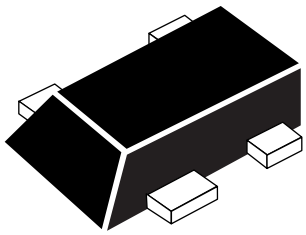
CEL

# NPN SILICON HIGH FREQUENCY TRANSISTOR

# NE661M04

## FEATURES

- **HIGH GAIN BANDWIDTH:** $f_T$ = 25 GHz
- **HIGH POWER GAIN:** $|S_{21E}|^2$ = 17 dB TYP at 2 GHz
- **LOW NOISE FIGURE:** NF = 1.2 dB at 2 GHz
- **HIGH MAXIMUM STABLE GAIN:** 22 dB @ 2 GHz
- **NEW LOW PROFILE M04 PACKAGE:**
  SOT-343 footprint, with a height of just 0.59 mm.
  Flat Lead Style for better RF performance.



M04

## DESCRIPTION

NEC's NE661M04 is fabricated using NEC's UHS0 25 GHz $f_T$ wafer process. With a typical transition frequency of 25 GHz the NE661M04 is usable in applications from 100 MHz to 10 GHz. The NE661M04 provides excellent low voltage/low current performance.

NEC's new low profile/flat lead style "M04" package is ideal for today's portable wireless applications. The NE661M04 is an ideal choice for LNA and oscillator requirements in all mobile communication systems.

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

| | PART NUMBER<br>EIAJ[1] REGISTERED NUMBER<br>PACKAGE OUTLINE | | NE661M04<br>2SC5507<br>M04 | | | |
|---|---|---|---|---|---|---|
| | **SYMBOLS** | **PARAMETERS AND CONDITIONS** | **UNITS** | **MIN** | **TYP** | **MAX** |
| DC | $I_{CBO}$ | Collector Cutoff Current at $V_{CE}$ = 5 V, $I_E$ = 0 | μA | | | 0.1 |
| DC | $I_{EBO}$ | Emitter Cutoff Current at $V_{EB}$ = 1 V, $I_C$ = 0 | μA | | | 0.1 |
| DC | $h_{FE}$ | Forward Current Gain[2] at $V_{CE}$ = 2 V, $I_C$ = 5 mA | | 50 | 70 | 100 |
| RF | $f_T$ | Gain Bandwidth at $V_{CE}$ = 3 V, $I_C$ = 10 mA, f = 2 GHz | GHz | 20 | 25 | |
| RF | MSG | Maximum Stable Gain[4] at $V_{CE}$ = 2 V, $I_C$ = 5 mA, f = 2 GHz | dB | | 22 | |
| RF | $\|S_{21E}\|^2$ | Insertion Power Gain at $V_{CE}$ = 2 V, $I_C$ = 5 mA, f = 2 GHz | dB | 14 | 17 | |
| RF | NF | Noise Figure at $V_{CE}$ = 2 V, $I_C$ = 2 mA, f = 2 GHz, $Z_{IN}$ = $Z_{OPT}$ | dB | | 1.2 | 1.5 |
| RF | P1dB | Output Power at 1 dB compression point at $V_{CE}$ = 2 V, $I_C$ = 5 mA, f = 2 GHz | dBm | | 5 | |
| RF | $IP_3$ | Third Order Intercept Point at $V_{CE}$ = 2 V, $I_C$ = 5 mA, f = 2 GHz | dBm | | 15 | |
| RF | Cre | Feedback Capacitance[3] at $V_{CB}$ = 2 V, $I_C$ = 0, f = 1 MHz | pF | | 0.08 | 0.12 |

Notes:

1. Electronic Industrial Association of Japan.
2. Pulsed measurement, pulse width ≤ 350 μs, duty cycle ≤ 2 %.
3. Capacitance is measured by capacitance meter (automatic balance bridge method) when emitter pin is connected to the guard pin.
4. $MSG = \left|\frac{S_{21}}{S_{12}}\right|$

## ABSOLUTE MAXIMUM RATINGS[1] ($T_A$ = 25°C)

| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|---|---|---|---|
| $V_{CBO}$ | Collector to Base Voltage | V | 15 |
| $V_{CEO}$ | Collector to Emitter Voltage | V | 3.3 |
| $V_{EBO}$ | Emitter to Base Voltage | V | 1.5 |
| $I_C$ | Collector Current | mA | 12 |
| $P_T$ | Total Power Dissipation | mW | 39 |
| $T_J$ | Junction Temperature | °C | 150 |
| $T_{STG}$ | Storage Temperature | °C | -65 to +150 |

Note:
1. Operation in excess of any one of these parameters may result in permanent damage.

## THERMAL RESISTANCE

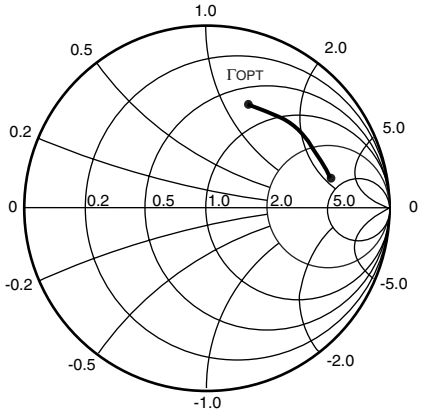
| ITEM | SYMBOL | VALUE | UNIT |
|---|---|---|---|
| Junction to Case Resistance | $R_{th\ j\text{-}c}$ | 240 | °C/W |
| Junction to Ambient Resistance | $R_{th\ j\text{-}a}$ | 650 | °C/W |

## TYPICAL NOISE PARAMETERS ($T_A$ = 25°C)

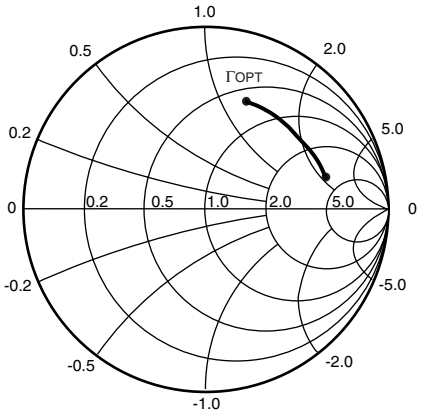
| FREQ. (GHz) | $NF_{OPT}$ (dB) | $G_A$ (dB) | $\Gamma_{OPT}$ MAG | $\Gamma_{OPT}$ ANG | Rn/50 |
|---|---|---|---|---|---|
| $V_C$ = 1 V, $I_C$ = 1 mA | | | | | |
| 0.50 | 1.08 | 21.40 | 0.67 | 13 | 0.60 |
| 0.90 | 1.13 | 18.90 | 0.64 | 31 | 0.64 |
| 1.00 | 1.14 | 18.40 | 0.64 | 33 | 0.64 |
| 1.50 | 1.20 | 15.70 | 0.63 | 43 | 0.64 |
| 2.00 | 1.29 | 14.20 | 0.62 | 50 | 0.62 |
| 2.50 | 1.40 | 13.20 | 0.61 | 59 | 0.55 |
| 3.00 | 1.55 | 12.50 | 0.60 | 67 | 0.45 |
| $V_C$ = 2 V, $I_C$ = 1 mA | | | | | |
| 0.50 | 1.12 | 21.70 | 0.69 | 13 | 0.57 |
| 0.90 | 1.15 | 19.50 | 0.66 | 26 | 0.56 |
| 1.00 | 1.16 | 19.10 | 0.65 | 30 | 0.55 |
| 1.50 | 1.23 | 16.50 | 0.64 | 37 | 0.69 |
| 2.00 | 1.32 | 14.70 | 0.64 | 46 | 0.68 |
| 2.50 | 1.45 | 13.90 | 0.63 | 60 | 0.55 |
| 3.00 | 1.60 | 13.30 | 0.62 | 69 | 0.52 |
| $V_C$ = 2 V, $I_C$ = 5 mA | | | | | |
| 0.50 | 1.69 | 27.41 | 0.41 | 14 | 0.60 |
| 0.90 | 1.70 | 23.80 | 0.41 | 30 | 0.64 |
| 1.00 | 1.70 | 23.00 | 0.41 | 34 | 0.64 |
| 1.50 | 1.72 | 20.24 | 0.40 | 40 | 0.64 |
| 2.00 | 1.75 | 17.93 | 0.39 | 47 | 0.62 |
| 2.50 | 1.79 | 16.77 | 0.38 | 55 | 0.55 |
| 3.00 | 1.85 | 16.30 | 0.36 | 64 | 0.45 |

## TYPICAL OPTIMAL NOISE MATCHING ($T_A$ = 25°C)

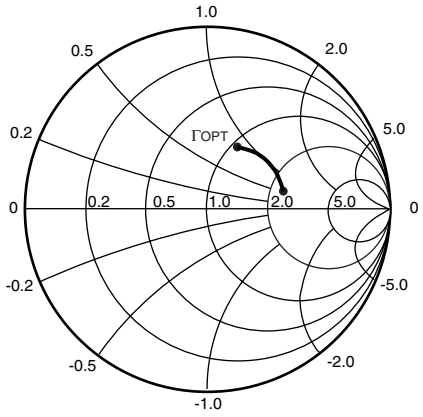
**$V_C$ = 1 V, $I_C$ = 1 mA**




**$V_C$ = 2 V, $I_C$ = 1 mA**

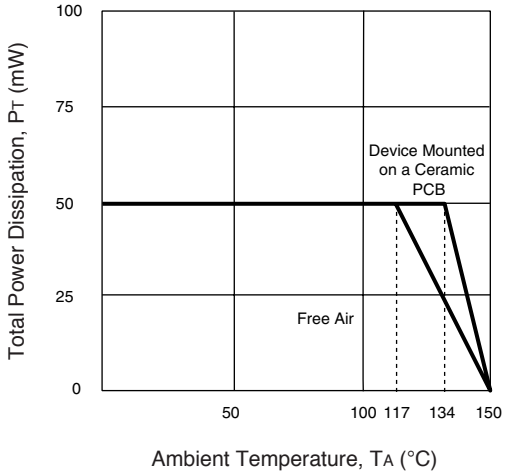



**$V_C$ = 2 V, $I_C$ = 5 mA**

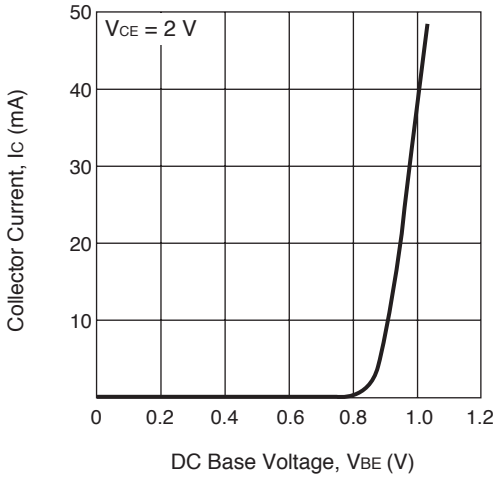


## TYPICAL PERFORMANCE CURVES ($T_A$ = 25°C)

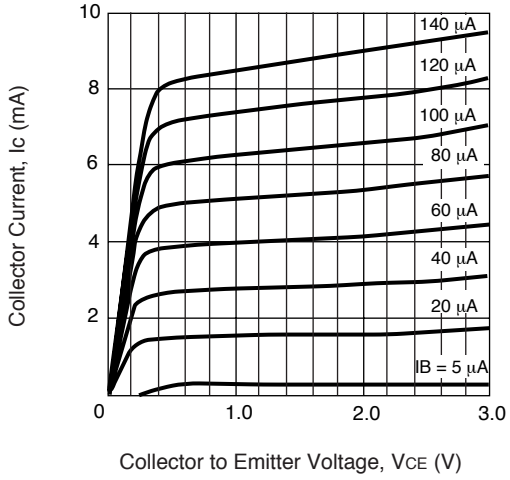
**DC POWER DERATING CURVES**



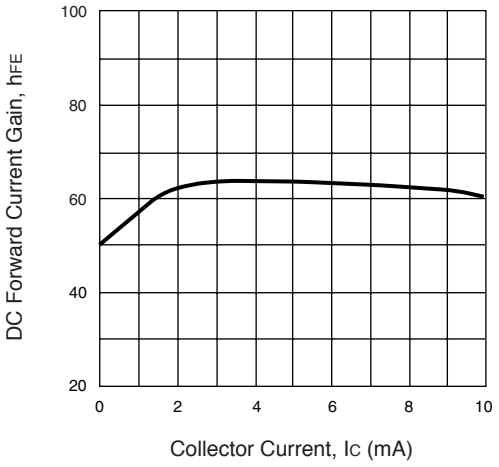

**COLLECTOR CURRENT vs. DC BASE VOLTAGE**



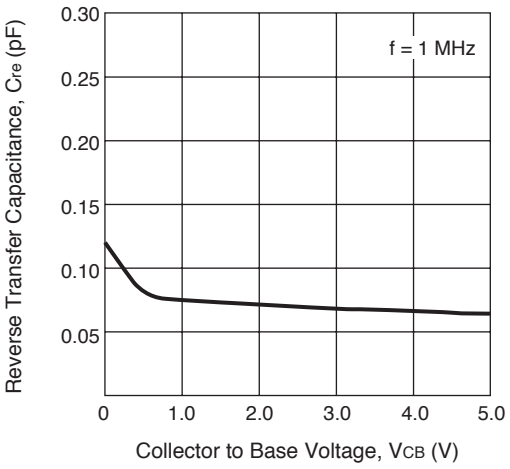

**COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE**



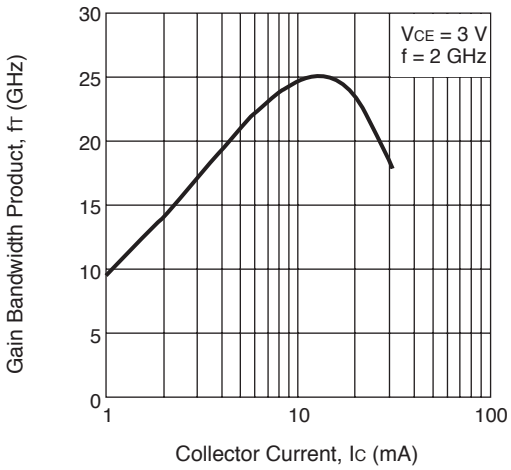

**FORWARD CURRENT GAIN vs. COLLECTOR GAIN**




**REVERSE TRANSFER CAPACITANCE vs. COLLECTOR BASE VOLTAGE**

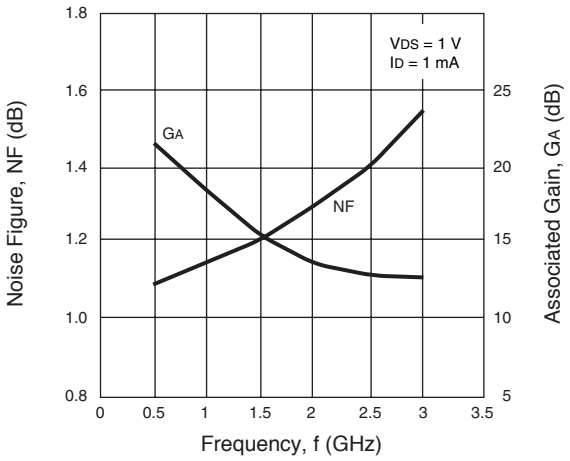



**GAIN BANDWIDTH PRODUCT vs. COLLECTOR CURRENT**

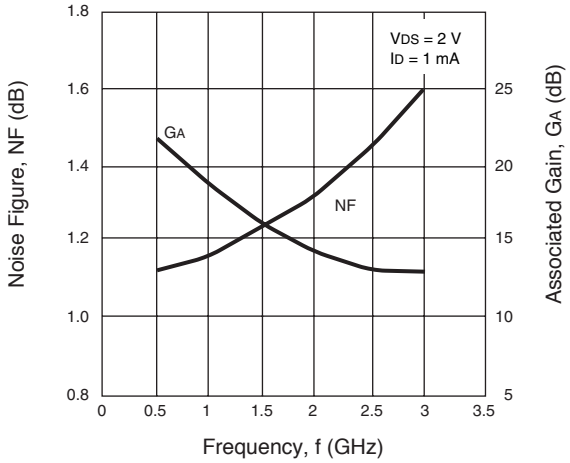


## TYPICAL PERFORMANCE CURVES ($T_A$ = 25°C)

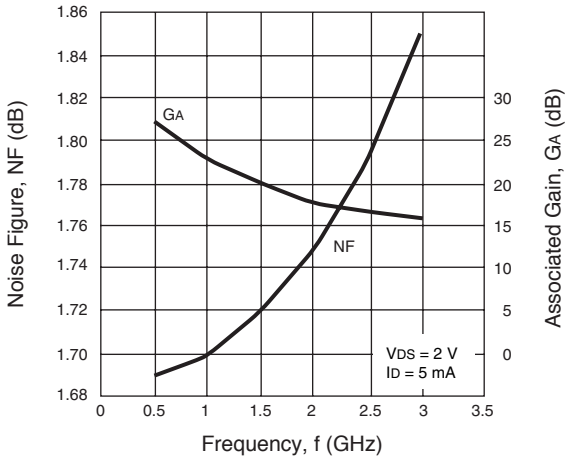
**NOISE FIGURE vs. FREQUENCY**



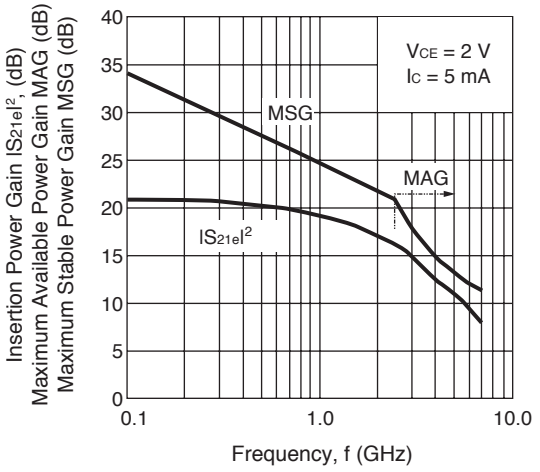

**NOISE FIGURE vs. FREQUENCY**



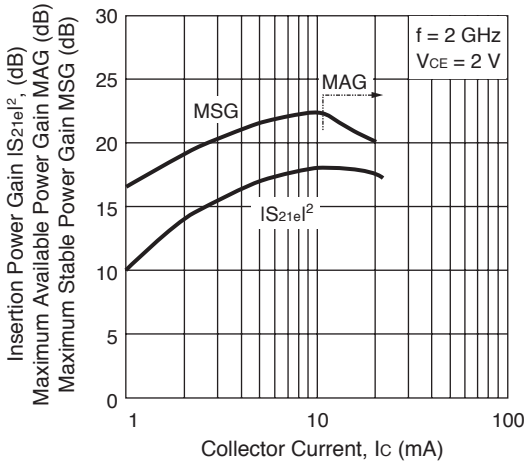

**NOISE FIGURE vs. FREQUENCY**



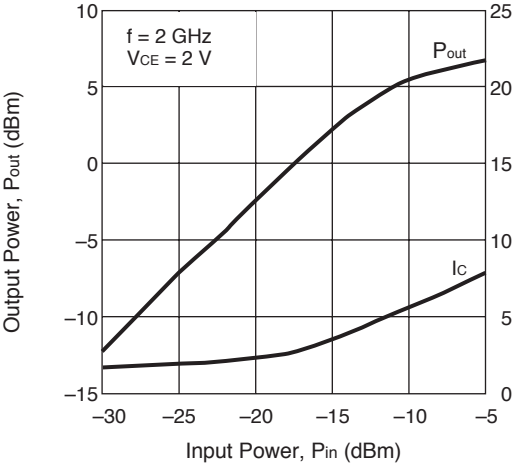

**INSERTION POWER GAIN, MAXIMUM AVAILABLE POWER GAIN, MAXIMUM STABLE POWER GAIN vs. FREQUENCY**



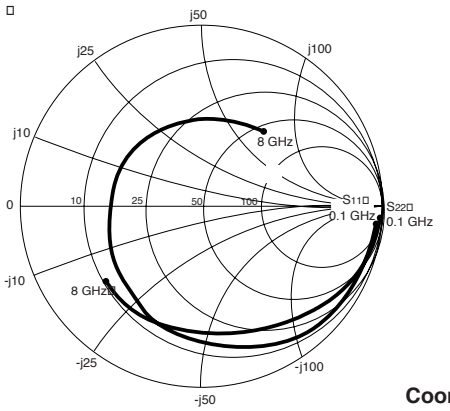

**INSERTION POWER GAIN, MAXIMUM AVAILABLE POWER GAIN, MAXIMUM STABLE POWER GAIN vs. COLLECTOR CURRENT**

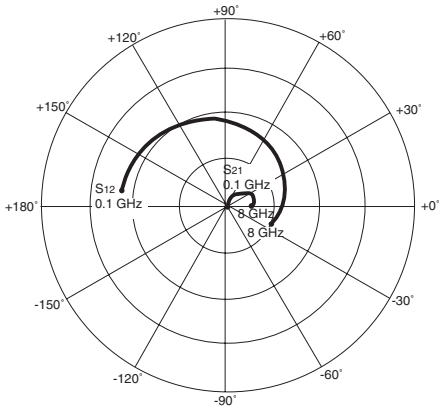



**OUTPUT, COLLECTOR CURRENT vs. INPUT POWER**



## TYPICAL SCATTERING PARAMETERS (TA = 25˚C)




**Coordinates in Ohms**
**Frequency in GHz**
**($V_{CE}$ = 1 V, $I_C$ = 1 mA)**

### $V_C$ = 1 V, $I_C$ = 1 mA

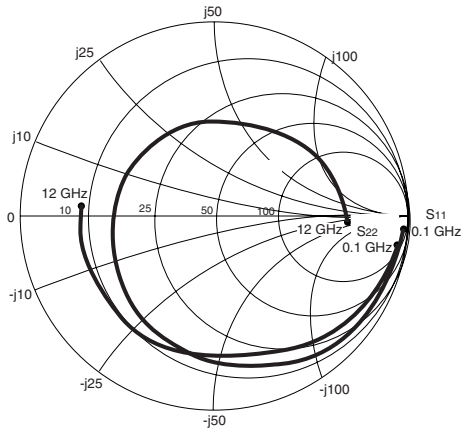
| FREQUENCY | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | | K | MAG[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| (GHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | (dB) |
| 0.10 | 0.944 | -4.3 | 2.912 | 172.0 | 0.005 | 84.9 | 0.991 | -4.3 | 0.15 | 27.53 |
| 0.20 | 0.943 | -8.0 | 2.868 | 171.3 | 0.009 | 77.9 | 0.970 | -7.6 | 0.22 | 24.88 |
| 0.30 | 0.941 | -11.9 | 2.845 | 168.3 | 0.013 | 75.1 | 0.955 | -10.2 | 0.22 | 23.30 |
| 0.40 | 0.939 | -15.4 | 2.837 | 164.2 | 0.017 | 73.0 | 0.943 | -12.8 | 0.23 | 22.21 |
| 0.50 | 0.935 | -19.2 | 2.845 | 160.7 | 0.021 | 70.8 | 0.935 | -15.2 | 0.22 | 21.37 |
| 0.70 | 0.930 | -26.7 | 2.807 | 153.5 | 0.028 | 66.3 | 0.922 | -19.9 | 0.22 | 20.00 |
| 1.00 | 0.916 | -37.4 | 2.734 | 144.1 | 0.038 | 59.6 | 0.906 | -26.7 | 0.22 | 18.57 |
| 1.50 | 0.862 | -55.4 | 2.614 | 126.2 | 0.051 | 46.5 | 0.850 | -37.3 | 0.39 | 17.08 |
| 2.00 | 0.807 | -72.7 | 2.526 | 110.8 | 0.061 | 36.2 | 0.821 | -46.6 | 0.49 | 16.16 |
| 2.50 | 0.755 | -89.4 | 2.337 | 96.3 | 0.068 | 26.8 | 0.794 | -55.1 | 0.61 | 15.38 |
| 3.00 | 0.693 | -106.9 | 2.236 | 82.4 | 0.071 | 18.3 | 0.768 | -62.8 | 0.75 | 14.96 |
| 3.50 | 0.636 | -124.7 | 2.095 | 68.9 | 0.072 | 10.7 | 0.744 | -70.1 | 0.92 | 14.61 |
| 4.00 | 0.585 | -143.5 | 1.977 | 55.6 | 0.071 | 4.5 | 0.723 | -77.2 | 1.11 | 12.45 |
| 5.00 | 0.515 | 178.7 | 1.746 | 30.4 | 0.066 | -2.9 | 0.696 | -91.7 | 1.53 | 9.96 |
| 6.00 | 0.489 | 143.2 | 1.521 | 6.9 | 0.061 | -1.9 | 0.689 | -106.9 | 1.89 | 8.49 |
| 7.00 | 0.480 | 109.3 | 1.325 | -14.4 | 0.066 | 0.9 | 0.688 | -119.9 | 2.05 | 7.22 |
| 8.00 | 0.495 | 75.6 | 1.155 | -34.5 | 0.076 | 2.0 | 0.679 | -131.9 | 2.04 | 5.98 |

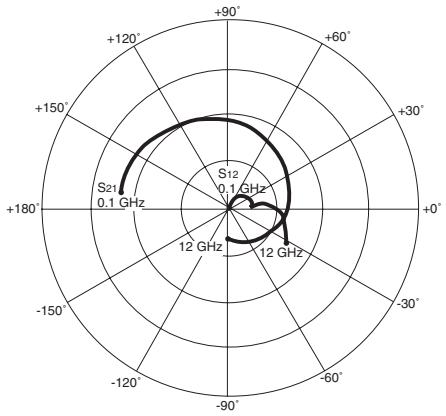
Note:
1. Gain Calculation:

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

## TYPICAL SCATTERING PARAMETERS (TA = 25°C)




**Coordinates in Ohms**
**Frequency in GHz**
**($V_{CE}$ = 2 V, $I_C$ = 1 mA)**

### $V_C$ = 2 V, $I_C$ = 1 mA

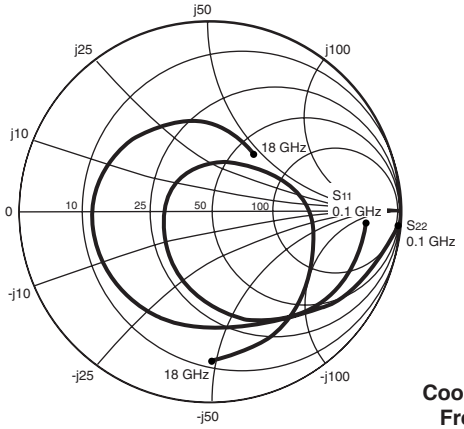
| FREQUENCY | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | | K | MAG[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| (GHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | (dB) |
| 0.10 | 0.946 | -4.2 | 2.929 | 172.1 | 0.005 | 84.2 | 0.992 | -4.2 | 0.16 | 28.12 |
| 0.20 | 0.945 | -7.7 | 2.882 | 171.5 | 0.008 | 76.7 | 0.971 | -7.4 | 0.25 | 25.51 |
| 0.30 | 0.943 | -11.6 | 2.860 | 168.6 | 0.012 | 74.8 | 0.956 | -10.0 | 0.24 | 23.91 |
| 0.40 | 0.941 | -14.9 | 2.853 | 164.6 | 0.015 | 72.6 | 0.944 | -12.4 | 0.25 | 22.79 |
| 0.50 | 0.938 | -18.6 | 2.861 | 161.2 | 0.018 | 70.6 | 0.937 | -14.7 | 0.24 | 21.95 |
| 0.70 | 0.933 | -25.9 | 2.825 | 154.2 | 0.025 | 66.5 | 0.924 | -19.3 | 0.23 | 20.61 |
| 1.00 | 0.921 | -36.3 | 2.756 | 145.0 | 0.033 | 60.4 | 0.909 | -25.9 | 0.23 | 19.19 |
| 1.50 | 0.869 | -53.9 | 2.643 | 127.4 | 0.045 | 47.8 | 0.856 | -36.2 | 0.40 | 17.72 |
| 2.00 | 0.816 | -70.7 | 2.563 | 112.3 | 0.053 | 38.1 | 0.829 | -45.2 | 0.50 | 16.82 |
| 2.50 | 0.765 | -87.0 | 2.377 | 98.0 | 0.059 | 29.2 | 0.805 | -53.4 | 0.62 | 16.05 |
| 3.50 | 0.647 | -121.6 | 2.142 | 70.9 | 0.063 | 14.4 | 0.759 | -68.1 | 0.94 | 15.33 |
| 3.00 | 0.703 | -104.1 | 2.281 | 84.2 | 0.062 | 21.3 | 0.781 | -60.9 | 0.76 | 15.65 |
| 4.00 | 0.593 | -139.9 | 2.027 | 57.7 | 0.062 | 9.4 | 0.740 | -75.2 | 1.14 | 12.87 |
| 5.00 | 0.518 | -177.4 | 1.799 | 32.7 | 0.057 | 4.6 | 0.716 | -89.6 | 1.58 | 10.51 |
| 6.00 | 0.485 | 147.0 | 1.573 | 9.1 | 0.056 | 8.2 | 0.711 | -104.7 | 1.86 | 9.10 |
| 7.00 | 0.472 | 112.6 | 1.372 | -12.2 | 0.064 | 11.0 | 0.711 | -117.7 | 1.89 | 7.86 |
| 8.00 | 0.483 | 78.3 | 1.197 | -32.2 | 0.078 | 10.5 | 0.704 | -129.7 | 1.82 | 6.62 |
| 9.00 | 0.541 | 49.9 | 1.039 | -51.0 | 0.098 | 4.2 | 0.700 | -142.3 | 1.56 | 5.85 |
| 10.00 | 0.604 | 28.4 | 0.914 | -67.6 | 0.120 | -3.8 | 0.697 | -154.8 | 1.30 | 5.53 |
| 11.00 | 0.653 | 10.2 | 0.821 | -84.2 | 0.144 | -15.4 | 0.698 | -169.7 | 1.07 | 5.90 |
| 12.00 | 0.691 | -7.9 | 0.734 | -101.2 | 0.168 | -29.3 | 0.693 | 173.1 | 0.96 | 6.41 |

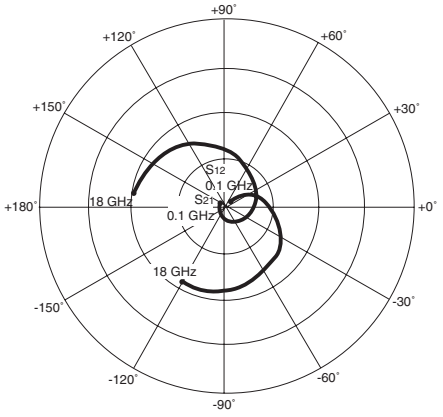
Note:
1. Gain Calculation:

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

## TYPICAL SCATTERING PARAMETERS (TA = 25°C)




**Coordinates in Ohms**
**Frequency in GHz**
**($V_{CE}$ = 2 V, $I_C$ = 5 mA)**

### $V_C$ = 2 V, $I_C$ = 5 mA

| FREQUENCY | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | | K | MAG[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| (GHz) | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | (dB) |
| 0.10 | 0.823 | -5.3 | 10.113 | 172.3 | 0.004 | 81.5 | 0.979 | -5.1 | 0.27 | 34.04 |
| 0.20 | 0.816 | -11.4 | 9.907 | 167.9 | 0.008 | 75.6 | 0.954 | -9.1 | 0.32 | 31.13 |
| 0.30 | 0.807 | -17.0 | 9.734 | 163.0 | 0.011 | 72.1 | 0.933 | -12.5 | 0.34 | 29.55 |
| 0.40 | 0.797 | -22.0 | 9.571 | 158.1 | 0.014 | 70.1 | 0.916 | -15.5 | 0.34 | 28.41 |
| 0.50 | 0.784 | -27.2 | 9.433 | 153.3 | 0.017 | 67.9 | 0.902 | -18.5 | 0.35 | 27.54 |
| 0.70 | 0.757 | -37.1 | 9.037 | 144.0 | 0.022 | 63.3 | 0.873 | -23.9 | 0.37 | 26.18 |
| 1.00 | 0.710 | -51.0 | 8.386 | 131.4 | 0.029 | 57.0 | 0.836 | -31.3 | 0.43 | 24.69 |
| 1.50 | 0.592 | -71.5 | 7.208 | 111.1 | 0.036 | 47.3 | 0.748 | -41.2 | 0.67 | 23.00 |
| 2.00 | 0.498 | -89.6 | 6.429 | 95.0 | 0.042 | 41.5 | 0.704 | -49.1 | 0.83 | 21.77 |
| 2.50 | 0.417 | -106.7 | 5.446 | 80.7 | 0.046 | 37.6 | 0.672 | -55.9 | 0.98 | 20.73 |
| 3.00 | 0.345 | -124.2 | 4.809 | 67.8 | 0.050 | 34.7 | 0.649 | -62.1 | 1.11 | 17.80 |
| 3.50 | 0.289 | -143.0 | 4.283 | 55.9 | 0.054 | 32.2 | 0.631 | -68.0 | 1.23 | 16.15 |
| 4.00 | 0.249 | -163.9 | 3.862 | 44.7 | 0.058 | 30.0 | 0.619 | -74.1 | 1.30 | 14.95 |
| 5.00 | 0.221 | 153.2 | 3.218 | 23.5 | 0.067 | 25.3 | 0.606 | -87.3 | 1.37 | 13.17 |
| 6.00 | 0.235 | 117.2 | 2.732 | 3.3 | 0.078 | 19.5 | 0.614 | -101.9 | 1.35 | 11.92 |
| 7.00 | 0.255 | 84.3 | 2.369 | -15.7 | 0.090 | 11.9 | 0.621 | -114.5 | 1.31 | 10.86 |
| 8.00 | 0.298 | 53.7 | 2.074 | -33.9 | 0.101 | 3.5 | 0.622 | -125.8 | 1.30 | 9.84 |
| 9.00 | 0.371 | 32.9 | 1.834 | -51.5 | 0.114 | -5.1 | 0.625 | -138.3 | 1.20 | 9.31 |
| 10.00 | 0.439 | 18.4 | 1.657 | -67.9 | 0.130 | -13.2 | 0.624 | -150.4 | 1.08 | 9.33 |
| 11.00 | 0.497 | 5.3 | 1.521 | -85.1 | 0.149 | -23.8 | 0.625 | -165.1 | 0.93 | 10.10 |
| 12.00 | 0.547 | -9.8 | 1.395 | -103.4 | 0.167 | -36.4 | 0.622 | 178.1 | 0.83 | 9.22 |
| 13.00 | 0.597 | -26.5 | 1.269 | -121.9 | 0.185 | -50.4 | 0.606 | 162.0 | 0.76 | 8.37 |
| 14.00 | 0.648 | -42.6 | 1.147 | -140.2 | 0.193 | -64.4 | 0.575 | 146.0 | 0.76 | 7.73 |
| 15.00 | 0.693 | -53.5 | 1.041 | -158.0 | 0.204 | -77.1 | 0.522 | 127.4 | 0.77 | 7.08 |
| 16.00 | 0.732 | -64.5 | 0.963 | -176.4 | 0.221 | -91.0 | 0.488 | 106.8 | 0.71 | 6.39 |
| 17.00 | 0.758 | -77.4 | 0.864 | 163.2 | 0.230 | -107.7 | 0.434 | 79.8 | 0.77 | 5.75 |
| 18.00 | 0.787 | -89.6 | 0.756 | 144.0 | 0.230 | -122.4 | 0.368 | 52.7 | 0.88 | 5.16 |

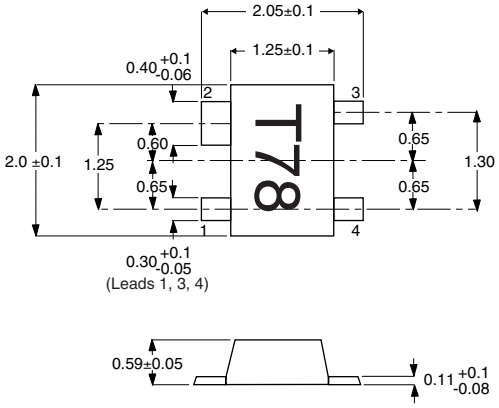
Note:
1. Gain Calculation:

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

## OUTLINE DIMENSIONS (Units in mm)

**PACKAGE OUTLINE M04**







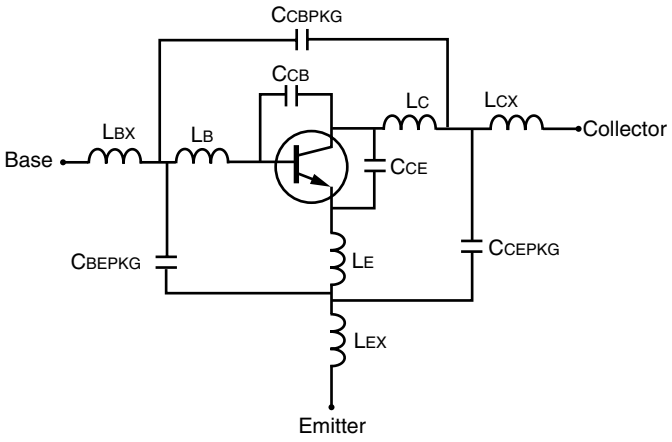
PIN CONNECTIONS
1. Emitter
2. Collector
3. Emitter
4. Base

## ORDERING INFORMATION

| PART NUMBER | QUANTITY | PACKAGING |
|---|---|---|
| NE661M04-T2-A | 3000 | Tape & Reel |

## NONLINEAR MODEL

### SCHEMATIC




### BJT NONLINEAR MODEL PARAMETERS (1)

| Parameters | Q1 | Parameters | Q1 |
|---|---|---|---|
| IS | 2.2e-18 | MJC | 0.33 |
| BF | 120 | XCJC | 1 |
| NF | 1 | CJS | 0 |
| VAF | 39.7 | VJS | 0.75 |
| IKF | 0.21 | MJS | 0 |
| ISE | 4.64e-14 | FC | 0.5 |
| NE | 2.09 | TF | 2e-12 |
| BR | 10 | XTF | 20 |
| NR | 1.004 | VTF | 10 |
| VAR | 1.9 | ITF | 0.1 |
| IKR | 0.1 | PTF | 200 |
| ISC | 1.1e-11 | TR | 1e-11 |
| NC | 41 | EG | 1.11 |
| RE | 3.5 | XTB | 0 |
| RB | 14 | XTI | 3 |
| RBM | 14 | KF | 0 |
| IRB | 0.004 | AF | 1 |
| RC | 8 | | |
| CJE | 0.3e-12 | | |
| VJE | 0.5 | | |
| MJE | 0.33 | | |
| CJC | 0.001e-12 | | |
| VJC | 0.75 | | |

(1) Gummel-Poon Model

### ADDITIONAL PARAMETERS

| Parameters | NE661M04 |
|---|---|
| $C_{CB}$ | 0.08e-12 |
| $C_{CE}$ | 0.1e-12 |
| $L_B$ | 0.93e-9 |
| $L_C$ | 0.6e-9 |
| $L_E$ | 0.2e-9 |
| $C_{CBPKG}$ | 0.001e-12 |
| $C_{CEPKG}$ | 0.25e-12 |
| $C_{BEPK}$ | 0.2e-12 |
| $L_{BX}$ | 0.2e-9 |
| $L_{CX}$ | 0.2e-9 |
| $L_{EX}$ | 0.05e-9 |

MODEL RANGE

Frequency: 0.1 to 18 GHz
Bias: $V_{CE}$ = 0.5 V to 2.5 V, $I_C$ = 1 mA to 7 mA
Date: 02/2002

Life Support Applications
These NEC products are not intended for use in life support devices, appliances, or systems where the malfunction of these products can reasonably be expected to result in personal injury. The customers of CEL using or selling these products for use in such applications do so at their own risk and agree to fully indemnify CEL for all damages resulting from such improper use or sale.

CEL California Eastern Laboratories

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Santa Clara, CA 95054-1817
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Facsimile: (408) 988-0279

Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL's understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

| Restricted Substance per RoHS | Concentration Limit per RoHS (values are not yet fixed) | Concentration contained in CEL devices | |
|---|---|---|---|
| Lead (Pb) | < 1000 PPM | -A | -AZ |
| | | Not Detected | (*) |
| Mercury | < 1000 PPM | Not Detected | |
| Cadmium | < 100 PPM | Not Detected | |
| Hexavalent Chromium | < 1000 PPM | Not Detected | |
| PBB | < 1000 PPM | Not Detected | |
| PBDE | < 1000 PPM | Not Detected | |

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

Important Information and Disclaimer: Information provided by CEL on its website or in other communications concerting the substance content of its products represents knowledge and belief as of the date that it is provided. CEL bases its knowledge and belief on information provided by third parties and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. CEL has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. CEL and CEL suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.
In no event shall CEL's liability arising out of such information exceed the total purchase price of the CEL part(s) at issue sold by CEL to customer on an annual basis.
See CEL Terms and Conditions for additional clarification of warranties and liability.