



THE DATASHEET OF 2SC4959



FEATURES

- LOW COST
- SMALL AND ULTRA SMALL SIZE PACKAGES
- LOW VOLTAGE/LOW CURRENT OPERATION
- HIGH GAIN BANDWIDTH PRODUCT: f_T of 12 GHz
- NOISE FIGURES OF 1.5 dB AT 2.0 GHz

DESCRIPTION

NEC's family of high frequency, low cost, surface mount devices are well suited for portable wireless communications and cellular radio applications.

The NE685 series of high f_T (12 GHz) devices is suitable for very low voltage/low current, low noise applications. These products are ideal for applications up to 2.4 GHz where low cost, high gain, low voltage, and low current are prime concerns.



ELECTRICAL CHARACTERISTICS (T_A = 25°C)

| SYMBOLS | PARAMETERS AND CONDITIONS | UNITS | PART NUMBER ¹ EIAJ ² REGISTERED NUMBER PACKAGE OUTLINE | | | NE68518 2SC5015 18 | | | NE68519 2SC5010 19 | | | NE68530 2SC4959 30 | | | NE68533 2SC4955 33 | | | NE68539/39R 2SC4957 39 | | |
|--------------------------------|--|-------|--|-----|-----|--------------------------|-----|------|--------------------------|-----|-----|--------------------------|------|-----|--------------------------|-----|-----|------------------------------|--|--|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | | | |
| f_T | Gain Bandwidth Product at V _{CE} = 3V, I _C = 10 mA, f = 2.0 GHz | GHz | | 12 | | | 12 | | | 12 | | | 12 | | | 12 | | | | |
| NF _{MIN} | Minimum Noise Figure at V _{CE} = 3 V, I _C = 3 mA, f = 2.0 GHz | dB | | 1.5 | 2.5 | | 1.5 | 2.5 | | 1.5 | 2.5 | | 1.5 | 2.5 | | 1.5 | 2.5 | | | |
| GNF | Associated Gain at V _{CE} = 3V, I _C = 3 mA, f = 2.0 GHz | dB | | 8.5 | | | 7.5 | | | 7 | | | 7 | | | 7.5 | | | | |
| MAG | Maximum Available Gain at V _{CE} = 3 V, I _C = 10 mA, f = 2.0 GHz | dB | | 12 | | | 11 | | | 10 | | | 10.5 | | | 11 | | | | |
| IS _{21E} ² | Insertion Power Gain at V _{CE} = 3V, I _C = 10 mA, f = 2.0 GHz | dB | 9 | 11 | | 7 | 9 | | 7 | 8.5 | | 7 | 8 | | 9 | 10 | | | | |
| h _{FE} | Forward Current Gain ³ at V _{CE} = 3 V, I _C = 10 mA | | 75 | 110 | 150 | 75 | 110 | 150 | 75 | 110 | 150 | 75 | 110 | 150 | 75 | 110 | 150 | | | |
| I _{CBO} | Collector Cutoff Current at V _{CB} = 5 V, I _E = 0 mA | μA | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 | | | |
| I _{EBO} | Emitter Cutoff Current at V _{EB} = 1 V, I _C = 0 mA | μA | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 | | | |
| CRE ⁴ | Feedback Capacitance at V _{CB} = 3 V, I _E = 0 mA, f = 1 MHz | pF | | 0.3 | 0.5 | | 0.4 | 0.7 | | 0.4 | 0.7 | | 0.4 | 0.7 | | 0.3 | 0.5 | | | |
| P _T | Total Power Dissipation | mW | | | 150 | | | 125 | | | 150 | | | 180 | | | 180 | | | |
| R _{TH(J-A)} | Thermal Resistance (Junction to Ambient) | °C/W | | | 833 | | | 1000 | | | 833 | | | 620 | | | 620 | | | |
| R _{TH(J-C)} | Thermal Resistance(Junction to Case) | °C/W | | | 200 | | | 200 | | | 200 | | | 200 | | | 200 | | | |

- Notes: 1. Precaution: Devices are ESD sensitive. Use proper handling procedures.
 2. Electronic Industrial Association of Japan.
 3. Pulsed measurement, PW ≤ 350 μs, duty cycle ≤ 2%.
 4. The emitter terminal should be connected to the ground terminal of the 3 terminal capacitance bridge.

NE685 SERIES

ABSOLUTE MAXIMUM RATINGS¹ (T_A = 25°C)

| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|------------------|------------------------------|-------|-------------|
| V _{CBO} | Collector to Base Voltage | V | 9 |
| V _{CEO} | Collector to Emitter Voltage | V | 6 |
| V _{EBO} | Emitter to Base Voltage | V | 2.0 |
| I _C | Collector Current | mA | 30 |
| 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.

NE68518

TYPICAL NOISE PARAMETERS (T_A = 25°C)

| FREQ. (MHz) | NF _{OPT} (dB) | G _A (dB) | Γ _{OPT} | | Rn/50 |
|---|---------------------------|------------------------|------------------|-----|-------|
| | | | MAG | ANG | |
| V _{CE} = 3 V, I _C = 3 mA | | | | | |
| 500 | 1.00 | 21.32 | 0.63 | 26 | 0.56 |
| 800 | 1.15 | 16.29 | 0.59 | 31 | 0.44 |
| 1000 | 1.20 | 14.66 | 0.56 | 39 | 0.40 |
| 1500 | 1.35 | 11.02 | 0.52 | 48 | 0.37 |
| 2000 | 1.50 | 8.67 | 0.47 | 53 | 0.33 |
| 2500 | 1.65 | 7.24 | 0.40 | 65 | 0.23 |
| V _{CE} = 3 V, I _C = 5 mA | | | | | |
| 500 | 1.20 | 21.15 | 0.55 | 19 | 0.47 |
| 800 | 1.25 | 17.29 | 0.51 | 31 | 0.42 |
| 1000 | 1.35 | 15.47 | 0.49 | 37 | 0.38 |
| 1500 | 1.45 | 11.87 | 0.46 | 44 | 0.35 |
| 2000 | 1.60 | 9.57 | 0.42 | 53 | 0.33 |
| 2500 | 1.75 | 7.90 | 0.36 | 60 | 0.22 |
| V _{CE} = 3 V, I _C = 10 mA | | | | | |
| 500 | 1.55 | 21.70 | 0.44 | 15 | 0.44 |
| 800 | 1.60 | 18.13 | 0.40 | 30 | 0.41 |
| 1000 | 1.65 | 16.20 | 0.38 | 36 | 0.39 |
| 1500 | 1.80 | 12.85 | 0.34 | 44 | 0.37 |
| 2000 | 1.90 | 10.60 | 0.30 | 50 | 0.34 |
| 2500 | 2.00 | 8.82 | 0.27 | 55 | 0.23 |

NE68519

TYPICAL NOISE PARAMETERS (T_A = 25°C)

| FREQ. (MHz) | NF _{OPT} (dB) | G _A (dB) | Γ _{OPT} | | Rn/50 |
|--|---------------------------|------------------------|------------------|-----|-------|
| | | | MAG | ANG | |
| V _{CE} = 2.5 V, I _C = 0.3 mA | | | | | |
| 500 | 1.07 | 12.6 | 0.80 | 17 | 1.70 |
| 800 | 1.25 | 8.6 | 0.79 | 32 | 1.55 |
| 1000 | 1.55 | 6.7 | 0.75 | 42 | 1.41 |
| V _{CE} = 2.5 V, I _C = 1.0 mA | | | | | |
| 500 | 0.87 | 16.9 | 0.73 | 14 | 0.80 |
| 800 | 0.99 | 12.8 | 0.67 | 27 | 0.65 |
| 1000 | 1.08 | 11.0 | 0.64 | 36 | 0.62 |
| 1500 | 1.31 | 7.5 | 0.60 | 52 | 0.52 |
| 2000 | 1.65 | 5.0 | 0.54 | 65 | 0.42 |
| V _{CE} = 3 V, I _C = 10 mA | | | | | |
| 500 | 1.05 | 19.3 | 0.65 | 14 | 0.57 |
| 800 | 1.12 | 15.8 | 0.58 | 27 | 0.50 |
| 1000 | 1.17 | 13.4 | 0.55 | 33 | 0.45 |
| 1500 | 1.31 | 9.9 | 0.50 | 47 | 0.38 |
| 2000 | 1.51 | 7.5 | 0.43 | 58 | 0.32 |
| 2500 | 1.75 | 5.5 | 0.32 | 69 | 0.21 |
| V _{CE} = 3 V, I _C = 5.0 mA | | | | | |
| 500 | 1.33 | 19.4 | 0.58 | 13 | 0.54 |
| 800 | 1.40 | 15.3 | 0.52 | 26 | 0.49 |
| 1000 | 1.45 | 13.5 | 0.50 | 33 | 0.46 |
| 1500 | 1.57 | 10.0 | 0.43 | 46 | 0.42 |
| 2000 | 1.71 | 7.5 | 0.36 | 54 | 0.38 |
| 2500 | 1.90 | 5.6 | 0.29 | 60 | 0.31 |

NE68530

TYPICAL NOISE PARAMETERS (T_A = 25°C)

| FREQ. (MHz) | NF _{OPT} (dB) | G _A (dB) | Γ _{OPT} | | Rn/50 |
|---|---------------------------|------------------------|------------------|-----|-------|
| | | | MAG | ANG | |
| V _{CE} = 0.5 V, I _C = 0.5 mA | | | | | |
| 500 | 0.95 | 10.87 | 0.81 | 15 | 1.20 |
| 800 | 1.05 | 7.82 | 0.75 | 24 | 1.02 |
| 1000 | 1.20 | 6.92 | 0.72 | 34 | 0.86 |
| V _{CE} = 0.75 V, I _C = 0.5 mA | | | | | |
| 500 | 0.97 | 11.28 | 0.82 | 14 | 1.15 |
| 800 | 1.15 | 8.64 | 0.76 | 24 | 1.00 |
| 1000 | 1.25 | 7.62 | 0.73 | 33 | 0.84 |
| V _{CE} = 1.0 V, I _C = 0.25 mA | | | | | |
| 500 | 1.10 | 8.73 | 0.85 | 13 | 1.69 |
| 800 | 1.20 | 6.83 | 0.80 | 25 | 1.65 |
| 1000 | 1.45 | 6.67 | 0.75 | 36 | 1.64 |
| V _{CE} = 1.0 V, I _C = 0.5 mA | | | | | |
| 500 | 0.95 | 11.93 | 0.78 | 12 | 1.02 |
| 800 | 1.12 | 8.71 | 0.76 | 22 | 0.99 |
| 1000 | 1.28 | 8.35 | 0.69 | 32 | 0.86 |
| V _{CE} = 1.0 V, I _C = 0.75 mA | | | | | |
| 500 | 0.90 | 12.92 | 0.77 | 11 | 0.92 |
| 800 | 1.02 | 10.03 | 0.73 | 21 | 0.84 |
| 1000 | 1.18 | 9.23 | 0.67 | 30 | 0.69 |
| V _{CE} = 1.0 V, I _C = 1.0 mA | | | | | |
| 500 | 0.88 | 14.48 | 0.75 | 13 | 0.82 |
| 800 | 1.00 | 10.96 | 0.71 | 21 | 0.76 |
| 1000 | 1.14 | 9.83 | 0.66 | 29 | 0.62 |
| V _{CE} = 1.0 V, I _C = 3.0 mA | | | | | |
| 500 | 0.98 | 17.29 | 0.60 | 10 | 0.52 |
| 800 | 1.07 | 13.62 | 0.57 | 18 | 0.50 |
| 1000 | 1.15 | 12.01 | 0.54 | 25 | 0.47 |
| 2000 | 1.52 | 6.41 | 0.43 | 27 | 0.38 |
| V _{CE} = 2.5 V, I _C = 0.3 mA | | | | | |
| 500 | 1.10 | 10.77 | 0.85 | 14 | 1.49 |
| 800 | 1.30 | 7.48 | 0.81 | 22 | 1.45 |
| 1000 | 1.47 | 6.76 | 0.78 | 30 | 1.37 |
| V _{CE} = 2.5 V, I _C = 1 mA | | | | | |
| 500 | 0.85 | 15.44 | 0.73 | 12 | 0.91 |
| 800 | 1.04 | 11.52 | 0.72 | 19 | 0.75 |
| 1000 | 1.16 | 10.45 | 0.69 | 27 | 0.68 |
| 2000 | 1.60 | 5.16 | 0.54 | 33 | 0.47 |
| V _{CE} = 2.5 V, I _C = 3 mA | | | | | |
| 500 | 1.08 | 18.11 | 0.65 | 11 | 0.60 |
| 800 | 1.15 | 14.37 | 0.60 | 17 | 0.53 |
| 1000 | 1.22 | 12.76 | 0.58 | 23 | 0.49 |
| 2000 | 1.68 | 7.19 | 0.48 | 20 | 0.41 |
| V _{CE} = 3 V, I _C = 3 mA | | | | | |
| 500 | 1.10 | 18.10 | 0.65 | 10 | 0.58 |
| 800 | 1.19 | 14.27 | 0.61 | 14 | 0.50 |
| 1000 | 1.25 | 12.77 | 0.60 | 23 | 0.49 |
| 2000 | 1.48 | 7.20 | 0.50 | 20 | 0.42 |
| 3000 | 1.74 | 5.22 | 0.32 | 28 | 0.22 |

NE68533

TYPICAL NOISE PARAMETERS (T_A = 25°C)

| FREQ. (MHz) | NF _{OPT} (dB) | GA (dB) | Γ _{OPT} | | Rn/50 |
|--|---------------------------|------------|------------------|-----|-------|
| | | | MAG | ANG | |
| V _{CE} = 0.5 V, I _C = 0.5 mA | | | | | |
| 500 | 0.9 | 12.03 | 0.76 | 19 | 1.19 |
| 800 | 1.1 | 10.22 | 0.72 | 37 | 0.84 |
| 1000 | 1.3 | 9.24 | 0.67 | 50 | 0.72 |
| V _{CE} = 1.0 V, I _C = 0.5 mA | | | | | |
| 500 | 0.9 | 13.19 | 0.75 | 18 | 1.23 |
| 800 | 1.0 | 10.87 | 0.73 | 35 | 0.89 |
| 1000 | 1.2 | 10.16 | 0.68 | 47 | 0.77 |
| V _{CE} = 1.0 V, I _C = 1.0 mA | | | | | |
| 500 | 0.9 | 14.57 | 0.73 | 17 | 0.74 |
| 800 | 1.0 | 12.04 | 0.67 | 33 | 0.54 |
| 1000 | 1.2 | 10.94 | 0.64 | 45 | 0.50 |
| V _{CE} = 2.5 V, I _C = 1 mA | | | | | |
| 500 | 0.9 | 15.67 | 0.73 | 16 | 0.77 |
| 800 | 1.0 | 12.73 | 0.68 | 30 | 0.57 |
| 1000 | 1.1 | 11.79 | 0.65 | 42 | 0.58 |
| 2000 | 1.6 | 4.73 | 0.59 | 53 | 0.36 |
| V _{CE} = 2.5 V, I _C = 3 mA | | | | | |
| 500 | 1.07 | 18.37 | 0.61 | 14 | 0.54 |
| 800 | 1.13 | 14.40 | 0.55 | 19 | 0.39 |
| 1000 | 1.30 | 13.15 | 0.56 | 35 | 0.40 |
| 2000 | 1.43 | 7.48 | 0.42 | 40 | 0.34 |
| 2500 | 1.63 | 6.59 | 0.24 | 69 | 0.22 |

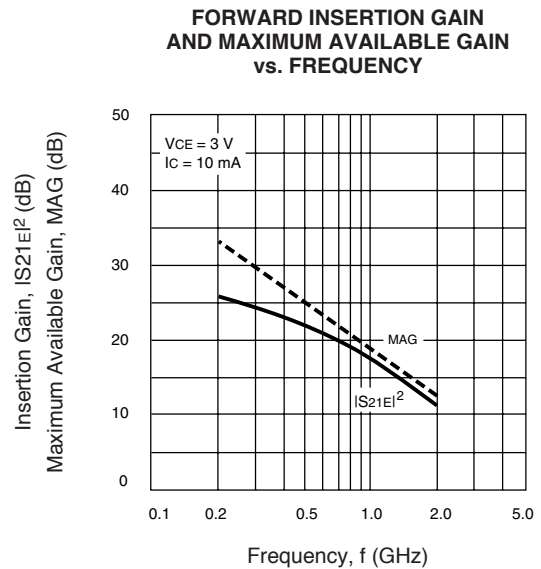
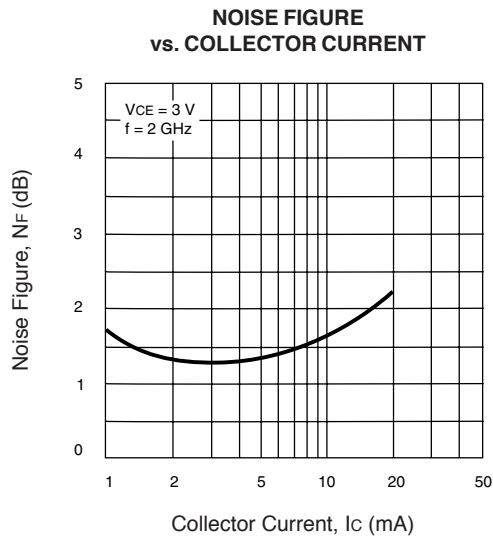
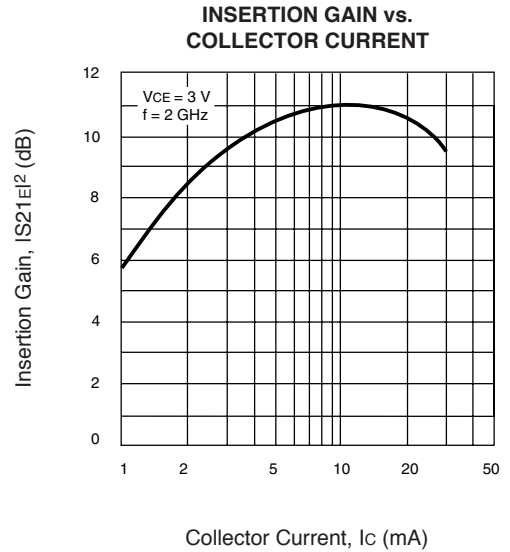
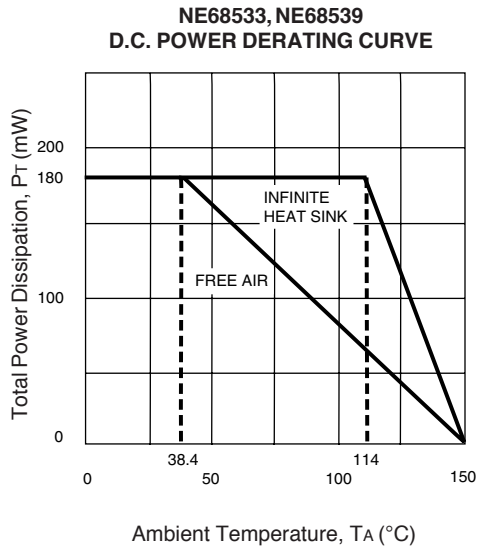
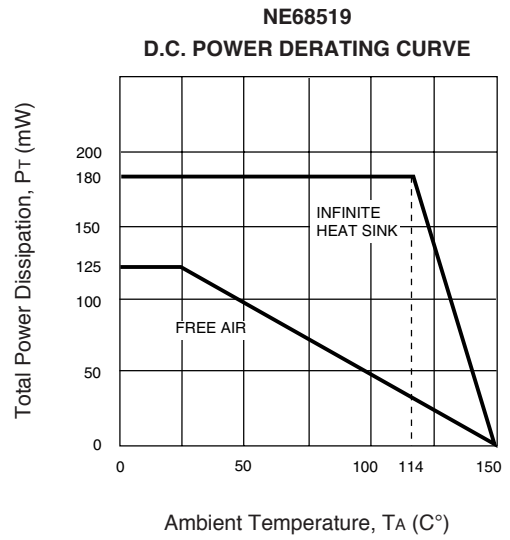
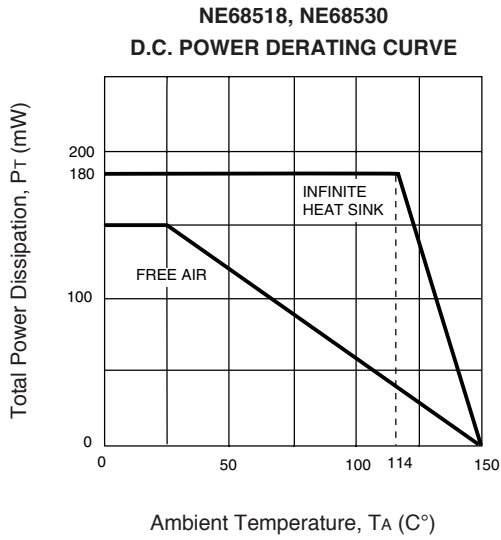
NE68539

TYPICAL NOISE PARAMETERS (T_A = 25°C)

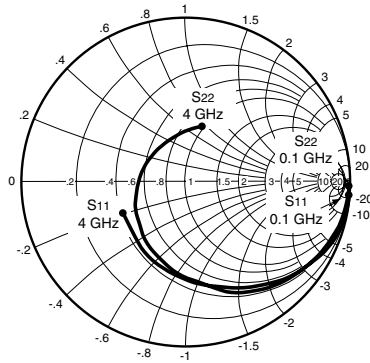
| FREQ. (MHz) | NF _{OPT} (dB) | GA (dB) | Γ _{OPT} | | Rn/50 |
|--|---------------------------|------------|------------------|-----|-------|
| | | | MAG | ANG | |
| V _{CE} = 2.5 V, I _C = 0.3 mA | | | | | |
| 500 | 1.42 | 13.3 | 0.80 | 18 | 2.52 |
| 800 | 1.58 | 9.7 | 0.72 | 32 | 1.40 |
| 1000 | 1.70 | 8.0 | 0.64 | 43 | 1.29 |
| V _{CE} = 2.5 V, I _C = 1.0 mA | | | | | |
| 500 | 0.85 | 16.3 | 0.72 | 17 | 0.66 |
| 800 | 0.98 | 12.6 | 0.61 | 29 | 0.50 |
| 1000 | 1.07 | 11.0 | 0.51 | 40 | 0.48 |
| 1500 | 1.29 | 7.8 | 0.38 | 55 | 0.39 |
| 2000 | 1.52 | 6.2 | 0.30 | 67 | 0.32 |
| V _{CE} = 2.5 V, I _C = 3.0 mA | | | | | |
| 500 | 1.17 | 18.2 | 0.63 | 19 | 0.46 |
| 800 | 1.30 | 14.9 | 0.51 | 29 | 0.38 |
| 1000 | 1.39 | 13.2 | 0.34 | 33 | 0.34 |
| 1500 | 1.69 | 10.0 | 0.23 | 28 | 0.30 |
| 2000 | 2.00 | 7.6 | 0.17 | 13 | 0.25 |
| 2500 | 2.33 | 5.8 | 0.16 | -13 | 0.21 |
| V _{CE} = 3 V, I _C = 5.0 mA | | | | | |
| 500 | 1.27 | 19.5 | 0.57 | 17 | 0.44 |
| 800 | 1.40 | 15.8 | 0.41 | 25 | 0.38 |
| 1000 | 1.50 | 14.1 | 0.31 | 26 | 0.35 |
| 1500 | 1.81 | 10.9 | 0.23 | 21 | 0.29 |
| 2000 | 2.13 | 8.6 | 0.19 | 10 | 0.26 |
| 2500 | 2.47 | 6.8 | 0.17 | -10 | 0.22 |

NE685 SERIES

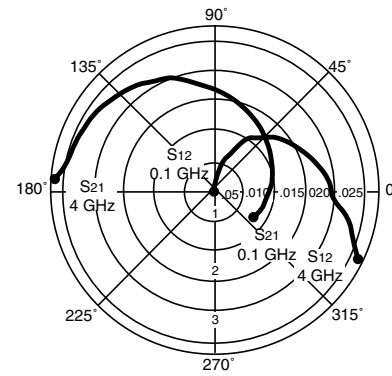
TYPICAL PERFORMANCE CURVES (TA = 25°C)



TYPICAL SCATTERING PARAMETERS (TA = 25°C)



Coordinates in Ohms
Frequency in GHz
(VCE = 2.5 V, IC = 1 mA)



NE68518

VCE = 0.5 V, IC = 0.5 mA

| FREQUENCY GHz | S11 | | S21 | | S12 | | S22 | | K | MAG ¹ (dB) |
|------------------|-------|----------|-------|---------|-------|---------|-------|----------|-------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 0.1 | 0.995 | -7.200 | 1.819 | 170.500 | 0.030 | 88.600 | 0.997 | -3.900 | 0.024 | 17.827 |
| 0.4 | 0.941 | -29.200 | 1.756 | 148.100 | 0.107 | 67.200 | 0.969 | -22.000 | 0.168 | 12.151 |
| 0.8 | 0.844 | -56.800 | 1.619 | 119.000 | 0.193 | 45.300 | 0.893 | -42.700 | 0.331 | 9.237 |
| 1.0 | 0.783 | -69.300 | 1.530 | 106.100 | 0.225 | 35.800 | 0.853 | -51.500 | 0.410 | 8.325 |
| 1.5 | 0.644 | -99.500 | 1.331 | 77.200 | 0.263 | 15.800 | 0.750 | -69.200 | 0.610 | 7.042 |
| 2.0 | 0.542 | -126.400 | 1.163 | 53.400 | 0.279 | -0.100 | 0.675 | -84.400 | 0.792 | 6.200 |
| 2.5 | 0.469 | -152.900 | 1.054 | 32.400 | 0.280 | -13.000 | 0.629 | -96.600 | 0.952 | 5.757 |
| 3.0 | 0.421 | -179.100 | 0.965 | 14.800 | 0.283 | -23.900 | 0.582 | -108.400 | 1.097 | 3.431 |

VCE = 1.0 V, IC = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|---------|-------|----------|-------|--------|
| 0.1 | 0.985 | -8.500 | 3.481 | 169.900 | 0.023 | 82.400 | 0.985 | -5.500 | 0.108 | 21.800 |
| 0.4 | 0.917 | -32.500 | 3.293 | 146.500 | 0.086 | 66.300 | 0.956 | -24.300 | 0.172 | 15.831 |
| 0.8 | 0.771 | -62.700 | 2.879 | 117.800 | 0.144 | 44.100 | 0.847 | -45.300 | 0.347 | 13.009 |
| 1.0 | 0.696 | -76.000 | 2.653 | 105.300 | 0.165 | 35.500 | 0.789 | -53.300 | 0.440 | 12.063 |
| 1.5 | 0.536 | -105.900 | 2.160 | 78.600 | 0.191 | 21.800 | 0.675 | -70.500 | 0.634 | 10.534 |
| 2.0 | 0.430 | -133.000 | 1.798 | 56.600 | 0.210 | 7.200 | 0.601 | -83.800 | 0.831 | 9.326 |
| 2.5 | 0.361 | -160.200 | 1.559 | 37.700 | 0.214 | -0.900 | 0.554 | -94.000 | 0.998 | 8.624 |
| 3.0 | 0.310 | 173.400 | 1.385 | 21.000 | 0.229 | -7.500 | 0.513 | -104.500 | 1.118 | 5.724 |
| 4.0 | 0.303 | 116.300 | 1.173 | -10.100 | 0.255 | -20.700 | 0.436 | -130.100 | 1.253 | 3.601 |

VCE = 2.5 V, IC = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|---------|-------|----------|-------|--------|
| 0.1 | 0.986 | -7.100 | 3.465 | 170.500 | 0.018 | 83.900 | 0.996 | -4.400 | 0.103 | 22.844 |
| 0.4 | 0.926 | -29.800 | 3.301 | 148.800 | 0.063 | 67.000 | 0.970 | -21.200 | 0.174 | 17.193 |
| 0.8 | 0.799 | -57.100 | 2.949 | 121.700 | 0.116 | 47.000 | 0.878 | -39.900 | 0.345 | 14.052 |
| 1.0 | 0.728 | -69.600 | 2.743 | 109.700 | 0.139 | 39.100 | 0.834 | -47.800 | 0.419 | 12.952 |
| 1.5 | 0.573 | -98.500 | 2.275 | 83.400 | 0.161 | 24.100 | 0.732 | -63.800 | 0.610 | 11.502 |
| 2.0 | 0.455 | -123.900 | 1.921 | 61.500 | 0.180 | 11.100 | 0.671 | -76.200 | 0.789 | 10.283 |
| 2.5 | 0.364 | -150.100 | 1.664 | 42.300 | 0.189 | 4.400 | 0.628 | -85.500 | 0.944 | 9.447 |
| 3.0 | 0.311 | -174.900 | 1.471 | 25.900 | 0.196 | -4.300 | 0.586 | -96.200 | 1.102 | 6.805 |
| 4.0 | 0.270 | 124.900 | 1.252 | -5.200 | 0.226 | -11.500 | 0.520 | -118.800 | 1.207 | 4.685 |

VCE = 3.0 V, IC = 10 mA

| | | | | | | | | | | |
|-----|-------|----------|--------|---------|-------|---------|-------|----------|-------|--------|
| 0.1 | 0.759 | -22.200 | 22.471 | 157.900 | 0.018 | 81.900 | 0.906 | -15.600 | 0.205 | 30.963 |
| 0.4 | 0.451 | -68.600 | 13.915 | 114.600 | 0.047 | 62.800 | 0.646 | -40.900 | 0.597 | 24.714 |
| 0.8 | 0.249 | -101.700 | 8.120 | 88.400 | 0.068 | 51.600 | 0.472 | -51.300 | 0.890 | 20.770 |
| 1.0 | 0.184 | -116.600 | 6.664 | 79.400 | 0.079 | 50.400 | 0.435 | -55.200 | 0.965 | 19.261 |
| 1.5 | 0.111 | -153.200 | 4.559 | 61.500 | 0.114 | 45.400 | 0.398 | -63.600 | 1.024 | 15.071 |
| 2.0 | 0.080 | 169.100 | 3.474 | 46.300 | 0.143 | 39.500 | 0.382 | -73.500 | 1.072 | 12.212 |
| 2.5 | 0.078 | 130.600 | 2.832 | 31.700 | 0.172 | 30.800 | 0.372 | -80.700 | 1.094 | 10.294 |
| 3.0 | 0.084 | 95.900 | 2.402 | 18.900 | 0.203 | 21.100 | 0.367 | -90.700 | 1.100 | 8.809 |
| 4.0 | 0.149 | 68.500 | 1.921 | -6.500 | 0.268 | 2.500 | 0.311 | -112.900 | 1.080 | 6.829 |
| 5.0 | 0.282 | 46.400 | 1.635 | -32.300 | 0.322 | -17.000 | 0.208 | -155.700 | 1.070 | 5.438 |

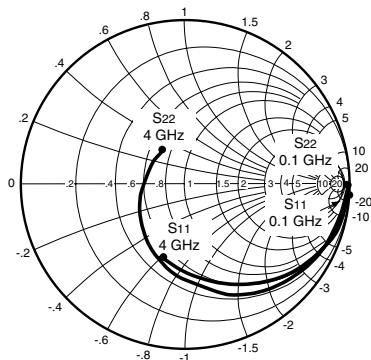
Note: 1. Gain Calculations:

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

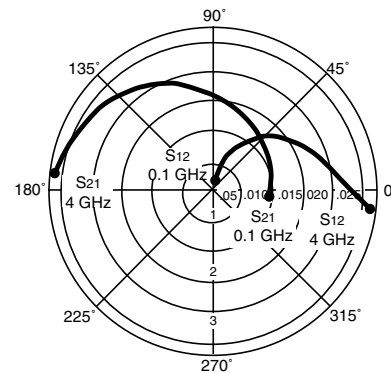
. When $K \leq 1$, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12}| |S_{21}|}$, $\Delta = S_{11} S_{22} - S_{21} S_{12}$

NE685 SERIES

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2.5 V, I_c = 1 mA)



NE68519

V_{CE} = 0.5 V, I_c = 0.5 mA

| FREQUENCY GHz | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | | K | MAG ¹ (dB) |
|------------------|-----------------|----------|-----------------|---------|-----------------|---------|-----------------|---------|-------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 0.1 | 0.983 | -7.500 | 1.790 | 169.200 | 0.034 | 85.200 | 0.999 | -6.200 | 0.064 | 17.214 |
| 0.4 | 0.944 | -31.700 | 1.711 | 146.200 | 0.117 | 66.600 | 0.967 | -22.300 | 0.169 | 11.651 |
| 0.8 | 0.838 | -59.400 | 1.539 | 116.800 | 0.194 | 44.600 | 0.884 | -41.400 | 0.359 | 8.994 |
| 1.0 | 0.779 | -71.400 | 1.444 | 104.200 | 0.221 | 35.800 | 0.844 | -49.300 | 0.443 | 8.152 |
| 1.5 | 0.646 | -98.900 | 1.254 | 77.100 | 0.264 | 17.600 | 0.757 | -64.300 | 0.644 | 6.767 |
| 2.0 | 0.531 | -123.400 | 1.125 | 54.600 | 0.290 | 3.700 | 0.686 | -77.100 | 0.816 | 5.888 |
| 2.5 | 0.438 | -149.700 | 1.041 | 33.900 | 0.289 | -6.300 | 0.622 | -87.200 | 1.000 | 5.533 |
| 3.0 | 0.371 | 178.600 | 0.972 | 16.200 | 0.293 | -16.600 | 0.568 | -98.700 | 1.132 | 2.997 |

V_{CE} = 1.0 V, I_c = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|---------|-------|----------|-------|--------|
| 0.1 | 0.974 | -7.900 | 3.439 | 169.200 | 0.024 | 81.200 | 0.998 | -5.000 | 0.156 | 21.562 |
| 0.4 | 0.905 | -35.600 | 3.225 | 144.300 | 0.087 | 63.200 | 0.943 | -24.600 | 0.210 | 15.690 |
| 0.8 | 0.757 | -65.100 | 2.742 | 115.500 | 0.150 | 46.000 | 0.829 | -44.700 | 0.354 | 12.620 |
| 1.0 | 0.687 | -77.600 | 2.500 | 103.600 | 0.167 | 36.900 | 0.775 | -52.100 | 0.459 | 11.752 |
| 1.5 | 0.536 | -104.500 | 2.026 | 78.200 | 0.198 | 22.500 | 0.674 | -65.600 | 0.680 | 10.100 |
| 2.0 | 0.417 | -127.700 | 1.711 | 57.400 | 0.216 | 13.000 | 0.607 | -76.000 | 0.873 | 8.988 |
| 2.5 | 0.322 | -155.300 | 1.511 | 38.400 | 0.228 | 5.000 | 0.546 | -84.000 | 1.047 | 6.892 |
| 3.0 | 0.254 | 172.200 | 1.367 | 21.800 | 0.252 | -0.500 | 0.496 | -94.000 | 1.127 | 5.176 |
| 4.0 | 0.280 | 104.200 | 1.171 | -9.300 | 0.283 | -11.200 | 0.387 | -120.900 | 1.240 | 3.217 |

V_{CE} = 2.5 V, I_c = 1.0 mA

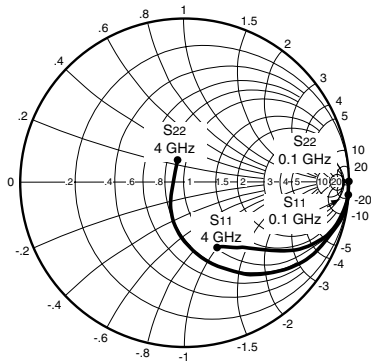
| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|--------|-------|----------|-------|--------|
| 0.1 | 0.983 | -9.100 | 3.424 | 169.500 | 0.020 | 83.400 | 0.996 | -6.000 | 0.070 | 22.335 |
| 0.4 | 0.913 | -31.900 | 3.197 | 147.200 | 0.078 | 66.500 | 0.961 | -21.800 | 0.190 | 16.126 |
| 0.8 | 0.784 | -59.700 | 2.774 | 119.400 | 0.127 | 48.500 | 0.864 | -39.700 | 0.347 | 13.393 |
| 1.0 | 0.714 | -71.600 | 2.548 | 107.600 | 0.144 | 39.600 | 0.818 | -46.700 | 0.450 | 12.478 |
| 1.5 | 0.566 | -97.300 | 2.102 | 82.700 | 0.173 | 25.900 | 0.727 | -59.900 | 0.653 | 10.846 |
| 2.0 | 0.448 | -119.900 | 1.783 | 62.000 | 0.190 | 17.100 | 0.659 | -69.500 | 0.844 | 9.724 |
| 2.5 | 0.346 | -142.800 | 1.564 | 43.800 | 0.201 | 10.000 | 0.609 | -77.700 | 1.022 | 7.997 |
| 3.0 | 0.272 | -169.700 | 1.425 | 27.300 | 0.217 | 4.500 | 0.564 | -86.900 | 1.127 | 6.005 |
| 4.0 | 0.242 | 121.300 | 1.229 | -3.600 | 0.258 | -5.400 | 0.465 | -110.900 | 1.216 | 3.974 |

V_{CE} = 3.0 V, I_c = 10 mA

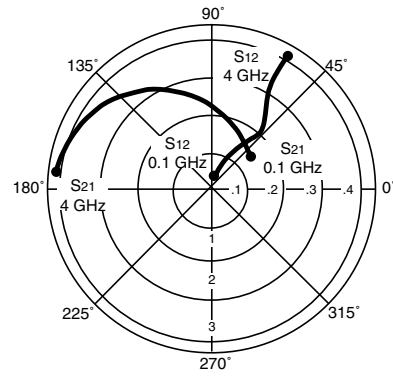
| | | | | | | | | | | |
|-----|-------|----------|--------|---------|-------|---------|-------|----------|-------|--------|
| 0.1 | 0.768 | -24.000 | 22.184 | 155.700 | 0.020 | 73.100 | 0.903 | -17.800 | 0.300 | 30.450 |
| 0.4 | 0.433 | -70.300 | 12.973 | 112.600 | 0.048 | 61.600 | 0.612 | -41.800 | 0.645 | 24.318 |
| 0.8 | 0.234 | -98.400 | 7.396 | 87.200 | 0.076 | 55.200 | 0.451 | -49.200 | 0.915 | 19.882 |
| 1.0 | 0.183 | -107.300 | 6.039 | 78.700 | 0.089 | 53.500 | 0.424 | -51.300 | 0.979 | 18.316 |
| 1.5 | 0.103 | -121.300 | 4.147 | 61.400 | 0.126 | 47.300 | 0.399 | -56.300 | 1.046 | 13.865 |
| 2.0 | 0.056 | -130.100 | 3.169 | 46.700 | 0.161 | 40.900 | 0.388 | -62.200 | 1.081 | 11.202 |
| 2.5 | 0.011 | -162.800 | 2.593 | 33.400 | 0.198 | 33.300 | 0.382 | -68.200 | 1.086 | 9.379 |
| 3.0 | 0.022 | 82.000 | 2.234 | 20.700 | 0.234 | 24.600 | 0.357 | -76.700 | 1.090 | 7.974 |
| 4.0 | 0.129 | 68.400 | 1.809 | -4.400 | 0.306 | 6.100 | 0.260 | -102.000 | 1.078 | 6.017 |
| 5.0 | 0.249 | 49.800 | 1.548 | -29.200 | 0.375 | -14.000 | 0.164 | -146.600 | 1.052 | 4.760 |

See note on previous page.

TYPICAL SCATTERING PARAMETERS (TA = 25°C)



Coordinates in Ohms
Frequency in GHz
(VCE = 2.5 V, IC = 1 mA)



NE68530

VCE = 0.5 V, IC = 0.5 mA

| FREQUENCY GHz | S11 | | S21 | | S12 | | S22 | | K | MAG ¹ (dB) |
|------------------|-------|----------|-------|---------|-------|--------|-------|---------|-------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 0.1 | 0.986 | -6.400 | 1.839 | 171.000 | 0.030 | 84.600 | 0.997 | -4.000 | 0.098 | 17.875 |
| 0.4 | 0.938 | -24.300 | 1.763 | 152.600 | 0.121 | 72.200 | 0.963 | -15.800 | 0.207 | 11.635 |
| 0.8 | 0.821 | -47.300 | 1.612 | 128.100 | 0.213 | 57.300 | 0.873 | -29.300 | 0.384 | 8.790 |
| 1.0 | 0.749 | -58.200 | 1.542 | 117.000 | 0.246 | 51.000 | 0.821 | -35.000 | 0.472 | 7.971 |
| 1.5 | 0.581 | -82.800 | 1.356 | 93.900 | 0.298 | 38.700 | 0.695 | -46.100 | 0.685 | 6.580 |
| 2.0 | 0.457 | -106.100 | 1.198 | 76.100 | 0.313 | 30.900 | 0.607 | -54.900 | 0.863 | 5.829 |
| 2.5 | 0.368 | -130.100 | 1.091 | 61.700 | 0.310 | 27.300 | 0.542 | -63.100 | 1.030 | 4.410 |
| 3.0 | 0.323 | -155.200 | 1.007 | 51.400 | 0.302 | 27.500 | 0.501 | -71.000 | 1.162 | 2.791 |

VCE = 1.0 V, IC = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|--------|-------|---------|-------|--------|
| 0.1 | 0.986 | -7.300 | 3.516 | 170.100 | 0.025 | 85.700 | 0.993 | -4.800 | 0.082 | 21.481 |
| 0.4 | 0.900 | -28.100 | 3.231 | 150.600 | 0.098 | 71.400 | 0.939 | -18.100 | 0.220 | 15.181 |
| 0.8 | 0.735 | -52.300 | 2.766 | 126.000 | 0.167 | 58.000 | 0.812 | -32.000 | 0.418 | 12.191 |
| 1.0 | 0.651 | -63.100 | 2.541 | 115.400 | 0.190 | 52.900 | 0.747 | -37.300 | 0.516 | 11.263 |
| 1.5 | 0.463 | -87.200 | 2.070 | 94.800 | 0.228 | 45.400 | 0.609 | -46.400 | 0.741 | 9.580 |
| 2.0 | 0.339 | -109.400 | 1.735 | 79.200 | 0.248 | 42.300 | 0.521 | -52.900 | 0.922 | 8.448 |
| 2.5 | 0.258 | -135.300 | 1.517 | 66.600 | 0.265 | 42.400 | 0.458 | -59.300 | 1.053 | 6.169 |
| 3.0 | 0.219 | -160.300 | 1.358 | 57.100 | 0.285 | 43.800 | 0.419 | -65.400 | 1.131 | 4.582 |
| 4.0 | 0.220 | 149.000 | 1.143 | 41.200 | 0.341 | 46.700 | 0.377 | -79.400 | 1.163 | 2.803 |

VCE = 2.5 V, IC = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|--------|-------|---------|-------|--------|
| 0.1 | 0.975 | -6.900 | 3.412 | 171.000 | 0.022 | 83.700 | 0.990 | -4.700 | 0.106 | 21.906 |
| 0.4 | 0.905 | -26.200 | 3.207 | 151.400 | 0.078 | 72.200 | 0.948 | -16.300 | 0.220 | 16.140 |
| 0.8 | 0.756 | -48.000 | 2.779 | 128.300 | 0.138 | 60.800 | 0.841 | -28.000 | 0.410 | 13.040 |
| 1.0 | 0.682 | -57.100 | 2.569 | 118.500 | 0.156 | 56.100 | 0.792 | -32.300 | 0.506 | 12.166 |
| 1.5 | 0.509 | -75.600 | 2.098 | 100.000 | 0.188 | 51.600 | 0.679 | -38.900 | 0.727 | 10.476 |
| 2.0 | 0.387 | -89.500 | 1.762 | 85.500 | 0.208 | 50.400 | 0.616 | -43.100 | 0.909 | 9.279 |
| 2.5 | 0.289 | -102.100 | 1.550 | 74.500 | 0.223 | 53.100 | 0.577 | -45.600 | 1.042 | 7.169 |
| 3.0 | 0.207 | -114.700 | 1.397 | 65.200 | 0.247 | 55.100 | 0.548 | -47.900 | 1.118 | 5.439 |
| 4.0 | 0.079 | -165.800 | 1.190 | 51.000 | 0.315 | 61.100 | 0.510 | -53.000 | 1.133 | 3.557 |

VCE = 3.0 V, IC = 10 mA

| | | | | | | | | | | |
|-----|-------|---------|--------|---------|-------|--------|-------|---------|-------|--------|
| 0.1 | 0.764 | -21.200 | 20.910 | 154.700 | 0.020 | 82.600 | 0.910 | -15.900 | 0.241 | 30.193 |
| 0.4 | 0.414 | -54.500 | 11.575 | 114.900 | 0.052 | 72.800 | 0.590 | -31.900 | 0.732 | 23.475 |
| 0.8 | 0.224 | -63.500 | 6.493 | 96.100 | 0.091 | 71.000 | 0.457 | -31.300 | 0.946 | 18.534 |
| 1.0 | 0.181 | -63.500 | 5.306 | 90.300 | 0.109 | 70.500 | 0.433 | -30.900 | 0.989 | 16.873 |
| 1.5 | 0.112 | -57.800 | 3.640 | 80.700 | 0.157 | 73.300 | 0.396 | -30.600 | 1.035 | 12.510 |
| 2.0 | 0.090 | -42.600 | 2.805 | 72.600 | 0.202 | 70.700 | 0.389 | -32.300 | 1.054 | 10.009 |
| 2.5 | 0.086 | -27.100 | 2.314 | 66.400 | 0.250 | 69.600 | 0.392 | -34.300 | 1.048 | 8.331 |
| 3.0 | 0.090 | -16.300 | 2.002 | 60.500 | 0.292 | 67.100 | 0.389 | -36.400 | 1.047 | 7.030 |
| 4.0 | 0.098 | 6.000 | 1.619 | 50.800 | 0.379 | 63.200 | 0.374 | -41.800 | 1.033 | 5.200 |
| 5.0 | 0.119 | 48.700 | 1.441 | 42.600 | 0.464 | 57.500 | 0.307 | -49.900 | 1.009 | 4.333 |

Note:

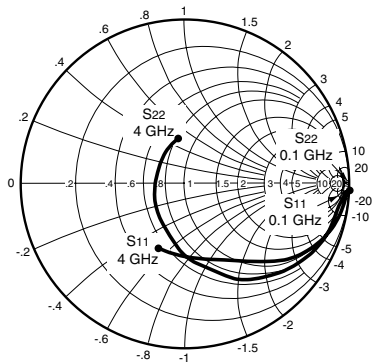
1. Gain Calculation:

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

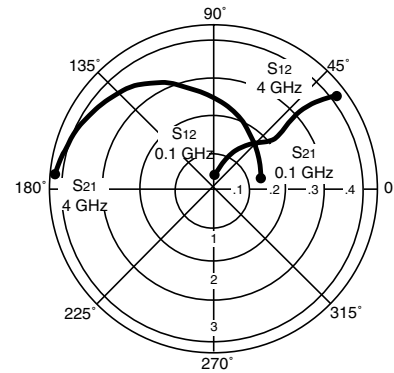
When $K \leq 1$, MAG is undefined and MSG values are used. $MSG = \frac{|S_{21}|}{|S_{12}|}$, $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12}| |S_{21}|}$, $\Delta = S_{11} S_{22} - S_{21} S_{12}$

NE685 SERIES

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)



Coordinates in Ohms
Frequency in GHz
(V_{CE} = 2.5 V, I_C = 1 mA)



NE68533

V_{CE} = 0.5 V, I_C = 0.5 mA

| FREQUENCY GHz | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | | K | MAG ¹ (dB) |
|------------------|-----------------|----------|-----------------|---------|-----------------|--------|-----------------|---------|-------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 0.1 | 0.972 | -5.500 | 1.901 | 170.500 | 0.035 | 85.600 | 0.998 | -5.200 | 0.089 | 17.349 |
| 0.4 | 0.932 | -27.300 | 1.813 | 149.900 | 0.129 | 69.000 | 0.955 | -19.900 | 0.202 | 11.478 |
| 0.8 | 0.803 | -52.500 | 1.670 | 122.400 | 0.222 | 52.000 | 0.856 | -36.200 | 0.396 | 8.764 |
| 1.0 | 0.730 | -63.900 | 1.582 | 110.500 | 0.254 | 45.100 | 0.803 | -42.800 | 0.486 | 7.944 |
| 1.5 | 0.560 | -90.700 | 1.382 | 85.700 | 0.299 | 31.600 | 0.686 | -56.800 | 0.681 | 6.648 |
| 2.0 | 0.434 | -116.300 | 1.218 | 66.500 | 0.310 | 22.800 | 0.604 | -67.900 | 0.855 | 5.943 |
| 2.5 | 0.355 | -143.400 | 1.095 | 51.200 | 0.305 | 17.500 | 0.558 | -77.900 | 1.000 | 5.449 |
| 3.0 | 0.322 | -171.000 | 1.020 | 39.300 | 0.291 | 17.400 | 0.522 | -89.000 | 1.125 | 3.302 |

V_{CE} = 1.0 V, I_C = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|--------|-------|----------|-------|--------|
| 0.1 | 0.968 | -7.000 | 3.509 | 170.100 | 0.029 | 84.200 | 0.995 | -5.800 | 0.103 | 20.828 |
| 0.4 | 0.887 | -31.300 | 3.234 | 147.200 | 0.103 | 68.200 | 0.928 | -21.900 | 0.231 | 14.969 |
| 0.8 | 0.708 | -58.800 | 2.767 | 119.700 | 0.170 | 52.700 | 0.790 | -37.900 | 0.443 | 12.116 |
| 1.0 | 0.618 | -70.000 | 2.533 | 108.800 | 0.192 | 47.400 | 0.727 | -43.700 | 0.544 | 11.203 |
| 1.5 | 0.432 | -96.400 | 2.036 | 86.400 | 0.223 | 39.300 | 0.601 | -55.000 | 0.767 | 9.605 |
| 2.0 | 0.304 | -122.100 | 1.711 | 69.000 | 0.243 | 36.000 | 0.521 | -63.300 | 0.948 | 8.476 |
| 2.5 | 0.233 | -150.700 | 1.482 | 55.100 | 0.260 | 35.300 | 0.473 | -71.100 | 1.071 | 5.929 |
| 3.0 | 0.208 | 178.200 | 1.339 | 43.600 | 0.283 | 36.100 | 0.439 | -79.700 | 1.122 | 4.625 |
| 4.0 | 0.243 | 125.700 | 1.142 | 25.100 | 0.358 | 36.500 | 0.396 | -100.200 | 1.097 | 3.140 |

V_{CE} = 2.5 V, I_C = 1.0 mA

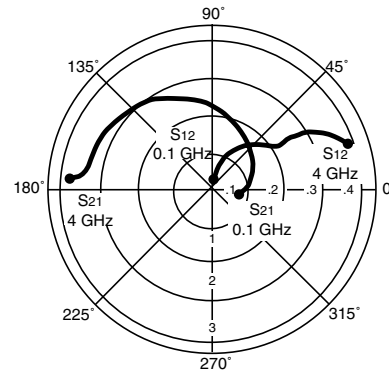
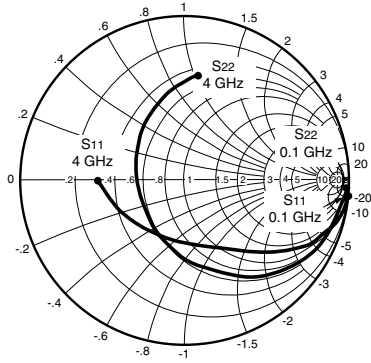
| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|--------|-------|---------|-------|--------|
| 0.1 | 0.965 | -6.600 | 3.502 | 170.700 | 0.024 | 83.800 | 0.997 | -4.900 | 0.112 | 21.641 |
| 0.4 | 0.899 | -28.400 | 3.250 | 149.500 | 0.087 | 70.400 | 0.942 | -18.800 | 0.222 | 15.724 |
| 0.8 | 0.735 | -53.600 | 2.835 | 123.300 | 0.146 | 55.900 | 0.823 | -33.100 | 0.429 | 12.882 |
| 1.0 | 0.647 | -64.000 | 2.618 | 112.700 | 0.166 | 50.800 | 0.767 | -38.300 | 0.529 | 11.979 |
| 1.5 | 0.459 | -88.200 | 2.135 | 90.500 | 0.196 | 43.200 | 0.651 | -48.400 | 0.751 | 10.371 |
| 2.0 | 0.320 | -110.600 | 1.797 | 73.100 | 0.216 | 40.500 | 0.576 | -55.900 | 0.934 | 9.201 |
| 2.5 | 0.233 | -137.000 | 1.559 | 59.000 | 0.234 | 40.400 | 0.531 | -62.900 | 1.053 | 6.834 |
| 3.0 | 0.185 | -167.900 | 1.404 | 47.600 | 0.258 | 41.900 | 0.498 | -70.400 | 1.106 | 5.378 |
| 4.0 | 0.201 | 131.100 | 1.194 | 28.900 | 0.337 | 42.900 | 0.459 | -88.600 | 1.062 | 3.973 |

V_{CE} = 3.0 V, I_C = 10 mA

| | | | | | | | | | | |
|-----|-------|---------|--------|---------|-------|--------|-------|----------|-------|--------|
| 0.1 | 0.719 | -23.600 | 21.206 | 153.800 | 0.020 | 77.800 | 0.909 | -16.700 | 0.289 | 30.254 |
| 0.4 | 0.370 | -58.400 | 11.262 | 112.100 | 0.056 | 68.700 | 0.570 | -34.900 | 0.762 | 23.034 |
| 0.8 | 0.180 | -70.900 | 6.280 | 91.400 | 0.096 | 68.900 | 0.428 | -36.300 | 0.960 | 18.157 |
| 1.0 | 0.130 | -71.700 | 5.142 | 85.100 | 0.117 | 68.400 | 0.400 | -36.900 | 0.994 | 16.429 |
| 1.5 | 0.055 | -66.900 | 3.540 | 72.600 | 0.168 | 65.900 | 0.363 | -40.600 | 1.033 | 12.121 |
| 2.0 | 0.019 | 16.800 | 2.757 | 62.400 | 0.220 | 62.100 | 0.341 | -45.900 | 1.037 | 9.798 |
| 2.5 | 0.045 | 61.700 | 2.272 | 53.100 | 0.270 | 57.600 | 0.324 | -52.500 | 1.038 | 8.062 |
| 3.0 | 0.072 | 68.000 | 1.983 | 45.000 | 0.319 | 52.800 | 0.310 | -60.200 | 1.027 | 6.928 |
| 4.0 | 0.127 | 71.700 | 1.625 | 30.200 | 0.410 | 43.000 | 0.283 | -80.800 | 1.008 | 5.448 |
| 5.0 | 0.197 | 70.300 | 1.421 | 16.400 | 0.493 | 32.800 | 0.244 | -108.000 | 0.993 | 4.597 |

See notes on previous page.

TYPICAL SCATTERING PARAMETERS (TA = 25°C)



Coordinates in Ohms
Frequency in GHz
(VCE = 2.5 V, IC = 1 mA)

NE68539

VCE = 0.5 V, IC = 0.5 mA

| FREQUENCY GHz | S11 | | S21 | | S12 | | S22 | | K | MAG ¹ (dB) |
|------------------|-------|----------|-------|---------|-------|--------|-------|---------|-------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 0.1 | 0.983 | -4.600 | 1.823 | 172.300 | 0.028 | 83.300 | 0.996 | -3.000 | 0.144 | 18.136 |
| 0.4 | 0.949 | -24.900 | 1.773 | 153.300 | 0.111 | 71.600 | 0.977 | -15.000 | 0.194 | 12.034 |
| 0.8 | 0.839 | -49.500 | 1.684 | 129.000 | 0.204 | 56.000 | 0.882 | -29.200 | 0.349 | 9.167 |
| 1.0 | 0.771 | -61.500 | 1.629 | 117.900 | 0.243 | 47.900 | 0.832 | -35.600 | 0.435 | 8.263 |
| 1.5 | 0.599 | -93.900 | 1.483 | 91.400 | 0.299 | 31.300 | 0.687 | -50.600 | 0.624 | 6.955 |
| 2.0 | 0.477 | -126.900 | 1.320 | 69.800 | 0.320 | 18.900 | 0.572 | -63.000 | 0.786 | 6.154 |
| 2.5 | 0.424 | -160.200 | 1.180 | 52.000 | 0.310 | 9.800 | 0.486 | -75.500 | 0.944 | 5.805 |
| 3.0 | 0.425 | 171.800 | 1.042 | 37.100 | 0.294 | 4.300 | 0.430 | -88.700 | 1.107 | 3.506 |

VCE = 1.0 V, IC = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|--------|-------|----------|-------|--------|
| 0.1 | 0.965 | -6.400 | 3.534 | 171.400 | 0.025 | 86.300 | 0.994 | -3.900 | 0.082 | 21.503 |
| 0.4 | 0.906 | -29.000 | 3.355 | 151.200 | 0.088 | 71.600 | 0.951 | -17.600 | 0.186 | 15.812 |
| 0.8 | 0.753 | -56.200 | 3.000 | 126.600 | 0.156 | 55.400 | 0.823 | -32.200 | 0.379 | 12.840 |
| 1.0 | 0.667 | -69.300 | 2.801 | 116.000 | 0.179 | 48.400 | 0.757 | -38.400 | 0.469 | 11.945 |
| 1.5 | 0.478 | -103.100 | 2.346 | 91.800 | 0.217 | 36.900 | 0.600 | -51.500 | 0.674 | 10.339 |
| 2.0 | 0.369 | -138.400 | 1.960 | 73.000 | 0.236 | 28.900 | 0.488 | -62.100 | 0.846 | 9.193 |
| 2.5 | 0.339 | -173.000 | 1.682 | 57.500 | 0.238 | 25.800 | 0.405 | -73.300 | 1.006 | 8.021 |
| 3.0 | 0.359 | 160.600 | 1.457 | 44.300 | 0.247 | 23.100 | 0.349 | -85.900 | 1.119 | 5.613 |
| 4.0 | 0.452 | 126.000 | 1.171 | 22.900 | 0.268 | 23.000 | 0.304 | -117.800 | 1.199 | 3.709 |

VCE = 2.5 V, IC = 1.0 mA

| | | | | | | | | | | |
|-----|-------|----------|-------|---------|-------|--------|-------|---------|-------|--------|
| 0.1 | 0.982 | -4.000 | 3.461 | 173.900 | 0.017 | 84.600 | 0.998 | -2.900 | 0.109 | 23.088 |
| 0.4 | 0.921 | -24.700 | 3.323 | 154.500 | 0.071 | 73.000 | 0.966 | -14.200 | 0.195 | 16.703 |
| 0.8 | 0.775 | -48.800 | 3.034 | 131.200 | 0.125 | 60.000 | 0.875 | -25.800 | 0.363 | 13.851 |
| 1.0 | 0.700 | -60.600 | 2.877 | 121.000 | 0.145 | 53.700 | 0.816 | -30.800 | 0.452 | 12.976 |
| 1.5 | 0.502 | -89.800 | 2.460 | 97.900 | 0.182 | 42.900 | 0.684 | -41.100 | 0.658 | 11.309 |
| 2.0 | 0.364 | -122.500 | 2.089 | 79.200 | 0.197 | 37.100 | 0.583 | -49.700 | 0.834 | 10.255 |
| 2.5 | 0.300 | -157.800 | 1.805 | 64.200 | 0.207 | 33.300 | 0.501 | -58.100 | 0.996 | 9.405 |
| 3.0 | 0.309 | 170.700 | 1.578 | 50.800 | 0.216 | 33.300 | 0.448 | -68.100 | 1.100 | 6.713 |
| 4.0 | 0.401 | 130.100 | 1.274 | 29.000 | 0.249 | 34.000 | 0.386 | -94.100 | 1.146 | 4.768 |

VCE = 3.0 V, IC = 10 mA

| | | | | | | | | | | |
|-----|-------|----------|--------|---------|-------|--------|-------|----------|-------|--------|
| 0.1 | 0.729 | -20.700 | 21.452 | 158.500 | 0.016 | 80.400 | 0.933 | -12.700 | 0.233 | 31.273 |
| 0.4 | 0.417 | -58.000 | 12.831 | 117.900 | 0.044 | 68.700 | 0.639 | -31.100 | 0.689 | 24.648 |
| 0.8 | 0.196 | -81.600 | 7.430 | 96.000 | 0.077 | 67.000 | 0.472 | -33.200 | 0.927 | 19.845 |
| 1.0 | 0.133 | -92.600 | 6.128 | 89.300 | 0.092 | 65.700 | 0.426 | -33.900 | 0.984 | 18.235 |
| 1.5 | 0.060 | -155.000 | 4.250 | 76.100 | 0.133 | 64.000 | 0.357 | -37.400 | 1.033 | 13.938 |
| 2.0 | 0.101 | 144.800 | 3.281 | 65.500 | 0.171 | 61.200 | 0.303 | -44.600 | 1.054 | 11.406 |
| 2.5 | 0.164 | 125.900 | 2.687 | 56.400 | 0.207 | 57.300 | 0.249 | -54.500 | 1.068 | 9.535 |
| 3.0 | 0.230 | 117.000 | 2.295 | 47.600 | 0.246 | 53.400 | 0.208 | -67.800 | 1.055 | 8.262 |
| 4.0 | 0.349 | 104.600 | 1.808 | 31.300 | 0.311 | 44.000 | 0.160 | -112.500 | 1.035 | 6.491 |
| 5.0 | 0.450 | 93.100 | 1.506 | 16.700 | 0.367 | 33.500 | 0.199 | -160.400 | 1.011 | 5.500 |

Note:

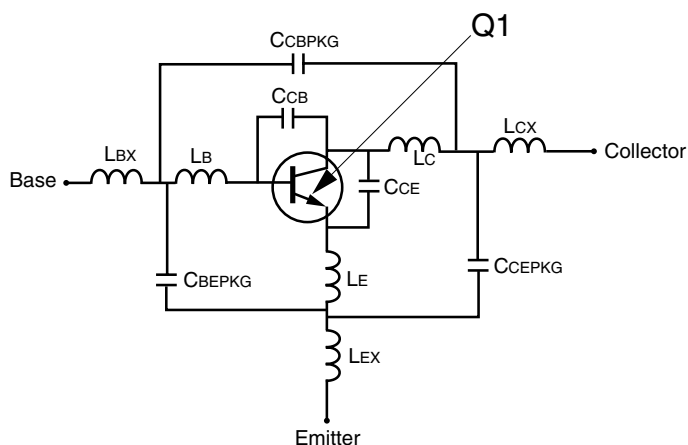
1. Gain Calculation:

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

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

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

| Parameters | Q1 | Parameters | Q1 |
|------------|----------|------------|-------|
| IS | 7e-16 | MJC | 0.34 |
| BF | 109 | XCJC | 0 |
| NF | 1 | CJS | 0 |
| VAF | 15 | VJS | 0.75 |
| IKF | 0.19 | MJS | 0 |
| ISE | 7.9e-13 | FC | 0.5 |
| NE | 2.19 | TF | 2e-12 |
| BR | 1 | XTF | 5.2 |
| NR | 1.08 | VTF | 4.58 |
| VAR | 12.4 | ITF | 0.011 |
| IKR | Infinity | PTF | 0 |
| ISC | 0 | TR | 1e-9 |
| NC | 2 | EG | 1.11 |
| RE | 1.3 | XTB | 0 |
| RB | 10 | XTI | 3 |
| RBM | 8.34 | KF | 0 |
| IRB | 0.009 | AF | 1 |
| RC | 10 | | |
| CJE | 0.4e-12 | | |
| VJE | 0.81 | | |
| MJE | 0.5 | | |
| CJC | 0.18e-12 | | |
| VJC | 0.75 | | |

(1) Gummel-Poon Model

UNITS

| Parameter | Units |
|-------------|---------|
| time | seconds |
| capacitance | farads |
| inductance | henries |
| resistance | ohms |
| voltage | volts |
| current | amps |

ADDITIONAL PARAMETERS

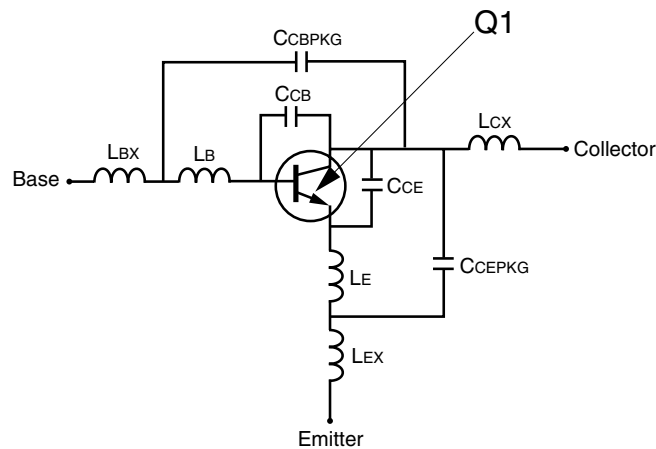
| Parameters | NE68518 |
|------------|-----------|
| CCB | 0.13e-12 |
| CCE | 0.14e-12 |
| LB | 1.55e-9 |
| LC | 1.25e-9 |
| LE | 0.94e-9 |
| CCBPKG | 0.066e-12 |
| CCEPKG | 0.44e-12 |
| CBEPKG | 0.36e-12 |
| LBX | 0.18e-9 |
| LCX | 0.18e-9 |
| LEX | 0.09e-9 |

MODEL RANGE

Frequency: 0.05 to 3.0 GHz
 Bias: V_{CE} = 0.5 V to 3.0 V, I_c = 0.5 mA to 20 mA

NE68519 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

| Parameters | Q1 | Parameters | Q1 |
|------------|----------|------------|---------|
| IS | 7.0e-16 | MJC | 0.34 |
| BF | 109 | XCJC | 0 |
| NF | 1 | CJS | 0 |
| VAF | 15 | VJS | 0.75 |
| IKF | 0.19 | MJS | 0 |
| ISE | 7.90e-13 | FC | 0.5 |
| NE | 2.19 | TF | 2.0e-12 |
| BR | 1 | XTF | 5.2 |
| NR | 1.08 | VTF | 4.58 |
| VAR | 12.4 | ITF | 0.011 |
| IKR | Infinity | PTF | 0 |
| ISC | 0 | TR | 1.0e-9 |
| NC | 2 | EG | 1.11 |
| RE | 1.3 | XTB | 0 |
| RB | 10 | XTI | 3 |
| RBM | 8.34 | KF | 0 |
| IRB | 0.009 | AF | 1 |
| RC | 10 | | |
| CJE | 0.4e-12 | | |
| VJE | 0.81 | | |
| MJE | 0.5 | | |
| CJC | 0.18e-12 | | |
| VJC | 0.75 | | |

(1) Gummel-Poon Model

UNITS

| Parameter | Units |
|-------------|---------|
| time | seconds |
| capacitance | farads |
| inductance | henries |
| resistance | ohms |
| voltage | volts |
| current | amps |

ADDITIONAL PARAMETERS

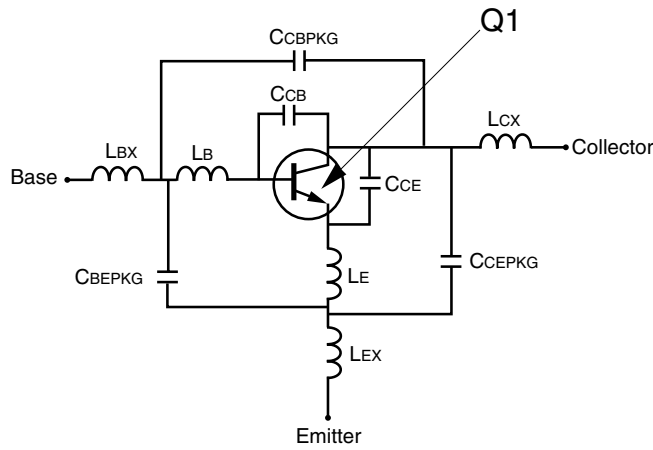
| Parameters | 68519 |
|------------|----------|
| CCB | 0.13e-12 |
| CCE | 0.14e-12 |
| LB | 0.9e-9 |
| LE | 0.9e-9 |
| CCBPKG | 0.17e-12 |
| CCEPKG | 0.21e-12 |
| LBX | 0.19e-9 |
| LCX | 0.19e-9 |
| LEX | 0.19e-9 |

MODEL RANGE

Frequency: 0.05 to 3.0 GHz

Bias: VCE = 0.5 V to 3.0 V, IC = 0.5 mA to 20 mA

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

| Parameters | Q1 | Parameters | Q1 |
|------------|----------|------------|-------|
| IS | 7e-16 | MJC | 0.34 |
| BF | 109 | XCJC | 0 |
| NF | 1 | CJS | 0 |
| VAF | 15 | VJS | 0.75 |
| IKF | 0.19 | MJS | 0 |
| ISE | 7.9e-13 | FC | 0.5 |
| NE | 2.19 | TF | 2e-12 |
| BR | 1 | XTF | 5.2 |
| NR | 1.08 | VTF | 4.58 |
| VAR | 12.4 | ITF | 0.011 |
| IKR | Infinity | PTF | 0 |
| ISC | 0 | TR | 1e-9 |
| NC | 2 | EG | 1.11 |
| RE | 1.3 | XTB | 0 |
| RB | 10 | XTI | 3 |
| RBM | 8.34 | KF | 0 |
| IRB | 0.009 | AF | 1 |
| RC | 10 | | |
| CJE | 0.40e-12 | | |
| VJE | 0.81 | | |
| MJE | 0.5 | | |
| CJC | 0.18e-12 | | |
| VJC | 0.75 | | |

(1) Gummel-Poon Model

UNITS

| Parameter | Units |
|-------------|---------|
| time | seconds |
| capacitance | farads |
| inductance | henries |
| resistance | ohms |
| voltage | volts |
| current | amps |

ADDITIONAL PARAMETERS

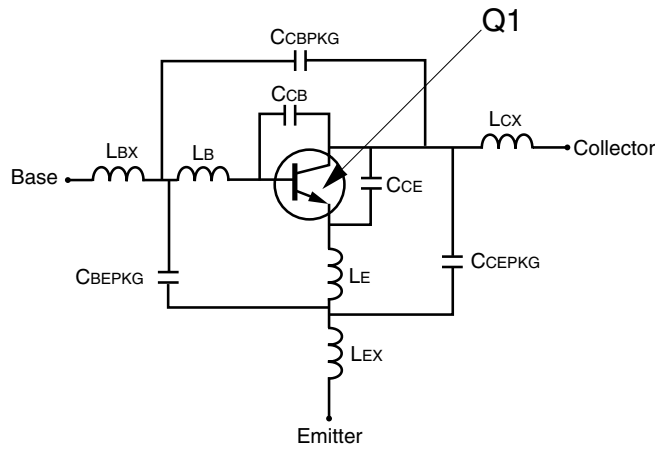
| Parameters | 68530 |
|------------|----------|
| CCB | 0.13e-12 |
| CCE | 0.14e-12 |
| LB | 0.41e-9 |
| LE | 1.43e-9 |
| CCBPKG | 0.12e-12 |
| CCEPKG | 0.04e-12 |
| CBEPKG | 0.04e-12 |
| LBX | 0.2e-9 |
| LCX | 0.2e-9 |
| LEX | 0.2e-9 |

MODEL RANGE

Frequency: 0.05 to 3.0 GHz
 Bias: VCE = 0.5 V to 3 V, Ic = 0.5 mA to 10 mA
 Date: 10/25/96

NE68533 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

| Parameters | Q1 | Parameters | Q1 |
|------------|----------|------------|-------|
| IS | 7e-16 | MJC | 0.34 |
| BF | 109 | XCJC | 0 |
| NF | 1 | CJS | 0 |
| VAF | 15 | VJS | 0.75 |
| IKF | 0.19 | MJS | 0 |
| ISE | 7.9e-13 | FC | 0.5 |
| NE | 2.19 | TF | 2e-12 |
| BR | 1 | XTF | 5.2 |
| NR | 1.08 | VTF | 4.58 |
| VAR | 12.4 | ITF | 0.011 |
| IKR | Infinity | PTF | 0 |
| ISC | 0 | TR | 1e-9 |
| NC | 2 | EG | 1.11 |
| RE | 1.3 | XTB | 0 |
| RB | 10 | XTI | 3 |
| RBM | 8.34 | KF | 0 |
| IRB | 0.009 | AF | 1 |
| RC | 10 | | |
| CJE | 0.40e-12 | | |
| VJE | 0.81 | | |
| MJE | 0.5 | | |
| CJC | 0.18e-12 | | |
| VJC | 0.75 | | |

(1) Gummel-Poon Model

UNITS

| Parameter | Units |
|-------------|---------|
| time | seconds |
| capacitance | farads |
| inductance | henries |
| resistance | ohms |
| voltage | volts |
| current | amps |

ADDITIONAL PARAMETERS

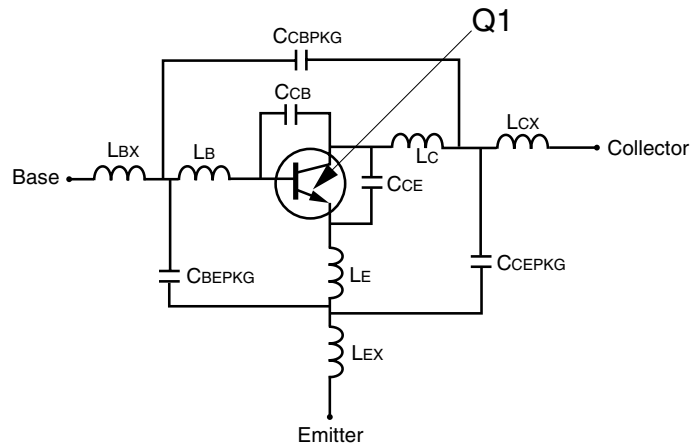
| Parameters | 68533 |
|------------|----------|
| CCB | 0.13e-12 |
| CCE | 0.14e-12 |
| LB | 0.85e-9 |
| LE | 1.15e-9 |
| CCBPKG | 0.15e-12 |
| CCEPKG | 0.1e-12 |
| CBEPKG | 0.05e-12 |
| LBX | 0.3e-9 |
| LCX | 0.3e-9 |
| LEX | 0.3e-9 |

MODEL RANGE

Frequency: 0.05 to 3.0 GHz
 Bias: $V_{CE} = 0.5 \text{ V to } 6 \text{ V}$, $I_c = 0.5 \text{ mA to } 20 \text{ mA}$
 Date: 7/97

NE68539 NONLINEAR MODEL

SCHEMATIC



BJT NONLINEAR MODEL PARAMETERS (1)

| Parameters | Q1 | Parameters | Q1 |
|------------|----------|------------|-------|
| IS | 7e-16 | MJC | 0.34 |
| BF | 109 | XCJC | 0 |
| NF | 1 | CJS | 0 |
| VAF | 15 | VJS | 0.75 |
| IKF | 0.19 | MJS | 0 |
| ISE | 7.9e-13 | FC | 0.5 |
| NE | 2.19 | TF | 2e-12 |
| BR | 1 | XTF | 5.2 |
| NR | 1.08 | VTF | 4.58 |
| VAR | 12.4 | ITF | 0.011 |
| IKR | Infinity | PTF | 0 |
| ISC | 0 | TR | 1e-9 |
| NC | 2 | EG | 1.11 |
| RE | 1.3 | XTB | 0 |
| RB | 10 | XTI | 3 |
| RBM | 8.34 | KF | 0 |
| IRB | 0.009 | AF | 1 |
| RC | 10 | | |
| CJE | 0.4e-12 | | |
| VJE | 0.81 | | |
| MJE | 0.5 | | |
| CJC | 0.18e-12 | | |
| VJC | 0.75 | | |

UNITS

| Parameter | Units |
|-------------|---------|
| time | seconds |
| capacitance | farads |
| inductance | henries |
| resistance | ohms |
| voltage | volts |
| current | amps |

ADDITIONAL PARAMETERS

| Parameters | 68539 |
|------------|----------|
| CCB | 0.13e-12 |
| CCE | 0.14e-12 |
| LB | 1.34e-9 |
| LC | 0.7e-9 |
| LE | 0.99e-9 |
| CCBPKG | 0.08e-12 |
| CCEPKG | 0.08e-12 |
| CBEPKG | 0.01e-12 |
| LBX | 0.39e-9 |
| LCX | 0.39e-9 |
| LEX | 0.2e-9 |

MODEL RANGE

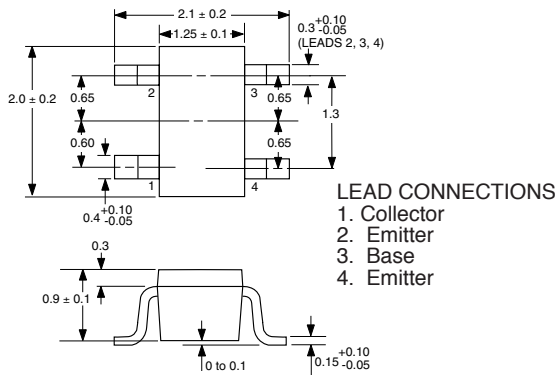
Frequency: 0.05 to 3.0 GHz
 Bias: VCE = 0.5 V to 3.0 V, IC = 0.5 mA to 20 mA
 Date: 6/12/96

(1) Gummel-Poon Model

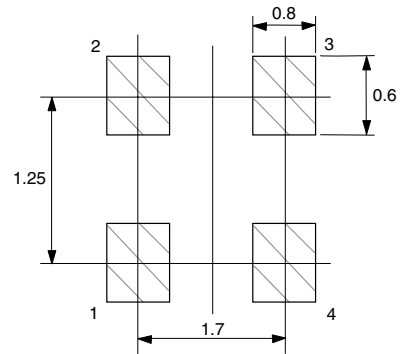
OUTLINE DIMENSIONS¹ (Units in mm)

PACKAGE OUTLINE 18

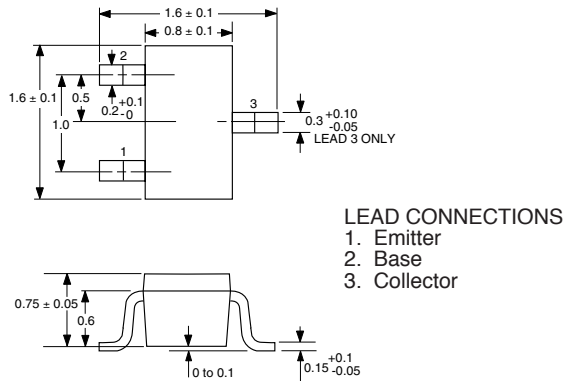
(SOT-343)



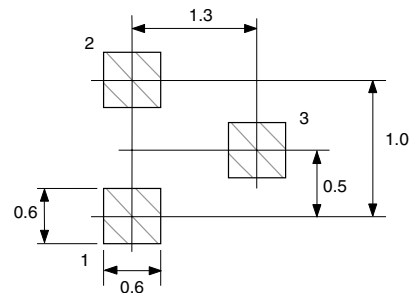
**OUTLINE 18
RECOMMENDED P.C.B. LAYOUT**



PACKAGE OUTLINE 19

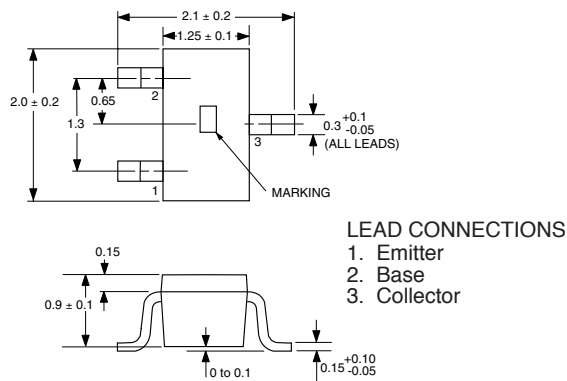


**OUTLINE 19
RECOMMENDED P.C.B. LAYOUT**

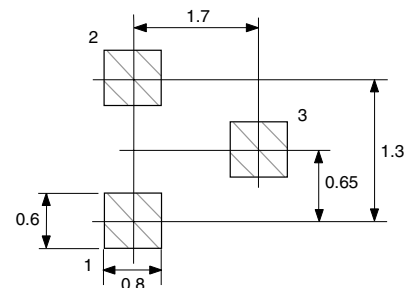


PACKAGE OUTLINE 30

(SOT-323)



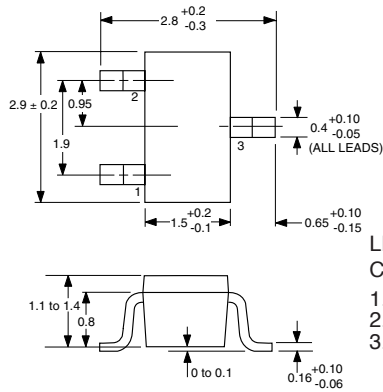
**OUTLINE 30
RECOMMENDED P.C.B. LAYOUT**



NE685 SERIES

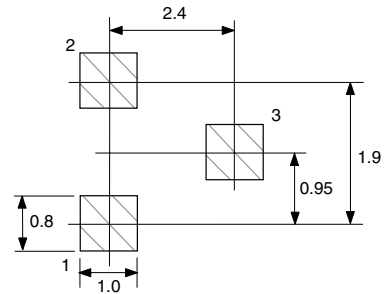
OUTLINE DIMENSIONS¹ (Units in mm)

PACKAGE OUTLINE 33
(SOT-23)

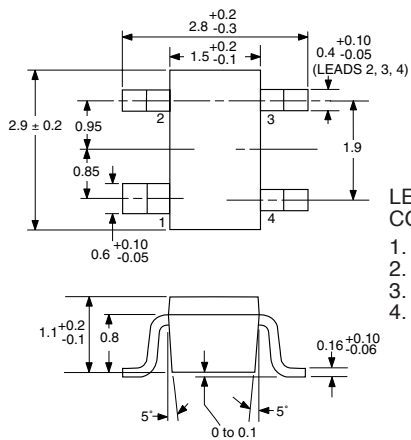


LEAD CONNECTIONS
1. Emitter
2. Base
3. Collector

OUTLINE 33
RECOMMENDED P.C.B. LAYOUT

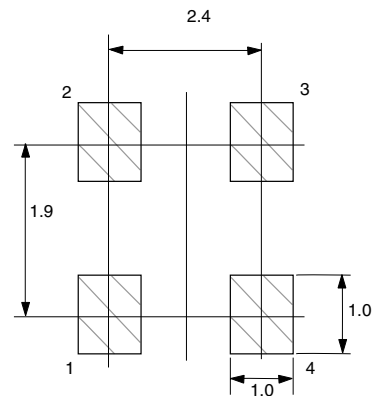


PACKAGE OUTLINE 39
(SOT-143)

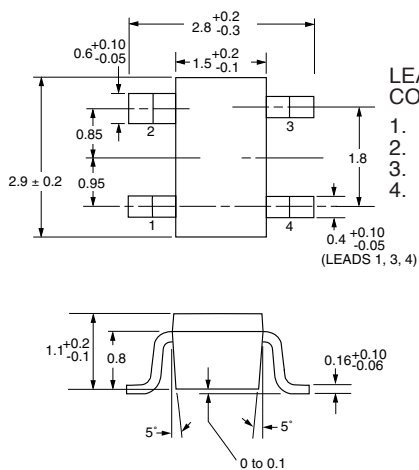


LEAD CONNECTIONS
1. Collector
2. Emitter
3. Base
4. Emitter

OUTLINE 39
RECOMMENDED P.C.B. LAYOUT

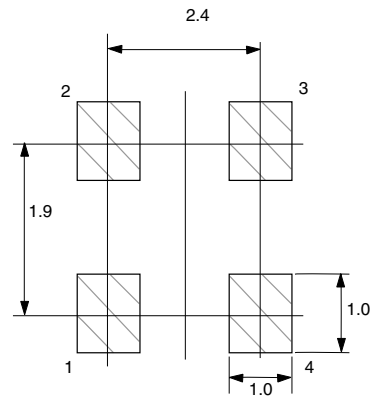


PACKAGE OUTLINE 39R
(SOT-143)



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

OUTLINE 39R
RECOMMENDED P.C.B. LAYOUT



ORDERING INFORMATION

| PART NUMBER | QUANTITY | PACKAGING |
|--------------------|-----------------|------------------|
| NE68518-T1-A | 3000 | Tape & Reel |
| NE68519-T1-A | 3000 | Tape & Reel |
| NE68530-T1-A | 3000 | Tape & Reel |
| NE68533-T1-A | 3000 | Tape & Reel |
| NE68539-T1-A | 3000 | Tape & Reel |
| NE68539R-T1 | 3000 | Tape & Reel |

Note:

1. Lead material: Cu
Lead plating: PbSn

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.

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 | |
|-------------------------------|---|--|-----|
| | | -A | -AZ |
| Lead (Pb) | < 1000 PPM | 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 | |

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