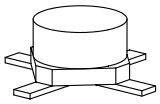
SIEMENS

## NPN Silicon RF Transistor — BFQ 70

- For low-noise IF and broadband amplifiers in antenna and telecommunications systems at collector currents from 2 mA to 20 mA.
- Hermetically sealed ceramic package
- HiRel/Mil screening available.




**ESD**: **E**lectro**s**tatic **d**ischarge sensitive device, observe handling precautions!

| Type | Marking | Ordering Code (tape and reel) | Pin Configuration 1 | 2 | 3 | 4 | Package[1] |
|---|---|---|---|---|---|---|---|
| BFQ 70 | 70 | Q62702-F774 | B | E | C | E | Cerex-X |

### Maximum Ratings

| Parameter | Symbol | Values | Unit |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE0}$ | 15 | V |
| Collector-emitter voltage, $V_{BE}$ = 0 | $V_{CES}$ | 20 | |
| Collector-base voltage | $V_{CB0}$ | 20 | |
| Emitter-base voltage | $V_{EB0}$ | 2.5 | |
| Collector current | $I_C$ | 35 | mA |
| Base current | $I_B$ | 4 | |
| Total power dissipation, $T_S \leq 121$ °C[3] | $P_{tot}$ | 300 | mW |
| Junction temperature | $T_j$ | 175 | °C |
| Ambient temperature range | $T_A$ | – 65 … + 175 | |
| Storage temperature range | $T_{stg}$ | – 65 … + 175 | |

### Thermal Resistance

| | | | |
|---|---|---|---|
| Junction - ambient[2] | $R_{th\ JA}$ | ≤ 260 | K/W |
| Junction - soldering point[3] | $R_{th\ JS}$ | ≤ 180 | |

1) For detailed dimensions see chapter Package Outlines.
2) Package mounted on alumina 16 mm × 25 mm × 0.7 mm.
3) $T_S$ is measured on the collector lead at the soldering point to the pcb.

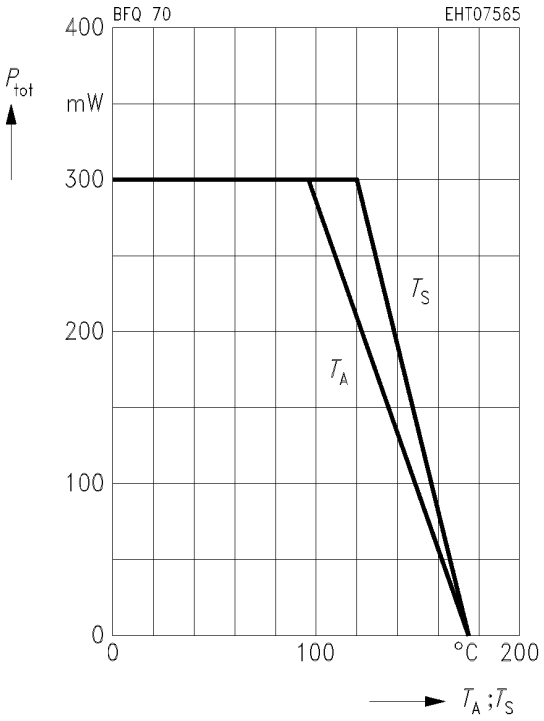
**Electrical Characteristics**
at $T_A$ = 25 °C, unless otherwise specified.

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| **DC Characteristics** | | | | | |
| Collector-emitter breakdown voltage<br>$I_C$ = 1 mA, $I_B$ = 0 | $V_{(BR)CE0}$ | 15 | – | – | V |
| Collector-base cutoff current<br>$V_{CB}$ = 10 V, $I_E$ = 0 | $I_{CB0}$ | – | – | 50 | nA |
| Emitter-base cutoff current<br>$V_{EB}$ = 2 V, $I_C$ = 0 | $I_{EB0}$ | – | – | 10 | µA |
| DC current gain<br>$I_C$ = 3 mA, $V_{CE}$ = 6 V<br>$I_C$ = 10 mA, $V_{CE}$ = 6 V | $h_{FE}$ | <br>50<br>50 | <br>–<br>130 | <br>250<br>– | – |
| Collector-emitter saturation voltage<br>$I_C$ = 20 mA, $I_B$ = 1 mA | $V_{CEsat}$ | – | 0.1 | 0.4 | V |
| Base-emitter voltage<br>$I_C$ = 10 mA, $V_{CE}$ = 6 V | $V_{BE}$ | – | 0.78 | – | |

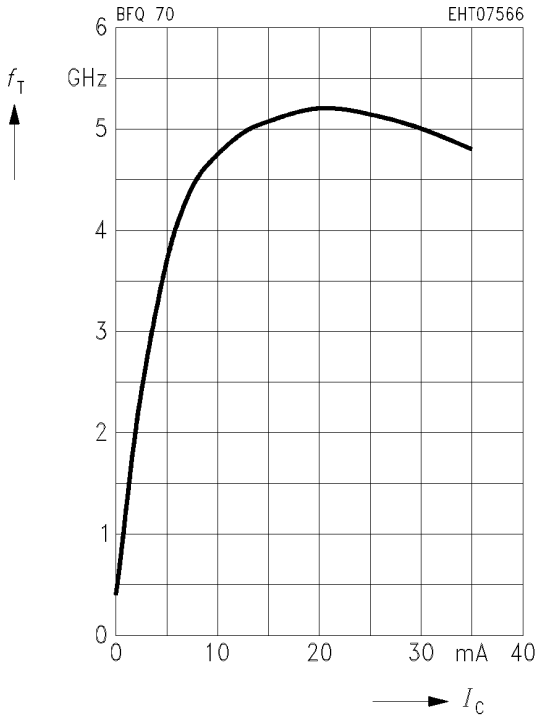
**Electrical Characteristics**
at $T_A$ = 25 °C, unless otherwise specified.

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| **AC Characteristics** | | | | | |
| Transition frequency<br>$I_C$ = 3 mA, $V_{CE}$ = 6 V, $f$ = 200 MHz<br>$I_C$ = 20 mA, $V_{CE}$ = 6 V, $f$ = 200 MHz | $f_T$ | <br>–<br>3.6 | <br>2.7<br>5 | <br>–<br>– | GHz |
| Collector-base capacitance<br>$V_{CB}$ = 6 V, $V_{BE}$ = $v_{be}$ = 0, $f$ = 1 MHz | $C_{cb}$ | – | 0.46 | 0.6 | pF |
| Collector-emitter capacitance<br>$V_{CE}$ = 6 V, $V_{BE}$ = $v_{be}$ = 0, $f$ = 1 MHz | $C_{ce}$ | – | 0.41 | – | |
| Input capacitance<br>$V_{EB}$ = 0.5 V, $I_C$ = $i_c$ = 0, $f$ = 1 MHz | $C_{ibo}$ | – | 2.2 | – | |
| Output capacitance<br>$V_{CE}$ = 6 V, $V_{BE}$ = $v_{be}$ = 0, $f$ = 1 MHz | $C_{obs}$ | – | 0.87 | 1.3 | |
| Noise figure<br>$I_C$ = 3 mA, $V_{CE}$ = 6 V, $f$ = 10 MHz, $Z_S$ = 75 Ω<br>$I_C$ = 4 mA, $V_{CE}$ = 6 V, $f$ = 800 MHz, $Z_S$ = 50 Ω | $F$ | <br>–<br>– | <br>0.9<br>1.5 | <br>1.2<br>– | dB |
| Power gain<br>$I_C$ = 20 mA, $V_{CE}$ = 6 V, $f$ = 800 MHz,<br>$Z_S$ = $Z_{Sopt}$, $Z_L$ = $Z_{Lopt}$ | $G_{pe}$ | – | 18 | – | |
| Transducer gain<br>$I_C$ = 10 mA, $V_{CE}$ = 6 V, $f$ = 1 GHz, $Z_0$ = 50 Ω | $\lvert S_{21e} \rvert^2$ | – | 13 | – | |
| Linear output voltage<br>two-tone intermodulation test<br>$I_C$ = 20 mA, $V_{CE}$ = 6 V, $d_{IM}$ = 60 dB,<br>$f_1$ = 806 MHz, $f_2$ = 810 MHz, $Z_S$ = $Z_L$ = 50 Ω | $V_{o1}$ = $V_{o2}$ | – | 170 | – | mV |
| Third order intercept point<br>$I_C$ = 20 mA, $V_{CE}$ = 6 V, $f$ = 800 MHz | $IP_3$ | – | 27.5 | – | dBm |

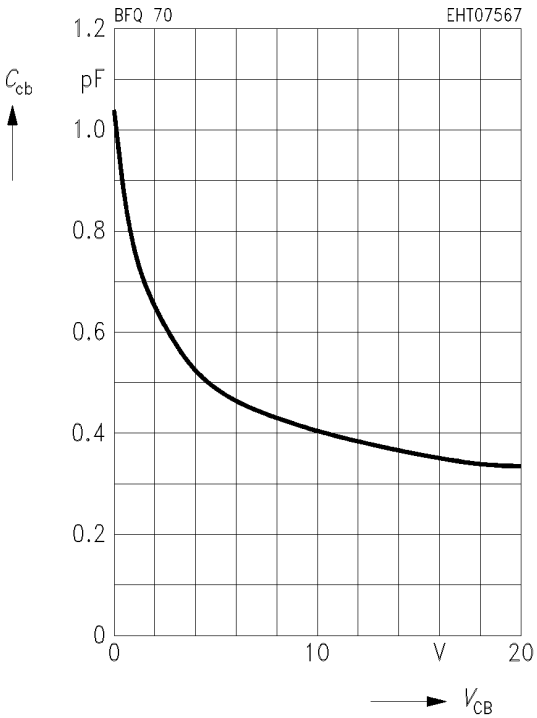
**Total power dissipation $P_{tot} = f(T_A^*; T_S)$**
*Package mounted on alumina




**Transition frequency $f_T = f(I_C)$**
$V_{CE}$ = 6 V, $f$ = 200 MHz



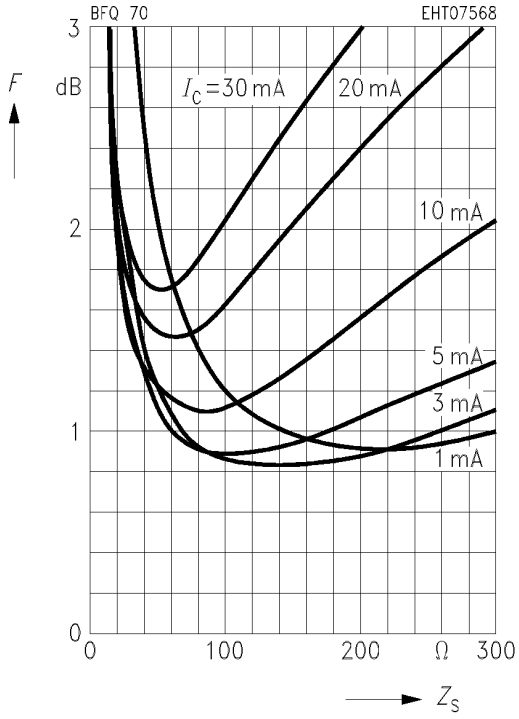

**Collector-base capacitance $C_{cb} = f(V_{CB})$**
$V_{BE}$ = $v_{be}$ = 0, $f$ = 1 MHz



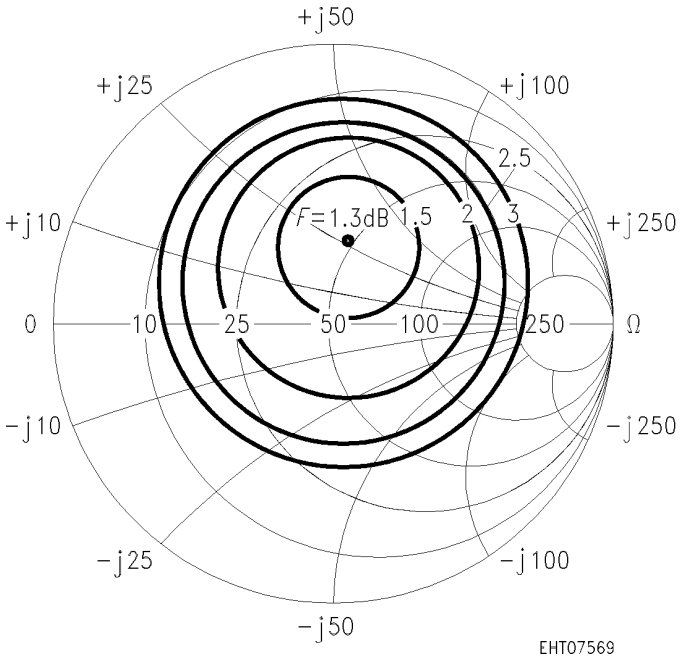
### Common Emitter Noise Parameters

| $f$ | $F_{min}$ | $G_p(F_{min})$ | $\Gamma_{opt}$ | | $R_N$ | $N$ | $F_{50\,\Omega}$ | $G_p(F_{50\Omega})$ |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **dB** | **dB** | **MAG** | **ANG** | Ω | **–** | **dB** | **dB** |
| $I_C$ = 3 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.01 | 0.8 | – | ($Z_S$ = 150 Ω) | | – | – | 1.2 | – |
| $I_C$ = 5 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.01 | 0.85 | – | ($Z_S$ = 100 Ω) | | – | – | 1.1 | – |
| 0.8 | 1.3 | 15.5 | 0.28 | 79 | 12 | 0.19 | 1.5 | 14.8 |

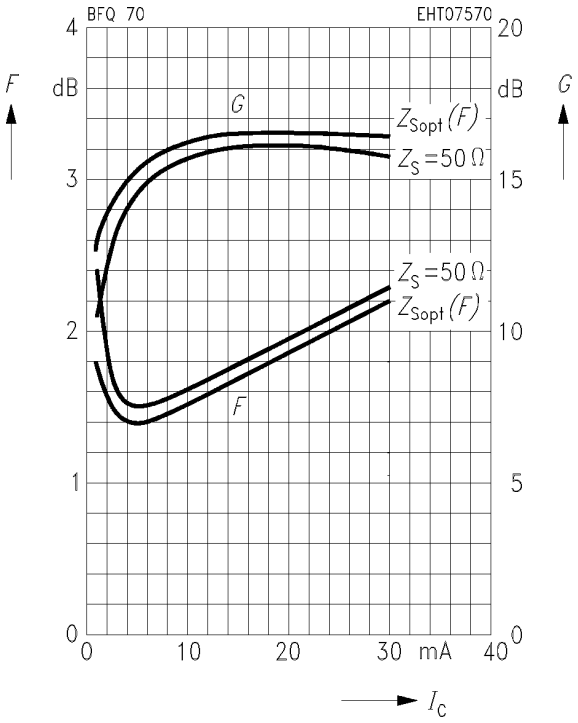
**Noise figure $F = f(Z_S)$**
$V_{CE}$ = 6 V, $f$ = 10 MHz



**Circles of constant noise figure $F = f(Z_S)$**
in $Z_S$-plane, $I_C$ = 5 mA, $V_{CE}$ = 6 V, $f$ = 800 MHz

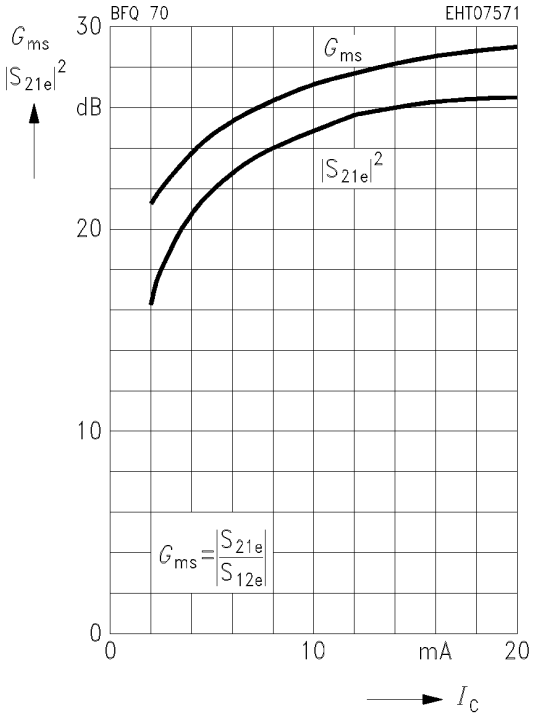



**Noise figure $F = f(I_C)$**
**Power gain $G = f(I_C)$**
$V_{CE}$ = 6 V, $f$ = 800 MHz, $Z_{Lopt}$ ($G$)

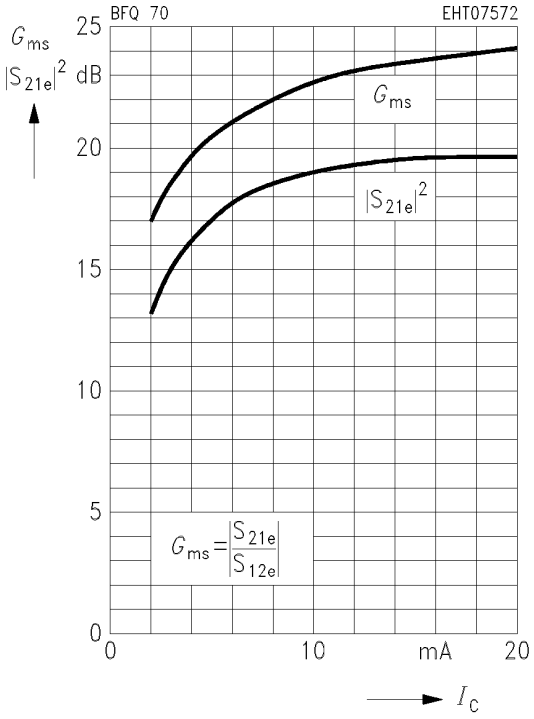


## Common Emitter Power Gain

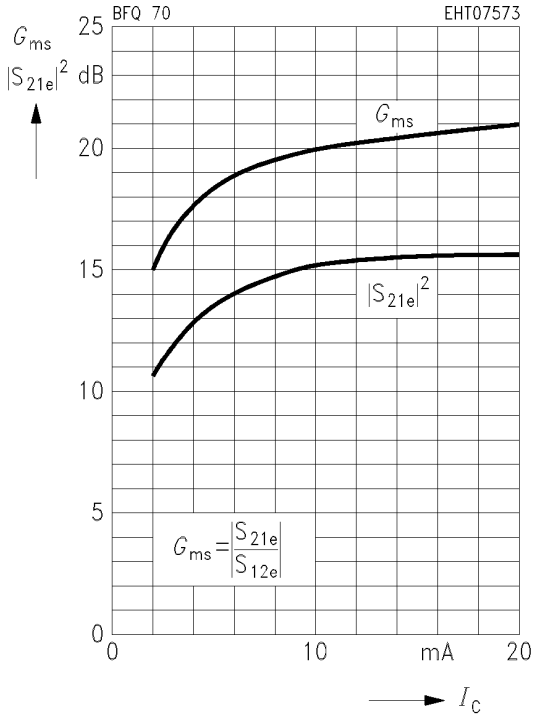
**Power gain $G_{ms}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 6 V, $f$ = 200 MHz, $Z_0$ = 50 Ω



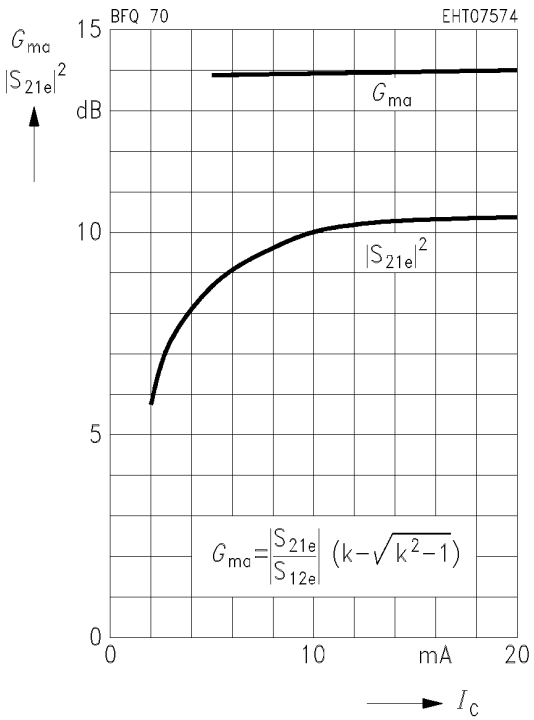

**Power gain $G_{ms}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 6 V, $f$ = 500 MHz, $Z_0$ = 50 Ω



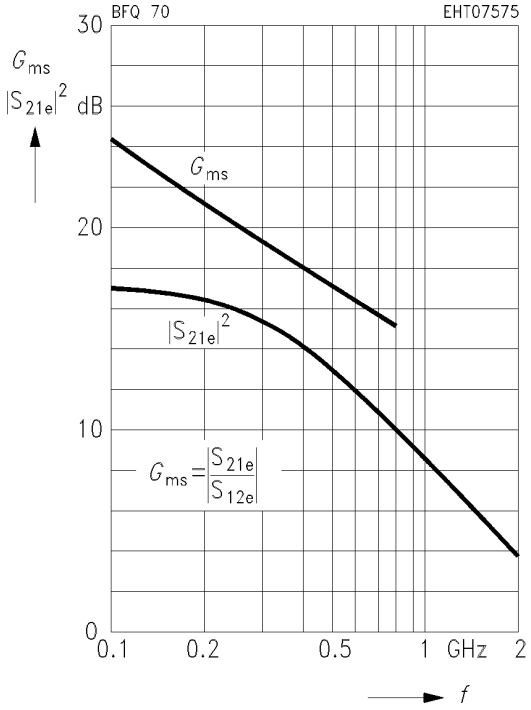

**Power gain $G_{ms}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 6 V, $f$ = 800 MHz, $Z_0$ = 50 Ω



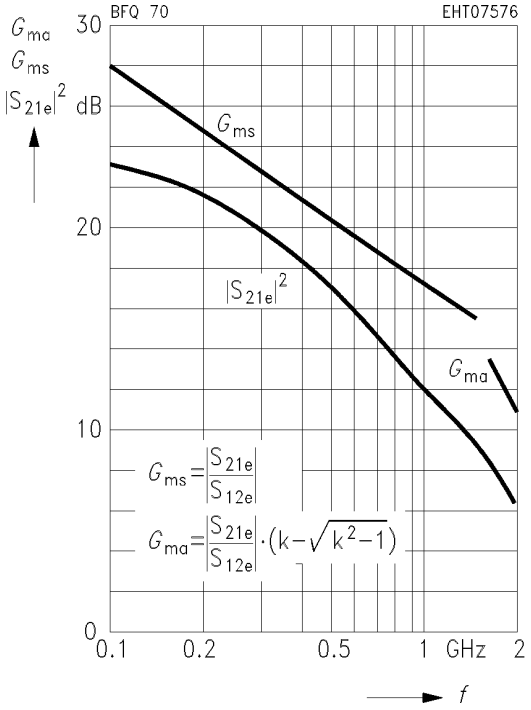

**Power gain $G_{ma}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 6 V, $f$ = 1.5 GHz, $Z_0$ = 50 Ω



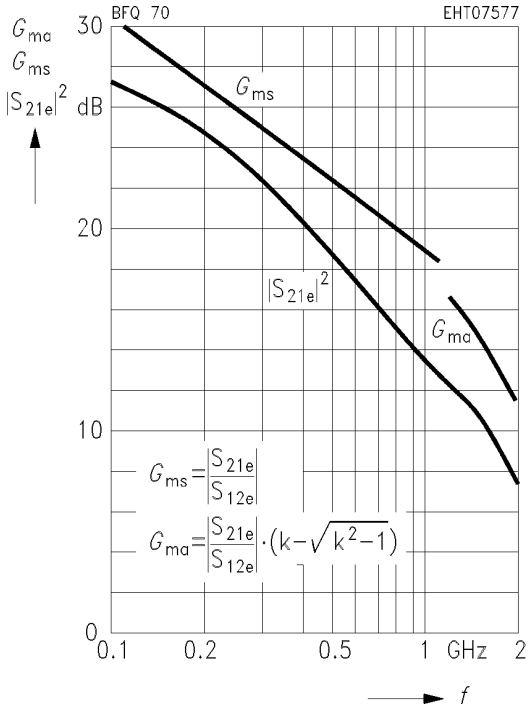
**Power gain $G_{ms}$, $|S_{21e}|^2 = f(f)$**
$I_C$ = 2 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



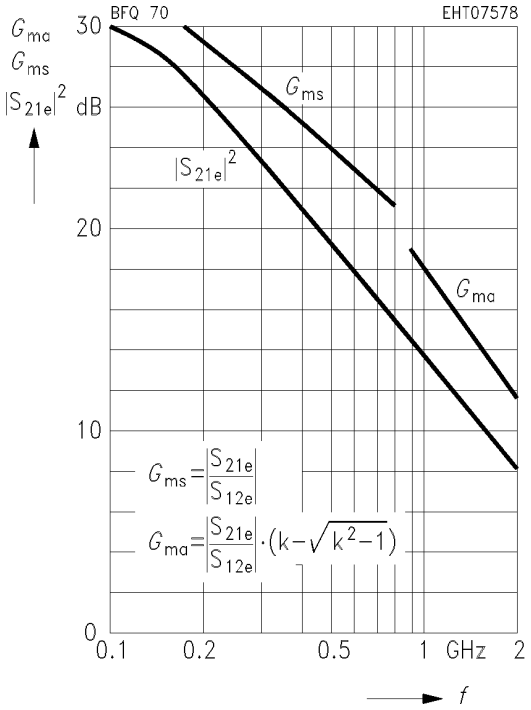

**Power gain $G_{ma}$, $G_{ms}$, $|S_{21e}|^2 = f(f)$**
$I_C$ = 5 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω




**Power gain $G_{ma}$, $G_{ms}$, $|S_{21e}|^2 = f(f)$**
$I_C$ = 10 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



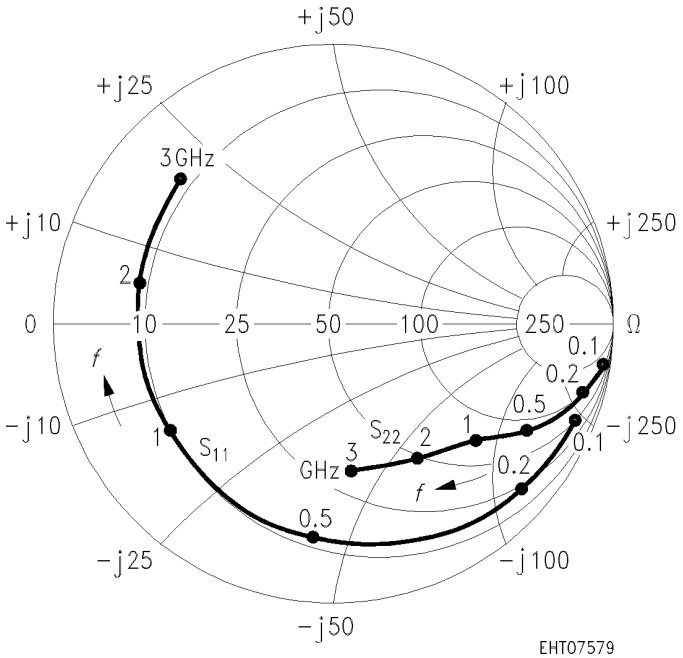

**Power gain $G_{ma}$, $G_{ms}$, $|S_{21e}|^2 = f(f)$**
$I_C$ = 20 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



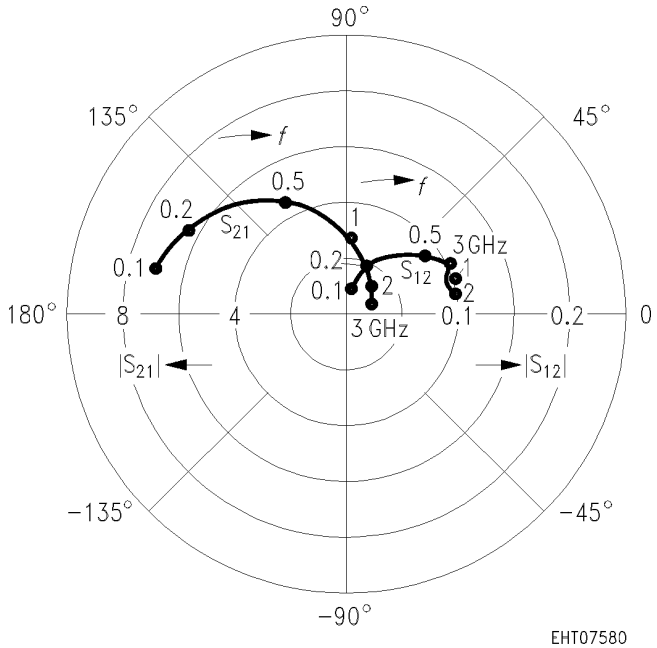
## Common Emitter S Parameters

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| $I_C$ = 2 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.92 | – 23 | 7.00 | 165 | 0.025 | 77 | 0.98 | – 8 |
| 0.2 | 0.89 | – 45 | 6.42 | 150 | 0.049 | 65 | 0.93 | – 16 |
| 0.3 | 0.84 | – 65 | 5.74 | 137 | 0.068 | 55 | 0.87 | – 22 |
| 0.4 | 0.80 | – 82 | 5.21 | 126 | 0.081 | 46 | 0.81 | – 28 |
| 0.6 | 0.74 | – 110 | 4.14 | 109 | 0.096 | 34 | 0.71 | – 34 |
| 0.8 | 0.71 | – 130 | 3.35 | 95 | 0.103 | 26 | 0.65 | – 38 |
| 1.0 | 0.69 | – 146 | 2.78 | 85 | 0.105 | 20 | 0.61 | – 41 |
| 1.2 | 0.68 | – 158 | 2.39 | 76 | 0.105 | 17 | 0.58 | – 44 |
| 1.5 | 0.67 | – 174 | 1.96 | 64 | 0.104 | 14 | 0.55 | – 49 |
| 1.8 | 0.68 | 174 | 1.66 | 53 | 0.102 | 13 | 0.54 | – 55 |
| 2.0 | 0.69 | 167 | 1.51 | 47 | 0.100 | 14 | 0.53 | – 60 |
| 2.5 | 0.70 | 152 | 1.24 | 33 | 0.100 | 19 | 0.51 | – 73 |
| 3.0 | 0.72 | 138 | 1.05 | 20 | 0.107 | 24 | 0.51 | – 87 |

**$S_{11}$, $S_{22}$ = $f$ ($f$)**
$I_C$ = 2 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



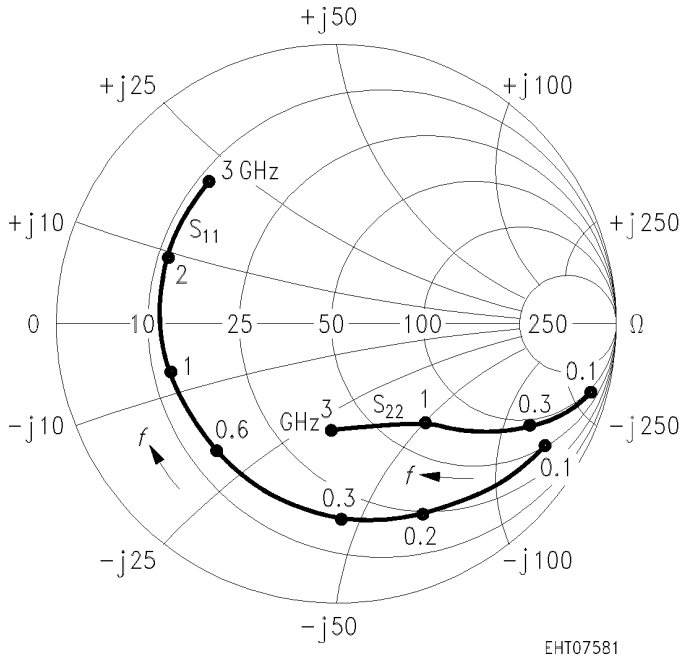

**$S_{12}$, $S_{21}$ = $f$ ($f$)**
$I_C$ = 2 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



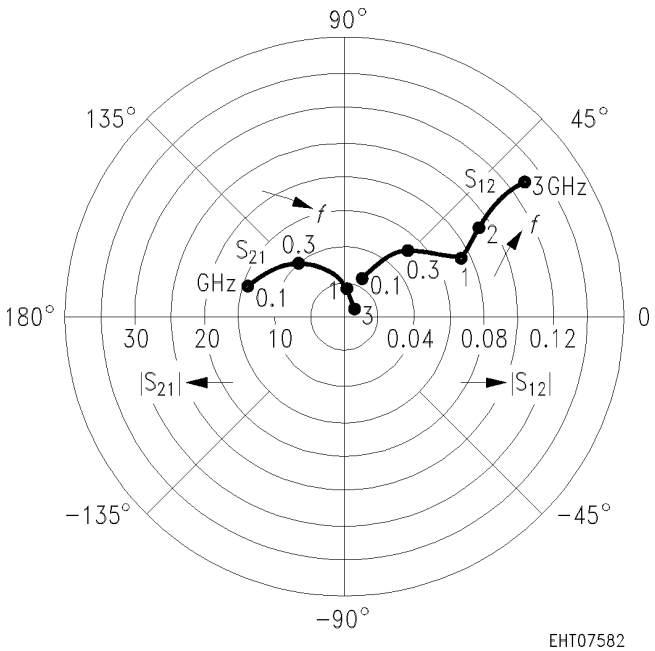
**Common Emitter S Parameters** (continued)

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 5 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.84 | – 35 | 14.47 | 159 | 0.023 | 73 | 0.95 | – 14 |
| 0.2 | 0.78 | – 66 | 12.38 | 139 | 0.042 | 58 | 0.83 | – 26 |
| 0.3 | 0.72 | – 90 | 10.21 | 125 | 0.053 | 47 | 0.72 | – 33 |
| 0.4 | 0.69 | – 109 | 8.66 | 114 | 0.060 | 40 | 0.63 | – 37 |
| 0.6 | 0.65 | – 135 | 6.32 | 99 | 0.068 | 34 | 0.52 | – 42 |
| 0.8 | 0.63 | – 152 | 4.90 | 88 | 0.072 | 31 | 0.46 | – 44 |
| 1.0 | 0.63 | – 165 | 3.97 | 79 | 0.075 | 30 | 0.43 | – 45 |
| 1.2 | 0.63 | – 175 | 3.38 | 72 | 0.079 | 30 | 0.40 | – 47 |
| 1.5 | 0.63 | 173 | 2.74 | 62 | 0.083 | 31 | 0.38 | – 51 |
| 1.8 | 0.63 | 164 | 2.29 | 53 | 0.090 | 33 | 0.37 | – 56 |
| 2.0 | 0.65 | 158 | 2.07 | 48 | 0.095 | 34 | 0.36 | – 61 |
| 2.5 | 0.66 | 145 | 1.70 | 35 | 0.109 | 36 | 0.34 | – 73 |
| 3.0 | 0.69 | 133 | 1.44 | 23 | 0.127 | 36 | 0.34 | – 87 |

***$S_{11}$, $S_{22}$ = f (f)***
$I_C$ = 5 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



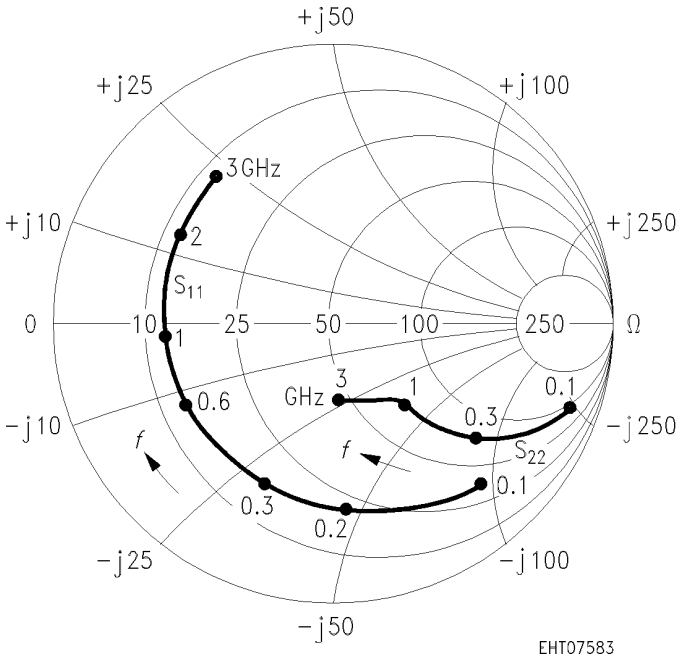

***$S_{12}$, $S_{21}$ = f (f)***
$I_C$ = 5 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



**Common Emitter S Parameters** (continued)

| *f* | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 10 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.73 | – 50 | 22.77 | 151 | 0.021 | 65 | 0.89 | – 21 |
| 0.2 | 0.67 | – 89 | 17.57 | 129 | 0.034 | 52 | 0.71 | – 34 |
| 0.3 | 0.63 | – 114 | 13.44 | 115 | 0.041 | 43 | 0.57 | – 41 |
| 0.4 | 0.62 | – 132 | 10.84 | 105 | 0.045 | 41 | 0.49 | – 44 |
| 0.6 | 0.60 | – 153 | 7.56 | 92 | 0.051 | 39 | 0.39 | – 45 |
| 0.8 | 0.60 | – 167 | 5.75 | 83 | 0.057 | 40 | 0.35 | – 46 |
| 1.0 | 0.61 | – 177 | 4.62 | 76 | 0.062 | 41 | 0.32 | – 47 |
| 1.2 | 0.61 | 175 | 3.90 | 70 | 0.068 | 43 | 0.30 | – 48 |
| 1.5 | 0.61 | 165 | 3.15 | 60 | 0.078 | 44 | 0.29 | – 51 |
| 1.8 | 0.62 | 157 | 2.62 | 52 | 0.089 | 44 | 0.28 | – 56 |
| 2.0 | 0.64 | 152 | 2.37 | 47 | 0.096 | 44 | 0.27 | – 61 |
| 2.5 | 0.65 | 141 | 1.94 | 35 | 0.117 | 44 | 0.25 | – 73 |
| 3.0 | 0.68 | 130 | 1.65 | 24 | 0.138 | 41 | 0.25 | – 88 |

***S*11, *S*22 = *f* (*f*)**
$I_C$ = 10 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



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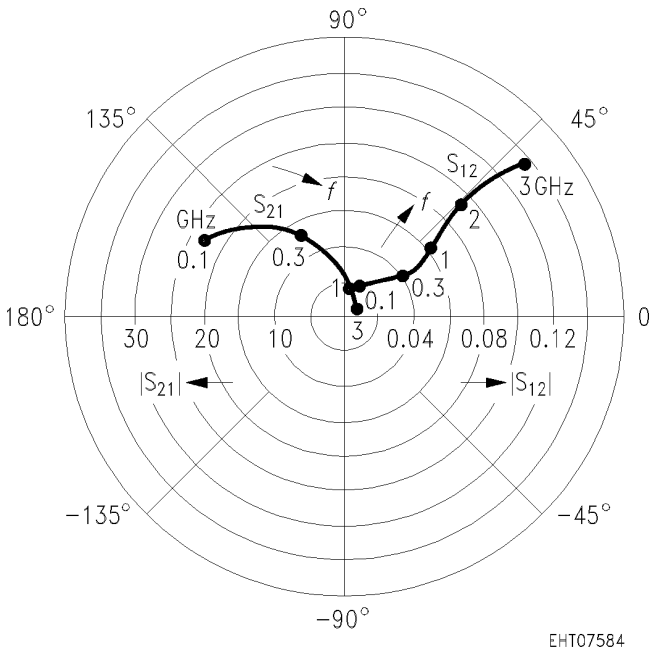
***S*12, *S*21 = *f* (*f*)**
$I_C$ = 10 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



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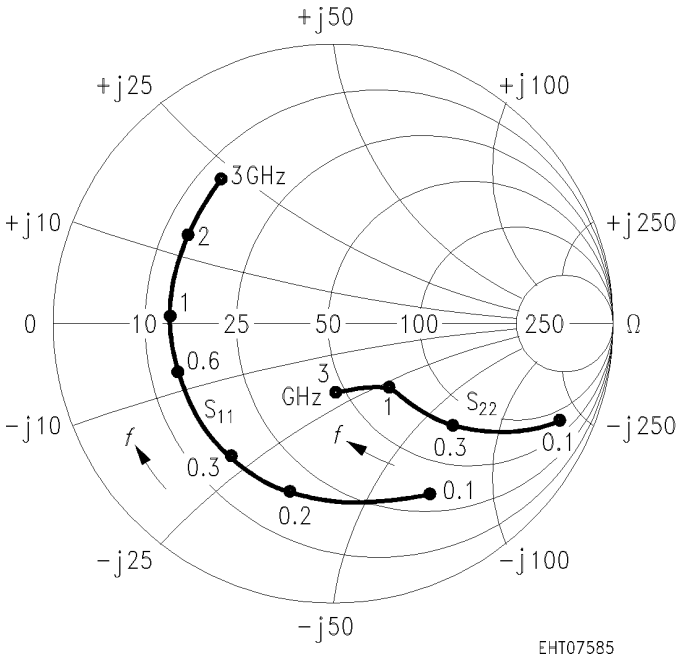
**Common Emitter S Parameters** (continued)

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 15 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.67 | – 62 | 27.86 | 146 | 0.019 | 64 | 0.84 | – 25 |
| 0.2 | 0.62 | – 104 | 20.01 | 123 | 0.029 | 49 | 0.63 | – 38 |
| 0.3 | 0.59 | – 128 | 14.73 | 110 | 0.035 | 44 | 0.50 | – 43 |
| 0.4 | 0.60 | – 143 | 11.63 | 101 | 0.038 | 43 | 0.42 | – 44 |
| 0.6 | 0.59 | – 162 | 7.97 | 89 | 0.045 | 44 | 0.34 | – 45 |
| 0.8 | 0.59 | – 173 | 6.02 | 81 | 0.051 | 46 | 0.30 | – 45 |
| 1.0 | 0.60 | 178 | 4.82 | 75 | 0.058 | 48 | 0.28 | – 45 |
| 1.2 | 0.60 | 171 | 4.07 | 68 | 0.065 | 49 | 0.27 | – 47 |
| 1.5 | 0.61 | 162 | 3.28 | 60 | 0.077 | 50 | 0.25 | – 50 |
| 1.8 | 0.62 | 154 | 2.73 | 52 | 0.090 | 49 | 0.25 | – 55 |
| 2.0 | 0.63 | 150 | 2.47 | 47 | 0.097 | 49 | 0.24 | – 60 |
| 2.5 | 0.65 | 139 | 2.02 | 35 | 0.120 | 47 | 0.22 | – 72 |
| 3.0 | 0.68 | 128 | 1.71 | 24 | 0.142 | 43 | 0.22 | – 87 |

***S*11, *S*22 = *f* (*f*)**
$I_C$ = 15 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω

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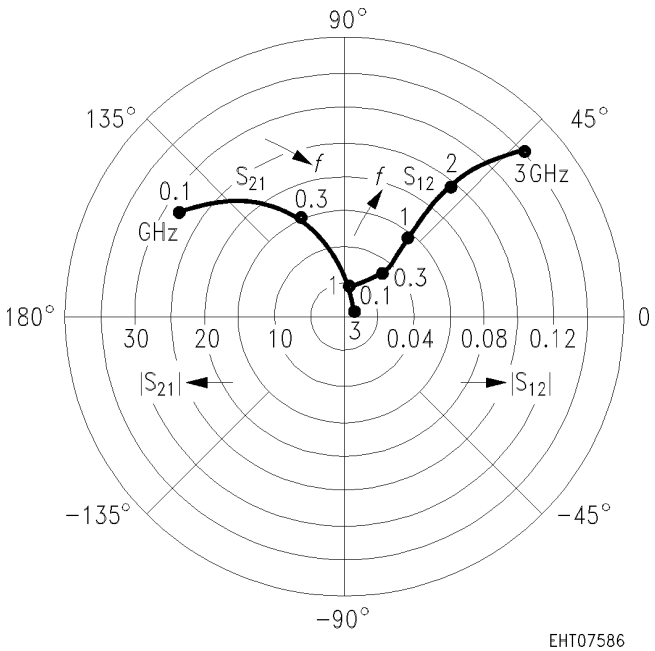
***S*12, *S*21 = *f* (*f*)**
$I_C$ = 15 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω

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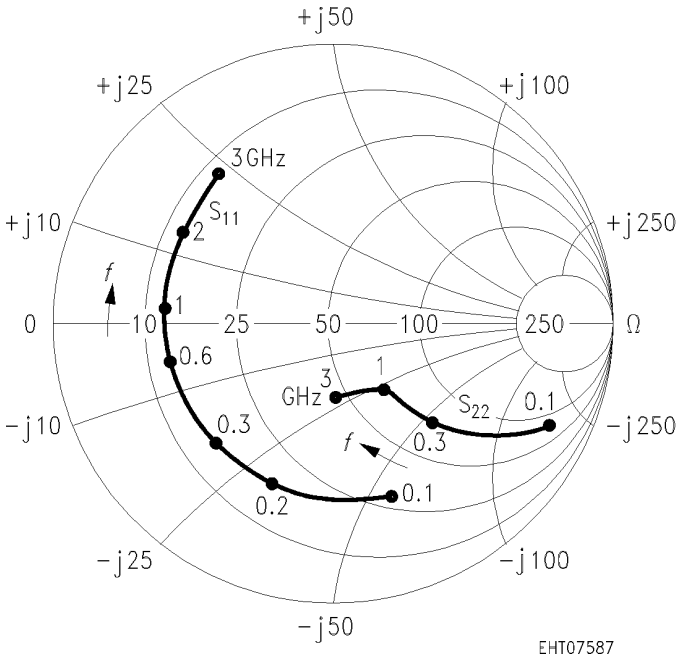
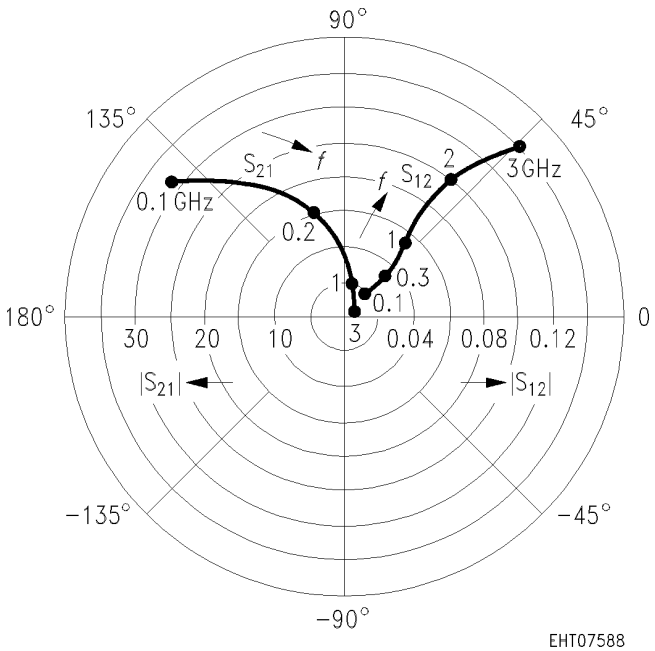
**Common Emitter S Parameters** (continued)

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 20 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.63 | – 71 | 31.01 | 142 | 0.017 | 59 | 0.81 | – 28 |
| 0.2 | 0.60 | – 113 | 21.18 | 119 | 0.026 | 48 | 0.58 | – 40 |
| 0.3 | 0.58 | – 136 | 15.24 | 107 | 0.031 | 45 | 0.45 | – 43 |
| 0.4 | 0.59 | – 150 | 11.90 | 98 | 0.034 | 45 | 0.38 | – 44 |
| 0.6 | 0.59 | – 166 | 8.08 | 88 | 0.041 | 47 | 0.32 | – 43 |
| 0.8 | 0.59 | – 177 | 6.09 | 80 | 0.048 | 50 | 0.29 | – 43 |
| 1.0 | 0.60 | 175 | 4.87 | 74 | 0.056 | 52 | 0.27 | – 44 |
| 1.2 | 0.60 | 169 | 4.11 | 68 | 0.064 | 53 | 0.26 | – 45 |
| 1.5 | 0.61 | 160 | 3.31 | 59 | 0.076 | 53 | 0.25 | – 48 |
| 1.8 | 0.62 | 153 | 2.75 | 51 | 0.089 | 52 | 0.24 | – 54 |
| 2.0 | 0.64 | 149 | 2.49 | 47 | 0.098 | 51 | 0.23 | – 58 |
| 2.5 | 0.65 | 138 | 2.03 | 35 | 0.120 | 49 | 0.21 | – 70 |
| 3.0 | 0.68 | 128 | 1.72 | 24 | 0.143 | 44 | 0.21 | – 86 |

***S*11, *S*22 = *f* (*f*)**
$I_C$ = 20 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



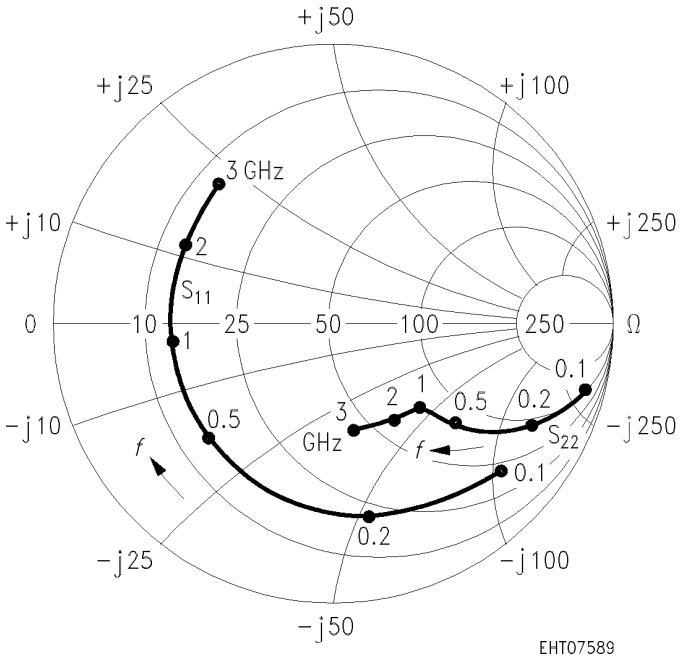

***S*12, *S*21 = *f* (*f*)**
$I_C$ = 20 mA, $V_{CE}$ = 6 V, $Z_0$ = 50 Ω



**Common Emitter S Parameters** (continued)

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 10 mA, $V_{CE}$ = 10 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.75 | – 45 | 22.64 | 153 | 0.018 | 67 | 0.91 | – 18 |
| 0.2 | 0.69 | – 83 | 17.84 | 131 | 0.030 | 53 | 0.75 | – 29 |
| 0.3 | 0.63 | – 109 | 13.82 | 117 | 0.037 | 45 | 0.63 | – 34 |
| 0.4 | 0.62 | – 127 | 11.23 | 107 | 0.041 | 42 | 0.55 | – 36 |
| 0.6 | 0.59 | – 149 | 7.88 | 93 | 0.046 | 40 | 0.46 | – 37 |
| 0.8 | 0.59 | – 164 | 6.01 | 84 | 0.051 | 41 | 0.42 | – 37 |
| 1.0 | 0.59 | – 174 | 4.83 | 77 | 0.056 | 43 | 0.40 | – 38 |
| 1.2 | 0.59 | 178 | 4.09 | 70 | 0.061 | 44 | 0.38 | – 40 |
| 1.5 | 0.59 | 167 | 3.29 | 61 | 0.070 | 46 | 0.37 | – 43 |
| 1.8 | 0.60 | 159 | 2.75 | 53 | 0.080 | 47 | 0.37 | – 48 |
| 2.0 | 0.62 | 153 | 2.49 | 48 | 0.087 | 47 | 0.36 | – 52 |
| 2.5 | 0.63 | 142 | 2.03 | 36 | 0.106 | 47 | 0.34 | – 62 |
| 3.0 | 0.66 | 131 | 1.73 | 25 | 0.126 | 45 | 0.33 | – 75 |

***S*11, *S*22 = *f* (*f*)**
$I_C$ = 10 mA, $V_{CE}$ = 10 V, $Z_0$ = 50 Ω

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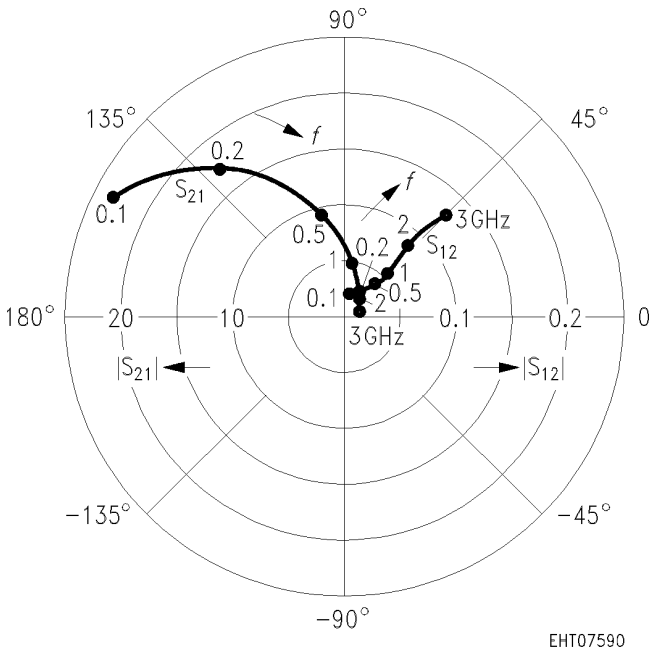
***S*12, *S*21 = *f* (*f*)**
$I_C$ = 10 mA, $V_{CE}$ = 10 V, $Z_0$ = 50 Ω




EHT07590