

To our customers,

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## Old Company Name in Catalogs and Other Documents

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Renesas Electronics website: <http://www.renesas.com>

April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (<http://www.renesas.com>)

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**PNP EPITAXIAL SILICON TRANSISTOR  
MICROWAVE AMPLIFIER**

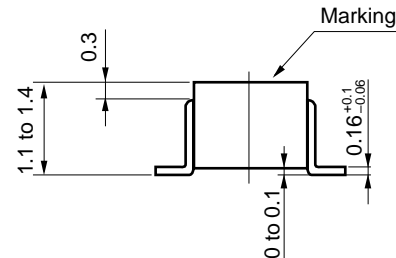
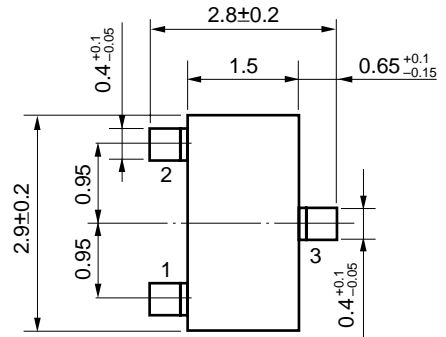
**FEATURES**

- High  $f_T$   
 $f_T = 8.5$  GHz TYP.
- High gain  
 $|S_{21e}|^2 = 12.0$  dB TYP. @  $f = 1.0$  GHz,  $V_{CE} = -8$  V,  $I_C = -20$  mA
- High-speed switching characteristics
- Equivalent NPN transistor is the 2SC3583.

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

| Parameter                    | Symbol    | Rating      | Unit |
|------------------------------|-----------|-------------|------|
| Collector to Base Voltage    | $V_{CB0}$ | -20         | V    |
| Collector to Emitter Voltage | $V_{CE0}$ | -12         | V    |
| Emitter to Base Voltage      | $V_{EB0}$ | -3.0        | V    |
| Collector Current            | $I_C$     | -50         | mA   |
| Total Power Dissipation      | $P_T$     | 200         | mW   |
| Junction Temperature         | $T_j$     | 150         | °C   |
| Storage Temperature          | $T_{stg}$ | -65 to +150 | °C   |

**PACKAGE DIMENSION (in millimeters)**



**PIN CONNECTIONS**

- 1: Emitter  
2: Base  
3: Collector    Marking: T92

**ELECTRICAL CHARACTERISTICS ( $T_A = 25$  °C)**

| Parameter                | Symbol        | Test Conditions                                | MIN. | TYP. | MAX. | Unit    |
|--------------------------|---------------|--|------|------|------|---------|
| Collector Cutoff Current | $I_{CB0}$     | $V_{CB} = -10$ V                               |      |      | -0.1 | $\mu$ A |
| Emitter Cutoff Current   | $I_{EB0}$     | $V_{EB} = -1$ V                                |      |      | -0.1 | $\mu$ A |
| DC Current Gain          | $h_{FE}$      | $V_{CE} = -8$ V, $I_C = -20$ mA                | 20   |      | 100  |         |
| Gain Bandwidth Product   | $f_T$         | $V_{CE} = -8$ V, $I_C = -20$ mA, $f = 1$ GHz   | 6.0  | 8.5  |      | GHz     |
| Collector Capacitance    | $C_{re}^*$    | $V_{CB} = -10$ V, $I_E = 0$ , $f = 1$ MHz      |      | 0.5  | 1    | pF      |
| Insertion Power Gain     | $ S_{21e} ^2$ | $V_{CE} = -8$ V, $I_C = -20$ mA, $f = 1.0$ GHz | 8.0  | 12.0 |      | dB      |
| Noise Figure             | NF            | $V_{CE} = -8$ V, $I_C = -3$ mA, $f = 1$ GHz    |      | 1.5  | 3    | dB      |

\* Measured by a 3-terminal bridge. Emitter and Case should be connected to the guard terminal.

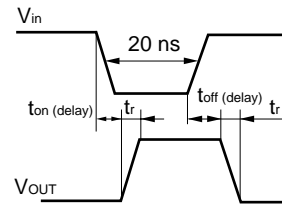
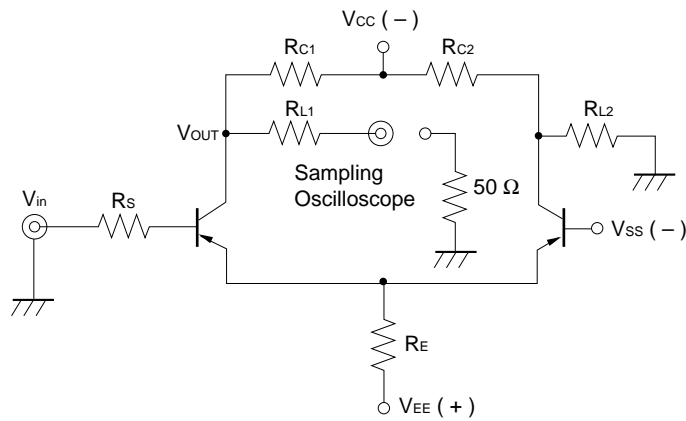
**$h_{FE}$  Classification**

|          |           |
|----------|-----------|
| Rank     | FB        |
| Marking  | T92       |
| $h_{FE}$ | 20 to 100 |

**SWITCHING CHARACTERISTICS**

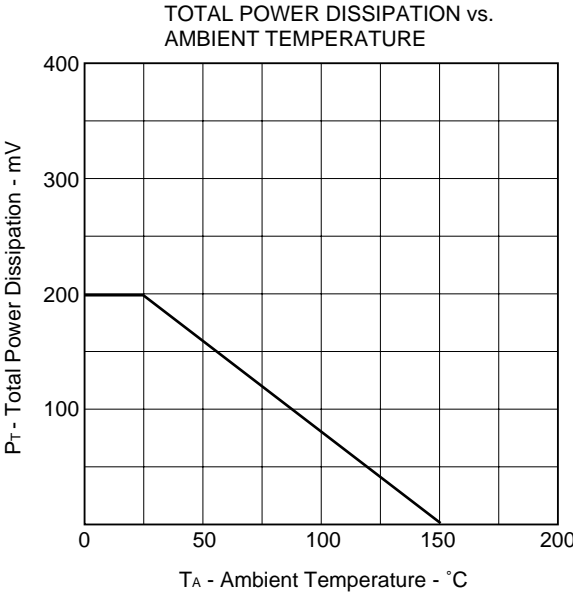
| Parameter           | Symbol                    | $V_{in} = 1\text{ V}$ | Unit |
|---------------------|---------------------------|-----------------------|------|
|                     |                           | TYP.                  |      |
| Turn-on Delay Time  | $t_{on} \text{ (delay)}$  | 1.08                  | ns   |
| Rise Time           | $t_r$                     | 0.66                  | ns   |
| Turn off Delay Time | $t_{off} \text{ (delay)}$ | 0.32                  | ns   |
| Fall Time           | $t_f$                     | 0.78                  | ns   |

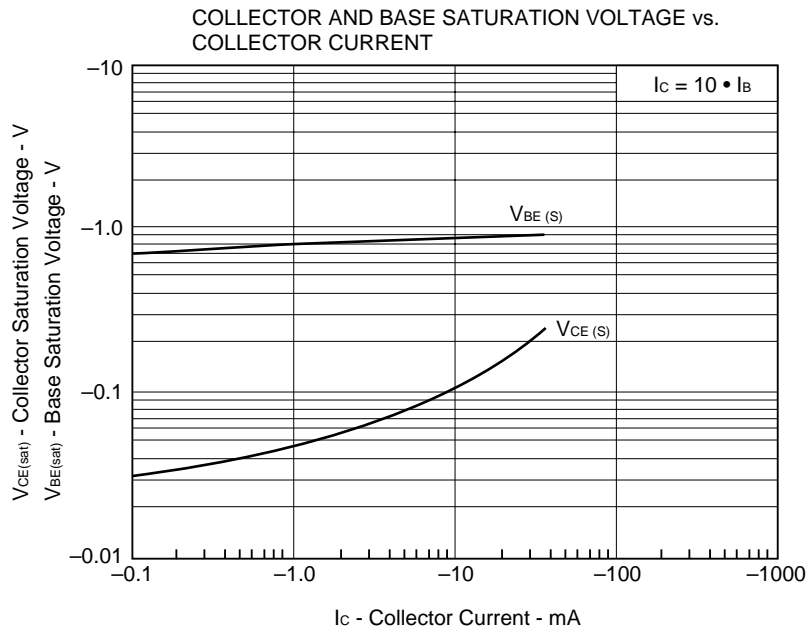
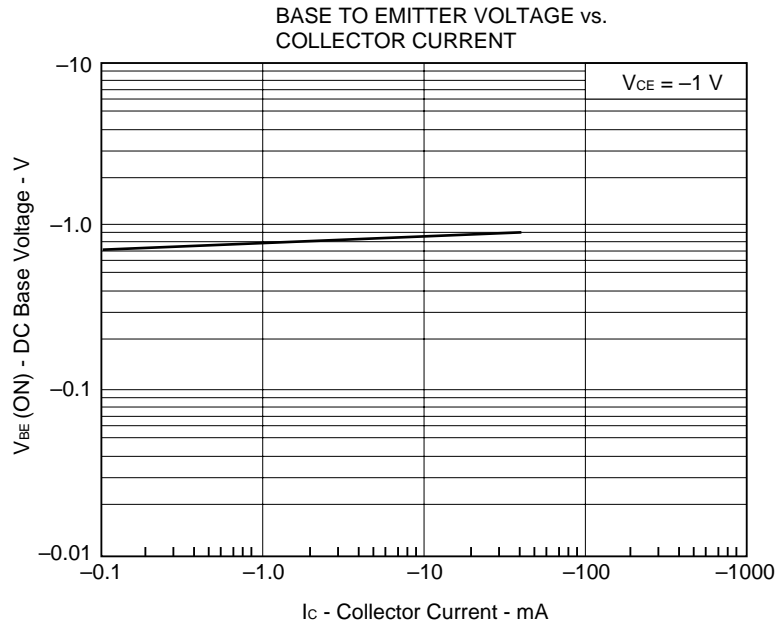
**SWITCHING TIME MEASUREMENT CIRCUIT**

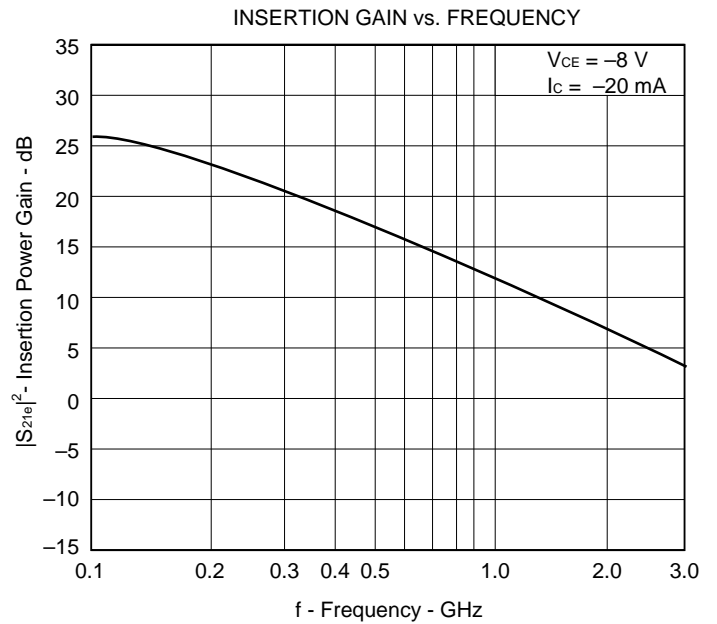
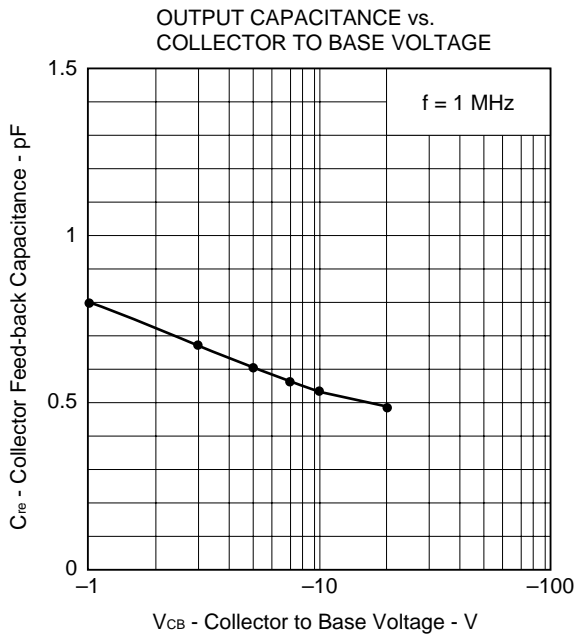
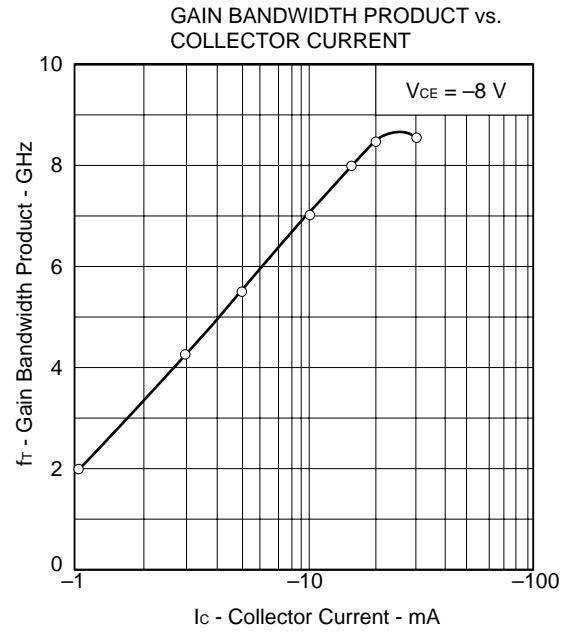
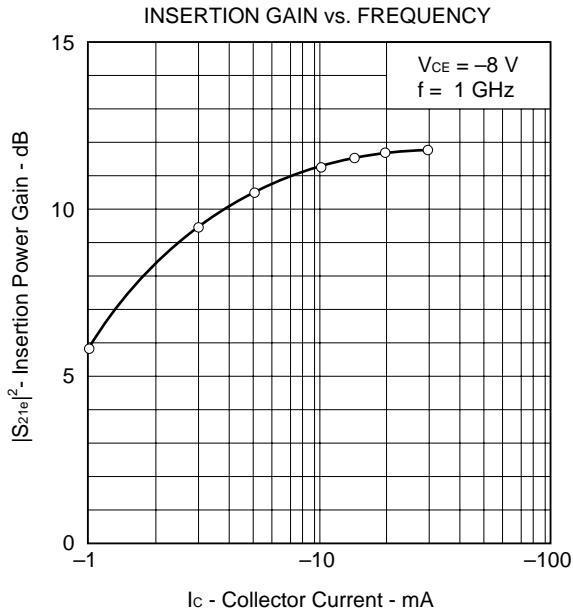


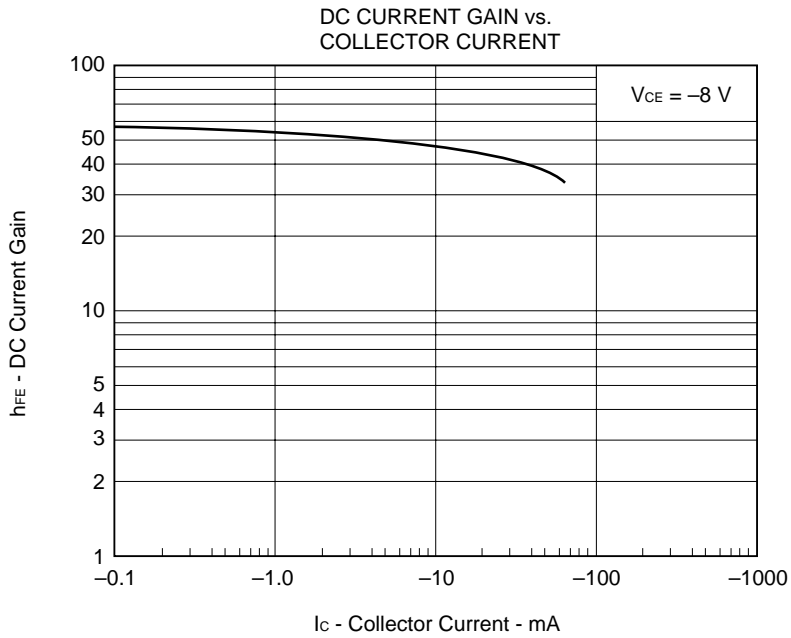
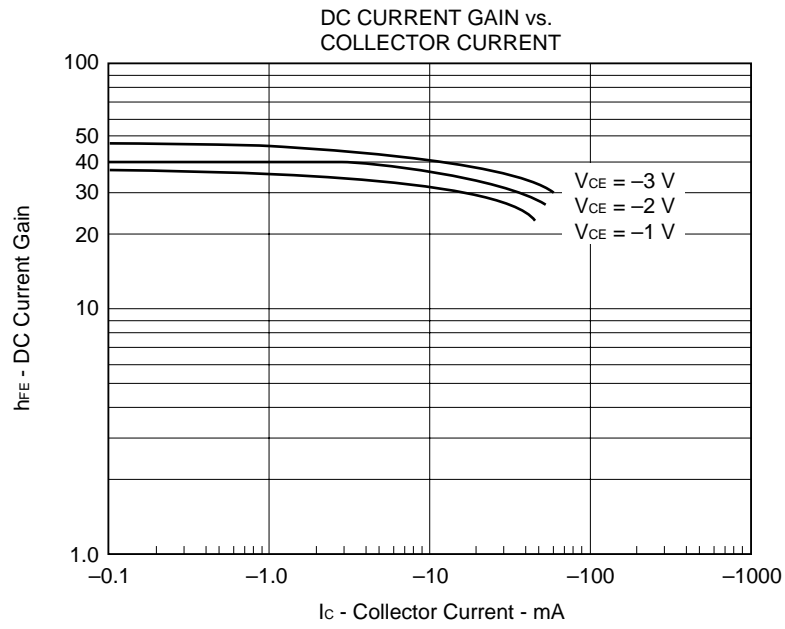
| $V_{in} = 1\text{ V}, V_{BB} = -0.5\text{ V}, R_{C1} = R_{C2}$ |              |              |              |              |          |          |
|--|--------------|--------------|--------------|--------------|----------|----------|
| $R_s$  | $R_C$        | $R_{L1}$     | $R_{L2}$     | $R_E$        | $V_{EE}$ | $V_{CC}$ |
| ( $\Omega$ )   | ( $\Omega$ ) | ( $\Omega$ ) | ( $\Omega$ ) | ( $\Omega$ ) | (V)      | (V)      |
| 160  | 1 k          | 200          | 250          | 2.7 k        | 27       | 26.3     |

TYPICAL CHARACTERISTICS



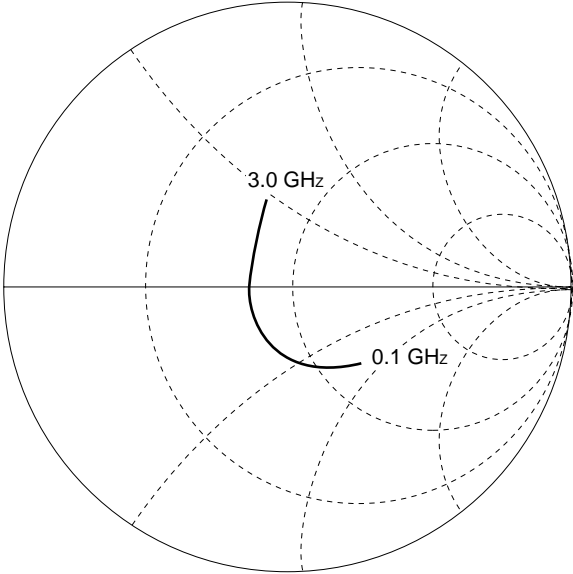






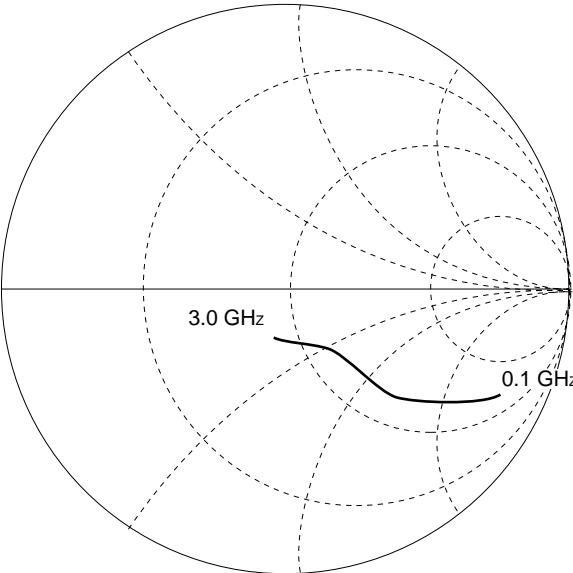


S<sub>11</sub>



V<sub>CE</sub> = -8 V  
I<sub>c</sub> = -20 mA

S<sub>22</sub>



V<sub>CE</sub> = -8 V  
I<sub>c</sub> = -20 mA

S-PARAMETER

( $V_{CE} = 1\text{ V}$ ,  $I_C = 5\text{ mA}$ ,  $Z_o = 50\ \Omega$ )

| f<br>MHz | S <sub>11</sub> |       | S <sub>21</sub> |      | S <sub>12</sub> |      | S <sub>22</sub> |       |
|----------|-----------------|-------|-----------------|------|-----------------|------|-----------------|-------|
|          | MAG             | ANG   | MAG             | ANG  | MAG             | ANG  | MAG             | ANG   |
| 100      | 0.553           | -43.7 | 11.03           | 150. | 0.423           | 71.2 | 0.666           | -25.0 |
| 200      | 0.460           | -78.2 | 8.780           | 129. | 0.691           | 59.4 | 0.696           | -42.2 |
| 300      | 0.427           | -104  | 7.003           | 115. | 0.857           | 54.4 | 0.556           | -52.9 |
| 400      | 0.393           | -123  | 5.700           | 105. | 0.983           | 52.7 | 0.461           | -59.5 |
| 500      | 0.377           | -138  | 4.74            | 97.6 | 0.109           | 52.2 | 0.392           | -64.2 |
| 600      | 0.367           | -149  | 4.053           | 91.2 | 0.120           | 52.5 | 0.341           | -67.4 |
| 700      | 0.362           | -159  | 3.549           | 85.9 | 0.131           | 52.9 | 0.307           | -70.5 |
| 800      | 0.363           | -168  | 3.151           | 61.3 | 0.143           | 53.1 | 0.280           | -73.7 |
| 900      | 0.364           | -175  | 2.847           | 77.0 | 0.154           | 53.8 | 0.258           | -76.1 |
| 1000     | 0.365           | 178   | 2.603           | 73.0 | 0.165           | 54.0 | 0.241           | -78.8 |
| 1100     | 0.369           | 172   | 2.391           | 69.3 | 0.176           | 54.4 | 0.227           | -82.0 |
| 1200     | 0.375           | 166   | 2.219           | 66.8 | 0.188           | 54.2 | 0.217           | -84.8 |
| 1300     | 0.376           | 162   | 2.070           | 62.7 | 0.200           | 54.4 | 0.207           | -88.4 |
| 1400     | 0.384           | 157   | 1.940           | 59.4 | 0.213           | 54.1 | 0.200           | -92.0 |
| 1500     | 0.391           | 153   | 1.838           | 56.3 | 0.225           | 53.8 | 0.192           | -94.9 |
| 1600     | 0.399           | 149   | 1.744           | 53.5 | 0.238           | 53.4 | 0.188           | -99.1 |
| 1700     | 0.405           | 146   | 1.659           | 50.8 | 0.250           | 52.9 | 0.184           | -102  |
| 1800     | 0.411           | 142   | 1.584           | 48.2 | 0.264           | 52.3 | 0.184           | -107  |
| 1900     | 0.418           | 139   | 1.520           | 45.6 | 0.277           | 51.7 | 0.182           | -111  |
| 2000     | 0.423           | 135   | 1.461           | 43.1 | 0.290           | 51.1 | 0.181           | -115  |
| 2100     | 0.429           | 132   | 1.408           | 40.9 | 0.302           | 50.2 | 0.180           | -119  |
| 2200     | 0.438           | 130   | 1.361           | 38.6 | 0.314           | 49.4 | 0.182           | -125  |
| 2300     | 0.444           | 127   | 1.316           | 36.4 | 0.328           | 48.5 | 0.181           | -128  |
| 2400     | 0.450           | 124   | 1.276           | 34.2 | 0.341           | 47.6 | 0.187           | -132  |
| 2500     | 0.457           | 122   | 1.239           | 32.3 | 0.353           | 46.5 | 0.188           | -137  |

**S-PARAMETER**

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

| f<br>MHz | S <sub>11</sub> |       | S <sub>21</sub> |      | S <sub>12</sub> |      | S <sub>22</sub> |       |
|----------|-----------------|-------|-----------------|------|-----------------|------|-----------------|-------|
|          | MAG             | ANG   | MAG             | ANG  | MAG             | ANG  | MAG             | ANG   |
| 100      | 0.595           | -34.2 | 11.62           | 154. | 0.0328          | 74.9 | 0.902           | -19.4 |
| 200      | 0.511           | -62.8 | 9.618           | 134. | 0.0573          | 64.8 | 0.760           | -33.2 |
| 300      | 0.432           | -86.0 | 7.920           | 120. | 0.0734          | 58.5 | 0.633           | -41.9 |
| 400      | 0.362           | -104  | 6.575           | 110. | 0.0852          | 57.1 | 0.542           | -47.3 |
| 500      | 0.345           | -119  | 5.511           | 102. | 0.0964          | 55.9 | 0.471           | -50.3 |
| 600      | 0.323           | -132  | 4.749           | 95.9 | 0.106           | 56.4 | 0.420           | -52.2 |
| 700      | 0.308           | -143  | 4.177           | 90.5 | 0.116           | 56.6 | 0.383           | -54.1 |
| 800      | 0.300           | -153  | 3.712           | 85.8 | 0.126           | 57.1 | 0.355           | -55.7 |
| 900      | 0.297           | -162  | 3.359           | 81.5 | 0.137           | 57.3 | 0.332           | -57.2 |
| 1000     | 0.295           | -170  | 3.064           | 77.6 | 0.147           | 57.9 | 0.315           | -58.9 |
| 1100     | 0.297           | -177  | 2.818           | 74.0 | 0.158           | 57.9 | 0.299           | -60.6 |
| 1200     | 0.300           | 176   | 2.617           | 70.6 | 0.169           | 58.3 | 0.287           | -62.1 |
| 1300     | 0.303           | 170   | 2.439           | 67.4 | 0.181           | 58.1 | 0.276           | -64.6 |
| 1400     | 0.308           | 164   | 2.284           | 64.2 | 0.192           | 58.1 | 0.266           | -66.5 |
| 1500     | 0.314           | 160   | 2.159           | 61.2 | 0.203           | 57.8 | 0.258           | -68.5 |
| 1600     | 0.322           | 155   | 2.046           | 58.4 | 0.215           | 57.5 | 0.250           | -71.4 |
| 1700     | 0.328           | 151   | 1.944           | 55.7 | 0.227           | 57.3 | 0.243           | -73.6 |
| 1800     | 0.335           | 147   | 1.855           | 53.0 | 0.240           | 56.5 | 0.241           | -76.9 |
| 1900     | 0.341           | 143   | 1.774           | 50.5 | 0.252           | 56.1 | 0.233           | -80.3 |
| 2000     | 0.349           | 140   | 1.705           | 48.1 | 0.264           | 55.5 | 0.230           | -83.1 |
| 2100     | 0.355           | 136   | 1.638           | 45.7 | 0.276           | 54.7 | 0.226           | -86.5 |
| 2200     | 0.364           | 133   | 1.583           | 43.5 | 0.289           | 54.2 | 0.222           | -90.7 |
| 2300     | 0.372           | 130   | 1.53            | 41.2 | 0.302           | 53.2 | 0.218           | -93.6 |
| 2400     | 0.378           | 128   | 1.479           | 39.0 | 0.314           | 52.5 | 0.218           | -97.5 |
| 2500     | 0.386           | 125   | 1.439           | 37.0 | 0.326           | 51.7 | 0.215           | -101. |

S-PARAMETER

( $V_{CE} = 8\text{ V}$ ,  $I_C = 5\text{ mA}$ ,  $Z_o = 50\ \Omega$ )

| f<br>MHz | S <sub>11</sub> |        | S <sub>21</sub> |      | S <sub>12</sub> |      | S <sub>22</sub> |        |
|----------|-----------------|--------|-----------------|------|-----------------|------|-----------------|--------|
|          | MAG             | ANG    | MAG             | ANG  | MAG             | ANG  | MAG             | ANG    |
| 100      | 0.679           | - 27.6 | 11.75           | 156. | 0.0289          | 76.9 | 0.918           | - 15.9 |
| 200      | 0.586           | - 51.4 | 10.01           | 138. | 0.0508          | 66.6 | 0.802           | - 27.7 |
| 300      | 0.491           | - 71.0 | 8.453           | 124. | 0.0670          | 61.8 | 0.690           | - 35.3 |
| 400      | 0.417           | - 87.3 | 7.152           | 114. | 0.0780          | 58.9 | 0.603           | - 39.9 |
| 500      | 0.362           | - 100  | 6.040           | 106. | 0.0886          | 58.3 | 0.534           | - 42.5 |
| 600      | 0.323           | - 113  | 5.245           | 99.6 | 0.0984          | 57.9 | 0.485           | - 44.0 |
| 700      | 0.293           | - 124  | 4.627           | 94.2 | 0.107           | 58.0 | 0.448           | - 45.5 |
| 800      | 0.274           | - 135  | 4.124           | 89.4 | 0.117           | 58.4 | 0.419           | - 46.6 |
| 900      | 0.261           | - 145  | 3.734           | 85.0 | 0.126           | 58.6 | 0.396           | - 47.7 |
| 1000     | 0.251           | - 154  | 3.419           | 81.2 | 0.135           | 59.4 | 0.377           | - 48.8 |
| 1100     | 0.247           | - 162  | 3.150           | 77.6 | 0.145           | 59.6 | 0.361           | - 50.2 |
| 1200     | 0.245           | - 170  | 2.919           | 74.2 | 0.155           | 59.6 | 0.350           | - 51.4 |
| 1300     | 0.245           | - 177  | 2.720           | 71.0 | 0.166           | 59.8 | 0.339           | - 53.2 |
| 1400     | 0.247           | 175    | 2.551           | 67.8 | 0.176           | 59.9 | 0.327           | - 54.6 |
| 1500     | 0.251           | 169    | 2.410           | 64.8 | 0.187           | 59.7 | 0.320           | - 56.1 |
| 1600     | 0.258           | 164    | 2.283           | 62.1 | 0.198           | 59.5 | 0.311           | - 58.2 |
| 1700     | 0.263           | 159    | 2.169           | 59.3 | 0.209           | 59.4 | 0.305           | - 59.8 |
| 1800     | 0.269           | 154    | 2.067           | 56.7 | 0.221           | 58.9 | 0.299           | - 62.4 |
| 1900     | 0.276           | 150    | 1.977           | 54.4 | 0.232           | 58.6 | 0.292           | - 64.9 |
| 2000     | 0.283           | 146    | 1.898           | 51.8 | 0.243           | 58.1 | 0.287           | - 67.0 |
| 2100     | 0.290           | 142    | 1.824           | 49.5 | 0.256           | 57.5 | 0.283           | - 69.6 |
| 2200     | 0.298           | 138    | 1.762           | 47.2 | 0.267           | 57.0 | 0.277           | - 72.9 |
| 2300     | 0.307           | 135    | 1.701           | 44.9 | 0.279           | 56.1 | 0.272           | - 75.1 |
| 2400     | 0.314           | 132    | 1.645           | 42.8 | 0.291           | 55.4 | 0.270           | - 78.7 |
| 2500     | 0.321           | 129    | 1.597           | 40.6 | 0.304           | 54.7 | 0.264           | - 81.3 |

**S-PARAMETER**

( $V_{CE} = 8\text{ V}$ ,  $I_C = 20\text{ mA}$ ,  $Z_o = 50\ \Omega$ )

| f<br>MHz | S <sub>11</sub> |        | S <sub>21</sub> |      | S <sub>12</sub> |      | S <sub>22</sub> |        |
|----------|-----------------|--------|-----------------|------|-----------------|------|-----------------|--------|
|          | MAG             | ANG    | MAG             | ANG  | MAG             | ANG  | MAG             | ANG    |
| 100      | 0.310           | - 47.6 | 20.39           | 144. | 0.0218          | 77.0 | 0.798           | - 25.2 |
| 200      | 0.243           | - 82.1 | 14.87           | 123. | 0.0375          | 72.7 | 0.611           | - 37.8 |
| 300      | 0.205           | - 107  | 11.25           | 111. | 0.0514          | 71.4 | 0.488           | - 43.1 |
| 400      | 0.165           | - 125  | 8.95            | 102. | 0.0643          | 71.6 | 0.417           | - 45.1 |
| 500      | 0.172           | - 140  | 7.329           | 96.6 | 0.0777          | 71.5 | 0.365           | - 45.7 |
| 600      | 0.169           | - 153  | 6.232           | 91.6 | 0.0909          | 71.5 | 0.331           | - 45.8 |
| 700      | 0.166           | - 163  | 5.414           | 87.5 | 0.104           | 71.0 | 0.308           | - 46.5 |
| 800      | 0.169           | - 173  | 4.778           | 83.5 | 0.117           | 70.6 | 0.289           | - 47.3 |
| 900      | 0.172           | 179    | 4.3             | 80.2 | 0.130           | 70.0 | 0.274           | - 47.9 |
| 1000     | 0.176           | 172    | 3.902           | 77.1 | 0.143           | 69.3 | 0.262           | - 49.1 |
| 1100     | 0.182           | 166    | 3.576           | 74.1 | 0.156           | 68.6 | 0.251           | - 50.4 |
| 1200     | 0.188           | 160    | 3.310           | 71.2 | 0.169           | 67.7 | 0.244           | - 51.5 |
| 1300     | 0.194           | 156    | 3.080           | 68.7 | 0.182           | 66.7 | 0.235           | - 53.7 |
| 1400     | 0.202           | 151    | 2.875           | 66.0 | 0.195           | 66.0 | 0.227           | - 55.6 |
| 1500     | 0.209           | 147    | 2.711           | 63.4 | 0.208           | 64.9 | 0.221           | - 57.0 |
| 1600     | 0.217           | 144    | 2.564           | 61.0 | 0.221           | 63.9 | 0.213           | - 59.5 |
| 1700     | 0.224           | 140    | 2.431           | 58.6 | 0.234           | 62.8 | 0.209           | - 61.7 |
| 1800     | 0.233           | 137    | 2.315           | 56.4 | 0.247           | 61.7 | 0.204           | - 64.7 |
| 1900     | 0.240           | 134    | 2.212           | 54.2 | 0.259           | 60.8 | 0.197           | - 67.9 |
| 2000     | 0.247           | 132    | 2.123           | 52.0 | 0.272           | 59.8 | 0.193           | - 70.0 |
| 2100     | 0.255           | 129    | 2.037           | 49.8 | 0.284           | 58.3 | 0.188           | - 73.3 |
| 2200     | 0.263           | 126    | 1.965           | 47.7 | 0.296           | 57.2 | 0.183           | - 77.5 |
| 2300     | 0.272           | 124    | 1.896           | 45.7 | 0.309           | 56.1 | 0.179           | - 80.1 |
| 2400     | 0.278           | 122    | 1.833           | 43.7 | 0.321           | 54.8 | 0.177           | - 84.0 |
| 2500     | 0.286           | 120    | 1.778           | 41.7 | 0.332           | 53.7 | 0.171           | - 87.7 |

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