

# BFR90

## CASE 317A-01, STYLE 2 HIGH FREQUENCY TRANSISTOR

NPN SILICON



### 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          | mA <sub>dc</sub>           |
| Total Device Dissipation @ $T_A = 60^\circ\text{C}$<br>Derate above $60^\circ\text{C}$ | $P_D$     | 180<br>2.0  | mW<br>mW/ $^\circ\text{C}$ |
| Storage Temperature                                                                    | $T_{stg}$ | -65 to +150 | $^\circ\text{C}$           |

### THERMAL CHARACTERISTICS

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

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted.)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

#### OFF CHARACTERISTICS

|                                                                                     |               |     |   |    |                  |
|-------------------------------------------------------------------------------------|---------------|-----|---|----|------------------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 1.0$ mA <sub>dc</sub> , $I_B = 0$ ) | $V_{(BR)CEO}$ | 15  | — | —  | Vdc              |
| Collector-Base Breakdown Voltage<br>( $I_C = 0.1$ mA <sub>dc</sub> , $I_E = 0$ )    | $V_{(BR)CBO}$ | 20  | — | —  | Vdc              |
| Emitter-Base Breakdown Voltage<br>( $I_E = 0.1$ mA <sub>dc</sub> , $I_C = 0$ )      | $V_{(BR)EBO}$ | 3.0 | — | —  | Vdc              |
| Collector Cutoff Current<br>( $V_{CB} = 10$ Vdc, $I_E = 0$ )                        | $I_{CBO}$     | —   | — | 50 | nA <sub>dc</sub> |

#### ON CHARACTERISTICS

|                                                                       |          |    |   |     |   |
|-----------------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain<br>( $I_C = 14$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc) | $h_{FE}$ | 25 | — | 250 | — |
|-----------------------------------------------------------------------|----------|----|---|-----|---|

#### SMALL SIGNAL CHARACTERISTICS

|                                                                                                       |          |   |     |     |     |
|-------------------------------------------------------------------------------------------------------|----------|---|-----|-----|-----|
| Current-Gain — Bandwidth Product<br>( $I_C = 14$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc, $f = 0.5$ GHz) | $f_T$    | — | 5.0 | —   | GHz |
| Collector-Base Capacitance<br>( $V_{CB} = 10$ Vdc, $I_E = 0$ , $f = 1.0$ MHz)                         | $C_{cb}$ | — | 0.5 | 1.0 | pF  |

#### FUNCTIONAL TEST

|                                                                                                                                                                                |           |        |            |        |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|------------|--------|----|
| Noise Figure<br>( $I_C = 2.0$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc, $f = 0.5$ GHz)<br>( $I_C = 2.0$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc, $f = 1.0$ GHz)                       | NF        | —<br>— | 2.4<br>3.0 | —<br>— | dB |
| Power Gain at Optimum Noise Figure<br>( $I_C = 2.0$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc, $f = 0.5$ GHz)<br>( $I_C = 2.0$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc, $f = 1.0$ GHz) | $G_{NF}$  | —<br>— | 15<br>10   | —<br>— | dB |
| Maximum Available Power(1)<br>( $I_C = 14$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc, $f = 0.5$ GHz)<br>( $I_C = 14$ mA <sub>dc</sub> , $V_{CE} = 10$ Vdc, $f = 1.0$ GHz)           | $G_{max}$ | —<br>— | 18<br>12   | —<br>— | dB |

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

FIGURE 1 – POWER DERATING

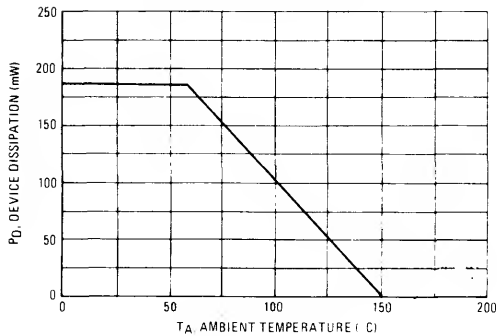


FIGURE 2 – POWER GAIN AND NOISE  
FIGURE versus FREQUENCY

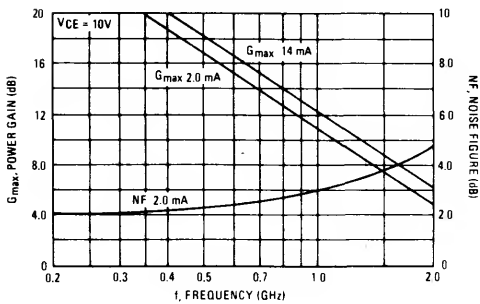


FIGURE 3 – POWER GAIN AND NOISE  
FIGURE versus COLLECTOR CURRENT

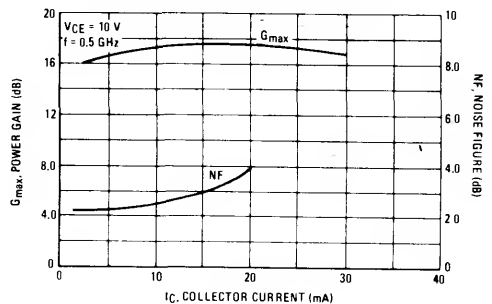


FIGURE 4 – S<sub>11</sub> PARAMETERS

| Frequency (MHz)         |                     | 200             |      | 500             |      | 800             |      | 1000            |      | 1500            |     |
|-------------------------|---------------------|-----------------|------|-----------------|------|-----------------|------|-----------------|------|-----------------|-----|
| V <sub>CE</sub> (Volts) | I <sub>C</sub> (mA) | S <sub>11</sub> | ∠φ   | S <sub>11</sub> | ∠φ   | S <sub>11</sub> | ∠φ   | S <sub>11</sub> | ∠φ   | S <sub>11</sub> | ∠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 |

FIGURE 5 – S<sub>22</sub> PARAMETERS

| Frequency (MHz)         |                     | 200             |     | 500             |     | 800             |     | 1000            |     | 1500            |     |
|-------------------------|---------------------|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|
| V <sub>CE</sub> (Volts) | I <sub>C</sub> (mA) | S <sub>22</sub> | ∠φ  | S <sub>22</sub> | ∠φ  | S <sub>22</sub> | ∠φ  | S <sub>22</sub> | ∠φ  | S <sub>22</sub> | ∠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 |

FIGURE 6 – S<sub>21</sub> PARAMETERS

| Frequency (MHz)            |                        | 200             |     | 500             |     | 800             |    | 1000            |    | 1500            |    |
|----------------------------|------------------------|-----------------|-----|-----------------|-----|-----------------|----|-----------------|----|-----------------|----|
| V <sub>CE</sub><br>(Volts) | I <sub>C</sub><br>(mA) | S <sub>21</sub> | ∠φ  | S <sub>21</sub> | ∠φ  | S <sub>21</sub> | ∠φ | S <sub>21</sub> | ∠φ | S <sub>21</sub> | ∠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 |

FIGURE 7 – S<sub>12</sub> PARAMETERS

| Frequency (MHz)            |                        | 200             |    | 500             |    | 800             |    | 1000            |    | 1500            |    |
|----------------------------|------------------------|-----------------|----|-----------------|----|-----------------|----|-----------------|----|-----------------|----|
| V <sub>CE</sub><br>(Volts) | I <sub>C</sub><br>(mA) | S <sub>12</sub> | ∠φ | S <sub>12</sub> | ∠φ | S <sub>12</sub> | ∠φ | S <sub>12</sub> | ∠φ | S <sub>12</sub> | ∠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 |