

**NEC**

**SILICON TRANSISTOR**  
**2SC5193**

**MICROWAVE LOW NOISE AMPLIFIER**  
**NPN SILICON EPITAXIAL TRANSISTOR**  
**COMPACT MINI MOLD**

**FEATURES**

- Low Voltage Operation, Low Phase Distortion
- Low Noise  
 $NF = 1.5 \text{ dB TYP. @ } V_{CE} = 3 \text{ V, } I_c = 7 \text{ mA, } f = 2 \text{ GHz}$   
 $NF = 1.7 \text{ dB TYP. @ } V_{CE} = 1 \text{ V, } I_c = 3 \text{ mA, } f = 2 \text{ GHz}$
- Large Absolute Maximum Collector Current  
 $I_c = 100 \text{ mA}$
- Compact Mini Mold Package  
 EIAJ: SC-70

**ORDERING INFORMATION**

| PART NUMBER | QUANTITY    | PACKING STYLE   |
|-------------|-------------|---|
| 2SC5193-T1  | 3 Kpcs/Reel | Embossed tape 8 mm wide.<br>Pin 3 (collector) face to perforation side of the tape.             |
| 2SC5193-T2  | 3 Kpcs/Reel | Embossed tape 8 mm wide.<br>Pin 1 (Emitter), Pin 2 (Base) face to perforation side of the tape. |

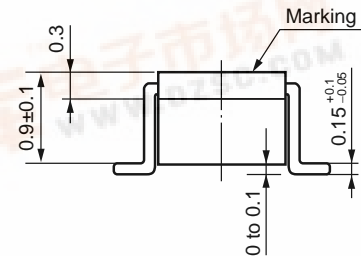
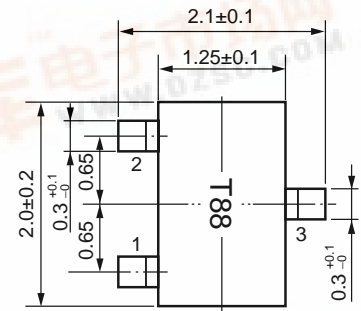
**Remark** If you require an evaluation sample, please contact an NEC Sales Representative. (Unit sample quantity is 50 pcs.)

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25 °C)**

| PARAMETER                    | SYMBOL           | RATING      | UNIT |
|------------------------------|------------------|-------------|------|
| Collector to Base Voltage    | V <sub>CB0</sub> | 9           | V    |
| Collector to Emitter Voltage | V <sub>CE0</sub> | 6           | V    |
| Emitter to Base Voltage      | V <sub>EB0</sub> | 2           | V    |
| Collector Current            | I <sub>c</sub>   | 100         | mA   |
| Total Power Dissipation      | P <sub>T</sub>   | 150         | mW   |
| Junction Temperature         | T <sub>j</sub>   | 150         | °C   |
| Storage Temperature          | T <sub>stg</sub> | -65 to +150 | °C   |

**PACKAGE DRAWING**

(Units: mm)



**PIN CONNECTIONS**

1. Emitter
2. Base
3. Collector



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

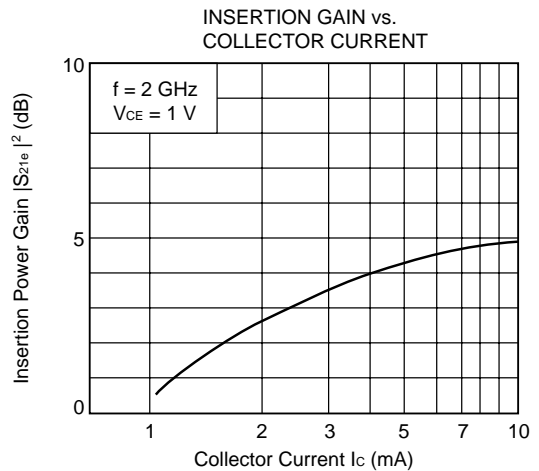
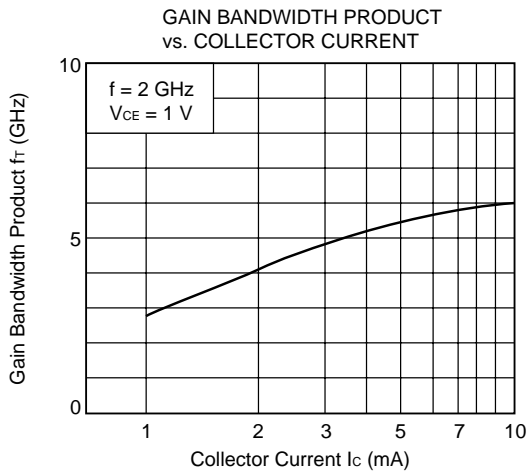
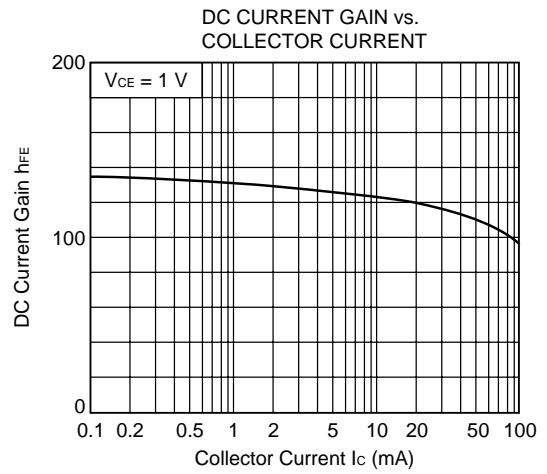
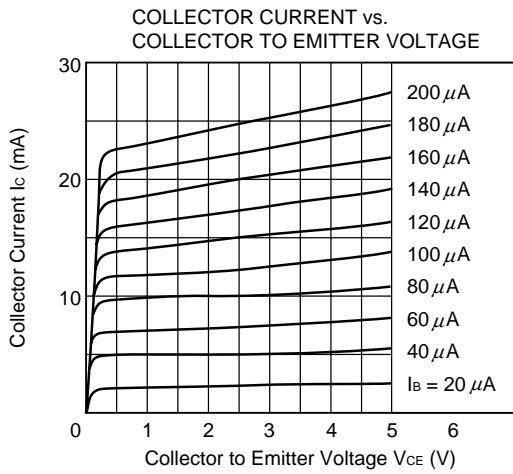
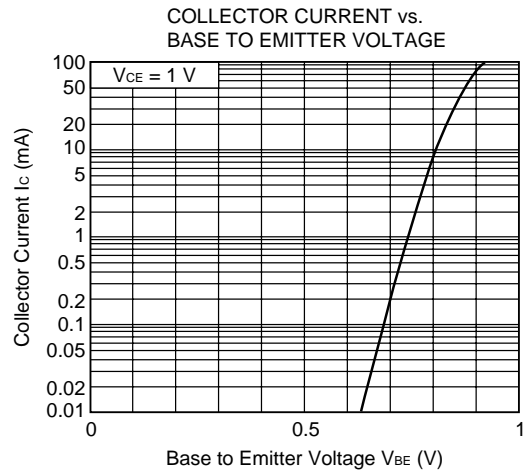
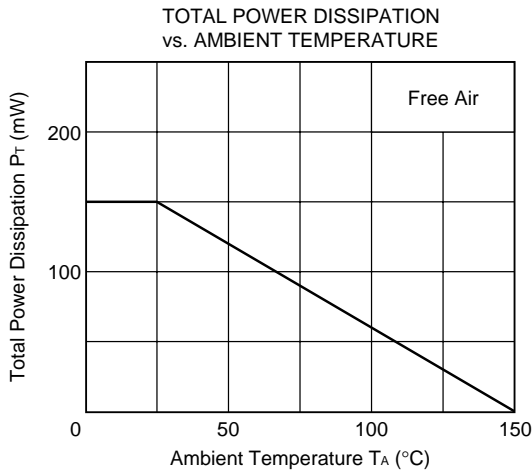
| PARAMETER                  | SYMBOL                          | CONDITION  | MIN. | TYP. | MAX. | UNIT |
|----------------------------|---------------------------------|--|------|------|------|------|
| Collector Cutoff Current   | I <sub>CB0</sub>                | V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0                                |      |      | 100  | nA   |
| Emitter Cutoff Current     | I <sub>EB0</sub>                | V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0                                |      |      | 100  | nA   |
| DC Current Gain            | h <sub>FE</sub>                 | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA <sup>Note 1</sup>           | 80   |      | 160  |      |
| Insertion Power Gain (1)   | S <sub>21e</sub>   <sup>2</sup> | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA, f = 2.0 GHz                | 2.5  | 3.5  |      | dB   |
| Insertion Power Gain (2)   | S <sub>21e</sub>   <sup>2</sup> | V <sub>CE</sub> = 3 V, I <sub>C</sub> = 20 mA, f = 2.0 GHz               |      | 6.5  |      | dB   |
| Noise Figure (1)           | NF                              | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA, f = 2.0 GHz                |      | 1.7  | 2.5  | dB   |
| Noise Figure (2)           | NF                              | V <sub>CE</sub> = 3 V, I <sub>C</sub> = 7 mA, f = 2.0 GHz                |      | 1.5  |      | dB   |
| Gain Bandwidth Product (1) | f <sub>T</sub>                  | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA, f = 2.0 GHz                | 4    | 4.5  |      | GHz  |
| Gain Bandwidth Product (2) | f <sub>T</sub>                  | V <sub>CE</sub> = 3 V, I <sub>C</sub> = 20 mA, f = 2.0 GHz               |      | 9    |      | GHz  |
| Collector Capacitance      | C <sub>re</sub>                 | V <sub>CB</sub> = 1 V, I <sub>E</sub> = 0, f = 1.0 MHz <sup>Note 2</sup> |      | 0.75 | 0.85 | pF   |

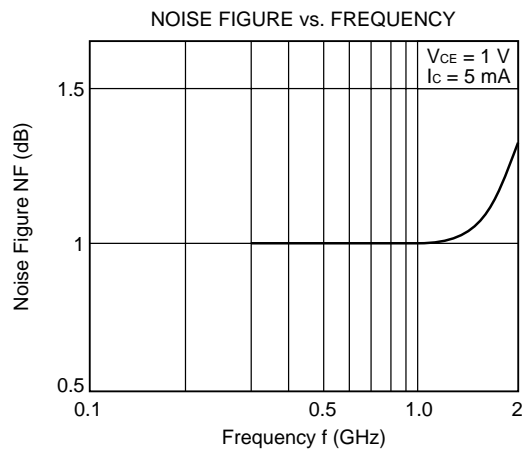
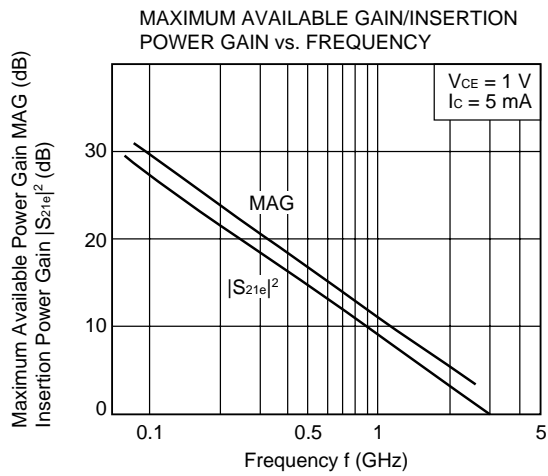
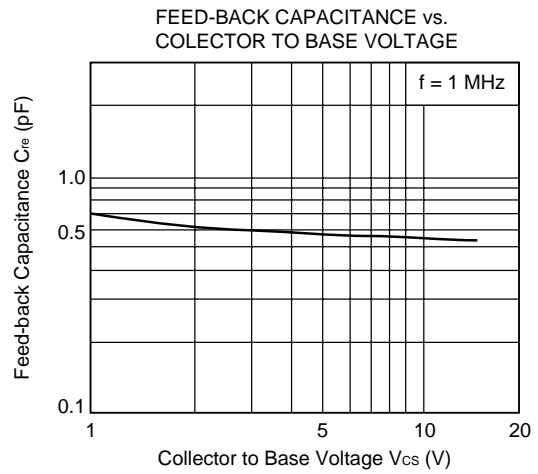
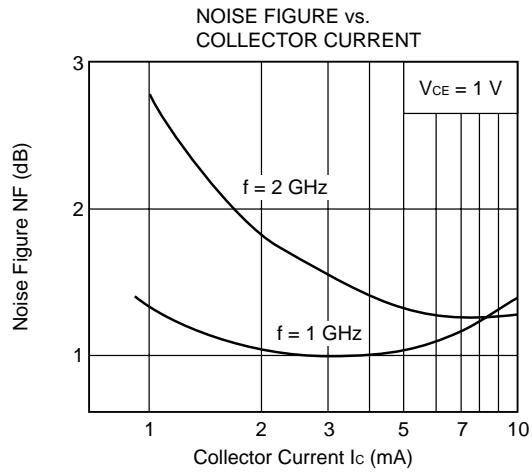
- Notes**
1. Pulse Measurement: PW ≤ 350 μs, Duty cycle ≤ 2 %, Pulsed
  2. Measured with 3-pin bridge, emitter and case should be connected to guard pin of bridge.

**h<sub>FE</sub> Classification**

|                 |           |
|-----------------|-----------|
| Rank            | FB        |
| Marking         | T88       |
| h <sub>FE</sub> | 80 to 160 |

TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C)





S-PARAMETER

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 1 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21   |       | S12   |      | S22   |       |
|--------------------|-------|--------|-------|-------|-------|------|-------|-------|
|                    | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 100.00             | 0.952 | -18.2  | 3.497 | 166.0 | 0.050 | 74.0 | 0.979 | -8.3  |
| 200.00             | 0.913 | -37.9  | 3.208 | 150.4 | 0.101 | 64.5 | 0.927 | -18.9 |
| 300.00             | 0.871 | -55.6  | 3.048 | 135.4 | 0.141 | 56.5 | 0.855 | -28.2 |
| 400.00             | 0.817 | -68.8  | 2.825 | 124.1 | 0.169 | 49.8 | 0.803 | -33.7 |
| 500.00             | 0.737 | -82.6  | 2.332 | 114.8 | 0.184 | 42.1 | 0.746 | -39.1 |
| 600.00             | 0.657 | -93.4  | 2.236 | 107.2 | 0.196 | 37.7 | 0.691 | -41.0 |
| 700.00             | 0.624 | -103.9 | 2.043 | 99.0  | 0.206 | 33.0 | 0.639 | -45.4 |
| 800.00             | 0.594 | -117.9 | 1.864 | 91.9  | 0.208 | 30.5 | 0.573 | -46.2 |
| 900.00             | 0.560 | -127.1 | 1.715 | 85.0  | 0.208 | 29.0 | 0.538 | -49.5 |
| 1000.00            | 0.544 | -137.1 | 1.593 | 80.3  | 0.203 | 27.8 | 0.494 | -51.7 |
| 1100.00            | 0.527 | -145.1 | 1.458 | 75.3  | 0.200 | 25.6 | 0.478 | -55.7 |
| 1200.00            | 0.534 | -154.5 | 1.391 | 70.9  | 0.195 | 24.4 | 0.450 | -60.1 |
| 1300.00            | 0.554 | -163.9 | 1.258 | 66.7  | 0.195 | 24.1 | 0.426 | -62.4 |
| 1400.00            | 0.566 | -169.0 | 1.200 | 63.5  | 0.194 | 25.6 | 0.409 | -66.3 |
| 1500.00            | 0.547 | -175.2 | 1.185 | 55.1  | 0.199 | 26.0 | 0.406 | -67.7 |
| 1600.00            | 0.523 | 179.3  | 1.176 | 51.3  | 0.201 | 29.6 | 0.392 | -72.4 |
| 1700.00            | 0.540 | 172.6  | 1.129 | 48.8  | 0.198 | 33.0 | 0.375 | -76.0 |
| 1800.00            | 0.530 | 165.2  | 1.109 | 47.4  | 0.199 | 37.3 | 0.370 | -80.9 |
| 1900.00            | 0.559 | 160.8  | 1.028 | 45.2  | 0.200 | 40.0 | 0.365 | -87.1 |
| 2000.00            | 0.571 | 156.2  | 0.981 | 43.6  | 0.203 | 43.2 | 0.364 | -91.0 |

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 3 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21   |       | S12   |      | S22   |        |
|--------------------|-------|--------|-------|-------|-------|------|-------|--------|
|                    | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG    |
| 100.00             | 0.864 | -29.3  | 8.784 | 157.7 | 0.050 | 64.3 | 0.927 | -16.5  |
| 200.00             | 0.768 | -37.8  | 7.364 | 136.9 | 0.088 | 56.8 | 0.797 | -34.0  |
| 300.00             | 0.675 | -79.1  | 6.372 | 139.7 | 0.115 | 51.1 | 0.667 | -46.3  |
| 400.00             | 0.584 | -94.9  | 5.374 | 110.1 | 0.130 | 47.2 | 0.568 | -52.1  |
| 500.00             | 0.504 | -110.1 | 4.501 | 102.3 | 0.138 | 44.1 | 0.485 | -55.8  |
| 600.00             | 0.455 | -123.0 | 3.906 | 96.2  | 0.148 | 43.4 | 0.430 | -57.0  |
| 700.00             | 0.428 | -134.7 | 3.298 | 89.7  | 0.156 | 42.3 | 0.380 | -61.3  |
| 800.00             | 0.405 | -145.9 | 2.938 | 84.1  | 0.163 | 42.8 | 0.321 | -63.1  |
| 900.00             | 0.381 | -154.2 | 2.915 | 79.4  | 0.171 | 43.7 | 0.286 | -64.8  |
| 1000.00            | 0.379 | -163.1 | 2.397 | 75.8  | 0.178 | 44.6 | 0.239 | -66.7  |
| 1100.00            | 0.374 | -171.9 | 2.196 | 72.0  | 0.184 | 44.7 | 0.246 | -70.8  |
| 1200.00            | 0.389 | -178.5 | 2.061 | 68.3  | 0.190 | 44.6 | 0.226 | -76.4  |
| 1300.00            | 0.404 | 174.9  | 1.916 | 64.3  | 0.198 | 44.2 | 0.201 | -79.4  |
| 1400.00            | 0.414 | 172.1  | 1.829 | 60.6  | 0.210 | 44.4 | 0.184 | -83.7  |
| 1500.00            | 0.411 | 165.7  | 1.759 | 55.5  | 0.225 | 44.2 | 0.176 | -85.9  |
| 1600.00            | 0.402 | 161.8  | 1.680 | 52.5  | 0.241 | 45.3 | 0.167 | -92.5  |
| 1700.00            | 0.417 | 156.7  | 1.606 | 50.1  | 0.249 | 48.9 | 0.159 | -97.7  |
| 1800.00            | 0.428 | 151.2  | 1.537 | 49.4  | 0.259 | 48.8 | 0.151 | -107.2 |
| 1900.00            | 0.446 | 148.4  | 1.458 | 47.4  | 0.265 | 48.7 | 0.130 | -114.4 |
| 2000.00            | 0.457 | 144.8  | 1.394 | 43.8  | 0.272 | 48.6 | 0.155 | -120.7 |

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 5 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21    |       | S12   |      | S22   |        |
|--------------------|-------|--------|--------|-------|-------|------|-------|--------|
|                    | MAG   | ANG    | MAG    | ANG   | MAG   | ANG  | MAG   | ANG    |
| 100.00             | 0.790 | -37.9  | 12.042 | 152.3 | 0.043 | 67.5 | 0.886 | -23.5  |
| 200.00             | 0.672 | -69.2  | 9.515  | 129.2 | 0.079 | 54.7 | 0.708 | -42.2  |
| 300.00             | 0.564 | -91.9  | 7.780  | 113.6 | 0.101 | 51.0 | 0.562 | -55.7  |
| 400.00             | 0.475 | -108.5 | 3.993  | 103.8 | 0.115 | 49.2 | 0.456 | -61.2  |
| 500.00             | 0.415 | -123.8 | 4.959  | 97.3  | 0.124 | 48.6 | 0.374 | -63.8  |
| 600.00             | 0.383 | -137.1 | 4.268  | 92.1  | 0.135 | 49.0 | 0.329 | -64.4  |
| 700.00             | 0.366 | -147.8 | 3.741  | 86.2  | 0.146 | 48.6 | 0.289 | -69.8  |
| 800.00             | 0.331 | -138.3 | 3.313  | 81.3  | 0.156 | 47.4 | 0.235 | -73.5  |
| 900.00             | 0.332 | -166.3 | 2.927  | 77.3  | 0.168 | 50.2 | 0.202 | -75.2  |
| 1000.00            | 0.335 | -174.3 | 2.677  | 74.1  | 0.179 | 51.1 | 0.181 | -76.6  |
| 1100.00            | 0.337 | 177.3  | 2.431  | 70.7  | 0.188 | 50.8 | 0.175 | -81.8  |
| 1200.00            | 0.333 | 172.0  | 2.282  | 67.4  | 0.197 | 50.3 | 0.158 | -90.1  |
| 1300.00            | 0.365 | 166.3  | 2.124  | 63.6  | 0.208 | 49.5 | 0.134 | -95.4  |
| 1400.00            | 0.375 | 164.2  | 2.027  | 59.9  | 0.222 | 48.9 | 0.120 | -101.8 |
| 1500.00            | 0.378 | 158.6  | 1.944  | 55.4  | 0.240 | 48.1 | 0.114 | -106.3 |
| 1600.00            | 0.373 | 155.0  | 1.850  | 52.7  | 0.258 | 48.4 | 0.112 | -116.2 |
| 1700.00            | 0.387 | 150.8  | 1.764  | 50.6  | 0.269 | 49.5 | 0.107 | -128.3 |
| 1800.00            | 0.401 | 146.1  | 1.679  | 50.0  | 0.279 | 50.2 | 0.109 | -137.3 |
| 1900.00            | 0.418 | 143.8  | 1.603  | 48.2  | 0.286 | 50.1 | 0.114 | -144.5 |
| 2000.00            | 0.429 | 140.6  | 1.526  | 46.7  | 0.294 | 49.5 | 0.125 | -150.2 |

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 7 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21    |       | S12   |      | S22   |        |
|--------------------|-------|--------|--------|-------|-------|------|-------|--------|
|                    | MAG   | ANG    | MAG    | ANG   | MAG   | ANG  | MAG   | ANG    |
| 100.00             | 0.736 | -44.1  | 14.388 | 148.1 | 0.041 | 61.2 | 0.833 | -28.2  |
| 200.00             | 0.603 | -77.3  | 10.890 | 124.2 | 0.074 | 53.6 | 0.642 | -48.4  |
| 300.00             | 0.494 | -100.6 | 8.181  | 109.3 | 0.094 | 51.9 | 0.497 | -62.1  |
| 400.00             | 0.415 | -117.8 | 6.500  | 100.3 | 0.108 | 51.7 | 0.389 | -68.0  |
| 500.00             | 0.369 | -133.0 | 5.307  | 94.7  | 0.118 | 52.1 | 0.310 | -70.2  |
| 600.00             | 0.350 | -145.9 | 4.558  | 89.8  | 0.132 | 52.9 | 0.271 | -70.5  |
| 700.00             | 0.336 | -155.9 | 3.974  | 84.3  | 0.144 | 52.7 | 0.240 | -77.0  |
| 800.00             | 0.324 | -166.0 | 3.500  | 79.9  | 0.156 | 53.1 | 0.191 | -83.3  |
| 900.00             | 0.309 | -173.7 | 3.096  | 76.3  | 0.169 | 53.8 | 0.158 | -85.9  |
| 1000.00            | 0.314 | 178.7  | 2.819  | 73.3  | 0.183 | 54.2 | 0.141 | -87.1  |
| 1100.00            | 0.319 | 171.0  | 2.583  | 70.1  | 0.193 | 53.7 | 0.139 | -93.2  |
| 1200.00            | 0.335 | 166.5  | 2.407  | 66.9  | 0.204 | 52.9 | 0.128 | -104.6 |
| 1300.00            | 0.347 | 161.6  | 2.235  | 63.3  | 0.215 | 51.8 | 0.106 | -113.9 |
| 1400.00            | 0.336 | 159.6  | 2.137  | 59.8  | 0.231 | 50.8 | 0.093 | -123.2 |
| 1500.00            | 0.362 | 154.5  | 2.032  | 55.5  | 0.250 | 49.7 | 0.093 | -129.3 |
| 1600.00            | 0.359 | 151.2  | 1.932  | 52.9  | 0.268 | 49.5 | 0.098 | -140.1 |
| 1700.00            | 0.373 | 147.4  | 1.845  | 50.9  | 0.280 | 50.4 | 0.102 | -133.9 |
| 1800.00            | 0.388 | 143.2  | 1.756  | 50.5  | 0.291 | 50.7 | 0.110 | -161.6 |
| 1900.00            | 0.404 | 141.0  | 1.676  | 48.7  | 0.299 | 50.5 | 0.116 | -167.2 |
| 2000.00            | 0.415 | 138.1  | 1.597  | 47.5  | 0.307 | 49.6 | 0.130 | -170.3 |

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 10 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21    |       | S12   |      | S22   |        |
|--------------------|-------|--------|--------|-------|-------|------|-------|--------|
|                    | MAG   | ANG    | MAG    | ANG   | MAG   | ANG  | MAG   | ANG    |
| 100.00             | 0.676 | -49.5  | 16.485 | 144.1 | 0.041 | 59.8 | 0.808 | -31.3  |
| 200.00             | 0.545 | -83.0  | 11.960 | 120.0 | 0.071 | 53.3 | 0.588 | -53.4  |
| 300.00             | 0.442 | -108.8 | 8.726  | 105.9 | 0.090 | 53.3 | 0.433 | -67.7  |
| 400.00             | 0.372 | -126.4 | 6.820  | 97.6  | 0.103 | 54.1 | 0.339 | -73.9  |
| 500.00             | 0.339 | -141.2 | 5.333  | 92.6  | 0.116 | 54.9 | 0.263 | -76.2  |
| 600.00             | 0.328 | -153.6 | 4.754  | 88.1  | 0.130 | 33.9 | 0.229 | -76.4  |
| 700.00             | 0.318 | -162.8 | 4.124  | 82.9  | 0.143 | 55.4 | 0.205 | -84.2  |
| 800.00             | 0.309 | -172.4 | 3.626  | 78.7  | 0.157 | 55.7 | 0.162 | -93.2  |
| 900.00             | 0.295 | -179.8 | 3.201  | 75.3  | 0.171 | 56.3 | 0.131 | -97.4  |
| 1000.00            | 0.303 | 173.2  | 2.922  | 72.6  | 0.186 | 56.4 | 0.115 | -99.3  |
| 1100.00            | 0.310 | 166.1  | 2.674  | 69.6  | 0.198 | 55.7 | 0.118 | -105.7 |
| 1200.00            | 0.326 | 162.2  | 2.480  | 66.5  | 0.209 | 54.5 | 0.113 | -119.6 |
| 1300.00            | 0.336 | 157.7  | 2.312  | 63.1  | 0.221 | 53.1 | 0.096 | -132.9 |
| 1400.00            | 0.345 | 156.0  | 2.205  | 39.5  | 0.237 | 51.9 | 0.089 | -144.2 |
| 1500.00            | 0.333 | 151.3  | 2.100  | 55.5  | 0.257 | 50.6 | 0.091 | -151.0 |
| 1600.00            | 0.351 | 148.1  | 1.989  | 55.0  | 0.276 | 50.2 | 0.101 | -159.3 |
| 1700.00            | 0.360 | 144.8  | 1.904  | 51.0  | 0.230 | 50.9 | 0.111 | -171.4 |
| 1800.00            | 0.380 | 140.9  | 1.804  | 50.7  | 0.300 | 51.0 | 0.122 | -177.0 |
| 1900.00            | 0.396 | 139.0  | 1.724  | 49.0  | 0.307 | 50.7 | 0.129 | 178.5  |
| 2000.00            | 0.407 | 136.0  | 1.642  | 47.6  | 0.315 | 49.7 | 0.143 | 177.0  |

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 1 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21   |       | S12   |      | S22   |       |
|--------------------|-------|--------|-------|-------|-------|------|-------|-------|
|                    | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 100.00             | 1.003 | -16.7  | 3.418 | 166.9 | 0.029 | 74.7 | 0.989 | -3.6  |
| 200.00             | 0.956 | -32.7  | 3.121 | 154.7 | 0.078 | 64.7 | 0.951 | -14.1 |
| 300.00             | 0.938 | -48.4  | 3.082 | 141.4 | 0.113 | 60.2 | 0.897 | -21.7 |
| 400.00             | 0.895 | -61.8  | 2.931 | 129.6 | 0.138 | 53.4 | 0.857 | -26.1 |
| 500.00             | 0.793 | -75.1  | 2.631 | 120.5 | 0.130 | 46.1 | 0.811 | -30.5 |
| 600.00             | 0.700 | -83.7  | 2.365 | 114.3 | 0.160 | 42.9 | 0.774 | -31.5 |
| 700.00             | 0.671 | -96.0  | 2.189 | 106.3 | 0.171 | 38.2 | 0.735 | -35.8 |
| 800.00             | 0.629 | -108.8 | 1.997 | 98.9  | 0.172 | 34.9 | 0.665 | -35.9 |
| 900.00             | 0.581 | -117.9 | 1.837 | 92.0  | 0.172 | 33.9 | 0.636 | -38.4 |
| 1000.00            | 0.554 | -127.4 | 1.706 | 87.7  | 0.170 | 33.3 | 0.590 | -39.3 |
| 1100.00            | 0.535 | -135.4 | 1.570 | 82.7  | 0.167 | 31.4 | 0.579 | -43.2 |
| 1200.00            | 0.531 | -145.8 | 1.510 | 78.0  | 0.162 | 30.6 | 0.541 | -47.1 |
| 1300.00            | 0.540 | -156.4 | 1.359 | 74.3  | 0.162 | 30.5 | 0.522 | -48.3 |
| 1400.00            | 0.542 | -161.9 | 1.299 | 71.7  | 0.162 | 32.5 | 0.510 | -51.5 |
| 1500.00            | 0.527 | -168.3 | 1.278 | 62.8  | 0.166 | 33.5 | 0.509 | -52.6 |
| 1600.00            | 0.497 | -174.3 | 1.272 | 58.3  | 0.169 | 37.6 | 0.493 | -56.2 |
| 1700.00            | 0.512 | 178.3  | 1.216 | 55.8  | 0.169 | 41.3 | 0.476 | -58.1 |
| 1800.00            | 0.492 | 170.4  | 1.209 | 54.2  | 0.171 | 46.9 | 0.469 | -62.0 |
| 1900.00            | 0.524 | 165.5  | 1.119 | 52.2  | 0.176 | 49.9 | 0.454 | -66.3 |
| 2000.00            | 0.534 | 159.9  | 1.069 | 50.4  | 0.180 | 33.4 | 0.454 | -69.3 |

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 3 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21   |       | S12   |      | S22   |       |
|--------------------|-------|--------|-------|-------|-------|------|-------|-------|
|                    | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 100.00             | 0.924 | -23.0  | 8.393 | 160.8 | 0.031 | 54.9 | 0.965 | -10.7 |
| 200.00             | 0.830 | -46.1  | 7.259 | 143.7 | 0.070 | 59.2 | 0.964 | -24.0 |
| 300.00             | 0.750 | -65.0  | 6.624 | 128.1 | 0.096 | 55.7 | 0.760 | -34.3 |
| 400.00             | 0.653 | -79.4  | 3.805 | 116.8 | 0.111 | 51.5 | 0.671 | -38.9 |
| 500.00             | 0.548 | -93.1  | 4.720 | 108.8 | 0.119 | 48.5 | 0.599 | -41.3 |
| 600.00             | 0.471 | -104.2 | 4.121 | 103.1 | 0.127 | 47.9 | 0.555 | -41.1 |
| 700.00             | 0.433 | -116.2 | 3.695 | 96.4  | 0.136 | 46.5 | 0.509 | -44.9 |
| 800.00             | 0.397 | -128.3 | 3.302 | 90.5  | 0.141 | 46.3 | 0.441 | -44.6 |
| 900.00             | 0.361 | -136.7 | 2.944 | 85.5  | 0.147 | 47.4 | 0.409 | -43.0 |
| 1000.00            | 0.345 | -146.1 | 2.696 | 82.0  | 0.153 | 48.6 | 0.378 | -44.9 |
| 1100.00            | 0.332 | -155.5 | 2.479 | 77.9  | 0.158 | 48.6 | 0.368 | -48.3 |
| 1200.00            | 0.336 | -164.1 | 2.328 | 74.3  | 0.163 | 48.8 | 0.338 | -52.4 |
| 1300.00            | 0.346 | -172.7 | 2.158 | 70.3  | 0.170 | 48.7 | 0.314 | -52.7 |
| 1400.00            | 0.332 | -177.1 | 2.063 | 67.1  | 0.180 | 49.3 | 0.300 | 54.5  |
| 1500.00            | 0.347 | 176.5  | 1.997 | 61.8  | 0.194 | 49.2 | 0.294 | -55.3 |
| 1600.00            | 0.338 | 171.8  | 1.906 | 58.4  | 0.207 | 50.6 | 0.282 | -58.8 |
| 1700.00            | 0.349 | 165.6  | 1.818 | 56.0  | 0.216 | 52.3 | 0.262 | -60.8 |
| 1800.00            | 0.355 | 139.2  | 1.740 | 55.1  | 0.225 | 54.4 | 0.251 | -64.3 |
| 1900.00            | 0.373 | 155.6  | 1.650 | 53.2  | 0.233 | 53.1 | 0.241 | -68.3 |
| 2000.00            | 0.387 | 131.2  | 1.376 | 31.6  | 0.240 | 55.5 | 0.239 | -72.5 |

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 5 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21    |       | S12   |      | S22   |       |
|--------------------|-------|--------|--------|-------|-------|------|-------|-------|
|                    | MAG   | ANG    | MAG    | ANG   | MAG   | ANG  | MAG   | ANG   |
| 100.00             | 0.865 | -27.8  | 11.588 | 156.9 | 0.036 | 49.9 | 0.938 | -13.2 |
| 200.00             | 0.742 | -53.4  | 9.364  | 137.4 | 0.066 | 58.5 | 0.805 | -29.3 |
| 300.00             | 0.637 | -73.2  | 8.312  | 121.7 | 0.086 | 53.0 | 0.675 | -40.3 |
| 400.00             | 0.531 | -87.6  | 6.607  | 110.7 | 0.100 | 53.2 | 0.576 | -44.3 |
| 500.00             | 0.438 | -101.3 | 5.519  | 103.7 | 0.109 | 52.0 | 0.500 | -45.6 |
| 600.00             | 0.376 | -113.3 | 4.799  | 98.6  | 0.118 | 52.5 | 0.461 | -44.5 |
| 700.00             | 0.343 | -125.0 | 4.262  | 92.5  | 0.128 | 52.0 | 0.418 | -48.1 |
| 800.00             | 0.315 | -136.9 | 3.784  | 87.3  | 0.135 | 52.5 | 0.357 | -47.9 |
| 900.00             | 0.286 | -145.5 | 3.354  | 83.0  | 0.143 | 53.5 | 0.325 | -47.4 |
| 1000.00            | 0.276 | -154.9 | 3.048  | 79.8  | 0.154 | 54.4 | 0.301 | -46.6 |
| 1100.00            | 0.268 | -164.6 | 2.812  | 76.3  | 0.163 | 54.4 | 0.294 | -50.1 |
| 1200.00            | 0.276 | -172.4 | 2.613  | 73.0  | 0.170 | 54.2 | 0.267 | -54.7 |
| 1300.00            | 0.286 | 179.9  | 2.441  | 69.4  | 0.180 | 53.6 | 0.243 | -54.8 |
| 1400.00            | 0.293 | 173.9  | 2.321  | 63.9  | 0.192 | 53.4 | 0.228 | -56.1 |
| 1500.00            | 0.294 | 169.9  | 2.232  | 61.4  | 0.207 | 52.8 | 0.222 | -57.0 |
| 1600.00            | 0.290 | 165.5  | 2.123  | 58.3  | 0.223 | 53.4 | 0.211 | -61.0 |
| 1700.00            | 0.303 | 160.1  | 2.030  | 56.3  | 0.234 | 54.4 | 0.191 | -63.5 |
| 1800.00            | 0.313 | 154.3  | 1.932  | 53.6  | 0.244 | 55.8 | 0.179 | -67.5 |
| 1900.00            | 0.330 | 151.2  | 1.836  | 53.8  | 0.252 | 56.0 | 0.171 | -71.9 |
| 2000.00            | 0.341 | 147.2  | 1.757  | 52.4  | 0.259 | 55.8 | 0.168 | -77.4 |



V<sub>CE</sub> = 3 V, I<sub>c</sub> = 7 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21    |       | S12   |      | S22   |       |
|--------------------|-------|--------|--------|-------|-------|------|-------|-------|
|                    | MAG   | ANG    | MAG    | ANG   | MAG   | ANG  | MAG   | ANG   |
| 100.00             | 0.811 | -32.6  | 14.032 | 153.7 | 0.027 | 57.0 | 0.922 | -18.2 |
| 200.00             | 0.668 | -59.1  | 11.239 | 132.2 | 0.063 | 56.7 | 0.752 | -33.9 |
| 300.00             | 0.553 | -79.0  | 8.969  | 116.7 | 0.081 | 55.4 | 0.611 | -44.6 |
| 400.00             | 0.449 | -93.3  | 7.293  | 106.9 | 0.094 | 55.4 | 0.510 | -47.9 |
| 500.00             | 0.370 | -107.1 | 6.039  | 100.6 | 0.103 | 55.3 | 0.435 | -48.1 |
| 600.00             | 0.318 | -119.6 | 5.212  | 93.8  | 0.114 | 56.2 | 0.400 | -46.5 |
| 700.00             | 0.290 | -131.1 | 4.581  | 90.2  | 0.125 | 55.8 | 0.364 | -50.1 |
| 800.00             | 0.268 | -142.9 | 4.057  | 85.5  | 0.134 | 56.2 | 0.305 | -50.1 |
| 900.00             | 0.244 | -151.8 | 3.587  | 81.6  | 0.145 | 57.1 | 0.275 | -49.0 |
| 1000.00            | 0.237 | -161.2 | 3.266  | 78.6  | 0.157 | 57.6 | 0.255 | -47.7 |
| 1100.00            | 0.233 | -170.9 | 3.003  | 75.4  | 0.167 | 57.5 | 0.249 | -51.5 |
| 1200.00            | 0.243 | -178.1 | 2.794  | 72.3  | 0.173 | 57.0 | 0.225 | -56.7 |
| 1300.00            | 0.253 | 174.8  | 2.596  | 68.9  | 0.186 | 56.1 | 0.199 | -56.7 |
| 1400.00            | 0.261 | 171.0  | 2.474  | 65.4  | 0.199 | 55.4 | 0.185 | -37.7 |
| 1500.00            | 0.265 | 165.4  | 2.365  | 61.3  | 0.216 | 54.6 | 0.179 | -38.7 |
| 1600.00            | 0.265 | 161.2  | 2.253  | 58.4  | 0.232 | 54.7 | 0.169 | -63.3 |
| 1700.00            | 0.277 | 156.4  | 2.153  | 56.5  | 0.245 | 55.5 | 0.149 | -66.8 |
| 1800.00            | 0.290 | 151.1  | 2.046  | 56.9  | 0.233 | 56.4 | 0.137 | -71.3 |
| 1900.00            | 0.306 | 148.3  | 1.943  | 54.2  | 0.264 | 56.4 | 0.130 | -76.7 |
| 2000.00            | 0.318 | 144.6  | 1.856  | 52.8  | 0.271 | 53.9 | 0.128 | -83.6 |

V<sub>CE</sub> = 3 V, I<sub>c</sub> = 10 mA, Z<sub>o</sub> = 50 Ω

| FREQUENCY<br>(MHz) | S11   |        | S21    |       | S12   |      | S22   |       |
|--------------------|-------|--------|--------|-------|-------|------|-------|-------|
|                    | MAG   | ANG    | MAG    | ANG   | MAG   | ANG  | MAG   | ANG   |
| 100.00             | 0.775 | -34.3  | 16.213 | 130.4 | 0.031 | 42.4 | 0.916 | -18.1 |
| 200.00             | 0.609 | -63.8  | 12.257 | 128.4 | 0.037 | 55.3 | 0.712 | -37.2 |
| 300.00             | 0.488 | -83.7  | 9.683  | 115.4 | 0.077 | 56.3 | 0.569 | -47.6 |
| 400.00             | 0.390 | -98.0  | 7.790  | 104.3 | 0.091 | 56.6 | 0.467 | -30.5 |
| 500.00             | 0.321 | -111.7 | 6.396  | 98.4  | 0.101 | 57.6 | 0.394 | -50.4 |
| 600.00             | 0.277 | -124.8 | 5.493  | 93.8  | 0.113 | 58.5 | 0.362 | -48.1 |
| 700.00             | 0.253 | -136.0 | 4.808  | 88.6  | 0.125 | 58.4 | 0.329 | -51.9 |
| 800.00             | 0.236 | -147.8 | 4.252  | 84.3  | 0.135 | 58.4 | 0.273 | -52.2 |
| 900.00             | 0.216 | -157.0 | 3.752  | 80.7  | 0.147 | 59.1 | 0.242 | -50.9 |
| 1000.00            | 0.212 | -166.4 | 3.408  | 77.8  | 0.160 | 59.6 | 0.224 | -49.1 |
| 1100.00            | 0.221 | -176.0 | 3.131  | 74.8  | 0.171 | 59.2 | 0.220 | -53.1 |
| 1200.00            | 0.221 | 177.3  | 2.909  | 71.9  | 0.180 | 58.5 | 0.197 | -59.1 |
| 1300.00            | 0.232 | 170.6  | 2.711  | 68.6  | 0.191 | 57.3 | 0.171 | -59.2 |
| 1400.00            | 0.240 | 167.1  | 2.581  | 65.2  | 0.205 | 56.3 | 0.157 | -60.1 |
| 1500.00            | 0.247 | 161.8  | 2.457  | 61.2  | 0.222 | 55.2 | 0.150 | -61.2 |
| 1600.00            | 0.248 | 158.0  | 2.335  | 58.5  | 0.239 | 55.2 | 0.141 | -66.8 |
| 1700.00            | 0.261 | 153.6  | 2.236  | 56.6  | 0.252 | 53.8 | 0.121 | -71.4 |
| 1800.00            | 0.275 | 148.5  | 2.120  | 56.2  | 0.263 | 56.5 | 0.101 | -77.2 |
| 1900.00            | 0.291 | 146.1  | 2.019  | 54.6  | 0.272 | 56.4 | 0.104 | -83.3 |
| 2000.00            | 0.302 | 142.6  | 1.923  | 53.2  | 0.279 | 56.8 | 0.104 | -91.6 |

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