DATA SHEET

NEC

# NPN SILICON RF TWIN TRANSISTOR

# μPA862TD

## NPN SILICON RF TRANSISTOR (WITH 2 DIFFERENT ELEMENTS) IN A 6-PIN LEAD-LESS MINIMOLD

### FEATURES

- Low voltage operation
- 2 different built-in transistors (2SC5435, 2SC5800)

  Q1: Built-in high gain transistor

  $f_T$ = 12.0 GHz TYP., $|S_{21e}|^2$ = 8.5 dB TYP. @ $V_{CE}$ = 3 V, $I_C$ = 10 mA, f = 2 GHz

  Q2: Built-in low phase distortion transistor suited for OSC operation

  $f_T$ = 4.5 GHz TYP., $|S_{21e}|^2$ = 4.0 dB TYP. @ $V_{CE}$ = 1 V, $I_C$ = 5 mA, f = 2 GHz
- 6-pin lead-less minimold package

### BUILT-IN TRANSISTORS

| | Q1 | Q2 |
|---|---|---|
| 3-pin thin-type ultra super minimold part No. | 2SC5435 | 2SC5800 |

### ORDERING INFORMATION

| Part Number | Quantity | Supplying Form |
|---|---|---|
| μPA862TD | 50 pcs (Non reel) | • 8 mm wide embossed taping |
| μPA862TD-T3 | 10 kpcs/reel | • Pin 1 (Q1 Collector), Pin 6 (Q1 Base) face the perforation side of the tape |

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

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



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## ABSOLUTE MAXIMUM RATINGS ($T_A$ = +25°C)

| Parameter | Symbol | Ratings | | Unit |
|---|---|---|---|---|
| | | Q1 | Q2 | |
| Collector to Base Voltage | $V_{CBO}$ | 9 | 9 | V |
| Collector to Emitter Voltage | $V_{CEO}$ | 6 | 5.5 | V |
| Emitter to Base Voltage | $V_{EBO}$ | 2 | 1.5 | V |
| Collector Current | $I_C$ | 30 | 100 | mA |
| Total Power Dissipation | $P_{tot}$ Note | 180 | 190 | mW |
| | | 210 in 2 elements | | |
| Junction Temperature | $T_j$ | 150 | | °C |
| Storage Temperature | $T_{stg}$ | −65 to +150 | | °C |

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

## ELECTRICAL CHARACTERISTICS ($T_A$ = +25°C)

### (1) Q1

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Collector Cut-off Current | $I_{CBO}$ | $V_{CB}$ = 5 V, $I_E$ = 0 mA | – | – | 100 | nA |
| Emitter Cut-off Current | $I_{EBO}$ | $V_{BE}$ = 1 V, $I_C$ = 0 mA | – | – | 100 | nA |
| DC Current Gain | $h_{FE}$ Note 1 | $V_{CE}$ = 3 V, $I_C$ = 10 mA | 75 | 110 | 150 | – |
| Gain Bandwidth Product | $f_T$ | $V_{CE}$ = 3 V, $I_C$ = 10 mA, f = 2 GHz | 10.0 | 12.0 | – | GHz |
| Insertion Power Gain | $\|S_{21e}\|^2$ | $V_{CE}$ = 3 V, $I_C$ = 10 mA, f = 2 GHz | 7.0 | 8.5 | – | dB |
| Noise Figure | NF | $V_{CE}$ = 3 V, $I_C$ = 3 mA, f = 2 GHz, $Z_S = Z_{opt}$ | – | 1.5 | 2.5 | dB |
| Reverse Transfer Capacitance | $C_{re}$ Note 2 | $V_{CB}$ = 3 V, $I_E$ = 0 mA, f = 1 MHz | – | 0.4 | 0.7 | pF |

### (2) Q2

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Collector Cut-off Current | $I_{CBO}$ | $V_{CB}$ = 5 V, $I_E$ = 0 mA | – | – | 600 | nA |
| Emitter Cut-off Current | $I_{EBO}$ | $V_{BE}$ = 1 V, $I_C$ = 0 mA | – | – | 600 | nA |
| DC Current Gain | $h_{FE}$ Note 1 | $V_{CE}$ = 1 V, $I_C$ = 5 mA | 100 | 120 | 145 | – |
| Gain Bandwidth Product (1) | $f_T$ | $V_{CE}$ = 1 V, $I_C$ = 5 mA, f = 2 GHz | 3.0 | 4.5 | – | GHz |
| Gain Bandwidth Product (2) | $f_T$ | $V_{CE}$ = 1 V, $I_C$ = 15 mA, f = 2 GHz | 5.0 | 6.5 | – | GHz |
| Insertion Power Gain (1) | $\|S_{21e}\|^2$ | $V_{CE}$ = 1 V, $I_C$ = 5 mA, f = 2 GHz | 3.0 | 4.0 | – | dB |
| Insertion Power Gain (2) | $\|S_{21e}\|^2$ | $V_{CE}$ = 1 V, $I_C$ = 15 mA, f = 2 GHz | 4.5 | 5.5 | – | dB |
| Noise Figure | NF | $V_{CE}$ = 1 V, $I_C$ = 10 mA, f = 2 GHz, $Z_S = Z_{opt}$ | – | 1.9 | 2.5 | dB |
| Reverse Transfer Capacitance | $C_{re}$ Note 2 | $V_{CB}$ = 0.5 V, $I_E$ = 0 mA, f = 1 MHz | – | 0.6 | 0.8 | pF |

**Notes 1.** Pulse measurement: PW ≤ 350 μs, Duty Cycle ≤ 2%

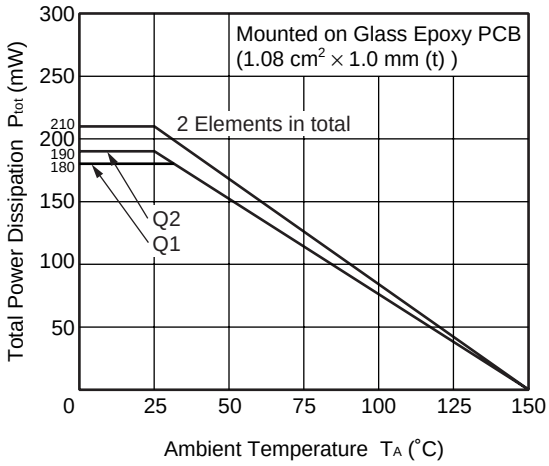
**2.** Collector to base capacitance when the emitter grounded

## $h_{FE}$ CLASSIFICATION

| Rank | FB |
|---|---|
| Marking | vY |
| $h_{FE}$ Value of Q1 | 75 to 150 |
| $h_{FE}$ Value of Q2 | 100 to 145 |

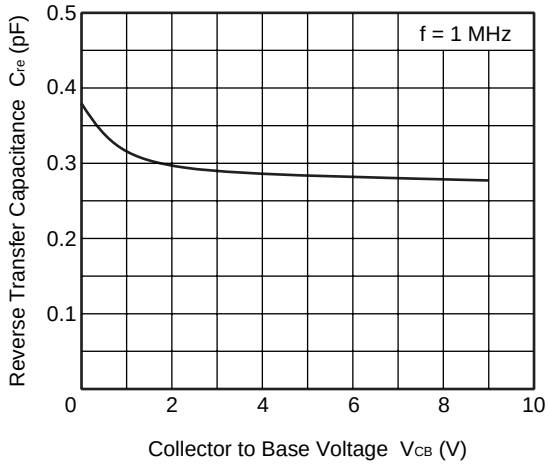
**TYPICAL CHARACTERISTICS (Unless otherwise specified, $T_A$ = +25°C)**

TOTAL POWER DISSIPATION
vs. AMBIENT TEMPERATURE



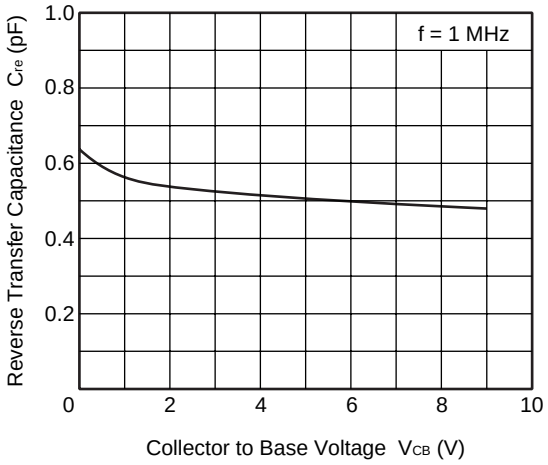

**Q1**

REVERSE TRANSFER CAPACITANCE
vs. COLLECTOR TO BASE VOLTAGE



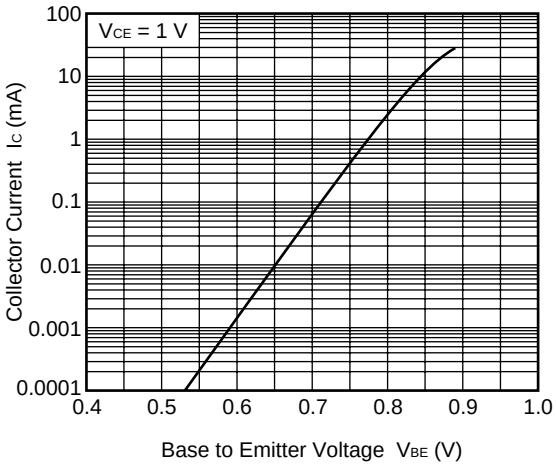

**Q2**

REVERSE TRANSFER CAPACITANCE
vs. COLLECTOR TO BASE VOLTAGE



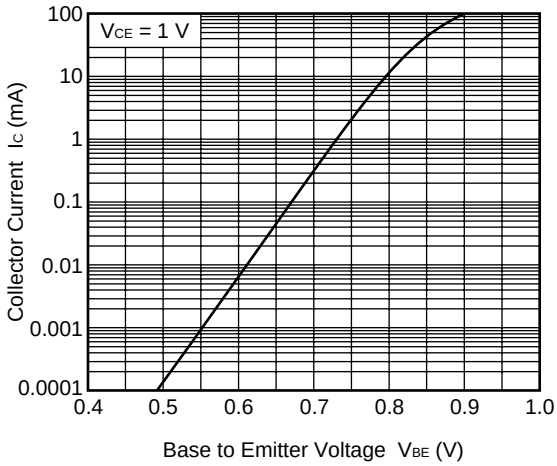
**Q1**

COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE

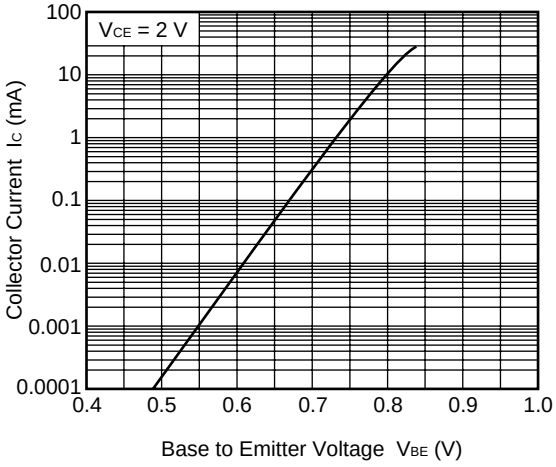



**Q2**

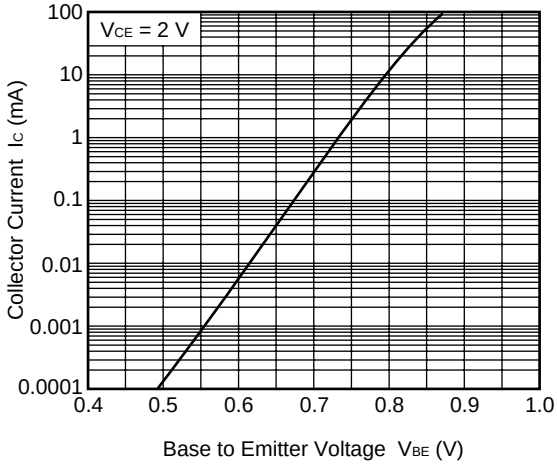
COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE



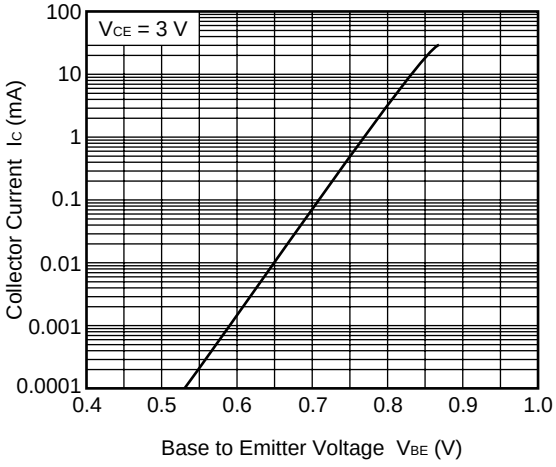

COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE




COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE

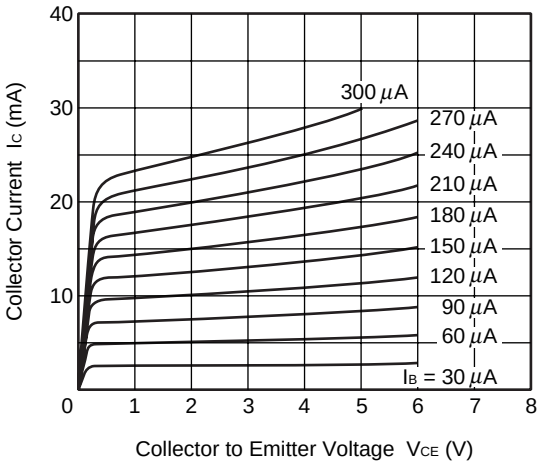



COLLECTOR CURRENT vs.
BASE TO EMITTER VOLTAGE



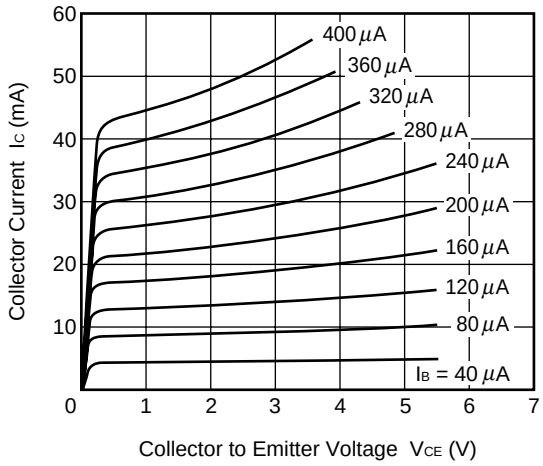
**Q1**

COLLECTOR CURRENT vs.
COLLECTOR TO EMITTER VOLTAGE



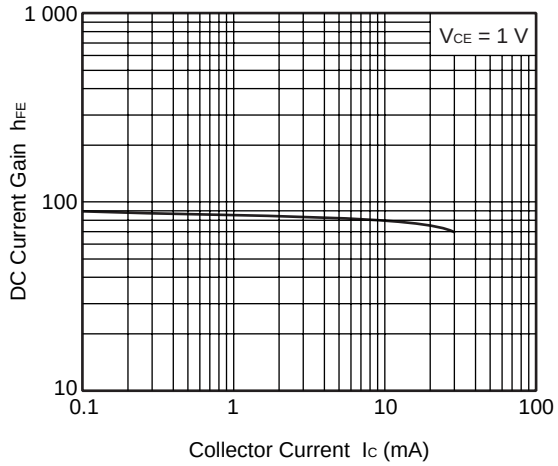

**Q2**

COLLECTOR CURRENT vs.
COLLECTOR TO EMITTER VOLTAGE



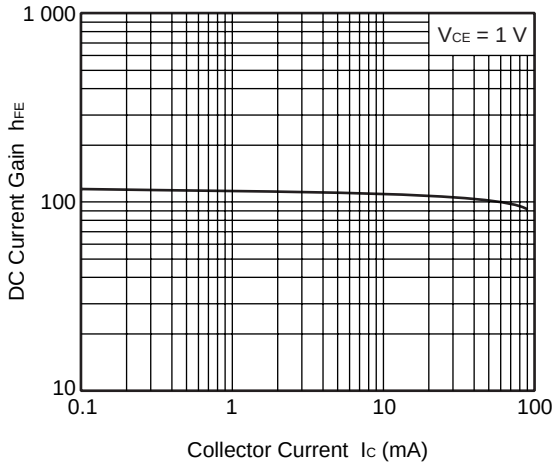
**Q1**

DC CURRENT GAIN vs.
COLLECTOR CURRENT

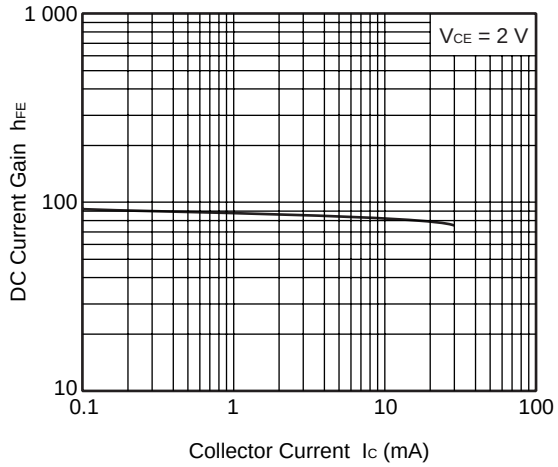



**Q2**

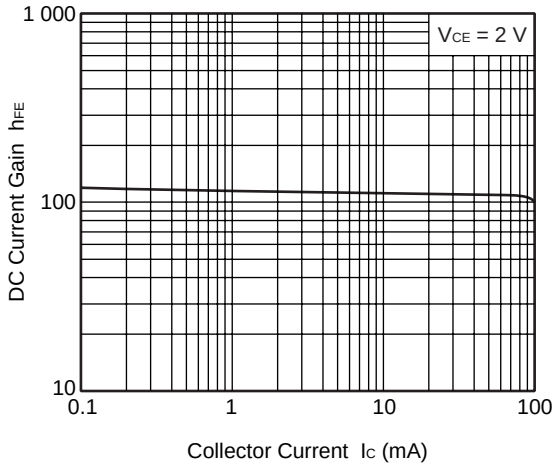
DC CURRENT GAIN vs.
COLLECTOR CURRENT



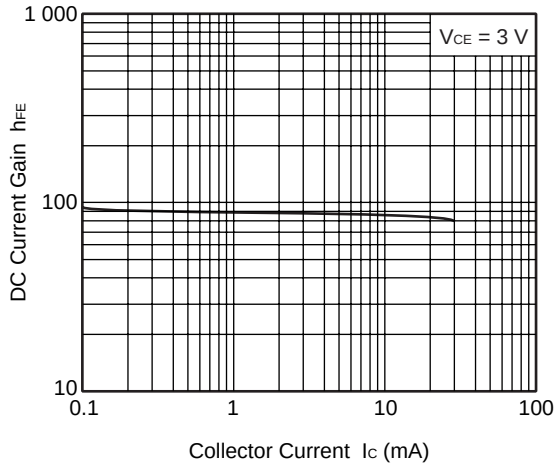

DC CURRENT GAIN vs.
COLLECTOR CURRENT




DC CURRENT GAIN vs.
COLLECTOR CURRENT

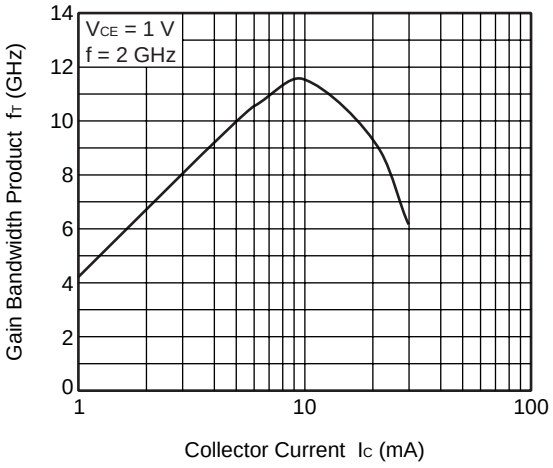



DC CURRENT GAIN vs.
COLLECTOR CURRENT



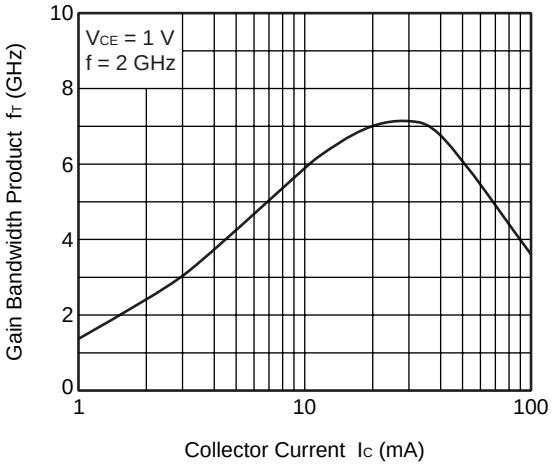
**Q1**

GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT

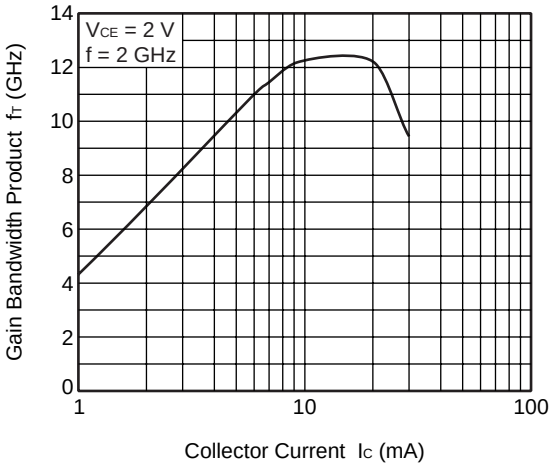



**Q2**

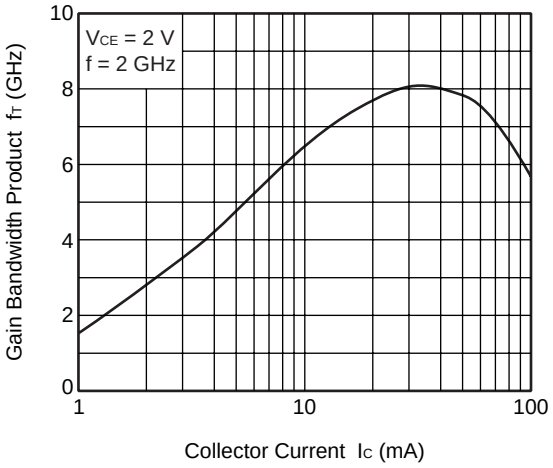
GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



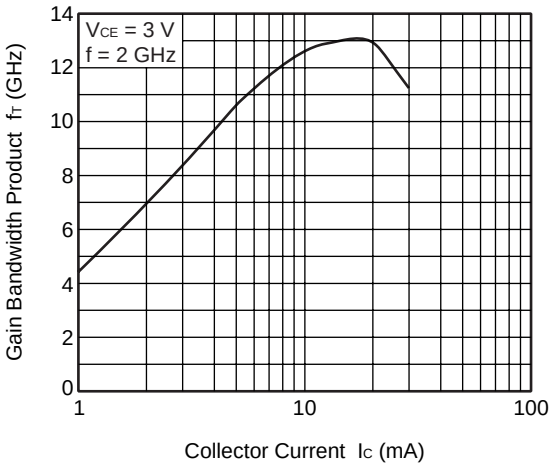

GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT




GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT

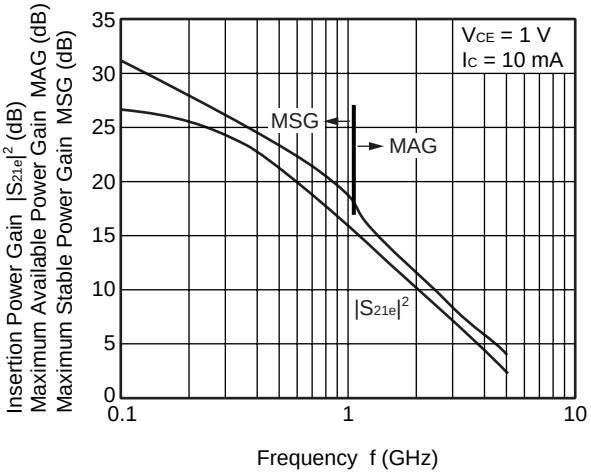



GAIN BANDWIDTH PRODUCT
vs. COLLECTOR CURRENT



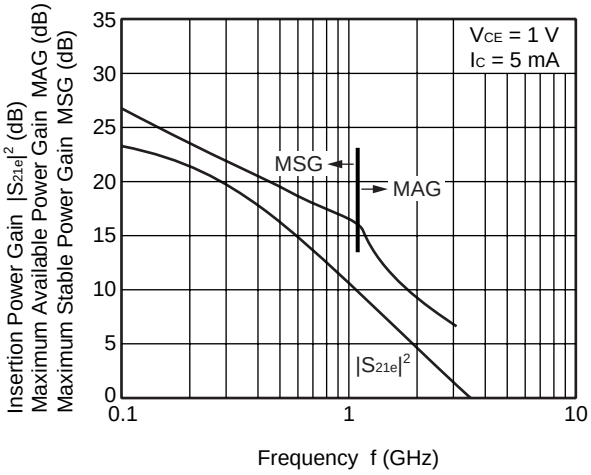
**Q1**

INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY

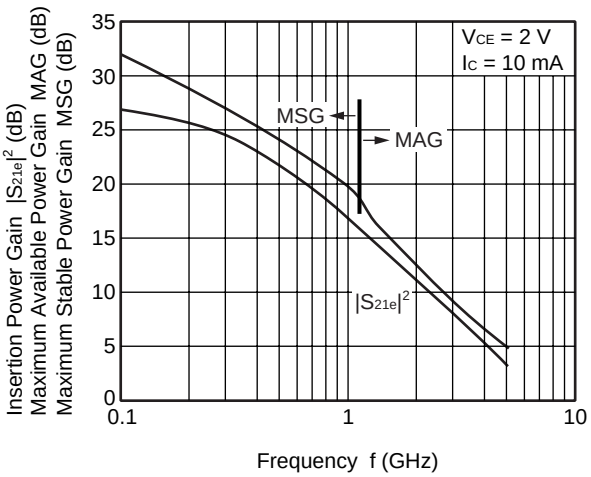



**Q2**

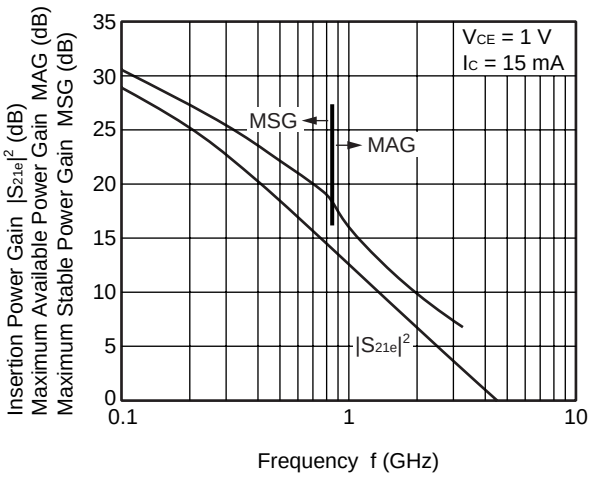
INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY



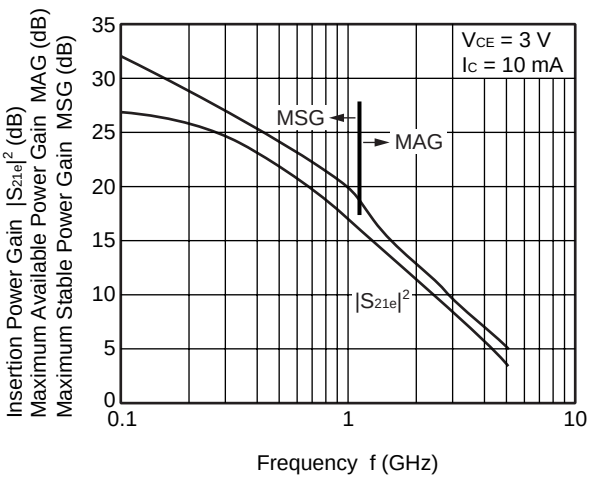

INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY




INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY




INSERTION POWER GAIN, MAG, MSG vs. FREQUENCY

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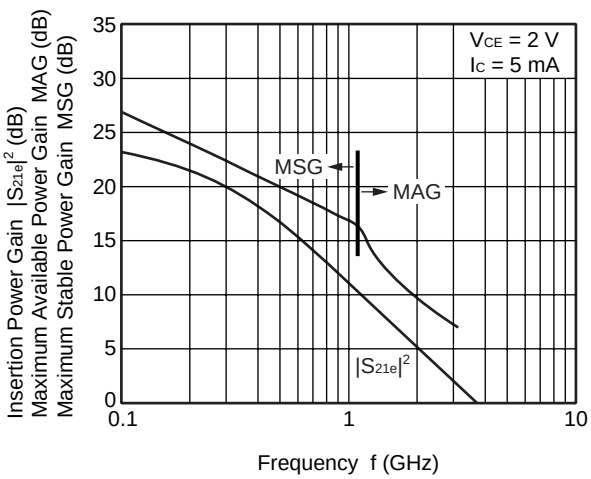
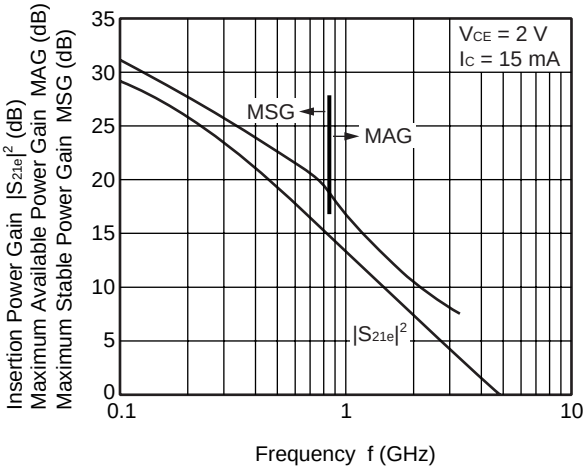


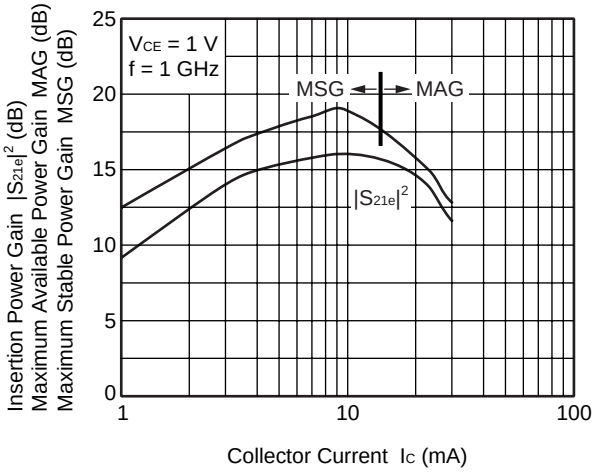
**Q2**

INSERTION POWER GAIN,
MAG, MSG vs. FREQUENCY



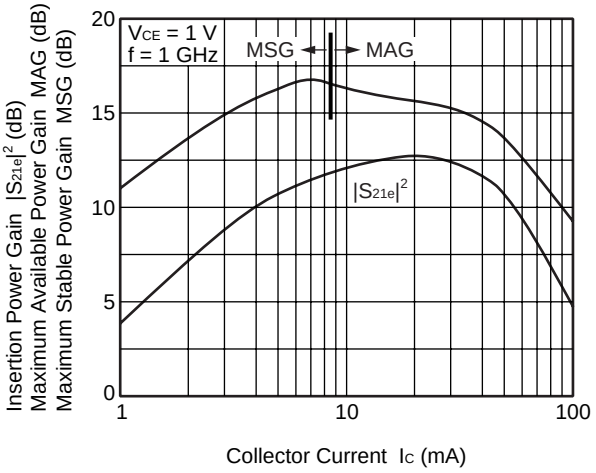
**Q1**

INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

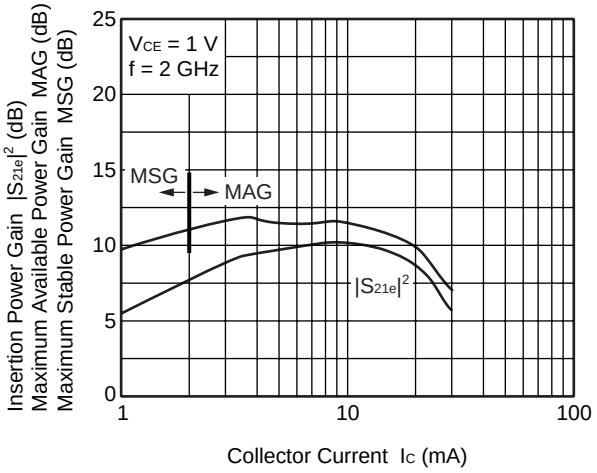



**Q2**

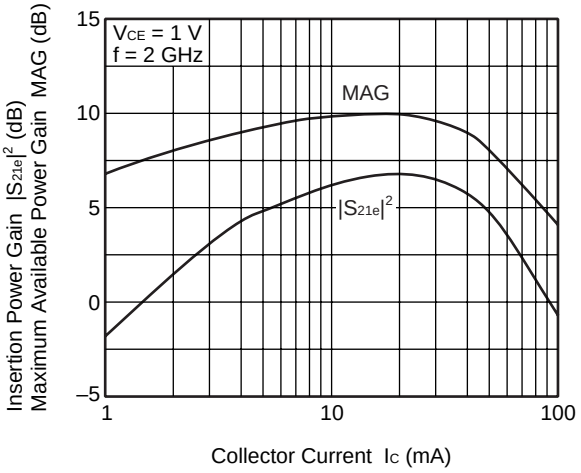
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



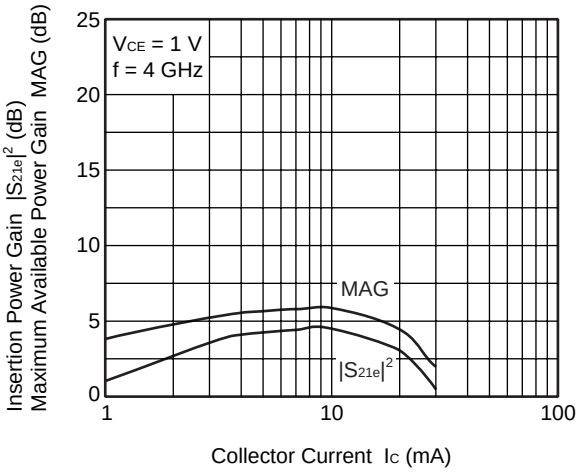

INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



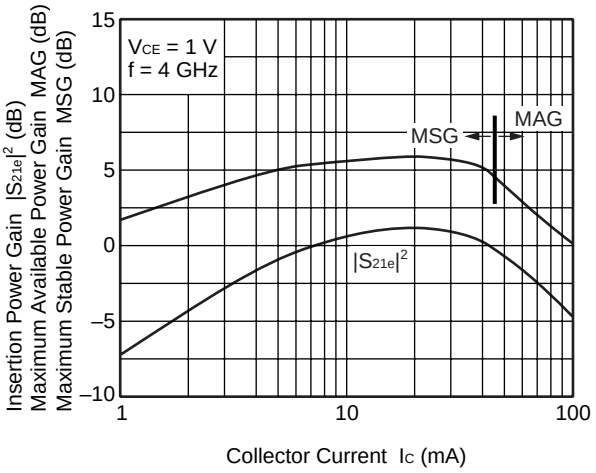

INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT




INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT

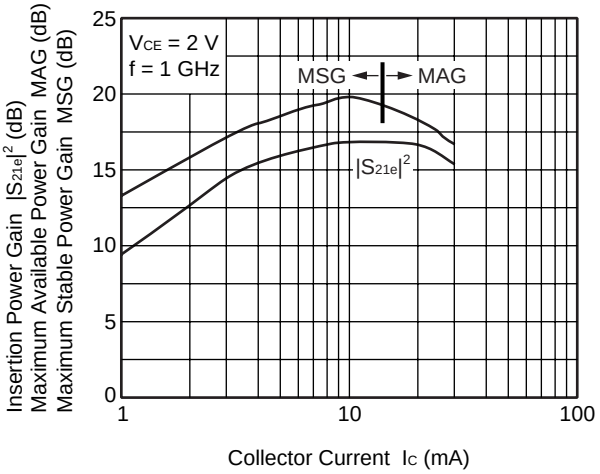



INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



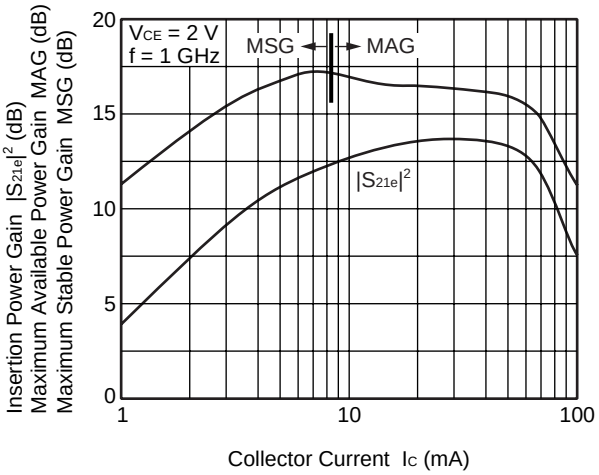
**Q1**

INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

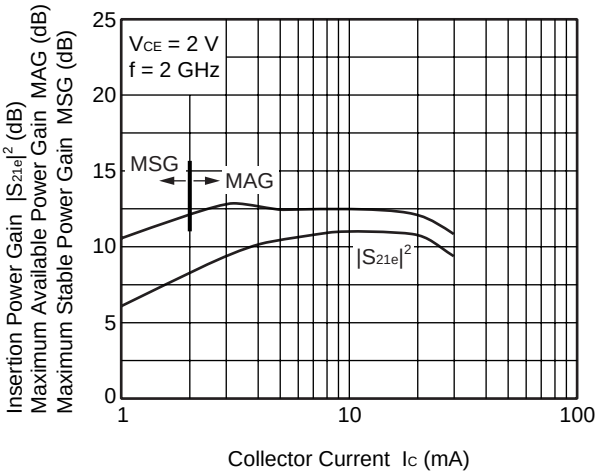



**Q2**

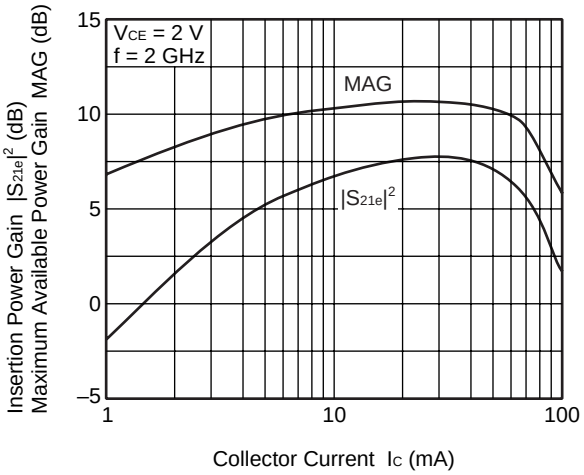
INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



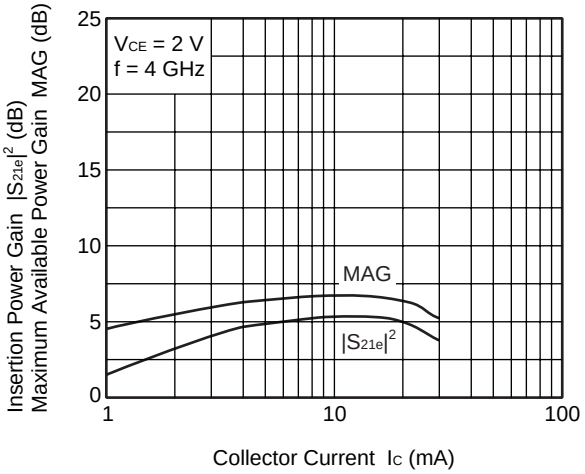

INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT



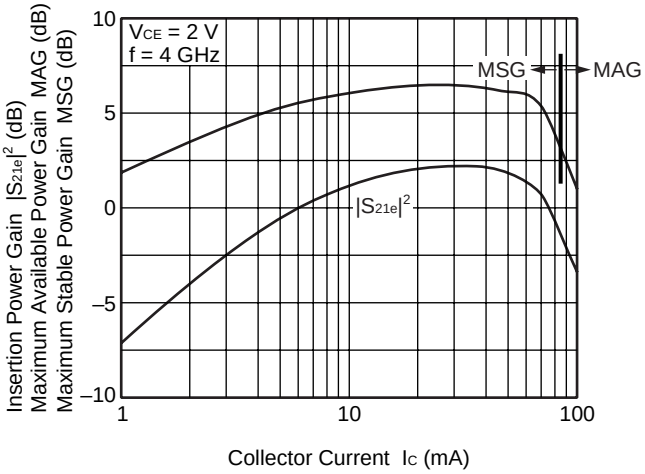

INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT




INSERTION POWER GAIN, MAG vs. COLLECTOR CURRENT

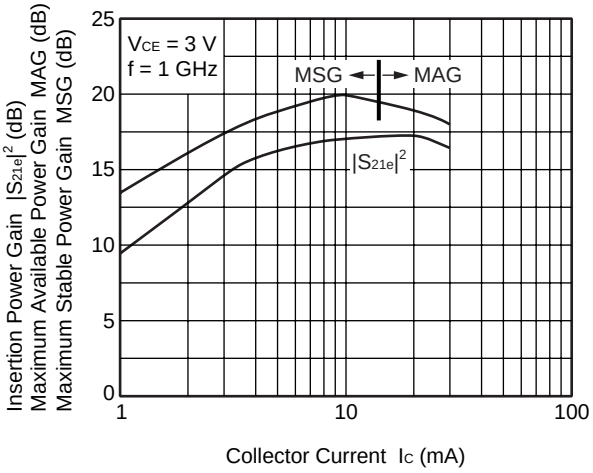



INSERTION POWER GAIN, MAG, MSG vs. COLLECTOR CURRENT

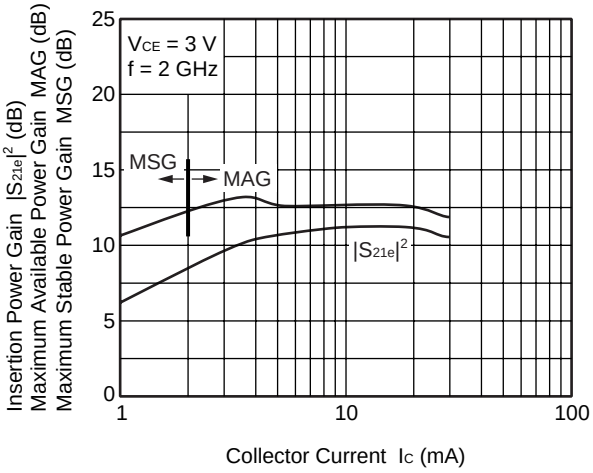


**Q1**

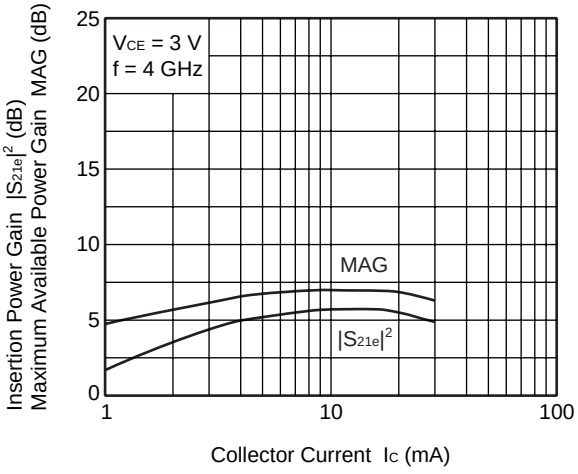
INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT




INSERTION POWER GAIN, MAG, MSG
vs. COLLECTOR CURRENT

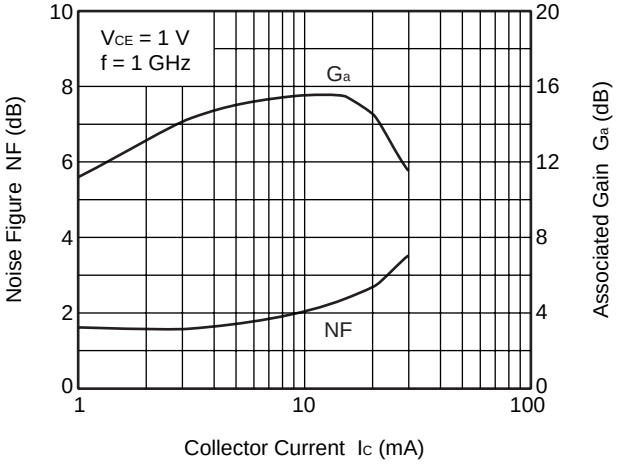



INSERTION POWER GAIN, MAG
vs. COLLECTOR CURRENT



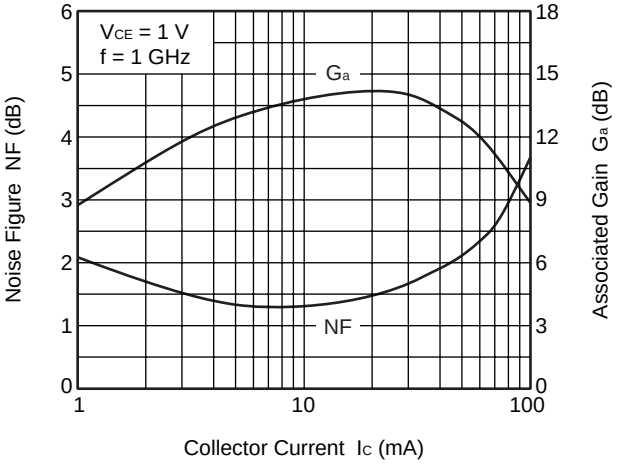
**Q1**

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT

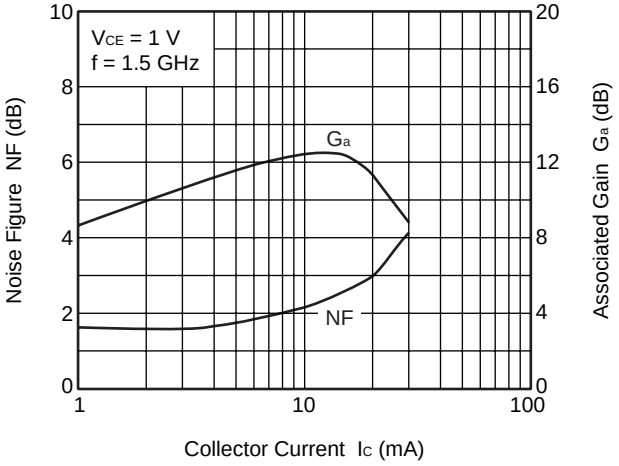



**Q2**

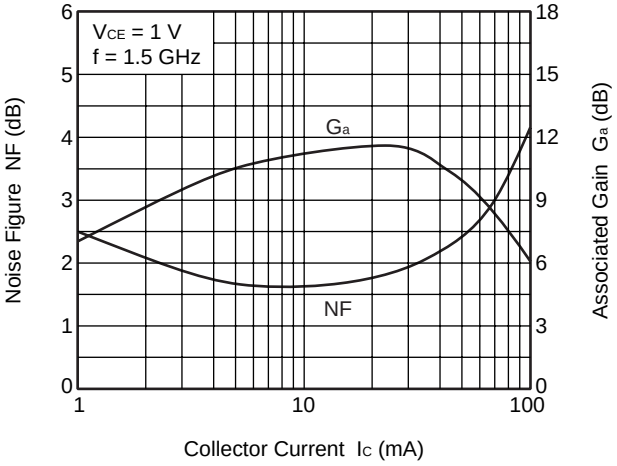
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



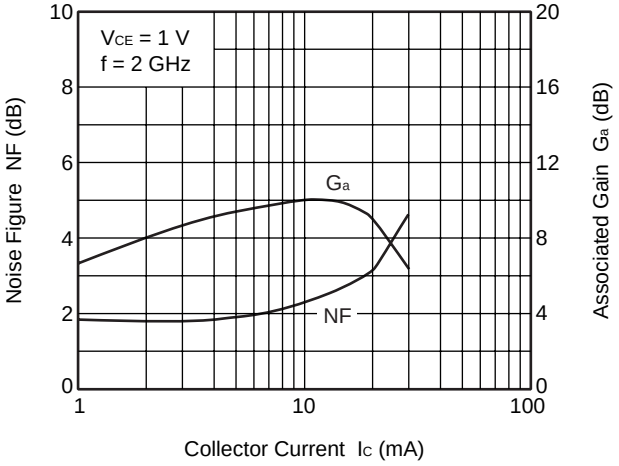

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



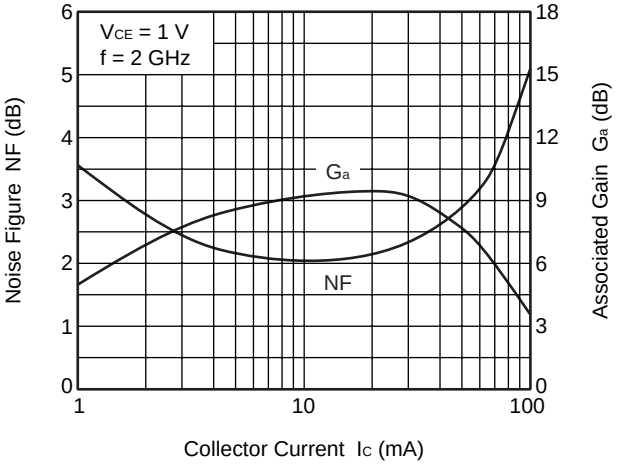

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT




NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT

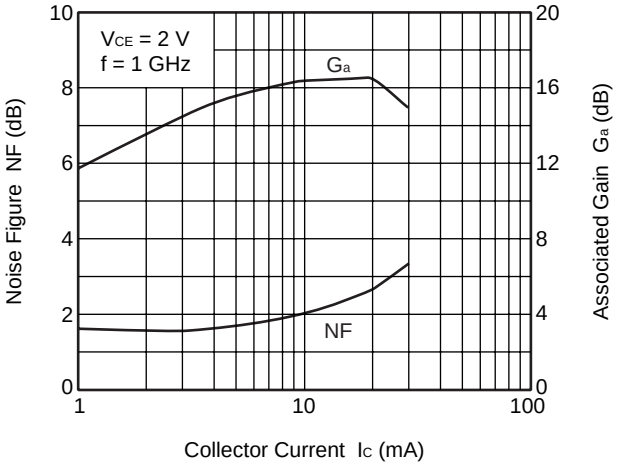



NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



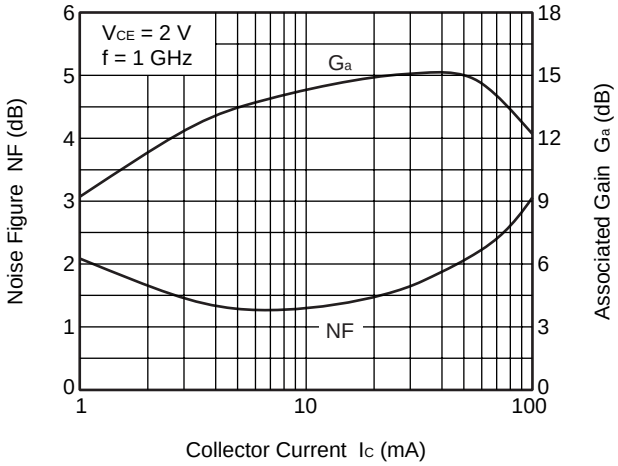
**Q1**

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT

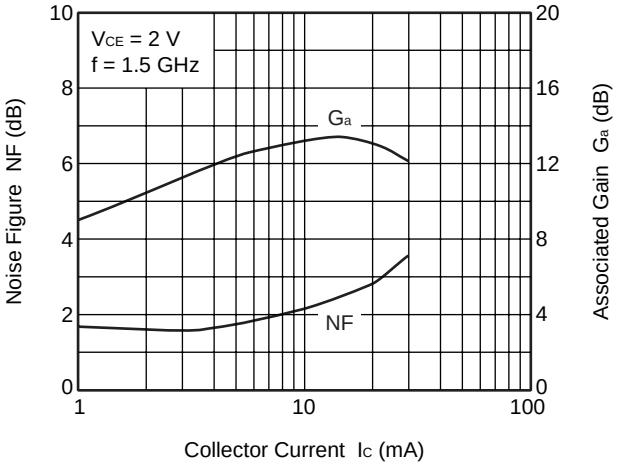



**Q2**

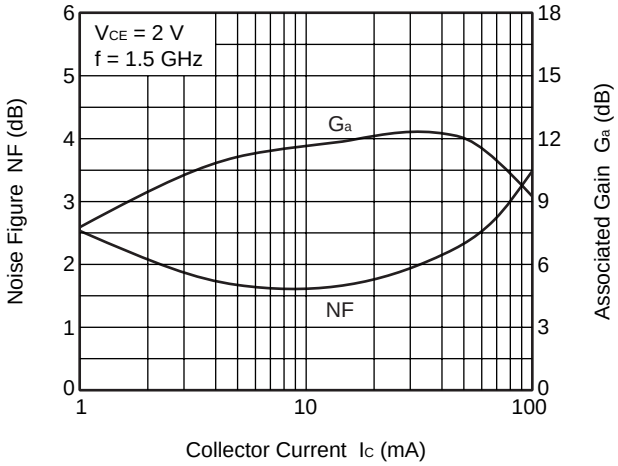
NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



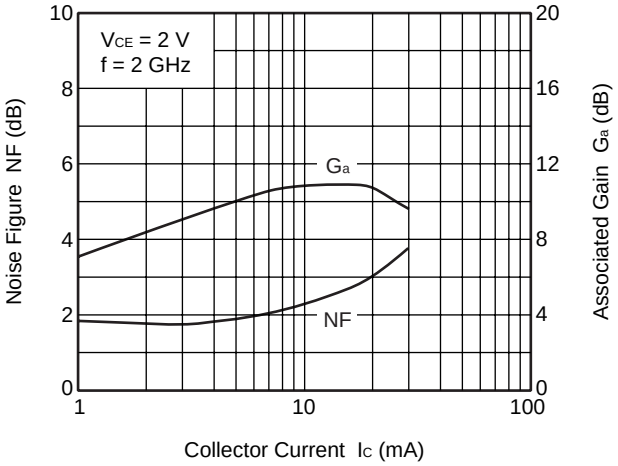

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT



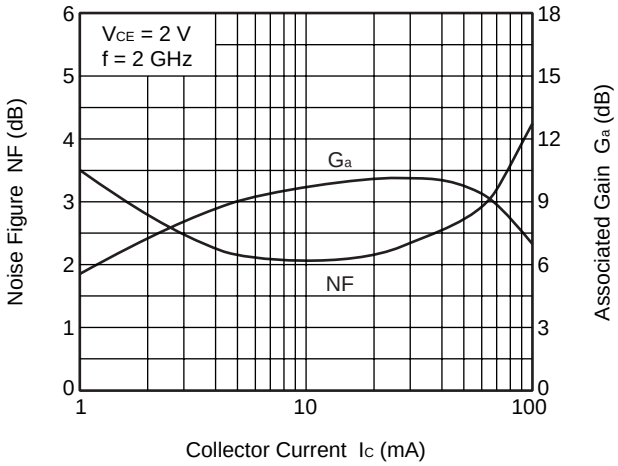

NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT




NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT

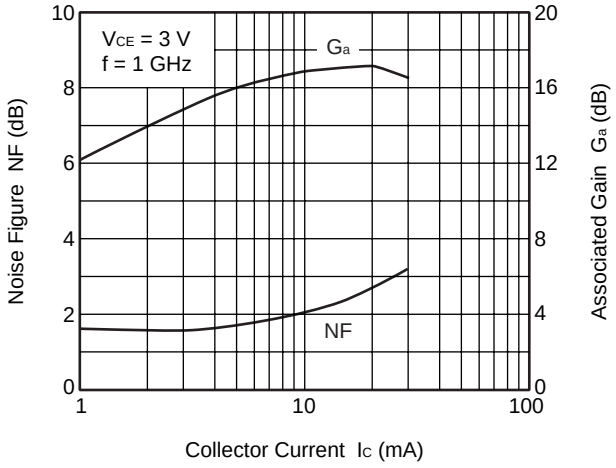



NOISE FIGURE, ASSOCIATED GAIN vs. COLLECTOR CURRENT

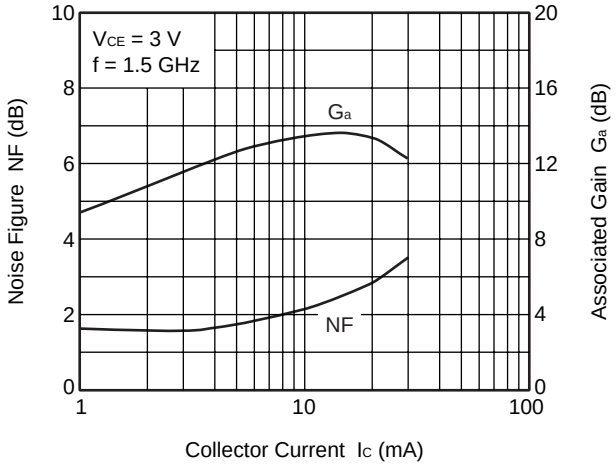


**Q1**

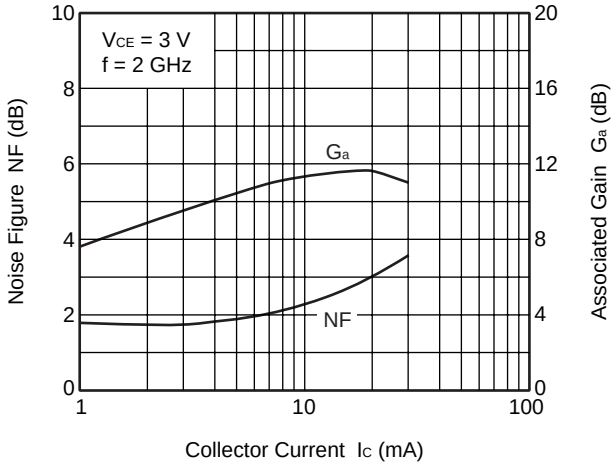
NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT




NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT




NOISE FIGURE, ASSOCIATED GAIN
vs. COLLECTOR CURRENT




**Remark** The graphs indicate nominal characteristics.

## S-PARAMETERS Q1

$V_{CE}$ = 1 V, $I_C$ = 1 mA, $Z_O$ = 50 Ω

| Frequency | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| (GHz) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.952 | –7.1 | 3.547 | 172.9 | 0.020 | 86.6 | 0.992 | –3.7 |
| 0.2 | 0.943 | –14.4 | 3.539 | 167.2 | 0.040 | 80.9 | 0.989 | –7.3 |
| 0.3 | 0.931 | –21.5 | 3.494 | 161.1 | 0.060 | 76.6 | 0.971 | –10.6 |
| 0.4 | 0.905 | –28.3 | 3.407 | 154.8 | 0.079 | 72.0 | 0.951 | –14.3 |
| 0.5 | 0.880 | –35.8 | 3.352 | 148.4 | 0.096 | 67.8 | 0.929 | –17.9 |
| 0.6 | 0.845 | –43.0 | 3.274 | 142.1 | 0.112 | 63.4 | 0.900 | –21.6 |
| 0.7 | 0.809 | –50.3 | 3.172 | 136.6 | 0.127 | 59.1 | 0.870 | –25.0 |
| 0.8 | 0.770 | –57.2 | 3.067 | 130.7 | 0.140 | 55.3 | 0.837 | –28.4 |
| 0.9 | 0.731 | –64.5 | 2.965 | 125.0 | 0.152 | 51.5 | 0.807 | –31.9 |
| 1.0 | 0.692 | –71.4 | 2.864 | 119.5 | 0.161 | 48.1 | 0.775 | –34.9 |
| 1.1 | 0.658 | –78.5 | 2.756 | 114.6 | 0.169 | 44.8 | 0.746 | –37.8 |
| 1.2 | 0.626 | –85.5 | 2.640 | 110.0 | 0.177 | 42.1 | 0.717 | –40.4 |
| 1.3 | 0.596 | –92.3 | 2.536 | 105.5 | 0.182 | 39.4 | 0.693 | –42.8 |
| 1.4 | 0.571 | –98.7 | 2.420 | 101.1 | 0.186 | 36.9 | 0.669 | –45.3 |
| 1.5 | 0.549 | –104.8 | 2.325 | 96.9 | 0.190 | 34.8 | 0.648 | –47.3 |
| 1.6 | 0.530 | –110.8 | 2.237 | 93.2 | 0.193 | 32.8 | 0.628 | –49.2 |
| 1.7 | 0.513 | –116.9 | 2.141 | 89.7 | 0.195 | 31.1 | 0.609 | –50.9 |
| 1.8 | 0.498 | –122.2 | 2.059 | 86.1 | 0.196 | 29.5 | 0.592 | –52.3 |
| 1.9 | 0.487 | –127.6 | 1.976 | 83.4 | 0.197 | 28.2 | 0.577 | –53.6 |
| 2.0 | 0.472 | –132.0 | 1.907 | 80.2 | 0.198 | 27.0 | 0.562 | –54.7 |
| 2.1 | 0.468 | –137.5 | 1.844 | 77.5 | 0.198 | 26.1 | 0.552 | –56.3 |
| 2.2 | 0.456 | –141.5 | 1.769 | 74.8 | 0.198 | 25.3 | 0.538 | –57.2 |
| 2.3 | 0.455 | –147.0 | 1.721 | 72.3 | 0.199 | 24.5 | 0.533 | –58.3 |
| 2.4 | 0.447 | –150.7 | 1.663 | 69.8 | 0.200 | 23.9 | 0.518 | –59.2 |
| 2.5 | 0.445 | –155.3 | 1.611 | 67.5 | 0.200 | 23.5 | 0.512 | –60.4 |
| 2.6 | 0.437 | –158.8 | 1.570 | 65.5 | 0.200 | 22.7 | 0.505 | –62.0 |
| 2.7 | 0.437 | –162.3 | 1.517 | 63.2 | 0.200 | 22.3 | 0.499 | –62.7 |
| 2.8 | 0.433 | –166.1 | 1.469 | 61.3 | 0.199 | 22.1 | 0.491 | –64.2 |
| 2.9 | 0.426 | –169.4 | 1.409 | 58.1 | 0.200 | 21.3 | 0.472 | –65.2 |
| 3.0 | 0.419 | –173.8 | 1.381 | 55.7 | 0.200 | 21.3 | 0.465 | –68.0 |
| 4.0 | 0.436 | 149.3 | 1.136 | 34.9 | 0.208 | 23.7 | 0.424 | –88.2 |
| 5.0 | 0.503 | 118.2 | 0.905 | 16.8 | 0.232 | 24.5 | 0.397 | –112.6 |

$V_{CE}$ = 1 V, $I_C$ = 3 mA, $Z_O$ = 50 Ω

| Frequency | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| (GHz) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.853 | –13.4 | 9.491 | 169.0 | 0.019 | 83.5 | 0.980 | –7.6 |
| 0.2 | 0.839 | –25.7 | 9.175 | 158.6 | 0.038 | 75.3 | 0.952 | –14.8 |
| 0.3 | 0.791 | –37.4 | 8.690 | 149.4 | 0.054 | 69.5 | 0.897 | –21.0 |
| 0.4 | 0.735 | –48.4 | 8.100 | 140.7 | 0.068 | 64.1 | 0.841 | –27.0 |
| 0.5 | 0.673 | –59.7 | 7.538 | 132.5 | 0.080 | 59.6 | 0.778 | –32.1 |
| 0.6 | 0.617 | –69.9 | 6.973 | 125.3 | 0.089 | 55.5 | 0.717 | –36.6 |
| 0.7 | 0.565 | –79.4 | 6.435 | 119.2 | 0.097 | 52.3 | 0.660 | –40.3 |
| 0.8 | 0.516 | –88.6 | 5.919 | 113.5 | 0.103 | 49.9 | 0.608 | –43.7 |
| 0.9 | 0.475 | –97.9 | 5.470 | 108.4 | 0.109 | 47.9 | 0.564 | –46.8 |
| 1.0 | 0.440 | –106.4 | 5.081 | 103.7 | 0.113 | 46.2 | 0.525 | –49.7 |
| 1.1 | 0.417 | –114.8 | 4.728 | 99.6 | 0.118 | 44.9 | 0.493 | –52.1 |
| 1.2 | 0.397 | –122.6 | 4.398 | 95.9 | 0.122 | 44.2 | 0.463 | –54.3 |
| 1.3 | 0.384 | –130.3 | 4.113 | 92.2 | 0.125 | 43.4 | 0.441 | –56.2 |
| 1.4 | 0.371 | –137.5 | 3.859 | 89.0 | 0.129 | 42.8 | 0.421 | –58.2 |
| 1.5 | 0.364 | –143.4 | 3.637 | 85.8 | 0.132 | 42.3 | 0.404 | –59.7 |
| 1.6 | 0.357 | –149.6 | 3.441 | 83.0 | 0.135 | 42.1 | 0.389 | –61.0 |
| 1.7 | 0.355 | –155.0 | 3.252 | 80.4 | 0.138 | 41.9 | 0.375 | –62.3 |
| 1.8 | 0.352 | –159.9 | 3.090 | 77.7 | 0.141 | 41.8 | 0.362 | –63.2 |
| 1.9 | 0.352 | –164.5 | 2.940 | 75.6 | 0.145 | 41.9 | 0.353 | –64.2 |
| 2.0 | 0.345 | –168.5 | 2.810 | 73.2 | 0.148 | 41.7 | 0.340 | –64.8 |
| 2.1 | 0.355 | –172.8 | 2.697 | 71.1 | 0.151 | 41.8 | 0.334 | –66.0 |
| 2.2 | 0.349 | –176.2 | 2.578 | 69.3 | 0.154 | 41.9 | 0.321 | –66.3 |
| 2.3 | 0.360 | 179.9 | 2.488 | 67.3 | 0.158 | 41.9 | 0.317 | –67.1 |
| 2.4 | 0.357 | 177.4 | 2.396 | 65.4 | 0.162 | 41.9 | 0.304 | –68.2 |
| 2.5 | 0.362 | 174.0 | 2.305 | 63.6 | 0.166 | 42.0 | 0.300 | –69.1 |
| 2.6 | 0.359 | 171.4 | 2.235 | 62.4 | 0.169 | 42.0 | 0.294 | –70.9 |
| 2.7 | 0.367 | 169.1 | 2.155 | 60.6 | 0.173 | 42.0 | 0.287 | –70.9 |
| 2.8 | 0.366 | 165.8 | 2.079 | 59.2 | 0.177 | 41.8 | 0.282 | –73.1 |
| 2.9 | 0.359 | 164.2 | 1.983 | 56.7 | 0.181 | 41.2 | 0.267 | –74.4 |
| 3.0 | 0.358 | 159.3 | 1.937 | 54.8 | 0.185 | 41.3 | 0.267 | –77.6 |
| 4.0 | 0.403 | 131.3 | 1.524 | 36.4 | 0.230 | 39.4 | 0.251 | –102.6 |
| 5.0 | 0.486 | 107.7 | 1.201 | 21.1 | 0.275 | 32.1 | 0.242 | –133.9 |

$V_{CE}$ = 1 V, $I_C$ = 5 mA, $Z_O$ = 50 Ω

| Frequency | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| (GHz) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.783 | –18.8 | 14.076 | 165.6 | 0.018 | 80.3 | 0.964 | –10.8 |
| 0.2 | 0.747 | –34.7 | 13.183 | 152.2 | 0.036 | 72.3 | 0.907 | –20.3 |
| 0.3 | 0.673 | –49.8 | 12.003 | 141.1 | 0.049 | 65.6 | 0.823 | –27.8 |
| 0.4 | 0.607 | –62.9 | 10.741 | 131.5 | 0.060 | 61.0 | 0.742 | –34.4 |
| 0.5 | 0.537 | –76.1 | 9.603 | 123.1 | 0.068 | 57.1 | 0.663 | –39.4 |
| 0.6 | 0.481 | –87.4 | 8.612 | 116.2 | 0.075 | 54.3 | 0.594 | –43.5 |
| 0.7 | 0.437 | –98.0 | 7.754 | 110.7 | 0.081 | 52.7 | 0.535 | –46.7 |
| 0.8 | 0.398 | –108.0 | 6.998 | 105.4 | 0.086 | 51.5 | 0.486 | –49.5 |
| 0.9 | 0.372 | –118.1 | 6.348 | 100.9 | 0.091 | 50.6 | 0.444 | –52.1 |
| 1.0 | 0.351 | –127.1 | 5.824 | 96.9 | 0.095 | 50.1 | 0.410 | –54.6 |
| 1.1 | 0.338 | –135.6 | 5.367 | 93.4 | 0.100 | 49.8 | 0.383 | –56.7 |
| 1.2 | 0.332 | –143.4 | 4.940 | 90.4 | 0.104 | 49.8 | 0.359 | –58.8 |
| 1.3 | 0.326 | –151.0 | 4.598 | 87.4 | 0.109 | 49.7 | 0.342 | –60.4 |
| 1.4 | 0.325 | –156.9 | 4.286 | 84.5 | 0.113 | 49.6 | 0.326 | –62.2 |
| 1.5 | 0.322 | –162.3 | 4.028 | 81.7 | 0.117 | 49.5 | 0.313 | –63.7 |
| 1.6 | 0.324 | –167.9 | 3.798 | 79.3 | 0.122 | 49.6 | 0.303 | –64.9 |
| 1.7 | 0.327 | –172.4 | 3.582 | 77.0 | 0.126 | 49.6 | 0.291 | –66.2 |
| 1.8 | 0.326 | –176.7 | 3.393 | 74.6 | 0.131 | 49.6 | 0.282 | –67.0 |
| 1.9 | 0.330 | 179.2 | 3.224 | 72.8 | 0.135 | 49.6 | 0.275 | –68.1 |
| 2.0 | 0.326 | 176.0 | 3.078 | 70.5 | 0.140 | 49.6 | 0.264 | –68.5 |
| 2.1 | 0.338 | 172.5 | 2.946 | 68.7 | 0.144 | 49.6 | 0.260 | –69.7 |
| 2.2 | 0.336 | 170.4 | 2.817 | 67.1 | 0.148 | 49.7 | 0.248 | –70.0 |
| 2.3 | 0.347 | 167.5 | 2.713 | 65.3 | 0.153 | 49.5 | 0.245 | –70.8 |
| 2.4 | 0.345 | 165.2 | 2.609 | 63.6 | 0.159 | 49.4 | 0.234 | –72.1 |
| 2.5 | 0.352 | 162.6 | 2.509 | 62.1 | 0.163 | 49.3 | 0.231 | –72.9 |
| 2.6 | 0.351 | 160.3 | 2.432 | 60.8 | 0.168 | 49.3 | 0.224 | –75.0 |
| 2.7 | 0.358 | 158.5 | 2.340 | 59.2 | 0.173 | 49.0 | 0.219 | –74.9 |
| 2.8 | 0.359 | 155.9 | 2.260 | 57.8 | 0.178 | 48.6 | 0.215 | –77.6 |
| 2.9 | 0.352 | 154.4 | 2.158 | 55.6 | 0.183 | 47.8 | 0.202 | –79.5 |
| 3.0 | 0.353 | 150.0 | 2.104 | 53.8 | 0.188 | 47.8 | 0.205 | –83.1 |
| 4.0 | 0.402 | 125.3 | 1.631 | 36.5 | 0.239 | 43.3 | 0.203 | –111.7 |
| 5.0 | 0.486 | 104.8 | 1.283 | 22.1 | 0.288 | 33.9 | 0.212 | –147.2 |

$V_{CE}$ = 1 V, $I_C$ = 7 mA, $Z_O$ = 50 Ω

| Frequency | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| (GHz) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) | MAG. | ANG. (deg.) |
| 0.1 | 0.731 | –22.4 | 17.662 | 162.6 | 0.018 | 78.1 | 0.946 | –13.2 |
| 0.2 | 0.666 | –42.3 | 16.079 | 147.1 | 0.033 | 70.1 | 0.866 | –24.3 |
| 0.3 | 0.585 | –59.7 | 14.117 | 135.1 | 0.045 | 63.9 | 0.761 | –32.4 |
| 0.4 | 0.515 | –74.0 | 12.267 | 125.3 | 0.054 | 59.6 | 0.666 | –38.8 |
| 0.5 | 0.451 | –88.1 | 10.693 | 117.2 | 0.061 | 57.0 | 0.584 | –43.3 |
| 0.6 | 0.402 | –100.5 | 9.403 | 110.6 | 0.067 | 55.3 | 0.515 | –46.9 |
| 0.7 | 0.369 | –111.7 | 8.357 | 105.7 | 0.072 | 54.5 | 0.460 | –49.5 |
| 0.8 | 0.341 | –122.4 | 7.466 | 100.9 | 0.077 | 54.0 | 0.414 | –52.0 |
| 0.9 | 0.326 | –132.1 | 6.722 | 96.9 | 0.082 | 53.8 | 0.378 | –54.2 |
| 1.0 | 0.313 | –141.7 | 6.135 | 93.3 | 0.087 | 54.0 | 0.348 | –56.6 |
| 1.1 | 0.309 | –149.3 | 5.624 | 90.1 | 0.092 | 53.9 | 0.325 | –58.5 |
| 1.2 | 0.309 | –156.8 | 5.163 | 87.3 | 0.097 | 54.2 | 0.304 | –60.5 |
| 1.3 | 0.309 | –163.3 | 4.802 | 84.6 | 0.102 | 54.2 | 0.290 | –62.1 |
| 1.4 | 0.311 | –168.8 | 4.464 | 82.0 | 0.107 | 54.2 | 0.278 | –63.8 |
| 1.5 | 0.312 | –173.7 | 4.191 | 79.4 | 0.112 | 54.3 | 0.267 | –65.3 |
| 1.6 | 0.316 | –178.2 | 3.945 | 77.1 | 0.117 | 54.2 | 0.259 | –66.6 |
| 1.7 | 0.320 | 178.1 | 3.712 | 75.0 | 0.122 | 54.2 | 0.249 | –67.9 |
| 1.8 | 0.320 | 174.4 | 3.516 | 72.8 | 0.127 | 54.2 | 0.241 | –68.7 |
| 1.9 | 0.327 | 170.6 | 3.333 | 71.1 | 0.132 | 54.1 | 0.236 | –69.8 |
| 2.0 | 0.324 | 168.0 | 3.181 | 69.1 | 0.137 | 53.9 | 0.227 | –70.2 |
| 2.1 | 0.338 | 165.7 | 3.047 | 67.3 | 0.142 | 53.9 | 0.224 | –71.4 |
| 2.2 | 0.334 | 162.9 | 2.914 | 65.8 | 0.147 | 53.8 | 0.212 | –71.5 |
| 2.3 | 0.348 | 160.7 | 2.803 | 64.2 | 0.153 | 53.6 | 0.210 | –72.5 |
| 2.4 | 0.345 | 159.0 | 2.694 | 62.5 | 0.158 | 53.3 | 0.199 | –73.9 |
| 2.5 | 0.353 | 156.7 | 2.591 | 61.0 | 0.163 | 53.0 | 0.197 | –74.8 |
| 2.6 | 0.353 | 154.3 | 2.509 | 59.9 | 0.169 | 52.8 | 0.192 | –77.4 |
| 2.7 | 0.359 | 153.2 | 2.414 | 58.3 | 0.174 | 52.4 | 0.186 | –77.2 |
| 2.8 | 0.361 | 150.8 | 2.330 | 57.2 | 0.179 | 51.8 | 0.183 | –80.3 |
| 2.9 | 0.354 | 149.1 | 2.223 | 55.0 | 0.185 | 50.9 | 0.171 | –82.7 |
| 3.0 | 0.355 | 145.1 | 2.167 | 53.2 | 0.191 | 50.7 | 0.175 | –86.6 |
| 4.0 | 0.404 | 122.9 | 1.674 | 36.3 | 0.244 | 45.0 | 0.183 | –117.4 |
| 5.0 | 0.490 | 103.1 | 1.316 | 22.5 | 0.294 | 34.8 | 0.204 | –154.4 |