

DATA SHEET

NEC

NPN SILICON RF TRANSISTOR 2SC5618

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

FEATURES

- NF = 1.5 dB TYP. @ $V_{CE} = 1\text{ V}$, $I_c = 3\text{ mA}$, $f = 2\text{ GHz}$
- NF = 1.4 dB TYP. @ $V_{CE} = 2\text{ V}$, $I_c = 3\text{ mA}$, $f = 2\text{ GHz}$
- 3-pin lead-less minimold package

ORDERING INFORMATION

| Part Number | Quantity | Supplying Form |
|-------------|-------------------|--|
| 2SC5618 | 50 pcs (Non reel) | • 8 mm wide embossed taping |
| 2SC5618-T3 | 10 kpcs/reel | • Pin 2 (Base) face the perforation side of the tape |

Remark To order evaluation samples, contact your nearby sales office.
The 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} | 5.0 | V |
| Collector to Emitter Voltage | V_{CEO} | 3.0 | V |
| Emitter to Base Voltage | V_{EBO} | 2.0 | V |
| Collector Current | I_c | 30 | mA |
| Total Power Dissipation | P_{tot} ^{Note} | 90 | 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.

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.
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_A = +25°C)

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|------------------------------|-----------------------------------|---|------|------|------|------|
| DC Characteristics | | | | | | |
| Collector Cut-off Current | I _{CBO} | V _{CB} = 5 V, I _E = 0 mA | – | – | 100 | nA |
| Emitter Cut-off Current | I _{EBO} | V _{EB} = 1 V, I _C = 0 mA | – | – | 100 | nA |
| DC Current Gain | h _{FE} ^{Note 1} | V _{CE} = 2 V, I _C = 20 mA | 70 | – | 130 | – |
| RF Characteristics | | | | | | |
| Gain Bandwidth Product (1) | f _T | V _{CE} = 2 V, I _C = 20 mA, f = 2 GHz | 9.0 | 14.0 | – | GHz |
| Gain Bandwidth Product (2) | f _T | V _{CE} = 1 V, I _C = 10 mA, f = 2 GHz | 7.0 | 12.0 | – | GHz |
| Insertion Power Gain (1) | S _{21e} ² | V _{CE} = 2 V, I _C = 20 mA, f = 2 GHz | 8.5 | 10.0 | – | dB |
| Insertion Power Gain (2) | S _{21e} ² | V _{CE} = 1 V, I _C = 10 mA, f = 2 GHz | 6.0 | 9.0 | – | dB |
| Noise Figure (1) | NF | V _{CE} = 2 V, I _C = 3 mA, f = 2 GHz, Z _S = Z _{opt} | – | 1.4 | 2.0 | dB |
| Noise Figure (2) | NF | V _{CE} = 1 V, I _C = 3 mA, f = 2 GHz, Z _S = Z _{opt} | – | 1.5 | 2.0 | dB |
| Reverse Transfer Capacitance | C _{re} ^{Note 2} | V _{CB} = 2 V, I _E = 0 mA, f = 1 MHz | – | 0.4 | 0.8 | pF |

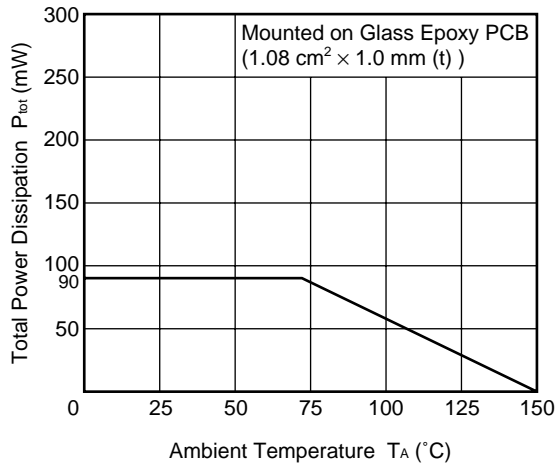
- Notes** 1. Pulse measurement: PW ≤ 350 μs, Duty Cycle ≤ 2%
 2. Collector to base capacitance when the emitter grounded

h_{FE} CLASSIFICATION

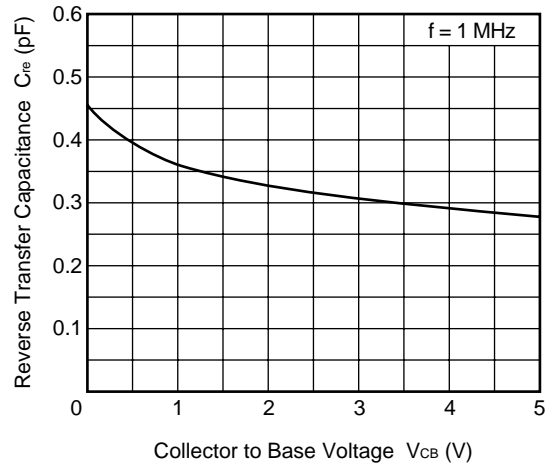
| Rank | EB | FB |
|-----------------------|-----------|-----------|
| Marking | W1 | W2 |
| h _{FE} Value | 70 to 100 | 90 to 130 |

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

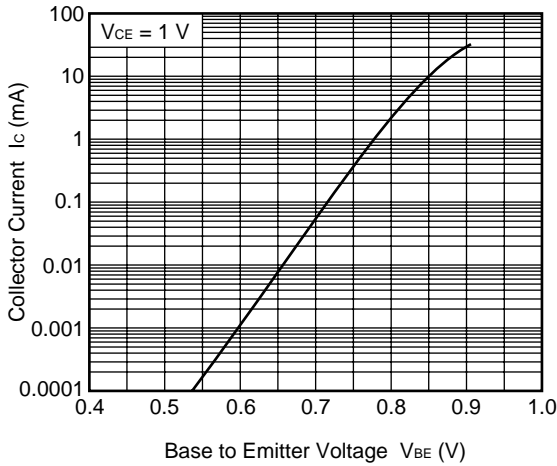
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



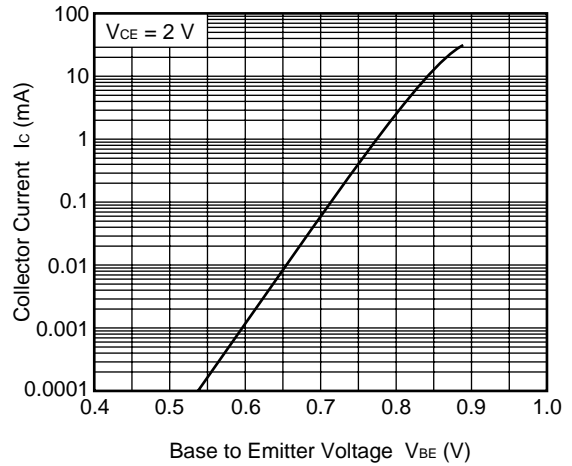
REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



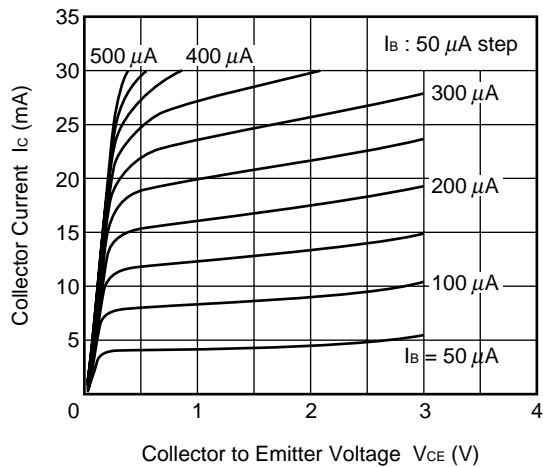
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



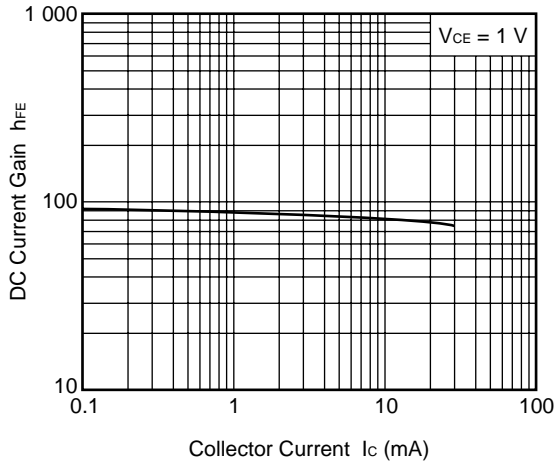
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



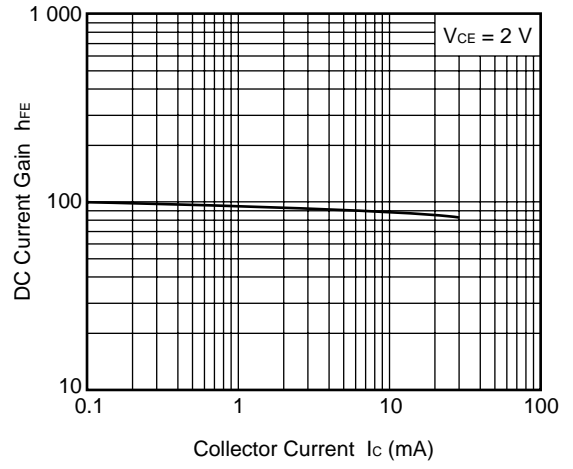
COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE



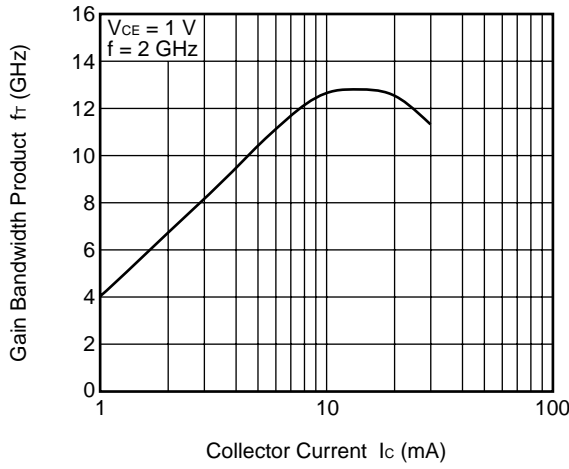
DC CURRENT GAIN vs.
COLLECTOR CURRENT



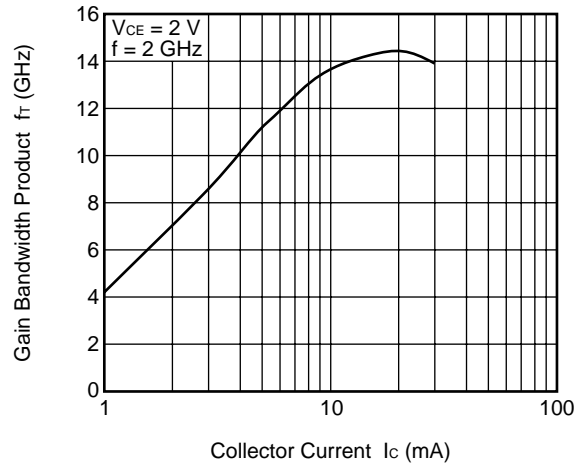
DC CURRENT GAIN vs.
COLLECTOR CURRENT



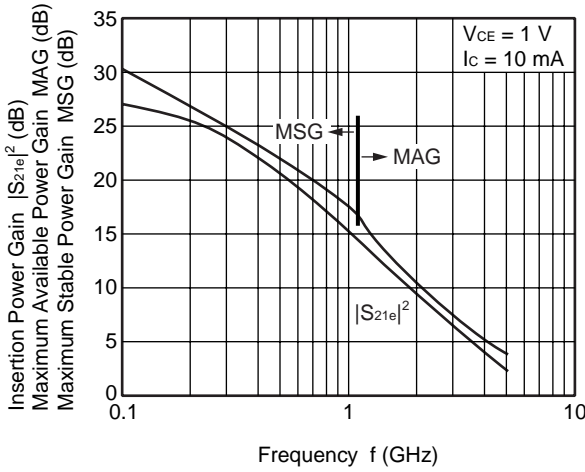
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



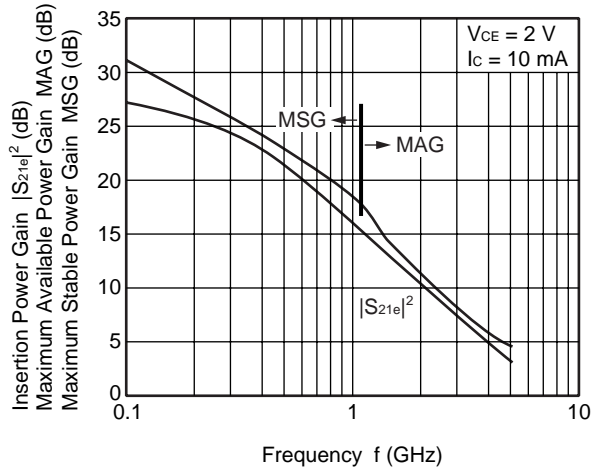
GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



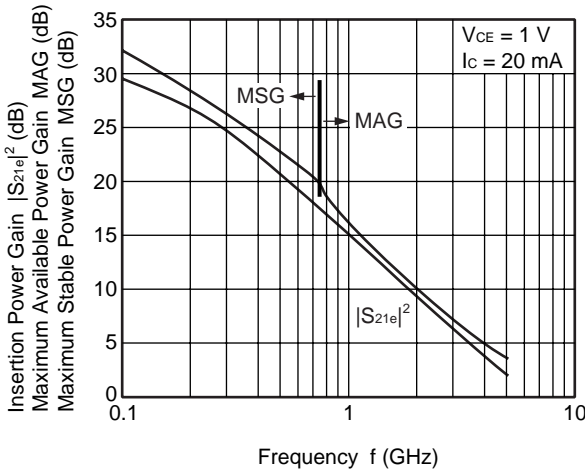
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



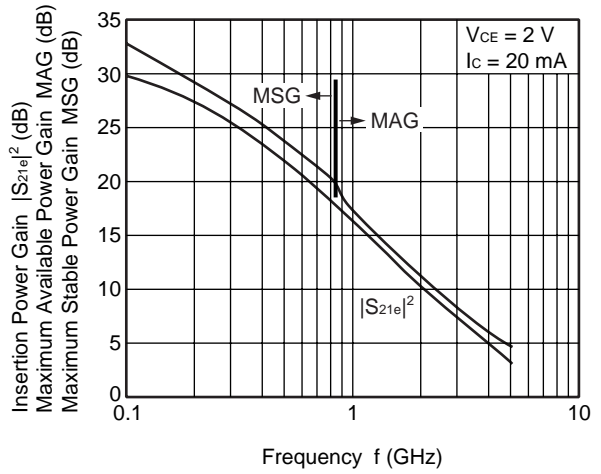
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



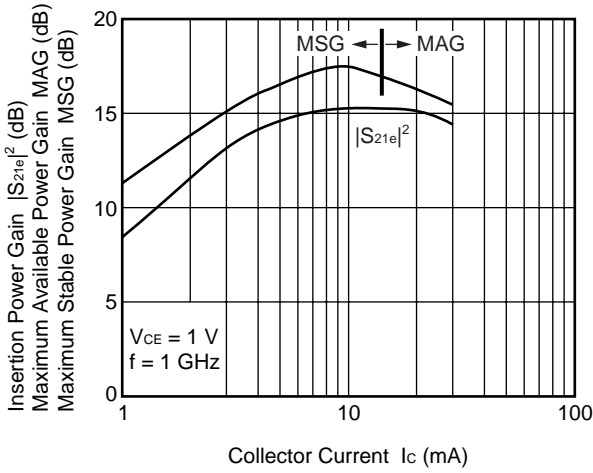
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



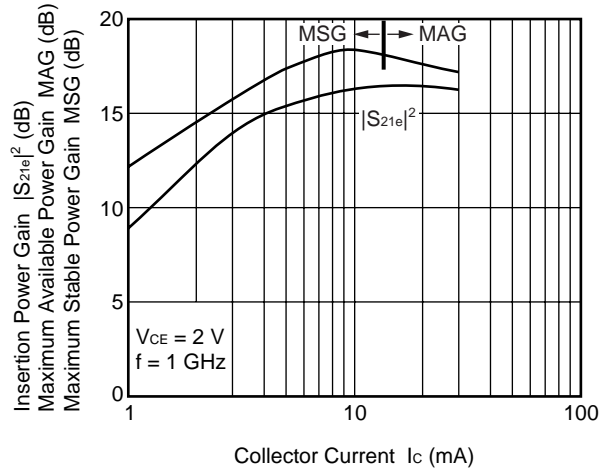
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



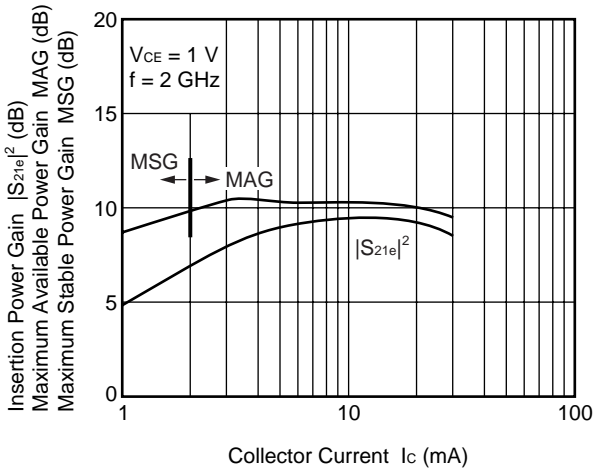
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



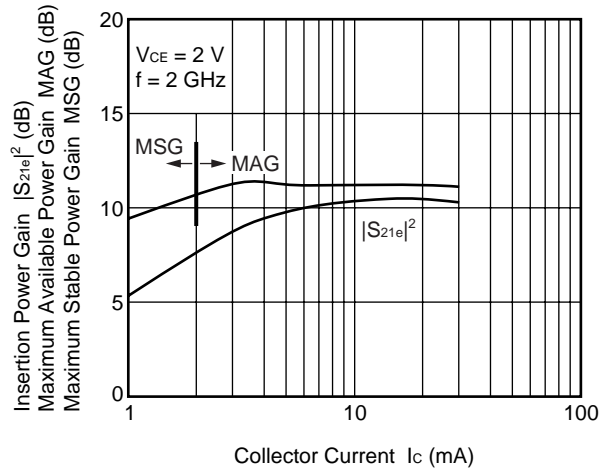
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



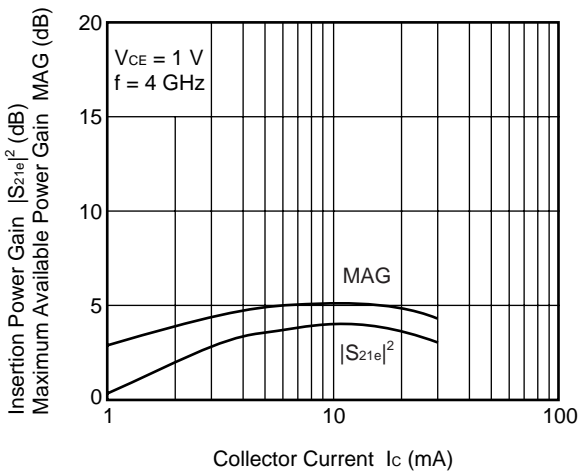
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



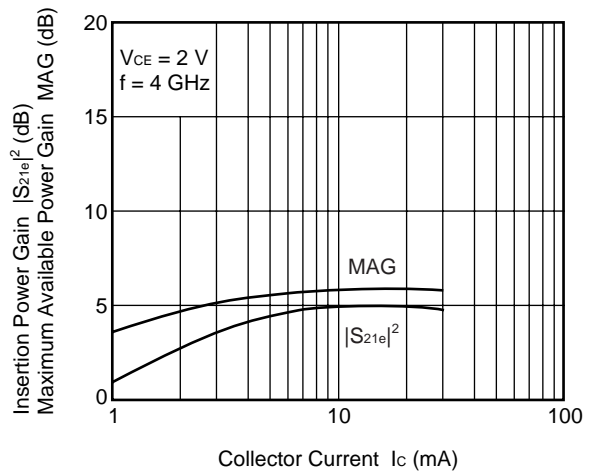
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



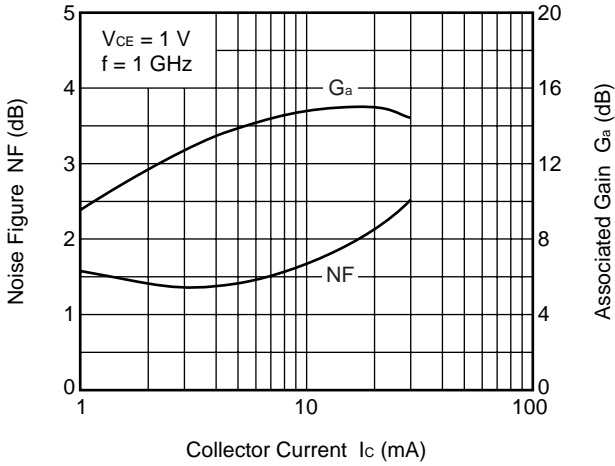
INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT



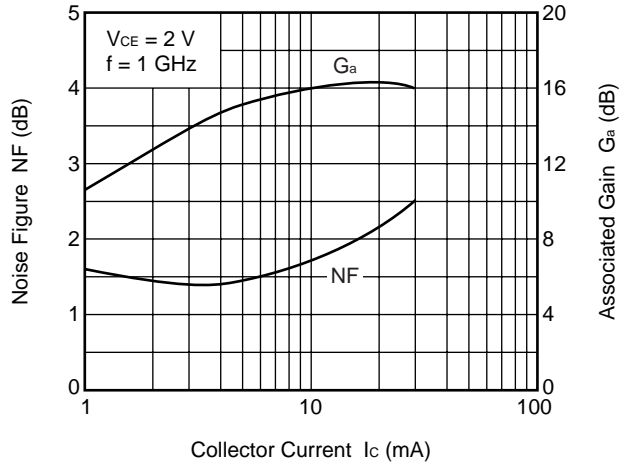
INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT



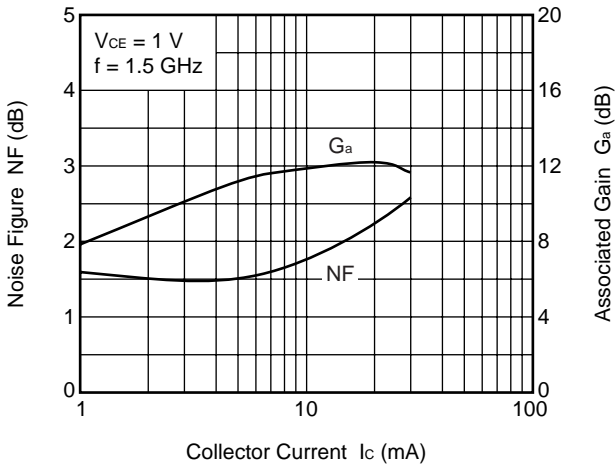
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



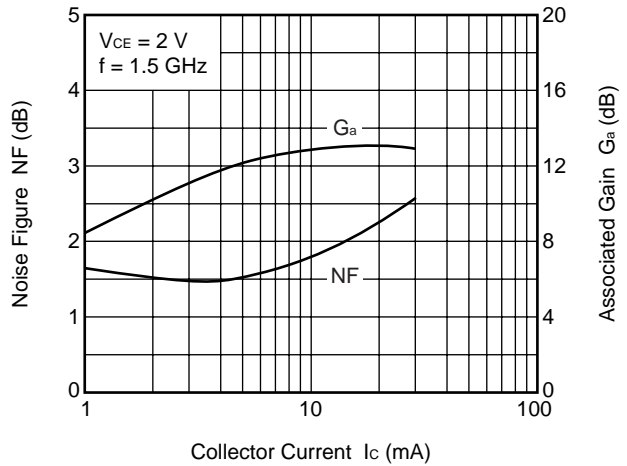
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



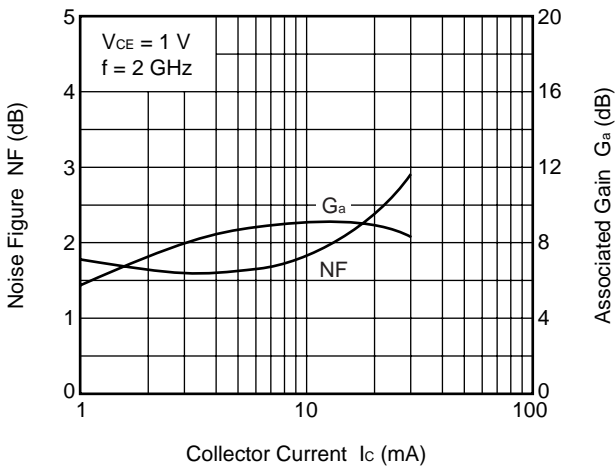
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



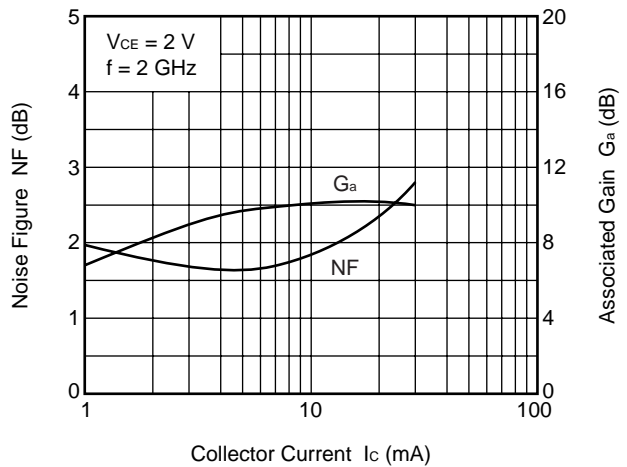
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



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 V, I_C = 1 mA, Z₀ = 50 Ω

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.971 | -8.1 | 3.566 | 171.3 | 0.027 | 81.0 | 0.996 | -4.3 |
| 0.2 | 0.964 | -15.7 | 3.474 | 165.9 | 0.052 | 79.6 | 0.982 | -9.1 |
| 0.3 | 0.927 | -24.6 | 3.380 | 159.0 | 0.078 | 74.5 | 0.971 | -13.4 |
| 0.4 | 0.916 | -33.3 | 3.330 | 151.6 | 0.101 | 69.3 | 0.942 | -18.2 |
| 0.5 | 0.891 | -40.9 | 3.277 | 145.0 | 0.124 | 64.4 | 0.920 | -22.4 |
| 0.6 | 0.841 | -48.6 | 3.145 | 137.9 | 0.143 | 59.5 | 0.875 | -26.8 |
| 0.7 | 0.808 | -56.4 | 3.043 | 132.2 | 0.160 | 55.5 | 0.846 | -30.5 |
| 0.8 | 0.765 | -63.4 | 2.920 | 125.9 | 0.174 | 51.4 | 0.800 | -34.3 |
| 0.9 | 0.723 | -70.7 | 2.786 | 120.9 | 0.186 | 47.8 | 0.766 | -37.8 |
| 1.0 | 0.692 | -77.7 | 2.669 | 115.6 | 0.196 | 44.6 | 0.723 | -41.1 |
| 1.1 | 0.654 | -84.7 | 2.554 | 110.4 | 0.205 | 41.4 | 0.696 | -44.2 |
| 1.2 | 0.627 | -91.5 | 2.461 | 105.7 | 0.212 | 38.9 | 0.662 | -47.0 |
| 1.3 | 0.599 | -98.3 | 2.338 | 101.3 | 0.218 | 36.1 | 0.642 | -49.7 |
| 1.4 | 0.568 | -104.7 | 2.241 | 96.6 | 0.222 | 33.6 | 0.609 | -52.1 |
| 1.5 | 0.545 | -110.7 | 2.141 | 92.9 | 0.227 | 31.6 | 0.593 | -54.4 |
| 1.6 | 0.522 | -117.1 | 2.052 | 88.9 | 0.229 | 29.6 | 0.563 | -56.4 |
| 1.7 | 0.511 | -122.8 | 1.976 | 85.6 | 0.231 | 27.9 | 0.547 | -58.5 |
| 1.8 | 0.487 | -128.7 | 1.894 | 81.6 | 0.232 | 26.4 | 0.521 | -59.9 |
| 1.9 | 0.475 | -133.2 | 1.824 | 78.9 | 0.232 | 25.1 | 0.506 | -61.9 |
| 2.0 | 0.475 | -139.3 | 1.750 | 75.6 | 0.233 | 24.2 | 0.486 | -63.4 |
| 2.1 | 0.469 | -144.3 | 1.694 | 72.9 | 0.233 | 23.3 | 0.473 | -65.4 |
| 2.2 | 0.465 | -148.5 | 1.651 | 70.4 | 0.232 | 22.5 | 0.457 | -66.8 |
| 2.3 | 0.458 | -152.9 | 1.588 | 67.3 | 0.232 | 21.9 | 0.450 | -69.0 |
| 2.4 | 0.453 | -157.7 | 1.548 | 65.4 | 0.230 | 21.1 | 0.437 | -70.3 |
| 2.5 | 0.455 | -162.1 | 1.493 | 63.0 | 0.230 | 20.7 | 0.431 | -72.4 |
| 2.6 | 0.454 | -166.1 | 1.451 | 59.9 | 0.228 | 19.3 | 0.426 | -74.1 |
| 2.7 | 0.455 | -169.4 | 1.416 | 58.0 | 0.228 | 19.0 | 0.420 | -75.9 |
| 2.8 | 0.455 | -172.9 | 1.372 | 55.6 | 0.227 | 18.4 | 0.413 | -77.0 |
| 2.9 | 0.455 | -176.0 | 1.336 | 53.6 | 0.229 | 19.0 | 0.405 | -78.6 |
| 3.0 | 0.450 | -179.8 | 1.300 | 51.6 | 0.227 | 19.0 | 0.394 | -79.7 |
| 4.0 | 0.482 | 150.1 | 1.044 | 32.6 | 0.229 | 24.6 | 0.348 | -99.2 |
| 5.0 | 0.566 | 128.8 | 0.891 | 17.6 | 0.268 | 28.8 | 0.305 | -125.4 |

$V_{CE} = 1\text{ V}$, $I_C = 3\text{ mA}$, $Z_0 = 50\ \Omega$

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.883 | -14.4 | 9.519 | 167.2 | 0.025 | 80.6 | 0.967 | -9.5 |
| 0.2 | 0.866 | -28.0 | 9.012 | 156.4 | 0.049 | 74.3 | 0.921 | -18.9 |
| 0.3 | 0.790 | -42.0 | 8.353 | 146.6 | 0.069 | 67.3 | 0.868 | -27.0 |
| 0.4 | 0.744 | -54.7 | 7.772 | 136.7 | 0.086 | 61.2 | 0.793 | -34.6 |
| 0.5 | 0.683 | -66.2 | 7.206 | 128.4 | 0.100 | 56.1 | 0.727 | -40.6 |
| 0.6 | 0.612 | -76.5 | 6.513 | 121.1 | 0.111 | 52.3 | 0.650 | -46.1 |
| 0.7 | 0.564 | -86.0 | 5.991 | 115.2 | 0.119 | 49.7 | 0.596 | -50.4 |
| 0.8 | 0.517 | -94.6 | 5.468 | 109.5 | 0.126 | 47.5 | 0.537 | -54.5 |
| 0.9 | 0.477 | -103.5 | 5.016 | 105.0 | 0.133 | 45.7 | 0.494 | -58.3 |
| 1.0 | 0.451 | -111.5 | 4.637 | 100.7 | 0.138 | 44.6 | 0.450 | -61.5 |
| 1.1 | 0.423 | -119.5 | 4.290 | 96.5 | 0.143 | 43.6 | 0.421 | -64.6 |
| 1.2 | 0.407 | -126.9 | 4.019 | 92.8 | 0.148 | 43.1 | 0.389 | -67.7 |
| 1.3 | 0.393 | -133.4 | 3.742 | 89.6 | 0.152 | 42.1 | 0.370 | -70.2 |
| 1.4 | 0.379 | -140.3 | 3.506 | 86.1 | 0.156 | 41.7 | 0.343 | -72.7 |
| 1.5 | 0.370 | -146.4 | 3.308 | 83.4 | 0.160 | 41.5 | 0.330 | -74.6 |
| 1.6 | 0.363 | -152.7 | 3.116 | 80.3 | 0.165 | 41.2 | 0.306 | -76.8 |
| 1.7 | 0.363 | -158.0 | 2.961 | 78.0 | 0.168 | 40.9 | 0.294 | -78.7 |
| 1.8 | 0.354 | -163.9 | 2.811 | 75.0 | 0.172 | 40.9 | 0.274 | -80.7 |
| 1.9 | 0.349 | -167.1 | 2.688 | 73.0 | 0.176 | 40.8 | 0.265 | -83.0 |
| 2.0 | 0.358 | -172.3 | 2.549 | 70.5 | 0.181 | 40.9 | 0.248 | -84.9 |
| 2.1 | 0.363 | -176.0 | 2.447 | 68.4 | 0.185 | 40.8 | 0.242 | -87.6 |
| 2.2 | 0.366 | -179.3 | 2.366 | 66.6 | 0.189 | 40.9 | 0.228 | -89.5 |
| 2.3 | 0.365 | 177.7 | 2.274 | 64.1 | 0.194 | 40.8 | 0.224 | -92.2 |
| 2.4 | 0.369 | 173.5 | 2.199 | 62.6 | 0.198 | 40.7 | 0.215 | -93.8 |
| 2.5 | 0.375 | 170.7 | 2.105 | 60.9 | 0.202 | 40.7 | 0.212 | -96.7 |
| 2.6 | 0.380 | 167.4 | 2.034 | 58.4 | 0.206 | 40.0 | 0.207 | -98.0 |
| 2.7 | 0.382 | 164.9 | 1.984 | 56.9 | 0.211 | 39.9 | 0.204 | -100.5 |
| 2.8 | 0.387 | 162.1 | 1.914 | 54.9 | 0.215 | 39.6 | 0.197 | -101.5 |
| 2.9 | 0.387 | 160.4 | 1.860 | 53.6 | 0.221 | 39.9 | 0.193 | -104.1 |
| 3.0 | 0.388 | 157.2 | 1.803 | 51.9 | 0.226 | 39.7 | 0.184 | -105.3 |
| 4.0 | 0.434 | 136.1 | 1.401 | 35.4 | 0.274 | 38.0 | 0.169 | -133.8 |
| 5.0 | 0.520 | 121.2 | 1.190 | 21.7 | 0.328 | 32.4 | 0.158 | -175.1 |

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

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.823 | -19.6 | 14.258 | 163.1 | 0.023 | 76.9 | 0.934 | -13.8 |
| 0.2 | 0.779 | -38.1 | 13.039 | 149.3 | 0.046 | 70.4 | 0.856 | -26.5 |
| 0.3 | 0.675 | -55.3 | 11.517 | 137.8 | 0.062 | 63.1 | 0.766 | -36.6 |
| 0.4 | 0.612 | -69.7 | 10.235 | 127.2 | 0.075 | 58.4 | 0.668 | -45.0 |
| 0.5 | 0.549 | -82.9 | 9.077 | 118.8 | 0.085 | 54.6 | 0.589 | -51.2 |
| 0.6 | 0.484 | -93.9 | 7.976 | 112.2 | 0.092 | 52.4 | 0.510 | -56.7 |
| 0.7 | 0.441 | -104.1 | 7.156 | 106.9 | 0.099 | 51.1 | 0.456 | -60.9 |
| 0.8 | 0.403 | -113.5 | 6.422 | 101.8 | 0.105 | 50.3 | 0.403 | -65.2 |
| 0.9 | 0.378 | -122.7 | 5.818 | 98.1 | 0.111 | 49.8 | 0.365 | -68.7 |
| 1.0 | 0.364 | -130.7 | 5.305 | 94.4 | 0.118 | 49.7 | 0.329 | -72.5 |
| 1.1 | 0.347 | -138.7 | 4.871 | 90.9 | 0.123 | 49.6 | 0.306 | -75.7 |
| 1.2 | 0.341 | -145.6 | 4.515 | 87.6 | 0.129 | 49.7 | 0.281 | -79.3 |
| 1.3 | 0.336 | -151.8 | 4.189 | 85.0 | 0.134 | 49.2 | 0.267 | -81.8 |
| 1.4 | 0.330 | -158.4 | 3.909 | 82.0 | 0.140 | 49.2 | 0.246 | -85.0 |
| 1.5 | 0.327 | -163.4 | 3.671 | 79.6 | 0.146 | 49.4 | 0.236 | -86.9 |
| 1.6 | 0.327 | -169.3 | 3.449 | 77.0 | 0.152 | 49.3 | 0.217 | -90.1 |
| 1.7 | 0.333 | -173.7 | 3.266 | 74.9 | 0.157 | 49.1 | 0.210 | -92.3 |
| 1.8 | 0.328 | -179.2 | 3.092 | 72.5 | 0.163 | 49.1 | 0.193 | -95.4 |
| 1.9 | 0.328 | 178.1 | 2.956 | 70.7 | 0.169 | 49.0 | 0.188 | -98.2 |
| 2.0 | 0.338 | 174.4 | 2.795 | 68.4 | 0.175 | 49.0 | 0.174 | -101.6 |
| 2.1 | 0.344 | 171.6 | 2.681 | 66.5 | 0.181 | 48.6 | 0.172 | -105.0 |
| 2.2 | 0.349 | 168.4 | 2.587 | 64.9 | 0.187 | 48.6 | 0.162 | -107.8 |
| 2.3 | 0.351 | 166.1 | 2.484 | 62.6 | 0.193 | 48.3 | 0.162 | -111.5 |
| 2.4 | 0.356 | 162.9 | 2.397 | 61.4 | 0.199 | 48.0 | 0.155 | -113.7 |
| 2.5 | 0.361 | 160.7 | 2.294 | 59.8 | 0.204 | 47.8 | 0.155 | -117.2 |
| 2.6 | 0.368 | 157.7 | 2.214 | 57.7 | 0.210 | 47.1 | 0.150 | -119.1 |
| 2.7 | 0.372 | 156.1 | 2.158 | 56.2 | 0.215 | 46.7 | 0.150 | -122.1 |
| 2.8 | 0.376 | 153.3 | 2.082 | 54.5 | 0.222 | 46.0 | 0.144 | -123.7 |
| 2.9 | 0.377 | 151.9 | 2.020 | 53.1 | 0.229 | 45.9 | 0.144 | -127.1 |
| 3.0 | 0.378 | 149.4 | 1.956 | 51.7 | 0.234 | 45.5 | 0.136 | -129.5 |
| 4.0 | 0.426 | 131.6 | 1.507 | 36.0 | 0.290 | 41.0 | 0.150 | -160.8 |
| 5.0 | 0.511 | 118.5 | 1.273 | 22.9 | 0.346 | 33.2 | 0.173 | 158.0 |

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

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.767 | -24.3 | 17.973 | 159.9 | 0.022 | 78.5 | 0.905 | -17.4 |
| 0.2 | 0.694 | -46.3 | 15.883 | 143.9 | 0.042 | 67.6 | 0.797 | -32.2 |
| 0.3 | 0.587 | -65.4 | 13.504 | 131.7 | 0.056 | 61.6 | 0.686 | -43.2 |
| 0.4 | 0.525 | -81.0 | 11.608 | 121.2 | 0.067 | 57.7 | 0.579 | -51.9 |
| 0.5 | 0.467 | -94.6 | 10.043 | 113.2 | 0.075 | 55.3 | 0.499 | -57.8 |
| 0.6 | 0.410 | -106.0 | 8.675 | 107.1 | 0.083 | 54.2 | 0.425 | -63.4 |
| 0.7 | 0.377 | -116.7 | 7.713 | 102.3 | 0.089 | 54.0 | 0.375 | -67.4 |
| 0.8 | 0.348 | -126.2 | 6.862 | 97.7 | 0.096 | 53.8 | 0.328 | -71.9 |
| 0.9 | 0.336 | -135.5 | 6.172 | 94.4 | 0.102 | 53.6 | 0.296 | -75.6 |
| 1.0 | 0.326 | -143.1 | 5.610 | 91.1 | 0.109 | 53.8 | 0.266 | -80.0 |
| 1.1 | 0.318 | -150.4 | 5.124 | 88.0 | 0.115 | 54.0 | 0.247 | -83.5 |
| 1.2 | 0.317 | -157.1 | 4.733 | 85.0 | 0.122 | 54.2 | 0.227 | -87.7 |
| 1.3 | 0.314 | -162.4 | 4.384 | 82.6 | 0.128 | 53.9 | 0.216 | -90.4 |
| 1.4 | 0.315 | -168.7 | 4.082 | 79.8 | 0.135 | 53.9 | 0.199 | -94.4 |
| 1.5 | 0.317 | -173.4 | 3.832 | 77.7 | 0.142 | 54.0 | 0.193 | -96.5 |
| 1.6 | 0.317 | -178.7 | 3.594 | 75.3 | 0.148 | 53.8 | 0.176 | -100.6 |
| 1.7 | 0.325 | 177.7 | 3.395 | 73.4 | 0.155 | 53.5 | 0.172 | -103.0 |
| 1.8 | 0.327 | 172.8 | 3.218 | 71.1 | 0.161 | 53.4 | 0.158 | -107.4 |
| 1.9 | 0.323 | 170.6 | 3.075 | 69.4 | 0.168 | 53.2 | 0.156 | -110.6 |
| 2.0 | 0.334 | 167.1 | 2.903 | 67.3 | 0.175 | 53.0 | 0.145 | -115.2 |
| 2.1 | 0.341 | 164.7 | 2.781 | 65.5 | 0.182 | 52.5 | 0.145 | -118.9 |
| 2.2 | 0.347 | 162.5 | 2.684 | 64.0 | 0.188 | 52.3 | 0.138 | -122.8 |
| 2.3 | 0.348 | 160.2 | 2.576 | 61.8 | 0.195 | 51.7 | 0.140 | -126.5 |
| 2.4 | 0.354 | 157.3 | 2.488 | 60.7 | 0.201 | 51.4 | 0.135 | -129.4 |
| 2.5 | 0.360 | 155.5 | 2.376 | 59.2 | 0.207 | 50.9 | 0.137 | -132.8 |
| 2.6 | 0.367 | 153.0 | 2.294 | 57.2 | 0.213 | 50.2 | 0.134 | -135.2 |
| 2.7 | 0.369 | 151.3 | 2.233 | 55.7 | 0.219 | 49.7 | 0.135 | -138.4 |
| 2.8 | 0.376 | 149.0 | 2.153 | 54.1 | 0.226 | 48.9 | 0.130 | -140.6 |
| 2.9 | 0.377 | 148.0 | 2.091 | 52.7 | 0.233 | 48.6 | 0.132 | -143.7 |
| 3.0 | 0.379 | 145.5 | 2.025 | 51.3 | 0.239 | 48.0 | 0.125 | -147.1 |
| 4.0 | 0.425 | 129.2 | 1.554 | 36.3 | 0.299 | 42.3 | 0.155 | -175.2 |
| 5.0 | 0.509 | 116.7 | 1.310 | 23.5 | 0.355 | 33.5 | 0.194 | 147.6 |

$V_{CE} = 1\text{ V}$, $I_C = 10\text{ mA}$, $Z_0 = 50\ \Omega$

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.686 | -31.4 | 22.299 | 156.2 | 0.021 | 77.4 | 0.860 | -21.8 |
| 0.2 | 0.601 | -55.9 | 18.761 | 137.7 | 0.038 | 66.2 | 0.721 | -38.9 |
| 0.3 | 0.492 | -77.4 | 15.302 | 125.4 | 0.050 | 60.2 | 0.594 | -50.3 |
| 0.4 | 0.436 | -93.6 | 12.698 | 115.3 | 0.060 | 58.5 | 0.486 | -59.0 |
| 0.5 | 0.393 | -108.4 | 10.732 | 108.0 | 0.067 | 57.5 | 0.411 | -64.7 |
| 0.6 | 0.350 | -120.2 | 9.197 | 102.5 | 0.075 | 57.2 | 0.344 | -70.4 |
| 0.7 | 0.327 | -130.3 | 8.080 | 98.2 | 0.082 | 57.7 | 0.301 | -74.4 |
| 0.8 | 0.314 | -140.0 | 7.158 | 94.2 | 0.089 | 58.0 | 0.262 | -79.5 |
| 0.9 | 0.306 | -148.6 | 6.424 | 91.1 | 0.096 | 58.0 | 0.236 | -83.6 |
| 1.0 | 0.304 | -155.9 | 5.812 | 88.2 | 0.104 | 58.2 | 0.212 | -88.9 |
| 1.1 | 0.302 | -162.3 | 5.294 | 85.4 | 0.111 | 58.4 | 0.198 | -92.8 |
| 1.2 | 0.305 | -168.0 | 4.879 | 82.8 | 0.118 | 58.6 | 0.183 | -98.0 |
| 1.3 | 0.305 | -172.9 | 4.506 | 80.5 | 0.125 | 58.3 | 0.176 | -101.0 |
| 1.4 | 0.308 | -178.2 | 4.181 | 77.9 | 0.132 | 58.1 | 0.163 | -106.1 |
| 1.5 | 0.312 | 177.9 | 3.936 | 76.0 | 0.140 | 58.0 | 0.159 | -108.3 |
| 1.6 | 0.317 | 173.3 | 3.688 | 73.7 | 0.147 | 57.8 | 0.147 | -113.7 |
| 1.7 | 0.324 | 170.7 | 3.483 | 72.0 | 0.154 | 57.4 | 0.145 | -116.3 |
| 1.8 | 0.327 | 165.7 | 3.298 | 69.9 | 0.161 | 57.1 | 0.135 | -122.1 |
| 1.9 | 0.325 | 163.5 | 3.149 | 68.3 | 0.168 | 56.7 | 0.136 | -125.4 |
| 2.0 | 0.337 | 161.0 | 2.974 | 66.3 | 0.176 | 56.2 | 0.128 | -131.3 |
| 2.1 | 0.346 | 159.1 | 2.848 | 64.6 | 0.183 | 55.6 | 0.132 | -134.7 |
| 2.2 | 0.348 | 157.5 | 2.744 | 63.2 | 0.191 | 55.2 | 0.127 | -139.4 |
| 2.3 | 0.350 | 155.5 | 2.637 | 61.1 | 0.198 | 54.6 | 0.131 | -142.9 |
| 2.4 | 0.356 | 152.9 | 2.544 | 60.1 | 0.204 | 54.1 | 0.127 | -146.0 |
| 2.5 | 0.364 | 151.2 | 2.431 | 58.5 | 0.211 | 53.4 | 0.132 | -148.9 |
| 2.6 | 0.371 | 148.8 | 2.348 | 56.6 | 0.217 | 52.6 | 0.129 | -151.5 |
| 2.7 | 0.372 | 147.3 | 2.282 | 55.2 | 0.224 | 51.9 | 0.132 | -154.2 |
| 2.8 | 0.379 | 145.5 | 2.205 | 53.6 | 0.231 | 51.1 | 0.129 | -157.0 |
| 2.9 | 0.380 | 144.4 | 2.139 | 52.3 | 0.238 | 50.6 | 0.132 | -159.5 |
| 3.0 | 0.382 | 142.1 | 2.070 | 51.1 | 0.245 | 49.9 | 0.127 | -163.5 |
| 4.0 | 0.427 | 127.2 | 1.585 | 36.2 | 0.306 | 43.2 | 0.167 | 173.4 |
| 5.0 | 0.512 | 115.7 | 1.331 | 23.8 | 0.362 | 33.6 | 0.217 | 140.7 |

$V_{CE} = 1\text{ V}$, $I_C = 20\text{ mA}$, $Z_0 = 50\ \Omega$

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.484 | -48.9 | 29.552 | 147.4 | 0.019 | 68.5 | 0.739 | -30.9 |
| 0.2 | 0.429 | -82.6 | 22.187 | 126.4 | 0.033 | 64.3 | 0.553 | -50.9 |
| 0.3 | 0.359 | -108.0 | 16.755 | 115.0 | 0.041 | 62.9 | 0.422 | -62.0 |
| 0.4 | 0.336 | -124.9 | 13.327 | 106.4 | 0.049 | 63.1 | 0.331 | -70.3 |
| 0.5 | 0.324 | -137.8 | 10.970 | 100.2 | 0.058 | 63.4 | 0.272 | -75.4 |
| 0.6 | 0.309 | -148.6 | 9.266 | 95.8 | 0.066 | 64.0 | 0.223 | -81.8 |
| 0.7 | 0.308 | -157.2 | 8.062 | 92.5 | 0.074 | 64.7 | 0.193 | -86.3 |
| 0.8 | 0.303 | -164.5 | 7.101 | 88.9 | 0.082 | 65.0 | 0.167 | -93.2 |
| 0.9 | 0.310 | -171.3 | 6.344 | 86.5 | 0.090 | 64.9 | 0.152 | -98.4 |
| 1.0 | 0.317 | -175.9 | 5.722 | 83.9 | 0.098 | 64.8 | 0.139 | -106.0 |
| 1.1 | 0.319 | 179.4 | 5.196 | 81.6 | 0.107 | 64.8 | 0.133 | -110.9 |
| 1.2 | 0.325 | 175.3 | 4.786 | 79.2 | 0.115 | 64.5 | 0.126 | -118.0 |
| 1.3 | 0.329 | 172.1 | 4.413 | 77.3 | 0.123 | 63.9 | 0.124 | -121.1 |
| 1.4 | 0.337 | 168.5 | 4.092 | 74.9 | 0.130 | 63.5 | 0.119 | -128.0 |
| 1.5 | 0.340 | 165.3 | 3.845 | 73.2 | 0.139 | 63.1 | 0.118 | -130.0 |
| 1.6 | 0.347 | 161.7 | 3.598 | 71.1 | 0.146 | 62.6 | 0.113 | -137.4 |
| 1.7 | 0.354 | 159.7 | 3.394 | 69.6 | 0.154 | 62.0 | 0.114 | -139.7 |
| 1.8 | 0.359 | 156.1 | 3.214 | 67.6 | 0.162 | 61.3 | 0.111 | -147.3 |
| 1.9 | 0.357 | 154.7 | 3.070 | 66.0 | 0.169 | 60.7 | 0.115 | -149.7 |
| 2.0 | 0.366 | 153.0 | 2.896 | 64.2 | 0.178 | 60.1 | 0.113 | -156.7 |
| 2.1 | 0.378 | 151.3 | 2.773 | 62.6 | 0.186 | 59.2 | 0.119 | -158.9 |
| 2.2 | 0.379 | 149.8 | 2.672 | 61.3 | 0.193 | 58.5 | 0.118 | -163.7 |
| 2.3 | 0.382 | 148.3 | 2.563 | 59.2 | 0.201 | 57.7 | 0.125 | -166.0 |
| 2.4 | 0.389 | 146.1 | 2.474 | 58.3 | 0.207 | 56.9 | 0.123 | -169.2 |
| 2.5 | 0.395 | 144.6 | 2.363 | 56.8 | 0.215 | 56.3 | 0.130 | -170.8 |
| 2.6 | 0.403 | 143.1 | 2.279 | 55.0 | 0.222 | 55.2 | 0.128 | -173.6 |
| 2.7 | 0.403 | 141.7 | 2.214 | 53.8 | 0.229 | 54.3 | 0.133 | -175.3 |
| 2.8 | 0.409 | 139.9 | 2.141 | 52.3 | 0.235 | 53.4 | 0.131 | -178.2 |
| 2.9 | 0.410 | 139.0 | 2.079 | 51.1 | 0.243 | 52.8 | 0.136 | -179.9 |
| 3.0 | 0.414 | 136.9 | 2.012 | 49.7 | 0.249 | 52.0 | 0.134 | 176.0 |
| 4.0 | 0.453 | 123.9 | 1.533 | 35.3 | 0.312 | 44.0 | 0.180 | 159.6 |
| 5.0 | 0.534 | 113.2 | 1.291 | 23.2 | 0.367 | 33.8 | 0.241 | 131.6 |

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

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.976 | -8.2 | 3.527 | 172.1 | 0.022 | 84.4 | 0.999 | -3.5 |
| 0.2 | 0.974 | -14.0 | 3.453 | 167.1 | 0.044 | 81.3 | 0.987 | -7.5 |
| 0.3 | 0.939 | -22.0 | 3.367 | 160.9 | 0.065 | 76.4 | 0.978 | -11.3 |
| 0.4 | 0.926 | -29.7 | 3.329 | 153.8 | 0.086 | 71.5 | 0.954 | -15.2 |
| 0.5 | 0.903 | -36.9 | 3.287 | 147.8 | 0.105 | 67.0 | 0.939 | -18.9 |
| 0.6 | 0.862 | -43.8 | 3.180 | 141.1 | 0.123 | 62.3 | 0.901 | -22.7 |
| 0.7 | 0.829 | -51.1 | 3.092 | 135.7 | 0.138 | 58.7 | 0.876 | -26.0 |
| 0.8 | 0.790 | -57.6 | 2.982 | 129.7 | 0.150 | 54.8 | 0.834 | -29.2 |
| 0.9 | 0.746 | -64.1 | 2.862 | 124.8 | 0.163 | 51.4 | 0.806 | -32.4 |
| 1.0 | 0.714 | -70.9 | 2.759 | 119.8 | 0.172 | 48.3 | 0.765 | -35.3 |
| 1.1 | 0.678 | -77.7 | 2.652 | 114.6 | 0.180 | 45.2 | 0.741 | -38.2 |
| 1.2 | 0.647 | -84.1 | 2.566 | 110.0 | 0.187 | 42.8 | 0.708 | -40.6 |
| 1.3 | 0.619 | -90.4 | 2.446 | 105.6 | 0.194 | 39.9 | 0.689 | -43.1 |
| 1.4 | 0.588 | -96.5 | 2.356 | 101.0 | 0.198 | 37.6 | 0.659 | -45.2 |
| 1.5 | 0.560 | -102.6 | 2.256 | 97.3 | 0.203 | 35.6 | 0.644 | -47.4 |
| 1.6 | 0.537 | -108.4 | 2.166 | 93.3 | 0.206 | 33.6 | 0.614 | -49.2 |
| 1.7 | 0.521 | -114.1 | 2.092 | 90.0 | 0.208 | 31.8 | 0.599 | -51.1 |
| 1.8 | 0.494 | -119.8 | 2.008 | 86.1 | 0.209 | 30.4 | 0.574 | -52.5 |
| 1.9 | 0.483 | -124.4 | 1.934 | 83.3 | 0.210 | 29.1 | 0.558 | -54.3 |
| 2.0 | 0.472 | -130.5 | 1.859 | 80.1 | 0.211 | 28.2 | 0.537 | -55.3 |
| 2.1 | 0.467 | -135.7 | 1.804 | 77.2 | 0.212 | 27.2 | 0.524 | -57.3 |
| 2.2 | 0.460 | -140.3 | 1.756 | 74.8 | 0.211 | 26.6 | 0.508 | -58.4 |
| 2.3 | 0.453 | -144.6 | 1.694 | 71.6 | 0.212 | 25.9 | 0.501 | -60.2 |
| 2.4 | 0.445 | -149.6 | 1.648 | 69.7 | 0.211 | 25.1 | 0.488 | -61.5 |
| 2.5 | 0.443 | -154.2 | 1.587 | 67.3 | 0.210 | 24.7 | 0.480 | -63.3 |
| 2.6 | 0.440 | -158.7 | 1.547 | 64.3 | 0.210 | 23.3 | 0.476 | -65.0 |
| 2.7 | 0.439 | -162.0 | 1.510 | 62.3 | 0.209 | 23.2 | 0.469 | -66.6 |
| 2.8 | 0.439 | -166.0 | 1.463 | 59.7 | 0.209 | 22.6 | 0.463 | -67.4 |
| 2.9 | 0.436 | -169.4 | 1.424 | 57.7 | 0.211 | 23.2 | 0.452 | -68.7 |
| 3.0 | 0.430 | -173.2 | 1.385 | 55.8 | 0.210 | 23.3 | 0.442 | -69.7 |
| 4.0 | 0.457 | 154.5 | 1.112 | 36.5 | 0.215 | 29.3 | 0.389 | -86.6 |
| 5.0 | 0.540 | 131.5 | 0.948 | 21.3 | 0.256 | 33.9 | 0.331 | -108.2 |

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

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.901 | -13.2 | 9.534 | 168.2 | 0.021 | 78.2 | 0.973 | -7.8 |
| 0.2 | 0.884 | -24.6 | 9.106 | 158.5 | 0.042 | 76.2 | 0.935 | -15.7 |
| 0.3 | 0.810 | -36.7 | 8.526 | 149.3 | 0.059 | 69.8 | 0.891 | -22.6 |
| 0.4 | 0.768 | -48.2 | 8.030 | 139.9 | 0.075 | 64.2 | 0.827 | -29.0 |
| 0.5 | 0.713 | -58.8 | 7.496 | 132.0 | 0.087 | 59.6 | 0.770 | -34.2 |
| 0.6 | 0.641 | -67.5 | 6.859 | 124.8 | 0.097 | 55.8 | 0.696 | -38.9 |
| 0.7 | 0.585 | -76.6 | 6.363 | 119.0 | 0.106 | 53.4 | 0.647 | -42.5 |
| 0.8 | 0.534 | -84.5 | 5.859 | 113.1 | 0.112 | 51.0 | 0.590 | -46.1 |
| 0.9 | 0.492 | -92.6 | 5.387 | 108.7 | 0.119 | 49.2 | 0.547 | -49.0 |
| 1.0 | 0.458 | -100.3 | 5.011 | 104.3 | 0.124 | 48.0 | 0.503 | -51.8 |
| 1.1 | 0.426 | -107.6 | 4.652 | 100.1 | 0.130 | 47.0 | 0.474 | -54.3 |
| 1.2 | 0.403 | -114.8 | 4.368 | 96.3 | 0.134 | 46.4 | 0.441 | -56.5 |
| 1.3 | 0.385 | -121.4 | 4.069 | 93.1 | 0.139 | 45.4 | 0.421 | -58.4 |
| 1.4 | 0.364 | -128.3 | 3.830 | 89.5 | 0.143 | 44.9 | 0.394 | -60.3 |
| 1.5 | 0.349 | -134.6 | 3.616 | 86.7 | 0.148 | 44.7 | 0.380 | -61.8 |
| 1.6 | 0.337 | -141.0 | 3.411 | 83.7 | 0.151 | 44.3 | 0.355 | -63.2 |
| 1.7 | 0.334 | -146.9 | 3.245 | 81.3 | 0.155 | 44.1 | 0.343 | -64.8 |
| 1.8 | 0.322 | -153.5 | 3.080 | 78.2 | 0.159 | 44.0 | 0.322 | -65.8 |
| 1.9 | 0.318 | -156.7 | 2.944 | 76.3 | 0.163 | 43.9 | 0.311 | -67.6 |
| 2.0 | 0.322 | -162.3 | 2.795 | 73.8 | 0.167 | 44.0 | 0.293 | -68.6 |
| 2.1 | 0.325 | -167.0 | 2.686 | 71.7 | 0.172 | 43.9 | 0.284 | -70.7 |
| 2.2 | 0.328 | -170.3 | 2.597 | 69.8 | 0.176 | 43.9 | 0.271 | -71.6 |
| 2.3 | 0.326 | -174.3 | 2.495 | 67.4 | 0.180 | 43.9 | 0.266 | -73.8 |
| 2.4 | 0.328 | -178.4 | 2.411 | 66.0 | 0.184 | 43.7 | 0.256 | -74.7 |
| 2.5 | 0.330 | 178.0 | 2.304 | 64.1 | 0.188 | 43.8 | 0.251 | -77.0 |
| 2.6 | 0.338 | 174.5 | 2.234 | 61.8 | 0.192 | 43.2 | 0.245 | -77.8 |
| 2.7 | 0.337 | 171.5 | 2.176 | 60.1 | 0.196 | 43.1 | 0.240 | -79.8 |
| 2.8 | 0.341 | 168.4 | 2.096 | 58.3 | 0.201 | 42.6 | 0.234 | -80.2 |
| 2.9 | 0.343 | 166.8 | 2.035 | 56.8 | 0.207 | 42.9 | 0.228 | -82.1 |
| 3.0 | 0.343 | 163.4 | 1.974 | 55.1 | 0.211 | 42.8 | 0.219 | -82.4 |
| 4.0 | 0.391 | 140.1 | 1.534 | 38.6 | 0.258 | 41.5 | 0.183 | -105.5 |
| 5.0 | 0.478 | 124.1 | 1.296 | 24.8 | 0.313 | 36.3 | 0.130 | -140.9 |

$V_{CE} = 2\text{ V}$, $I_c = 5\text{ mA}$, $Z_o = 50\ \Omega$

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.849 | -17.3 | 14.332 | 164.5 | 0.019 | 84.6 | 0.947 | -11.2 |
| 0.2 | 0.804 | -32.8 | 13.240 | 151.9 | 0.038 | 72.3 | 0.880 | -21.8 |
| 0.3 | 0.705 | -47.5 | 11.913 | 141.0 | 0.053 | 66.1 | 0.805 | -30.3 |
| 0.4 | 0.641 | -60.8 | 10.727 | 130.8 | 0.065 | 61.6 | 0.714 | -37.4 |
| 0.5 | 0.574 | -72.7 | 9.646 | 122.6 | 0.075 | 57.9 | 0.640 | -42.6 |
| 0.6 | 0.502 | -82.2 | 8.564 | 115.7 | 0.083 | 55.5 | 0.563 | -47.1 |
| 0.7 | 0.451 | -91.4 | 7.731 | 110.4 | 0.090 | 54.4 | 0.511 | -50.3 |
| 0.8 | 0.408 | -100.4 | 6.974 | 105.3 | 0.095 | 53.4 | 0.456 | -53.4 |
| 0.9 | 0.374 | -108.7 | 6.341 | 101.4 | 0.102 | 52.6 | 0.418 | -56.0 |
| 1.0 | 0.351 | -116.7 | 5.810 | 97.6 | 0.107 | 52.4 | 0.380 | -58.5 |
| 1.1 | 0.329 | -124.7 | 5.338 | 94.1 | 0.113 | 52.2 | 0.355 | -60.8 |
| 1.2 | 0.313 | -131.9 | 4.969 | 90.7 | 0.118 | 52.4 | 0.328 | -63.0 |
| 1.3 | 0.306 | -138.4 | 4.609 | 88.0 | 0.124 | 51.9 | 0.312 | -64.8 |
| 1.4 | 0.295 | -145.9 | 4.307 | 84.8 | 0.129 | 51.9 | 0.289 | -66.7 |
| 1.5 | 0.288 | -151.8 | 4.052 | 82.6 | 0.135 | 51.9 | 0.279 | -68.0 |
| 1.6 | 0.284 | -158.2 | 3.809 | 80.0 | 0.140 | 51.7 | 0.258 | -69.5 |
| 1.7 | 0.288 | -163.6 | 3.605 | 78.0 | 0.146 | 51.6 | 0.250 | -71.0 |
| 1.8 | 0.278 | -169.6 | 3.421 | 75.4 | 0.151 | 51.6 | 0.231 | -72.3 |
| 1.9 | 0.277 | -173.0 | 3.265 | 73.5 | 0.156 | 51.5 | 0.224 | -74.4 |
| 2.0 | 0.290 | -177.4 | 3.095 | 71.4 | 0.162 | 51.5 | 0.208 | -75.7 |
| 2.1 | 0.296 | 178.5 | 2.962 | 69.4 | 0.168 | 51.2 | 0.202 | -78.4 |
| 2.2 | 0.298 | 175.9 | 2.860 | 67.9 | 0.174 | 51.1 | 0.191 | -79.5 |
| 2.3 | 0.298 | 173.0 | 2.749 | 65.7 | 0.180 | 50.9 | 0.187 | -82.4 |
| 2.4 | 0.303 | 169.5 | 2.651 | 64.4 | 0.185 | 50.6 | 0.179 | -83.3 |
| 2.5 | 0.310 | 166.7 | 2.537 | 62.8 | 0.190 | 50.3 | 0.176 | -86.4 |
| 2.6 | 0.315 | 163.5 | 2.448 | 60.8 | 0.195 | 49.6 | 0.171 | -87.1 |
| 2.7 | 0.317 | 161.5 | 2.380 | 59.2 | 0.201 | 49.2 | 0.167 | -89.7 |
| 2.8 | 0.323 | 158.6 | 2.300 | 57.5 | 0.207 | 48.6 | 0.161 | -90.0 |
| 2.9 | 0.324 | 156.9 | 2.230 | 56.0 | 0.214 | 48.5 | 0.157 | -92.6 |
| 3.0 | 0.326 | 153.9 | 2.158 | 54.6 | 0.219 | 48.2 | 0.148 | -93.2 |
| 4.0 | 0.375 | 134.9 | 1.660 | 39.0 | 0.274 | 44.2 | 0.130 | -124.7 |
| 5.0 | 0.465 | 121.2 | 1.400 | 26.0 | 0.329 | 36.8 | 0.107 | -176.8 |

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

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.781 | -21.4 | 18.207 | 161.6 | 0.019 | 80.8 | 0.921 | -14.2 |
| 0.2 | 0.725 | -39.6 | 16.322 | 146.8 | 0.036 | 70.3 | 0.828 | -26.5 |
| 0.3 | 0.616 | -56.5 | 14.168 | 135.0 | 0.049 | 64.7 | 0.731 | -35.7 |
| 0.4 | 0.549 | -70.2 | 12.343 | 124.5 | 0.059 | 60.9 | 0.629 | -42.8 |
| 0.5 | 0.482 | -82.7 | 10.808 | 116.7 | 0.067 | 58.1 | 0.553 | -47.4 |
| 0.6 | 0.416 | -92.8 | 9.422 | 110.4 | 0.075 | 57.1 | 0.478 | -51.5 |
| 0.7 | 0.375 | -102.5 | 8.418 | 105.5 | 0.081 | 56.8 | 0.428 | -54.2 |
| 0.8 | 0.336 | -111.7 | 7.516 | 100.7 | 0.087 | 56.4 | 0.378 | -57.0 |
| 0.9 | 0.313 | -120.9 | 6.785 | 97.4 | 0.093 | 56.2 | 0.345 | -59.3 |
| 1.0 | 0.298 | -128.7 | 6.187 | 93.9 | 0.100 | 56.2 | 0.311 | -61.7 |
| 1.1 | 0.284 | -136.7 | 5.652 | 90.9 | 0.106 | 56.4 | 0.290 | -63.9 |
| 1.2 | 0.277 | -143.9 | 5.238 | 87.8 | 0.112 | 56.5 | 0.266 | -66.2 |
| 1.3 | 0.272 | -150.2 | 4.861 | 85.3 | 0.118 | 56.2 | 0.254 | -67.9 |
| 1.4 | 0.269 | -157.4 | 4.519 | 82.6 | 0.124 | 56.2 | 0.234 | -69.8 |
| 1.5 | 0.265 | -162.7 | 4.254 | 80.4 | 0.130 | 56.2 | 0.226 | -71.2 |
| 1.6 | 0.265 | -169.2 | 3.988 | 78.0 | 0.137 | 56.1 | 0.208 | -72.9 |
| 1.7 | 0.269 | -173.4 | 3.772 | 76.1 | 0.143 | 55.9 | 0.201 | -74.4 |
| 1.8 | 0.268 | -179.3 | 3.574 | 73.9 | 0.149 | 55.6 | 0.185 | -76.1 |
| 1.9 | 0.266 | 178.2 | 3.408 | 72.1 | 0.155 | 55.6 | 0.179 | -78.6 |
| 2.0 | 0.280 | 174.4 | 3.225 | 70.1 | 0.161 | 55.3 | 0.165 | -80.1 |
| 2.1 | 0.286 | 171.0 | 3.087 | 68.3 | 0.168 | 54.9 | 0.161 | -83.3 |
| 2.2 | 0.289 | 168.5 | 2.978 | 66.8 | 0.174 | 54.6 | 0.150 | -84.8 |
| 2.3 | 0.289 | 165.8 | 2.859 | 64.7 | 0.181 | 54.2 | 0.148 | -88.4 |
| 2.4 | 0.296 | 162.5 | 2.756 | 63.6 | 0.186 | 53.7 | 0.141 | -89.5 |
| 2.5 | 0.302 | 160.3 | 2.636 | 62.0 | 0.192 | 53.4 | 0.139 | -93.1 |
| 2.6 | 0.310 | 157.5 | 2.540 | 60.1 | 0.198 | 52.6 | 0.134 | -94.0 |
| 2.7 | 0.312 | 155.6 | 2.479 | 58.5 | 0.204 | 52.1 | 0.132 | -97.0 |
| 2.8 | 0.318 | 153.5 | 2.386 | 57.1 | 0.210 | 51.4 | 0.126 | -97.5 |
| 2.9 | 0.320 | 151.9 | 2.315 | 55.7 | 0.218 | 51.1 | 0.123 | -100.7 |
| 3.0 | 0.321 | 149.3 | 2.242 | 54.2 | 0.223 | 50.6 | 0.115 | -101.9 |
| 4.0 | 0.373 | 131.9 | 1.717 | 39.3 | 0.281 | 45.3 | 0.110 | -139.2 |
| 5.0 | 0.460 | 119.4 | 1.444 | 26.5 | 0.337 | 37.0 | 0.112 | 163.5 |

$V_{CE} = 2\text{ V}$, $I_C = 10\text{ mA}$, $Z_0 = 50\ \Omega$

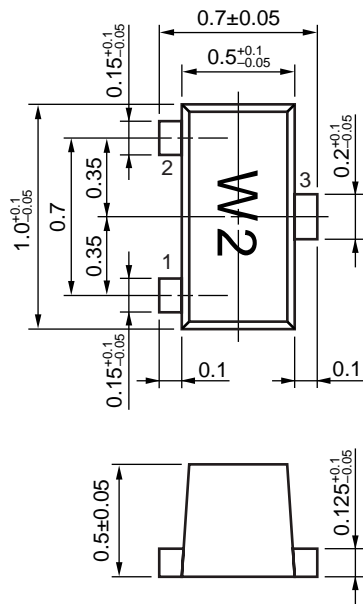
| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.712 | -25.5 | 22.714 | 158.0 | 0.017 | 74.0 | 0.884 | -17.4 |
| 0.2 | 0.638 | -47.2 | 19.532 | 141.0 | 0.033 | 68.1 | 0.764 | -31.5 |
| 0.3 | 0.520 | -66.1 | 16.216 | 128.9 | 0.044 | 63.9 | 0.648 | -40.9 |
| 0.4 | 0.453 | -80.7 | 13.709 | 118.8 | 0.053 | 61.1 | 0.542 | -47.6 |
| 0.5 | 0.396 | -93.9 | 11.746 | 111.3 | 0.061 | 60.0 | 0.467 | -51.6 |
| 0.6 | 0.342 | -104.5 | 10.099 | 105.6 | 0.068 | 59.6 | 0.397 | -55.1 |
| 0.7 | 0.311 | -115.2 | 8.920 | 101.3 | 0.074 | 60.1 | 0.353 | -57.3 |
| 0.8 | 0.283 | -124.6 | 7.918 | 97.0 | 0.081 | 60.1 | 0.310 | -59.9 |
| 0.9 | 0.271 | -133.7 | 7.104 | 93.9 | 0.088 | 60.2 | 0.281 | -62.0 |
| 1.0 | 0.262 | -141.7 | 6.456 | 91.0 | 0.094 | 60.3 | 0.252 | -64.5 |
| 1.1 | 0.254 | -149.2 | 5.882 | 88.0 | 0.101 | 60.5 | 0.236 | -66.6 |
| 1.2 | 0.252 | -156.2 | 5.437 | 85.4 | 0.108 | 60.6 | 0.215 | -69.1 |
| 1.3 | 0.251 | -162.3 | 5.029 | 83.2 | 0.115 | 60.3 | 0.206 | -70.9 |
| 1.4 | 0.253 | -168.4 | 4.674 | 80.5 | 0.121 | 60.2 | 0.189 | -73.2 |
| 1.5 | 0.254 | -173.1 | 4.383 | 78.7 | 0.128 | 60.1 | 0.183 | -74.4 |
| 1.6 | 0.255 | -179.5 | 4.118 | 76.3 | 0.135 | 59.7 | 0.167 | -76.7 |
| 1.7 | 0.263 | 177.3 | 3.890 | 74.7 | 0.142 | 59.3 | 0.162 | -78.4 |
| 1.8 | 0.263 | 171.9 | 3.682 | 72.5 | 0.149 | 59.1 | 0.147 | -80.6 |
| 1.9 | 0.261 | 169.8 | 3.513 | 70.9 | 0.155 | 58.8 | 0.144 | -83.4 |
| 2.0 | 0.275 | 166.4 | 3.318 | 69.0 | 0.162 | 58.4 | 0.130 | -85.6 |
| 2.1 | 0.284 | 164.4 | 3.178 | 67.3 | 0.169 | 57.8 | 0.128 | -89.6 |
| 2.2 | 0.287 | 161.7 | 3.063 | 65.9 | 0.176 | 57.5 | 0.119 | -91.7 |
| 2.3 | 0.288 | 159.8 | 2.942 | 63.8 | 0.182 | 56.9 | 0.118 | -95.8 |
| 2.4 | 0.296 | 157.0 | 2.834 | 62.8 | 0.188 | 56.3 | 0.112 | -97.4 |
| 2.5 | 0.303 | 154.9 | 2.710 | 61.4 | 0.195 | 55.8 | 0.112 | -101.9 |
| 2.6 | 0.312 | 152.5 | 2.614 | 59.4 | 0.201 | 54.9 | 0.107 | -103.1 |
| 2.7 | 0.312 | 151.0 | 2.540 | 58.1 | 0.207 | 54.3 | 0.106 | -106.9 |
| 2.8 | 0.318 | 148.7 | 2.451 | 56.5 | 0.214 | 53.4 | 0.100 | -107.4 |
| 2.9 | 0.320 | 147.6 | 2.378 | 55.2 | 0.221 | 53.0 | 0.100 | -111.6 |
| 3.0 | 0.324 | 145.3 | 2.302 | 53.9 | 0.227 | 52.4 | 0.091 | -113.6 |
| 4.0 | 0.372 | 129.6 | 1.759 | 39.4 | 0.287 | 46.2 | 0.102 | -154.4 |
| 5.0 | 0.459 | 118.0 | 1.475 | 27.0 | 0.342 | 37.3 | 0.127 | 150.6 |

$V_{CE} = 2\text{ V}$, $I_C = 20\text{ mA}$, $Z_0 = 50\ \Omega$

| Frequency (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.534 | -36.7 | 31.060 | 150.4 | 0.016 | 70.9 | 0.796 | -24.0 |
| 0.2 | 0.457 | -66.2 | 24.217 | 130.4 | 0.029 | 67.6 | 0.624 | -39.8 |
| 0.3 | 0.357 | -88.3 | 18.723 | 118.6 | 0.036 | 65.5 | 0.495 | -47.9 |
| 0.4 | 0.317 | -104.4 | 15.065 | 109.7 | 0.044 | 65.3 | 0.398 | -52.8 |
| 0.5 | 0.288 | -118.2 | 12.526 | 103.4 | 0.052 | 65.1 | 0.337 | -54.9 |
| 0.6 | 0.258 | -130.8 | 10.611 | 98.7 | 0.060 | 65.9 | 0.282 | -57.3 |
| 0.7 | 0.245 | -140.8 | 9.265 | 95.3 | 0.067 | 66.7 | 0.249 | -58.2 |
| 0.8 | 0.238 | -150.4 | 8.174 | 91.6 | 0.074 | 66.6 | 0.217 | -60.3 |
| 0.9 | 0.237 | -158.4 | 7.304 | 89.1 | 0.082 | 66.6 | 0.197 | -62.0 |
| 1.0 | 0.241 | -164.8 | 6.593 | 86.6 | 0.089 | 66.5 | 0.175 | -64.6 |
| 1.1 | 0.240 | -170.9 | 5.995 | 84.2 | 0.097 | 66.6 | 0.165 | -66.7 |
| 1.2 | 0.244 | -176.3 | 5.536 | 81.9 | 0.104 | 66.5 | 0.150 | -69.6 |
| 1.3 | 0.249 | -180.0 | 5.107 | 79.9 | 0.112 | 65.9 | 0.145 | -71.6 |
| 1.4 | 0.257 | 175.3 | 4.743 | 77.5 | 0.119 | 65.4 | 0.131 | -74.2 |
| 1.5 | 0.259 | 171.4 | 4.455 | 75.9 | 0.127 | 65.2 | 0.129 | -75.7 |
| 1.6 | 0.266 | 167.0 | 4.165 | 73.9 | 0.134 | 64.7 | 0.115 | -78.5 |
| 1.7 | 0.274 | 164.7 | 3.935 | 72.4 | 0.141 | 63.9 | 0.113 | -80.4 |
| 1.8 | 0.280 | 159.9 | 3.725 | 70.3 | 0.148 | 63.5 | 0.101 | -83.7 |
| 1.9 | 0.278 | 158.4 | 3.548 | 68.8 | 0.155 | 62.9 | 0.100 | -87.5 |
| 2.0 | 0.289 | 156.1 | 3.351 | 67.0 | 0.163 | 62.2 | 0.088 | -91.1 |
| 2.1 | 0.297 | 154.8 | 3.206 | 65.5 | 0.170 | 61.5 | 0.088 | -96.2 |
| 2.2 | 0.302 | 153.4 | 3.088 | 64.2 | 0.177 | 60.9 | 0.081 | -99.8 |
| 2.3 | 0.305 | 151.8 | 2.964 | 62.1 | 0.184 | 60.2 | 0.082 | -105.2 |
| 2.4 | 0.310 | 149.1 | 2.856 | 61.3 | 0.190 | 59.4 | 0.077 | -107.6 |
| 2.5 | 0.318 | 148.0 | 2.733 | 59.9 | 0.197 | 58.8 | 0.079 | -113.3 |
| 2.6 | 0.326 | 146.0 | 2.632 | 58.0 | 0.204 | 57.8 | 0.075 | -115.0 |
| 2.7 | 0.328 | 144.7 | 2.564 | 56.9 | 0.211 | 56.9 | 0.076 | -120.0 |
| 2.8 | 0.334 | 143.0 | 2.468 | 55.3 | 0.217 | 55.9 | 0.071 | -121.5 |
| 2.9 | 0.336 | 142.0 | 2.397 | 54.2 | 0.225 | 55.4 | 0.072 | -126.4 |
| 3.0 | 0.338 | 139.7 | 2.316 | 52.8 | 0.231 | 54.7 | 0.066 | -130.2 |
| 4.0 | 0.387 | 126.6 | 1.762 | 38.8 | 0.292 | 47.4 | 0.095 | -172.2 |
| 5.0 | 0.474 | 116.2 | 1.478 | 26.7 | 0.347 | 37.7 | 0.141 | 138.8 |

PACKAGE DIMENSIONS

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



(Bottom View)

PIN CONNECTIONS

- 1. Emitter
- 2. Base
- 3. Collector

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