

**NPN SILICON EPITAXIAL TRANSISTOR (WITH 2 DIFFERENT ELEMENTS)
IN A 6-PIN THIN-TYPE SMALL MINI MOLD PACKAGE****DESCRIPTION**

The μ PA836TF has two different built-in transistors (Q1 and Q2) for low noise amplification in the VHF band to UHF band.

FEATURES

- Low noise
Q1 : NF = 1.5 dB TYP. @f = 2 GHz, V_{CE} = 3 V, I_c = 3 mA
Q2 : NF = 1.7 dB TYP. @f = 2 GHz, V_{CE} = 1 V, I_c = 3 mA
- High gain
Q1 : $|S_{21e}|^2$ = 8.5 dB TYP. @f = 2 GHz, V_{CE} = 3 V, I_c = 10 mA
Q2 : $|S_{21e}|^2$ = 3.5 dB TYP. @f = 2 GHz, V_{CE} = 1 V, I_c = 3 mA
- 6-pin thin-type small mini mold package
- 2 different transistors on-chip (2SC5193, 2SC4959)

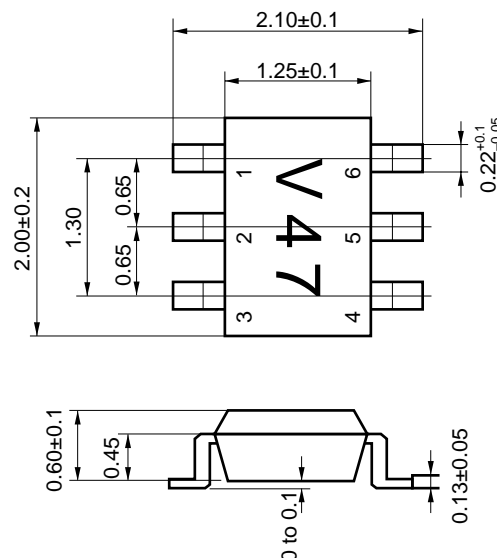
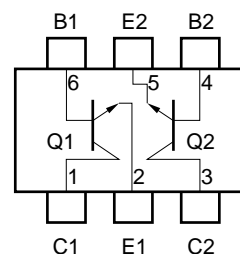
ON-CHIP TRANSISTORS

| | Q1 | Q2 |
|--------------------------------|---------|---------|
| 3-pin small mini mold part No. | 2SC4959 | 2SC5193 |

The μ PA833TF features the Q1 and Q2 in inverted positions.

ORDERING INFORMATION

| PART NUMBER | QUANTITY | PACKING STYLE |
|------------------|----------------------------------|--|
| μ PA836TF | Loose products (50 pcs) | 8-mm wide embossed tape. Pin 6 (Q1 Base), pin 5 (Q2 Emitter), and pin 4 (Q2 Base) face perforated side of tape. |
| μ PA836TF-T1 | Taping products (3 kpcs/reel) | |

PACKAGE DRAWINGS (Unit:mm)**PIN CONFIGURATION (Top View)****PIN CONNECTIONS**

- | | |
|-------------------|-----------------|
| 1. Collector (Q1) | 4. Base (Q2) |
| 2. Emitter (Q1) | 5. Emitter (Q2) |
| 3. Collector (Q2) | 6. Base (Q1) |

Caution is required concerning excess input, such as from static electricity because the high-frequency process is used for this device.

The information in this document is subject to change without notice.

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

| PARAMETER | SYMBOL | RATING | | UNIT |
|------------------------------|------------------|-----------------------------------|------------------|------|
| | | Q1 | Q2 | |
| Collector to base voltage | V _{CBO} | 9 | 9 | V |
| Collector to emitter voltage | V _{CEO} | 6 | 6 | V |
| Emitter to base voltage | V _{EBO} | 2 | 2 | V |
| Collector current | I _C | 30 | 100 | mA |
| Total power dissipation | P _T | 150 in 1 element | 150 in 1 element | mW |
| | | 200 in 2 elements ^{Note} | | |
| Junction temperature | T _J | 150 | 150 | °C |
| Storage temperature | T _{stg} | −65 to +150 | | °C |

Note 110 mW must not be exceeded for 1 element.

(1) Q1

ELECTRICAL CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|--------------------------|---------------------------------|--|------|------|------|------|
| Collector cutoff current | I _{CBO} | V _{CB} = 5 V, I _E = 0 | | | 0.1 | μA |
| Emitter cutoff current | I _{EBO} | V _{EB} = 1 V, I _C = 0 | | | 0.1 | μA |
| DC current gain | h _{FE} | V _{CE} = 3 V, I _C = 10 mA ^{Note 1} | 75 | | 150 | |
| Gain bandwidth product | f _T | V _{CE} = 3 V, I _C = 10 mA, f = 2 GHz | | 12 | | GHz |
| Feedback capacitance | C _{re} | V _{CB} = 3 V, I _E = 0, f = 1 MHz ^{Note 2} | | 0.4 | 0.7 | pF |
| Insertion power gain | S _{21e} ² | V _{CE} = 3 V, I _C = 10 mA, f = 2 GHz | 7 | 8.5 | | dB |
| Noise figure | NF | V _{CE} = 3 V, I _C = 3 mA, f = 2 GHz | | 1.5 | 2.5 | dB |

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

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.

(2) Q2

ELECTRICAL CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|----------------------------|---------------|--|------|------|------|------|
| Collector cutoff current | I_{CBO} | $V_{CB} = 5\text{ V}, I_E = 0$ | | | 0.1 | μA |
| Emitter cutoff current | I_{EBO} | $V_{EB} = 1\text{ V}, I_C = 0$ | | | 0.1 | μA |
| DC current gain | h_{FE} | $V_{CE} = 1\text{ V}, I_C = 3\text{ mA}$ ^{Note 1} | 100 | | 145 | |
| Gain bandwidth product (1) | f_T | $V_{CE} = 1\text{ V}, I_C = 3\text{ mA}, f = 2\text{ GHz}$ | 4.0 | 4.5 | | GHz |
| Gain bandwidth product (2) | f_T | $V_{CE} = 3\text{ V}, I_C = 20\text{ mA}, f = 2\text{ GHz}$ | | 9.0 | | GHz |
| Feedback capacitance | C_{re} | $V_{CB} = 1\text{ V}, I_E = 0, f = 1\text{ MHz}$ ^{Note 2} | | 0.75 | 0.85 | pF |
| Insertion power gain (1) | $ S_{21e} ^2$ | $V_{CE} = 1\text{ V}, I_C = 3\text{ mA}, f = 2\text{ GHz}$ | 2.5 | 3.5 | | dB |
| Insertion power gain (2) | $ S_{21e} ^2$ | $V_{CE} = 3\text{ V}, I_C = 20\text{ mA}, f = 2\text{ GHz}$ | | 6.5 | | dB |
| Noise figure (1) | NF | $V_{CE} = 1\text{ V}, I_C = 3\text{ mA}, f = 2\text{ GHz}$ | | 1.7 | 2.5 | dB |
| Noise figure (2) | NF | $V_{CE} = 3\text{ V}, I_C = 7\text{ mA}, f = 2\text{ GHz}$ | | 1.5 | | dB |

Notes 1. Pulse measurement: $PW \leq 350\text{ μs}$, Duty cycle $\leq 2\%$

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.

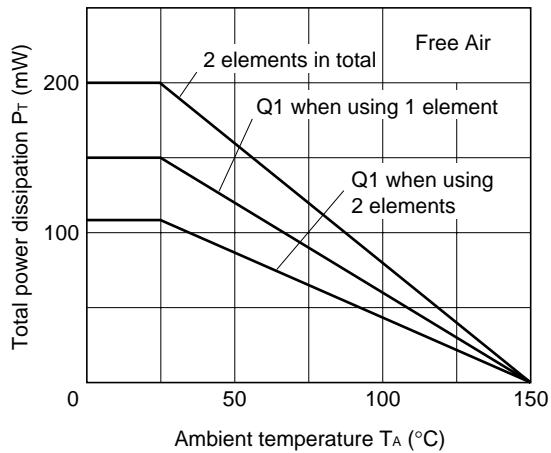
h_{FE} CLASSIFICATION

| | |
|----------------------|------------|
| Rank | FB |
| Marking | V47 |
| h_{FE} value of Q1 | 75 to 150 |
| h_{FE} value of Q2 | 100 to 145 |

TYPICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

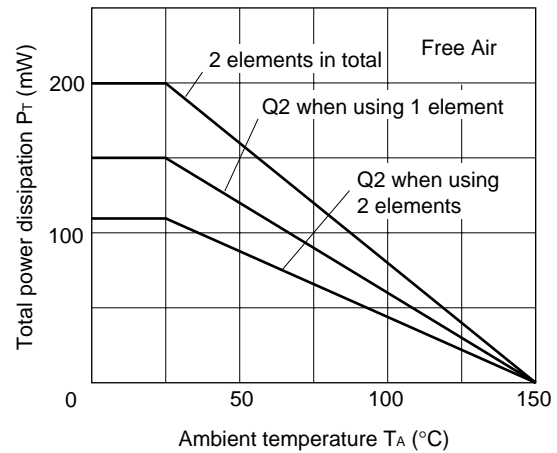
Q1

Total Power Dissipation vs. Ambient Temperature

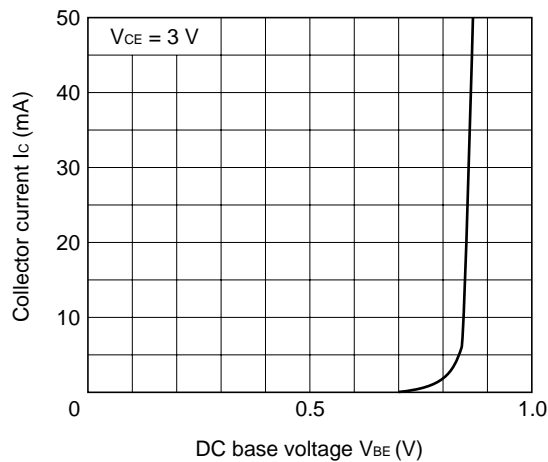


Q2

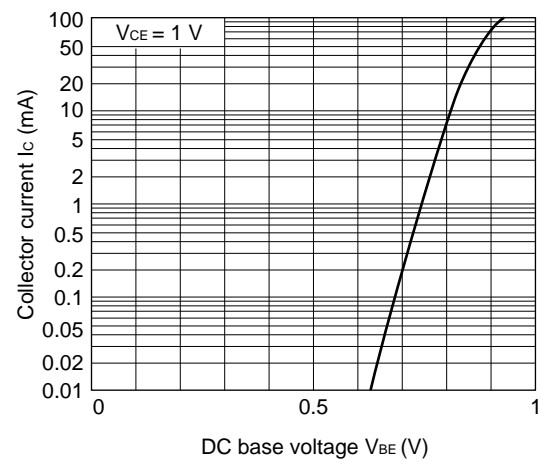
Total Power Dissipation vs. Ambient Temperature



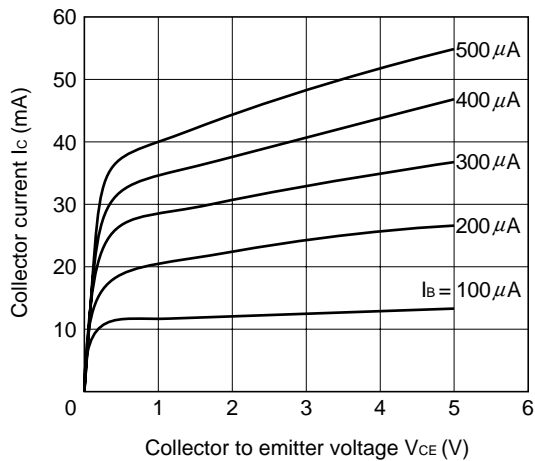
Collector Current vs. DC Base Voltage



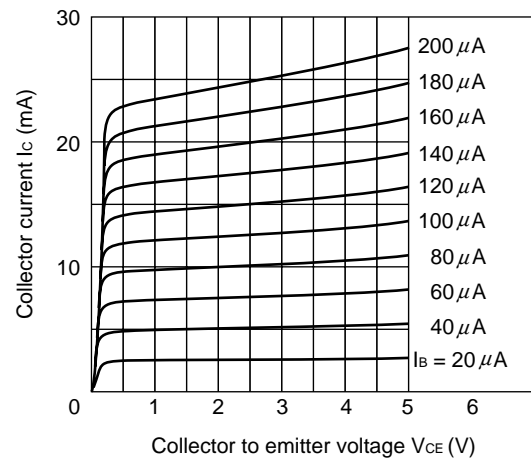
Collector Current vs. DC Base Voltage



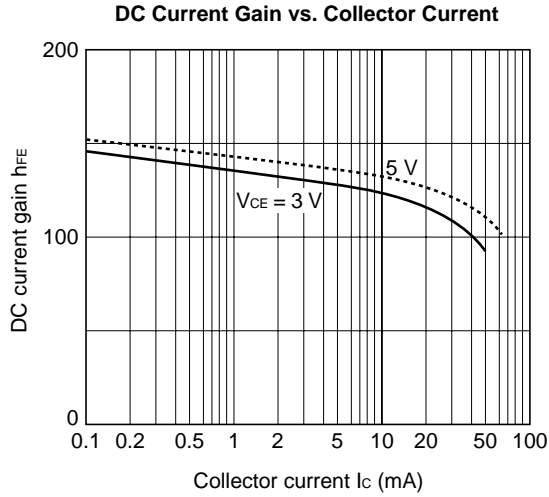
Collector Current vs. Collector to Emitter Voltage



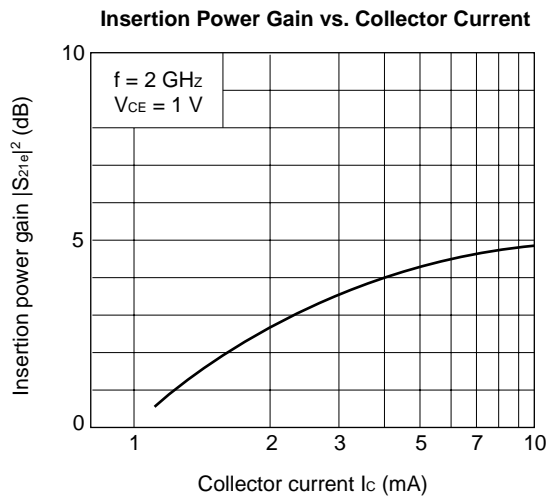
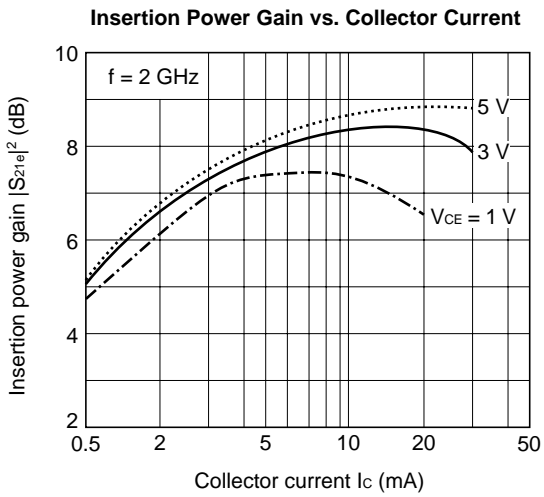
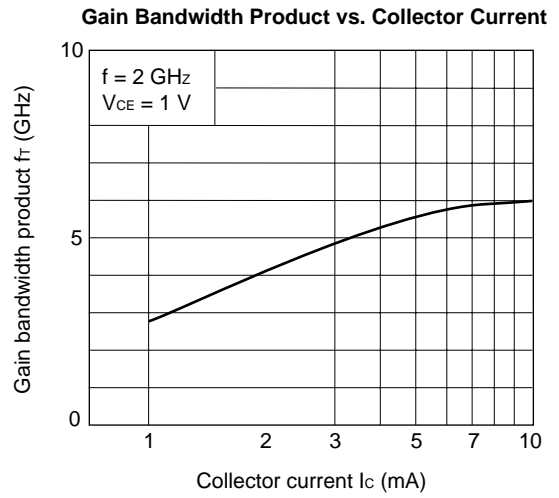
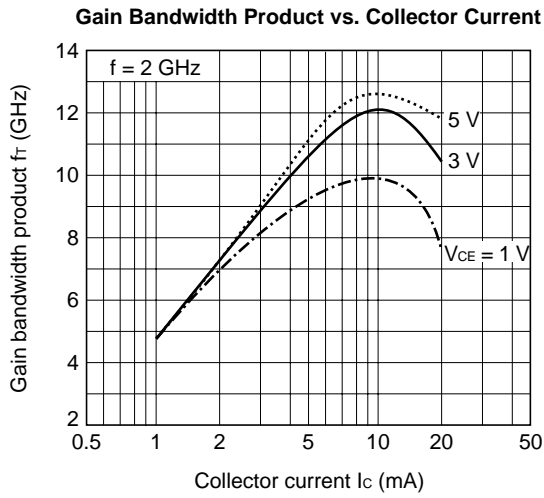
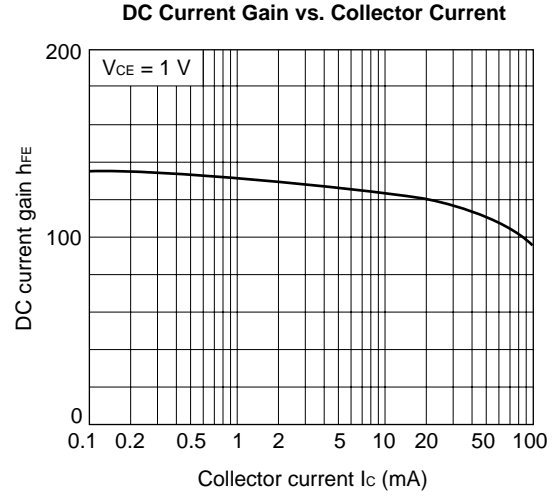
Collector Current vs. Collector to Emitter Voltage



Q1

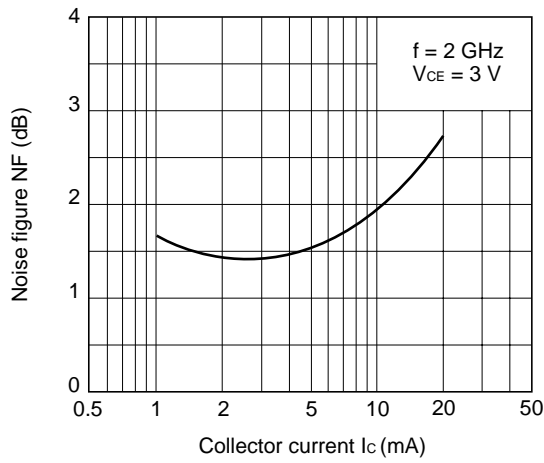


Q2



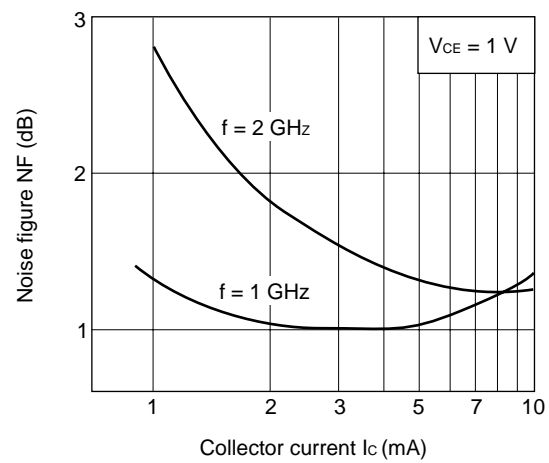
Q1

Noise Figure vs. Collector Current

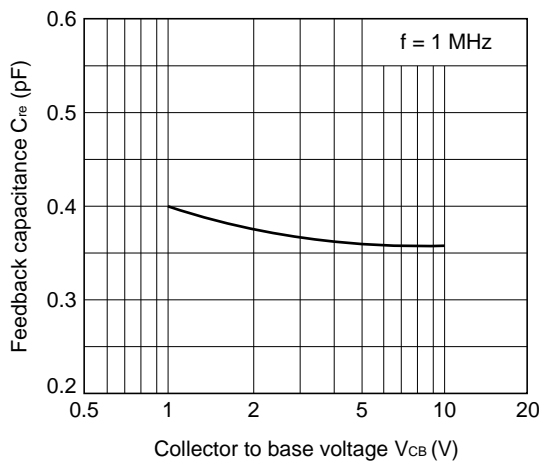


Q2

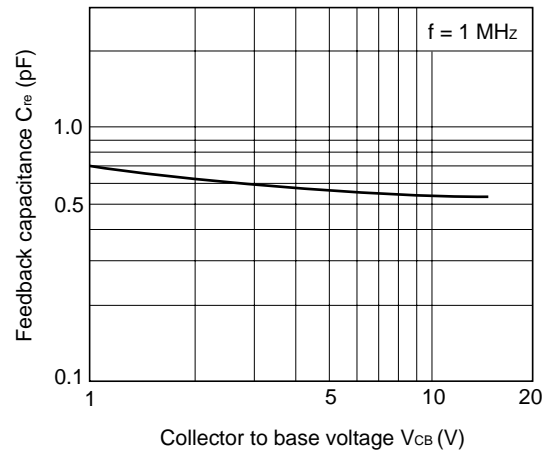
Noise Figure vs. Collector Current



Feedback Capacitance vs. Collector to Base Voltage

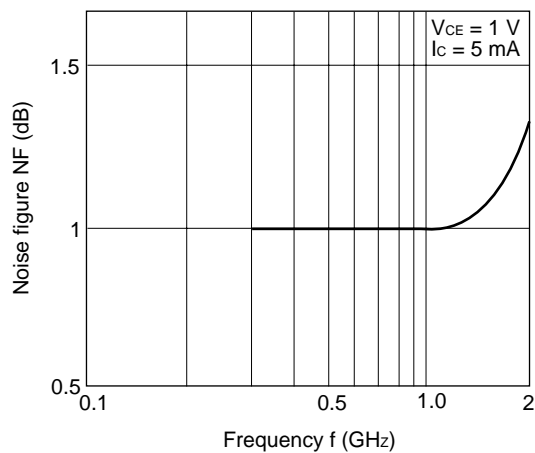


Feedback Capacitance vs. Collector to Base Voltage

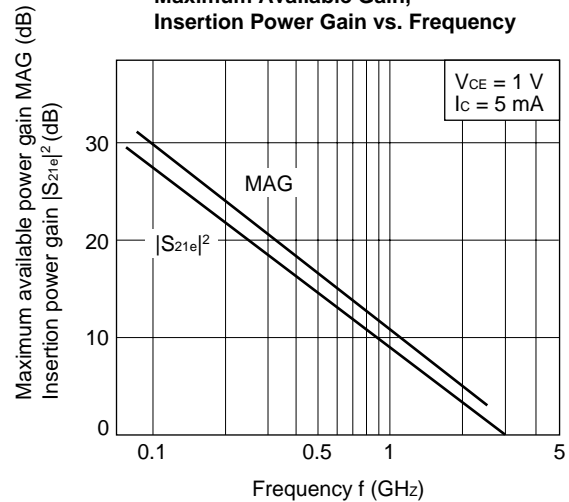


Q2

Noise Figure vs. Frequency



Maximum Available Gain, Insertion Power Gain vs. Frequency



S-PARAMETERS Q1

V_{CE} = 3 V, I_c = 1 mA, Z₀ = 50 Ω

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|------|--------|-----|-------|------|--------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .98 | -5.93 | 2.38 | 172.32 | .02 | 85.76 | 1.00 | -3.86 | |
| .20 | .97 | -11.90 | 2.36 | 165.08 | .04 | 81.15 | .99 | -7.44 | |
| .30 | .95 | -18.17 | 2.39 | 158.35 | .06 | 76.27 | .97 | -11.14 | |
| .40 | .93 | -24.00 | 2.35 | 151.83 | .07 | 72.22 | .96 | -14.73 | |
| .50 | .90 | -30.10 | 2.35 | 145.70 | .09 | 68.30 | .94 | -18.02 | |
| .60 | .87 | -36.17 | 2.33 | 140.22 | .10 | 64.18 | .92 | -21.42 | |
| .70 | .84 | -42.49 | 2.30 | 134.45 | .12 | 60.68 | .89 | -24.18 | |
| .80 | .80 | -48.69 | 2.29 | 129.32 | .13 | 56.90 | .87 | -27.47 | |
| .90 | .76 | -55.28 | 2.29 | 123.53 | .14 | 53.94 | .84 | -29.94 | |
| 1.00 | .73 | -61.26 | 2.24 | 118.31 | .15 | 51.07 | .81 | -32.50 | |
| 1.10 | .68 | -68.07 | 2.22 | 113.44 | .16 | 48.11 | .79 | -34.89 | |
| 1.20 | .64 | -74.79 | 2.19 | 108.30 | .16 | 45.85 | .76 | -36.89 | |
| 1.30 | .60 | -81.83 | 2.15 | 103.55 | .17 | 43.33 | .74 | -39.11 | |
| 1.40 | .55 | -89.00 | 2.12 | 98.67 | .17 | 41.40 | .72 | -40.93 | |
| 1.50 | .51 | -96.77 | 2.10 | 93.80 | .18 | 39.24 | .69 | -42.90 | |
| 1.60 | .47 | -104.09 | 2.05 | 89.19 | .18 | 37.66 | .67 | -44.72 | |
| 1.70 | .43 | -112.09 | 2.00 | 84.74 | .19 | 36.24 | .65 | -46.39 | |
| 1.80 | .40 | -120.45 | 1.95 | 80.45 | .19 | 34.56 | .63 | -48.25 | |
| 1.90 | .37 | -129.41 | 1.90 | 76.40 | .19 | 33.39 | .61 | -49.75 | |
| 2.00 | .35 | -138.38 | 1.84 | 72.75 | .19 | 32.40 | .60 | -51.51 | |
| 2.10 | .33 | -148.11 | 1.81 | 68.64 | .19 | 31.72 | .58 | -52.83 | |
| 2.20 | .32 | -157.58 | 1.76 | 64.92 | .20 | 30.93 | .57 | -54.63 | |
| 2.30 | .31 | -166.88 | 1.71 | 61.22 | .20 | 30.18 | .55 | -56.25 | |
| 2.40 | .31 | -176.01 | 1.66 | 58.06 | .20 | 30.03 | .54 | -58.11 | |
| 2.50 | .31 | 175.03 | 1.62 | 54.64 | .20 | 29.55 | .53 | -59.91 | |
| 2.60 | .31 | 166.46 | 1.58 | 51.50 | .20 | 29.28 | .51 | -61.71 | |
| 2.70 | .32 | 159.62 | 1.53 | 48.49 | .20 | 29.00 | .50 | -63.72 | |
| 2.80 | .33 | 152.04 | 1.49 | 45.40 | .21 | 28.82 | .49 | -65.70 | |
| 2.90 | .34 | 145.83 | 1.46 | 42.65 | .21 | 28.80 | .48 | -67.81 | |
| 3.00 | .35 | 140.64 | 1.41 | 40.02 | .21 | 28.96 | .47 | -69.74 | |

V_{CE} = 3 V, I_c = 3 mA, Z₀ = 50 Ω

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|------|--------|-----|-------|-----|--------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .94 | −9.29 | 6.55 | 168.08 | .02 | 84.10 | .98 | −6.91 | |
| .20 | .90 | −18.39 | 6.32 | 157.85 | .04 | 76.93 | .95 | −13.21 | |
| .30 | .85 | −27.47 | 6.21 | 148.76 | .05 | 71.79 | .91 | −18.80 | |
| .40 | .80 | −36.15 | 5.98 | 140.53 | .06 | 66.81 | .86 | −23.80 | |
| .50 | .74 | −44.62 | 5.77 | 133.00 | .07 | 63.60 | .81 | −27.41 | |
| .60 | .67 | −52.69 | 5.51 | 126.23 | .08 | 60.13 | .76 | −31.19 | |
| .70 | .60 | −60.71 | 5.28 | 119.27 | .09 | 58.07 | .72 | −33.67 | |
| .80 | .54 | −68.45 | 5.03 | 113.12 | .10 | 55.93 | .68 | −36.31 | |
| .90 | .47 | −75.60 | 4.76 | 107.23 | .11 | 54.62 | .64 | −38.10 | |
| 1.00 | .42 | −82.57 | 4.50 | 101.99 | .11 | 53.45 | .61 | −39.74 | |
| 1.10 | .36 | −89.81 | 4.25 | 97.09 | .12 | 52.36 | .58 | −41.44 | |
| 1.20 | .32 | −96.78 | 4.02 | 92.52 | .13 | 51.59 | .56 | −42.63 | |
| 1.30 | .28 | −104.70 | 3.80 | 88.51 | .13 | 50.82 | .54 | −44.03 | |
| 1.40 | .24 | −112.82 | 3.60 | 84.54 | .14 | 50.32 | .52 | −45.49 | |
| 1.50 | .21 | −122.39 | 3.42 | 80.83 | .15 | 49.61 | .50 | −46.74 | |
| 1.60 | .19 | −132.58 | 3.25 | 77.42 | .15 | 48.93 | .48 | −48.15 | |
| 1.70 | .17 | −143.90 | 3.10 | 74.15 | .16 | 48.63 | .46 | −49.50 | |
| 1.80 | .16 | −156.26 | 2.96 | 70.97 | .16 | 47.95 | .45 | −51.09 | |
| 1.90 | .16 | −168.80 | 2.83 | 67.97 | .17 | 47.25 | .44 | −52.53 | |
| 2.00 | .16 | 179.12 | 2.70 | 64.83 | .18 | 46.70 | .42 | −54.02 | |
| 2.10 | .16 | 167.80 | 2.60 | 62.14 | .18 | 46.24 | .41 | −55.57 | |
| 2.20 | .17 | 157.86 | 2.50 | 59.47 | .19 | 45.72 | .40 | −57.43 | |
| 2.30 | .19 | 149.77 | 2.40 | 56.62 | .19 | 44.99 | .39 | −59.14 | |
| 2.40 | .20 | 142.43 | 2.31 | 54.07 | .20 | 44.36 | .37 | −61.28 | |
| 2.50 | .22 | 136.13 | 2.24 | 51.62 | .21 | 43.76 | .36 | −63.34 | |
| 2.60 | .23 | 130.97 | 2.16 | 49.11 | .21 | 42.91 | .35 | −65.48 | |
| 2.70 | .25 | 126.43 | 2.09 | 46.64 | .22 | 42.33 | .34 | −67.77 | |
| 2.80 | .26 | 122.06 | 2.02 | 44.41 | .22 | 41.59 | .33 | −70.30 | |
| 2.90 | .28 | 118.64 | 1.96 | 42.02 | .23 | 40.99 | .32 | −72.81 | |
| 3.00 | .29 | 115.80 | 1.89 | 39.81 | .23 | 40.27 | .31 | −75.36 | |

S-PARAMETERS Q1

$V_{CE} = 3\text{ V}$, $I_C = 5\text{ mA}$, $Z_0 = 50\ \Omega$

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|-------|--------|-----|-------|-----|--------|--|
| GHZ | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .90 | -12.12 | 10.05 | 165.07 | .02 | 82.08 | .97 | -9.12 | |
| .20 | .84 | -23.51 | 9.49 | 152.86 | .03 | 74.99 | .92 | -17.06 | |
| .30 | .77 | -34.84 | 9.08 | 142.06 | .05 | 69.42 | .85 | -23.23 | |
| .40 | .69 | -45.03 | 8.52 | 132.57 | .06 | 65.57 | .78 | -28.22 | |
| .50 | .60 | -54.58 | 7.94 | 123.96 | .07 | 63.02 | .72 | -31.57 | |
| .60 | .52 | -62.89 | 7.32 | 116.79 | .08 | 60.80 | .66 | -34.45 | |
| .70 | .44 | -70.48 | 6.74 | 109.99 | .08 | 59.78 | .62 | -36.34 | |
| .80 | .38 | -77.63 | 6.21 | 104.22 | .09 | 58.73 | .58 | -38.08 | |
| .90 | .32 | -84.12 | 5.71 | 99.08 | .10 | 57.98 | .55 | -39.38 | |
| 1.00 | .28 | -90.92 | 5.28 | 94.41 | .11 | 57.45 | .53 | -40.58 | |
| 1.10 | .23 | -97.81 | 4.90 | 90.40 | .11 | 56.92 | .50 | -41.81 | |
| 1.20 | .20 | -105.44 | 4.56 | 86.53 | .12 | 56.41 | .48 | -42.73 | |
| 1.30 | .17 | -114.52 | 4.27 | 83.13 | .13 | 55.94 | .46 | -43.87 | |
| 1.40 | .14 | -124.74 | 4.01 | 79.77 | .13 | 55.49 | .45 | -45.20 | |
| 1.50 | .13 | -137.90 | 3.78 | 76.56 | .14 | 54.85 | .43 | -46.37 | |
| 1.60 | .11 | -152.33 | 3.58 | 73.63 | .15 | 54.15 | .42 | -47.87 | |
| 1.70 | .11 | -167.88 | 3.39 | 70.79 | .15 | 53.69 | .40 | -49.23 | |
| 1.80 | .11 | 177.28 | 3.23 | 67.93 | .16 | 52.89 | .39 | -50.80 | |
| 1.90 | .12 | 163.98 | 3.08 | 65.32 | .17 | 52.20 | .38 | -52.29 | |
| 2.00 | .13 | 152.80 | 2.93 | 62.58 | .18 | 51.42 | .37 | -54.00 | |
| 2.10 | .14 | 143.82 | 2.81 | 60.07 | .18 | 50.75 | .36 | -55.75 | |
| 2.20 | .16 | 136.52 | 2.70 | 57.67 | .19 | 50.10 | .35 | -57.73 | |
| 2.30 | .17 | 130.81 | 2.59 | 55.05 | .20 | 49.15 | .33 | -59.61 | |
| 2.40 | .19 | 126.04 | 2.50 | 52.83 | .20 | 48.36 | .32 | -62.01 | |
| 2.50 | .21 | 121.76 | 2.41 | 50.64 | .21 | 47.56 | .31 | -64.32 | |
| 2.60 | .22 | 118.20 | 2.33 | 48.15 | .22 | 46.64 | .30 | -66.89 | |
| 2.70 | .24 | 115.10 | 2.25 | 45.92 | .22 | 45.70 | .29 | -69.48 | |
| 2.80 | .25 | 111.94 | 2.17 | 43.83 | .23 | 44.66 | .28 | -72.54 | |
| 2.90 | .27 | 109.74 | 2.10 | 41.74 | .24 | 43.87 | .27 | -75.25 | |
| 3.00 | .28 | 107.74 | 2.03 | 39.80 | .24 | 42.91 | .26 | -78.22 | |

$V_{CE} = 3\text{ V}$, $I_C = 10\text{ mA}$, $Z_0 = 50\ \Omega$

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|-------|--------|-----|-------|-----|--------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .82 | -17.52 | 16.52 | 159.99 | .02 | 80.28 | .94 | -12.68 | |
| .20 | .72 | -33.22 | 14.93 | 144.21 | .03 | 72.82 | .85 | -22.43 | |
| .30 | .60 | -46.83 | 13.32 | 131.03 | .04 | 68.07 | .75 | -28.43 | |
| .40 | .49 | -57.62 | 11.65 | 120.45 | .05 | 65.62 | .67 | -32.14 | |
| .50 | .40 | -65.90 | 10.15 | 112.22 | .06 | 65.03 | .60 | -34.25 | |
| .60 | .33 | -72.93 | 8.90 | 105.22 | .07 | 63.86 | .56 | -35.78 | |
| .70 | .27 | -79.33 | 7.89 | 100.37 | .08 | 63.74 | .52 | -36.80 | |
| .80 | .22 | -85.38 | 7.07 | 95.73 | .08 | 63.50 | .49 | -37.69 | |
| .90 | .18 | -91.73 | 6.39 | 91.61 | .09 | 63.16 | .46 | -38.46 | |
| 1.00 | .15 | -98.81 | 5.83 | 87.88 | .10 | 62.77 | .45 | -39.30 | |
| 1.10 | .12 | -107.45 | 5.35 | 84.47 | .11 | 62.22 | .43 | -40.19 | |
| 1.20 | .10 | -118.22 | 4.95 | 81.32 | .11 | 61.85 | .41 | -41.01 | |
| 1.30 | .08 | -133.80 | 4.62 | 78.49 | .12 | 61.19 | .40 | -42.05 | |
| 1.40 | .07 | -153.77 | 4.31 | 75.63 | .13 | 60.72 | .39 | -43.42 | |
| 1.50 | .07 | -176.19 | 4.05 | 72.83 | .14 | 59.79 | .38 | -44.69 | |
| 1.60 | .07 | 164.45 | 3.82 | 70.28 | .15 | 59.22 | .36 | -46.17 | |
| 1.70 | .08 | 149.79 | 3.61 | 67.81 | .15 | 58.31 | .35 | -47.69 | |
| 1.80 | .10 | 138.91 | 3.42 | 65.32 | .16 | 57.24 | .34 | -49.53 | |
| 1.90 | .11 | 131.52 | 3.26 | 62.88 | .17 | 56.34 | .33 | -51.25 | |
| 2.00 | .13 | 125.94 | 3.12 | 60.46 | .18 | 55.55 | .32 | -53.15 | |
| 2.10 | .15 | 121.31 | 2.98 | 58.25 | .19 | 54.57 | .31 | -55.05 | |
| 2.20 | .16 | 117.28 | 2.85 | 56.06 | .19 | 53.65 | .30 | -57.33 | |
| 2.30 | .18 | 114.88 | 2.74 | 53.72 | .20 | 52.42 | .29 | -59.70 | |
| 2.40 | .20 | 111.75 | 2.64 | 51.59 | .21 | 51.55 | .28 | -62.40 | |
| 2.50 | .21 | 109.57 | 2.54 | 49.58 | .22 | 50.37 | .27 | -65.07 | |
| 2.60 | .23 | 107.60 | 2.45 | 47.36 | .22 | 49.19 | .26 | -67.95 | |
| 2.70 | .24 | 105.45 | 2.36 | 45.20 | .23 | 48.18 | .25 | -71.01 | |
| 2.80 | .26 | 103.59 | 2.29 | 43.25 | .24 | 47.05 | .24 | -74.44 | |
| 2.90 | .27 | 102.11 | 2.21 | 41.26 | .25 | 45.94 | .23 | -78.01 | |
| 3.00 | .29 | 100.79 | 2.14 | 39.46 | .25 | 45.03 | .21 | -81.46 | |

S-PARAMETERS Q2

V_{CE} = 3 V, I_c = 1 mA, Z₀ = 50 Ω

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|------|--------|-----|-------|-----|---------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .97 | -14.32 | 2.42 | 166.29 | .04 | 80.18 | .99 | -7.24 | |
| .20 | .95 | -28.41 | 2.36 | 154.31 | .07 | 70.77 | .96 | -14.16 | |
| .30 | .91 | -42.45 | 2.34 | 143.61 | .10 | 62.19 | .91 | -20.19 | |
| .40 | .88 | -55.88 | 2.25 | 133.74 | .13 | 54.42 | .87 | -25.69 | |
| .50 | .83 | -69.17 | 2.21 | 124.69 | .14 | 48.08 | .81 | -30.13 | |
| .60 | .79 | -81.80 | 2.14 | 116.51 | .16 | 42.00 | .77 | -34.32 | |
| .70 | .75 | -93.67 | 2.06 | 108.52 | .17 | 37.41 | .72 | -37.52 | |
| .80 | .72 | -104.67 | 1.98 | 101.49 | .17 | 33.30 | .68 | -40.84 | |
| .90 | .69 | -115.37 | 1.91 | 94.57 | .18 | 29.92 | .65 | -43.52 | |
| 1.00 | .67 | -124.80 | 1.81 | 88.40 | .18 | 27.31 | .62 | -46.09 | |
| 1.10 | .65 | -133.94 | 1.74 | 82.84 | .18 | 25.22 | .59 | -48.86 | |
| 1.20 | .63 | -142.25 | 1.66 | 77.30 | .18 | 23.77 | .57 | -51.18 | |
| 1.30 | .62 | -149.96 | 1.59 | 72.44 | .17 | 22.66 | .55 | -53.96 | |
| 1.40 | .61 | -157.13 | 1.52 | 67.64 | .17 | 22.22 | .53 | -56.90 | |
| 1.50 | .61 | -163.80 | 1.46 | 63.16 | .17 | 22.24 | .51 | -59.93 | |
| 1.60 | .61 | -169.92 | 1.40 | 58.91 | .17 | 22.91 | .49 | -63.04 | |
| 1.70 | .61 | -175.60 | 1.35 | 54.92 | .16 | 24.02 | .48 | -66.60 | |
| 1.80 | .61 | 179.06 | 1.30 | 51.14 | .16 | 25.66 | .46 | -70.43 | |
| 1.90 | .61 | 174.00 | 1.25 | 47.55 | .16 | 27.51 | .45 | -74.41 | |
| 2.00 | .61 | 169.35 | 1.21 | 43.93 | .16 | 30.08 | .44 | -78.77 | |
| 2.10 | .62 | 165.00 | 1.17 | 40.40 | .16 | 32.69 | .43 | -83.40 | |
| 2.20 | .62 | 160.73 | 1.13 | 37.13 | .17 | 35.27 | .42 | -88.74 | |
| 2.30 | .63 | 156.90 | 1.09 | 33.87 | .17 | 37.61 | .41 | -94.25 | |
| 2.40 | .64 | 153.27 | 1.06 | 30.94 | .18 | 40.19 | .40 | -100.25 | |
| 2.50 | .64 | 149.69 | 1.02 | 28.22 | .19 | 41.91 | .39 | -106.64 | |
| 2.60 | .65 | 146.37 | .99 | 25.33 | .20 | 43.39 | .38 | -113.50 | |
| 2.70 | .66 | 143.12 | .96 | 22.63 | .21 | 44.65 | .38 | -120.35 | |
| 2.80 | .67 | 140.20 | .93 | 20.16 | .23 | 45.36 | .38 | -127.21 | |
| 2.90 | .67 | 137.30 | .91 | 17.86 | .24 | 45.73 | .38 | -134.04 | |
| 3.00 | .68 | 134.75 | .88 | 15.55 | .26 | 45.51 | .39 | -141.18 | |

V_{CE} = 3 V, I_c = 3 mA, Z₀ = 50 Ω

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|------|--------|-----|-------|-----|---------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .91 | -20.77 | 6.78 | 160.00 | .04 | 76.08 | .95 | -14.28 | |
| .20 | .84 | -40.45 | 6.30 | 145.15 | .06 | 64.72 | .86 | -26.08 | |
| .30 | .76 | -59.61 | 5.98 | 132.53 | .08 | 56.56 | .75 | -34.42 | |
| .40 | .69 | -77.35 | 5.54 | 121.70 | .10 | 50.58 | .66 | -41.09 | |
| .50 | .62 | -93.52 | 5.09 | 112.12 | .11 | 47.02 | .58 | -45.13 | |
| .60 | .57 | -107.23 | 4.61 | 104.36 | .12 | 44.57 | .51 | -48.78 | |
| .70 | .53 | -119.29 | 4.20 | 97.25 | .12 | 43.10 | .46 | -51.09 | |
| .80 | .50 | -129.99 | 3.84 | 91.32 | .13 | 42.46 | .42 | -53.42 | |
| .90 | .48 | -139.30 | 3.51 | 85.88 | .13 | 41.93 | .38 | -55.21 | |
| 1.00 | .47 | -147.65 | 3.25 | 80.98 | .14 | 42.00 | .36 | -56.92 | |
| 1.10 | .46 | -155.28 | 3.00 | 76.59 | .15 | 42.04 | .33 | -58.86 | |
| 1.20 | .46 | -161.91 | 2.80 | 72.45 | .15 | 42.33 | .31 | -60.52 | |
| 1.30 | .46 | -168.23 | 2.62 | 68.51 | .16 | 42.54 | .28 | -62.72 | |
| 1.40 | .46 | -173.80 | 2.46 | 64.85 | .16 | 43.09 | .26 | -65.15 | |
| 1.50 | .46 | -179.07 | 2.33 | 61.22 | .17 | 43.12 | .25 | -67.97 | |
| 1.60 | .47 | 176.01 | 2.20 | 57.78 | .18 | 43.42 | .23 | -70.92 | |
| 1.70 | .47 | 171.72 | 2.10 | 54.61 | .18 | 43.54 | .21 | -74.72 | |
| 1.80 | .48 | 167.62 | 2.00 | 51.39 | .19 | 43.72 | .20 | -78.93 | |
| 1.90 | .49 | 163.82 | 1.91 | 48.33 | .20 | 43.74 | .19 | -83.74 | |
| 2.00 | .49 | 160.12 | 1.83 | 45.19 | .21 | 43.70 | .17 | -89.34 | |
| 2.10 | .50 | 156.73 | 1.76 | 42.17 | .22 | 43.54 | .16 | -95.60 | |
| 2.20 | .51 | 153.44 | 1.69 | 39.41 | .23 | 43.20 | .15 | -103.80 | |
| 2.30 | .52 | 150.43 | 1.63 | 36.46 | .23 | 42.72 | .14 | -112.05 | |
| 2.40 | .53 | 147.65 | 1.58 | 33.95 | .24 | 42.35 | .14 | -122.10 | |
| 2.50 | .54 | 144.71 | 1.52 | 31.01 | .25 | 42.00 | .13 | -132.57 | |
| 2.60 | .55 | 142.10 | 1.47 | 28.44 | .26 | 41.31 | .14 | -143.43 | |
| 2.70 | .56 | 139.53 | 1.42 | 25.86 | .27 | 40.67 | .14 | -154.35 | |
| 2.80 | .57 | 137.12 | 1.37 | 23.37 | .28 | 40.00 | .15 | -163.63 | |
| 2.90 | .58 | 134.87 | 1.34 | 21.21 | .29 | 39.04 | .16 | -171.94 | |
| 3.00 | .59 | 132.90 | 1.29 | 18.97 | .30 | 38.08 | .17 | -179.42 | |

S-PARAMETERS Q2

$V_{CE} = 3 \text{ V}$, $I_C = 5 \text{ mA}$, $Z_0 = 50 \Omega$

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|-------|--------|-----|-------|-----|---------|--|
| GHZ | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .84 | -26.28 | 10.60 | 155.28 | .03 | 73.62 | .91 | -19.87 | |
| .20 | .75 | -50.58 | 9.48 | 138.37 | .06 | 62.12 | .77 | -34.36 | |
| .30 | .64 | -73.48 | 8.58 | 124.39 | .07 | 55.68 | .63 | -43.20 | |
| .40 | .56 | -93.24 | 7.56 | 113.09 | .08 | 52.30 | .53 | -49.31 | |
| .50 | .49 | -109.26 | 6.59 | 104.26 | .09 | 50.89 | .45 | -52.83 | |
| .60 | .45 | -122.23 | 5.76 | 97.42 | .10 | 50.06 | .39 | -55.78 | |
| .70 | .43 | -133.23 | 5.10 | 91.52 | .11 | 49.97 | .34 | -57.54 | |
| .80 | .41 | -142.94 | 4.57 | 86.44 | .12 | 50.11 | .31 | -59.42 | |
| .90 | .40 | -151.05 | 4.13 | 81.93 | .13 | 50.05 | .27 | -60.94 | |
| 1.00 | .40 | -158.37 | 3.78 | 77.69 | .13 | 50.37 | .25 | -62.43 | |
| 1.10 | .40 | -164.99 | 3.47 | 73.94 | .14 | 50.41 | .23 | -64.37 | |
| 1.20 | .40 | -170.84 | 3.22 | 70.16 | .15 | 50.44 | .20 | -66.17 | |
| 1.30 | .40 | -176.20 | 3.00 | 66.81 | .16 | 50.23 | .18 | -68.33 | |
| 1.40 | .41 | 178.98 | 2.81 | 63.48 | .17 | 49.93 | .17 | -71.42 | |
| 1.50 | .41 | 174.38 | 2.64 | 60.16 | .18 | 49.56 | .15 | -75.30 | |
| 1.60 | .42 | 170.27 | 2.50 | 57.17 | .19 | 49.03 | .13 | -79.54 | |
| 1.70 | .43 | 166.51 | 2.37 | 54.26 | .20 | 48.51 | .12 | -85.04 | |
| 1.80 | .44 | 162.78 | 2.25 | 51.23 | .21 | 48.06 | .10 | -91.47 | |
| 1.90 | .44 | 159.51 | 2.15 | 48.45 | .22 | 47.32 | .09 | -100.05 | |
| 2.00 | .45 | 156.30 | 2.05 | 45.69 | .23 | 46.68 | .08 | -111.15 | |
| 2.10 | .46 | 153.32 | 1.97 | 42.82 | .24 | 45.83 | .08 | -122.79 | |
| 2.20 | .47 | 150.34 | 1.89 | 40.28 | .25 | 44.90 | .07 | -139.24 | |
| 2.30 | .49 | 147.64 | 1.82 | 37.34 | .26 | 43.80 | .08 | -153.84 | |
| 2.40 | .50 | 145.08 | 1.76 | 34.99 | .27 | 43.04 | .08 | -167.79 | |
| 2.50 | .51 | 142.45 | 1.69 | 32.37 | .28 | 41.96 | .09 | -179.51 | |
| 2.60 | .52 | 140.11 | 1.63 | 29.82 | .28 | 40.68 | .11 | 170.08 | |
| 2.70 | .53 | 137.76 | 1.58 | 27.34 | .29 | 39.87 | .12 | 161.83 | |
| 2.80 | .54 | 135.51 | 1.53 | 25.00 | .30 | 38.78 | .14 | 156.48 | |
| 2.90 | .55 | 133.53 | 1.48 | 22.88 | .31 | 37.50 | .15 | 151.05 | |
| 3.00 | .56 | 131.71 | 1.44 | 20.88 | .32 | 36.35 | .17 | 146.82 | |

$V_{CE} = 3 \text{ V}$, $I_C = 7 \text{ mA}$, $Z_0 = 50 \Omega$

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|-------|--------|-----|-------|-----|---------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .78 | -31.29 | 13.97 | 151.51 | .03 | 71.78 | .87 | -24.42 | |
| .20 | .66 | -59.66 | 12.04 | 132.90 | .05 | 60.97 | .70 | -40.28 | |
| .30 | .54 | -84.82 | 10.35 | 118.21 | .07 | 56.44 | .55 | -48.33 | |
| .40 | .47 | -104.53 | 8.72 | 107.56 | .08 | 55.05 | .45 | -54.30 | |
| .50 | .42 | -119.83 | 7.38 | 99.69 | .09 | 54.45 | .37 | -57.44 | |
| .60 | .39 | -132.03 | 6.34 | 93.65 | .10 | 54.56 | .32 | -60.00 | |
| .70 | .37 | -142.05 | 5.56 | 88.39 | .11 | 54.88 | .28 | -61.66 | |
| .80 | .36 | -150.83 | 4.94 | 83.86 | .11 | 55.01 | .24 | -63.45 | |
| .90 | .36 | -158.17 | 4.45 | 79.83 | .12 | 55.07 | .21 | -65.04 | |
| 1.00 | .36 | -164.78 | 4.05 | 75.94 | .13 | 55.03 | .19 | -66.66 | |
| 1.10 | .36 | -170.73 | 3.71 | 72.52 | .15 | 54.76 | .17 | -68.84 | |
| 1.20 | .37 | -175.89 | 3.43 | 69.04 | .15 | 54.31 | .15 | -71.21 | |
| 1.30 | .37 | 179.16 | 3.19 | 65.94 | .17 | 53.90 | .13 | -74.02 | |
| 1.40 | .38 | 174.81 | 2.98 | 62.71 | .18 | 53.37 | .12 | -78.28 | |
| 1.50 | .39 | 170.80 | 2.80 | 59.72 | .19 | 52.52 | .10 | -83.83 | |
| 1.60 | .40 | 166.95 | 2.64 | 56.84 | .20 | 51.77 | .09 | -90.66 | |
| 1.70 | .40 | 163.55 | 2.51 | 54.06 | .21 | 50.73 | .07 | -100.27 | |
| 1.80 | .42 | 160.17 | 2.38 | 51.26 | .22 | 49.92 | .06 | -113.19 | |
| 1.90 | .42 | 157.10 | 2.27 | 48.51 | .23 | 48.83 | .06 | -128.68 | |
| 2.00 | .43 | 154.21 | 2.17 | 45.65 | .24 | 47.90 | .05 | -148.70 | |
| 2.10 | .45 | 151.39 | 2.08 | 43.23 | .25 | 46.78 | .06 | -164.37 | |
| 2.20 | .46 | 148.60 | 1.99 | 40.65 | .26 | 45.58 | .07 | 179.05 | |
| 2.30 | .47 | 146.09 | 1.91 | 38.02 | .27 | 44.32 | .08 | 168.05 | |
| 2.40 | .48 | 143.75 | 1.85 | 35.58 | .28 | 43.15 | .09 | 159.41 | |
| 2.50 | .49 | 141.28 | 1.78 | 33.14 | .29 | 41.96 | .11 | 152.83 | |
| 2.60 | .50 | 138.97 | 1.72 | 30.76 | .29 | 40.73 | .13 | 147.19 | |
| 2.70 | .51 | 136.66 | 1.65 | 28.32 | .30 | 39.56 | .15 | 142.36 | |
| 2.80 | .53 | 134.75 | 1.61 | 26.15 | .31 | 38.16 | .16 | 139.39 | |
| 2.90 | .54 | 132.61 | 1.56 | 23.94 | .32 | 36.97 | .18 | 135.62 | |
| 3.00 | .55 | 131.03 | 1.51 | 21.87 | .33 | 35.50 | .19 | 132.79 | |

S-PARAMETERS Q2

V_{CE} = 3 V, I_c = 10 mA, Z₀ = 50 Ω

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|-------|--------|-----|-------|-----|---------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .70 | -38.41 | 18.28 | 146.82 | .03 | 69.80 | .82 | -29.66 | |
| .20 | .56 | -71.49 | 14.88 | 126.35 | .05 | 61.45 | .61 | -46.31 | |
| .30 | .45 | -97.54 | 11.94 | 112.07 | .06 | 58.70 | .46 | -54.40 | |
| .40 | .39 | -116.40 | 9.67 | 102.58 | .07 | 58.67 | .37 | -59.06 | |
| .50 | .35 | -130.54 | 8.00 | 95.72 | .08 | 59.11 | .30 | -61.94 | |
| .60 | .34 | -141.64 | 6.81 | 90.48 | .09 | 59.40 | .26 | -64.34 | |
| .70 | .33 | -150.51 | 5.91 | 85.85 | .10 | 59.73 | .22 | -65.99 | |
| .80 | .33 | -158.31 | 5.24 | 81.79 | .11 | 59.53 | .19 | -68.05 | |
| .90 | .33 | -164.94 | 4.70 | 78.04 | .12 | 59.10 | .16 | -70.00 | |
| 1.00 | .33 | -170.77 | 4.27 | 74.52 | .14 | 58.94 | .14 | -72.05 | |
| 1.10 | .34 | -176.02 | 3.90 | 71.29 | .15 | 58.12 | .12 | -75.15 | |
| 1.20 | .34 | 179.29 | 3.60 | 68.08 | .16 | 57.53 | .11 | -78.53 | |
| 1.30 | .35 | 175.03 | 3.35 | 65.10 | .17 | 56.63 | .09 | -83.55 | |
| 1.40 | .36 | 171.11 | 3.12 | 62.00 | .18 | 55.78 | .07 | -91.04 | |
| 1.50 | .37 | 167.43 | 2.93 | 59.24 | .19 | 54.68 | .06 | -101.03 | |
| 1.60 | .38 | 163.97 | 2.76 | 56.49 | .20 | 53.56 | .05 | -116.44 | |
| 1.70 | .39 | 160.78 | 2.62 | 53.77 | .21 | 52.45 | .05 | -135.60 | |
| 1.80 | .40 | 157.85 | 2.49 | 51.11 | .22 | 51.12 | .05 | -157.62 | |
| 1.90 | .41 | 155.01 | 2.37 | 48.55 | .24 | 49.98 | .05 | -175.46 | |
| 2.00 | .42 | 152.28 | 2.26 | 45.88 | .25 | 48.84 | .06 | 168.53 | |
| 2.10 | .43 | 149.67 | 2.17 | 43.38 | .26 | 47.60 | .08 | 160.16 | |
| 2.20 | .44 | 147.06 | 2.08 | 40.98 | .27 | 45.92 | .09 | 151.50 | |
| 2.30 | .45 | 144.72 | 2.00 | 38.47 | .28 | 44.63 | .11 | 146.27 | |
| 2.40 | .47 | 142.40 | 1.92 | 36.25 | .29 | 43.30 | .12 | 141.74 | |
| 2.50 | .48 | 140.09 | 1.85 | 33.78 | .30 | 41.93 | .14 | 138.30 | |
| 2.60 | .49 | 137.98 | 1.79 | 31.35 | .30 | 40.49 | .16 | 134.62 | |
| 2.70 | .50 | 135.73 | 1.72 | 29.17 | .31 | 39.21 | .18 | 131.40 | |
| 2.80 | .51 | 133.91 | 1.66 | 27.03 | .32 | 37.72 | .19 | 129.30 | |
| 2.90 | .53 | 131.85 | 1.61 | 24.92 | .33 | 36.31 | .21 | 126.68 | |
| 3.00 | .54 | 130.31 | 1.57 | 22.81 | .34 | 34.93 | .22 | 124.44 | |

V_{CE} = 3 V, I_c = 20 mA, Z₀ = 50 Ω

| FREQUENCY | | S11 | | S21 | | S12 | | S22 | |
|-----------|-----|---------|-------|--------|-----|-------|-----|---------|--|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| .10 | .51 | -57.90 | 27.75 | 136.02 | .02 | 69.14 | .70 | -39.87 | |
| .20 | .37 | -97.17 | 19.04 | 114.46 | .04 | 64.83 | .46 | -56.12 | |
| .30 | .31 | -120.97 | 13.81 | 103.21 | .05 | 65.82 | .33 | -62.80 | |
| .40 | .29 | -137.00 | 10.72 | 95.92 | .06 | 66.30 | .26 | -66.88 | |
| .50 | .28 | -148.56 | 8.73 | 90.60 | .08 | 66.42 | .21 | -69.42 | |
| .60 | .28 | -157.11 | 7.34 | 86.37 | .09 | 66.46 | .17 | -72.27 | |
| .70 | .28 | -164.14 | 6.36 | 82.37 | .10 | 66.07 | .14 | -74.72 | |
| .80 | .29 | -170.13 | 5.60 | 78.94 | .11 | 65.59 | .12 | -78.14 | |
| .90 | .29 | -175.24 | 5.00 | 75.67 | .13 | 64.35 | .10 | -82.37 | |
| 1.00 | .30 | -179.80 | 4.54 | 72.57 | .14 | 63.61 | .08 | -87.43 | |
| 1.10 | .31 | 176.11 | 4.14 | 69.68 | .15 | 62.44 | .06 | -95.70 | |
| 1.20 | .32 | 172.24 | 3.81 | 66.74 | .16 | 61.26 | .05 | -106.92 | |
| 1.30 | .33 | 168.89 | 3.54 | 64.03 | .18 | 60.00 | .04 | -125.19 | |
| 1.40 | .33 | 165.67 | 3.30 | 61.30 | .19 | 58.62 | .04 | -147.69 | |
| 1.50 | .34 | 162.54 | 3.09 | 58.59 | .20 | 57.19 | .04 | -169.73 | |
| 1.60 | .36 | 159.63 | 2.92 | 56.05 | .21 | 55.87 | .05 | 172.11 | |
| 1.70 | .37 | 156.95 | 2.75 | 53.51 | .22 | 54.21 | .06 | 160.94 | |
| 1.80 | .38 | 154.25 | 2.62 | 50.89 | .24 | 52.77 | .08 | 151.72 | |
| 1.90 | .39 | 151.91 | 2.49 | 48.43 | .25 | 51.15 | .09 | 146.45 | |
| 2.00 | .40 | 149.52 | 2.37 | 46.16 | .26 | 49.78 | .11 | 140.92 | |
| 2.10 | .41 | 147.23 | 2.28 | 43.59 | .27 | 48.30 | .12 | 137.70 | |
| 2.20 | .43 | 144.75 | 2.18 | 41.14 | .28 | 46.71 | .14 | 134.44 | |
| 2.30 | .44 | 142.69 | 2.08 | 38.93 | .29 | 44.97 | .15 | 131.54 | |
| 2.40 | .45 | 140.59 | 2.01 | 36.56 | .30 | 43.43 | .17 | 129.29 | |
| 2.50 | .46 | 138.42 | 1.94 | 34.42 | .31 | 41.99 | .19 | 127.04 | |
| 2.60 | .48 | 136.43 | 1.86 | 32.01 | .32 | 40.23 | .21 | 124.65 | |
| 2.70 | .49 | 134.31 | 1.79 | 29.91 | .32 | 38.85 | .22 | 122.41 | |
| 2.80 | .50 | 132.45 | 1.74 | 27.72 | .33 | 37.40 | .24 | 120.79 | |
| 2.90 | .51 | 130.66 | 1.68 | 25.97 | .34 | 35.83 | .25 | 118.94 | |
| 3.00 | .52 | 129.12 | 1.63 | 23.88 | .35 | 34.25 | .27 | 117.03 | |

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NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

Anti-radioactive design is not implemented in this product.