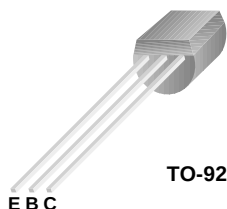
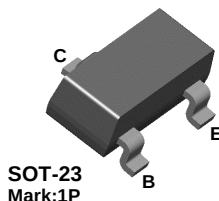


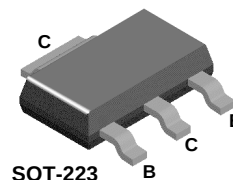
## PN2222A



## MMBT2222A



## PZT2222A



### 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 \* $T_a=25^\circ\text{C}$ 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 | $^\circ\text{C}$ |

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

#### NOTES:

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

### Electrical Characteristics $T_a=25^\circ\text{C}$ unless otherwise noted

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

\* Pulse Test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$

## Electrical Characteristics $T_a=25^{\circ}\text{C}$ unless otherwise noted (Continued)

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

## Thermal Characteristics $T_a=25^{\circ}\text{C}$ unless otherwise noted

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

\* Device mounted on FR-4 PCB  $1.6" \times 1.6" \times 0.06"$ .

\*\* Device mounted on FR-4 PCB  $36\text{mm} \times 18\text{mm} \times 1.5\text{mm}$ ; mounting pad for the collector lead min.  $6\text{cm}^2$ .

## 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

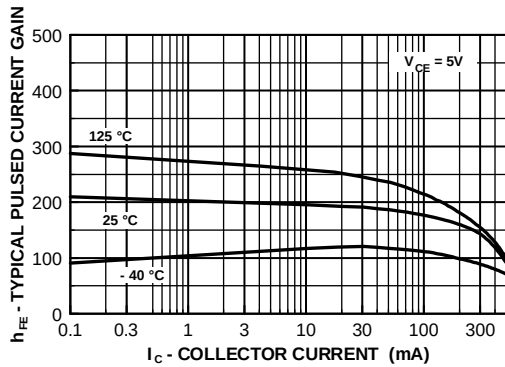


Figure 1. Typical Pulsed Current Gain vs Collector Current

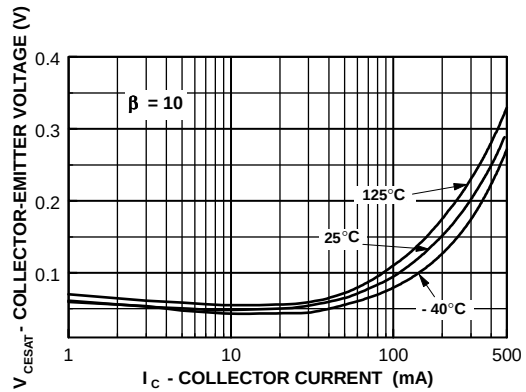


Figure 2. Collector-Emitter Saturation Voltage vs Collector Current

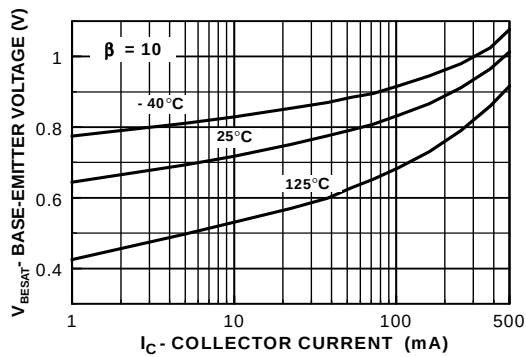


Figure 3. Base-Emitter Saturation Voltage vs Collector Current

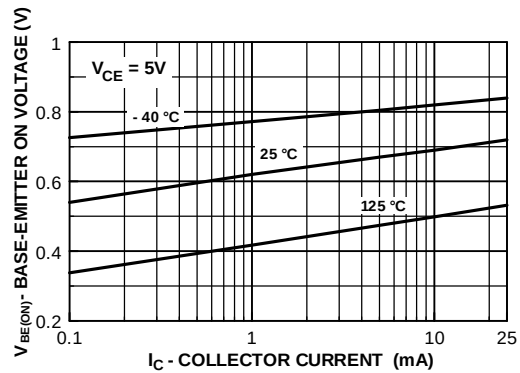


Figure 4. Base-Emitter On Voltage vs Collector Current

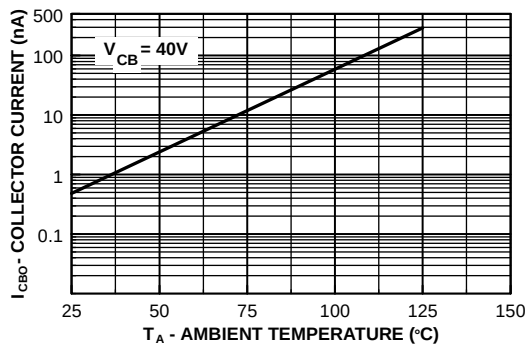


Figure 5. Collector Cutoff Current vs Ambient Temperature

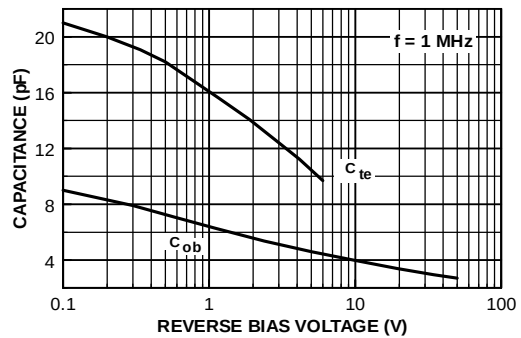


Figure 6. Emitter Transition and Output Capacitance vs Reverse Bias Voltage

## Typical Characteristics

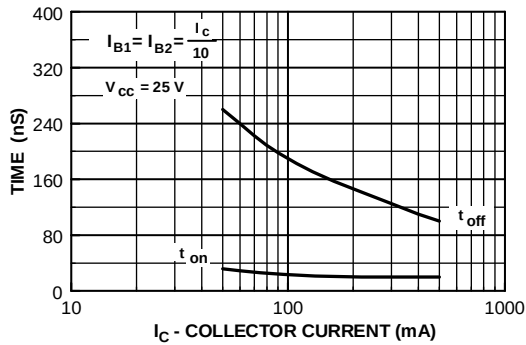


Figure 7. Turn On and Turn Off Times vs Collector Current

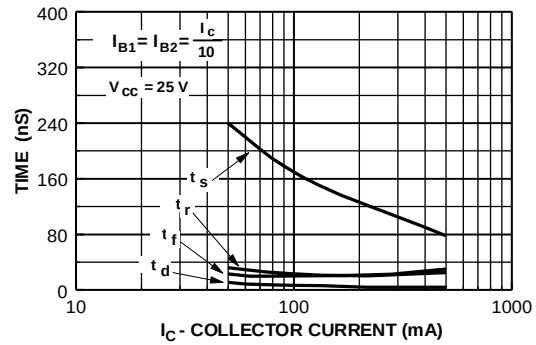


Figure 8. Switching Times vs Collector Current

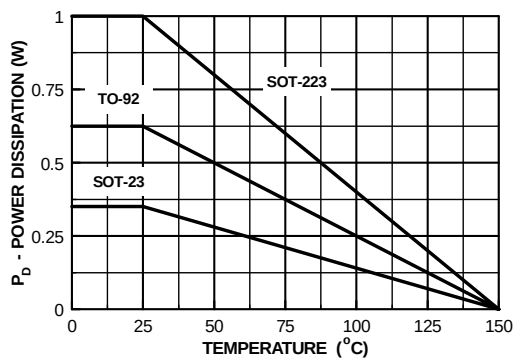


Figure 9. Power Dissipation vs Ambient Temperature

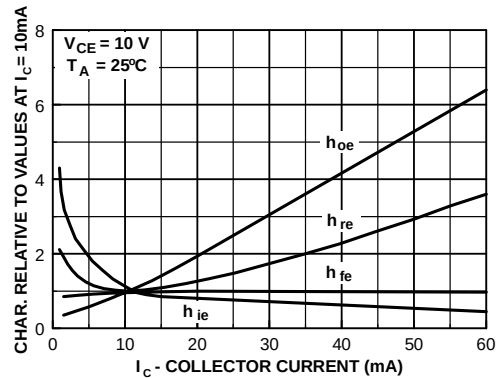


Figure 10. Common Emitter Characteristics

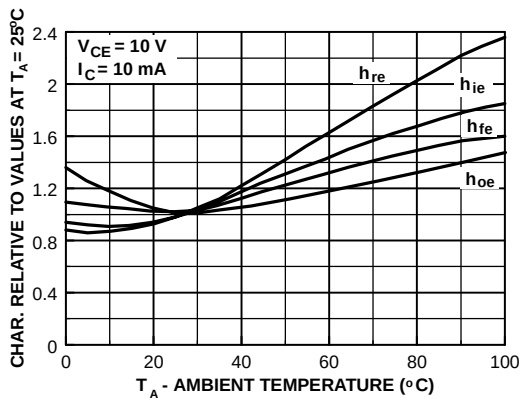


Figure 11. Common Emitter Characteristics

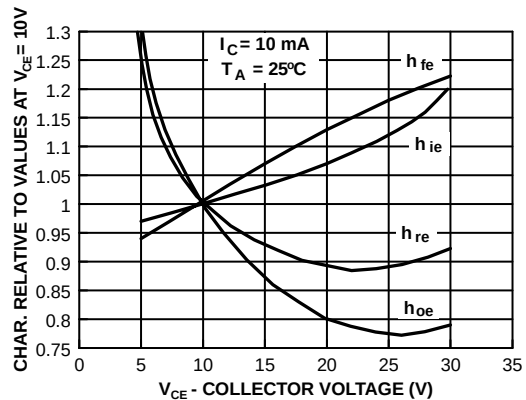
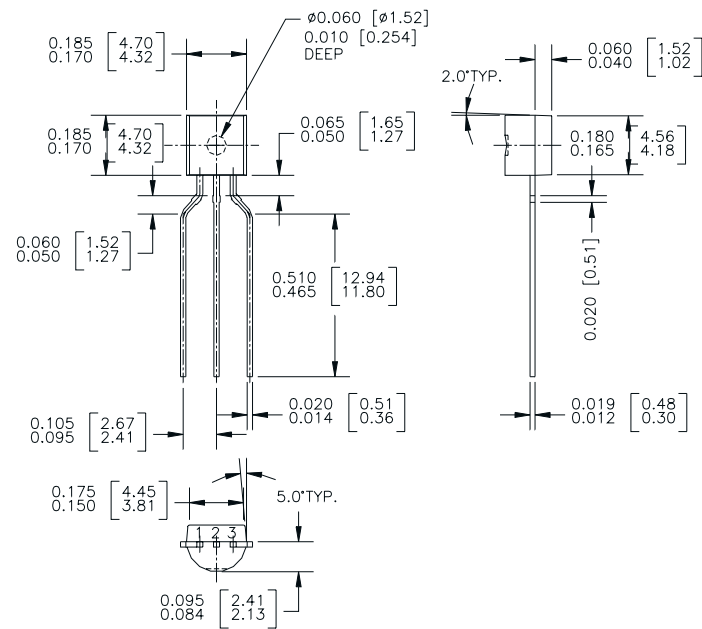


Figure 12. Common Emitter Characteristics

## Package Dimensions

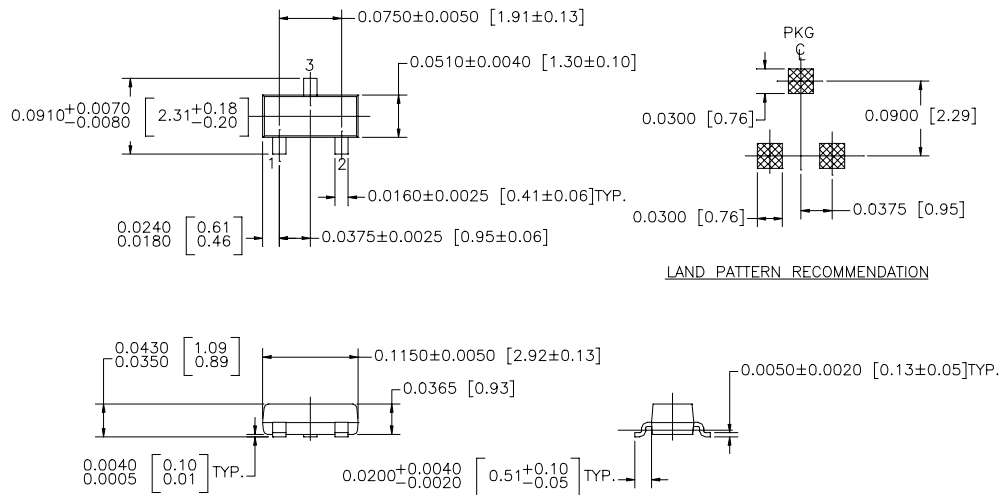
### TO-92



Dimensions in Millimeters

## Package Dimensions (Continued)

### SOT-23



CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

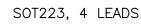
SOT 23, 3 LEADS LOW PROFILE

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

# SOT-223



Dimensions in Millimeters

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| Bottomless <sup>™</sup>                          | FPS <sup>™</sup>                | MICROCOUPLER <sup>™</sup> | PowerTrench <sup>®</sup>        | SuperSOT <sup>™</sup> -6    |
| CoolFET <sup>™</sup>                             | FRFET <sup>™</sup>              | MicroFET <sup>™</sup>     | QFET <sup>®</sup>               | SuperSOT <sup>™</sup> -8    |
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| The Power Franchise <sup>®</sup>                 |                                 | PACMAN <sup>™</sup>       | SPM <sup>™</sup>                |                             |
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|--------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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