

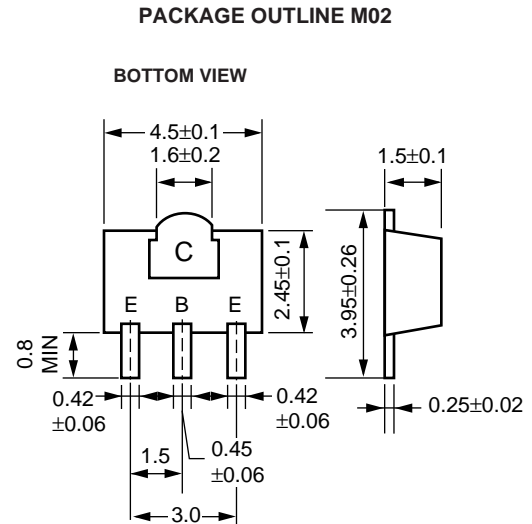
FEATURES

- **HIGH COLLECTOR CURRENT:**
250 mA MAX
- **NEW HIGH GAIN POWER MINI-MOLD PACKAGE**
(SOT-89 TYPE)
- **HIGH OUTPUT POWER AT 1 dB COMPRESSION:**
27 dBm TYP at 1 GHz
- **HIGH IP₃:**
37 dBm TYP at 1 GHz

DESCRIPTION

The NE461M02 is an NPN silicon epitaxial bipolar transistor designed for medium power applications requiring high dynamic range and low intermodulation distortion. This device offers excellent performance and reliability at low cost through NEC's titanium, platinum, gold metallization system and direct nitride passivation of the surface of the chip. The NE461M02 is an excellent choice for low noise amplifiers in the VHF to UHF band and is suitable for CATV and other telecommunication applications.

OUTLINE DIMENSIONS (Units in mm)



PIN CONNECTIONS
E: Emitter
C: Collector
B: Base

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

| PART NUMBER EIAJ ¹ REGISTERED NUMBER PACKAGE OUTLINE | | | NE461M02 2SC5337 M02 | | |
|---|---|-------|----------------------------|------|-----|
| SYMBOLS | PARAMETERS AND CONDITIONS | UNITS | MIN | TYP | MAX |
| I _{CBO} | Collector Cutoff Current at V _{CB} = 20 V, I _E = 0 | μA | | 0.01 | 5.0 |
| I _{EBO} | Emitter Cutoff Current at V _{EB} = 2 V, I _C = 0 | μA | | 0.03 | 5.0 |
| h _{FE} ² | DC Current Gain at V _{CE} = 10 V, I _C = 50 mA | | 40 | 120 | 200 |
| S _{21E} ² | Insertion Power Gain at V _{CE} = 10 V, I _C = 50 mA, f = 1 GHz | dB | 7.0 | 8.3 | |
| NF ¹ | Noise Figure 1 at V _{CE} = 10 V, I _C = 50 mA, f = 500 MHz ³ | dB | | 1.5 | 3.5 |
| NF ² | Noise Figure 2 at V _{CE} = 10 V, I _C = 50 mA, f = 1 GHz ³ | dB | | 2.0 | 3.5 |
| IM ₂ | 2nd Order Intermodulation Distortion V _{CE} = 10 V, I _C = 50 mA, R _s = R _L = 75 Ω P _{in} = 105 dB μV/75 Ω, f ₁ = 190 MHz f ₂ = 90 MHz, f = f ₁ - f ₂ | dB | | 59.0 | |
| IM ₃ | 3rd Order Intermodulation Distortion V _{CE} = 10 V, I _C = 50 mA, R _s = R _L = 75 Ω P _{in} = 105 dB μV/75 Ω, f ₁ = 190 MHz f ₂ = 200 MHz, f = 2 × f ₁ - f ₂ | dB | | 82.0 | |

Notes:

1. Electronic Industrial Association of Japan.
2. Pulsed measurement, pulse width ≤ 350 μs, duty cycle ≤ 2 %.
3. R_s = R_L = 50 Ω, tuned.

ABSOLUTE MAXIMUM RATINGS¹ (T_A = 25°C)

| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|------------------|--------------------------------------|-------|-------------|
| V _{CB0} | Collector to Base Voltage | V | 30 |
| V _{CE0} | Collector to Emitter Voltage | V | 15 |
| V _{EB0} | Emitter to Base Voltage | V | 3.0 |
| I _C | Collector Current | mA | 250 |
| P _T | Total Power Dissipation ² | W | 2.0 |
| T _J | Junction Temperature | °C | 150 |
| T _{STG} | Storage Temperature | °C | -65 to +150 |

Notes:

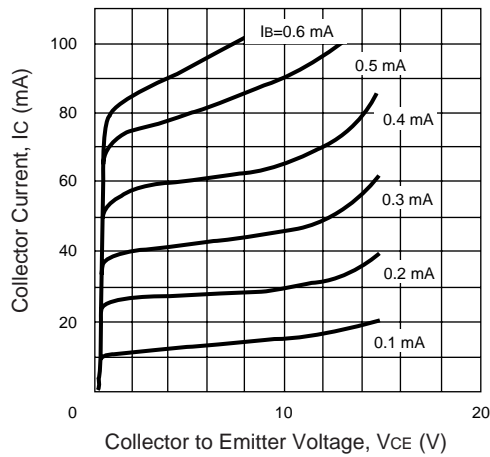
1. Operation in excess of any one of these parameters may result in permanent damage.
2. Device mounted on 0.7 mm x 16 cm² double-sided ceramic substrate (copper plating).

ORDERING INFORMATION

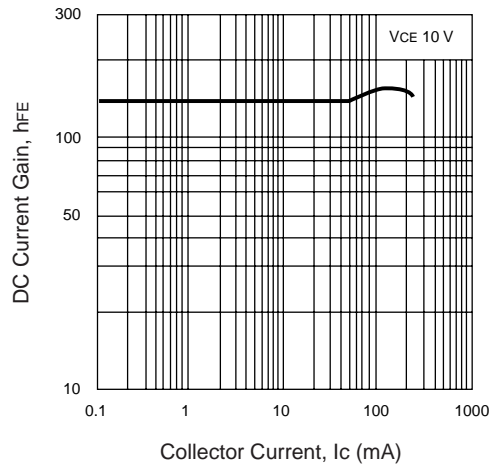
| PART NUMBER | QUANTITY | PACKAGING |
|-------------|----------|-------------|
| NE461M02-T1 | 1000 | Tape & Reel |

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

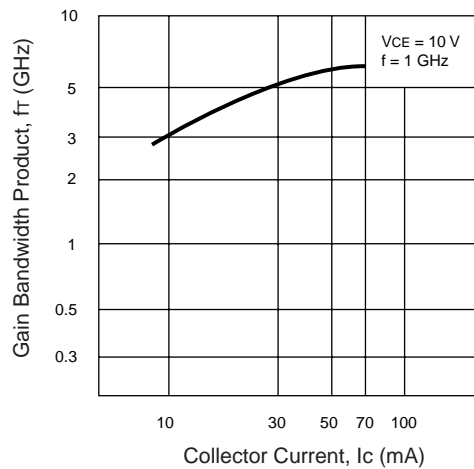
COLLECTOR CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



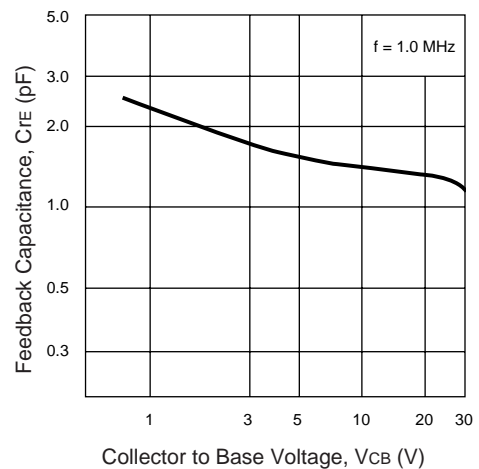
DC CURRENT GAIN VS. COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

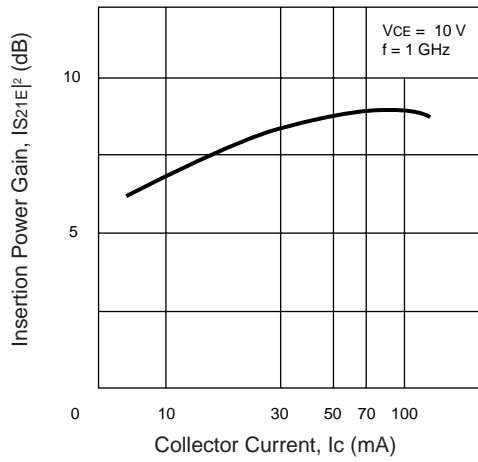


FEEDBACK CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE

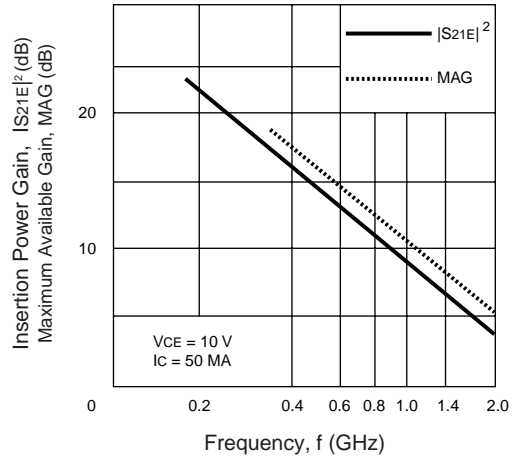


TYPICAL PERFORMANCE CURVES (TA = 25°C)

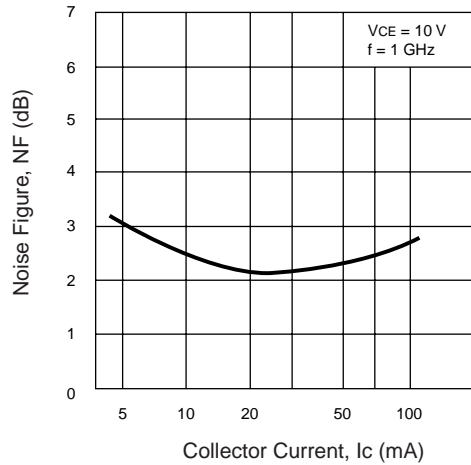
INSERTION POWER GAIN vs. COLLECTOR CURRENT



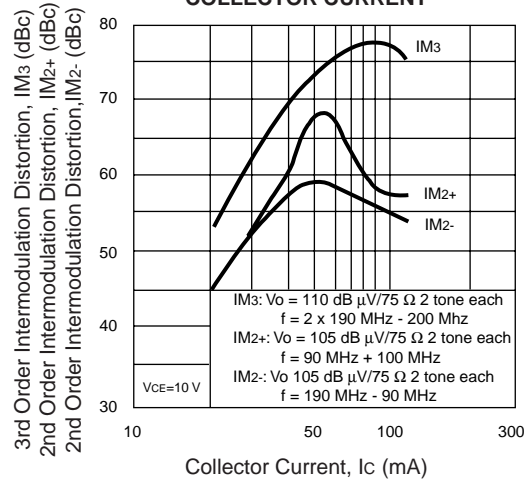
INSERTION POWER GAIN and MAXIMUM AVAILABLE GAIN vs. FREQUENCY



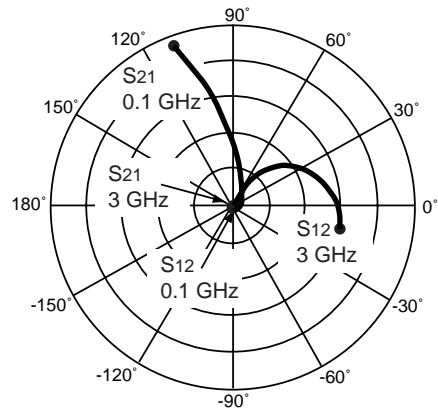
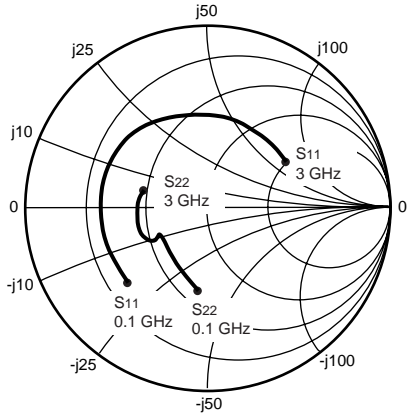
NOISE FIGURE vs. COLLECTOR CURRENT



3RD ORDER INTERMODULATION DISTORTION 2ND ORDER INTERMODULATION DISTORTION (+) & 2ND ORDER INTERMODULATION DISTORTION (-) vs. COLLECTOR CURRENT



TYPICAL SCATTERING PARAMETERS (TA = 25°C)



Coordinates in Ohms
Frequency in GHz
Vce = 10 V, Ic = 50 mA

NE461M02

VCE = 5 V, Ic = 50 mA

| FREQUENCY | S11 | | S21 | | S12 | | S22 | | K | MAG ¹ |
|-----------|-------|--------|--------|-------|-------|------|-------|--------|------|------------------|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | (dB) |
| 0.100 | 0.603 | -142.0 | 22.351 | 109.2 | 0.031 | 47.3 | 0.456 | -100.7 | 0.50 | 28.6 |
| 0.200 | 0.615 | -165.0 | 11.847 | 95.2 | 0.042 | 52.4 | 0.345 | -129.0 | 0.77 | 24.5 |
| 0.400 | 0.618 | 178.5 | 6.043 | 83.2 | 0.066 | 60.8 | 0.309 | -147.0 | 0.97 | 19.6 |
| 0.600 | 0.616 | 168.9 | 4.072 | 75.1 | 0.092 | 63.4 | 0.307 | -152.1 | 1.04 | 15.3 |
| 0.800 | 0.612 | 161.2 | 3.089 | 68.2 | 0.119 | 63.4 | 0.310 | -153.5 | 1.06 | 12.7 |
| 1.000 | 0.607 | 154.4 | 2.506 | 61.8 | 0.146 | 62.2 | 0.315 | -153.6 | 1.07 | 10.8 |
| 1.200 | 0.602 | 148.0 | 2.123 | 55.8 | 0.172 | 60.4 | 0.321 | -153.3 | 1.07 | 9.3 |
| 1.400 | 0.596 | 142.0 | 1.858 | 50.2 | 0.198 | 58.2 | 0.328 | -152.8 | 1.06 | 8.2 |
| 1.600 | 0.588 | 136.2 | 1.661 | 44.9 | 0.224 | 55.9 | 0.335 | -152.2 | 1.06 | 7.3 |
| 1.800 | 0.581 | 130.6 | 1.514 | 39.8 | 0.250 | 53.3 | 0.341 | -151.7 | 1.05 | 6.5 |
| 2.000 | 0.572 | 125.0 | 1.397 | 35.1 | 0.275 | 50.6 | 0.347 | -151.5 | 1.04 | 5.9 |
| 2.200 | 0.563 | 119.6 | 1.307 | 30.3 | 0.300 | 47.8 | 0.353 | -151.4 | 1.03 | 5.4 |
| 2.400 | 0.553 | 114.0 | 1.232 | 25.9 | 0.325 | 44.9 | 0.359 | -151.4 | 1.02 | 5.0 |
| 2.600 | 0.544 | 108.4 | 1.169 | 21.6 | 0.349 | 41.9 | 0.363 | -151.8 | 1.01 | 4.6 |
| 2.800 | 0.535 | 102.7 | 1.118 | 17.5 | 0.373 | 38.8 | 0.369 | -152.4 | 1.00 | 4.5 |
| 3.000 | 0.527 | 97.0 | 1.074 | 13.4 | 0.396 | 35.6 | 0.373 | -153.3 | 1.00 | 4.3 |

VCE = 10 V, Ic = 50 mA

| FREQUENCY | S11 | | S21 | | S12 | | S22 | | K | MAG ¹ |
|-----------|-------|--------|--------|-------|-------|------|-------|--------|------|------------------|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | (dB) |
| 0.100 | 0.599 | -137.2 | 23.210 | 109.9 | 0.031 | 48.0 | 0.455 | -97.0 | 0.48 | 28.7 |
| 0.200 | 0.602 | -162.2 | 12.353 | 95.7 | 0.042 | 51.4 | 0.335 | -125.3 | 0.75 | 24.7 |
| 0.400 | 0.601 | 179.8 | 6.307 | 83.5 | 0.066 | 60.0 | 0.295 | -143.9 | 0.97 | 19.8 |
| 0.600 | 0.599 | 169.8 | 4.248 | 75.4 | 0.091 | 62.8 | 0.292 | -149.2 | 1.03 | 15.6 |
| 0.800 | 0.596 | 161.9 | 3.220 | 68.4 | 0.117 | 63.0 | 0.295 | -150.6 | 1.06 | 12.9 |
| 1.000 | 0.591 | 155.0 | 2.609 | 62.1 | 0.144 | 61.9 | 0.301 | -150.7 | 1.07 | 11.0 |
| 1.200 | 0.586 | 148.5 | 2.208 | 56.1 | 0.169 | 60.2 | 0.309 | -150.3 | 1.07 | 9.6 |
| 1.400 | 0.581 | 142.4 | 1.929 | 50.5 | 0.195 | 58.1 | 0.317 | -149.7 | 1.06 | 8.4 |
| 1.600 | 0.573 | 136.6 | 1.722 | 45.2 | 0.220 | 55.8 | 0.325 | -149.1 | 1.06 | 7.5 |
| 1.800 | 0.566 | 131.0 | 1.568 | 40.1 | 0.245 | 53.3 | 0.333 | -148.6 | 1.05 | 6.7 |
| 2.000 | 0.557 | 125.5 | 1.444 | 35.3 | 0.270 | 50.7 | 0.340 | -148.3 | 1.04 | 6.1 |
| 2.200 | 0.549 | 120.1 | 1.349 | 30.5 | 0.295 | 48.0 | 0.347 | -148.2 | 1.03 | 5.6 |
| 2.400 | 0.540 | 114.5 | 1.269 | 26.1 | 0.319 | 45.1 | 0.354 | -148.2 | 1.02 | 5.2 |
| 2.600 | 0.531 | 108.9 | 1.202 | 21.8 | 0.342 | 42.2 | 0.360 | -148.6 | 1.01 | 4.8 |
| 2.800 | 0.523 | 103.2 | 1.148 | 17.6 | 0.366 | 39.1 | 0.366 | -149.2 | 1.00 | 4.8 |
| 3.000 | 0.515 | 97.5 | 1.101 | 13.5 | 0.388 | 36.0 | 0.372 | -150.1 | 0.99 | 4.5 |

Note:

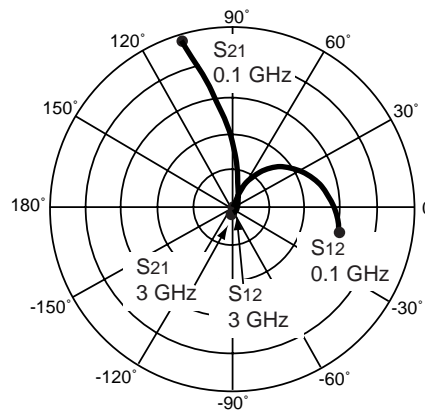
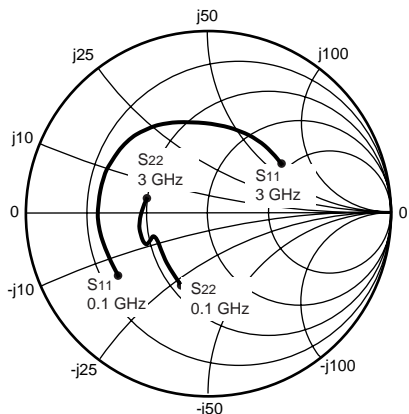
1. Gain Calculations:

$$MAG = \frac{|S_{21}|}{|S_{12}|} \left(K \pm \sqrt{K^2 - 1} \right). \text{ When } K \leq 1, \text{ MAG is undefined and MSG values are used. } MSG = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

TYPICAL SCATTERING PARAMETERS (TA = 25°C)



Coordinates in Ohms
Frequency in GHz
VCE = 12 V, IC = 100 mA

NE461M02

VCE = 10 V, IC = 100 mA

| FREQUENCY GHz | S11 | | S21 | | S12 | | S22 | | K | MAG ¹ (dB) |
|------------------|-------|--------|--------|-------|-------|------|-------|--------|------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 0.100 | 0.596 | -144.8 | 23.959 | 106.7 | 0.029 | 48.5 | 0.422 | -108.4 | 0.56 | 29.2 |
| 0.200 | 0.601 | -166.5 | 12.575 | 93.9 | 0.040 | 55.6 | 0.334 | -135.7 | 0.82 | 25.0 |
| 0.400 | 0.601 | 177.5 | 6.386 | 82.7 | 0.066 | 63.6 | 0.308 | -152.0 | 0.99 | 19.9 |
| 0.600 | 0.600 | 168.1 | 4.296 | 75.0 | 0.093 | 65.3 | 0.306 | -156.5 | 1.04 | 15.4 |
| 0.800 | 0.597 | 160.4 | 3.258 | 68.3 | 0.120 | 64.7 | 0.309 | -157.7 | 1.06 | 12.9 |
| 1.000 | 0.593 | 153.6 | 2.640 | 62.1 | 0.147 | 63.1 | 0.313 | -157.8 | 1.06 | 11.0 |
| 1.200 | 0.588 | 147.2 | 2.236 | 56.3 | 0.174 | 60.9 | 0.318 | -157.4 | 1.06 | 9.5 |
| 1.400 | 0.581 | 141.2 | 1.953 | 50.8 | 0.201 | 58.5 | 0.324 | -156.6 | 1.06 | 8.4 |
| 1.600 | 0.574 | 135.3 | 1.747 | 45.6 | 0.227 | 55.9 | 0.330 | -155.7 | 1.05 | 7.5 |
| 1.800 | 0.565 | 129.6 | 1.590 | 40.6 | 0.252 | 53.1 | 0.335 | -154.9 | 1.05 | 6.7 |
| 2.000 | 0.556 | 124.1 | 1.468 | 35.8 | 0.277 | 50.3 | 0.341 | -154.2 | 1.04 | 6.1 |
| 2.200 | 0.547 | 118.7 | 1.371 | 31.1 | 0.302 | 47.4 | 0.346 | -153.5 | 1.03 | 5.5 |
| 2.400 | 0.535 | 113.0 | 1.292 | 26.6 | 0.325 | 44.3 | 0.351 | -153.0 | 1.02 | 5.1 |
| 2.600 | 0.524 | 107.5 | 1.225 | 22.3 | 0.348 | 41.3 | 0.355 | -152.8 | 1.02 | 4.7 |
| 2.800 | 0.515 | 101.8 | 1.170 | 18.1 | 0.371 | 38.2 | 0.359 | -152.8 | 1.01 | 4.4 |
| 3.000 | 0.505 | 96.1 | 1.122 | 14.1 | 0.393 | 35.1 | 0.363 | -153.0 | 1.00 | 4.2 |

VCE = 12 V, IC = 100 mA

| FREQUENCY GHz | S11 | | S21 | | S12 | | S22 | | K | MAG ¹ (dB) |
|------------------|-------|--------|--------|-------|-------|------|-------|--------|------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 0.100 | 0.596 | -143.1 | 24.061 | 106.9 | 0.029 | 48.3 | 0.416 | -107.7 | 0.56 | 29.3 |
| 0.200 | 0.598 | -165.5 | 12.640 | 94.0 | 0.040 | 55.1 | 0.328 | -135.1 | 0.82 | 25.0 |
| 0.400 | 0.597 | 178.0 | 6.417 | 82.7 | 0.065 | 63.0 | 0.301 | -151.6 | 0.99 | 19.9 |
| 0.600 | 0.595 | 168.4 | 4.313 | 74.9 | 0.093 | 64.8 | 0.299 | -156.2 | 1.04 | 15.4 |
| 0.800 | 0.592 | 160.6 | 3.268 | 68.2 | 0.120 | 64.3 | 0.302 | -157.4 | 1.06 | 12.8 |
| 1.000 | 0.588 | 153.7 | 2.647 | 62.0 | 0.147 | 62.8 | 0.306 | -157.4 | 1.07 | 11.0 |
| 1.200 | 0.583 | 147.3 | 2.241 | 56.2 | 0.173 | 60.7 | 0.312 | -156.9 | 1.07 | 9.5 |
| 1.400 | 0.576 | 141.3 | 1.957 | 50.7 | 0.199 | 58.3 | 0.318 | -156.1 | 1.07 | 8.3 |
| 1.600 | 0.568 | 135.5 | 1.750 | 45.5 | 0.225 | 55.8 | 0.324 | -155.2 | 1.06 | 7.4 |
| 1.800 | 0.560 | 129.9 | 1.593 | 40.5 | 0.250 | 53.1 | 0.330 | -154.3 | 1.05 | 6.6 |
| 2.000 | 0.550 | 124.4 | 1.471 | 35.6 | 0.275 | 50.2 | 0.336 | -153.5 | 1.04 | 6.0 |
| 2.200 | 0.540 | 119.0 | 1.373 | 31.0 | 0.300 | 47.4 | 0.342 | -152.8 | 1.03 | 5.5 |
| 2.400 | 0.530 | 113.5 | 1.294 | 26.4 | 0.323 | 44.3 | 0.347 | -152.3 | 1.03 | 5.0 |
| 2.600 | 0.520 | 107.9 | 1.228 | 22.1 | 0.346 | 41.3 | 0.353 | -152.0 | 1.02 | 4.6 |
| 2.800 | 0.510 | 102.3 | 1.172 | 17.9 | 0.369 | 38.2 | 0.357 | -151.9 | 1.01 | 4.4 |
| 3.000 | 0.502 | 96.7 | 1.123 | 13.8 | 0.391 | 35.0 | 0.362 | -152.2 | 1.01 | 4.1 |

Note:

1. Gain Calculations:

$$MAG = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1})$$

When $K \leq 1$, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}$, $\Delta = S_{11} S_{22} - S_{21} S_{12}$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

EXCLUSIVE NORTH AMERICAN AGENT FOR NEC RF, MICROWAVE & OPTOELECTRONIC SEMICONDUCTORS

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