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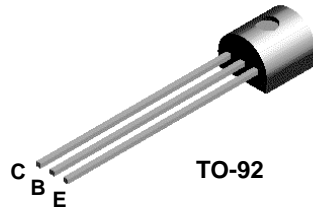


**ON Semiconductor®**

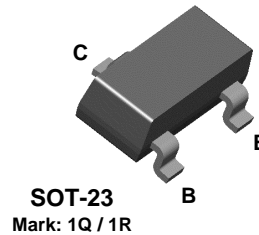
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**2N5088**  
**2N5089**



**MMBT5088**  
**MMBT5089**



## NPN General Purpose Amplifier

This device is designed for low noise, high gain, general purpose amplifier applications at collector currents from 1μA to 50 mA.

### Absolute Maximum Ratings\*

TA = 25°C unless otherwise noted

| Symbol                            | Parameter  | Value         | Units |   |
|-----------------------------------|--|---------------|-------|---|
| V <sub>CEO</sub>                  | Collector-Emitter Voltage                        | <b>2N5088</b> | 30    | V |
|                                   |  | <b>2N5089</b> | 25    | V |
| V <sub>CBO</sub>                  | Collector-Base Voltage                           | <b>2N5088</b> | 35    | V |
|                                   |  | <b>2N5089</b> | 30    | V |
| V <sub>EBO</sub>                  | Emitter-Base Voltage                             | 4.5           | V     |   |
| I <sub>C</sub>                    | Collector Current - Continuous                   | 100           | mA    |   |
| 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.

### Thermal Characteristics

TA = 25°C unless otherwise noted

| Symbol           | Characteristic                                | Max                            |  | Units |
|------------------|---|--------------------------------|--|-------|
|                  |   | <b>2N5088</b><br><b>2N5089</b> | * <b>MMBT5088</b><br>* <b>MMBT5089</b> |       |
| P <sub>D</sub>   | Total Device Dissipation<br>Derate above 25°C | 625                            | 350                                    | mW    |
|                  |   | 5.0                            | 2.8                                    | 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                            | 357                                    | °C/W  |

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

## 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* | $I_C = 1.0 \text{ mA}, I_B = 0$   | <b>5088</b> | 30  | V     |
|                            |                                      |                                   | <b>5089</b> | 25  | V     |
| $V_{(BR)CBO}$              | Collector-Base Breakdown Voltage     | $I_C = 100 \mu\text{A}, I_E = 0$  | <b>5088</b> | 35  | V     |
|                            |                                      |                                   | <b>5089</b> | 30  | V     |
| $I_{CBO}$                  | Collector Cutoff Current             | $V_{CB} = 20 \text{ V}, I_E = 0$  | <b>5088</b> | 50  | nA    |
|                            |                                      | $V_{CB} = 15 \text{ V}, I_E = 0$  | <b>5089</b> | 50  | nA    |
| $I_{EBO}$                  | Emitter Cutoff Current               | $V_{EB} = 3.0 \text{ V}, I_C = 0$ |             | 50  | nA    |
|                            |                                      | $V_{EB} = 4.5 \text{ V}, I_C = 0$ |             | 100 | nA    |

### ON CHARACTERISTICS

|   |                                      |   |             |     |      |  |
|---|--------------------------------------|---|-------------|-----|------|--|
| $h_{FE}$  | DC Current Gain                      | $I_C = 100 \mu\text{A}, V_{CE} = 5.0 \text{ V}$ | <b>5088</b> | 300 | 900  |  |
|   |                                      |   | <b>5089</b> | 400 | 1200 |  |
|   |                                      | $I_C = 1.0 \text{ mA}, V_{CE} = 5.0 \text{ V}$  | <b>5088</b> | 350 |      |  |
|   |                                      |   | <b>5089</b> | 450 |      |  |
| $I_C = 10 \text{ mA}, V_{CE} = 5.0 \text{ V}^*$ |                                      | <b>5088</b>                                     | 300         |     |      |  |
|   |                                      | <b>5089</b>                                     | 400         |     |      |  |
| $V_{CE(sat)}$                                   | Collector-Emitter Saturation Voltage | $I_C = 10 \text{ mA}, I_B = 1.0 \text{ mA}$     |             | 0.5 | V    |  |
| $V_{BE(on)}$                                    | Base-Emitter On Voltage              | $I_C = 10 \text{ mA}, V_{CE} = 5.0 \text{ V}$   |             | 0.8 | V    |  |

### SMALL SIGNAL CHARACTERISTICS

|          |                                  |   |             |     |      |     |
|----------|----------------------------------|---|-------------|-----|------|-----|
| $f_T$    | Current Gain - Bandwidth Product | $I_C = 500 \mu\text{A}, V_{CE} = 5.0 \text{ mA},$<br>$f = 20 \text{ MHz}$ |             | 50  |      | MHz |
| $C_{cb}$ | Collector-Base Capacitance       | $V_{CB} = 5.0 \text{ V}, I_E = 0, f = 100 \text{ kHz}$                    |             |     | 4.0  | pF  |
| $C_{eb}$ | Emitter-Base Capacitance         | $V_{BE} = 0.5 \text{ V}, I_C = 0, f = 100 \text{ kHz}$                    |             |     | 10   | pF  |
| $h_{fe}$ | Small-Signal Current Gain        | $I_C = 1.0 \text{ mA}, V_{CE} = 5.0 \text{ V},$                           | <b>5088</b> | 350 | 1400 |     |
|          |                                  | $f = 1.0 \text{ kHz}$   | <b>5089</b> | 450 | 1800 |     |
| NF       | Noise Figure                     | $I_C = 100 \mu\text{A}, V_{CE} = 5.0 \text{ V},$                          | <b>5088</b> |     | 3.0  | dB  |
|          |                                  | $R_S = 10 \text{ k}\Omega,$<br>$f = 10 \text{ Hz to } 15.7 \text{ kHz}$   | <b>5089</b> |     | 2.0  | dB  |

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

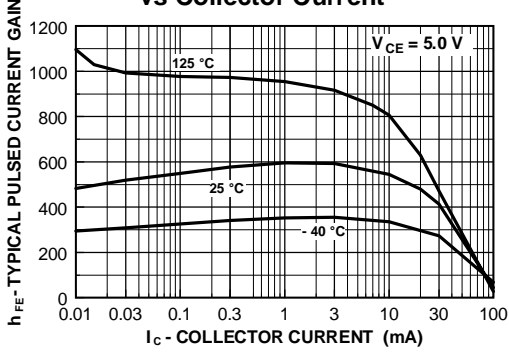
### Spice Model

NPN (Is=5.911f Xti=3 Eg=1.11 Vaf=62.37 Bf=1.122K Ne=1.394 Ise=5.911f Ikf=14.92m Xtb=1.5 Br=1.271 Nc=2 Isc=0 Ikr=0 Rc=1.61 Cjc=4.017p Mjc=.3174 Vjc=.75 Fc=.5 Cje=4.973p Mje=.4146 Vje=.75 Tr=4.673n Tf=821.7p Itf=.35 Vtf=4 Xtf=7 Rb=10)

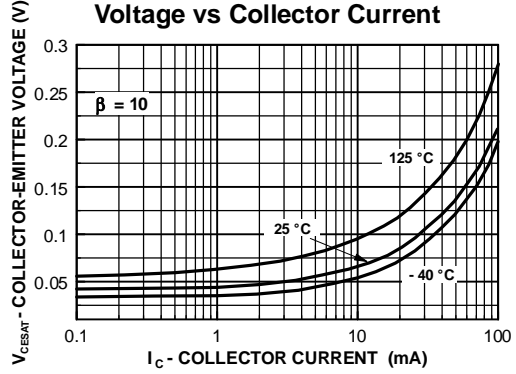
2N5088 / MMBT5088 / 2N5089 / MMBT5089

Typical Characteristics

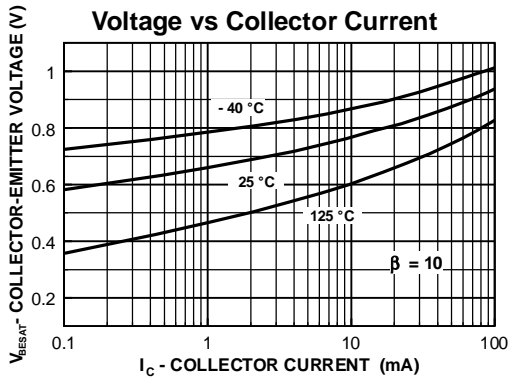
Typical Pulsed Current Gain vs Collector Current



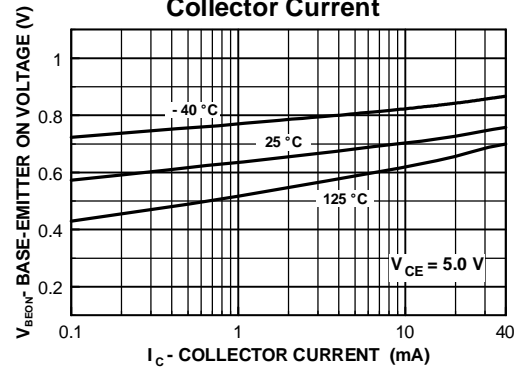
Collector-Emitter Saturation Voltage vs Collector Current



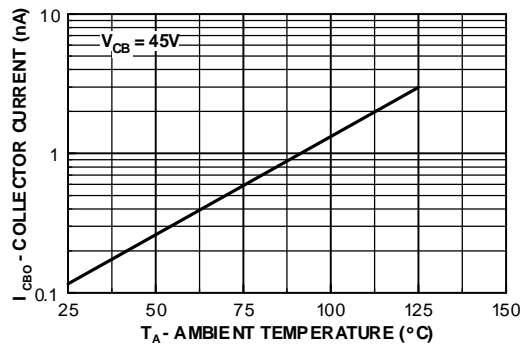
Base-Emitter Saturation Voltage vs Collector Current



Base-Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs Ambient Temperature



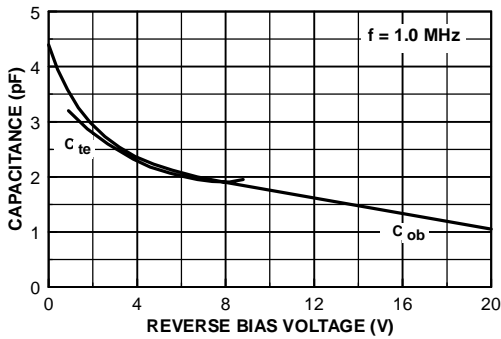
# NPN General Purpose Amplifier

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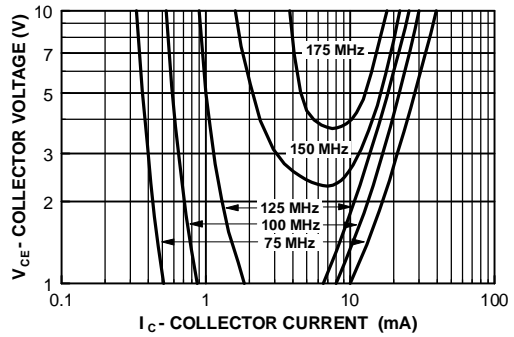
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## Typical Characteristics (continued)

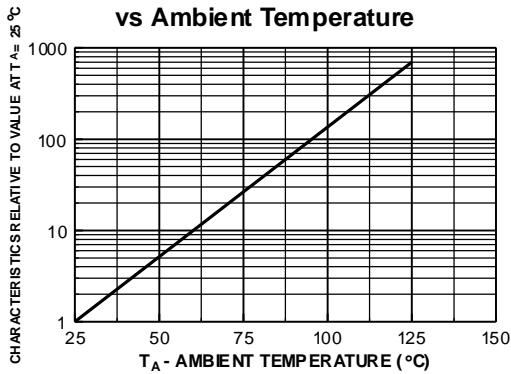
### Input and Output Capacitance vs Reverse Bias Voltage



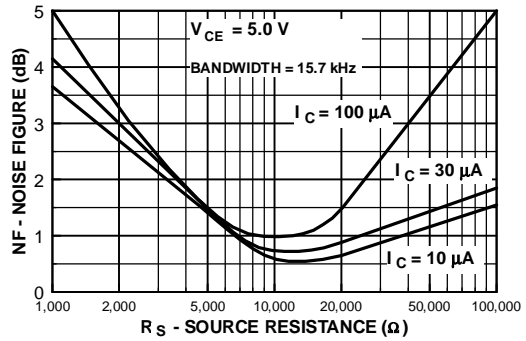
### Contours of Constant Gain Bandwidth Product ( $f_T$ )



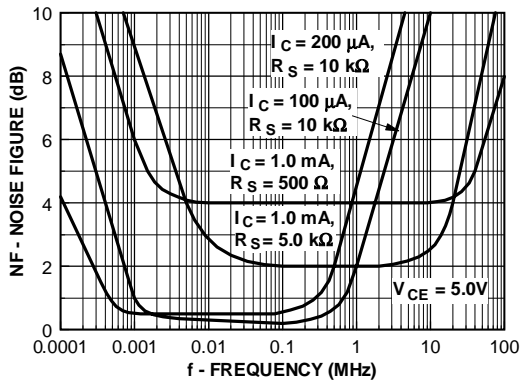
### Normalized Collector-Cutoff Current vs Ambient Temperature



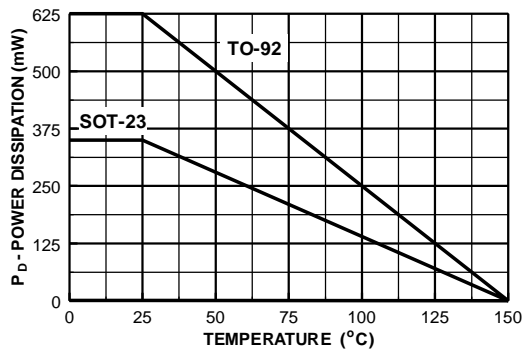
### Wideband Noise Frequency vs Source Resistance



### Noise Figure vs Frequency

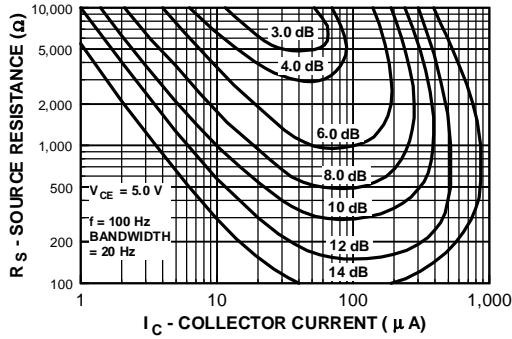


### Power Dissipation vs Ambient Temperature

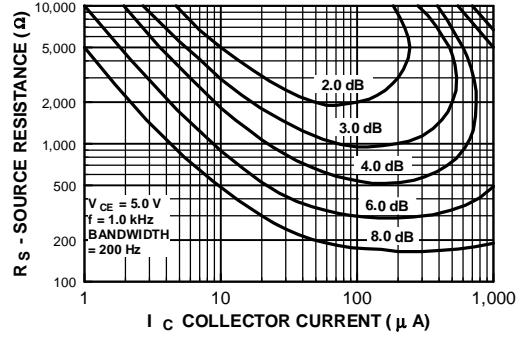


Typical Characteristics (continued)

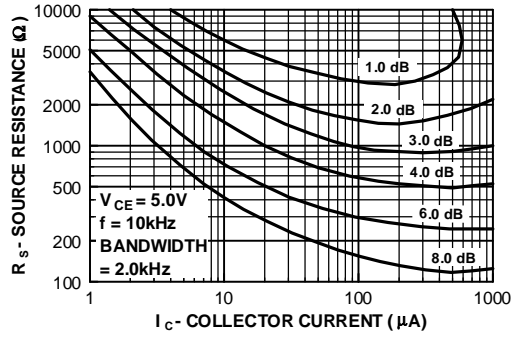
Contours of Constant  
Narrow Band Noise Figure



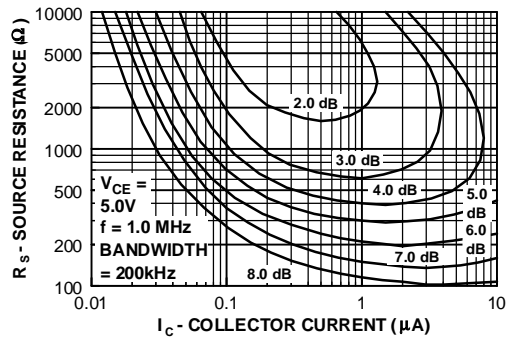
Contours of Constant  
Narrow Band Noise Figure



Contours of Constant  
Narrow Band Noise Figure

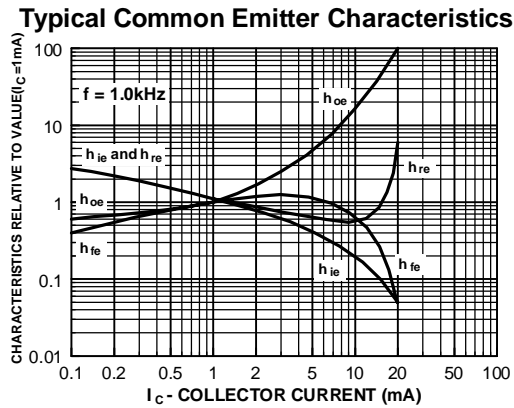
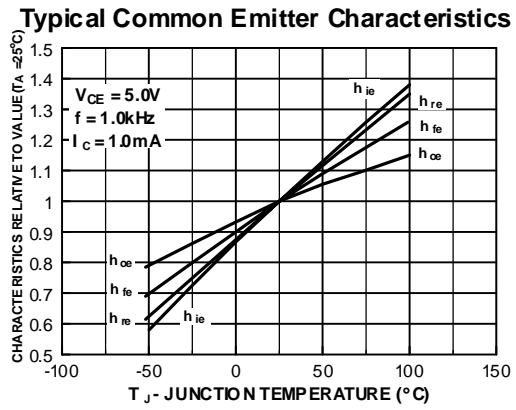
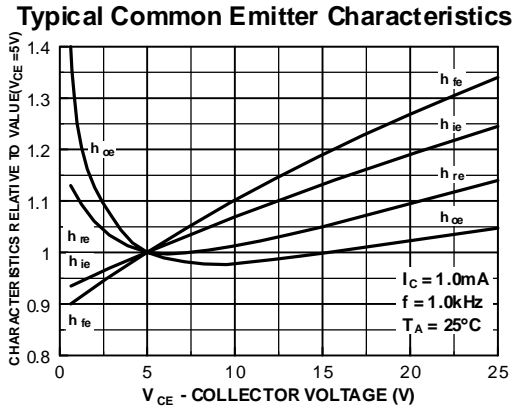


Contours of Constant  
Narrow Band Noise Figure



NPN General Purpose Amplifier  
(continued)

Typical Common Emitter Characteristics (f = 1.0 kHz)



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