# P2N2222A

# Amplifier Transistors

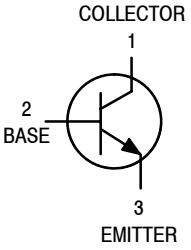
## NPN Silicon

**ON Semiconductor®**

**http://onsemi.com**

### Features

- These are Pb-Free Devices*




**MAXIMUM RATINGS** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Value | Unit |
|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 40 | Vdc |
| Collector-Base Voltage | $V_{CBO}$ | 75 | Vdc |
| Emitter-Base Voltage | $V_{EBO}$ | 6.0 | Vdc |
| Collector Current - Continuous | $I_C$ | 600 | mAdc |
| Total Device Dissipation @ $T_A$ = 25°C<br>Derate above 25°C | $P_D$ | 625<br>5.0 | mW<br>mW/°C |
| Total Device Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 1.5<br>12 | W<br>mW/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | -55 to +150 | °C |

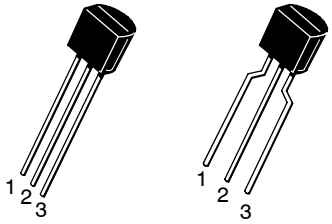
**THERMAL CHARACTERISTICS**

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 200 | °C/W |
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 83.3 | °C/W |

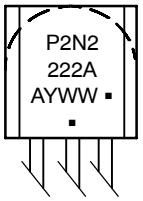
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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

**TO-92**
**CASE 29**
**STYLE 17**




**MARKING DIAGRAM**




A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb-Free Package
(Note: Microdot may be in either location)

**ORDERING INFORMATION**

| Device | Package | Shipping† |
|---|---|---|
| P2N2222AG | TO-92<br>(Pb-Free) | 5000 Units/Bulk |
| P2N2222ARL1G | TO-92<br>(Pb-Free) | 2000/Tape & Ammo |

†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.

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | |
| Collector−Emitter Breakdown Voltage ($I_C$ = 10 mAdc, $I_B$ = 0) | $V_{(BR)CEO}$ | 40 | – | Vdc |
| Collector−Base Breakdown Voltage ($I_C$ = 10 μAdc, $I_E$ = 0) | $V_{(BR)CBO}$ | 75 | – | Vdc |
| Emitter−Base Breakdown Voltage ($I_E$ = 10 μAdc, $I_C$ = 0) | $V_{(BR)EBO}$ | 6.0 | – | Vdc |
| Collector Cutoff Current ($V_{CE}$ = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc) | $I_{CEX}$ | – | 10 | nAdc |
| Collector Cutoff Current ($V_{CB}$ = 60 Vdc, $I_E$ = 0)<br>($V_{CB}$ = 60 Vdc, $I_E$ = 0, $T_A$ = 150°C) | $I_{CBO}$ | –<br>– | 0.01<br>10 | μAdc |
| Emitter Cutoff Current ($V_{EB}$ = 3.0 Vdc, $I_C$ = 0) | $I_{EBO}$ | – | 10 | nAdc |
| Collector Cutoff Current ($V_{CE}$ = 10 V) | $I_{CEO}$ | – | 10 | nAdc |
| Base Cutoff Current ($V_{CE}$ = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc) | $I_{BEX}$ | – | 20 | nAdc |
| **ON CHARACTERISTICS** | | | | |
| DC Current Gain<br>($I_C$ = 0.1 mAdc, $V_{CE}$ = 10 Vdc)<br>($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, $T_A$ = −55°C)<br>($I_C$ = 150 mAdc, $V_{CE}$ = 10 Vdc) (Note 1)<br>($I_C$ = 150 mAdc, $V_{CE}$ = 1.0 Vdc) (Note 1)<br>($I_C$ = 500 mAdc, $V_{CE}$ = 10 Vdc) (Note 1) | $h_{FE}$ | <br>35<br>50<br>75<br>35<br>100<br>50<br>40 | <br>–<br>–<br>–<br>–<br>300<br>–<br>– | – |
| Collector−Emitter Saturation Voltage (Note 1)<br>($I_C$ = 150 mAdc, $I_B$ = 15 mAdc)<br>($I_C$ = 500 mAdc, $I_B$ = 50 mAdc) | $V_{CE(sat)}$ | <br>–<br>– | <br>0.3<br>1.0 | Vdc |
| Base−Emitter Saturation Voltage (Note 1)<br>($I_C$ = 150 mAdc, $I_B$ = 15 mAdc)<br>($I_C$ = 500 mAdc, $I_B$ = 50 mAdc) | $V_{BE(sat)}$ | <br>0.6<br>– | <br>1.2<br>2.0 | Vdc |
| **SMALL−SIGNAL CHARACTERISTICS** | | | | |
| Current−Gain − Bandwidth Product (Note 2)<br>($I_C$ = 20 mAdc, $V_{CE}$ = 20 Vdc, f = 100 MHz)C | $f_T$ | 300 | – | MHz |
| Output Capacitance ($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 1.0 MHz) | $C_{obo}$ | – | 8.0 | pF |
| Input Capacitance ($V_{EB}$ = 0.5 Vdc, $I_C$ = 0, f = 1.0 MHz) | $C_{ibo}$ | – | 25 | pF |
| Input Impedance<br>($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | $h_{ie}$ | <br>2.0<br>0.25 | <br>8.0<br>1.25 | kΩ |
| Voltage Feedback Ratio<br>($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | $h_{re}$ | <br>–<br>– | <br>8.0<br>4.0 | X $10^{-4}$ |
| Small−Signal Current Gain<br>($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | $h_{fe}$ | <br>50<br>75 | <br>300<br>375 | – |
| Output Admittance<br>($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | $h_{oe}$ | <br>5.0<br>25 | <br>35<br>200 | μMhos |
| Collector Base Time Constant ($I_E$ = 20 mAdc, $V_{CB}$ = 20 Vdc, f = 31.8 MHz) | $rb'C_c$ | – | 150 | ps |
| Noise Figure ($I_C$ = 100 μAdc, $V_{CE}$ = 10 Vdc, $R_S$ = 1.0 kΩ, f = 1.0 kHz) | $N_F$ | – | 4.0 | dB |

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. $f_T$ is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted) (Continued)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS** | | | | | |
| Delay Time | ($V_{CC}$ = 30 Vdc, $V_{BE(off)}$ = −2.0 Vdc, $I_C$ = 150 mAdc, $I_{B1}$ = 15 mAdc) (Figure 1) | $t_d$ | – | 10 | ns |
| Rise Time | | $t_r$ | – | 25 | ns |
| Storage Time | ($V_{CC}$ = 30 Vdc, $I_C$ = 150 mAdc, $I_{B1}$ = $I_{B2}$ = 15 mAdc) (Figure 2) | $t_s$ | – | 225 | ns |
| Fall Time | | $t_f$ | – | 60 | ns |

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

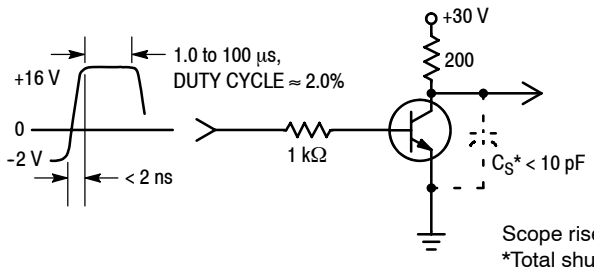



**Figure 1. Turn−On Time**

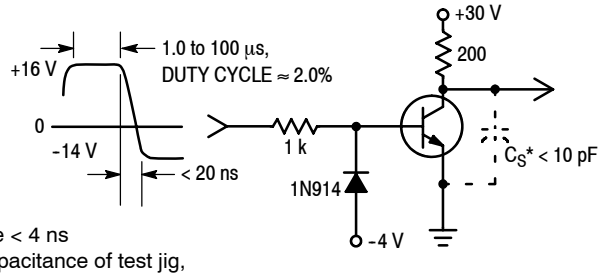



**Figure 2. Turn−Off Time**

Scope rise time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

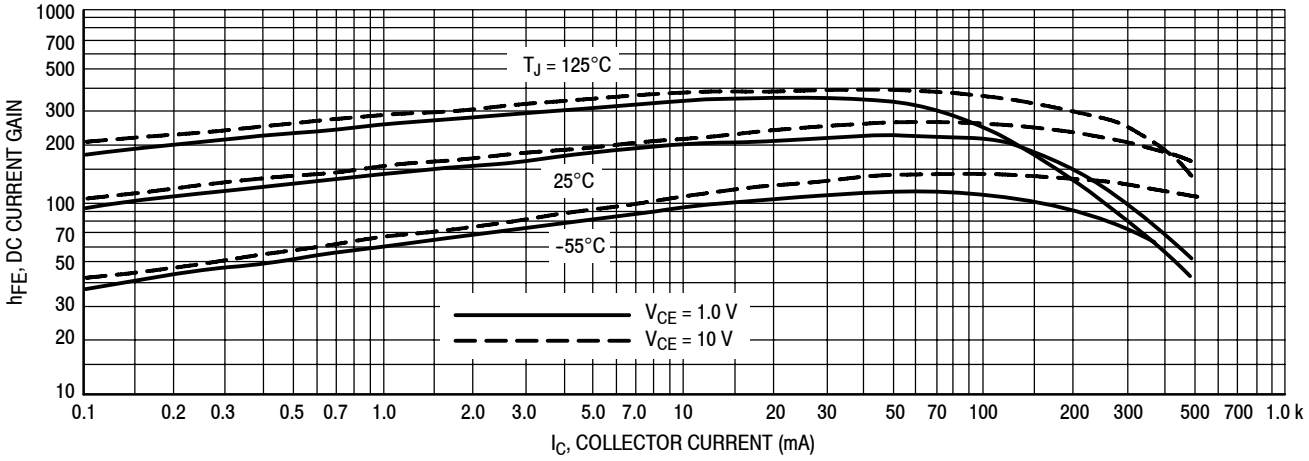



**Figure 3. DC Current Gain**

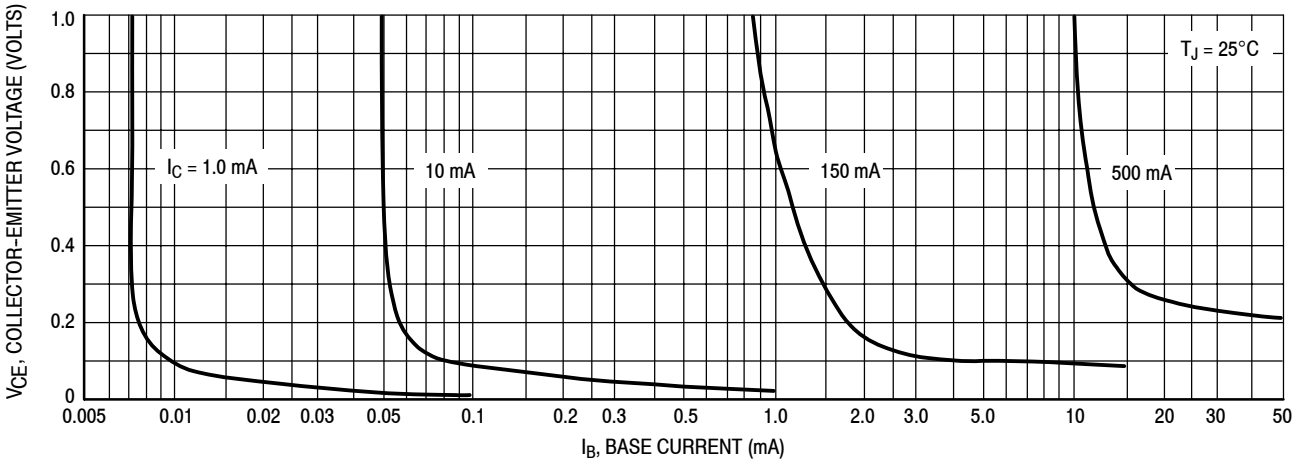



**Figure 4. Collector Saturation Region**

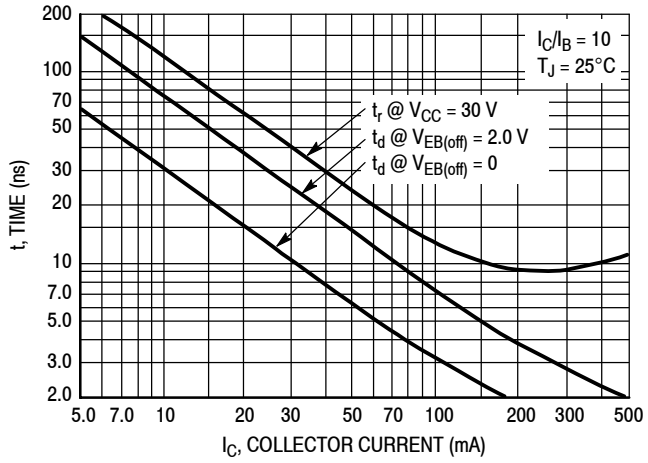



**Figure 5. Turn−On Time**

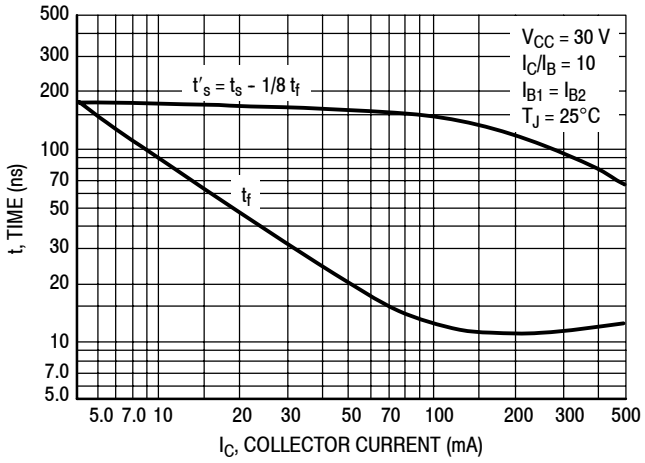



**Figure 6. Turn−Off Time**

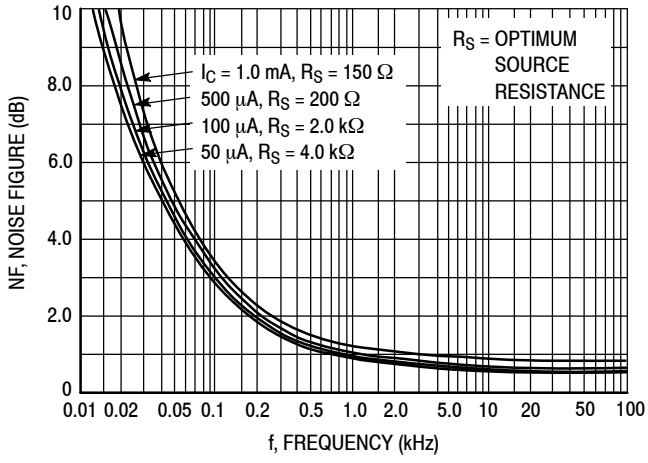



**Figure 7. Frequency Effects**

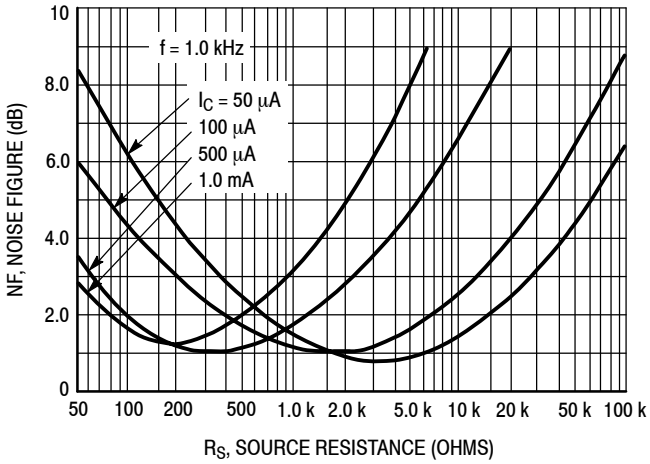



**Figure 8. Source Resistance Effects**

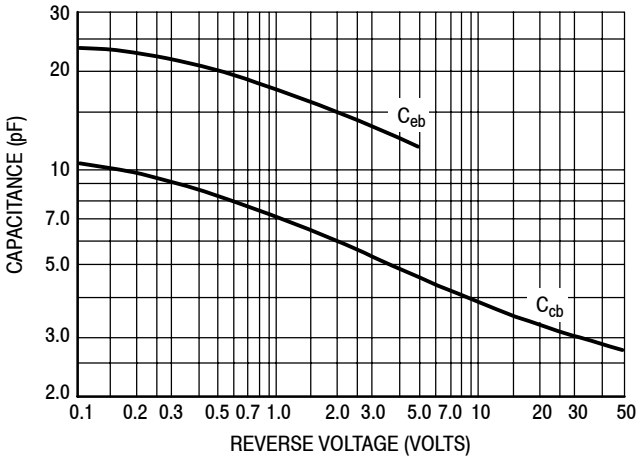



**Figure 9. Capacitances**

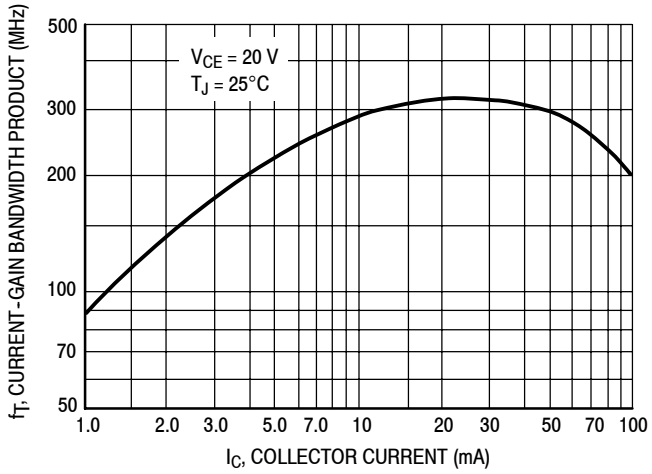



**Figure 10. Current−Gain Bandwidth Product**

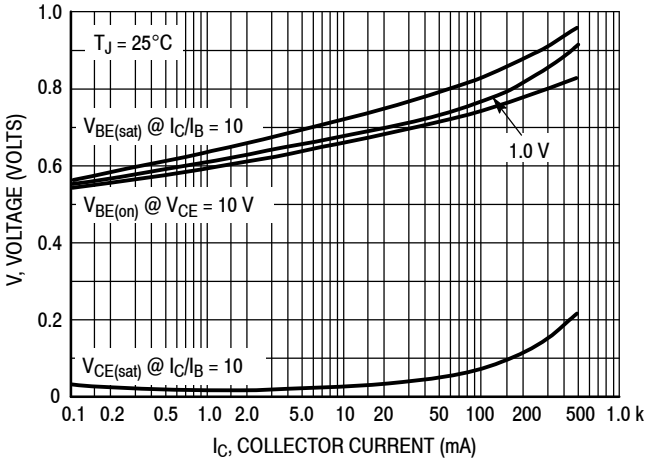



**Figure 11. “On” Voltages**

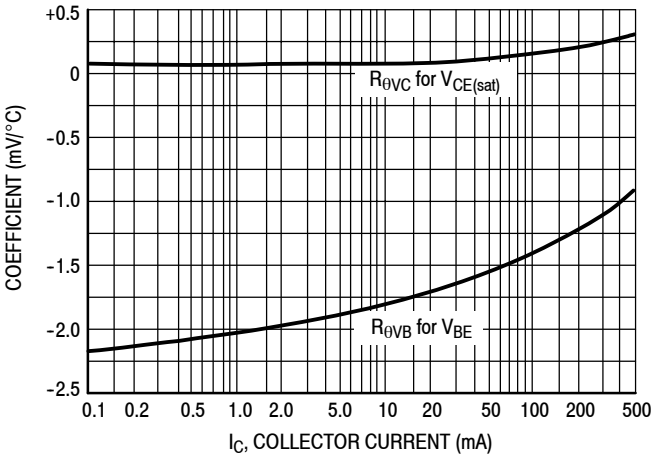
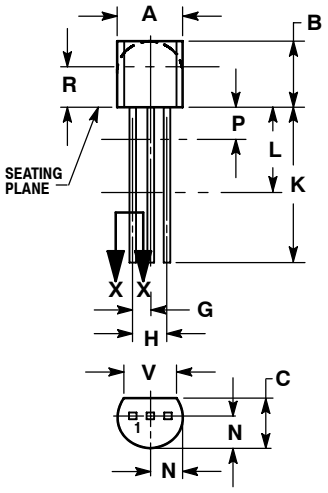


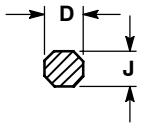

**Figure 12. Temperature Coefficients**

## PACKAGE DIMENSIONS

**TO−92 (TO−226)**
CASE 29−11
ISSUE AM



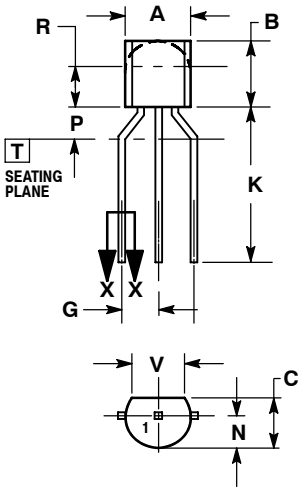

STRAIGHT LEAD
BULK PACK



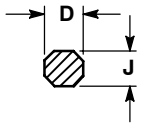

**SECTION X−X**

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.175 | 0.205 | 4.45 | 5.20 |
| B | 0.170 | 0.210 | 4.32 | 5.33 |
| C | 0.125 | 0.165 | 3.18 | 4.19 |
| D | 0.016 | 0.021 | 0.407 | 0.533 |
| G | 0.045 | 0.055 | 1.15 | 1.39 |
| H | 0.095 | 0.105 | 2.42 | 2.66 |
| J | 0.015 | 0.020 | 0.39 | 0.50 |
| K | 0.500 | --- | 12.70 | --- |
| L | 0.250 | --- | 6.35 | --- |
| N | 0.080 | 0.105 | 2.04 | 2.66 |
| P | --- | 0.100 | --- | 2.54 |
| R | 0.115 | --- | 2.93 | --- |
| V | 0.135 | --- | 3.43 | --- |




BENT LEAD
TAPE & REEL
AMMO PACK




**SECTION X−X**

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 4.45 | 5.20 |
| B | 4.32 | 5.33 |
| C | 3.18 | 4.19 |
| D | 0.40 | 0.54 |
| G | 2.40 | 2.80 |
| J | 0.39 | 0.50 |
| K | 12.70 | --- |
| N | 2.04 | 2.66 |
| P | 1.50 | 4.00 |
| R | 2.93 | --- |
| V | 3.43 | --- |

STYLE 17:
PIN 1. COLLECTOR
2. BASE
3. EMITTER



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