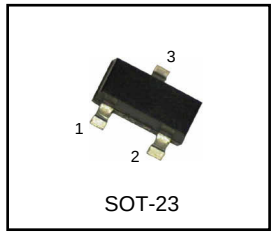
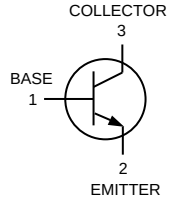
# General Purpose Transistor

## NPN Silicon

**MMBT2222A**




SOT-23




### MAXIMUM RATINGS

| Rating | 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 |

### THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max. | Unit |
|---|---|---|---|
| Total Device Dissipation FR-5 Board(1) $T_A$=25°C<br>Derate above 25°C | $P_D$ | 225<br>1.8 | mW<br>mW / °C |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | 556 | °C / W |
| Total Device Dissipation Alumina Substrate,(2) $T_A$=25°C<br>Derate above 25°C | $P_D$ | 300<br>2.4 | mW<br>mW / °C |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | 417 | °C / W |
| Junction and Storage Temperature | $T_J$,$T_{STG}$ | -55 to +150 | °C |

### DEVICE MARKING

**MMBT2222A=1P**

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

| Characteristic | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | |
| Collector-Emitter Breakdowe Voltage<br>( $I_C$=10mAdc, $I_B$=0 ) | $V_{(BR)CEO}$ | 40 | - | Vdc |
| Collector-Emitter Breakdowe Voltage<br>( $I_C$=10uAdc, $I_E$=0 ) | $V_{(BR)CBO}$ | 75 | - | Vdc |
| Emitter - Base Breakdowe Voltage<br>( $I_E$=10 uAdc, $I_C$=0 ) | $V_{(BR)EBO}$ | 6.0 | - | Vdc |
| Collector Cutoff Current<br>( $V_{CE}$=60 Vdc, $V_{EB\ (off)}$=3.0 Vdc ) | $I_{CEX}$ | - | 10 | nAdc |
| Collector Cutoff Current<br>( $V_{CB}$=60 Vdc, $I_E$=0 )<br>( $V_{CB}$=60 Vdc, $I_E$=0, $T_A$=125°C ) | $I_{CBO}$ | -<br>- | 0.01<br>10 | uAdc |
| Emitter Cutoff Current ( $V_{EB}$=3.0 Vdc, $I_C$=0 ) | $I_{EBO}$ | - | 100 | nAdc |
| Base Cutoff Current ( $V_{CE}$=60 V, $V_{EB\ (off)}$=3.0 Vdc ) | $I_{BL}$ | - | 20 | nAdc |

(1) FR-5=1.0 x 0.75 x 0.062in.
(2) Alumina=0.4 x 0.3 x 0.024in. 99.5% alumina.

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

| Characteristic | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| **ON CHARACTERISTICS**(3) | | | | |
| DC Current Gain | | | | |
| ( $I_C$=0.1 mAdc, $V_{CE}$=10 Vdc ) | $H_{FE}$ | 35 | - | - |
| ( $I_C$=1.0 mAdc, $V_{CE}$=10 Vdc ) | | 50 | - | |
| ( $I_C$=10 mAdc, $V_{CE}$=10 Vdc ) | | 75 | - | |
| ( $I_C$=10 mAdc, $V_{CE}$=10 Vdc, $T_A$=-55°C ) | | 35 | - | |
| ( $I_C$=150 mAdc, $V_{CE}$=10 Vdc )(3) | | 100 | 300 | |
| ( $I_C$=150 mAdc, $V_{CE}$=1.0 Vdc )(3) | | 50 | - | |
| ( $I_C$=500 mAdc, $V_{CE}$=10 Vdc )(3) | | 40 | - | |
| Collector-Emitter Saturation Voltage(3) | $V_{CE}$(sat) | | | Vdc |
| ( $I_C$=150 mAdc, $I_B$=15 mAdc ) | | - | 0.3 | |
| ( $I_C$=500 mAdc, $I_B$=50 mAdc ) | | - | 1.0 | |
| Base-Emitter Saturation Voltage(3) | $V_{BE}$(sat) | | | Vdc |
| ( $I_C$=150 mAdc, $I_B$=15 mAdc ) | | 0.6 | 1.2 | |
| ( $I_C$=500 mAdc, $I_B$=50 mAdc ) | | - | 2.0 | |
| **SMALL-SIGNAL CHARACTERISTIC** | | | | |
| Current-Gain-Bandwidth Product(4) | $f_T$ | 300 | - | MHz |
| ( $I_C$=20 mAdc, $V_{CE}$=20 Vdc, f=100 MHz ) | | | | |
| Output Capacitance | Cobo | - | 8.0 | pF |
| ( $V_{CB}$=10 Vdc, $I_E$=0, f=1.0 MHz ) | | | | |
| Input Capacitance | Cibo | - | 25 | pF |
| ( $V_{EB}$=0.5 Vdc, $I_C$=0, f=1.0 MHz ) | | | | |
| Input Impedance | hie | | | k ohms |
| ( $V_{CE}$=10 Vdc, $I_C$=1.0 mAdc, f=1.0 kHz ) | | 2.0 | 8.0 | |
| ( $V_{CE}$=10 Vdc, $I_C$=10 mAdc, f=1.0 kHz ) | | 0.25 | 1.25 | |
| Voltage Feedback Ratio | hre | | | X $10^{-4}$ |
| ( $V_{CE}$=10 Vdc, $I_C$=1.0 mAdc, f=1.0 kHz ) | | - | 8.0 | |
| ( $V_{CE}$=10 Vdc, $I_C$=10 mAdc, f=1.0 kHz ) | | - | 4.0 | |
| Small-Signal Current Gain | hfe | | | - |
| ( $V_{CE}$=10 Vdc, $I_C$=1.0 mAdc, f=1.0 kHz ) | | 50 | 300 | |
| ( $V_{CE}$=10 Vdc, $I_C$=10 mAdc, f=1.0 kHz ) | | 75 | 375 | |
| Output Admittance | hoe | | | u mhos |
| ( $V_{CE}$=10 Vdc, $I_C$=1.0 mAdc, f=1.0 kHz ) | | 5.0 | 35 | |
| ( $V_{CE}$=10 Vdc, $I_C$=10 mAdc, f=1.0 kHz ) | | 25 | 200 | |
| Collector Base Time Constant | rb, Cc | - | 150 | ps |
| ( $V_{CB}$=10 Vdc, $I_C$=100 uAdc, $R_S$ = 1.0 k ohms, f=1.0 kHz ) | | | | |
| Noise Figure | NF | - | 4.0 | dB |
| ( $V_{CE}$=10 Vdc, $I_C$=100 uAdc, $R_S$=1.0 k ohm, f=1.0 kHz ) | | | | |

**SWITCHING CHARACTERISTICS**

| | | | | | |
|---|---|---|---|---|---|
| Delay Time | ( $V_{CC}$=30 Vdc, $V_{BE\ (off)}$ = -0.5 Vdc, $I_C$ =150 mAdc, $I_{B1}$ = 15 mAdc ) | td | - | 10 | nS |
| Rise Time | | tr | - | 25 | |
| Storage Time | ( $V_{CC}$=30 Vdc, $I_C$ = 150 mAdc, $I_{B1}$ =$I_{B2}$ = 15 mAdc ) | ts | - | 225 | nS |
| Fall Time | | tf | - | 60 | |

(3) Pulse Test : Pulse Width ≦ 300 uS, Duty Cycle ≦ 2.0%.
(2) fT is defined as the frequency at which hfe extrapolates to unity.

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

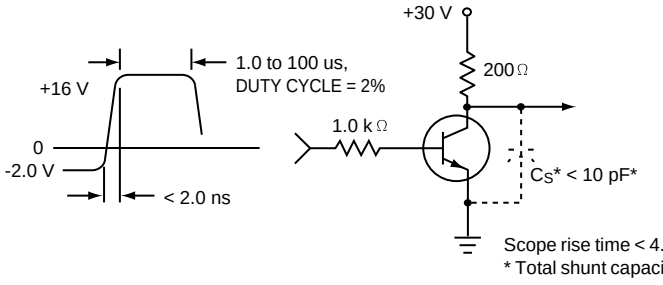



**Figure 1. Turn-On Time**

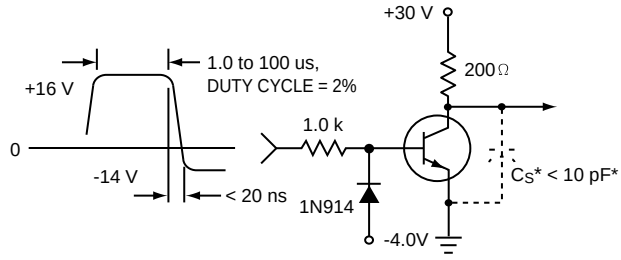



**Figure 2. Turn-Off Time**

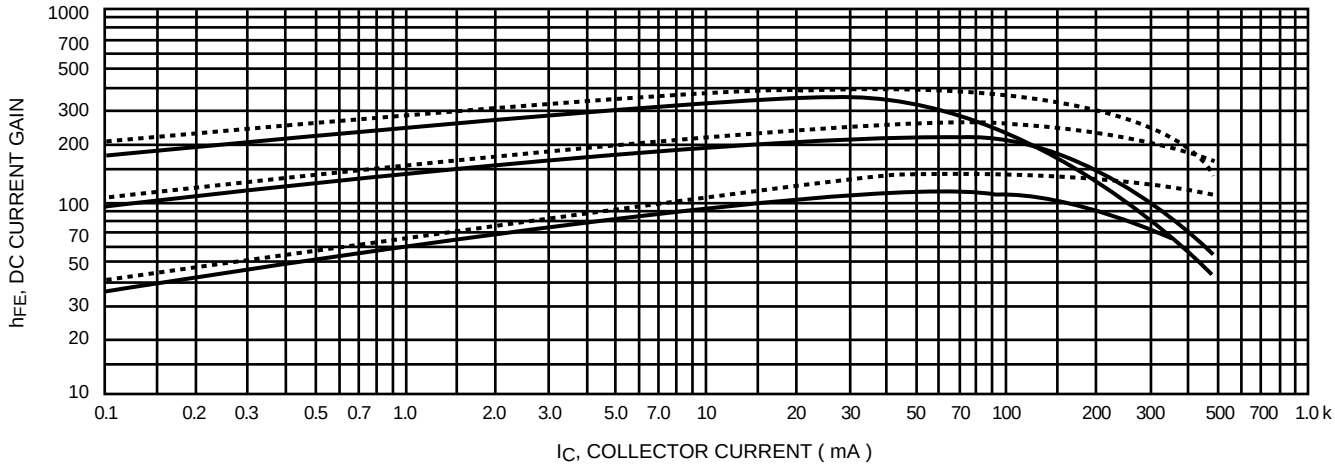



**Figure 3. DC Current Gain**

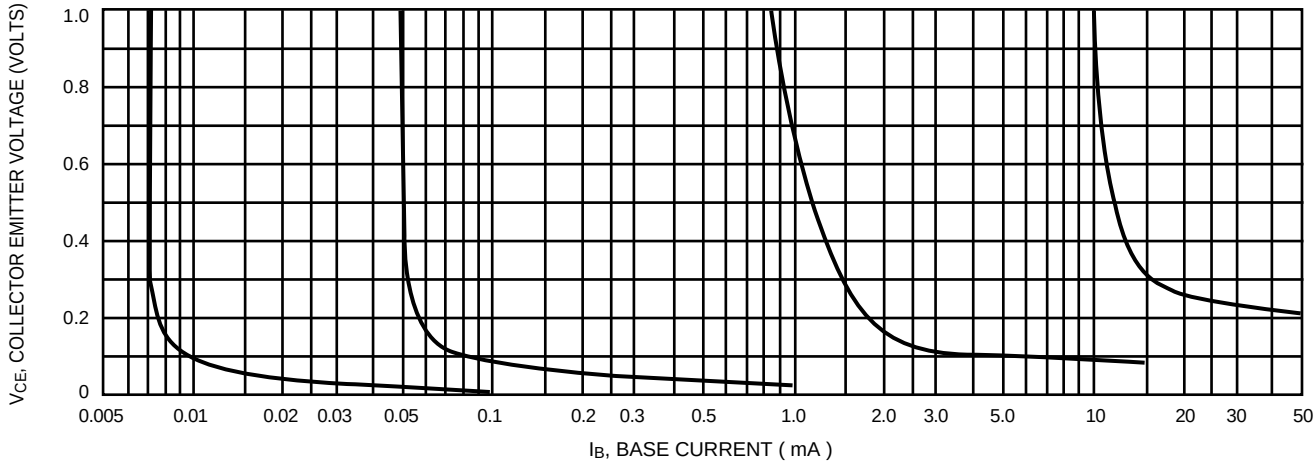



**Figure 4. Collector Saturation Region**

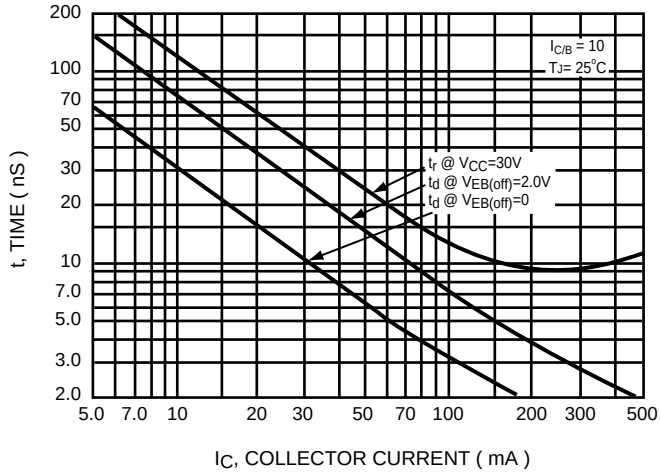



**Figure 5. Turn - On Time**

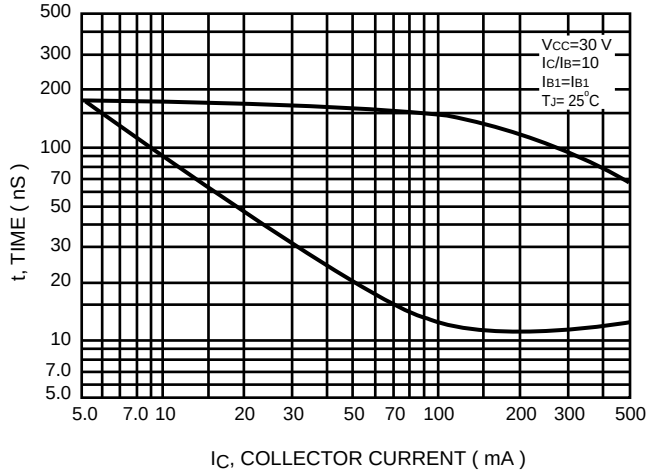



**Figure 6. Turn - Off Time**

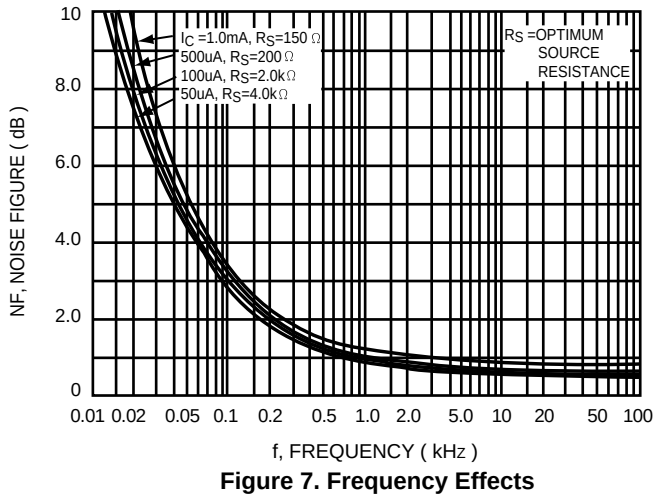



**Figure 7. Frequency Effects**

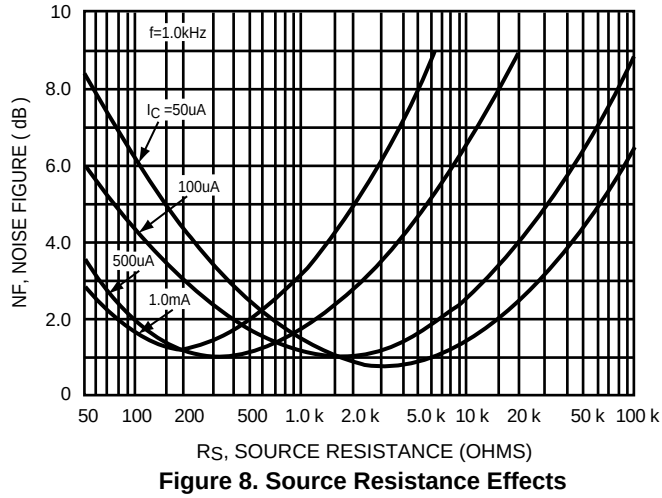



**Figure 8. Source Resistance Effects**

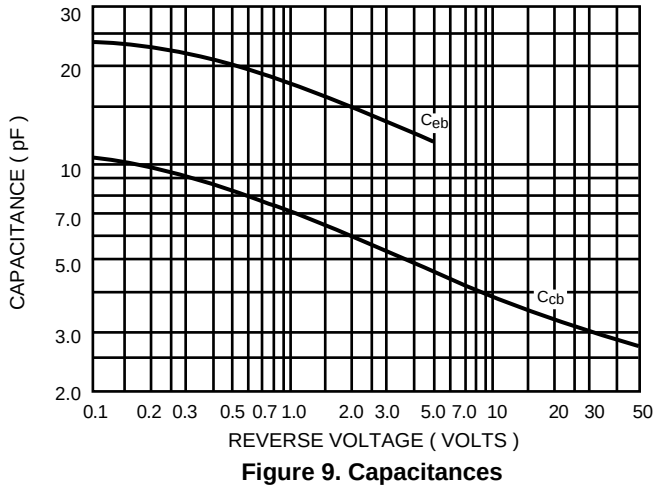



**Figure 9. Capacitances**

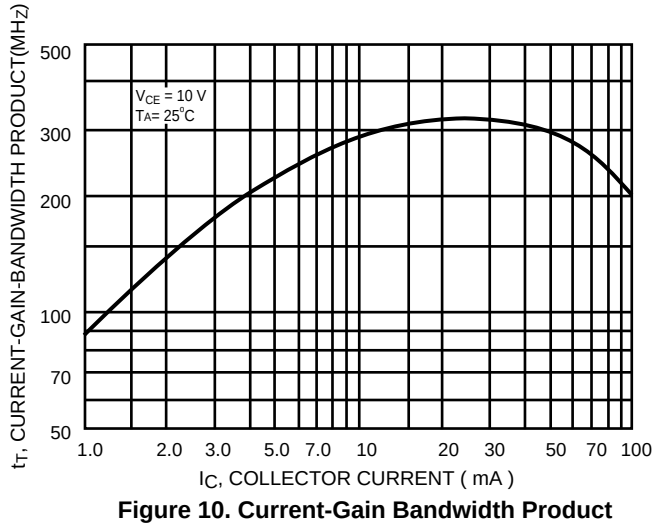



**Figure 10. Current-Gain Bandwidth Product**

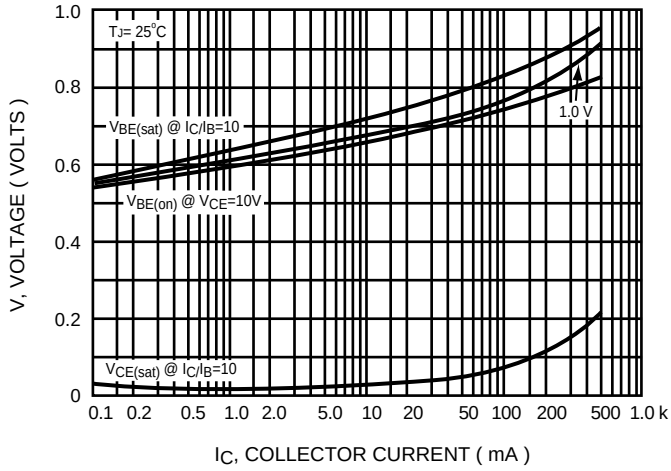



**Figure 11. " On " Voltage**

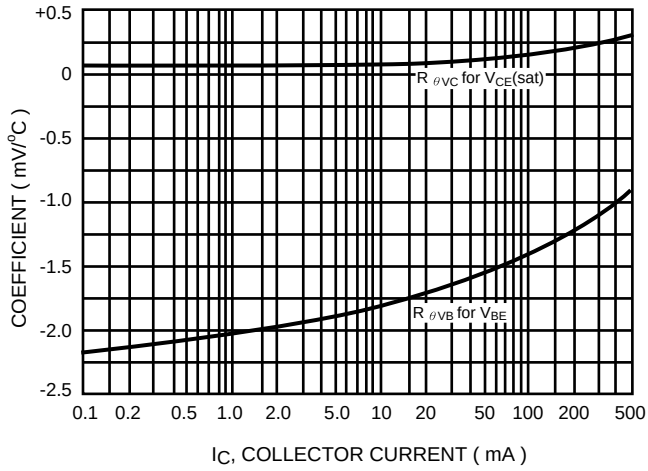



**Figure 12. Temperature Coefficients**