

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL, 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 | $^\circ\text{C}$ |

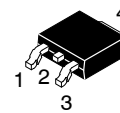
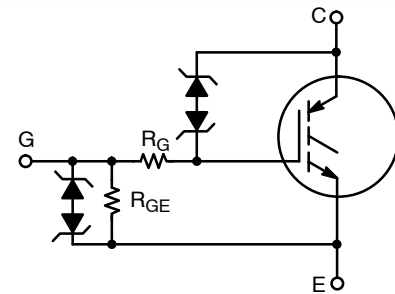
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.



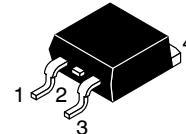
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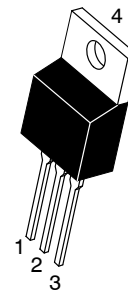
15 AMPS
410 VOLTS
 $V_{CE(on)} \leq 2.1 \text{ V @}$
 $I_C = 10 \text{ A}, V_{GE} \geq 4.5 \text{ V}$



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 ($-55^{\circ} \leq T_J \leq 175^{\circ}C$)

| Characteristic | Symbol | Value | Unit |
|---|----------|------------|------|
| Single Pulse Collector-to-Emitter Avalanche Energy $V_{CC} = 50\text{ V}$, $V_{GE} = 5.0\text{ V}$, Pk $I_L = 16.6\text{ A}$, $L = 1.8\text{ mH}$, Starting $T_J = 25^{\circ}C$ $V_{CC} = 50\text{ V}$, $V_{GE} = 5.0\text{ V}$, Pk $I_L = 15\text{ A}$, $L = 1.8\text{ mH}$, Starting $T_J = 125^{\circ}C$ | E_{AS} | 250 200 | mJ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Value | Unit |
|---|--|-------|---------------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 1.4 | $^{\circ}C/W$ |
| Thermal Resistance, Junction to Ambient | DPAK (Note 1) $R_{\theta JA}$ | 100 | |
| | D ² PAK (Note 1) $R_{\theta JA}$ | 50 | |
| | TO-220 $R_{\theta JA}$ | 62.5 | |
| Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 5 seconds | T_L | 275 | $^{\circ}C$ |

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 $150^{\circ}C$ | 380 | 410 | 440 | V_{DC} |
| | | $I_C = 10\text{ mA}$ | $T_J = -40^{\circ}C$ to $150^{\circ}C$ | 380 | 410 | 440 | |
| Zero Gate Voltage Collector Current | I_{CES} | $V_{CE} = 350\text{ V}$, $V_{GE} = 0\text{ V}$ | $T_J = 25^{\circ}C$ | - | 2.0 | 20 | μA_{DC} |
| | | | $T_J = 150^{\circ}C$ | - | 10 | 40* | |
| | | | $T_J = -40^{\circ}C$ | - | 1.0 | 10 | |
| Reverse Collector-Emitter Leakage Current | I_{ECS} | $V_{CE} = -24\text{ V}$ | $T_J = 25^{\circ}C$ | - | 0.7 | 2.0 | mA |
| | | | $T_J = 150^{\circ}C$ | - | 12 | 25* | |
| | | | $T_J = -40^{\circ}C$ | - | 0.1 | 1.0 | |
| Reverse Collector-Emitter Clamp Voltage | $BV_{CES(R)}$ | $I_C = -75\text{ mA}$ | $T_J = 25^{\circ}C$ | 27 | 33 | 37 | V_{DC} |
| | | | $T_J = 150^{\circ}C$ | 30 | 36 | 40 | |
| | | | $T_J = -40^{\circ}C$ | 25 | 31 | 35 | |
| Gate-Emitter Clamp Voltage | BV_{GES} | $I_G = 5.0\text{ mA}$ | $T_J = -40^{\circ}C$ to $150^{\circ}C$ | 11 | 13 | 15 | V_{DC} |
| Gate-Emitter Leakage Current | I_{GES} | $V_{GE} = 10\text{ V}$ | $T_J = -40^{\circ}C$ to $150^{\circ}C$ | 384 | 640 | 1000 | μA_{DC} |
| Gate Resistor | R_G | - | $T_J = -40^{\circ}C$ to $150^{\circ}C$ | - | 70 | - | Ω |
| Gate Emitter Resistor | R_{GE} | - | $T_J = -40^{\circ}C$ to $150^{\circ}C$ | 10 | 16 | 26 | k Ω |

ON CHARACTERISTICS (Note 2)

| | | | | | | | |
|--|--------------|--|----------------------|------|-----|------|-----------------|
| Gate Threshold Voltage | $V_{GE(th)}$ | $I_C = 1.0\text{ mA}$, $V_{GE} = V_{CE}$ | $T_J = 25^{\circ}C$ | 1.1 | 1.4 | 1.9 | V_{DC} |
| | | | $T_J = 150^{\circ}C$ | 0.75 | 1.0 | 1.4 | |
| | | | $T_J = -40^{\circ}C$ | 1.2 | 1.6 | 2.1* | |
| Threshold Temperature Coefficient (Negative) | - | - | - | - | 3.4 | - | mV/ $^{\circ}C$ |

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

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

*Maximum Value of Characteristic across Temperature Range.

**NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL,
NGP15N41ACL**

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.

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL, NGP15N41ACL

TYPICAL ELECTRICAL CHARACTERISTICS (unless otherwise noted)

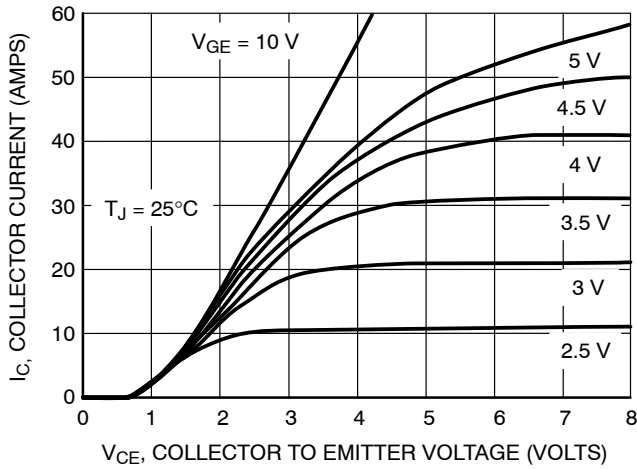


Figure 1. Output Characteristics

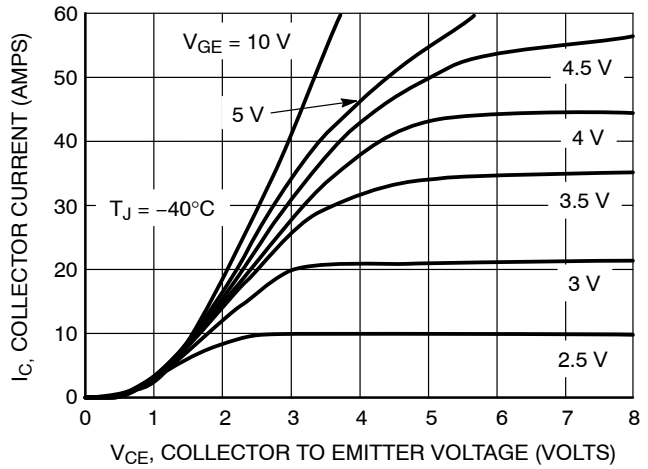


Figure 2. Output Characteristics

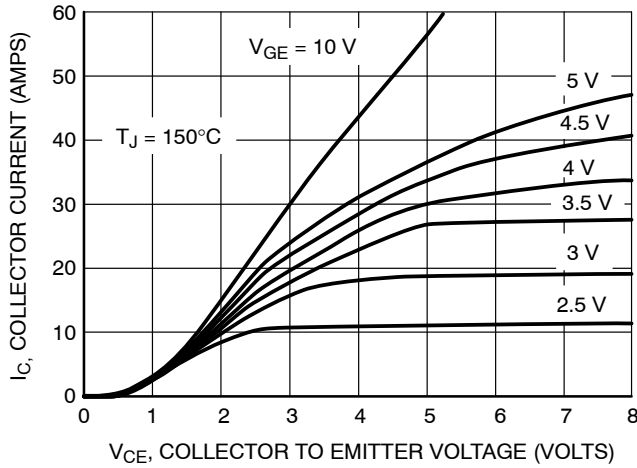


Figure 3. Output Characteristics

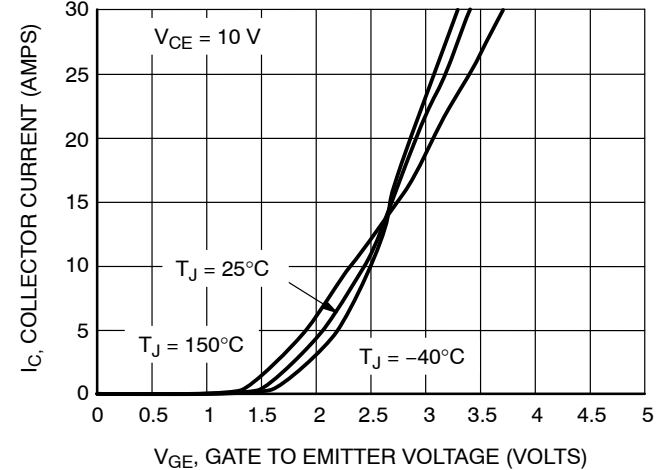


Figure 4. Transfer Characteristics

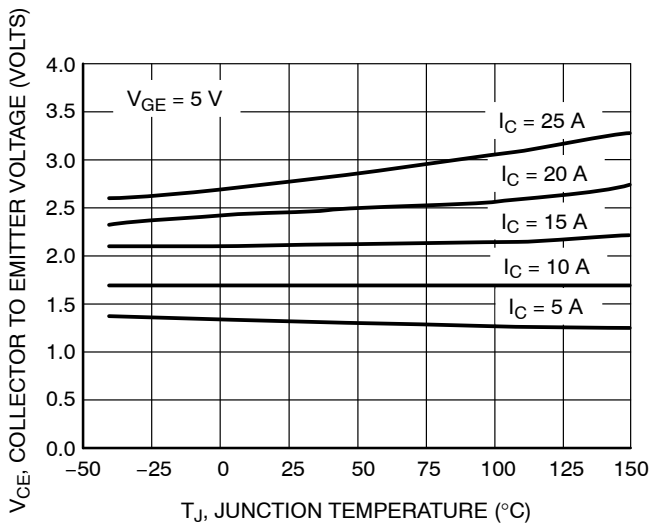


Figure 5. Collector-to-Emitter Saturation Voltage versus Junction Temperature

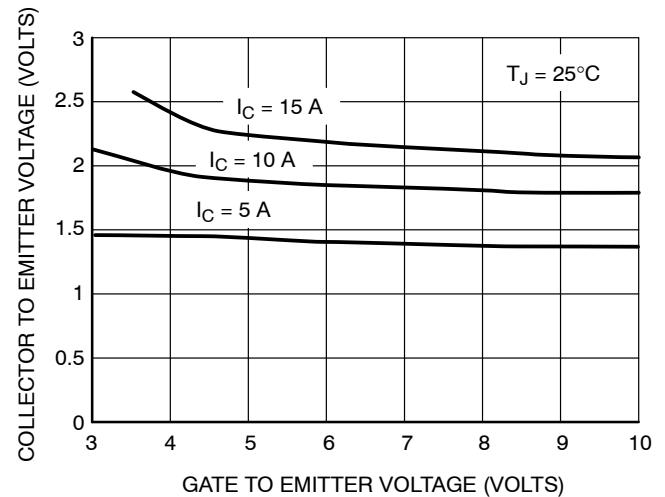


Figure 6. Collector-to-Emitter Voltage versus Gate-to-Emitter Voltage

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL, NGP15N41ACL

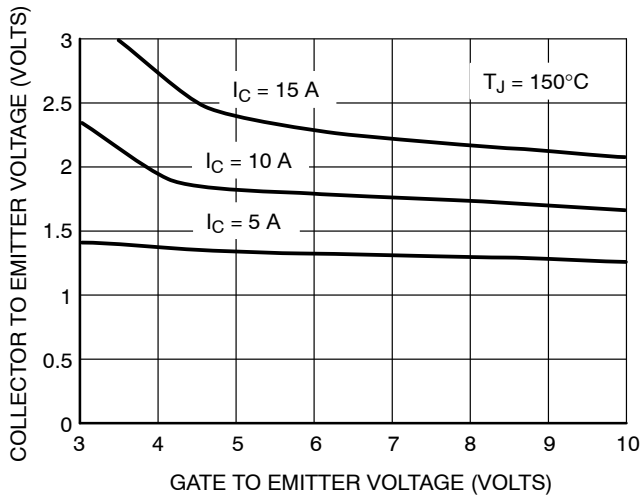


Figure 7. Collector-to-Emitter Voltage versus Gate-to-Emitter Voltage

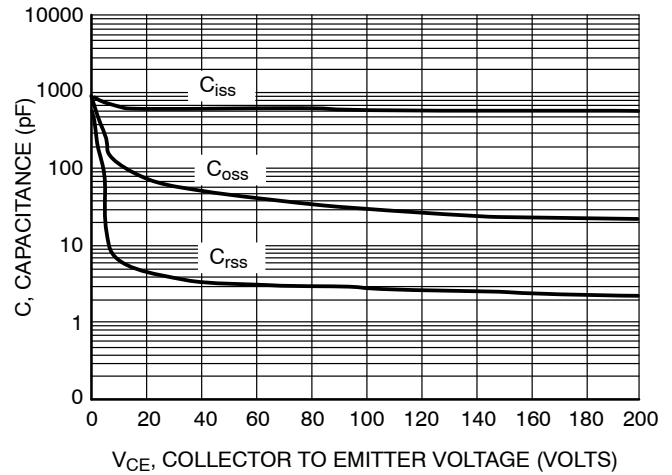


Figure 8. Capacitance Variation

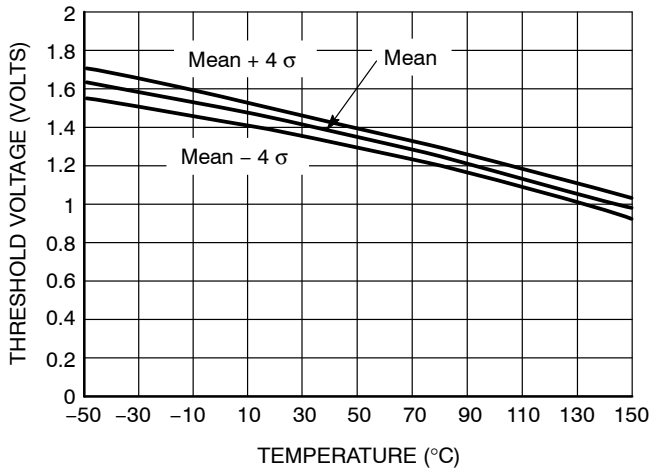


Figure 9. Gate Threshold Voltage versus Temperature

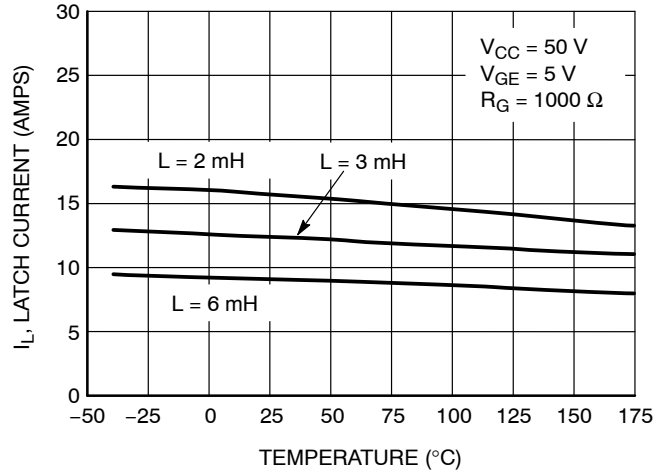


Figure 10. Minimum Open Secondary Latch Current versus Temperature

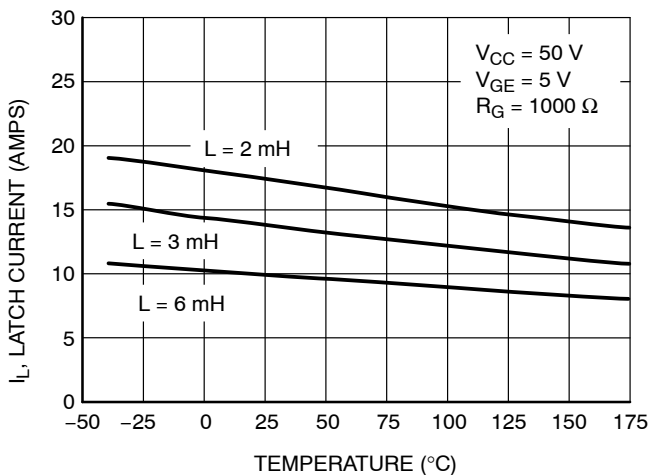


Figure 11. Typical Open Secondary Latch Current versus Temperature

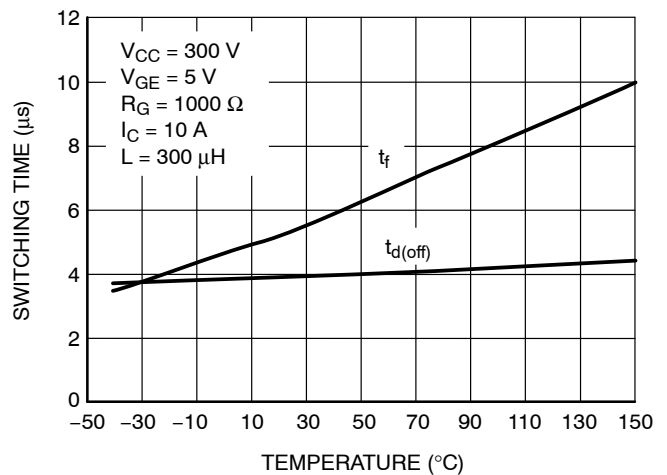
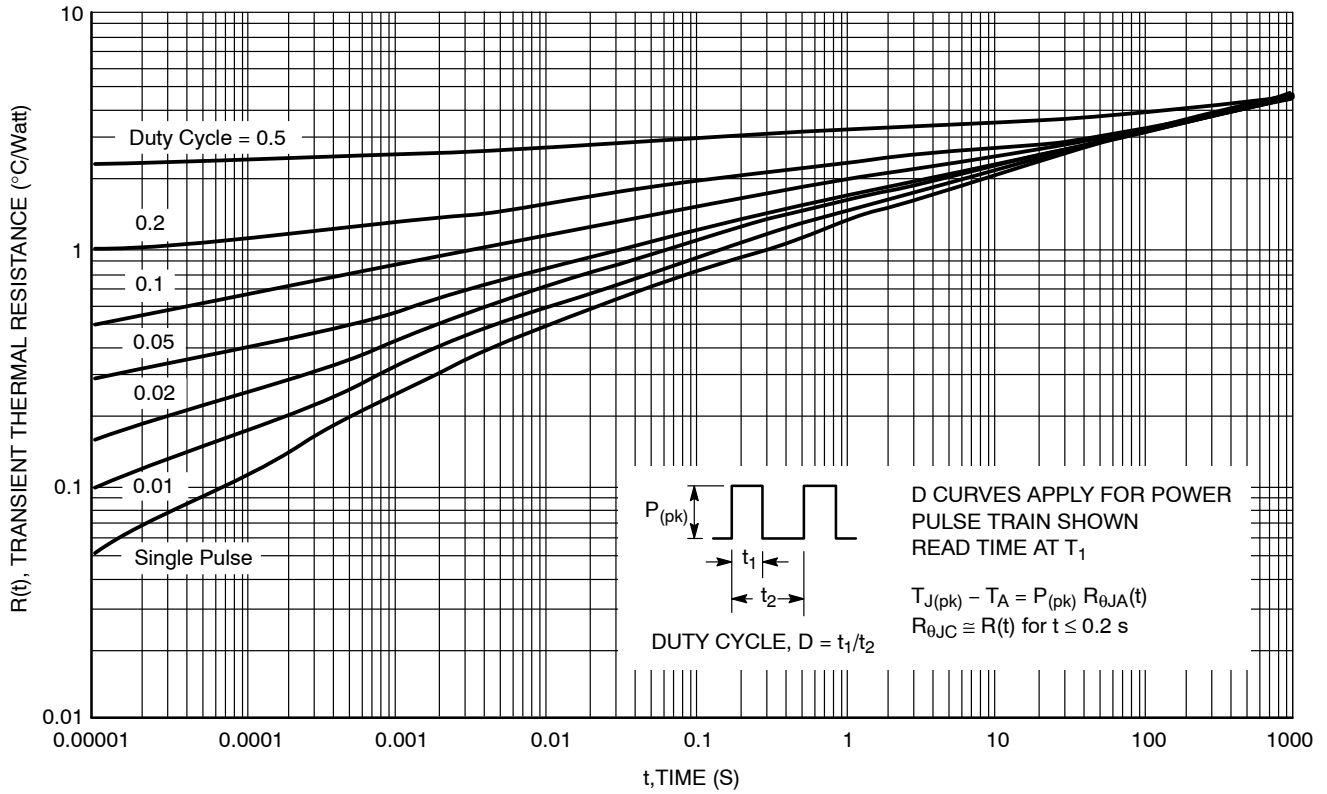
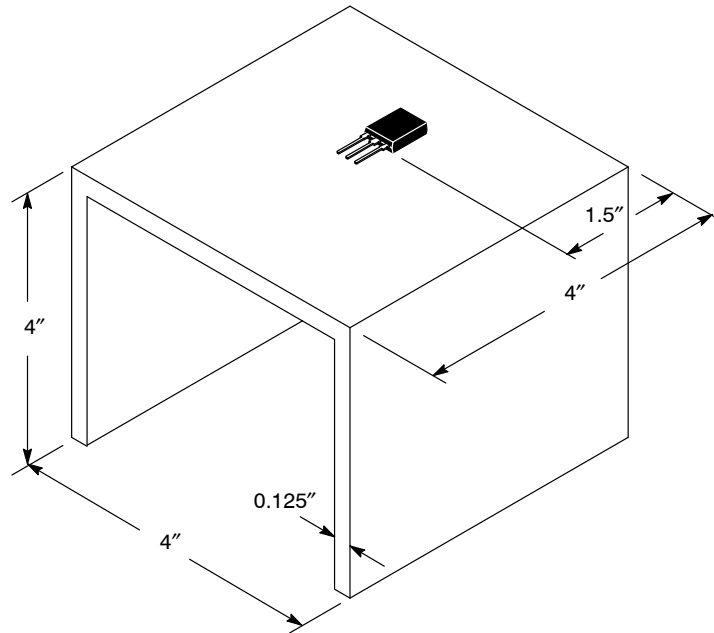


Figure 12. Inductive Switching Fall Time versus Temperature

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL,
 NGP15N41ACL



**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)**

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL, NGP15N41ACL

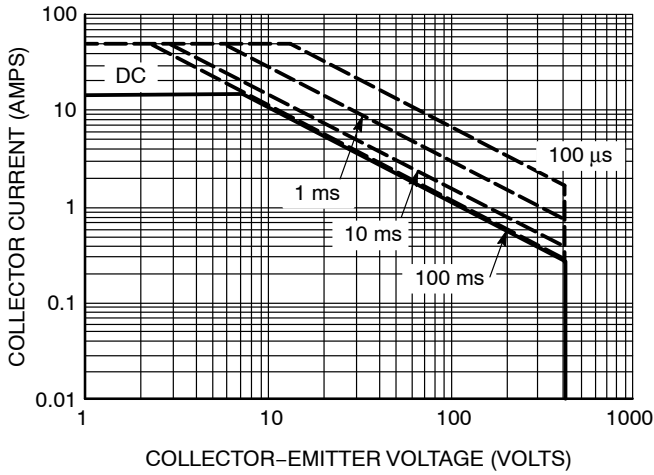


Figure 15. Single Pulse Safe Operating Area (Mounted on an Infinite Heatsink at $T_A = 25^\circ\text{C}$)

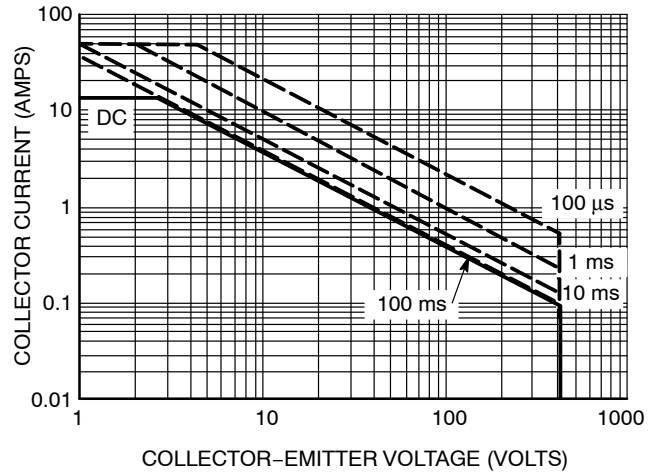


Figure 16. Single Pulse Safe Operating Area (Mounted on an Infinite Heatsink at $T_A = 125^\circ\text{C}$)

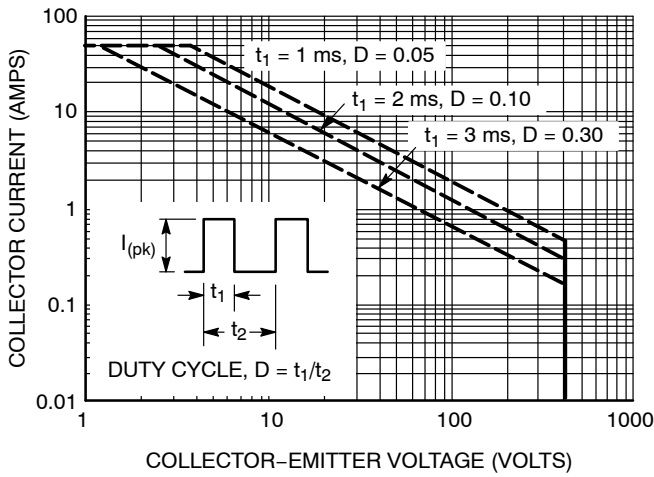


Figure 17. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at $T_C = 25^\circ\text{C}$)

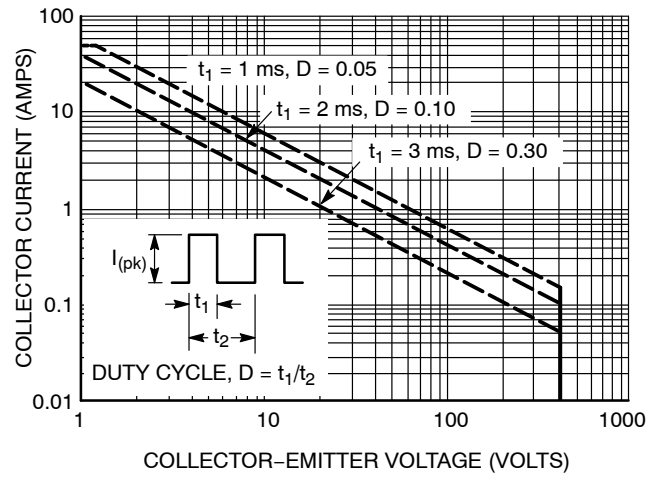


Figure 18. Pulse Train Safe Operating Area (Mounted on an Infinite Heatsink at $T_C = 125^\circ\text{C}$)

**NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL,
NGP15N41ACL**

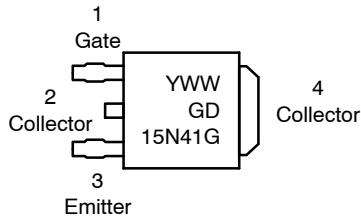
ORDERING INFORMATION

| Device | Package Type | Shipping† |
|---------------|---------------------------------|------------------|
| NGD15N41CLT4G | DPAK (Pb-Free) | 2500/Tape & Reel |
| NGD15N41ACL4G | | |
| NGB15N41CLT4G | D ² PAK (Pb-Free) | 800/Tape & Reel |
| NGB15N41ACL4G | | |
| NGP15N41CLG | TO-220 (Pb-Free) | 50 Units/Rail |
| NGP15N41ACLG | | |

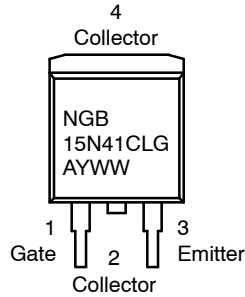
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

MARKING DIAGRAMS

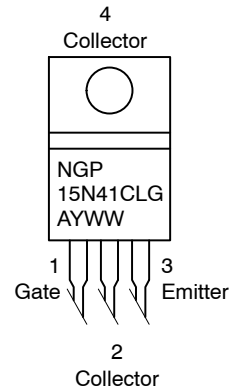
**DPAK
CASE 369C
STYLE 7**



**D²PAK
CASE 418B
STYLE 4**



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

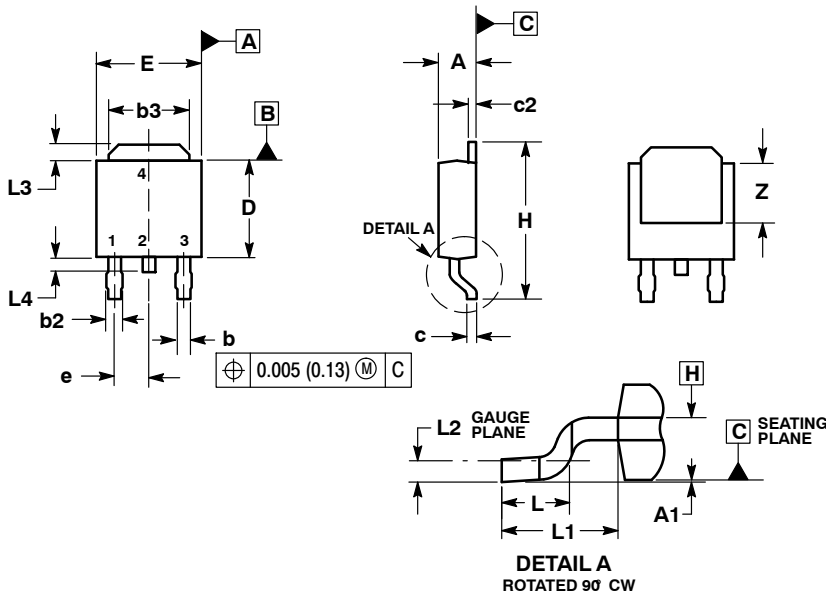


A = Assembly Location
 Y = Year
 WW = Work Week
 G = Pb-Free Device

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL, NGP15N41ACL

PACKAGE DIMENSIONS

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

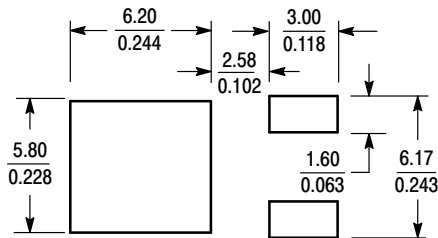


NOTES:

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:

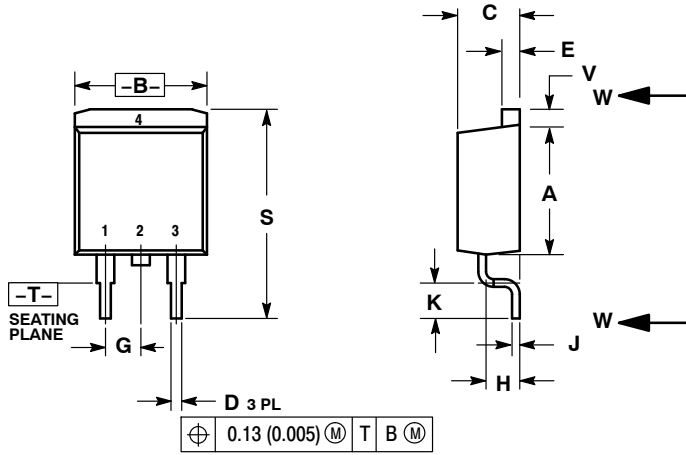
- PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

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

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL,
NGP15N41ACL

PACKAGE DIMENSIONS

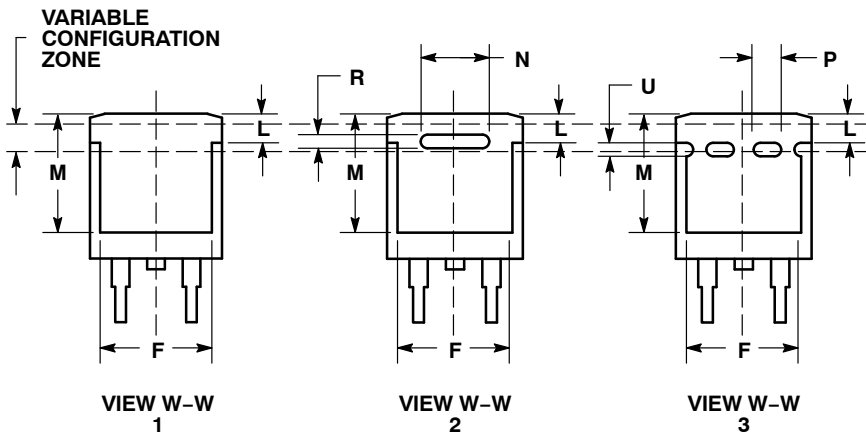
D²PAK
CASE 418B-04
ISSUE K



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.

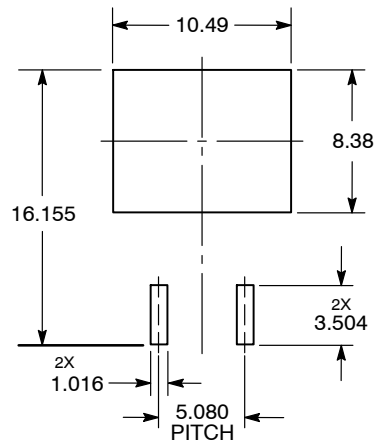
| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.340 | 0.380 | 8.64 | 9.65 |
| B | 0.380 | 0.405 | 9.65 | 10.29 |
| C | 0.160 | 0.190 | 4.06 | 4.83 |
| D | 0.020 | 0.035 | 0.51 | 0.89 |
| E | 0.045 | 0.055 | 1.14 | 1.40 |
| F | 0.310 | 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
- COLLECTOR
- EMITTER
- COLLECTOR

SOLDERING FOOTPRINT*



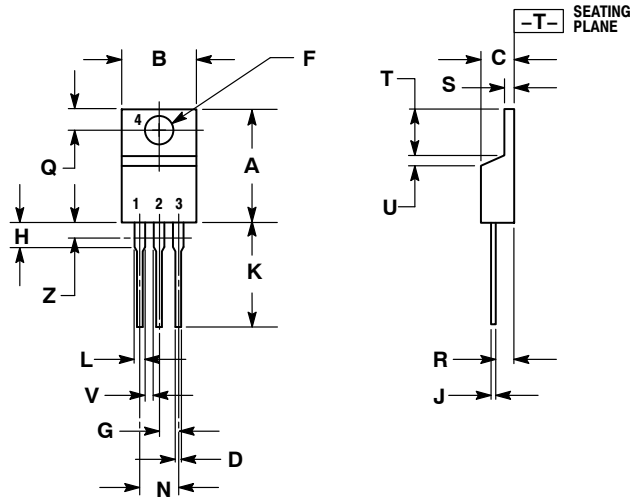
DIMENSIONS: MILLIMETERS

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

NGD15N41CL, NGD15N41ACL, NGB15N41CL, NGB15N41ACL, NGP15N41CL, 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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