

# DATA SHEET

**BFM520**

Dual NPN wideband transistor

Product specification  
Supersedes data of 1995 Sep 04

1996 Oct 08



## Dual NPN wideband transistor

BFM520

## FEATURES

- Small size
- Temperature and  $h_{FE}$  matched
- Low noise and high gain
- High gain at low current and low capacitance at low voltage
- Gold metallization ensures excellent reliability.

## APPLICATIONS

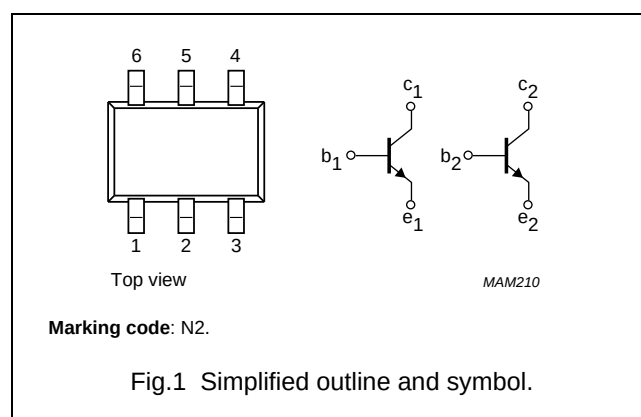
- Oscillator and buffer amplifiers
- Balanced amplifiers
- LNA/mixers.

## DESCRIPTION

Dual transistor with two silicon NPN RF dies in a surface mount 6-pin SOT363 (S-mini) package. The transistor is primarily intended for wideband applications in the GHz-range in the RF front end of analog and digital cellular phones, cordless phones, radar detectors, pagers and satellite TV-tuners.

## PINNING - SOT363A

| PIN | SYMBOL | DESCRIPTION |
|-----|--------|-------------|
| 1   | $b_1$  | base 1      |
| 2   | $e_1$  | emitter 1   |
| 3   | $c_2$  | collector 2 |
| 4   | $b_2$  | base 2      |
| 5   | $e_2$  | emitter 2   |
| 6   | $c_1$  | collector 1 |



## QUICK REFERENCE DATA

| SYMBOL                       | PARAMETER                                           | CONDITIONS                                                                | MIN. | TYP. | MAX. | UNIT |
|------------------------------|-----------------------------------------------------|---------------------------------------------------------------------------|------|------|------|------|
| <b>Any single transistor</b> |                                                     |                                                                           |      |      |      |      |
| $C_{re}$                     | feedback capacitance                                | $I_e = 0$ ; $V_{CB} = 3$ V; $f = 1$ MHz                                   | –    | 0.4  | –    | pF   |
| $f_T$                        | transition frequency                                | $I_C = 20$ mA; $V_{CE} = 3$ V; $f = 900$ MHz                              | –    | 9    | –    | GHz  |
| $ S_{21} ^2$                 | insertion power gain                                | $I_C = 20$ mA; $V_{CE} = 3$ V;<br>$f = 900$ MHz; $T_{amb} = 25$ °C        | 13   | 14.5 | –    | dB   |
| $G_{UM}$                     | maximum unilateral power gain                       | $I_C = 20$ mA; $V_{CE} = 3$ V;<br>$f = 900$ MHz; $T_{amb} = 25$ °C        | –    | 15   | –    | dB   |
| F                            | noise figure                                        | $I_C = 5$ mA; $V_{CE} = 3$ V;<br>$f = 900$ MHz; $\Gamma_S = \Gamma_{opt}$ | –    | 1.2  | 1.6  | dB   |
| $R_{th\ j-s}$                | thermal resistance from junction to soldering point | single loaded                                                             | –    | –    | 230  | K/W  |
|                              |                                                     | double loaded                                                             | –    | –    | 115  | K/W  |

## Dual NPN wideband transistor

BFM520

**LIMITING VALUES**

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

| SYMBOL                       | PARAMETER                 | CONDITIONS                            | MIN. | MAX. | UNIT |
|------------------------------|---------------------------|---------------------------------------|------|------|------|
| <b>Any single transistor</b> |                           |                                       |      |      |      |
| V <sub>CBO</sub>             | collector-base voltage    | open emitter                          | –    | 20   | V    |
| V <sub>CEO</sub>             | collector-emitter voltage | open base                             | –    | 8    | V    |
| V <sub>EBO</sub>             | emitter-base voltage      | open collector                        | –    | 2.5  | V    |
| I <sub>C</sub>               | DC collector current      |                                       | –    | 70   | mA   |
| P <sub>tot</sub>             | total power dissipation   | up to T <sub>s</sub> = 118 °C; note 1 | –    | 1    | W    |
| T <sub>stg</sub>             | storage temperature       |                                       | –65  | +175 | °C   |
| T <sub>j</sub>               | junction temperature      |                                       | –    | 175  | °C   |

**THERMAL CHARACTERISTICS**

| SYMBOL              | PARAMETER                                                   | CONDITIONS    | VALUE | UNIT |
|---------------------|-------------------------------------------------------------|---------------|-------|------|
| R <sub>th j-s</sub> | thermal resistance from junction to soldering point; note 1 | single loaded | 230   | K/W  |
|                     |                                                             | double loaded | 115   | K/W  |

**Note to the Limiting values and Thermal characteristics**

1. T<sub>s</sub> is the temperature at the soldering point of the collector pin.

## Dual NPN wideband transistor

## BFM520

## CHARACTERISTICS

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

| SYMBOL                                             | PARAMETER                                                                   | CONDITIONS                                                                             | MIN. | TYP. | MAX. | UNIT |
|----------------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------|------|------|------|
| <b>DC characteristics of any single transistor</b> |                                                                             |                                                                                        |      |      |      |      |
| $V_{(BR)CBO}$                                      | collector-base breakdown voltage                                            | $I_C = 2.5\text{ }\mu\text{A}; I_E = 0$                                                | 20   | –    | –    | V    |
| $V_{(BR)CEO}$                                      | collector-emitter breakdown voltage                                         | $I_C = 10\text{ }\mu\text{A}; I_B = 0$                                                 | 8    | –    | –    | V    |
| $V_{(BR)EBO}$                                      | emitter-base breakdown voltage                                              | $I_E = 2.5\text{ }\mu\text{A}; I_C = 0$                                                | 2.5  | –    | –    | V    |
| $I_{CBO}$                                          | collector-base leakage current                                              | $V_{CB} = 6\text{ V}; I_E = 0$                                                         | –    | –    | 50   | nA   |
| $h_{FE}$                                           | DC current gain                                                             | $I_C = 20\text{ mA}; V_{CE} = 6\text{ V}$                                              | 60   | 120  | 250  |      |
| <b>DC characteristics of the dual transistor</b>   |                                                                             |                                                                                        |      |      |      |      |
| $\Delta h_{FE}$                                    | ratio of highest and lowest DC current gain                                 | $I_{C1} = I_{C2} = 20\text{ mA}; V_{CE1} = V_{CE2} = 6\text{ V}$                       | 1    | 1.2  | –    |      |
| $\Delta V_{BEO}$                                   | difference between highest and lowest base-emitter voltage (offset voltage) | $I_{E1} = I_{E2} = 30\text{ mA}; T_{amb} = 25\text{ °C}$                               | 0    | 1    | –    | mV   |
| <b>AC characteristics of any single transistor</b> |                                                                             |                                                                                        |      |      |      |      |
| $f_T$                                              | transition frequency                                                        | $I_C = 20\text{ mA}; V_{CE} = 3\text{ V}; f = 1\text{ GHz}$                            | –    | 9    | –    | GHz  |
| $C_c$                                              | collector capacitance                                                       | $I_E = I_{e0} = 0; V_{CB} = 3\text{ V}; f = 1\text{ MHz}$                              | –    | 0.5  | –    | pF   |
| $C_{re}$                                           | feedback capacitance                                                        | $I_C = 0; V_{CB} = 3\text{ V}; f = 1\text{ MHz}$                                       | –    | 0.4  | –    | pF   |
| $G_{UM}$                                           | maximum unilateral power gain; note 1                                       | $I_C = 20\text{ mA}; V_{CE} = 3\text{ V}; T_{amb} = 25\text{ °C}; f = 900\text{ MHz}$  | –    | 15   | –    | dB   |
|                                                    |                                                                             | $I_C = 20\text{ mA}; V_{CE} = 3\text{ V}; T_{amb} = 25\text{ °C}; f = 2\text{ GHz}$    | –    | 9    | –    | dB   |
| $ S_{21} ^2$                                       | insertion power gain                                                        | $I_C = 20\text{ mA}; V_{CE} = 3\text{ V}; f = 900\text{ MHz}; T_{amb} = 25\text{ °C}$  | 13   | 14.5 | –    | dB   |
| F                                                  | noise figure                                                                | $I_C = 5\text{ mA}; V_{CE} = 3\text{ V}; f = 900\text{ MHz}; \Gamma_S = \Gamma_{opt}$  | –    | 1.2  | 1.6  | dB   |
|                                                    |                                                                             | $I_C = 20\text{ mA}; V_{CE} = 3\text{ V}; f = 900\text{ MHz}; \Gamma_S = \Gamma_{opt}$ | –    | 1.7  | 2.1  | dB   |
|                                                    |                                                                             | $I_C = 5\text{ mA}; V_{CE} = 3\text{ V}; f = 2\text{ GHz}; \Gamma_S = \Gamma_{opt}$    | –    | 1.9  | –    | dB   |

## Note

1.  $G_{UM}$  is the maximum unilateral power gain, assuming  $s_{12}$  is zero.  $G_{UM} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$  dB

Dual NPN wideband transistor

BFM520

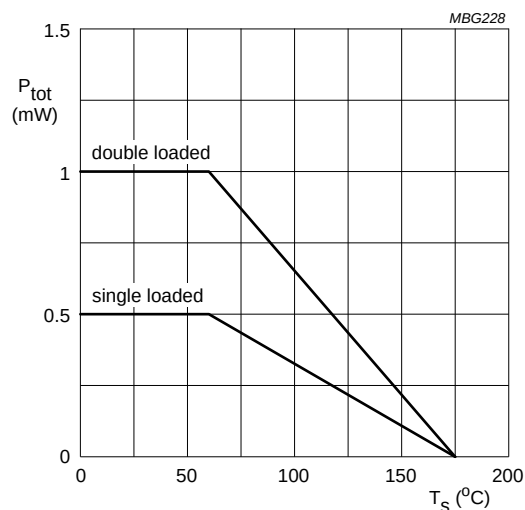
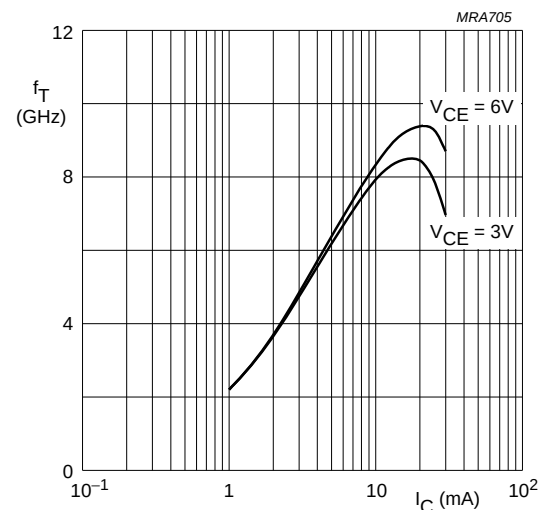
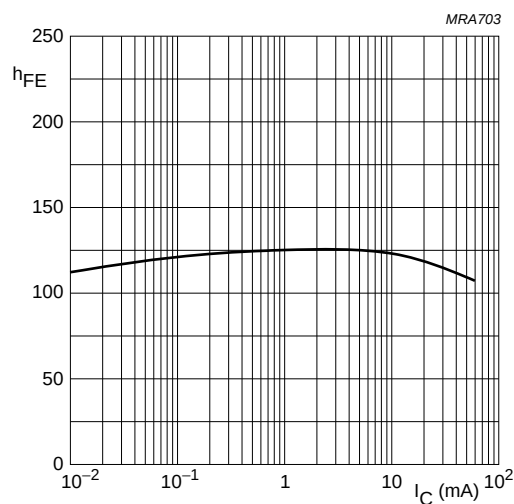


Fig.2 Power derating as a function of soldering point temperature; typical values.



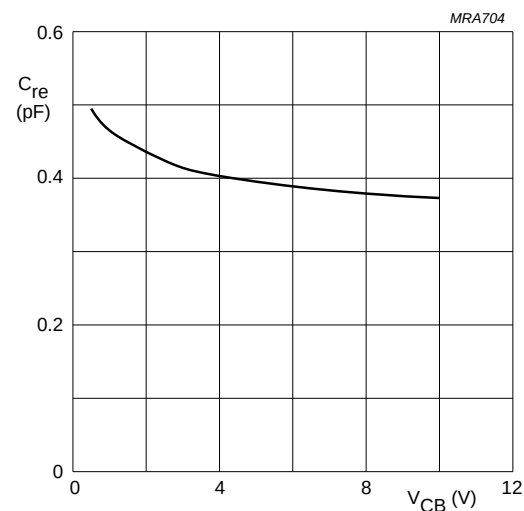
$f = 1\text{ GHz}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig.3 Transition frequency as a function of collector current; typical values.



$V_{CE} = 6\text{ V}$ .

Fig.4 DC current gain as a function of collector current; typical values.

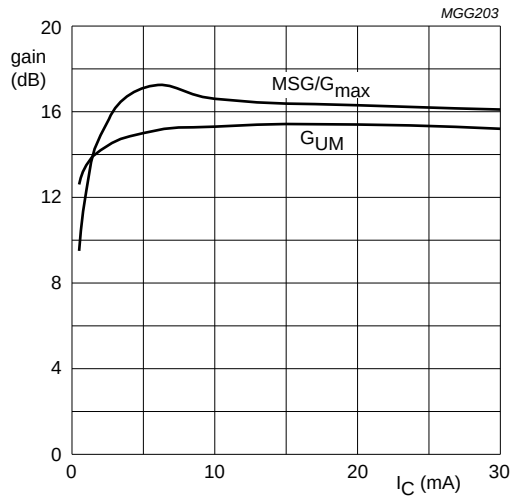


$I_C = 0$ ;  $f = 1\text{ MHz}$ .

Fig.5 Feedback capacitance as a function of collector-base voltage; typical values.

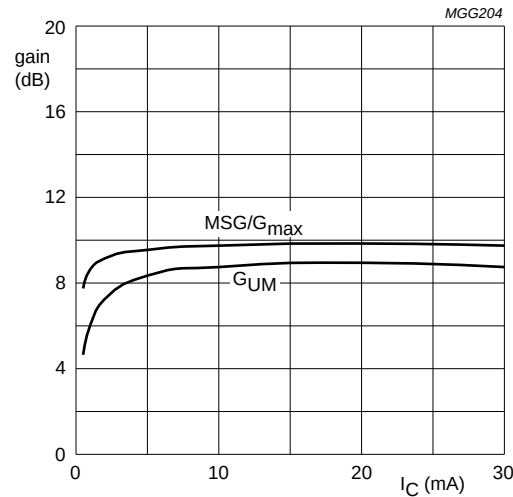
Dual NPN wideband transistor

BFM520



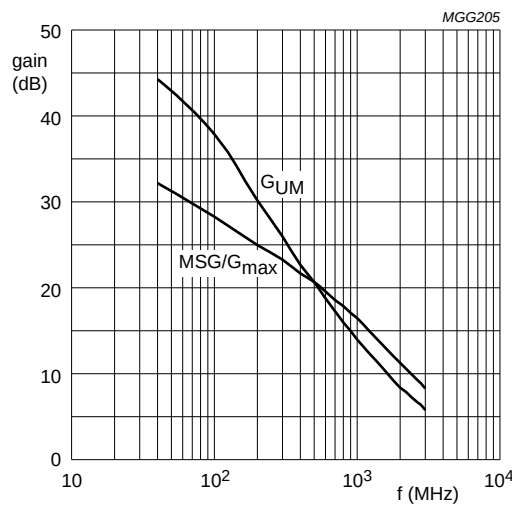
f = 900 MHz; V<sub>CE</sub> = 3 V.

Fig.6 Gain as a function of collector current; typical values.



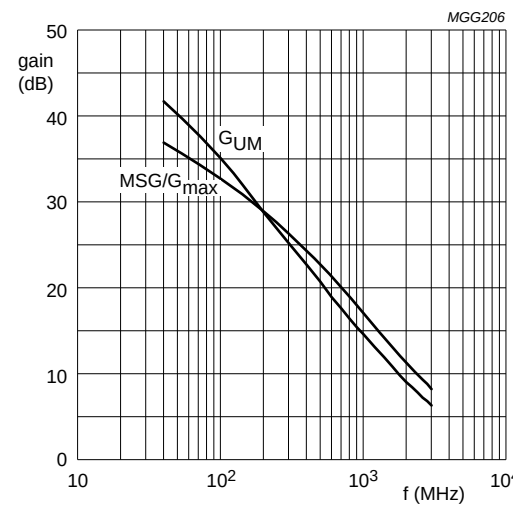
f = 2 GHz; V<sub>CE</sub> = 3 V.

Fig.7 Gain as a function of collector current; typical values.



I<sub>C</sub> = 5 mA; V<sub>CE</sub> = 3 V.

Fig.8 Gain as a function of frequency; typical values.

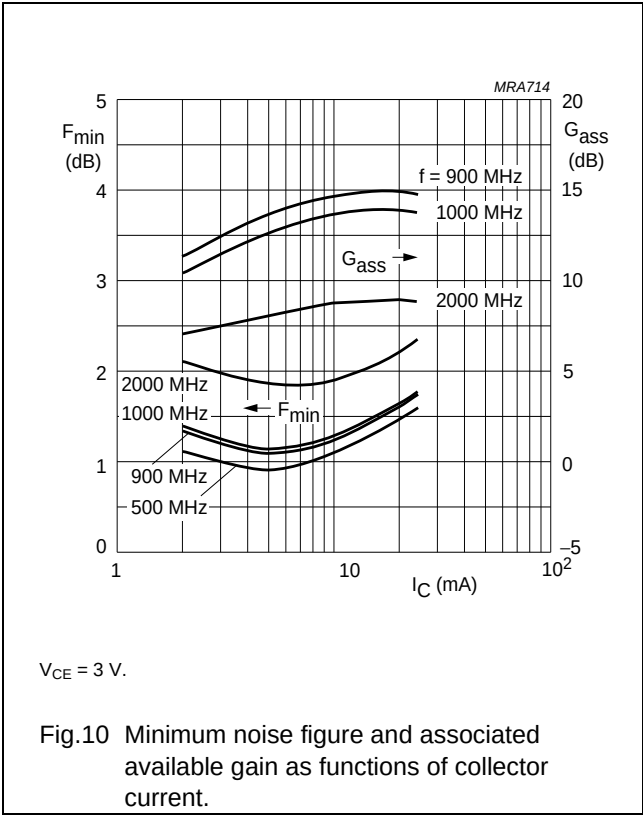
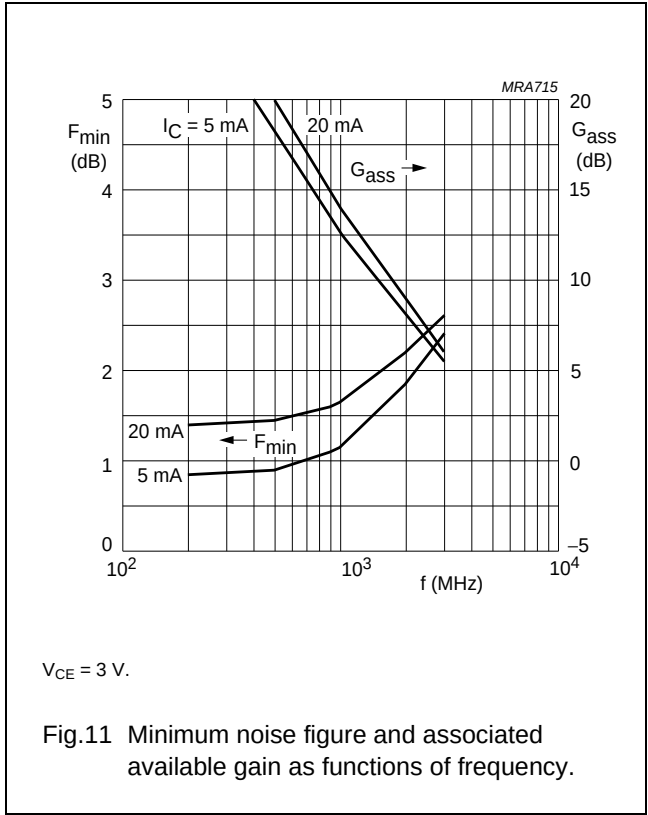


I<sub>C</sub> = 20 mA; V<sub>CE</sub> = 3 V.

Fig.9 Gain as a function of frequency; typical values.

Dual NPN wideband transistor

BFM520



Dual NPN wideband transistor

BFM520

APPLICATION INFORMATION

SPICE parameters for any single BFM520 die

| SEQUENCE No.      | PARAMETER | VALUE | UNIT |
|-------------------|-----------|-------|------|
| 1                 | IS        | 1.016 | fA   |
| 2                 | BF        | 220.1 | –    |
| 3                 | NF        | 1.000 | –    |
| 4                 | VAF       | 48.06 | V    |
| 5                 | IKF       | 510.0 | mA   |
| 6                 | ISE       | 283.0 | fA   |
| 7                 | NE        | 2.035 | –    |
| 8                 | BR        | 100.7 | –    |
| 9                 | NR        | 0.988 | –    |
| 10                | VAR       | 1.692 | V    |
| 11                | IKR       | 2.352 | mA   |
| 12                | ISC       | 24.48 | aA   |
| 13                | NC        | 1.022 | –    |
| 14                | RB        | 10.00 | Ω    |
| 15                | IRB       | 1.000 | μA   |
| 16                | RBM       | 10.00 | Ω    |
| 17                | RE        | 0.775 | Ω    |
| 18                | RC        | 2.210 | Ω    |
| 19 <sup>(1)</sup> | XTB       | 0.000 | –    |
| 20 <sup>(1)</sup> | EG        | 1.110 | eV   |
| 21 <sup>(1)</sup> | XTI       | 3.000 | –    |
| 22                | CJE       | 1.245 | pF   |
| 23                | VJE       | 600.0 | mV   |
| 24                | MJE       | 0.258 | –    |
| 25                | TF        | 8.616 | ps   |
| 26                | XTF       | 6.788 | –    |
| 27                | VTF       | 1.414 | V    |
| 28                | ITF       | 110.3 | mA   |
| 29                | PTF       | 45.01 | deg  |
| 30                | CJC       | 447.6 | fF   |
| 31                | VJC       | 189.2 | mV   |
| 32                | MJC       | 0.071 | –    |
| 33                | XCJC      | 0.130 | –    |
| 34                | TR        | 543.7 | ps   |
| 35 <sup>(1)</sup> | CJS       | 0.000 | F    |
| 36 <sup>(1)</sup> | VJS       | 750.0 | mV   |
| 37 <sup>(1)</sup> | MJS       | 0.000 | –    |
| 38                | FC        | 0.780 | –    |

Note

1. These parameters have not been extracted, the default values are shown.

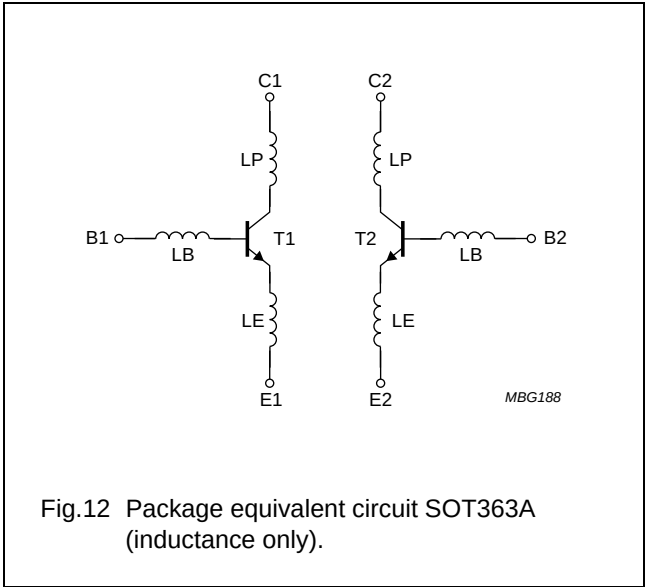


Fig.12 Package equivalent circuit SOT363A (inductance only).

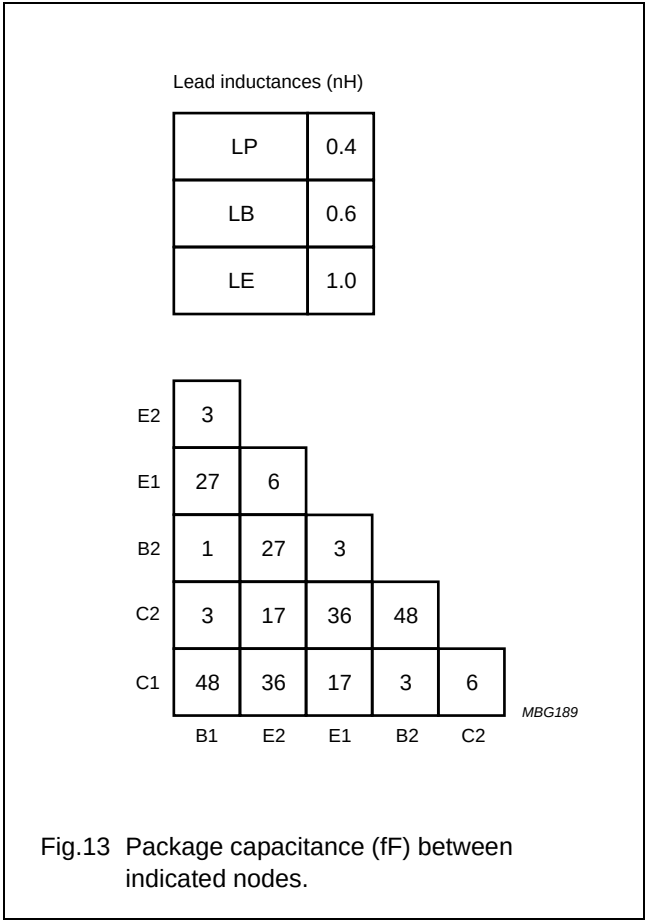


Fig.13 Package capacitance (fF) between indicated nodes.

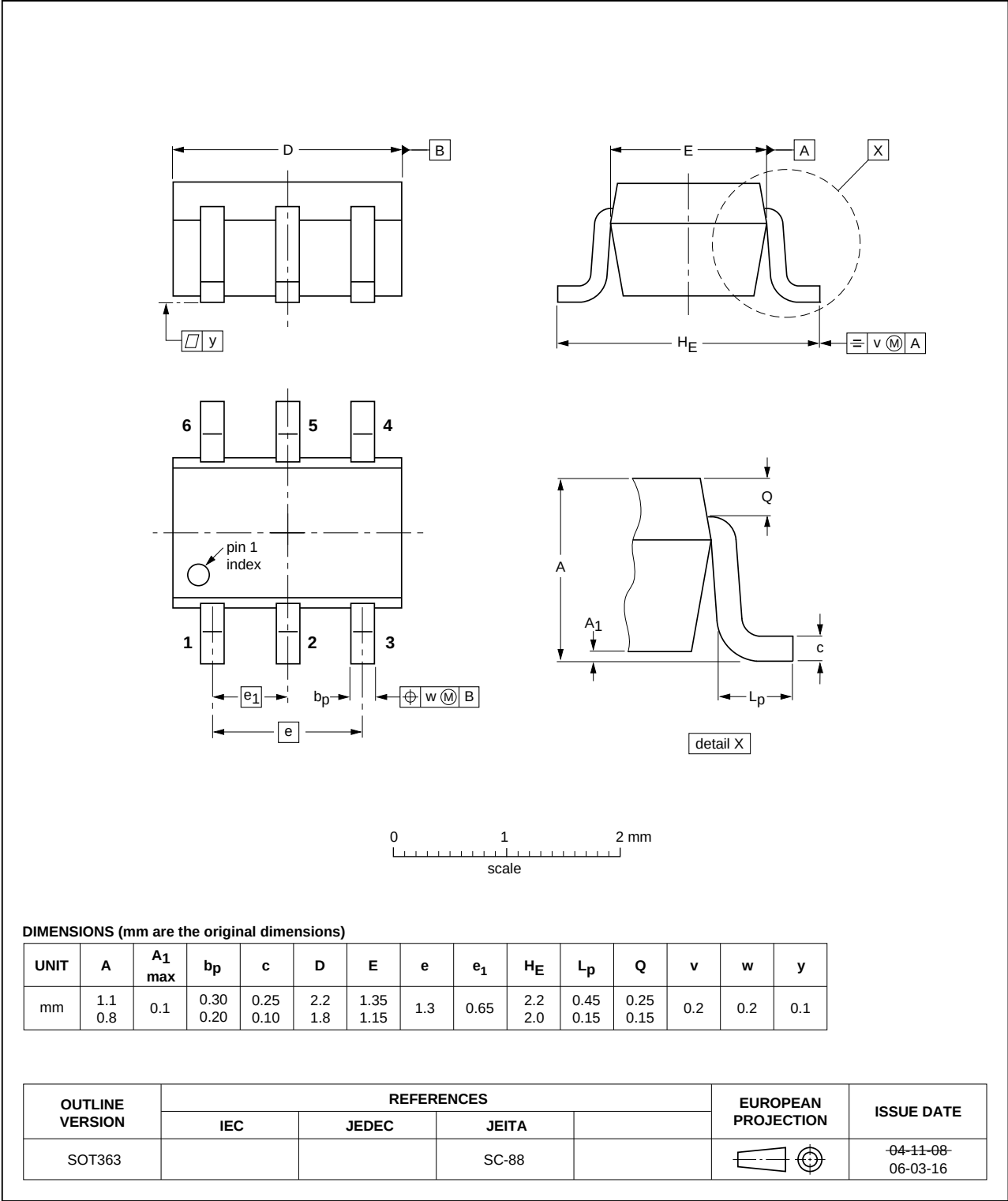
Dual NPN wideband transistor

BFM520

PACKAGE OUTLINE

Plastic surface-mounted package; 6 leads

SOT363



## Dual NPN wideband transistor

BFM520

## DATA SHEET STATUS

| DOCUMENT STATUS <sup>(1)</sup> | PRODUCT STATUS <sup>(2)</sup> | DEFINITION                                                                            |
|--------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| Objective data sheet           | Development                   | This document contains data from the objective specification for product development. |
| Preliminary data sheet         | Qualification                 | This document contains data from the preliminary specification.                       |
| Product data sheet             | Production                    | This document contains the product specification.                                     |

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