



Mercedes-Benz AG

CMBTRX1

User Manual

Continental Automotive GmbH
Siemensstrasse 12
93055 Regensburg
Germany

Document History

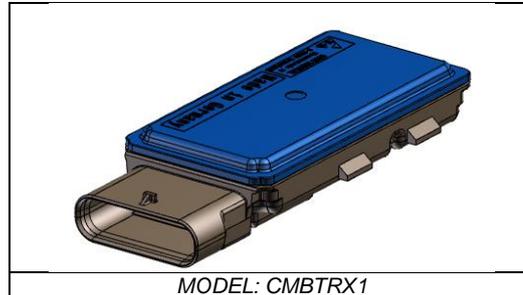
Date	Version	Changes
16.09.2021	1	initial version
24.09.2021	2	chapter 7: corrections of abbreviations
28.10.2021	3	chapter 2.7.1: changed UWB protocol standard

Table of Contents

1	GENERALS DESCRIPTION	4
1.1	Product Appearance	4
1.2	System Functional Description	4
1.3	System Overview BLE UWB Digital Access	5
1.4	Function Flow	5
1.5	Shutdown of the UWB system	7
1.6	UWB duty cycle limiter	7
1.7	Parts of Certification	7
2	FEATURES	8
2.1	TRX Radio Device Class	8
2.2	Electrical Device Class	8
2.3	Device XTAL Frequencies and Clocks	9
2.4	Component Block Diagram	9
2.5	Variants	10
2.6	Pinning Information; I/O-Port Description	12
2.7	Radio Features	13
2.8	Power Supply with Main μ C	14
2.9	Antenna Design	16
3	OTHER NORMS AND INTERFACE FEATURES	17
4	DIMENSIONS AND CONCEPTS	18
4.1	Concept	18
4.2	Housing (TRX) dimensions	18
4.3	PCB dimensions	19
4.4	Shielding (UWB section)	19
5	PCB DESIGN	20
5.1	PCB Layer Information	21
6	PRODUCT MARKING	24
6.1	Product Marking CMBTRX	24
7	TABLE OF ABBREVIATIONS	24

1 Generals Description

1.1 Product Appearance

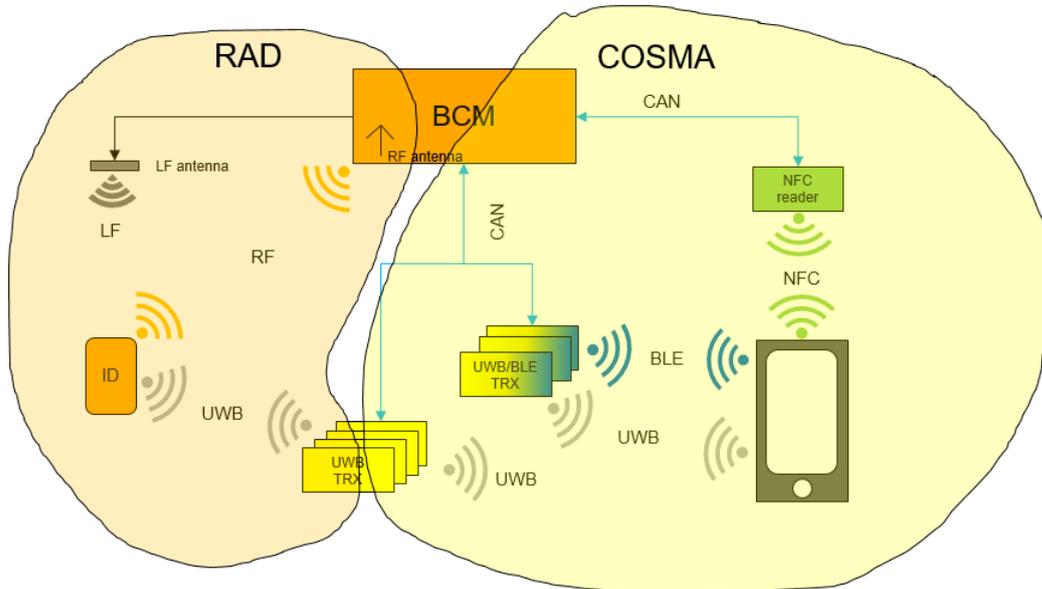


1.2 System Functional Description



The Mercedes-Benz CMBTRX1 is a UWB (Ultra Wide Band) and BLE (Bluetooth® Low Energy) transceiver module for car access and user localization purposes. Two CMBTRX1 are mounted in the headliner of the car and four in the front and rear bumpers. 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.

1.3 System Overview BLE UWB Digital Access



1.4 Function Flow

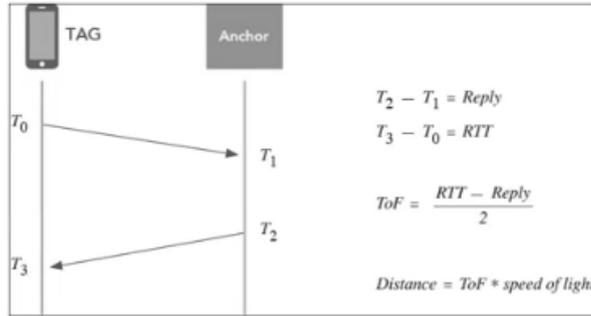
1.4.1 System Wake up with learned Smartphone

- 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 authentication 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 authentication 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.

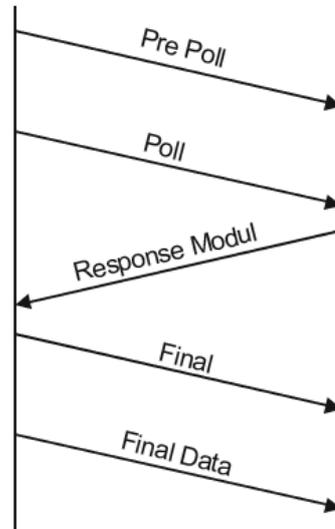
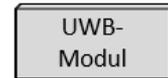
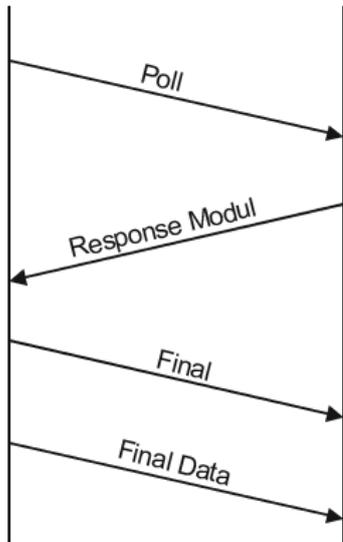
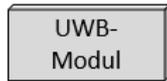
The distance is measured by ToF Measurement



TAG: smartphone or key fob
Anchor: UWB+BLE TRx

with Key Fob

with Smartphone



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 \geq 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

<i>Variants (placement options)</i>		
UWB+BLE		
CMBTRX1		Daisy Chain

Manufacturer:

Continental Automotive GmbH
Siemensstrasse 12
93055 Regensburg
Germany

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.

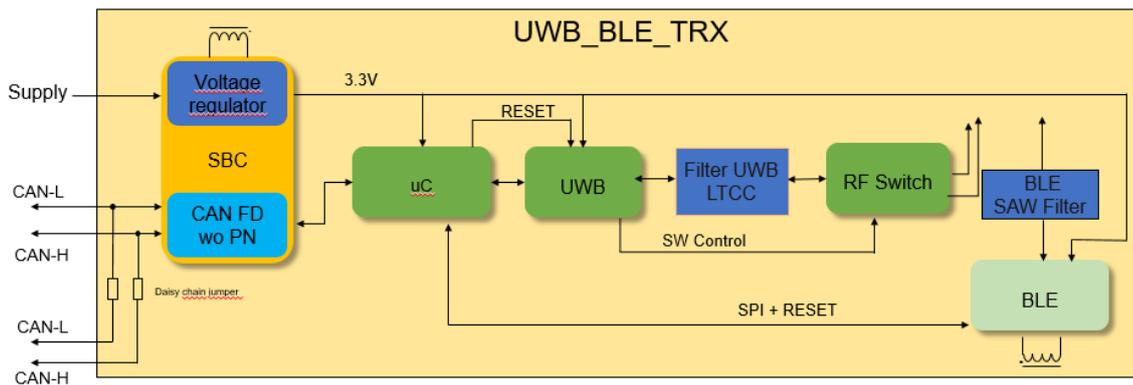
2.2 Electrical Device Class

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

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 μ C): 16MHz (± 100 ppm)

2.4 Component Block Diagram



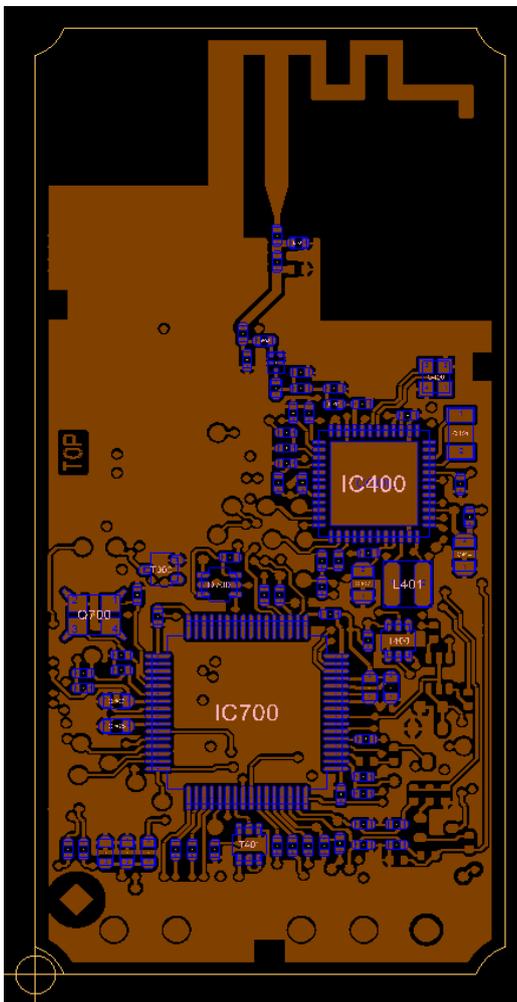
2.5 Variants

<i>Variants (placement options)</i>		
UWB+BLE		
CMBTRX1		Daisy Chain

2.5.1 UWB+BLE (CMBTRX1)

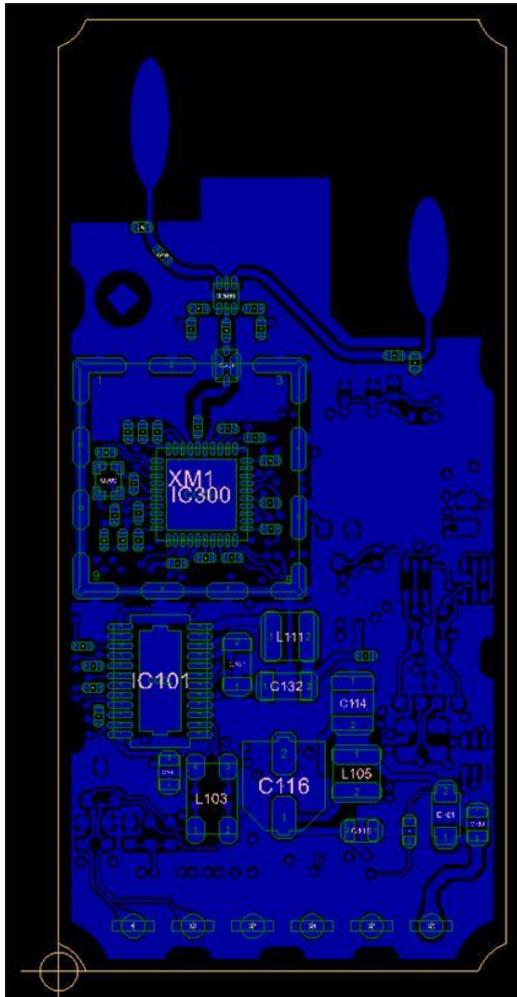
2.5.1.1 PCB TOP

CMBTRX1 TOP



2.5.1.2 PCB BOT

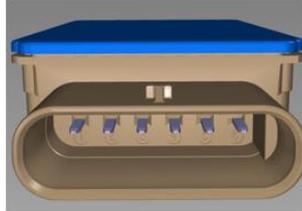
CMBTRX1 BOT



2.6 Pinning Information; I/O-Port Description

2.6.1 Connector standard with daisy chain, no CAN coding (CMBTRX1)

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



Pos.	Stiftgehäuse/ PIN housing	PIN	PIN Beschreibung/ PIN Description	passende Kupplungen / matching clutches (Tyco)			
				A2239059710	A2239059810	A2239059910	
3	6-polig nach AV MB Nr.: A211 002 9899 Var. 1, Kod A, B und C 6 pole acc. to interface drawing MB No.: A211 002 9899 version 1, coding A, B and C 	1	CAN Low	Coding A A000 545 8939 oder/or A034 545 8626	Coding B A000 545 5842 oder/or A034 545 8726	Coding C A000 545 6342	
		2	CAN High				
		3	GND				
		4	AI_SEL_IN_B				
		5	AI_SEL_IN_A				
		6	KL30				
2	Gehäusedeckel Housing Cover	DuPont Crastin HR 5430 HFS BK238 LT - Black			DBL 5410	DIN 16742 - TG7	A3C064435XX00
1	Gehäuse Housing	DuPont Crastin HR5330HFSBK591 - Black			DBL 5410	DIN 16742 - TG7	A3C064436XX00
	Name	Material	Material acc. to (DBL/DIN):	Untol. dimensions acc. to:	Continental Part No.		

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.	
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

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 \triangleq 1.26mW typ. +3.0dBm \triangleq 2.00mW max. +5.0dBm \triangleq 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 μ C

2.8.1 Main μ C Device

Main μ C			
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 interface	

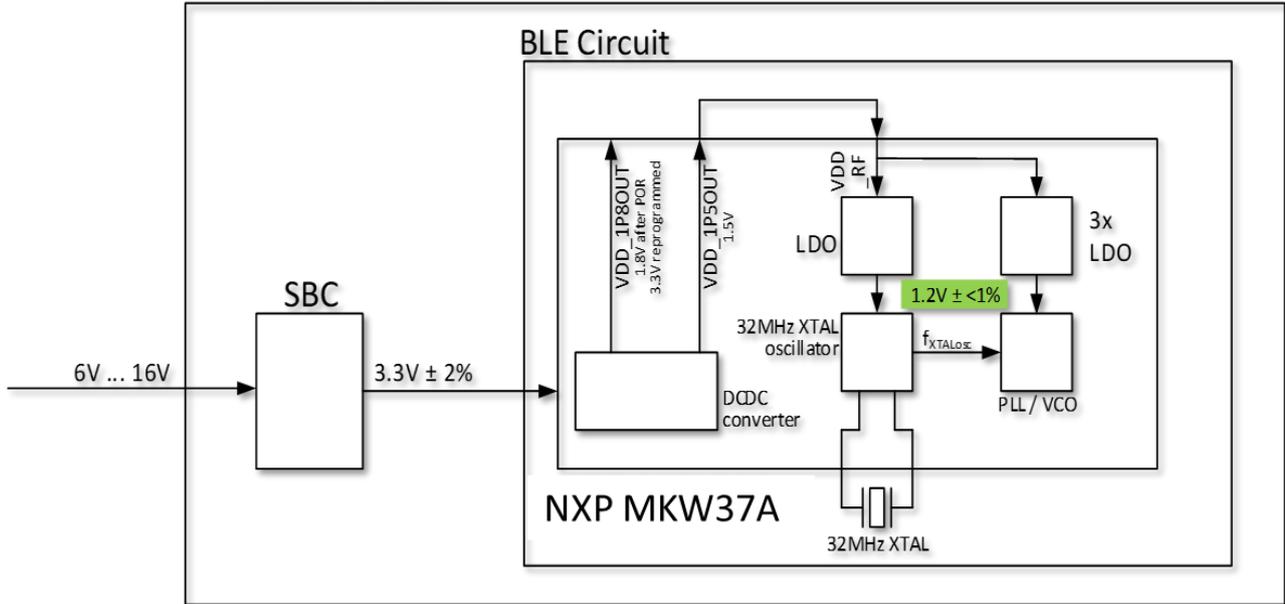
2.8.2 CAN Interface with power supply and μ C device

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	Trgged by main μ C (typ 10sec periode), defined by application settings
6	BUCK frequency	1MHz	Vbat 12V

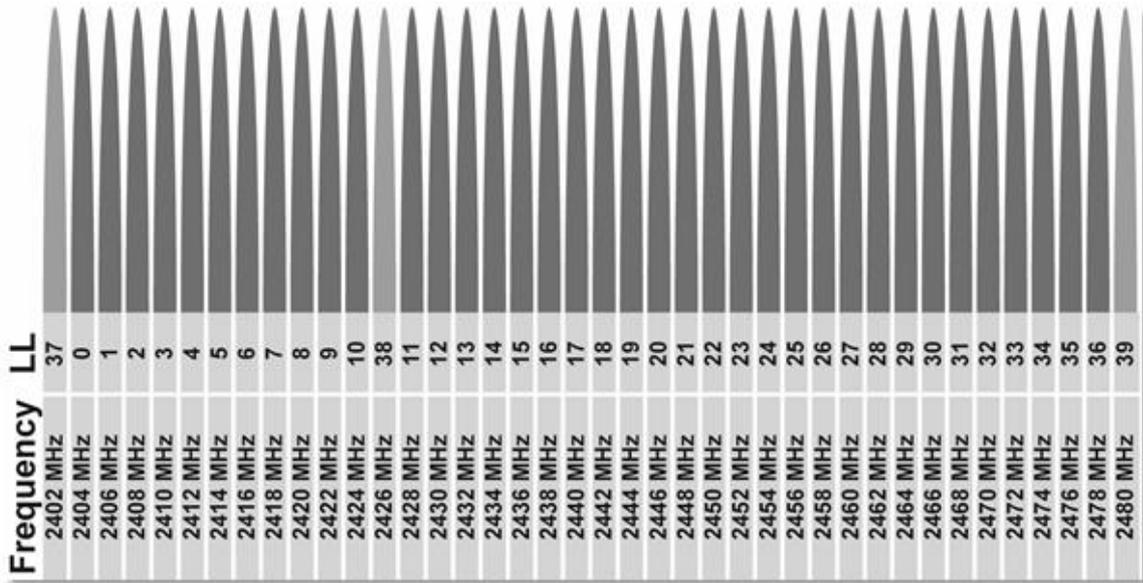
2.8.3 BLE internal power supply

BLE supply of radio unit: 1.2V, tolerance $\pm 1\%$ for an operating voltage of 6V to 16V

PF UWB+BLE TRX

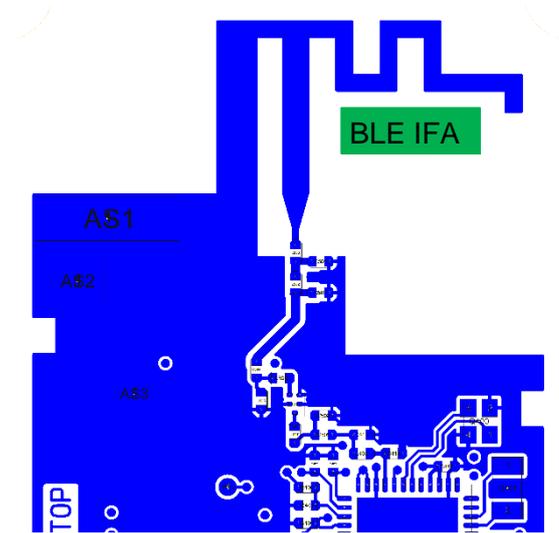


2.8.4 BLE Frequency Allocation

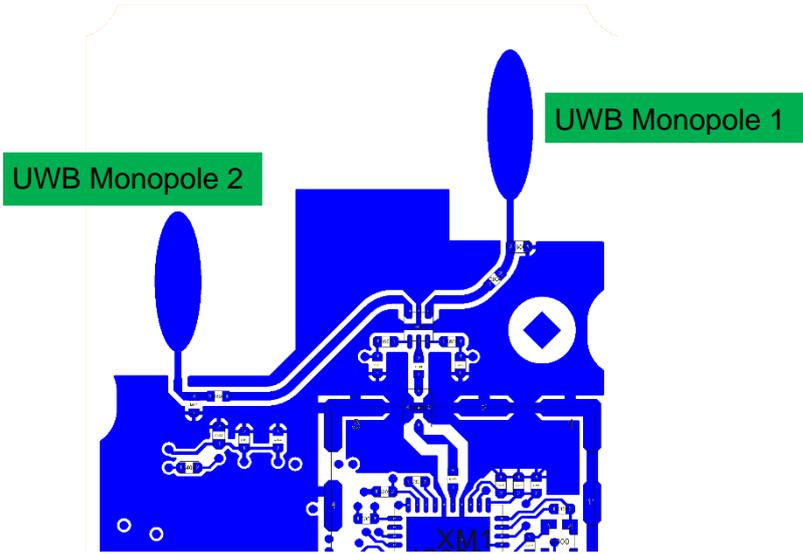


2.9 Antenna Design

2.9.1 BLE Antenna (PCB TOP)



2.9.2 UWB Antenna (PCB BOT)

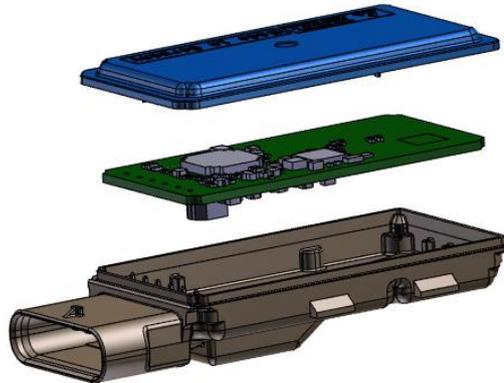


3 Other Norms and Interface Features

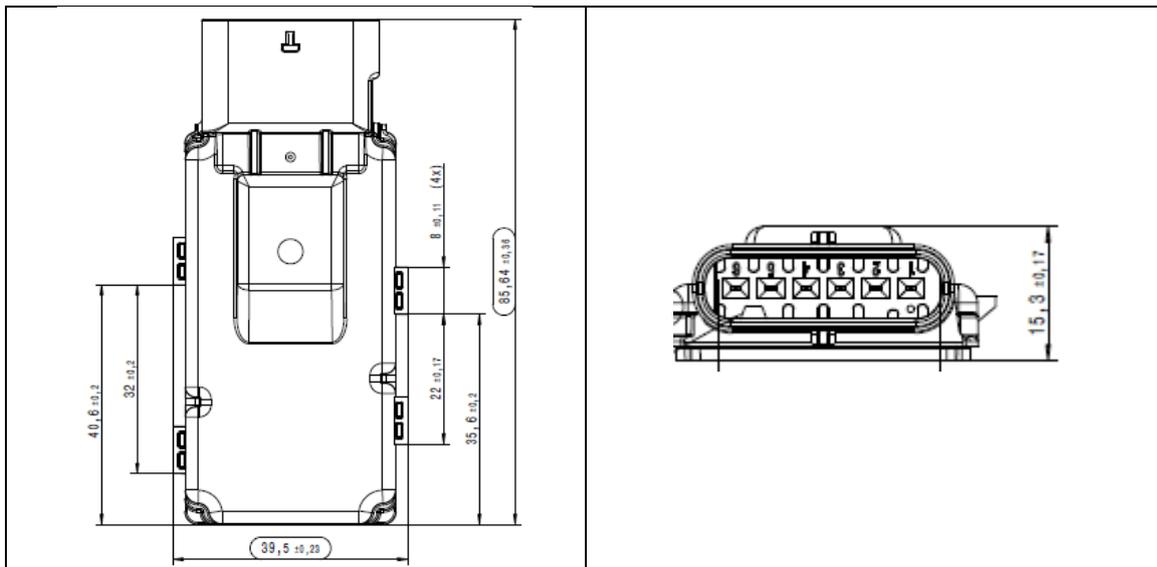
No	Parameter	Min	Typ.	Max.	Remark
	Dimension	85.6x39.5x15.3			(CMBTRX1)
	Weight		28	28.4	(CMBTRX1)
3	Material	PBT GF30			(CMBTRX1)
4	IPX	IP5KX, IPX6K, IPX9K			((CMBTRX1) DIN 400 50 Part 9
5	ESD Protection	+/-15kVGS95002			Electrostatic Discharge HBM JEDEC JS-001-2017 [330Ohm, 150pF]
6	RoHs		X		
7	Lead 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.			(CMBTRX1)
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)		n.a	1A	(CMBTRX1): Power supply by ECU incl. current limitation (MAU)
CAN					
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 types					
26	Type	Printed PCB			
27	Count of different antennas	3			2x switchable (UWB), 1x fix (BLE)
28	Antenna Diversity	UWB			Only for UWB

4 Dimensions and concepts

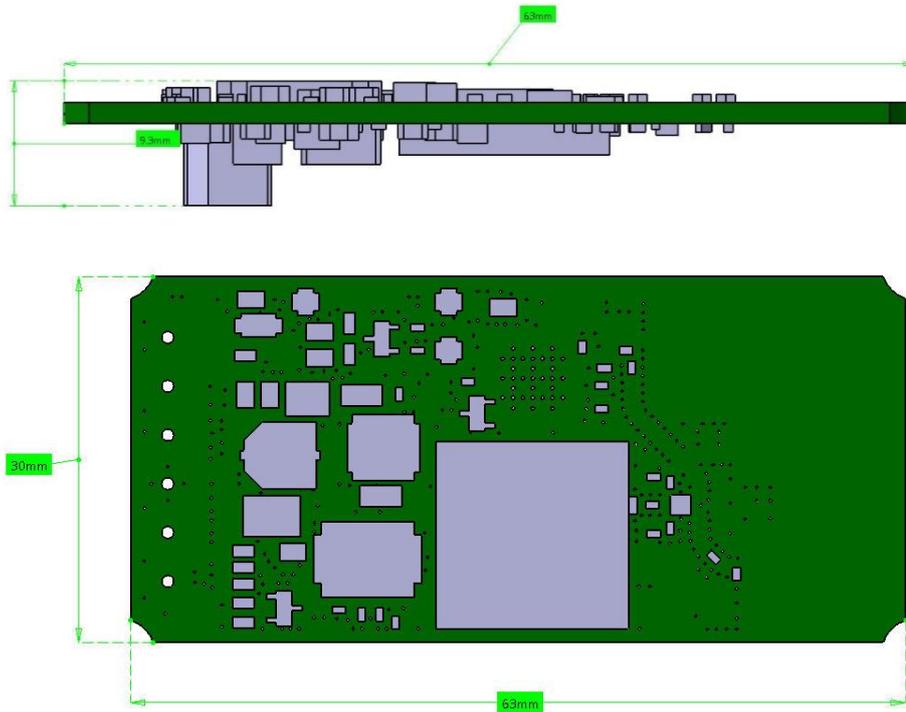
4.1 Concept



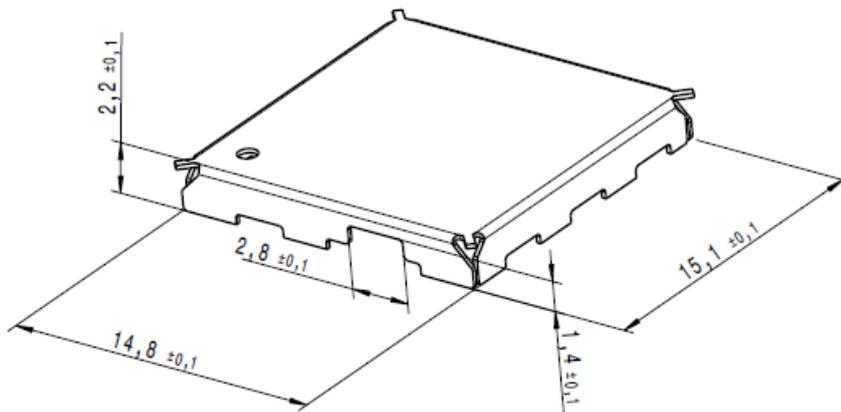
4.2 Housing (TRX) dimensions



4.3 PCB dimensions



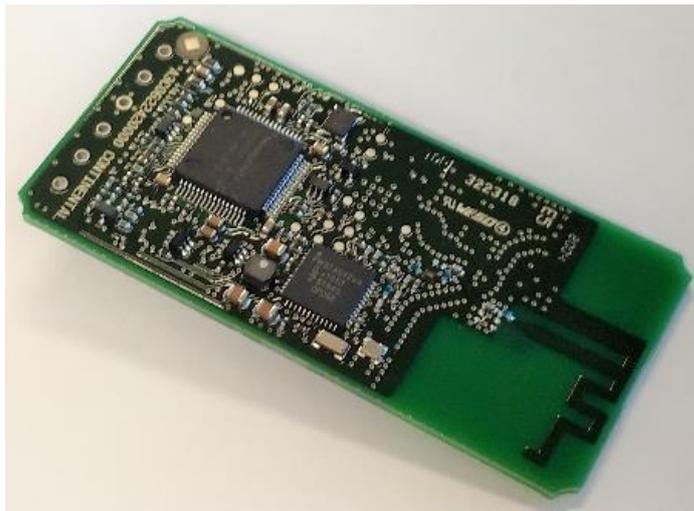
4.4 Shielding (UWB section)



5 PCB Design



PCB BOT side (prototype)

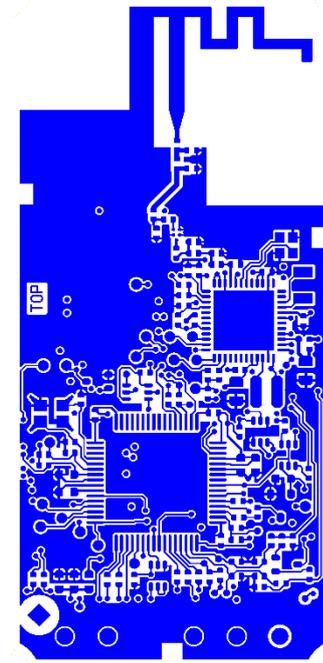


PCB TOP side (prototype)

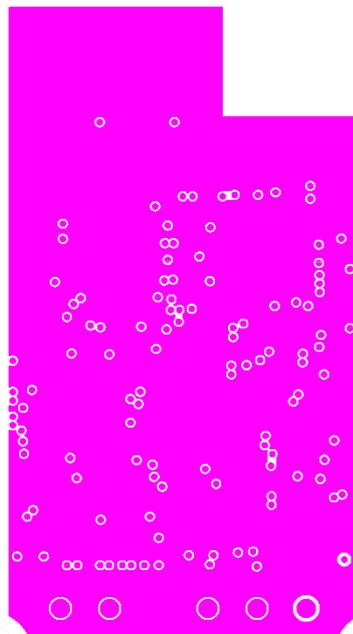
5.1 PCB Layer Information

all layers shown from TOP side view

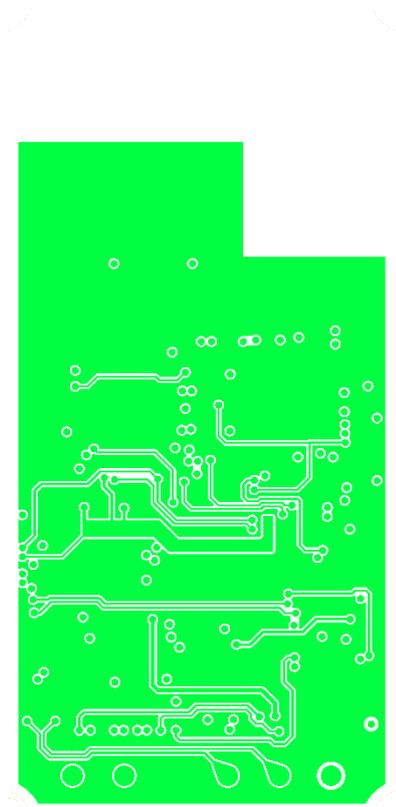
5.1.1 Layer 1 - TOP



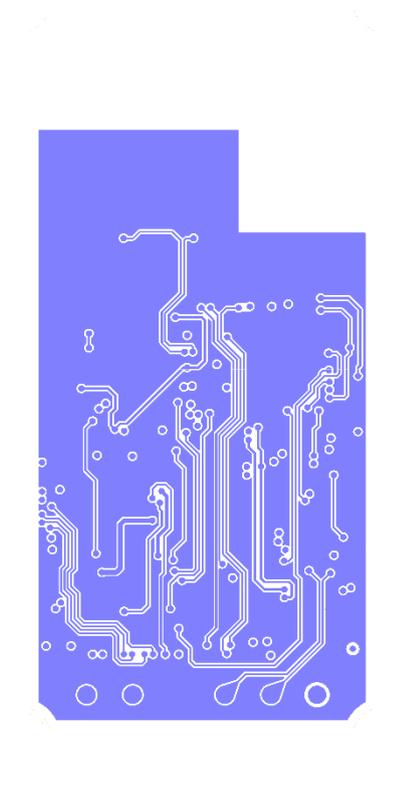
5.1.2 Layer 2 – IN1



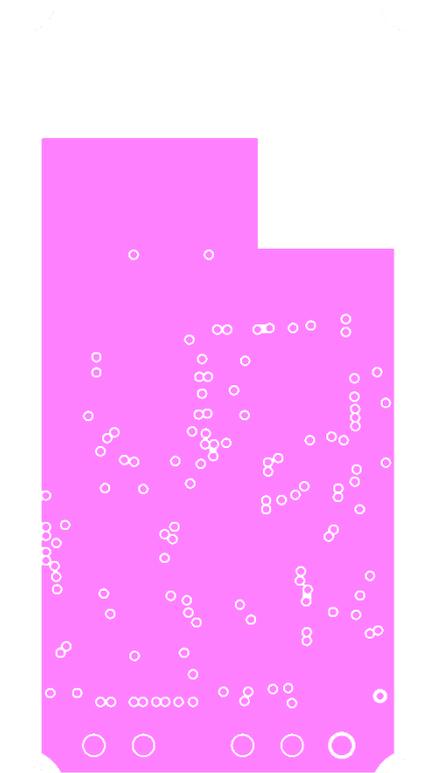
5.1.3 Layer 3 – IN2



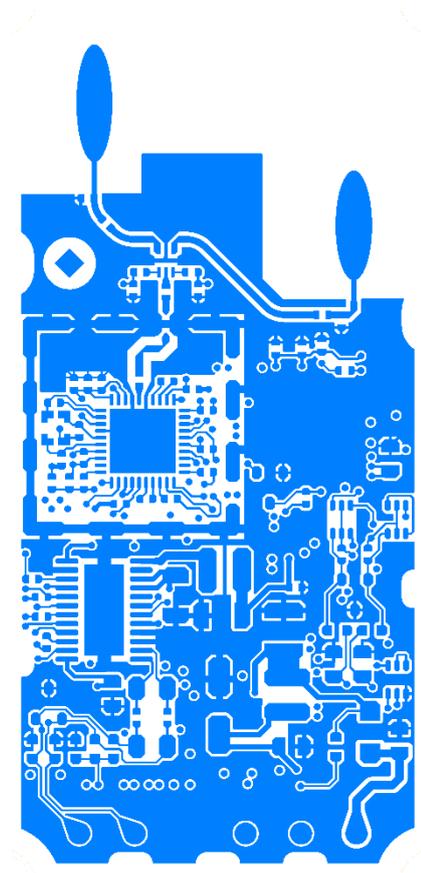
5.1.4 Layer 4 – IN3



5.1.5 Layer 5 – IN4

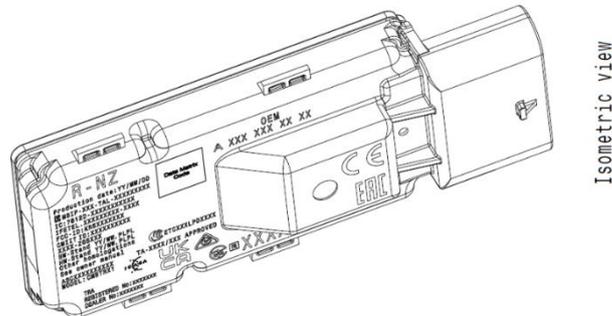


5.1.6 Layer 6 - BOT

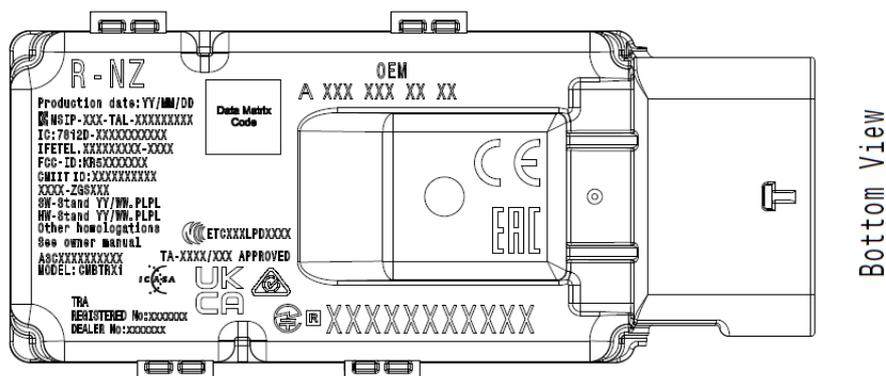


6 Product Marking

6.1 Product Marking CMBTRX



6.1.1 Label 1



7 Table of abbreviations

Abbreviation	Explanation
UWB	Ultra Wide Band
BLE	Bluetooth® 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

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 CMBTRX1

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/mb>

Technical information

Frequency Band: 6489.6 - 7987.2 MHz

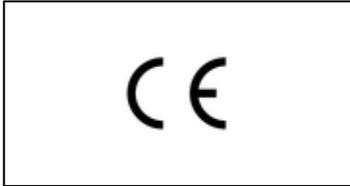
Maximum Power: 12 dBm

Manufacturer and Address

Manufacturer: Continental Automotive GmbH

Address: Siemensstrasse 12, 93055 Regensburg, Germany

Phone: +49 941 790-0



Annex 4: Statement for Canada

Model: CMBTRX1

IC: 7812D- CMBTRX1

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.

Annex 5 Statement for USA

Model: CMBTRX1

FCC ID: KR5CMBTRX1

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.