

### 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<sub>A</sub> = 25°C)

| SYMBOLS                        | PARAMETERS AND CONDITIONS  | UNITS | PART NUMBER <sup>1</sup><br>EIAJ <sup>2</sup> REGISTERED NUMBER<br>PACKAGE OUTLINE |     |     | NE68518<br>2SC5015<br>18 |     |      | NE68519<br>2SC5010<br>19 |     |     | NE68530<br>2SC4959<br>30 |      |     | NE68533<br>2SC4955<br>33 |     |     | NE68539/39R<br>2SC4957<br>39 |  |  |
|--------------------------------|--|-------|--|-----|-----|--------------------------|-----|------|--------------------------|-----|-----|--------------------------|------|-----|--------------------------|-----|-----|------------------------------|--|--|
|                                |  |       | MIN  | TYP | MAX | MIN                      | TYP | MAX  | MIN                      | TYP | MAX | MIN                      | TYP  | MAX | MIN                      | TYP | MAX |                              |  |  |
| $f_T$                          | Gain Bandwidth Product at V <sub>CE</sub> = 3V, I <sub>C</sub> = 10 mA, f = 2.0 GHz  | GHz   |  | 12  |     |                          | 12  |      |                          | 12  |     |                          | 12   |     |                          | 12  |     |                              |  |  |
| NF <sub>MIN</sub>              | Minimum Noise Figure at V <sub>CE</sub> = 3 V, I <sub>C</sub> = 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 <sub>CE</sub> = 3V, I <sub>C</sub> = 3 mA, f = 2.0 GHz          | dB    |  | 8.5 |     |                          | 7.5 |      |                          | 7   |     |                          | 7    |     |                          | 7.5 |     |                              |  |  |
| MAG                            | Maximum Available Gain at V <sub>CE</sub> = 3 V, I <sub>C</sub> = 10 mA, f = 2.0 GHz | dB    |  | 12  |     |                          | 11  |      |                          | 10  |     |                          | 10.5 |     |                          | 11  |     |                              |  |  |
| IS <sub>21E</sub> <sup>2</sup> | Insertion Power Gain at V <sub>CE</sub> = 3V, I <sub>C</sub> = 10 mA, f = 2.0 GHz    | dB    | 9  | 11  |     | 7                        | 9   |      | 7                        | 8.5 |     | 7                        | 8    |     | 9                        | 10  |     |                              |  |  |
| h <sub>FE</sub>                | Forward Current Gain <sup>3</sup> at V <sub>CE</sub> = 3 V, I <sub>C</sub> = 10 mA   |       | 75   | 110 | 150 | 75                       | 110 | 150  | 75                       | 110 | 150 | 75                       | 110  | 150 | 75                       | 110 | 150 |                              |  |  |
| I <sub>CBO</sub>               | Collector Cutoff Current at V <sub>CB</sub> = 5 V, I <sub>E</sub> = 0 mA             | μA    |  |     | 0.1 |                          |     | 0.1  |                          |     | 0.1 |                          |      | 0.1 |                          |     | 0.1 |                              |  |  |
| I <sub>EBO</sub>               | Emitter Cutoff Current at V <sub>EB</sub> = 1 V, I <sub>C</sub> = 0 mA               | μA    |  |     | 0.1 |                          |     | 0.1  |                          |     | 0.1 |                          |      | 0.1 |                          |     | 0.1 |                              |  |  |
| CRE <sup>4</sup>               | Feedback Capacitance at V <sub>CB</sub> = 3 V, I <sub>E</sub> = 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 <sub>T</sub>                 | Total Power Dissipation  | mW    |  |     | 150 |                          |     | 125  |                          |     | 150 |                          |      | 180 |                          |     | 180 |                              |  |  |
| R <sub>TH(J-A)</sub>           | Thermal Resistance (Junction to Ambient)   | °C/W  |  |     | 833 |                          |     | 1000 |                          |     | 833 |                          |      | 620 |                          |     | 620 |                              |  |  |
| R <sub>TH(J-C)</sub>           | 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 RATINGS<sup>1</sup> (T<sub>A</sub> = 25°C)

| SYMBOLS          | PARAMETERS                   | UNITS | RATINGS     |
|------------------|------------------------------|-------|-------------|
| V <sub>CBO</sub> | Collector to Base Voltage    | V     | 9           |
| V <sub>CEO</sub> | Collector to Emitter Voltage | V     | 6           |
| V <sub>EBO</sub> | Emitter to Base Voltage      | V     | 2.0         |
| I <sub>C</sub>   | Collector Current            | mA    | 30          |
| T <sub>J</sub>   | Junction Temperature         | °C    | 150         |
| T <sub>STG</sub> | 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<sub>A</sub> = 25°C)

| FREQ.<br>(MHz)                                | NF <sub>OPT</sub><br>(dB) | G <sub>A</sub><br>(dB) | Γ <sub>OPT</sub> |     | Rn/50 |
|---|---------------------------|------------------------|------------------|-----|-------|
|   |                           |                        | MAG              | ANG |       |
| V <sub>CE</sub> = 3 V, I <sub>C</sub> = 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 <sub>CE</sub> = 3 V, I <sub>C</sub> = 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 <sub>CE</sub> = 3 V, I <sub>C</sub> = 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<sub>A</sub> = 25°C)

| FREQ.<br>(MHz)                                   | NF <sub>OPT</sub><br>(dB) | G <sub>A</sub><br>(dB) | Γ <sub>OPT</sub> |     | Rn/50 |
|--|---------------------------|------------------------|------------------|-----|-------|
|  |                           |                        | MAG              | ANG |       |
| V <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 3 V, I <sub>C</sub> = 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 <sub>CE</sub> = 3 V, I <sub>C</sub> = 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<sub>A</sub> = 25°C)

| FREQ.<br>(MHz)                                    | NF <sub>OPT</sub><br>(dB) | G <sub>A</sub><br>(dB) | Γ <sub>OPT</sub> |     | Rn/50 |
|---|---------------------------|------------------------|------------------|-----|-------|
|   |                           |                        | MAG              | ANG |       |
| V <sub>CE</sub> = 0.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 0.75 V, I <sub>C</sub> = 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 <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 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 <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 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 <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 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 <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 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 <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 3 V, I <sub>C</sub> = 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<sub>A</sub> = 25°C)

| FREQ.<br>(MHz)                                   | NF <sub>OPT</sub><br>(dB) | GA<br>(dB) | Γ <sub>OPT</sub> |     | Rn/50 |
|--|---------------------------|------------|------------------|-----|-------|
|  |                           |            | MAG              | ANG |       |
| V <sub>CE</sub> = 0.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 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 <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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  |

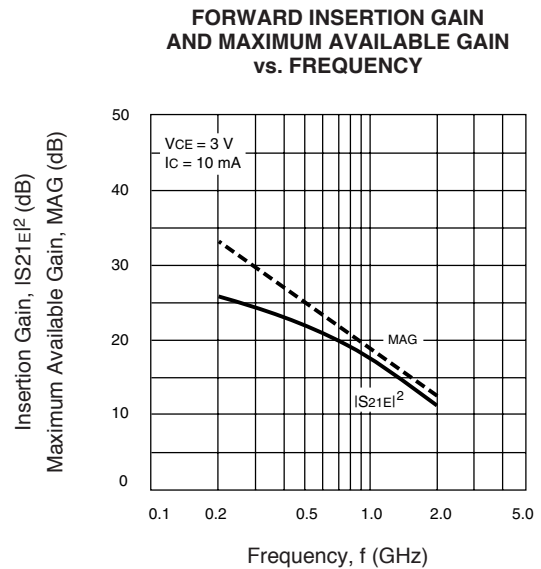
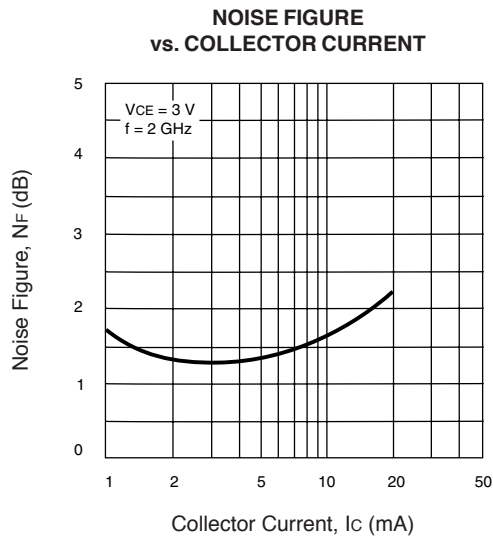
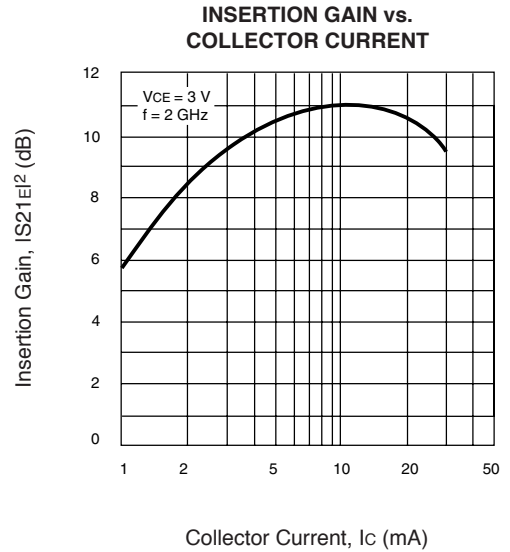
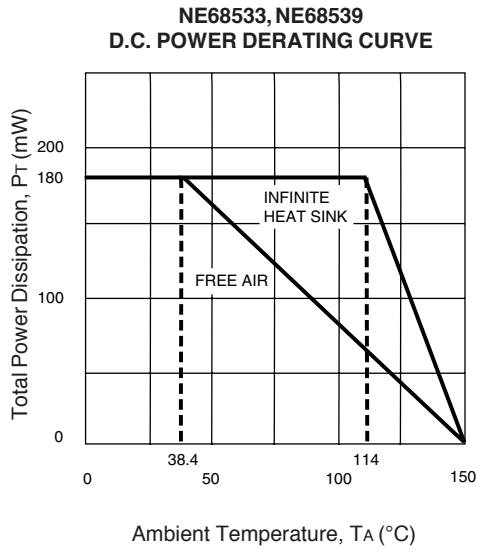
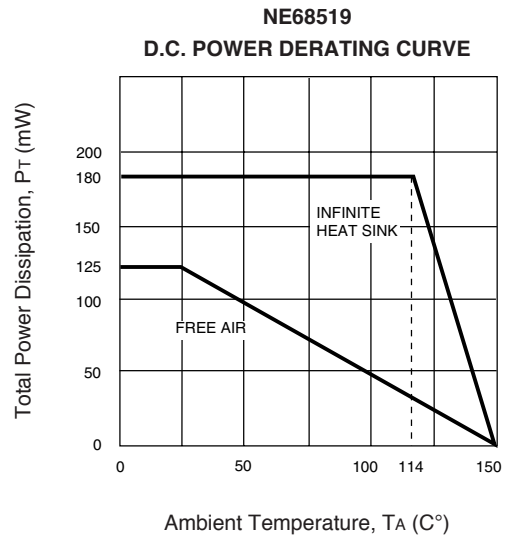
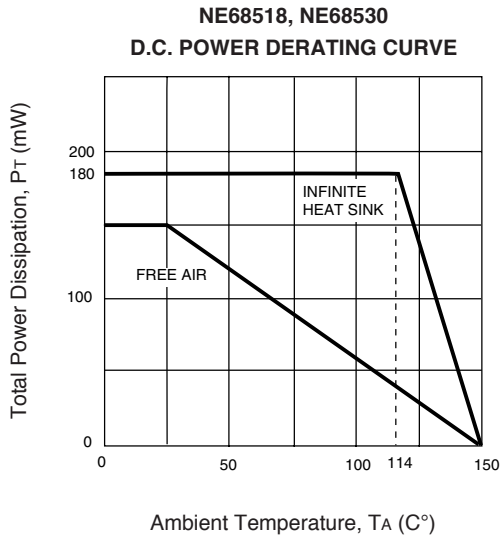
## NE68539

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

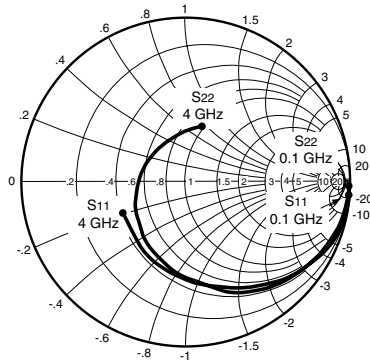
| FREQ.<br>(MHz)                                   | NF <sub>OPT</sub><br>(dB) | GA<br>(dB) | Γ <sub>OPT</sub> |     | Rn/50 |
|--|---------------------------|------------|------------------|-----|-------|
|  |                           |            | MAG              | ANG |       |
| V <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 2.5 V, I <sub>C</sub> = 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 <sub>CE</sub> = 3 V, I <sub>C</sub> = 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

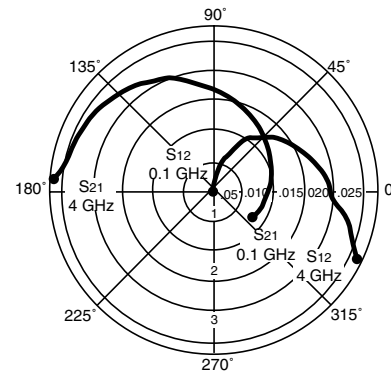
## TYPICAL PERFORMANCE CURVES (TA = 25°C)



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 | S11   |          | S21   |         | S12   |         | S22   |          | K     | MAG <sup>1</sup> |
|-----------|-------|----------|-------|---------|-------|---------|-------|----------|-------|------------------|
| GHz       | MAG   | ANG      | MAG   | ANG     | MAG   | ANG     | MAG   | ANG      |       | (dB)             |
| 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  |

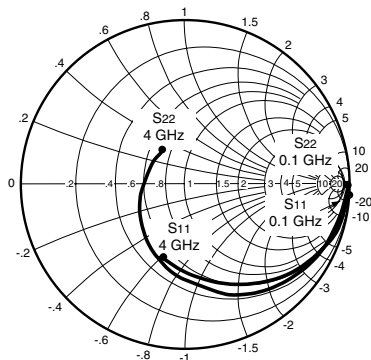
Note: 1. Gain Calculations:

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

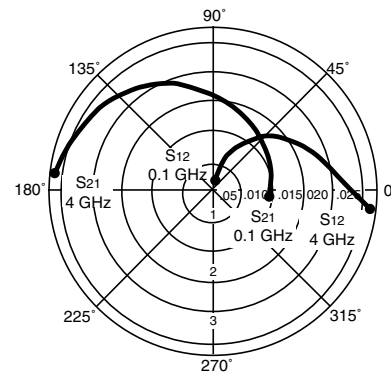
. When  $K \leq 1$ , MAG is undefined and MSG values are used.  $MSG = \frac{|S_{21}|}{|S_{12}|}$ ,  $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12}| |S_{21}|}$ ,  $\Delta = S_{11} S_{22} - S_{21} S_{12}$

# NE685 SERIES

## TYPICAL SCATTERING PARAMETERS (T<sub>A</sub> = 25°C)



Coordinates in Ohms  
Frequency in GHz  
(V<sub>CE</sub> = 2.5 V, I<sub>c</sub> = 1 mA)



### NE68519

V<sub>CE</sub> = 0.5 V, I<sub>c</sub> = 0.5 mA

| FREQUENCY<br>GHz | S <sub>11</sub> |          | S <sub>21</sub> |         | S <sub>12</sub> |         | S <sub>22</sub> |         | K     | MAG <sup>1</sup><br>(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<sub>CE</sub> = 1.0 V, I<sub>c</sub> = 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<sub>CE</sub> = 2.5 V, I<sub>c</sub> = 1.0 mA

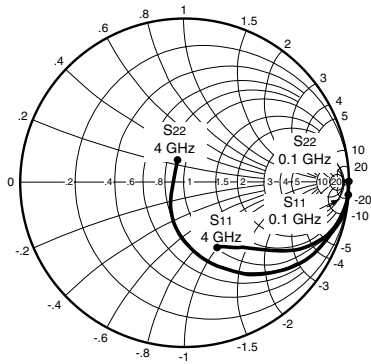
|     |       |          |       |         |       |        |       |          |       |        |
|-----|-------|----------|-------|---------|-------|--------|-------|----------|-------|--------|
| 0.1 | 0.983 | -9.100   | 3.424 | 169.500 | 0.020 | 83.400 | 0.996 | -6.000   | 0.070 | 22.335 |
| 0.4 | 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<sub>CE</sub> = 3.0 V, I<sub>c</sub> = 10 mA

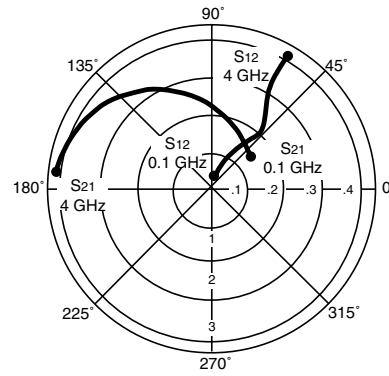
|     |       |          |        |         |       |         |       |          |       |        |
|-----|-------|----------|--------|---------|-------|---------|-------|----------|-------|--------|
| 0.1 | 0.768 | -24.000  | 22.184 | 155.700 | 0.020 | 73.100  | 0.903 | -17.800  | 0.300 | 30.450 |
| 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<br>GHz | S11   |          | S21   |         | S12   |        | S22   |         | K     | MAG <sup>1</sup><br>(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:

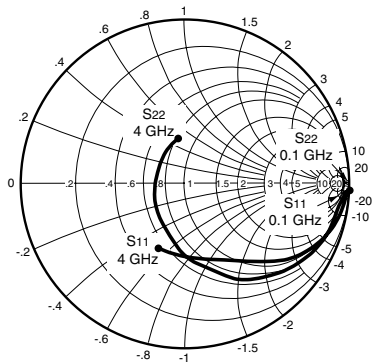
1. Gain Calculation:

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

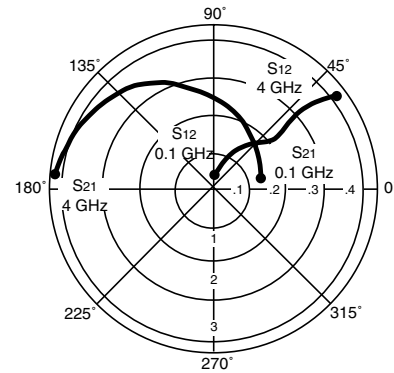
When  $K \leq 1$ , MAG is undefined and MSG values are used.  $MSG = \frac{|S_{21}|}{|S_{12}|}$ ,  $K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12}| |S_{21}|}$ ,  $\Delta = S_{11} S_{22} - S_{21} S_{12}$

# NE685 SERIES

## TYPICAL SCATTERING PARAMETERS (T<sub>A</sub> = 25°C)



Coordinates in Ohms  
Frequency in GHz  
(V<sub>CE</sub> = 2.5 V, I<sub>C</sub> = 1 mA)



### NE68533

V<sub>CE</sub> = 0.5 V, I<sub>C</sub> = 0.5 mA

| FREQUENCY<br>GHz | S <sub>11</sub> |          | S <sub>21</sub> |         | S <sub>12</sub> |        | S <sub>22</sub> |         | K     | MAG <sup>1</sup><br>(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<sub>CE</sub> = 1.0 V, I<sub>C</sub> = 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<sub>CE</sub> = 2.5 V, I<sub>C</sub> = 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  |

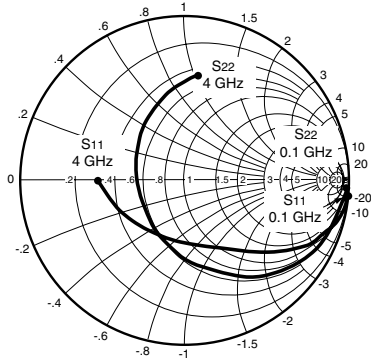
V<sub>CE</sub> = 3.0 V, I<sub>C</sub> = 10 mA

|     |       |         |        |         |       |        |       |          |       |        |
|-----|-------|---------|--------|---------|-------|--------|-------|----------|-------|--------|
| 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  |

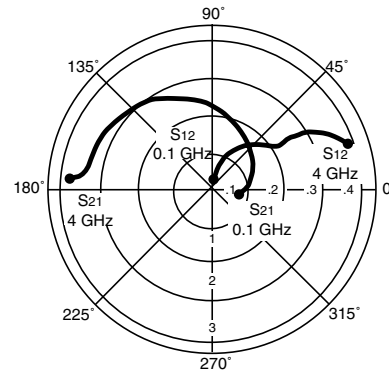
See notes on previous page.



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<br>GHz | S11   |          | S21   |         | S12   |        | S22   |         | K     | MAG <sup>1</sup><br>(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:

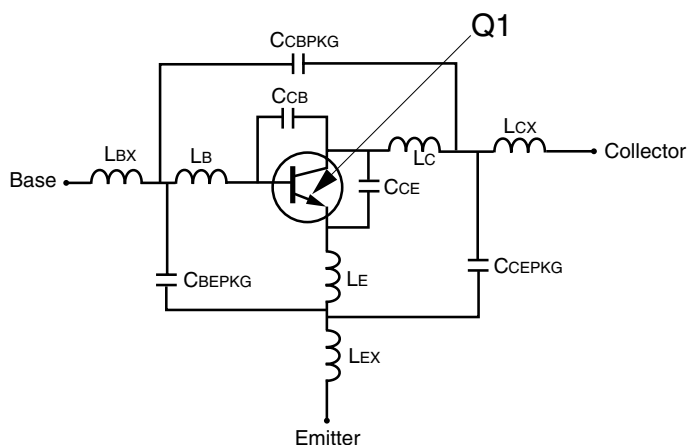
$$MAG = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1})$$

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

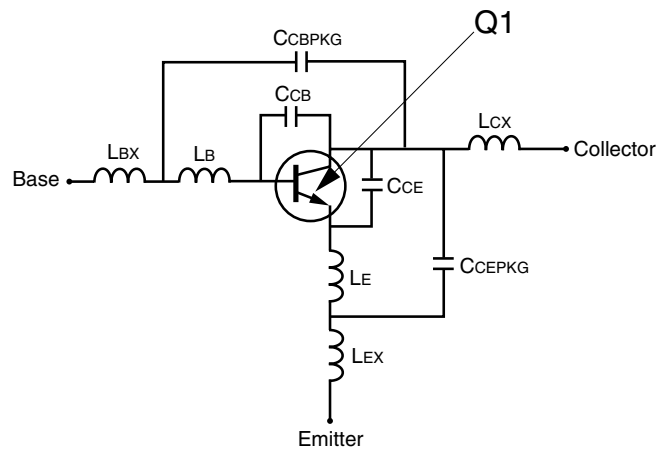
| Parameters | NE68518   |
|------------|-----------|
| CCB        | 0.13e-12  |
| CCE        | 0.14e-12  |
| LB         | 1.55e-9   |
| LC         | 1.25e-9   |
| LE         | 0.94e-9   |
| CCBPKG     | 0.066e-12 |
| CCEPKG     | 0.44e-12  |
| CBEPKG     | 0.36e-12  |
| LBX        | 0.18e-9   |
| LCX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

MODEL RANGE

Frequency: 0.05 to 3.0 GHz  
 Bias: V<sub>CE</sub> = 0.5 V to 3.0 V, I<sub>c</sub> = 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

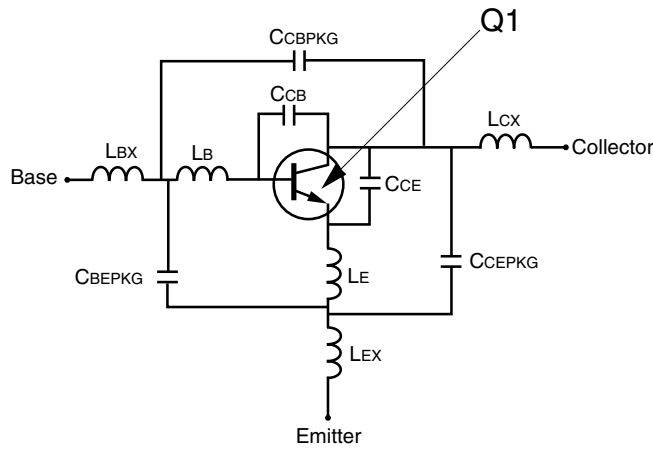
| Parameters | 68519    |
|------------|----------|
| CCB        | 0.13e-12 |
| CCE        | 0.14e-12 |
| LB         | 0.9e-9   |
| LE         | 0.9e-9   |
| CCBPKG     | 0.17e-12 |
| CCEPKG     | 0.21e-12 |
| LBX        | 0.19e-9  |
| LCX        | 0.19e-9  |
| LEX        | 0.19e-9  |

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**

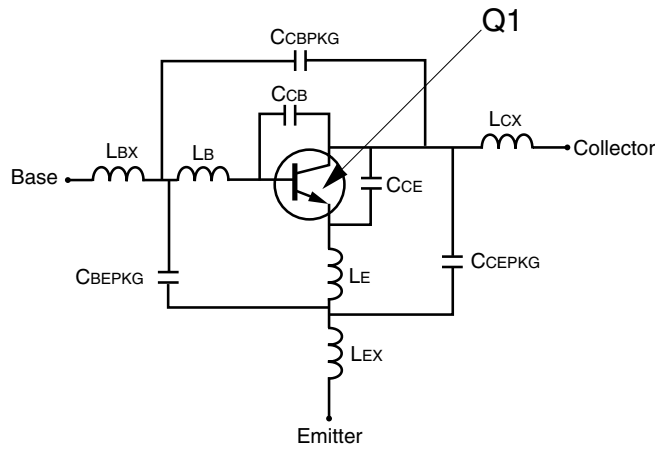
| Parameters | 68530    |
|------------|----------|
| CCB        | 0.13e-12 |
| CCE        | 0.14e-12 |
| LB         | 0.41e-9  |
| LE         | 1.43e-9  |
| CCBPKG     | 0.12e-12 |
| CCEPKG     | 0.04e-12 |
| CBEPKG     | 0.04e-12 |
| LBX        | 0.2e-9   |
| LCX        | 0.2e-9   |
| LEX        |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

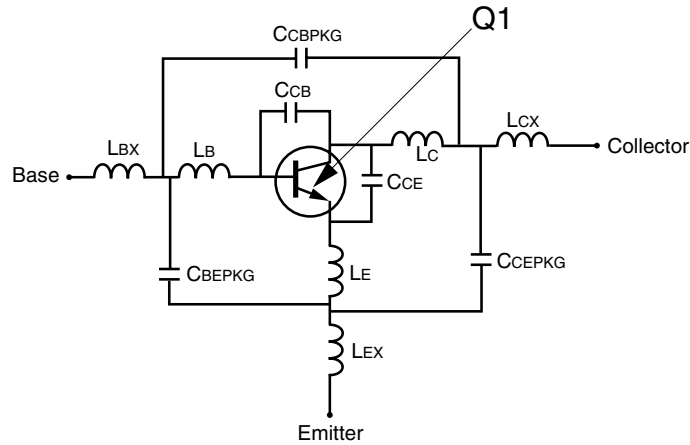
| Parameters | 68533    |
|------------|----------|
| CCB        | 0.13e-12 |
| CCE        | 0.14e-12 |
| LB         | 0.85e-9  |
| LE         | 1.15e-9  |
| CCBPKG     | 0.15e-12 |
| CCEPKG     | 0.1e-12  |
| CBEPKG     | 0.05e-12 |
| LBX        | 0.3e-9   |
| LCX        | 0.3e-9   |
| LEX        |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

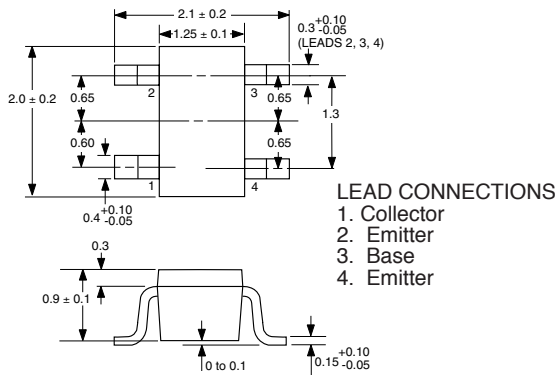
Frequency: 0.05 to 3.0 GHz  
 Bias: VCE = 0.5 V to 3.0 V, IC = 0.5 mA to 20 mA  
 Date: 6/12/96

(1) Gummel-Poon Model

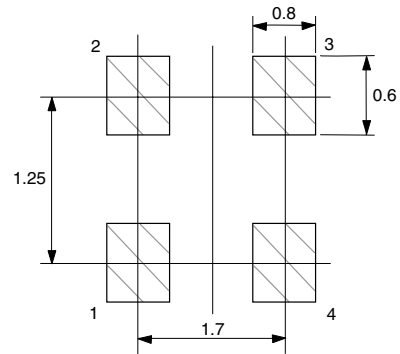
**OUTLINE DIMENSIONS<sup>1</sup>** (Units in mm)

**PACKAGE OUTLINE 18**

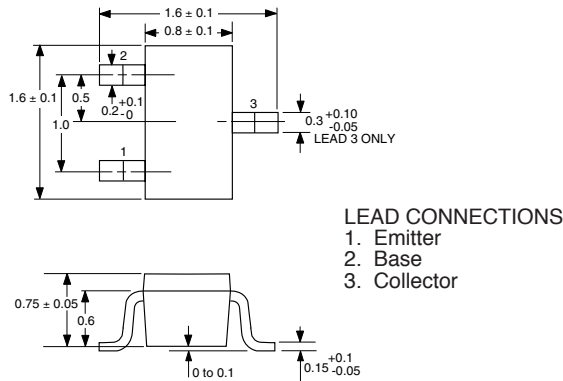
(SOT-343)



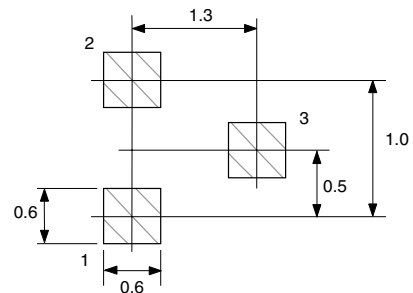
**OUTLINE 18  
RECOMMENDED P.C.B. LAYOUT**



**PACKAGE OUTLINE 19**

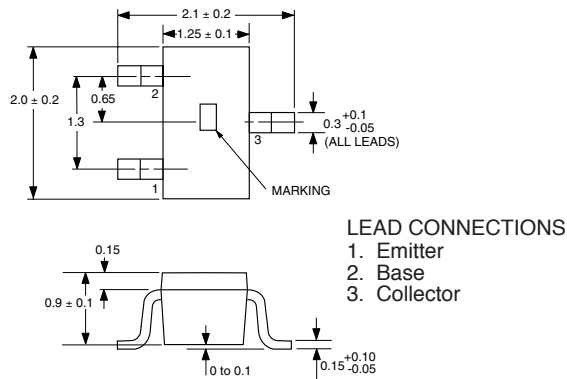


**OUTLINE 19  
RECOMMENDED P.C.B. LAYOUT**

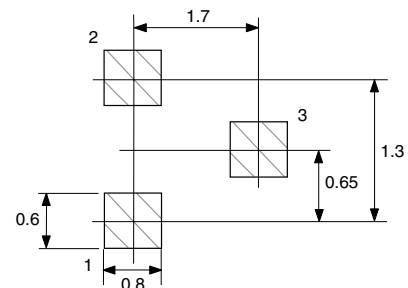


**PACKAGE OUTLINE 30**

(SOT-323)



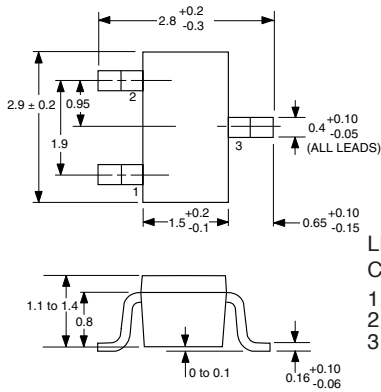
**OUTLINE 30  
RECOMMENDED P.C.B. LAYOUT**



# NE685 SERIES

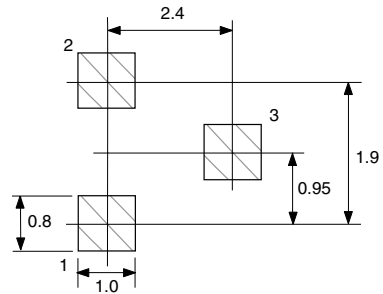
## OUTLINE DIMENSIONS<sup>1</sup> (Units in mm)

**PACKAGE OUTLINE 33**  
(SOT-23)

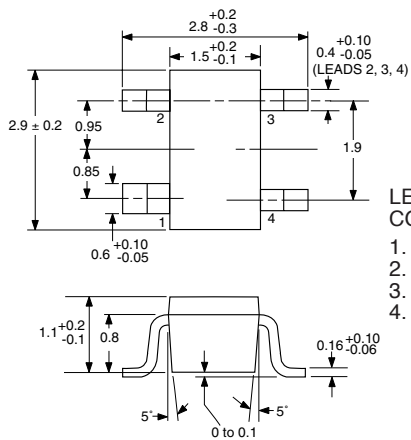


**LEAD CONNECTIONS**  
1. Emitter  
2. Base  
3. Collector

**OUTLINE 33**  
**RECOMMENDED P.C.B. LAYOUT**

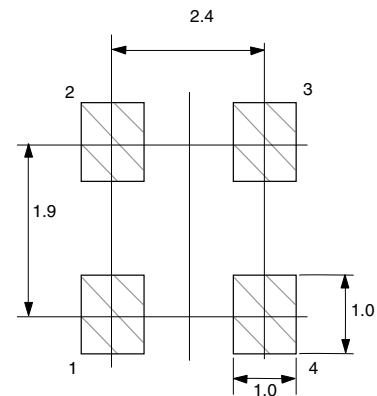


**PACKAGE OUTLINE 39**  
(SOT-143)

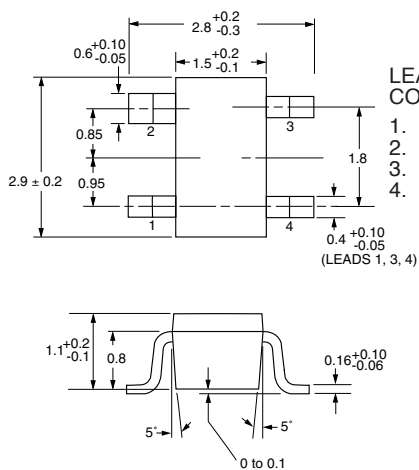


**LEAD CONNECTIONS**  
1. Collector  
2. Emitter  
3. Base  
4. Emitter

**OUTLINE 39**  
**RECOMMENDED P.C.B. LAYOUT**

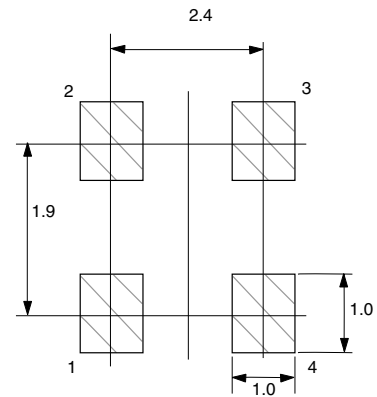


**PACKAGE OUTLINE 39R**  
(SOT-143)



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

**OUTLINE 39R**  
**RECOMMENDED P.C.B. LAYOUT**





**ORDERING INFORMATION**

| <b>PART NUMBER</b> | <b>QUANTITY</b> | <b>PACKAGING</b> |
|--------------------|-----------------|------------------|
| 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.

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

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DATA SUBJECT TO CHANGE WITHOUT NOTICE

Internet: <http://WWW.CEL.COM>

02/24/2002

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                           |     |

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 concerning 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.