BGB707L7ESD

SiGe:C Wideband MMIC LNA with Integrated ESD Protection

RF & Protection Devices

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BGB707L7ESD, SiGe:C Wideband MMIC LNA with Integrated ESD Protection

Revision History: 2009-08-14, Rev. 3.1

Prevision History: Target Datasheets Rev. 1.0 - 1.3, Preliminary Datasheet Rev. 2.0, Final Data Sheet Rev. 3.0	
Rev. 3.1	typical electrical performance added for the SDMB application in chapter 6.2.2

1 SiGe:C Wideband MMIC LNA with Integrated ESD Protection

Features

- High performance general purpose wideband MMIC LNA
- 150 GHz fT-Silicon Germanium Carbon technology
- ESD protection integrated for all pins (3 kV for RF input vs. GND, 2 kV for all other pin combinations, HBM)
- Very high gain at low current consumption
- High input compression point
- Excellent noise figure from latest SiGe:C technology
- Integrated active biasing circuit enables stable operation point against temperature- and processing-variations
- Operation voltage: 1.8 V to 4.0 V
- Adjustable operation current 2.1 mA to 25 mA by external resistor
- Power-off function
- Very small and leadless package TSLP-7-1, 2.0 x 1.3 x 0.4 mm
- Pb-free (RoHS compliant) and halogen-free (WEEE compliant) package

RoHS

Applications

- FM Radio, Mobile TV, RKE, AMR, Cellular, ZigBee, GPS, WiMAX, SDARs, Satellite Radio, Bluetooth, WiFi, Cordless phone, UMTS, WLAN, UWB, LNB

2 Product Brief

The BGB707L7ESD is a Silicon Germanium Carbon (SiGe:C) low noise amplifier MMIC with integrated ESD protection and active biasing. The device is as flexible as a discrete transistor and features high gain, reduced power consumption and very low distortion for a very wide range of applications.

The Device is based upon Infineon Technologies cost effective SiGe:C technology and comes in a low profile TSLP-7-1 leadless green package

Type	Package	Marking
BGB707L7ESD	TSLP-7-1	AZ

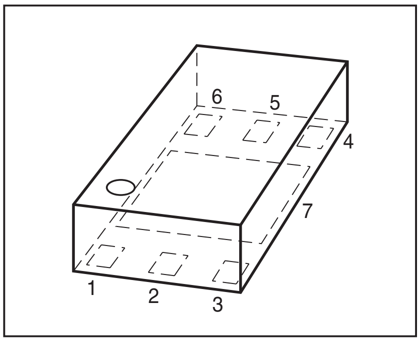

Figure 1 Pinning PG-TSLP-7-1

Table 1 Pinning table

Pin	Function
1	V_{CC}
2	Bias Out
3	RF In
4	RF Out
5	Control On/Off
6	Current Adjust
7	GND

The following diagram shows the principal schematic how the BGB707L7ESD is used in a circuit. The Power On/Off function is controlled by applying V_{ctrl}. By using an external resistor R_{ext} the pre-set current of 2.1 mA (which is adjusted by the integrated biasing when R_{ext} is omitted) can be increased. Base- and collector voltages are applied to the respective pins RF In and RF Out by external inductors.

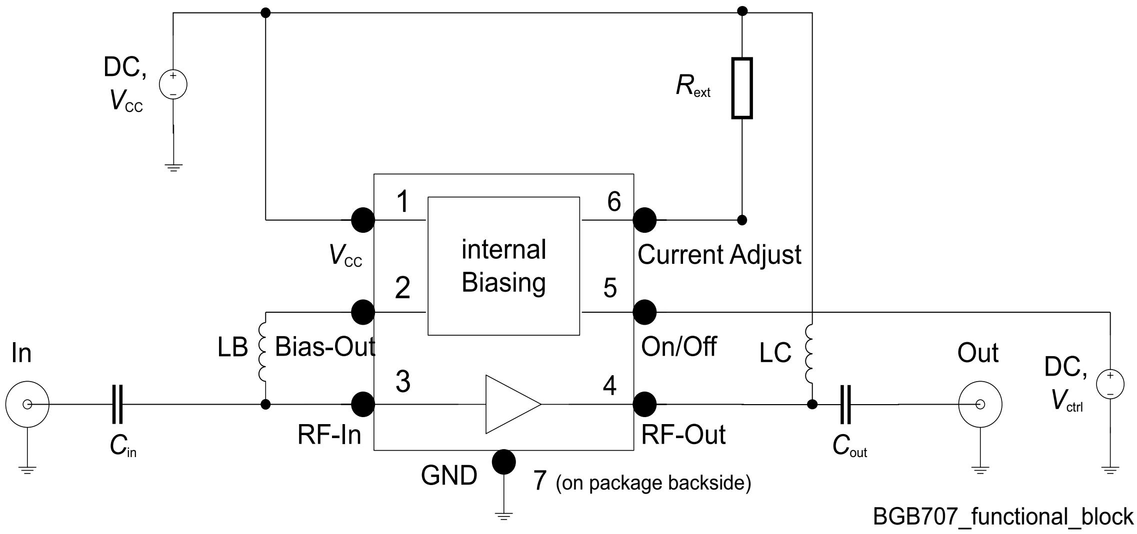

Figure 2 Functional block

3 Maximum Ratings

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

Parameter	Symbol	Value	Unit
Supply Voltage T_A = -55°C	V_{CC}	4.0 3.5	V
Supply Current at V_{CC} pin	I_{CC}	25	mA
DC Current at RF In pin	I_B	2	mA
Voltage at Ctrl On/Off pin	V_{ctrl}	4.0	V
Total Power Dissipation T_S<112°C[1)]	P_{tot}	100	mW
Operation Junction Temperature	T_{JOp}	-55...150	°C
Storage Temperature	T_{Stg}	-55...150	°C

1) T_S is the soldering point temperature. T_S is measured at the GND pin (7) at the soldering point to the pcb

Note: Exceeding only one of the above maximum rating limits even for a short moment may cause permanent damage to the device. Even if the device continues to operate, its lifetime may be considerably shortened. Maximum ratings are stress ratings only and do not mean unaffected functional operation and lifetime at others than standard operation conditions.

4 Thermal Characteristics

Table 3 Thermal Resistance

Parameter	Symbol	Value	Unit
Junction - Soldering Point[1)]	R_{thJS}	375	K/W

1) For calculation of R_{thJA} please refer to Application Note Thermal Resistance

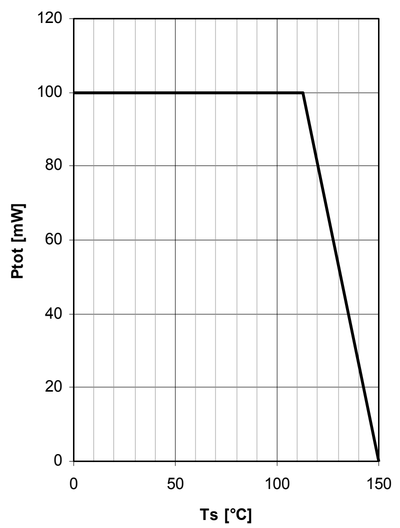

Figure 3 Total Power Dissipation Ptot = f (Ts)

5 Operation Conditions

Table 4 Operation Conditions

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{CC}	1.8	3.0	4.0	V	
Voltage Ctrl On/Off pin in On mode	$V_{ctrl-on}$	1.2		4.0	V	
Voltage Ctrl On/Off pin in Off mode	$V_{ctrl-off}$	-0.3		0.3	V	

6 Electrical Characteristics

6.1 DC Characteristics

Table 5 DC Characteristics at T_A = 25°C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Current	I_{CC}				mA	V_{CC} = 3 V, V_{Ctrl} = 3 V
		1.6	2.1	2.6		R_{ext} = open
			3			R_{ext} = 12 kΩ
			4.2			R_{ext} = 4.7 kΩ
			6			R_{ext} = 2.4 kΩ
			10			R_{ext} = 1 kΩ
Collector Current in Off mode	I_{CC-off}			6	µA	V_{CC} = 4 V, V_{Ctrl} = 0 V
Current into Ctrl On/Off pin in On mode	$I_{Ctrl-on}$		14	20	µA	V_{CC} = 3 V, V_{Ctrl} = 3 V
Current into Ctrl On/Off pin in Off mode	$I_{Ctrl-off}$			0.1	µA	V_{CC} = 4 V, V_{Ctrl} = 0 V

6.2 AC Characteristics

AC characteristics are described in two sub-chapters, first for 100MHz FM Radio applications, then for higher frequencies in a 50Ω environment.

6.2.1 AC Characteristics in FM Radio Applications

Two BGB707L7ESD FM radio application notes are available on our website **www.infineon.com/BGB707**. Depending on the impedance of the used antenna, please consult AN177 for high-ohmic antennas and AN181 for 50Ω antennas. In this chapter you find a summary of the electrical performance as described in these application notes in table form.

6.2.1.1 High-ohmic FM Radio Antenna

Table 6 AC Characteristics in the FM Radio application as described in AN177
T_A = 25°C, , V_{CC} = 3.0 V, I_{CC} = 3.0 mA, V_{Ctrl} = 3.0 V, f = 100 MHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transducer Gain	$\|S_{21}\|^2$		12		dB	
Input Return Loss	RL_{IN}		0.5 1)		dB	
Output Return Loss	RL_{OUT}		16		dB	
Noise Figure (Z_s = 50 Ω)	NF		1.0		dB	
Input 1 dB Gain Compression Point 2)	IP_{1dB}		-5.5		dBm	
Input 3rd Order Intercept Point 3)	IIP_3		-12.5		dBm	

1) LNA presents a high input impedance match over the 76-108 MHz FM radio band.
2) I_{CC} increases as RF input power level approaches IP1dB.
3) IIP_3 value depends on termination of all intermodulation frequency components. Termination used for the measurement is 50 Ω from 0.1 to 6 GHz.

6.2.1.2 50Ω FM Radio Antenna

Table 7 AC Characteristics in the FM Radio application as described in AN181
T_A = 25°C, V_{CC} = 2.8 V, I_{CC} = 4.2 mA, V_{Ctrl} = 2.8 V, f = 100 MHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transducer Gain	$\|S_{21}\|^2$	13.5	15	16.5	dB	
Input Return Loss	RL_{IN}		7.5		dB	
Output Return Loss	RL_{OUT}		14.5		dB	
Noise figure (Z_s = 50 Ω)	NF		1.35	1.9	dB	
Input 1 dB Gain Compression Point 1) 3)	IP_{1dB}		-10		dBm	
Input 3rd Order Intercept Point 2) 3)	IIP_3	-7.5	-6		dBm	

1) I_{CC} increases as RF input power level approaches IP1dB.
2) IIP_3 value depends on termination of all intermodulation frequency components. Termination used for the measurement is 50 Ω from 0.1 to 6 GHz.
3) Verified by random sampling

6.2.2 AC Characteristics in the SDMB Application

A technical report TR122 for LNA applications in the frequency range 2.3 GHz to 2.7 GHz is available on our website **www.infineon.com/BGB707**. In this chapter you find a summary of the electrical performance for the SDMB application as described in technical report TR122 in table form.

Table 8 AC Characteristics in the SDMB application as described in TR122<
T_A = 25°C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Frequency Range	$Freq$		2.6		GHz	
Supply Voltage	Vcc		2.8		V	
Bias Current	Icc	4.4	5.6	6.8	mA	
Transducer Gain	$\|S_{21}\|^2$	13	15	17	dB	Power @ port1 = -30 dBm
Transducer Gain (off mode)	$\|S_{21}\|^2_{off}$		-18		dB	
Noise Figure (Z_s = 50 Ω)	NF		1.15	1.5	dB	Including SMA connectors / PCB losses of 0.1 dB
Input Return Loss	RL_{IN}		13.2		dB	
Output Return Loss	RL_{OUT}		12		dB	
Reverse Isolation	I_{REV}		27.8		dB	Power @ port2 = -10 dBm
Input P1dB	IP_{1dB}		-9.6		dBm	
Output P1dB	OP_{1dB}		4.4		dBm	
Input IP3	IIP_3		-1.4		dBm	Input power = -30 dBm
Output IP3	OIP_3		13.6		dBm	
On Switching Time	T_{on}		1.5		µs	Measured with C_2 = 1nF
Off Switching Time	T_{off}		4.2		µs	
Stability	k		>1			Stability measured up to 10 GHz

6.2.3 AC Characteristics in Test Fixture

For frequencies from 150 MHz to 10 GHz the measurement setup is a test fixture with Bias-T's in a 50 Ω system at T_A = 25 °C.

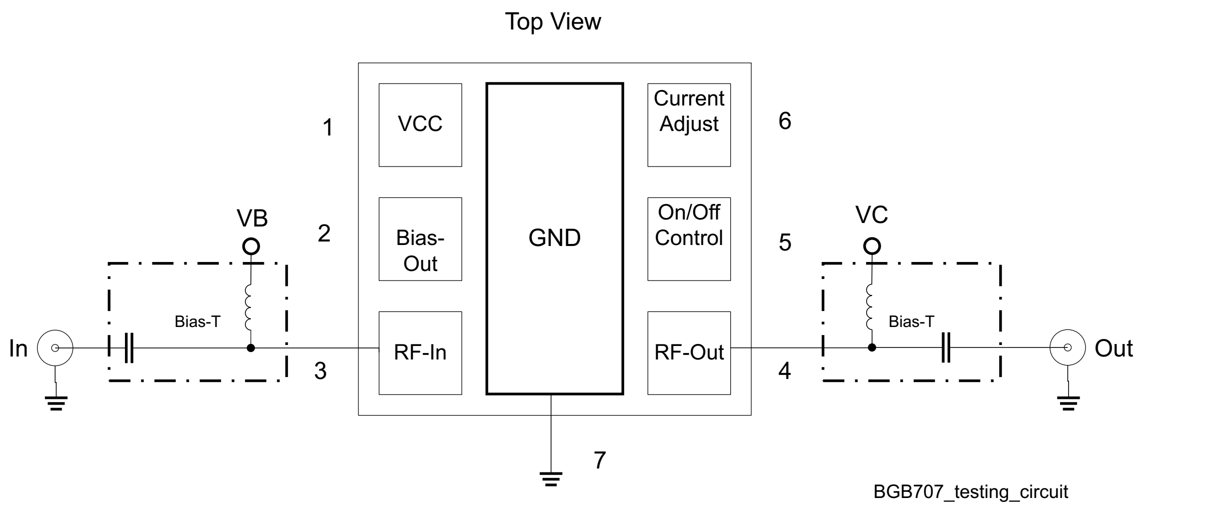

Figure 4 Testing circuit for frequencies from 150 MHz to 10 GHz

Table 9 AC Characteristics V_C = 3 V, f = 150 MHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure	NF_{min}				dB	$Z_S = Z_{Sopt}$
			0.4			I_C = 2.1 mA
			0.4			I_C = 3 mA
			0.5			I_C = 6 mA
			0.55			I_C = 10 mA
Transducer Gain	$\|S_{21}\|^2$				dB	$Z_S = Z_L$ = 50 Ω
			17			I_C = 2.1 mA
			19			I_C = 3 mA
			24			I_C = 6 mA
			27			I_C = 10 mA
Maximum Power Gain	G_{ms}				dB	$Z_L = Z_{Lopt}$, $Z_S = Z_{Sopt}$
			31.5			I_C = 2.1 mA
			33			I_C = 3 mA
			35			I_C = 6 mA
			37			I_C = 10 mA
Input 1 dB Gain Compression Point[1)]	$IP_{1dB,m}$		-12.5		dBm	I_{Cq} = 2.1 mA[2)]
			-14			I_{Cq} = 3 mA
			-19			I_{Cq} = 6 mA
			-24			I_{Cq} = 10 mA
Input 3rd Order Intercept Point[3)]	$IIP_{3,m}$		-26.5		dBm	I_C = 2.1 mA

Table 9 AC Characteristics V_C = 3 V, f = 150 MHz (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
			-25			I_C = 3 mA
			-18			I_C = 6 mA
			-8.5			I_C = 10 mA

1) $IP_{1dB,m}$ is the input compression point achieved when the device is matched at the input with S_{11} = -10dB. Therefore the $IP_{1dB,m}$ value is a good indicator for the linearity achievable in the application.
2) I_{Cq} is the quiescent current, that is at small RF input power level. I_C increases as RF input power level approaches P1dB.
3) $IIP_{3,m}$ is the input 3rd order intercept point achieved when the device is matched at the input with S_{11} = -10dB.

Table 10 AC Characteristics V_C = 3 V, f = 450 MHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure	NF_{min}				dB	$Z_S = Z_{Sopt}$
			0.45			I_C = 2.1 mA
			0.45			I_C = 3 mA
			0.5			I_C = 6 mA
			0.6			I_C = 10 mA
Transducer Gain	$\|S_{21}\|^2$				dB	$Z_S = Z_L$ = 50 Ω
			17			I_C = 2.1 mA
			19			I_C = 3 mA
			24			I_C = 6 mA
			27			I_C = 10 mA
Maximum Power Gain	G_{ms}				dB	$Z_L = Z_{Lopt}$, $Z_S = Z_{Sopt}$
			27			I_C = 2.1 mA
			28			I_C = 3 mA
			30.5			I_C = 6 mA
			32			I_C = 10 mA
Input 1 dB Gain Compression Point[1]	$IP_{1dB,m}$		-12		dBm	I_{Cq} = 2.1 mA[2]
			-13.5			I_{Cq} = 3 mA
			-19.5			I_{Cq} = 6 mA
			-23.5			I_{Cq} = 10 mA
Input 3rd Order Intercept Point[3]	$IIP_{3,m}$		-25.5		dBm	I_C = 2.1 mA
			-24			I_C = 3 mA
			-17.5			I_C = 6 mA
			-13			I_C = 10 mA

1) $IP_{1dB,m}$ as is the input compression point achieved when the device is matched at the input with S_{11} = -10dB. Therefore the $IP_{1dB,m}$ value is a good indicator for the linearity achievable in the application.
2) I_{Cq} is the quiescent current, that is at small RF input power level. I_C increases as RF input power level approaches P1dB.
3) $IIP_{3,m}$ is the input 3rd order intercept point achieved when the device is matched at the input with S_{11} = -10dB.

Table 11 AC Characteristics V_C = 3 V, f = 900 MHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure	NF_{min}				dB	$Z_S = Z_{Sopt}$
			0.55			I_C = 2.1 mA
			0.55			I_C = 3 mA
			0.6			I_C = 6 mA
			0.7			I_C = 10 mA
Transducer Gain	$\|S_{21}\|^2$				dB	$Z_S = Z_L$ = 50 Ω
			17			I_C = 2.1 mA
			19			I_C = 3 mA
			23.5			I_C = 6 mA
			26			I_C = 10 mA
Maximum Power Gain	G_{ms}				dB	$Z_L = Z_{Lopt}$, $Z_S = Z_{Sopt}$
			24			I_C = 2.1 mA
			25			I_C = 3 mA
			27.5			I_C = 6 mA
			29			I_C = 10 mA
Input 1 dB Gain Compression Point[1]	$IP_{1dB,m}$		-10		dBm	I_{Cq} = 2.1 mA[2]
			-12			I_{Cq} = 3 mA
			-18			I_{Cq} = 6 mA
			-22.5			I_{Cq} = 10 mA
Input 3rd Order Intercept Point[3]	$IIP_{3,m}$		-23		dBm	I_C = 2.1 mA
			-21			I_C = 3 mA
			-14.5			I_C = 6 mA
			-11.5			I_C = 10 mA

1) $IP_{1dB,m}$ is the input compression point achieved when the device is matched at the input with S_{11} = -10dB. Therefore the $IP_{1dB,m}$ value is a good indicator for the linearity achievable in the application.
2) I_{Cq} is the quiescent current, that is at small RF input power level. I_C increases as RF input power level approaches P1dB.
3) $IIP_{3,m}$ is the input 3rd order intercept point achieved when the device is matched at the input with S_{11} = -10dB.

Table 12 AC Characteristics V_C = 3 V, f = 1.9 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure	NF_{min}				dB	$Z_S = Z_{Sopt}$
			0.6			I_C = 2.1 mA
			0.6			I_C = 3 mA
			0.6			I_C = 6 mA
			0.7			I_C = 10 mA
Transducer Gain	$\|S_{21}\|^2$				dB	$Z_S = Z_L$ = 50 Ω
			16			I_C = 2.1 mA
			18			I_C = 3 mA
			21.5			I_C = 6 mA

Table 12 AC Characteristics V_C = 3 V, f = 1.9 GHz (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
			23			I_C = 10 mA
Maximum Power Gain	G_{ms}				dB	$Z_L = Z_{Lopt}$, $Z_S = Z_{Sopt}$
			21			I_C = 2.1 mA
			22			I_C = 3 mA
			24			I_C = 6 mA
			26			I_C = 10 mA
Input 1 dB Gain Compression Point[1]	$IP_{1dB,m}$		-5		dBm	I_{Cq} = 2.1 mA[2]
			-7			I_{Cq} = 3 mA
			-12.5			I_{Cq} = 6 mA
			-16.5			I_{Cq} = 10 mA
Input 3rd Order Intercept Point[3]	$IIP_{3,m}$		-16.5		dBm	I_C = 2.1 mA
			-15			I_C = 3 mA
			-10			I_C = 6 mA
			-8.5			I_C = 10 mA

1) $IP_{1dB,m}$ is the input compression point achieved when the device is matched at the input with S_{11} = -10dB. Therefore the $IP_{1dB,m}$ value is a good indicator for the linearity achievable in the application.
2) I_{Cq} is the quiescent current, that is at small RF input power level. I_C increases as RF input power level approaches P1dB.
3) $IIP_{3,m}$ is the input 3rd order intercept point achieved when the device is matched at the input with S_{11} = -10dB.

Table 13 AC Characteristics V_C = 3 V, f = 2.4 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure	NF_{min}				dB	$Z_S = Z_{Sopt}$
			0.65			I_C = 2.1 mA
			0.6			I_C = 3 mA
			0.6			I_C = 6 mA
			0.7			I_C = 10 mA
Transducer Gain	$\|S_{21}\|^2$				dB	$Z_S = Z_L$ = 50 Ω
			15.5			I_C = 2.1 mA
			17			I_C = 3 mA
			20			I_C = 6 mA
			21.5			I_C = 10 mA
Maximum Power Gain	G_{ms}				dB	$Z_L = Z_{Lopt}$, $Z_S = Z_{Sopt}$
			20			I_C = 2.1 mA
			21			I_C = 3 mA
			23			I_C = 6 mA
			25			I_C = 10 mA
Input 1 dB Gain Compression Point[1]	$IP_{1dB,m}$		-3		dBm	I_{Cq} = 2.1 mA[2]
			-4.5			I_{Cq} = 3 mA
			-9.5			I_{Cq} = 6 mA

Table 13 AC Characteristics V_C = 3 V, f = 2.4 GHz (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
			-12.5			I_{Cq} = 10 mA
Input 3rd Order Intercept Point[3]	$IIP_{3,m}$		-13		dBm	I_C = 2.1 mA
			-11.5			I_C = 3 mA
			-6			I_C = 6 mA
			-5.5			I_C = 10 mA

1) $IP_{1dB,m}$ is the input compression point achieved when the device is matched at the input with S_{11} = -10dB. Therefore the $IP_{1dB,m}$ value is a good indicator for the linearity achievable in the application.
2) I_{Cq} is the quiescent current, that is at small RF input power level. I_C increases as RF input power level approaches P1dB.
3) $IIP_{3,m}$ is the input 3rd order intercept point achieved when the device is matched at the input with S_{11} = -10dB.

Table 14 AC Characteristics V_C = 3 V, f = 5.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure	NF_{min}				dB	$Z_S = Z_{Sopt}$
			1.05			I_C = 2.1 mA
			1			I_C = 3 mA
			0.9			I_C = 6 mA
			0.95			I_C = 10 mA
Transducer Gain	$\|S_{21}\|^2$				dB	$Z_S = Z_L = 50\ \Omega$
			11.5			I_C = 2.1 mA
			13			I_C = 3 mA
			15			I_C = 6 mA
			15.5			I_C = 10 mA
Maximum Power Gain	G_{ms}				dB	$Z_L = Z_{Lopt}$, $Z_S = Z_{Sopt}$
			17.5			I_C = 2.1 mA
			18.5			I_C = 3 mA
			20			I_C = 6 mA
			19			I_C = 10 mA
Input 1 dB Gain Compression Point[1]	$IP_{1dB,m}$		-1		dBm	I_C = 2.1 mA
			-3			I_C = 3 mA
			-7			I_C = 6 mA
			-9.5			I_C = 10 mA
Input 3rd Order Intercept Point[2]	$IIP_{3,m}$		-4		dBm	I_C = 2.1 mA
			-2.5			I_C = 3 mA
			2			I_C = 6 mA
			2.5			I_C = 10 mA

1) $IP_{1dB,m}$ is the input compression point achieved when the device is matched at the input with S_{11} = -10dB. Therefore the $IP_{1dB,m}$ value is a good indicator for the linearity achievable in the application.
2) $IIP_{3,m}$ is the input 3rd order intercept point achieved when the device is matched at the input with S_{11} = -10dB.

Table 15 AC Characteristics V_C = 3 V, f = 10 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure	NF_{min}				dB	$Z_S = Z_{Sopt}$
			2			I_C = 2.1 mA
			1.8			I_C = 3 mA
			1.5			I_C = 6 mA
			1.5			I_C = 10 mA
Transducer Gain	$\|S_{21}\|^2$				dB	$Z_S = Z_L = 50\ \Omega$
			5.5			I_C = 2.1 mA
			7			I_C = 3 mA
			9			I_C = 6 mA
			10			I_C = 10 mA
Maximum Power Gain	G_{ms}				dB	$Z_L = Z_{Lopt}$, $Z_S = Z_{Sopt}$
			14.5			I_C = 2.1 mA
			15			I_C = 3 mA
			15.5			I_C = 6 mA
			15.5			I_C = 10 mA
Input 1 dB Gain Compression Point[1)]	$IP_{1dB,m}$		1.5		dBm	I_C = 2.1 mA
			0.5			I_C = 3 mA
			-2.5			I_C = 6 mA
			-4			I_C = 10 mA
Input 3rd Order Intercept Point[2)]	$IIP_{3,m}$		-1		dBm	I_C = 2.1 mA
			-0.5			I_C = 3 mA
			1.5			I_C = 6 mA
			5			I_C = 10 mA

1) $IP_{1dB,m}$ is the input compression point achieved when the device is matched at the input with S_{11} = -10dB. Therefore the $IP_{1dB,m}$ value is a good indicator for the linearity achievable in the application.

2) $IIP_{3,m}$ is the input 3rd order intercept point achieved when the device is matched at the input with S_{11} = -10dB.

7 Package Information

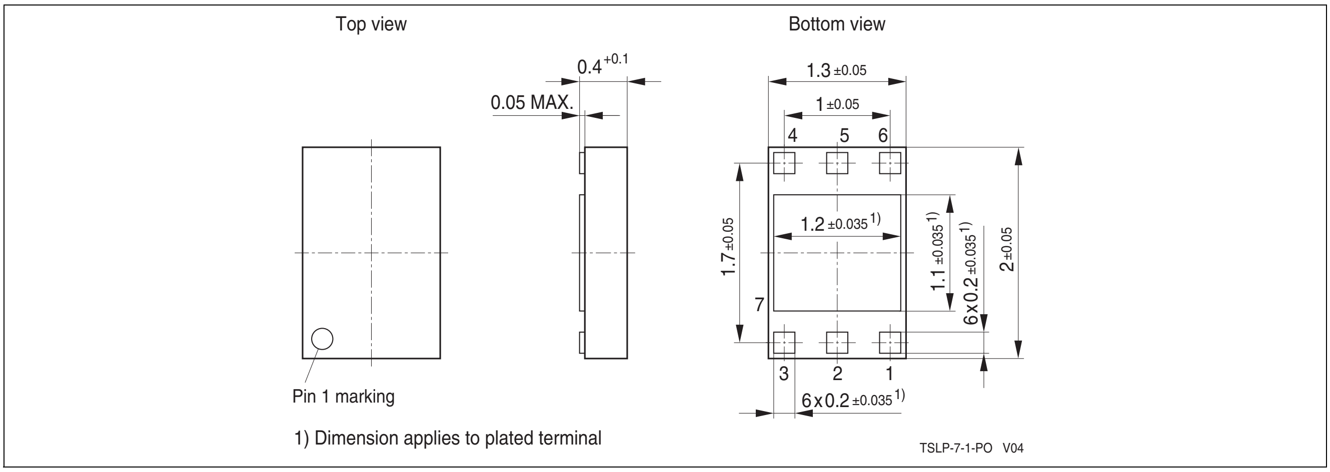

Figure 5 Package Outline TSLP-7-1

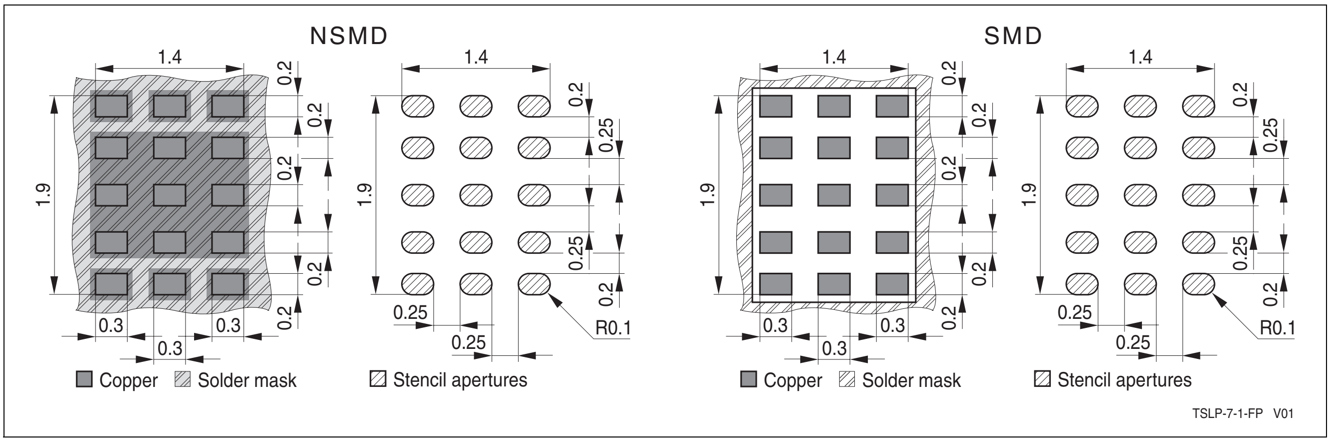

Figure 6 Footprint

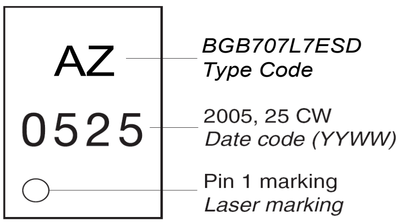

Figure 7 Marking Layout (top view)

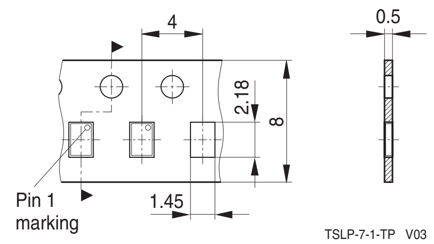

Figure 8 Tape Dimensions