

To our customers,

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## Old Company Name in Catalogs and Other Documents

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Renesas Electronics website: <http://www.renesas.com>

April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (<http://www.renesas.com>)

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# NPN SILICON RF TRANSISTOR

## 2SC5787

### NPN SILICON RF TRANSISTOR FOR HIGH-FREQUENCY LOW NOISE 3-PIN LEAD-LESS MINIMOLD

#### FEATURES

- Ideal for 3 GHz or higher OSC applications
- Low noise, high gain  
 $f_T = 20 \text{ GHz TYP.}, |S_{21e}|^2 = 13 \text{ dB TYP. @ } V_{CE} = 1 \text{ V, } I_C = 20 \text{ mA, } f = 2 \text{ GHz}$   
 $NF = 1.4 \text{ dB TYP. @ } V_{CE} = 1 \text{ V, } I_C = 5 \text{ mA, } f = 2 \text{ GHz, } Z_S = Z_{opt}$
- UHS0 technology ( $f_T = 25 \text{ GHz}$ ) adopted
- High reliability through use of gold electrodes
- 3-pin lead-less minimold package (1005 PKG)

#### ORDERING INFORMATION

| Part Number | Quantity          | Supplying Form                                                                                                                              |
|-------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 2SC5787     | 50 pcs (Non reel) | <ul style="list-style-type: none"> <li>• 8 mm wide embossed taping</li> <li>• Pin 2 (Base) face the perforation side of the tape</li> </ul> |
| 2SC5787-T3  | 10 kpcs/reel      |                                                                                                                                             |

**Remark** To order evaluation samples, consult your NEC sales representative.  
Unit sample quantity is 50 pcs.

#### ABSOLUTE MAXIMUM RATINGS ( $T_A = +25^\circ\text{C}$ )

| Parameter                    | Symbol                  | Ratings     | Unit             |
|------------------------------|-------------------------|-------------|------------------|
| Collector to Base Voltage    | $V_{CBO}$               | 9.0         | V                |
| Collector to Emitter Voltage | $V_{CEO}$               | 3.0         | V                |
| Emitter to Base Voltage      | $V_{EBO}$               | 1.5         | V                |
| Collector Current            | $I_C$                   | 35          | mA               |
| Total Power Dissipation      | $P_{tot}^{\text{Note}}$ | 105         | mW               |
| Junction Temperature         | $T_j$                   | 150         | $^\circ\text{C}$ |
| Storage Temperature          | $T_{stg}$               | -65 to +150 | $^\circ\text{C}$ |

**Note** Mounted on  $1.08 \text{ cm}^2 \times 1.0 \text{ mm}$  (t) glass epoxy PCB

Because this product uses high-frequency technology, avoid excessive static electricity, etc.

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Not all devices/types available in every country. Please check with local NEC Compound Semiconductor Devices representative for availability and additional information.

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = +25°C)**

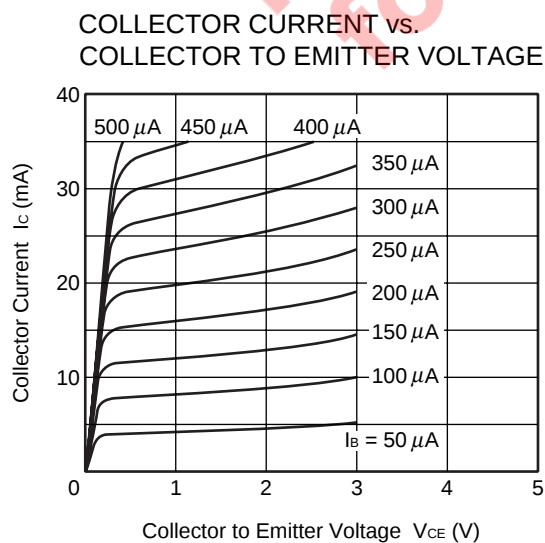
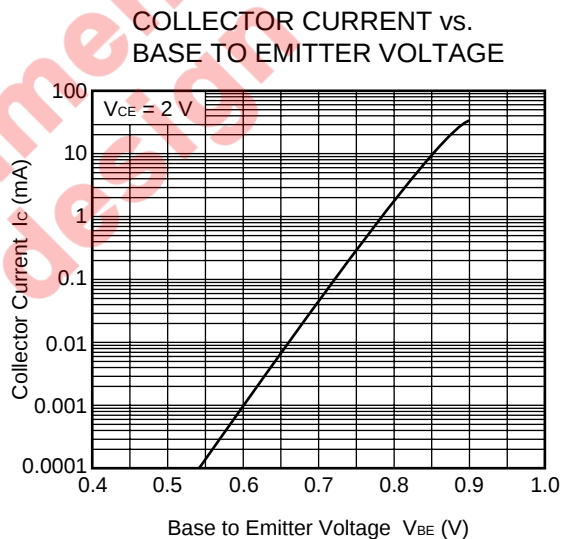
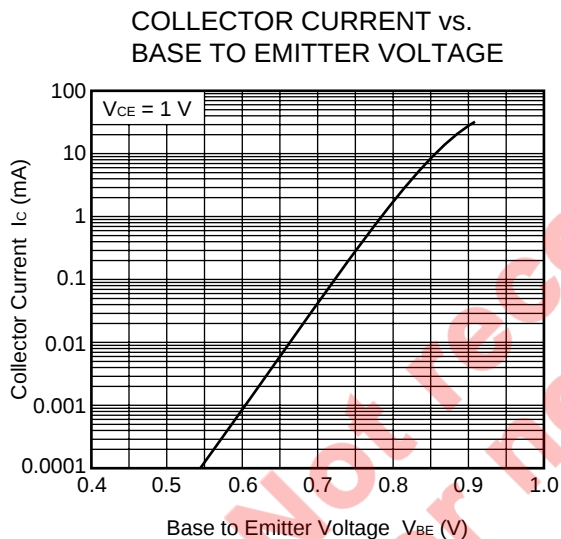
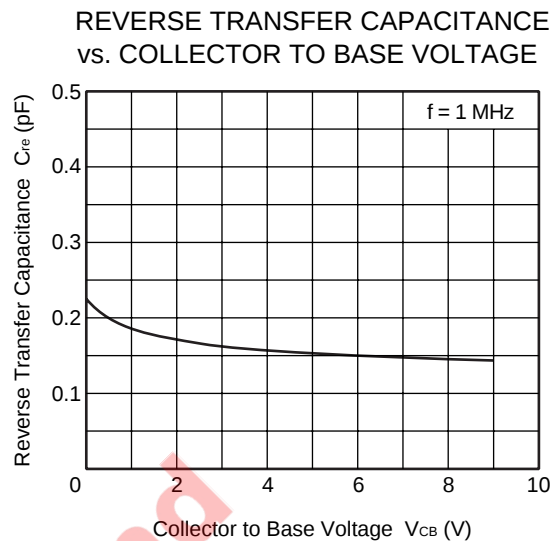
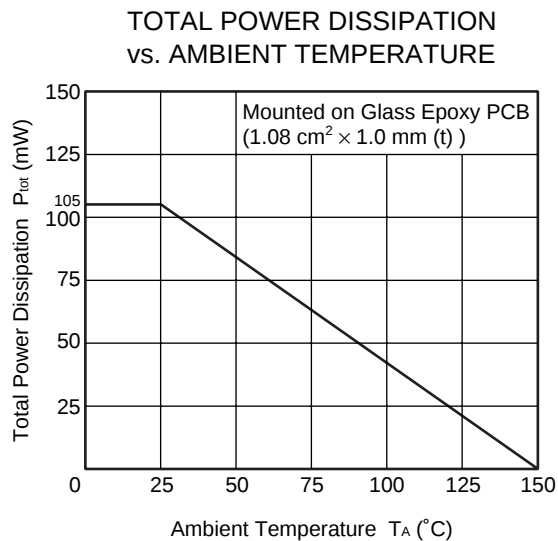
| Parameter                    | Symbol                            | Test Conditions                                                                               | MIN. | TYP. | MAX. | Unit |
|------------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------|------|------|------|------|
| DC Characteristics           |                                   |                                                                                               |      |      |      |      |
| Collector Cut-off Current    | I <sub>CBO</sub>                  | V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0 mA                                                  | —    | —    | 100  | nA   |
| Emitter Cut-off Current      | I <sub>EBO</sub>                  | V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0 mA                                                  | —    | —    | 100  | nA   |
| DC Current Gain              | h <sub>FE</sub> <sup>Note 1</sup> | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 5 mA                                                  | 50   | —    | 100  | —    |
| RF Characteristics           |                                   |                                                                                               |      |      |      |      |
| Gain Bandwidth Product       | f <sub>T</sub>                    | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 20 mA, f = 2 GHz                                      | 17   | 20   | —    | GHz  |
| Insertion Power Gain         | S <sub>21e</sub>   <sup>2</sup>   | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 20 mA, f = 2 GHz                                      | 11   | 13   | —    | dB   |
| Noise Figure                 | NF                                | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 5 mA, f = 2 GHz,<br>Z <sub>S</sub> = Z <sub>opt</sub> | —    | 1.4  | 2.5  | dB   |
| Reverse Transfer Capacitance | C <sub>re</sub> <sup>Note 2</sup> | V <sub>CB</sub> = 0.5 V, I <sub>E</sub> = 0 mA, f = 1 MHz                                     | —    | 0.22 | 0.30 | pF   |

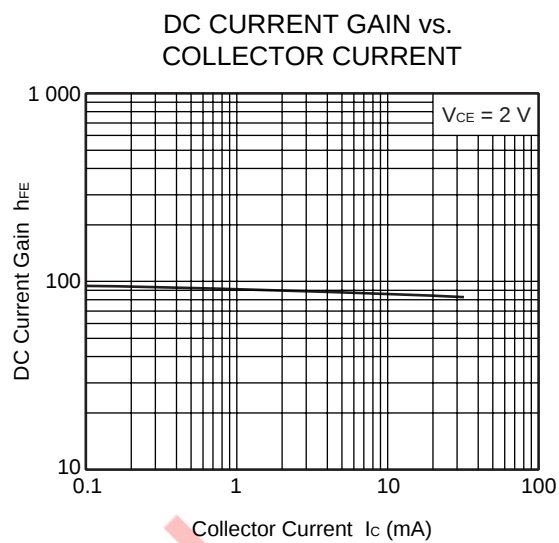
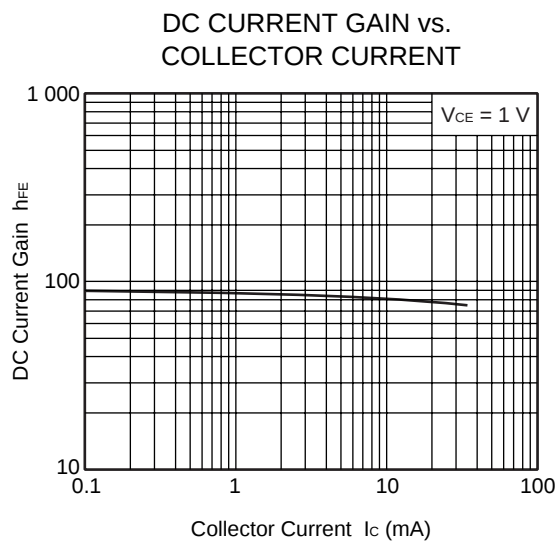
- Notes** 1. Pulse measurement: PW ≤ 350 μs, Duty Cycle ≤ 2%  
 2. Collector to base capacitance when the emitter grounded

**h<sub>FE</sub> CLASSIFICATION**

|                       |           |
|-----------------------|-----------|
| Rank                  | FB        |
| Marking               | B7        |
| h <sub>FE</sub> Value | 50 to 100 |

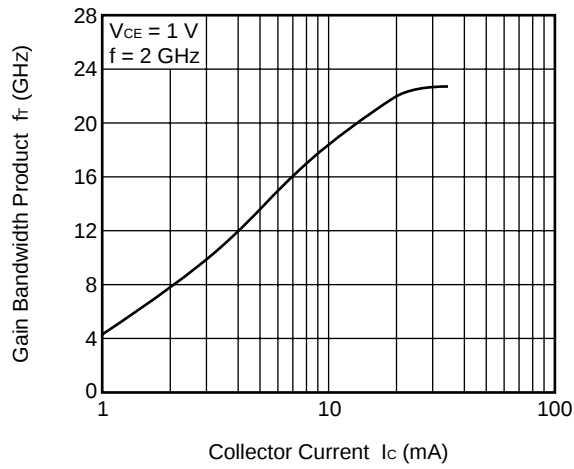
**TYPICAL CHARACTERISTICS (Unless otherwise specified,  $T_A = +25^\circ\text{C}$ )**



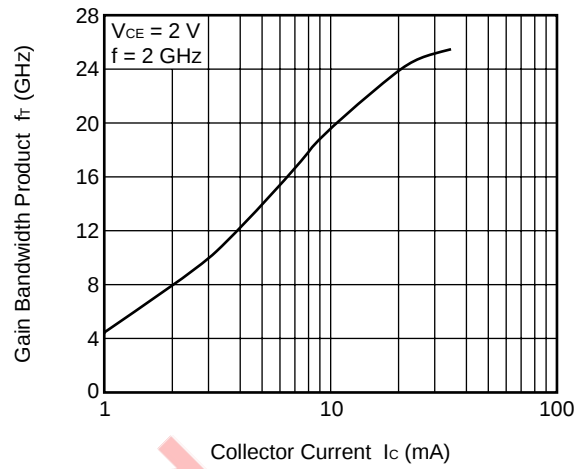


Not recommended  
for new design

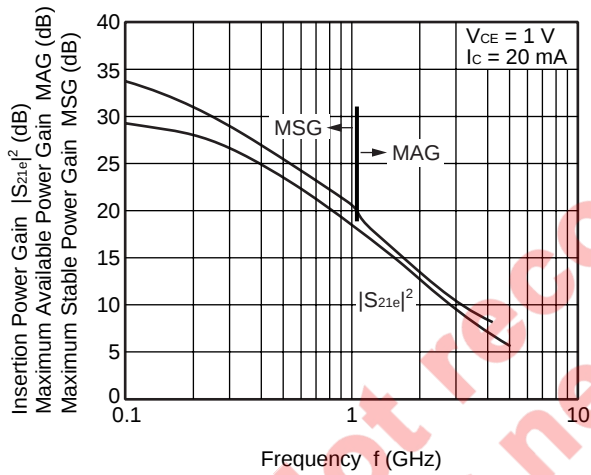
GAIN BANDWIDTH PRODUCT  
vs. COLLECTOR CURRENT



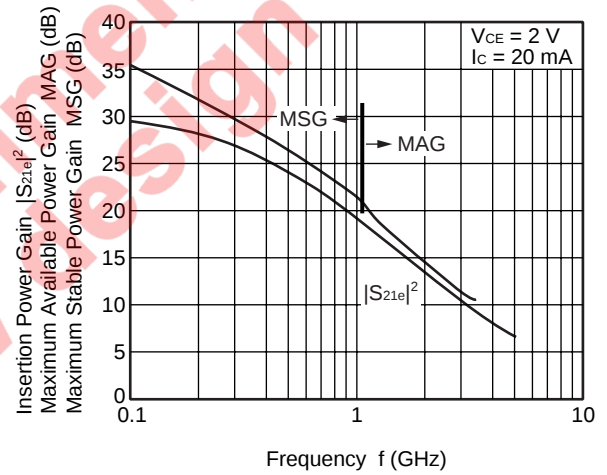
GAIN BANDWIDTH PRODUCT  
vs. COLLECTOR CURRENT



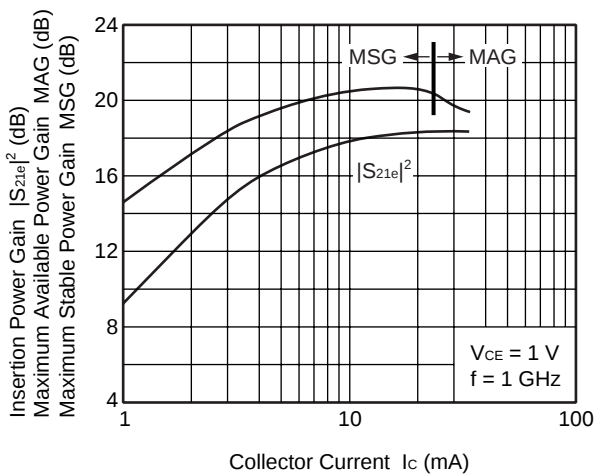
INSERTION POWER GAIN,  
MAG, MSG vs. FREQUENCY



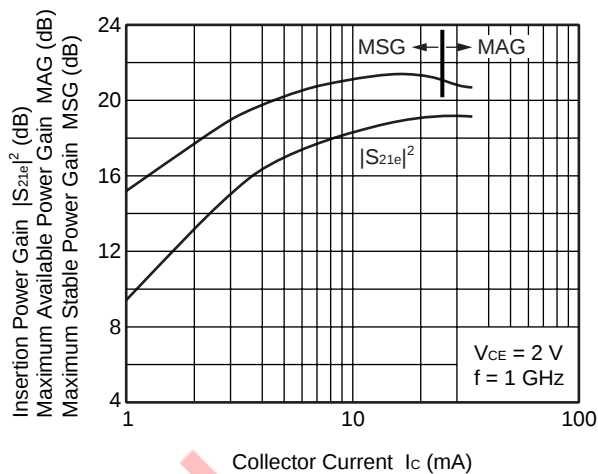
INSERTION POWER GAIN,  
MAG, MSG vs. FREQUENCY



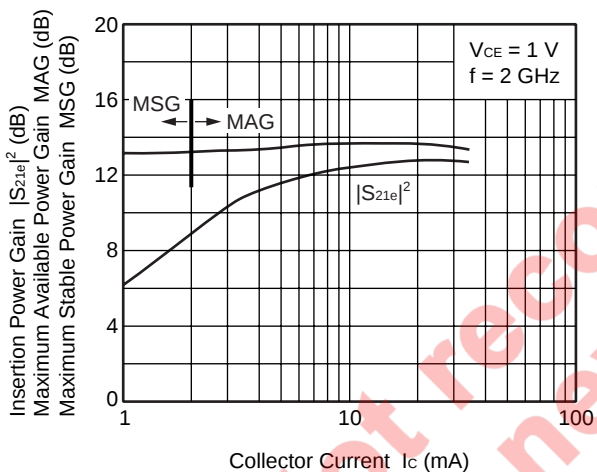
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



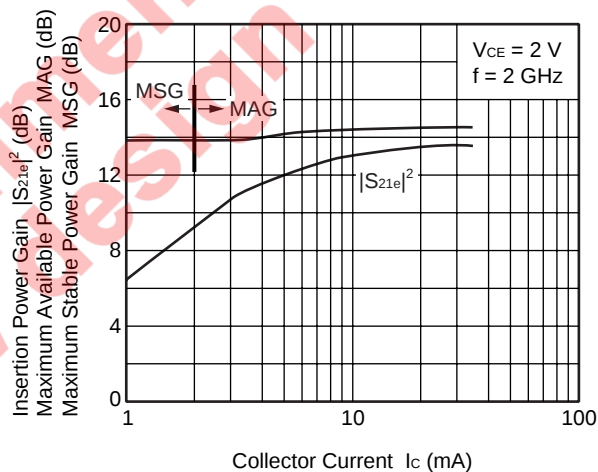
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



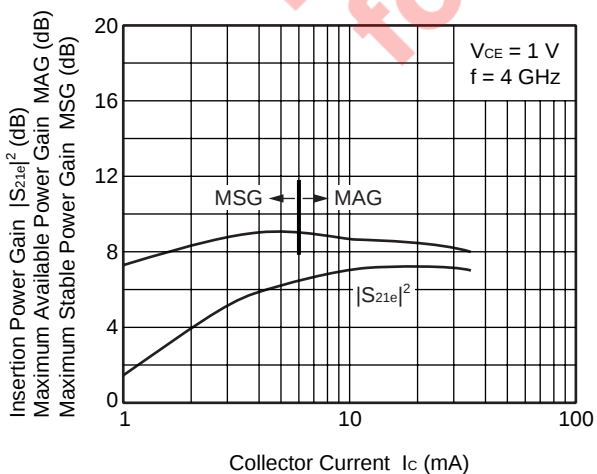
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



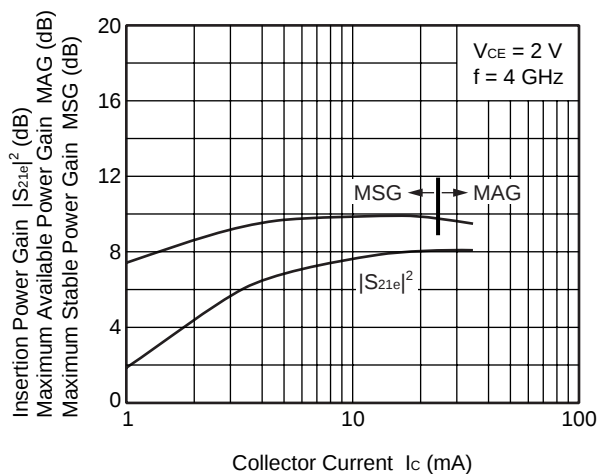
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



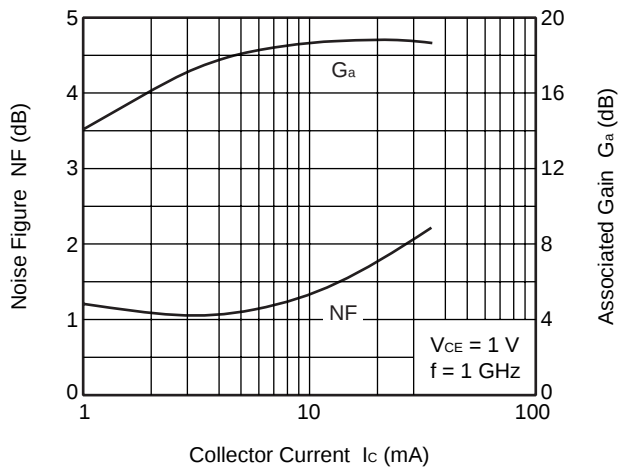
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



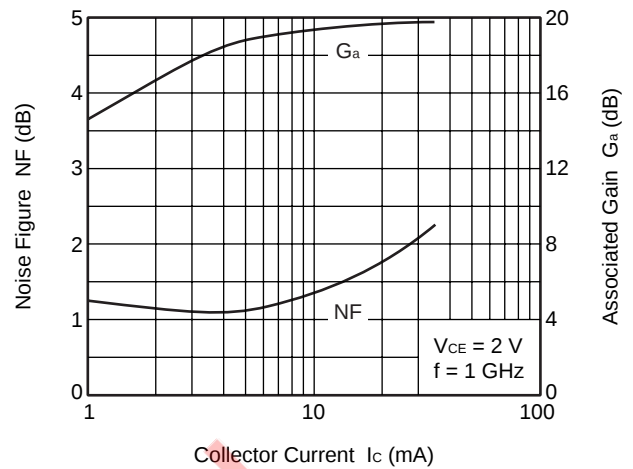
INSERTION POWER GAIN, MAG, MSG  
vs. COLLECTOR CURRENT



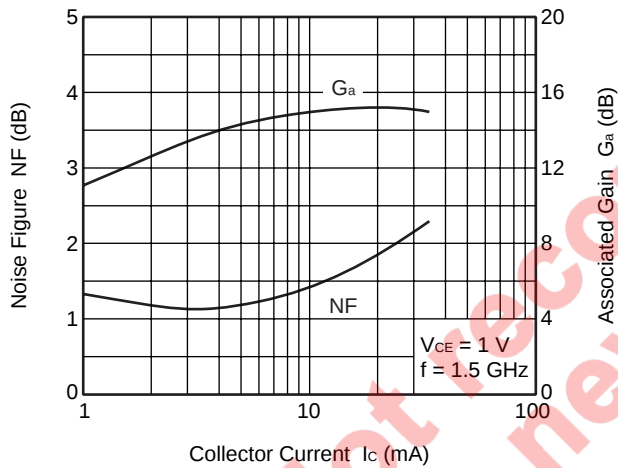
NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



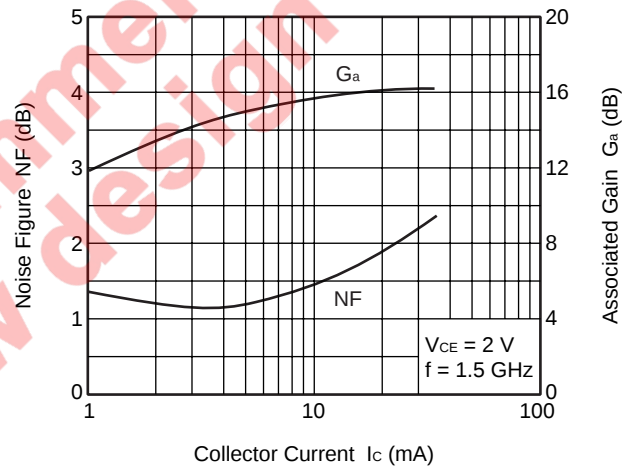
NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



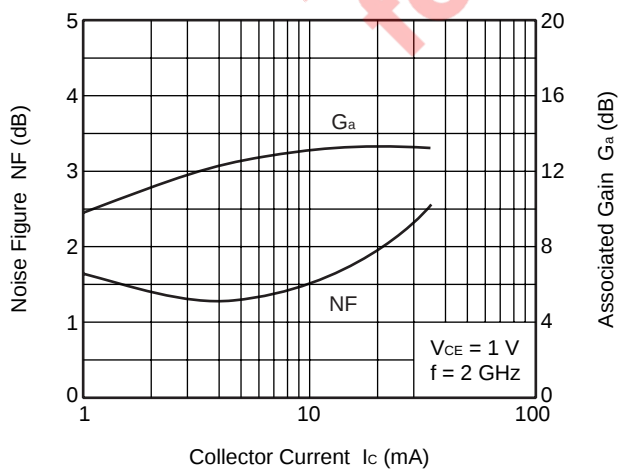
NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



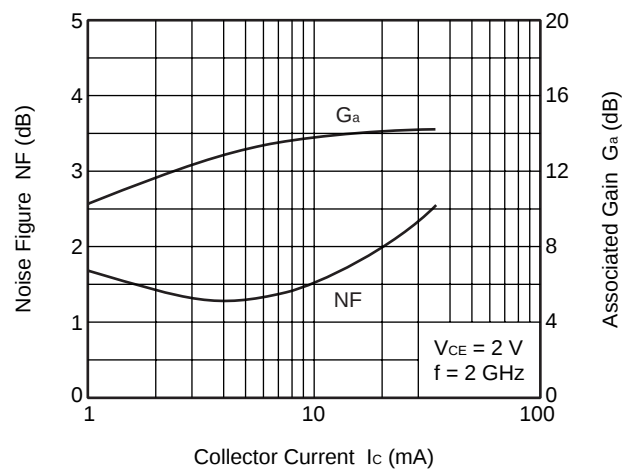
NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



NOISE FIGURE, ASSOCIATED GAIN  
vs. COLLECTOR CURRENT



**Remark** The graphs indicate nominal characteristics.

S-PARAMETERS

$V_{CE} = 1\text{ V}$ ,  $I_C = 1\text{ mA}$ ,  $Z_0 = 50\ \Omega$

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.957           | -5.9           | 3.498           | 176.3          | 0.014           | 90.4           | 0.995           | -3.6           |
| 0.2                | 0.948           | -13.1          | 3.497           | 167.7          | 0.027           | 81.4           | 0.985           | -7.0           |
| 0.3                | 0.935           | -20.0          | 3.456           | 162.0          | 0.040           | 76.6           | 0.977           | -10.5          |
| 0.4                | 0.914           | -26.4          | 3.391           | 156.1          | 0.052           | 72.3           | 0.960           | -14.0          |
| 0.5                | 0.891           | -33.1          | 3.334           | 149.9          | 0.063           | 67.8           | 0.942           | -17.2          |
| 0.6                | 0.862           | -39.3          | 3.273           | 144.7          | 0.073           | 63.9           | 0.921           | -20.5          |
| 0.7                | 0.838           | -45.9          | 3.199           | 139.3          | 0.082           | 59.9           | 0.899           | -23.8          |
| 0.8                | 0.812           | -52.3          | 3.116           | 133.9          | 0.090           | 56.6           | 0.875           | -26.9          |
| 0.9                | 0.780           | -58.5          | 3.013           | 128.6          | 0.096           | 53.2           | 0.851           | -29.9          |
| 1.0                | 0.748           | -64.6          | 2.919           | 123.6          | 0.101           | 50.3           | 0.827           | -32.8          |
| 1.1                | 0.719           | -70.7          | 2.820           | 118.9          | 0.105           | 47.4           | 0.802           | -35.7          |
| 1.2                | 0.690           | -76.8          | 2.729           | 114.3          | 0.108           | 45.1           | 0.779           | -38.1          |
| 1.3                | 0.665           | -82.9          | 2.636           | 109.8          | 0.109           | 43.0           | 0.758           | -40.7          |
| 1.4                | 0.638           | -88.3          | 2.544           | 105.6          | 0.110           | 41.2           | 0.740           | -43.0          |
| 1.5                | 0.615           | -94.1          | 2.451           | 101.4          | 0.110           | 39.6           | 0.723           | -45.3          |
| 1.6                | 0.596           | -99.6          | 2.363           | 97.5           | 0.109           | 38.6           | 0.707           | -47.7          |
| 1.7                | 0.579           | -105.1         | 2.277           | 94.1           | 0.107           | 38.1           | 0.690           | -49.6          |
| 1.8                | 0.562           | -110.3         | 2.213           | 90.6           | 0.105           | 38.0           | 0.678           | -51.7          |
| 1.9                | 0.547           | -115.4         | 2.121           | 87.5           | 0.103           | 38.5           | 0.668           | -53.6          |
| 2.0                | 0.538           | -120.4         | 2.056           | 84.2           | 0.100           | 39.4           | 0.658           | -55.4          |
| 2.1                | 0.527           | -124.9         | 1.974           | 81.5           | 0.098           | 40.7           | 0.648           | -57.4          |
| 2.2                | 0.519           | -129.8         | 1.918           | 78.3           | 0.096           | 42.6           | 0.639           | -59.3          |
| 2.3                | 0.511           | -134.0         | 1.856           | 75.5           | 0.094           | 45.2           | 0.630           | -61.2          |
| 2.4                | 0.506           | -138.5         | 1.800           | 72.6           | 0.093           | 48.2           | 0.626           | -63.1          |
| 2.5                | 0.499           | -142.7         | 1.743           | 69.8           | 0.092           | 51.7           | 0.618           | -65.1          |
| 2.6                | 0.493           | -146.9         | 1.689           | 67.4           | 0.093           | 55.8           | 0.614           | -67.2          |
| 2.7                | 0.493           | -151.1         | 1.636           | 64.8           | 0.095           | 59.6           | 0.607           | -69.1          |
| 2.8                | 0.488           | -155.0         | 1.589           | 62.5           | 0.098           | 63.9           | 0.604           | -71.0          |
| 2.9                | 0.484           | -159.3         | 1.541           | 60.3           | 0.102           | 67.7           | 0.597           | -73.4          |
| 3.0                | 0.486           | -162.9         | 1.498           | 57.6           | 0.108           | 71.6           | 0.595           | -75.6          |
| 4.0                | 0.516           | 162.3          | 1.187           | 37.5           | 0.220           | 83.5           | 0.577           | -99.6          |
| 5.0                | 0.600           | 139.0          | 0.972           | 22.2           | 0.355           | 71.1           | 0.569           | -132.8         |

$V_{CE} = 1\text{ V}$ ,  $I_C = 3\text{ mA}$ ,  $Z_o = 50\ \Omega$ 

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.874           | -9.0           | 9.218           | 171.6          | 0.014           | 84.1           | 0.979           | -6.0           |
| 0.2                | 0.852           | -19.1          | 9.002           | 161.7          | 0.025           | 78.4           | 0.954           | -11.6          |
| 0.3                | 0.813           | -28.7          | 8.618           | 153.1          | 0.037           | 72.9           | 0.921           | -17.0          |
| 0.4                | 0.766           | -37.4          | 8.211           | 145.2          | 0.047           | 68.7           | 0.877           | -21.7          |
| 0.5                | 0.717           | -45.7          | 7.730           | 137.7          | 0.055           | 64.7           | 0.832           | -26.0          |
| 0.6                | 0.663           | -53.1          | 7.285           | 131.4          | 0.063           | 61.6           | 0.786           | -29.7          |
| 0.7                | 0.617           | -60.5          | 6.836           | 125.3          | 0.068           | 59.1           | 0.742           | -33.1          |
| 0.8                | 0.573           | -67.1          | 6.399           | 119.8          | 0.073           | 57.1           | 0.700           | -35.8          |
| 0.9                | 0.529           | -73.8          | 5.984           | 114.8          | 0.077           | 55.6           | 0.664           | -38.4          |
| 1.0                | 0.491           | -79.8          | 5.604           | 110.1          | 0.081           | 54.7           | 0.630           | -40.7          |
| 1.1                | 0.461           | -85.7          | 5.239           | 106.1          | 0.083           | 54.1           | 0.599           | -43.3          |
| 1.2                | 0.428           | -91.9          | 4.961           | 102.4          | 0.086           | 54.1           | 0.571           | -44.7          |
| 1.3                | 0.403           | -97.4          | 4.675           | 98.6           | 0.089           | 54.2           | 0.549           | -46.4          |
| 1.4                | 0.380           | -102.9         | 4.417           | 95.1           | 0.092           | 54.5           | 0.530           | -48.1          |
| 1.5                | 0.361           | -108.0         | 4.196           | 91.8           | 0.094           | 54.9           | 0.513           | -49.7          |
| 1.6                | 0.342           | -113.7         | 3.986           | 88.9           | 0.096           | 55.7           | 0.498           | -51.2          |
| 1.7                | 0.332           | -119.3         | 3.792           | 86.2           | 0.099           | 56.5           | 0.485           | -52.7          |
| 1.8                | 0.320           | -124.2         | 3.628           | 83.6           | 0.102           | 57.5           | 0.473           | -54.1          |
| 1.9                | 0.313           | -128.9         | 3.456           | 81.0           | 0.104           | 58.6           | 0.465           | -55.4          |
| 2.0                | 0.305           | -133.6         | 3.318           | 78.7           | 0.107           | 59.6           | 0.455           | -56.7          |
| 2.1                | 0.300           | -137.4         | 3.166           | 76.5           | 0.111           | 60.7           | 0.448           | -58.1          |
| 2.2                | 0.298           | -142.0         | 3.058           | 74.1           | 0.114           | 61.9           | 0.440           | -59.7          |
| 2.3                | 0.293           | -145.8         | 2.936           | 71.8           | 0.118           | 62.9           | 0.435           | -61.1          |
| 2.4                | 0.290           | -150.0         | 2.833           | 69.7           | 0.123           | 63.9           | 0.429           | -62.5          |
| 2.5                | 0.289           | -154.2         | 2.737           | 67.5           | 0.127           | 65.0           | 0.424           | -63.9          |
| 2.6                | 0.288           | -157.5         | 2.647           | 65.8           | 0.131           | 66.0           | 0.420           | -65.4          |
| 2.7                | 0.288           | -161.3         | 2.554           | 63.8           | 0.137           | 66.9           | 0.416           | -66.9          |
| 2.8                | 0.288           | -164.6         | 2.478           | 61.8           | 0.142           | 67.9           | 0.412           | -68.5          |
| 2.9                | 0.286           | -168.3         | 2.401           | 60.0           | 0.148           | 68.4           | 0.407           | -70.5          |
| 3.0                | 0.291           | -171.0         | 2.326           | 57.9           | 0.154           | 69.2           | 0.407           | -72.1          |
| 4.0                | 0.350           | 160.1          | 1.831           | 40.4           | 0.238           | 71.0           | 0.390           | -94.4          |
| 5.0                | 0.466           | 142.5          | 1.531           | 24.1           | 0.332           | 63.4           | 0.377           | -125.3         |

$V_{CE} = 1\text{ V}$ ,  $I_C = 5\text{ mA}$ ,  $Z_o = 50\ \Omega$ 

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.814           | -12.0          | 13.715          | 168.7          | 0.013           | 84.4           | 0.963           | -8.0           |
| 0.2                | 0.769           | -23.5          | 13.118          | 156.8          | 0.024           | 77.9           | 0.921           | -15.1          |
| 0.3                | 0.710           | -34.5          | 12.219          | 146.6          | 0.034           | 71.6           | 0.866           | -21.5          |
| 0.4                | 0.653           | -44.1          | 11.267          | 137.8          | 0.042           | 67.4           | 0.804           | -26.7          |
| 0.5                | 0.589           | -53.0          | 10.291          | 129.9          | 0.050           | 64.7           | 0.744           | -30.9          |
| 0.6                | 0.529           | -60.4          | 9.433           | 123.5          | 0.056           | 62.7           | 0.689           | -34.2          |
| 0.7                | 0.478           | -67.6          | 8.649           | 117.6          | 0.061           | 61.3           | 0.638           | -37.1          |
| 0.8                | 0.436           | -74.1          | 7.940           | 112.6          | 0.066           | 60.7           | 0.596           | -39.4          |
| 0.9                | 0.397           | -80.6          | 7.292           | 108.0          | 0.070           | 60.2           | 0.559           | -41.4          |
| 1.0                | 0.361           | -86.2          | 6.740           | 103.8          | 0.074           | 60.2           | 0.529           | -43.1          |
| 1.1                | 0.334           | -92.3          | 6.236           | 100.4          | 0.078           | 60.4           | 0.499           | -45.3          |
| 1.2                | 0.307           | -98.5          | 5.852           | 97.0           | 0.082           | 61.0           | 0.474           | -46.2          |
| 1.3                | 0.289           | -104.7         | 5.474           | 93.7           | 0.086           | 61.5           | 0.454           | -47.6          |
| 1.4                | 0.269           | -109.7         | 5.135           | 90.7           | 0.090           | 61.9           | 0.438           | -49.0          |
| 1.5                | 0.256           | -115.5         | 4.852           | 87.9           | 0.094           | 62.5           | 0.424           | -50.2          |
| 1.6                | 0.241           | -120.9         | 4.589           | 85.4           | 0.098           | 63.3           | 0.412           | -51.5          |
| 1.7                | 0.236           | -126.5         | 4.343           | 83.0           | 0.102           | 63.7           | 0.402           | -52.8          |
| 1.8                | 0.228           | -131.7         | 4.144           | 80.7           | 0.107           | 64.4           | 0.392           | -54.0          |
| 1.9                | 0.224           | -136.0         | 3.952           | 78.7           | 0.111           | 65.0           | 0.384           | -55.1          |
| 2.0                | 0.221           | -141.7         | 3.779           | 76.7           | 0.116           | 65.6           | 0.377           | -56.4          |
| 2.1                | 0.217           | -144.7         | 3.599           | 74.9           | 0.121           | 66.0           | 0.370           | -57.6          |
| 2.2                | 0.218           | -149.5         | 3.468           | 72.6           | 0.125           | 66.4           | 0.364           | -59.0          |
| 2.3                | 0.214           | -153.2         | 3.327           | 70.8           | 0.131           | 66.9           | 0.359           | -60.2          |
| 2.4                | 0.215           | -157.0         | 3.211           | 68.7           | 0.136           | 67.1           | 0.354           | -61.7          |
| 2.5                | 0.215           | -160.9         | 3.093           | 66.9           | 0.141           | 67.5           | 0.350           | -63.0          |
| 2.6                | 0.215           | -164.5         | 2.990           | 65.2           | 0.147           | 67.7           | 0.346           | -64.6          |
| 2.7                | 0.218           | -167.4         | 2.885           | 63.4           | 0.153           | 67.9           | 0.342           | -65.9          |
| 2.8                | 0.220           | -170.8         | 2.795           | 61.8           | 0.159           | 68.2           | 0.339           | -67.5          |
| 2.9                | 0.220           | -175.3         | 2.704           | 60.1           | 0.165           | 68.1           | 0.336           | -69.5          |
| 3.0                | 0.224           | -177.3         | 2.623           | 58.2           | 0.172           | 68.3           | 0.335           | -70.9          |
| 4.0                | 0.293           | 157.4          | 2.054           | 42.1           | 0.249           | 67.0           | 0.315           | -93.8          |
| 5.0                | 0.411           | 142.4          | 1.731           | 26.8           | 0.330           | 59.6           | 0.296           | -125.0         |

$V_{CE} = 1\text{ V}$ ,  $I_C = 7\text{ mA}$ ,  $Z_0 = 50\ \Omega$

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.751           | -13.8          | 17.289          | 166.4          | 0.013           | 88.0           | 0.948           | -9.5           |
| 0.2                | 0.704           | -27.1          | 16.208          | 153.1          | 0.023           | 77.2           | 0.891           | -17.8          |
| 0.3                | 0.635           | -39.0          | 14.738          | 142.0          | 0.032           | 71.2           | 0.822           | -24.6          |
| 0.4                | 0.562           | -48.8          | 13.254          | 132.7          | 0.040           | 67.9           | 0.747           | -29.8          |
| 0.5                | 0.497           | -57.4          | 11.850          | 124.6          | 0.046           | 65.7           | 0.680           | -33.7          |
| 0.6                | 0.439           | -65.2          | 10.665          | 118.4          | 0.053           | 64.4           | 0.622           | -36.8          |
| 0.7                | 0.393           | -72.2          | 9.647           | 113.0          | 0.058           | 63.9           | 0.572           | -39.0          |
| 0.8                | 0.352           | -78.3          | 8.746           | 108.2          | 0.062           | 63.7           | 0.531           | -40.8          |
| 0.9                | 0.315           | -84.4          | 7.994           | 104.1          | 0.067           | 63.9           | 0.497           | -42.4          |
| 1.0                | 0.284           | -90.3          | 7.331           | 100.2          | 0.072           | 64.1           | 0.469           | -43.9          |
| 1.1                | 0.266           | -96.4          | 6.746           | 97.2           | 0.076           | 64.7           | 0.441           | -45.8          |
| 1.2                | 0.241           | -103.3         | 6.296           | 94.2           | 0.081           | 65.2           | 0.419           | -46.6          |
| 1.3                | 0.223           | -109.0         | 5.873           | 91.3           | 0.086           | 65.7           | 0.403           | -47.7          |
| 1.4                | 0.210           | -114.6         | 5.512           | 88.6           | 0.091           | 66.0           | 0.389           | -48.9          |
| 1.5                | 0.196           | -120.6         | 5.179           | 86.0           | 0.096           | 66.3           | 0.376           | -50.1          |
| 1.6                | 0.189           | -126.2         | 4.892           | 83.7           | 0.101           | 66.8           | 0.366           | -51.4          |
| 1.7                | 0.186           | -131.9         | 4.640           | 81.6           | 0.106           | 67.2           | 0.356           | -52.5          |
| 1.8                | 0.180           | -137.9         | 4.407           | 79.4           | 0.111           | 67.5           | 0.348           | -53.7          |
| 1.9                | 0.177           | -142.4         | 4.196           | 77.4           | 0.116           | 67.7           | 0.340           | -54.8          |
| 2.0                | 0.179           | -147.0         | 4.013           | 75.5           | 0.121           | 68.0           | 0.334           | -56.0          |
| 2.1                | 0.177           | -150.9         | 3.821           | 73.8           | 0.127           | 68.1           | 0.328           | -57.2          |
| 2.2                | 0.180           | -155.4         | 3.673           | 71.8           | 0.132           | 68.1           | 0.323           | -58.7          |
| 2.3                | 0.178           | -159.2         | 3.524           | 70.1           | 0.138           | 68.3           | 0.319           | -59.9          |
| 2.4                | 0.178           | -163.4         | 3.400           | 68.1           | 0.144           | 68.3           | 0.315           | -61.3          |
| 2.5                | 0.180           | -166.6         | 3.269           | 66.4           | 0.150           | 68.3           | 0.310           | -62.6          |
| 2.6                | 0.182           | -170.5         | 3.161           | 64.9           | 0.155           | 68.3           | 0.306           | -64.0          |
| 2.7                | 0.185           | -173.6         | 3.050           | 63.2           | 0.162           | 68.1           | 0.303           | -65.4          |
| 2.8                | 0.186           | -176.9         | 2.962           | 61.5           | 0.168           | 68.1           | 0.299           | -67.0          |
| 2.9                | 0.189           | -178.7         | 2.857           | 60.1           | 0.174           | 67.9           | 0.297           | -69.0          |
| 3.0                | 0.194           | -177.4         | 2.772           | 58.3           | 0.181           | 67.8           | 0.296           | -70.3          |
| 4.0                | 0.265           | -154.5         | 2.164           | 43.1           | 0.256           | 65.1           | 0.275           | -94.2          |
| 5.0                | 0.382           | -142.2         | 1.825           | 28.7           | 0.331           | 57.3           | 0.250           | -127.2         |

$V_{CE} = 1\text{ V}$ ,  $I_C = 10\text{ mA}$ ,  $Z_O = 50\ \Omega$ 

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.675           | -16.2          | 21.450          | 163.8          | 0.012           | 89.2           | 0.927           | -11.4          |
| 0.2                | 0.615           | -30.4          | 19.591          | 149.0          | 0.022           | 75.8           | 0.852           | -20.7          |
| 0.3                | 0.539           | -43.5          | 17.269          | 136.9          | 0.031           | 70.5           | 0.767           | -27.9          |
| 0.4                | 0.468           | -53.4          | 15.113          | 127.6          | 0.037           | 68.3           | 0.683           | -32.8          |
| 0.5                | 0.404           | -61.8          | 13.234          | 119.7          | 0.044           | 67.5           | 0.612           | -36.1          |
| 0.6                | 0.351           | -69.4          | 11.718          | 113.9          | 0.050           | 67.1           | 0.555           | -38.7          |
| 0.7                | 0.310           | -76.2          | 10.489          | 108.7          | 0.055           | 67.0           | 0.509           | -40.6          |
| 0.8                | 0.274           | -82.3          | 9.426           | 104.4          | 0.060           | 67.2           | 0.471           | -41.9          |
| 0.9                | 0.241           | -88.1          | 8.533           | 100.4          | 0.066           | 67.6           | 0.440           | -43.2          |
| 1.0                | 0.217           | -94.3          | 7.802           | 97.1           | 0.071           | 68.0           | 0.415           | -44.4          |
| 1.1                | 0.204           | -101.0         | 7.152           | 94.5           | 0.076           | 68.4           | 0.390           | -46.2          |
| 1.2                | 0.185           | -107.9         | 6.658           | 91.7           | 0.082           | 68.9           | 0.371           | -46.4          |
| 1.3                | 0.170           | -114.5         | 6.203           | 89.1           | 0.087           | 69.2           | 0.356           | -47.5          |
| 1.4                | 0.162           | -119.9         | 5.795           | 86.6           | 0.093           | 69.3           | 0.344           | -48.6          |
| 1.5                | 0.151           | -126.9         | 5.450           | 84.2           | 0.098           | 69.4           | 0.333           | -49.7          |
| 1.6                | 0.145           | -133.8         | 5.139           | 82.2           | 0.104           | 69.5           | 0.324           | -51.0          |
| 1.7                | 0.146           | -139.0         | 4.859           | 80.2           | 0.109           | 69.6           | 0.316           | -52.2          |
| 1.8                | 0.143           | -145.4         | 4.622           | 78.3           | 0.115           | 69.7           | 0.308           | -53.3          |
| 1.9                | 0.143           | -150.0         | 4.393           | 76.3           | 0.121           | 69.7           | 0.302           | -54.6          |
| 2.0                | 0.147           | -155.5         | 4.195           | 74.5           | 0.127           | 69.7           | 0.297           | -55.8          |
| 2.1                | 0.144           | -157.3         | 3.987           | 73.0           | 0.133           | 69.6           | 0.291           | -57.0          |
| 2.2                | 0.148           | -163.1         | 3.838           | 71.1           | 0.139           | 69.3           | 0.286           | -58.5          |
| 2.3                | 0.148           | -166.9         | 3.679           | 69.4           | 0.145           | 69.2           | 0.283           | -59.6          |
| 2.4                | 0.150           | -170.6         | 3.548           | 67.7           | 0.151           | 69.0           | 0.279           | -61.2          |
| 2.5                | 0.153           | -174.2         | 3.410           | 66.0           | 0.157           | 68.8           | 0.275           | -62.4          |
| 2.6                | 0.156           | -177.9         | 3.303           | 64.5           | 0.163           | 68.5           | 0.271           | -64.0          |
| 2.7                | 0.159           | -179.7         | 3.180           | 63.0           | 0.170           | 68.2           | 0.268           | -65.4          |
| 2.8                | 0.162           | -177.0         | 3.084           | 61.4           | 0.176           | 68.0           | 0.265           | -67.1          |
| 2.9                | 0.166           | -172.5         | 2.982           | 60.1           | 0.182           | 67.5           | 0.263           | -69.2          |
| 3.0                | 0.171           | -171.2         | 2.887           | 58.4           | 0.189           | 67.3           | 0.261           | -70.4          |
| 4.0                | 0.246           | -151.5         | 2.243           | 44.0           | 0.263           | 63.4           | 0.240           | -95.8          |
| 5.0                | 0.361           | -140.7         | 1.899           | 30.0           | 0.333           | 55.4           | 0.214           | -131.0         |

$V_{CE} = 1\text{ V}$ ,  $I_C = 20\text{ mA}$ ,  $Z_O = 50\ \Omega$

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.525           | -20.5          | 29.163          | 158.8          | 0.013           | 82.1           | 0.871           | -14.8          |
| 0.2                | 0.446           | -36.9          | 25.100          | 141.2          | 0.020           | 75.4           | 0.763           | -25.9          |
| 0.3                | 0.368           | -52.1          | 20.892          | 128.5          | 0.028           | 73.2           | 0.655           | -32.9          |
| 0.4                | 0.306           | -61.5          | 17.541          | 119.5          | 0.034           | 71.9           | 0.567           | -37.0          |
| 0.5                | 0.254           | -69.7          | 14.890          | 112.3          | 0.041           | 72.0           | 0.500           | -39.2          |
| 0.6                | 0.215           | -77.6          | 12.939          | 107.2          | 0.047           | 72.4           | 0.448           | -40.9          |
| 0.7                | 0.185           | -84.0          | 11.382          | 102.6          | 0.053           | 72.4           | 0.409           | -41.9          |
| 0.8                | 0.164           | -91.2          | 10.138          | 99.1           | 0.059           | 72.7           | 0.378           | -42.7          |
| 0.9                | 0.142           | -97.8          | 9.107           | 95.8           | 0.066           | 73.1           | 0.354           | -43.6          |
| 1.0                | 0.128           | -105.6         | 8.276           | 92.8           | 0.072           | 73.0           | 0.335           | -44.6          |
| 1.1                | 0.124           | -114.5         | 7.561           | 90.5           | 0.078           | 73.2           | 0.314           | -46.4          |
| 1.2                | 0.112           | -124.6         | 7.020           | 88.3           | 0.085           | 73.3           | 0.298           | -46.7          |
| 1.3                | 0.106           | -132.3         | 6.511           | 86.0           | 0.091           | 73.2           | 0.287           | -47.7          |
| 1.4                | 0.103           | -140.9         | 6.081           | 83.8           | 0.097           | 72.9           | 0.277           | -48.9          |
| 1.5                | 0.101           | -147.5         | 5.711           | 81.7           | 0.104           | 72.8           | 0.268           | -50.0          |
| 1.6                | 0.102           | -155.6         | 5.354           | 79.9           | 0.110           | 72.5           | 0.262           | -51.4          |
| 1.7                | 0.105           | -160.6         | 5.070           | 78.0           | 0.117           | 72.1           | 0.255           | -52.7          |
| 1.8                | 0.107           | -166.4         | 4.816           | 76.4           | 0.123           | 72.0           | 0.249           | -54.1          |
| 1.9                | 0.110           | -170.6         | 4.578           | 74.8           | 0.129           | 71.7           | 0.244           | -55.2          |
| 2.0                | 0.117           | -174.3         | 4.369           | 73.1           | 0.136           | 71.3           | 0.239           | -56.5          |
| 2.1                | 0.117           | -177.1         | 4.158           | 71.8           | 0.143           | 70.9           | 0.235           | -57.9          |
| 2.2                | 0.124           | 179.3          | 3.988           | 70.1           | 0.149           | 70.3           | 0.230           | -59.5          |
| 2.3                | 0.123           | 174.7          | 3.822           | 68.5           | 0.156           | 70.0           | 0.227           | -60.9          |
| 2.4                | 0.130           | 172.9          | 3.683           | 66.9           | 0.162           | 69.4           | 0.223           | -62.5          |
| 2.5                | 0.133           | 169.7          | 3.543           | 65.4           | 0.168           | 69.1           | 0.220           | -64.0          |
| 2.6                | 0.139           | 167.2          | 3.423           | 64.1           | 0.175           | 68.6           | 0.217           | -65.7          |
| 2.7                | 0.142           | 165.9          | 3.300           | 62.7           | 0.182           | 67.9           | 0.214           | -67.3          |
| 2.8                | 0.145           | 163.2          | 3.200           | 61.1           | 0.189           | 67.5           | 0.211           | -69.3          |
| 2.9                | 0.149           | 160.0          | 3.089           | 59.9           | 0.195           | 66.8           | 0.209           | -71.6          |
| 3.0                | 0.154           | 159.1          | 2.988           | 58.4           | 0.202           | 66.3           | 0.208           | -72.9          |
| 4.0                | 0.233           | 145.5          | 2.312           | 44.7           | 0.275           | 61.0           | 0.190           | -102.3         |
| 5.0                | 0.344           | 137.2          | 1.948           | 31.6           | 0.340           | 52.4           | 0.169           | -144.0         |

$V_{CE} = 2\text{ V}$ ,  $I_C = 1\text{ mA}$ ,  $Z_0 = 50\ \Omega$ 

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.967           | -5.7           | 3.494           | 176.4          | 0.012           | 92.9           | 0.995           | -3.2           |
| 0.2                | 0.950           | -12.5          | 3.491           | 168.4          | 0.024           | 81.8           | 0.987           | -6.4           |
| 0.3                | 0.937           | -18.8          | 3.459           | 162.8          | 0.035           | 77.1           | 0.979           | -9.6           |
| 0.4                | 0.919           | -25.0          | 3.409           | 157.1          | 0.045           | 73.2           | 0.964           | -12.7          |
| 0.5                | 0.896           | -31.3          | 3.345           | 151.0          | 0.055           | 69.1           | 0.948           | -15.7          |
| 0.6                | 0.869           | -37.5          | 3.289           | 146.0          | 0.064           | 65.3           | 0.930           | -18.8          |
| 0.7                | 0.846           | -43.6          | 3.223           | 140.8          | 0.072           | 61.5           | 0.908           | -21.7          |
| 0.8                | 0.820           | -49.6          | 3.145           | 135.6          | 0.079           | 58.2           | 0.888           | -24.6          |
| 0.9                | 0.790           | -55.7          | 3.050           | 130.5          | 0.084           | 55.1           | 0.864           | -27.4          |
| 1.0                | 0.759           | -61.7          | 2.961           | 125.6          | 0.089           | 52.3           | 0.844           | -30.1          |
| 1.1                | 0.729           | -67.5          | 2.874           | 121.0          | 0.092           | 49.7           | 0.822           | -32.7          |
| 1.2                | 0.701           | -73.2          | 2.778           | 116.4          | 0.095           | 47.4           | 0.802           | -35.2          |
| 1.3                | 0.674           | -79.0          | 2.696           | 112.0          | 0.096           | 45.5           | 0.780           | -37.7          |
| 1.4                | 0.649           | -84.6          | 2.600           | 107.9          | 0.096           | 43.7           | 0.764           | -39.9          |
| 1.5                | 0.625           | -90.0          | 2.514           | 103.7          | 0.096           | 42.5           | 0.747           | -42.1          |
| 1.6                | 0.603           | -95.6          | 2.427           | 99.9           | 0.095           | 41.8           | 0.732           | -44.3          |
| 1.7                | 0.585           | -101.1         | 2.340           | 96.4           | 0.093           | 41.4           | 0.718           | -46.4          |
| 1.8                | 0.567           | -106.3         | 2.277           | 92.9           | 0.092           | 41.7           | 0.705           | -48.3          |
| 1.9                | 0.554           | -111.2         | 2.191           | 89.5           | 0.089           | 42.6           | 0.694           | -50.1          |
| 2.0                | 0.540           | -116.3         | 2.117           | 86.4           | 0.087           | 43.9           | 0.685           | -51.9          |
| 2.1                | 0.529           | -120.6         | 2.038           | 83.6           | 0.085           | 45.9           | 0.676           | -53.7          |
| 2.2                | 0.520           | -125.5         | 1.982           | 80.4           | 0.083           | 48.5           | 0.667           | -55.7          |
| 2.3                | 0.511           | -129.6         | 1.916           | 77.7           | 0.082           | 52.1           | 0.660           | -57.4          |
| 2.4                | 0.502           | -134.4         | 1.863           | 74.7           | 0.082           | 55.6           | 0.655           | -59.3          |
| 2.5                | 0.496           | -138.6         | 1.808           | 72.0           | 0.082           | 59.9           | 0.648           | -61.1          |
| 2.6                | 0.491           | -143.0         | 1.751           | 69.5           | 0.083           | 64.4           | 0.644           | -63.0          |
| 2.7                | 0.485           | -147.0         | 1.693           | 66.9           | 0.086           | 68.9           | 0.637           | -64.9          |
| 2.8                | 0.482           | -151.0         | 1.649           | 64.6           | 0.091           | 73.3           | 0.633           | -66.8          |
| 2.9                | 0.477           | -155.0         | 1.603           | 62.2           | 0.096           | 77.1           | 0.626           | -69.0          |
| 3.0                | 0.477           | -159.0         | 1.552           | 59.7           | 0.103           | 80.8           | 0.625           | -71.1          |
| 4.0                | 0.502           | 165.1          | 1.241           | 39.5           | 0.223           | 89.2           | 0.608           | -94.2          |
| 5.0                | 0.586           | 140.9          | 1.018           | 23.6           | 0.363           | 75.3           | 0.596           | -126.4         |

$V_{CE} = 2\text{ V}$ ,  $I_C = 3\text{ mA}$ ,  $Z_0 = 50\ \Omega$

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.888           | -8.2           | 9.232           | 172.0          | 0.011           | 91.6           | 0.982           | -5.4           |
| 0.2                | 0.860           | -18.1          | 9.035           | 162.5          | 0.022           | 78.5           | 0.960           | -10.3          |
| 0.3                | 0.822           | -26.4          | 8.690           | 154.4          | 0.032           | 73.8           | 0.932           | -15.2          |
| 0.4                | 0.781           | -34.5          | 8.306           | 146.8          | 0.041           | 70.3           | 0.891           | -19.4          |
| 0.5                | 0.732           | -42.1          | 7.861           | 139.3          | 0.048           | 66.3           | 0.851           | -23.2          |
| 0.6                | 0.681           | -49.0          | 7.412           | 133.2          | 0.055           | 63.4           | 0.809           | -26.6          |
| 0.7                | 0.639           | -55.9          | 6.991           | 127.3          | 0.060           | 60.8           | 0.767           | -29.7          |
| 0.8                | 0.590           | -62.1          | 6.577           | 121.9          | 0.065           | 59.2           | 0.731           | -32.2          |
| 0.9                | 0.548           | -68.1          | 6.166           | 116.9          | 0.069           | 57.8           | 0.695           | -34.6          |
| 1.0                | 0.507           | -73.7          | 5.808           | 112.3          | 0.072           | 57.1           | 0.664           | -36.7          |
| 1.1                | 0.471           | -79.4          | 5.465           | 108.2          | 0.075           | 56.7           | 0.635           | -38.5          |
| 1.2                | 0.439           | -84.3          | 5.160           | 104.5          | 0.077           | 56.6           | 0.611           | -40.2          |
| 1.3                | 0.412           | -89.8          | 4.875           | 100.9          | 0.079           | 56.9           | 0.586           | -41.9          |
| 1.4                | 0.388           | -94.9          | 4.604           | 97.4           | 0.082           | 57.2           | 0.569           | -43.4          |
| 1.5                | 0.364           | -99.9          | 4.377           | 94.1           | 0.084           | 58.0           | 0.553           | -44.9          |
| 1.6                | 0.345           | -105.3         | 4.167           | 91.2           | 0.086           | 58.9           | 0.538           | -46.3          |
| 1.7                | 0.332           | -110.0         | 3.967           | 88.4           | 0.089           | 59.8           | 0.525           | -47.7          |
| 1.8                | 0.319           | -115.1         | 3.802           | 85.8           | 0.091           | 61.2           | 0.513           | -48.9          |
| 1.9                | 0.307           | -119.6         | 3.628           | 83.0           | 0.094           | 62.4           | 0.505           | -50.1          |
| 2.0                | 0.300           | -124.4         | 3.481           | 80.7           | 0.097           | 63.6           | 0.496           | -51.4          |
| 2.1                | 0.293           | -127.9         | 3.327           | 78.6           | 0.100           | 65.0           | 0.490           | -52.6          |
| 2.2                | 0.285           | -132.3         | 3.210           | 76.2           | 0.103           | 66.2           | 0.483           | -54.1          |
| 2.3                | 0.280           | -136.4         | 3.083           | 73.9           | 0.108           | 67.6           | 0.477           | -55.3          |
| 2.4                | 0.275           | -141.1         | 2.982           | 71.6           | 0.112           | 68.6           | 0.472           | -56.7          |
| 2.5                | 0.270           | -144.7         | 2.878           | 69.6           | 0.116           | 69.9           | 0.467           | -58.0          |
| 2.6                | 0.271           | -148.3         | 2.782           | 68.0           | 0.121           | 71.0           | 0.464           | -59.5          |
| 2.7                | 0.269           | -152.0         | 2.688           | 65.8           | 0.126           | 72.0           | 0.460           | -60.9          |
| 2.8                | 0.268           | -155.6         | 2.609           | 64.0           | 0.132           | 73.0           | 0.456           | -62.4          |
| 2.9                | 0.266           | -159.8         | 2.522           | 62.2           | 0.138           | 73.7           | 0.452           | -64.2          |
| 3.0                | 0.267           | -162.2         | 2.450           | 60.1           | 0.144           | 74.6           | 0.451           | -65.7          |
| 4.0                | 0.320           | 166.3          | 1.944           | 42.6           | 0.230           | 76.5           | 0.434           | -86.2          |
| 5.0                | 0.435           | 147.4          | 1.638           | 26.2           | 0.330           | 68.4           | 0.418           | -115.1         |

$V_{CE} = 2\text{ V}$ ,  $I_C = 5\text{ mA}$ ,  $Z_0 = 50\ \Omega$

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.834           | -10.8          | 13.678          | 169.2          | 0.011           | 81.4           | 0.968           | -6.9           |
| 0.2                | 0.782           | -21.0          | 13.160          | 158.0          | 0.021           | 79.7           | 0.932           | -13.3          |
| 0.3                | 0.734           | -31.4          | 12.347          | 148.2          | 0.030           | 73.4           | 0.883           | -18.8          |
| 0.4                | 0.674           | -39.8          | 11.437          | 139.7          | 0.038           | 69.3           | 0.828           | -23.5          |
| 0.5                | 0.615           | -48.2          | 10.513          | 131.8          | 0.044           | 66.5           | 0.774           | -27.2          |
| 0.6                | 0.554           | -54.7          | 9.700           | 125.6          | 0.050           | 64.5           | 0.723           | -30.2          |
| 0.7                | 0.501           | -61.2          | 8.946           | 119.8          | 0.055           | 63.2           | 0.675           | -32.7          |
| 0.8                | 0.459           | -67.2          | 8.225           | 114.8          | 0.059           | 62.7           | 0.635           | -34.8          |
| 0.9                | 0.414           | -72.5          | 7.581           | 110.2          | 0.063           | 62.4           | 0.600           | -36.6          |
| 1.0                | 0.379           | -77.7          | 7.042           | 106.0          | 0.067           | 62.6           | 0.569           | -38.1          |
| 1.1                | 0.345           | -83.0          | 6.563           | 102.4          | 0.070           | 62.8           | 0.544           | -39.4          |
| 1.2                | 0.319           | -88.0          | 6.130           | 99.1           | 0.074           | 63.2           | 0.520           | -40.9          |
| 1.3                | 0.295           | -93.0          | 5.745           | 95.9           | 0.077           | 63.9           | 0.500           | -42.1          |
| 1.4                | 0.275           | -97.5          | 5.408           | 93.0           | 0.081           | 64.5           | 0.485           | -43.3          |
| 1.5                | 0.256           | -102.5         | 5.108           | 90.1           | 0.085           | 65.2           | 0.472           | -44.5          |
| 1.6                | 0.240           | -107.7         | 4.828           | 87.6           | 0.089           | 65.9           | 0.460           | -45.6          |
| 1.7                | 0.232           | -112.5         | 4.580           | 85.2           | 0.093           | 66.6           | 0.449           | -46.9          |
| 1.8                | 0.220           | -117.6         | 4.373           | 83.0           | 0.097           | 67.4           | 0.440           | -47.8          |
| 1.9                | 0.213           | -122.1         | 4.171           | 80.7           | 0.101           | 68.2           | 0.432           | -48.8          |
| 2.0                | 0.209           | -127.5         | 3.988           | 78.7           | 0.105           | 68.9           | 0.425           | -49.9          |
| 2.1                | 0.202           | -130.5         | 3.805           | 76.9           | 0.110           | 69.5           | 0.419           | -51.0          |
| 2.2                | 0.199           | -135.6         | 3.663           | 74.7           | 0.114           | 70.0           | 0.413           | -52.3          |
| 2.3                | 0.195           | -139.4         | 3.522           | 72.8           | 0.120           | 70.6           | 0.409           | -53.5          |
| 2.4                | 0.193           | -143.5         | 3.395           | 70.7           | 0.125           | 70.9           | 0.404           | -54.7          |
| 2.5                | 0.193           | -147.6         | 3.269           | 69.0           | 0.130           | 71.3           | 0.400           | -55.9          |
| 2.6                | 0.191           | -151.1         | 3.164           | 67.3           | 0.135           | 71.8           | 0.396           | -57.1          |
| 2.7                | 0.192           | -155.3         | 3.050           | 65.6           | 0.141           | 72.2           | 0.394           | -58.4          |
| 2.8                | 0.191           | -158.1         | 2.963           | 63.9           | 0.147           | 72.5           | 0.389           | -59.8          |
| 2.9                | 0.191           | -162.8         | 2.867           | 62.4           | 0.153           | 72.7           | 0.386           | -61.5          |
| 3.0                | 0.192           | -165.8         | 2.777           | 60.4           | 0.159           | 72.9           | 0.385           | -62.9          |
| 4.0                | 0.254           | 165.2          | 2.191           | 44.6           | 0.238           | 72.2           | 0.365           | -83.4          |
| 5.0                | 0.373           | 148.8          | 1.861           | 29.2           | 0.323           | 64.6           | 0.338           | -111.7         |

$V_{CE} = 2\text{ V}$ ,  $I_C = 7\text{ mA}$ ,  $Z_0 = 50\ \Omega$ 

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.773           | -12.2          | 17.302          | 167.1          | 0.012           | 86.2           | 0.956           | -8.3           |
| 0.2                | 0.720           | -24.0          | 16.283          | 154.5          | 0.021           | 77.1           | 0.907           | -15.4          |
| 0.3                | 0.657           | -34.7          | 14.949          | 143.8          | 0.029           | 72.1           | 0.846           | -21.4          |
| 0.4                | 0.591           | -43.6          | 13.554          | 134.8          | 0.035           | 69.8           | 0.778           | -26.1          |
| 0.5                | 0.525           | -51.1          | 12.204          | 126.9          | 0.041           | 67.5           | 0.717           | -29.5          |
| 0.6                | 0.466           | -57.7          | 11.059          | 120.8          | 0.047           | 66.2           | 0.662           | -32.2          |
| 0.7                | 0.417           | -63.8          | 10.035          | 115.1          | 0.051           | 65.7           | 0.614           | -34.3          |
| 0.8                | 0.375           | -69.2          | 9.130           | 110.4          | 0.056           | 65.7           | 0.576           | -35.9          |
| 0.9                | 0.337           | -74.5          | 8.366           | 106.2          | 0.060           | 66.0           | 0.542           | -37.3          |
| 1.0                | 0.302           | -79.0          | 7.705           | 102.5          | 0.065           | 66.4           | 0.514           | -38.4          |
| 1.1                | 0.275           | -83.8          | 7.144           | 99.1           | 0.069           | 66.8           | 0.490           | -39.6          |
| 1.2                | 0.250           | -88.9          | 6.639           | 96.0           | 0.073           | 67.5           | 0.470           | -40.7          |
| 1.3                | 0.230           | -93.4          | 6.197           | 93.2           | 0.078           | 67.9           | 0.452           | -41.6          |
| 1.4                | 0.214           | -98.2          | 5.832           | 90.5           | 0.082           | 68.3           | 0.439           | -42.6          |
| 1.5                | 0.197           | -102.8         | 5.477           | 87.9           | 0.087           | 68.9           | 0.426           | -43.6          |
| 1.6                | 0.186           | -108.3         | 5.174           | 85.7           | 0.091           | 69.4           | 0.417           | -44.7          |
| 1.7                | 0.175           | -112.9         | 4.904           | 83.5           | 0.096           | 69.7           | 0.408           | -45.8          |
| 1.8                | 0.167           | -119.0         | 4.670           | 81.4           | 0.101           | 70.3           | 0.400           | -46.8          |
| 1.9                | 0.162           | -123.7         | 4.453           | 79.4           | 0.106           | 70.8           | 0.393           | -47.8          |
| 2.0                | 0.161           | -129.3         | 4.257           | 77.5           | 0.110           | 71.0           | 0.387           | -48.8          |
| 2.1                | 0.157           | -132.1         | 4.058           | 75.8           | 0.116           | 71.2           | 0.382           | -49.8          |
| 2.2                | 0.154           | -137.3         | 3.905           | 73.8           | 0.121           | 71.4           | 0.376           | -51.1          |
| 2.3                | 0.151           | -141.5         | 3.746           | 72.0           | 0.127           | 71.7           | 0.372           | -52.2          |
| 2.4                | 0.150           | -146.0         | 3.609           | 70.2           | 0.132           | 71.7           | 0.368           | -53.5          |
| 2.5                | 0.148           | -149.6         | 3.479           | 68.5           | 0.137           | 71.8           | 0.364           | -54.6          |
| 2.6                | 0.148           | -154.1         | 3.363           | 67.0           | 0.143           | 71.9           | 0.360           | -55.8          |
| 2.7                | 0.150           | -157.5         | 3.244           | 65.4           | 0.149           | 72.0           | 0.357           | -57.0          |
| 2.8                | 0.151           | -161.4         | 3.147           | 63.7           | 0.155           | 72.1           | 0.354           | -58.4          |
| 2.9                | 0.151           | -165.8         | 3.043           | 62.3           | 0.161           | 71.9           | 0.351           | -60.2          |
| 3.0                | 0.154           | -168.4         | 2.948           | 60.6           | 0.168           | 72.1           | 0.351           | -61.4          |
| 4.0                | 0.217           | 163.3          | 2.318           | 45.6           | 0.243           | 70.0           | 0.328           | -82.1          |
| 5.0                | 0.337           | 148.9          | 1.976           | 31.1           | 0.322           | 62.4           | 0.294           | -110.3         |

$V_{CE} = 2\text{ V}$ ,  $I_C = 10\text{ mA}$ ,  $Z_O = 50\ \Omega$ 

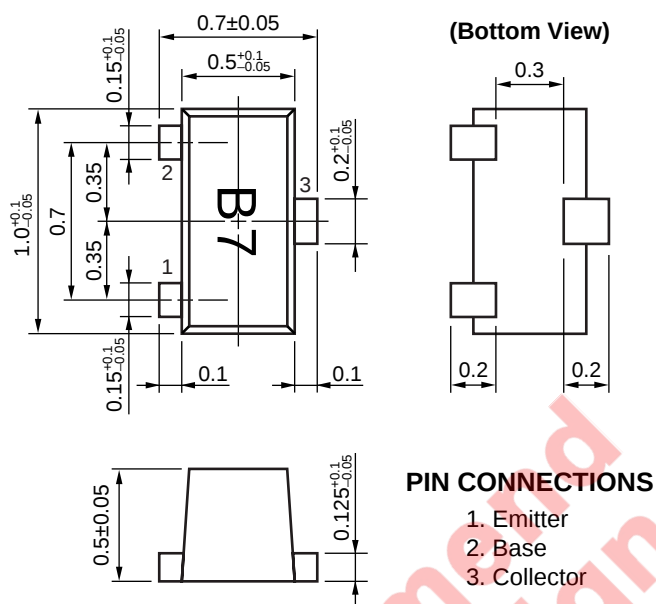
| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.708           | -13.4          | 21.482          | 164.6          | 0.012           | 83.9           | 0.938           | -9.6           |
| 0.2                | 0.643           | -26.6          | 19.762          | 150.5          | 0.019           | 77.4           | 0.874           | -17.8          |
| 0.3                | 0.575           | -37.8          | 17.645          | 138.9          | 0.027           | 72.9           | 0.797           | -24.1          |
| 0.4                | 0.501           | -46.7          | 15.589          | 129.7          | 0.033           | 70.5           | 0.721           | -28.4          |
| 0.5                | 0.433           | -53.9          | 13.747          | 122.0          | 0.039           | 69.2           | 0.655           | -31.3          |
| 0.6                | 0.379           | -59.3          | 12.249          | 116.1          | 0.044           | 68.5           | 0.601           | -33.5          |
| 0.7                | 0.336           | -65.3          | 11.000          | 111.0          | 0.049           | 68.8           | 0.557           | -34.9          |
| 0.8                | 0.299           | -69.9          | 9.923           | 106.5          | 0.054           | 69.1           | 0.521           | -36.1          |
| 0.9                | 0.265           | -74.1          | 9.007           | 102.7          | 0.059           | 69.6           | 0.490           | -37.1          |
| 1.0                | 0.236           | -79.3          | 8.255           | 99.4           | 0.064           | 70.2           | 0.466           | -37.9          |
| 1.1                | 0.214           | -83.3          | 7.626           | 96.2           | 0.069           | 70.4           | 0.444           | -38.8          |
| 1.2                | 0.191           | -87.5          | 7.063           | 93.6           | 0.074           | 70.9           | 0.427           | -39.6          |
| 1.3                | 0.175           | -92.5          | 6.595           | 91.0           | 0.079           | 71.3           | 0.412           | -40.6          |
| 1.4                | 0.160           | -96.7          | 6.163           | 88.5           | 0.084           | 71.5           | 0.400           | -41.5          |
| 1.5                | 0.147           | -102.3         | 5.803           | 86.2           | 0.089           | 71.8           | 0.389           | -42.4          |
| 1.6                | 0.136           | -108.2         | 5.468           | 84.1           | 0.094           | 72.0           | 0.380           | -43.5          |
| 1.7                | 0.129           | -113.6         | 5.173           | 82.1           | 0.099           | 72.2           | 0.372           | -44.5          |
| 1.8                | 0.125           | -119.7         | 4.929           | 80.1           | 0.105           | 72.4           | 0.365           | -45.4          |
| 1.9                | 0.121           | -125.2         | 4.690           | 78.4           | 0.110           | 72.5           | 0.359           | -46.6          |
| 2.0                | 0.117           | -131.0         | 4.476           | 76.7           | 0.115           | 72.4           | 0.353           | -47.6          |
| 2.1                | 0.116           | -132.7         | 4.266           | 75.1           | 0.121           | 72.6           | 0.349           | -48.7          |
| 2.2                | 0.116           | -139.0         | 4.102           | 73.3           | 0.126           | 72.4           | 0.344           | -50.0          |
| 2.3                | 0.114           | -143.8         | 3.933           | 71.6           | 0.133           | 72.4           | 0.341           | -51.0          |
| 2.4                | 0.112           | -148.3         | 3.792           | 69.9           | 0.139           | 72.1           | 0.337           | -52.3          |
| 2.5                | 0.115           | -152.2         | 3.650           | 68.2           | 0.144           | 72.1           | 0.333           | -53.3          |
| 2.6                | 0.115           | -156.9         | 3.530           | 66.9           | 0.150           | 71.9           | 0.330           | -54.8          |
| 2.7                | 0.118           | -162.0         | 3.402           | 65.3           | 0.156           | 71.7           | 0.327           | -56.0          |
| 2.8                | 0.117           | -165.0         | 3.301           | 63.8           | 0.162           | 71.5           | 0.324           | -57.4          |
| 2.9                | 0.119           | -169.2         | 3.190           | 62.4           | 0.168           | 71.2           | 0.322           | -59.2          |
| 3.0                | 0.123           | -172.8         | 3.091           | 60.8           | 0.175           | 71.0           | 0.321           | -60.2          |
| 4.0                | 0.191           | 160.7          | 2.417           | 46.7           | 0.248           | 68.1           | 0.294           | -81.3          |
| 5.0                | 0.310           | 148.4          | 2.065           | 32.7           | 0.322           | 60.4           | 0.254           | -110.2         |

$V_{CE} = 2\text{ V}$ ,  $I_C = 20\text{ mA}$ ,  $Z_O = 50\ \Omega$

| Frequency<br>(GHz) | S <sub>11</sub> |                | S <sub>21</sub> |                | S <sub>12</sub> |                | S <sub>22</sub> |                |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|                    | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) | MAG.            | ANG.<br>(deg.) |
| 0.1                | 0.573           | -16.8          | 29.364          | 160.0          | 0.008           | 90.2           | 0.897           | -12.4          |
| 0.2                | 0.485           | -31.3          | 25.742          | 143.3          | 0.017           | 77.0           | 0.801           | -21.8          |
| 0.3                | 0.411           | -41.9          | 21.722          | 130.9          | 0.024           | 74.8           | 0.705           | -27.7          |
| 0.4                | 0.350           | -49.1          | 18.424          | 121.9          | 0.030           | 73.9           | 0.622           | -31.1          |
| 0.5                | 0.294           | -55.4          | 15.761          | 114.8          | 0.036           | 73.6           | 0.559           | -32.9          |
| 0.6                | 0.249           | -60.4          | 13.774          | 109.6          | 0.042           | 73.9           | 0.510           | -34.1          |
| 0.7                | 0.219           | -63.9          | 12.164          | 105.0          | 0.048           | 73.8           | 0.472           | -34.8          |
| 0.8                | 0.189           | -68.0          | 10.865          | 101.4          | 0.053           | 74.6           | 0.442           | -35.3          |
| 0.9                | 0.165           | -71.1          | 9.776           | 98.1           | 0.059           | 74.8           | 0.418           | -35.8          |
| 1.0                | 0.145           | -75.9          | 8.919           | 95.2           | 0.064           | 75.1           | 0.399           | -36.3          |
| 1.1                | 0.127           | -79.6          | 8.197           | 92.6           | 0.070           | 75.1           | 0.382           | -37.1          |
| 1.2                | 0.114           | -84.0          | 7.557           | 90.1           | 0.076           | 75.3           | 0.368           | -37.7          |
| 1.3                | 0.100           | -89.6          | 7.037           | 87.9           | 0.082           | 75.3           | 0.356           | -38.6          |
| 1.4                | 0.089           | -95.0          | 6.572           | 85.8           | 0.088           | 75.1           | 0.346           | -39.5          |
| 1.5                | 0.080           | -100.3         | 6.163           | 83.7           | 0.093           | 75.0           | 0.338           | -40.4          |
| 1.6                | 0.073           | -107.5         | 5.794           | 81.9           | 0.099           | 74.9           | 0.331           | -41.5          |
| 1.7                | 0.073           | -114.2         | 5.478           | 80.2           | 0.105           | 74.9           | 0.324           | -42.6          |
| 1.8                | 0.067           | -123.7         | 5.216           | 78.6           | 0.111           | 74.6           | 0.318           | -43.6          |
| 1.9                | 0.066           | -130.1         | 4.946           | 77.1           | 0.117           | 74.3           | 0.313           | -44.8          |
| 2.0                | 0.067           | -138.0         | 4.734           | 75.5           | 0.123           | 74.0           | 0.308           | -45.7          |
| 2.1                | 0.067           | -140.1         | 4.506           | 74.0           | 0.129           | 73.7           | 0.304           | -46.8          |
| 2.2                | 0.067           | -149.2         | 4.328           | 72.5           | 0.134           | 73.3           | 0.299           | -48.2          |
| 2.3                | 0.068           | -154.6         | 4.146           | 70.9           | 0.141           | 73.0           | 0.297           | -49.2          |
| 2.4                | 0.068           | -159.0         | 3.995           | 69.4           | 0.147           | 72.5           | 0.293           | -50.5          |
| 2.5                | 0.070           | -163.7         | 3.844           | 67.9           | 0.153           | 72.3           | 0.290           | -51.5          |
| 2.6                | 0.074           | -169.7         | 3.715           | 66.5           | 0.160           | 72.0           | 0.286           | -52.8          |
| 2.7                | 0.077           | -173.0         | 3.584           | 65.1           | 0.166           | 71.5           | 0.284           | -54.2          |
| 2.8                | 0.080           | -176.1         | 3.472           | 63.7           | 0.172           | 71.1           | 0.280           | -55.6          |
| 2.9                | 0.084           | -178.0         | 3.356           | 62.5           | 0.178           | 70.6           | 0.278           | -57.4          |
| 3.0                | 0.086           | -174.7         | 3.251           | 61.0           | 0.185           | 70.2           | 0.278           | -58.6          |
| 4.0                | 0.162           | -155.5         | 2.530           | 47.8           | 0.256           | 65.9           | 0.249           | -81.3          |
| 5.0                | 0.278           | -146.1         | 2.157           | 34.7           | 0.326           | 57.8           | 0.202           | -112.0         |

★ PACKAGE DIMENSIONS

3-PIN LEAD-LESS MINIMOLD (UNIT: mm)



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