Audi AG

UWBtrx22 and UWBBLE22

User Manual

Continental Automotive GmbH
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Germany

Internal

Document History

Date	Version	Changes
21.09.2021	1	initial version
24.09.2021	2	chapter 1.4.2: UWB ranging sequences added chapter 7: corrections of abbreviations
28.10.2021	3	chapter 2.7.1: changed UWB protocol standard

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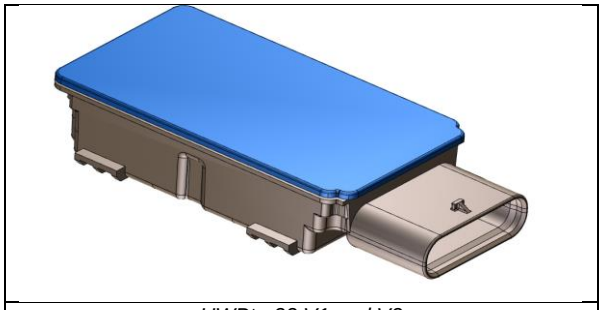
1 General Description

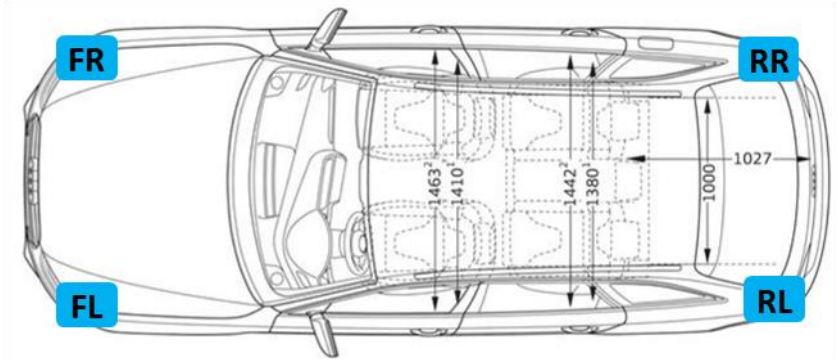
1.1 Product Appearence



UWBtrx22 V1 and V2

1.2 System Functional Description

The Audi UWBtrx22 (UWB only) and UWBBLE22 (UWB+BLE) is an UWB (Ultra Wide Band) and BLE (Bluetooth® Low Energy) transceiver module for car access and user localization purposes. This equipment should be installed and operated with minimum distance 10 mm between the radiator and your body.
There are several system setups possible. For RAD (relay attack defense) function 4 UWBtrx22 transceivers are in the rear and front bumpers.



Example schematic

For CoSmA (Continental Smartphone based Access) functionality additional 2 to 4 UWBBLE22 are mounted in the headliner of the car. Typically, half of the transceivers are equipped also with BLE (UWB+BLE).

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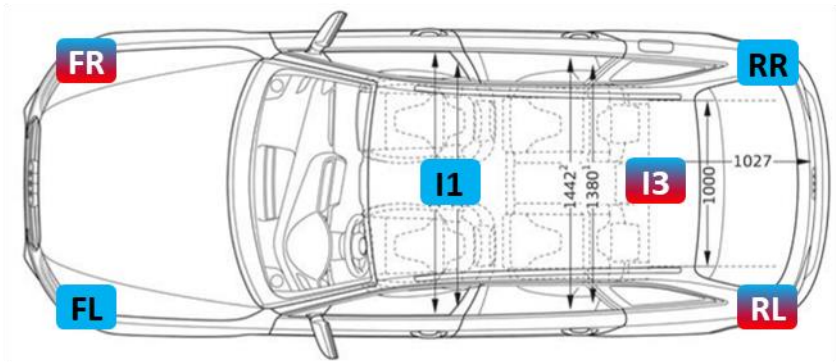
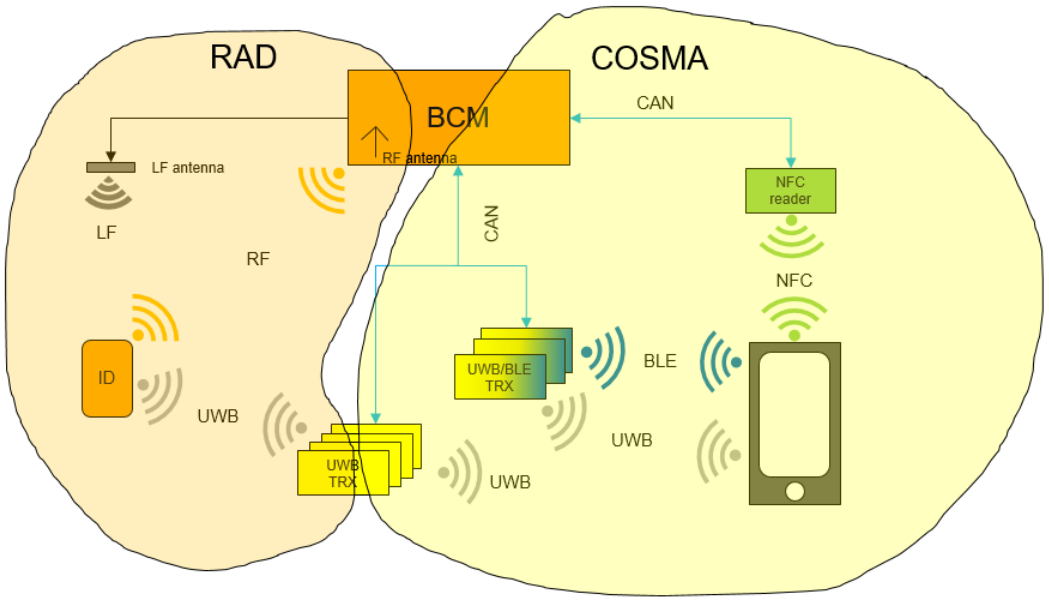


Example schematic
BLUE: UWB-Only, BLUE/RED: UWB+BLE

They are all connected to a central control unit via CAN interface.
The BLE link is used for data exchange between the car and the smartphone or key fob whereas the UWB link is for position detection between them.
The system includes at least one smartphone with UWB and BLE functionality and one key fob with the same features.

Abbreviation	Location
FR	Front right bumper
FL	Front left bumper
RR	Rear right bumper
RL	Rear left bumper
I	Interior / headliner

1.3 System Overview BLE UWB Digital Access



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1.4 Function Flow

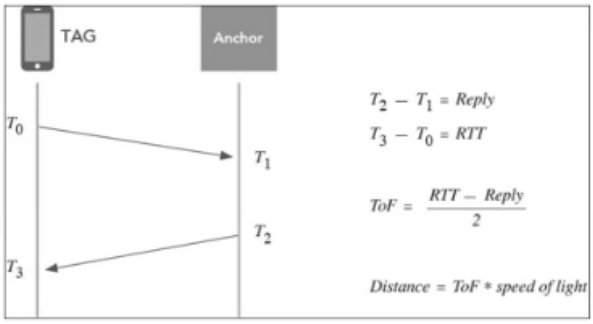
1.4.1 System Wake up with learned Smartphone

- The car is in BLE advertisement mode.
- The learned smart phone is in BLE range and detected.
- The BLE connection is active (BLE ADV switched off).
- Check digital key ok.
- BLE authentification ok.
- Smartphone and UWB+BLE TRx switch UWB reception on.
- Smartphone sends one UWB data package to UWB+BLE TRx.
- UWB+BLE TRx sends UWB response to smartphone.
- UWB function switch off.

1.4.2 System Wake up with learned Key Fob

- The learned key fob is in 125kHz range and detected.
- Localization 125kHz and 434MHz authentification ok.
- Key fob and UWB+BLE TRx switch UWB reception on.
- Key fob sends one UWB data package to UWB+BLE TRx.
- UWB+BLE TRx sends UWB response to key fob.
- UWB function switch off.

The distance is measured by ToF measurement



TAG: smartphone or key fob
Anchor: UWB+BLE/UWB-Only TRx

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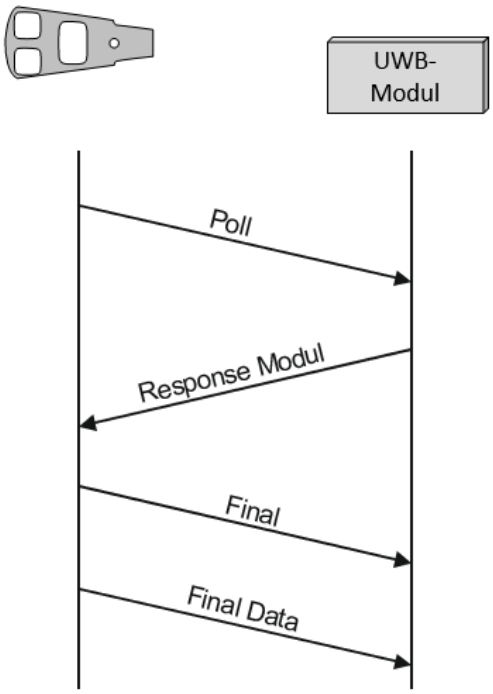
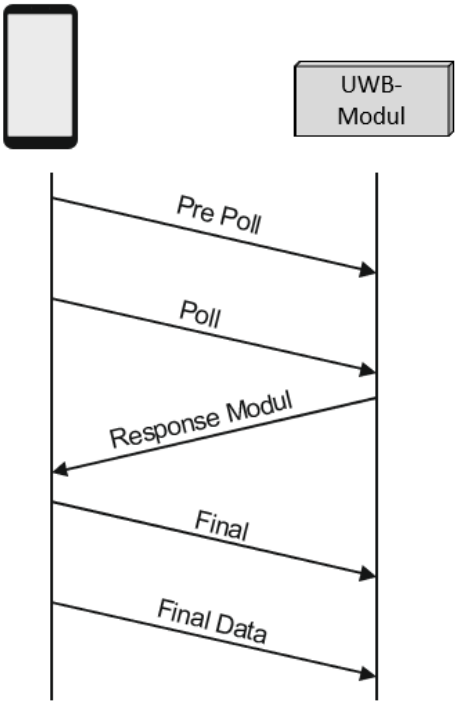
with Key Fob



with Smartphone



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1.5 Shutdown of the UWB system

UWB packets may be exchanged when a device needs to be located to execute vehicle features or to establish driving readiness. Once the features' execution was completed or driving readiness is established and the vehicle is moving at a certain speed, the UWB system gets inactive after a timeout.

The UWB system is disabled in the following additional conditions:

- Smartphone or key fob is out of range
- Smartphone or key fob is detected in range
- Car is in parking mode
- Ignition is ON (any drive mode is active)
- System is deactivated with diagnostic command

1.6 UWB duty cycle limiter

To satisfy the EU EN302065-3-1 limits (see picture below) a duty cycle limiter is implemented in the product SW. Several frame counters make sure that frame transmission is muted in case the duty cycle limit would be violated.

Ton max = 5 ms
Toff mean ≥ 38 ms (averaged over 1 sec)
Σ Toff > 950 ms per second
Σ Ton < 18 s per hour (see Note 1)

1.7 Parts of Certification

Variants (placement options)					
UWB+BLE			UWB-Only		
UWBBLE22	V1	CAN Coding	UWBtrx22	V2	CAN Coding

Manufacturer:

Continental Automotive GmbH
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2 Features

- The UWB+BLE TRx stand-alone transceiver is a bidirectional BLE and UWB band RF transceiver with integrated antenna, private high-speed CAN communication interface and integrated 12/3V power supply.
- The electrical wiring of the applications (UWB+BLE and UWB-Only) is optimized for the application in electric vehicles. A corresponding wiring cares for the necessary protection against high voltage overload.
- In addition, a protective wiring protects the HF-path at the antenna base against ESD-damage.
- The output emitted by the transceiver is configurable and calibrated in the final production test.
- The transceivers are permanently connected to VBatt +12V. If the TRx are deactivated, it's switched to stand-by mode without any reception and transmitting functionality.

2.1 TRX Radio Device Class

- BLE - low power mid range device for BLE communication with mobile devices. For indoor and outdoor position detection.
- UWB - low power short range device for outdoor position detection.

2.2 Electrical Device Class

- Low power device with integrated power management and ISO CAN interface

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2.3 Device XTAL Frequencies and Clocks

- BLE: 32.0 MHz (±50 ppm)
  32.768 kHz (-300 ppm … +100 ppm)
- UWB: 55.2 MHz (±15 ppm)
- TVII (main µC): 16MHz (±100 ppm)

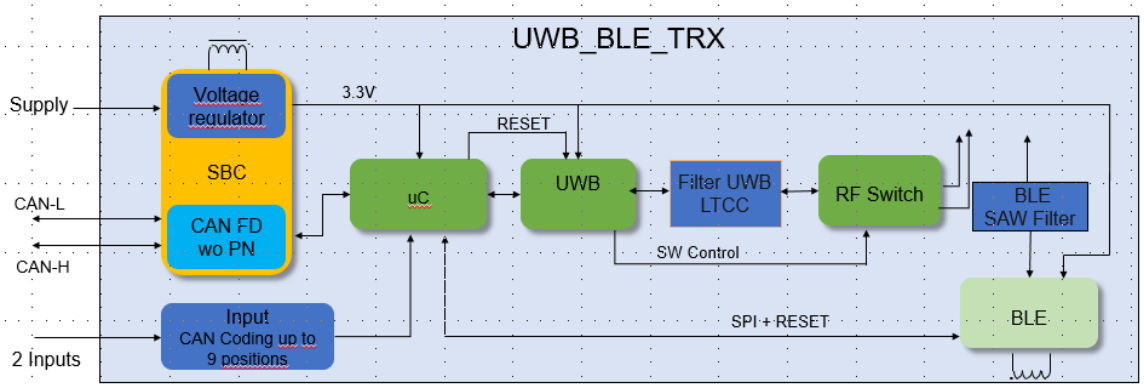
2.4 Component Block Diagram

Difference between HW versions (placement options only):

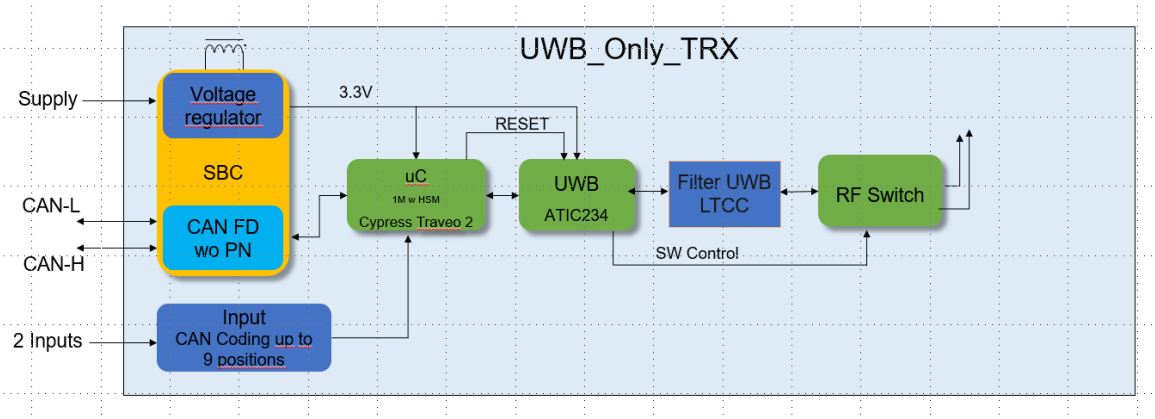
- UWB+BLE ***(UWBBLE22 V1)*** and UWB-Only ***UWBtrx22 V2)***
  - BLE components/function not assembled.
  - BLE SW part deactivated

→ Same components (PCB ASSY) used for BLE and UWB sections within all applications

2.4.1 Block diagram UWB+BLE TRX with CAN ID Coding (UWBBLE22 V1)



2.4.2 Block diagram UWB-Only TRX with CAN ID Coding (UWBtrx22 V2)



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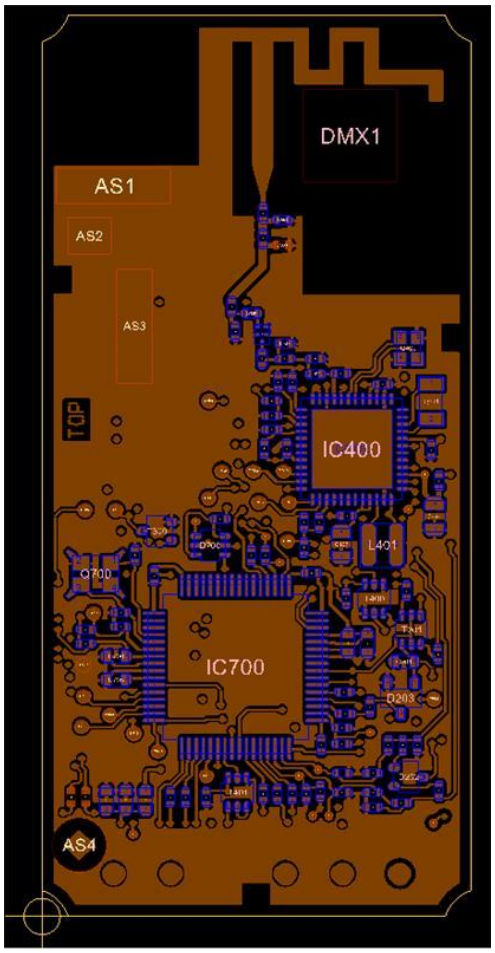
2.5 Variants

C					
UWB+BLE			UWB Only		
UWBBLE22	V1	CAN Coding	UWBtrx22	V2	CAN Coding

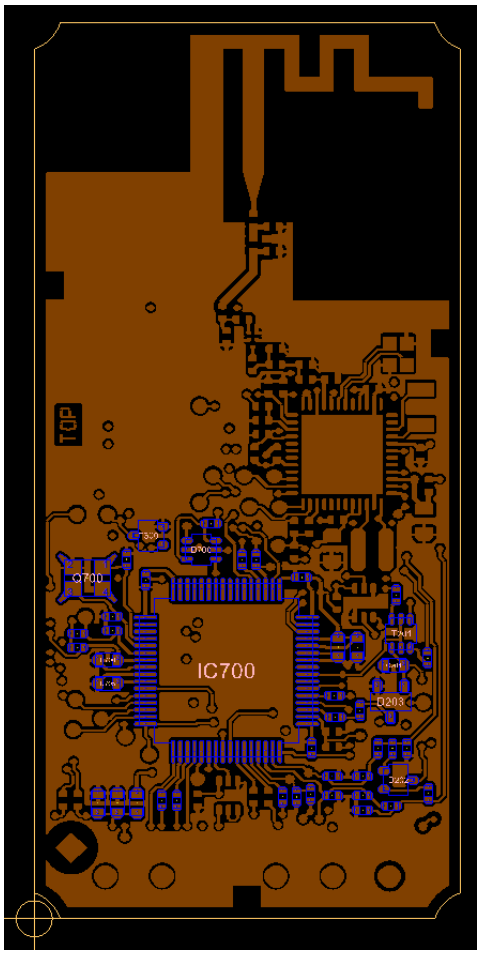
2.5.1 UWB+BLE (UWBBLE22 V1) vs. UWB-Only (UWBtrx22 V2) (placement options)

2.5.1.1 PCB TOP

UWBBLE22 **V1** TOP



UWBtrx22 **V2** TOP



TOP: BLE components not populated in UWB-Only version

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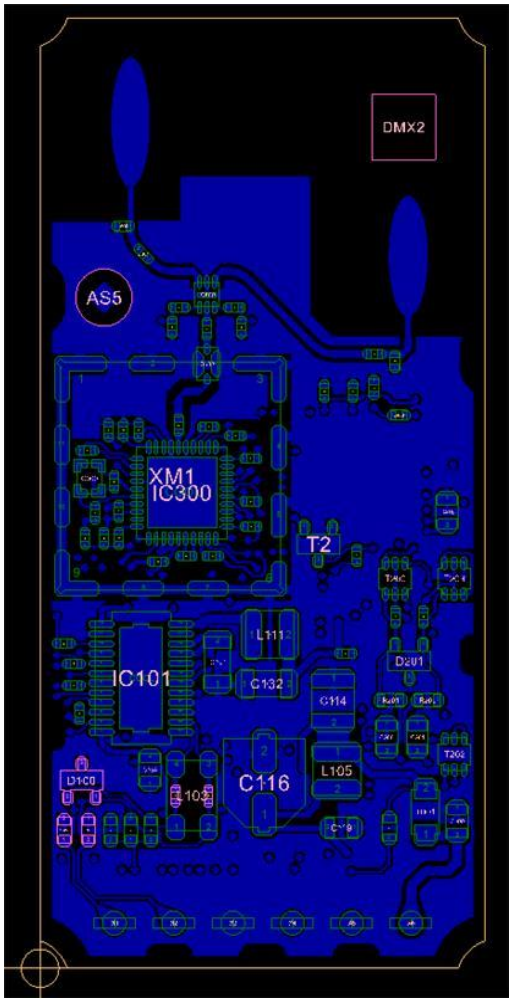
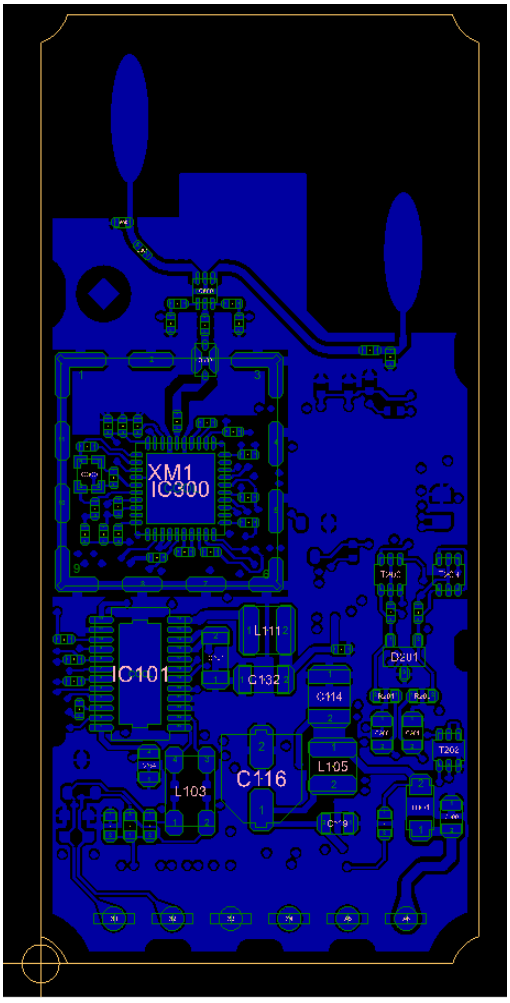
2.5.1.2 PCB BOT

UWBBLE22 **V1** BOT



UWBtrx22 **V2** BOT



BOT: BLE components not populated in UWB-Only version, no difference @ BOT

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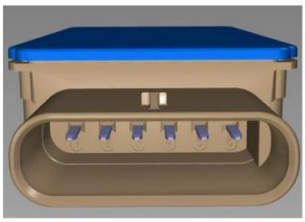
2.6 Pinning Information

2.6.1 Connector standard with CAN coding ***(UWBBLE22 V1 and UWBtrx22 V2)***

1	2	3	4	5	6
CAN-L	CAN-H	GND	IN B	INA	Vbat



2.6.1.1 I/O-Port Description

Pin	Name	Signaly	Remark
1	CAN-L	CAN LOW	CAN +
2	CAN-H	CAN HIGH	CAN -
3	GND	KL31E	Ground
4	IN-B	CAN ID Coding Input B	GND, Open, Vbat (#)
5	IN-A	CAN ID Coding Input A	GND, Open, Vbat (#)
6	Vbat	KL30	Vbat +12V

(#) Configuration of CAN ID in CAN network according to connector configuration

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2.7 Radio Features

2.7.1 UWB Device

UWB			
1	Chip Type	ATIC234 (NXP VBond), NCJ29D5	
2	UWB Protocol	Compliant with: Car Connectivity Consortium Digital Key Release 3 Technical Specification Version 1.0.0	
3	Frequency Bands	Center frequency CH5 6489.6 MHz CH6 6988.8 MHz CH8 7488.0 MHz CH9 7987.2 MHz 10 dB Bandwidth approx. 580 MHz	CH7 not supported IC HW supports center frequencies in the range of 6.5 – 8.0 GHz TRX implementation supports IEEE802.15.4 Homologation of channels according to availability
4	FLASH memory (EROM)	256 kB	
5	ROM	64 kB	
6	RAM	32 kB	
7	Flash over	SPI (CAN)	
8	Low Power RTC	n.a.	Not required
9	Crystal Clock	55,2 MHz	
10	Antenna Diversity	yes (switched diversity)	ANT selection determined on frame level by protocol or mode setting (tbd)
11	TX: Peak Envelope Power	Max. +12 dBm	at IC output
12	TX: Signal Bandwidth UWB	min. 500 MHz	FCC/ETSI compliant
13	TX: Mean Power Spectral Density	max. -41.3 dBm/MHz	radiated FCC/ETSI compliant
14	TX: Peak Power (RBW=50 MHz)	max. 0 dBm	radiated FCC/ETSI compliant
15	TX: Power settings	4 (depending on packaging position) x2 (separate for each ANT) x4 (separate for each CH)	homologation for stand-alone and metal-plate
16	TX: Modes	FC1T1ND RRC_0.45_min (CH 5/9) FC1T1ND RRC_0.45_lin(CH 5/9) FC1T2 (CH 5/9) ECO_FC1T1ND (CH 5/6/8/9)	ANT1 and ANT2 Payload-length 84 byte
17	RX: Sensitivity (6.8 MBit/s, 64 MHz PRF, 20 Byte PSDU)	CH5: typ. -93,5 dBm CH9: typ -92 dBm	at ANT footpoint; FC1T2 (CH 5/9)
18	Maximum antenna gain	CH5 / CH6 / CH8 / CH9 Ant1: 6.8 / 7.0 / 6.5 / 5.4 dBi Ant2: 3.9 / 3.4 / 5.0 / 4.8 dBi	Monopol Antenna

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2.7.2 BLE Device

BLE			
1	Chip Type	NXP MKW37A512VFT4	BLE 5.0 compliant
2	BLE Norm	5.0 + LR	only LE 1M PHY and LE Coded PHY with S = 2 will be used
3	Form	QFN48_WF	
4	ROM	32bit, 256KB Flash + 256KB FlexNVM	
5	RAM	SRAM 64KB	
6	EEProm	8KB FlexRAM supp. EEProm Emulation	
7	Flash over	Internal Connector + CAN	
8	Low Power RTC	32.768kHz	
9	Crystal Clock	32MHz	
10	BLE Tx Output power	min. +1.0dBm ≙ 1.26mW typ. +3.0dBm ≙ 2.00mW max. +5.0dBm ≙ 3.16mW	
11	Sensitivity	LE 1M PHY: typ. -96dBm min. -90dBm LE Coded PHY with S = 2: typ. -99dBm min. -93dBm	
12	Use case	BLE Car Access	
13	Data Rate	LE 1M PHY: 1MBit/s LE Coded PHY with S = 2: 500kBit/s	
14	Maximum antenna gain	CH37 / CH38 / CH39 5.8 / 5.0 / 5.0 dBi	IFA (inverted-F antenna)

2.8 Power Supply with Main µC

2.8.1 Main µC Device

Main µC			
1	Chip Type	TV II CYT2B73CAS REV-D	32 bit ARM Cortex M4/M0
2	Crystal Clock	16MHz	Nx3225
3	Internal clock frequencies	160MHz M4 core, 100 MHz M0 core	
4	Form	QFP64	
5	SRAM	128KB	
6	ROM	32KB	
7	Code Flash	1088KB	
8	Work Flash	96KB	
9	EEPROM	86	
10	Flashed by	J-tag interface production / CAN intnerface	

2.8.2 CAN Interface with power supply and µC device

SBC			
1	Chip Type	TLE9471	
2	VCC2	5V	CAN supply
3	VCC1	3V3	Internal TRX supply
4	CAN interface	Full CAN-FD supported	Termination application specific
5	Watch Dog	Window watch dog	Trggerd by main µC (typ 10sec periode), defined by application settings
6	BUCK frequency	1MHz	Vbat 12V

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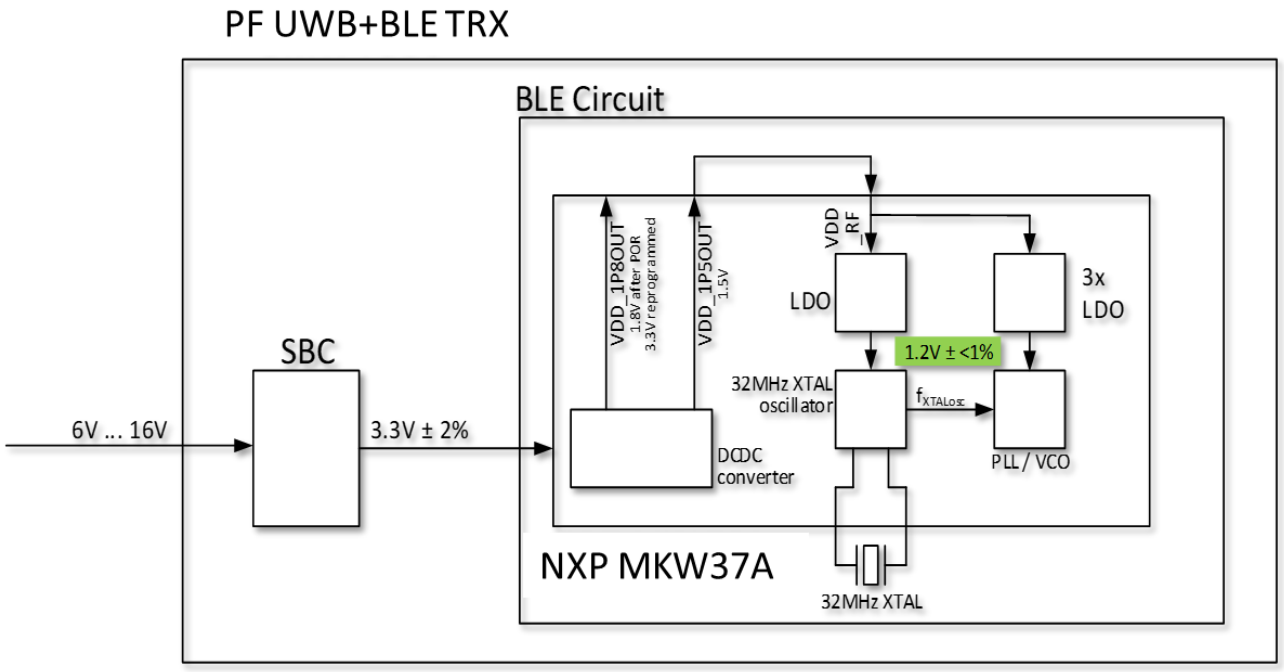
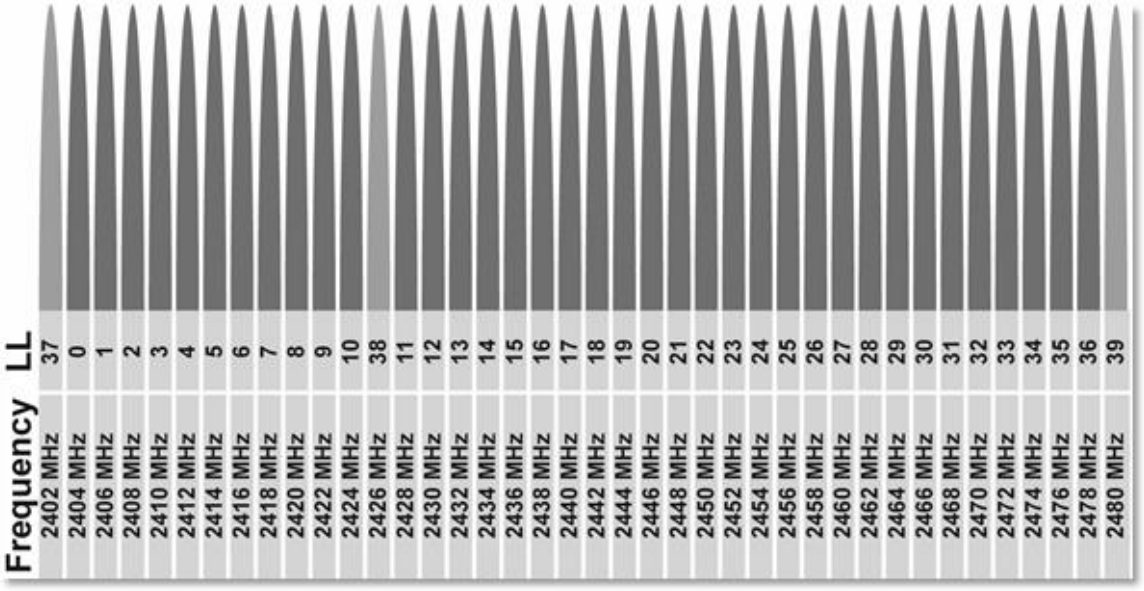
2.8.3 BLE internal power supply

BLE supply of radio unit: 1.2V, tolerance <±1% for an operating voltage of 6V to 16V



2.8.4 BLE Frequency Allocation



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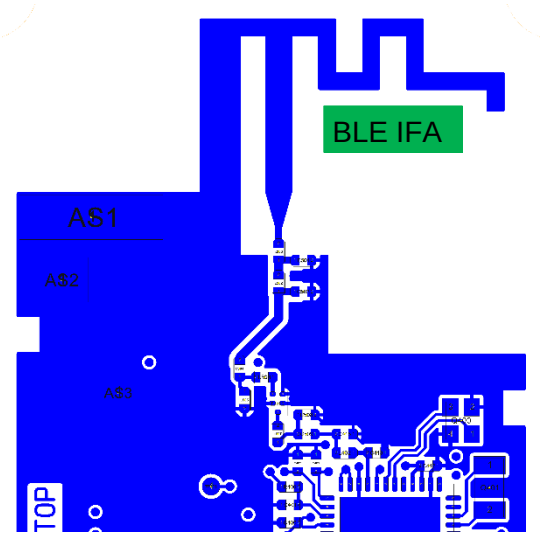
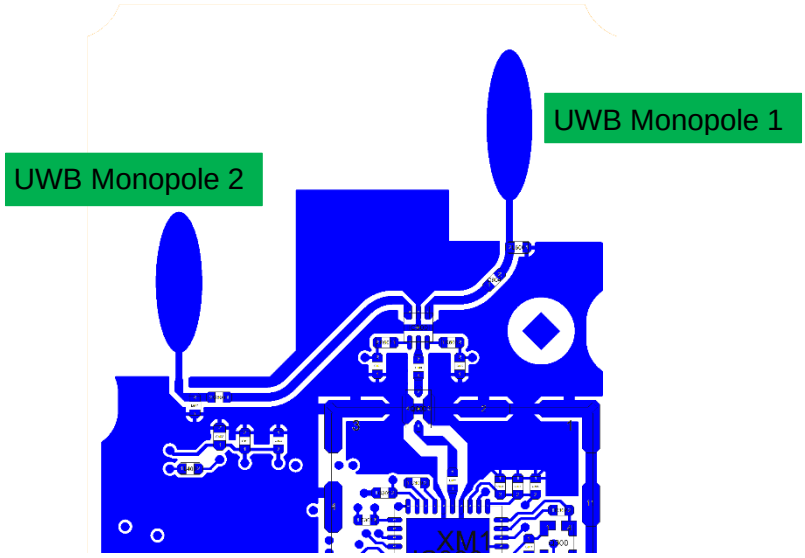
2.9 Antenna Design

2.9.1 BLE Antenna (PCB TOP)



2.9.2 UWB Antenna (PCB BOT)



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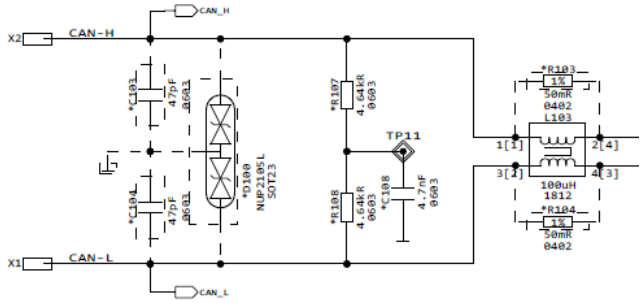
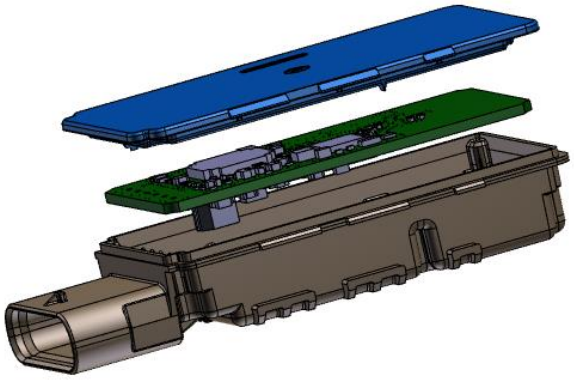
3 Other Norms and Interface Features

No	Parameter	Min	Typ.	Max.	Remark
1	Dimensions (LxBxH mm)		86.4 x 40.6 x 14.4		(UWBBLE22 V1 and UWBtrx22 V2)
2	Weight (g)		28.6	29.0	(UWBBLE22 V1)
			28.3	28.7	(UWBtrx22 V2)
3	Material		PBT GF30		(UWBBLE22 V1 and UWBtrx22 V2)
4	IPX		IP X7/IP X9K		(UWBBLE22 V1 and UWBtrx22 V2) DIN 400 50 Part 9
5	ESD Protection		+/-15kVGS95002		Electrostatic Discharge HBM JEDEC JS-001-2017 [330Ohm, 150pF]
6	RoHs		X		
7	Lead Free (%)		99,9		
8	Temperatur Area (C°)	-40C°	< >	+105C°	
9	Voltage Area (V)	6	< >	16	CAN FD ISO
10	Current (mA)	0,1	15	500	Depending on use case
11	Connector Type		Press fit		MCON-6
12	Overvolt Protection @Norm		<+40V		
13	Short circuit @ Norm		EN 62368-1		(UWBBLE22 V1 and UWBtrx22 V2) NFT passed: Report: 21045420-19729-0 (ib-lenhardt)
14	Reverse polarity protection		> -40V		
15	QV compliant @Norm		10424707_SPE_000_AA		COA Platform QV
16	EMC compliant @Norm		10432948_SPE_000_AA		COA Platform QV
17	CE certified		X		EU
Interface					
18	Count of Pins	-	6	-	
19	Fuse (A)		10	16	UWBBLE22 V1 and UWBtrx22 V2) KL30-KL31E
20	CAN Type		CAN- FD		
21	Baudrate		500kBit/s to 2Mbit/sec		
22	CAN aktiv @ (V)	6	<12>	16	Voltage area CAN active
23	CAN Termination A		9K2		
24	CAN Termination B		open		
25	5CAN Interface				
Antenna					
26	Type		BLE: IFA UWB: Monopole		Printed PCB
27	Number of Antennas		3		2x switchable (UWB), 1x fix (BLE)
28	Antenna Diversity		UWB		UWB only

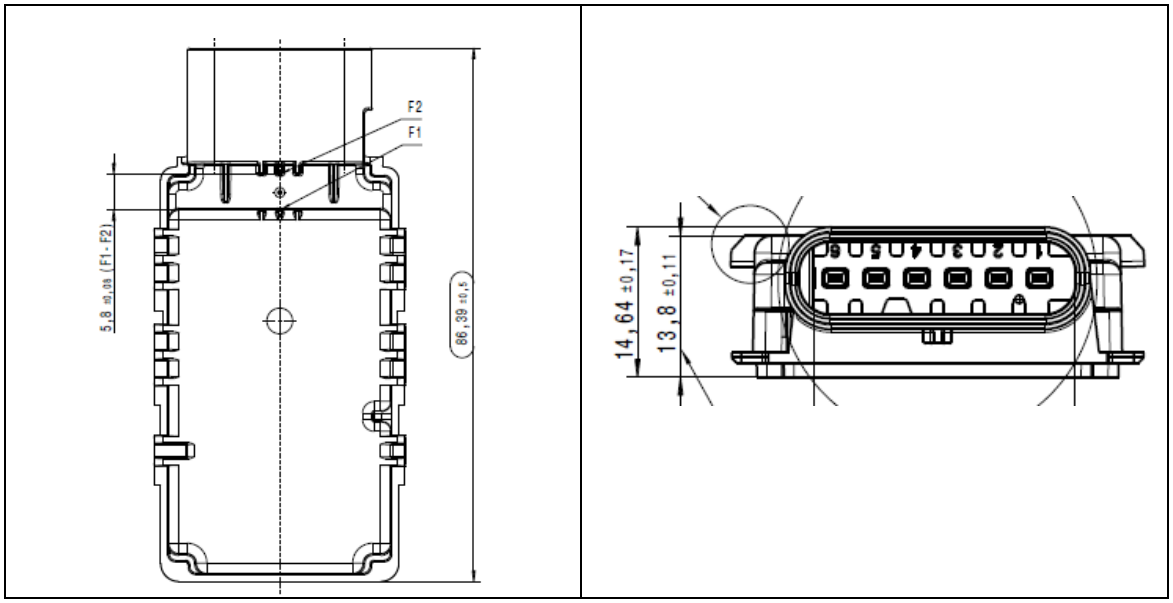
Internal

4 Dimensions and Concepts

4.1 Concept



4.2 Housing (TRx) dimensions



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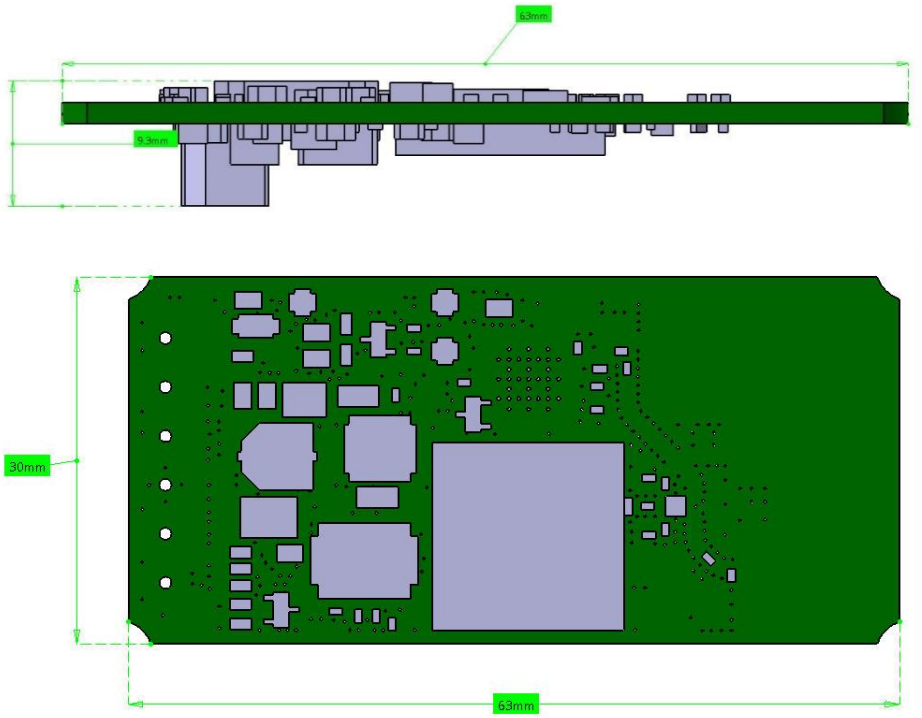
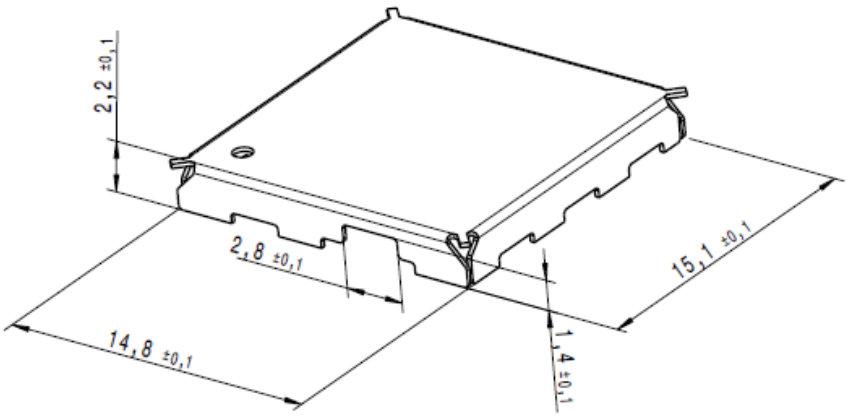
4.3 PCB dimensions



4.4 Shielding (UWB section)



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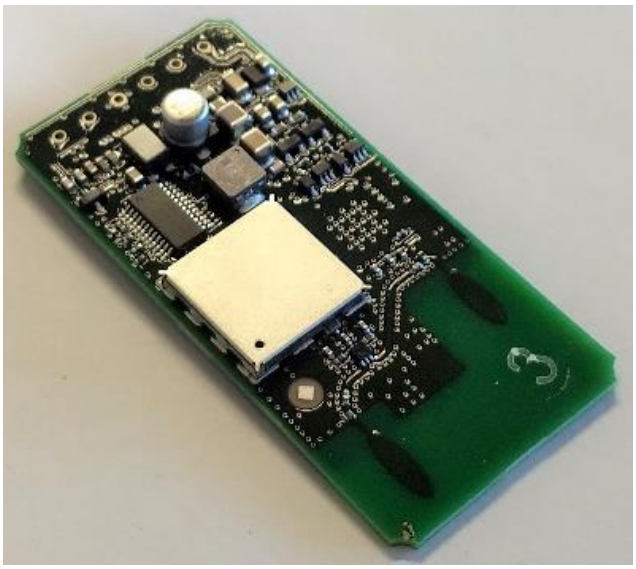
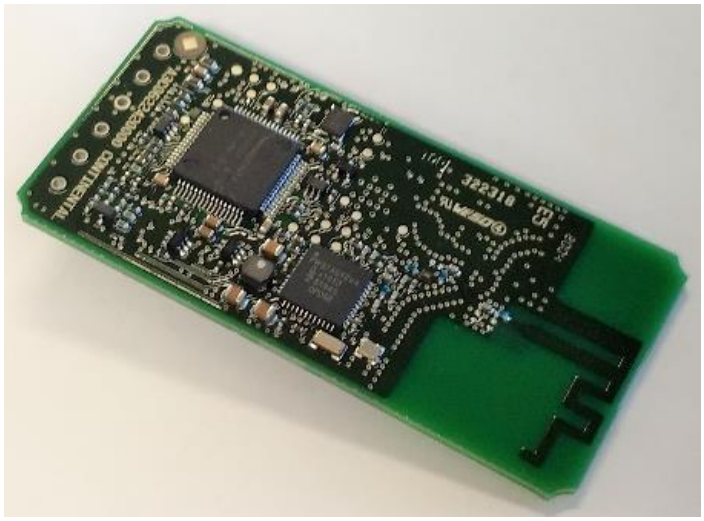
5 PCB Design



PCB BOT side (prototype)



PCB TOP side (prototype)

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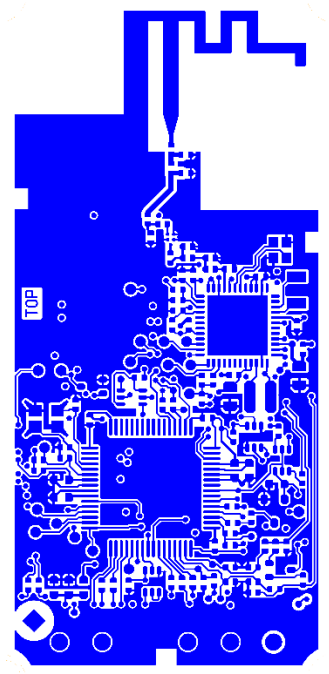
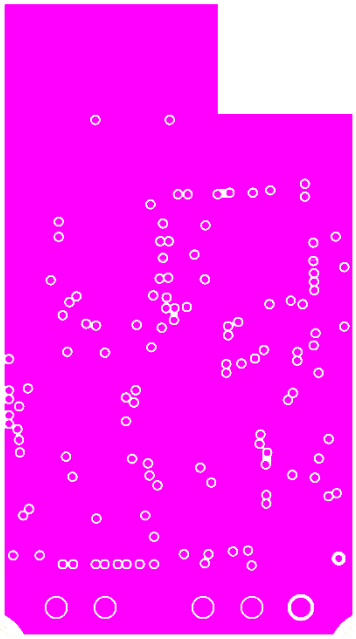
5.1 PCB Layer Information

all layers shown from TOP side view

5.1.1 Layer 1 - TOP



5.1.2 Layer 2 – IN1



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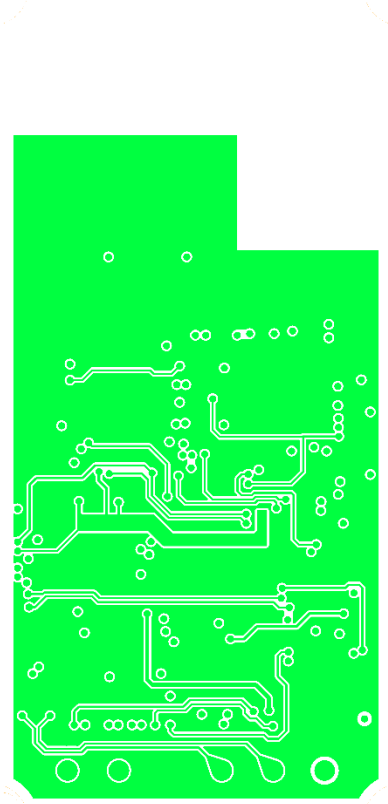
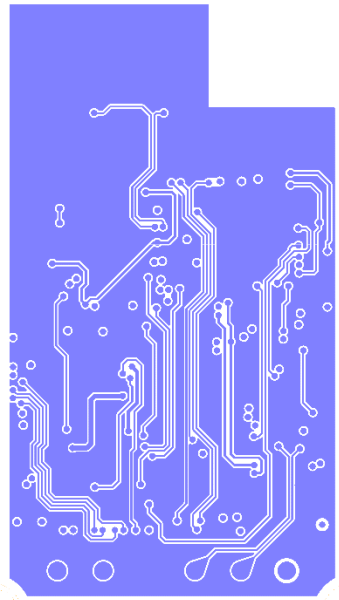
5.1.3 Layer 3 – IN2

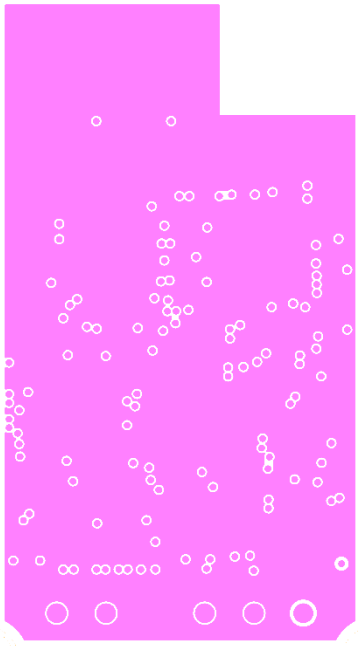


5.1.4 Layer 4 – IN3

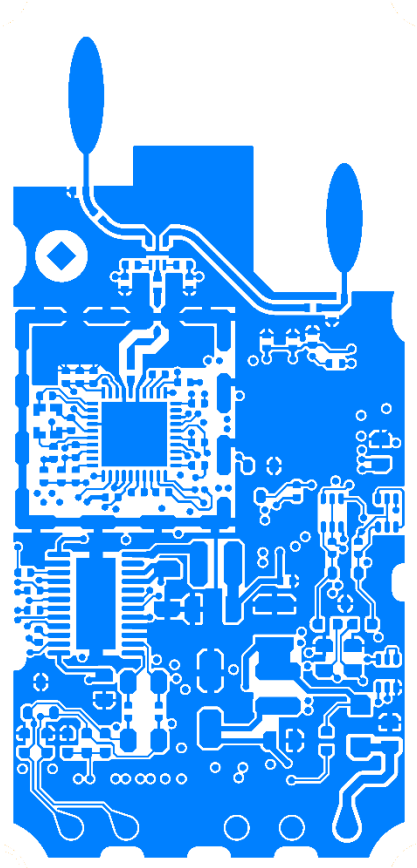


Internal

5.1.5 Layer 5 – IN4



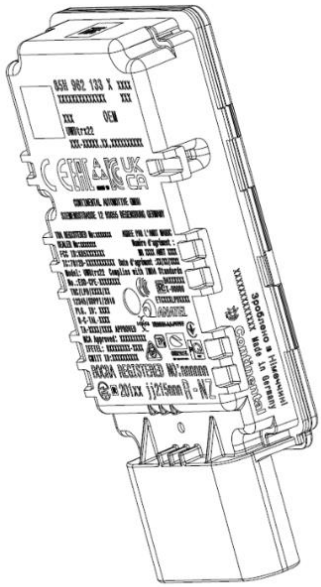
5.1.6 Layer 6 - BOT



Internal

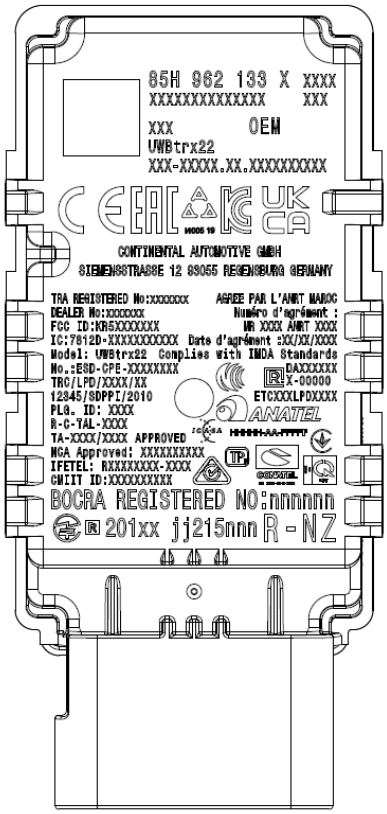
6 Product Marking

6.1 Product Marking UWBBLE22 V1



Isometric view

6.1.1 Label 1

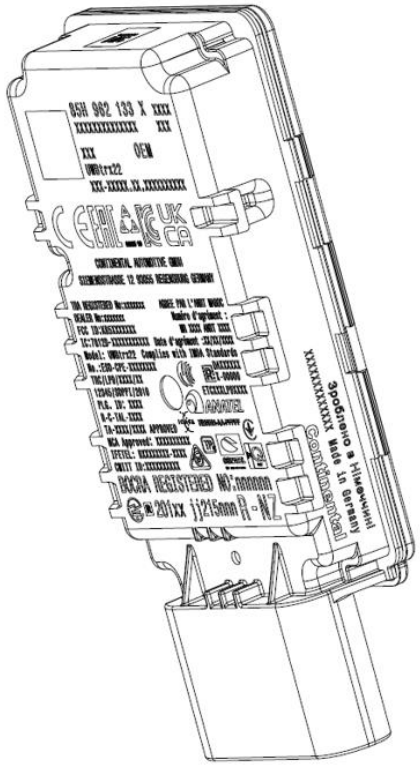


Bottom view

Internal

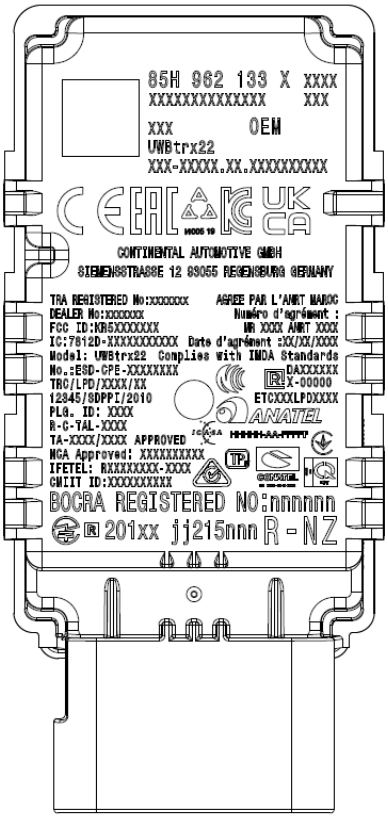
6.1.2 Label 2

6.2 Product Marking UWBtrx22 V2



Internal

6.2.1 Label 1



Bottom view

6.2.2 Label 2

Side view

Internal

7 Table of abbreviations

Abbreviation	Explanation
UWB	Ultra Wide Band
BLE	Blutooth® Low Energy
PCB	Printed Circuit Board
RAD	Relay Attack Defense
CoSmA	Continental Smartphone based Access
TRx	Transceiver
BCM	Body Control Module
RF	Radio Frequency
NFC	Near Field Communication
HW	Hardware
CAN	Controller Area Network

Internal

Annex 1: Warning statement for Taiwan

取得審驗證明之低功率射頻器材，非經核准，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。低功率射頻器材之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前述合法通信，指依電信管理法規定作業之無線電通信。低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾
For low-power radio frequency equipment that has been certified, companies, firms, or users are not allowed to change the frequency, increase the power, or change the characteristics and functions of the original design without approval. The use of low-power radio frequency equipment must not affect flight safety and interfere with legal communications; if interference is found, it should be stopped immediately and improved to no interference before continuing to use. The aforementioned legal communication refers to radio communication operated in accordance with the provisions of the Telecommunications Administration Law. Low-power radio frequency equipment must endure the interference of legal communications or industrial, scientific and medical radio wave radiation electrical equipment.

Annex 2: Statement for Mexico

For equipment operated in 902-928MHz, 2400-2483.5MHz, 5725-5850MHz.

La operación de este equipo está sujeta a las siguientes dos condiciones:	The operation of this equipment is subject to the following two conditions
1. Es posible que este equipo o dispositivo no cause interferencia perjudicial y	1. it is possible that this equipment or device may not cause harmful interference, and
2. Este equipo o dispositivo debe aceptar cualquier interferencia, incluyendo la que pueda causar su operación no deseada.	2. this equipment or device must accept any interference, including interference that may cause undesired operation.

La antena no se puede quitar	Antenna can not be detached

Annex 3: Statement for CE

European Union: Declaration of Conformity

Hereby, Continental declares that the radio equipment type UWBtrx22 and UWBBLE22 is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address:http://continental-homologation.com/audi

Technical information
Frequency Band: 6489.6 - 7987.2 MHz
Maximum Power: 12 dBm

Internal

Manufacturer and Address
Manufacturer: Continental Automotive GmbH
Address: Siemensstrasse 12, 93055 Regensburg, Germany
Phone: +49 941 790-0

Annex 4: Statement for Canada

Model: UWBtrx22 and UWBBLE22
IC: 7812D- UWBtrx22
IC: 7812D- UWBBLE22
This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :
(1) l'appareil ne doit pas produire de brouillage, et
(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Internal

Annex 5 Statement for USA

Model: UWBtrx22 and UWBBLE22
FCC ID: KR5 UWBtrx22
FCC ID: UWBBLE22
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference,
and
(2) this device must accept any interference received, including interference that may cause undesired operation.
Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Annex 6 Statement for UKCA

UKCA	**SIMPLIFIED UK DECLARATION OF CONFORMITY**	Hereby, Continental Automotive GmbH declares that the radio equipment type UWBtrx22 and UWBBLE22 is in compliance with the UK Radio Equipment Regulations 2017. The full text of the UK declaration of conformity is available at the following internet address: https://continental-homologation.com
		Frequency band(s) in which the radio equipment operates :6-8.5 GHZ
		Maximum radio-frequency power transmitted in the frequency band(s) in which the radio equipment operates: -3.69dBm EIRP (peak)

Internal