

GENERAL PURPOSE FET N-CHANNEL GaAs MES FET

DESCRIPTION

NE76184A is a N-channel GaAs MES FET housed in ceramic package. The device is fabricated by ion implantation for improved RF and DC performance reliability and uniformity. Its excellent low noise and high associated gain make it suitable for DBS, TVRO, GPS and another commercial systems.

FEATURES

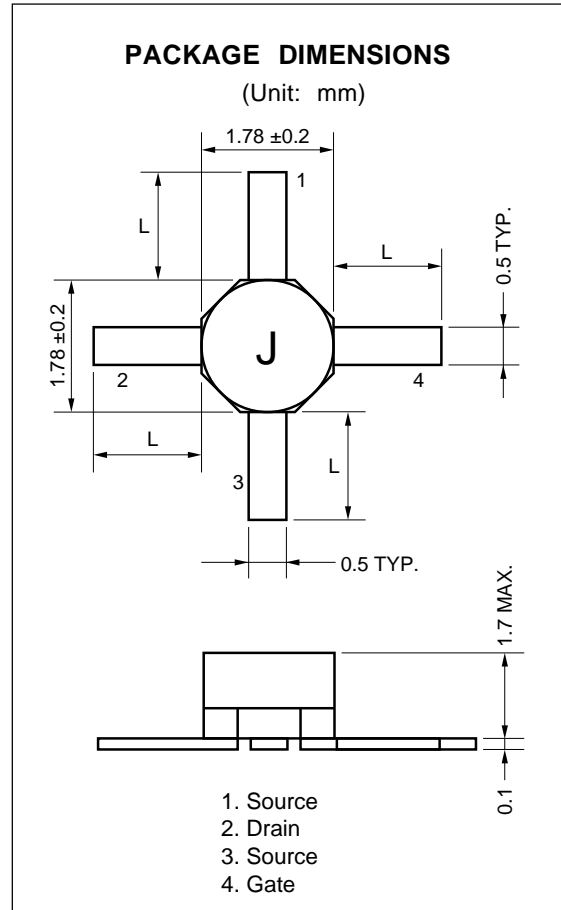
- Low noise figure & High associated gain  
NF = 0.8 dB TYP.,  $G_a$  = 12 dB TYP. at  $f = 4$  GHz

ORDERING INFORMATION

| PART NUMBER                 | SUPPLYING FORM | LEAD LENGTH      |
|-----------------------------|----------------|------------------|
| NE76184A-SL                 | STICK          | L = 1.7 mm MIN.  |
| NE76184A-T1<br>NE76184A-T1A | Tape & reel    | L = 1.0 ± 0.2 mm |

ABSOLUTE MAXIMUM RATINGS (TA = 25 °C)

|                         |           |             |    |
|-------------------------|-----------|-------------|----|
| Drain to Source Voltage | $V_{DS}$  | 5.0         | V  |
| Gate to Source Voltage  | $V_{GSO}$ | -5.0        | V  |
| Gate to Drain Voltage   | $V_{GDO}$ | -6.0        | V  |
| Drain Current           | $I_D$     | 100         | mA |
| Total Power Dissipation | $P_{tot}$ | 300         | mW |
| Channel Temperature     | $T_{ch}$  | 150         | °C |
| Storage Temperature     | $T_{stg}$ | -65 to +150 | °C |



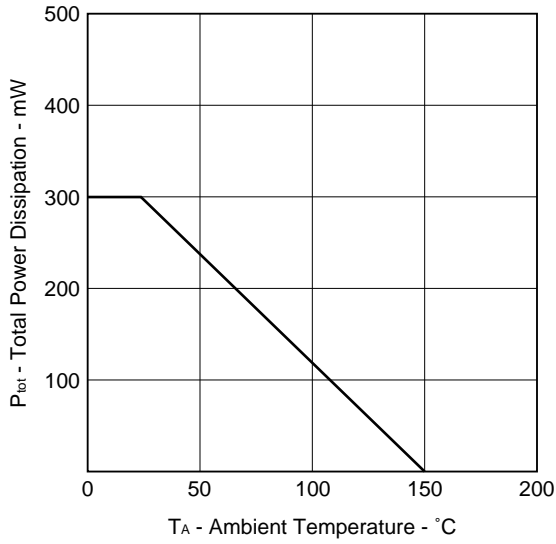
ELECTRICAL CHARACTERISTICS (TA = 25 °C)

| PARAMETER                     | SYMBOL        | MIN. | TYP. | MAX. | UNIT    | TEST CONDITIONS                   |              |
|-------------------------------|---------------|------|------|------|---------|-----------------------------------|--------------|
| Gate to Source Leak Current   | $I_{GSO}$     | -    | -    | 10   | $\mu A$ | $V_{GS} = -5$ V                   |              |
| Saturated Drain Current       | $I_{DSS}$     | 30   | -    | 100  | mA      | $V_{DS} = 3$ V, $V_{GS} = 0$      |              |
| Gate to Source Cutoff Voltage | $V_{GS(off)}$ | -0.5 | -    | -3.0 | V       | $V_{DS} = 3$ V, $I_D = 100 \mu A$ |              |
| Transconductance              | $g_m$         | 20   | 45   | -    | mS      | $V_{DS} = 3$ V, $I_D = 10$ mA     |              |
| Noise Figure                  | NF            | -    | 0.8  | 1.4  | dB      | $V_{DD} = 3$ V<br>$I_D = 10$ mA   |              |
| Associated Gain               | $G_a$         | -    | 12   | -    | dB      |                                   | $f = 4$ GHz  |
| Power Gain                    | $G_s$         | -    | 6    | -    | dB      |                                   | $f = 12$ GHz |

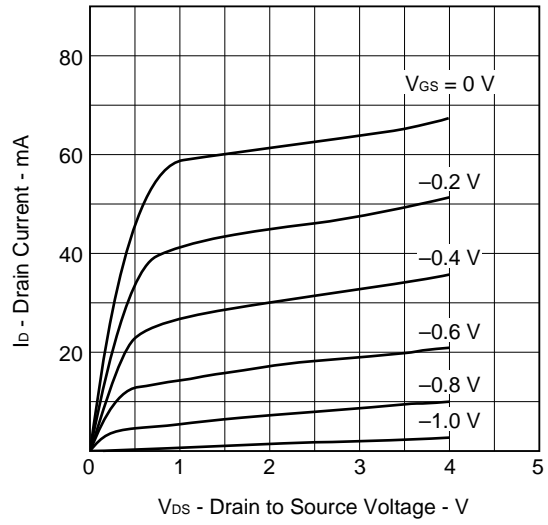
$I_{DSS}$  rank is specified as follows. (K: 30 to 100 mA, N: 30 to 65 mA, M: 55 to 100 mA)

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

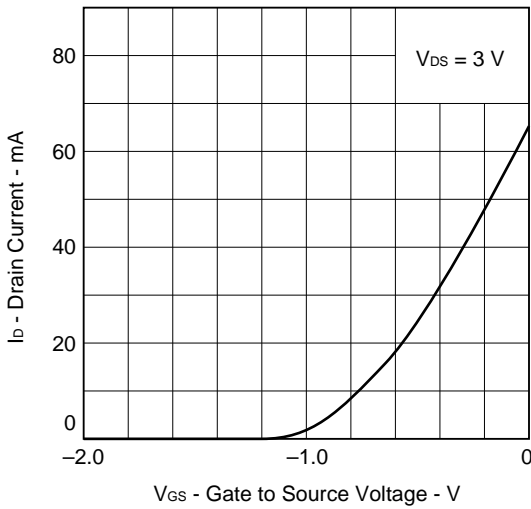
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



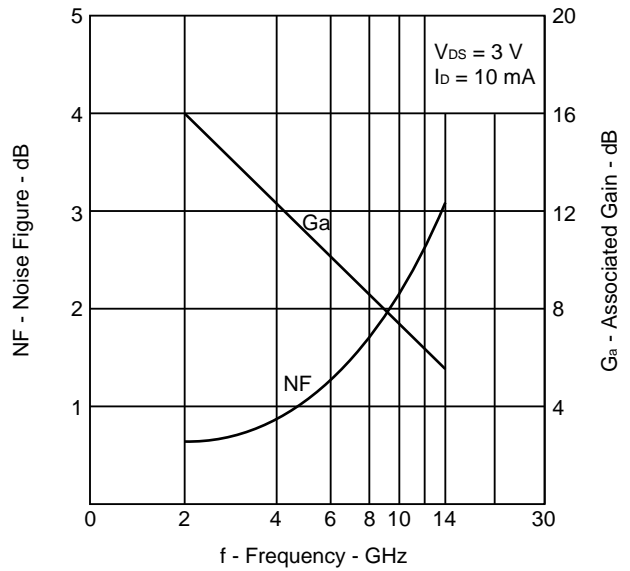
DRAIN CURRENT vs. DRAIN TO SOURCE VOLTAGE



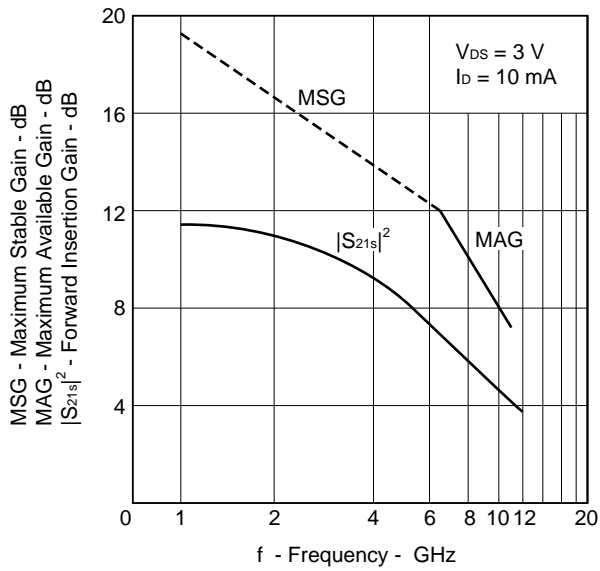
DRAIN CURRENT vs. GATE TO SOURCE VOLTAGE



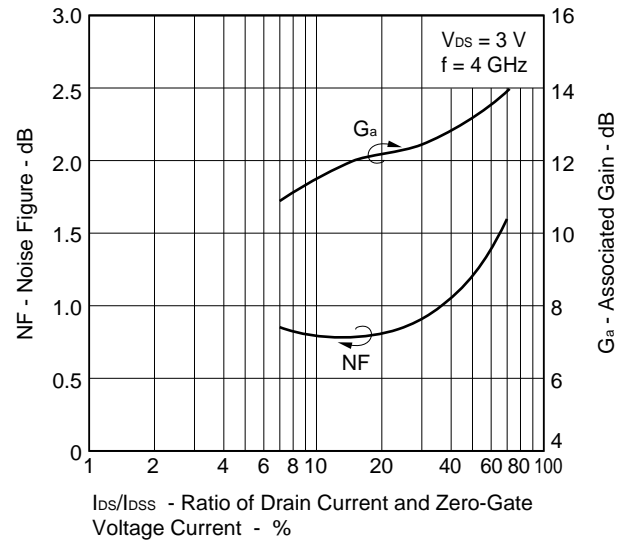
NOISE FIGURE, ASSOCIATED GAIN vs. FREQUENCY



MAXIMUM AVAILABLE GAIN, FORWARD INSERTION GAIN vs. FREQUENCY



NOISE FIGURE, ASSOCIATED GAIN vs. RATIO OF DRAIN CURRENT AND ZERO-GATE VOLTAGE CURRENT

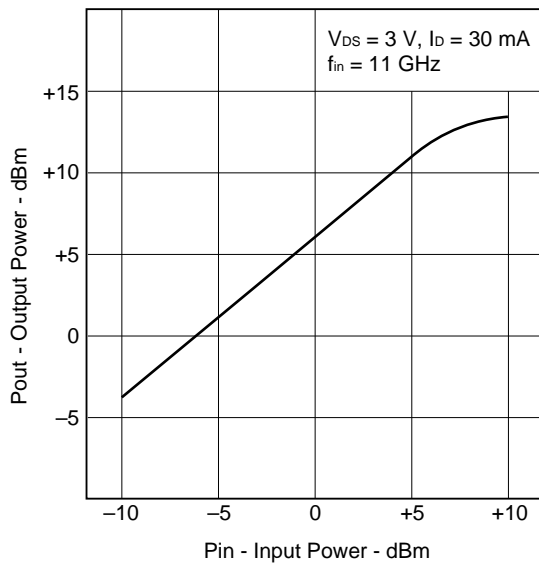


Gain Calculations

$$MSG = \frac{|S_{21}|}{|S_{12}|} \quad K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2|S_{12}||S_{21}|}$$

$$MSG = \frac{|S_{21}|}{|S_{12}|} \left( K \pm \sqrt{K^2 - 1} \right) \quad \Delta = S_{11} \cdot S_{22} - S_{21} \cdot S_{12}$$

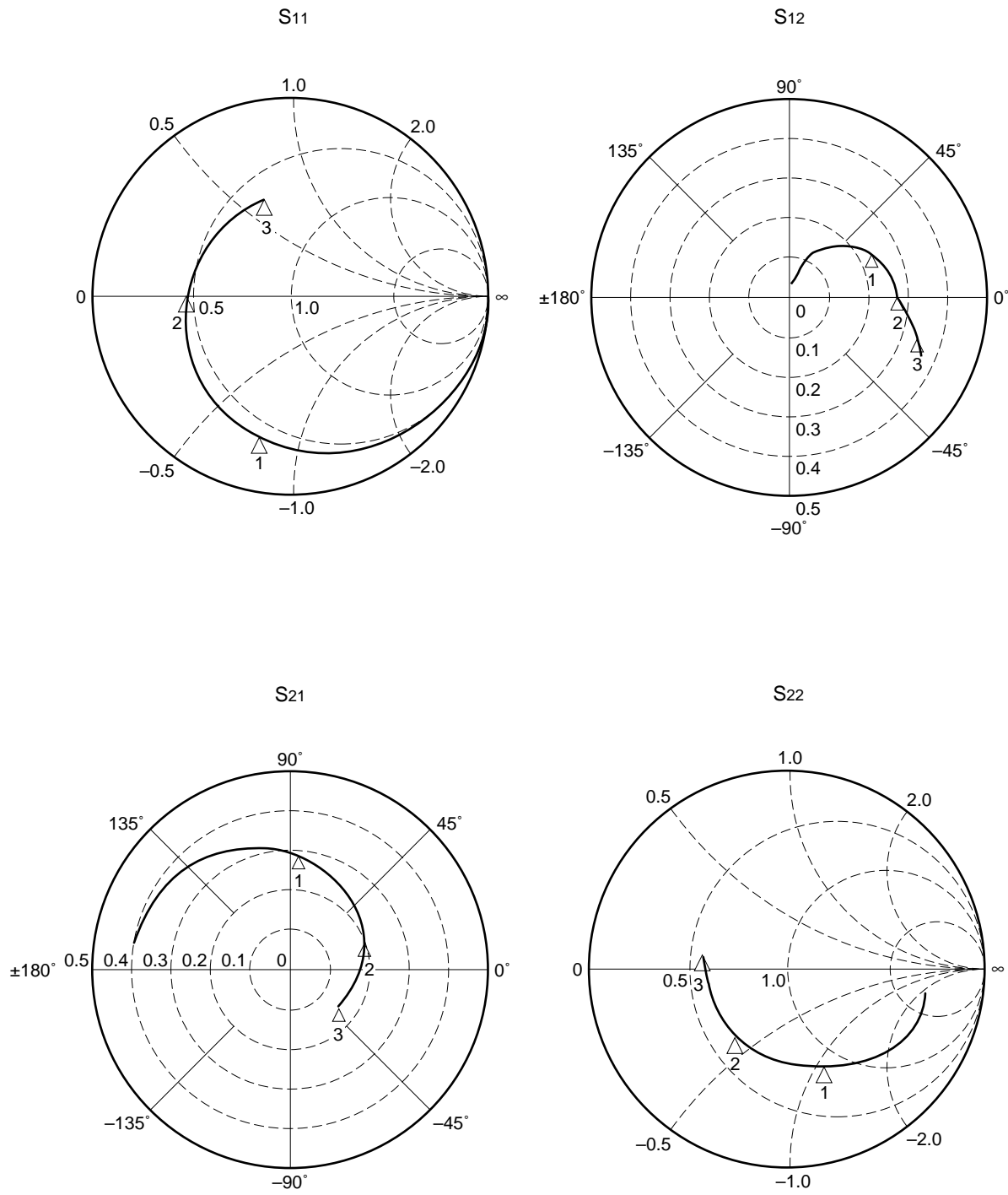
OUTPUT POWER vs. INPUT POWER



**S-PARAMETERS**

$V_{DS} = 3\text{ V}$ ,  $I_D = 10\text{ mA}$

START 500 MHz STOP 12 GHz STEP 500 MHz



- Marker**
- 1. 4 GHz
  - 2. 8 GHz
  - 3. 12 GHz

**S-PARAMETER**

MAG. AND ANG.

$V_{DS} = 3\text{ V}$ ,  $I_D = 10\text{ mA}$

| FREQUENCY<br>MHz | S11   |        | S21   |       | S12   |       | S22   |        |
|------------------|-------|--------|-------|-------|-------|-------|-------|--------|
|                  | MAG.  | ANG.   | MAG.  | ANG.  | MAG.  | ANG.  | MAG.  | ANG.   |
| 500.0000         | 0.993 | -14.4  | 3.919 | 166.5 | 0.022 | 80.3  | 0.716 | -9.9   |
| 1000.0000        | 0.971 | -28.4  | 3.820 | 153.5 | 0.042 | 71.6  | 0.702 | -19.1  |
| 1500.0000        | 0.936 | -41.9  | 3.714 | 140.9 | 0.061 | 62.0  | 0.682 | -28.2  |
| 2000.0000        | 0.896 | -54.8  | 3.562 | 129.0 | 0.079 | 54.1  | 0.652 | -36.8  |
| 2500.0000        | 0.850 | -67.4  | 3.388 | 117.8 | 0.092 | 46.4  | 0.623 | -44.8  |
| 3000.0000        | 0.808 | -79.4  | 3.238 | 107.0 | 0.103 | 39.9  | 0.592 | -52.6  |
| 3500.0000        | 0.761 | -91.3  | 3.069 | 96.4  | 0.112 | 33.5  | 0.563 | -60.9  |
| 4000.0000        | 0.720 | -102.7 | 2.909 | 86.4  | 0.120 | 27.5  | 0.533 | -68.1  |
| 4500.0000        | 0.681 | -113.9 | 2.765 | 77.0  | 0.125 | 22.2  | 0.501 | -75.7  |
| 5000.0000        | 0.647 | -124.4 | 2.623 | 67.9  | 0.127 | 17.6  | 0.475 | -83.5  |
| 5500.0000        | 0.615 | -134.9 | 2.485 | 59.1  | 0.131 | 13.6  | 0.454 | -91.4  |
| 6000.0000        | 0.588 | -144.8 | 2.365 | 50.7  | 0.131 | 9.6   | 0.437 | -98.9  |
| 6500.0000        | 0.566 | -154.5 | 2.252 | 42.6  | 0.133 | 6.5   | 0.425 | -107.1 |
| 7000.0000        | 0.547 | -163.6 | 2.151 | 34.7  | 0.135 | 3.7   | 0.418 | -114.4 |
| 7500.0000        | 0.531 | -172.4 | 2.064 | 27.3  | 0.136 | 1.9   | 0.414 | -121.8 |
| 8000.0000        | 0.517 | 178.7  | 1.985 | 19.6  | 0.139 | -0.8  | 0.415 | -129.3 |
| 8500.0000        | 0.503 | 169.6  | 1.909 | 12.2  | 0.141 | -3.0  | 0.418 | -136.4 |
| 9000.0000        | 0.492 | 160.5  | 1.843 | 5.0   | 0.143 | -5.3  | 0.418 | -143.7 |
| 9500.0000        | 0.482 | 151.1  | 1.783 | -2.5  | 0.148 | -7.3  | 0.417 | -151.0 |
| 10000.0000       | 0.475 | 141.3  | 1.726 | -9.6  | 0.152 | -9.4  | 0.419 | -158.4 |
| 10500.0000       | 0.475 | 131.5  | 1.668 | -17.0 | 0.156 | -11.3 | 0.418 | -166.4 |
| 11000.0000       | 0.477 | 121.6  | 1.613 | -23.8 | 0.160 | -13.8 | 0.421 | -174.2 |
| 11500.0000       | 0.481 | 112.1  | 1.554 | -31.0 | 0.165 | -16.2 | 0.431 | 177.3  |
| 12000.0000       | 0.489 | 102.7  | 1.503 | -38.0 | 0.170 | -18.8 | 0.441 | 169.6  |

$V_{DS} = 3\text{ V}$ ,  $I_D = 30\text{ mA}$

| FREQUENCY<br>MHz | S11   |        | S21   |       | S12   |       | S22   |        |
|------------------|-------|--------|-------|-------|-------|-------|-------|--------|
|                  | MAG.  | ANG.   | MAG.  | ANG.  | MAG.  | ANG.  | MAG.  | ANG.   |
| 500.0000         | 0.990 | -16.6  | 5.304 | 165.1 | 0.019 | 79.5  | 0.617 | -10.3  |
| 1000.0000        | 0.957 | -32.6  | 5.115 | 150.9 | 0.037 | 71.5  | 0.599 | -19.9  |
| 1500.0000        | 0.911 | -47.6  | 4.866 | 137.4 | 0.052 | 62.3  | 0.577 | -28.9  |
| 2000.0000        | 0.860 | -62.0  | 4.587 | 124.8 | 0.065 | 55.0  | 0.545 | -37.4  |
| 2500.0000        | 0.805 | -75.5  | 4.282 | 113.3 | 0.075 | 48.7  | 0.515 | -44.9  |
| 3000.0000        | 0.755 | -88.4  | 4.009 | 102.5 | 0.085 | 42.9  | 0.485 | -52.1  |
| 3500.0000        | 0.707 | -100.7 | 3.741 | 92.1  | 0.092 | 38.2  | 0.456 | -59.4  |
| 4000.0000        | 0.663 | -112.5 | 3.493 | 82.3  | 0.097 | 33.6  | 0.431 | -66.6  |
| 4500.0000        | 0.626 | -124.0 | 3.275 | 73.3  | 0.103 | 30.2  | 0.404 | -73.7  |
| 5000.0000        | 0.594 | -134.8 | 3.078 | 64.5  | 0.107 | 26.7  | 0.382 | -81.2  |
| 5500.0000        | 0.566 | -145.4 | 2.888 | 56.2  | 0.110 | 23.3  | 0.365 | -88.5  |
| 6000.0000        | 0.546 | -155.4 | 2.729 | 48.2  | 0.114 | 21.3  | 0.351 | -96.3  |
| 6500.0000        | 0.528 | -165.1 | 2.581 | 40.6  | 0.118 | 18.6  | 0.343 | -104.1 |
| 7000.0000        | 0.513 | -174.3 | 2.455 | 33.0  | 0.122 | 17.1  | 0.339 | -111.7 |
| 7500.0000        | 0.501 | 176.9  | 2.344 | 25.8  | 0.128 | 14.8  | 0.340 | -119.3 |
| 8000.0000        | 0.490 | 167.9  | 2.242 | 18.5  | 0.133 | 13.1  | 0.343 | -126.8 |
| 8500.0000        | 0.480 | 158.9  | 2.151 | 11.3  | 0.139 | 10.6  | 0.350 | -133.8 |
| 9000.0000        | 0.472 | 149.8  | 2.069 | 4.2   | 0.147 | 7.6   | 0.350 | -141.3 |
| 9500.0000        | 0.466 | 140.6  | 1.997 | -2.7  | 0.153 | 5.5   | 0.352 | -148.9 |
| 10000.0000       | 0.465 | 130.8  | 1.924 | -9.7  | 0.161 | 2.2   | 0.355 | -156.2 |
| 10500.0000       | 0.468 | 121.2  | 1.855 | -16.8 | 0.168 | -0.6  | 0.357 | -165.0 |
| 11000.0000       | 0.476 | 112.0  | 1.791 | -23.4 | 0.175 | -4.6  | 0.363 | -173.1 |
| 11500.0000       | 0.483 | 102.7  | 1.727 | -30.4 | 0.182 | -7.6  | 0.373 | 178.2  |
| 12000.0000       | 0.494 | 93.9   | 1.665 | -37.2 | 0.189 | -10.6 | 0.385 | 169.9  |

**AMP PARAMETERS**

$V_{DS} = 3\text{ V}$ ,  $I_D = 10\text{ mA}$

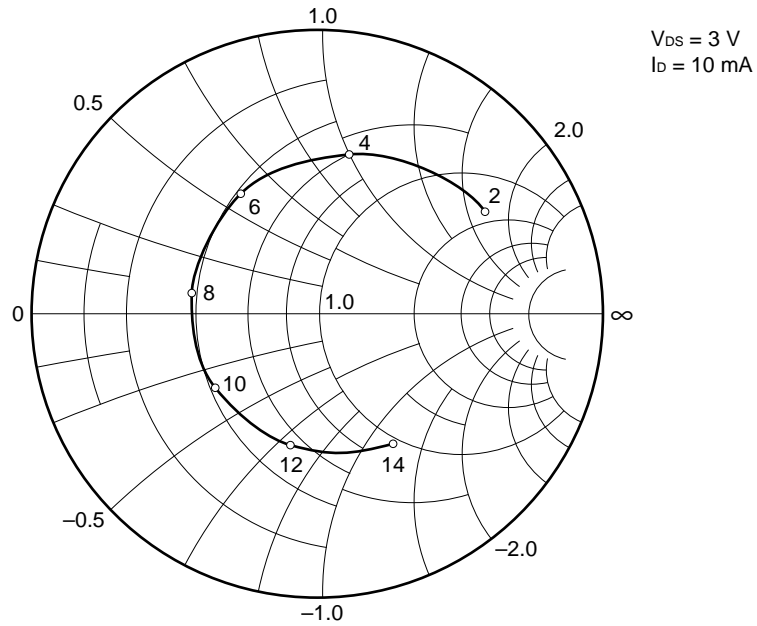
| FREQUENCY<br>MHz | $G_{U_{max}}$<br>dB | $G_{A_{max}}$<br>dB | $ S_{21} ^2$<br>dB | $ S_{12} ^2$<br>dB | K    | Delay<br>ns | Mason's U<br>dB | $G_1$<br>dB | $G_2$<br>dB |
|------------------|---------------------|---------------------|--------------------|--------------------|------|-------------|-----------------|-------------|-------------|
| 500.0000         | 33.77               |                     | 11.86              | -33.16             | 0.07 | 0.072       | 49.375          | 18.78       | 3.13        |
| 1000.0000        | 27.00               |                     | 11.64              | -27.43             | 0.14 | 0.072       |                 | 12.40       | 2.95        |
| 1500.0000        | 23.21               |                     | 11.40              | -24.28             | 0.23 | 0.070       | 29.663          | 9.10        | 2.72        |
| 2000.0000        | 20.48               |                     | 11.03              | -22.09             | 0.30 | 0.066       | 28.208          | 7.04        | 2.41        |
| 2500.0000        | 18.30               |                     | 10.60              | -20.74             | 0.37 | 0.062       | 25.690          | 5.57        | 2.14        |
| 3000.0000        | 16.68               |                     | 10.21              | -19.78             | 0.43 | 0.060       | 25.762          | 4.60        | 1.88        |
| 3500.0000        | 15.16               |                     | 9.74               | -18.99             | 0.50 | 0.059       | 24.501          | 3.76        | 1.66        |
| 4000.0000        | 13.90               |                     | 9.28               | -18.42             | 0.57 | 0.056       | 23.383          | 3.17        | 1.45        |
| 4500.0000        | 12.80               |                     | 8.83               | -18.06             | 0.64 | 0.052       | 21.885          | 2.71        | 1.25        |
| 5000.0000        | 11.84               |                     | 8.38               | -17.91             | 0.72 | 0.051       | 20.810          | 2.35        | 1.11        |
| 5500.0000        | 10.97               |                     | 7.91               | -17.68             | 0.79 | 0.049       | 20.093          | 2.06        | 1.00        |
| 6000.0000        | 10.24               |                     | 7.48               | -17.62             | 0.86 | 0.046       | 18.766          | 1.84        | 0.92        |
| 6500.0000        | 9.59                |                     | 7.05               | -17.50             | 0.92 | 0.045       | 18.307          | 1.67        | 0.86        |
| 7000.0000        | 9.03                |                     | 6.65               | -17.40             | 0.98 | 0.044       | 17.776          | 1.54        | 0.84        |
| 7500.0000        | 8.55                | 10.85               | 6.29               | -17.35             | 1.03 | 0.041       | 17.422          | 1.44        | 0.82        |
| 8000.0000        | 8.13                | 10.17               | 5.95               | -17.13             | 1.05 | 0.042       | 17.410          | 1.35        | 0.82        |
| 8500.0000        | 7.72                | 9.49                | 5.62               | -17.05             | 1.09 | 0.041       | 16.680          | 1.27        | 0.83        |
| 9000.0000        | 7.35                | 8.99                | 5.31               | -16.87             | 1.12 | 0.040       | 16.073          | 1.20        | 0.84        |
| 9500.0000        | 7.00                | 8.57                | 5.02               | -16.60             | 1.14 | 0.042       | 15.587          | 1.15        | 0.83        |
| 10000.0000       | 6.69                | 8.20                | 4.74               | -16.38             | 1.15 | 0.040       | 14.945          | 1.11        | 0.84        |
| 10500.0000       | 6.39                | 7.84                | 4.44               | -16.16             | 1.16 | 0.041       | 14.161          | 1.11        | 0.83        |
| 11000.0000       | 6.12                | 7.58                | 4.16               | -15.89             | 1.16 | 0.038       | 13.620          | 1.12        | 0.85        |
| 11500.0000       | 5.86                | 7.31                | 3.83               | -15.67             | 1.16 | 0.040       | 12.913          | 1.14        | 0.89        |
| 12000.0000       | 5.67                | 7.19                | 3.54               | -15.37             | 1.14 | 0.039       | 12.582          | 1.19        | 0.94        |

$V_{DS} = 3\text{ V}$ ,  $I_D = 30\text{ mA}$

| FREQUENCY<br>MHz | $G_{U_{max}}$<br>dB | $G_{A_{max}}$<br>dB | $ S_{21} ^2$<br>dB | $ S_{12} ^2$<br>dB | K    | Delay<br>ns | Mason's U<br>dB | $G_1$<br>dB | $G_2$<br>dB |
|------------------|---------------------|---------------------|--------------------|--------------------|------|-------------|-----------------|-------------|-------------|
| 500.0000         | 33.74               |                     | 14.49              | -34.36             | 0.09 | 0.079       | 38.817          | 17.17       | 2.08        |
| 1000.0000        | 26.88               |                     | 14.18              | -28.71             | 0.19 | 0.079       | 41.142          | 10.77       | 1.93        |
| 1500.0000        | 23.20               |                     | 13.74              | -25.66             | 0.29 | 0.075       | 31.251          | 7.71        | 1.75        |
| 2000.0000        | 20.60               |                     | 13.23              | -23.68             | 0.38 | 0.070       | 29.809          | 5.84        | 1.53        |
| 2500.0000        | 18.51               |                     | 12.63              | -22.51             | 0.47 | 0.064       | 27.934          | 4.53        | 1.34        |
| 3000.0000        | 16.90               |                     | 12.06              | -21.42             | 0.55 | 0.060       | 27.066          | 3.67        | 1.16        |
| 3500.0000        | 15.48               |                     | 11.46              | -20.70             | 0.63 | 0.058       | 26.502          | 3.00        | 1.01        |
| 4000.0000        | 14.27               |                     | 10.86              | -20.27             | 0.72 | 0.054       | 24.356          | 2.51        | 0.89        |
| 4500.0000        | 13.24               |                     | 10.30              | -19.73             | 0.79 | 0.050       | 24.031          | 2.16        | 0.77        |
| 5000.0000        | 12.34               |                     | 9.76               | -19.43             | 0.87 | 0.048       | 22.392          | 1.89        | 0.69        |
| 5500.0000        | 11.51               |                     | 9.21               | -19.15             | 0.94 | 0.047       | 20.841          | 1.68        | 0.62        |
| 6000.0000        | 10.83               |                     | 8.72               | -18.90             | 1.00 | 0.044       | 20.194          | 1.54        | 0.57        |
| 6500.0000        | 10.19               | 12.13               | 8.24               | -18.55             | 1.04 | 0.042       | 19.396          | 1.42        | 0.54        |
| 7000.0000        | 9.66                | 11.34               | 7.80               | -18.25             | 1.08 | 0.042       | 19.008          | 1.33        | 0.53        |
| 7500.0000        | 9.16                | 10.79               | 7.40               | -17.85             | 1.09 | 0.040       | 18.783          | 1.26        | 0.53        |
| 8000.0000        | 8.75                | 10.29               | 7.01               | -17.50             | 1.10 | 0.040       | 18.372          | 1.19        | 0.55        |
| 8500.0000        | 8.35                | 9.85                | 6.65               | -17.17             | 1.12 | 0.040       | 17.707          | 1.14        | 0.57        |
| 9000.0000        | 7.98                | 9.48                | 6.32               | -16.68             | 1.11 | 0.039       | 17.361          | 1.10        | 0.57        |
| 9500.0000        | 7.65                | 9.10                | 6.01               | -16.32             | 1.11 | 0.039       | 16.512          | 1.07        | 0.57        |
| 10000.0000       | 7.33                | 8.81                | 5.68               | -15.87             | 1.10 | 0.039       | 16.047          | 1.06        | 0.59        |
| 10500.0000       | 7.03                | 8.50                | 5.37               | -15.51             | 1.10 | 0.039       | 15.174          | 1.07        | 0.59        |
| 11000.0000       | 6.79                | 8.33                | 5.06               | -15.16             | 1.09 | 0.037       | 14.844          | 1.11        | 0.61        |
| 11500.0000       | 6.55                | 8.15                | 4.75               | -14.80             | 1.07 | 0.039       | 14.143          | 1.16        | 0.65        |
| 12000.0000       | 6.34                | 8.02                | 4.43               | -14.48             | 1.05 | 0.038       | 13.483          | 1.22        | 0.70        |

NOISE PARAMETERS

< $\Gamma_{opt}$ . vs. frequency>



START 2 GHz, STOP 14 GHz, STEP 2 GHz

<Noise Parameter>

V<sub>DS</sub> = 3 V, I<sub>D</sub> = 10 mA

| Freq.<br>(GHz) | NF <sub>MIN.</sub><br>(dB) | G <sub>a</sub><br>(dB) | $\Gamma_{opt}$ . |            | R <sub>n</sub> /50 |
|----------------|----------------------------|------------------------|------------------|------------|--------------------|
|                |                            |                        | MAG.             | ANG.(deg.) |                    |
| 2.0            | 0.65                       | 16.0                   | 0.75             | 37         | 0.52               |
| 4.0            | 0.80                       | 12.2                   | 0.66             | 78         | 0.42               |
| 6.0            | 1.25                       | 10.3                   | 0.56             | 124        | 0.33               |
| 8.0            | 1.75                       | 8.5                    | 0.49             | 166        | 0.20               |
| 10.0           | 2.10                       | 7.6                    | 0.47             | -151       | 0.28               |
| 12.0           | 2.65                       | 6.5                    | 0.45             | -112       | 0.49               |
| 14.0           | 3.20                       | 5.5                    | 0.46             | -64        | 0.56               |

**RECOMMENDED SOLDERING CONDITIONS**

The following conditions (see table below) must be met when soldering this product.

Please consult with our sales offices in case other soldering process is used, or in case soldering is done under different conditions.

**<TYPES OF SURFACE MOUNT DEVICE>**

For more details, refer to our document “SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL” (IEI-1207).

| Soldering process      | Soldering conditions   | Symbol  |
|------------------------|--|---------|
| Infrared ray reflow    | Peak package’s surface temperature: 230 °C or below,<br>Reflow time: 30 seconds or below (210 °C or higher),<br>Number of reflow process: 1, Exposure limit*: None | IR30-00 |
| Partial heating method | Terminal temperature: 230 °C or below,<br>Flow time: 10 seconds or below,<br>Exposure limit*: None   |         |

\* Exposure limit before soldering after dry-pack package is opened.  
Storage conditions: 25 °C and relative humidity at 65 % or less.

**Note** Do not apply more than a single process at once, except for “Partial heating method”.

**PRECAUTION** Avoid high static voltage and electric fields, because this device is MES FET with GaAs shottky barrier gate.

**Caution**

**The Great Care must be taken in dealing with the devices in this guide.  
The reason is that the material of the devices is GaAs (Gallium Arsenide), which is designated as harmful substance according to the Japanese law concerned.  
Keep the Japanese law concerned and so on, especially in case of removal.**



[MEMO]

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While NEC Corporation has been making continuous effort to enhance the reliability of its semiconductor devices, the possibility of defects cannot be eliminated entirely. To minimize risks of damage or injury to persons or property arising from a defect in an NEC semiconductor device, customer must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features.

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.

The quality grade of NEC devices in "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact NEC Sales Representative in advance.

Anti-radioactive design is not implemented in this product.