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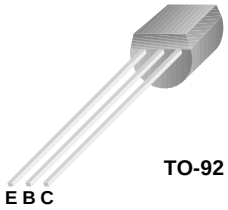
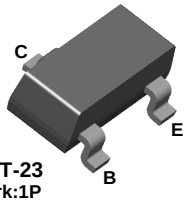
# PN2222A MMBT2222A PZT2222A




TO-92




SOT-23
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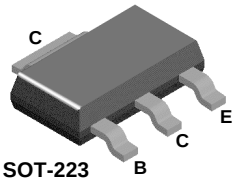



SOT-223

## NPN General Purpose Amplifier

- This device is for use as a medium power amplifier and switch requiring collector currents up to 500mA.
- Sourced from process 19.

## Absolute Maximum Ratings * $T_a$=25°C unless otherwise noted

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $V_{CEO}$ | Collector-Emitter Voltage | 40 | V |
| $V_{CBO}$ | Collector-Base Voltage | 75 | V |
| $V_{EBO}$ | Emitter-Base Voltage | 6.0 | V |
| $I_C$ | Collector Current | 1.0 | A |
| $T_{STG}$ | Operating and Storage Junction Temperature Range | - 55 ~ 150 | °C |

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired

**NOTES:**
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations

## Electrical Characteristics $T_a$=25°C unless otherwise noted

| Symbol | Parameter | Test Condition | Min. | Max. | Units |
|---|---|---|---|---|---|
| **Off Characteristics** | | | | | |
| $BV_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage * | $I_C$ = 10mA, $I_B$ = 0 | 40 | | V |
| $BV_{(BR)CBO}$ | Collector-Base Breakdown Voltage | $I_C$ = 10μA, $I_E$ = 0 | 75 | | V |
| $BV_{(BR)EBO}$ | Emitter-Base Breakdown Voltage | $I_E$ = 10μA, $I_C$ = 0 | 6.0 | | V |
| $I_{CEX}$ | Collector Cutoff Current | $V_{CE}$ = 60V, $V_{EB(off)}$ = 3.0V | | 10 | nA |
| $I_{CBO}$ | Collector Cutoff Current | $V_{CB}$ = 60V, $I_E$ = 0<br>$V_{CB}$ = 60V, $I_E$ = 0, $T_a$ = 125°C | | 0.01<br>10 | μA<br>μA |
| $I_{EBO}$ | Emitter Cutoff Current | $V_{EB}$ = 3.0V, $I_C$ = 0 | | 10 | μA |
| $I_{BL}$ | Base Cutoff Current | $V_{CE}$ = 60V, $V_{EB(off)}$ = 3.0V | | 20 | μA |
| **On Characteristics** | | | | | |
| $h_{FE}$ | DC Current Gain | $I_C$ = 0.1mA, $V_{CE}$ = 10V<br>$I_C$ = 1.0mA, $V_{CE}$ = 10V<br>$I_C$ = 10mA, $V_{CE}$ = 10V<br>$I_C$ = 10mA, $V_{CE}$ = 10V, $T_a$ = -55°C<br>$I_C$ = 150mA, $V_{CE}$ = 10V *<br>$I_C$ = 150mA, $V_{CE}$ = 10V *<br>$I_C$ = 500mA, $V_{CE}$ = 10V * | 35<br>50<br>75<br>35<br>100<br>50<br>40 | <br><br><br><br>300<br><br> | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage * | $I_C$ = 150mA, $V_{CE}$ = 10V<br>$I_C$ = 500mA, $V_{CE}$ = 10V | | 0.3<br>1.0 | V<br>V |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage * | $I_C$ = 150mA, $V_{CE}$ = 10V<br>$I_C$ = 500mA, $V_{CE}$ = 10V | 0.6 | 1.2<br>2.0 | V<br>V |

* Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2.0%

## Electrical Characteristics Ta=25°C unless otherwise noted (Continued)

| Symbol | Parameter | Test Condition | Min. | Max. | Units |
|---|---|---|---|---|---|
| **Small Signal Characteristics** | | | | | |
| $f_T$ | Current Gain Bandwidth Product | $I_C$ = 20mA, $V_{CE}$ = 20V, f = 100MHz | 300 | | MHz |
| $C_{obo}$ | Output Capacitance | $V_{CB}$ = 10V, $I_E$ = 0, f = 1MHz | | 8.0 | pF |
| $C_{ibo}$ | Input Capacitance | $V_{EB}$ = 0.5V, $I_C$ = 0, f = 1MHz | | 25 | pF |
| $rb'C_c$ | Collector Base Time Constant | $I_C$ = 20mA, $V_{CB}$ = 20V, f = 31.8MHz | | 150 | pS |
| NF | Noise Figure | $I_C$ = 100µA, $V_{CE}$ = 10V, $R_S$ = 1.0KΩ, f = 1.0KHz | | 4.0 | dB |
| $Re(h_{ie})$ | Real Part of Common-Emitter High Frequency Input Impedance | $I_C$ = 20mA, $V_{CE}$ = 20V, f = 300MHz | | 60 | Ω |
| **Switching Characteristics** | | | | | |
| $t_d$ | Delay Time | $V_{CC}$ = 30V, $V_{EB(off)}$ = 0.5V, $I_C$ = 150mA, $I_{B1}$ = 15mA | | 10 | ns |
| $t_r$ | Rise Time | | | 25 | ns |
| $t_s$ | Storage Time | $V_{CC}$ = 30V, $I_C$ = 150mA, $I_{B1}$ = $I_{B2}$ = 15mA | | 225 | ns |
| $t_f$ | Fall Time | | | 60 | ns |

## Thermal Characteristics $T_a$=25°C unless otherwise noted

| Symbol | Parameter | Max. | | | Units |
|---|---|---|---|---|---|
| | | PN2222A | *MMBT2222A | **PZT2222A | |
| $P_D$ | Total Device Dissipation<br>Derate above 25°C | 625<br>5.0 | 350<br>2.8 | 1,000<br>8.0 | mW<br>mW/°C |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 83.3 | | | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 200 | 357 | 125 | °C/W |

* Device mounted on FR-4 PCB 1.6" × 1.6" × 0.06".
** Device mounted on FR-4 PCB 36mm × 18mm × 1.5mm; mounting pad for the collector lead min. 6cm$^2$.

# Spice Model

NPN (Is = 14.34f Xti = 3 Eg = 1.11 Vaf = 74.03 Bf = 255.9 Ne = 1.307 Ise = 14.34 Ikf = .2847 Xtb = 1.5 Br = 6.092 Isc = 0 Ikr = 0 Rc = 1 Cjc = 7.306p Mjc = .3416 Vjc = .75 Fc = .5 Cje = 22.01p Mje = .377 Vje = .75 Tr = 46.91n Tf = 411.1p Itf = .6 Vtf = 1.7 Xtf = 3 Rb = 10)

# Typical Characteristics

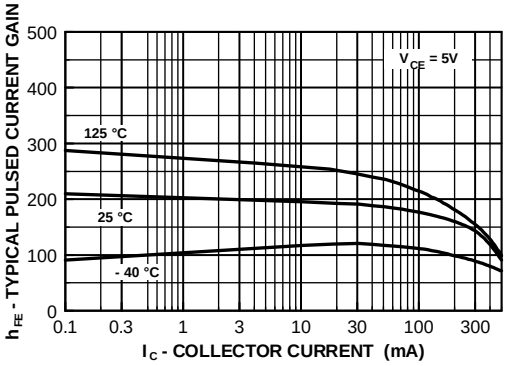



**Figure 1. Typical Pulsed Current Gain vs Collector Current**

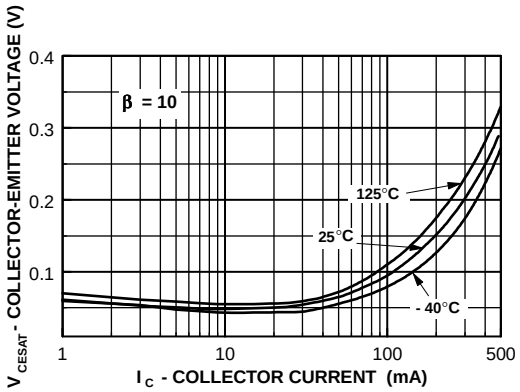



**Figure 2. Collector-Emitter Saturation Voltage vs Collector Current**

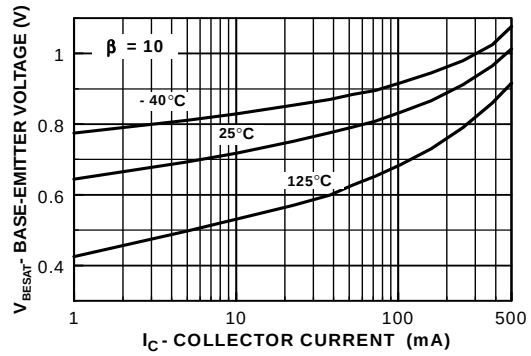



**Figure 3. Base-Emitter Saturation Voltage vs Collector Current**

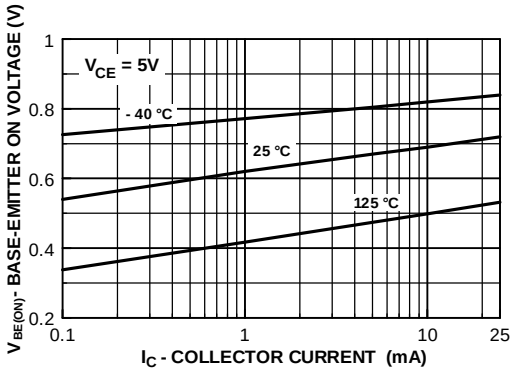



**Figure 4. Base-Emitter On Voltage vs Collector Current**

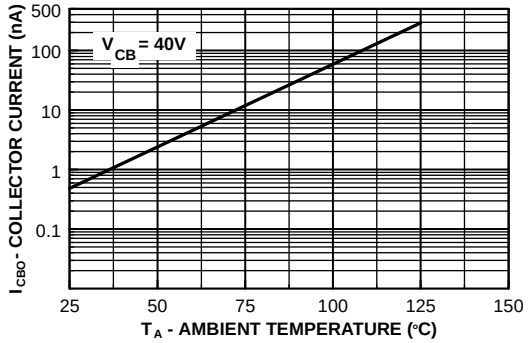



**Figure 5. Collector Cutoff Current vs Ambient Temperature**

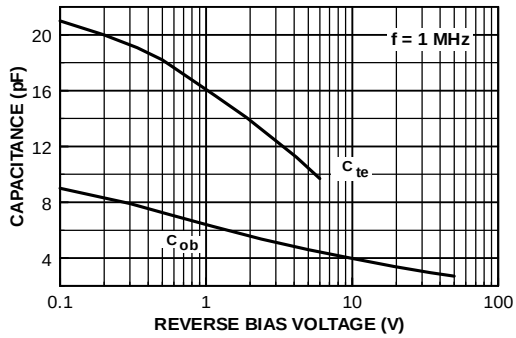



**Figure 6. Emitter Transition and Output Capacitance vs Reverse Bias Voltage**

# Typical Characteristics

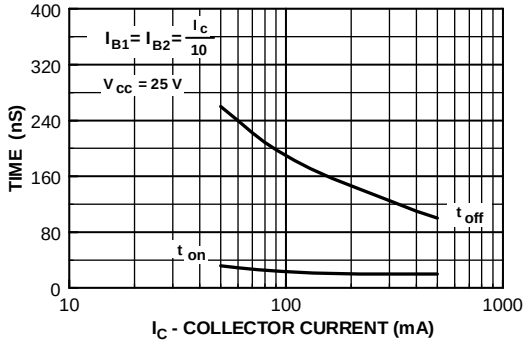



**Figure 7. Turn On and Turn Off Times vs Collector Current**

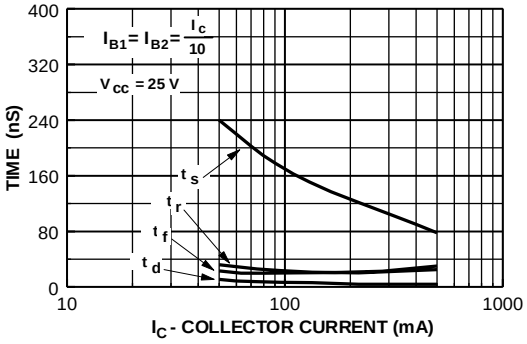



**Figure 8. Switching Times vs Collector Current**

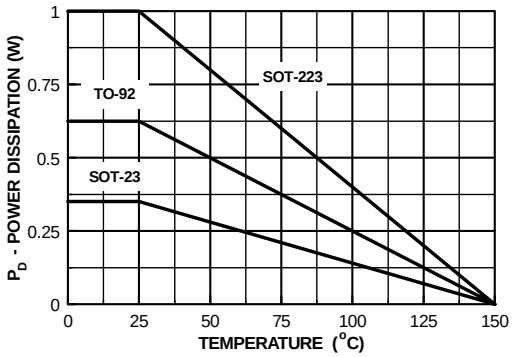



**Figure 9. Power Dissipation vs Ambient Temperature**

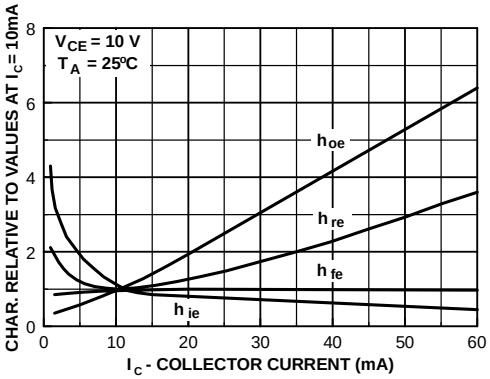



**Figure 10. Common Emitter Characteristics**

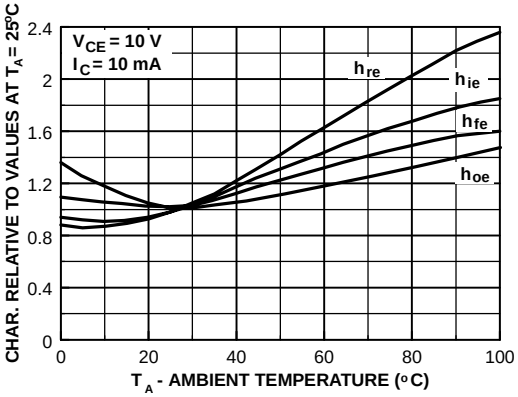



**Figure 11. Common Emitter Characteristics**

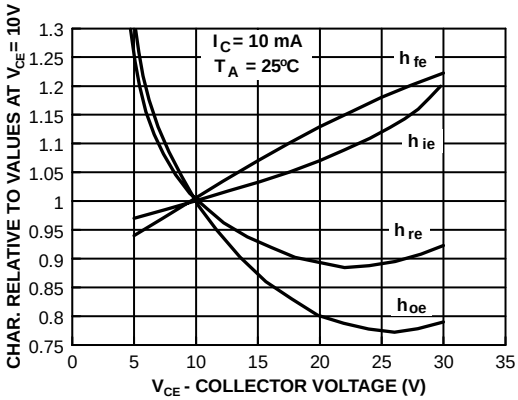
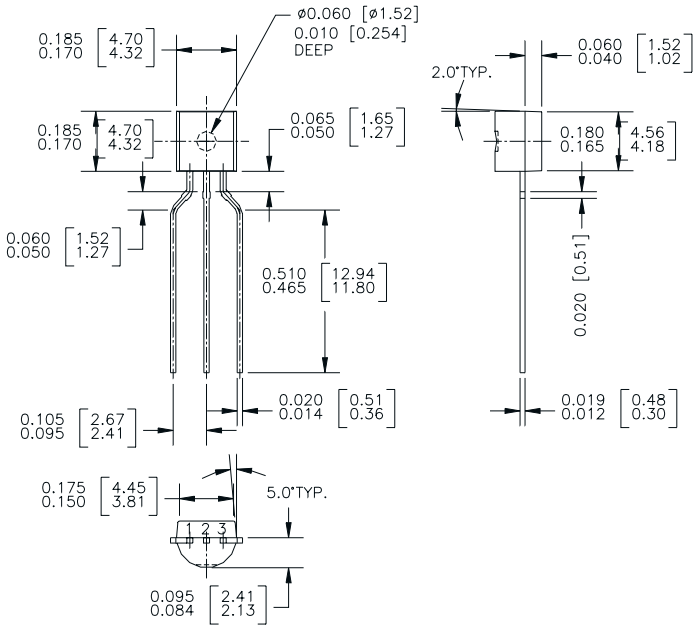



**Figure 12. Common Emitter Characteristics**

## Package Dimensions

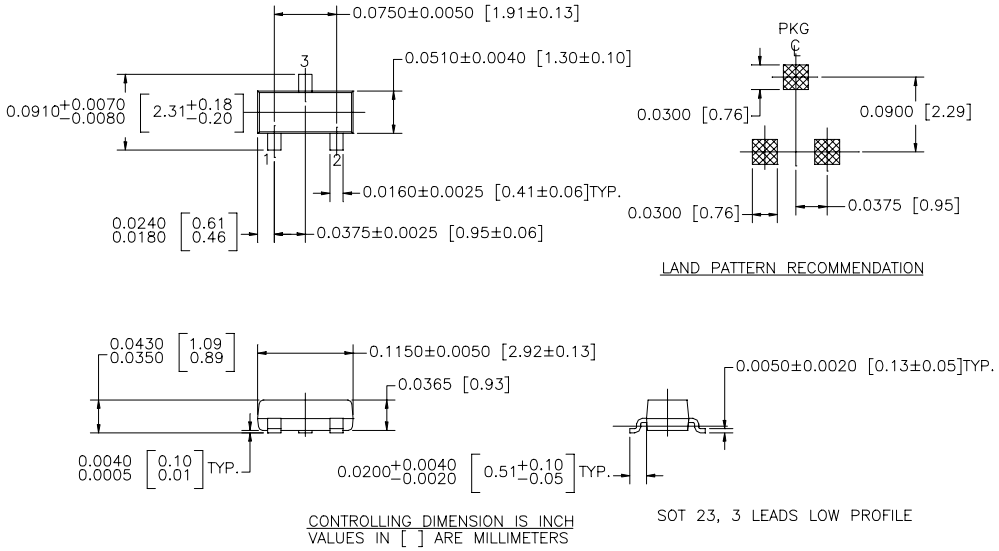
# TO-92




Dimensions in Millimeters

## Package Dimensions (Continued)

# SOT-23



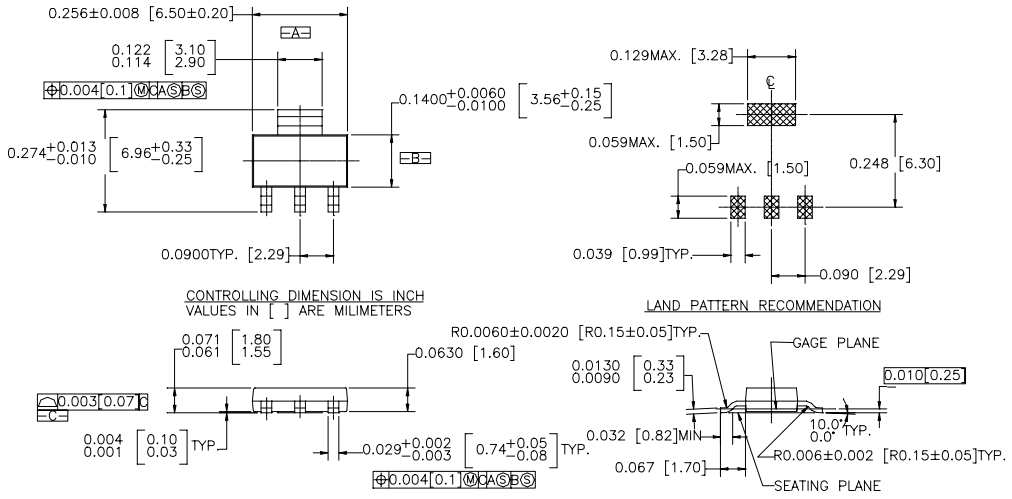

NOTE : UNLESS OTHERWISE SPECIFIED

1. STANDARD LEAD FINISH 150 MICROINCHES / 3.81 MICROMETERS MINIMUM TIN / LEAD (SOLDER) ON ALLOY 42
2. REFERENCE JEDEC REGISTRATION TO−236, VARIATION AB, ISSUE G, DATED JUL 1993

Dimensions in Millimeters

## Package Dimensions (Continued)

# SOT-223




NOTES : UNLESS OTHERWISE SPECIFIED
1. STANDARD LEAD FINISH TO BE 150 MICROINCHES/ 3.81 MICROMETERS MINIMUM TIN/LEAD (SOLDER) ON COPPER.
2. REFERENCE JEDEC REGISTRATION TO−261, VARIATION AA, ISSUE A, DATED JAN 1990

SOT223, 4 LEADS

Dimensions in Millimeters

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