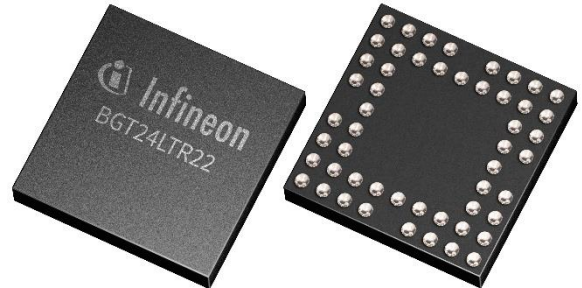


BGT24LTR22

Low Power Multichannel 24GHz Radar MMIC for Smart Sensing Applications

Features

- 24 GHz transceiver MMIC (2 TX, 2 RX)
- Fully integrated low phase noise VCO
- Medium power amplifier with variable output power
- Integrated power detectors
- Homodyne low noise quadrature receivers
- Configurable analog baseband amplification stages
- Frequency divider
- Low power consumption
- Multimode operation (Master/Slave)
- Fully ESD protected device
- Single ended RF terminals
- Single supply voltage 1.5V
- WFWLB-52-3 pin plastic package sized 3.63mmx3.63mm
- Pb-free (RoHS compliant) package



Potential Applications

- Smart home appliances
- Drone collision avoidance
- Traffic monitoring
- Security applications

Description

BGT24LTR22 is a low power, low noise multi-channel Silicon Germanium transceiver MMIC for 24 GHz radar applications. It provides building blocks for analog signal generation and reception, operating in the frequency range from 24.0 GHz up to 24.25 GHz. Integrated digital blocks controlling the chip are implemented in order to support radar system design.

The device is manufactured in Infineon's B11HFC BiCMOS technology offering a cutoff frequency higher than 300GHz. It is housed in Infineon's plastic embedded Wafer Level Ball Grid Array (eWLB) package which can be processed in standard SMT flow.

Table of Content

Features	1
Potential Applications.....	1
Description	1
Table of Content	2
1 Electrical Characteristics	3
1.1 Absolute Maximum Ratings	3
1.2 ESD Integrity	4
1.3 Power Supply.....	4
1.4 TX Section	4
1.5 RX Section	5
1.6 Frequency Divider	6
2 SPI Interface.....	7
2.1 SPI Timing Requirements.....	7
3 Block Diagram and Pin Description.....	8
3.1 Block Diagram	8
3.2 Pin Out	9
3.3 Pin Definition and Function	9
4 Package Dimensions and Footprint	11

1 Electrical Characteristics

Attention: Test ■ means that the parameter is not subject to production test. It was verified by design or characterization respectively.

1.1 Absolute Maximum Ratings

Table 1 Absolute Maximum Ratings: $T_A = -40^\circ\text{C} \dots 85^\circ\text{C}$; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	-0.3	-	$V_{DD,max} + 0.3$	V	
DC voltage at RF pins	$V_{DC,RF}$	0	-	0	V	DC-short at RF pins (RX1, RX2, TX1, TX2) to GND
DC voltage at VCO tuning pin VTUNE	V_{TUNE}	0	-	5	V	
Voltage applied to all other user I/O pins	$V_{DC,I/O}$	-0.3	-	$V_{DD} + 0.3$	V	
RF input power RX inputs	P_{RF}	-	-	0	dBm	Pins RX1, RX2
Total power dissipation	P_{DISS}	-	-	500	mW	
Storage temperature range	T_{STG}	-40	-	150	$^\circ\text{C}$	
Operational temperature range	T_C	-40	-	+85	$^\circ\text{C}$	Temperature at package soldering point
Thermal resistance of package	$R_{th,P}$	-	18	-	K/W	Represents bulk silicon to package solder balls

Attention: Stresses exceeding 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. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

Electrical Characteristics

1.2 ESD Integrity

Table 2 ESD integrity

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
ESD robustness HBM ¹	$V_{\text{ESD-HBM}}$	-1	-	1	kV	All pins
ESD robustness CDM ²	$V_{\text{ESD-CDM}}$	-500	-	500	V	All pins

1) According to ANSI/ESDA/JEDEC JS-001 (R = 1.5kOhm, C = 100pF) for Electrostatic Discharge Sensitivity Testing, Human Body Model (HBM)-Component Level

2) According to ESDA/JEDEC JS-002 Field-Induced Charged Device Model (CDM), Test Method for Electrostatic-Discharge-Withstand Thresholds of Microelectronic Components

Please note that this result is subject to:

- lot variations within the manufacturing process as specified by Infineon
- changes in the specific test setup

1.3 Power Supply

Table 3 Power Supply Electrical Characteristics: $T_A = -40\text{ }^{\circ}\text{C} \dots 85\text{ }^{\circ}\text{C}$

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	1.45	1.5	1.6	V	
Supply current nominal operation mode	$I_{\text{DD-ON}}$	-	170	230	mA	SPI Settings – Refer to AN607
Supply current in reduced power consumption mode	$I_{\text{DD-RED}}$	-	135	-	mA	SPI Settings – Refer to AN607
Supply current standby-mode	$I_{\text{DD-STDBY}}$	-	-	1	mA	SPI Settings – Refer to AN607

1.4 TX Section

Table 4 TX Section Electrical Characteristics: $T_A = -40\text{ }^{\circ}\text{C} \dots 85\text{ }^{\circ}\text{C}$, $V_{\text{DD}} = 1.45\text{ V} \dots 1.6\text{ V}$; all parameters are for master mode operation (unless otherwise specified)

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
VCO frequency range	f_{VCO}	24.0	-	24.25	GHz	
VCO phase noise	P_N	-	-65 -85	-50 -70	dBc/Hz	@10kHz offset @100kHz offset
VCO AM noise	P_{AM}	-	-148	-	dBc/Hz	@100kHz offset
Tuning voltage to cover VCO frequency range	V_{TUNE}	0	0.7	3	V	ISM band covered from 0 V to 1.5 V

Electrical Characteristics

Table 4 TX Section Electrical Characteristics: $T_A = -40\text{ }^{\circ}\text{C} \dots 85\text{ }^{\circ}\text{C}$, $V_{DD} = 1.45\text{ V} \dots 1.6\text{ V}$; all parameters are for master mode operation (unless otherwise specified)

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
VCO tuning sensitivity within VCO frequency range	$\Delta f / \Delta V_{TUNE}$	500	1600	3000	MHz/V	
VCO temperature drift within VCO frequency range	$\Delta f / \Delta T$	-	-5	-	MHz/K	
2 nd Harmonic suppression	$\Delta P_{fund,H2}$	15	27	-	dBc	
VCO nonharmonic suppression	P_{SPUR}	-	-55	-40	dBm	
TX output power ¹	P_{TX1}	1	5	9.5	dBm	
TX output power dynamic range	ΔP_{OUT}	17	24	-	dB	
TX load impedance	Z_{TX1}	-	50	-	Ω	Single-ended at outer edge of compensation structure on PCB as indicated in AN607

1.5 RX Section

Table 5 RX Section Electrical Characteristics: $T_A = -40\text{ }^{\circ}\text{C} \dots 85\text{ }^{\circ}\text{C}$, $V_{DD} = 1.45\text{ V} \dots 1.6\text{ V}$; all parameters are within master mode operation (unless otherwise specified)

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
RX frequency range	f_{RX}	24.0	-	24.25	GHz	
Single-sideband noise figure ¹	NF_{SSB}	-	8	16.5	dB	@ $f_{IF} = 200\text{ kHz}$ – Bypass Mode SPI configurable – Refer to AN607
		-	8.5	15.5		@ $f_{IF} = 200\text{ kHz}$ – ABB Mode SPI configurable – Refer to AN607
RF downconverter conversion gain ¹	G_{DC}	16	25	33	dB	@ $f_{IF} = 200\text{ kHz}$ – Bypass Mode SPI configurable – Refer to AN607
Analog baseband Gain	G_{ABB}	-	0/30/35/40/ 45/50/55/60	-	dB	Configurable via SPI
Input 1 dB compression point	IP_{1dB}	-	-19	-	dBm	RX in Bypass Mode
LO input power	P_{LOIN}	-	-10	-	dBm	For slave mode operation

¹ Refer to AN607 for more details about parameter variation over temperature

Electrical Characteristics

Table 5 RX Section Electrical Characteristics: $T_A = -40\text{ }^{\circ}\text{C} \dots 85\text{ }^{\circ}\text{C}$, $V_{DD} = 1.45\text{ V} \dots 1.6\text{ V}$; all parameters are within master mode operation (unless otherwise specified)

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Baseband high pass filters cut off frequency	F_{c-hpf}	-	20/50/80/100	-	kHz	Configurable via SPI 1 st order, -3 dB definition
Baseband low pass filters cut off frequency	F_{c-lpf}	-	600	-	kHz	4 th order, -3 dB definition
Quadrature phase imbalance	ε_P	-10	-	10	deg	
Quadrature amplitude imbalance	ε_A	-1.5	-	1.5	dB	
IF output impedance	Z_{IF}	-	400	-	Ω	Differential
IF output impedance – Bypass Mode	Z_{IFBY}	-	1	-	k Ω	Differential
IF output common mode voltage	V_{IFCMD}	-	0.75	-	V	
IF output power supply rejection ratio	$PSRR$	-	60	-	dB	@ DC
RX input impedance	Z_{RXIN}	-	50	-	Ω	Single-ended at outer edge of compensation structure on PCB as indicated in AN607

1.6 Frequency Divider

Table 6 Frequency Divider Electrical Characteristics: $T_A = -40\text{ }^{\circ}\text{C} \dots 85\text{ }^{\circ}\text{C}$, $V_{DD} = 1.45\text{ V} \dots 1.6\text{ V}$,
Freq = 24GHz

Parameter	Symbol	Value			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Dividing factor 1	D_{DIV1}	-	2 ²⁰	-	-	selectable via SPI
Dividing factor 2	D_{DIV2}	-	2 ¹⁶	-	-	selectable via SPI
Dividing factor 3	D_{DIV3}	-	2 ¹⁴	-	-	selectable via SPI
Dividing factor 4	D_{DIV4}	-	2 ¹³	-	-	selectable via SPI
Dividing factor 5	D_{DIV5}	-	16	-	-	selectable via SPI
Divider output power	P_{DIV5}	-13	-5	0	dBm	For dividing factor 5 - @50 Ohms load
Divider output voltage range	V_{DIV}	0	-	V_{DD}	V	For dividing factors 1 to 4
External capacitive load	$C_{extLoad}$	-	-	15	pF	For dividing factors 1 to 4

SPI Interface

2 SPI Interface

2.1 SPI Timing Requirements

The BGT24LTR22 is configured using a 4-wire SPI interface. It is used to configure the internal modules of the BGT24LTR22 chip via registers. The main tasks are to set the mode of operation of the TX and/or RX chain and the baseband section. Communication with an external micro controller is done via the four dedicated pins SPIDI, SPIDO, SPICS and SPICLK. Figure 1 demonstrates how the timing of the SPI behaves. The “working edge” is the rising edge of the clock *SPICLK*. The master application processor presents data for BGT24LTR22 at the falling edge on *SPIDI*, BGT24LTR22 samples data at the rising edge. Read data is presented for the master on the rising edge on *SPIDO*. Refer to the application note AN607 for all details related to the SPI registers to control the MMIC.

*Note: Asynchronous reset (*SPIRST*) must be de-asserted at least 10 ns before the falling edge of *SPICLK*.*

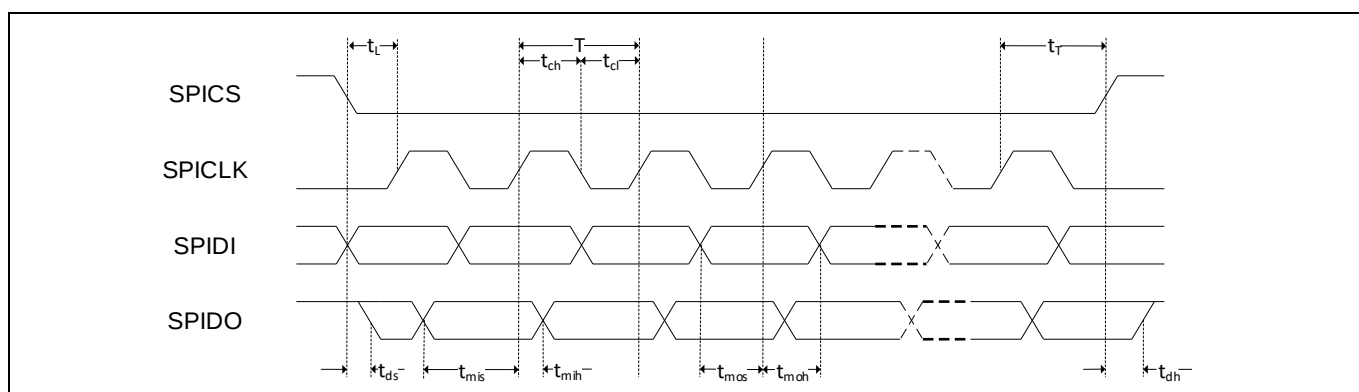


Figure 1 SPI timing diagram

Table 7 SPI Interface timing requirements

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
SPI clock period	T	20			ns	50MHz, with <1% clock jitter
Clock high time	t_{ch}	9			ns	
Clock low time	t_{cl}	9			ns	
Setup time SPIDI	t_{mos}	5			ns	
Hold time SPIDI	t_{moh}	5			ns	
Setup time SPIDO	t_{mis}	5			ns	
Hold time SPIDO	t_{mih}	1			ns	
Delay time from the output pad logic	$t_{pad_out_dly}$			5	ns	

BGT24LTR22

Low Power Multichannel 24GHz Radar MMIC for Smart Sensing Applications

Block Diagram and Pin Description

3 Block Diagram and Pin Description

3.1 Block Diagram

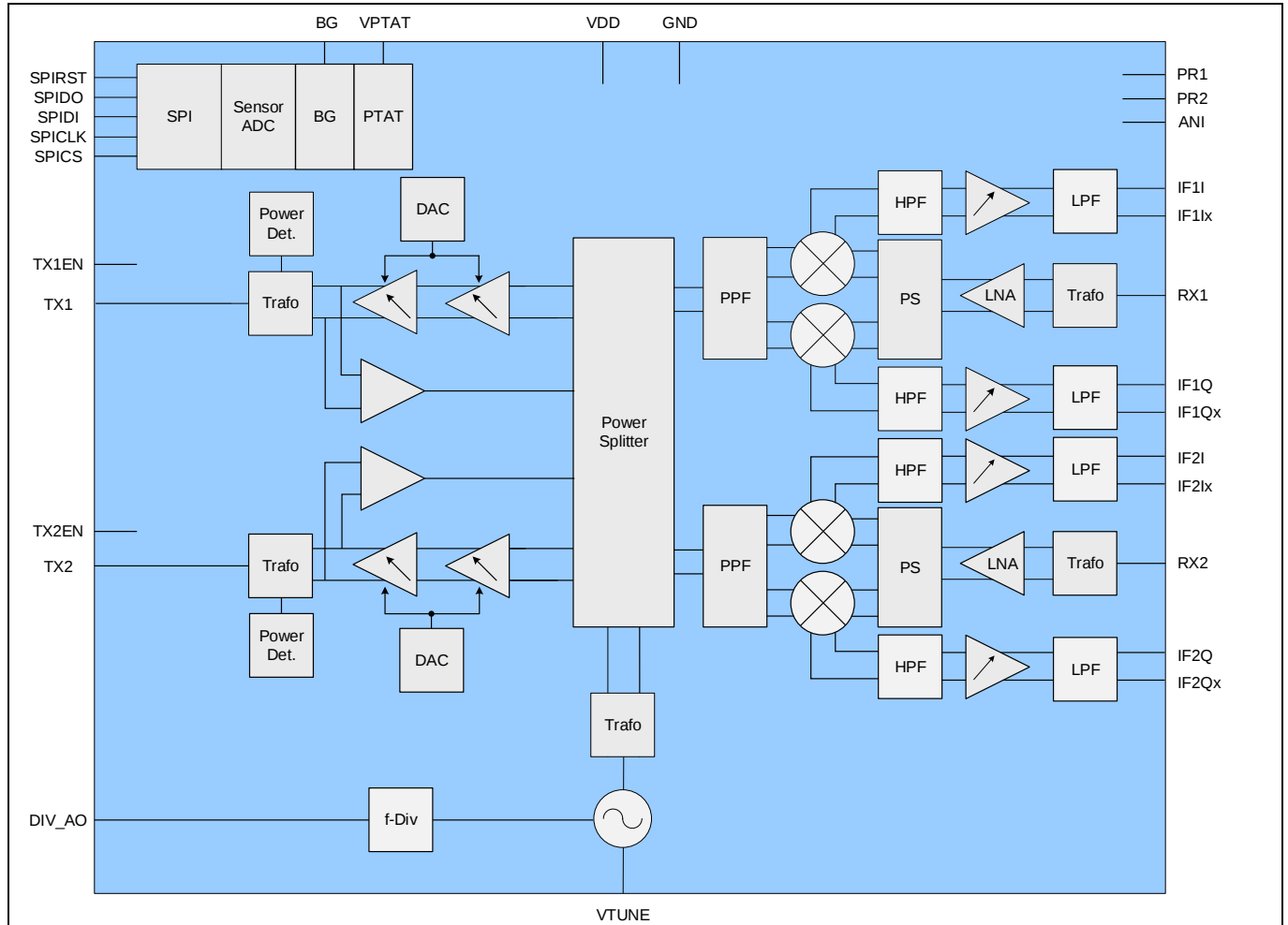


Figure 2 BGT24LTR22 block diagram

3.2 Pin Out

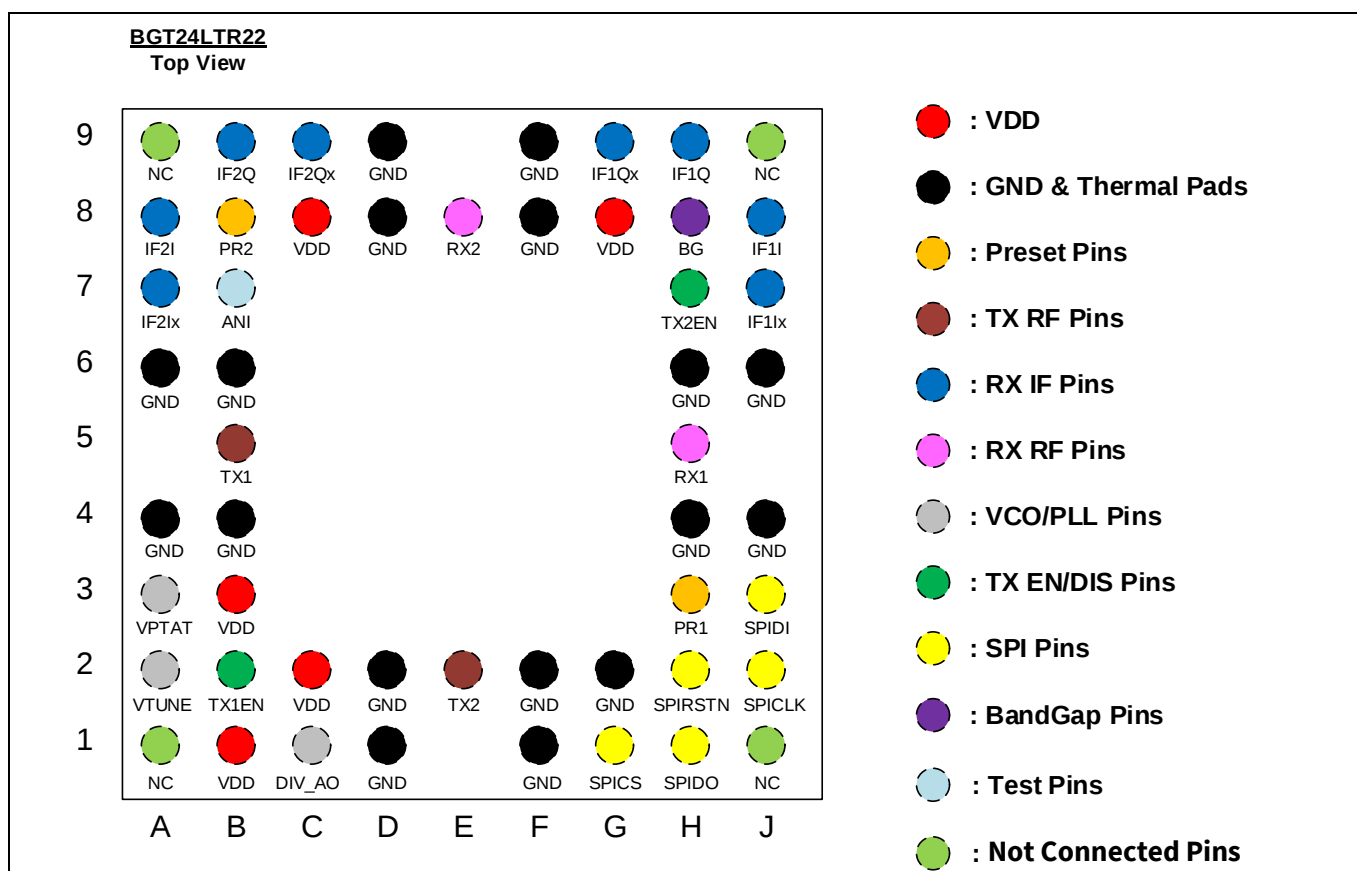


Figure 3 Pin out (top view)

3.3 Pin Definition and Function

Table 8 Pin definition and function

Pin Number	Name	Function
A1, A9, J1, J9	NC	No connection
B1, B3, C2, C8, G8	VDD	DC supply voltage
H5	RX1	RF input - receiver 1
E8	RX2	RF input - receiver 2
E2	TX2	Bidirectional RF I/O RF output – transmitter 2/LO input 2
B5	TX1	Bidirectional RF I/O RF output – transmitter 1/LO input 1
J8, J7	IF1I, IF1Ix	Complementary in phase downconverter IF output – receiver 1
H9, G9	IF1Q, IF1Qx	Complementary quadrature phase downconverter IF output - receiver 1
A8, A7	IF2I, IF2Ix	Complementary in-phase downconverter IF output – receiver 2

Table 8 Pin definition and function

Pin Number	Name	Function
B9, C9	IF2Q, IF2Qx	Complementary quadrature phase downconverter IF output - receiver 2
A4, A6, B4, B6, D1, D2, D8, D9, F1, F2, F8, F9, G2*, H4, H6, J4, J6	GND	Ground
H3	PR1	Mode select – pin 1
B8	PR2	Mode select - pin 2
C1	DIV_AO	Frequency divider output
B2	TX1EN	Enable transmitter 1
H7	TX2EN	Enable transmitter 2
H8	BG	Bandgap voltage output
A2	VTUNE	VCO frequency tuning input
A3	VPTAT	PTAT voltage source output
G1	SPICS	SPI chip select (spi_cs_i)
H1	SPIDO	SPI data out (spi_do_o)
H2	SPIRST	SPI reset
J2	SPICLK	SPI clock (spi_clk_i)
J3	SPIDI	SPI data in (spi_di_i)
B7	ANI	Analog input for testing

Note: It is mandatory to connect Pin G2 to ground for SPI programming

BGT24LTR22

Low Power Multichannel 24GHz Radar MMIC for Smart Sensing Applications

Package Dimensions and Footprint

4 Package Dimensions and Footprint

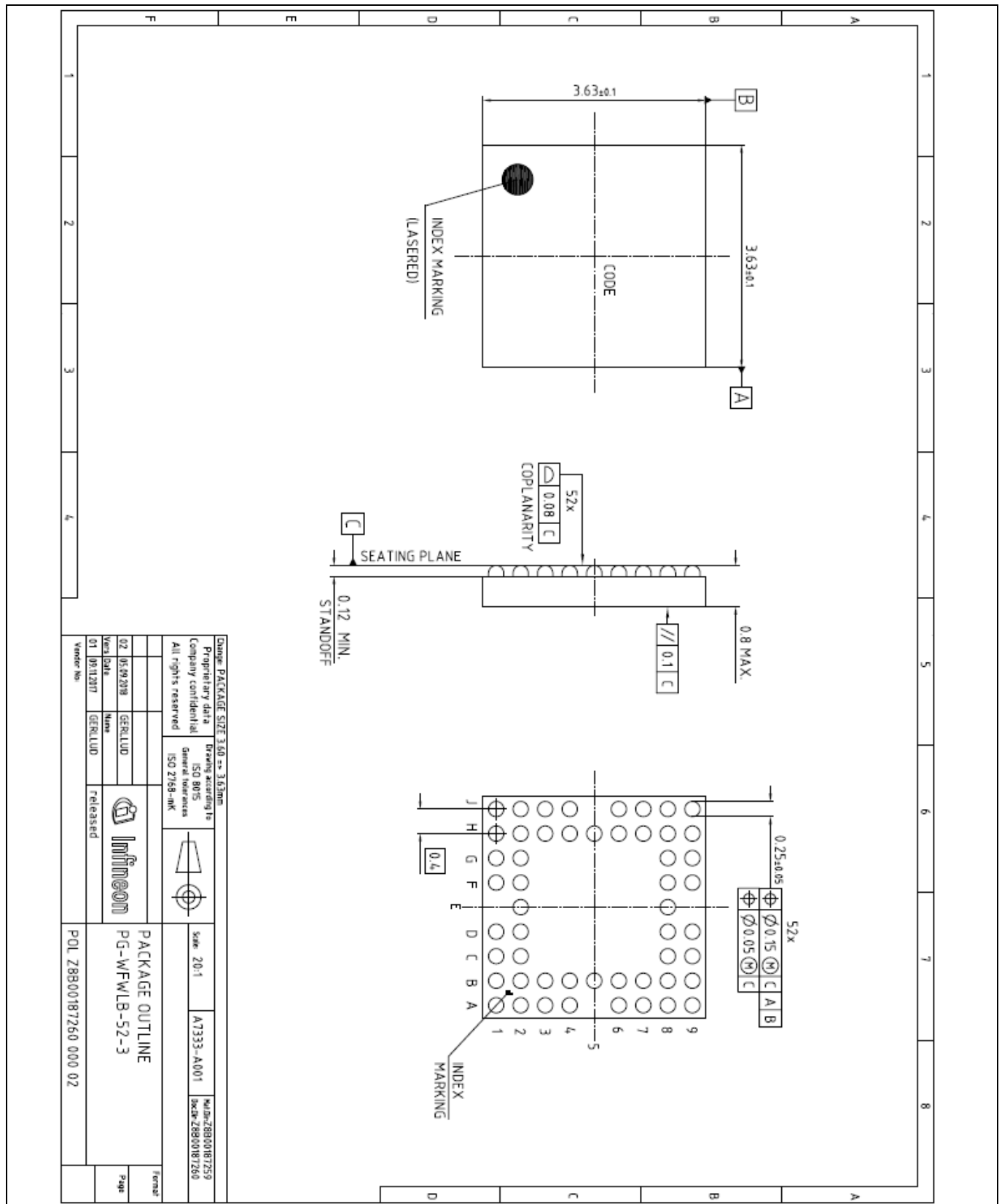


Figure 4 Package outline. Top, side and bottom view of WFWLB-52-3

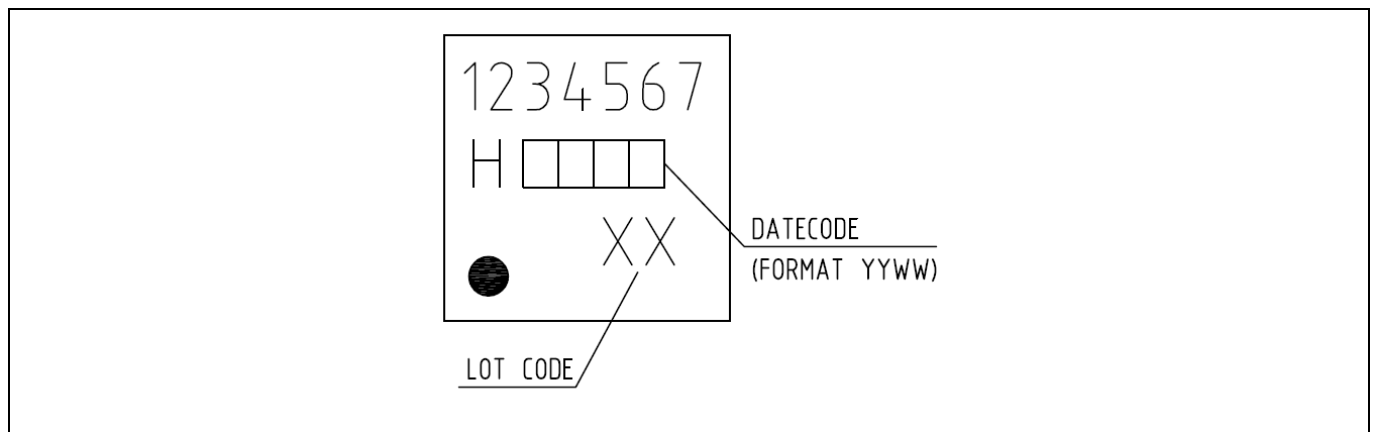


Figure 5 **Marking layout of WFWLB-52-3**

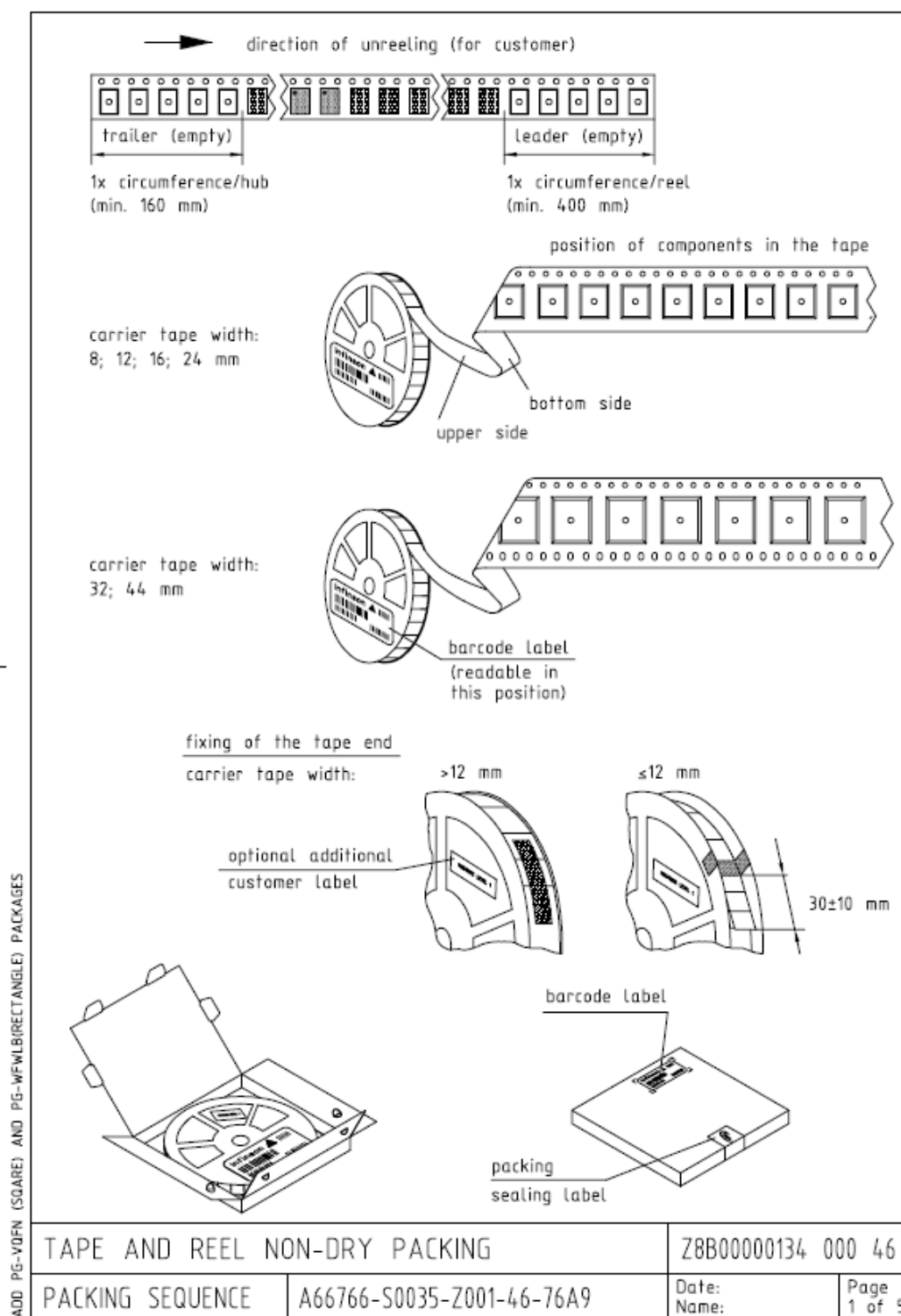


Figure 6 Tape and reel of WFWLB-52-3

Revision history

Document version	Date of release	Description of changes
V1.0	dd/mm/2020	First release

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2020-01-26

Published by

**Infineon Technologies AG
81726 München, Germany**

**© 2020 Infineon Technologies AG.
All Rights Reserved.**

Do you have a question about this document?

Email: erratum@infineon.com

Document reference

ifx1

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology delivery terms and conditions and prices please contact your nearest Infineon Technologies office (www.infineon.com).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.