

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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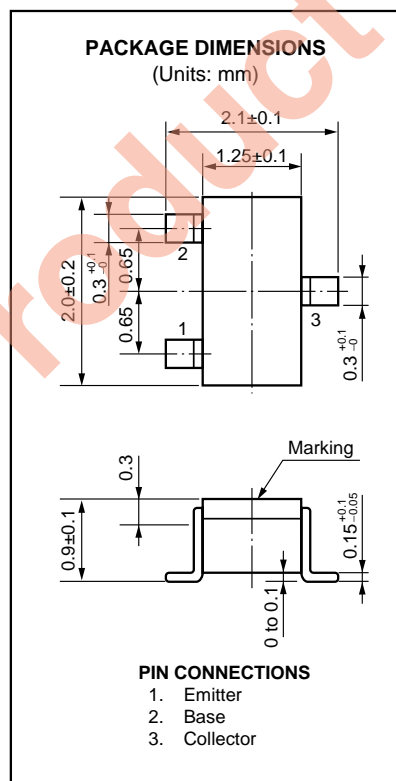
NPN SILICON EPITAXIAL TRANSISTOR  
3 PINS SUPER MINI MOLD

FEATURES

- Excellent Low NF in Low Frequency Band
- Low Voltage Use
- Low  $C_{ob}$  : 0.9 pF TYP.
- Low Noise Voltage : 90 mV TYP.
- Super Mini Mold Package. EIAJ : SC-70

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

|                              |           |             |                  |
|------------------------------|-----------|-------------|------------------|
| Collector to Base Voltage    | $V_{CBO}$ | 25          | V                |
| Collector to Emitter Voltage | $V_{CEO}$ | 13          | V                |
| Emitter to Base Voltage      | $V_{EBO}$ | 3.0         | V                |
| Collector Current            | $I_c$     | 50          | mA               |
| Total Power Dissipation      | $P_T$     | 120         | mW               |
| Junction Temperature         | $T_j$     | 125         | $^\circ\text{C}$ |
| Storage Temperature          | $T_{stg}$ | -55 to +125 | $^\circ\text{C}$ |



ELECTRICAL CHARACTERISTICS ( $T_a = 25\text{ }^\circ\text{C}$ )

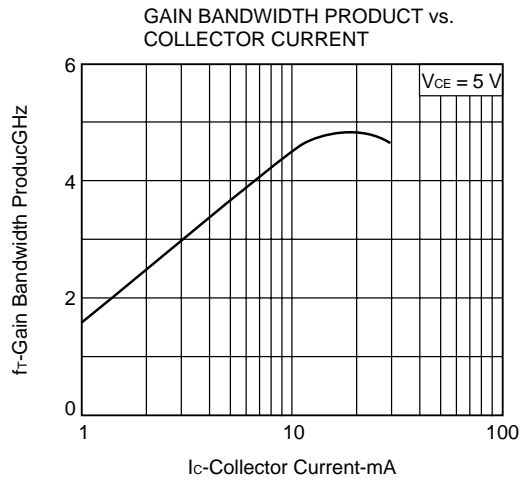
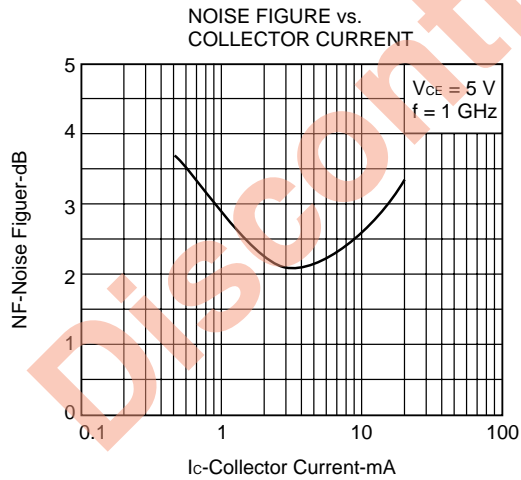
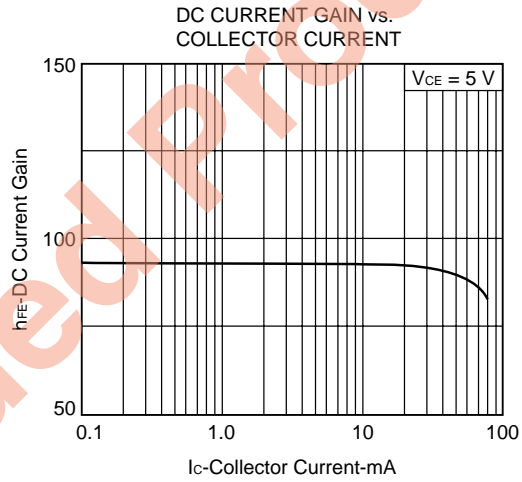
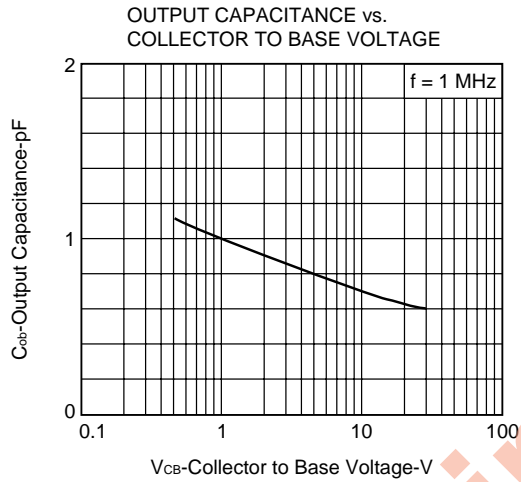
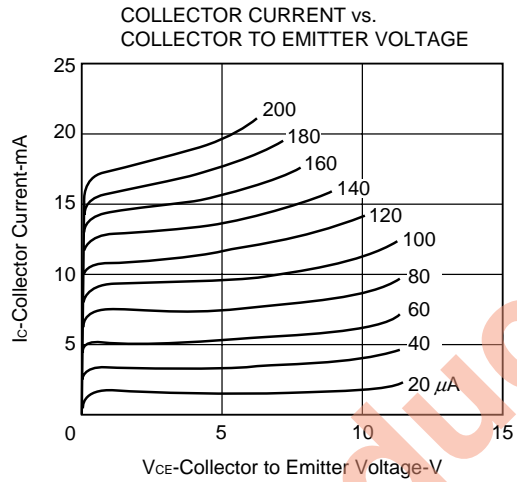
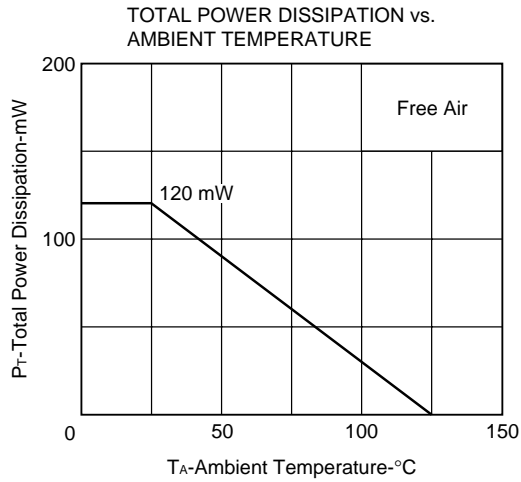
| PARAMETER                            | SYMBOL        | MIN. | TYP. | MAX. | UNIT          | TEST CONDITIONS  |
|--------------------------------------|---------------|------|------|------|---------------|--|
| Collector Cutoff Current             | $I_{cBO}$     |      |      | 0.1  | $\mu\text{A}$ | $V_{CB} = 15\text{ V}, I_E = 0$                            |
| Emitter Cutoff Current               | $I_{EBO}$     |      |      | 0.1  | $\mu\text{A}$ | $V_{EB} = 2\text{ V}, I_C = 0$                             |
| Collector to Base Saturation Voltage | $V_{CE(sat)}$ |      |      | 0.3  | V             | $h_{FE} = 10, I_C = 5\text{ mA}$                           |
| DC Current Gain                      | $h_{FE}$      | 60   |      | 150  |               | $V_{CE} = 5\text{ V}, I_C = 5\text{ mA}^*$                 |
| Gain Bandwidth Product               | $f_T$         | 2.5  | 3.5  |      | GHZ           | $V_{CE} = 5\text{ V}, I_C = 5\text{ mA}$                   |
| Collector Capacitance                | $C_{ob}$      |      | 0.8  | 1.2  | pF            | $V_{CB} = 5\text{ V}, I_E = 0, f = 1\text{ MHz}$           |
| Insertion Power Gain                 | $ S_{21e} ^2$ | 7.0  | 9.0  |      | dB            | $V_{CE} = 5\text{ V}, I_C = 5\text{ mA}, f = 1\text{ GHz}$ |
| Noise Figure                         | NF            |      | 3.0  |      | dB            | $V_{CE} = 5\text{ V}, I_C = 5\text{ mA}, f = 1\text{ GHz}$ |
| Noise Voltage                        | NV            |      | 90   | 200  | mV            | See Test Circuit   |

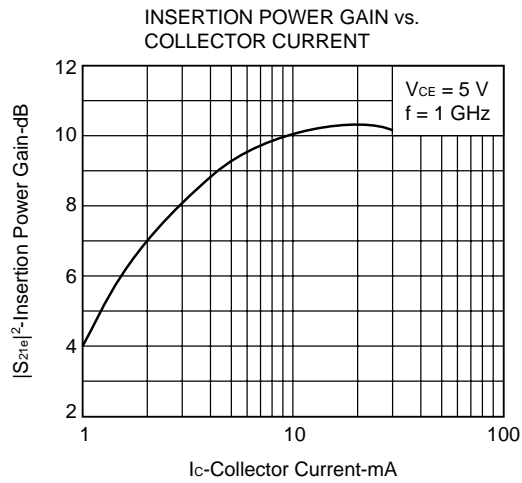
\*1 Pulse Measurement  $PW \leq 350\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$

**$h_{FE}$  Classification**

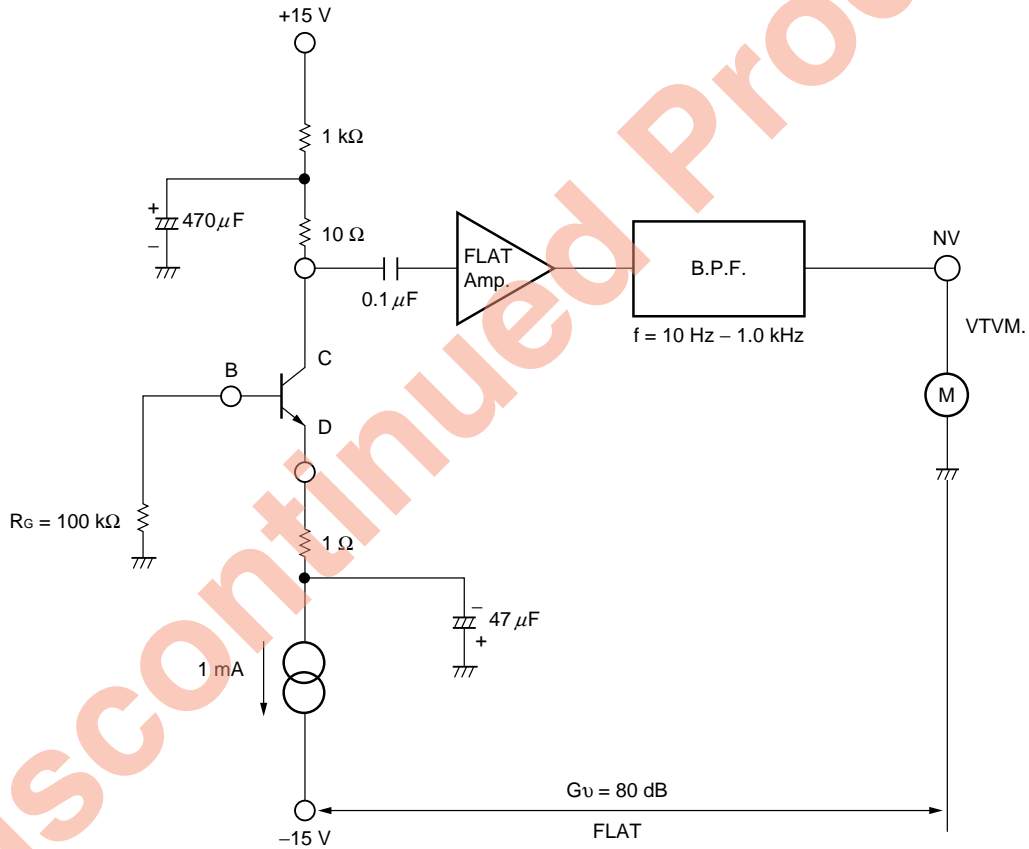
|          |           |
|----------|-----------|
| Rank     | R13       |
| Marking  | R13       |
| $h_{FE}$ | 60 to 150 |

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





**NOISE VOLTAGE TEST CIRCUIT**



$V_{CE} \approx 5 \text{ V}$ ,  $I_C = 1 \text{ mA}$ ,  $R_E = 100 \text{ k}\Omega$ ,  $G_V = 80 \text{ dB}$ , FLAT ( $f = 80 \text{ Hz}$  to  $1.0 \text{ kHz}$ )

Discontinued Product

**S-PARAMETER**

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

| FREQUENCY<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   |
| 100.00           | .825            | -29.9  | 8.599           | 152.6 | .032            | 69.6 | .913            | -18.0 |
| 200.00           | .707            | -57.5  | 7.843           | 133.7 | .052            | 59.2 | .764            | -28.7 |
| 300.00           | .609            | -81.0  | 6.756           | 119.8 | .064            | 52.2 | .653            | -34.1 |
| 400.00           | .515            | -103.6 | 5.998           | 107.7 | .073            | 50.2 | .577            | -36.7 |
| 500.00           | .462            | -120.2 | 5.166           | 99.0  | .080            | 49.9 | .528            | -37.8 |
| 600.00           | .429            | -133.1 | 4.492           | 92.1  | .086            | 49.9 | .493            | -39.2 |
| 700.00           | .408            | -144.4 | 3.971           | 86.1  | .094            | 50.3 | .469            | -40.3 |
| 800.00           | .395            | -153.1 | 3.540           | 81.0  | .100            | 51.5 | .452            | -41.6 |
| 900.00           | .387            | -161.0 | 3.200           | 76.4  | .107            | 52.3 | .440            | -43.4 |
| 1000.00          | .381            | -168.0 | 2.921           | 72.1  | .116            | 52.9 | .430            | -44.8 |
| 1100.00          | .382            | -174.0 | 2.681           | 68.3  | .124            | 53.3 | .424            | -46.6 |
| 1200.00          | .379            | -179.6 | 2.482           | 64.7  | .132            | 53.6 | .417            | -48.2 |
| 1300.00          | .379            | 175.3  | 2.319           | 61.0  | .140            | 53.8 | .410            | -50.6 |
| 1400.00          | .380            | 170.4  | 2.173           | 57.6  | .148            | 54.3 | .406            | -52.7 |
| 1500.00          | .384            | 165.9  | 2.055           | 54.5  | .157            | 54.3 | .402            | -55.2 |
| 1600.00          | .387            | 161.9  | 1.942           | 51.4  | .166            | 54.3 | .401            | -57.3 |
| 1700.00          | .392            | 157.6  | 1.840           | 48.2  | .175            | 54.4 | .397            | -59.9 |
| 1800.00          | .394            | 154.1  | 1.751           | 45.3  | .185            | 54.2 | .397            | -62.6 |
| 1900.00          | .398            | 150.6  | 1.686           | 42.5  | .194            | 53.9 | .393            | -65.4 |
| 2000.00          | .403            | 146.9  | 1.607           | 39.7  | .203            | 53.6 | .393            | -68.0 |
| 2100.00          | .407            | 143.8  | 1.549           | 37.0  | .214            | 52.9 | .391            | -71.1 |
| 2200.00          | .413            | 140.5  | 1.488           | 34.0  | .225            | 52.5 | .389            | -74.2 |
| 2300.00          | .419            | 137.5  | 1.442           | 31.6  | .235            | 51.9 | .389            | -76.9 |
| 2400.00          | .422            | 134.6  | 1.391           | 29.2  | .246            | 51.3 | .389            | -80.2 |
| 2500.00          | .428            | 131.7  | 1.349           | 26.7  | .257            | 50.6 | .390            | -83.4 |
| 2600.00          | .431            | 129.1  | 1.309           | 24.4  | .268            | 49.8 | .391            | -86.2 |
| 2700.00          | .434            | 126.2  | 1.272           | 22.0  | .279            | 48.9 | .388            | -89.5 |
| 2800.00          | .439            | 123.5  | 1.238           | 19.8  | .290            | 48.0 | .389            | -92.7 |
| 2900.00          | .446            | 120.8  | 1.205           | 17.7  | .302            | 46.9 | .392            | -95.7 |
| 3000.00          | .449            | 118.1  | 1.173           | 15.5  | .313            | 46.1 | .391            | -99.0 |

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

| FREQUENCY<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    |
| 100.00           | .897            | -22.4  | 5.520           | 157.8 | .034            | 73.0 | .951            | -13.5  |
| 200.00           | .812            | -44.7  | 5.218           | 140.7 | .059            | 60.4 | .848            | -23.6  |
| 300.00           | .732            | -64.1  | 4.687           | 127.6 | .075            | 52.4 | .756            | -30.2  |
| 400.00           | .639            | -85.1  | 4.506           | 115.7 | .085            | 47.9 | .678            | -33.9  |
| 500.00           | .575            | -101.5 | 4.069           | 106.2 | .093            | 45.2 | .624            | -36.4  |
| 600.00           | .524            | -116.0 | 3.669           | 98.0  | .100            | 44.0 | .582            | -38.4  |
| 700.00           | .485            | -128.8 | 3.347           | 90.8  | .105            | 43.0 | .554            | -40.1  |
| 800.00           | .462            | -138.9 | 3.016           | 84.9  | .109            | 43.4 | .531            | -41.7  |
| 900.00           | .443            | -147.9 | 2.752           | 79.5  | .114            | 44.0 | .515            | -43.6  |
| 1000.00          | .431            | -156.2 | 2.540           | 74.8  | .119            | 44.5 | .503            | -45.4  |
| 1100.00          | .425            | -163.2 | 2.345           | 70.4  | .125            | 45.2 | .494            | -47.4  |
| 1200.00          | .420            | -169.7 | 2.182           | 66.4  | .130            | 46.4 | .485            | -49.0  |
| 1300.00          | .417            | -175.4 | 2.041           | 62.2  | .136            | 46.8 | .478            | -51.4  |
| 1400.00          | .414            | 178.9  | 1.927           | 58.7  | .142            | 48.2 | .472            | -53.6  |
| 1500.00          | .417            | 173.7  | 1.815           | 55.1  | .149            | 48.7 | .468            | -56.0  |
| 1600.00          | .418            | 169.1  | 1.724           | 51.8  | .156            | 49.4 | .467            | -58.4  |
| 1700.00          | .422            | 164.3  | 1.641           | 48.5  | .164            | 50.0 | .461            | -61.0  |
| 1800.00          | .423            | 160.1  | 1.563           | 45.4  | .171            | 50.3 | .460            | -63.7  |
| 1900.00          | .426            | 156.1  | 1.495           | 42.5  | .180            | 50.8 | .457            | -66.5  |
| 2000.00          | .429            | 151.9  | 1.438           | 39.5  | .189            | 51.2 | .454            | -69.4  |
| 2100.00          | .434            | 148.5  | 1.384           | 36.5  | .199            | 51.4 | .453            | -72.2  |
| 2200.00          | .439            | 144.9  | 1.328           | 33.8  | .210            | 51.2 | .452            | -75.4  |
| 2300.00          | .444            | 141.4  | 1.289           | 31.1  | .219            | 51.2 | .451            | -78.2  |
| 2400.00          | .447            | 138.2  | 1.244           | 28.7  | .231            | 51.0 | .451            | -81.3  |
| 2500.00          | .453            | 135.1  | 1.206           | 26.2  | .241            | 50.5 | .451            | -84.5  |
| 2600.00          | .457            | 132.2  | 1.171           | 23.8  | .252            | 50.1 | .453            | -87.6  |
| 2700.00          | .462            | 129.0  | 1.138           | 21.5  | .263            | 49.7 | .450            | -90.9  |
| 2800.00          | .465            | 126.1  | 1.107           | 19.3  | .274            | 48.6 | .452            | -94.0  |
| 2900.00          | .470            | 123.1  | 1.075           | 17.1  | .288            | 48.1 | .454            | -97.2  |
| 3000.00          | .473            | 120.2  | 1.048           | 15.1  | .301            | 47.4 | .454            | -100.6 |

**S-PARAMETER**

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

| FREQUENCY<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    |
| 100.00           | .959            | -15.4  | 1.976           | 163.0 | .037            | 78.4 | .986            | -7.6   |
| 200.00           | .934            | -30.3  | 1.937           | 150.1 | .069            | 67.7 | .954            | -14.3  |
| 300.00           | .894            | -44.3  | 1.833           | 138.1 | .096            | 58.6 | .912            | -20.4  |
| 400.00           | .837            | -59.6  | 1.886           | 127.6 | .114            | 51.1 | .863            | -25.4  |
| 500.00           | .795            | -72.5  | 1.785           | 118.4 | .128            | 44.4 | .823            | -29.2  |
| 600.00           | .744            | -85.9  | 1.732           | 109.5 | .138            | 39.7 | .785            | -32.6  |
| 700.00           | .696            | -98.9  | 1.706           | 101.0 | .144            | 35.4 | .755            | -35.6  |
| 800.00           | .662            | -109.3 | 1.595           | 93.5  | .147            | 32.3 | .729            | -38.4  |
| 900.00           | .624            | -120.3 | 1.545           | 86.7  | .148            | 29.4 | .708            | -41.2  |
| 1000.00          | .600            | -129.5 | 1.474           | 80.6  | .149            | 28.2 | .693            | -43.7  |
| 1100.00          | .580            | -138.2 | 1.391           | 75.1  | .148            | 27.2 | .681            | -46.1  |
| 1200.00          | .561            | -146.6 | 1.338           | 69.7  | .148            | 26.7 | .668            | -48.4  |
| 1300.00          | .550            | -153.6 | 1.262           | 64.9  | .147            | 26.7 | .658            | -51.4  |
| 1400.00          | .538            | -160.9 | 1.214           | 60.3  | .145            | 27.4 | .650            | -53.8  |
| 1500.00          | .534            | -167.6 | 1.159           | 56.0  | .144            | 28.5 | .645            | -56.9  |
| 1600.00          | .530            | -173.5 | 1.110           | 52.2  | .143            | 30.4 | .641            | -59.4  |
| 1700.00          | .525            | -179.6 | 1.064           | 48.4  | .143            | 32.5 | .635            | -62.3  |
| 1800.00          | .526            | 175.2  | 1.018           | 44.8  | .145            | 34.9 | .635            | -65.3  |
| 1900.00          | .526            | 170.0  | .981            | 41.7  | .147            | 37.5 | .632            | -68.4  |
| 2000.00          | .524            | 165.0  | .952            | 38.3  | .152            | 40.2 | .627            | -71.5  |
| 2100.00          | .527            | 160.4  | .914            | 35.4  | .157            | 42.7 | .625            | -74.6  |
| 2200.00          | .529            | 155.7  | .882            | 32.4  | .164            | 45.1 | .621            | -78.2  |
| 2300.00          | .533            | 151.3  | .857            | 29.9  | .172            | 47.3 | .622            | -81.1  |
| 2400.00          | .535            | 147.3  | .827            | 27.5  | .183            | 48.7 | .622            | -84.6  |
| 2500.00          | .539            | 143.3  | .802            | 25.3  | .193            | 50.0 | .621            | -88.0  |
| 2600.00          | .541            | 139.5  | .781            | 23.0  | .205            | 51.1 | .621            | -91.3  |
| 2700.00          | .544            | 135.5  | .759            | 21.0  | .218            | 51.8 | .619            | -94.9  |
| 2800.00          | .546            | 132.0  | .741            | 19.2  | .232            | 52.1 | .619            | -98.1  |
| 2900.00          | .550            | 128.5  | .719            | 17.5  | .248            | 52.1 | .619            | -101.7 |
| 3000.00          | .550            | 124.9  | .702            | 16.0  | .264            | 52.0 | .617            | -105.3 |

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

| FREQUENCY<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    |
| 100.00           | .821            | -31.6  | 8.542           | 151.6 | .036            | 68.8 | .898            | -20.4  |
| 200.00           | .694            | -61.7  | 7.754           | 131.9 | .058            | 56.8 | .733            | -32.5  |
| 300.00           | .596            | -86.5  | 6.608           | 117.7 | .071            | 50.5 | .613            | -38.7  |
| 400.00           | .511            | -109.7 | 5.804           | 105.5 | .079            | 48.7 | .533            | -41.6  |
| 500.00           | .465            | -125.9 | 4.962           | 97.0  | .087            | 47.8 | .481            | -42.9  |
| 600.00           | .439            | -138.8 | 4.292           | 90.2  | .095            | 48.1 | .444            | -44.4  |
| 700.00           | .420            | -149.5 | 3.782           | 84.4  | .102            | 48.7 | .420            | -45.7  |
| 800.00           | .411            | -157.8 | 3.370           | 79.4  | .110            | 49.8 | .402            | -47.1  |
| 900.00           | .406            | -165.4 | 3.037           | 74.7  | .118            | 49.5 | .388            | -48.8  |
| 1000.00          | .402            | -172.0 | 2.768           | 70.6  | .126            | 50.8 | .379            | -50.4  |
| 1100.00          | .402            | -177.8 | 2.550           | 66.9  | .134            | 51.5 | .371            | -52.3  |
| 1200.00          | .401            | 176.9  | 2.358           | 63.1  | .143            | 51.7 | .365            | -54.2  |
| 1300.00          | .403            | 172.0  | 2.205           | 59.4  | .151            | 51.6 | .359            | -56.8  |
| 1400.00          | .403            | 167.4  | 2.067           | 56.1  | .160            | 52.3 | .355            | -58.9  |
| 1500.00          | .408            | 163.3  | 1.953           | 52.9  | .170            | 52.3 | .350            | -61.6  |
| 1600.00          | .410            | 159.4  | 1.845           | 49.6  | .179            | 52.3 | .349            | -64.1  |
| 1700.00          | .415            | 155.3  | 1.755           | 46.6  | .189            | 51.9 | .345            | -67.1  |
| 1800.00          | .417            | 151.8  | 1.673           | 43.6  | .198            | 51.5 | .344            | -69.5  |
| 1900.00          | .422            | 148.4  | 1.595           | 40.8  | .208            | 51.1 | .343            | -72.8  |
| 2000.00          | .425            | 145.0  | 1.537           | 38.1  | .219            | 50.8 | .341            | -75.6  |
| 2100.00          | .430            | 141.9  | 1.481           | 35.0  | .229            | 50.0 | .340            | -79.0  |
| 2200.00          | .435            | 138.8  | 1.423           | 32.5  | .241            | 49.6 | .338            | -82.4  |
| 2300.00          | .441            | 135.7  | 1.377           | 30.0  | .251            | 48.9 | .338            | -85.3  |
| 2400.00          | .445            | 132.9  | 1.329           | 27.6  | .261            | 48.2 | .339            | -88.6  |
| 2500.00          | .449            | 130.2  | 1.288           | 25.2  | .273            | 47.3 | .340            | -92.0  |
| 2600.00          | .452            | 127.5  | 1.253           | 22.8  | .283            | 46.6 | .343            | -95.3  |
| 2700.00          | .458            | 124.7  | 1.218           | 20.6  | .295            | 45.4 | .341            | -98.6  |
| 2800.00          | .461            | 122.1  | 1.185           | 18.4  | .306            | 44.5 | .343            | -102.0 |
| 2900.00          | .466            | 119.6  | 1.153           | 16.3  | .319            | 43.5 | .346            | -105.1 |
| 3000.00          | .469            | 116.8  | 1.124           | 14.2  | .329            | 42.5 | .345            | -108.6 |

**S-PARAMETER**

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

| FREQUENCY<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    |
| 100.00           | .880            | -24.7  | 5.495           | 155.5 | .038            | 71.6 | .943            | -15.4  |
| 200.00           | .800            | -47.6  | 5.185           | 139.2 | .067            | 59.3 | .827            | -26.6  |
| 300.00           | .720            | -67.8  | 4.623           | 125.7 | .085            | 50.5 | .724            | -33.9  |
| 400.00           | .628            | -89.8  | 4.411           | 113.5 | .095            | 46.1 | .640            | -37.9  |
| 500.00           | .567            | -106.7 | 3.961           | 104.0 | .103            | 43.3 | .583            | -40.7  |
| 600.00           | .521            | -121.1 | 3.544           | 95.9  | .109            | 41.9 | .539            | -42.8  |
| 700.00           | .488            | -133.7 | 3.211           | 88.8  | .114            | 41.1 | .509            | -44.8  |
| 800.00           | .467            | -143.5 | 2.895           | 83.0  | .119            | 41.3 | .486            | -46.5  |
| 900.00           | .453            | -152.5 | 2.636           | 77.6  | .124            | 41.6 | .468            | -48.4  |
| 1000.00          | .444            | -160.4 | 2.431           | 72.9  | .131            | 42.4 | .456            | -50.4  |
| 1100.00          | .439            | -166.9 | 2.244           | 68.5  | .136            | 43.2 | .447            | -52.3  |
| 1200.00          | .434            | -173.2 | 2.085           | 64.6  | .142            | 44.1 | .437            | -54.3  |
| 1300.00          | .432            | -178.8 | 1.951           | 60.5  | .147            | 44.5 | .429            | -56.8  |
| 1400.00          | .432            | 176.0  | 1.836           | 56.9  | .154            | 45.7 | .425            | -59.0  |
| 1500.00          | .434            | 171.0  | 1.733           | 53.3  | .161            | 46.0 | .419            | -61.8  |
| 1600.00          | .436            | 166.4  | 1.646           | 49.8  | .168            | 46.7 | .418            | -64.2  |
| 1700.00          | .440            | 161.7  | 1.568           | 46.5  | .177            | 47.1 | .412            | -67.2  |
| 1800.00          | .442            | 158.0  | 1.498           | 43.5  | .185            | 47.5 | .413            | -70.0  |
| 1900.00          | .445            | 154.0  | 1.431           | 40.7  | .194            | 47.8 | .410            | -73.0  |
| 2000.00          | .447            | 150.0  | 1.381           | 37.7  | .204            | 48.1 | .408            | -76.1  |
| 2100.00          | .453            | 146.6  | 1.324           | 34.8  | .213            | 47.9 | .407            | -79.1  |
| 2200.00          | .457            | 143.3  | 1.275           | 32.0  | .224            | 47.7 | .404            | -82.5  |
| 2300.00          | .462            | 139.8  | 1.236           | 29.3  | .234            | 47.6 | .404            | -85.5  |
| 2400.00          | .466            | 136.7  | 1.193           | 26.9  | .244            | 47.4 | .405            | -88.8  |
| 2500.00          | .470            | 133.5  | 1.156           | 24.5  | .256            | 46.8 | .406            | -92.1  |
| 2600.00          | .474            | 130.6  | 1.123           | 22.1  | .266            | 46.6 | .408            | -95.5  |
| 2700.00          | .479            | 127.4  | 1.093           | 19.9  | .278            | 45.7 | .406            | -99.0  |
| 2800.00          | .483            | 124.7  | 1.067           | 17.6  | .290            | 44.8 | .409            | -102.2 |
| 2900.00          | .487            | 121.8  | 1.036           | 15.5  | .302            | 44.2 | .411            | -105.4 |
| 3000.00          | .489            | 119.0  | 1.009           | 13.5  | .316            | 43.4 | .411            | -109.0 |

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

| FREQUENCY<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    |
| 100.00           | .958            | -15.9  | 1.956           | 162.3 | .041            | 78.7 | .985            | -8.5   |
| 200.00           | .930            | -31.7  | 1.926           | 148.8 | .078            | 66.6 | .945            | -16.1  |
| 300.00           | .885            | -46.3  | 1.817           | 136.3 | .109            | 56.9 | .898            | -22.7  |
| 400.00           | .829            | -62.1  | 1.875           | 125.5 | .129            | 49.0 | .844            | -28.0  |
| 500.00           | .784            | -75.4  | 1.763           | 116.0 | .144            | 42.6 | .800            | -32.1  |
| 600.00           | .734            | -89.0  | 1.710           | 106.9 | .154            | 37.3 | .757            | -35.8  |
| 700.00           | .687            | -102.2 | 1.675           | 98.3  | .160            | 33.2 | .725            | -39.0  |
| 800.00           | .654            | -112.7 | 1.565           | 90.9  | .164            | 29.8 | .698            | -41.9  |
| 900.00           | .619            | -123.6 | 1.509           | 84.0  | .165            | 27.0 | .677            | -44.8  |
| 1000.00          | .595            | -132.7 | 1.435           | 78.1  | .165            | 25.8 | .658            | -47.4  |
| 1100.00          | .579            | -141.4 | 1.356           | 72.3  | .165            | 24.4 | .648            | -50.1  |
| 1200.00          | .561            | -149.6 | 1.300           | 67.0  | .163            | 24.0 | .634            | -52.6  |
| 1300.00          | .552            | -156.3 | 1.225           | 62.1  | .161            | 23.7 | .624            | -55.5  |
| 1400.00          | .541            | -163.5 | 1.178           | 57.7  | .160            | 24.1 | .615            | -58.3  |
| 1500.00          | .540            | -169.8 | 1.124           | 53.5  | .159            | 25.6 | .609            | -61.3  |
| 1600.00          | .535            | -175.7 | 1.076           | 49.4  | .158            | 27.0 | .605            | -64.2  |
| 1700.00          | .532            | 178.4  | 1.036           | 45.7  | .157            | 28.7 | .601            | -67.2  |
| 1800.00          | .533            | 173.2  | .988            | 42.3  | .157            | 30.7 | .599            | -70.3  |
| 1900.00          | .535            | 168.3  | .951            | 39.1  | .160            | 33.0 | .596            | -73.6  |
| 2000.00          | .533            | 163.2  | .923            | 36.0  | .164            | 35.6 | .592            | -76.9  |
| 2100.00          | .538            | 158.8  | .887            | 33.0  | .169            | 38.1 | .590            | -80.3  |
| 2200.00          | .539            | 154.5  | .858            | 30.0  | .175            | 40.2 | .585            | -83.9  |
| 2300.00          | .543            | 150.0  | .832            | 27.5  | .184            | 42.4 | .587            | -87.1  |
| 2400.00          | .545            | 146.1  | .803            | 25.2  | .193            | 43.8 | .586            | -90.7  |
| 2500.00          | .548            | 142.2  | .779            | 23.0  | .203            | 45.4 | .587            | -94.1  |
| 2600.00          | .551            | 138.4  | .759            | 20.8  | .215            | 46.4 | .587            | -97.8  |
| 2700.00          | .554            | 134.7  | .738            | 18.9  | .229            | 47.1 | .585            | -101.4 |
| 2800.00          | .556            | 131.3  | .722            | 17.3  | .241            | 47.5 | .584            | -105.0 |
| 2900.00          | .560            | 127.6  | .700            | 15.6  | .257            | 47.5 | .586            | -108.6 |
| 3000.00          | .561            | 124.1  | .682            | 14.1  | .271            | 47.5 | .584            | -112.5 |



**S-PARAMETER**

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

| FREQUENCY<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    |
| 100.00           | .875            | -28.8  | 5.383           | 153.3 | .054            | 68.7 | .915            | -21.3  |
| 200.00           | .768            | -56.7  | 5.024           | 134.1 | .089            | 54.1 | .760            | -36.1  |
| 300.00           | .683            | -79.9  | 4.387           | 119.8 | .108            | 44.9 | .633            | -45.4  |
| 400.00           | .603            | -103.8 | 4.057           | 107.2 | .119            | 40.5 | .540            | -50.6  |
| 500.00           | .552            | -121.1 | 3.566           | 97.8  | .128            | 38.2 | .477            | -54.2  |
| 600.00           | .521            | -134.7 | 3.134           | 89.9  | .135            | 37.0 | .431            | -57.2  |
| 700.00           | .501            | -146.4 | 2.803           | 83.1  | .141            | 36.1 | .399            | -59.6  |
| 800.00           | .488            | -155.3 | 2.518           | 77.4  | .146            | 36.6 | .375            | -62.0  |
| 900.00           | .481            | -163.2 | 2.281           | 72.2  | .152            | 36.7 | .358            | -64.5  |
| 1000.00          | .476            | -170.1 | 2.097           | 67.5  | .158            | 36.9 | .345            | -67.1  |
| 1100.00          | .475            | -176.0 | 1.936           | 63.3  | .164            | 37.6 | .336            | -69.3  |
| 1200.00          | .473            | 178.3  | 1.807           | 59.2  | .171            | 38.1 | .325            | -72.1  |
| 1300.00          | .473            | 173.3  | 1.689           | 55.2  | .178            | 38.6 | .319            | -75.1  |
| 1400.00          | .473            | 168.7  | 1.591           | 51.4  | .186            | 39.3 | .313            | -77.9  |
| 1500.00          | .478            | 164.3  | 1.509           | 47.9  | .194            | 39.6 | .311            | -81.4  |
| 1600.00          | .480            | 160.2  | 1.429           | 44.6  | .201            | 39.8 | .309            | -84.2  |
| 1700.00          | .482            | 156.1  | 1.359           | 41.4  | .210            | 40.1 | .306            | -87.9  |
| 1800.00          | .486            | 152.3  | 1.305           | 38.3  | .219            | 40.3 | .306            | -91.1  |
| 1900.00          | .489            | 148.9  | 1.250           | 35.5  | .228            | 40.2 | .306            | -94.6  |
| 2000.00          | .492            | 145.2  | 1.206           | 32.6  | .238            | 40.1 | .306            | -98.6  |
| 2100.00          | .496            | 142.0  | 1.158           | 29.7  | .248            | 39.8 | .306            | -102.2 |
| 2200.00          | .501            | 138.8  | 1.120           | 27.0  | .259            | 39.8 | .306            | -105.8 |
| 2300.00          | .507            | 135.7  | 1.087           | 24.4  | .269            | 39.4 | .309            | -109.5 |
| 2400.00          | .509            | 132.7  | 1.051           | 22.0  | .279            | 38.8 | .312            | -113.2 |
| 2500.00          | .514            | 130.0  | 1.023           | 19.7  | .291            | 38.3 | .315            | -116.9 |
| 2600.00          | .516            | 127.0  | .994            | 17.4  | .301            | 37.8 | .318            | -120.7 |
| 2700.00          | .521            | 124.1  | .967            | 15.4  | .313            | 37.0 | .321            | -124.3 |
| 2800.00          | .523            | 121.5  | .944            | 13.3  | .324            | 36.1 | .324            | -127.8 |
| 2900.00          | .526            | 118.7  | .920            | 11.3  | .337            | 35.1 | .328            | -131.3 |
| 3000.00          | .529            | 116.1  | .900            | 9.4   | .349            | 34.4 | .332            | -135.0 |

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

| FREQUENCY<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    |
| 100.00           | .777            | -40.1  | 8.180           | 146.3 | .050            | 63.4 | .849            | -28.7  |
| 200.00           | .656            | -76.1  | 7.303           | 125.8 | .076            | 50.6 | .642            | -44.9  |
| 300.00           | .572            | -103.7 | 6.019           | 111.1 | .089            | 45.1 | .505            | -53.4  |
| 400.00           | .514            | -126.3 | 5.080           | 99.8  | .099            | 43.2 | .421            | -57.6  |
| 500.00           | .486            | -141.4 | 4.275           | 91.6  | .107            | 43.1 | .367            | -60.3  |
| 600.00           | .472            | -152.6 | 3.666           | 85.1  | .116            | 44.0 | .329            | -62.9  |
| 700.00           | .464            | -161.6 | 3.212           | 79.5  | .124            | 44.4 | .303            | -65.1  |
| 800.00           | .459            | -169.1 | 2.847           | 74.6  | .133            | 45.2 | .283            | -67.2  |
| 900.00           | .458            | -175.5 | 2.567           | 70.0  | .142            | 45.8 | .271            | -69.6  |
| 1000.00          | .458            | 178.8  | 2.344           | 65.9  | .151            | 46.3 | .260            | -72.0  |
| 1100.00          | .459            | 173.8  | 2.156           | 62.2  | .161            | 46.2 | .253            | -74.6  |
| 1200.00          | .460            | 169.2  | 1.999           | 58.3  | .170            | 46.7 | .247            | -77.2  |
| 1300.00          | .460            | 164.9  | 1.871           | 54.6  | .180            | 46.6 | .241            | -80.4  |
| 1400.00          | .461            | 160.9  | 1.755           | 51.3  | .191            | 46.4 | .238            | -83.4  |
| 1500.00          | .467            | 157.1  | 1.659           | 48.1  | .201            | 46.3 | .236            | -86.8  |
| 1600.00          | .469            | 153.5  | 1.574           | 44.8  | .212            | 46.0 | .236            | -89.7  |
| 1700.00          | .474            | 149.7  | 1.501           | 41.6  | .223            | 45.5 | .234            | -93.5  |
| 1800.00          | .476            | 146.5  | 1.431           | 38.8  | .233            | 45.0 | .235            | -96.7  |
| 1900.00          | .480            | 143.4  | 1.368           | 36.0  | .245            | 44.4 | .234            | -100.7 |
| 2000.00          | .484            | 140.1  | 1.323           | 33.4  | .255            | 43.7 | .235            | -104.3 |
| 2100.00          | .487            | 137.2  | 1.273           | 30.5  | .267            | 43.1 | .238            | -108.3 |
| 2200.00          | .492            | 134.5  | 1.224           | 27.9  | .279            | 42.3 | .240            | -112.1 |
| 2300.00          | .496            | 131.4  | 1.190           | 25.4  | .289            | 41.4 | .240            | -115.7 |
| 2400.00          | .499            | 128.8  | 1.151           | 23.1  | .300            | 40.5 | .246            | -119.3 |
| 2500.00          | .503            | 126.2  | 1.119           | 20.8  | .311            | 39.4 | .248            | -122.8 |
| 2600.00          | .506            | 123.7  | 1.088           | 18.4  | .322            | 38.6 | .253            | -126.7 |
| 2700.00          | .509            | 121.0  | 1.060           | 16.4  | .334            | 37.3 | .256            | -130.1 |
| 2800.00          | .512            | 118.4  | 1.037           | 14.2  | .345            | 36.2 | .259            | -133.6 |
| 2900.00          | .516            | 116.0  | 1.009           | 12.2  | .356            | 35.3 | .264            | -136.8 |
| 3000.00          | .519            | 113.4  | .986            | 10.2  | .368            | 33.9 | .267            | -140.6 |

**S-PARAMETER**

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

| FREQUENCY<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    |
| 100.00           | .954            | -17.7  | 1.929           | 160.5 | .059            | 76.3 | .976            | -11.1  |
| 200.00           | .914            | -35.8  | 1.909           | 144.6 | .108            | 63.2 | .920            | -21.1  |
| 300.00           | .862            | -52.0  | 1.776           | 130.9 | .146            | 51.8 | .853            | -29.4  |
| 400.00           | .799            | -69.5  | 1.819           | 119.1 | .170            | 44.0 | .783            | -35.7  |
| 500.00           | .749            | -84.0  | 1.707           | 109.0 | .188            | 36.7 | .727            | -40.8  |
| 600.00           | .701            | -98.0  | 1.626           | 99.3  | .198            | 31.9 | .678            | -44.9  |
| 700.00           | .658            | -111.6 | 1.577           | 90.6  | .204            | 27.2 | .642            | -48.6  |
| 800.00           | .628            | -122.1 | 1.464           | 83.0  | .207            | 23.9 | .612            | -51.8  |
| 900.00           | .599            | -132.6 | 1.391           | 76.2  | .207            | 21.6 | .588            | -55.2  |
| 1000.00          | .582            | -141.4 | 1.320           | 70.2  | .207            | 19.3 | .569            | -58.3  |
| 1100.00          | .571            | -149.4 | 1.239           | 64.5  | .206            | 18.0 | .559            | -61.3  |
| 1200.00          | .558            | -157.2 | 1.183           | 59.4  | .203            | 17.2 | .543            | -64.2  |
| 1300.00          | .554            | -163.5 | 1.118           | 54.4  | .201            | 16.7 | .534            | -67.6  |
| 1400.00          | .545            | -169.9 | 1.068           | 50.0  | .198            | 16.9 | .526            | -70.7  |
| 1500.00          | .547            | -176.0 | 1.022           | 46.0  | .196            | 17.3 | .520            | -74.4  |
| 1600.00          | .545            | 178.6  | .979            | 42.1  | .194            | 18.1 | .517            | -77.7  |
| 1700.00          | .546            | 173.2  | .939            | 38.4  | .193            | 19.7 | .512            | -81.2  |
| 1800.00          | .548            | 168.4  | .899            | 34.9  | .192            | 21.1 | .512            | -84.8  |
| 1900.00          | .549            | 164.0  | .865            | 31.9  | .194            | 23.0 | .511            | -88.6  |
| 2000.00          | .550            | 159.2  | .838            | 29.0  | .196            | 24.9 | .507            | -92.3  |
| 2100.00          | .556            | 155.1  | .808            | 26.1  | .200            | 27.0 | .508            | -96.0  |
| 2200.00          | .558            | 150.9  | .782            | 23.3  | .205            | 29.1 | .505            | -100.3 |
| 2300.00          | .563            | 147.0  | .757            | 20.9  | .212            | 31.0 | .507            | -103.9 |
| 2400.00          | .566            | 143.2  | .733            | 18.8  | .219            | 32.4 | .508            | -107.8 |
| 2500.00          | .570            | 139.5  | .713            | 16.7  | .229            | 33.5 | .511            | -111.9 |
| 2600.00          | .573            | 136.1  | .694            | 14.9  | .240            | 34.8 | .511            | -115.7 |
| 2700.00          | .575            | 132.5  | .677            | 13.2  | .252            | 35.5 | .511            | -119.7 |
| 2800.00          | .578            | 129.1  | .661            | 11.7  | .264            | 36.3 | .512            | -123.5 |
| 2900.00          | .583            | 125.7  | .643            | 10.2  | .278            | 36.5 | .515            | -127.4 |
| 3000.00          | .583            | 122.4  | .630            | 9.0   | .293            | 36.6 | .517            | -131.5 |

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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.

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Anti-radioactive design is not implemented in this product.