BFR740EL3

SiGe:C NPN RF bipolar transistor

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Product description

The BFR740EL3 is a wideband RF heterojunction bipolar transistor (HBT) available in a low profile package.

Feature list

- Low noise figure NF_{min} = 0.5 dB at 1.9 GHz 3 V, 6 mA; 0.8 dB at 5.5 GHz, 3 V, 6 mA
- High power gain G_{ms} = 20 dB at 5.5 GHz, 3 V, 15 mA
- Low profile and small form factor leadless package
- High sensitivity low noise laser receiver matrix
- High RF transistor h_{FE} controllability

Product validation

Qualified for industrial applications according to the relevant tests of JEDEC JESD47, JESD22, and J-STD-020.
Qualified for industrial applications according to the relevant tests of AEC-Q 101.

Potential applications

- Wireless communications: WLAN 2.4 GHz and 5-6 GHz bands, WiMax and UWB
- Satellite communication systems: GNSS navigation systems (GPS, GLONASS, BeiDou, Galileo), satellite radio (SDARs, DAB) and C-band LNB
- Multimedia applications such as portable TV, CATV and FM radio
- ISM applications like RKE, AMR and Zigbee, as well as for emerging wireless applications
- Lidar based systems

Device information

Table 1 Part information

Product name / Ordering code	Package	Pin configuration			Marking	Pieces / Reel
BFR740EL3 / BFR740EL3E6829XTSA1	TSLP-3-10	1 = B	2 = C	3 = E	R2	15000

Attention: ***ESD (Electrostatic discharge) sensitive device, observe handling precautions***

Table of contents

1 Absolute maximum ratings

Table 2 Absolute maximum ratings at T_A = 25 °C (unless otherwise specified)

Parameter	Symbol	Values		Unit	Note or test condition
		Min.	Max.		
Collector emitter voltage	V_{CEO}	–	4.0	V	Open base
			3.5		T_A = -55 °C, open base
Collector emitter voltage	V_{CES}		13		E-B short circuited
Collector base voltage	V_{CBO}		13		Open emitter
Emitter base voltage	V_{EBO}		1.2		Open collector
Base current	I_B		4	mA	–
Collector current	I_C		40		
Total power dissipation[1)]	P_{tot}		160	mW	$T_S \leq$ 105 °C
Junction temperature	T_J		150	°C	–
Storage temperature	T_{Stg}	-55			

Attention: ***Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Exceeding only one of these values may cause irreversible damage to the integrated circuit.***

1 T_S is the soldering point temperature. T_S is measured on the emitter lead at the soldering point of the PCB.

2 Thermal characteristics

Table 3 Thermal resistance

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Junction - soldering point	R_{thJS}	–	280	–	K/W	

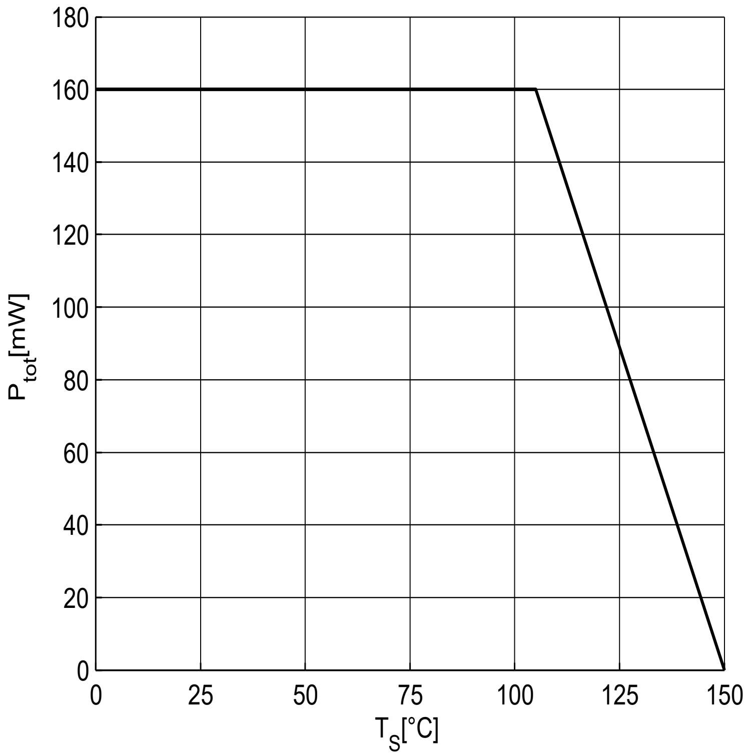

Figure 1 Total power dissipation P_{tot} = f(T_S)

3 Electrical characteristics

3.1 DC characteristics

Table 4 **DC characteristics at T_A = 25 °C**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Collector emitter breakdown voltage	$V_{(BR)CEO}$	4	4.7	–	V	I_C = 1 mA, I_B = 0, open base
Collector emitter leakage current	I_{CES}	–	1 1	400 [2)] 40 [2)]	nA	V_{CE} = 13 V, V_{BE} = 0 V_{CE} = 5 V, V_{BE} = 0 E-B short circuited
Collector base leakage current	I_{CBO}		1	40 [2)]		V_{CB} = 5 V, I_E = 0, open emitter
Emitter base leakage current	I_{EBO}		1	40 [2)]		V_{EB} = 0.5 V, I_C = 0, open collector
DC current gain	h_{FE}	160	210	250		V_{CE} = 3 V, I_C = 25 mA, pulse measured

3.2 General AC characteristics

Table 5 **General AC characteristics at T_A = 25 °C**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Transition frequency	f_T	–	42	–	GHz	V_{CE} = 3 V, I_C = 25 mA, f = 2 GHz
Collector base capacitance	C_{CB}		0.09	0.12	pF	V_{CB} = 3 V, V_{BE} = 0, f = 1 MHz, emitter grounded
Collector emitter capacitance	C_{CE}		0.3	–		V_{CE} = 3 V, V_{BE} = 0, f = 1 MHz, base grounded
Emitter base capacitance	C_{EB}		0.4			V_{EB} = 0.5 V, V_{CB} = 0, f = 1 MHz, collector grounded

2 Maximum values not limited by the device but by the short cycle time of the 100% test.

3.3 Frequency dependent AC characteristics

Measurement setup is a test fixture with Bias-T's in a 50 Ω system, T_A = 25 °C.

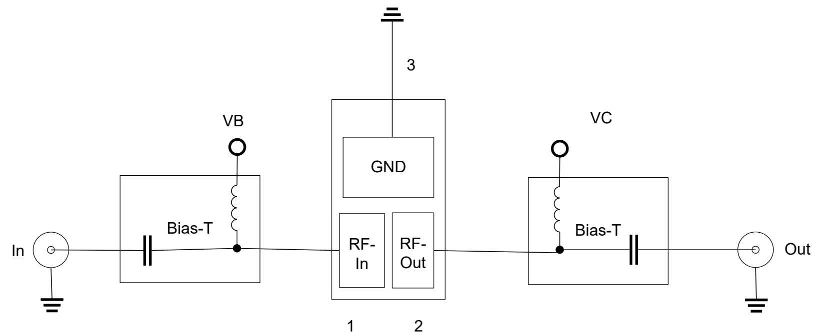

Figure 2 **Testing circuit**

Table 6 **AC characteristics, V_{CE} = 3 V, f = 150 MHz**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		35			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		29.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.45			I_C = 6 mA
• Associated gain	G_{ass}		27.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		21			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		3.5			

Table 7 **AC characteristics, V_{CE} = 3 V, f = 450 MHz**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		31			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		29			
Noise figure						
• Minimum noise figure	NF_{min}		0.45			I_C = 6 mA
• Associated gain	G_{ass}		26.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		21			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		7			

Table 8 AC characteristics, V_{CE} = 3 V, f = 900 MHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		28			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		27			
Noise figure						
• Minimum noise figure	NF_{min}		0.45			I_C = 6 mA
• Associated gain	G_{ass}		25			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		22.5			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		8			

Table 9 AC characteristics, V_{CE} = 3 V, f = 1.5 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		25.5			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		25			
Noise figure						
• Minimum noise figure	NF_{min}		0.5			I_C = 6 mA
• Associated gain	G_{ass}		22.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		23			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		8			

Table 10 AC characteristics, V_{CE} = 3 V, f = 1.9 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		24.5			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		23.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.5			I_C = 6 mA
• Associated gain	G_{ass}		21			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		23			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		8			

Table 11 AC characteristics, V_{CE} = 3 V, f = 2.4 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		23.5			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		21.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.5			I_C = 6 mA
• Associated gain	G_{ass}		19.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		23			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		8			

Table 12 AC characteristics, V_{CE} = 3 V, f = 3.5 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		22			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		18.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.6			I_C = 6 mA
• Associated gain	G_{ass}		16.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		24.5			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		9			

Table 13 AC characteristics, V_{CE} = 3 V, f = 5.5 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		20			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		14.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.8			I_C = 6 mA
• Associated gain	G_{ass}		13			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		25			$Z_S = Z_L$ = 50 Ω, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		9.5			

Table 14 AC characteristics, V_{CE} = 3 V, f = 10 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ma}		13			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		9			
Noise figure						
• Minimum noise figure	NF_{min}		1.3			I_C = 6 mA
• Associated gain	G_{ass}		8.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		24			$Z_S = Z_L = 50\ \Omega$, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		9			

Table 15 AC characteristics, V_{CE} = 3 V, f = 12 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ma}		11			I_C = 15 mA
• Transducer gain	$\|S_{21}\|^2$		7			
Noise figure						
• Minimum noise figure	NF_{min}		1.5			I_C = 6 mA
• Associated gain	G_{ass}		7.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		20.5			$Z_S = Z_L = 50\ \Omega$, I_C = 15 mA
• 1 dB gain compression point at output	OP_{1dB}		6.5			

***Note**: $G_{ms} = |S_{21} / S_{12}|$ for $k < 1$; $G_{ma} = |S_{21} / S_{12}|(k-(k^2-1)^{1/2})$ for $k > 1$. In order to get the NF_{min} values stated in this chapter, the test fixture losses have been subtracted from all measured results. OIP_3 value depends on termination of all intermodulation frequency components. Termination used for this measurement is 50 Ω from 0.2 MHz to 12 GHz.*

3.4 Characteristic DC diagrams

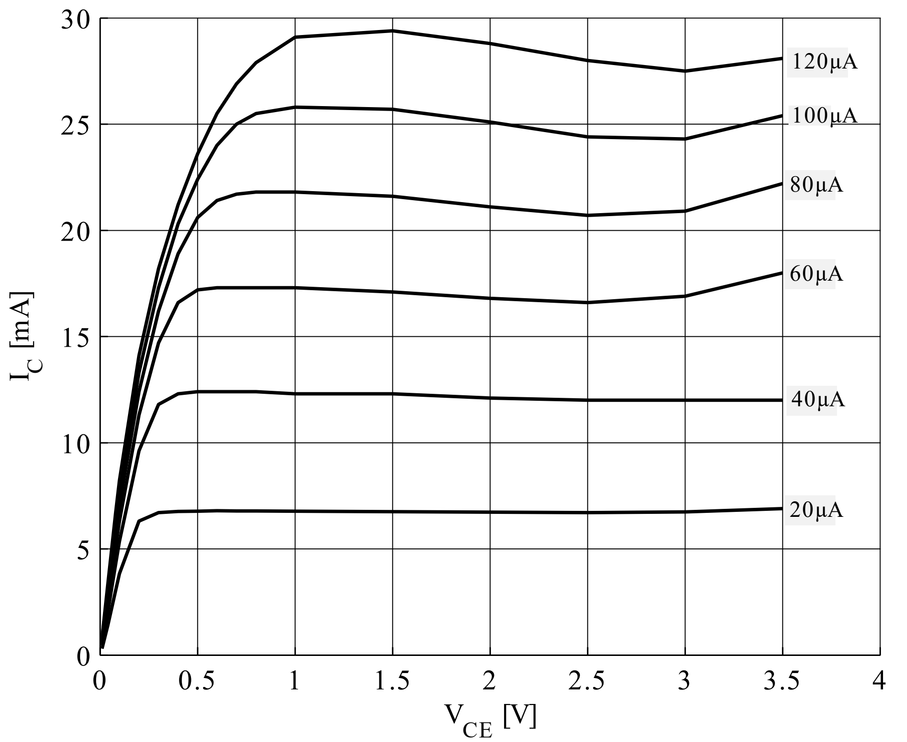

Figure 3 **Collector current vs. collector emitter voltage I_C = f(V_{CE}), I_B = parameter**

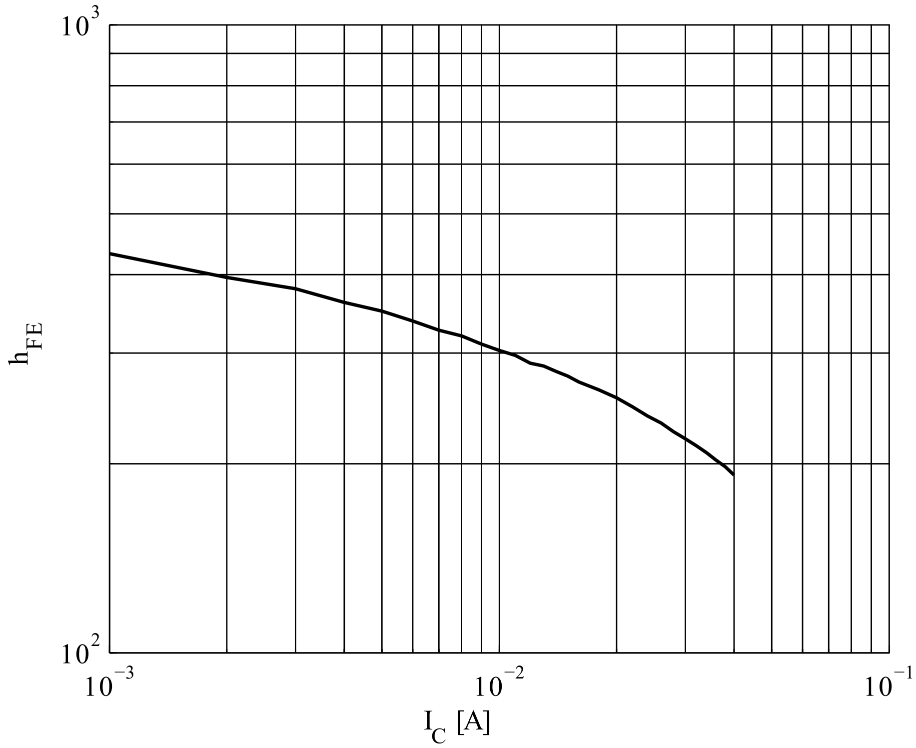

Figure 4 **DC current gain h_{FE} = f(I_C), V_{CE} = 3 V**

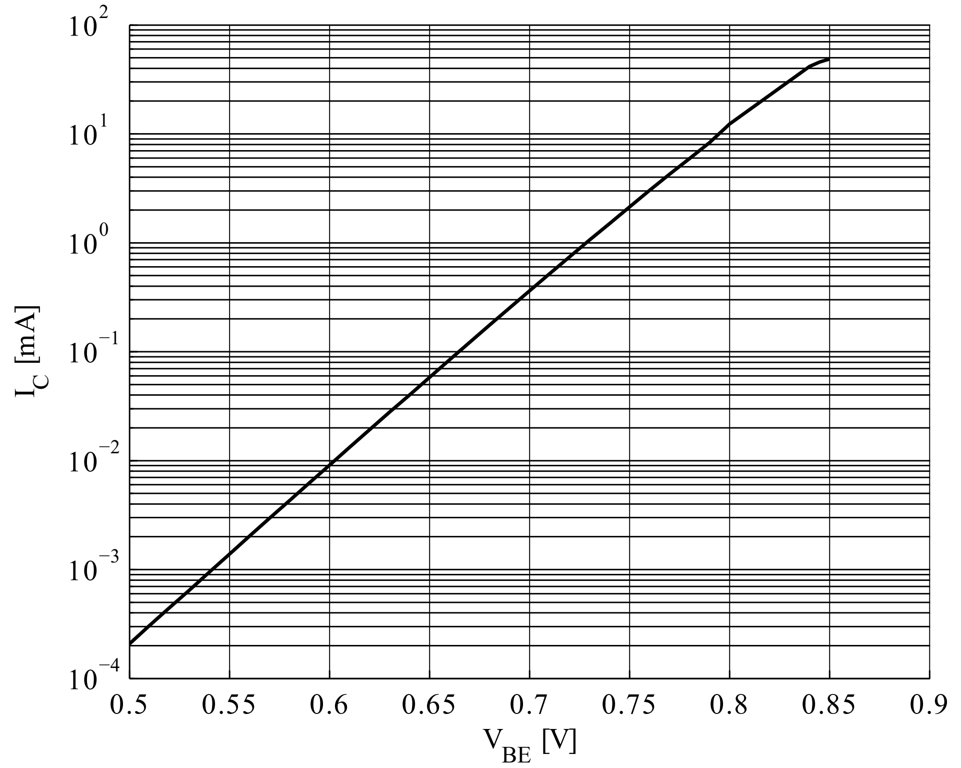

Figure 5 **Collector current vs. base emitter forward voltage I_C = f(V_{BE}), V_{CE} = 2 V**

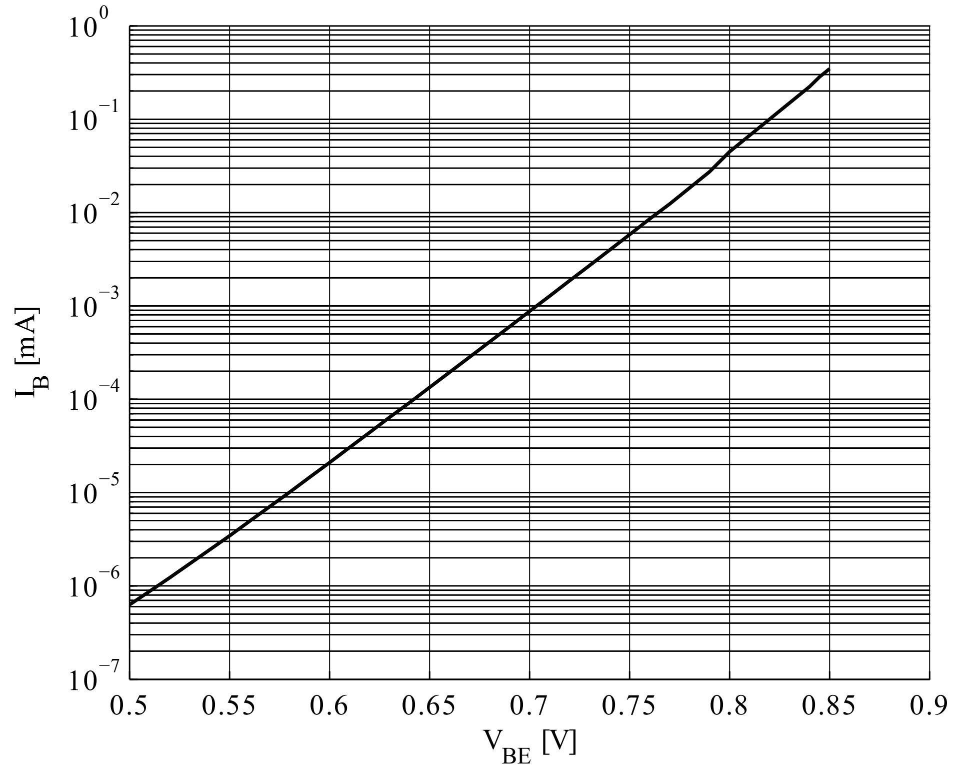

Figure 6 **Base current vs. base emitter forward voltage I_B = f(V_{BE}), V_{CE} = 2 V**

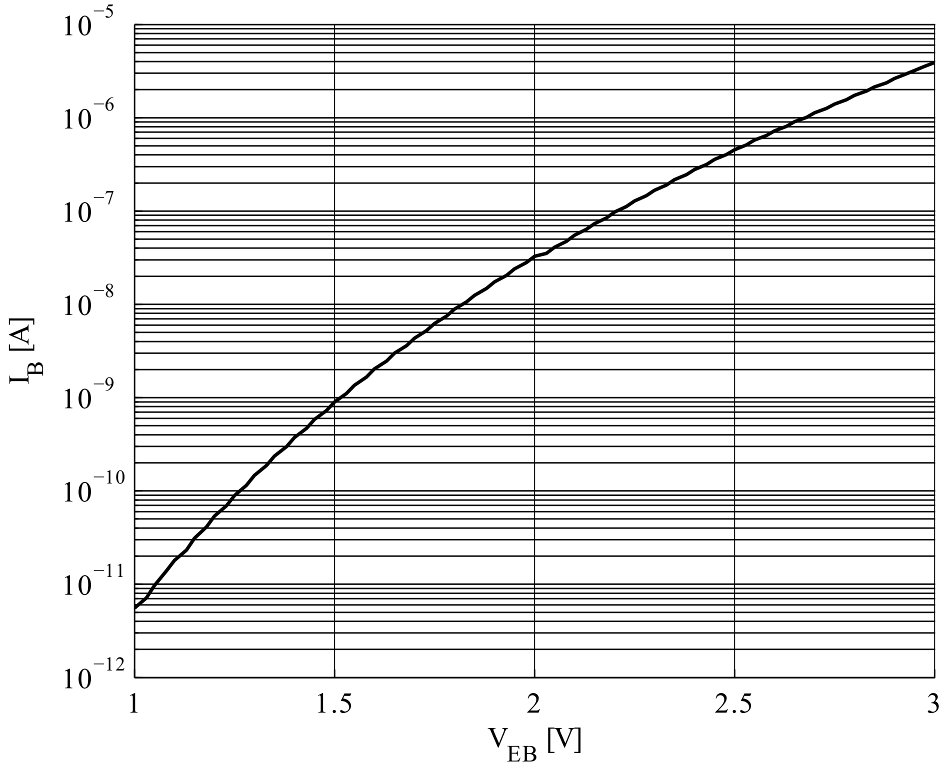

Figure 7 **Base current vs. base emitter reverse voltage I_B = f(V_{EB}), V_{CE} = 2 V**

3.5 Characteristic AC diagrams

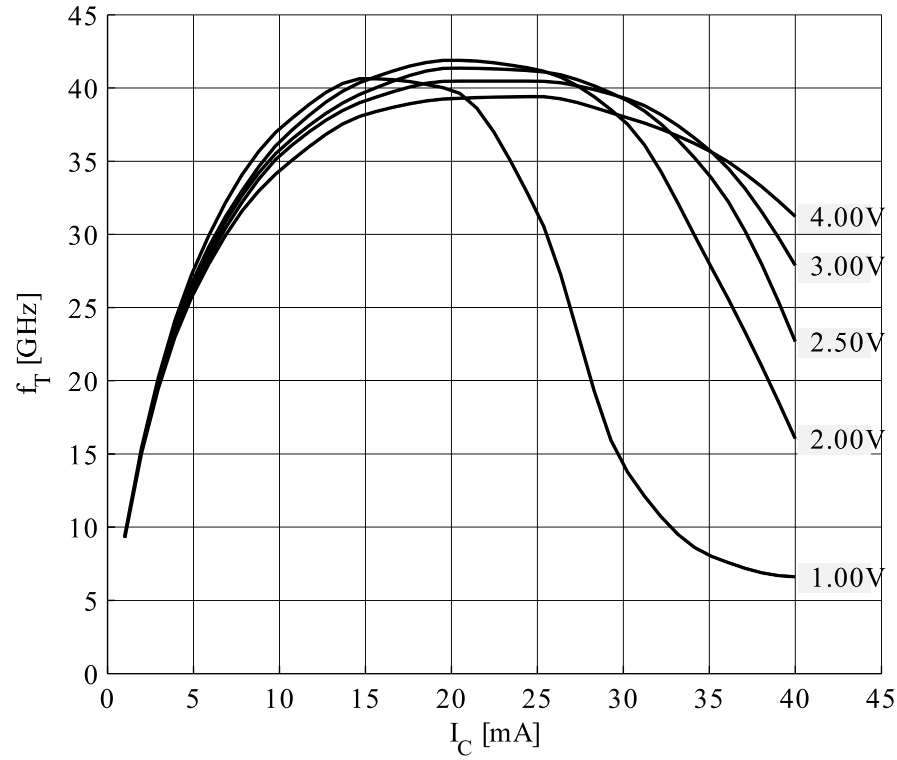

Figure 8 Transition frequency f_T = f(I_C), f = 2 GHz, V_{CE} = parameter

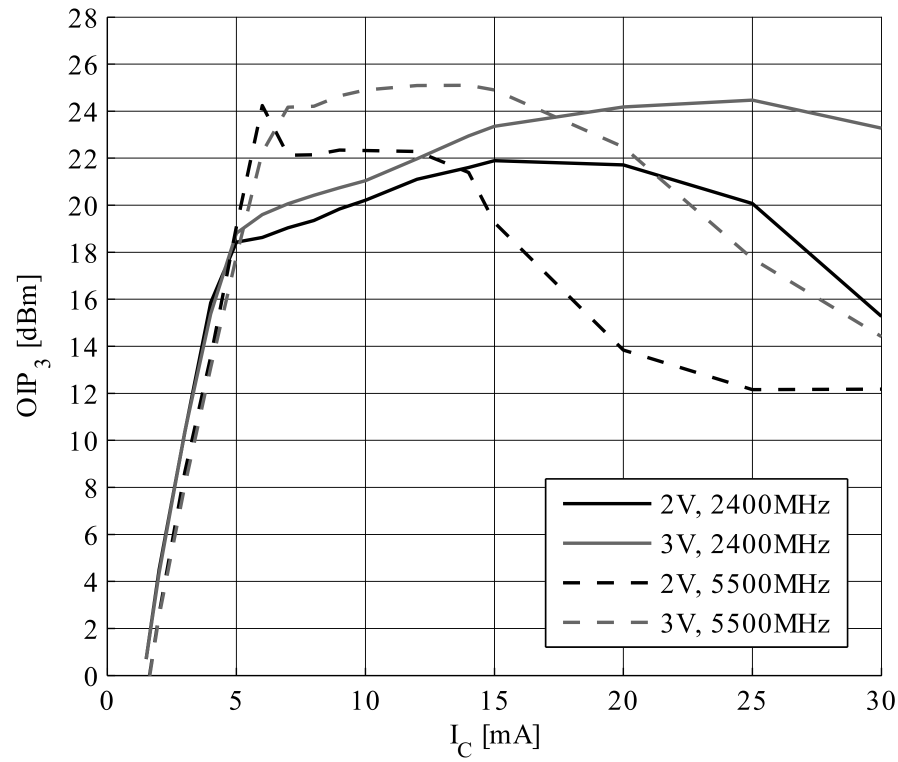

Figure 9 3rd order intercept point at output OIP_3 = f(I_C), Z_S = Z_L = 50 Ω, V_{CE}, f = parameter

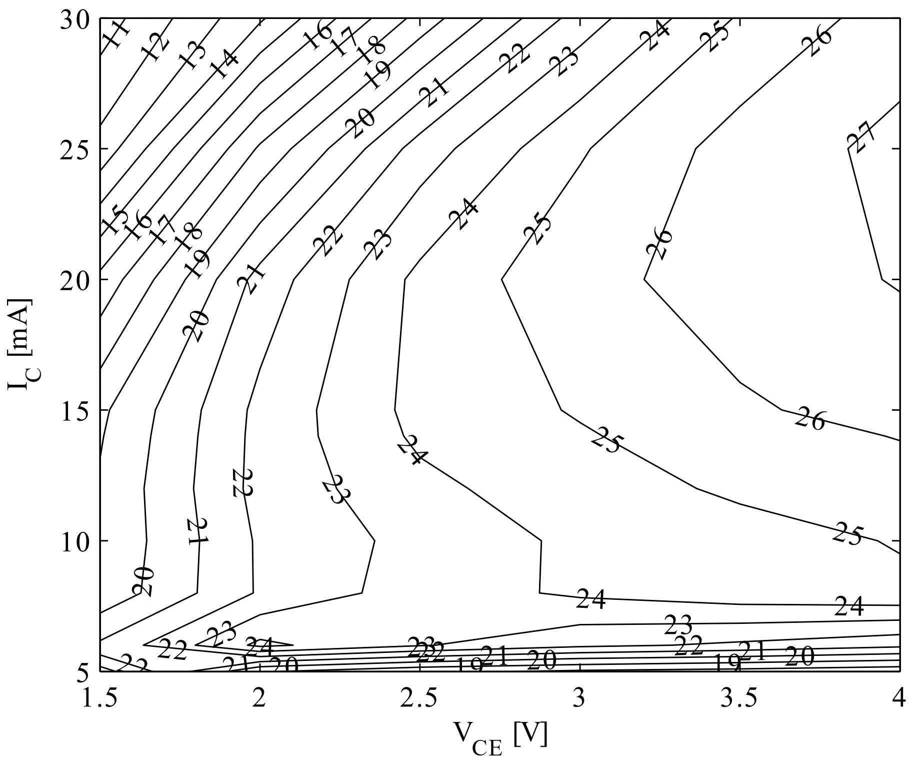

Figure 10 **3rd order intercept point at output OIP_3 [dBm] = f(I_C , V_{CE}), Z_S = Z_L = 50 Ω, f = 5.5 GHz**

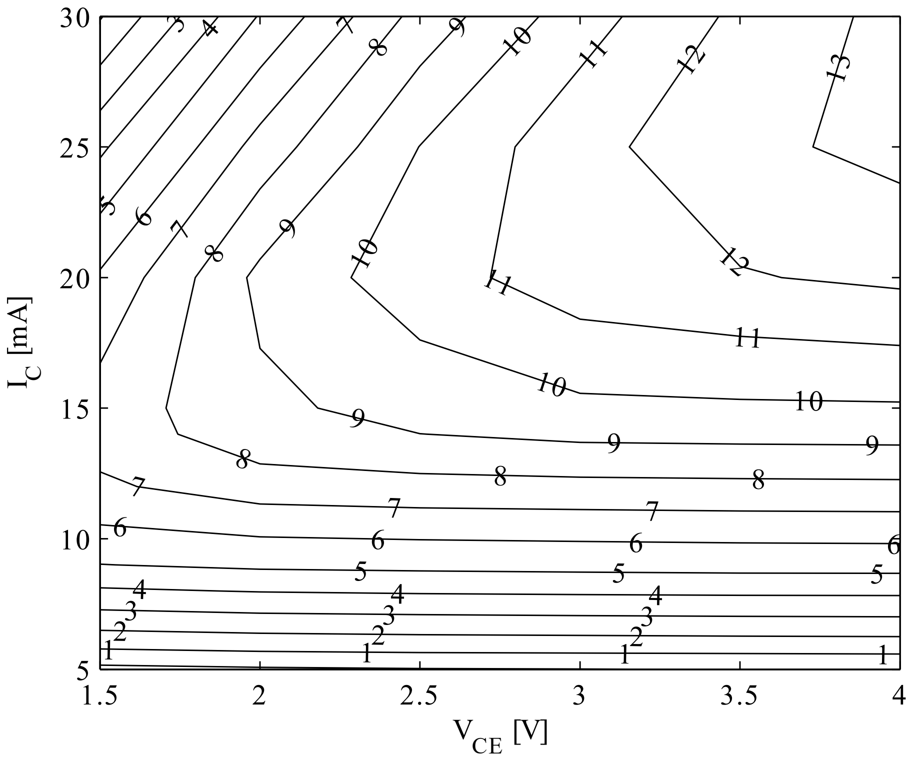

Figure 11 **Compression point at output OP_{1dB} [dBm] = f(I_C, V_{CE}), Z_S = Z_L = 50 Ω, f = 5.5 GHz**

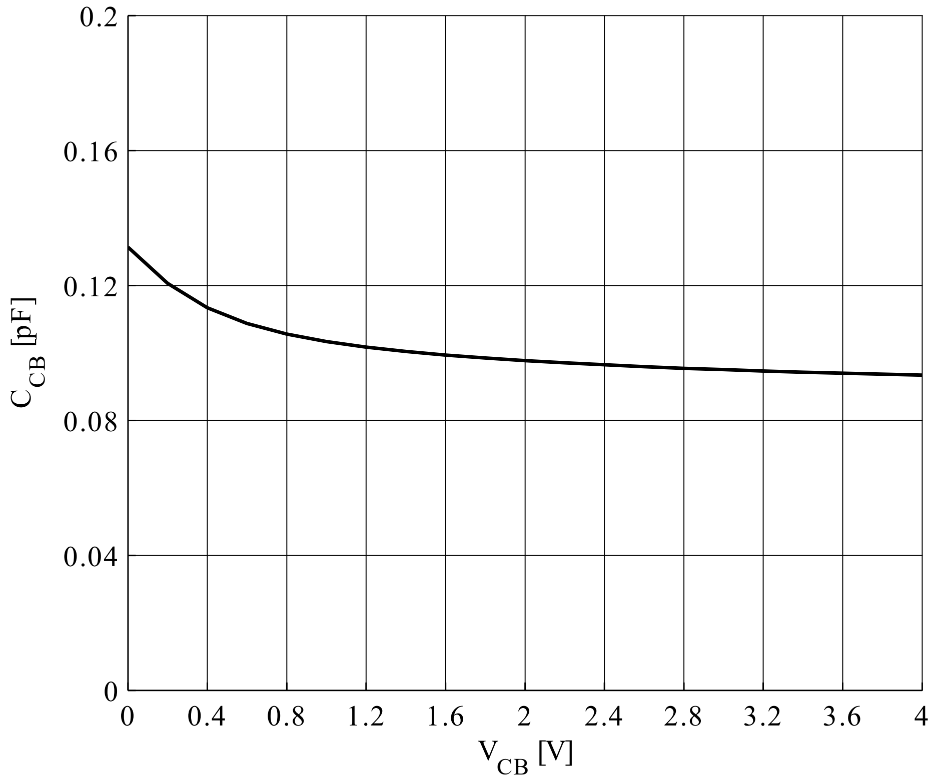

Figure 12 **Collector base capacitance C_{CB} = f(V_{CB}), f = 1 MHz**

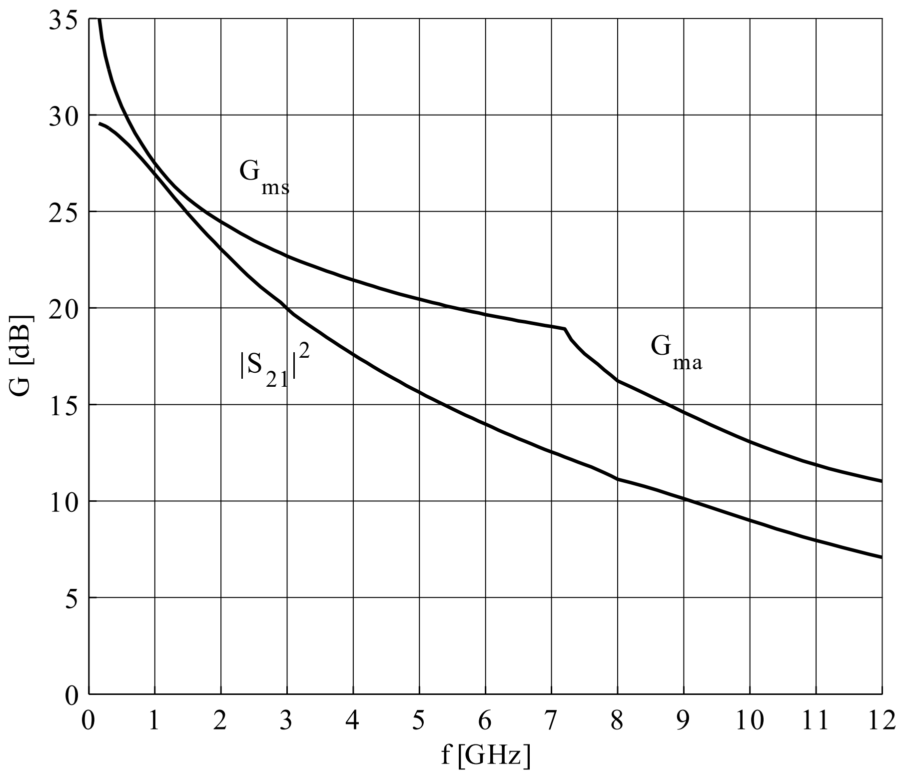

Figure 13 **Gain G_{ma}, G_{ms}, $|S_{21}|^2$ = f(f), V_{CE} = 3 V, I_C = 15 mA**

Electrical characteristics

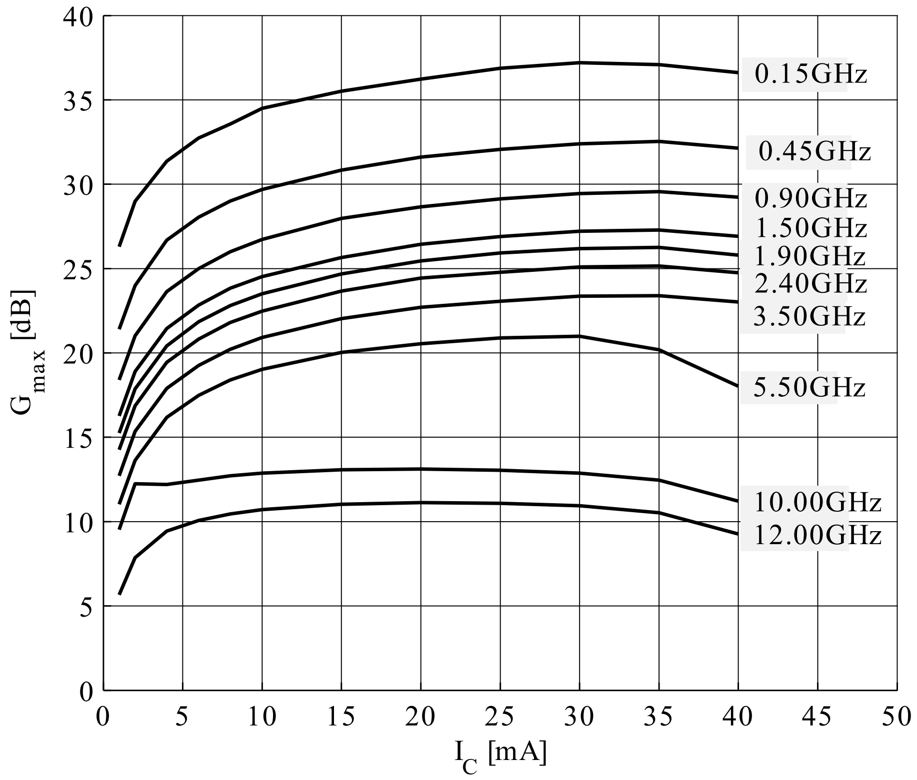

Figure 14 Maximum power gain $G_{max} = f(I_C)$, $V_{CE} = 3$ V, f = parameter

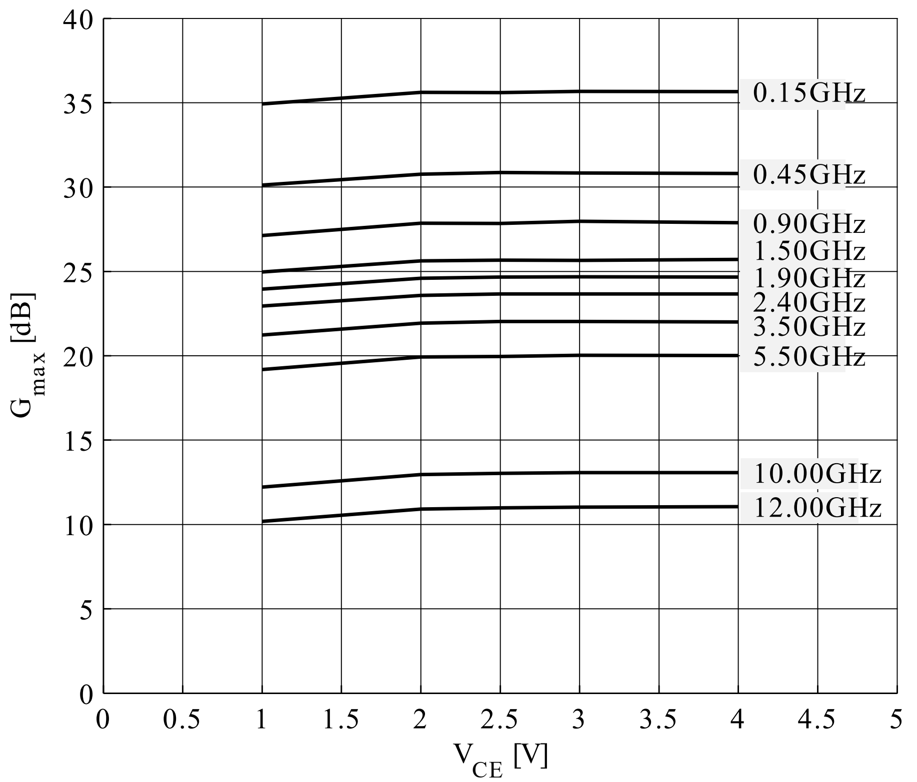

Figure 15 Maximum power gain $G_{max} = f(V_{CE})$, $I_C = 15$ mA, f = parameter

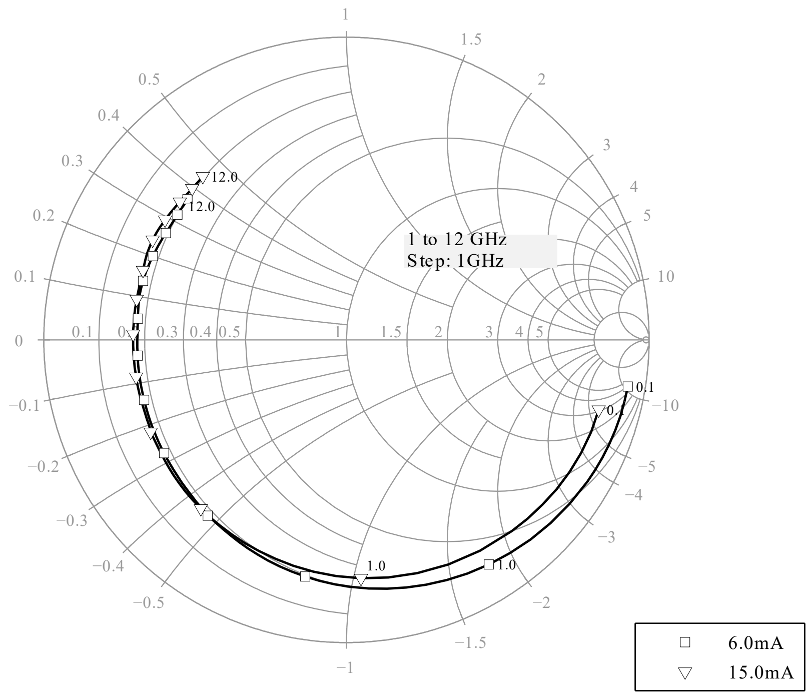

Figure 16 Input reflection coefficient S_{11} = f(f), V_{CE} = 3 V, I_C = 6 / 15 mA

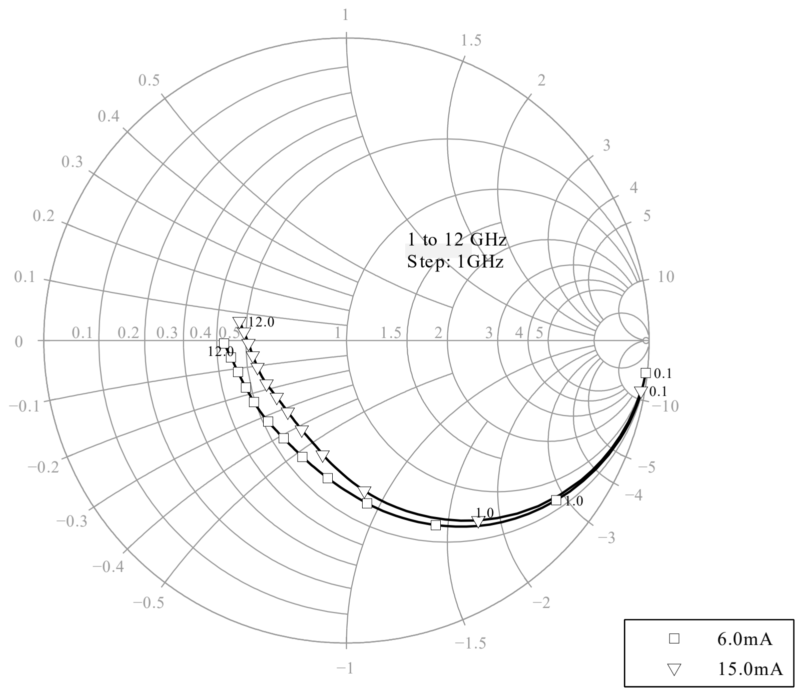

Figure 17 Output reflection coefficient S_{22} = f(f), V_{CE} = 3 V, I_C = 6 / 15 mA

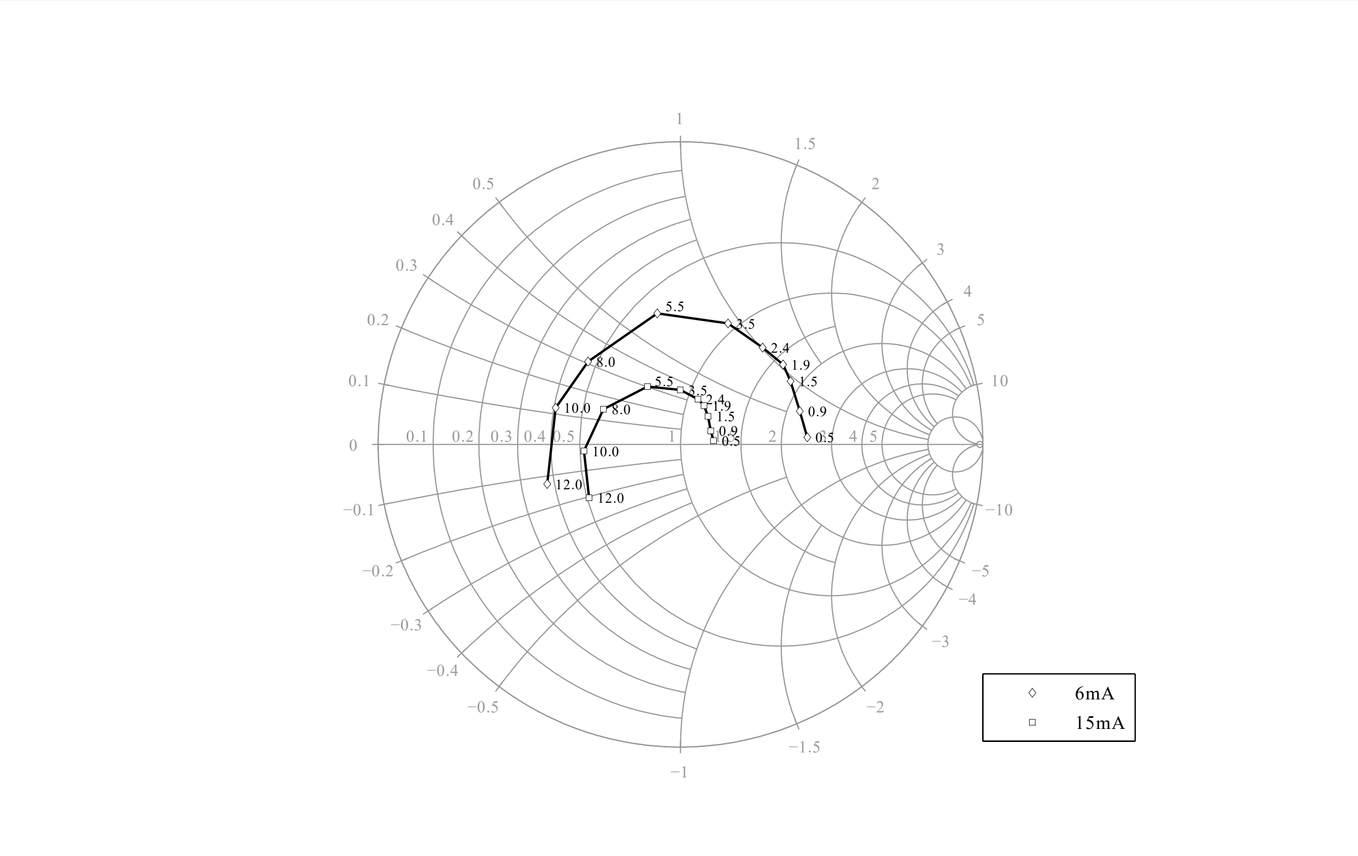

Figure 18 **Source impedance for minimum noise figure $Z_{S,opt}$ = f(f), V_{CE} = 3 V, I_C = 6 / 15 mA**

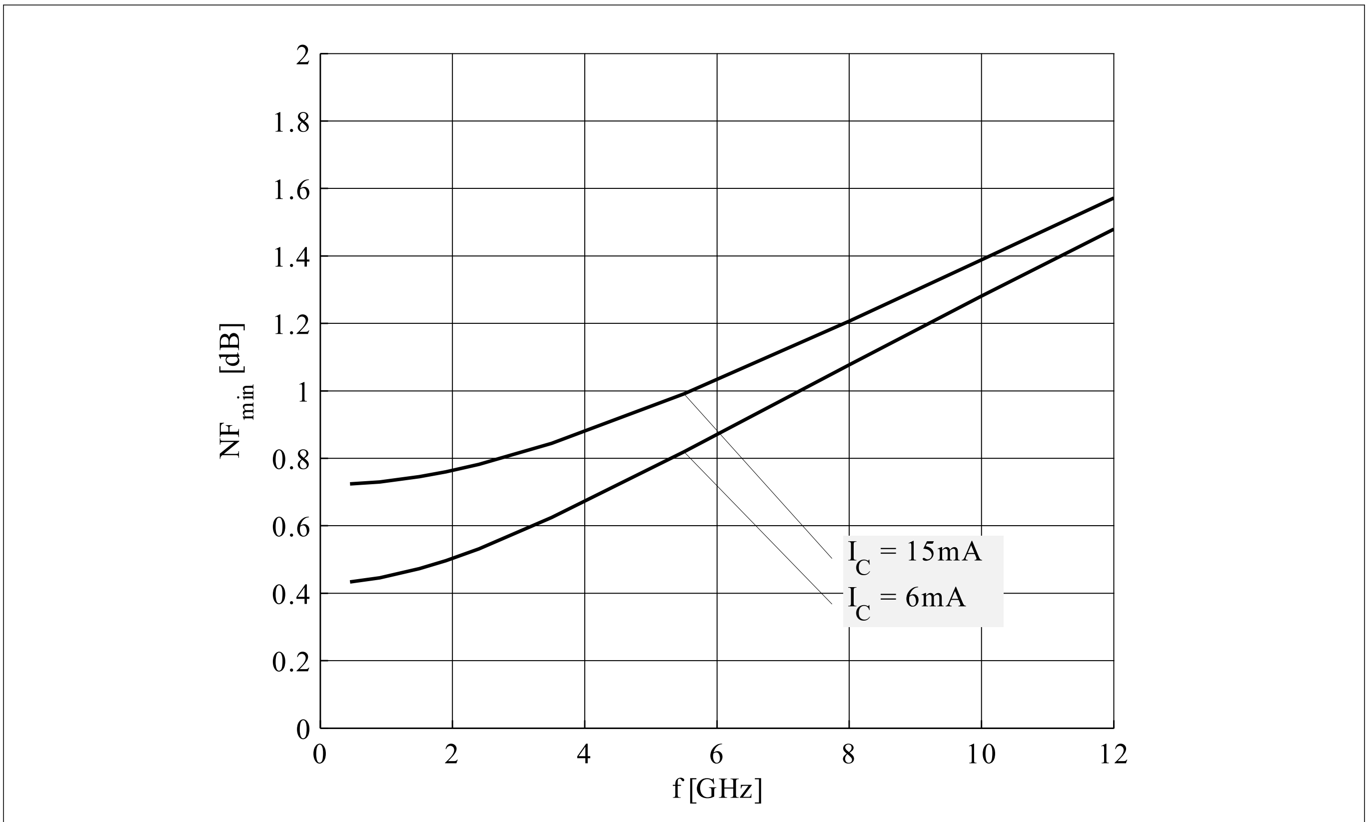

Figure 19 **Noise figure NF_{min} = f(f), V_{CE} = 3 V, Z_S = $Z_{S,opt}$, I_C = 6 / 15 mA**

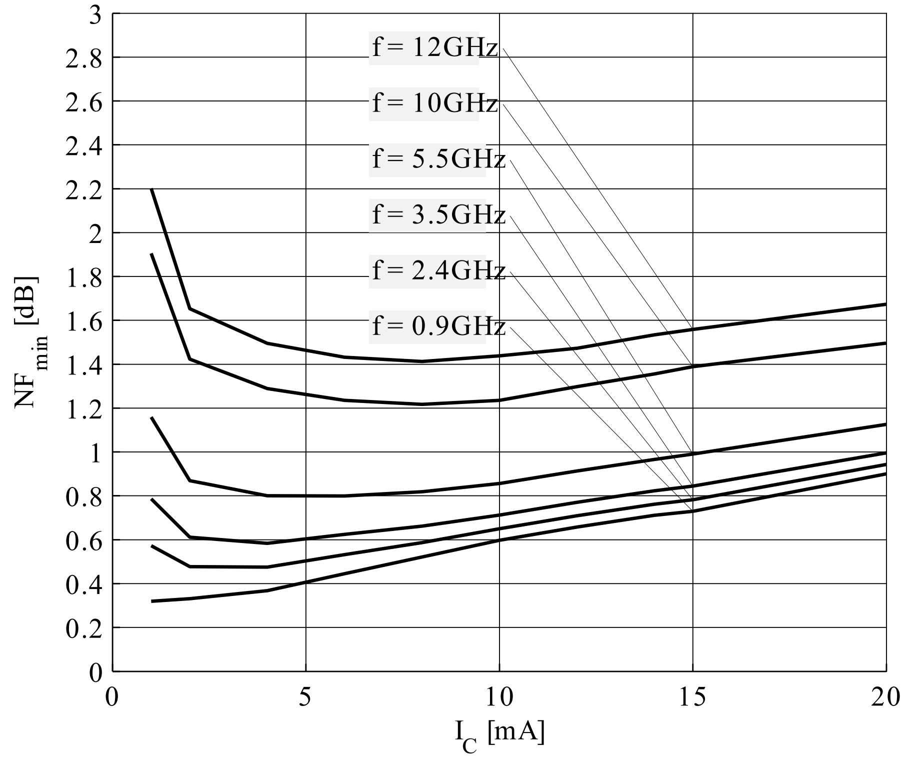

Figure 20 **Noise figure NF_{min} = f(I_C), V_{CE} = 3 V, Z_S = $Z_{S,opt}$, f = parameter**

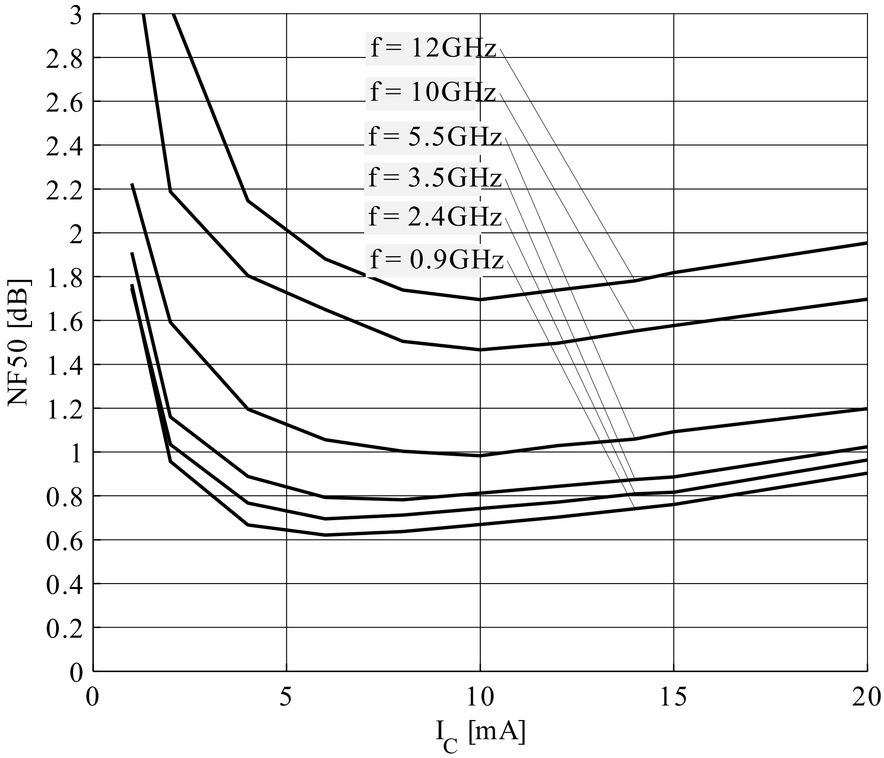

Figure 21 **Noise figure NF_{50} = f(I_C), V_{CE} = 3 V, Z_S = 50 Ω, f = parameter**

***Note**: The curves shown in this chapter have been generated using typical devices but shall not be considered as a guarantee that all devices have identical characteristic curves. T_A = 25 °C.*

4 Package information TSLP-3-10

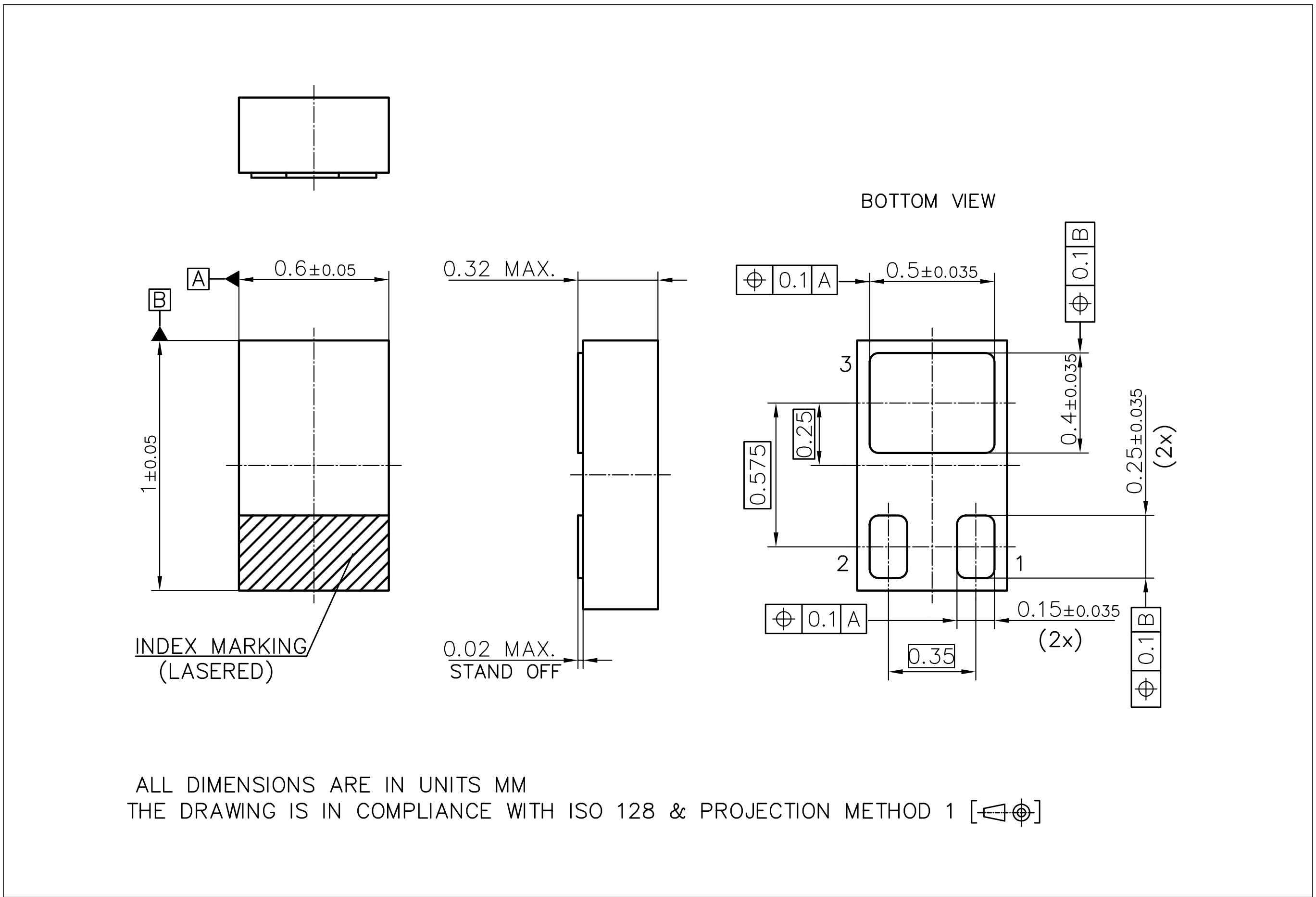

Figure 22 **Package outline**

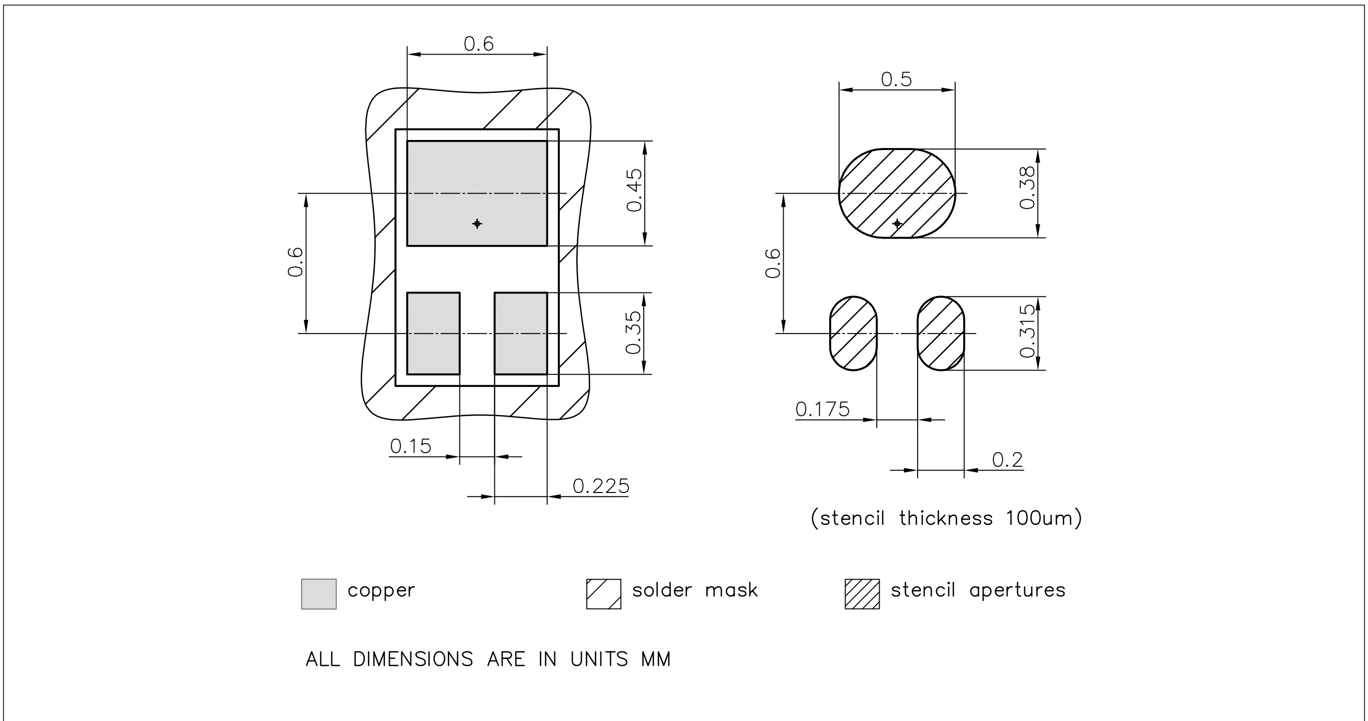

Figure 23 **Foot print**

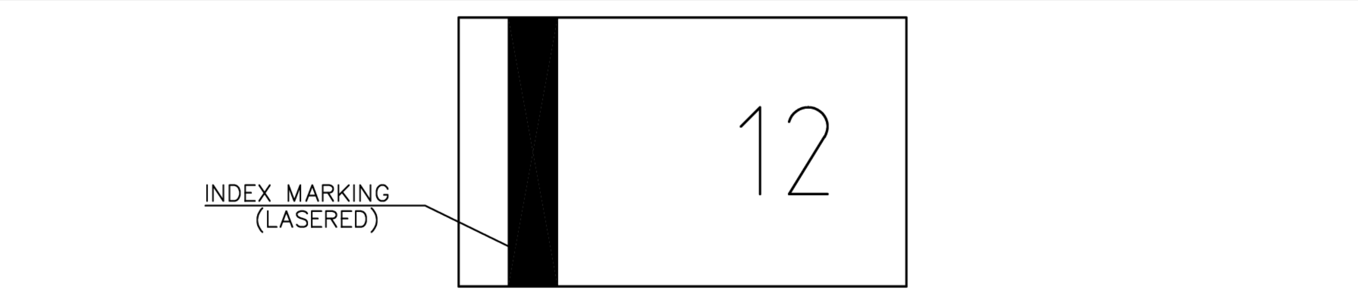

Figure 24 **Marking layout example**

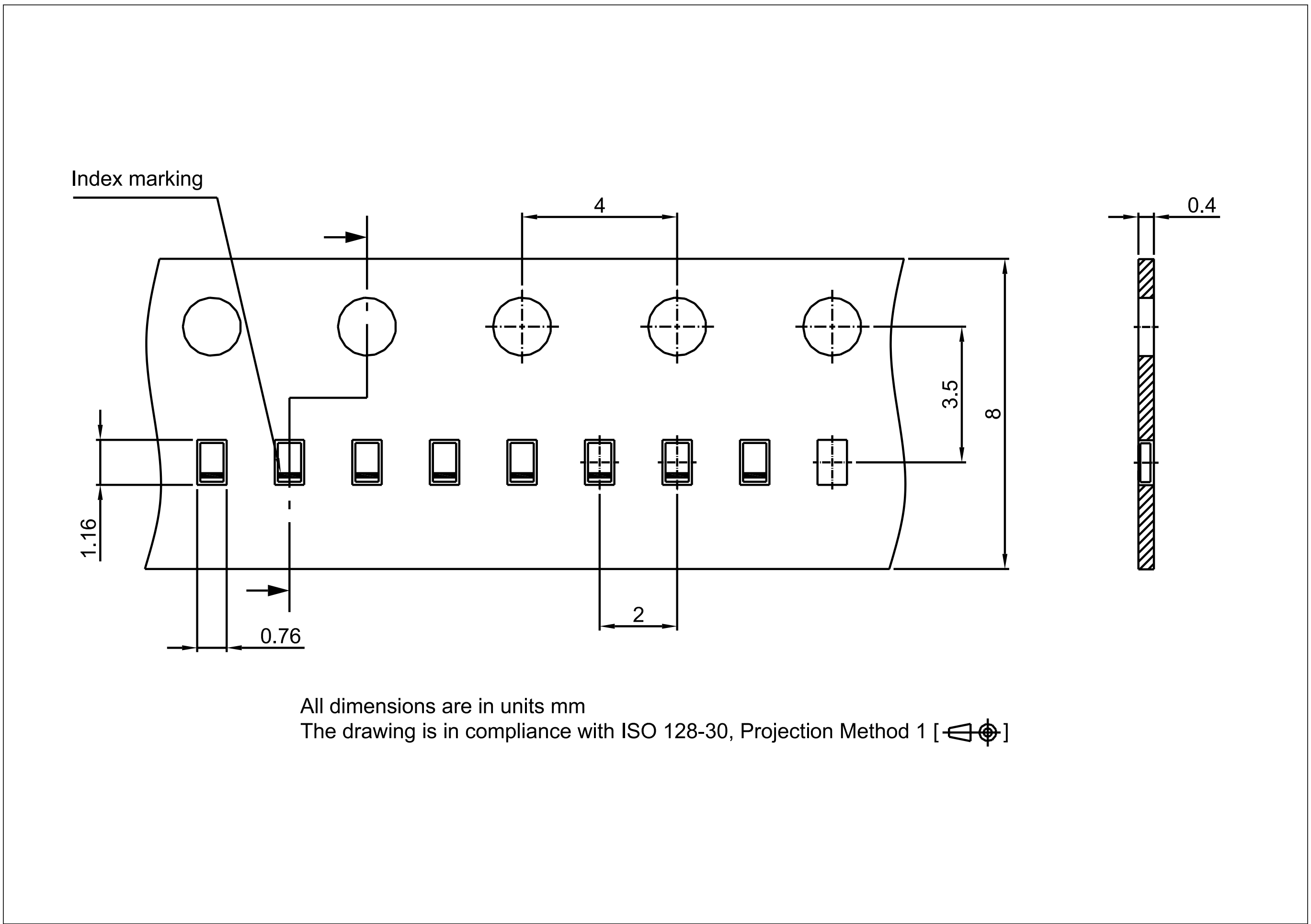

Figure 25 **Tape information**

***Note**:* *For recommendation on board assembly see the website of package PG-TSLP-3-10.*
The marking layout is an example. For the real marking code refer to the device information on the first page. The number of characters shown in the layout example is not necessarily the real one. The marking layout can consist of less characters.

Revision history

Document version	Date of release	Description of changes
1.0	2018-09-26	First datasheet release
1.1	2023-12-04	Tape change: New tape drawing
1.2	2024-07-01	Updated product validation

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