

# BFG424F

NPN 25 GHz wideband transistor

Rev. 2 — 13 September 2011

Product data sheet

## 1. Product profile

### 1.1 General description

NPN double polysilicon wideband transistor with buried layer for low voltage applications in a plastic, 4-pin dual-emitter SOT343F package.

#### CAUTION



This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling.

勝特力材料 886-3-5753170  
勝特力电子(上海) 86-21-34970699  
勝特力电子(深圳) 86-755-83298787  
[Http://www.100y.com.tw](http://www.100y.com.tw)

### 1.2 Features and benefits

- Very high power gain
- Low noise figure
- High transition frequency
- Emitter is thermal lead
- Low feedback capacitance

### 1.3 Applications

- Radio Frequency (RF) front end wideband applications such as:
  - ◆ analog and digital cellular telephones
  - ◆ cordless telephones (Cordless Telephone (CT), Personal Handy-phone System (PHS), Digital Enhanced Cordless Telecommunications (DECT), etc.)
  - ◆ radar detectors
  - ◆ pagers
  - ◆ Satellite Antenna TeleVision (SATV) tuners
  - ◆ high frequency oscillators e.g. Dielectric Resonator Oscillator (DRO) for Low Noise Block (LNB)

### 1.4 Quick reference data

Table 1. Quick reference data

| Symbol    | Parameter                 | Conditions                     | Min               | Typ | Max | Unit |
|-----------|---------------------------|--------------------------------|-------------------|-----|-----|------|
| $V_{CBO}$ | collector-base voltage    | open emitter                   | -                 | -   | 10  | V    |
| $V_{CEO}$ | collector-emitter voltage | open base                      | -                 | -   | 4.5 | V    |
| $I_C$     | collector current         |                                | -                 | 25  | 30  | mA   |
| $P_{tot}$ | total power dissipation   | $T_{sp} \leq 90^\circ\text{C}$ | <a href="#">1</a> | -   | 135 | mW   |



Table 1. Quick reference data ...continued

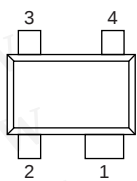
| Symbol       | Parameter                  | Conditions                                                                                                      | Min | Typ | Max | Unit |
|--------------|----------------------------|-----------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $h_{FE}$     | DC current gain            | $I_C = 25 \text{ mA}$ ; $V_{CE} = 2 \text{ V}$ ;<br>$T_j = 25 \text{ }^\circ\text{C}$                           | 50  | 80  | 120 |      |
| $C_{CBS}$    | collector-base capacitance | $V_{CB} = 2 \text{ V}$ ; $f = 1 \text{ MHz}$                                                                    | -   | 102 | -   | fF   |
| $f_T$        | transition frequency       | $I_C = 25 \text{ mA}$ ; $V_{CE} = 2 \text{ V}$ ;<br>$f = 2 \text{ GHz}$ ; $T_{amb} = 25 \text{ }^\circ\text{C}$ | -   | 25  | -   | GHz  |
| $G_{p(max)}$ | maximum power gain         | $I_C = 25 \text{ mA}$ ; $V_{CE} = 2 \text{ V}$ ;<br>$f = 2 \text{ GHz}$ ; $T_{amb} = 25 \text{ }^\circ\text{C}$ | [2] | 23  | -   | dB   |
| NF           | noise figure               | $I_C = 2 \text{ mA}$ ; $V_{CE} = 2 \text{ V}$ ;<br>$f = 2 \text{ GHz}$ ; $\Gamma_S = \Gamma_{opt}$              | -   | 1.2 | -   | dB   |

[1]  $T_{sp}$  is the temperature at the soldering point of the emitter pins.

[2]  $G_{p(max)}$  is the maximum power gain, if  $K > 1$ . If  $K < 1$  then  $G_{p(max)}$  = Maximum Stable Gain (MSG), see Figure 8.

## 2. Pinning information

Table 2. Pinning

| Pin | Description | Simplified outline                                                                    | Symbol                                                                                |
|-----|-------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1   | emitter     |  |  |
| 2   | base        |                                                                                       |                                                                                       |
| 3   | emitter     |                                                                                       |                                                                                       |
| 4   | collector   |                                                                                       |                                                                                       |

## 3. Ordering information

Table 3. Ordering information

| Type number | Package |                                                                     |         |
|-------------|---------|---------------------------------------------------------------------|---------|
|             | Name    | Description                                                         | Version |
| BFG424F     | -       | plastic surface mounted flat pack package; reverse pinning; 4 leads | SOT343F |

## 4. Marking

Table 4. Marking

| Type number | Marking code <sup>[1]</sup> |
|-------------|-----------------------------|
| BFG424F     | NE*                         |

[1] \* = p: made in Hong Kong.

## 5. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol    | Parameter                 | Conditions                               | Min | Max  | Unit               |
|-----------|---------------------------|------------------------------------------|-----|------|--------------------|
| $V_{CBO}$ | collector-base voltage    | open emitter                             | -   | 10   | V                  |
| $V_{CEO}$ | collector-emitter voltage | open base                                | -   | 4.5  | V                  |
| $V_{EBO}$ | emitter-base voltage      | open collector                           | -   | 1    | V                  |
| $I_C$     | collector current         |                                          | -   | 30   | mA                 |
| $P_{tot}$ | total power dissipation   | $T_{sp} \leq 90\text{ }^{\circ}\text{C}$ | [1] | 135  | mW                 |
| $T_{stg}$ | storage temperature       |                                          | -65 | +150 | $^{\circ}\text{C}$ |
| $T_j$     | junction temperature      |                                          | -   | 150  | $^{\circ}\text{C}$ |

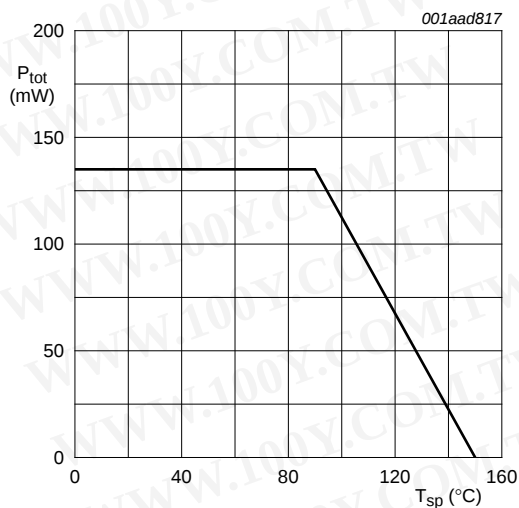
[1]  $T_{sp}$  is the temperature at the soldering point of the emitter pins.

## 6. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol         | Parameter                                        | Conditions                               | Typ     | Unit |
|----------------|--------------------------------------------------|------------------------------------------|---------|------|
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | $T_{sp} \leq 90\text{ }^{\circ}\text{C}$ | [1] 340 | K/W  |

[1]  $T_{sp}$  is the temperature at the soldering point of the emitter pins.



**Fig 1. Power derating curve**

## 7. Characteristics

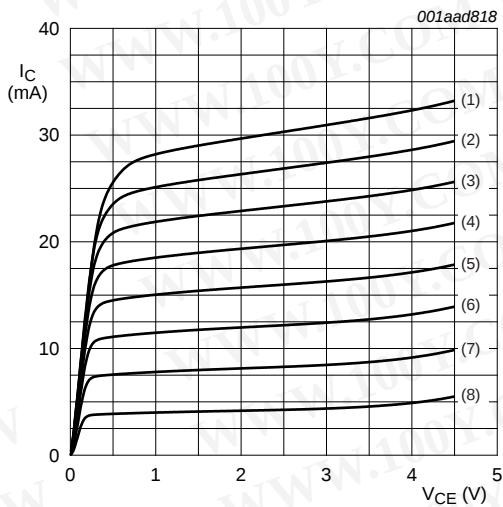
**Table 7. Characteristics**

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

| Symbol        | Parameter                                     | Conditions                                                                                                  | Min | Typ  | Max | Unit |
|---------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| $V_{(BR)CBO}$ | collector-base breakdown voltage              | $I_C = 2.5\text{ }\mu\text{A}$ ; $I_E = 0\text{ mA}$                                                        | 10  | -    | -   | V    |
| $V_{(BR)CEO}$ | collector-emitter breakdown voltage           | $I_C = 1\text{ mA}$ ; $I_B = 0\text{ mA}$                                                                   | 4.5 | -    | -   | V    |
| $V_{(BR)EBO}$ | open-collector emitter-base breakdown voltage | $I_E = 2.5\text{ }\mu\text{A}$ ; $I_C = 0\text{ mA}$                                                        | 1   | -    | -   | V    |
| $I_{CBO}$     | collector-base cut-off current                | $I_E = 0\text{ mA}$ ; $V_{CB} = 4.5\text{ V}$                                                               | -   | -    | 15  | nA   |
| $h_{FE}$      | DC current gain                               | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$                                                                | 50  | 80   | 120 |      |
| $C_{CES}$     | collector-emitter capacitance                 | $V_{CB} = 2\text{ V}$ ; $f = 1\text{ MHz}$                                                                  | -   | 363  | -   | fF   |
| $C_{EBS}$     | emitter-base capacitance                      | $V_{EB} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$                                                                | -   | 475  | -   | fF   |
| $C_{CBS}$     | collector-base capacitance                    | $V_{CB} = 2\text{ V}$ ; $f = 1\text{ MHz}$                                                                  | -   | 102  | -   | fF   |
| $f_T$         | transition frequency                          | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$  | -   | 25   | -   | GHz  |
| $G_{p(max)}$  | maximum power gain                            | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$  | [1] | 23   | -   | dB   |
| $ S_{21} ^2$  | insertion power gain                          | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$  | -   | 18.5 | -   | dB   |
| NF            | noise figure                                  | $I_C = 2\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 900\text{ MHz}$ ; $\Gamma_S = \Gamma_{opt}$              | -   | 0.8  | -   | dB   |
|               |                                               | $I_C = 2\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $\Gamma_S = \Gamma_{opt}$                | -   | 1.2  | -   | dB   |
| $P_{L(1dB)}$  | output power at 1 dB gain compression         | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $Z_S = Z_{S(opt)}$ ; $Z_L = Z_{L(opt)}$ | [2] | 12   | -   | dBm  |
| IP3           | third-order intercept point                   | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $Z_S = Z_{S(opt)}$ ; $Z_L = Z_{L(opt)}$ | [2] | 22   | -   | dBm  |

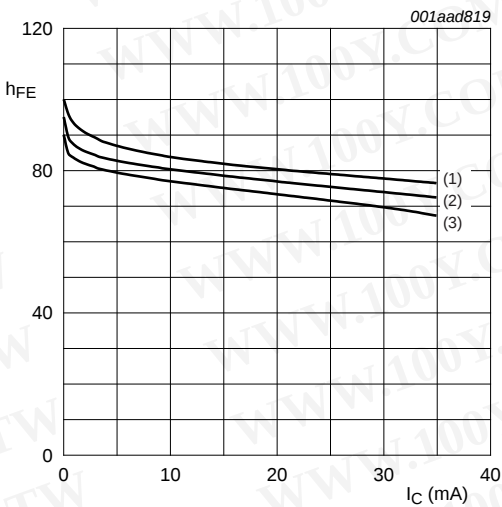
[1]  $G_{p(max)}$  is the maximum power gain, if  $K > 1$ . If  $K < 1$  then  $G_{p(max)} = \text{MSG}$ , see [Figure 8](#).

[2]  $Z_S$  is optimized for noise;  $Z_L$  is optimized for gain.



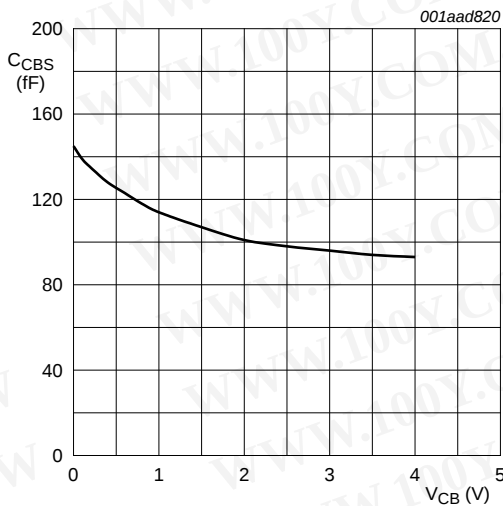
- (1) I<sub>B</sub> = 400 μA
- (2) I<sub>B</sub> = 350 μA
- (3) I<sub>B</sub> = 300 μA
- (4) I<sub>B</sub> = 250 μA
- (5) I<sub>B</sub> = 200 μA
- (6) I<sub>B</sub> = 150 μA
- (7) I<sub>B</sub> = 100 μA
- (8) I<sub>B</sub> = 50 μA

Fig 2. Collector current as a function of collector-emitter voltage; typical values



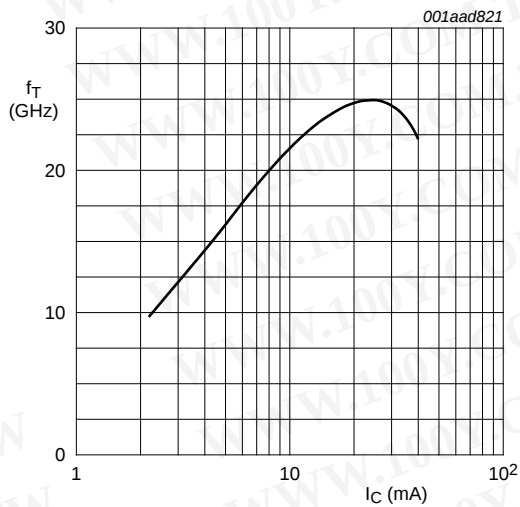
- (1) V<sub>CE</sub> = 3 V
- (2) V<sub>CE</sub> = 2 V
- (3) V<sub>CE</sub> = 1 V

Fig 3. DC current gain as a function of collector current; typical values



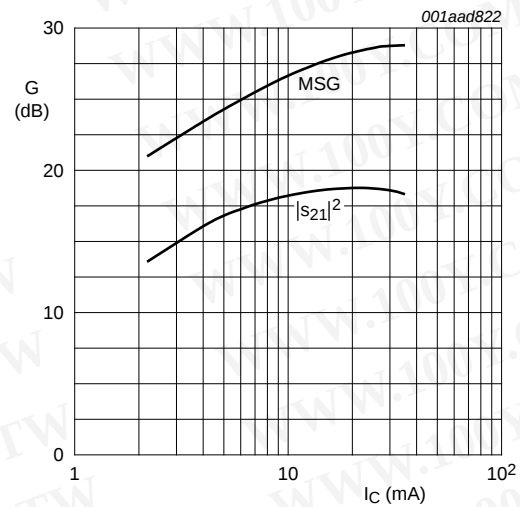
f = 1 MHz

Fig 4. Collector-base capacitance as a function of collector-base voltage; typical values



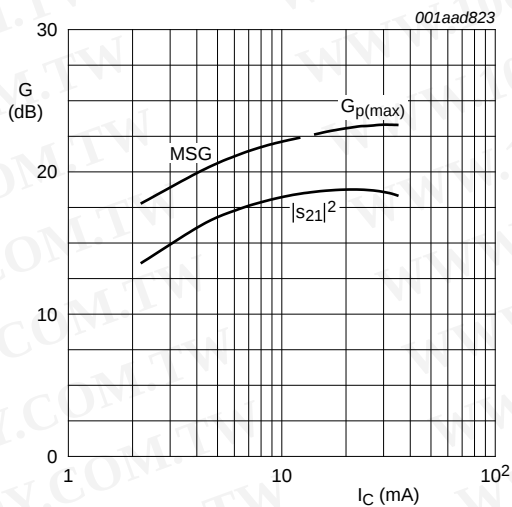
$V_{CE} = 2 \text{ V}$ ;  $f = 2 \text{ GHz}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$

**Fig 5. Transition frequency as a function of collector current; typical values**



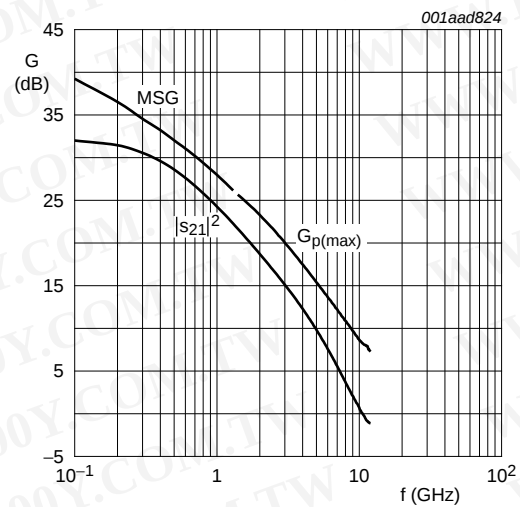
$V_{CE} = 2 \text{ V}$ ;  $f = 0.9 \text{ GHz}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$

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



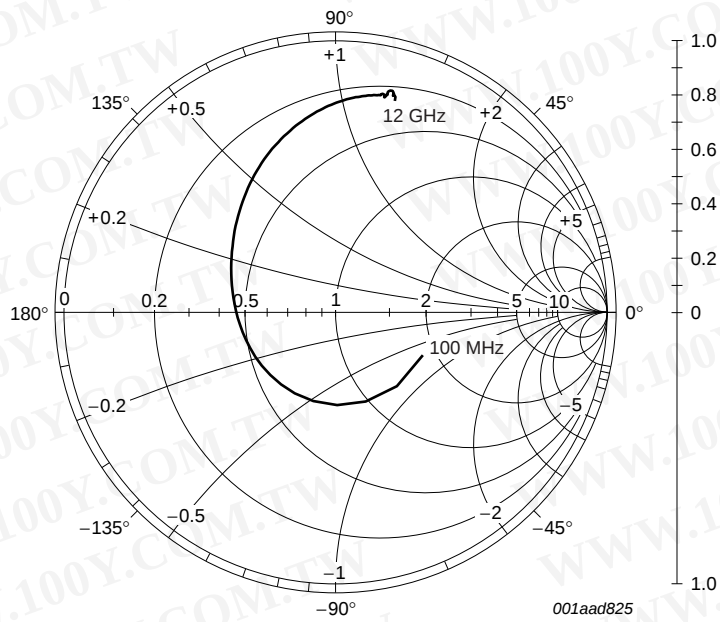
$V_{CE} = 2 \text{ V}$ ;  $f = 2 \text{ GHz}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$

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



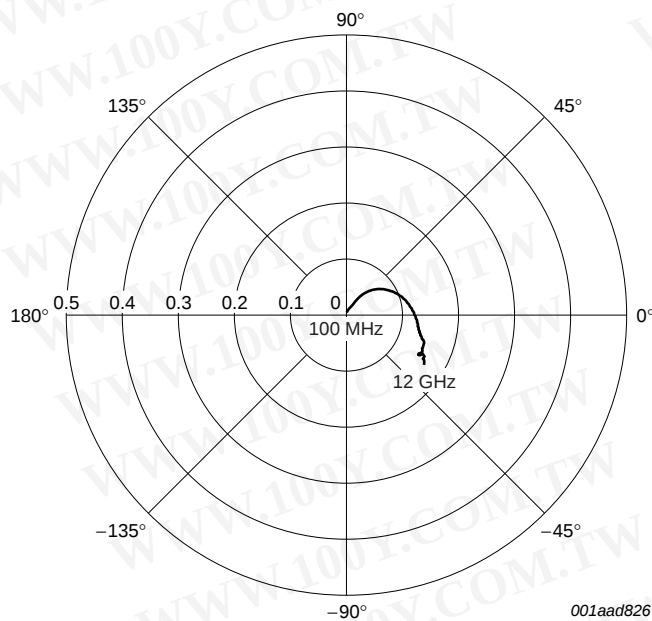
$V_{CE} = 2 \text{ V}$ ;  $I_C = 25 \text{ mA}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$

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



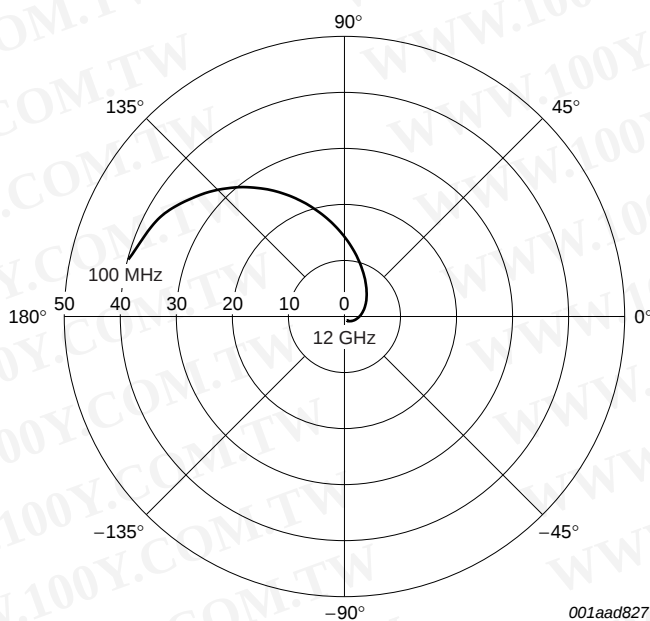
$V_{CE} = 2\text{ V}$ ;  $I_C = 25\text{ mA}$ ;  $Z_0 = 50\ \Omega$

**Fig 9. Common emitter input reflection coefficient ( $s_{11}$ ); typical values**



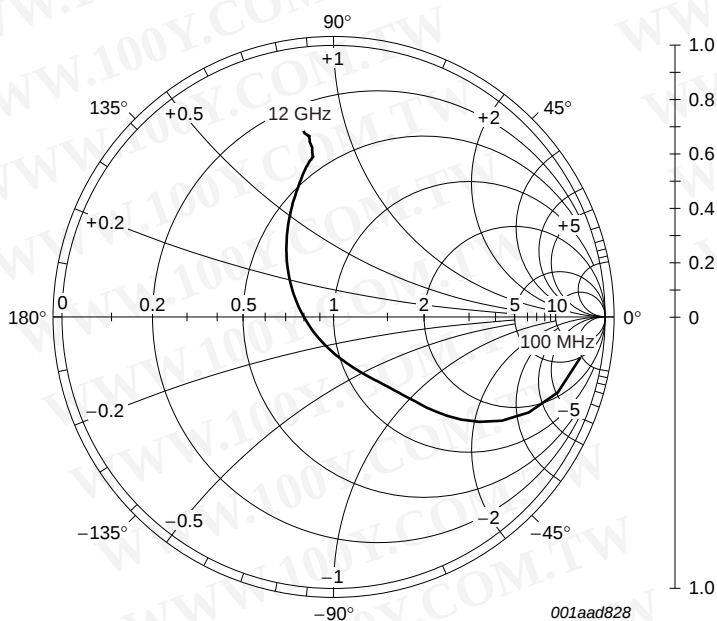
$V_{CE} = 2\text{ V}$ ;  $I_C = 25\text{ mA}$

**Fig 10. Common emitter reverse transmission coefficient ( $s_{12}$ ); typical values**



$V_{CE} = 2 \text{ V}; I_C = 25 \text{ mA}$

**Fig 11. Common emitter forward transmission coefficient ( $s_{21}$ ); typical values**



$V_{CE} = 2 \text{ V}; I_C = 25 \text{ mA}; Z_0 = 50 \Omega$

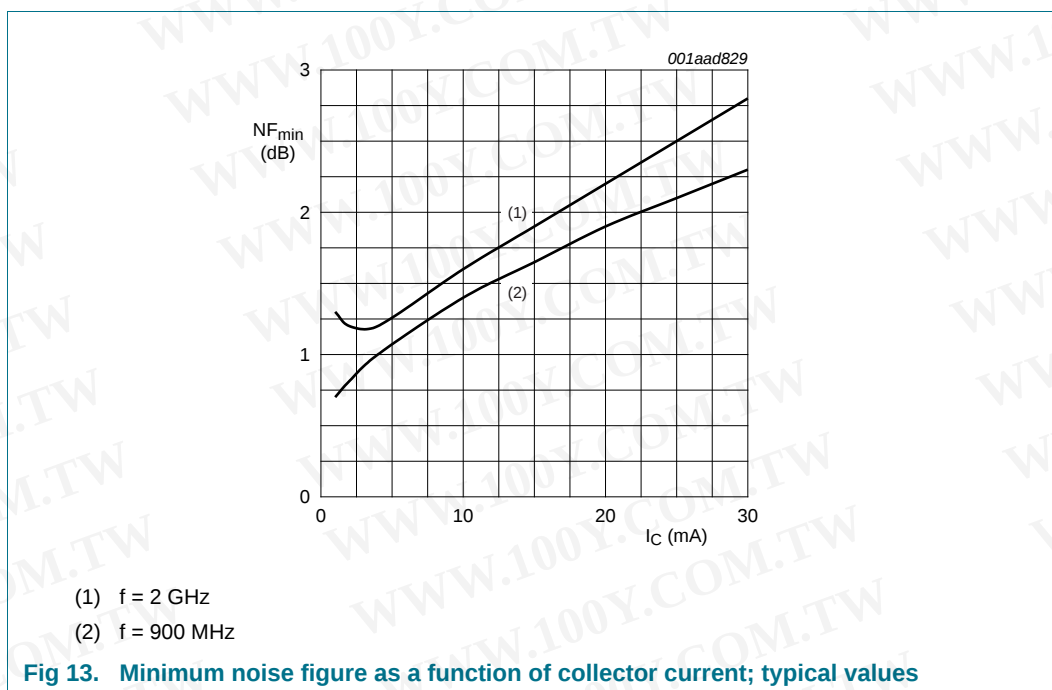
**Fig 12. Common emitter input reflection coefficient ( $s_{22}$ ); typical values**

## 7.1 Noise data

Table 8. Noise data

$V_{CE} = 2\text{ V}$ ; typical values.

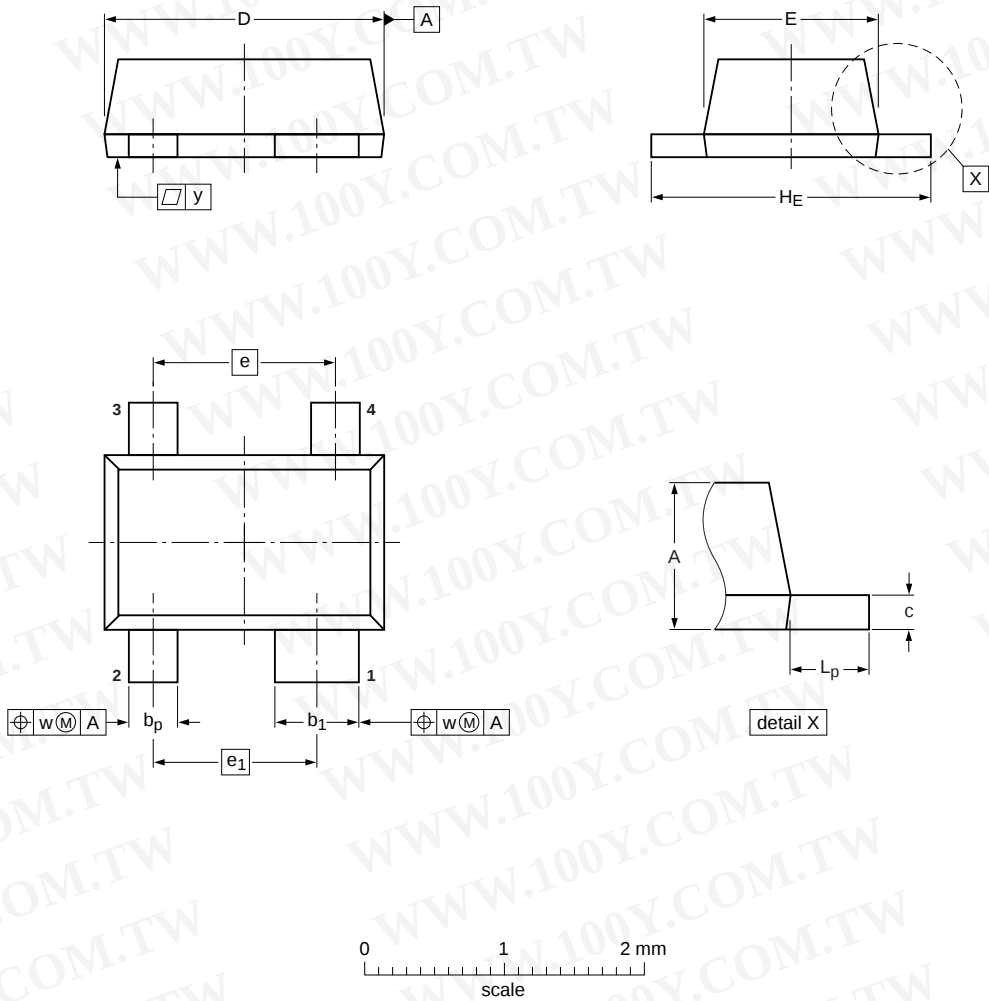
| f<br>(MHz) | I <sub>C</sub><br>(mA) | NF <sub>min</sub><br>(dB) | Γ <sub>opt</sub> |        | r <sub>n</sub><br>(Ω) |
|------------|------------------------|---------------------------|------------------|--------|-----------------------|
|            |                        |                           | ratio            | (deg)  |                       |
| 900        | 1                      | 0.7                       | 0.67             | 19.1   | 0.40                  |
|            | 2                      | 0.81                      | 0.48             | 17.8   | 0.27                  |
|            | 4                      | 1                         | 0.28             | 11.7   | 0.24                  |
|            | 10                     | 1.4                       | 0.02             | -63.9  | 0.19                  |
|            | 15                     | 1.65                      | 0.11             | -162.4 | 0.18                  |
|            | 20                     | 1.9                       | 0.19             | -165.5 | 0.18                  |
|            | 25                     | 2.1                       | 0.25             | -166.3 | 0.19                  |
|            | 30                     | 2.3                       | 0.29             | -166.5 | 0.19                  |
| 2000       | 1                      | 1.3                       | 0.56             | 57.5   | 0.36                  |
|            | 2                      | 1.2                       | 0.43             | 57.2   | 0.25                  |
|            | 4                      | 1.2                       | 0.22             | 60.8   | 0.18                  |
|            | 10                     | 1.6                       | 0.06             | 137.4  | 0.19                  |
|            | 15                     | 1.9                       | 0.13             | -162.1 | 0.20                  |
|            | 20                     | 2.2                       | 0.17             | -155.5 | 0.20                  |
|            | 25                     | 2.5                       | 0.22             | -152.2 | 0.21                  |
|            | 30                     | 2.8                       | 0.27             | -150.8 | 0.25                  |



8. Package outline

Plastic surface-mounted flat pack package; reverse pinning; 4 leads

SOT343F



DIMENSIONS (mm are the original dimensions)

| UNIT | A<br>max     | b <sub>p</sub> | b <sub>1</sub> | c            | D          | E            | e   | e <sub>1</sub> | H <sub>E</sub> | L <sub>p</sub> | w   | y   |
|------|--------------|----------------|----------------|--------------|------------|--------------|-----|----------------|----------------|----------------|-----|-----|
| mm   | 0.75<br>0.65 | 0.4<br>0.3     | 0.7<br>0.5     | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15 | 1.3 | 1.15           | 2.2<br>2.0     | 0.48<br>0.38   | 0.2 | 0.1 |

| OUTLINE<br>VERSION | REFERENCES |       |       |  | EUROPEAN<br>PROJECTION                                                                | ISSUE DATE           |
|--------------------|------------|-------|-------|--|---------------------------------------------------------------------------------------|----------------------|
|                    | IEC        | JEDEC | JEITA |  |                                                                                       |                      |
| SOT343F            |            |       |       |  |  | 05-07-12<br>06-03-16 |

Fig 14. Package outline SOT343F

## 9. Revision history

Table 9. Revision history

| Document ID    | Release date                                                                                                                                                                                                                                         | Data sheet status  | Change notice | Supersedes  |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|-------------|
| BFG424F v.2    | 20110913                                                                                                                                                                                                                                             | Product data sheet | -             | BFG424F v.1 |
| Modifications: | <ul style="list-style-type: none"><li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>Legal texts have been adapted to the new company name where appropriate.</li></ul> |                    |               |             |
| BFG424F v.1    | 20060321                                                                                                                                                                                                                                             | Product data sheet | -             | -           |

## 10. Legal information

### 10.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition                                                                            |
|-----------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

## 12. Contents

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勝特力材料 886-3-5753170  
勝特力电子(上海) 86-21-34970699  
勝特力电子(深圳) 86-755-83298787  
[Http://www.100y.com.tw](http://www.100y.com.tw)

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For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

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