## The RF Line
# NPN Silicon High-Frequency Transistor

**BFR90**

Designed primarily for use in high–gain, low–noise, small–signal amplifiers. Also used in applications requiring fast switching times.

- High Current–Gain — Bandwidth Product —
  $f_T$ = 5.0 GHz (Typ) @ $I_C$ = 14 mA
- Low Noise Figure —
  NF = 2.4 dB (Typ) @ f = 0.5 GHz
  = 3.0 dB (Typ) @ f = 1.0 GHz
- High Power Gain —
  $G_{max}$ = 18 dB (Typ) @ f = 0.5 GHz
  = 12 dB (Typ) @ f = 1.0 GHz

**$f_T$ = 5.0 GHz @ 14 mA**
**HIGH–FREQUENCY**
**TRANSISTOR**
**NPN SILICON**

**CASE 317A–01, STYLE 2**

**MAXIMUM RATINGS**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector–Emitter Voltage | $V_{CEO}$ | 15 | Vdc |
| Collector–Base Voltage | $V_{CBO}$ | 20 | Vdc |
| Emitter–Base Voltage | $V_{EBO}$ | 3.0 | Vdc |
| Collector Current — Continuous | $I_C$ | 30 | mAdc |
| Total Device Dissipation @ $T_A$ = 25°C (1)<br>Derate above 25°C | $P_D$ | 250<br>2.0 | mW<br>mW/°C |
| Storage Temperature Range | $T_{stg}$ | –55 to +150 | °C |

**THERMAL CHARACTERISTICS**

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 500 | °C/W |

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector–Emitter Breakdown Voltage ($I_C$ = 1.0 mAdc, $I_B$ = 0) | $V_{(BR)CEO}$ | 15 | — | — | Vdc |
| Collector–Base Breakdown Voltage ($I_C$ = 0.1 mAdc, $I_E$ = 0) | $V_{(BR)CBO}$ | 20 | — | — | Vdc |
| Emitter–Base Breakdown Voltage ($I_E$ = 0.1 mAdc, $I_C$ = 0) | $V_{(BR)EBO}$ | 3.0 | — | — | Vdc |
| Collector Cutoff Current ($V_{CB}$ = 10 Vdc, $I_E$ = 0) | $I_{CBO}$ | — | — | 50 | nAdc |
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain ($I_C$ = 14 mAdc, $V_{CE}$ = 10 Vdc) | $h_{FE}$ | 25 | — | 250 | — |

(continued)

NOTE:
1. Device mounted on .062" 2 oz. copper G10 board material, collector pad area 110 X 700 mils.

**REV 1**

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Current–Gain — Bandwidth Product ($I_C$ = 14 mAdc, $V_{CE}$ = 10 Vdc, f = 0.5 GHz) | $f_T$ | — | 5.0 | — | GHz |
| Collector–Base Capacitance ($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 1.0 MHz) | $C_{cb}$ | — | 0.5 | 1.0 | pF |
| **FUNCTIONAL TESTS** | | | | | |
| Noise Figure | NF | | | | dB |
| ($I_C$ = 2.0 mAdc, $V_{CE}$ = 10 Vdc, f = 0.5 GHz) | | — | 2.4 | — | |
| ($I_C$ = 2.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 GHz) | | — | 3.0 | — | |
| Power Gain at Optimum Noise Figure | $G_{NF}$ | | | | dB |
| ($I_C$ = 2.0 mAdc, $V_{CE}$ = 10 Vdc, f = 0.5 GHz) | | — | 15 | — | |
| ($I_C$ = 2.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 GHz) | | — | 10 | — | |
| Maximum Available Power Gain (1) | $G_{max}$ | | | | dB |
| ($I_C$ = 14 mAdc, $V_{CE}$ = 10 Vdc, f = 0.5 GHz) | | — | 18 | — | |
| ($I_C$ = 14 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 GHz) | | — | 12 | — | |

NOTE: 1. $G_{max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

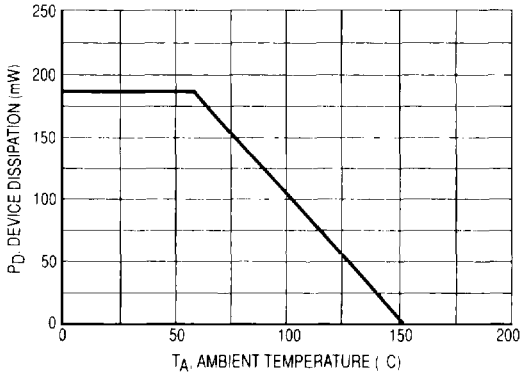


**Figure 1. Power Derating**

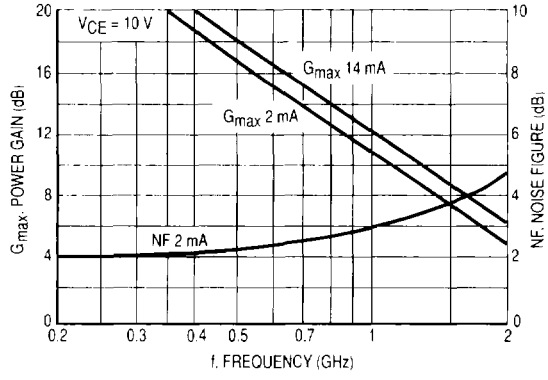


**Figure 2. Power Gain and Noise Figure versus Frequency**

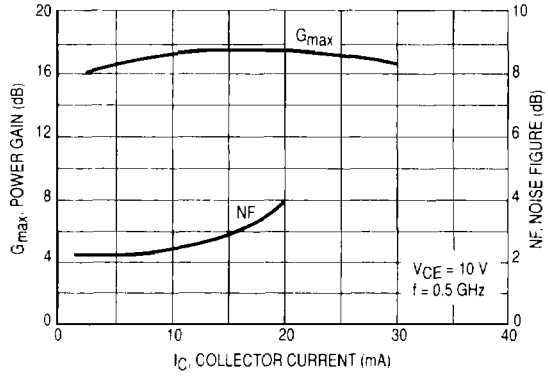


**Figure 3. Power Gain and Noise Figure versus Collector Current**

| Frequency (MHz) | | 200 | | 500 | | 800 | | 1000 | | 1500 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_{CE}$ (Volts) | $I_C$ (mA) | $S_{11}$ | ∠ϕ | $S_{11}$ | ∠ϕ | $S_{11}$ | ∠ϕ | $S_{11}$ | ∠ϕ | $S_{11}$ | ∠ϕ |
| 5.0 | 2.0 | 0.77 | −45 | 0.48 | −90 | 0.33 | −125 | 0.27 | −160 | 0.28 | 170 |
| | 5.0 | 0.52 | −60 | 0.25 | −110 | 0.18 | −150 | 0.18 | 170 | 0.21 | 145 |
| | 10 | 0.33 | −75 | 0.15 | −125 | 0.13 | −175 | 0.15 | 150 | 0.20 | 130 |
| | 20 | 0.20 | −95 | 0.12 | −155 | 0.14 | 165 | 0.17 | 145 | 0.22 | 130 |
| | 30 | 0.17 | −116 | 0.14 | −170 | 0.17 | 160 | 0.21 | 145 | 0.26 | 130 |
| 10 | 2.0 | 0.79 | −40 | 0.50 | −80 | 0.33 | −115 | 0.26 | −150 | 0.25 | 175 |
| | 5.0 | 0.56 | −55 | 0.27 | −95 | 0.16 | −135 | 0.13 | −175 | 0.17 | 150 |
| | 10 | 0.39 | −65 | 0.16 | −105 | 0.10 | −150 | 0.10 | 165 | 0.15 | 140 |
| | 20 | 0.25 | −75 | 0.10 | −120 | 0.09 | −175 | 0.12 | 150 | 0.18 | 130 |
| | 30 | 0.25 | −75 | 0.10 | −120 | 0.09 | −175 | 0.12 | 150 | 0.18 | 130 |

**Table 1. $S_{11}$ Parameters**

| Frequency (MHz) | | 200 | | 500 | | 800 | | 1000 | | 1500 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_{CE}$ (Volts) | $I_C$ (mA) | $S_{22}$ | ∠ϕ | $S_{22}$ | ∠ϕ | $S_{22}$ | ∠ϕ | $S_{22}$ | ∠ϕ | $S_{22}$ | ∠ϕ |
| 5.0 | 2.0 | 0.89 | −20 | 0.69 | −30 | 0.61 | −35 | 0.55 | −35 | 0.52 | −45 |
| | 5.0 | 0.75 | −25 | 0.55 | −30 | 0.50 | −30 | 0.47 | −30 | 0.43 | −40 |
| | 10 | 0.64 | −25 | 0.49 | −25 | 0.45 | −25 | 0.43 | −30 | 0.40 | −35 |
| | 20 | 0.57 | −25 | 0.47 | −20 | 0.44 | −25 | 0.43 | −25 | 0.40 | −35 |
| | 30 | 0.55 | −20 | 0.47 | −20 | 0.46 | −20 | 0.44 | −25 | 0.42 | −35 |
| 10 | 2.0 | 0.91 | −15 | 0.74 | −25 | 0.66 | −30 | 0.62 | −35 | 0.59 | −40 |
| | 5.0 | 0.79 | −20 | 0.61 | −25 | 0.56 | −25 | 0.54 | −30 | 0.51 | −35 |
| | 10 | 0.70 | −20 | 0.56 | −20 | 0.53 | −25 | 0.51 | −25 | 0.48 | −35 |
| | 20 | 0.63 | −20 | 0.54 | −25 | 0.53 | −20 | 0.51 | −25 | 0.49 | −35 |
| | 30 | 0.63 | −15 | 0.56 | −15 | 0.55 | −20 | 0.54 | −25 | 0.52 | −35 |

**Table 2. $S_{22}$ Parameters**

| Frequency (MHz) | | 200 | | 500 | | 800 | | 1000 | | 1500 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_{CE}$ (Volts) | $I_C$ (mA) | $S_{21}$ | ∠ϕ | $S_{21}$ | ∠ϕ | $S_{21}$ | ∠ϕ | $S_{21}$ | ∠ϕ | $S_{21}$ | ∠ϕ |
| 5.0 | 2.0 | 5.76 | 140 | 3.81 | 105 | 2.73 | 90 | 2.20 | 75 | 1.70 | 60 |
| | 5.0 | 9.92 | 125 | 5.24 | 95 | 3.50 | 80 | 2.80 | 70 | 2.10 | 60 |
| | 10 | 12.33 | 115 | 5.82 | 90 | 3.79 | 75 | 2.90 | 65 | 2.20 | 55 |
| | 20 | 13.62 | 105 | 6.00 | 85 | 3.88 | 75 | 2.95 | 65 | 2.25 | 55 |
| | 30 | 13.41 | 105 | 5.80 | 80 | 3.74 | 75 | 2.85 | 65 | 2.15 | 55 |
| 10 | 2.0 | 5.77 | 145 | 3.88 | 110 | 2.80 | 90 | 2.25 | 75 | 1.75 | 60 |
| | 5.0 | 10.05 | 130 | 5.42 | 95 | 3.60 | 80 | 2.85 | 70 | 2.10 | 60 |
| | 10 | 12.56 | 115 | 6.00 | 90 | 3.90 | 80 | 3.05 | 70 | 2.25 | 55 |
| | 20 | 13.77 | 110 | 6.13 | 85 | 3.92 | 75 | 3.05 | 65 | 2.20 | 55 |
| | 30 | 13.23 | 105 | 5.79 | 85 | 3.70 | 75 | 2.85 | 65 | 2.15 | 55 |

**Table 3. $S_{21}$ Parameters**

| Frequency (MHz) | | 200 | | 500 | | 800 | | 1000 | | 1500 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_{CE}$ (Volts) | $I_C$ (mA) | $S_{12}$ | ∠ϕ | $S_{12}$ | ∠ϕ | $S_{12}$ | ∠ϕ | $S_{12}$ | ∠ϕ | $S_{12}$ | ∠ϕ |
| 5.0 | 2.0 | 0.06 | 65 | 0.10 | 55 | 0.12 | 55 | 0.14 | 55 | 0.17 | 60 |
| | 5.0 | 0.05 | 65 | 0.08 | 65 | 0.12 | 65 | 0.15 | 65 | 0.19 | 65 |
| | 10 | 0.04 | 65 | 0.08 | 70 | 0.12 | 70 | 0.15 | 70 | 0.20 | 65 |
| | 20 | 0.04 | 75 | 0.08 | 75 | 0.12 | 75 | 0.15 | 70 | 0.20 | 70 |
| | 30 | 0.03 | 75 | 0.07 | 75 | 0.11 | 75 | 0.15 | 75 | 0.19 | 70 |
| 10 | 2.0 | 0.05 | 70 | 0.03 | 55 | 0.11 | 55 | 0.12 | 55 | 0.15 | 60 |
| | 5.0 | 0.04 | 65 | 0.07 | 65 | 0.10 | 65 | 0.13 | 65 | 0.17 | 70 |
| | 10 | 0.04 | 65 | 0.07 | 70 | 0.10 | 70 | 0.13 | 70 | 0.17 | 70 |
| | 20 | 0.03 | 70 | 0.07 | 75 | 0.10 | 75 | 0.13 | 75 | 0.17 | 70 |
| | 30 | 0.03 | 75 | 0.06 | 75 | 0.10 | 75 | 0.13 | 75 | 0.17 | 70 |

**Table 4. $S_{12}$ Parameters**