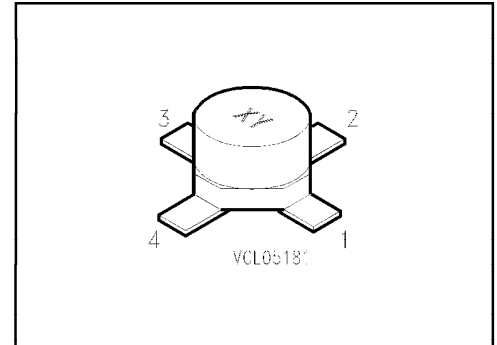


## NPN Silicon RF Transistor

**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: Electrostatic discharge sensitive device, observe handling precautions!**

| Type    | Marking | Ordering Code<br>(tape and reel) | Pin Configuration |   |   |   | Package <sup>1)</sup> |
|---------|---------|----------------------------------|-------------------|---|---|---|-----------------------|
|         |         |                                  | 1                 | 2 | 3 | 4 |                       |
| BFQ 73S | 73S     | Q62702-F1104                     | B                 | E | C | E | Cerrec-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, $T_s \leq 110\text{ °C}^3)$ | $P_{tot}$ | 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 <sup>2)</sup>         | $R_{th\ JA}$ | $\leq 210$ | K/W |
| Junction - soldering point <sup>3)</sup> | $R_{th\ JS}$ | $\leq 130$ |     |

1) For detailed information see chapter Package Outlines.

2) Package mounted on alumina  $15\text{ mm} \times 16.7\text{ mm} \times 0.7\text{ mm}$ .

3)  $T_s$  is measured on the collector lead at the soldering point to the pcb.

**Electrical Characteristics**at  $T_A = 25\text{ °C}$ , unless otherwise specified.

| Parameter | Symbol | Values |      |      | Unit |
|-----------|--------|--------|------|------|------|
|           |        | min.   | typ. | max. |      |

**DC Characteristics**

|  |               |    |     |     |               |
|--|---------------|----|-----|-----|---------------|
| Collector-emitter breakdown voltage<br>$I_C = 1\text{ mA}$ , $I_B = 0$               | $V_{(BR)CE0}$ | 15 | –   | –   | V             |
| Collector-base cutoff current<br>$V_{CB} = 10\text{ V}$ , $I_E = 0$                  | $I_{CB0}$     | –  | –   | 100 | nA            |
| Emitter-base cutoff current<br>$V_{EB} = 2\text{ V}$ , $I_C = 0$                     | $I_{EB0}$     | –  | –   | 10  | $\mu\text{A}$ |
| DC current gain<br>$I_C = 50\text{ mA}$ , $V_{CE} = 5\text{ V}$                      | $h_{FE}$      | 30 | 90  | 250 | –             |
| Collector-emitter saturation voltage<br>$I_C = 75\text{ mA}$ , $I_B = 7.5\text{ mA}$ | $V_{CEsat}$   | –  | 0.2 | 0.5 | V             |

## Electrical Characteristics

at  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise specified.

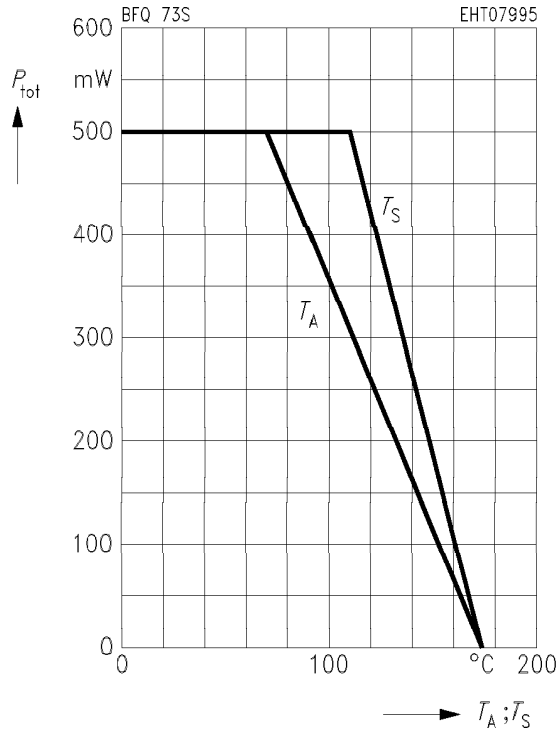
| Parameter | Symbol | Values |      |      | Unit |
|-----------|--------|--------|------|------|------|
|           |        | min.   | typ. | max. |      |

## AC Characteristics

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

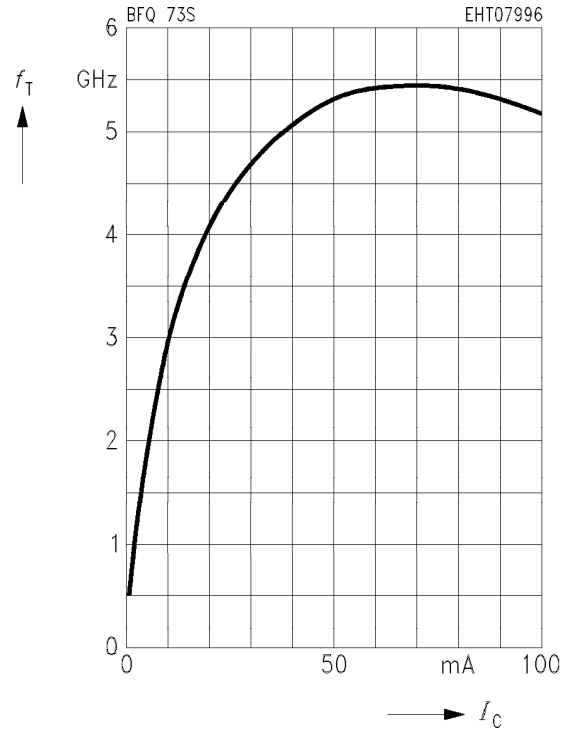
**Total power dissipation  $P_{tot} = f(T_A^*; T_S)$**

\* Package mounted on alumina



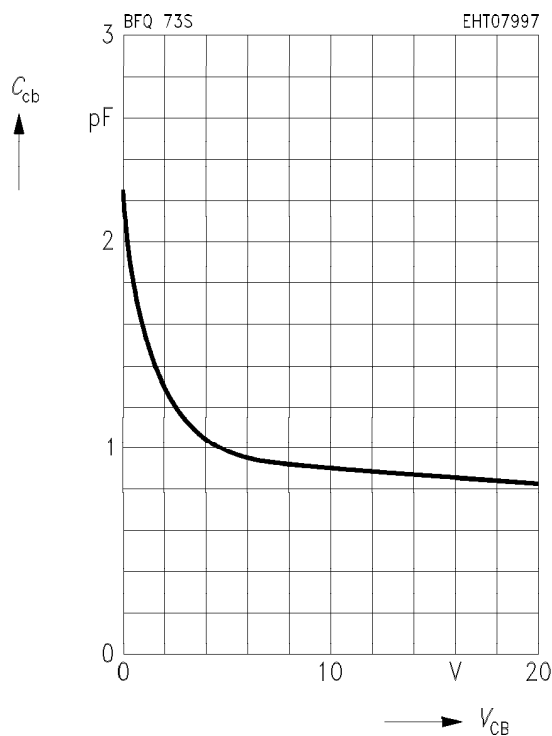
**Transition frequency  $f_T = f(I_C)$**

$V_{CE} = 5 \text{ V}, f = 200 \text{ MHz}$



**Collector-base capacitance  $C_{cb} = f(V_{CB})$**

$V_{BE} = v_{be} = 0, f = 1 \text{ MHz}$



### 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 | $\Omega$ | —   | dB             | dB                  |

$I_C = 5 \text{ mA}, V_{CE} = 5 \text{ V}, Z_0 = 50 \Omega$

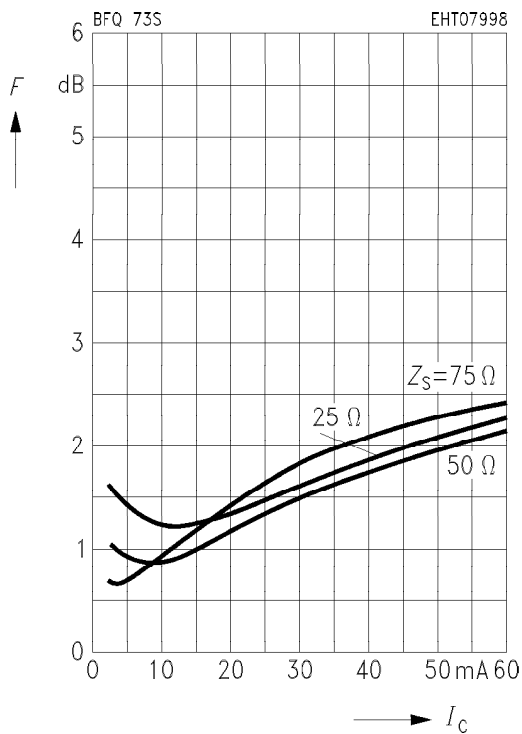
|      |     |   |                         |  |   |   |   |   |
|------|-----|---|-------------------------|--|---|---|---|---|
| 0.01 | 0.9 | — | (Z <sub>s</sub> = 50 Ω) |  | — | — | — | — |
|------|-----|---|-------------------------|--|---|---|---|---|

$I_C = 50 \text{ mA}, V_{CE} = 5 \text{ V}, Z_0 = 50 \Omega$

|      |     |    |                         |     |   |      |     |   |
|------|-----|----|-------------------------|-----|---|------|-----|---|
| 0.01 | 2.0 | —  | (Z <sub>s</sub> = 50 Ω) |     | — | —    | —   | — |
| 0.8  | 2.5 | 14 | 0.41                    | 163 | 9 | 0.39 | 3.8 | — |

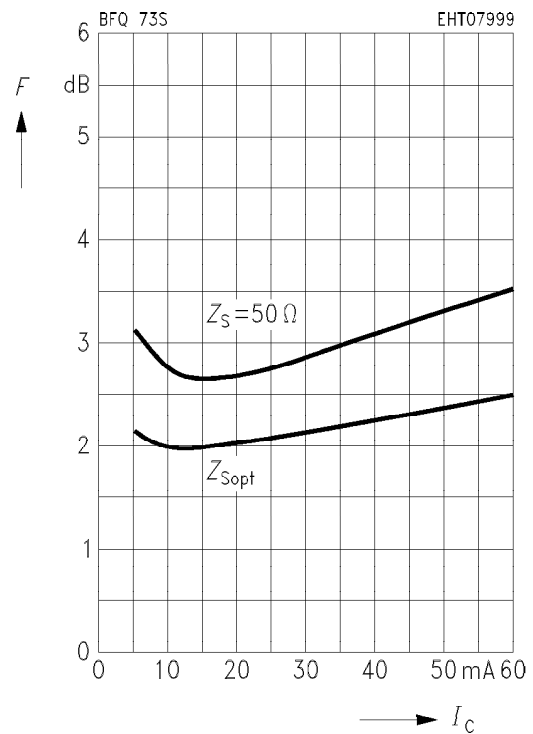
### Noise figure $F = f(I_C)$

$V_{CE} = 10 \text{ V}, f = 10 \text{ MHz}, Z_S = 50 \Omega$



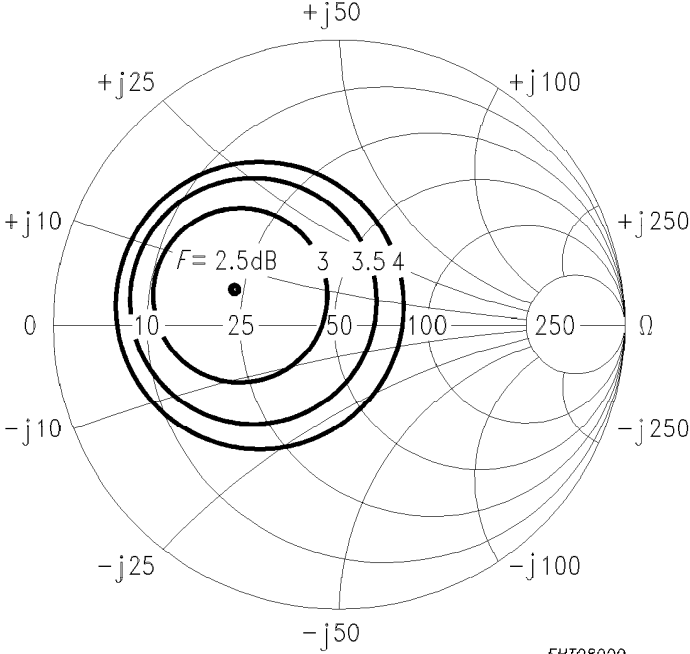
### Noise figure $F = f(I_C)$

$V_{CE} = 5 \text{ V}, f = 800 \text{ MHz}$



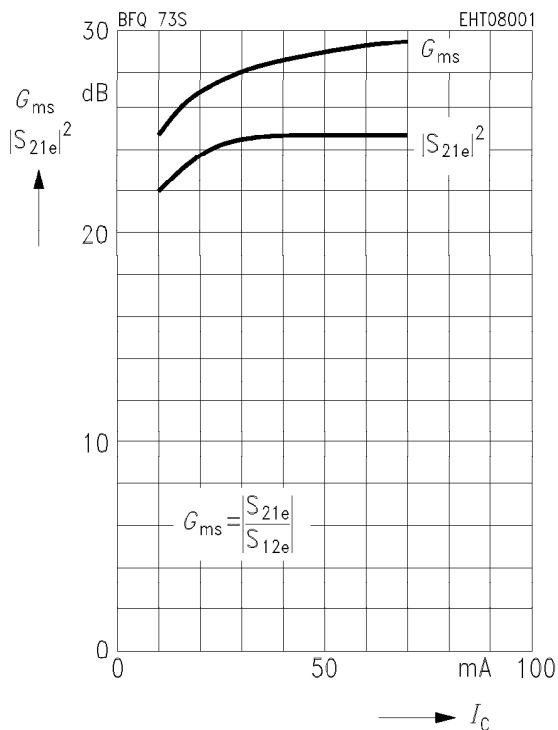
**Circles of constant noise figure  $F = f(Z_s)$   
and available power gain  $G_{av} = f(Z_s)$**

$I_C = 50 \text{ mA}$ ,  $V_{CE} = 5 \text{ V}$ ,  $f = 800 \text{ MHz}$ ,  
 $Z_0 = 50 \Omega$

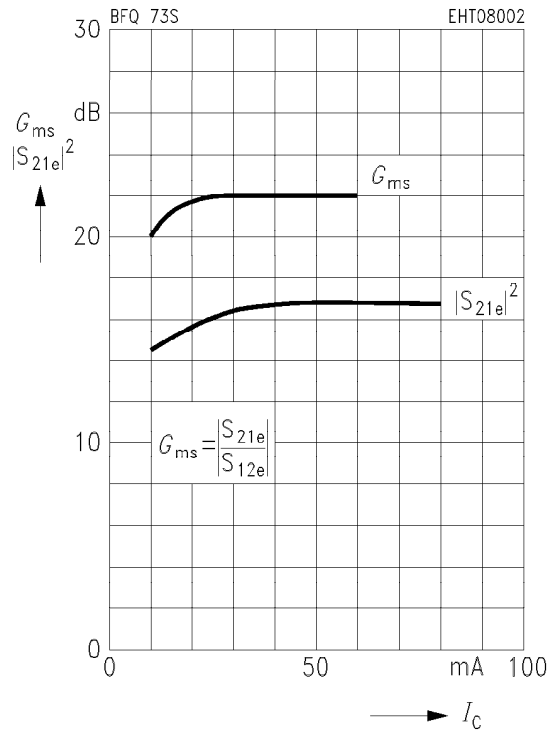


**Common Emitter Power Gain**

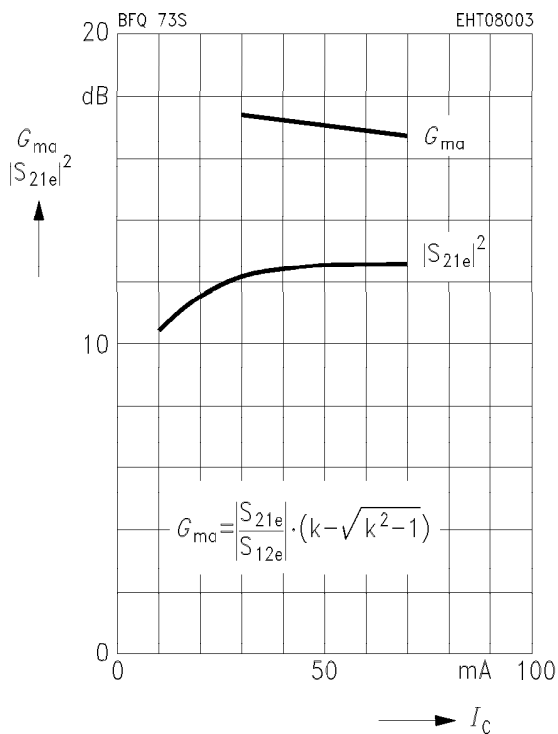
**Power gain  $G_{ms}$ ,  $|S_{21e}|^2 = f(I_c)$**   
 $V_{CE} = 5 \text{ V}, f = 200 \text{ MHz}, Z_0 = 50 \Omega$



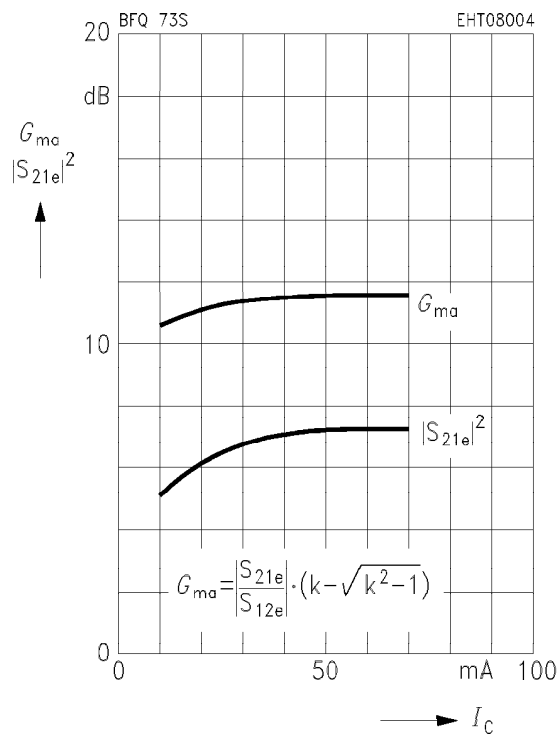
**Power gain  $G_{ms}$ ,  $|S_{21e}|^2 = f(I_c)$**   
 $V_{CE} = 5 \text{ V}, f = 500 \text{ MHz}, Z_0 = 50 \Omega$



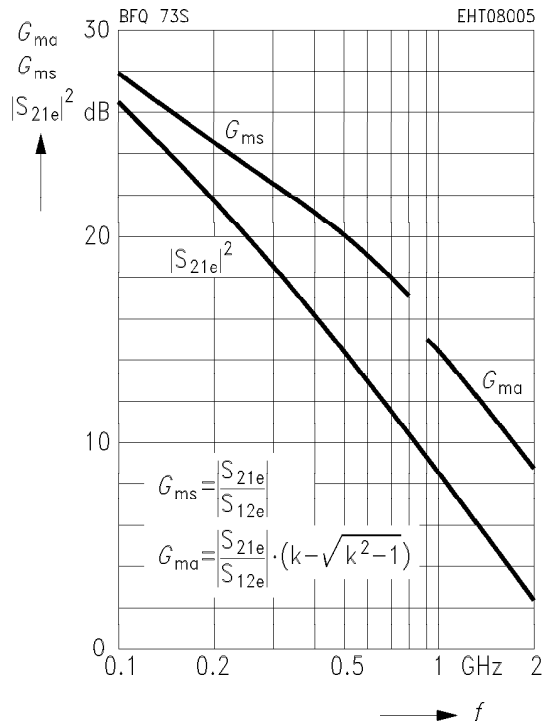
**Power gain  $G_{ma}$ ,  $|S_{21e}|^2 = f(I_c)$**   
 $V_{CE} = 5 \text{ V}, f = 800 \text{ MHz}, Z_0 = 50 \Omega$



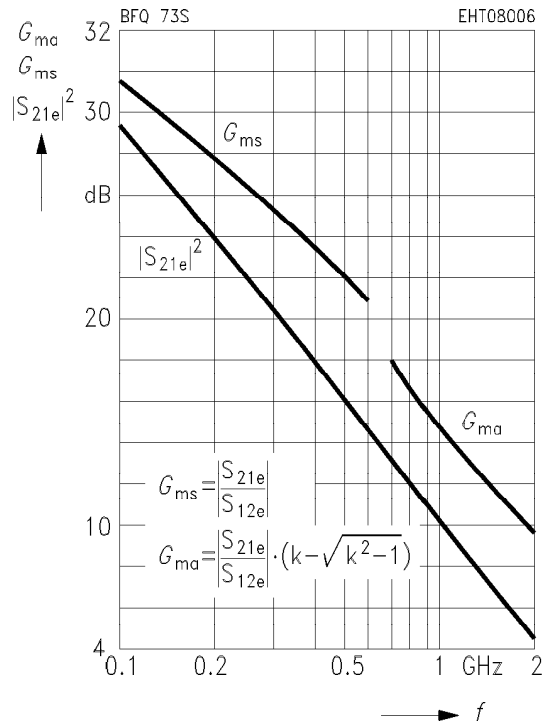
**Power gain  $G_{ma}$ ,  $|S_{21e}|^2 = f(I_c)$**   
 $V_{CE} = 5 \text{ V}, f = 1.5 \text{ GHz}, Z_0 = 50 \Omega$



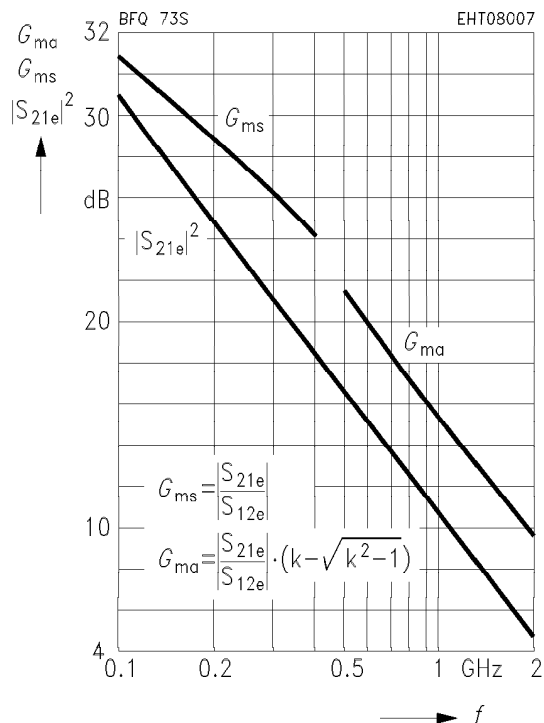
**Power gain  $G_{ma}$ ,  $G_{ms}$ ,  $|S_{21e}|^2 = f(f)$**   
 $I_C = 10 \text{ mA}$ ,  $V_{CE} = 5 \text{ V}$ ,  $Z_0 = 50 \Omega$



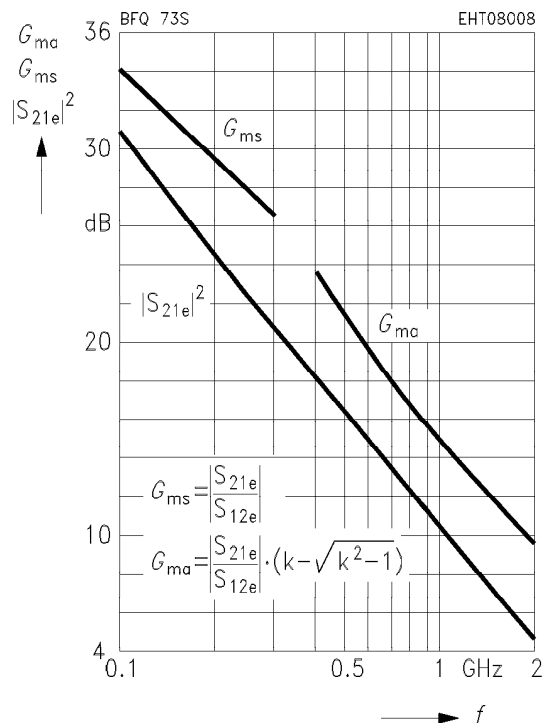
**Power gain  $G_{ma}$ ,  $G_{ms}$ ,  $|S_{21e}|^2 = f(f)$**   
 $I_C = 30 \text{ mA}$ ,  $V_{CE} = 5 \text{ V}$ ,  $Z_0 = 50 \Omega$



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



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

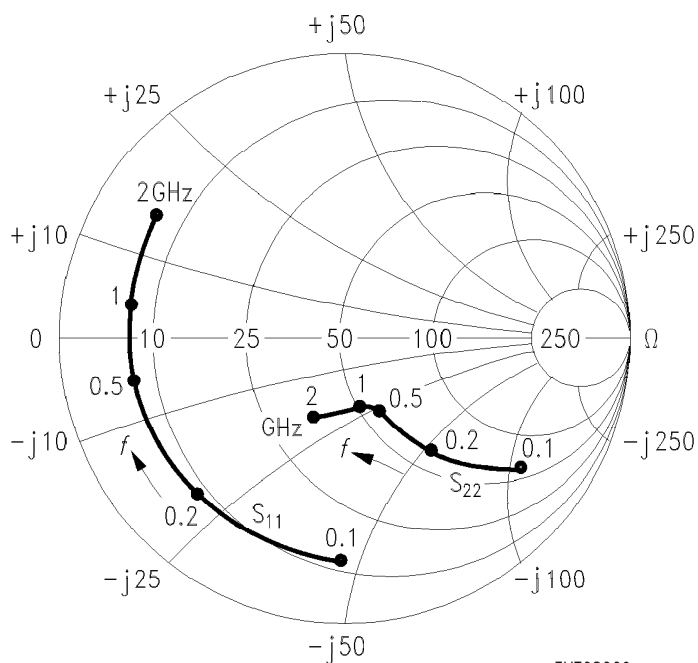


### Common Emitter S Parameters

| $f$  | $S_{11}$ |       | $S_{21}$ |     | $S_{12}$ |     | $S_{22}$ |       |
|--|----------|-------|----------|-----|----------|-----|----------|-------|
| GHz  | MAG      | ANG   | MAG      | ANG | MAG      | ANG | MAG      | ANG   |
| $I_C = 10 \text{ mA}, V_{CE} = 5 \text{ V}, Z_0 = 50 \Omega$ |          |       |          |     |          |     |          |       |
| 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 |

$S_{11}, S_{22} = f(f)$

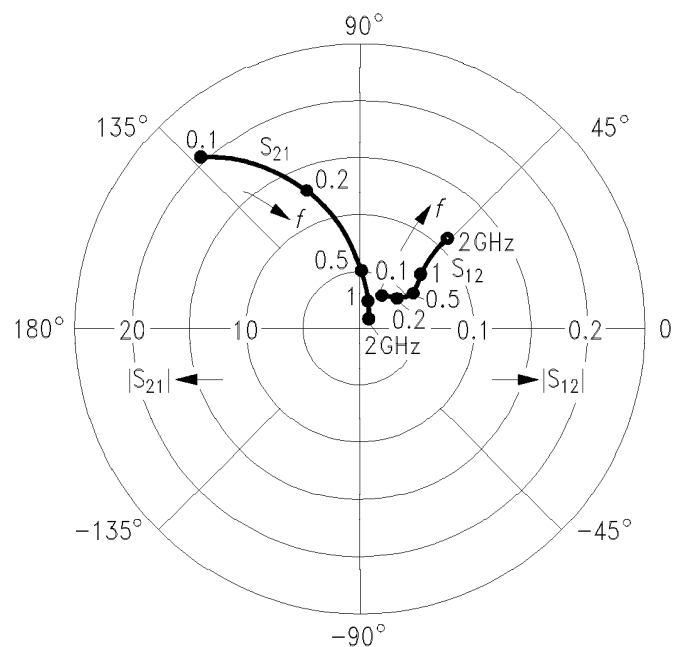
$I_C = 10 \text{ mA}, V_{CE} = 5 \text{ V}, Z_0 = 50 \Omega$



EHT08009

$S_{12}, S_{21} = f(f)$

$I_C = 10 \text{ mA}, V_{CE} = 5 \text{ V}, Z_0 = 50 \Omega$

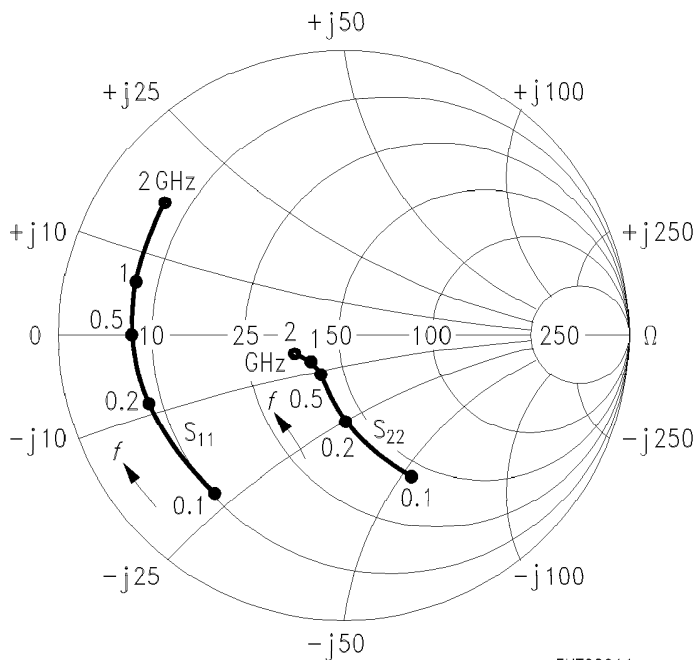


EHT08010

Common Emitter S Parameters (continued)

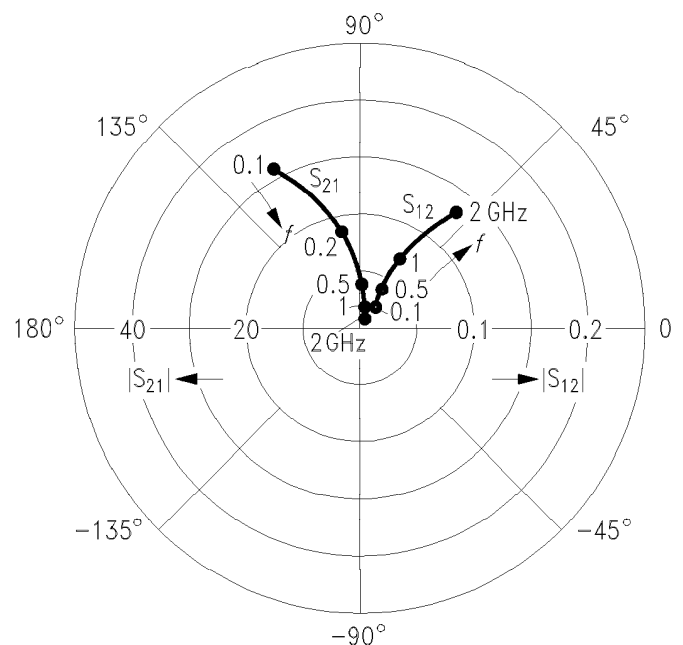
| $f$  | $S_{11}$ |       | $S_{21}$ |     | $S_{12}$ |     | $S_{22}$ |       |
|--|----------|-------|----------|-----|----------|-----|----------|-------|
| GHz  | MAG      | ANG   | MAG      | ANG | MAG      | ANG | MAG      | ANG   |
| $I_C = 30 \text{ mA}, V_{CE} = 5 \text{ V}, Z_0 = 50 \Omega$ |          |       |          |     |          |     |          |       |
| 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 |

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



EHT08011

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



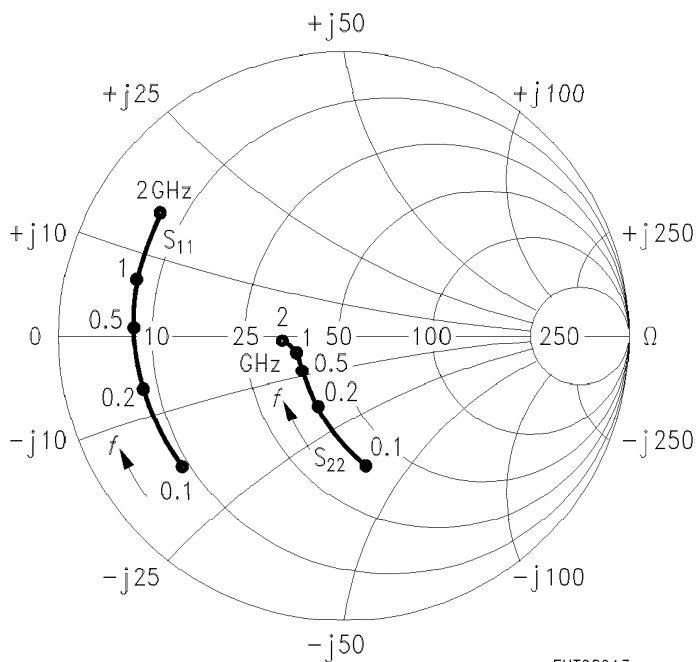
EHT08012

### Common Emitter S Parameters (continued)

| $f$ | $S_{11}$ |      | $S_{21}$ |     | $S_{12}$ |     | $S_{22}$ |      |
|-----|----------|------|----------|-----|----------|-----|----------|------|
|     | MAG      | ANG  | MAG      | ANG | MAG      | ANG | MAG      | ANG  |
| 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 |

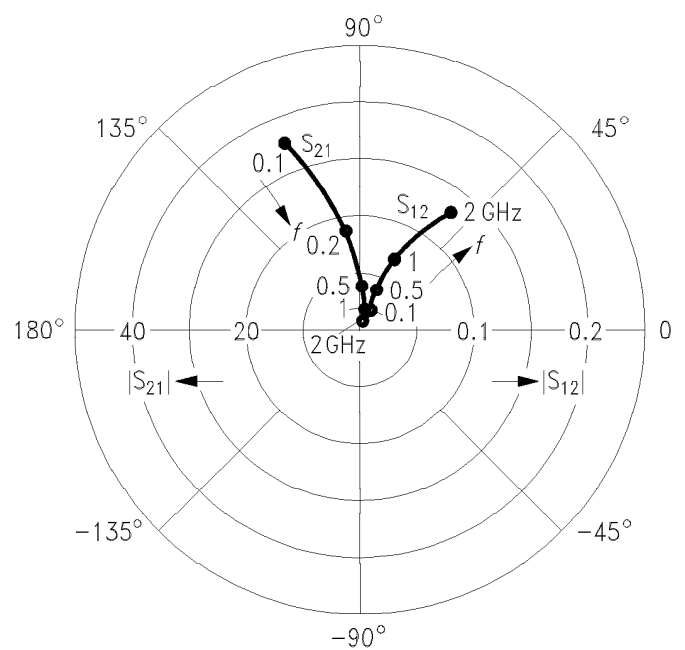
$I_C = 50 \text{ mA}, V_{CE} = 5 \text{ V}, Z_0 = 50 \Omega$

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



EHT08013

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

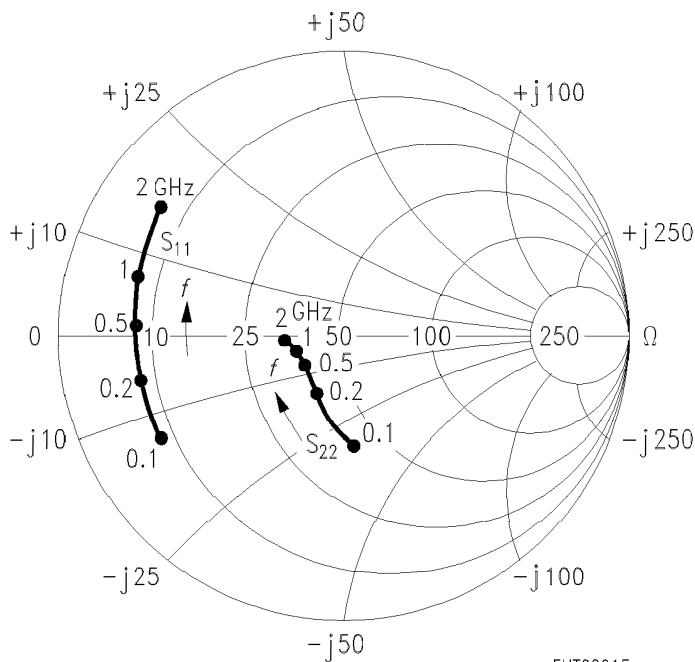


EHT08014

### Common Emitter S Parameters (continued)

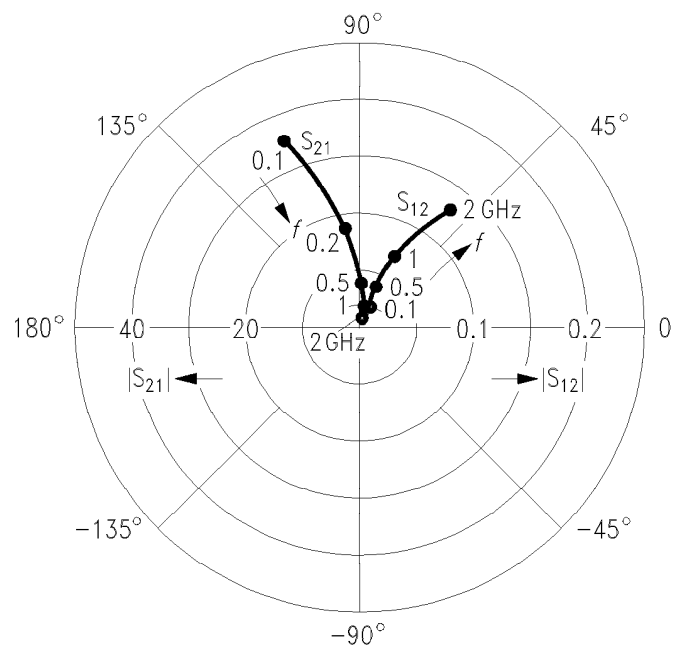
| <i>f</i>  | <i>S</i> <sub>11</sub> |      | <i>S</i> <sub>21</sub> |     | <i>S</i> <sub>12</sub> |     | <i>S</i> <sub>22</sub> |      |
|---|------------------------|------|------------------------|-----|------------------------|-----|------------------------|------|
|   | MAG                    | ANG  | MAG                    | ANG | MAG                    | ANG | MAG                    | ANG  |
| <i>I</i> <sub>C</sub> = 70 mA, <i>V</i> <sub>CE</sub> = 5 V, <i>Z</i> <sub>0</sub> = 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*<sub>11</sub>, *S*<sub>22</sub> = *f*(*f*)  
*I*<sub>C</sub> = 70 mA, *V*<sub>CE</sub> = 5 V, *Z*<sub>0</sub> = 50 Ω



EHT08015

*S*<sub>12</sub>, *S*<sub>21</sub> = *f*(*f*)  
*I*<sub>C</sub> = 70 mA, *V*<sub>CE</sub> = 5 V, *Z*<sub>0</sub> = 50 Ω

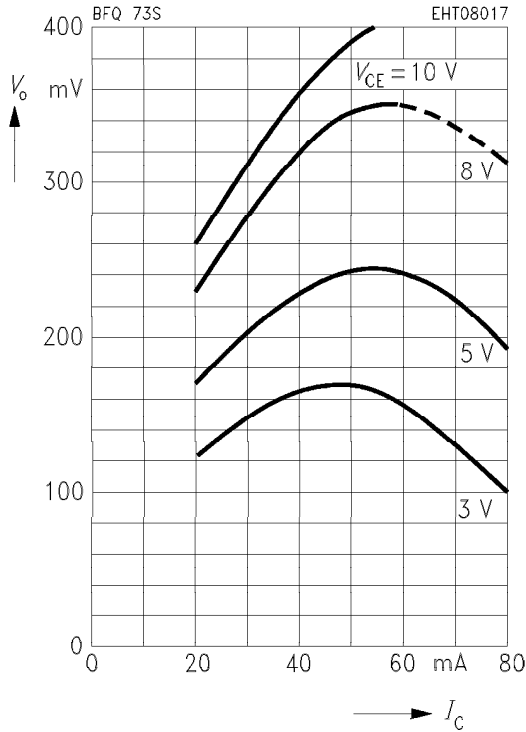


EHT08016

**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,  $Z_s = Z_L = 50 \Omega$



**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  $P_o = 10 \log (V_o^2 / (50 \Omega \cdot 1mW))$  (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  $P_o$ :

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

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

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