

# DATA SHEET

**BFG94**

**NPN 6 GHz wideband transistor**

Product specification  
File under Discrete Semiconductors, SC14

September 1995

NPN 6 GHz wideband transistor

BFG94

FEATURES

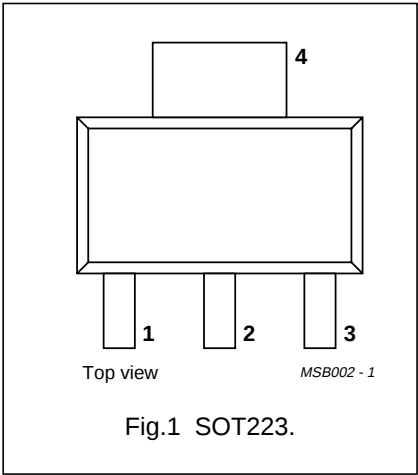
- High power gain
- Low noise figure
- Low intermodulation distortion
- Gold metallization ensures excellent reliability.

PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | emitter     |
| 2   | base        |
| 3   | emitter     |
| 4   | collector   |

DESCRIPTION

NPN transistor mounted in a plastic SOT223 envelope. It is primarily intended for use in communication and instrumentation systems.



QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                             | CONDITIONS                                                                                                                                                          | MIN. | TYP. | MAX. | UNIT |
|-----------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_{CBO}$ | collector-base voltage                | open emitter                                                                                                                                                        | —    | —    | 15   | V    |
| $V_{CEO}$ | collector-emitter voltage             | open base                                                                                                                                                           | —    | —    | 12   | V    |
| $I_C$     | DC collector current                  |                                                                                                                                                                     | —    | —    | 60   | mA   |
| $P_{tot}$ | total power dissipation               | up to $T_s = 140\text{ }^{\circ}\text{C}$ (note 1)                                                                                                                  | —    | —    | 700  | mW   |
| $C_{re}$  | feedback capacitance                  | $I_C = 0$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ MHz}$                                                                                                             | —    | —    | 0.8  | pF   |
| $f_T$     | transition frequency                  | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                         | 4    | 6    | —    | GHz  |
| $G_{UM}$  | maximum unilateral power gain         | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                         | 11.5 | 13.5 | —    | dB   |
| $V_O$     | output voltage                        | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $d_{im} = -60\text{ dB}$ ; $R_L = 75\text{ }\Omega$ ; $f = 800\text{ MHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ | —    | 500  | —    | mV   |
| $P_{L1}$  | output power at 1 dB gain compression | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                         | —    | 21.5 | —    | dBm  |

Note

1.  $T_s$  is the temperature at the soldering point of the collector tab.

## NPN 6 GHz wideband transistor

BFG94

**LIMITING VALUES**

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL    | PARAMETER                 | CONDITIONS                           | MIN. | MAX. | UNIT |
|-----------|---------------------------|--------------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage    | open emitter                         | –    | 15   | V    |
| $V_{CEO}$ | collector-emitter voltage | open base                            | –    | 12   | V    |
| $V_{EBO}$ | emitter-base voltage      | open collector                       | –    | 2    | V    |
| $I_C$     | DC collector current      |                                      | –    | 60   | mA   |
| $P_{tot}$ | total power dissipation   | up to $T_s = 140\text{ °C}$ (note 1) | –    | 700  | mW   |
| $T_{stg}$ | storage temperature       |                                      | –65  | 150  | °C   |
| $T_j$     | junction temperature      |                                      | –    | 175  | °C   |

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                                           | CONDITIONS                           | THERMAL RESISTANCE |
|---------------|-----------------------------------------------------|--------------------------------------|--------------------|
| $R_{th\ j-s}$ | thermal resistance from junction to soldering point | up to $T_s = 140\text{ °C}$ (note 1) | 50 K/W             |

**Note**

1.  $T_s$  is the temperature at the soldering point of the collector tab.

## NPN 6 GHz wideband transistor

## BFG94

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL    | PARAMETER                               | CONDITIONS                                                                                                                                         | MIN. | TYP. | MAX. | UNIT |
|-----------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{CBO}$ | collector cut-off current               | $I_E = 0$ ; $V_{CB} = 10\text{ V}$                                                                                                                 | –    | –    | 100  | nA   |
| $h_{FE}$  | DC current gain                         | $I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$                                                                                                       | 45   | 90   | –    |      |
|           |                                         | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$                                                                                                      | –    | 100  | –    |      |
| $C_c$     | collector capacitance                   | $I_E = I_e = 0$ ; $V_{CB} = 10\text{ V}$ ; $f = 1\text{ MHz}$                                                                                      | –    | 0.9  | 2    | pF   |
| $C_e$     | emitter capacitance                     | $I_C = I_e = 0$ ; $V_{EB} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$                                                                                     | –    | 2.9  | 4.5  | pF   |
| $C_{re}$  | feedback capacitance                    | $I_C = I_c = 0$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ MHz}$                                                                                      | –    | 0.5  | 0.8  | pF   |
| $f_T$     | transition frequency                    | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                        | 4    | –    | –    | GHz  |
|           |                                         | $I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                         | 4    | 6    | –    | GHz  |
| $G_{UM}$  | maximum unilateral power gain (note1)   | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                        | 11.5 | 13.5 | –    | dB   |
| F         | minimum noise figure                    | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$                                                   | –    | 2.7  | –    | dB   |
|           |                                         | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$                                                     | –    | 3    | –    | dB   |
| $V_O$     | output voltage                          | note 2                                                                                                                                             | –    | 500  | –    | mV   |
| $d_2$     | second order intermodulation distortion | note 3                                                                                                                                             | –    | –51  | –    | dB   |
| $P_{L1}$  | output power at 1 dB gain compression   | $I_C = 45\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $R_L = 50\text{ }\Omega$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; measured at $f = 1\text{ GHz}$ | –    | 21.5 | –    | dBm  |
| ITO       | third order intercept point             | note 4                                                                                                                                             | –    | 34   | –    | dBm  |

## Notes

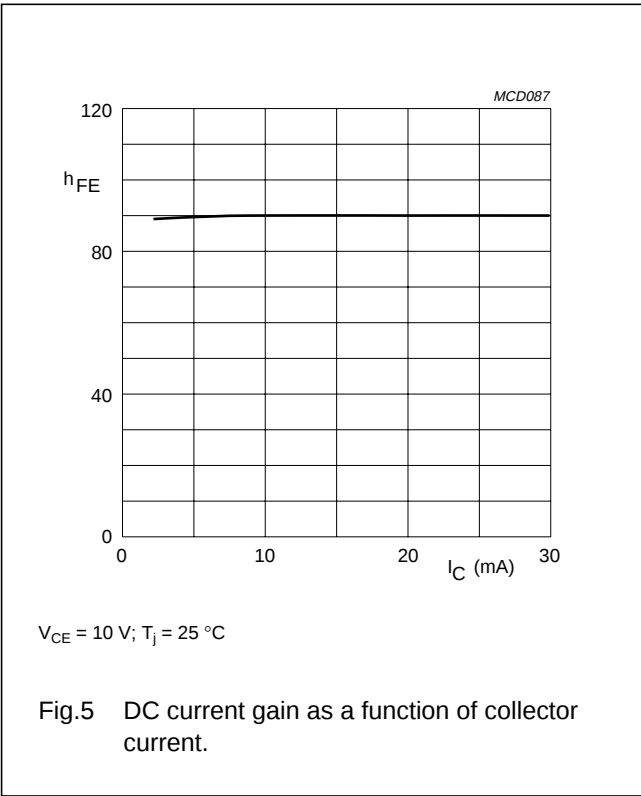
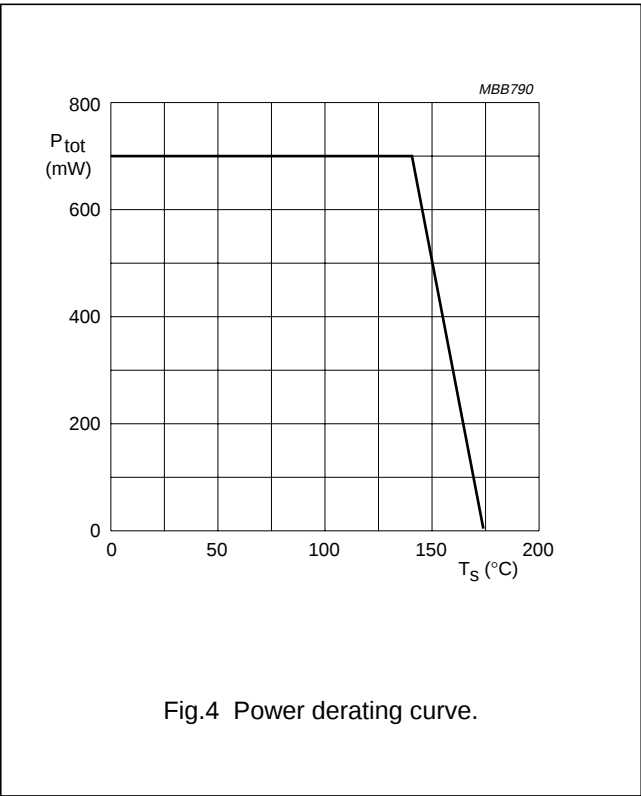
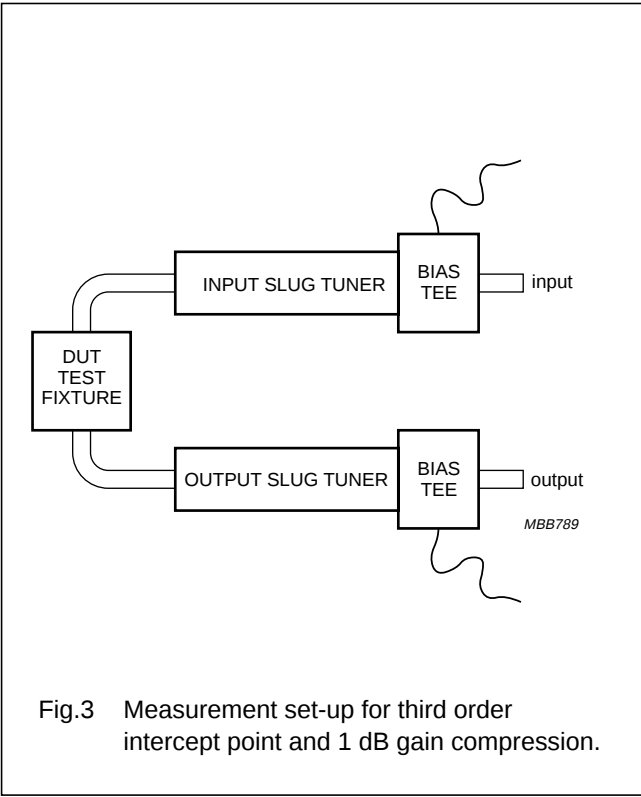
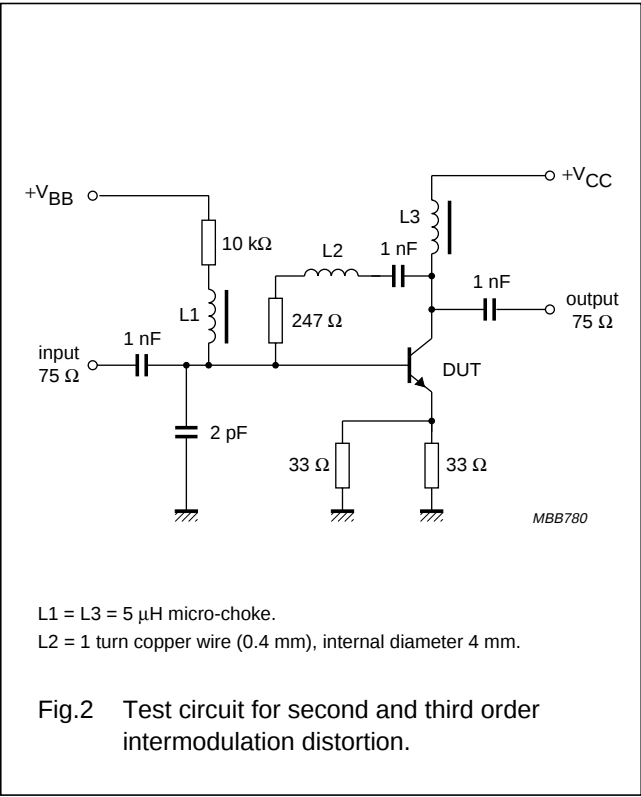
1.  $G_{UM}$  is the maximum unilateral power gain, assuming  $S_{12}$  is zero and

$$G_{UM} = 10 \log \left( \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)} \right) \text{dB}.$$

2.  $d_{im} = -60\text{ dB}$  (DIN 45004B, par 6.3: 3-tone);  $I_C = 45\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  
 $V_p = V_O$  at  $d_{im} = -60\text{ dB}$ ;  $f_p = 795.25\text{ MHz}$ ;  
 $V_q = V_O - 6\text{ dB}$ ;  $V_r = V_O - 6\text{ dB}$ ;  
 $f_q = 803.25\text{ MHz}$ ;  $f_r = 805.25\text{ MHz}$ ;  
 measured at  $f_{(p+q-r)} = 793.25\text{ MHz}$ .
3.  $I_C = 45\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  
 $V_q = V_O = 280\text{ mV}$ ;  
 $f_p = 250\text{ MHz}$ ;  $f_q = 560\text{ MHz}$ ;  
 measured at  $f_{(p+q)} = 810\text{ MHz}$ .
4.  $I_C = 45\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $R_L = 50\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  
 $f_p = 1000\text{ MHz}$ ;  $f_q = 1001\text{ MHz}$ ;  
 measured at  $f_{(2p-q)}$  and  $f_{(2q-p)}$ .

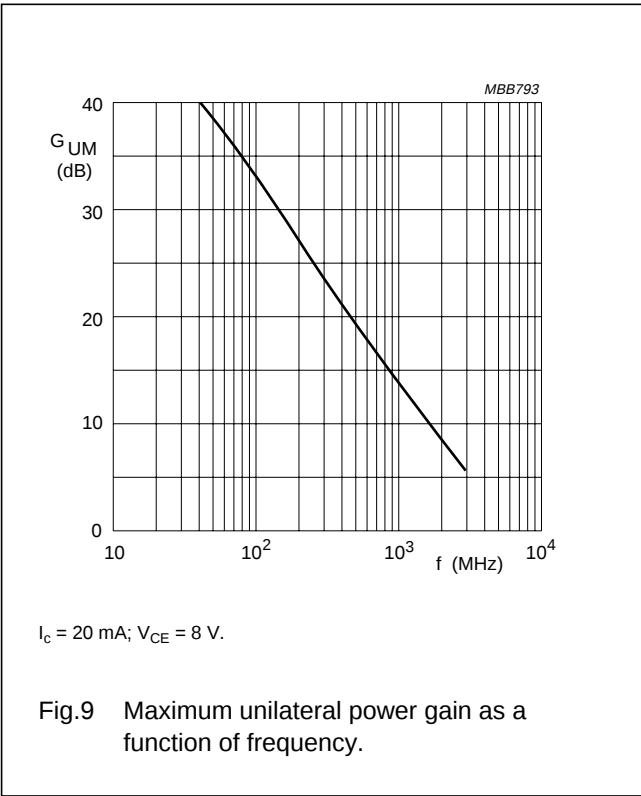
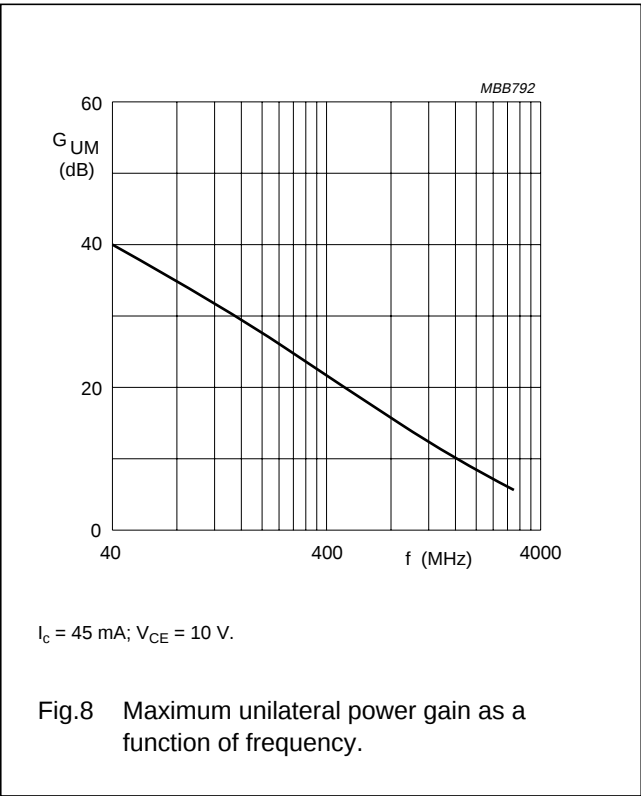
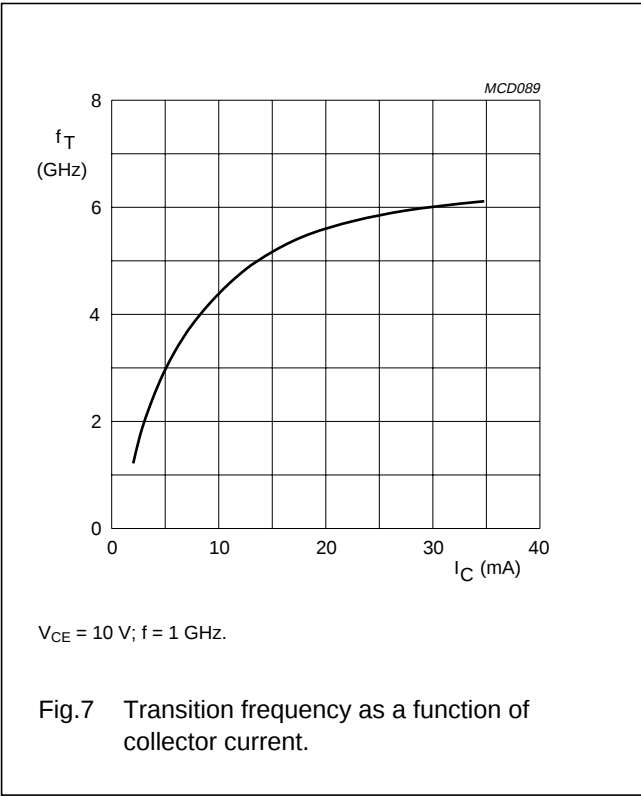
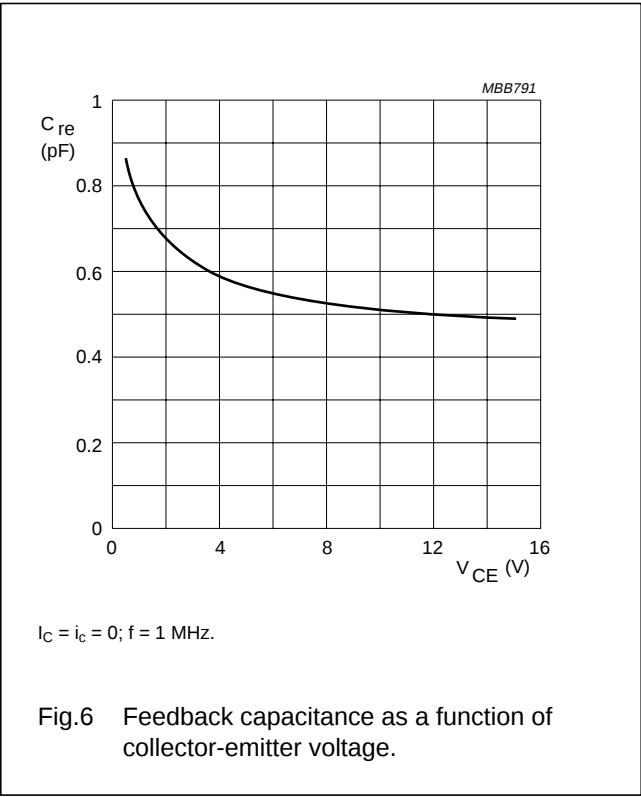
NPN 6 GHz wideband transistor

BFG94



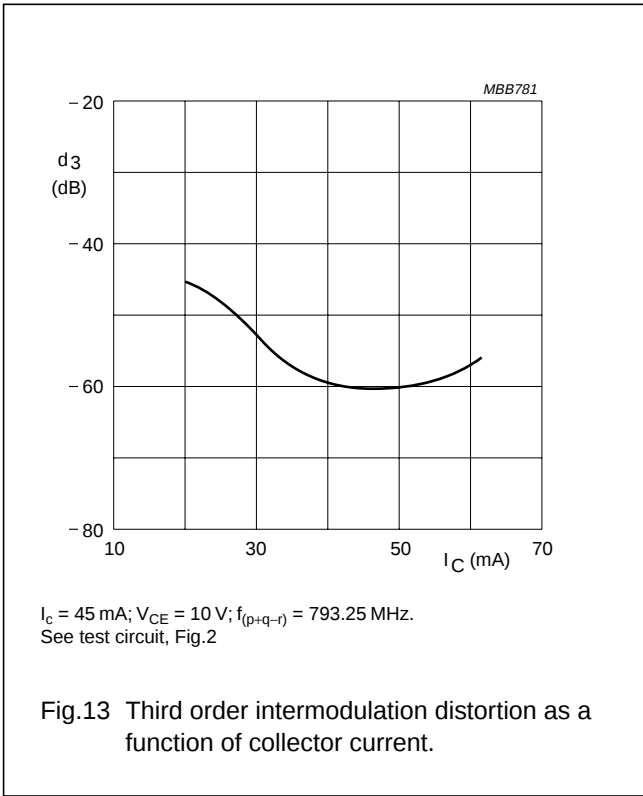
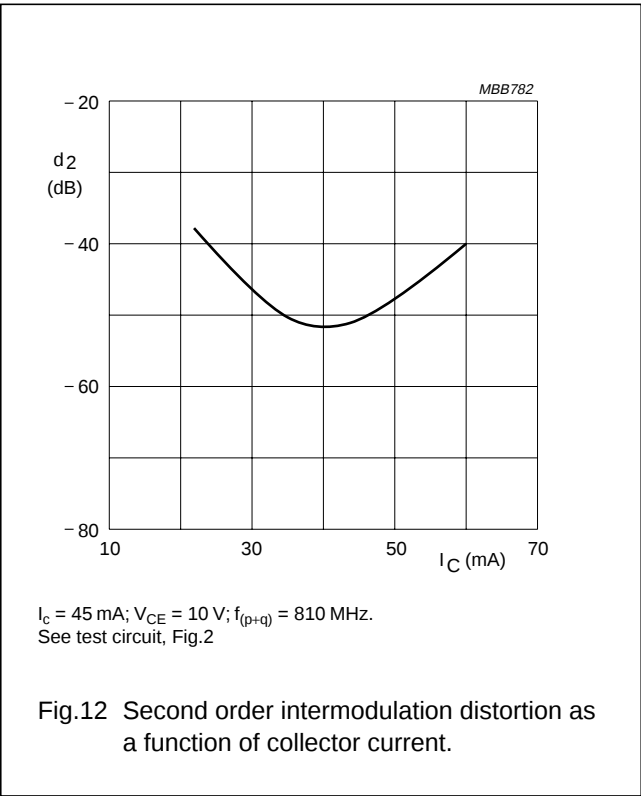
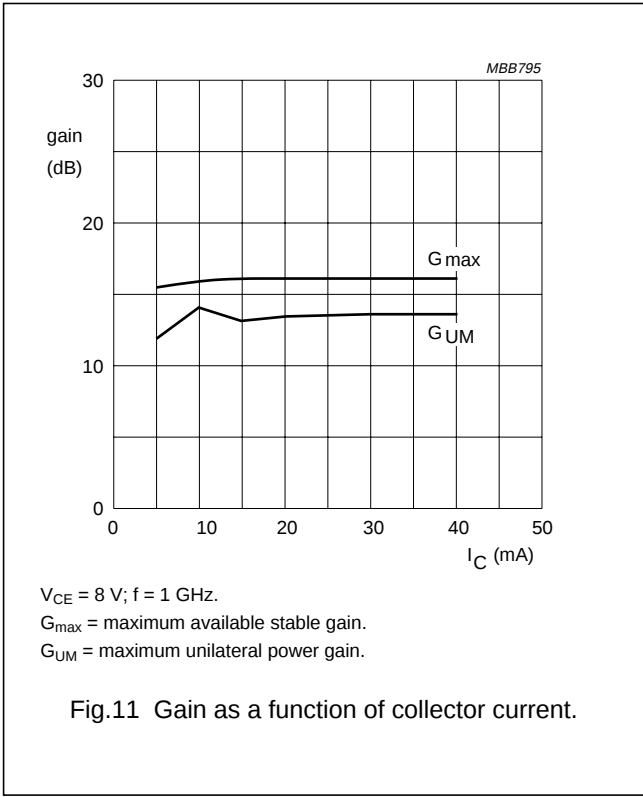
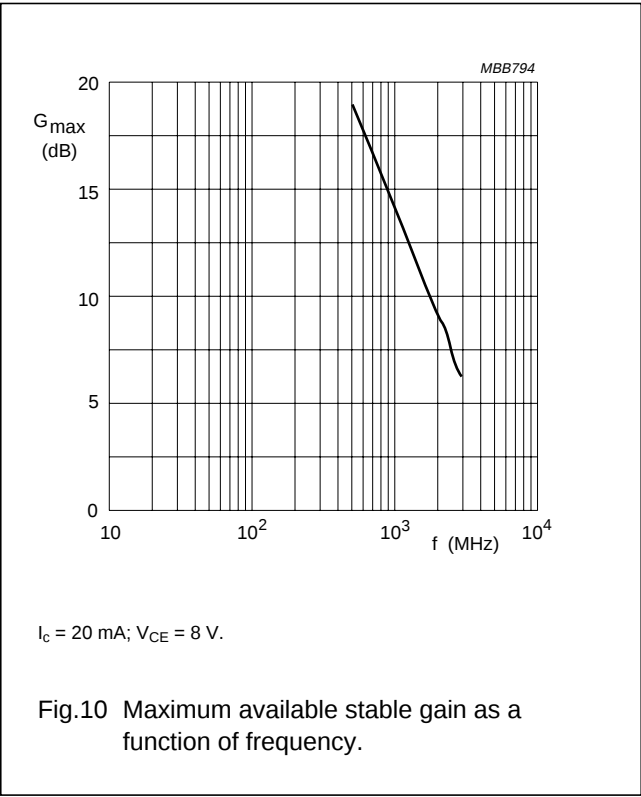
NPN 6 GHz wideband transistor

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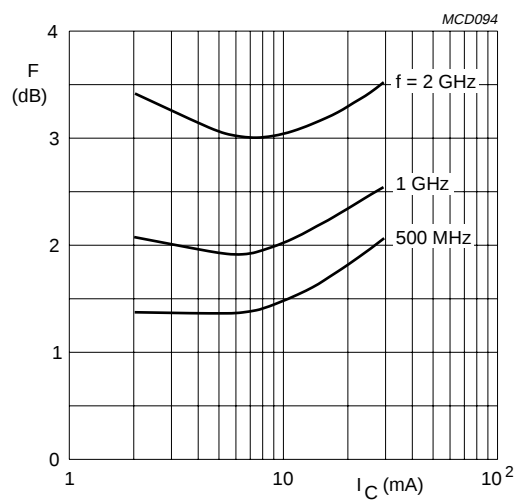
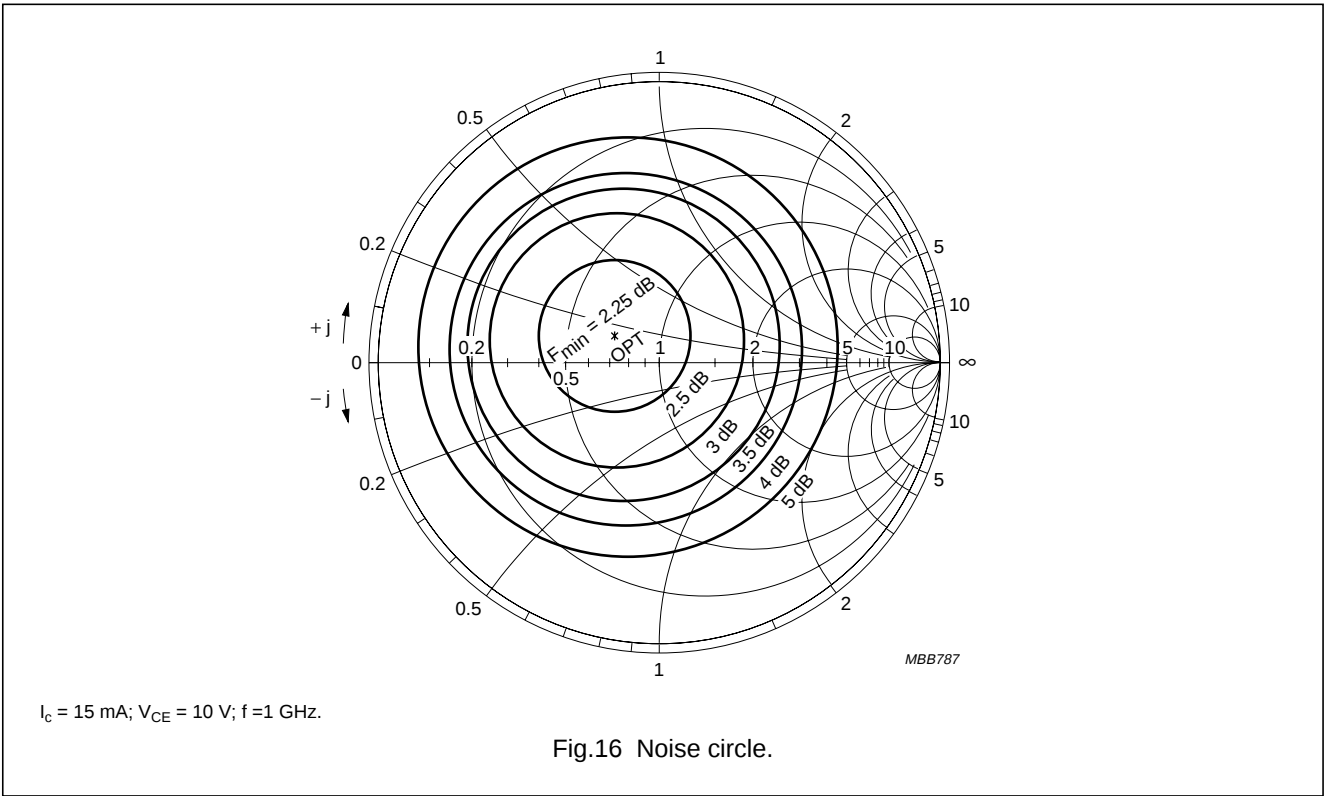
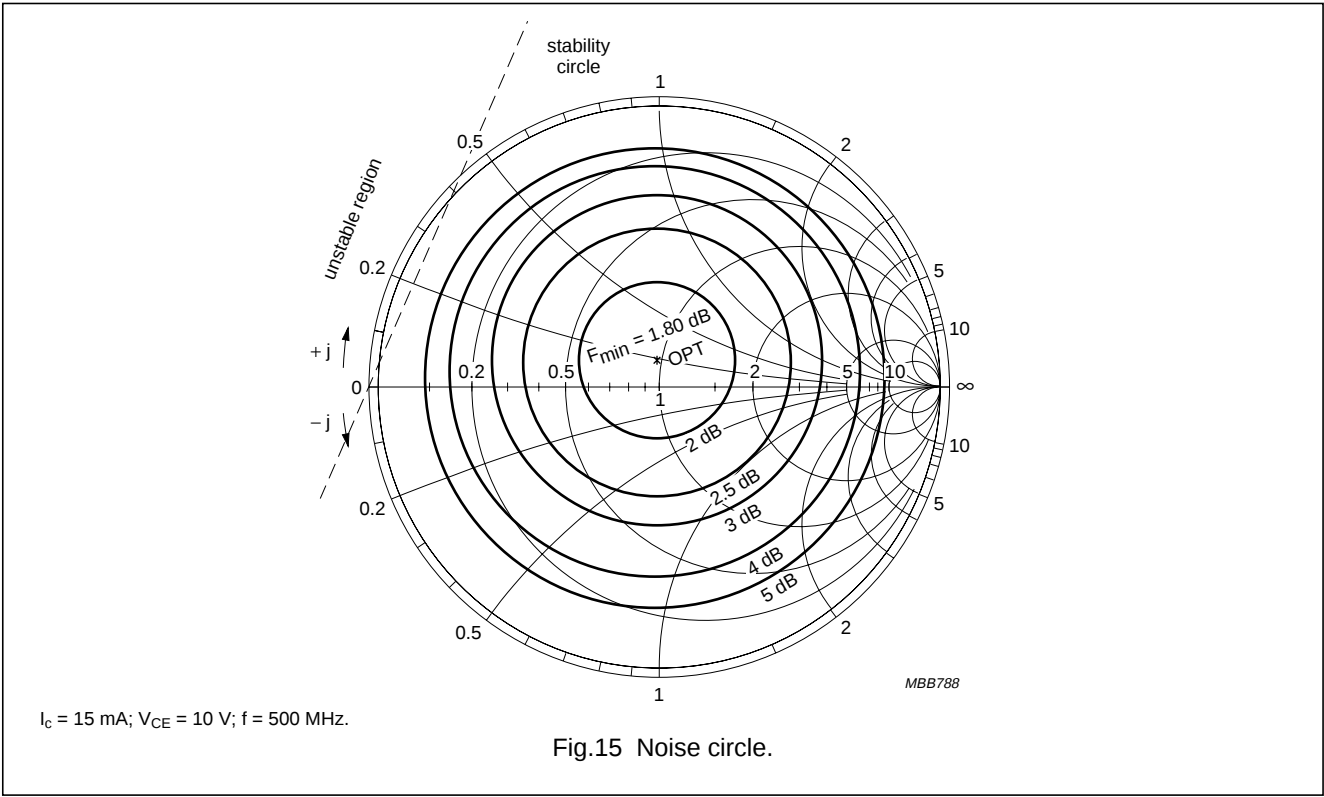
 $V_{CE} = 8$  V.

Fig.14 Minimum noise figure as a function of collector current.

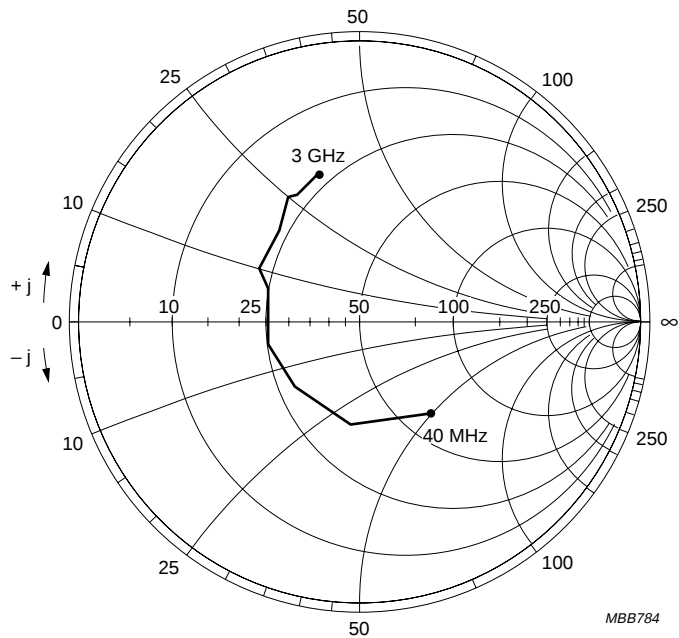
NPN 6 GHz wideband transistor

BFG94



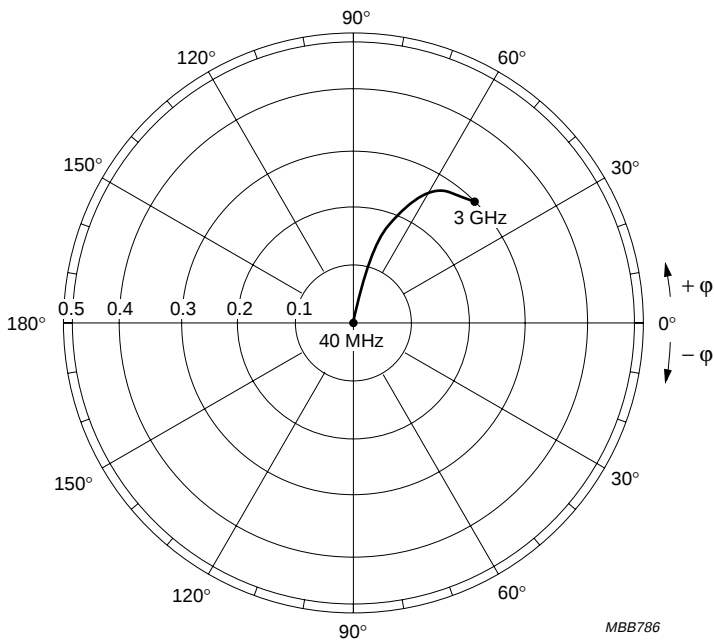
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$I_C = 45 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ .  
 $Z_0 = 50 \Omega$ .

Fig.17 Common emitter input reflection coefficient ( $S_{11}$ ).

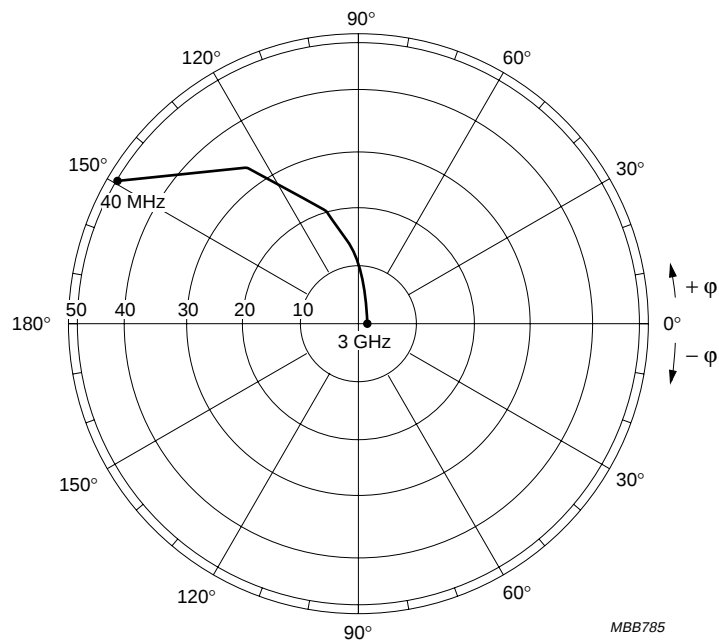


$I_C = 45 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ .

Fig.18 Common emitter forward transmission coefficient ( $S_{21}$ ).

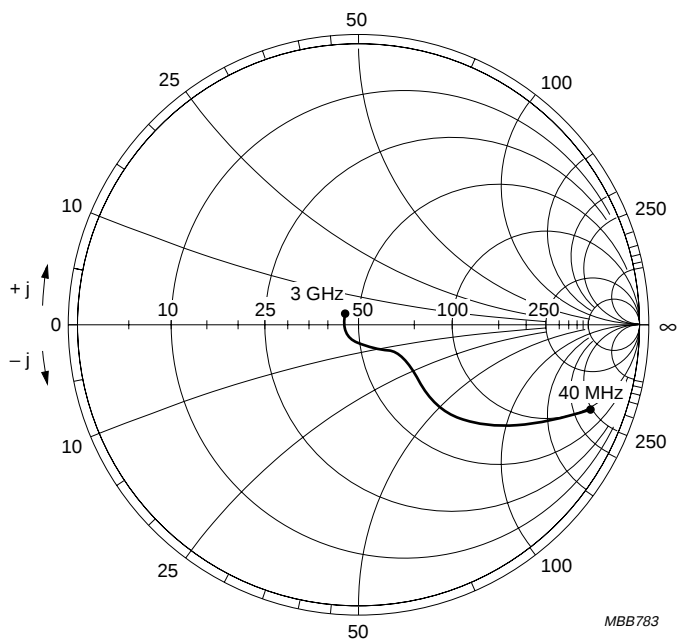
NPN 6 GHz wideband transistor

BFG94



$I_C = 45 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ .

Fig.19 Common emitter reverse transmission coefficient ( $S_{12}$ ).



$I_C = 45 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ .  
 $Z_O = 50 \Omega$ .

Fig.20 Common emitter output reflection coefficient ( $S_{22}$ ).

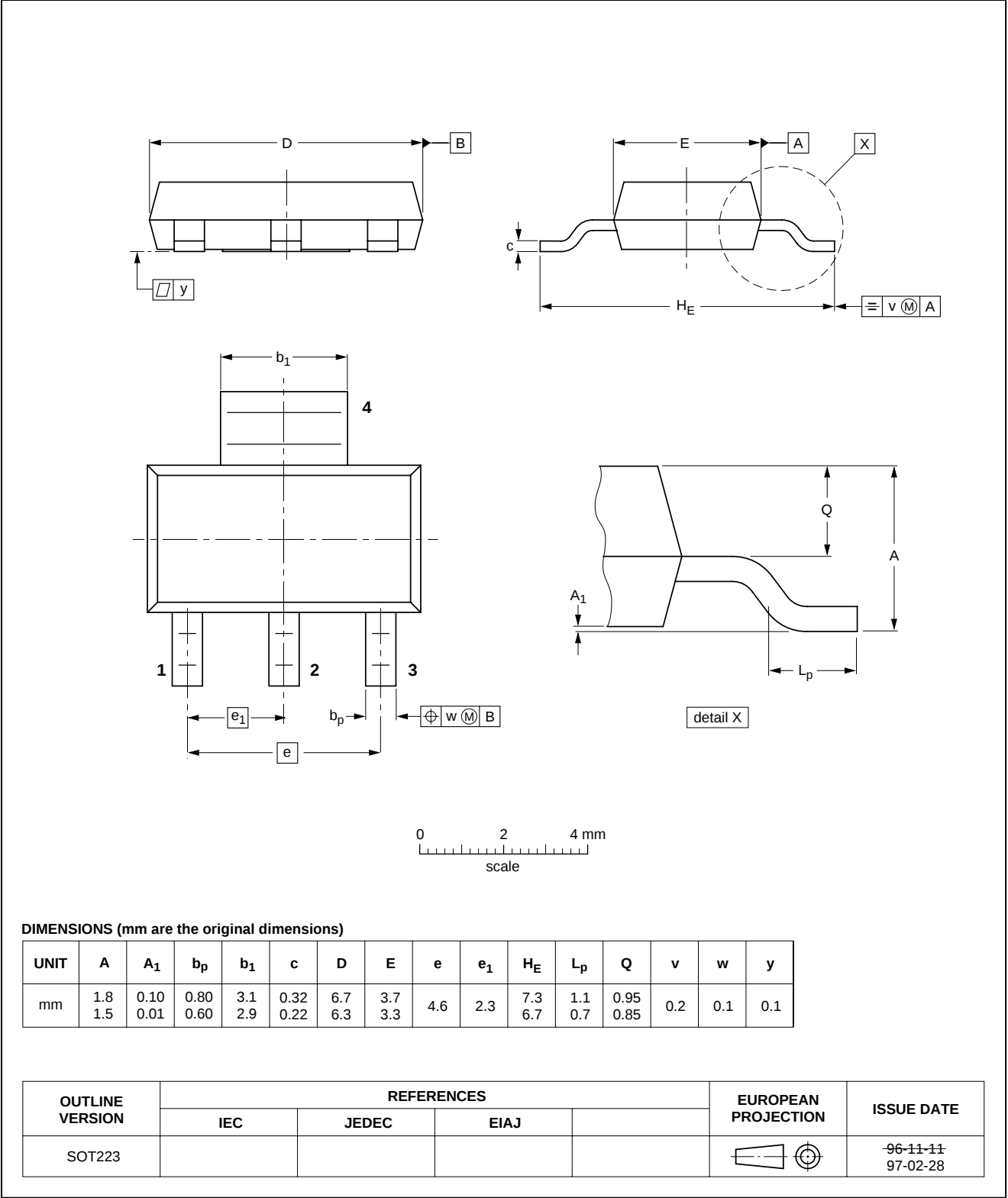
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PACKAGE OUTLINE

Plastic surface mounted package; collector pad for good heat transfer; 4 leads

SOT223



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**DEFINITIONS**

| <b>Data Sheet Status</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Objective specification                                                                                                                                                                                                                                                                                                                                                                                                                                   | This data sheet contains target or goal specifications for product development.       |
| Preliminary specification                                                                                                                                                                                                                                                                                                                                                                                                                                 | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification                                                                                                                                                                                                                                                                                                                                                                                                                                     | This data sheet contains final product specifications.                                |
| <b>Limiting values</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                       |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. |                                                                                       |
| <b>Application information</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                       |
| Where application information is given, it is advisory and does not form part of the specification.                                                                                                                                                                                                                                                                                                                                                       |                                                                                       |

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