

N AMER PHILIPS/DISCRETE 67E D

## NPN 9 GHz wideband transistor

BFS505

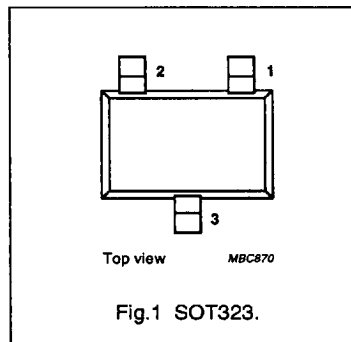
## FEATURES

- Low current consumption
- High power gain
- Low noise figure
- High transition frequency
- Gold metallization ensures excellent reliability
- SOT323 envelope.

## PINNING

| PIN      | DESCRIPTION |
|----------|-------------|
| Code: N0 |             |
| 1        | base        |
| 2        | emitter     |
| 3        | collector   |

## PIN CONFIGURATION



## DESCRIPTION

NPN transistor in a plastic SOT323 envelope.

It is intended for low power amplifiers, oscillators and mixers particularly in RF portable communication equipment (cellular phones, cordless phones, pagers) up to 2 GHz.

## QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                     | CONDITIONS                                                                                           | MIN. | TYP. | MAX. | UNIT |
|-----------|-------------------------------|------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_{CBO}$ | collector-base voltage        | open emitter                                                                                         | —    | —    | 20   | V    |
| $V_{CES}$ | collector-emitter voltage     | $R_{BE} = 0$                                                                                         | —    | —    | 15   | V    |
| $I_C$     | DC collector current          |                                                                                                      | —    | —    | 18   | mA   |
| $P_{tot}$ | total power dissipation       | up to $T_s = 122^\circ\text{C}$ (note 1)                                                             | —    | —    | 150  | mW   |
| $h_{FE}$  | DC current gain               | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_j = 25^\circ\text{C}$                               | 60   | 120  | 250  |      |
| $f_T$     | transition frequency          | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25^\circ\text{C}$      | —    | 9    | —    | GHz  |
| $G_{UM}$  | maximum unilateral power gain | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25^\circ\text{C}$    | —    | 17   | —    | dB   |
| F         | noise figure                  | $I_C = 1.25\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25^\circ\text{C}$ | —    | 1.2  | 1.7  | dB   |

## Note

1.  $T_s$  is the temperature at the soldering point of the collector tab.

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67E D

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BFS505

**LIMITING VALUES**

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL    | PARAMETER                 | CONDITIONS                           | MIN. | MAX. | UNIT |
|-----------|---------------------------|--------------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage    | open emitter                         | –    | 20   | V    |
| $V_{CES}$ | collector-emitter voltage | $R_{BE} = 0$                         | –    | 15   | V    |
| $V_{EBO}$ | emitter-base voltage      | open collector                       | –    | 2.5  | V    |
| $I_C$     | DC collector current      |                                      | –    | 18   | mA   |
| $P_{tot}$ | total power dissipation   | up to $T_s = 122\text{ °C}$ (note 1) | –    | 150  | mW   |
| $T_{stg}$ | storage temperature       |                                      | –65  | 150  | °C   |
| $T_j$     | junction temperature      |                                      | –    | 150  | °C   |

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                                           | CONDITIONS                           | THERMAL RESISTANCE |
|---------------|-----------------------------------------------------|--------------------------------------|--------------------|
| $R_{th\ j-s}$ | thermal resistance from junction to soldering point | up to $T_s = 122\text{ °C}$ (note 1) | 190 K/W            |

**Note**

1.  $T_s$  is the temperature at the soldering point of the collector tab.

## NPN 9 GHz wideband transistor

BFS505

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified.

| SYMBOL           | PARAMETER                                 | CONDITIONS                                                                                                                                                         | MIN. | TYP. | MAX. | UNIT |
|------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{\text{CBO}}$ | collector cut-off current                 | $I_E = 0$ ; $V_{\text{CB}} = 6\text{ V}$                                                                                                                           | —    | —    | 50   | nA   |
| $h_{\text{FE}}$  | DC current gain                           | $I_C = 5\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$                                                                                                                 | 60   | 120  | 250  |      |
| $C_e$            | emitter capacitance                       | $I_C = I_e = 0$ ; $V_{\text{EB}} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$                                                                                              | —    | 0.4  | —    | pF   |
| $C_c$            | collector capacitance                     | $I_E = I_e = 0$ ; $V_{\text{CB}} = 6\text{ V}$ ; $f = 1\text{ MHz}$                                                                                                | —    | 0.4  | —    | pF   |
| $C_{\text{re}}$  | feedback capacitance                      | $I_C = 0$ ; $V_{\text{CB}} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$                                                                                                    | —    | 0.3  | —    | pF   |
| $f_T$            | transition frequency                      | $I_C = 5\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ; $f = 1\text{ GHz}$ ;<br>$T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$                                         | —    | 9    | —    | GHz  |
| $G_{\text{UM}}$  | maximum unilateral power gain<br>(note 1) | $I_C = 5\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ;<br>$T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$                                       | —    | 17   | —    | dB   |
|                  |                                           | $I_C = 5\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ; $f = 2\text{ GHz}$ ;<br>$T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$                                         | —    | 10   | —    | dB   |
| $ S_{21} ^2$     | insertion power gain                      | $I_C = 5\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ;<br>$T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$                                       | 13   | 14   | —    | dB   |
| F                | noise figure                              | $\Gamma_s = \Gamma_{\text{opt}}$ ; $I_C = 1.25\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ;<br>$f = 900\text{ MHz}$ ; $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$ | —    | 1.2  | 1.7  | dB   |
|                  |                                           | $\Gamma_s = \Gamma_{\text{opt}}$ ; $I_C = 5\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ;<br>$f = 900\text{ MHz}$ ; $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$    | —    | 1.6  | 2.1  | dB   |
|                  |                                           | $\Gamma_s = \Gamma_{\text{opt}}$ ; $I_C = 1.25\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ;<br>$f = 2\text{ GHz}$ ; $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$   | —    | 1.9  | —    | dB   |
| $P_{\text{L1}}$  | output power at 1 dB gain<br>compression  | $I_C = 5\text{ mA}$ ; $V_{\text{CE}} = 6\text{ V}$ ; $R_L = 50\text{ }\Omega$ ;<br>$f = 900\text{ MHz}$ ; $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$            | —    | 4    | —    | dBm  |
| ITO              | third order intercept point               | note 2                                                                                                                                                             | —    | 10   | —    | dBm  |

## Notes

- $G_{\text{UM}}$  is the maximum unilateral power gain, assuming  $S_{12}$  is zero and  $G_{\text{UM}} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$  dB.
- $I_C = 5\text{ mA}$ ;  $V_{\text{CE}} = 6\text{ V}$ ;  $R_L = 50\text{ }\Omega$ ;  $f = 900\text{ MHz}$ ;  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$ ;  
 $f_p = 900\text{ MHz}$ ;  $f_q = 902\text{ MHz}$ ; measured at  $f_{(2p-q)} = 898\text{ MHz}$  and at  $f_{(2q-p)} = 904\text{ MHz}$ .

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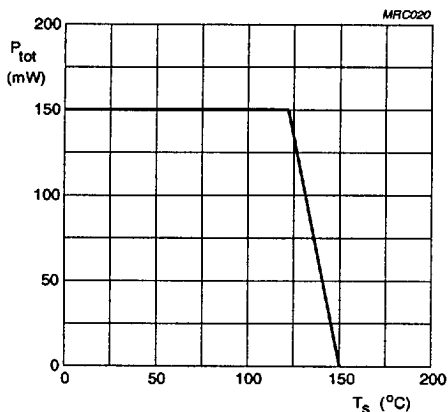


Fig.2 Power derating curve.

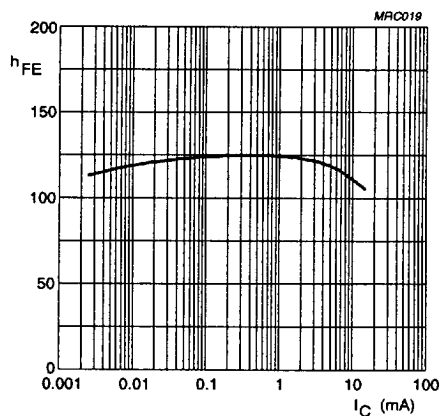
 $V_{CE} = 6\text{ V}; T_J = 25^\circ\text{C}.$ 

Fig.3 DC current gain as a function of collector current.

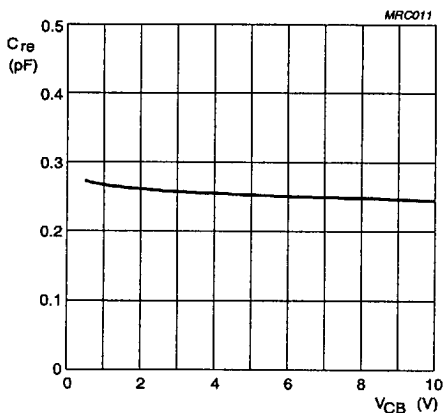
 $I_C = 0; f = 1\text{ MHz}.$ 

Fig.4 Feedback capacitance as a function of collector-base voltage.

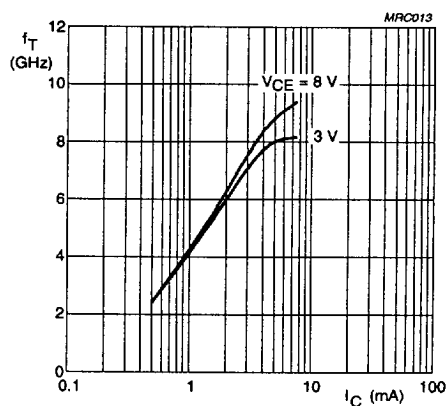
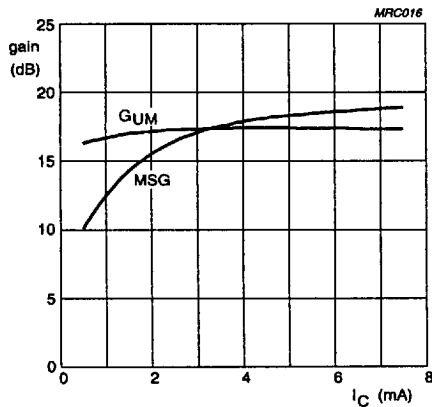
 $f = 1\text{ GHz}; T_{amb} = 25^\circ\text{C}.$ 

Fig.5 Transition frequency as a function of collector current.

## NPN 9 GHz wideband transistor

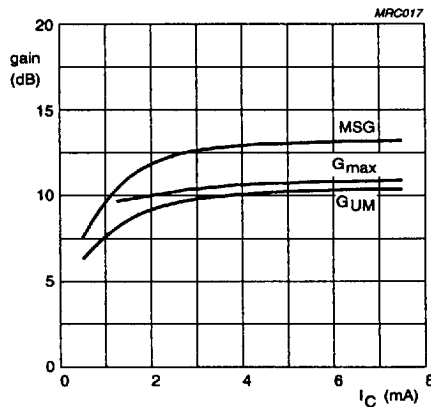
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In Figs 6 to 9,  $G_{UM}$  = maximum unilateral power gain;  $MSG$  = maximum stable gain;  $G_{max}$  = maximum available gain.



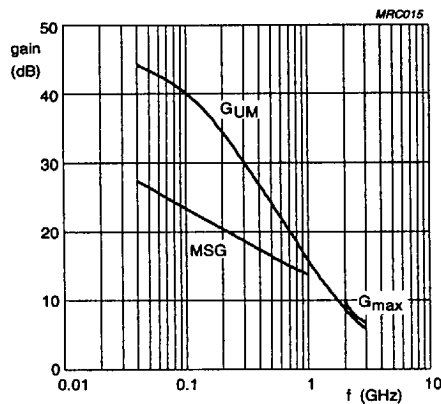
$V_{CE} = 6\text{ V}$ ;  $f = 900\text{ MHz}$ ;  $T_{amb} = 25\text{ °C}$ .

Fig.6 Gain as a function of collector current.



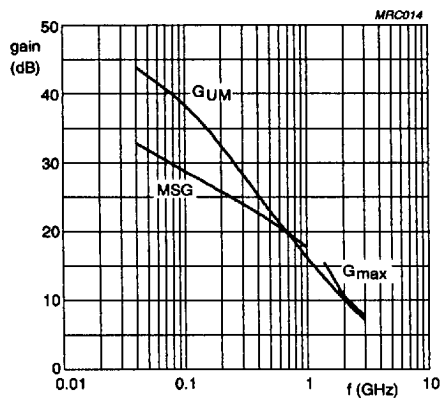
$V_{CE} = 6\text{ V}$ ;  $f = 2\text{ GHz}$ ;  $T_{amb} = 25\text{ °C}$ .

Fig.7 Gain as a function of collector current.



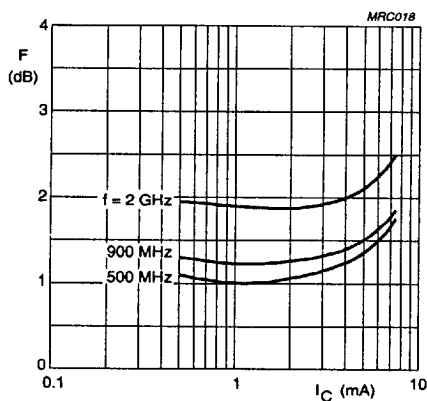
$I_C = 1.25\text{ mA}$ ;  $V_{CE} = 6\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ .

Fig.8 Gain as a function of frequency.



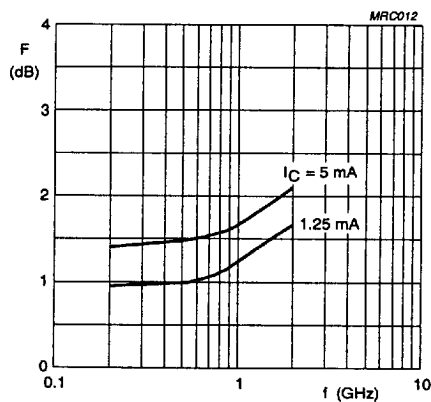
$I_C = 5\text{ mA}$ ;  $V_{CE} = 6\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ .

Fig.9 Gain as a function of frequency.



$V_{CE} = 6$  V;  $T_{amb} = 25$  °C.

Fig.10 Minimum noise figure as a function of collector current.



$V_{CE} = 6$  V;  $T_{amb} = 25$  °C.

Fig.11 Minimum noise figure as a function of frequency.

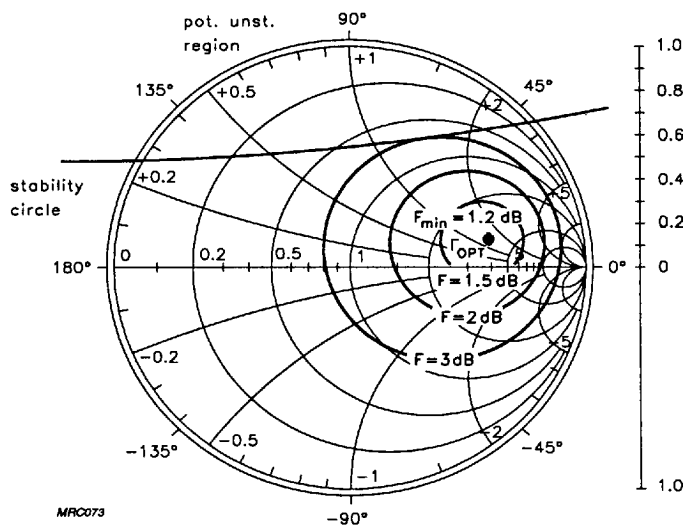


Fig.12 Noise circle.

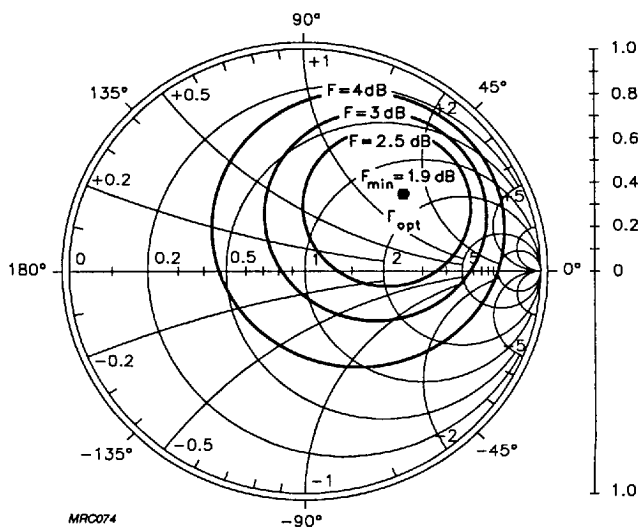
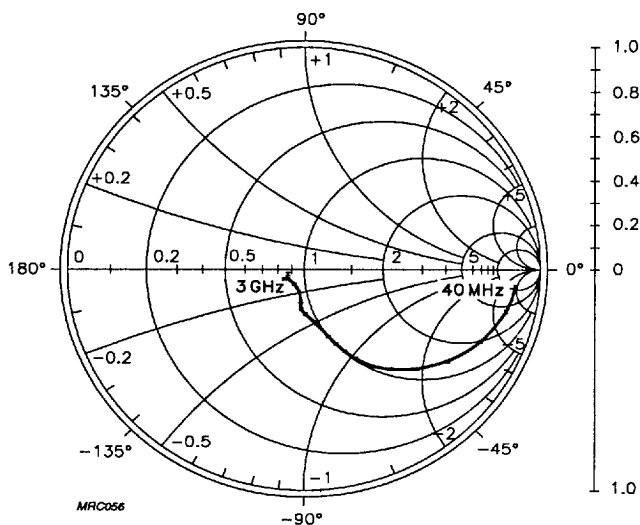
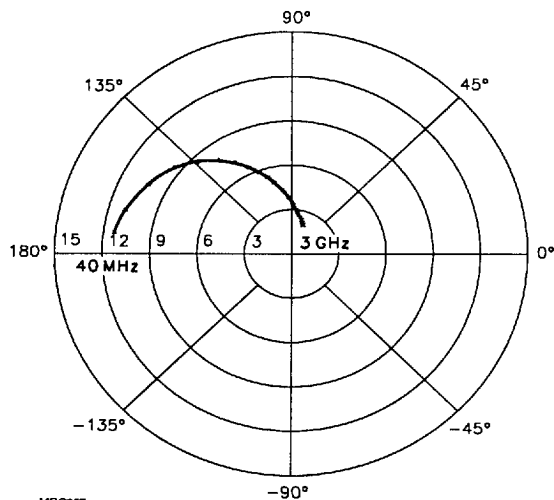


Fig.13 Noise circle.

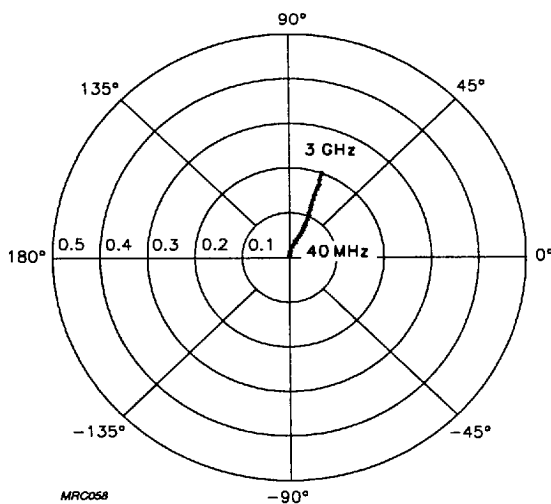
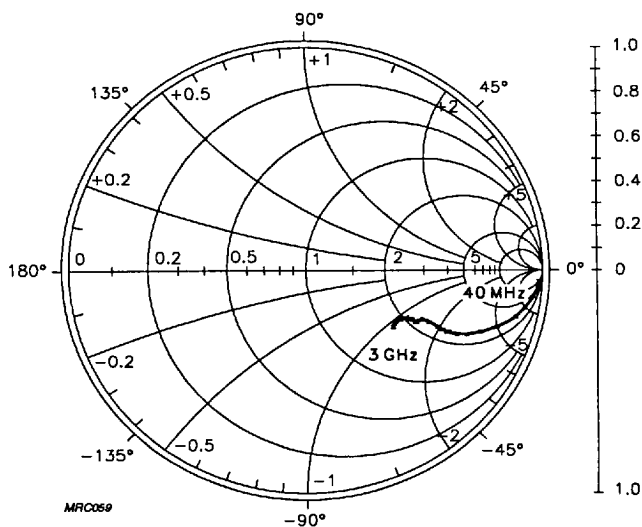
## NPN 9 GHz wideband transistor

BFS505

Fig.14 Common emitter input reflection coefficient ( $S_{11}$ ).Fig.15 Common emitter forward transmission coefficient ( $S_{21}$ ).

## NPN 9 GHz wideband transistor

BFS505

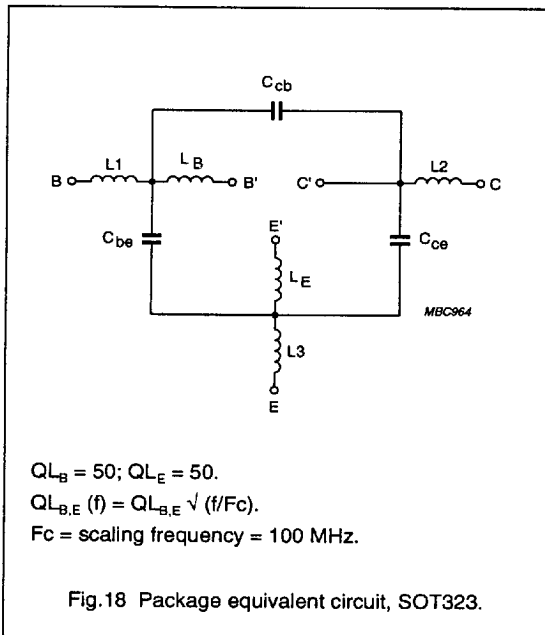
Fig.16 Common emitter reverse transmission coefficient ( $S_{12}$ ).Fig.17 Common emitter output reflection coefficient ( $S_{22}$ ).

## NPN 9 GHz wideband transistor

BFS505

## SPICE parameters for BFR505 crystal

|             |              |          |
|-------------|--------------|----------|
| 1           | IS = 134.1   | aA       |
| 2           | BF = 180.0   | —        |
| 3           | NF = 988.2   | m        |
| 4           | VA = 38.34   | V        |
| 5           | IKF = 150.0  | A        |
| 6           | ISE = 27.81  | fA       |
| 7           | NE = 2.051   | —        |
| 8           | BR = 55.19   | —        |
| 9           | NR = 982.2   | m        |
| 10          | VAR = 2.459  | V        |
| 11          | IKR = 2.920  | mA       |
| 12          | ISC = 17.45  | aA       |
| 13          | NC = 1.062   | —        |
| 14          | RB = 20.00   | $\Omega$ |
| 15          | IRB = 1.000  | $\mu$ A  |
| 16          | RBM = 20.00  | $\Omega$ |
| 17          | RE = 1.171   | $\Omega$ |
| 18          | RC = 4.350   | $\Omega$ |
| 19 (note 1) | XTB = 0.000  | —        |
| 20 (note 1) | EG = 1.110   | EV       |
| 21 (note 1) | XTI = 3.000  | —        |
| 22          | CJE = 284.7  | fF       |
| 23          | VJE = 600.0  | mV       |
| 24          | MJE = 303.6  | m        |
| 25          | TF = 7.037   | ps       |
| 26          | XTF = 12.34  | —        |
| 27          | VTF = 1.701  | V        |
| 28          | ITF = 30.64  | mA       |
| 29          | PTF = 0.000  | deg      |
| 30          | CJC = 242.4  | fF       |
| 31          | VJC = 188.6  | mV       |
| 32          | MJC = 41.49  | m        |
| 33          | XCJC = 130.0 | m        |
| 34          | TR = 1.332   | ns       |
| 35 (note 1) | CJS = 0.000  | F        |
| 36 (note 1) | VJS = 750.0  | mV       |
| 37 (note 1) | MJS = 0.000  | —        |
| 38          | FC = 897.4   | m        |



## List of components (see Fig.18)

| DESIGNATION | VALUE   |
|-------------|---------|
| $C_{be}$    | 2 fF    |
| $C_{cb}$    | 100 fF  |
| $C_{ce}$    | 100 fF  |
| L1          | 0.34 nH |
| L2          | 0.10 nH |
| L3          | 0.34 nH |
| $L_B$       | 0.60 nH |
| $L_E$       | 0.60 nH |

## Note

- These parameters have not been extracted, the default values are shown.

## NPN 9 GHz wideband transistor

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Table 1 Common emitter scattering parameters,  $I_C = 0.5$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.987           | -1.7          | 1.389           | 177.6         | 0.006           | 88.4          | 0.999           | -0.9          | 44.2                    |
| 100        | 0.985           | -4.0          | 1.385           | 174.3         | 0.016           | 85.8          | 0.998           | -2.3          | 41.3                    |
| 200        | 0.979           | -8.2          | 1.371           | 168.8         | 0.031           | 82.1          | 0.992           | -4.6          | 34.5                    |
| 300        | 0.969           | -12.2         | 1.372           | 163.8         | 0.046           | 79.0          | 0.983           | -7.0          | 29.6                    |
| 400        | 0.956           | -16.5         | 1.368           | 158.8         | 0.061           | 76.5          | 0.975           | -9.3          | 26.4                    |
| 500        | 0.944           | -20.3         | 1.349           | 154.5         | 0.076           | 73.0          | 0.966           | -11.7         | 24.0                    |
| 600        | 0.929           | -24.0         | 1.307           | 150.1         | 0.089           | 71.4          | 0.957           | -13.7         | 21.7                    |
| 700        | 0.912           | -27.6         | 1.290           | 146.0         | 0.101           | 69.1          | 0.944           | -15.7         | 19.6                    |
| 800        | 0.891           | -31.1         | 1.279           | 141.8         | 0.112           | 66.8          | 0.931           | -17.5         | 17.8                    |
| 900        | 0.867           | -34.6         | 1.267           | 137.2         | 0.122           | 64.2          | 0.917           | -19.0         | 16.1                    |
| 1000       | 0.839           | -38.2         | 1.239           | 133.1         | 0.131           | 61.6          | 0.900           | -20.6         | 14.3                    |
| 1200       | 0.782           | -45.8         | 1.218           | 125.4         | 0.147           | 56.4          | 0.859           | -23.8         | 11.6                    |
| 1400       | 0.732           | -53.4         | 1.220           | 118.9         | 0.161           | 52.9          | 0.822           | -26.7         | 10.0                    |
| 1600       | 0.694           | -60.4         | 1.212           | 113.0         | 0.175           | 49.7          | 0.798           | -29.6         | 8.9                     |
| 1800       | 0.654           | -65.9         | 1.158           | 108.0         | 0.180           | 47.3          | 0.772           | -31.9         | 7.6                     |
| 2000       | 0.592           | -71.9         | 1.123           | 101.9         | 0.185           | 45.0          | 0.742           | -33.4         | 6.4                     |
| 2200       | 0.533           | -79.9         | 1.106           | 96.7          | 0.189           | 43.0          | 0.708           | -35.4         | 5.3                     |
| 2400       | 0.491           | -89.3         | 1.104           | 90.2          | 0.195           | 41.0          | 0.679           | -38.1         | 4.7                     |
| 2600       | 0.480           | -97.2         | 1.073           | 86.8          | 0.196           | 39.7          | 0.662           | -41.2         | 4.3                     |
| 2800       | 0.459           | -102.6        | 1.080           | 84.0          | 0.196           | 40.6          | 0.656           | -43.2         | 4.1                     |
| 3000       | 0.421           | -107.2        | 1.048           | 80.2          | 0.196           | 41.2          | 0.644           | -44.3         | 3.6                     |

## NPN 9 GHz wideband transistor

BFS505

Table 2 Common emitter scattering parameters,  $I_C = 1.25$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.968           | -2.4          | 3.435           | 176.5         | 0.006           | 89.0          | 0.997           | -1.4          | 44.4                    |
| 100        | 0.963           | -6.0          | 3.400           | 171.9         | 0.015           | 84.7          | 0.993           | -3.4          | 40.3                    |
| 200        | 0.947           | -11.9         | 3.325           | 164.8         | 0.030           | 79.5          | 0.980           | -6.9          | 34.3                    |
| 300        | 0.924           | -17.8         | 3.288           | 158.3         | 0.044           | 76.0          | 0.959           | -10.1         | 29.6                    |
| 400        | 0.895           | -23.6         | 3.226           | 152.3         | 0.058           | 72.6          | 0.937           | -13.2         | 26.4                    |
| 500        | 0.867           | -28.9         | 3.115           | 147.1         | 0.070           | 69.3          | 0.915           | -16.2         | 23.8                    |
| 600        | 0.836           | -33.7         | 2.986           | 142.3         | 0.081           | 66.7          | 0.892           | -18.7         | 21.6                    |
| 700        | 0.802           | -38.6         | 2.911           | 137.7         | 0.090           | 64.6          | 0.868           | -20.7         | 19.8                    |
| 800        | 0.763           | -43.0         | 2.827           | 132.9         | 0.098           | 62.6          | 0.843           | -22.3         | 18.2                    |
| 900        | 0.722           | -47.3         | 2.725           | 128.2         | 0.105           | 60.5          | 0.819           | -23.6         | 16.7                    |
| 1000       | 0.679           | -51.5         | 2.619           | 123.9         | 0.111           | 58.5          | 0.794           | -24.9         | 15.4                    |
| 1200       | 0.593           | -60.7         | 2.472           | 116.1         | 0.121           | 55.3          | 0.740           | -27.0         | 13.2                    |
| 1400       | 0.524           | -69.9         | 2.373           | 109.4         | 0.131           | 53.9          | 0.696           | -29.0         | 11.8                    |
| 1600       | 0.474           | -77.1         | 2.237           | 103.6         | 0.140           | 52.8          | 0.668           | -31.1         | 10.7                    |
| 1800       | 0.425           | -82.6         | 2.080           | 98.9          | 0.144           | 52.8          | 0.643           | -32.4         | 9.5                     |
| 2000       | 0.362           | -88.4         | 1.949           | 93.5          | 0.150           | 52.8          | 0.619           | -32.9         | 8.5                     |
| 2200       | 0.307           | -97.9         | 1.858           | 89.0          | 0.156           | 53.1          | 0.588           | -33.9         | 7.7                     |
| 2400       | 0.278           | -109.5        | 1.788           | 83.6          | 0.164           | 53.1          | 0.561           | -36.0         | 7.0                     |
| 2600       | 0.273           | -117.6        | 1.691           | 80.7          | 0.170           | 53.6          | 0.546           | -38.9         | 6.4                     |
| 2800       | 0.260           | -122.5        | 1.655           | 78.3          | 0.176           | 55.6          | 0.544           | -40.8         | 6.2                     |
| 3000       | 0.277           | -127.2        | 1.573           | 74.9          | 0.183           | 56.9          | 0.540           | -41.5         | 5.7                     |

Table 3 Noise data,  $I_C = 1.25$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | F <sub>min</sub><br>(dB) | Γ <sub>opt</sub> |       | R <sub>n</sub> |
|------------|--------------------------|------------------|-------|----------------|
|            |                          | (RAT)            | (DEG) |                |
| 500        | 1.00                     | 0.716            | 9.00  | 0.770          |
| 900        | 1.20                     | 0.659            | 12.00 | 0.740          |
| 2000       | 1.90                     | 0.505            | 37.00 | 0.580          |

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NPN 9 GHz wideband transistor

BFS505

Table 4 Common emitter scattering parameters,  $I_C = 2.5$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.938           | -3.6          | 6.470           | 175.0         | 0.006           | 87.8          | 0.993           | -2.1          | 43.9                    |
| 100        | 0.927           | -8.8          | 6.361           | 168.6         | 0.015           | 83.1          | 0.984           | -5.0          | 39.7                    |
| 200        | 0.893           | -17.2         | 6.103           | 159.2         | 0.029           | 77.0          | 0.954           | -9.8          | 33.1                    |
| 300        | 0.848           | -25.3         | 5.871           | 151.0         | 0.042           | 72.1          | 0.914           | -13.9         | 28.7                    |
| 400        | 0.796           | -33.0         | 5.600           | 143.7         | 0.053           | 69.0          | 0.873           | -17.4         | 25.6                    |
| 500        | 0.747           | -39.8         | 5.282           | 137.5         | 0.062           | 66.0          | 0.834           | -20.4         | 23.2                    |
| 600        | 0.696           | -45.9         | 4.983           | 131.8         | 0.070           | 64.2          | 0.798           | -22.6         | 21.2                    |
| 700        | 0.641           | -51.7         | 4.731           | 126.4         | 0.078           | 62.7          | 0.766           | -24.1         | 19.6                    |
| 800        | 0.586           | -56.6         | 4.453           | 121.2         | 0.084           | 61.6          | 0.738           | -24.9         | 18.2                    |
| 900        | 0.533           | -61.0         | 4.189           | 116.5         | 0.089           | 60.9          | 0.712           | -25.5         | 17.0                    |
| 1000       | 0.482           | -65.3         | 3.922           | 112.3         | 0.093           | 60.1          | 0.686           | -25.9         | 15.8                    |
| 1200       | 0.391           | -74.5         | 3.521           | 104.9         | 0.102           | 59.3          | 0.636           | -26.6         | 13.9                    |
| 1400       | 0.331           | -83.8         | 3.217           | 99.2          | 0.112           | 59.9          | 0.600           | -27.5         | 12.6                    |
| 1600       | 0.292           | -90.9         | 2.923           | 94.2          | 0.123           | 60.2          | 0.579           | -29.1         | 11.5                    |
| 1800       | 0.252           | -95.0         | 2.658           | 90.4          | 0.130           | 61.3          | 0.562           | -29.7         | 10.4                    |
| 2000       | 0.203           | -101.0        | 2.442           | 86.1          | 0.139           | 61.9          | 0.546           | -29.7         | 9.5                     |
| 2200       | 0.164           | -114.3        | 2.287           | 82.6          | 0.148           | 62.7          | 0.521           | -30.2         | 8.7                     |
| 2400       | 0.154           | -130.8        | 2.172           | 78.2          | 0.160           | 63.1          | 0.498           | -32.2         | 8.1                     |
| 2600       | 0.162           | -138.6        | 2.025           | 75.9          | 0.169           | 63.2          | 0.484           | -35.3         | 7.4                     |
| 2800       | 0.155           | -142.0        | 1.959           | 74.0          | 0.178           | 64.9          | 0.485           | -37.3         | 7.1                     |
| 3000       | 0.130           | -148.7        | 1.852           | 70.9          | 0.190           | 65.5          | 0.485           | -38.2         | 6.6                     |

Table 5 Noise data,  $I_C = 2.5$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | F <sub>min</sub><br>(dB) | $\Gamma_{opt}$ |       | R <sub>n</sub> |
|------------|--------------------------|----------------|-------|----------------|
|            |                          | (RAT)          | (DEG) |                |
| 500        | 1.10                     | 0.640          | 9.00  | 0.610          |
| 900        | 1.25                     | 0.581          | 10.00 | 0.650          |
| 2000       | 1.90                     | 0.410          | 37.00 | 0.530          |

## NPN 9 GHz wideband transistor

BFS505

Table 6 Common emitter scattering parameters,  $I_C = 3.75$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.909           | -4.6          | 9.162           | 173.7         | 0.006           | 86.4          | 0.989           | -2.6          | 43.6                    |
| 100        | 0.891           | -11.3         | 8.921           | 165.9         | 0.015           | 82.2          | 0.975           | -6.3          | 38.9                    |
| 200        | 0.840           | -21.9         | 8.412           | 154.7         | 0.028           | 74.9          | 0.928           | -11.9         | 32.4                    |
| 300        | 0.744           | -31.7         | 7.908           | 145.3         | 0.039           | 70.4          | 0.871           | -16.2         | 28.1                    |
| 400        | 0.704           | -40.7         | 7.358           | 137.0         | 0.049           | 67.2          | 0.818           | -19.7         | 25.1                    |
| 500        | 0.640           | -48.3         | 6.782           | 130.1         | 0.057           | 64.9          | 0.771           | -22.2         | 22.8                    |
| 600        | 0.578           | -54.9         | 6.255           | 124.1         | 0.064           | 63.8          | 0.732           | -23.8         | 21.0                    |
| 700        | 0.517           | -60.7         | 5.781           | 118.5         | 0.070           | 63.3          | 0.701           | -24.7         | 19.5                    |
| 800        | 0.462           | -65.1         | 5.313           | 113.7         | 0.075           | 63.2          | 0.676           | -25.0         | 18.2                    |
| 900        | 0.410           | -69.1         | 4.903           | 109.3         | 0.080           | 62.9          | 0.653           | -25.0         | 17.0                    |
| 1000       | 0.362           | -73.0         | 4.523           | 105.4         | 0.085           | 63.0          | 0.631           | -25.0         | 15.9                    |
| 1200       | 0.285           | -82.2         | 3.953           | 99.0          | 0.095           | 63.2          | 0.589           | -24.8         | 14.2                    |
| 1400       | 0.238           | -92.1         | 3.544           | 94.1          | 0.106           | 64.4          | 0.559           | -25.5         | 12.9                    |
| 1600       | 0.208           | -98.9         | 3.182           | 89.9          | 0.118           | 64.8          | 0.542           | -26.9         | 11.8                    |
| 1800       | 0.176           | -102.7        | 2.874           | 86.4          | 0.126           | 66.0          | 0.530           | -27.5         | 10.7                    |
| 2000       | 0.134           | -110.3        | 2.624           | 82.6          | 0.137           | 66.5          | 0.518           | -27.4         | 9.8                     |
| 2200       | 0.108           | -129.8        | 2.447           | 79.6          | 0.148           | 67.1          | 0.497           | -27.8         | 9.1                     |
| 2400       | 0.112           | -150.3        | 2.314           | 75.6          | 0.161           | 67.3          | 0.474           | -29.7         | 8.4                     |
| 2600       | 0.125           | -155.4        | 2.149           | 73.6          | 0.171           | 67.2          | 0.461           | -33.0         | 7.7                     |
| 2800       | 0.120           | -158.1        | 2.071           | 71.9          | 0.182           | 68.4          | 0.463           | -35.4         | 7.4                     |
| 3000       | 0.100           | -167.8        | 1.954           | 69.0          | 0.194           | 68.7          | 0.465           | -36.3         | 6.9                     |

Table 7 Noise data,  $I_C = 3.75$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | F <sub>min</sub><br>(dB) | $\Gamma_{opt}$ |       | R <sub>n</sub> |
|------------|--------------------------|----------------|-------|----------------|
|            |                          | (RAT)          | (DEG) |                |
| 500        | 1.20                     | 0.591          | 8.00  | 0.570          |
| 900        | 1.35                     | 0.503          | 9.00  | 0.630          |
| 2000       | 2.00                     | 0.352          | 41.00 | 0.490          |

## NPN 9 GHz wideband transistor

BFS505

Table 8 Common emitter scattering parameters,  $I_C = 5$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.881           | -5.6          | 11.534          | 172.6         | 0.006           | 87.2          | 0.986           | -3.1          | 43.4                    |
| 100        | 0.856           | -13.6         | 11.129          | 163.5         | 0.015           | 80.4          | 0.965           | -7.4          | 38.4                    |
| 200        | 0.788           | -26.1         | 10.306          | 150.8         | 0.027           | 73.9          | 0.904           | -13.5         | 31.8                    |
| 300        | 0.707           | -37.3         | 9.476           | 140.4         | 0.037           | 69.1          | 0.835           | -17.7         | 27.7                    |
| 400        | 0.624           | -47.1         | 8.592           | 131.5         | 0.046           | 66.7          | 0.774           | -20.8         | 24.8                    |
| 500        | 0.552           | -55.0         | 7.742           | 124.4         | 0.053           | 64.9          | 0.726           | -22.7         | 22.6                    |
| 600        | 0.487           | -61.6         | 6.993           | 118.4         | 0.059           | 64.6          | 0.687           | -23.8         | 20.8                    |
| 700        | 0.429           | -66.8         | 6.339           | 113.1         | 0.065           | 64.6          | 0.660           | -24.2         | 19.4                    |
| 800        | 0.379           | -70.9         | 5.748           | 108.7         | 0.071           | 64.9          | 0.638           | -24.2         | 18.1                    |
| 900        | 0.332           | -74.6         | 5.247           | 104.7         | 0.076           | 65.3          | 0.619           | -24.0         | 17.0                    |
| 1000       | 0.289           | -78.3         | 4.805           | 101.2         | 0.081           | 65.5          | 0.600           | -23.7         | 16.0                    |
| 1200       | 0.221           | -88.0         | 4.147           | 95.5          | 0.092           | 66.1          | 0.565           | -23.2         | 14.2                    |
| 1400       | 0.184           | -99.0         | 3.685           | 91.1          | 0.103           | 67.4          | 0.539           | -23.7         | 13.0                    |
| 1600       | 0.162           | -106.2        | 3.293           | 87.2          | 0.116           | 67.9          | 0.525           | -25.2         | 11.9                    |
| 1800       | 0.134           | -109.9        | 2.962           | 84.1          | 0.125           | 68.8          | 0.516           | -25.8         | 10.9                    |
| 2000       | 0.097           | -120.7        | 2.701           | 80.5          | 0.137           | 69.1          | 0.506           | -25.8         | 10.0                    |
| 2200       | 0.083           | -147.1        | 2.513           | 77.8          | 0.148           | 69.6          | 0.486           | -26.2         | 9.2                     |
| 2400       | 0.099           | -168.2        | 2.374           | 74.0          | 0.162           | 69.6          | 0.464           | -28.2         | 8.6                     |
| 2600       | 0.111           | -169.6        | 2.199           | 72.1          | 0.173           | 69.4          | 0.451           | -31.5         | 7.9                     |
| 2800       | 0.108           | -171.6        | 2.115           | 70.6          | 0.184           | 70.4          | 0.454           | -34.0         | 7.6                     |
| 3000       | 0.091           | 177.0         | 1.994           | 67.7          | 0.197           | 70.4          | 0.457           | -35.1         | 7.0                     |

Table 9 Noise data,  $I_C = 5$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | F <sub>min</sub><br>(dB) | $\Gamma_{opt}$ |       | R <sub>n</sub> |
|------------|--------------------------|----------------|-------|----------------|
|            |                          | (RAT)          | (DEG) |                |
| 500        | 1.45                     | 0.536          | 7.00  | 0.550          |
| 900        | 1.60                     | 0.487          | 8.00  | 0.570          |
| 2000       | 2.10                     | 0.297          | 41.00 | 0.470          |

## NPN 9 GHz wideband transistor

BFS505

Table 10 Common emitter scattering parameters,  $I_C = 7.5$  mA;  $V_{CE} = 3$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.828           | -7.5          | 15.309          | 170.7         | 0.006           | 84.7          | 0.979           | -3.8          | 42.5                    |
| 100        | 0.790           | -18.2         | 14.502          | 159.5         | 0.014           | 78.8          | 0.946           | -9.0          | 37.3                    |
| 200        | 0.693           | -33.9         | 12.929          | 144.4         | 0.025           | 71.9          | 0.861           | -15.4         | 30.9                    |
| 300        | 0.592           | -46.9         | 11.369          | 132.7         | 0.034           | 67.8          | 0.778           | -19.0         | 27.0                    |
| 400        | 0.500           | -57.3         | 9.871           | 123.5         | 0.042           | 66.5          | 0.715           | -21.1         | 24.2                    |
| 500        | 0.428           | -65.2         | 8.598           | 116.7         | 0.048           | 65.9          | 0.669           | -22.1         | 22.1                    |
| 600        | 0.370           | -71.3         | 7.566           | 111.2         | 0.054           | 66.5          | 0.637           | -22.5         | 20.5                    |
| 700        | 0.320           | -76.1         | 6.726           | 106.7         | 0.060           | 67.4          | 0.616           | -22.5         | 19.1                    |
| 800        | 0.279           | -79.9         | 6.020           | 102.8         | 0.066           | 68.2          | 0.601           | -22.2         | 17.9                    |
| 900        | 0.240           | -83.7         | 5.446           | 99.4          | 0.071           | 68.5          | 0.587           | -21.8         | 16.8                    |
| 1000       | 0.205           | -87.8         | 4.954           | 96.3          | 0.077           | 69.1          | 0.574           | -21.3         | 15.8                    |
| 1200       | 0.153           | -100.2        | 4.229           | 91.3          | 0.088           | 69.8          | 0.545           | -20.7         | 14.2                    |
| 1400       | 0.129           | -114.7        | 3.733           | 87.5          | 0.101           | 71.0          | 0.525           | -21.3         | 12.9                    |
| 1600       | 0.117           | -123.3        | 3.318           | 84.0          | 0.114           | 71.3          | 0.514           | -23.0         | 11.8                    |
| 1800       | 0.095           | -129.6        | 2.982           | 81.2          | 0.124           | 72.0          | 0.508           | -23.8         | 10.8                    |
| 2000       | 0.070           | -150.3        | 2.713           | 77.9          | 0.137           | 72.1          | 0.500           | -23.9         | 9.9                     |
| 2200       | 0.078           | 179.9         | 2.521           | 75.4          | 0.148           | 72.3          | 0.482           | -24.4         | 9.2                     |
| 2400       | 0.104           | 167.8         | 2.379           | 71.9          | 0.163           | 72.2          | 0.461           | -26.4         | 8.6                     |
| 2600       | 0.116           | 170.6         | 2.201           | 70.1          | 0.174           | 71.8          | 0.448           | -30.0         | 7.9                     |
| 2800       | 0.112           | 169.7         | 2.114           | 68.7          | 0.185           | 72.7          | 0.451           | -32.6         | 7.5                     |
| 3000       | 0.102           | 156.4         | 1.991           | 65.9          | 0.199           | 72.5          | 0.454           | -33.9         | 7.0                     |

## NPN 9 GHz wideband transistor

BFS505

Table 11 Common emitter scattering parameters,  $I_C = 0.5$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.988           | -1.5          | 1.295           | 177.7         | 0.006           | 88.8          | 0.998           | -0.9          | 43.7                    |
| 100        | 0.987           | -3.9          | 1.298           | 174.4         | 0.015           | 85.7          | 0.997           | -2.2          | 40.9                    |
| 200        | 0.982           | -7.8          | 1.284           | 169.2         | 0.030           | 82.3          | 0.992           | -4.5          | 34.7                    |
| 300        | 0.972           | -11.7         | 1.292           | 164.3         | 0.045           | 79.3          | 0.984           | -6.7          | 30.0                    |
| 400        | 0.960           | -15.7         | 1.296           | 159.5         | 0.060           | 76.9          | 0.976           | -9.0          | 26.6                    |
| 500        | 0.949           | -19.4         | 1.277           | 155.2         | 0.074           | 74.3          | 0.969           | -11.2         | 24.2                    |
| 600        | 0.934           | -23.1         | 1.265           | 150.8         | 0.087           | 72.0          | 0.959           | -13.3         | 22.0                    |
| 700        | 0.918           | -26.6         | 1.250           | 146.8         | 0.100           | 69.9          | 0.949           | -15.2         | 20.0                    |
| 800        | 0.898           | -29.9         | 1.229           | 142.6         | 0.110           | 67.6          | 0.938           | -16.9         | 18.1                    |
| 900        | 0.875           | -33.4         | 1.225           | 138.1         | 0.120           | 64.9          | 0.922           | -18.6         | 16.3                    |
| 1000       | 0.849           | -36.8         | 1.201           | 134.0         | 0.129           | 62.3          | 0.907           | -20.1         | 14.6                    |
| 1200       | 0.794           | -44.0         | 1.169           | 126.5         | 0.145           | 57.2          | 0.866           | -23.4         | 11.7                    |
| 1400       | 0.748           | -51.3         | 1.166           | 120.1         | 0.161           | 53.7          | 0.831           | -26.3         | 10.0                    |
| 1600       | 0.712           | -58.0         | 1.158           | 114.3         | 0.175           | 50.4          | 0.809           | -29.1         | 9.0                     |
| 1800       | 0.674           | -63.3         | 1.104           | 109.3         | 0.181           | 48.1          | 0.783           | -31.4         | 7.6                     |
| 2000       | 0.612           | -69.0         | 1.075           | 103.1         | 0.186           | 45.6          | 0.751           | -33.1         | 6.3                     |
| 2200       | 0.552           | -76.6         | 1.067           | 97.9          | 0.190           | 43.5          | 0.717           | -35.1         | 5.3                     |
| 2400       | 0.508           | -85.8         | 1.074           | 91.4          | 0.196           | 41.4          | 0.687           | -37.8         | 4.7                     |
| 2600       | 0.494           | -93.7         | 1.050           | 88.2          | 0.197           | 40.0          | 0.670           | -40.9         | 4.2                     |
| 2800       | 0.472           | -99.0         | 1.063           | 85.3          | 0.198           | 40.6          | 0.665           | -43.0         | 4.2                     |
| 3000       | 0.434           | -103.4        | 1.034           | 81.5          | 0.198           | 41.0          | 0.653           | -44.0         | 3.6                     |

## NPN 9 GHz wideband transistor

## BFS505

Table 12 Common emitter scattering parameters,  $I_C = 1.25$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.971           | -2.3          | 3.306           | 176.6         | 0.006           | 87.8          | 0.996           | -1.4          | 44.2                    |
| 100        | 0.967           | -5.6          | 3.287           | 172.2         | 0.015           | 84.6          | 0.993           | -3.3          | 41.1                    |
| 200        | 0.953           | -11.3         | 3.219           | 165.4         | 0.030           | 80.4          | 0.980           | -6.6          | 34.6                    |
| 300        | 0.931           | -16.9         | 3.184           | 159.1         | 0.044           | 76.5          | 0.962           | -9.8          | 30.1                    |
| 400        | 0.904           | -22.4         | 3.133           | 153.3         | 0.058           | 73.2          | 0.942           | -12.8         | 26.8                    |
| 500        | 0.878           | -27.4         | 3.029           | 148.3         | 0.069           | 70.3          | 0.921           | -15.7         | 24.2                    |
| 600        | 0.848           | -32.2         | 2.937           | 143.4         | 0.080           | 67.5          | 0.899           | -18.2         | 22.0                    |
| 700        | 0.815           | -36.7         | 2.863           | 138.9         | 0.090           | 65.3          | 0.877           | -20.3         | 20.2                    |
| 800        | 0.779           | -41.0         | 2.779           | 134.2         | 0.098           | 63.4          | 0.854           | -21.8         | 18.6                    |
| 900        | 0.738           | -45.1         | 2.696           | 129.5         | 0.105           | 61.2          | 0.828           | -23.3         | 17.1                    |
| 1000       | 0.696           | -49.2         | 2.595           | 125.2         | 0.111           | 59.4          | 0.803           | -24.5         | 15.7                    |
| 1200       | 0.613           | -57.8         | 2.447           | 117.6         | 0.121           | 56.0          | 0.748           | -26.9         | 13.4                    |
| 1400       | 0.544           | -66.5         | 2.354           | 111.0         | 0.132           | 54.5          | 0.705           | -28.9         | 12.0                    |
| 1600       | 0.496           | -73.5         | 2.222           | 105.2         | 0.142           | 53.1          | 0.678           | -31.1         | 10.8                    |
| 1800       | 0.449           | -78.6         | 2.068           | 100.5         | 0.146           | 52.9          | 0.652           | -32.5         | 9.7                     |
| 2000       | 0.383           | -83.8         | 1.940           | 95.1          | 0.152           | 52.7          | 0.625           | -33.0         | 8.6                     |
| 2200       | 0.325           | -92.6         | 1.857           | 90.5          | 0.157           | 52.9          | 0.594           | -34.0         | 7.7                     |
| 2400       | 0.290           | -103.7        | 1.793           | 85.1          | 0.166           | 52.9          | 0.566           | -36.1         | 7.1                     |
| 2600       | 0.284           | -111.9        | 1.701           | 82.1          | 0.171           | 53.1          | 0.550           | -39.0         | 6.5                     |
| 2800       | 0.269           | -116.2        | 1.668           | 79.7          | 0.177           | 55.0          | 0.547           | -40.9         | 6.3                     |
| 3000       | 0.235           | -120.1        | 1.588           | 76.2          | 0.184           | 56.3          | 0.543           | -41.6         | 5.8                     |

Table 13 Noise data,  $I_C = 1.25$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | F <sub>min</sub><br>(dB) | $\Gamma_{opt}$ |       | R <sub>n</sub> |
|------------|--------------------------|----------------|-------|----------------|
|            |                          | (RAT)          | (DEG) |                |
| 500        | 1.00                     | 0.739          | 8.00  | 0.820          |
| 900        | 1.20                     | 0.602          | 12.00 | 0.810          |
| 2000       | 1.90                     | 0.544          | 39.00 | 0.600          |

## NPN 9 GHz wideband transistor

BFS505

Table 14 Common emitter scattering parameters,  $I_C = 2.5$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.945           | -3.3          | 6.332           | 175.1         | 0.006           | 85.0          | 0.993           | -1.9          | 44.4                    |
| 100        | 0.935           | -8.2          | 6.233           | 169.0         | 0.015           | 83.1          | 0.985           | -4.9          | 40.2                    |
| 200        | 0.904           | -16.2         | 6.000           | 160.0         | 0.029           | 77.5          | 0.957           | -9.4          | 33.7                    |
| 300        | 0.862           | -23.8         | 5.801           | 152.1         | 0.041           | 73.3          | 0.919           | -13.5         | 29.2                    |
| 400        | 0.813           | -31.1         | 5.557           | 145.0         | 0.053           | 69.8          | 0.881           | -17.0         | 26.1                    |
| 500        | 0.764           | -37.5         | 5.254           | 138.9         | 0.062           | 66.8          | 0.843           | -20.1         | 23.6                    |
| 600        | 0.714           | -43.4         | 4.982           | 133.3         | 0.071           | 64.7          | 0.808           | -22.3         | 21.6                    |
| 700        | 0.662           | -48.9         | 4.744           | 127.9         | 0.078           | 63.5          | 0.776           | -24.0         | 20.0                    |
| 800        | 0.609           | -53.4         | 4.471           | 122.9         | 0.084           | 62.5          | 0.748           | -25.0         | 18.6                    |
| 900        | 0.557           | -57.6         | 4.216           | 118.1         | 0.089           | 61.4          | 0.721           | -25.6         | 17.3                    |
| 1000       | 0.506           | -61.6         | 3.961           | 113.8         | 0.094           | 60.5          | 0.694           | -26.1         | 16.1                    |
| 1200       | 0.415           | -70.1         | 3.559           | 106.5         | 0.103           | 59.6          | 0.642           | -26.9         | 14.2                    |
| 1400       | 0.352           | -78.6         | 3.264           | 100.7         | 0.114           | 59.9          | 0.605           | -27.9         | 12.8                    |
| 1600       | 0.311           | -84.8         | 2.969           | 95.7          | 0.124           | 60.0          | 0.583           | -29.4         | 11.7                    |
| 1800       | 0.271           | -88.4         | 2.705           | 91.9          | 0.131           | 61.0          | 0.564           | -30.1         | 10.6                    |
| 2000       | 0.218           | -93.1         | 2.487           | 87.5          | 0.140           | 61.5          | 0.547           | -30.0         | 9.7                     |
| 2200       | 0.175           | -104.0        | 2.332           | 84.0          | 0.150           | 62.2          | 0.521           | -30.5         | 8.9                     |
| 2400       | 0.157           | -120.1        | 2.217           | 79.5          | 0.162           | 62.5          | 0.497           | -32.4         | 8.3                     |
| 2600       | 0.162           | -128.1        | 2.070           | 77.2          | 0.170           | 62.6          | 0.482           | -35.4         | 7.6                     |
| 2800       | 0.155           | -131.0        | 2.003           | 75.3          | 0.179           | 64.2          | 0.483           | -37.5         | 7.3                     |
| 3000       | 0.126           | -135.6        | 1.893           | 72.2          | 0.191           | 64.8          | 0.483           | -38.2         | 6.8                     |

Table 15 Noise data,  $I_C = 2.5$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | F <sub>min</sub><br>(dB) | $\Gamma_{opt}$ |       | R <sub>n</sub> |
|------------|--------------------------|----------------|-------|----------------|
|            |                          | (RAT)          | (DEG) |                |
| 500        | 1.10                     | 0.692          | 8.00  | 0.660          |
| 900        | 1.25                     | 0.612          | 9.00  | 0.700          |
| 2000       | 1.90                     | 0.439          | 36.00 | 0.580          |

N AMER PHILIPS/DISCRETE 67E D

NPN 9 GHz wideband transistor

BFS505

Table 16 Common emitter scattering parameters,  $I_C = 3.75$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.920           | -4.2          | 8.980           | 173.9         | 0.006           | 87.6          | 0.990           | -2.5          | 44.1                    |
| 100        | 0.905           | -10.4         | 8.768           | 166.6         | 0.015           | 81.9          | 0.976           | -6.1          | 39.5                    |
| 200        | 0.858           | -20.3         | 8.301           | 155.8         | 0.028           | 75.7          | 0.933           | -11.5         | 33.0                    |
| 300        | 0.797           | -29.5         | 7.844           | 146.7         | 0.039           | 71.2          | 0.880           | -15.9         | 28.7                    |
| 400        | 0.730           | -37.8         | 7.335           | 138.6         | 0.049           | 68.1          | 0.829           | -19.4         | 25.6                    |
| 500        | 0.668           | -45.0         | 6.790           | 131.9         | 0.057           | 65.8          | 0.782           | -22.1         | 23.3                    |
| 600        | 0.606           | -51.2         | 6.296           | 125.9         | 0.065           | 64.5          | 0.743           | -23.8         | 21.5                    |
| 700        | 0.545           | -56.6         | 5.846           | 120.3         | 0.071           | 63.7          | 0.712           | -24.9         | 19.9                    |
| 800        | 0.491           | -60.7         | 5.389           | 115.5         | 0.077           | 63.7          | 0.685           | -25.3         | 18.6                    |
| 900        | 0.439           | -64.4         | 4.987           | 111.1         | 0.082           | 63.3          | 0.660           | -25.5         | 17.4                    |
| 1000       | 0.390           | -67.9         | 4.613           | 107.1         | 0.087           | 63.1          | 0.637           | -25.4         | 16.3                    |
| 1200       | 0.308           | -75.8         | 4.044           | 100.6         | 0.096           | 63.2          | 0.592           | -25.4         | 14.4                    |
| 1400       | 0.258           | -84.4         | 3.632           | 95.6          | 0.108           | 64.1          | 0.560           | -26.0         | 13.1                    |
| 1600       | 0.226           | -90.2         | 3.264           | 91.3          | 0.119           | 64.5          | 0.543           | -27.5         | 12.0                    |
| 1800       | 0.192           | -92.4         | 2.949           | 87.9          | 0.128           | 65.5          | 0.530           | -28.0         | 11.0                    |
| 2000       | 0.146           | -96.6         | 2.695           | 84.0          | 0.139           | 65.9          | 0.516           | -27.8         | 10.1                    |
| 2200       | 0.112           | -112.1        | 2.515           | 81.0          | 0.149           | 66.5          | 0.494           | -28.1         | 9.3                     |
| 2400       | 0.105           | -133.5        | 2.379           | 77.0          | 0.163           | 66.5          | 0.470           | -30.0         | 8.7                     |
| 2600       | 0.116           | -140.7        | 2.212           | 74.9          | 0.173           | 66.5          | 0.456           | -33.2         | 8.0                     |
| 2800       | 0.111           | -142.3        | 2.131           | 73.2          | 0.183           | 67.7          | 0.459           | -35.5         | 7.6                     |
| 3000       | 0.087           | -149.4        | 2.012           | 70.4          | 0.196           | 67.9          | 0.460           | -36.3         | 7.1                     |

Table 17 Noise data,  $I_C = 3.75$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | F <sub>min</sub><br>(dB) | $\Gamma_{opt}$ |       | R <sub>n</sub> |
|------------|--------------------------|----------------|-------|----------------|
|            |                          | (RAT)          | (DEG) |                |
| 500        | 1.20                     | 0.628          | 8.00  | 0.640          |
| 900        | 1.35                     | 0.544          | 9.00  | 0.670          |
| 2000       | 2.00                     | 0.388          | 37.00 | 0.540          |

## NPN 9 GHz wideband transistor

BFS505

**Table 18** Common emitter scattering parameters,  $I_C = 5 \text{ mA}$ ;  $V_{CE} = 6 \text{ V}$ 

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.898           | -5.0          | 11.309          | 172.9         | 0.006           | 85.6          | 0.986           | -2.9          | 43.9                    |
| 100        | 0.876           | -12.4         | 10.944          | 164.5         | 0.014           | 80.8          | 0.968           | -7.1          | 39.2                    |
| 200        | 0.815           | -23.8         | 10.199          | 152.4         | 0.027           | 74.7          | 0.911           | -13.1         | 32.6                    |
| 300        | 0.738           | -34.2         | 9.448           | 142.3         | 0.037           | 70.1          | 0.846           | -17.5         | 28.4                    |
| 400        | 0.658           | -43.3         | 8.631           | 133.5         | 0.047           | 67.4          | 0.786           | -20.7         | 25.4                    |
| 500        | 0.588           | -50.7         | 7.824           | 126.5         | 0.054           | 65.8          | 0.737           | -22.9         | 23.1                    |
| 600        | 0.522           | -56.8         | 7.109           | 120.5         | 0.060           | 65.0          | 0.698           | -24.2         | 21.3                    |
| 700        | 0.463           | -61.6         | 6.473           | 115.2         | 0.067           | 65.0          | 0.669           | -24.8         | 19.8                    |
| 800        | 0.411           | -65.1         | 5.887           | 110.7         | 0.072           | 65.1          | 0.646           | -24.8         | 18.5                    |
| 900        | 0.362           | -68.3         | 5.388           | 106.6         | 0.078           | 65.4          | 0.624           | -24.7         | 17.4                    |
| 1000       | 0.319           | -71.4         | 4.945           | 103.0         | 0.083           | 65.5          | 0.604           | -24.4         | 16.3                    |
| 1200       | 0.246           | -79.1         | 4.279           | 97.2          | 0.093           | 65.9          | 0.565           | -23.9         | 14.6                    |
| 1400       | 0.204           | -88.1         | 3.811           | 92.7          | 0.105           | 66.9          | 0.538           | -24.4         | 13.3                    |
| 1600       | 0.178           | -93.6         | 3.406           | 88.8          | 0.118           | 67.3          | 0.523           | -25.9         | 12.2                    |
| 1800       | 0.149           | -95.5         | 3.062           | 85.6          | 0.127           | 68.1          | 0.512           | -26.4         | 11.1                    |
| 2000       | 0.107           | -100.3        | 2.796           | 82.0          | 0.138           | 68.4          | 0.501           | -26.3         | 10.2                    |
| 2200       | 0.079           | -121.0        | 2.602           | 79.2          | 0.150           | 68.8          | 0.481           | -26.5         | 9.5                     |
| 2400       | 0.081           | -147.7        | 2.458           | 75.5          | 0.164           | 68.8          | 0.458           | -28.4         | 8.9                     |
| 2600       | 0.094           | -152.6        | 2.280           | 73.6          | 0.174           | 68.4          | 0.444           | -31.7         | 8.2                     |
| 2800       | 0.092           | -153.1        | 2.191           | 72.0          | 0.185           | 69.5          | 0.447           | -34.2         | 7.8                     |
| 3000       | 0.070           | -163.4        | 2.066           | 69.2          | 0.198           | 69.5          | 0.450           | -35.1         | 7.3                     |

**Table 19** Noise data,  $I_C = 5 \text{ mA}$ ;  $V_{CE} = 6 \text{ V}$ 

| f<br>(MHz) | F <sub>min</sub><br>(dB) | $\Gamma_{opt}$ |       | R <sub>n</sub> |
|------------|--------------------------|----------------|-------|----------------|
|            |                          | (RAT)          | (DEG) |                |
| 500        | 1.45                     | 0.584          | 8.00  | 0.630          |
| 900        | 1.60                     | 0.506          | 9.00  | 0.680          |
| 2000       | 2.20                     | 0.365          | 35.00 | 0.550          |

## NPN 9 GHz wideband transistor

## BFS505

Table 20 Common emitter scattering parameters,  $I_C = 7.5$  mA;  $V_{CE} = 6$  V

| f<br>(MHz) | S <sub>11</sub> |               | S <sub>21</sub> |               | S <sub>12</sub> |               | S <sub>22</sub> |               | G <sub>UM</sub><br>(dB) |
|------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-------------------------|
|            | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) | MAG.<br>(RAT)   | ANG.<br>(DEG) |                         |
| 40         | 0.858           | -6.5          | 15.093          | 171.3         | 0.006           | 85.9          | 0.980           | -3.6          | 43.5                    |
| 100        | 0.827           | -15.8         | 14.388          | 161.1         | 0.014           | 80.3          | 0.952           | -8.6          | 38.4                    |
| 200        | 0.740           | -29.8         | 12.990          | 146.8         | 0.026           | 72.8          | 0.874           | -15.0         | 32.0                    |
| 300        | 0.640           | -41.6         | 11.565          | 135.4         | 0.035           | 69.2          | 0.794           | -19.0         | 27.9                    |
| 400        | 0.548           | -51.1         | 10.151          | 126.2         | 0.043           | 67.2          | 0.729           | -21.5         | 25.0                    |
| 500        | 0.475           | -58.2         | 8.909           | 119.3         | 0.049           | 66.5          | 0.680           | -22.9         | 22.8                    |
| 600        | 0.414           | -63.6         | 7.884           | 113.8         | 0.056           | 66.6          | 0.646           | -23.5         | 21.1                    |
| 700        | 0.361           | -67.7         | 7.037           | 109.0         | 0.062           | 67.3          | 0.621           | -23.7         | 19.7                    |
| 800        | 0.316           | -70.6         | 6.315           | 105.1         | 0.068           | 68.0          | 0.604           | -23.4         | 18.4                    |
| 900        | 0.275           | -73.0         | 5.720           | 101.5         | 0.073           | 68.3          | 0.587           | -22.9         | 17.3                    |
| 1000       | 0.237           | -75.8         | 5.211           | 98.4          | 0.079           | 68.5          | 0.572           | -22.4         | 16.3                    |
| 1200       | 0.178           | -84.2         | 4.459           | 93.2          | 0.090           | 69.2          | 0.541           | -21.7         | 14.6                    |
| 1400       | 0.145           | -93.9         | 3.943           | 89.4          | 0.103           | 70.2          | 0.518           | -22.2         | 13.4                    |
| 1600       | 0.126           | -100.6        | 3.507           | 85.8          | 0.116           | 70.5          | 0.506           | -23.7         | 12.3                    |
| 1800       | 0.102           | -101.2        | 3.143           | 83.0          | 0.126           | 71.1          | 0.498           | -24.4         | 11.2                    |
| 2000       | 0.065           | -110.2        | 2.867           | 79.6          | 0.139           | 71.0          | 0.490           | -24.3         | 10.4                    |
| 2200       | 0.049           | -145.1        | 2.661           | 77.1          | 0.151           | 71.2          | 0.471           | -24.6         | 9.6                     |
| 2400       | 0.068           | -174.5        | 2.511           | 73.6          | 0.166           | 71.1          | 0.449           | -26.5         | 9.0                     |
| 2600       | 0.081           | -172.9        | 2.323           | 71.9          | 0.176           | 70.5          | 0.435           | -30.0         | 8.3                     |
| 2800       | 0.080           | -171.8        | 2.231           | 70.5          | 0.188           | 71.5          | 0.438           | -32.7         | 7.9                     |
| 3000       | 0.063           | 173.4         | 2.101           | 67.8          | 0.201           | 71.2          | 0.442           | -33.7         | 7.4                     |