

## SILICON TRANSISTOR 2SC5180

### NPN EPITAXIAL SILICON TRANSISTOR IN SUPER MINI-MOLD PACKAGE FOR LOW-NOISE MICROWAVE AMPLIFICATION

#### FEATURES

- Low current consumption and high gain  
 $|S_{21e}|^2 = 12 \text{ dB TYP. @ } V_{CE} = 2 \text{ V, } I_C = 7 \text{ mA, } f = 2 \text{ GHz}$   
 $|S_{21e}|^2 = 11 \text{ dB TYP. @ } V_{CE} = 1 \text{ V, } I_C = 5 \text{ mA, } f = 2 \text{ GHz}$
- Supper Mini-Mold package

#### ORDERING INFORMATION

| PART NUMBER | QUANTITY         | ARRANGEMENT                                                                                  |
|-------------|------------------|----------------------------------------------------------------------------------------------|
| 2SC5180-T1  | 3 000 units/reel | Embossed tape, 8 mm wide, pins No. 3 (base) and No. 4 (emitter) facing the perforations      |
| 2SC5180-T2  |                  | Embossed tape, 8 mm wide, pins No. 1 (collector) and No. 2 (emitter) facing the perforations |

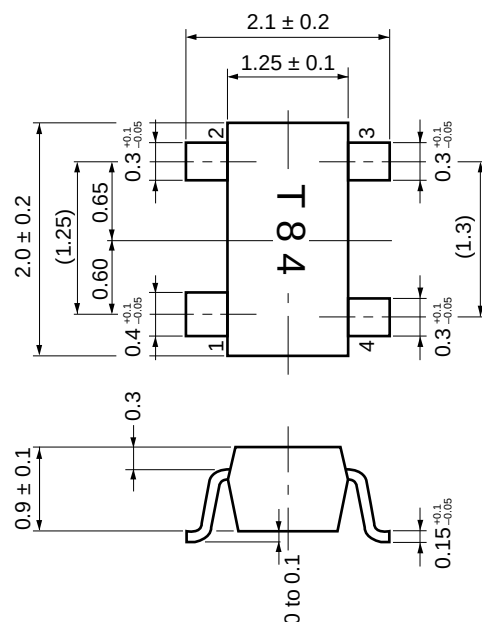
\* Contact your NEC sales representatives to order samples for evaluation (available in batches of 50).

#### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ )

|                              |           |             |                  |
|------------------------------|-----------|-------------|------------------|
| Collector to Base Voltage    | $V_{CBO}$ | 5           | V                |
| Collector to Emitter Voltage | $V_{CEO}$ | 3           | V                |
| Emitter to Base Voltage      | $V_{EBO}$ | 2           | V                |
| Collector Current            | $I_C$     | 10          | mA               |
| Total Power Dissipation      | $P_T$     | 30          | mW               |
| Junction Temperature         | $T_j$     | 150         | $^\circ\text{C}$ |
| Storage Temperature          | $T_{stg}$ | -65 to +150 | $^\circ\text{C}$ |

#### PACKAGE DIMENSIONS

(Units : mm)



#### PIN CONNECTIONS

1. Collector
2. Emitter
3. Base
4. Emitter

**Caution;** This transistor uses high-frequency technology. Be careful not to allow excessive current to flow through the transistor, including static electricity.

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

| PARAMETER                  | SYMBOL                          | MIN. | TYP. | MAX. | UNIT | CONDITIONS                                                            |
|----------------------------|---------------------------------|------|------|------|------|-----------------------------------------------------------------------|
| Collector Cutoff Current   | I <sub>CBO</sub>                |      |      | 100  | nA   | V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0                             |
| Emitter Cutoff Current     | I <sub>EBO</sub>                |      |      | 100  | nA   | V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0                             |
| DC Current Gain            | h <sub>FE</sub>                 | 70   |      | 140  |      | V <sub>CE</sub> = 2 V, I <sub>C</sub> = 7 mA* <sup>1</sup>            |
| Insertion Power Gain (1)   | S <sub>21e</sub>   <sup>2</sup> | 10   | 12   |      | dB   | V <sub>CE</sub> = 2 V, I <sub>C</sub> = 7 mA, f = 2 GHz               |
| Insertion Power Gain (2)   | S <sub>21e</sub>   <sup>2</sup> | 8.5  | 11   |      | dB   | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 5 mA, f = 2 GHz               |
| Noise Figure (1)           | NF                              |      | 1.5  | 2.0  | dB   | V <sub>CE</sub> = 2 V, I <sub>C</sub> = 3 mA, f = 2 GHz               |
| Noise Figure (2)           | NF                              |      | 1.5  | 2.0  | dB   | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 3 mA, f = 2 GHz               |
| Gain Bandwidth Product (1) | f <sub>T</sub>                  | 12   | 15.5 |      | GHz  | V <sub>CE</sub> = 2 V, I <sub>C</sub> = 7 mA, f = 2 GHz               |
| Gain Bandwidth Product (2) | f <sub>T</sub>                  | 10   | 13   |      | GHz  | V <sub>CE</sub> = 1 V, I <sub>C</sub> = 5 mA, f = 2 GHz               |
| Feedback Capacitance       | C <sub>re</sub>                 |      | 0.3  | 0.5  | pF   | V <sub>CB</sub> = 2 V, I <sub>E</sub> = 0 mA, f = 1 MHz* <sup>2</sup> |

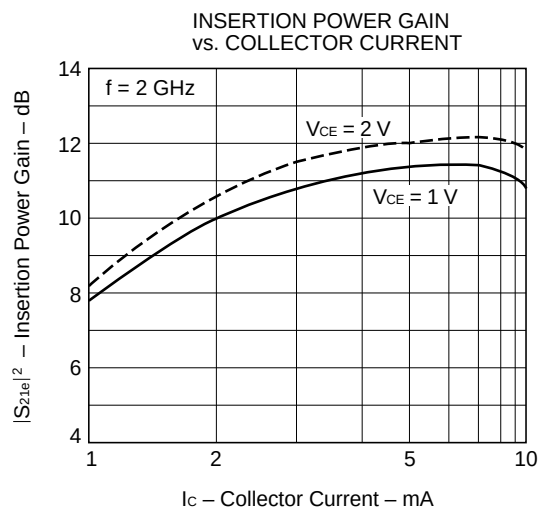
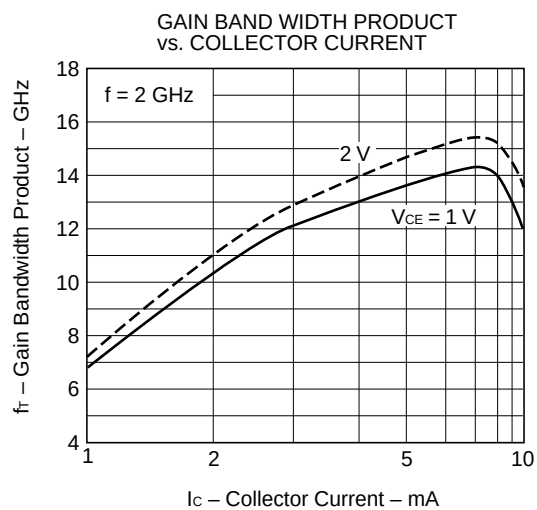
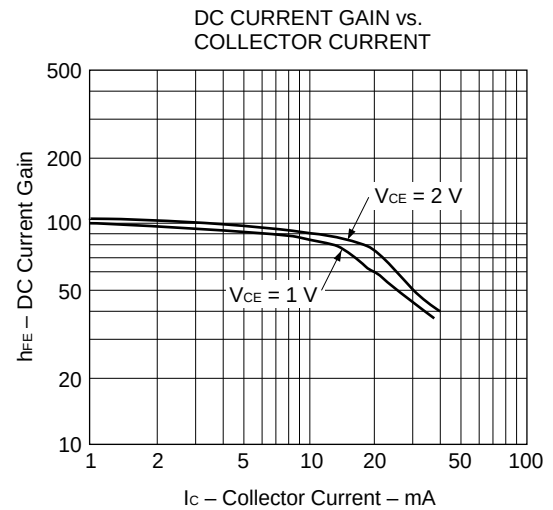
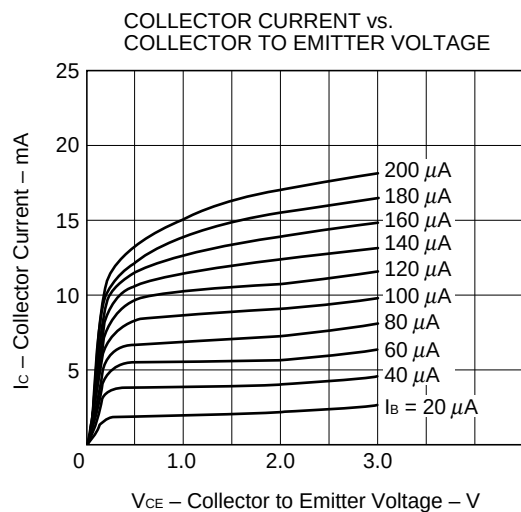
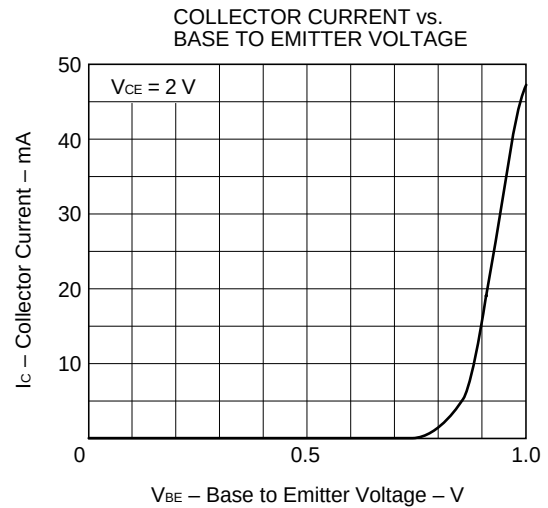
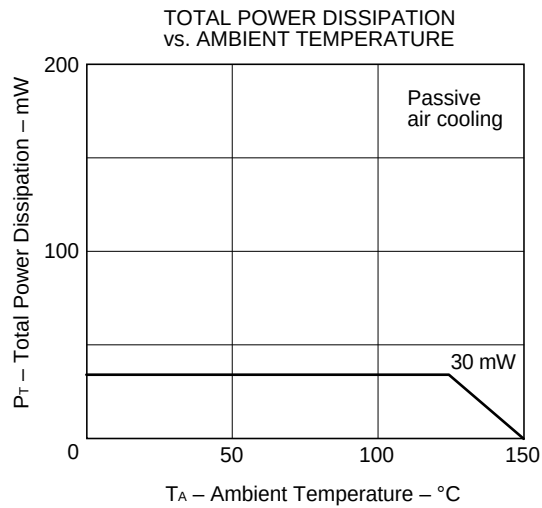
\* 1 : Measured with pulses : Pulse width  $\leq 350 \mu\text{s}$ , duty cycle  $\leq 2 \%$ , pulsed

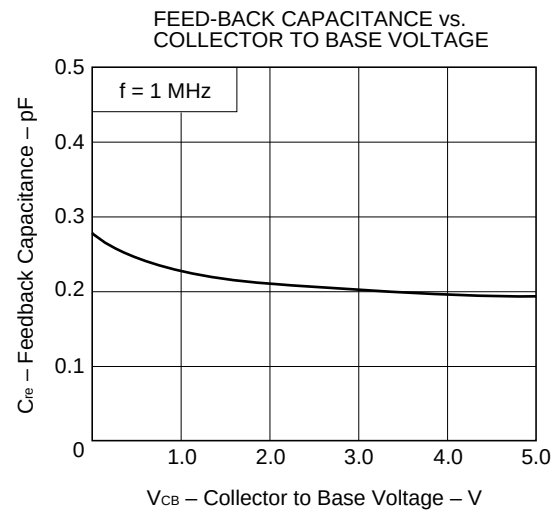
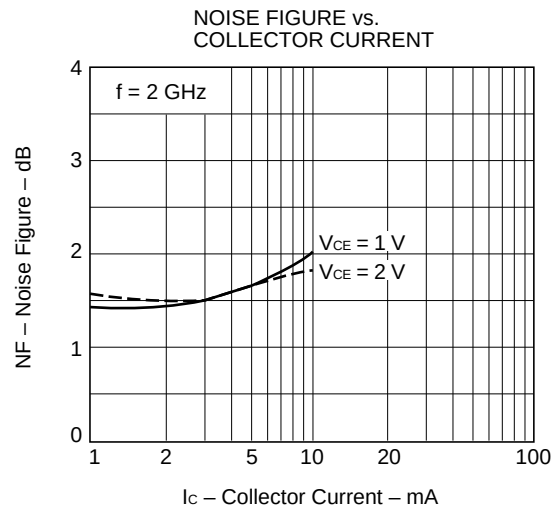
\* 2 : Measured with a three-terminal bridge. The emitter and case terminal are connected to the guard terminal of the bridge.

**h<sub>FE</sub> class**

|                 |           |
|-----------------|-----------|
| Class           | FB        |
| Marking         | T84       |
| h <sub>FE</sub> | 70 to 140 |

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





# S-PARAMETER

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 1 mA, Z<sub>0</sub> = 50 Ω

| FREQUENCY | S11   |       | S21   |       | S12   |      | S22   |       |
|-----------|-------|-------|-------|-------|-------|------|-------|-------|
|           | MAG   | ANG   | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00    | 0.916 | -28.0 | 3.247 | 147.1 | 0.074 | 65.6 | 0.960 | -21.2 |
| 800.00    | 0.816 | -36.9 | 3.092 | 136.2 | 0.111 | 58.6 | 0.887 | -26.2 |
| 1000.00   | 0.741 | -47.1 | 2.929 | 125.5 | 0.140 | 54.4 | 0.810 | -32.8 |
| 1200.00   | 0.691 | -55.8 | 2.864 | 116.5 | 0.158 | 52.2 | 0.788 | -39.3 |
| 1400.00   | 0.628 | -63.3 | 2.762 | 109.6 | 0.179 | 48.2 | 0.744 | -44.5 |
| 1600.00   | 0.558 | -72.3 | 2.590 | 100.9 | 0.195 | 44.8 | 0.692 | -49.2 |
| 1800.00   | 0.508 | -80.9 | 2.505 | 93.4  | 0.199 | 43.7 | 0.647 | -54.7 |
| 2000.00   | 0.444 | -87.8 | 2.293 | 88.1  | 0.196 | 39.5 | 0.602 | -58.2 |
| 2200.00   | 0.386 | -94.3 | 2.111 | 81.8  | 0.201 | 35.8 | 0.575 | -61.2 |

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 3 mA, Z<sub>0</sub> = 50 Ω

| FREQUENCY | S11   |        | S21   |       | S12   |      | S22   |       |
|-----------|-------|--------|-------|-------|-------|------|-------|-------|
|           | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00    | 0.694 | -43.6  | 6.614 | 129.7 | 0.063 | 57.9 | 0.819 | -30.4 |
| 800.00    | 0.557 | -54.5  | 5.730 | 117.1 | 0.090 | 54.4 | 0.707 | -35.6 |
| 1000.00   | 0.463 | -63.1  | 5.054 | 106.4 | 0.113 | 52.6 | 0.609 | -41.1 |
| 1200.00   | 0.394 | -70.7  | 4.628 | 99.0  | 0.125 | 54.2 | 0.575 | -45.5 |
| 1400.00   | 0.325 | -78.9  | 4.123 | 92.2  | 0.143 | 52.5 | 0.526 | -48.8 |
| 1600.00   | 0.269 | -88.2  | 3.744 | 84.3  | 0.157 | 51.5 | 0.478 | -52.5 |
| 1800.00   | 0.226 | -96.9  | 3.488 | 79.4  | 0.160 | 52.5 | 0.441 | -57.0 |
| 2000.00   | 0.181 | -103.5 | 3.085 | 75.5  | 0.166 | 50.8 | 0.412 | -57.9 |
| 2200.00   | 0.146 | -111.9 | 2.776 | 70.5  | 0.174 | 48.1 | 0.401 | -60.0 |

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 5 mA, Z<sub>0</sub> = 50 Ω

| FREQUENCY | S11   |        | S21   |       | S12   |      | S22   |       |
|-----------|-------|--------|-------|-------|-------|------|-------|-------|
|           | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00    | 0.556 | -51.5  | 7.925 | 120.8 | 0.055 | 57.5 | 0.729 | -33.5 |
| 800.00    | 0.430 | -61.6  | 6.573 | 108.7 | 0.083 | 55.0 | 0.614 | -37.4 |
| 1000.00   | 0.338 | -68.2  | 5.644 | 98.8  | 0.102 | 54.0 | 0.527 | -41.0 |
| 1200.00   | 0.271 | -75.3  | 5.047 | 92.4  | 0.117 | 57.7 | 0.498 | -44.6 |
| 1400.00   | 0.217 | -84.1  | 4.409 | 86.0  | 0.133 | 56.5 | 0.451 | -47.5 |
| 1600.00   | 0.171 | -94.6  | 3.985 | 78.8  | 0.148 | 55.9 | 0.414 | -50.0 |
| 1800.00   | 0.137 | -104.4 | 3.674 | 74.9  | 0.155 | 57.4 | 0.382 | -53.9 |
| 2000.00   | 0.100 | -114.7 | 3.229 | 71.4  | 0.162 | 55.7 | 0.361 | -55.0 |
| 2200.00   | 0.079 | -125.3 | 2.897 | 66.9  | 0.173 | 53.0 | 0.357 | -57.2 |

V<sub>CE</sub> = 1 V, I<sub>c</sub> = 7 mA, Z<sub>0</sub> = 50 Ω

| FREQUENCY | S11   |        | S21   |       | S12   |      | S22   |       |
|-----------|-------|--------|-------|-------|-------|------|-------|-------|
|           | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00    | 0.455 | -57.2  | 8.518 | 114.4 | 0.051 | 56.0 | 0.657 | -34.1 |
| 800.00    | 0.335 | -67.4  | 6.873 | 103.1 | 0.075 | 55.1 | 0.557 | -36.6 |
| 1000.00   | 0.252 | -73.2  | 5.825 | 93.9  | 0.095 | 56.7 | 0.480 | -39.2 |
| 1200.00   | 0.194 | -80.5  | 5.131 | 88.3  | 0.113 | 59.7 | 0.453 | -41.8 |
| 1400.00   | 0.148 | -91.1  | 4.447 | 82.0  | 0.129 | 58.7 | 0.417 | -44.6 |
| 1600.00   | 0.114 | -105.9 | 4.018 | 75.3  | 0.145 | 58.7 | 0.385 | -46.8 |
| 1800.00   | 0.087 | -119.5 | 3.682 | 71.9  | 0.152 | 60.6 | 0.357 | -50.6 |
| 2000.00   | 0.062 | -140.8 | 3.230 | 68.6  | 0.161 | 58.1 | 0.341 | -51.5 |
| 2200.00   | 0.051 | -160.7 | 2.893 | 64.4  | 0.170 | 55.7 | 0.342 | -54.0 |

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

| FREQUENCY<br>MHz | S11   |        | S21   |       | S12   |      | S22   |       |
|------------------|-------|--------|-------|-------|-------|------|-------|-------|
|                  | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00           | 0.359 | -65.9  | 8.500 | 108.9 | 0.048 | 54.8 | 0.603 | -33.1 |
| 800.00           | 0.255 | -78.2  | 6.731 | 98.1  | 0.071 | 56.3 | 0.516 | -34.4 |
| 1000.00          | 0.177 | -83.8  | 5.648 | 89.6  | 0.090 | 56.8 | 0.449 | -35.9 |
| 1200.00          | 0.127 | -96.6  | 4.927 | 84.4  | 0.109 | 61.7 | 0.431 | -38.2 |
| 1400.00          | 0.098 | -115.6 | 4.251 | 78.2  | 0.125 | 61.4 | 0.400 | -40.5 |
| 1600.00          | 0.081 | -141.9 | 3.839 | 71.9  | 0.143 | 61.2 | 0.377 | -42.8 |
| 1800.00          | 0.072 | -162.7 | 3.504 | 68.8  | 0.150 | 62.1 | 0.351 | -46.1 |
| 2000.00          | 0.070 | 170.9  | 3.072 | 65.8  | 0.157 | 60.3 | 0.338 | -47.5 |
| 2200.00          | 0.074 | 157.1  | 2.748 | 61.5  | 0.167 | 57.2 | 0.342 | -50.4 |

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

| FREQUENCY<br>MHz | S11   |       | S21   |       | S12   |      | S22   |       |
|------------------|-------|-------|-------|-------|-------|------|-------|-------|
|                  | MAG   | ANG   | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00           | 0.927 | -26.3 | 3.263 | 148.6 | 0.065 | 64.5 | 0.968 | -19.5 |
| 800.00           | 0.827 | -34.2 | 3.122 | 138.1 | 0.101 | 59.7 | 0.903 | -24.1 |
| 1000.00          | 0.758 | -43.7 | 2.962 | 127.7 | 0.129 | 54.9 | 0.828 | -30.3 |
| 1200.00          | 0.712 | -52.2 | 2.910 | 118.9 | 0.146 | 54.2 | 0.808 | -36.5 |
| 1400.00          | 0.653 | -59.1 | 2.825 | 112.3 | 0.165 | 50.6 | 0.769 | -41.3 |
| 1600.00          | 0.581 | -67.5 | 2.657 | 103.8 | 0.181 | 47.3 | 0.723 | -46.0 |
| 1800.00          | 0.530 | -75.7 | 2.578 | 96.3  | 0.185 | 46.0 | 0.673 | -51.3 |
| 2000.00          | 0.469 | -82.1 | 2.368 | 91.0  | 0.184 | 41.5 | 0.630 | -54.7 |
| 2200.00          | 0.410 | -87.5 | 2.184 | 84.7  | 0.188 | 38.2 | 0.607 | -57.4 |

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

| FREQUENCY<br>MHz | S11   |       | S21   |       | S12   |      | S22   |       |
|------------------|-------|-------|-------|-------|-------|------|-------|-------|
|                  | MAG   | ANG   | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00           | 0.727 | -39.7 | 6.761 | 131.7 | 0.057 | 58.1 | 0.841 | -27.8 |
| 800.00           | 0.587 | -49.7 | 5.910 | 119.4 | 0.084 | 55.8 | 0.737 | -32.4 |
| 1000.00          | 0.490 | -57.4 | 5.229 | 108.8 | 0.104 | 54.2 | 0.645 | -37.5 |
| 1200.00          | 0.425 | -64.5 | 4.812 | 101.3 | 0.120 | 55.7 | 0.608 | -41.8 |
| 1400.00          | 0.354 | -70.8 | 4.314 | 94.8  | 0.135 | 55.3 | 0.562 | -45.1 |
| 1600.00          | 0.295 | -78.5 | 3.919 | 86.9  | 0.148 | 54.1 | 0.517 | -48.3 |
| 1800.00          | 0.251 | -85.1 | 3.662 | 81.8  | 0.151 | 54.8 | 0.478 | -52.4 |
| 2000.00          | 0.203 | -89.4 | 3.243 | 77.9  | 0.156 | 52.9 | 0.449 | -53.6 |
| 2200.00          | 0.167 | -93.9 | 2.924 | 73.0  | 0.164 | 50.9 | 0.441 | -55.6 |

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

| FREQUENCY<br>MHz | S11   |       | S21   |       | S12   |      | S22   |       |
|------------------|-------|-------|-------|-------|-------|------|-------|-------|
|                  | MAG   | ANG   | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00           | 0.592 | -46.3 | 8.189 | 122.9 | 0.052 | 59.4 | 0.763 | -30.6 |
| 800.00           | 0.457 | -55.1 | 6.849 | 110.9 | 0.074 | 56.6 | 0.655 | -33.8 |
| 1000.00          | 0.369 | -60.0 | 5.900 | 101.1 | 0.096 | 54.1 | 0.564 | -37.6 |
| 1200.00          | 0.305 | -66.2 | 5.303 | 94.7  | 0.111 | 58.0 | 0.533 | -40.7 |
| 1400.00          | 0.249 | -72.3 | 4.651 | 88.4  | 0.126 | 58.2 | 0.495 | -43.3 |
| 1600.00          | 0.198 | -79.2 | 4.202 | 81.2  | 0.139 | 58.2 | 0.460 | -45.6 |
| 1800.00          | 0.160 | -85.2 | 3.888 | 77.2  | 0.146 | 59.2 | 0.425 | -59.3 |
| 2000.00          | 0.121 | -89.1 | 3.419 | 73.8  | 0.151 | 57.5 | 0.404 | -50.4 |
| 2200.00          | 0.096 | -92.3 | 3.069 | 69.3  | 0.161 | 54.4 | 0.403 | -52.2 |

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

| FREQUENCY | S11   |       | S21   |       | S12   |      | S22   |       |
|-----------|-------|-------|-------|-------|-------|------|-------|-------|
| MHz       | MAG   | ANG   | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00    | 0.489 | -50.8 | 8.917 | 116.7 | 0.045 | 58.5 | 0.701 | -31.1 |
| 800.00    | 0.371 | -58.8 | 7.266 | 105.4 | 0.070 | 57.0 | 0.601 | -33.3 |
| 1000.00   | 0.287 | -62.3 | 6.166 | 96.2  | 0.090 | 57.4 | 0.523 | -35.7 |
| 1200.00   | 0.233 | -67.2 | 5.456 | 90.6  | 0.106 | 61.2 | 0.501 | -38.3 |
| 1400.00   | 0.181 | -72.6 | 4.743 | 84.5  | 0.122 | 62.0 | 0.465 | -40.4 |
| 1600.00   | 0.138 | -80.1 | 4.283 | 77.7  | 0.137 | 61.2 | 0.436 | -42.7 |
| 1800.00   | 0.105 | -86.5 | 3.937 | 74.2  | 0.143 | 62.8 | 0.404 | -45.9 |
| 2000.00   | 0.072 | -91.2 | 3.456 | 71.1  | 0.149 | 60.2 | 0.389 | -47.1 |
| 2200.00   | 0.052 | -93.0 | 3.097 | 66.9  | 0.159 | 57.3 | 0.391 | -49.2 |

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

| FREQUENCY | S11   |        | S21   |       | S12   |      | S22   |       |
|-----------|-------|--------|-------|-------|-------|------|-------|-------|
| MHz       | MAG   | ANG    | MAG   | ANG   | MAG   | ANG  | MAG   | ANG   |
| 600.00    | 0.404 | -55.4  | 9.236 | 111.8 | 0.039 | 55.3 | 0.660 | -30.2 |
| 800.00    | 0.298 | -62.9  | 7.374 | 101.0 | 0.064 | 57.2 | 0.569 | -31.4 |
| 1000.00   | 0.221 | -65.2  | 6.206 | 92.5  | 0.087 | 60.1 | 0.501 | -33.0 |
| 1200.00   | 0.169 | -69.5  | 5.441 | 87.4  | 0.102 | 63.5 | 0.483 | -35.3 |
| 1400.00   | 0.128 | -76.3  | 4.701 | 81.4  | 0.119 | 63.3 | 0.456 | -37.4 |
| 1600.00   | 0.089 | -86.1  | 4.244 | 75.0  | 0.134 | 63.5 | 0.430 | -39.5 |
| 1800.00   | 0.062 | -96.1  | 3.888 | 71.9  | 0.140 | 64.0 | 0.400 | -42.5 |
| 2000.00   | 0.035 | -112.1 | 3.408 | 68.9  | 0.147 | 62.4 | 0.388 | -43.8 |
| 2200.00   | 0.021 | -121.3 | 3.050 | 64.8  | 0.156 | 59.6 | 0.393 | -46.2 |

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