DATA SHEET

NEC

# SILICON TRANSISTOR
# 2SC5191

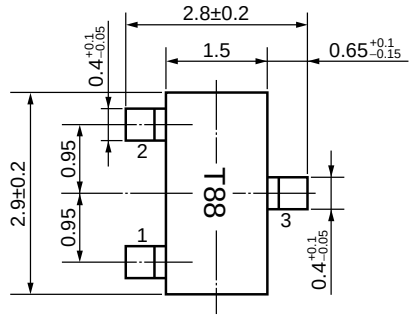
## MICROWAVE LOW NOISE AMPLIFIER
## NPN SILICON EPITAXIAL TRANSISTOR

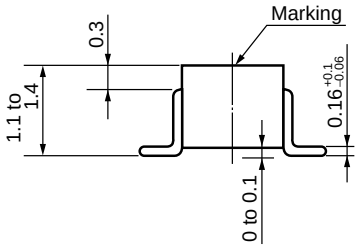
### FEATURES

- Low Voltage Operation, Low Phase Distortion
- Low Noise
  NF = 1.5 dB TYP. @ $V_{CE}$ = 3 V, $I_C$ = 7 mA, f = 2 GHz
  NF = 1.7 dB TYP. @ $V_{CE}$ = 1 V, $I_C$ = 3 mA, f = 2 GHz
- Large Absolute Maximum Collector Current
  $I_C$ = 100 mA
- Mini Mold Package
  EIAJ: SC-59

### PACKAGE DRAWINGS

(Unit: mm)




**PIN CONNECTIONS**

1. Emitter
2. Base
3. Collector

### ORDERING INFORMATION

| PART NUMBER | QUANTITY | PACKING STYLE |
|---|---|---|
| 2SC5191-T1 | 3 Kpcs/Reel | Embossed tape 8 mm wide.<br>Pin 3 (collector) face to perforation side of the tape. |
| 2SC5191-T2 | 3 Kpcs/Reel | Embossed tape 8 mm wide.<br>Pin 1 (Emitter), Pin 2 (Base) face to perforation side of the tape. |

**Remark** If you require an evaluation sample, please contact an NEC Sales Representative. (Unit sample quantity is 50 pcs.)

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

| PARAMETER | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Collector to Base Voltage | $V_{CBO}$ | 9 | V |
| Collector to Emitter Voltage | $V_{CEO}$ | 6 | V |
| Emitter to Base Voltage | $V_{EBO}$ | 2 | V |
| Collector Current | $I_C$ | 100 | mA |
| Total Power Dissipation | $P_T$ | 200 | mW |
| Junction Temperature | $T_j$ | 150 | °C |
| Storage Temperature | $T_{stg}$ | −65 to +150 | °C |

**This device uses radio frequency technology. Take due precautions to protect it from excessive input levels such as static electricity.**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## ELECTRICAL CHARACTERISTICS ($T_A$ = 25 °C)

| PARAMETER | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Collector Cutoff Current | $I_{CBO}$ | $V_{CB}$ = 5 V, $I_E$ = 0 | | | 100 | nA |
| Emitter Cutoff Current | $I_{EBO}$ | $V_{EB}$ = 1 V, $I_C$ = 0 | | | 100 | nA |
| DC Current Gain | $h_{FE}$ | $V_{CE}$ = 1 V, $I_C$ = 3 mA[Note 1] | 80 | | 160 | |
| Insertion Power Gain (1) | $\|S_{21e}\|^2$ | $V_{CE}$ = 1 V, $I_C$ = 3 mA, f = 2.0 GHz | 2.5 | 3.5 | | dB |
| Insertion Power Gain (2) | $\|S_{21e}\|^2$ | $V_{CE}$ = 3 V, $I_C$ = 20 mA, f = 2.0 GHz | | 6.5 | | dB |
| Noise Figure (1) | NF | $V_{CE}$ = 1 V, $I_C$ = 3 mA, f = 2.0 GHz | | 1.7 | 2.5 | dB |
| Noise Figure (2) | NF | $V_{CE}$ = 3 V, $I_C$ = 7 mA, f = 2.0 GHz | | 1.5 | | dB |
| Gain Bandwidth Product (1) | $f_T$ | $V_{CE}$ = 1 V, $I_C$ = 3 mA, f = 2.0 GHz | 4 | 4.5 | | GHz |
| Gain Bandwidth Product (2) | $f_T$ | $V_{CE}$ = 3 V, $I_C$ = 20 mA, f = 2.0 GHz | | 8.5 | | GHz |
| Collector Capacitance | $C_{re}$ | $V_{CB}$ = 1 V, $I_E$ = 0, f = 1.0 MHz[Note 2] | | 0.75 | 0.85 | pF |

**Notes 1.** Pulse Measurement: PW ≤ 350 $\mu$s, Duty cycle ≤ 2 %, Pulsed

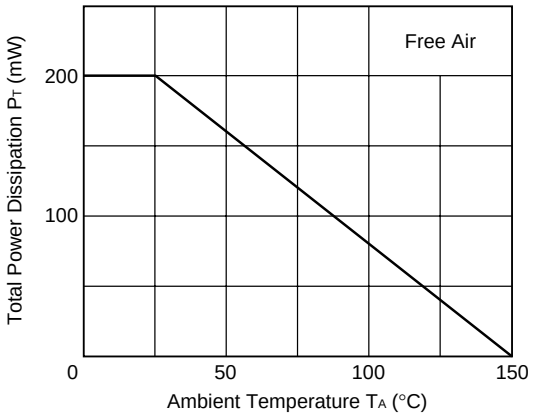
**2.** Measured with 3-pin bridge, emitter and case should be connected to guard pin of bridge.

### $h_{FE}$ Classification

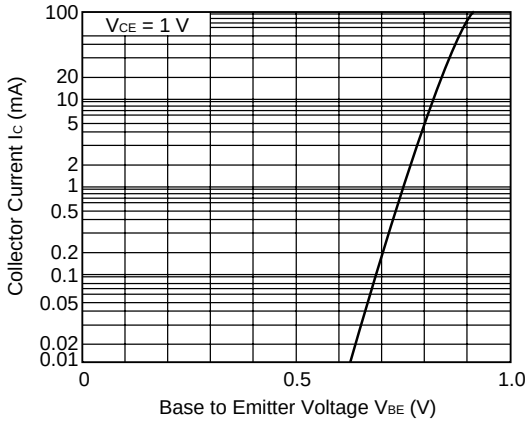
| Rank | FB |
|---|---|
| Marking | T88 |
| $h_{FE}$ | 80 to 160 |

## TYPICAL CHARACTERISTICS ($T_A$ = 25 °C)

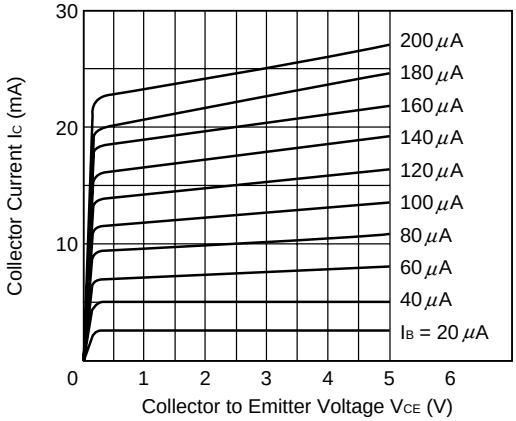
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



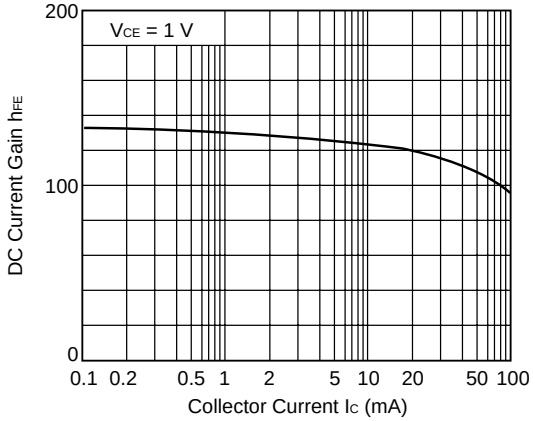

COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



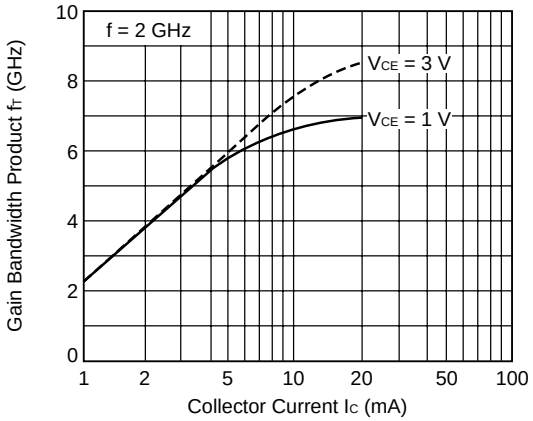

COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE



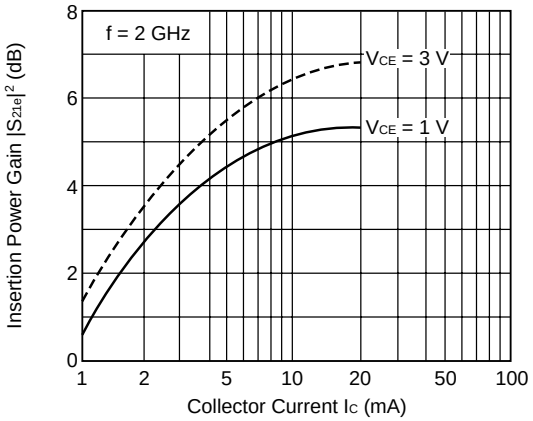

DC CURRENT GAIN vs. COLLECTOR CURRENT



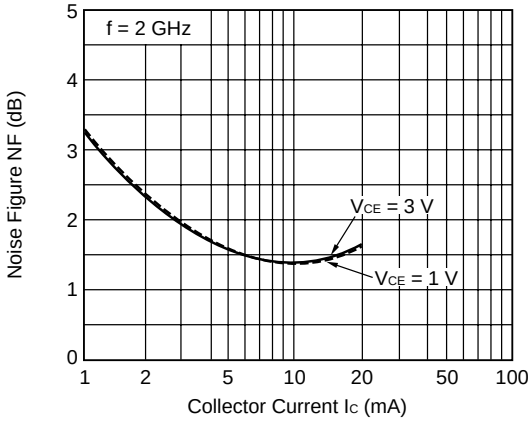

GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



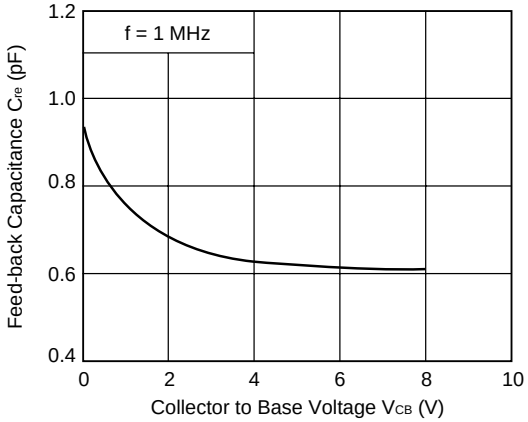

INSERTION GAIN vs. COLLECTOR CURRENT



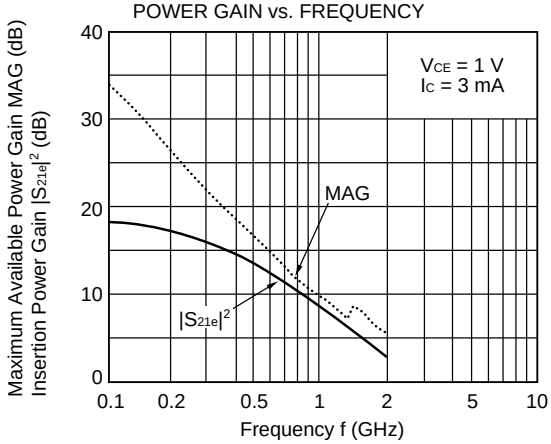
NOISE FIGURE vs.
COLLECTOR CURRENT




FEED-BACK CAPACITANCE vs.
COLECTOR TO BASE VOLTAGE




MAXIMUM AVAILABLE GAIN/INSERTION
POWER GAIN vs. FREQUENCY



## S-PARAMETERS

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

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.969 | –17.1 | 3.342 | 165.9 | 0.058 | 80.2 | 0.990 | –9.6 |
| 200.00 | 0.923 | –34.8 | 3.220 | 152.2 | 0.099 | 71.6 | 0.948 | –17.9 |
| 300.00 | 0.868 | –51.0 | 3.032 | 139.4 | 0.141 | 61.0 | 0.877 | –26.0 |
| 400.00 | 0.831 | –65.4 | 2.785 | 128.8 | 0.167 | 49.6 | 0.821 | –33.3 |
| 500.00 | 0.762 | –79.3 | 2.592 | 118.8 | 0.186 | 45.7 | 0.766 | –38.6 |
| 600.00 | 0.715 | –91.0 | 2.355 | 109.3 | 0.202 | 37.4 | 0.710 | –42.5 |
| 700.00 | 0.678 | –103.8 | 2.190 | 100.6 | 0.210 | 34.9 | 0.664 | –46.5 |
| 800.00 | 0.645 | –113.9 | 2.020 | 94.1 | 0.219 | 30.8 | 0.629 | –50.1 |
| 900.00 | 0.617 | –124.9 | 1.849 | 86.6 | 0.216 | 26.8 | 0.599 | –54.8 |
| 1000.00 | 0.600 | –134.1 | 1.759 | 80.4 | 0.226 | 23.6 | 0.573 | –56.2 |
| 1100.00 | 0.586 | –141.8 | 1.638 | 75.2 | 0.220 | 25.1 | 0.546 | –60.1 |
| 1200.00 | 0.559 | –150.3 | 1.530 | 70.0 | 0.223 | 23.0 | 0.514 | –60.4 |
| 1300.00 | 0.556 | –158.1 | 1.459 | 65.1 | 0.213 | 24.1 | 0.513 | –64.9 |
| 1400.00 | 0.551 | –166.4 | 1.379 | 61.2 | 0.216 | 26.2 | 0.495 | –66.4 |
| 1500.00 | 0.532 | –171.2 | 1.288 | 56.1 | 0.207 | 24.3 | 0.481 | –69.4 |
| 1600.00 | 0.553 | –177.8 | 1.237 | 53.3 | 0.209 | 25.5 | 0.477 | –72.0 |
| 1700.00 | 0.552 | 176.8 | 1.206 | 50.2 | 0.214 | 26.9 | 0.468 | –75.2 |
| 1800.00 | 0.548 | 170.0 | 1.145 | 46.7 | 0.204 | 29.2 | 0.470 | –78.4 |
| 1900.00 | 0.537 | 164.3 | 1.058 | 43.5 | 0.199 | 30.8 | 0.470 | –80.9 |
| 2000.00 | 0.552 | 160.5 | 1.051 | 41.2 | 0.209 | 31.8 | 0.442 | –84.6 |

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

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.878 | –27.3 | 8.524 | 158.6 | 0.042 | 70.2 | 0.931 | –17.4 |
| 200.00 | 0.795 | –52.6 | 7.536 | 140.5 | 0.086 | 63.9 | 0.840 | –32.4 |
| 300.00 | 0.692 | –73.3 | 6.465 | 125.8 | 0.113 | 52.7 | 0.708 | –43.3 |
| 400.00 | 0.612 | –90.3 | 5.488 | 115.3 | 0.123 | 47.8 | 0.602 | –51.1 |
| 500.00 | 0.553 | –105.9 | 4.763 | 106.3 | 0.143 | 44.7 | 0.535 | –56.7 |
| 600.00 | 0.511 | –117.9 | 4.142 | 98.5 | 0.153 | 43.8 | 0.479 | –61.1 |
| 700.00 | 0.477 | –130.1 | 3.673 | 92.1 | 0.156 | 42.1 | 0.422 | –64.5 |
| 800.00 | 0.449 | –139.3 | 3.273 | 86.6 | 0.164 | 40.8 | 0.386 | –67.9 |
| 900.00 | 0.443 | –149.3 | 2.951 | 81.4 | 0.166 | 42.2 | 0.362 | –70.5 |
| 1000.00 | 0.427 | –158.0 | 2.727 | 76.5 | 0.185 | 41.3 | 0.337 | –73.2 |
| 1100.00 | 0.430 | –165.7 | 2.524 | 72.4 | 0.183 | 40.8 | 0.318 | –75.0 |
| 1200.00 | 0.414 | –171.7 | 2.338 | 68.5 | 0.196 | 42.5 | 0.287 | –79.0 |
| 1300.00 | 0.409 | –178.9 | 2.194 | 64.4 | 0.205 | 42.9 | 0.295 | –81.7 |
| 1400.00 | 0.421 | 177.0 | 2.072 | 61.3 | 0.211 | 42.6 | 0.277 | –83.9 |
| 1500.00 | 0.397 | 170.0 | 1.924 | 57.3 | 0.221 | 41.8 | 0.264 | –86.1 |
| 1600.00 | 0.430 | 165.1 | 1.823 | 55.2 | 0.228 | 41.2 | 0.258 | –87.3 |
| 1700.00 | 0.415 | 161.5 | 1.753 | 52.2 | 0.242 | 43.4 | 0.257 | –94.1 |
| 1800.00 | 0.446 | 155.0 | 1.641 | 48.9 | 0.252 | 44.0 | 0.242 | –96.0 |
| 1900.00 | 0.414 | 150.3 | 1.561 | 46.7 | 0.261 | 42.6 | 0.239 | –95.3 |
| 2000.00 | 0.432 | 147.2 | 1.523 | 44.6 | 0.268 | 42.8 | 0.227 | –103.4 |

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

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.828 | –34.9 | 12.029 | 153.2 | 0.047 | 72.5 | 0.896 | –23.8 |
| 200.00 | 0.698 | –64.4 | 9.922 | 133.0 | 0.076 | 59.6 | 0.750 | –41.2 |
| 300.00 | 0.586 | –86.5 | 8.024 | 118.3 | 0.100 | 52.5 | 0.602 | –53.1 |
| 400.00 | 0.513 | –103.4 | 6.568 | 108.6 | 0.111 | 49.5 | 0.488 | –61.1 |
| 500.00 | 0.461 | –118.7 | 5.561 | 100.5 | 0.121 | 48.7 | 0.428 | –66.7 |
| 600.00 | 0.423 | –132.0 | 4.754 | 93.8 | 0.129 | 46.9 | 0.363 | –71.2 |
| 700.00 | 0.409 | –143.3 | 4.178 | 88.3 | 0.147 | 49.8 | 0.330 | –74.3 |
| 800.00 | 0.379 | –152.0 | 3.699 | 83.5 | 0.156 | 47.9 | 0.299 | –77.4 |
| 900.00 | 0.396 | –160.6 | 3.317 | 78.8 | 0.162 | 47.2 | 0.275 | –82.9 |
| 1000.00 | 0.380 | –169.2 | 3.040 | 74.6 | 0.178 | 48.4 | 0.260 | –84.9 |
| 1100.00 | 0.386 | –175.8 | 2.810 | 70.8 | 0.185 | 49.2 | 0.237 | –87.8 |
| 1200.00 | 0.379 | 177.9 | 2.596 | 67.4 | 0.200 | 48.0 | 0.222 | –90.4 |
| 1300.00 | 0.374 | 172.3 | 2.412 | 63.9 | 0.208 | 48.2 | 0.224 | –95.8 |
| 1400.00 | 0.385 | 167.2 | 2.269 | 60.9 | 0.216 | 47.4 | 0.203 | –97.8 |
| 1500.00 | 0.366 | 162.1 | 2.136 | 57.4 | 0.233 | 46.8 | 0.197 | –101.8 |
| 1600.00 | 0.394 | 157.6 | 1.994 | 55.6 | 0.247 | 47.5 | 0.189 | –105.4 |
| 1700.00 | 0.387 | 154.4 | 1.940 | 52.4 | 0.253 | 48.2 | 0.200 | –107.6 |
| 1800.00 | 0.401 | 149.9 | 1.822 | 50.2 | 0.265 | 46.1 | 0.186 | –112.3 |
| 1900.00 | 0.394 | 143.8 | 1.705 | 47.1 | 0.276 | 47.1 | 0.181 | –108.8 |
| 2000.00 | 0.413 | 142.2 | 1.661 | 45.5 | 0.294 | 46.2 | 0.183 | –122.0 |

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

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.765 | –41.7 | 14.938 | 148.5 | 0.047 | 67.6 | 0.856 | –29.5 |
| 200.00 | 0.621 | –74.7 | 11.624 | 127.4 | 0.069 | 57.3 | 0.675 | –49.1 |
| 300.00 | 0.514 | –97.4 | 8.988 | 113.0 | 0.089 | 52.6 | 0.516 | –61.4 |
| 400.00 | 0.450 | –114.0 | 7.200 | 104.2 | 0.105 | 48.1 | 0.417 | –69.3 |
| 500.00 | 0.417 | –129.8 | 6.002 | 96.8 | 0.119 | 51.6 | 0.358 | –75.2 |
| 600.00 | 0.382 | –141.2 | 5.090 | 90.7 | 0.132 | 50.0 | 0.312 | –77.7 |
| 700.00 | 0.370 | –153.0 | 4.437 | 85.7 | 0.138 | 54.3 | 0.274 | –81.5 |
| 800.00 | 0.352 | –161.1 | 3.924 | 81.5 | 0.152 | 52.4 | 0.248 | –88.8 |
| 900.00 | 0.368 | –168.9 | 3.502 | 77.3 | 0.158 | 53.2 | 0.231 | –92.2 |
| 1000.00 | 0.358 | –177.0 | 3.198 | 73.1 | 0.176 | 53.7 | 0.211 | –93.2 |
| 1100.00 | 0.360 | 177.8 | 2.961 | 70.1 | 0.191 | 52.3 | 0.191 | –100.3 |
| 1200.00 | 0.360 | 171.7 | 2.726 | 66.8 | 0.206 | 53.1 | 0.185 | –101.6 |
| 1300.00 | 0.365 | 165.9 | 2.534 | 63.2 | 0.217 | 52.1 | 0.187 | –105.6 |
| 1400.00 | 0.369 | 160.9 | 2.380 | 60.3 | 0.235 | 51.6 | 0.171 | –111.0 |
| 1500.00 | 0.351 | 155.9 | 2.225 | 57.4 | 0.240 | 50.3 | 0.165 | –119.0 |
| 1600.00 | 0.382 | 153.0 | 2.099 | 55.6 | 0.258 | 50.4 | 0.157 | –119.3 |
| 1700.00 | 0.374 | 150.9 | 2.035 | 52.8 | 0.267 | 50.3 | 0.166 | –125.9 |
| 1800.00 | 0.395 | 145.3 | 1.909 | 50.1 | 0.276 | 47.7 | 0.166 | –132.7 |
| 1900.00 | 0.389 | 140.7 | 1.796 | 48.2 | 0.279 | 48.1 | 0.156 | –130.1 |
| 2000.00 | 0.394 | 137.7 | 1.732 | 46.0 | 0.307 | 45.0 | 0.158 | –138.8 |

$V_{CE}$ = 1 V, $I_C$ = 10 mA, $Z_O$ = 50 Ω

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.709 | –49.2 | 17.593 | 143.9 | 0.046 | 65.1 | 0.813 | –35.5 |
| 200.00 | 0.559 | –84.3 | 12.812 | 122.2 | 0.062 | 62.1 | 0.599 | –55.4 |
| 300.00 | 0.453 | –107.2 | 9.641 | 108.9 | 0.078 | 52.2 | 0.458 | –68.8 |
| 400.00 | 0.402 | –124.4 | 7.603 | 100.7 | 0.099 | 55.9 | 0.354 | –78.2 |
| 500.00 | 0.380 | –139.0 | 6.276 | 93.8 | 0.108 | 52.3 | 0.308 | –84.6 |
| 600.00 | 0.354 | –149.7 | 5.297 | 88.3 | 0.122 | 55.0 | 0.254 | –88.0 |
| 700.00 | 0.346 | –160.7 | 4.604 | 83.8 | 0.140 | 56.0 | 0.232 | –93.3 |
| 800.00 | 0.334 | –168.4 | 4.044 | 79.8 | 0.145 | 57.5 | 0.208 | –98.3 |
| 900.00 | 0.356 | –175.4 | 3.614 | 75.9 | 0.163 | 55.1 | 0.202 | –102.5 |
| 1000.00 | 0.346 | 176.7 | 3.290 | 72.1 | 0.173 | 54.1 | 0.177 | –107.7 |
| 1100.00 | 0.353 | 171.9 | 3.049 | 69.0 | 0.191 | 53.3 | 0.167 | –110.5 |
| 1200.00 | 0.360 | 166.4 | 2.806 | 65.7 | 0.201 | 54.7 | 0.157 | –116.5 |
| 1300.00 | 0.351 | 161.2 | 2.610 | 62.6 | 0.218 | 53.0 | 0.161 | –120.6 |
| 1400.00 | 0.361 | 156.0 | 2.434 | 60.1 | 0.240 | 53.4 | 0.150 | –128.5 |
| 1500.00 | 0.351 | 150.0 | 2.296 | 57.6 | 0.255 | 50.8 | 0.140 | –131.4 |
| 1600.00 | 0.378 | 149.4 | 2.154 | 55.4 | 0.269 | 52.3 | 0.160 | –137.6 |
| 1700.00 | 0.356 | 146.5 | 2.090 | 52.4 | 0.279 | 50.8 | 0.166 | –136.0 |
| 1800.00 | 0.386 | 141.6 | 1.942 | 50.7 | 0.295 | 49.8 | 0.139 | –138.1 |
| 1900.00 | 0.379 | 139.0 | 1.844 | 47.8 | 0.297 | 48.5 | 0.143 | –138.2 |
| 2000.00 | 0.404 | 135.6 | 1.787 | 45.7 | 0.309 | 47.5 | 0.148 | –148.3 |

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

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.963 | –15.6 | 3.352 | 167.4 | 0.039 | 69.0 | 0.987 | –7.2 |
| 200.00 | 0.935 | –31.4 | 3.268 | 155.2 | 0.077 | 70.7 | 0.966 | –14.3 |
| 300.00 | 0.889 | –45.5 | 3.121 | 143.4 | 0.110 | 63.1 | 0.912 | –20.7 |
| 400.00 | 0.846 | –59.2 | 2.893 | 133.6 | 0.133 | 52.8 | 0.872 | –26.2 |
| 500.00 | 0.791 | –71.9 | 2.735 | 124.1 | 0.152 | 50.6 | 0.824 | –30.9 |
| 600.00 | 0.734 | –83.7 | 2.517 | 115.0 | 0.163 | 43.2 | 0.782 | –34.5 |
| 700.00 | 0.694 | –96.2 | 2.371 | 106.7 | 0.156 | 39.1 | 0.737 | –38.5 |
| 800.00 | 0.668 | –105.7 | 2.182 | 99.9 | 0.184 | 35.4 | 0.689 | –40.8 |
| 900.00 | 0.633 | –117.2 | 2.022 | 92.6 | 0.183 | 33.0 | 0.660 | –45.4 |
| 1000.00 | 0.611 | –127.2 | 1.927 | 86.7 | 0.181 | 32.4 | 0.648 | –46.8 |
| 1100.00 | 0.597 | –135.2 | 1.796 | 81.0 | 0.183 | 30.1 | 0.610 | –48.9 |
| 1200.00 | 0.564 | –143.3 | 1.681 | 76.1 | 0.171 | 29.2 | 0.590 | –50.7 |
| 1300.00 | 0.544 | –151.2 | 1.601 | 71.1 | 0.180 | 29.4 | 0.587 | –53.7 |
| 1400.00 | 0.543 | –159.7 | 1.510 | 66.8 | 0.169 | 29.2 | 0.581 | –55.6 |
| 1500.00 | 0.531 | –165.5 | 1.410 | 61.6 | 0.173 | 30.4 | 0.565 | –58.4 |
| 1600.00 | 0.542 | –173.1 | 1.336 | 58.9 | 0.172 | 32.6 | 0.552 | –60.9 |
| 1700.00 | 0.535 | –178.3 | 1.314 | 56.0 | 0.178 | 34.3 | 0.541 | –63.7 |
| 1800.00 | 0.529 | 174.4 | 1.244 | 52.3 | 0.161 | 36.6 | 0.545 | –66.0 |
| 1900.00 | 0.515 | 169.5 | 1.163 | 48.4 | 0.171 | 38.1 | 0.548 | –68.1 |
| 2000.00 | 0.531 | 164.3 | 1.136 | 46.0 | 0.183 | 40.1 | 0.530 | –71.4 |

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

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.896 | –23.6 | 8.711 | 160.8 | 0.040 | 74.9 | 0.949 | –13.8 |
| 200.00 | 0.812 | –45.2 | 7.884 | 144.2 | 0.071 | 66.3 | 0.877 | –24.9 |
| 300.00 | 0.715 | –63.9 | 6.914 | 130.2 | 0.092 | 59.1 | 0.757 | –34.5 |
| 400.00 | 0.636 | –79.4 | 5.959 | 119.9 | 0.103 | 51.9 | 0.673 | –40.1 |
| 500.00 | 0.566 | –92.8 | 5.241 | 111.0 | 0.116 | 48.4 | 0.609 | –44.6 |
| 600.00 | 0.516 | –104.7 | 4.591 | 103.1 | 0.124 | 45.4 | 0.546 | –47.4 |
| 700.00 | 0.464 | –117.5 | 4.116 | 96.5 | 0.131 | 42.4 | 0.499 | –50.0 |
| 800.00 | 0.428 | –127.4 | 3.676 | 91.1 | 0.149 | 44.5 | 0.465 | –52.8 |
| 900.00 | 0.427 | –138.6 | 3.330 | 85.4 | 0.144 | 44.9 | 0.433 | –55.1 |
| 1000.00 | 0.389 | –147.0 | 3.073 | 81.1 | 0.155 | 45.7 | 0.420 | –55.8 |
| 1100.00 | 0.384 | –154.9 | 2.843 | 76.8 | 0.162 | 45.7 | 0.389 | –57.5 |
| 1200.00 | 0.380 | –162.2 | 2.638 | 72.7 | 0.168 | 46.5 | 0.363 | –57.4 |
| 1300.00 | 0.364 | –170.0 | 2.470 | 68.8 | 0.176 | 47.0 | 0.367 | –60.1 |
| 1400.00 | 0.378 | –177.8 | 2.325 | 65.7 | 0.191 | 49.7 | 0.360 | –62.3 |
| 1500.00 | 0.361 | 178.3 | 2.162 | 61.6 | 0.190 | 46.6 | 0.333 | –64.2 |
| 1600.00 | 0.382 | 172.1 | 2.045 | 59.6 | 0.203 | 47.2 | 0.320 | –65.9 |
| 1700.00 | 0.371 | 169.0 | 1.973 | 56.6 | 0.210 | 49.3 | 0.328 | –70.4 |
| 1800.00 | 0.386 | 162.2 | 1.854 | 53.8 | 0.217 | 48.5 | 0.311 | –72.5 |
| 1900.00 | 0.373 | 156.8 | 1.749 | 50.6 | 0.230 | 50.1 | 0.321 | –73.1 |
| 2000.00 | 0.387 | 153.1 | 1.703 | 48.6 | 0.236 | 50.1 | 0.299 | –75.8 |

$V_{CE}$ = 3 V, $I_C$ = 5 mA, $Z_O$ = 50 Ω

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.847 | –29.5 | 12.405 | 156.1 | 0.040 | 66.7 | 0.922 | –18.5 |
| 200.00 | 0.718 | –54.0 | 10.551 | 137.2 | 0.064 | 65.1 | 0.805 | –31.9 |
| 300.00 | 0.607 | –74.5 | 8.790 | 122.8 | 0.083 | 59.2 | 0.662 | –41.3 |
| 400.00 | 0.525 | –89.4 | 7.304 | 113.1 | 0.097 | 53.0 | 0.566 | –47.1 |
| 500.00 | 0.454 | –103.9 | 6.251 | 104.8 | 0.102 | 51.9 | 0.494 | –50.6 |
| 600.00 | 0.402 | –115.9 | 5.383 | 97.9 | 0.115 | 51.6 | 0.445 | –52.2 |
| 700.00 | 0.379 | –127.6 | 4.744 | 92.2 | 0.124 | 53.4 | 0.401 | –55.5 |
| 800.00 | 0.349 | –137.8 | 4.216 | 87.5 | 0.127 | 51.1 | 0.377 | –56.2 |
| 900.00 | 0.347 | –148.2 | 3.784 | 82.7 | 0.145 | 52.8 | 0.348 | –59.2 |
| 1000.00 | 0.318 | –155.9 | 3.477 | 78.6 | 0.157 | 53.3 | 0.326 | –59.1 |
| 1100.00 | 0.323 | –163.8 | 3.202 | 75.0 | 0.162 | 52.3 | 0.293 | –63.5 |
| 1200.00 | 0.320 | –171.7 | 2.963 | 71.4 | 0.175 | 52.8 | 0.288 | –63.2 |
| 1300.00 | 0.313 | –177.4 | 2.751 | 67.9 | 0.191 | 53.5 | 0.294 | –66.9 |
| 1400.00 | 0.320 | 175.0 | 2.589 | 65.1 | 0.192 | 50.9 | 0.281 | –68.0 |
| 1500.00 | 0.305 | 169.8 | 2.421 | 61.2 | 0.195 | 51.4 | 0.263 | –68.7 |
| 1600.00 | 0.327 | 163.6 | 2.276 | 59.4 | 0.210 | 53.1 | 0.245 | –71.4 |
| 1700.00 | 0.308 | 162.5 | 2.203 | 56.8 | 0.226 | 51.8 | 0.248 | –75.4 |
| 1800.00 | 0.341 | 156.8 | 2.069 | 53.9 | 0.230 | 51.2 | 0.236 | –76.9 |
| 1900.00 | 0.327 | 148.3 | 1.951 | 51.1 | 0.239 | 51.3 | 0.241 | –78.1 |
| 2000.00 | 0.333 | 147.6 | 1.891 | 49.4 | 0.254 | 50.4 | 0.226 | –83.2 |

$V_{CE}$ = 3 V, $I_C$ = 7 mA, $Z_O$ = 50 Ω

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.780 | –33.5 | 15.604 | 151.8 | 0.034 | 75.0 | 0.889 | –22.4 |
| 200.00 | 0.639 | –61.9 | 12.605 | 131.6 | 0.059 | 62.9 | 0.738 | –37.1 |
| 300.00 | 0.520 | –82.6 | 10.059 | 117.5 | 0.080 | 59.3 | 0.580 | –46.6 |
| 400.00 | 0.442 | –97.6 | 8.162 | 108.4 | 0.085 | 56.6 | 0.494 | –52.5 |
| 500.00 | 0.382 | –112.6 | 6.855 | 100.9 | 0.098 | 55.7 | 0.427 | –54.4 |
| 600.00 | 0.346 | –124.7 | 5.848 | 94.6 | 0.108 | 56.5 | 0.373 | –55.5 |
| 700.00 | 0.318 | –136.6 | 5.125 | 89.5 | 0.118 | 57.5 | 0.344 | –58.1 |
| 800.00 | 0.295 | –144.5 | 4.525 | 85.3 | 0.131 | 57.5 | 0.314 | –60.2 |
| 900.00 | 0.297 | –156.6 | 4.059 | 80.8 | 0.134 | 55.0 | 0.290 | –63.1 |
| 1000.00 | 0.282 | –164.9 | 3.730 | 77.0 | 0.153 | 56.6 | 0.284 | –62.8 |
| 1100.00 | 0.285 | –170.0 | 3.414 | 73.7 | 0.164 | 58.3 | 0.269 | –64.7 |
| 1200.00 | 0.279 | –177.0 | 3.152 | 70.5 | 0.178 | 56.0 | 0.247 | –67.7 |
| 1300.00 | 0.269 | 176.0 | 2.945 | 67.1 | 0.188 | 55.8 | 0.234 | –70.3 |
| 1400.00 | 0.295 | 169.7 | 2.762 | 64.6 | 0.204 | 57.0 | 0.224 | –70.8 |
| 1500.00 | 0.278 | 163.5 | 2.572 | 61.2 | 0.213 | 54.7 | 0.222 | –73.1 |
| 1600.00 | 0.297 | 161.3 | 2.427 | 59.6 | 0.225 | 53.1 | 0.225 | –74.4 |
| 1700.00 | 0.281 | 156.8 | 2.331 | 56.8 | 0.240 | 53.9 | 0.212 | –82.0 |
| 1800.00 | 0.318 | 151.6 | 2.194 | 54.5 | 0.247 | 52.9 | 0.198 | 82.6 |
| 1900.00 | 0.293 | 144.1 | 2.073 | 51.3 | 0.263 | 52.6 | 0.210 | –82.6 |
| 2000.00 | 0.307 | 144.2 | 2.009 | 49.7 | 0.266 | 51.3 | 0.183 | –89.8 |

$V_{CE}$ = 3 V, $I_C$ = 10 mA, $Z_O$ = 50 Ω

| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| (MHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 100.00 | 0.731 | –39.7 | 18.468 | 148.0 | 0.036 | 64.3 | 0.857 | –27.2 |
| 200.00 | 0.570 | –68.3 | 14.160 | 127.2 | 0.055 | 62.0 | 0.676 | –41.8 |
| 300.00 | 0.453 | –88.8 | 10.931 | 113.5 | 0.070 | 57.7 | 0.530 | –50.0 |
| 400.00 | 0.381 | –104.3 | 8.738 | 105.0 | 0.085 | 59.4 | 0.432 | –56.4 |
| 500.00 | 0.334 | –119.4 | 7.284 | 98.1 | 0.093 | 58.9 | 0.380 | –57.7 |
| 600.00 | 0.297 | –131.4 | 6.170 | 92.4 | 0.103 | 60.7 | 0.332 | –60.1 |
| 700.00 | 0.285 | –145.7 | 5.377 | 87.6 | 0.121 | 57.6 | 0.297 | –61.5 |
| 800.00 | 0.254 | –151.0 | 4.738 | 83.8 | 0.133 | 61.4 | 0.278 | –62.8 |
| 900.00 | 0.274 | –161.8 | 4.232 | 79.8 | 0.142 | 62.0 | 0.248 | –65.8 |
| 1000.00 | 0.250 | –169.5 | 3.882 | 76.2 | 0.158 | 60.6 | 0.237 | –65.0 |
| 1100.00 | 0.263 | –176.4 | 3.572 | 72.8 | 0.164 | 58.0 | 0.228 | –68.8 |
| 1200.00 | 0.260 | 176.4 | 3.289 | 70.0 | 0.182 | 58.9 | 0.198 | –70.3 |
| 1300.00 | 0.251 | 170.1 | 3.069 | 66.6 | 0.192 | 56.8 | 0.211 | –71.3 |
| 1400.00 | 0.259 | 166.9 | 2.885 | 64.3 | 0.201 | 56.1 | 0.202 | –75.4 |
| 1500.00 | 0.253 | 161.3 | 2.685 | 60.9 | 0.214 | 54.6 | 0.186 | –80.0 |
| 1600.00 | 0.283 | 155.7 | 2.519 | 59.4 | 0.230 | 55.9 | 0.180 | –80.6 |
| 1700.00 | 0.270 | 152.5 | 2.427 | 56.9 | 0.243 | 56.3 | 0.171 | –81.9 |
| 1800.00 | 0.310 | 146.5 | 2.278 | 54.8 | 0.256 | 52.8 | 0.175 | –86.6 |
| 1900.00 | 0.281 | 141.1 | 2.145 | 51.8 | 0.268 | 54.0 | 0.169 | –86.4 |
| 2000.00 | 0.306 | 139.5 | 2.088 | 50.1 | 0.281 | 51.6 | 0.160 | –98.9 |

**[MEMO]**

**[MEMO]**