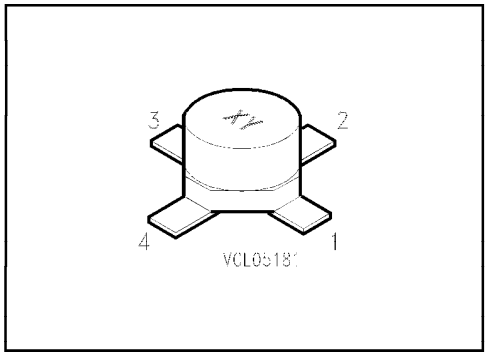
SIEMENS

## NPN Silicon RF Transistor

**BFQ 73S**

- For low-noise, low-distortion broadband amplifiers in antenna and telecommunications systems up to 2 GHz at collector currents from 10 mA to 70 mA.
- Hermetically sealed ceramic package.
- HiRel/Mil screening available.
- CECC-type available: CECC 50002/261.




**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 73S | 73S | Q62702-F1104 | B | E | C | E | Cerec-X |

### Maximum Ratings

| Parameter | Symbol | Values | Unit |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE0}$ | 15 | V |
| Collector-base voltage | $V_{CB0}$ | 20 | |
| Emitter-base voltage | $V_{EB0}$ | 3 | |
| Collector current | $I_C$ | 100 | mA |
| Total power dissipation, $T_S \leq 110$ °C[3] | $P_{tot}$ | 500 | 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] | $R_{th\ JA}$ | ≤ 210 | K/W |
| Junction - soldering point[3] | $R_{th\ JS}$ | ≤ 130 | |

1) For detailed information see chapter Package Outlines.
2) Package mounted on alumina 15 mm × 16.7 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.

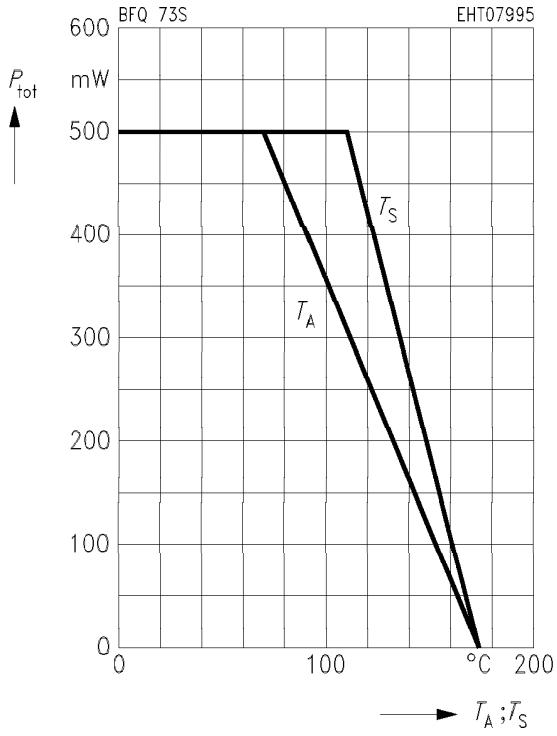
| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| **DC Characteristics** | | | | | |
| Collector-emitter breakdown voltage<br>$I_C$ = 1 mA, $I_B$ = 0 | $V_{(BR)CE0}$ | 15 | – | – | V |
| Collector-base cutoff current<br>$V_{CB}$ = 10 V, $I_E$ = 0 | $I_{CB0}$ | – | – | 100 | nA |
| Emitter-base cutoff current<br>$V_{EB}$ = 2 V, $I_C$ = 0 | $I_{EB0}$ | – | – | 10 | µA |
| DC current gain<br>$I_C$ = 50 mA, $V_{CE}$ = 5 V | $h_{FE}$ | 30 | 90 | 250 | – |
| Collector-emitter saturation voltage<br>$I_C$ = 75 mA, $I_B$ = 7.5 mA | $V_{CEsat}$ | – | 0.2 | 0.5 | V |

## Electrical Characteristics

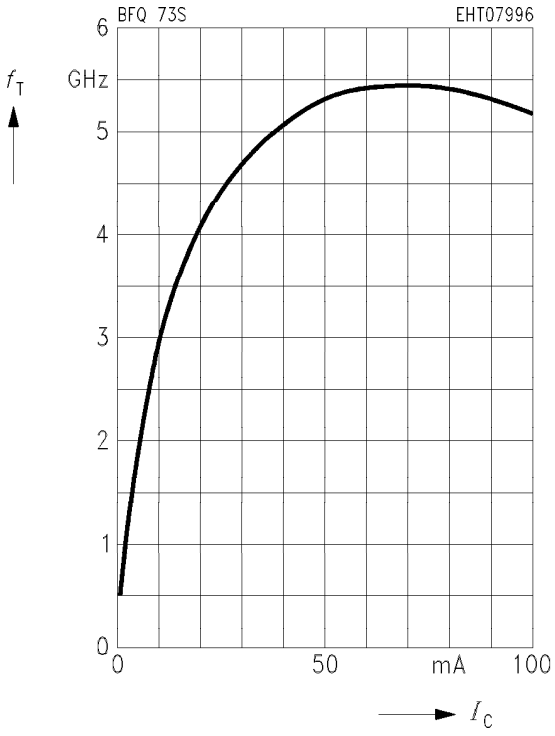
at $T_A$ = 25 °C, unless otherwise specified.

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| **AC Characteristics** | | | | | |
| Transition frequency<br>$I_C$ = 50 mA, $V_{CE}$ = 5 V, $f$ = 200 MHz<br>$I_C$ = 75 mA, $V_{CE}$ = 5 V, $f$ = 200 MHz | $f_t$ | <br>–<br>– | <br>5.3<br>5.4 | <br>–<br>– | GHz |
| Collector-base capacitance<br>$V_{CB}$ = 10 V, $V_{BE}$ = $v_{be}$ = 0, $f$ = 1 MHz | $C_{cb}$ | – | 0.9 | – | pF |
| Collector-emitter capacitance<br>$V_{CE}$ = 10 V, $V_{BE}$ = $v_{be}$ = 0, $f$ = 1 MHz | $C_{ce}$ | – | 0.4 | – | |
| Input capacitance<br>$V_{EB}$ = 0.5 V, $I_C$ = $i_c$ = 0, $f$ = 1 MHz | $C_{ibo}$ | – | 5 | – | |
| Output capacitance<br>$V_{CE}$ = 10 V, $V_{BE}$ = $v_{be}$ = 0, $f$ = 1 MHz | $C_{obs}$ | – | 1.3 | – | |
| Noise figure<br>$I_C$ = 5 mA, $V_{CE}$ = 10 V, $f$ = 10 MHz, $Z_S$ = 50 Ω<br>$I_C$ = 50 mA, $V_{CE}$ = 5 V, $f$ = 800 MHz, $Z_S$ = $Z_{Sopt}$ | $F$ | <br>–<br>– | <br>0.9<br>2.5 | <br>–<br>– | dB |
| Power gain<br>$I_C$ = 50 mA, $V_{CE}$ = 5 V, $f$ = 800 MHz,<br>$Z_S$ = $Z_{Sopt}$, $Z_L$ = $Z_{Lopt}$ | $G_{pe}$ | – | 15 | – | |
| Transducer gain<br>$I_C$ = 50 mA, $V_{CE}$ = 5 V, $f$ = 1 GHz, $Z_0$ = 50 Ω | $\lvert S_{21e}\rvert^2$ | – | 10.5 | – | |
| Linear output voltage<br>two-tone intermodulation test<br>$I_C$ = 50 mA, $V_{CE}$ = 10 V, $d_{IM}$ = 60 dB<br>$f_1$ = 806 MHz, $f_2$ = 810 MHz, $Z_S$ = $Z_L$ = 50 Ω | $V_{o1}$ = $V_{o2}$ | – | 400 | – | mV |
| Third order intercept point<br>$I_C$ = 50 mA, $V_{CE}$ = 10 V, $f$ = 800 MHz | $IP_3$ | – | 35 | – | dBm |

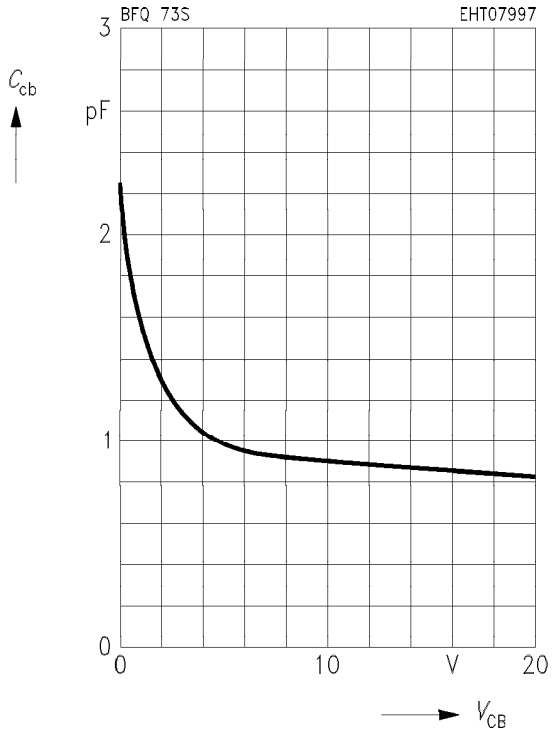
**Total power dissipation $P_{tot} = f(T_A^*; T_S)$**
* Package mounted on alumina




**Transition frequency $f_T = f(I_C)$**
$V_{CE}$ = 5 V, $f$ = 200 MHz



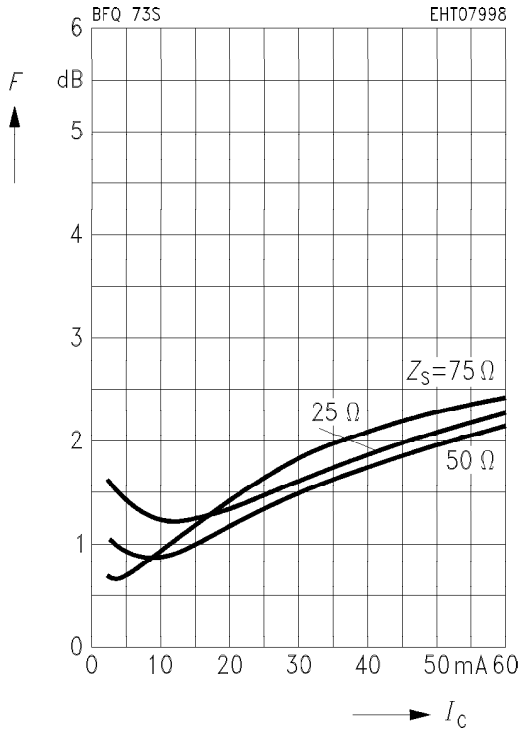

**Collector-base capacitance $C_{cb} = f(V_{CB})$**
$V_{BE} = v_{be} = 0$, $f$ = 1 MHz



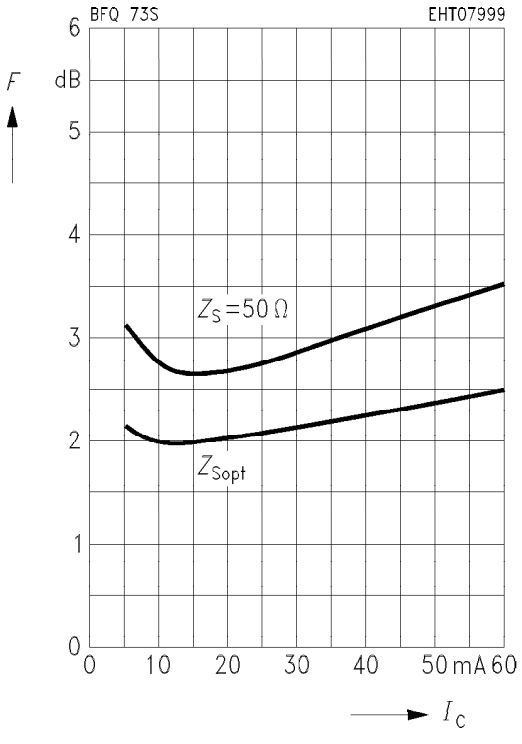
## Common Emitter Noise Parameters

| $f$ | $F_{min}$ | $G_p(F_{min})$ | $\Gamma_{opt}$ | | $R_N$ | $N$ | $F_{50\,\Omega}$ | $G_p(F_{50\Omega})$ |
|---|---|---|---|---|---|---|---|---|
| GHz | dB | dB | MAG | ANG | Ω | – | dB | dB |
| $I_C$ = 5 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.01 | 0.9 | – | ($Z_S$ = 50 Ω) | | – | – | – | – |
| $I_C$ = 50 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.01 | 2.0 | – | ($Z_S$ = 50 Ω) | | – | – | – | – |
| 0.8 | 2.5 | 14 | 0.41 | 163 | 9 | 0.39 | 3.8 | – |

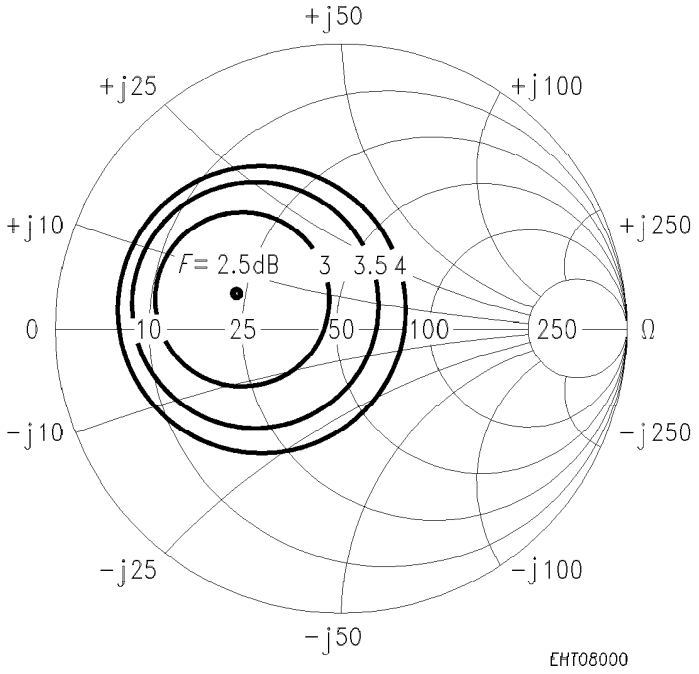
**Noise figure $F = f(I_C)$**
$V_{CE}$ = 10 V, $f$ = 10 MHz, $Z_S$ = 50 Ω




**Noise figure $F = f(I_C)$**
$V_{CE}$ = 5 V, $f$ = 800 MHz

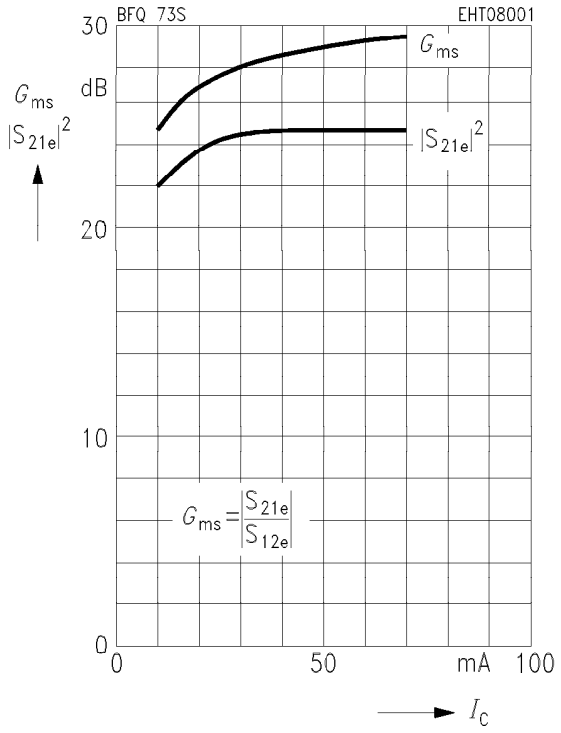


**Circles of constant noise figure $F = f(Z_S)$ and available power gain $G_{av} = f(Z_S)$**
$I_C$ = 50 mA, $V_{CE}$ = 5 V, $f$ = 800 MHz,
$Z_0$ = 50 Ω

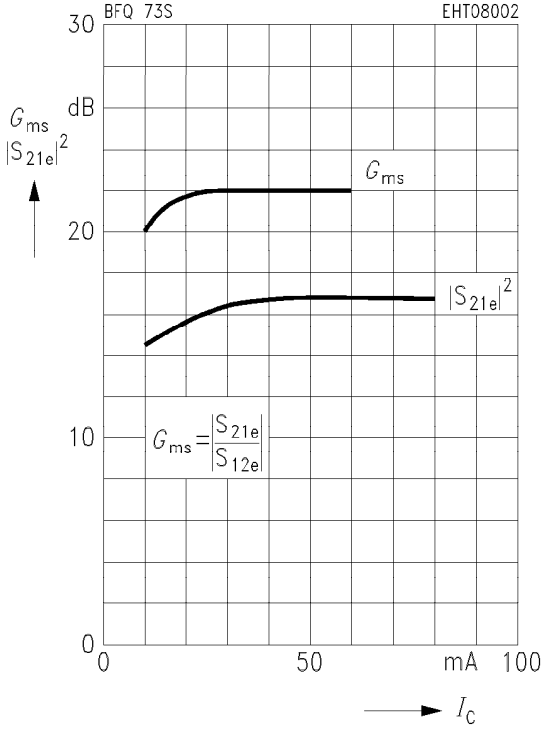


## Common Emitter Power Gain

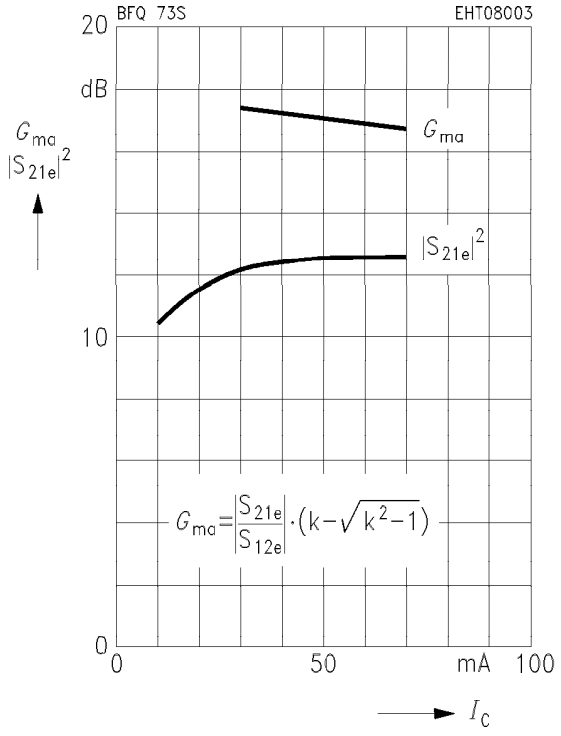
**Power gain $G_{ms}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 5 V, $f$ = 200 MHz, $Z_0$ = 50 Ω



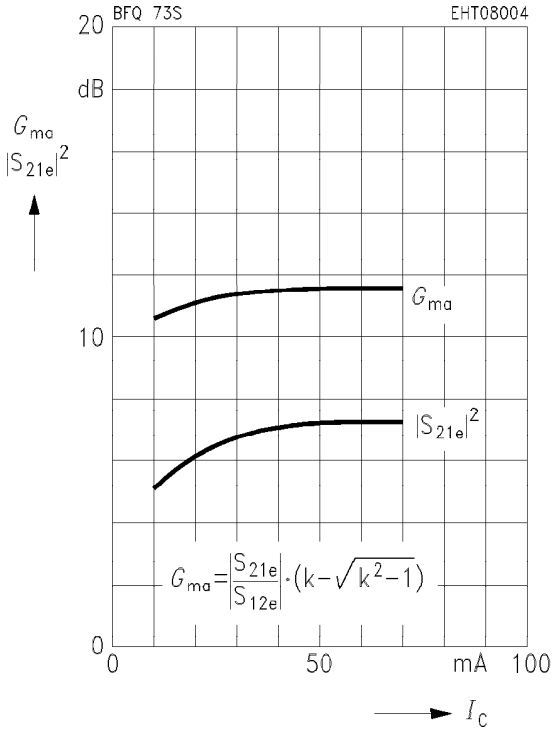

**Power gain $G_{ms}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 5 V, $f$ = 500 MHz, $Z_0$ = 50 Ω



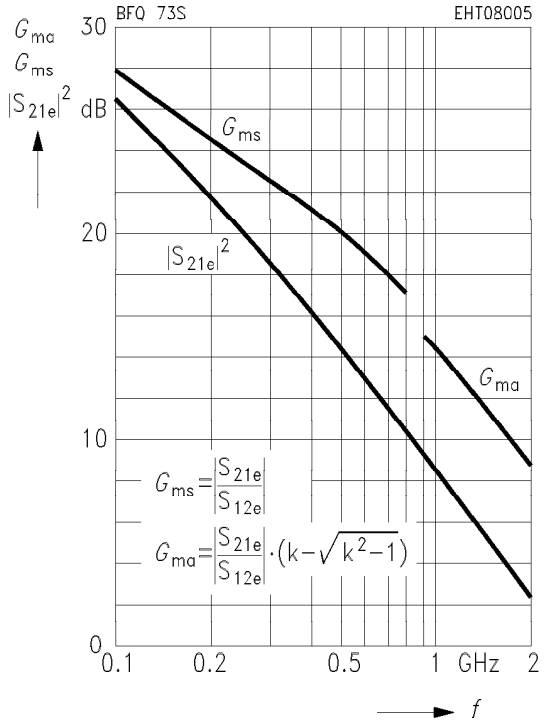

**Power gain $G_{ma}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 5 V, $f$ = 800 MHz, $Z_0$ = 50 Ω



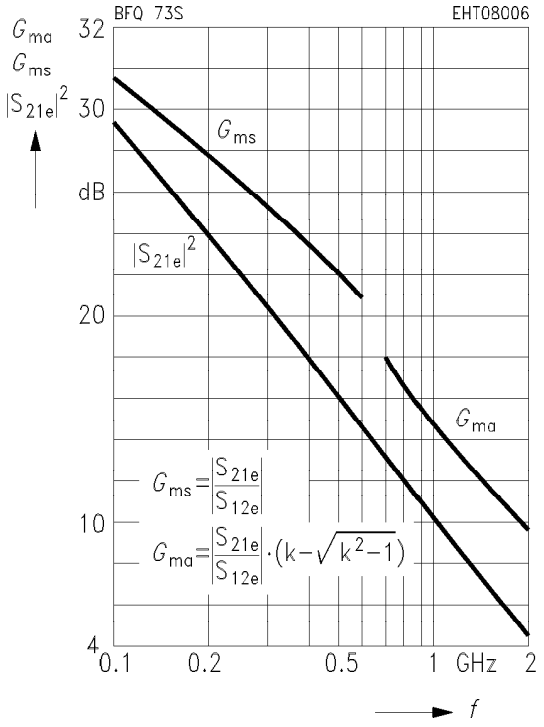

**Power gain $G_{ma}$, $|S_{21e}|^2 = f(I_C)$**
$V_{CE}$ = 5 V, $f$ = 1.5 GHz, $Z_0$ = 50 Ω



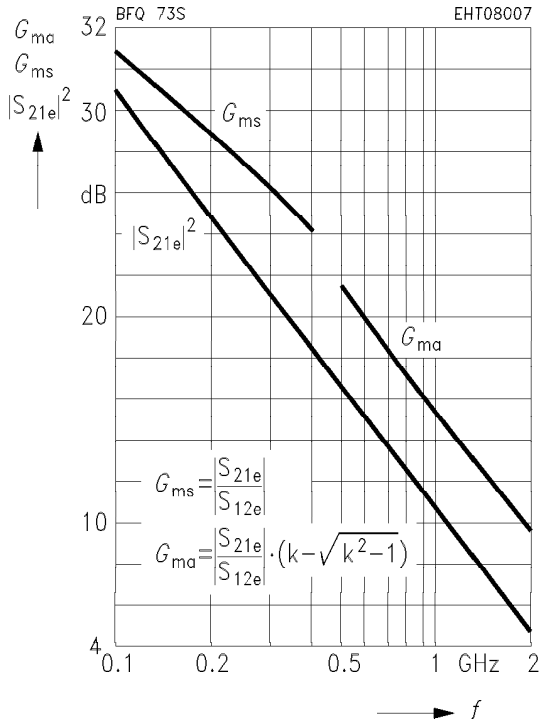
**Power gain $G_{ma}$, $G_{ms}$, $|S_{21e}|^2 = f(f)$**
$I_C$ = 10 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω



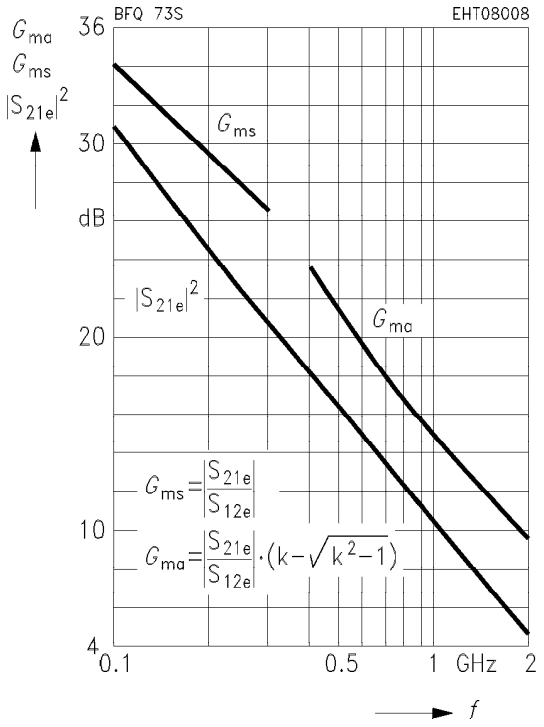

**Power gain $G_{ma}$, $G_{ms}$, $|S_{21e}|^2 = f(f)$**
$I_C$ = 30 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω




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



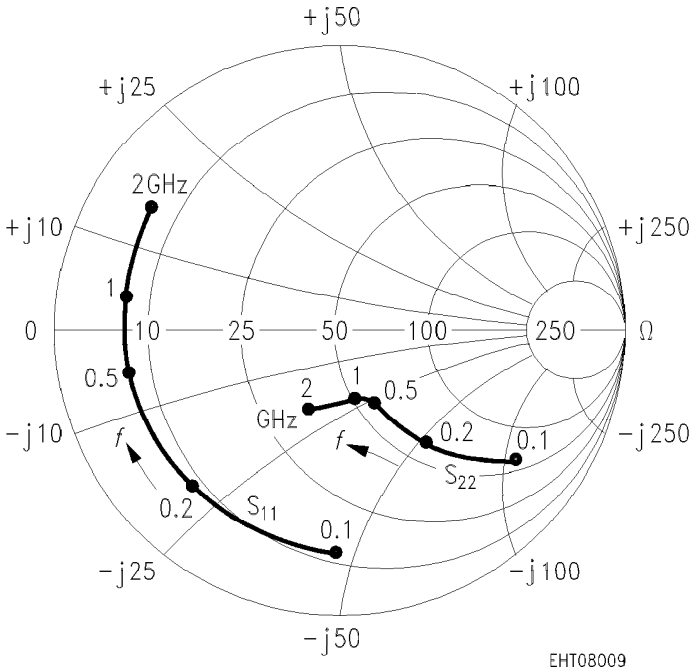

**Power gain $G_{ma}$, $G_{ms}$, $|S_{21e}|^2 = f(f)$**
$I_C$ = 70 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω



## Common Emitter S Parameters

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| $I_C$ = 10 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.78 | – 92 | 20.39 | 132 | 0.034 | 48 | 0.71 | – 39 |
| 0.3 | 0.75 | – 152 | 8.63 | 97 | 0.047 | 30 | 0.34 | – 57 |
| 0.5 | 0.75 | – 169 | 5.27 | 84 | 0.053 | 31 | 0.26 | – 61 |
| 0.8 | 0.75 | 177 | 3.29 | 71 | 0.060 | 35 | 0.23 | – 68 |
| 1.0 | 0.76 | 171 | 2.63 | 63 | 0.066 | 39 | 0.22 | – 73 |
| 1.2 | 0.77 | 165 | 2.21 | 57 | 0.073 | 42 | 0.22 | – 79 |
| 1.4 | 0.77 | 159 | 1.91 | 50 | 0.081 | 43 | 0.23 | – 84 |
| 1.6 | 0.77 | 155 | 1.68 | 44 | 0.089 | 45 | 0.24 | – 91 |
| 1.8 | 0.78 | 151 | 1.49 | 38 | 0.098 | 45 | 0.25 | – 98 |
| 2.0 | 0.79 | 147 | 1.34 | 32 | 0.107 | 46 | 0.26 | – 106 |

$S_{11}$, $S_{22}$ = $f$ ($f$)
$I_C$ = 10 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω

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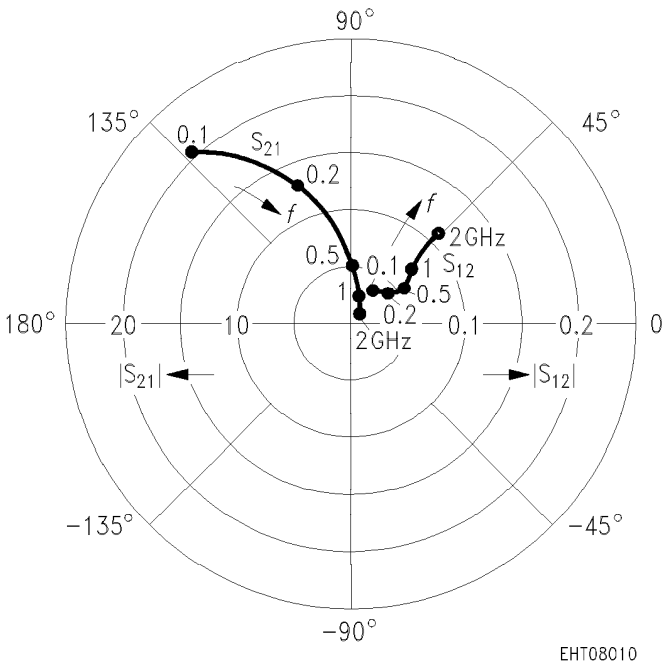
$S_{12}$, $S_{21}$ = $f$ ($f$)
$I_C$ = 10 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω

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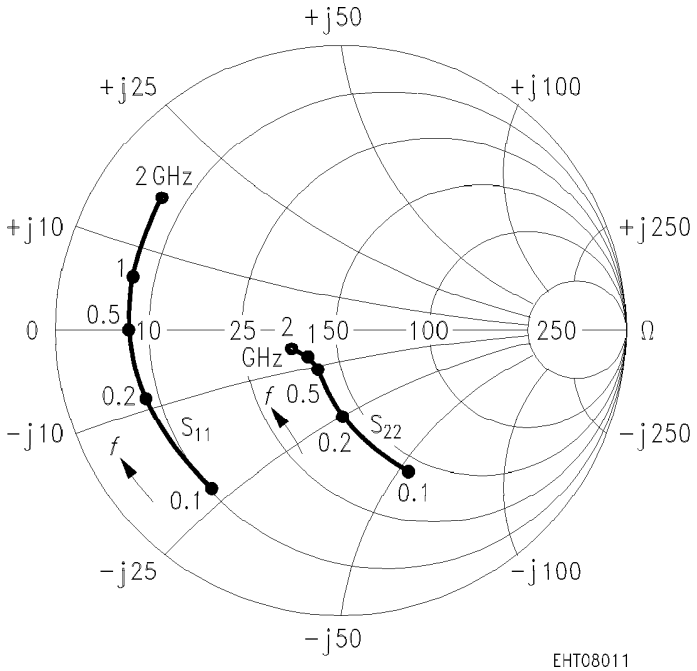
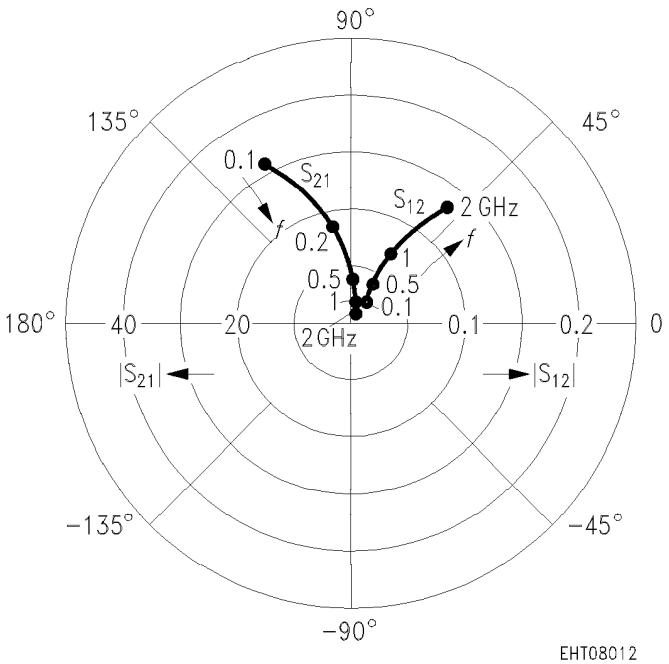
**Common Emitter S Parameters** (continued)

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 30 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.72 | – 30 | 31.12 | 117 | 0.022 | 44 | 0.49 | – 66 |
| 0.3 | 0.73 | – 168 | 11.01 | 91 | 0.029 | 45 | 0.20 | – 103 |
| 0.5 | 0.74 | – 179 | 6.61 | 82 | 0.040 | 51 | 0.15 | – 119 |
| 0.8 | 0.73 | 170 | 4.10 | 71 | 0.056 | 55 | 0.14 | – 132 |
| 1.0 | 0.75 | 166 | 3.27 | 64 | 0.067 | 56 | 0.13 | – 139 |
| 1.2 | 0.75 | 161 | 2.75 | 59 | 0.079 | 56 | 0.13 | – 144 |
| 1.4 | 0.76 | 156 | 2.38 | 53 | 0.090 | 55 | 0.14 | – 146 |
| 1.6 | 0.75 | 152 | 2.09 | 47 | 0.102 | 54 | 0.14 | – 148 |
| 1.8 | 0.76 | 149 | 1.85 | 41 | 0.113 | 52 | 0.16 | – 152 |
| 2.0 | 0.78 | 145 | 1.67 | 36 | 0.123 | 51 | 0.17 | – 157 |

$S_{11}$, $S_{22}$ = $f$ ($f$)
$I_C$ = 30 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω



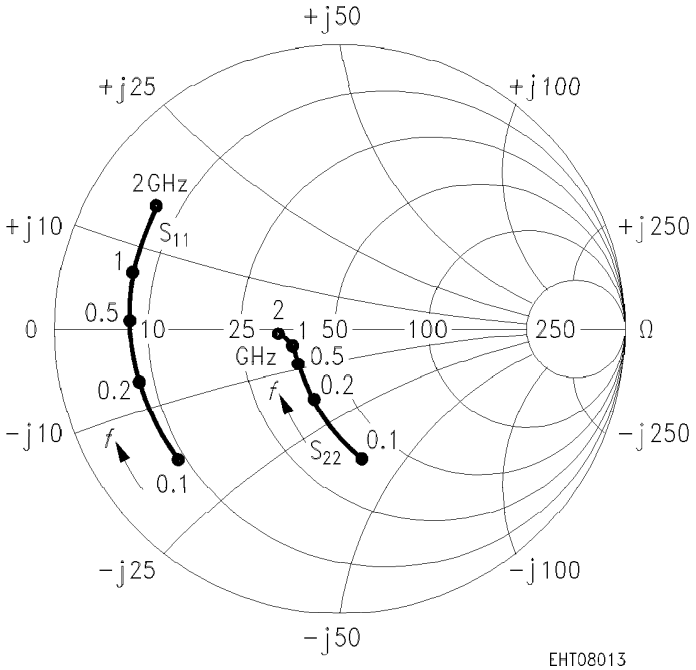

$S_{12}$, $S_{21}$ = $f$ ($f$)
$I_C$ = 30 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω



**Common Emitter S Parameters** (continued)

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 50 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.72 | – 142 | 33.86 | 111 | 0.018 | 43 | 0.42 | – 79 |
| 0.3 | 0.73 | – 173 | 11.49 | 90 | 0.027 | 52 | 0.19 | – 122 |
| 0.5 | 0.73 | 177 | 6.87 | 81 | 0.038 | 58 | 0.16 | – 139 |
| 0.8 | 0.73 | 169 | 4.25 | 70 | 0.056 | 60 | 0.15 | – 152 |
| 1.0 | 0.75 | 165 | 3.39 | 64 | 0.068 | 60 | 0.15 | – 158 |
| 1.2 | 0.75 | 160 | 2.85 | 59 | 0.080 | 59 | 0.15 | – 162 |
| 1.4 | 0.75 | 155 | 2.46 | 53 | 0.092 | 58 | 0.15 | – 165 |
| 1.6 | 0.75 | 152 | 2.16 | 48 | 0.105 | 56 | 0.16 | – 166 |
| 1.8 | 0.75 | 148 | 1.92 | 42 | 0.116 | 53 | 0.17 | – 169 |
| 2.0 | 0.78 | 144 | 1.72 | 37 | 0.126 | 52 | 0.18 | – 172 |

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

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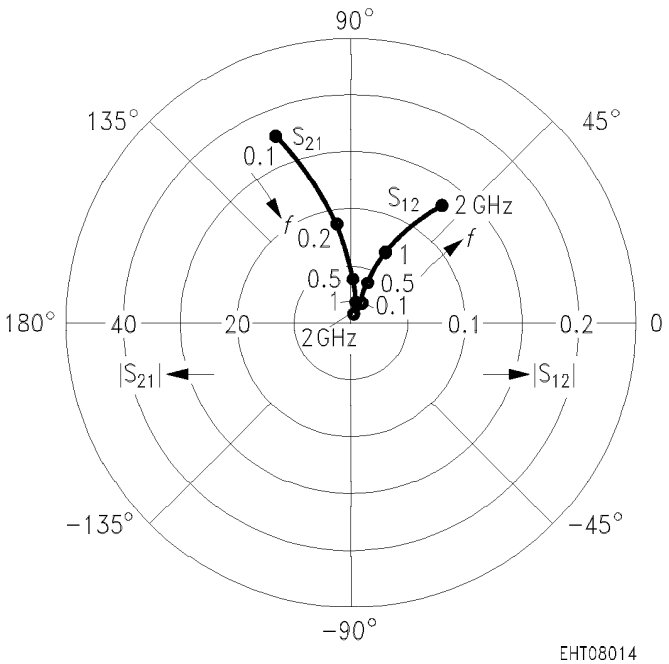
$S_{12}$, $S_{21}$ = $f$ ($f$)
$I_C$ = 50 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω

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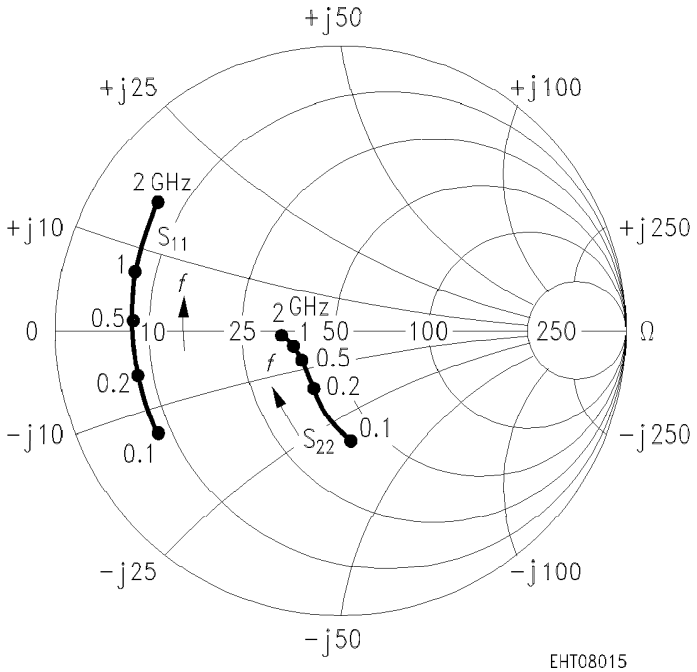
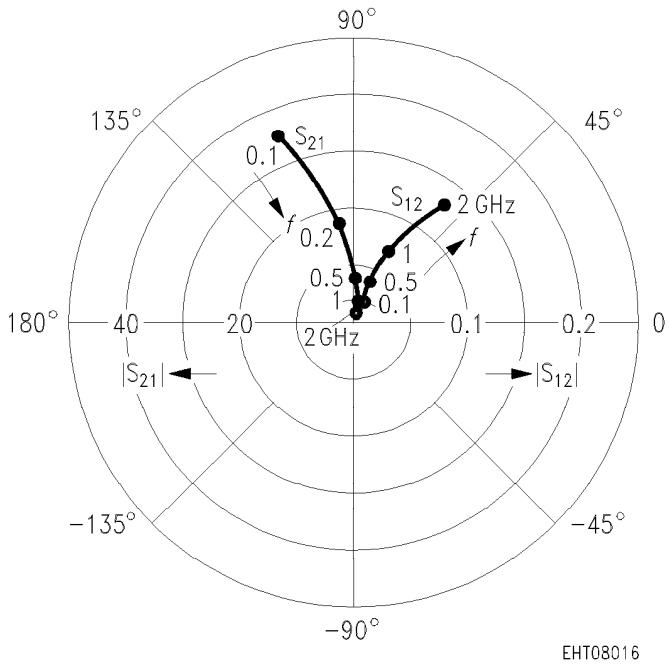
**Common Emitter S Parameters** (continued)

| $f$ | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| **GHz** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** | **MAG** | **ANG** |
| $I_C$ = 70 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω | | | | | | | | |
| 0.1 | 0.72 | – 149 | 34.51 | 108 | 0.014 | 42 | 0.37 | – 87 |
| 0.3 | 0.73 | – 175 | 11.47 | 89 | 0.025 | 56 | 0.18 | – 130 |
| 0.5 | 0.73 | 176 | 6.84 | 80 | 0.037 | 62 | 0.16 | – 146 |
| 0.8 | 0.74 | 168 | 4.24 | 70 | 0.056 | 63 | 0.16 | – 157 |
| 1.0 | 0.75 | 164 | 3.38 | 64 | 0.069 | 62 | 0.16 | – 163 |
| 1.2 | 0.75 | 159 | 2.84 | 59 | 0.081 | 61 | 0.16 | – 167 |
| 1.4 | 0.76 | 155 | 2.45 | 53 | 0.093 | 59 | 0.16 | – 170 |
| 1.6 | 0.75 | 151 | 2.15 | 48 | 0.105 | 57 | 0.16 | – 171 |
| 1.8 | 0.77 | 148 | 1.91 | 42 | 0.177 | 54 | 0.17 | – 173 |
| 2.0 | 0.78 | 144 | 1.71 | 38 | 0.127 | 52 | 0.18 | – 177 |

$S_{11}$, $S_{22}$ = $f$ ($f$)
$I_C$ = 70 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω

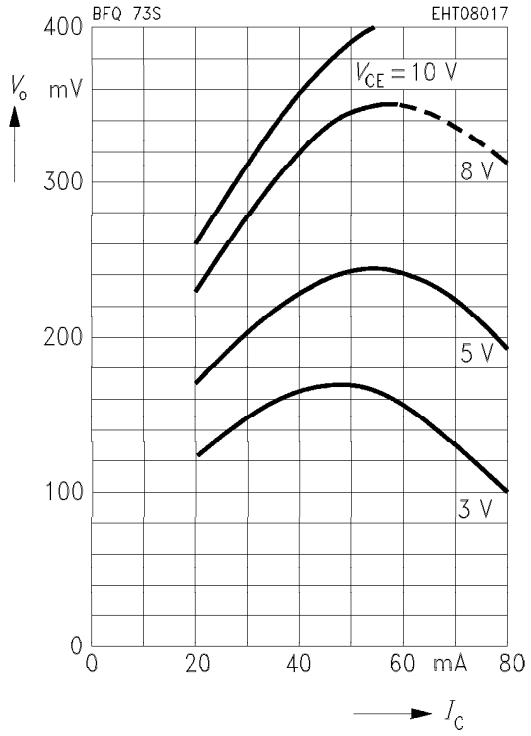



$S_{12}$, $S_{21}$ = $f$ ($f$)
$I_C$ = 70 mA, $V_{CE}$ = 5 V, $Z_0$ = 50 Ω



## Common Emitter Large Signal Parameters

**Linear output voltage $V_o = f(I_C)$**
$d_{IM}$ = 60 dB, $f_1$ = 806 MHz,
$f_2$ = 810 MHz, $Z_S = Z_L$ = 50 Ω




**Note:**

The transistor is driven by 2 adjacent signals $f_1$, $f_2$ with equal output power levels $P_o$ for each carrier.

The distance $d_{IM}$ between $P_o$ and the third order intermodulation products $P_{IM}$ ($2f_1 - f_2$ or $2f_2 - f_1$) is:

$d_{IM} = P_o - P_{IM}$
where $P_o$ = 10 log ($V_o^2$ / (50 Ω • 1mW)) (dBm)
and $V_o$ = linear output voltage of each carrier.

The 3rd order intercept point $IP_3$ will be found by extrapolation to the point where $P_{IM}$ would be identical to $P_o$:

$IP_3$ (output) = $P_o + d_{IM}/2$.

Linear output voltages for other $d_{IM}$ (e.g. 50 dB) can be calculated thereby.