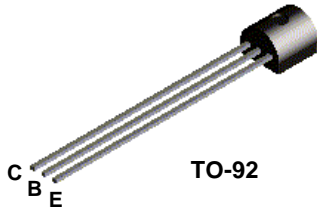


# N

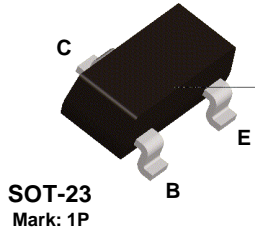
**Discrete POWER & Signal Technologies**

PN2222A / MMBT2222A / MMPQ2222 / NMT2222 / PZT2222A

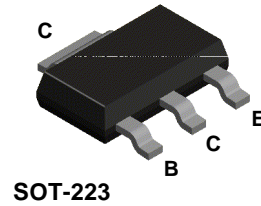
## PN2222A



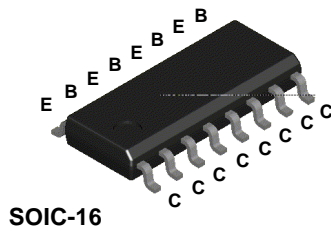
## MMBT2222A



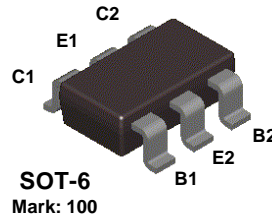
## PZT2222A



## MMPQ2222



## NMT2222



## NPN General Purpose Amplifier

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

### Absolute Maximum Ratings\*

TA = 25°C unless otherwise noted

| Symbol                            | Parameter  | Value       | Units |
|-----------------------------------|--|-------------|-------|
| V <sub>CEO</sub>                  | Collector-Emitter Voltage                        | 40          | V     |
| V <sub>CBO</sub>                  | Collector-Base Voltage                           | 75          | V     |
| V <sub>EBO</sub>                  | Emitter-Base Voltage                             | 6.0         | V     |
| I <sub>C</sub>                    | Collector Current - Continuous                   | 1.0         | A     |
| T <sub>J</sub> , T <sub>stg</sub> | Operating and Storage Junction Temperature Range | -55 to +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.

## NPN General Purpose Amplifier

(continued)

### Electrical Characteristics

TA = 25°C unless otherwise noted

| Symbol                     | Parameter                            | Test Conditions   | Min | Max        | Units                          |
|----------------------------|--------------------------------------|---|-----|------------|--------------------------------|
| <b>OFF CHARACTERISTICS</b> |                                      |   |     |            |                                |
| $V_{(BR)CEO}$              | Collector-Emitter Breakdown Voltage* | $I_C = 10 \text{ mA}, I_B = 0$  | 40  |            | V                              |
| $V_{(BR)CBO}$              | Collector-Base Breakdown Voltage     | $I_C = 10 \text{ } \mu\text{A}, I_E = 0$  | 75  |            | V                              |
| $V_{(BR)EBO}$              | Emitter-Base Breakdown Voltage       | $I_E = 10 \text{ } \mu\text{A}, I_C = 0$  | 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>$V_{CB} = 60 \text{ V}, I_E = 0, T_A = 150^\circ\text{C}$ |     | 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         | nA                             |
| $I_{BL}$                   | Base Cutoff Current                  | $V_{CE} = 60 \text{ V}, V_{EB(OFF)} = 3.0 \text{ V}$  |     | 20         | nA                             |

### ON CHARACTERISTICS

|               |                                       |   |   |            |        |
|---------------|---------------------------------------|---|---|------------|--------|
| $h_{FE}$      | 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>$I_C = 150 \text{ mA}, V_{CE} = 1.0 \text{ V}^*$<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* | $I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$<br>$I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$  |   | 0.3<br>1.0 | V<br>V |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage*      | $I_C = 150 \text{ mA}, I_B = 1.0 \text{ mA}$<br>$I_C = 500 \text{ mA}, I_B = 5.0 \text{ mA}$  | 0.6                                     | 1.2<br>2.0 | V<br>V |

### SMALL SIGNAL CHARACTERISTICS (except MMPQ2222 and NMT2222)

|              |  |  |     |     |          |
|--------------|--|--|-----|-----|----------|
| $f_T$        | Current Gain - Bandwidth Product                           | $I_C = 20 \text{ mA}, V_{CE} = 20 \text{ V}, f = 100 \text{ MHz}$  | 300 |     | MHz      |
| $C_{obo}$    | Output Capacitance   | $V_{CB} = 10 \text{ V}, I_E = 0, f = 100 \text{ kHz}$  |     | 8.0 | pF       |
| $C_{ibo}$    | Input Capacitance  | $V_{EB} = 0.5 \text{ V}, I_C = 0, f = 100 \text{ kHz}$   |     | 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   | $I_C = 100 \text{ } \mu\text{A}, V_{CE} = 10 \text{ V},$<br>$R_S = 1.0 \text{ k}\Omega, f = 1.0 \text{ kHz}$ |     | 4.0 | dB       |
| $Re(h_{ie})$ | Real Part of Common-Emitter High Frequency Input Impedance | $I_C = 20 \text{ mA}, V_{CE} = 20 \text{ V}, f = 300 \text{ MHz}$  |     | 60  | $\Omega$ |

### SWITCHING CHARACTERISTICS (except MMPQ2222 and NMT2222)

|       |              |   |  |     |    |
|-------|--------------|---|--|-----|----|
| $t_d$ | Delay Time   | $V_{CC} = 30 \text{ V}, V_{BE(OFF)} = 0.5 \text{ V},$ |  | 10  | ns |
| $t_r$ | Rise Time    | $I_C = 150 \text{ mA}, I_{B1} = 15 \text{ mA}$        |  | 25  | ns |
| $t_s$ | Storage Time | $V_{CC} = 30 \text{ V}, I_C = 150 \text{ mA},$        |  | 225 | ns |
| $t_f$ | Fall Time    | $I_{B1} = I_{B2} = 15 \text{ mA}$                     |  | 60  | ns |

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

### Spice Model

NPN (Is=14.34f Xti=3 Eg=1.11 Vaf=74.03 Bf=255.9 Ne=1.307 Ise=14.34f Ikf=.2847 Xtb=1.5 Br=6.092 Nc=2 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)

PN2222A / MMBT2222A / MMPQ2222 / NMT2222 / PZT2222A

# NPN General Purpose Amplifier

(continued)

## Thermal Characteristics

TA = 25°C unless otherwise noted

| Symbol           | Characteristic                                | Max     |           | Units |
|------------------|---|---------|-----------|-------|
|                  |   | PN2222A | *PZT2222A |       |
| P <sub>D</sub>   | Total Device Dissipation<br>Derate above 25°C | 625     | 1,000     | mW    |
|                  |   | 5.0     | 8.0       | mW/°C |
| R <sub>θJC</sub> | Thermal Resistance, Junction to Case          | 83.3    |           | °C/W  |
| R <sub>θJA</sub> | Thermal Resistance, Junction to Ambient       | 200     | 125       | °C/W  |

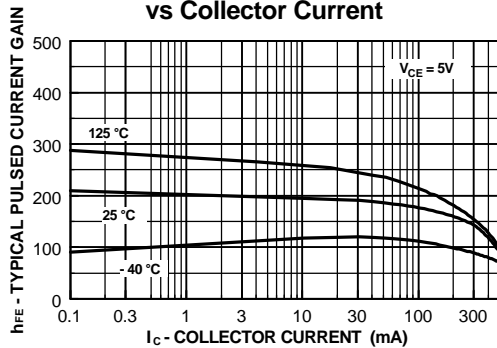
| Symbol           | Characteristic   | Max         |          | Units |
|------------------|--|-------------|----------|-------|
|                  |  | **MMBT2222A | MMPQ2222 |       |
| P <sub>D</sub>   | Total Device Dissipation<br>Derate above 25°C                          | 350         | 1,000    | mW    |
|                  |  | 2.8         | 8.0      | mW/°C |
| R <sub>θJA</sub> | Thermal Resistance, Junction to Ambient<br>Effective 4 Die<br>Each Die | 357         |          | °C/W  |
|                  |  |             | 125      | °C/W  |
|                  |  |             | 240      | °C/W  |

\* Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6  $\mu$ m

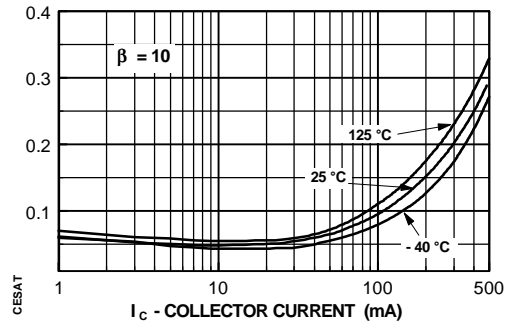
\*\* Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

## Typical Characteristics

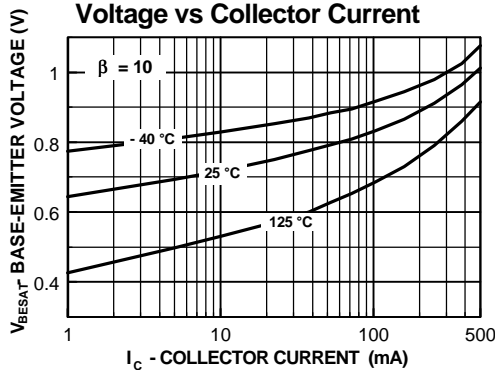
Typical Pulsed Current Gain vs Collector Current



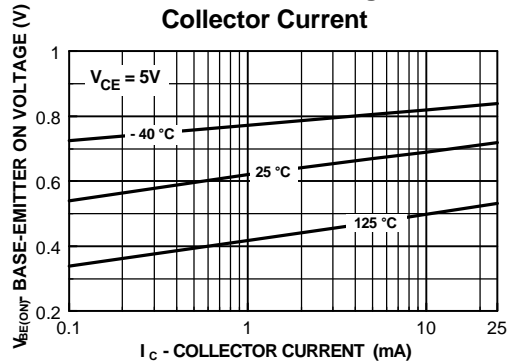
Collector-Emitter Saturation Voltage vs Collector Current



Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current



PN2222A / MMBT2222A / MMPQ2222 / NMT2222 / PZT2222A

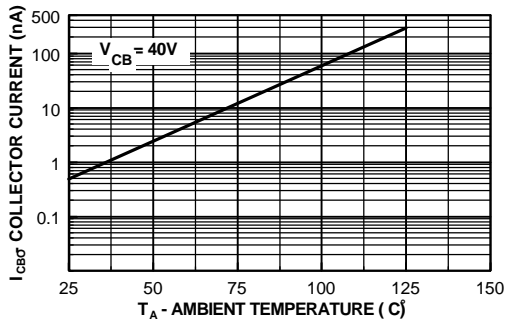
# NPN General Purpose Amplifier

(continued)

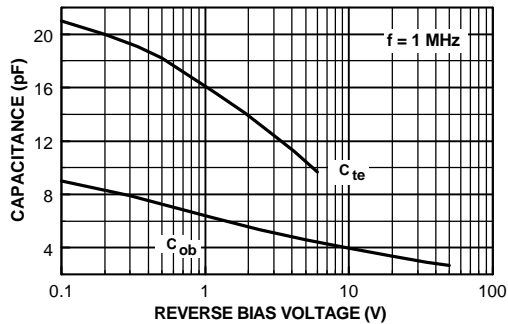
PN2222A / MMBT2222A / MMPQ2222 / NMT2222 / PZT2222A

## Typical Characteristics (continued)

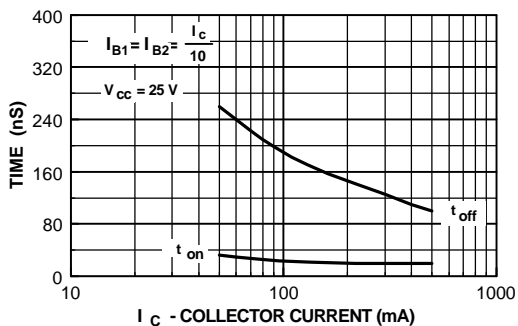
**Collector-Cutoff Current vs Ambient Temperature**



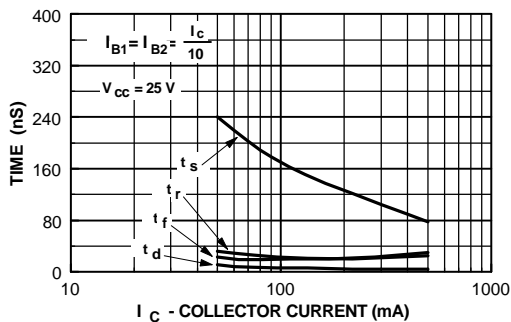
**Emitter Transition and Output Capacitance vs Reverse Bias Voltage**



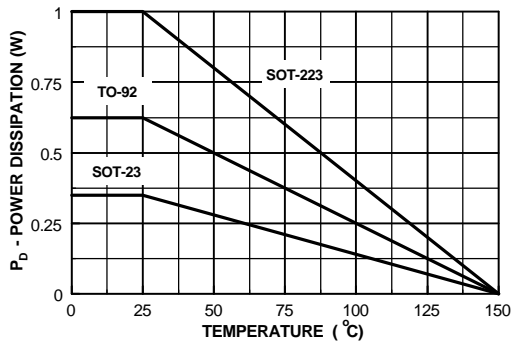
**Turn On and Turn Off Times vs Collector Current**



**Switching Times vs Collector Current**



**Power Dissipation vs Ambient Temperature**



Test Circuits

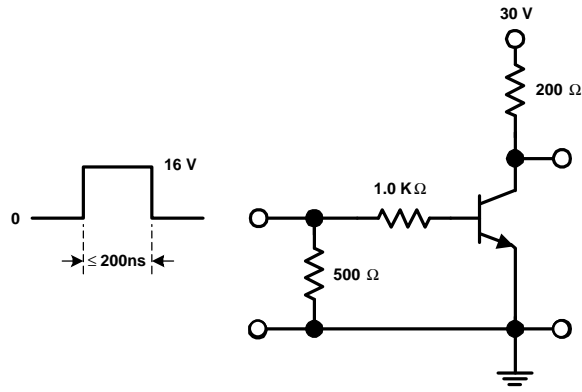


FIGURE 1: Saturated Turn-On Switching Time

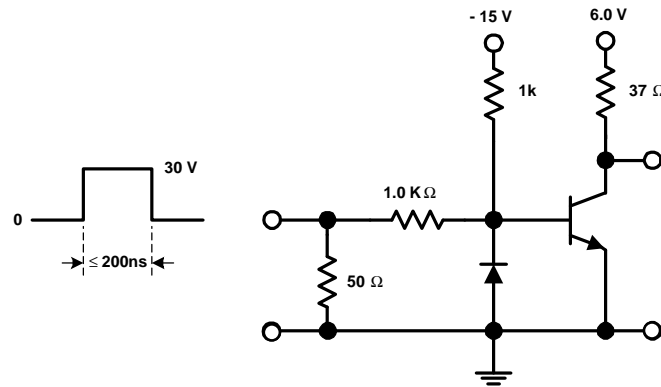


FIGURE 2: Saturated Turn-Off Switching Time