

# BFU668F

NPN wideband silicon RF transistor

Rev. 3 — 24 January 2012

Product data sheet

## 1. Product profile

### 1.1 General description

NPN silicon microwave transistor in a plastic, 4-pin dual-emitter SOT343F package offering an innovative Ku-band DRO solution.

#### 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

- DROs with good output power and low phase noise at very low current consumption: 5 dBm and  $-55$  dBc/Hz/1 kHz at 12 mA
- Low-noise, high gain for low cost LNA solutions
- 40 GHz  $f_T$  silicon technology

### 1.3 Applications

- Ku-band DROs in Ku-band LNBS
- C-band, low current LNAs



### 1.4 Quick reference data

**Table 1. Quick reference data**

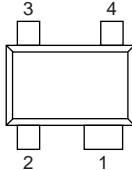
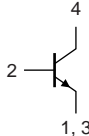
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CBO}$	collector-base voltage	open emitter	-	-	16	V
$V_{CEO}$	collector-emitter voltage	open base	-	-	5.5	V
$V_{EBO}$	emitter-base voltage	open collector	-	-	2.5	V
$I_C$	collector current		-	15	40	mA
$P_{tot}$	total power dissipation	$T_{sp} \leq 90\text{ }^\circ\text{C}$	[1]	-	200	mW
$h_{FE}$	DC current gain	$I_C = 10\text{ mA}; V_{CE} = 3.5\text{ V}; T_j = 25\text{ }^\circ\text{C}$	90	135	200	
$C_{CBS}$	collector-base capacitance	$V_{CB} = 2\text{ V}; f = 1\text{ MHz}$	-	138	-	fF
$f_T$	transition frequency	$I_C = 15\text{ mA}; V_{CE} = 3.5\text{ V}; f = 2\text{ GHz}; T_{amb} = 25\text{ }^\circ\text{C}$	-	20	-	GHz
$IP3_{o(max)}$	maximum output third-order intercept point	$I_C = 15\text{ mA}; V_{CE} = 3.5\text{ V}; f = 10\text{ GHz}; T_{amb} = 25\text{ }^\circ\text{C}; Z_S = Z_L = 50\text{ }\Omega;$	-	24	-	dBm
$G_{p(max)}$	maximum power gain	$I_C = 15\text{ mA}; V_{CE} = 3.5\text{ V}; f = 10.0\text{ GHz}; T_{amb} = 25\text{ }^\circ\text{C}$	[2]	-	10.5	dB
NF	noise figure	$I_C = 15\text{ mA}; V_{CE} = 3.5\text{ V}; f = 10.0\text{ GHz}; \Gamma_S = \Gamma_{opt}; T_{amb} = 25\text{ }^\circ\text{C}$	-	1.7	-	dB
$P_{L(1dB)}$	output power at 1 dB gain compression	$I_C = 15\text{ mA}; V_{CE} = 3.5\text{ V}; Z_S = Z_L = 50\text{ }\Omega; f = 10\text{ GHz}; T_{amb} = 25\text{ }^\circ\text{C}$	-	12	-	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		 <p style="text-align: right;"><i>mbb159</i></p>
2	base		
3	emitter		
4	collector		

### 3. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
BFU668F	-	plastic surface-mounted flat pack package; reverse pinning; 4 leads	SOT343F

### 4. Marking

Table 4. Marking

Type number	Marking	Description
BFU668F	ZA*	* = 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
$V_{CBO}$	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		-	40	mA
$P_{tot}$	total power dissipation	$T_{sp} \leq 90\text{ °C}$	[1]	200	mW
$T_{stg}$	storage temperature		-65	+150	°C
$T_j$	junction temperature		-	150	°C

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

### 6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point		270	K/W

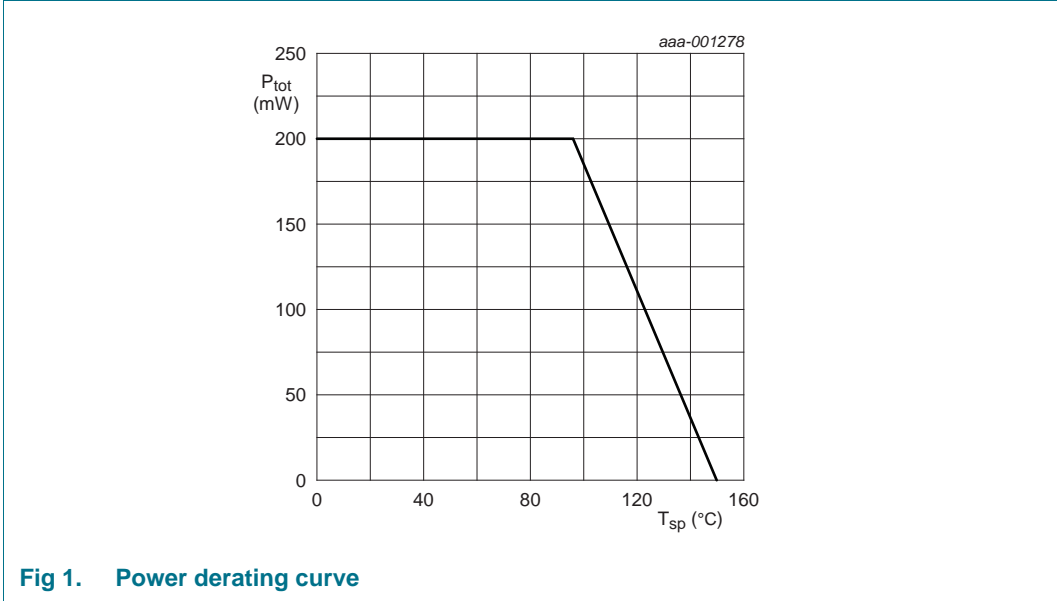


Fig 1. Power derating curve

## 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	$I_C = 2.5\ \mu\text{A}; I_E = 0\ \text{mA}$	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		-	15	40	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	$I_C = 10\ \text{mA}; V_{CE} = 3.5\ \text{V}$	90	135	200	
$C_{CES}$	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	$I_C = 15\ \text{mA}; V_{CE} = 3.5\ \text{V}; f = 2\ \text{GHz}; T_{amb} = 25\text{ °C}$	-	20	-	GHz
$G_{p(max)}$	maximum power gain	$I_C = 15\ \text{mA}; V_{CE} = 3.5\ \text{V}; T_{amb} = 25\text{ °C}$ <a href="#">[1]</a>				
		$f = 5.8\ \text{GHz}$	-	14.5	-	dB
		$f = 10.0\ \text{GHz}$	-	10.5	-	dB
$ S_{21} ^2$	insertion power gain	$I_C = 15\ \text{mA}; V_{CE} = 3.5\ \text{V}; T_{amb} = 25\text{ °C}$				
		$f = 5.8\ \text{GHz}$	-	9.5	-	dB
		$f = 10.0\ \text{GHz}$	-	5.0	-	dB
NF	noise figure	$I_C = 15\ \text{mA}; V_{CE} = 3.5\ \text{V}; \Gamma_S = \Gamma_{opt}; T_{amb} = 25\text{ °C}$				
		$f = 5.8\ \text{GHz}$	-	1.3	-	dB
		$f = 10.0\ \text{GHz}$	-	1.7	-	dB
$G_{ass}$	associated gain	$I_C = 15\ \text{mA}; V_{CE} = 3.5\ \text{V}; \Gamma_S = \Gamma_{opt}; T_{amb} = 25\text{ °C}$				
		$f = 5.8\ \text{GHz}$	-	13	-	dB
		$f = 10.0\ \text{GHz}$	-	9.5	-	dB
$P_{L(1dB)}$	output power at 1 dB gain compression	$I_C = 15\ \text{mA}; V_{CE} = 3.5\ \text{V}; Z_S = Z_L = 50\ \Omega; T_{amb} = 25\text{ °C}$				
		$f = 5.8\ \text{GHz}$	-	13	-	dBm
		$f = 10.0\ \text{GHz}$	-	12	-	dBm
$IP3_{o(max)}$	maximum output third-order intercept point	$I_C = 15\ \text{mA}; V_{CE} = 3.5\ \text{V}; Z_S = Z_L = 50\ \Omega; T_{amb} = 25\text{ °C}$				
		$f = 5.8\ \text{GHz}$	-	24	-	dBm
		$f = 10.0\ \text{GHz}$	-	24	-	dBm

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

## 8. Application information

### 8.1 BFU668F Ku-band Dielectric Resonator Oscillator (DRO)

Figure 2 shows a typical DRO circuit using BFU668F as active device. The schematic highlights the bias elements. Evaluation tests, done by replacing the existing transistor with BFU668F, on three different DRO LNBs / configurations, have proven:

- BFU668F achieves similar Phase Noise and RF power as the replaced transistor
- BFU668F achieves same RF performances at approximately half of the bias current

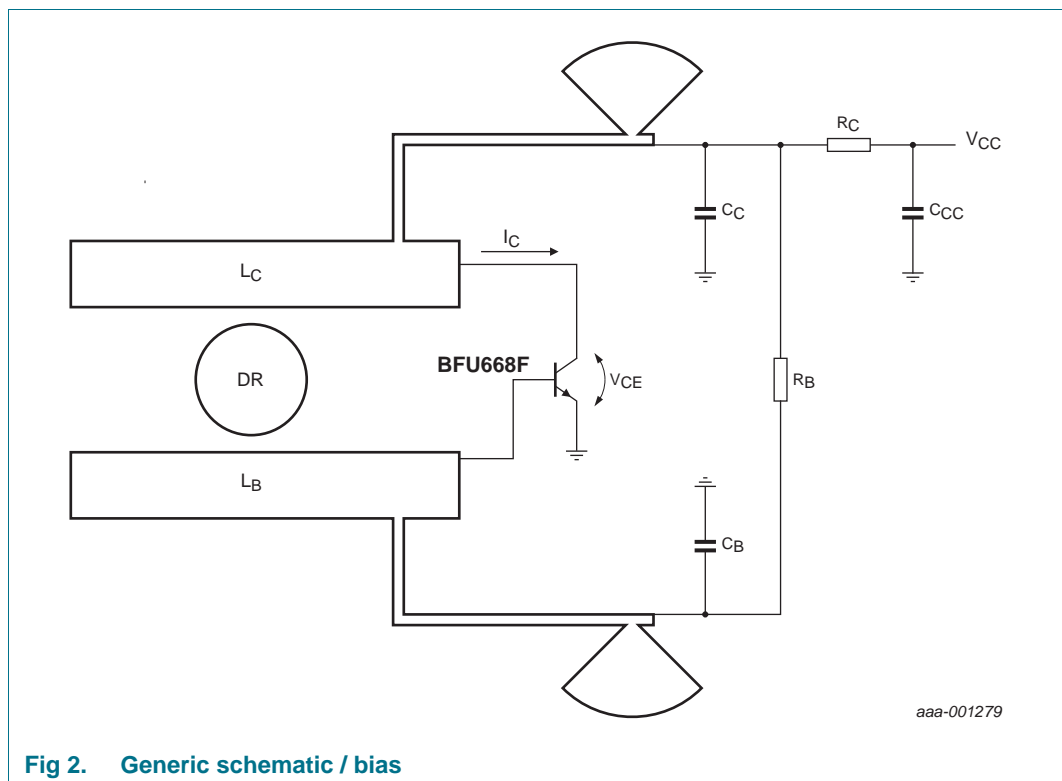
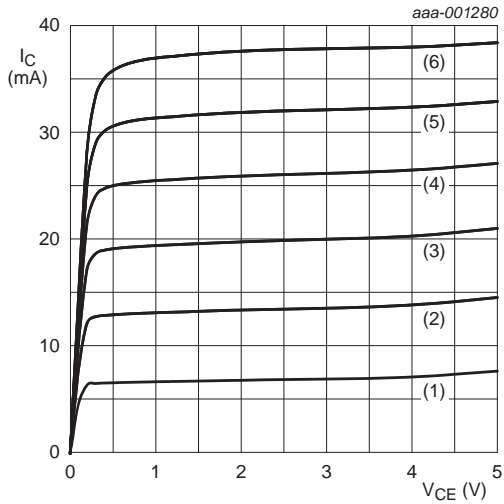


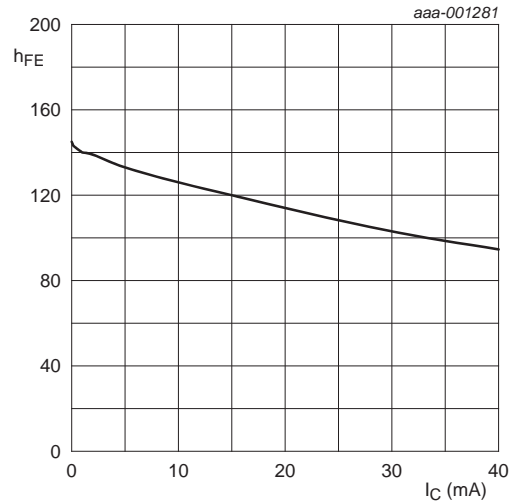
Fig 2. Generic schematic / bias

**8.2 Graphs**



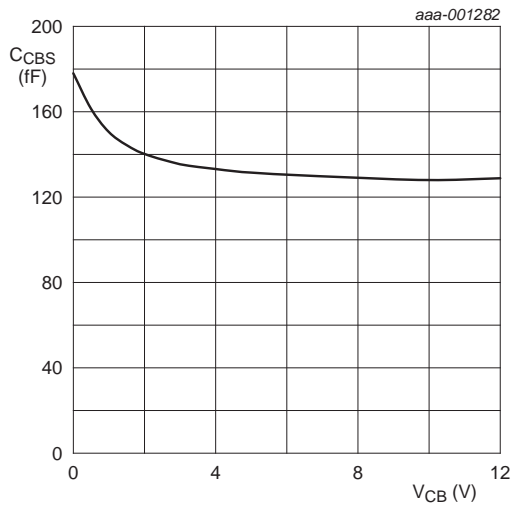
- $T_{amb} = 25\text{ }^{\circ}\text{C}.$
- (1)  $I_B = 50\text{ }\mu\text{A}$
  - (2)  $I_B = 100\text{ }\mu\text{A}$
  - (3)  $I_B = 150\text{ }\mu\text{A}$
  - (4)  $I_B = 200\text{ }\mu\text{A}$
  - (5)  $I_B = 250\text{ }\mu\text{A}$
  - (6)  $I_B = 300\text{ }\mu\text{A}$

**Fig 3. Collector current as a function of collector-emitter voltage; typical values**



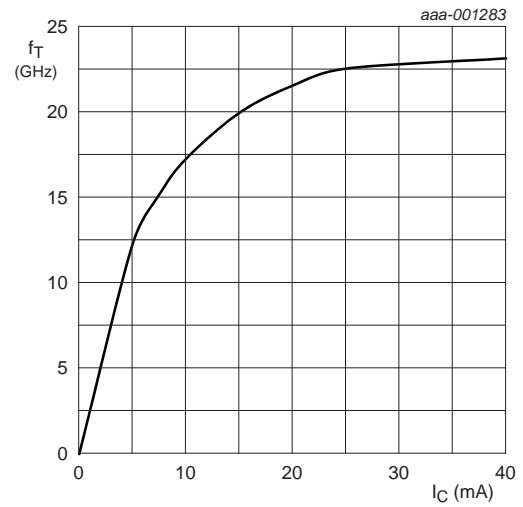
$V_{CE} = 2\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}.$

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



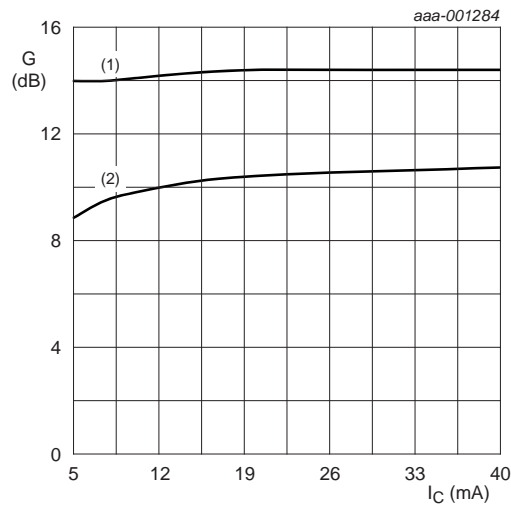
$f = 1 \text{ MHz}$ ,  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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



$V_{CE} = 3.5 \text{ V}$ ;  $f = 2 \text{ GHz}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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

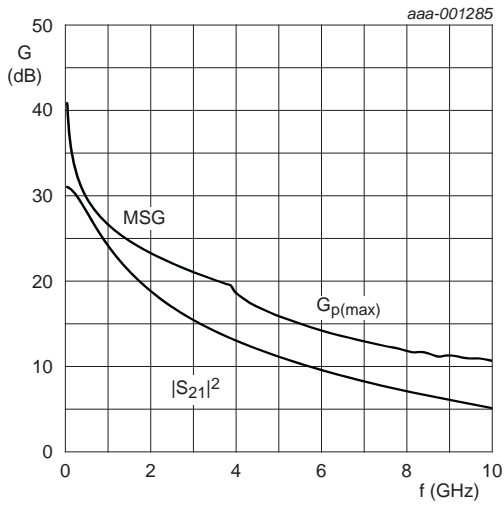


$V_{CE} = 3.5 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

- (1)  $f = 5.8 \text{ GHz}$
- (2)  $f = 10.0 \text{ GHz}$

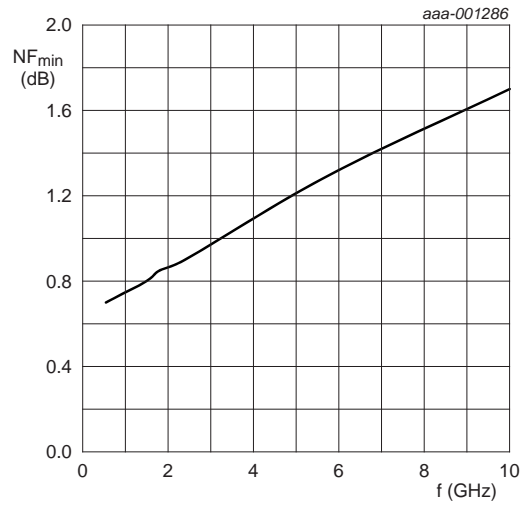
**Fig 7. Gain as a function of collector current; typical value**





$V_{CE} = 3.5 \text{ V}$ ;  $I_C = 15 \text{ mA}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .

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



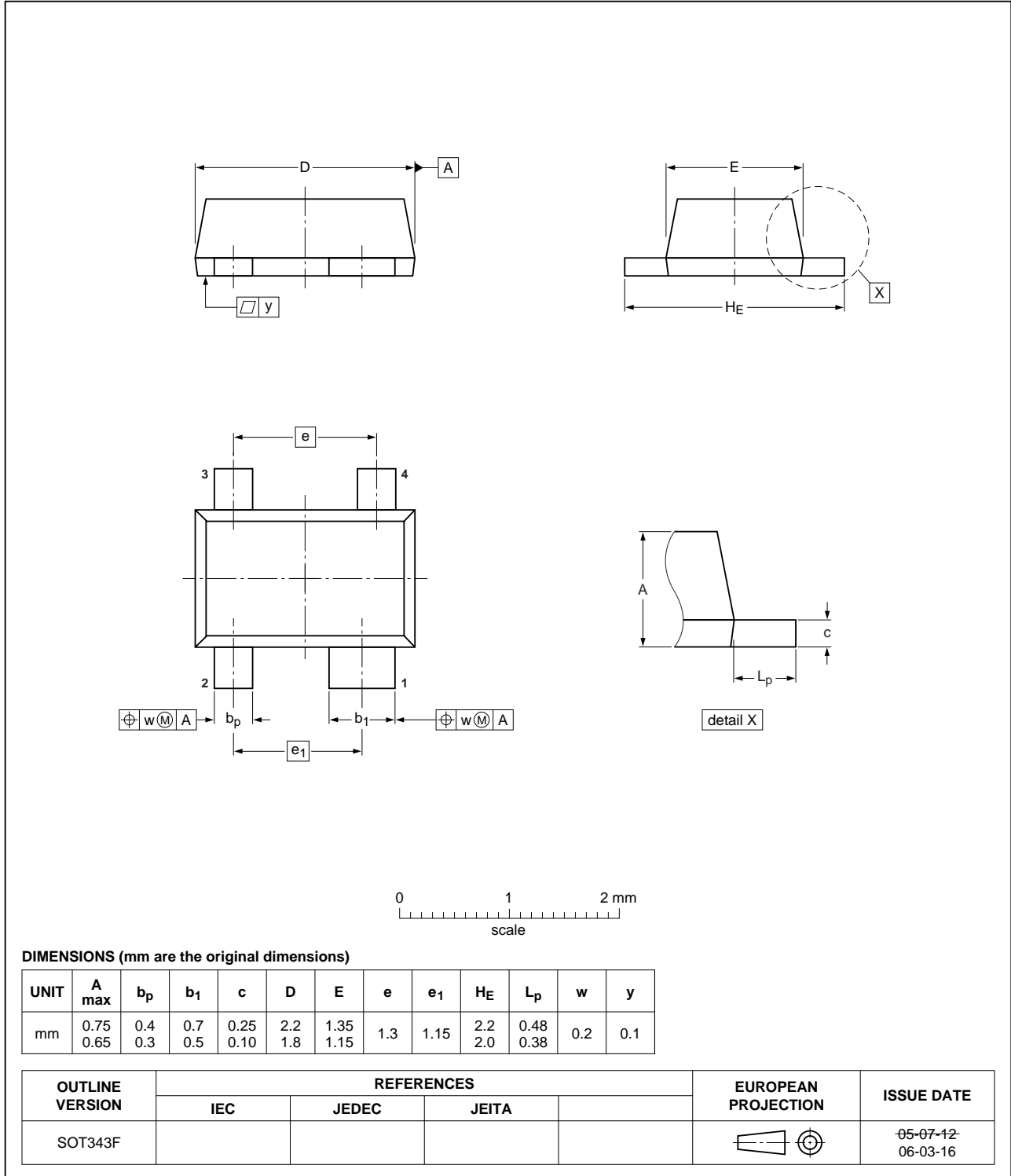
$V_{CE} = 3.5 \text{ V}$ ;  $I_C = 15 \text{ mA}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .

**Fig 9. Minimum noise figure as a function of frequency; typical values**

**9. Package outline**

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

SOT343F



**Fig 10. Package outline SOT343F**

## 10. Abbreviations

**Table 8. Abbreviations**

Acronym	Description
DC	Direct Current
DRO	Dielectric Resonator Oscillator
Ku	Kurtz under
LNA	Low Noise Amplifier
LNB	Low Noise Block
NPN	Negative-Positive-Negative
RF	Radio Frequency

## 11. Revision history

**Table 9. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BFU668F v.3	20120124	Product data sheet	-	BFU668F v.2
Modifications:	<ul style="list-style-type: none"><li>• <a href="#">Table 1 on page 2</a>: maximum value for <math>h_{FE}</math> has been changed.</li><li>• <a href="#">Table 7 on page 5</a>: maximum value for <math>h_{FE}</math> has been changed.</li></ul>			
BFU668F v.2	20120120	Product data sheet	-	BFU668F v.1
BFU668F v.1	20111108	Product data sheet	-	-

## 12. Legal information

### 12.1 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".

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