Ordering number : ENN7410

NPN Epitaxial Planar Silicon Transistor

# SBFP405D

## UHF to C Band Low Noise Amplifier, Oscillation Applications

## Features

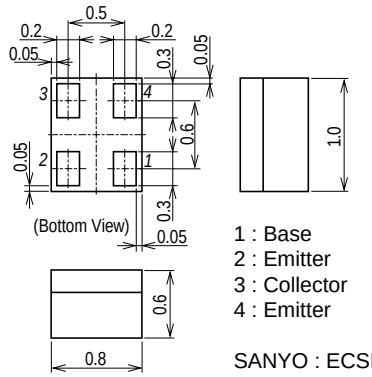
- Low noise : NF=1.25dB typ (f=1.8GHz).
- High cutoff frequency : $f_T$=25GHz typ($V_{CE}$=3V).
- Low voltage operation.
- High gain : $|S21e|^2$=18dB typ (f=1.8GHz).

## Package Dimensions

unit : mm

2215

[SBFP405D-TL]




1 : Base
2 : Emitter
3 : Collector
4 : Emitter

SANYO : ECSP1008-4

## Specifications

### Absolute Maximum Ratings at Ta=25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Collector-to-Base Voltage | $V_{CBO}$ | | 15 | V |
| Collector-to-Emitter Voltage | $V_{CEO}$ | | 4.5 | V |
| Emitter-to-Base Voltage | $V_{EBO}$ | | 1.5 | V |
| Collector Current | $I_C$ | | 12 | mA |
| Collector Dissipation | $P_C$ | | 55 | mW |
| Junction Temperature | Tj | | 150 | °C |
| Storage Temperature | Tstg | | −55 to +150 | °C |

### Electrical Characteristics at Ta=25°C

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Collector Cutoff Current | $I_{CBO}$ | $V_{CB}$=5V, $I_E$=0 | | | 150 | nA |
| Emitter Cutoff Current | $I_{EBO}$ | $V_{EB}$=1.5V, $I_C$=0 | | | 15 | μA |
| DC Current Gain | $h_{FE}$ | $V_{CE}$=4V, $I_C$=5mA | 50 | | 150 | |
| Gain-Bandwidth Product | $f_T$ | $V_{CE}$=3V, $I_C$=10mA | 18 | 25 | | GHz |
| Reverse Transfer Capacitance | Cre | $V_{CB}$=1V, f=1MHz | | 0.13 | 0.23 | pF |
| Forward Transfer Gain | $\|S21e\|^2$ | $V_{CE}$=2V, $I_C$=5mA, f=1.8GHz | 14 | 18 | | dB |
| Noise Figure | NF | $V_{CE}$=2V, $I_C$=2mA, f=1.8GHz | | 1.25 | 1.65 | dB |

Marking : AB




**SANYO Electric Co.,Ltd. Semiconductor Company**

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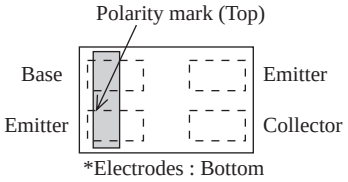
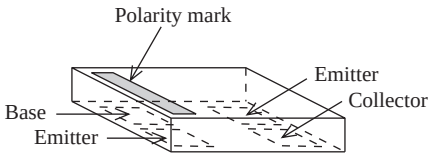
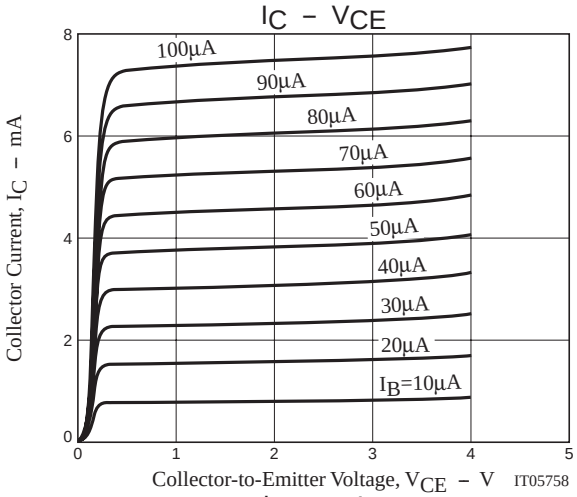
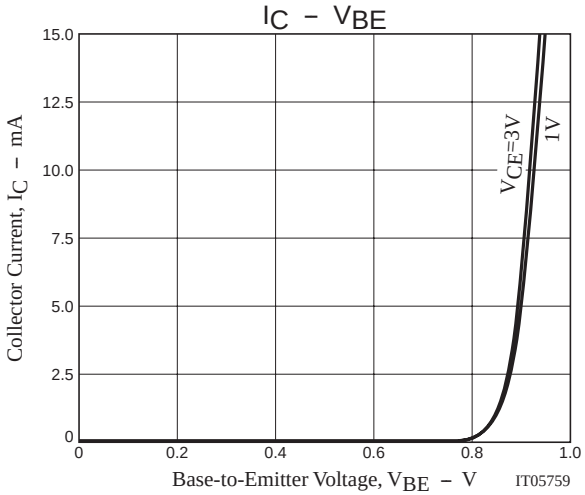
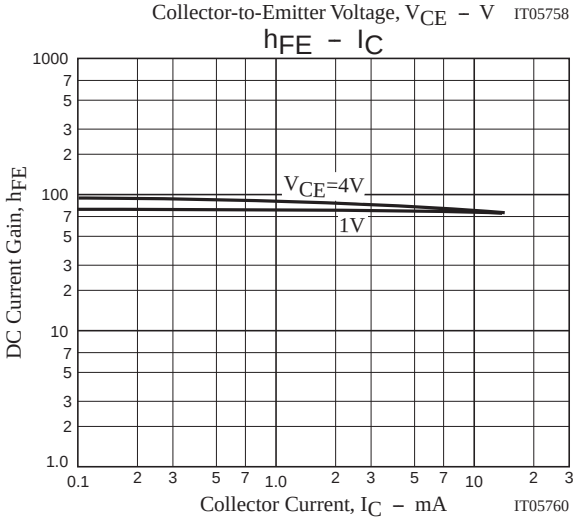
**Electrical Connection** (Top view)

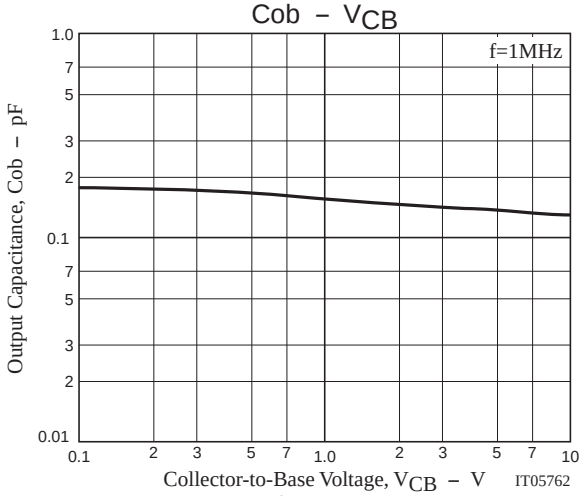


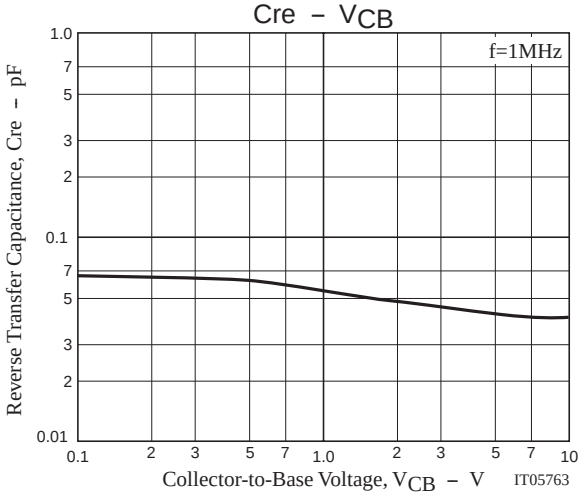



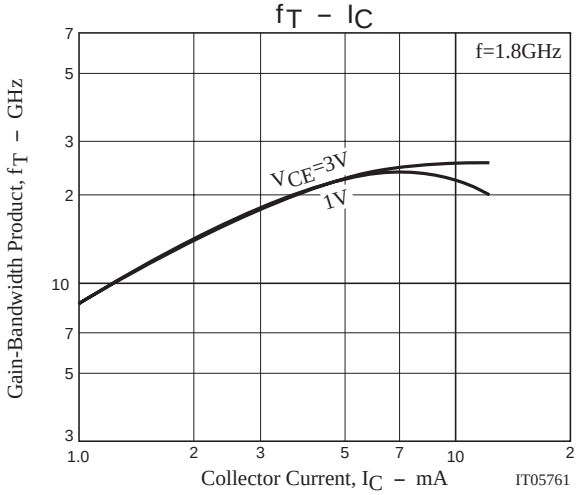



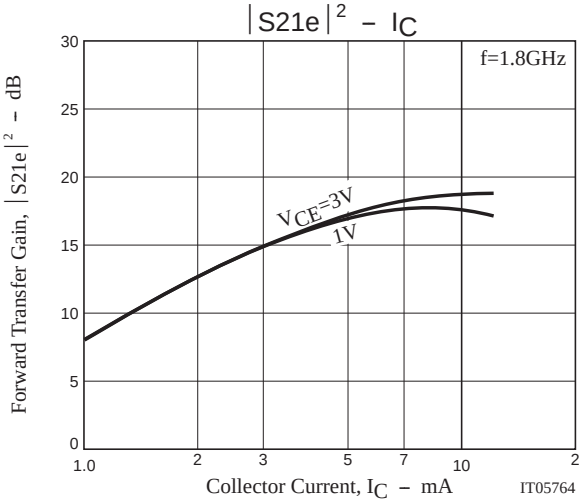



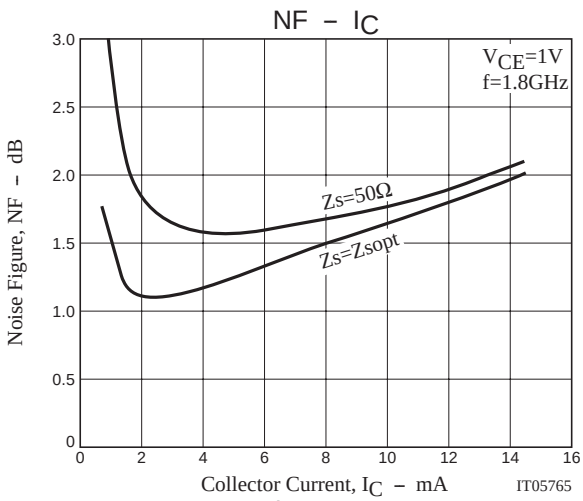



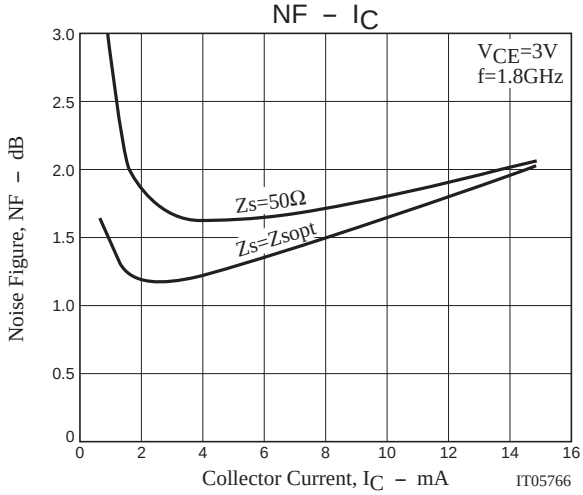



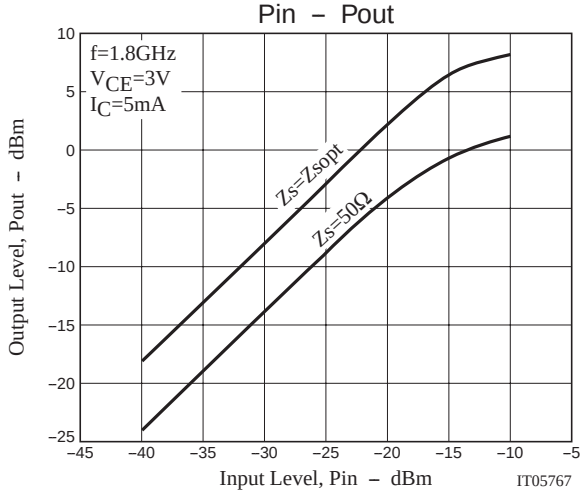



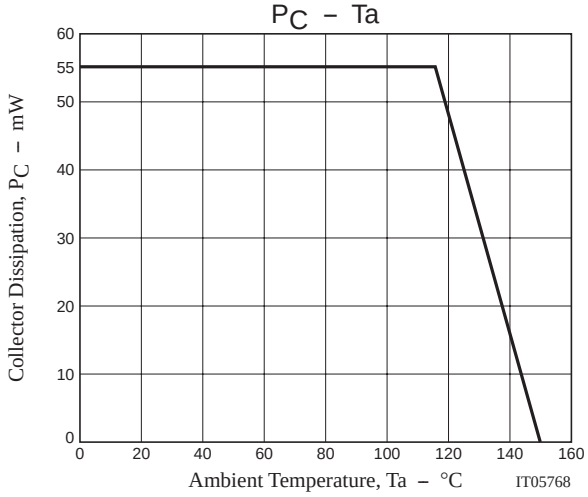




|S21e|² – IC
f=1.8GHz
VCE=3V
1V
Forward Transfer Gain, |S21e|² – dB
Collector Current, IC – mA
IT05764


NF – IC
VCE=1V
f=1.8GHz
Zs=50Ω
Zs=Zsopt
Noise Figure, NF – dB
Collector Current, IC – mA
IT05765


NF – IC
VCE=3V
f=1.8GHz
Zs=50Ω
Zs=Zsopt
Noise Figure, NF – dB
Collector Current, IC – mA
IT05766


Pin – Pout
f=1.8GHz
VCE=3V
IC=5mA
Zs=Zsopt
Zs=50Ω
Output Level, Pout – dBm
Input Level, Pin – dBm
IT05767


PC – Ta
Collector Dissipation, PC – mW
Ambient Temperature, Ta – °C
IT05768

## S Parameters (Common emitter)

$V_{CE}$=1V, $I_C$=1mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.965 | –4.8 | 2.574 | 173.7 | 0.008 | 99.9 | 0.998 | –2.8 |
| 400 | 0.966 | –9.4 | 2.284 | 168.3 | 0.016 | 83.0 | 0.992 | –5.7 |
| 600 | 0.958 | –14.1 | 2.341 | 163.2 | 0.025 | 79.4 | 0.984 | –8.4 |
| 800 | 0.944 | –19.6 | 2.615 | 157.8 | 0.032 | 78.0 | 0.973 | –11.2 |
| 1000 | 0.938 | –22.9 | 2.153 | 151.5 | 0.040 | 76.2 | 0.964 | –13.7 |
| 1200 | 0.917 | –29.4 | 2.609 | 148.4 | 0.047 | 72.7 | 0.948 | –16.2 |
| 1400 | 0.908 | –33.8 | 2.460 | 144.2 | 0.055 | 70.3 | 0.935 | –18.5 |
| 1600 | 0.896 | –37.5 | 2.258 | 139.8 | 0.061 | 66.6 | 0.920 | –21.1 |
| 1800 | 0.865 | –43.9 | 2.510 | 134.5 | 0.068 | 64.5 | 0.899 | –23.1 |
| 2000 | 0.855 | –47.1 | 2.258 | 130.5 | 0.074 | 61.6 | 0.884 | –25.3 |
| 2200 | 0.830 | –53.5 | 2.417 | 127.1 | 0.079 | 59.3 | 0.863 | –27.1 |
| 2400 | 0.808 | –58.4 | 2.397 | 123.1 | 0.085 | 57.4 | 0.848 | –28.7 |
| 2600 | 0.800 | –61.0 | 2.159 | 119.3 | 0.090 | 54.4 | 0.830 | –30.8 |
| 2800 | 0.760 | –67.8 | 2.332 | 114.7 | 0.093 | 52.5 | 0.811 | –32.5 |
| 3000 | 0.753 | –71.1 | 2.171 | 111.8 | 0.098 | 50.5 | 0.797 | –34.0 |
| 3200 | 0.724 | –76.7 | 2.219 | 108.2 | 0.102 | 48.4 | 0.778 | –35.6 |
| 3400 | 0.696 | –81.9 | 2.227 | 104.3 | 0.105 | 46.5 | 0.763 | –36.9 |
| 3600 | 0.687 | –84.5 | 2.069 | 101.2 | 0.109 | 44.4 | 0.749 | –38.6 |
| 3800 | 0.653 | –90.8 | 2.149 | 97.4 | 0.112 | 42.9 | 0.732 | –39.8 |
| 4000 | 0.635 | –95.1 | 2.092 | 94.3 | 0.114 | 41.6 | 0.720 | –40.9 |
| 4200 | 0.616 | –99.2 | 2.031 | 91.2 | 0.117 | 40.1 | 0.706 | –42.3 |
| 4400 | 0.579 | –105.2 | 2.076 | 86.8 | 0.119 | 39.1 | 0.691 | –43.3 |
| 4600 | 0.573 | –108.0 | 1.954 | 84.2 | 0.122 | 37.5 | 0.680 | –44.5 |
| 4800 | 0.545 | –113.8 | 1.975 | 80.7 | 0.123 | 36.6 | 0.668 | –45.8 |
| 5000 | 0.524 | –118.6 | 1.930 | 77.7 | 0.126 | 35.6 | 0.658 | –46.8 |
| 5200 | 0.514 | –122.0 | 1.863 | 75.2 | 0.127 | 34.4 | 0.647 | –48.1 |
| 5400 | 0.488 | –127.1 | 1.859 | 71.8 | 0.128 | 33.3 | 0.635 | –49.3 |
| 5600 | 0.475 | –131.3 | 1.806 | 69.2 | 0.130 | 32.6 | 0.624 | –50.3 |
| 5800 | 0.453 | –136.5 | 1.792 | 66.2 | 0.132 | 31.9 | 0.613 | –51.4 |
| 6000 | 0.438 | –140.9 | 1.755 | 63.3 | 0.134 | 31.2 | 0.606 | –52.4 |

## S Parameters (Common emitter)

$V_{CE}$=1V, $I_C$=3mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.904 | −7.4 | 6.859 | 170.4 | 0.006 | 117.0 | 0.987 | −4.2 |
| 400 | 0.898 | −13.9 | 6.054 | 162.6 | 0.015 | 78.5 | 0.977 | −8.3 |
| 600 | 0.872 | −21.4 | 6.220 | 155.7 | 0.023 | 77.9 | 0.956 | −12.2 |
| 800 | 0.838 | −29.2 | 6.500 | 148.6 | 0.029 | 72.6 | 0.930 | −15.8 |
| 1000 | 0.821 | −33.2 | 5.498 | 141.6 | 0.036 | 70.8 | 0.905 | −19.1 |
| 1200 | 0.765 | −43.6 | 6.278 | 135.6 | 0.041 | 66.7 | 0.873 | −22.0 |
| 1400 | 0.741 | −49.0 | 5.781 | 130.7 | 0.046 | 65.5 | 0.846 | −24.4 |
| 1600 | 0.711 | −55.1 | 5.510 | 125.8 | 0.050 | 62.6 | 0.814 | −27.1 |
| 1800 | 0.656 | −62.8 | 5.556 | 119.5 | 0.055 | 61.2 | 0.785 | −28.7 |
| 2000 | 0.632 | −67.3 | 5.114 | 115.3 | 0.059 | 59.0 | 0.760 | −30.7 |
| 2200 | 0.579 | −75.2 | 5.138 | 109.8 | 0.063 | 58.2 | 0.734 | −32.1 |
| 2400 | 0.549 | −80.4 | 4.873 | 105.8 | 0.067 | 56.9 | 0.713 | −33.3 |
| 2600 | 0.524 | −85.0 | 4.594 | 102.1 | 0.070 | 55.5 | 0.691 | −34.8 |
| 2800 | 0.479 | −91.3 | 4.481 | 97.5 | 0.073 | 54.5 | 0.671 | −35.8 |
| 3000 | 0.460 | −95.5 | 4.225 | 94.3 | 0.077 | 54.2 | 0.654 | −36.9 |
| 3200 | 0.423 | −101.4 | 4.119 | 90.4 | 0.080 | 53.4 | 0.637 | −37.8 |
| 3400 | 0.399 | −106.1 | 3.937 | 87.1 | 0.083 | 52.4 | 0.621 | −38.7 |
| 3600 | 0.380 | −110.5 | 3.763 | 84.1 | 0.086 | 51.5 | 0.609 | −39.7 |
| 3800 | 0.355 | −115.6 | 3.637 | 80.9 | 0.089 | 51.4 | 0.596 | −40.4 |
| 4000 | 0.340 | −120.1 | 3.484 | 78.1 | 0.092 | 51.0 | 0.584 | −41.2 |
| 4200 | 0.320 | −124.9 | 3.358 | 75.2 | 0.096 | 50.3 | 0.574 | −42.0 |
| 4400 | 0.303 | −129.9 | 3.243 | 72.3 | 0.099 | 50.0 | 0.563 | −43.0 |
| 4600 | 0.292 | −134.1 | 3.111 | 69.8 | 0.102 | 49.3 | 0.554 | −43.8 |
| 4800 | 0.277 | −139.2 | 3.013 | 67.1 | 0.106 | 48.7 | 0.544 | −44.7 |
| 5000 | 0.267 | −143.9 | 2.899 | 64.8 | 0.109 | 48.0 | 0.536 | −45.6 |
| 5200 | 0.256 | −148.6 | 2.807 | 62.3 | 0.112 | 47.6 | 0.528 | −46.4 |
| 5400 | 0.246 | −153.4 | 2.721 | 60.0 | 0.115 | 46.6 | 0.521 | −47.3 |
| 5600 | 0.237 | −158.4 | 2.635 | 57.7 | 0.119 | 46.3 | 0.513 | −48.0 |
| 5800 | 0.229 | −163.4 | 2.556 | 55.4 | 0.112 | 45.9 | 0.505 | −49.0 |
| 6000 | 0.224 | −168.4 | 2.479 | 53.1 | 0.126 | 45.1 | 0.499 | −50.0 |

## S Parameters (Common emitter)

$V_{CE}$=1V, $I_C$=5mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.845 | –9.9 | 10.216 | 168.0 | 0.007 | 81.9 | 0.984 | –5.1 |
| 400 | 0.832 | –18.4 | 8.970 | 158.3 | 0.014 | 84.3 | 0.961 | –10.3 |
| 600 | 0.792 | –27.9 | 9.214 | 150.2 | 0.022 | 75.9 | 0.927 | –14.5 |
| 800 | 0.743 | –37.2 | 9.227 | 142.1 | 0.028 | 71.8 | 0.890 | –18.3 |
| 1000 | 0.714 | –42.6 | 7.977 | 135.1 | 0.033 | 69.5 | 0.854 | –21.7 |
| 1200 | 0.637 | –54.2 | 8.507 | 127.2 | 0.037 | 66.8 | 0.815 | –24.2 |
| 1400 | 0.604 | –60.6 | 7.778 | 121.7 | 0.042 | 63.8 | 0.782 | –26.3 |
| 1600 | 0.557 | –68.2 | 7.394 | 115.9 | 0.045 | 63.3 | 0.747 | –28.5 |
| 1800 | 0.506 | –75.1 | 7.048 | 110.1 | 0.049 | 62.3 | 0.719 | –29.8 |
| 2000 | 0.472 | –80.8 | 6.528 | 105.7 | 0.053 | 61.2 | 0.693 | –31.3 |
| 2200 | 0.428 | –87.5 | 6.218 | 100.7 | 0.057 | 60.2 | 0.670 | –32.3 |
| 2400 | 0.400 | –92.6 | 5.816 | 96.9 | 0.060 | 59.7 | 0.649 | –33.4 |
| 2600 | 0.373 | –97.8 | 5.462 | 93.3 | 0.064 | 59.6 | 0.630 | –34.3 |
| 2800 | 0.343 | –103.2 | 5.172 | 89.6 | 0.067 | 58.9 | 0.613 | –35.1 |
| 3000 | 0.322 | –107.8 | 4.870 | 86.6 | 0.070 | 58.9 | 0.599 | –35.9 |
| 3200 | 0.298 | –113.2 | 4.641 | 83.3 | 0.074 | 58.6 | 0.584 | –36.7 |
| 3400 | 0.281 | –118.1 | 4.405 | 80.5 | 0.078 | 57.7 | 0.572 | –37.4 |
| 3600 | 0.265 | –122.8 | 4.189 | 77.8 | 0.081 | 57.5 | 0.561 | –38.2 |
| 3800 | 0.250 | –127.9 | 4.004 | 75.1 | 0.084 | 56.9 | 0.551 | –38.8 |
| 4000 | 0.238 | –132.7 | 3.824 | 72.6 | 0.088 | 56.0 | 0.542 | –39.5 |
| 4200 | 0.255 | –137.8 | 3.664 | 70.0 | 0.093 | 56.0 | 0.532 | –40.3 |
| 4400 | 0.215 | –142.9 | 3.516 | 67.6 | 0.096 | 55.1 | 0.524 | –41.1 |
| 4600 | 0.207 | –147.7 | 3.373 | 65.3 | 0.100 | 54.7 | 0.517 | –41.9 |
| 4800 | 0.199 | –153.1 | 3.247 | 62.9 | 0.104 | 53.8 | 0.509 | –42.9 |
| 5000 | 0.192 | –158.1 | 3.122 | 60.7 | 0.108 | 53.2 | 0.502 | –43.7 |
| 5200 | 0.186 | –163.7 | 3.015 | 58.5 | 0.112 | 52.6 | 0.495 | –44.4 |
| 5400 | 0.181 | –168.9 | 2.910 | 56.4 | 0.116 | 51.9 | 0.488 | –45.2 |
| 5600 | 0.177 | –173.7 | 2.816 | 54.3 | 0.119 | 50.9 | 0.482 | –46.0 |
| 5800 | 0.174 | –179.2 | 2.728 | 52.3 | 0.124 | 50.2 | 0.474 | –46.9 |
| 6000 | 0.171 | 175.5 | 2.640 | 50.2 | 0.127 | 49.4 | 0.469 | –47.9 |

## S Parameters (Common emitter)

$V_{CE}$=1V, $I_C$=7mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.797 | –12.6 | 12.594 | 165.6 | 0.008 | 80.8 | 0.975 | –5.8 |
| 400 | 0.766 | –23.9 | 10.931 | 154.2 | 0.015 | 77.1 | 0.946 | –11.4 |
| 600 | 0.715 | –34.8 | 11.250 | 145.4 | 0.020 | 71.3 | 0.903 | –16.0 |
| 800 | 0.660 | –44.6 | 10.950 | 136.8 | 0.026 | 70.7 | 0.858 | –19.7 |
| 1000 | 0.618 | –52.0 | 9.601 | 129.4 | 0.031 | 67.3 | 0.816 | –22.7 |
| 1200 | 0.539 | –63.0 | 9.676 | 121.1 | 0.035 | 66.8 | 0.775 | –25.0 |
| 1400 | 0.502 | –70.1 | 8.786 | 115.3 | 0.039 | 65.4 | 0.741 | –26.8 |
| 1600 | 0.453 | –77.6 | 8.204 | 109.6 | 0.042 | 64.2 | 0.708 | –28.5 |
| 1800 | 0.411 | –84.0 | 7.639 | 104.4 | 0.046 | 63.1 | 0.681 | –29.6 |
| 2000 | 0.378 | –90.2 | 7.036 | 100.1 | 0.049 | 62.8 | 0.657 | –30.8 |
| 2200 | 0.345 | –96.2 | 6.587 | 95.8 | 0.054 | 62.5 | 0.636 | –31.6 |
| 2400 | 0.320 | –101.4 | 6.125 | 92.2 | 0.056 | 62.7 | 0.618 | –32.5 |
| 2600 | 0.297 | –106.9 | 5.720 | 88.8 | 0.060 | 61.9 | 0.602 | –33.3 |
| 2800 | 0.274 | –112.0 | 5.377 | 85.6 | 0.063 | 62.3 | 0.586 | –34.0 |
| 3000 | 0.257 | –117.3 | 5.047 | 82.7 | 0.068 | 61.9 | 0.573 | –34.7 |
| 3200 | 0.240 | –122.5 | 4.780 | 79.9 | 0.072 | 61.1 | 0.561 | –35.4 |
| 3400 | 0.226 | –127.8 | 4.523 | 77.2 | 0.076 | 61.1 | 0.551 | –36.0 |
| 3600 | 0.214 | –132.9 | 4.298 | 74.7 | 0.079 | 60.4 | 0.541 | –36.8 |
| 3800 | 0.204 | –138.3 | 4.093 | 72.2 | 0.084 | 59.8 | 0.532 | –37.5 |
| 4000 | 0.195 | –143.2 | 3.905 | 69.9 | 0.087 | 59.4 | 0.524 | –38.3 |
| 4200 | 0.187 | –148.9 | 3.734 | 67.5 | 0.092 | 58.5 | 0.516 | –38.9 |
| 4400 | 0.179 | –154.2 | 3.578 | 65.2 | 0.095 | 57.8 | 0.509 | –39.8 |
| 4600 | 0.175 | –159.4 | 3.431 | 63.0 | 0.100 | 57.2 | 0.502 | –40.4 |
| 4800 | 0.169 | –165.1 | 3.297 | 60.7 | 0.103 | 56.6 | 0.494 | –41.4 |
| 5000 | 0.166 | –170.3 | 3.169 | 58.8 | 0.108 | 55.6 | 0.489 | –42.2 |
| 5200 | 0.164 | –175.9 | 3.055 | 56.6 | 0.112 | 55.3 | 0.482 | –43.0 |
| 5400 | 0.160 | 178.7 | 2.948 | 54.6 | 0.116 | 54.2 | 0.475 | –43.7 |
| 5600 | 0.159 | 173.7 | 2.852 | 52.6 | 0.120 | 53.3 | 0.470 | –44.6 |
| 5800 | 0.158 | 168.3 | 2.759 | 50.6 | 0.124 | 52.5 | 0.463 | –45.6 |
| 6000 | 0.157 | 163.4 | 2.670 | 48.6 | 0.128 | 51.6 | 0.458 | –46.5 |

## S Parameters (Common emitter)

$V_{CE}$=1V, $I_C$=10mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.706 | –19.6 | 15.145 | 161.4 | 0.008 | 94.0 | 0.963 | –6.7 |
| 400 | 0.649 | –36.5 | 12.907 | 147.4 | 0.014 | 78.8 | 0.920 | –12.9 |
| 600 | 0.588 | –50.2 | 13.039 | 137.1 | 0.019 | 71.1 | 0.862 | –17.4 |
| 800 | 0.529 | –61.0 | 12.097 | 128.0 | 0.024 | 69.6 | 0.810 | –20.7 |
| 1000 | 0.471 | –71.1 | 10.682 | 120.1 | 0.028 | 67.1 | 0.765 | –23.1 |
| 1200 | 0.413 | –80.6 | 10.062 | 112.8 | 0.032 | 66.0 | 0.725 | –24.9 |
| 1400 | 0.379 | –88.6 | 9.033 | 107.0 | 0.036 | 66.0 | 0.693 | –26.1 |
| 1600 | 0.342 | –95.5 | 8.299 | 102.0 | 0.039 | 65.9 | 0.665 | –27.5 |
| 1800 | 0.311 | –101.5 | 7.624 | 97.7 | 0.043 | 65.9 | 0.642 | –28.2 |
| 2000 | 0.287 | –108.4 | 6.979 | 93.7 | 0.046 | 65.3 | 0.621 | –29.2 |
| 2200 | 0.265 | –114.7 | 6.482 | 90.1 | 0.050 | 65.1 | 0.604 | –29.9 |
| 2400 | 0.248 | –120.2 | 6.009 | 86.9 | 0.054 | 64.6 | 0.589 | –30.5 |
| 2600 | 0.233 | –126.1 | 5.590 | 83.9 | 0.057 | 65.3 | 0.576 | –31.2 |
| 2800 | 0.218 | –132.0 | 5.235 | 81.0 | 0.062 | 64.9 | 0.563 | –31.9 |
| 3000 | 0.208 | –137.6 | 4.904 | 78.3 | 0.065 | 65.2 | 0.553 | –32.5 |
| 3200 | 0.198 | –143.4 | 4.631 | 75.8 | 0.069 | 64.2 | 0.542 | –33.3 |
| 3400 | 0.190 | –149.1 | 4.375 | 73.4 | 0.074 | 63.9 | 0.534 | –33.8 |
| 3600 | 0.185 | –154.8 | 4.153 | 71.0 | 0.077 | 63.4 | 0.525 | –34.7 |
| 3800 | 0.179 | –160.6 | 3.949 | 68.7 | 0.082 | 62.7 | 0.518 | –35.4 |
| 4000 | 0.176 | –165.4 | 3.768 | 66.5 | 0.086 | 62.0 | 0.511 | –36.1 |
| 4200 | 0.173 | –171.2 | 3.599 | 64.3 | 0.091 | 61.4 | 0.504 | –36.9 |
| 4400 | 0.170 | –176.5 | 3.442 | 62.1 | 0.095 | 60.8 | 0.498 | –37.8 |
| 4600 | 0.169 | 178.6 | 3.303 | 60.0 | 0.098 | 60.1 | 0.492 | –38.4 |
| 4800 | 0.168 | 173.1 | 3.169 | 57.9 | 0.103 | 59.1 | 0.486 | –39.4 |
| 5000 | 0.168 | 168.4 | 3.049 | 56.0 | 0.107 | 58.2 | 0.480 | –40.2 |
| 5200 | 0.169 | 163.3 | 2.938 | 53.9 | 0.111 | 57.4 | 0.474 | –41.2 |
| 5400 | 0.170 | 158.6 | 2.830 | 52.0 | 0.115 | 56.6 | 0.469 | –42.0 |
| 5600 | 0.172 | 154.8 | 2.739 | 50.1 | 0.120 | 56.0 | 0.464 | –42.9 |
| 5800 | 0.173 | 150.3 | 2.651 | 48.2 | 0.124 | 54.4 | 0.458 | –43.9 |
| 6000 | 0.174 | 146.0 | 2.565 | 46.2 | 0.128 | 53.8 | 0.452 | –44.8 |

## S Parameters (Common emitter)

$V_{CE}$=3V, $I_C$=1mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.970 | –4.3 | 2.491 | 174.5 | 0.007 | 85.4 | 0.998 | –2.1 |
| 400 | 0.968 | –8.4 | 2.216 | 169.5 | 0.013 | 84.3 | 0.994 | –4.4 |
| 600 | 0.961 | –13.0 | 2.270 | 164.7 | 0.019 | 81.0 | 0.989 | –6.7 |
| 800 | 0.947 | –18.1 | 2.556 | 159.6 | 0.024 | 80.4 | 0.983 | –9.0 |
| 1000 | 0.944 | –21.1 | 2.097 | 153.7 | 0.030 | 78.2 | 0.975 | –11.0 |
| 1200 | 0.922 | –27.4 | 2.553 | 150.7 | 0.036 | 75.4 | 0.966 | –13.2 |
| 1400 | 0.917 | –31.5 | 2.420 | 146.7 | 0.043 | 73.0 | 0.955 | –15.2 |
| 1600 | 0.905 | –34.9 | 2.209 | 142.4 | 0.048 | 70.0 | 0.944 | –17.6 |
| 1800 | 0.878 | –40.9 | 2.480 | 137.4 | 0.053 | 68.3 | 0.929 | –19.2 |
| 2000 | 0.868 | –44.0 | 2.226 | 133.5 | 0.057 | 65.8 | 0.916 | –21.2 |
| 2200 | 0.845 | –50.0 | 2.387 | 130.3 | 0.062 | 63.7 | 0.900 | –22.9 |
| 2400 | 0.823 | –54.6 | 2.382 | 126.4 | 0.066 | 61.7 | 0.886 | –24.4 |
| 2600 | 0.818 | –57.0 | 2.129 | 122.7 | 0.070 | 59.4 | 0.872 | –26.1 |
| 2800 | 0.778 | –63.5 | 2.322 | 118.3 | 0.074 | 57.0 | 0.856 | –27.7 |
| 3000 | 0.722 | –66.7 | 2.161 | 115.5 | 0.079 | 55.4 | 0.843 | –29.1 |
| 3200 | 0.743 | –71.9 | 2.205 | 111.9 | 0.081 | 53.3 | 0.828 | –30.6 |
| 3400 | 0.715 | –77.0 | 2.234 | 108.1 | 0.085 | 51.9 | 0.815 | –31.8 |
| 3600 | 0.709 | –79.4 | 2.064 | 105.0 | 0.088 | 49.0 | 0.803 | –33.3 |
| 3800 | 0.673 | –85.6 | 2.155 | 101.4 | 0.089 | 48.4 | 0.788 | –34.5 |
| 4000 | 0.655 | –89.8 | 2.108 | 98.4 | 0.093 | 47.2 | 0.780 | –35.6 |
| 4200 | 0.640 | –93.6 | 2.034 | 95.4 | 0.095 | 45.9 | 0.766 | –36.9 |
| 4400 | 0.599 | –99.3 | 2.095 | 91.1 | 0.096 | 45.4 | 0.754 | –37.8 |
| 4600 | 0.594 | –102.0 | 1.966 | 88.5 | 0.099 | 43.8 | 0.743 | –38.9 |
| 4800 | 0.563 | –107.6 | 1.998 | 85.0 | 0.101 | 42.9 | 0.733 | –40.2 |
| 5000 | 0.540 | –112.1 | 1.964 | 82.2 | 0.103 | 42.1 | 0.724 | –41.0 |
| 5200 | 0.531 | –115.6 | 1.885 | 79.6 | 0.104 | 40.8 | 0.713 | –42.4 |
| 5400 | 0.502 | –120.7 | 1.887 | 76.1 | 0.105 | 40.0 | 0.702 | –43.4 |
| 5600 | 0.492 | –124.7 | 1.836 | 73.5 | 0.107 | 39.5 | 0.694 | –44.4 |
| 5800 | 0.466 | –129.7 | 1.823 | 70.5 | 0.109 | 38.8 | 0.684 | –45.4 |
| 6000 | 0.448 | –133.9 | 1.792 | 67.5 | 0.111 | 37.7 | 0.675 | –46.4 |

## S Parameters (Common emitter)

$V_{CE}$=3V, $I_C$=3mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.909 | –6.3 | 6.617 | 171.4 | 0.006 | 76.4 | 0.993 | –3.0 |
| 400 | 0.905 | –12.3 | 5.865 | 164.3 | 0.011 | 82.5 | 0.984 | –6.2 |
| 600 | 0.885 | –19.0 | 6.017 | 157.7 | 0.017 | 78.2 | 0.970 | –9.3 |
| 800 | 0.851 | –26.4 | 6.363 | 151.0 | 0.022 | 75.1 | 0.953 | –12.1 |
| 1000 | 0.839 | –30.0 | 5.366 | 144.4 | 0.027 | 74.0 | 0.936 | –14.8 |
| 1200 | 0.783 | –39.6 | 6.177 | 138.6 | 0.031 | 70.5 | 0.912 | –17.2 |
| 1400 | 0.764 | –44.7 | 5.728 | 133.8 | 0.036 | 69.8 | 0.890 | –19.3 |
| 1600 | 0.737 | –50.0 | 5.425 | 129.2 | 0.040 | 66.8 | 0.867 | –21.7 |
| 1800 | 0.683 | –57.4 | 5.553 | 123.0 | 0.043 | 64.8 | 0.844 | –23.1 |
| 2000 | 0.661 | –61.4 | 5.104 | 119.0 | 0.046 | 63.5 | 0.823 | –24.8 |
| 2200 | 0.607 | –69.0 | 5.178 | 113.5 | 0.049 | 62.1 | 0.802 | –26.2 |
| 2400 | 0.575 | –73.9 | 4.935 | 109.5 | 0.053 | 61.8 | 0.785 | –27.5 |
| 2600 | 0.554 | –77.9 | 4.638 | 106.0 | 0.056 | 61.1 | 0.765 | –28.7 |
| 2800 | 0.505 | –84.0 | 4.567 | 101.2 | 0.058 | 60.9 | 0.749 | –29.7 |
| 3000 | 0.486 | –88.0 | 4.311 | 98.1 | 0.061 | 59.3 | 0.733 | –30.8 |
| 3200 | 0.446 | –93.5 | 4.213 | 94.0 | 0.064 | 58.7 | 0.718 | –31.8 |
| 3400 | 0.419 | –98.1 | 4.049 | 90.7 | 0.067 | 58.2 | 0.706 | –32.6 |
| 3600 | 0.400 | –102.1 | 3.868 | 87.8 | 0.069 | 58.1 | 0.694 | –33.7 |
| 3800 | 0.372 | –107.1 | 3.750 | 84.4 | 0.071 | 57.4 | 0.682 | –34.5 |
| 4000 | 0.355 | –111.1 | 3.598 | 81.7 | 0.075 | 56.8 | 0.673 | –35.3 |
| 4200 | 0.334 | –115.5 | 3.473 | 78.8 | 0.078 | 56.2 | 0.663 | –36.1 |
| 4400 | 0.313 | –119.8 | 3.352 | 75.9 | 0.081 | 56.1 | 0.654 | –37.0 |
| 4600 | 0.301 | –123.9 | 3.219 | 73.5 | 0.084 | 55.3 | 0.645 | –37.7 |
| 4800 | 0.282 | –128.6 | 3.123 | 70.7 | 0.087 | 55.0 | 0.636 | –38.7 |
| 5000 | 0.269 | –132.7 | 3.005 | 68.5 | 0.090 | 54.6 | 0.630 | –39.4 |
| 5200 | 0.257 | –137.7 | 2.910 | 65.9 | 0.093 | 53.9 | 0.621 | –40.4 |
| 5400 | 0.243 | –142.4 | 2.820 | 63.5 | 0.096 | 53.5 | 0.614 | –41.2 |
| 5600 | 0.235 | –146.8 | 2.735 | 61.3 | 0.099 | 52.8 | 0.608 | –42.1 |
| 5800 | 0.244 | –151.7 | 2.652 | 59.0 | 0.102 | 52.5 | 0.600 | –43.0 |
| 6000 | 0.214 | –156.1 | 2.572 | 56.8 | 0.105 | 51.9 | 0.593 | –43.8 |

## S Parameters (Common emitter)

$V_{CE}$=3V, $I_C$=5mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.855 | –8.4 | 10.168 | 169.2 | 0.005 | 65.5 | 0.989 | –3.7 |
| 400 | 0.846 | –15.7 | 9.044 | 160.6 | 0.011 | 79.1 | 0.973 | –7.6 |
| 600 | 0.809 | –24.5 | 9.220 | 152.6 | 0.016 | 77.5 | 0.950 | –10.9 |
| 800 | 0.759 | –33.4 | 9.325 | 114.7 | 0.020 | 75.2 | 0.924 | –13.9 |
| 1000 | 0.738 | –38.0 | 8.063 | 138.0 | 0.025 | 70.8 | 0.897 | –16.5 |
| 1200 | 0.659 | –49.0 | 8.655 | 130.2 | 0.028 | 70.5 | 0.868 | –18.7 |
| 1400 | 0.629 | –54.9 | 7.976 | 124.8 | 0.032 | 68.6 | 0.843 | –20.5 |
| 1600 | 0.583 | –61.7 | 7.572 | 119.2 | 0.035 | 66.9 | 0.816 | –22.5 |
| 1800 | 0.529 | –68.5 | 7.284 | 113.3 | 0.038 | 67.1 | 0.793 | –23.7 |
| 2000 | 0.496 | –73.4 | 6.753 | 108.9 | 0.041 | 66.4 | 0.772 | –25.0 |
| 2200 | 0.448 | –79.8 | 6.470 | 103.8 | 0.044 | 65.9 | 0.752 | –26.1 |
| 2400 | 0.417 | –84.5 | 6.059 | 100.0 | 0.047 | 65.6 | 0.735 | –27.2 |
| 2600 | 0.390 | –89.1 | 5.698 | 96.4 | 0.050 | 64.7 | 0.718 | –28.1 |
| 2800 | 0.356 | –94.2 | 5.410 | 92.6 | 0.053 | 64.6 | 0.704 | –28.9 |
| 3000 | 0.334 | –98.3 | 5.099 | 89.5 | 0.056 | 64.9 | 0.691 | –29.8 |
| 3200 | 0.307 | –102.9 | 4.862 | 86.2 | 0.058 | 64.5 | 0.678 | –30.7 |
| 3400 | 0.287 | –107.4 | 4.617 | 83.4 | 0.062 | 63.9 | 0.668 | –31.4 |
| 3600 | 0.270 | –111.8 | 4.399 | 80.7 | 0.065 | 63.0 | 0.658 | –32.2 |
| 3800 | 0.252 | –116.4 | 4.202 | 77.9 | 0.068 | 63.1 | 0.647 | –32.9 |
| 4000 | 0.239 | –120.6 | 4.017 | 75.4 | 0.071 | 62.5 | 0.641 | –33.7 |
| 4200 | 0.224 | –125.2 | 3.851 | 72.9 | 0.075 | 62.0 | 0.632 | –34.5 |
| 4400 | 0.210 | –129.6 | 3.693 | 70.5 | 0.078 | 61.5 | 0.625 | –35.2 |
| 4600 | 0.200 | –134.2 | 3.543 | 68.3 | 0.082 | 61.0 | 0.618 | –36.0 |
| 4800 | 0.188 | –139.1 | 3.412 | 65.8 | 0.085 | 60.2 | 0.610 | –36.9 |
| 5000 | 0.179 | –143.6 | 3.280 | 63.8 | 0.089 | 60.0 | 0.606 | –37.7 |
| 5200 | 0.172 | –149.5 | 3.168 | 61.6 | 0.092 | 59.3 | 0.597 | –38.6 |
| 5400 | 0.163 | –154.7 | 3.057 | 59.4 | 0.096 | 58.6 | 0.592 | –39.4 |
| 5600 | 0.159 | –159.7 | 2.959 | 57.4 | 0.099 | 58.3 | 0.586 | –40.3 |
| 5800 | 0.153 | –165.2 | 2.862 | 55.3 | 0.102 | 57.0 | 0.579 | –41.1 |
| 6000 | 0.146 | –170.3 | 2.773 | 53.3 | 0.106 | 56.4 | 0.573 | –42.0 |

## S Parameters (Common emitter)

$V_{CE}$=3V, $I_C$=7mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.809 | –9.9 | 13.020 | 167.7 | 0.007 | 82.9 | 0.986 | –4.2 |
| 400 | 0.791 | –18.9 | 11.613 | 157.8 | 0.011 | 79.9 | 0.965 | –8.4 |
| 600 | 0.740 | –29.3 | 11.705 | 148.5 | 0.015 | 74.8 | 0.933 | –11.9 |
| 800 | 0.682 | –39.1 | 11.441 | 139.8 | 0.019 | 73.5 | 0.901 | –14.9 |
| 1000 | 0.648 | –45.1 | 10.083 | 132.8 | 0.023 | 71.5 | 0.868 | –17.3 |
| 1200 | 0.564 | –55.9 | 10.150 | 124.3 | 0.026 | 69.1 | 0.840 | –19.2 |
| 1400 | 0.526 | –62.2 | 9.285 | 118.6 | 0.030 | 69.1 | 0.812 | –20.8 |
| 1600 | 0.476 | –69.1 | 8.659 | 112.7 | 0.032 | 69.1 | 0.786 | –22.4 |
| 1800 | 0.429 | –75.2 | 8.090 | 107.4 | 0.035 | 68.7 | 0.764 | –23.5 |
| 2000 | 0.396 | –80.4 | 7.472 | 103.0 | 0.038 | 67.9 | 0.745 | –24.6 |
| 2200 | 0.358 | –86.3 | 6.997 | 98.6 | 0.041 | 68.3 | 0.727 | –25.5 |
| 2400 | 0.330 | –90.9 | 6.511 | 94.9 | 0.045 | 67.4 | 0.712 | –26.6 |
| 2600 | 0.306 | –95.4 | 6.088 | 91.6 | 0.047 | 68.0 | 0.697 | –27.3 |
| 2800 | 0.280 | –100.1 | 5.717 | 88.3 | 0.050 | 68.1 | 0.685 | –28.1 |
| 3000 | 0.260 | –104.4 | 5.378 | 85.4 | 0.053 | 67.2 | 0.672 | –28.8 |
| 3200 | 0.240 | –109.2 | 5.088 | 82.4 | 0.057 | 67.5 | 0.661 | –29.7 |
| 3400 | 0.223 | –113.8 | 4.821 | 79.9 | 0.060 | 66.6 | 0.652 | –30.3 |
| 3600 | 0.210 | –118.3 | 4.577 | 77.2 | 0.064 | 66.8 | 0.642 | –31.1 |
| 3800 | 0.196 | –123.2 | 4.362 | 74.8 | 0.067 | 65.8 | 0.634 | –31.9 |
| 4000 | 0.185 | –127.6 | 4.159 | 72.4 | 0.071 | 65.9 | 0.628 | –32.7 |
| 4200 | 0.175 | –132.6 | 3.979 | 70.1 | 0.074 | 65.1 | 0.620 | –33.5 |
| 4400 | 0.164 | –137.5 | 3.809 | 67.8 | 0.078 | 64.1 | 0.615 | –34.3 |
| 4600 | 0.156 | –142.5 | 3.652 | 65.7 | 0.081 | 63.9 | 0.608 | –35.0 |
| 4800 | 0.148 | –148.4 | 3.509 | 63.4 | 0.084 | 63.1 | 0.601 | –36.0 |
| 5000 | 0.141 | –153.4 | 3.374 | 61.5 | 0.089 | 62.4 | 0.597 | –36.7 |
| 5200 | 0.137 | –159.6 | 3.254 | 59.4 | 0.092 | 61.9 | 0.590 | –37.6 |
| 5400 | 0.131 | –165.7 | 3.138 | 57.3 | 0.096 | 61.2 | 0.584 | –38.4 |
| 5600 | 0.129 | –170.7 | 3.035 | 55.4 | 0.099 | 60.1 | 0.579 | –39.2 |
| 5800 | 0.126 | –177.0 | 2.935 | 53.4 | 0.102 | 59.2 | 0.572 | –40.1 |
| 6000 | 0.122 | 177.3 | 2.839 | 51.5 | 0.106 | 58.7 | 0.567 | –41.1 |

## S Parameters (Common emitter)

$V_{CE}$=3V, $I_C$=10mA, $Z_O$=50Ω

| Freq(MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 200 | 0.744 | –12.4 | 16.473 | 165.7 | 0.004 | 84.1 | 0.979 | –4.8 |
| 400 | 0.713 | –23.6 | 14.723 | 154.1 | 0.011 | 81.9 | 0.951 | –9.3 |
| 600 | 0.648 | –35.9 | 14.478 | 143.3 | 0.015 | 74.5 | 0.913 | –12.9 |
| 800 | 0.580 | –46.5 | 13.572 | 133.7 | 0.018 | 71.6 | 0.874 | –15.6 |
| 1000 | 0.533 | –54.2 | 12.081 | 126.1 | 0.021 | 72.1 | 0.839 | –17.6 |
| 1200 | 0.458 | –63.7 | 11.356 | 118.0 | 0.024 | 71.6 | 0.809 | –19.3 |
| 1400 | 0.418 | –70.4 | 10.263 | 112.2 | 0.027 | 71.4 | 0.783 | –20.6 |
| 1600 | 0.374 | –77.0 | 9.371 | 106.7 | 0.030 | 70.4 | 0.760 | –21.9 |
| 1800 | 0.336 | –82.7 | 8.592 | 102.0 | 0.033 | 71.4 | 0.741 | –22.8 |
| 2000 | 0.306 | –88.1 | 7.889 | 97.9 | 0.036 | 71.7 | 0.723 | –23.8 |
| 2200 | 0.278 | –93.8 | 7.295 | 94.0 | 0.039 | 71.8 | 0.709 | –24.7 |
| 2400 | 0.255 | –98.4 | 6.751 | 90.6 | 0.042 | 71.0 | 0.693 | –25.6 |
| 2600 | 0.235 | –103.2 | 6.283 | 87.5 | 0.045 | 70.9 | 0.681 | –26.3 |
| 2800 | 0.215 | –108.1 | 5.873 | 84.5 | 0.049 | 71.3 | 0.670 | –27.0 |
| 3000 | 0.200 | –113.0 | 5.509 | 81.8 | 0.052 | 70.5 | 0.659 | –27.8 |
| 3200 | 0.184 | –117.9 | 5.194 | 79.2 | 0.055 | 70.5 | 0.649 | –28.6 |
| 3400 | 0.172 | –123.3 | 4.904 | 76.8 | 0.059 | 69.9 | 0.642 | –29.2 |
| 3600 | 0.162 | –128.4 | 4.654 | 74.4 | 0.062 | 69.2 | 0.633 | –30.1 |
| 3800 | 0.152 | –133.8 | 4.422 | 72.0 | 0.066 | 69.3 | 0.626 | –30.8 |
| 4000 | 0.144 | –138.8 | 4.215 | 69.8 | 0.070 | 68.1 | 0.620 | –31.6 |
| 4200 | 0.138 | –144.7 | 4.027 | 67.7 | 0.074 | 67.7 | 0.613 | –32.4 |
| 4400 | 0.130 | –150.1 | 3.847 | 65.5 | 0.077 | 67.1 | 0.608 | –33.2 |
| 4600 | 0.126 | –155.6 | 3.691 | 63.5 | 0.080 | 66.2 | 0.602 | –34.0 |
| 4800 | 0.120 | –162.8 | 3.543 | 61.3 | 0.084 | 65.3 | 0.595 | –34.9 |
| 5000 | 0.117 | –168.5 | 3.404 | 59.4 | 0.088 | 64.5 | 0.592 | –35.7 |
| 5200 | 0.115 | –175.1 | 3.282 | 57.5 | 0.092 | 63.7 | 0.585 | –36.6 |
| 5400 | 0.112 | 178.4 | 3.162 | 55.5 | 0.096 | 63.0 | 0.580 | –37.4 |
| 5600 | 0.113 | 173.8 | 3.056 | 53.6 | 0.099 | 62.3 | 0.576 | –38.3 |
| 5800 | 0.113 | 167.0 | 2.955 | 51.7 | 0.103 | 61.2 | 0.569 | –39.2 |
| 6000 | 0.111 | 161.4 | 2.857 | 49.8 | 0.107 | 60.6 | 0.564 | –40.1 |

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