

## NPN 8 GHz wideband transistor

T-31-17

BFG65

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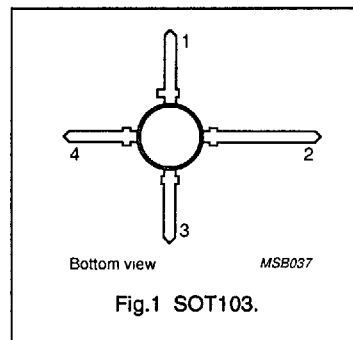
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## DESCRIPTION

NPN transistor in a four-lead dual emitter plastic envelope (SOT103). It is designed for wideband application in the GHz range, such as satellite TV systems and repeater amplifiers in fibre-optical systems. The device features a very high transition frequency, high gain and a very low noise figure up to 2 GHz.

## PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | emitter     |
| 2   | collector   |
| 3   | emitter     |
| 4   | base        |



## QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                                | CONDITIONS                                                                                | MIN. | TYP. | MAX. | UNIT             |
|-----------|------------------------------------------|-------------------------------------------------------------------------------------------|------|------|------|------------------|
| $V_{CBO}$ | collector-base voltage                   | open emitter                                                                              | —    | —    | 20   | V                |
| $V_{CEO}$ | collector-emitter voltage                | open base                                                                                 | —    | —    | 10   | V                |
| $I_C$     | DC collector current                     |                                                                                           | —    | —    | 50   | mA               |
| $P_{tot}$ | total power dissipation                  | up to $T_s = 158^\circ\text{C}$ (note 1)                                                  | —    | —    | 300  | mW               |
| $T_j$     | junction temperature                     |                                                                                           | —    | —    | 175  | $^\circ\text{C}$ |
| $h_{FE}$  | DC current gain                          | $I_C = 15\text{ mA}$ ; $V_{CE} = 5\text{ V}$                                              | 60   | 100  | —    |                  |
| $f_T$     | transition frequency                     | $I_C = 15\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ;<br>$f = 500\text{ MHz}$                    | —    | 8    | —    | GHz              |
| $G_{UM}$  | maximum unilateral power gain            | $I_C = 15\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ;<br>$f = 2\text{ GHz}$                      | —    | 10.5 | —    | dB               |
| F         | noise figure at optimum source impedance | $Z_S = 50\ \Omega$ ; $I_C = 15\text{ mA}$ ;<br>$V_{CE} = 8\text{ V}$ ; $f = 1\text{ GHz}$ | —    | 1.7  | —    | dB               |

## 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                |
| $V_{CEO}$ | collector-emitter voltage | open base                                | —    | 10   | V                |
| $V_{EBO}$ | emitter-base voltage      | open collector                           | —    | 2.5  | V                |
| $I_C$     | DC collector current      |                                          | —    | 50   | mA               |
| $P_{tot}$ | total power dissipation   | up to $T_s = 158^\circ\text{C}$ (note 1) | —    | 300  | mW               |
| $T_{stg}$ | storage temperature range |                                          | —65  | 150  | $^\circ\text{C}$ |
| $T_j$     | junction temperature      |                                          | —    | 175  | $^\circ\text{C}$ |

## Note

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

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## THERMAL RESISTANCE

| SYMBOL        | PARAMETER                        | THERMAL RESISTANCE |
|---------------|----------------------------------|--------------------|
| $R_{th\ j-s}$ | from junction to soldering point | 55 K/W             |

## CHARACTERISTICS

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

| SYMBOL    | PARAMETER                                | CONDITIONS                                                                                                                     | MIN. | TYP. | MAX. | UNIT |
|-----------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{CBO}$ | collector cut-off current                | $I_E = 0; V_{CB} = 5\text{ V}$                                                                                                 | —    | —    | 50   | nA   |
| $h_{FE}$  | DC current gain                          | $I_C = 15\text{ mA}; V_{CE} = 5\text{ V}$                                                                                      | 60   | 100  | —    |      |
| $f_T$     | transition frequency                     | $I_C = 15\text{ mA}; V_{CE} = 8\text{ V};$<br>$f = 500\text{ MHz}$                                                             | —    | 8    | —    | GHz  |
| $C_c$     | collector capacitance                    | $I_E = I_s = 0; V_{CB} = 8\text{ V};$<br>$f = 1\text{ MHz}$                                                                    | —    | 1.1  | —    | pF   |
| $C_e$     | emitter capacitance                      | $I_C = I_c = 0; V_{EB} = 0.5\text{ V};$<br>$f = 1\text{ MHz}$                                                                  | —    | 1.3  | —    | pF   |
| $C_{re}$  | feedback capacitance                     | $I_C = 0; V_{CE} = 8\text{ V};$<br>$f = 1\text{ MHz}$                                                                          | —    | 0.5  | —    | pF   |
| $G_{UM}$  | maximum unilateral power gain (note 1)   | $I_C = 15\text{ mA}; V_{CE} = 8\text{ V};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C}; f = 800\text{ MHz}$                       | —    | 18.5 | —    | dB   |
|           |                                          | $I_C = 15\text{ mA}; V_{CE} = 8\text{ V};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C}; f = 2\text{ GHz}$                         | —    | 10.5 | —    | dB   |
| F         | noise figure at optimum source impedance | $Z_S = 50\text{ }\Omega; I_C = 5\text{ mA}; V_{CE} = 8\text{ V};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C}; f = 1\text{ GHz}$  | —    | 1.3  | —    | dB   |
|           |                                          | $Z_S = 50\text{ }\Omega; I_C = 15\text{ mA}; V_{CE} = 8\text{ V};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C}; f = 1\text{ GHz}$ | —    | 1.7  | —    | dB   |
|           |                                          | $Z_S = 50\text{ }\Omega; I_C = 5\text{ mA}; V_{CE} = 8\text{ V};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C}; f = 2\text{ GHz}$  | —    | 2.1  | —    | dB   |
|           |                                          | $Z_S = 50\text{ }\Omega; I_C = 15\text{ mA}; V_{CE} = 8\text{ V};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C}; f = 2\text{ GHz}$ | —    | 2.7  | —    | dB   |

## Note

1.  $G_{UM}$  is the maximum unilateral power gain, assuming  $S_{12}$  is zero and  $G_{UM} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$  dB.

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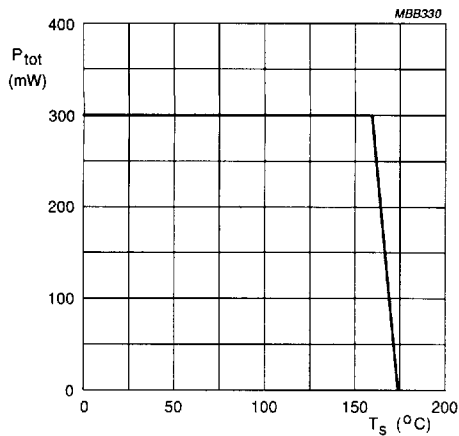


Fig.2 Power derating curve.

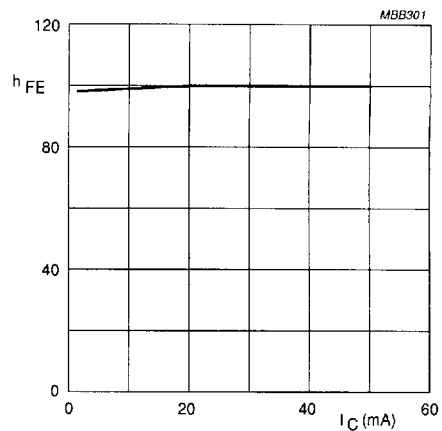
 $V_{CE} = 8 \text{ V}; T_j = 25^\circ\text{C}.$ 

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

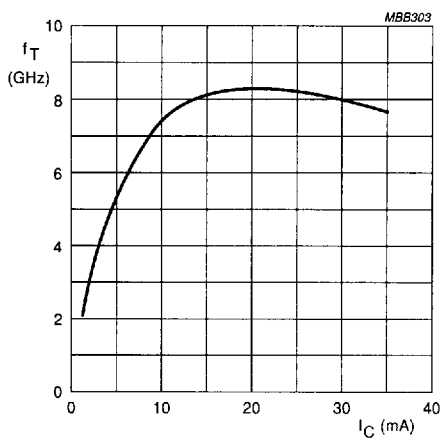
 $V_{CE} = 8 \text{ V}; f = 500 \text{ MHz}.$ 

Fig.4 Transition frequency as a function of collector current.

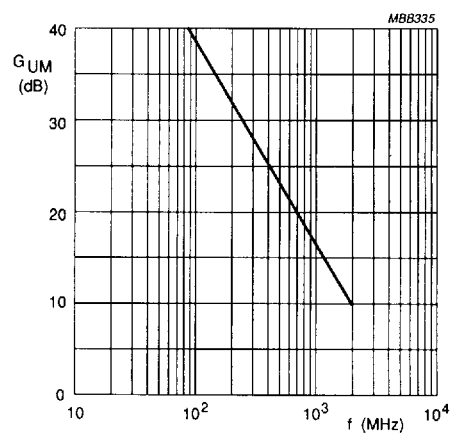
 $V_{CE} = 8 \text{ V}; I_C = 15 \text{ mA}; T_{amb} = 25^\circ\text{C}.$ 

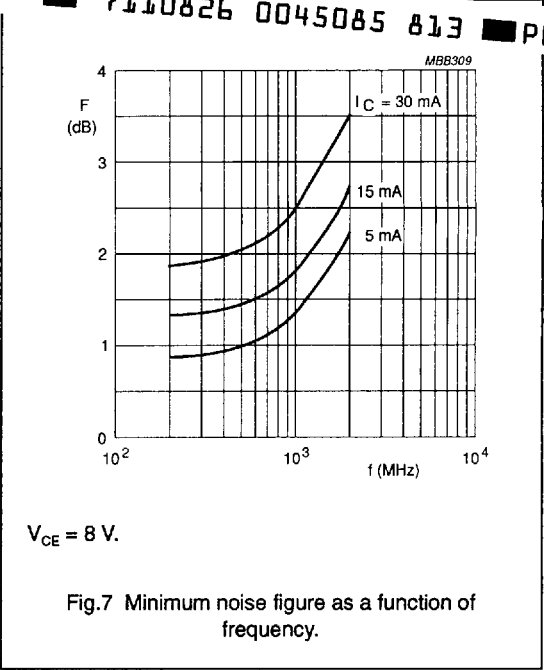
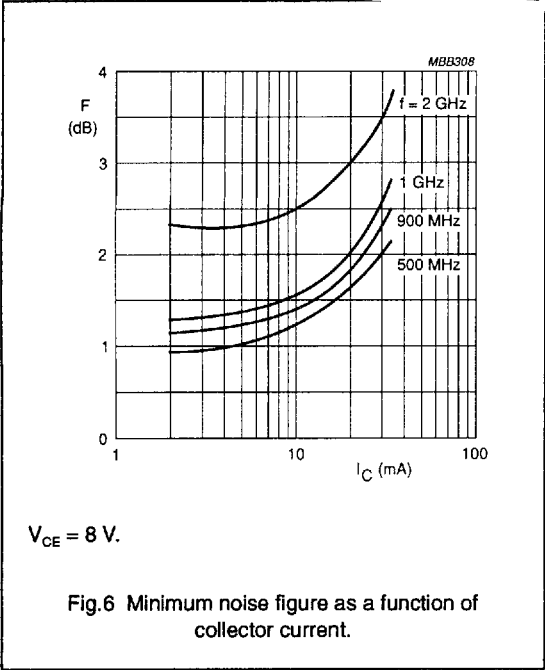
Fig.5 Maximum unilateral power gain as a function of frequency.

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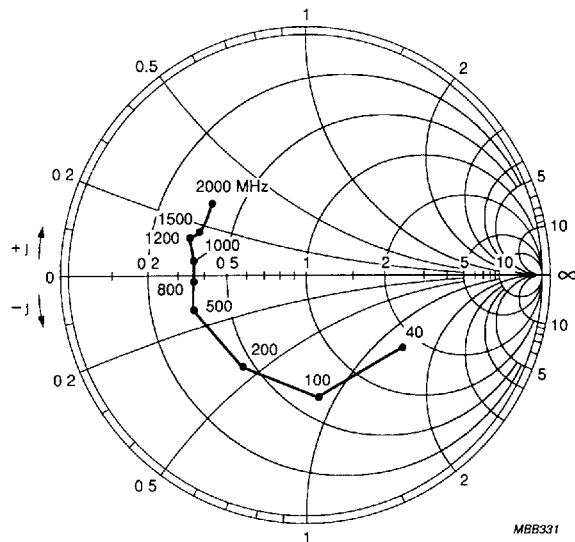
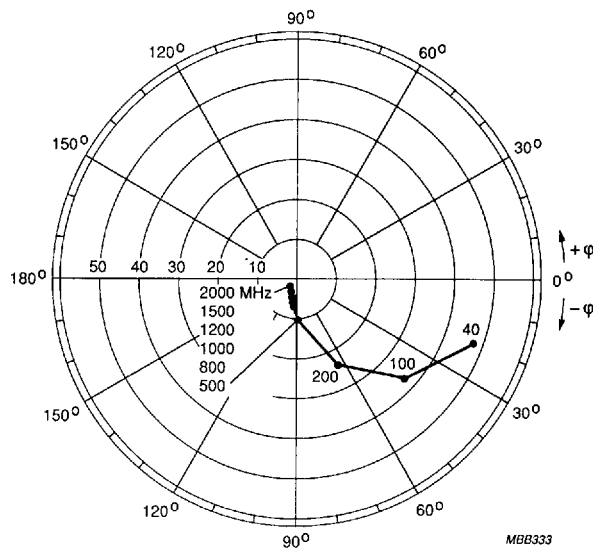
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 $V_{CE} = 8 \text{ V}; I_C = 30 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}.$ Fig.8 Common emitter input reflection coefficient ( $S_{11}$ ). $V_{CE} = 8 \text{ V}; I_C = 30 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}.$ Fig.9 Common emitter forward transmission coefficient ( $S_{21}$ ).

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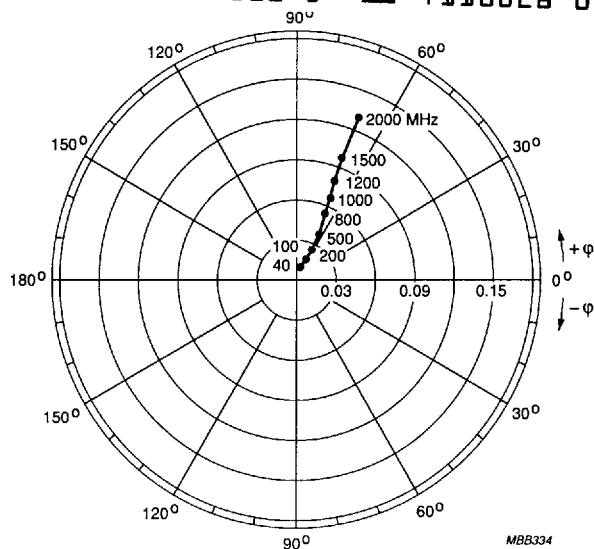
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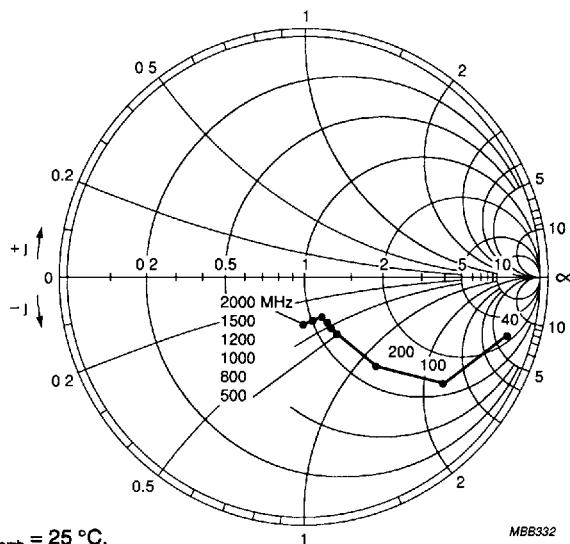
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 $V_{CE} = 8 \text{ V}; I_C = 30 \text{ mA}; T_{amb} = 25^\circ \text{C}.$ 

MBB334

Fig.10 Common emitter reverse transmission coefficient ( $S_{12}$ ). $V_{CE} = 8 \text{ V}; I_C = 30 \text{ mA}; T_{amb} = 25^\circ \text{C}.$ 

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Fig.11 Common emitter output reflection coefficient ( $S_{22}$ ).

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Table 1 Common emitter scattering parameters,  $V_{CE} = 8 \text{ V}$ ,  $I_C = 10 \text{ mA}$ 

| 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         | 0.737           | -20.0         | 26.381          | 167.0         | 0.010           | 79.3          | 0.968           | -10.5         | 43.8                    |
| 100        | 0.700           | -47.4         | 23.940          | 150.5         | 0.022           | 66.7          | 0.880           | -24.6         | 37.0                    |
| 200        | 0.627           | -84.5         | 18.946          | 129.8         | 0.036           | 53.4          | 0.702           | -40.8         | 30.7                    |
| 300        | 0.584           | -110.8        | 14.923          | 115.9         | 0.043           | 46.2          | 0.563           | -50.6         | 26.9                    |
| 400        | 0.567           | -128.6        | 12.112          | 106.4         | 0.048           | 43.2          | 0.470           | -56.6         | 24.4                    |
| 500        | 0.558           | -141.7        | 10.112          | 98.9          | 0.052           | 41.6          | 0.411           | -60.6         | 22.5                    |
| 600        | 0.550           | -151.2        | 8.653           | 93.1          | 0.055           | 41.1          | 0.371           | -63.5         | 20.9                    |
| 700        | 0.542           | -159.6        | 7.515           | 88.2          | 0.059           | 41.6          | 0.343           | -65.2         | 19.6                    |
| 800        | 0.533           | -166.2        | 6.667           | 84.1          | 0.062           | 42.2          | 0.320           | -66.4         | 18.4                    |
| 900        | 0.533           | -171.9        | 5.964           | 79.9          | 0.066           | 42.5          | 0.302           | -67.1         | 17.4                    |
| 1000       | 0.532           | -178.0        | 5.380           | 76.3          | 0.069           | 43.3          | 0.284           | -67.9         | 16.4                    |
| 1200       | 0.535           | 171.5         | 4.564           | 69.2          | 0.077           | 43.6          | 0.256           | -72.3         | 14.9                    |
| 1400       | 0.551           | 162.8         | 3.934           | 62.9          | 0.084           | 43.6          | 0.236           | -79.7         | 13.7                    |
| 1600       | 0.551           | 156.2         | 3.452           | 57.1          | 0.092           | 44.1          | 0.238           | -85.4         | 12.6                    |
| 1800       | 0.552           | 149.7         | 3.143           | 50.8          | 0.101           | 43.6          | 0.245           | -89.6         | 11.8                    |
| 2000       | 0.558           | 142.9         | 2.848           | 45.4          | 0.110           | 42.2          | 0.240           | -92.6         | 11.0                    |
| 2200       | 0.580           | 135.9         | 2.597           | 40.2          | 0.119           | 41.8          | 0.225           | -97.8         | 10.3                    |
| 2400       | 0.602           | 130.7         | 2.402           | 35.7          | 0.127           | 40.8          | 0.217           | -107.2        | 9.8                     |
| 2600       | 0.617           | 127.0         | 2.229           | 30.1          | 0.135           | 38.8          | 0.230           | -117.1        | 9.3                     |
| 2800       | 0.622           | 121.6         | 2.099           | 24.4          | 0.143           | 37.1          | 0.248           | -123.5        | 8.8                     |
| 3000       | 0.623           | 116.7         | 1.971           | 20.1          | 0.154           | 36.0          | 0.256           | -126.1        | 8.3                     |

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Table 2 Common emitter scattering parameters,  $V_{CE} = 8\text{ V}$ ,  $I_C = 15\text{ mA}$ 

| 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         | 0.653           | -25.8         | 34.244          | 164.3         | 0.009           | 77.1          | 0.950           | -13.2         | 43.2                    |
| 100        | 0.620           | -59.5         | 29.823          | 145.1         | 0.020           | 63.6          | 0.827           | -29.8         | 36.6                    |
| 200        | 0.563           | -100.4        | 21.965          | 123.5         | 0.031           | 52.1          | 0.616           | -46.9         | 30.6                    |
| 300        | 0.541           | -125.7        | 16.612          | 110.5         | 0.036           | 46.6          | 0.476           | -55.9         | 27.0                    |
| 400        | 0.537           | -141.4        | 13.167          | 101.8         | 0.041           | 46.1          | 0.391           | -61.3         | 24.6                    |
| 500        | 0.534           | -152.8        | 10.854          | 95.2          | 0.045           | 45.8          | 0.340           | -64.8         | 22.7                    |
| 600        | 0.532           | -161.2        | 9.223           | 89.9          | 0.048           | 46.6          | 0.306           | -66.9         | 21.2                    |
| 700        | 0.527           | -168.0        | 7.978           | 85.5          | 0.053           | 47.5          | 0.284           | -68.3         | 19.8                    |
| 800        | 0.522           | -173.9        | 7.061           | 81.7          | 0.057           | 48.9          | 0.265           | -69.3         | 18.7                    |
| 900        | 0.523           | -179.3        | 6.308           | 77.8          | 0.062           | 49.1          | 0.250           | -69.8         | 17.7                    |
| 1000       | 0.522           | 175.9         | 5.693           | 74.4          | 0.066           | 49.8          | 0.236           | -70.4         | 16.7                    |
| 1200       | 0.532           | 166.2         | 4.809           | 67.8          | 0.074           | 49.8          | 0.211           | -74.9         | 15.3                    |
| 1400       | 0.545           | 158.3         | 4.141           | 61.9          | 0.084           | 49.2          | 0.195           | -83.3         | 14.0                    |
| 1600       | 0.550           | 152.6         | 3.629           | 56.2          | 0.093           | 49.2          | 0.200           | -89.1         | 12.9                    |
| 1800       | 0.550           | 146.6         | 3.287           | 50.2          | 0.103           | 48.0          | 0.208           | -93.1         | 12.1                    |
| 2000       | 0.558           | 139.8         | 2.987           | 45.1          | 0.113           | 46.2          | 0.205           | -95.9         | 11.3                    |
| 2200       | 0.575           | 133.8         | 2.710           | 39.8          | 0.123           | 45.0          | 0.191           | -101.4        | 10.6                    |
| 2400       | 0.597           | 128.4         | 2.515           | 35.5          | 0.131           | 43.5          | 0.185           | -112.1        | 10.1                    |
| 2600       | 0.615           | 125.1         | 2.326           | 30.4          | 0.140           | 41.3          | 0.199           | -122.5        | 9.6                     |
| 2800       | 0.620           | 119.6         | 2.197           | 24.3          | 0.148           | 39.0          | 0.218           | -128.8        | 9.2                     |
| 3000       | 0.624           | 114.6         | 2.060           | 20.3          | 0.159           | 37.3          | 0.225           | -130.9        | 8.6                     |



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Table 3 Common emitter scattering parameters,  $V_{CE} = 8\text{ V}$ ,  $I_C = 20\text{ mA}$ 

| 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         | 0.586           | -31.0         | 40.395          | 162.1         | 0.009           | 77.1          | 0.933           | -15.3         | 42.9                    |
| 100        | 0.561           | -70.0         | 33.893          | 141.0         | 0.019           | 61.3          | 0.782           | -33.7         | 36.4                    |
| 200        | 0.527           | -112.1        | 23.701          | 119.4         | 0.028           | 51.7          | 0.556           | -50.7         | 30.5                    |
| 300        | 0.521           | -135.9        | 17.482          | 107.2         | 0.032           | 48.3          | 0.421           | -59.2         | 27.1                    |
| 400        | 0.524           | -149.8        | 13.702          | 99.1          | 0.037           | 49.1          | 0.343           | -63.9         | 24.7                    |
| 500        | 0.526           | -159.7        | 11.222          | 92.9          | 0.041           | 50.1          | 0.297           | -67.1         | 22.8                    |
| 600        | 0.528           | -167.3        | 9.485           | 88.0          | 0.045           | 50.7          | 0.269           | -69.0         | 21.3                    |
| 700        | 0.522           | -173.2        | 8.189           | 83.7          | 0.050           | 52.1          | 0.250           | -70.2         | 19.9                    |
| 800        | 0.518           | -178.7        | 7.244           | 80.1          | 0.055           | 53.1          | 0.234           | -70.6         | 18.8                    |
| 900        | 0.520           | 176.9         | 6.460           | 76.5          | 0.060           | 53.5          | 0.221           | -71.0         | 17.8                    |
| 1000       | 0.522           | 171.6         | 5.822           | 73.2          | 0.064           | 53.7          | 0.209           | -71.6         | 16.9                    |
| 1200       | 0.532           | 163.2         | 4.930           | 66.9          | 0.074           | 53.5          | 0.186           | -76.3         | 15.5                    |
| 1400       | 0.545           | 156.1         | 4.221           | 61.1          | 0.084           | 52.6          | 0.172           | -85.2         | 14.2                    |
| 1600       | 0.548           | 150.2         | 3.702           | 55.6          | 0.094           | 52.0          | 0.179           | -91.4         | 13.1                    |
| 1800       | 0.547           | 144.5         | 3.361           | 49.7          | 0.105           | 50.5          | 0.188           | -95.3         | 12.2                    |
| 2000       | 0.557           | 138.2         | 3.046           | 44.6          | 0.115           | 48.2          | 0.185           | -98.1         | 11.4                    |
| 2200       | 0.575           | 132.3         | 2.775           | 39.6          | 0.125           | 46.8          | 0.172           | -103.7        | 10.7                    |
| 2400       | 0.604           | 127.3         | 2.566           | 35.4          | 0.134           | 45.2          | 0.168           | -115.1        | 10.3                    |
| 2600       | 0.609           | 124.2         | 2.381           | 30.1          | 0.142           | 42.5          | 0.183           | -126.0        | 9.7                     |
| 2800       | 0.617           | 119.1         | 2.239           | 24.4          | 0.152           | 40.1          | 0.204           | -132.0        | 9.3                     |
| 3000       | 0.620           | 114.1         | 2.087           | 20.3          | 0.162           | 38.2          | 0.210           | -133.7        | 8.7                     |