

# BFU660F

NPN wideband silicon RF transistor

Rev. 1 — 11 January 2011

Product data sheet

## 1. Product profile

### 1.1 General description

NPN silicon microwave transistor for high speed, low noise applications in a plastic, 4-pin dual-emitter SOT343F package.

#### CAUTION



This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices.

Such precautions are described in the *ANSI/ESD S20.20*, *IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

### 1.2 Features and benefits

- Low noise high linearity RF transistor
- High output third-order intercept point 27 dBm at 1.8 GHz
- 40 GHz  $f_T$  silicon technology

### 1.3 Applications

- Analog/digital cordless applications
- X-band high output buffer amplifier
- ZigBee
- SDARS second stage LNA
- LTE, cellular, UMTS



## 1.4 Quick reference data

Table 1. Quick reference data

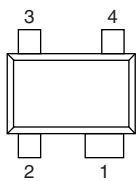
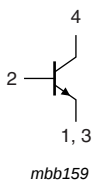
| Symbol       | Parameter                             | Conditions                                                                                                                                          | Min | Typ  | Max | Unit |
|--------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| $V_{CBO}$    | collector-base voltage                | open emitter                                                                                                                                        | -   | -    | 16  | V    |
| $V_{CEO}$    | collector-emitter voltage             | open base                                                                                                                                           | -   | -    | 5.5 | V    |
| $V_{EBO}$    | emitter-base voltage                  | open collector                                                                                                                                      | -   | -    | 2.5 | V    |
| $I_C$        | collector current                     |                                                                                                                                                     | -   | 30   | 60  | mA   |
| $P_{tot}$    | total power dissipation               | $T_{sp} \leq 90\text{ }^{\circ}\text{C}$                                                                                                            | [1] | -    | 225 | mW   |
| $h_{FE}$     | DC current gain                       | $I_C = 10\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ;<br>$T_j = 25\text{ }^{\circ}\text{C}$                                                                | 90  | 135  | 180 |      |
| $C_{CBS}$    | collector-base capacitance            | $V_{CB} = 2\text{ V}$ ; $f = 1\text{ MHz}$                                                                                                          | -   | 138  | -   | fF   |
| $f_T$        | transition frequency                  | $I_C = 20\text{ mA}$ ; $V_{CE} = 1\text{ V}$ ;<br>$f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                       | -   | 21   | -   | GHz  |
| $IP3_O$      | output third-order intercept point    | $I_C = 40\text{ mA}$ ; $V_{CE} = 4\text{ V}$ ;<br>$f = 5.8\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                     | -   | 28   | -   | dBm  |
| $G_{p(max)}$ | maximum power gain                    | $I_C = 30\text{ mA}$ ; $V_{CE} = 1\text{ V}$ ;<br>$f = 1.8\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                     | [2] | -    | 24  | dB   |
| NF           | noise figure                          | $I_C = 6\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ;<br>$f = 1.8\text{ GHz}$ ; $\Gamma_S = \Gamma_{opt}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$       | -   | 0.65 | -   | dB   |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | $I_C = 60\text{ mA}$ ; $V_{CE} = 4\text{ V}$ ;<br>$Z_S = Z_L = 50\text{ }\Omega$ ;<br>$f = 1.8\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ | -   | 17   | -   | dBm  |

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

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

## 2. Pinning information

Table 2. Discrete pinning

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

## 3. Ordering information

Table 3. Ordering information

| Type number | Package |                                                                     |         |
|-------------|---------|---------------------------------------------------------------------|---------|
|             | Name    | Description                                                         | Version |
| BFU660F     | -       | plastic surface-mounted flat pack package; reverse pinning; 4 leads | SOT343F |

4. Marking

| Table 4. Marking |         |                           |
|------------------|---------|---------------------------|
| Type number      | Marking | Description               |
| BFU660F          | D3*     | * = p : made in Hong Kong |
|                  |         | * = t : made in Malaysia  |
|                  |         | * = w : made in China     |

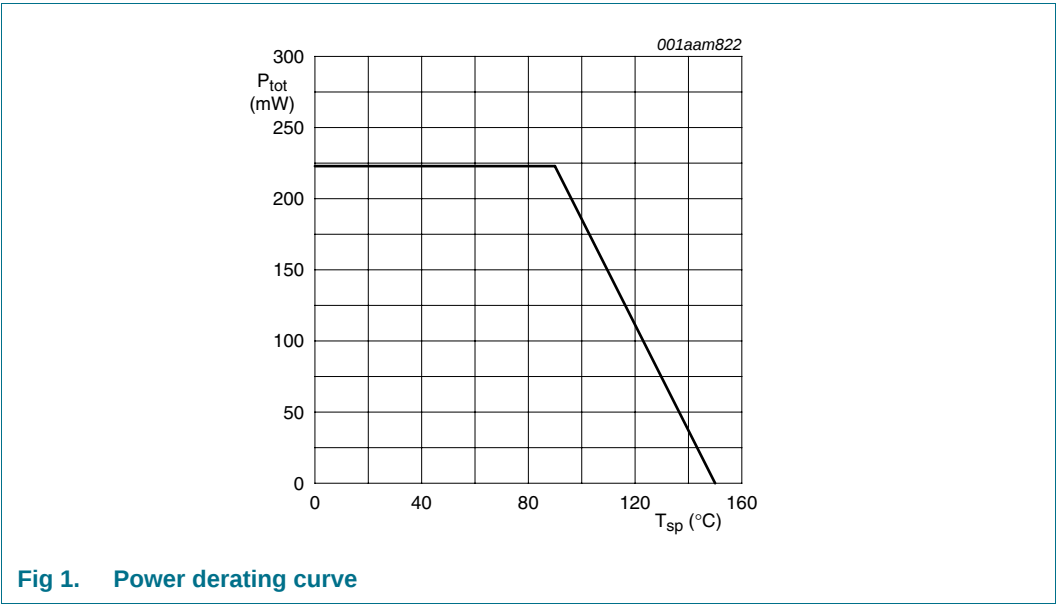
5. Limiting values

| Table 5. Limiting values                                           |                           |                         |       |      |      |
|--------------------------------------------------------------------|---------------------------|-------------------------|-------|------|------|
| In accordance with the Absolute Maximum Rating System (IEC 60134). |                           |                         |       |      |      |
| Symbol                                                             | Parameter                 | Conditions              | Min   | Max  | Unit |
| V <sub>CBO</sub>                                                   | collector-base voltage    | open emitter            | -     | 16   | V    |
| V <sub>CEO</sub>                                                   | collector-emitter voltage | open base               | -     | 5.5  | V    |
| V <sub>EBO</sub>                                                   | emitter-base voltage      | open collector          | -     | 2.5  | V    |
| I <sub>C</sub>                                                     | collector current         |                         | -     | 60   | mA   |
| P <sub>tot</sub>                                                   | total power dissipation   | T <sub>sp</sub> ≤ 90 °C | [1] - | 225  | mW   |
| T <sub>stg</sub>                                                   | storage temperature       |                         | -65   | +150 | °C   |
| T <sub>j</sub>                                                     | junction temperature      |                         | -     | 150  | °C   |

[1] T<sub>sp</sub> is the temperature at the solder point of the emitter lead.

6. Thermal characteristics

| Table 6. Thermal characteristics |                                                  |            |     |      |
|----------------------------------|--------------------------------------------------|------------|-----|------|
| Symbol                           | Parameter                                        | Conditions | Typ | Unit |
| R <sub>th(j-sp)</sub>            | thermal resistance from junction to solder point |            | 270 | K/W  |



## 7. Characteristics

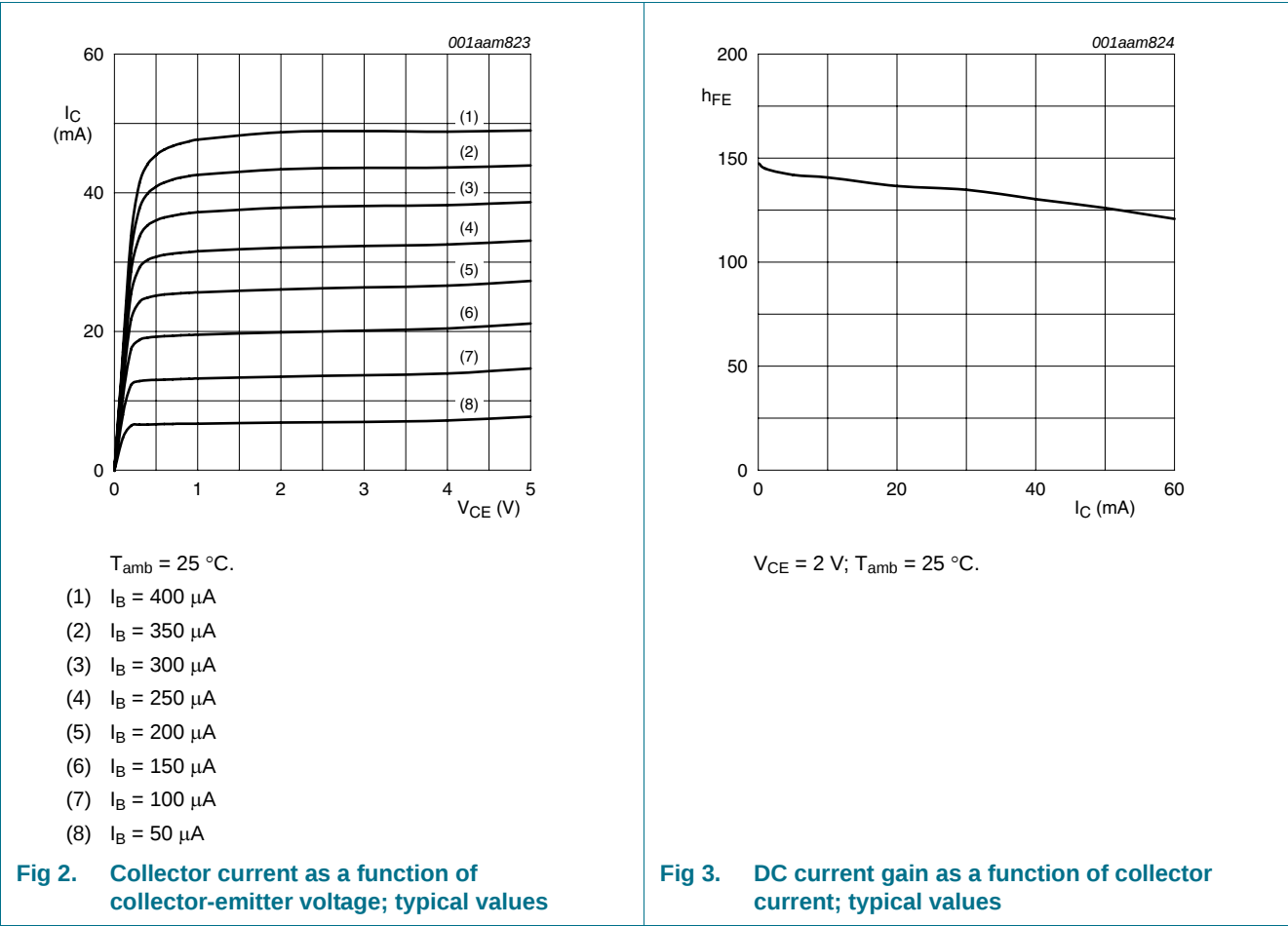
**Table 7. Characteristics**
 $T_j = 25\text{ °C}$  unless otherwise specified

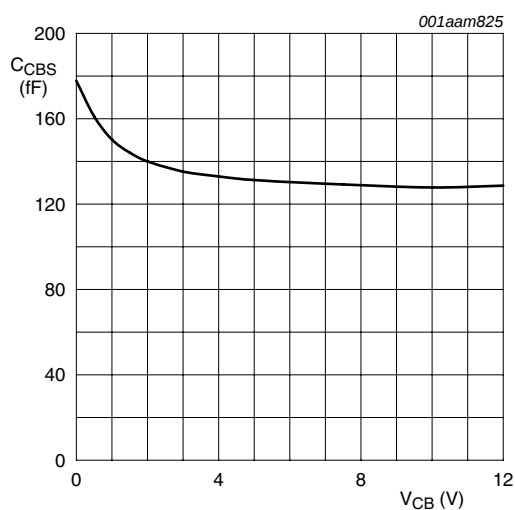
| Symbol        | Parameter                             | Conditions                                                                                               | Min | Typ  | Max | Unit |
|---------------|---------------------------------------|----------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| $V_{(BR)CBO}$ | collector-base breakdown voltage      | $I_C = 2.5\text{ }\mu\text{A}$ ; $I_E = 0\text{ mA}$                                                     | 16  | -    | -   | V    |
| $V_{(BR)CEO}$ | collector-emitter breakdown voltage   | $I_C = 1\text{ mA}$ ; $I_B = 0\text{ mA}$                                                                | 5.5 | -    | -   | V    |
| $I_C$         | collector current                     |                                                                                                          | -   | 30   | 60  | mA   |
| $I_{CBO}$     | collector-base cut-off current        | $I_E = 0\text{ mA}$ ; $V_{CB} = 8\text{ V}$                                                              | -   | -    | 100 | nA   |
| $h_{FE}$      | DC current gain                       | $I_C = 10\text{ mA}$ ; $V_{CE} = 2\text{ V}$                                                             | 90  | 135  | 180 |      |
| $C_{CES}$     | collector-emitter capacitance         | $V_{CB} = 2\text{ V}$ ; $f = 1\text{ MHz}$                                                               | -   | 297  | -   | fF   |
| $C_{EBS}$     | emitter-base capacitance              | $V_{EB} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$                                                             | -   | 664  | -   | fF   |
| $C_{CBS}$     | collector-base capacitance            | $V_{CB} = 2\text{ V}$ ; $f = 1\text{ MHz}$                                                               | -   | 138  | -   | fF   |
| $f_T$         | transition frequency                  | $I_C = 20\text{ mA}$ ; $V_{CE} = 1\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$             | -   | 21   | -   | GHz  |
| $G_{p(max)}$  | maximum power gain                    | $I_C = 30\text{ mA}$ ; $V_{CE} = 1\text{ V}$ ; $T_{amb} = 25\text{ °C}$ <a href="#">[1]</a>              |     |      |     |      |
|               |                                       | $f = 1.5\text{ GHz}$                                                                                     | -   | 25   | -   | dB   |
|               |                                       | $f = 1.8\text{ GHz}$                                                                                     | -   | 24   | -   | dB   |
|               |                                       | $f = 2.4\text{ GHz}$                                                                                     | -   | 22   | -   | dB   |
| $ S_{21} ^2$  | insertion power gain                  | $I_C = 30\text{ mA}$ ; $V_{CE} = 1\text{ V}$ ; $T_{amb} = 25\text{ °C}$                                  |     |      |     |      |
|               |                                       | $f = 1.5\text{ GHz}$                                                                                     | -   | 20   | -   | dB   |
|               |                                       | $f = 1.8\text{ GHz}$                                                                                     | -   | 18.5 | -   | dB   |
|               |                                       | $f = 2.4\text{ GHz}$                                                                                     | -   | 16   | -   | dB   |
| NF            | noise figure                          | $I_C = 6\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $\Gamma_S = \Gamma_{opt}$ ; $T_{amb} = 25\text{ °C}$       |     |      |     |      |
|               |                                       | $f = 1.5\text{ GHz}$                                                                                     | -   | 0.60 | -   | dB   |
|               |                                       | $f = 1.8\text{ GHz}$                                                                                     | -   | 0.65 | -   | dB   |
|               |                                       | $f = 2.4\text{ GHz}$                                                                                     | -   | 0.70 | -   | dB   |
| $G_{ass}$     | associated gain                       | $I_C = 6\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $\Gamma_S = \Gamma_{opt}$ ; $T_{amb} = 25\text{ °C}$       |     |      |     |      |
|               |                                       | $f = 1.5\text{ GHz}$                                                                                     | -   | 21   | -   | dB   |
|               |                                       | $f = 1.8\text{ GHz}$                                                                                     | -   | 20   | -   | dB   |
|               |                                       | $f = 2.4\text{ GHz}$                                                                                     | -   | 17.5 | -   | dB   |
| $P_{L(1dB)}$  | output power at 1 dB gain compression | $I_C = 60\text{ mA}$ ; $V_{CE} = 4\text{ V}$ ; $Z_S = Z_L = 50\text{ }\Omega$ ; $T_{amb} = 25\text{ °C}$ |     |      |     |      |
|               |                                       | $f = 1.5\text{ GHz}$                                                                                     | -   | 17   | -   | dBm  |
|               |                                       | $f = 1.8\text{ GHz}$                                                                                     | -   | 17   | -   | dBm  |
|               |                                       | $f = 2.4\text{ GHz}$                                                                                     | -   | 16   | -   | dBm  |
|               |                                       | $f = 5.8\text{ GHz}$                                                                                     | -   | 18.5 | -   | dBm  |

Table 7. Characteristics ...continued  
*T<sub>j</sub> = 25 °C unless otherwise specified*

| Symbol           | Parameter                          | Conditions                                                                                                         | Min | Typ | Max | Unit |
|------------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| IP3 <sub>O</sub> | output third-order intercept point | I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 4 V;<br>Z <sub>S</sub> = Z <sub>L</sub> = 50 Ω; T <sub>amb</sub> = 25 °C |     |     |     |      |
|                  |                                    | f = 1.5 GHz                                                                                                        | -   | 27  | -   | dBm  |
|                  |                                    | f = 1.8 GHz                                                                                                        | -   | 27  | -   | dBm  |
|                  |                                    | f = 2.4 GHz                                                                                                        | -   | 27  | -   | dBm  |
|                  |                                    | f = 5.8 GHz                                                                                                        | -   | 28  | -   | dBm  |

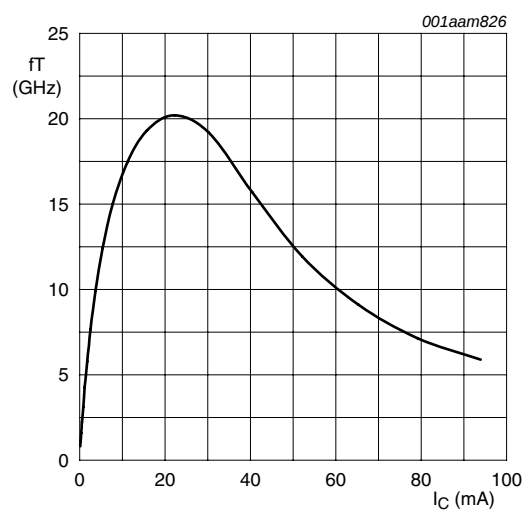
[1] G<sub>p(max)</sub> is the maximum power gain, if K > 1. If K < 1 then G<sub>p(max)</sub> = MSG.





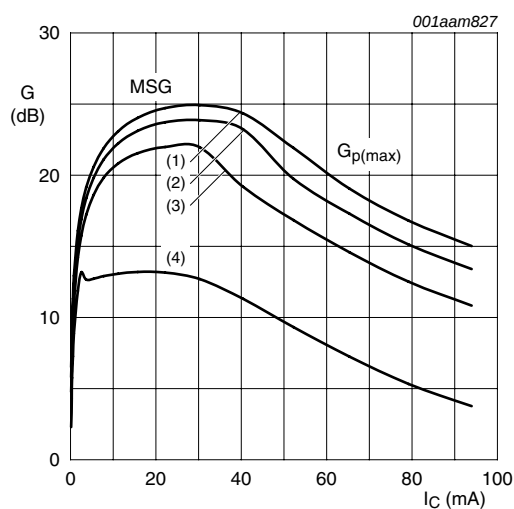
$f = 1 \text{ MHz}$ ,  $T_{amb} = 25 \text{ }^{\circ}\text{C}$ .

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



$V_{CE} = 1 \text{ V}$ ;  $f = 2 \text{ GHz}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$ .

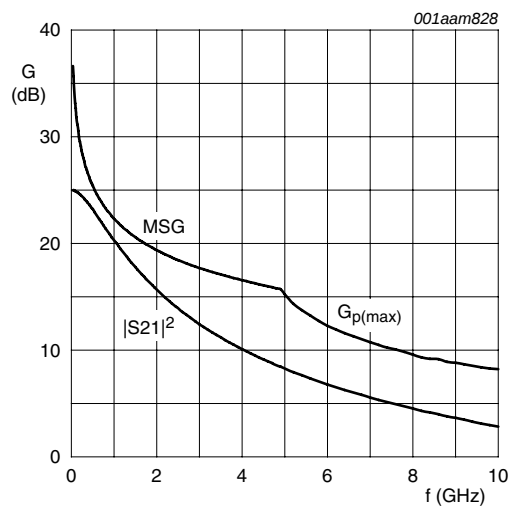
**Fig 5. Transition frequency as a function of collector current; typical values**



$V_{CE} = 1 \text{ V}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$ .

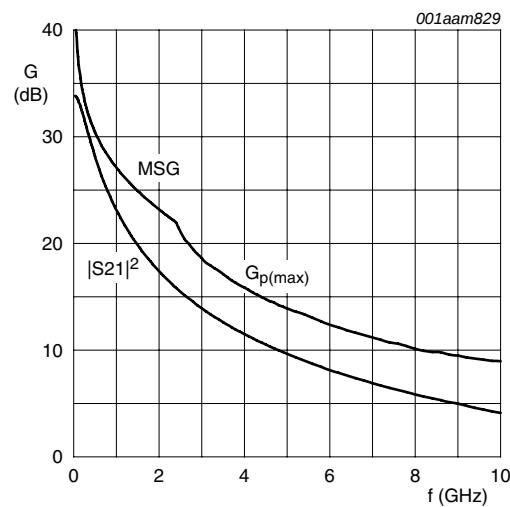
- (1)  $f = 1.5 \text{ GHz}$
- (2)  $f = 1.8 \text{ GHz}$
- (3)  $f = 2.4 \text{ GHz}$
- (4)  $f = 5.8 \text{ GHz}$
- (5)  $f = 12 \text{ GHz}$

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



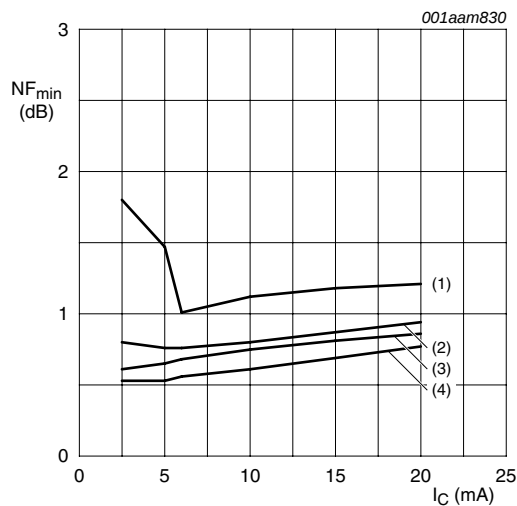
$V_{CE} = 1\text{ V}$ ;  $I_C = 5\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig 7. Gain as a function of frequency; typical values



$V_{CE} = 1\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

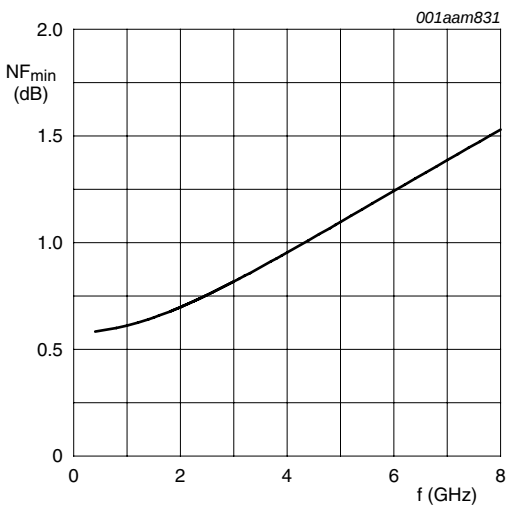
Fig 8. Gain as a function of frequency; typical values



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

- (1)  $f = 5.8\text{ GHz}$
- (2)  $f = 2.4\text{ GHz}$
- (3)  $f = 1.8\text{ GHz}$
- (4)  $f = 1.5\text{ GHz}$

Fig 9. Minimum noise figure as a function of collector current; typical values



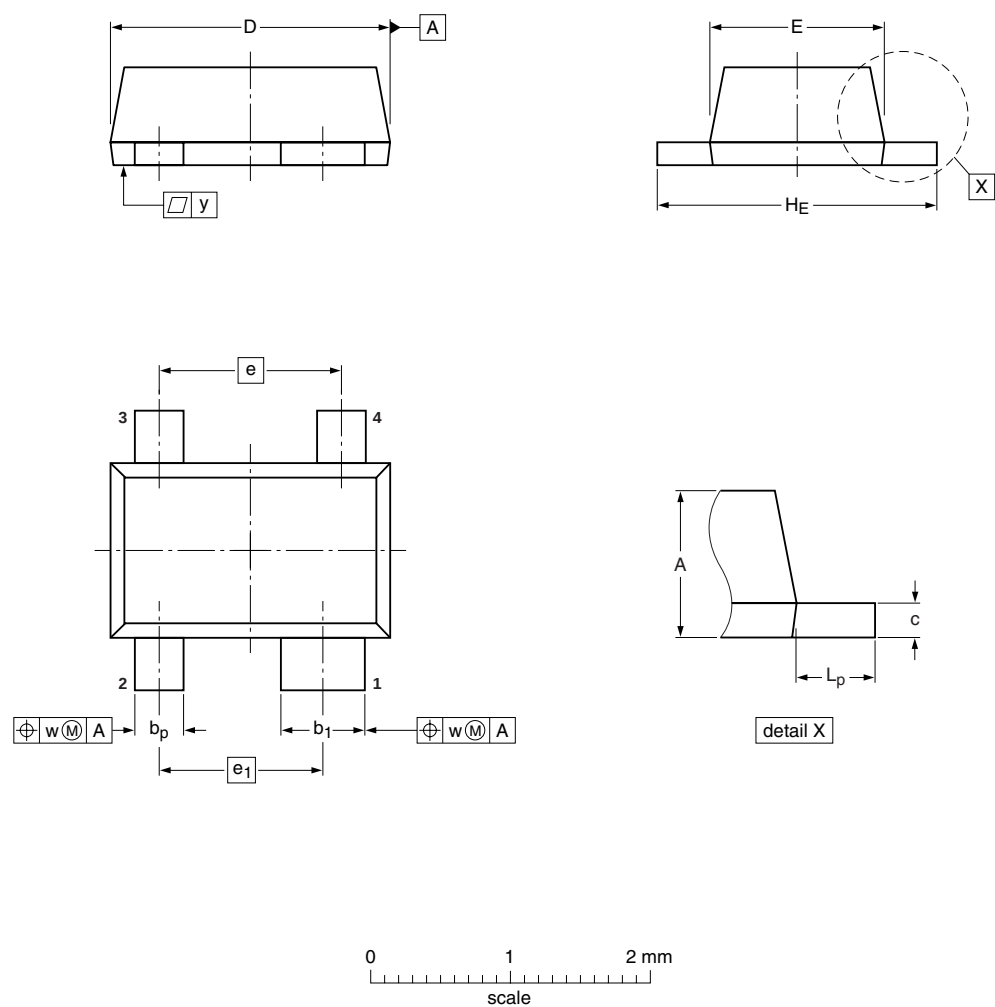
$V_{CE} = 2\text{ V}$ ;  $I_C = 6\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig 10. Minimum noise figure as a function of frequency; typical values

8. Package outline

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

SOT343F



| DIMENSIONS (mm are the original dimensions) |                  |                |                |              |            |              |     |                |                |                |     |     |
|---------------------------------------------|------------------|----------------|----------------|--------------|------------|--------------|-----|----------------|----------------|----------------|-----|-----|
| UNIT                                        | A <sub>max</sub> | 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 11. Package outline SOT343F

## 9. Abbreviations

Table 8. Abbreviations

| Acronym | Description                                |
|---------|--------------------------------------------|
| DC      | Direct Current                             |
| LNA     | Low Noise Amplifier                        |
| LTE     | Long Term Evolution                        |
| NPN     | Negative-Positive-Negative                 |
| RF      | Radio Frequency                            |
| SDARS   | Satellite Digital Audio Radio Service      |
| UMTS    | Universal Mobile Telecommunications System |

## 10. Revision history

Table 9. Revision history

| Document ID | Release date | Data sheet status  | Change notice | Supersedes |
|-------------|--------------|--------------------|---------------|------------|
| BFU660F v.1 | 20110111     | Product data sheet | -             | -          |

## 11. Legal information

### 11.1 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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## 13. Contents

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|           |                                          |           |
|-----------|------------------------------------------|-----------|
| <b>1</b>  | <b>Product profile</b> . . . . .         | <b>1</b>  |
| 1.1       | General description . . . . .            | 1         |
| 1.2       | Features and benefits . . . . .          | 1         |
| 1.3       | Applications . . . . .                   | 1         |
| 1.4       | Quick reference data . . . . .           | 2         |
| <b>2</b>  | <b>Pinning information</b> . . . . .     | <b>2</b>  |
| <b>3</b>  | <b>Ordering information</b> . . . . .    | <b>2</b>  |
| <b>4</b>  | <b>Marking</b> . . . . .                 | <b>3</b>  |
| <b>5</b>  | <b>Limiting values</b> . . . . .         | <b>3</b>  |
| <b>6</b>  | <b>Thermal characteristics</b> . . . . . | <b>3</b>  |
| <b>7</b>  | <b>Characteristics</b> . . . . .         | <b>4</b>  |
| <b>8</b>  | <b>Package outline</b> . . . . .         | <b>8</b>  |
| <b>9</b>  | <b>Abbreviations</b> . . . . .           | <b>9</b>  |
| <b>10</b> | <b>Revision history</b> . . . . .        | <b>9</b>  |
| <b>11</b> | <b>Legal information</b> . . . . .       | <b>10</b> |
| 11.1      | Data sheet status . . . . .              | 10        |
| 11.2      | Definitions . . . . .                    | 10        |
| 11.3      | Disclaimers . . . . .                    | 10        |
| 11.4      | Trademarks . . . . .                     | 11        |
| <b>12</b> | <b>Contact information</b> . . . . .     | <b>11</b> |
| <b>13</b> | <b>Contents</b> . . . . .                | <b>12</b> |

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