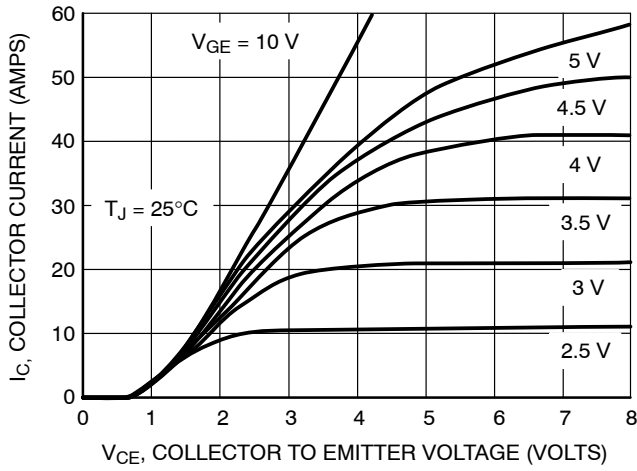


Figure 1. Output Characteristics

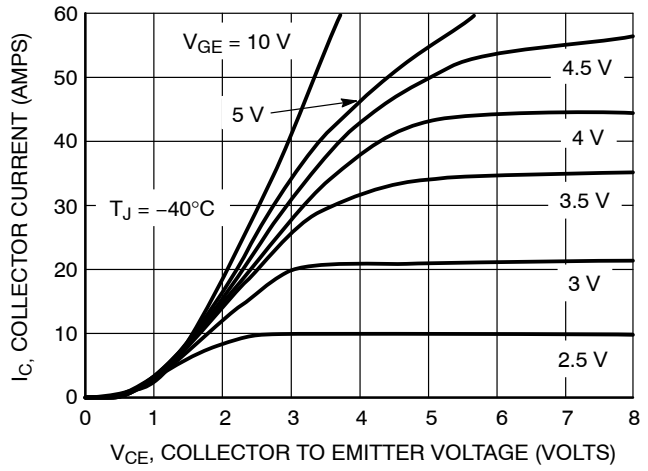


Figure 2. Output Characteristics

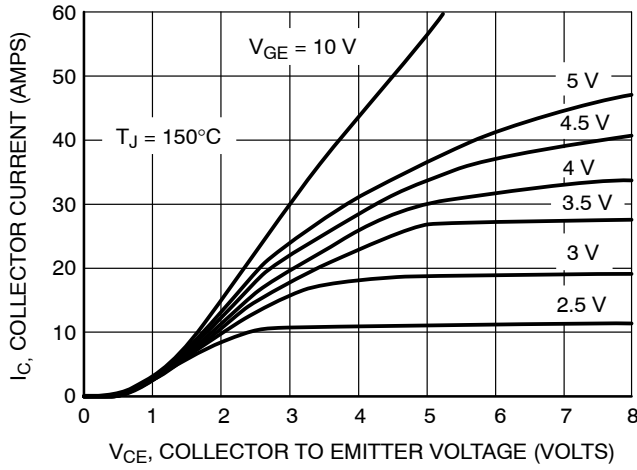


Figure 3. Output Characteristics

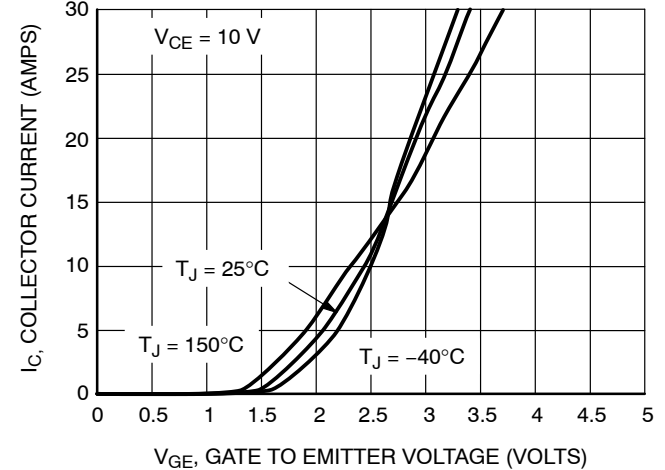


Figure 4. Transfer Characteristics

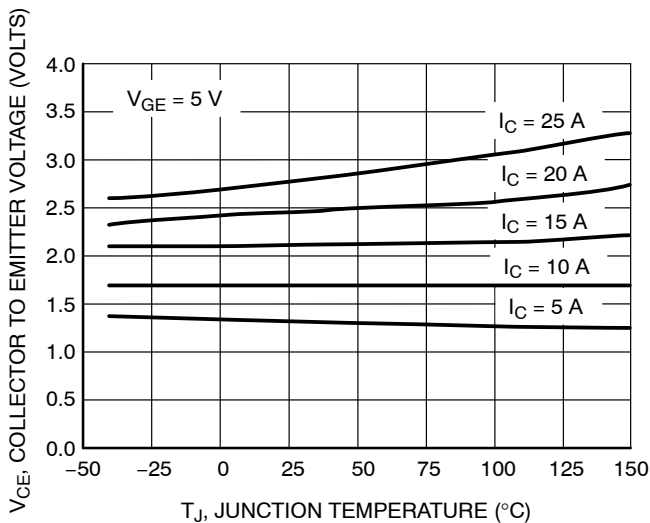


Figure 5. Collector-to-Emitter Saturation Voltage versus Junction Temperature

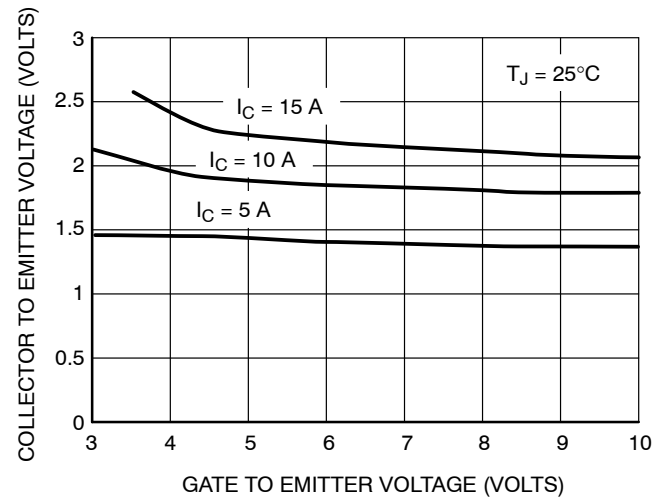


Figure 6. Collector-to-Emitter Voltage versus Gate-to-Emitter Voltage

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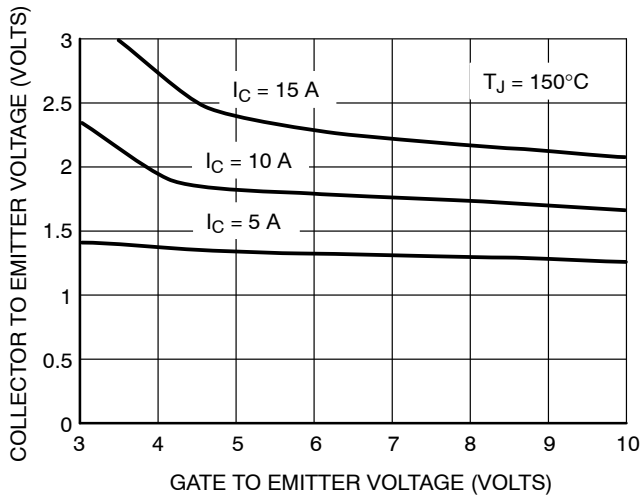


Figure 7. Collector-to-Emitter Voltage versus Gate-to-Emitter Voltage

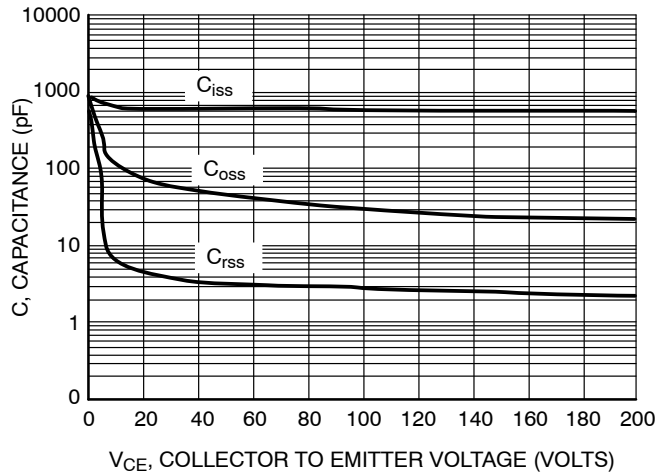


Figure 8. Capacitance Variation

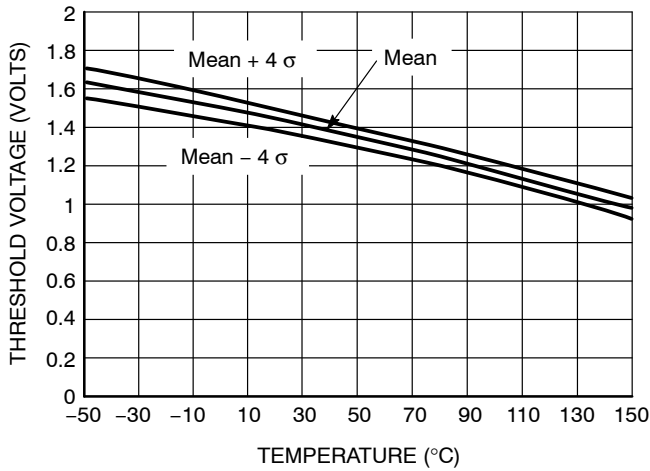


Figure 9. Gate Threshold Voltage versus Temperature

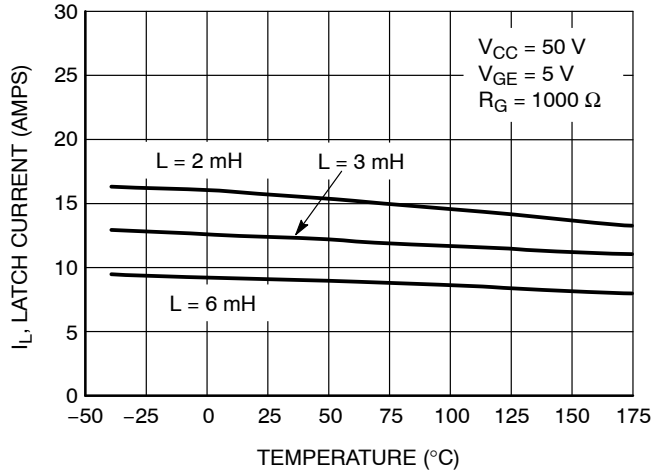


Figure 10. Minimum Open Secondary Latch Current versus Temperature

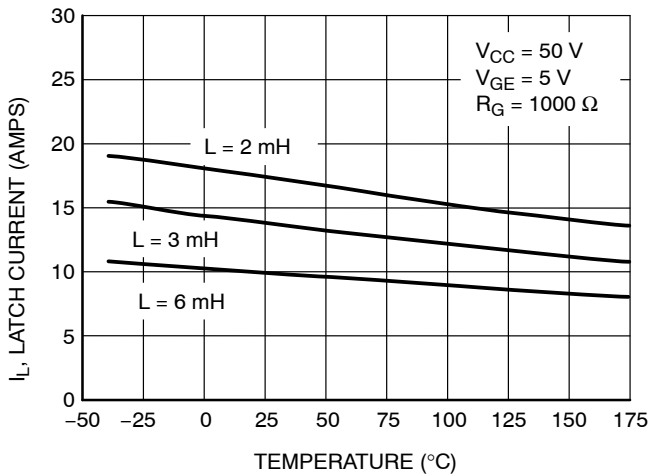


Figure 11. Typical Open Secondary Latch Current versus Temperature

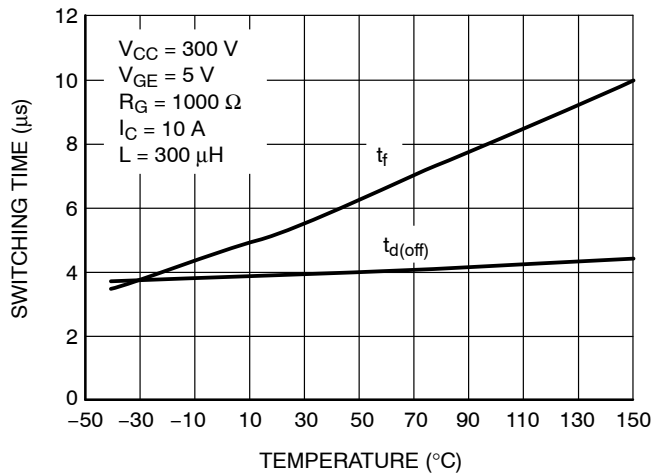


Figure 12. Inductive Switching Fall Time versus Temperature

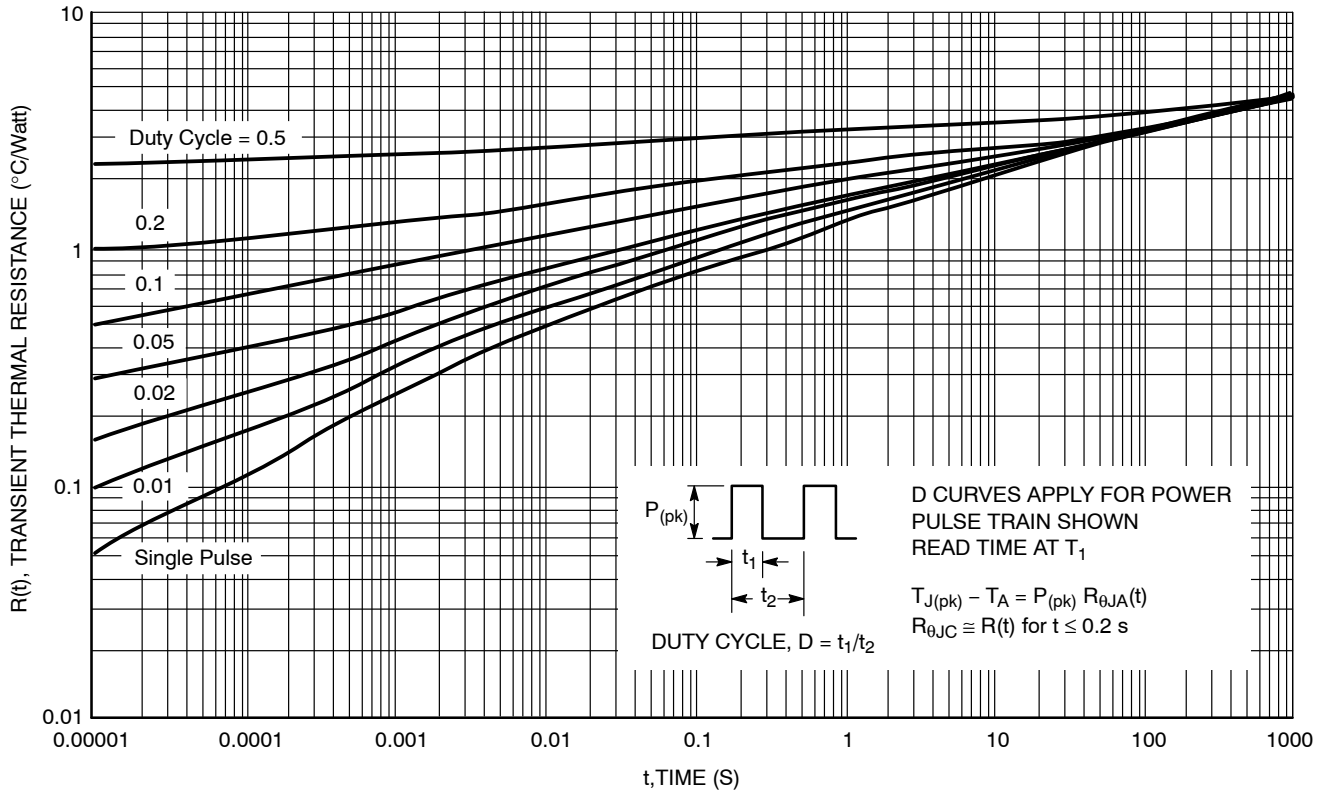


Figure 13. Transient Thermal Resistance (Non-normalized Junction-to-Ambient mounted on fixture in Figure 14)

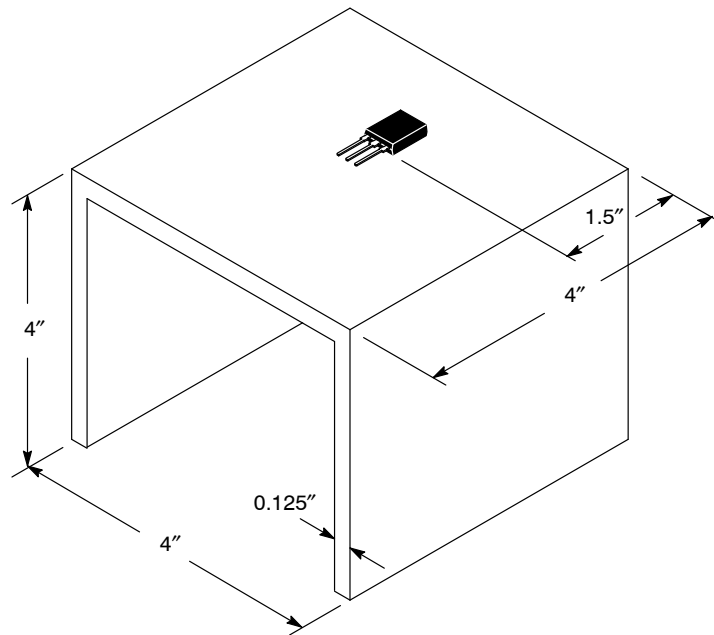


Figure 14. Test Fixture for Transient Thermal Curve (48 square inches of 1/8" thick aluminum)

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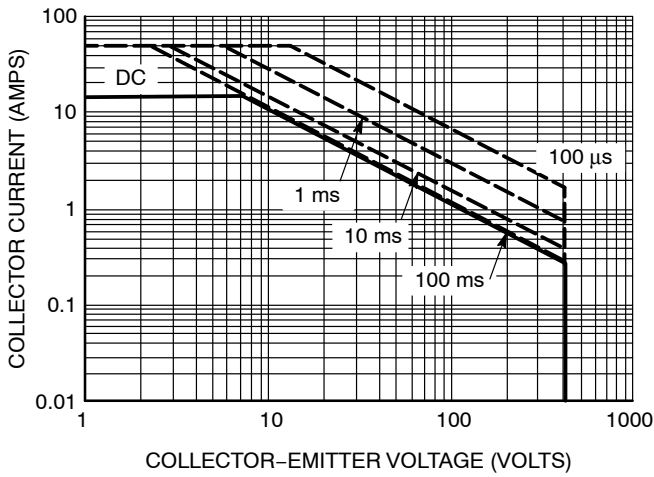


Figure 15. Single Pulse Safe Operating Area (Mounted on an Infinite Heatsink at $T_A = 25^\circ\text{C}$)

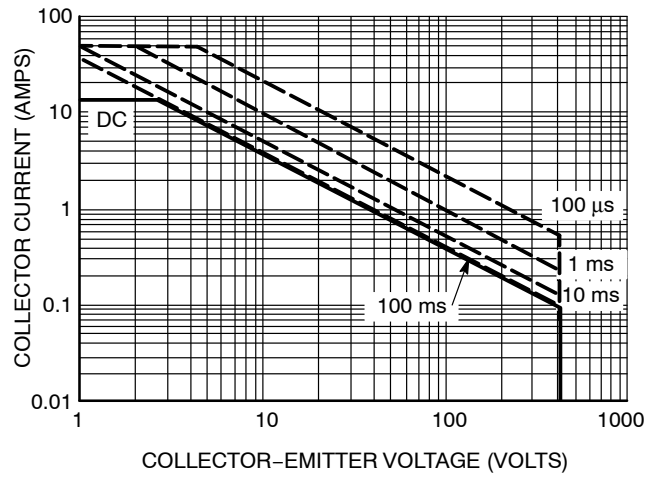


Figure 16. Single Pulse Safe Operating Area (Mounted on an Infinite Heatsink at $T_A = 125^\circ\text{C}$)

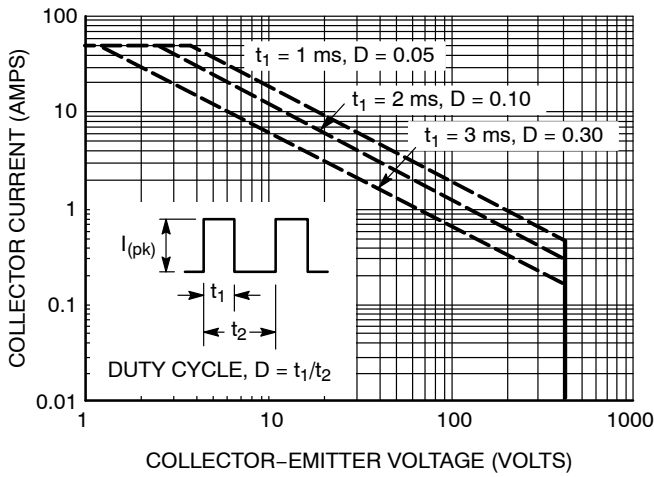


Figure 17. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at $T_C = 25^\circ\text{C}$)

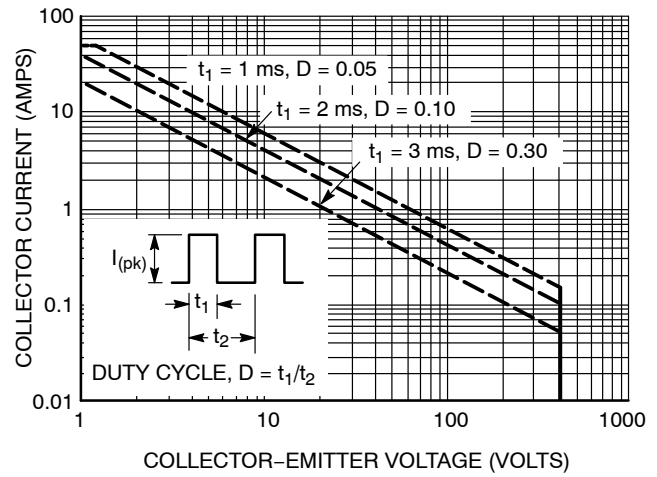


Figure 18. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at $T_C = 125^\circ\text{C}$)

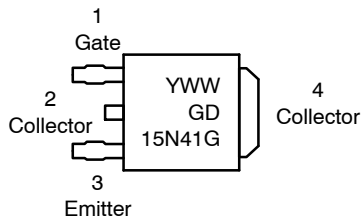
NGD15N41ACL, NGB15N41ACL, NGP15N41ACL

ORDERING INFORMATION

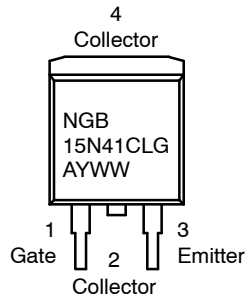
Device	Package Type	Shipping
NGD15N41ACL4G	DPAK (Pb-Free)	2500/Tape & Reel
NGB15N41ACL4G	D ² PAK (Pb-Free)	800/Tape & Reel
NGP15N41ACLG	TO-220 (Pb-Free)	50 Units/Rail

MARKING DIAGRAMS

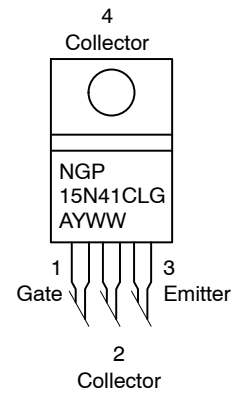
**DPAK
CASE 369C
STYLE 7**



**D²PAK
CASE 418B
STYLE 4**



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

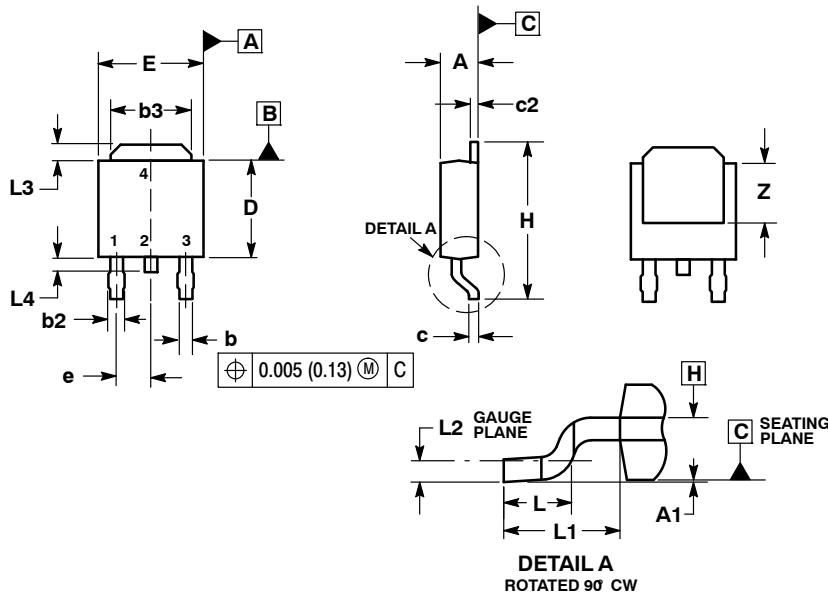


A = Assembly Location
Y = Year
WW = Work Week
G = Pb-Free Device

NGD15N41ACL, NGB15N41ACL, NGP15N41ACL

PACKAGE DIMENSIONS

DPAK (SINGLE GAUGE) CASE 369C-01 ISSUE D

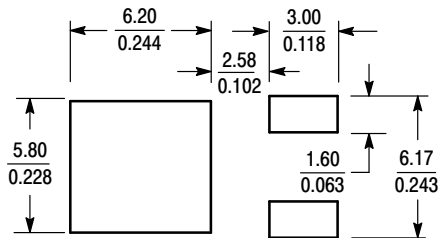


NOTES:

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



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

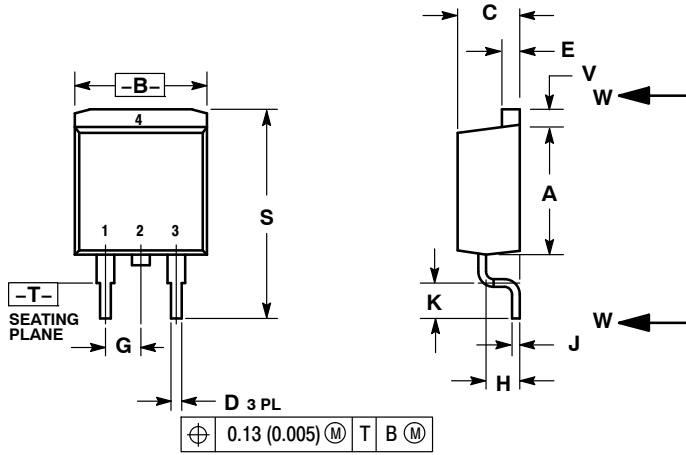
STYLE 2:

- PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

NGD15N41ACL, NGB15N41ACL, NGP15N41ACL

PACKAGE DIMENSIONS

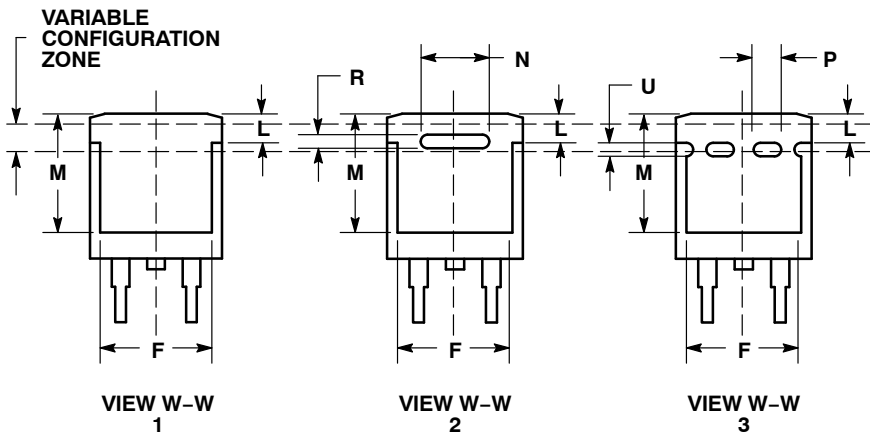
D²PAK
CASE 418B-04
ISSUE K



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.

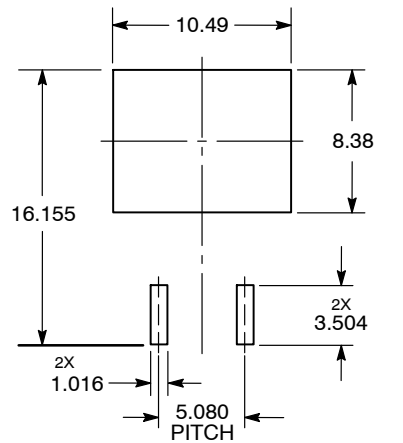
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.340	0.380	8.64	9.65
B	0.380	0.405	9.65	10.29
C	0.160	0.190	4.06	4.83
D	0.020	0.035	0.51	0.89
E	0.045	0.055	1.14	1.40
F	0.310	0.350	7.87	8.89
G	0.100 BSC		2.54 BSC	
H	0.080	0.110	2.03	2.79
J	0.018	0.025	0.46	0.64
K	0.090	0.110	2.29	2.79
L	0.052	0.072	1.32	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



STYLE 4:

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

SOLDERING FOOTPRINT

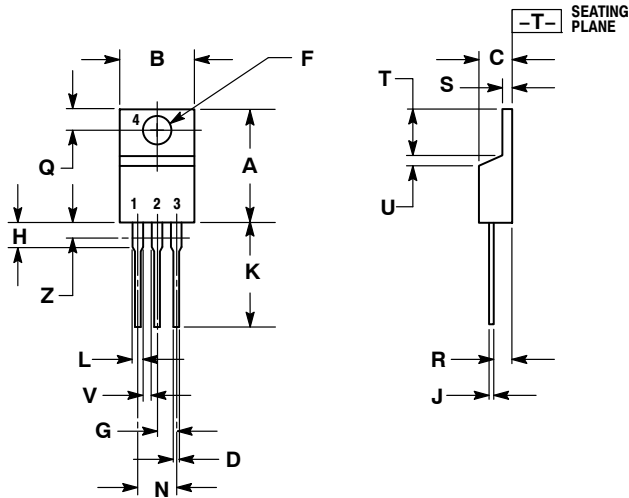


DIMENSIONS: MILLIMETERS

NGD15N41ACL, NGB15N41ACL, NGP15N41ACL

PACKAGE DIMENSIONS

TO-220
CASE 221A-09
ISSUE AF



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	0.161	3.61	4.09
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.014	0.025	0.36	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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