

Technical Documentation

FBD6

Smart Car access, Ranging and Vital Sign Detection (VSD) devices.

Document History

MKS version	Date	Status	Description
1.1	2024-08-12	Draft	Initial version
1.2	2024-10-11	Final	Updated
1.3	2024-11-06		Technical data summary table updated

Content

1	FBD6 overview	4
2	Communication technologies	4
3	FBD6 Technical data summary	5
4	FBD6 pictures	6
5	FBD6 PCB photographs	8
6	FBD6 electrical circuit block diagram	10
6.1	Power Supply section	10
6.2	UWB-Transceiver + Microcontroller section	11
6.3	Flash section:	11
6.4	BLE-Transceiver section:	11
7	FBD6 Modes of operation	12
7.1	Ranging mode	12
7.1.1	Ranging with mobile devices (Smart Phone)	12
7.1.2	Ranging With Key fob	12
7.2	Vital Sign Detection (VSD)	12
8	Test sample overview	13
8.1	FBD6 test setup	15
8.1.1	FBD6 photo sample	16
9	FBD6 circuit diagram	17
10	FBD6 bill of material	18
11	FBD6 printed circuit board layout	21

1 FBD6 overview

This document is to describe the Hella FBD6 car access, secure ranging, and Vital Sign Detection (VSD) devices in the context of the radio type approval process. FBD6 devices are anchor devices intended to communicate with multiple associated mobile devices (smartphones) or with the key fob that act as a user interface to operate the locking system, engine start / stop system and several comfort functions of a vehicle in a very convenient way. Communication with the mobile devices takes part utilizing **Ultra-Wide Band (UWB)** and **Bluetooth Low Energy (BLE)** technology.

Mobile devices and key fobs mentioned are not in the scope of this document.

There may be multiple devices mounted at a single vehicle. Mounting positions may be in the interior of the vehicle and on the exterior periphery (e.g. bumper area).

The devices can be assigned to the different mounting positions via coding inputs. Depending on the mounting position and vehicle type, different settings for the radiated power of the devices can be assigned. The interface to the vehicle is realized via a connector.

Images of the devices are given in chapter 4.

2 Communication technologies

There are two basic communication technologies implemented in the FBD6 devices:

- **Bluetooth Low Energy (BLE)** communication, used for device pairing, activate UWB based ranging and data transfer. CC2745R10 chip from Texas Instruments.
- **Ultra-Wide Band (UWB)** communication, used for secure ranging operations and Vital Sign Detection (VSD). NPX NCJ29D6AHN chip.

This device complies with art 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.

CAUTION TO USERS

Changes or modifications not expressly approved by the party responsible for compliance could void the users authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference

by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The 15.521 Technical requirements applicable to all UWB devices.

(a) UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

Date:
2024-11-06

Processed:
S. Karadag E-CA-D-HW

Revision: 1.3

Page 4 of 24

3 FBD6 Technical data summary

The following table shows the basic technical characteristics of the FBD6 devices:

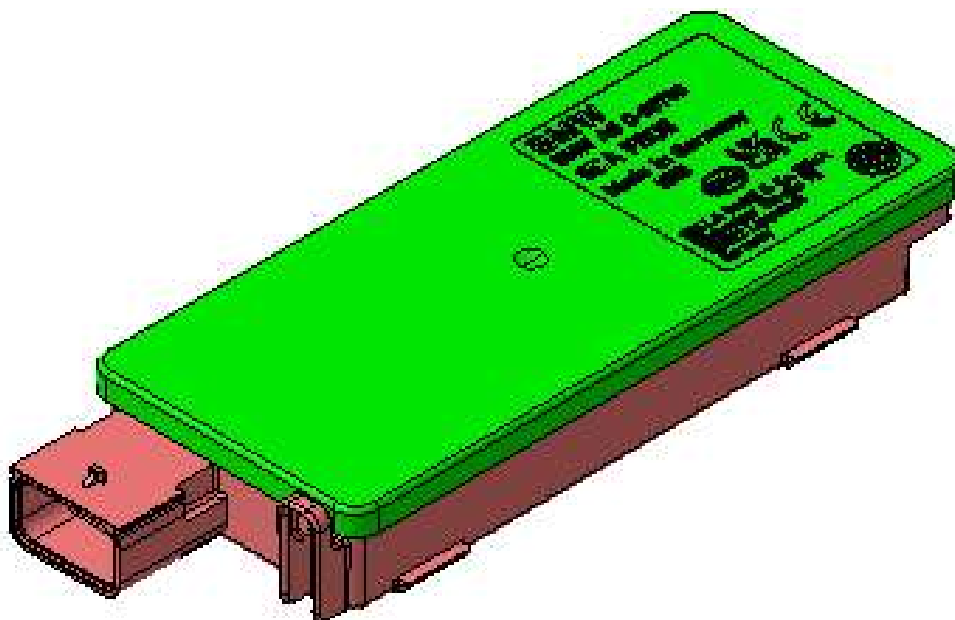
Designation		FBD6	FCC ID: NBGFB6D6
Function		satellite anchor device for car access, ranging and Vital Sign Detection (VSD) system	
Power supply		12V DC from vehicle power supply system	
Max Input Current at 12V supply		150mA	
Operating temperature range		-40 to +105°C	
Communication technologies		• UWB • BLE	
HW Version		7.1	
SW Version		S08, SXX (future SW updates) ⁽⁵⁾	
UWB	Standard	IEEE15.802.4x	
	Frequency range	CH8: : 7.238 – 7.738 GHz CH9: 7.7372 – 8.2372 GHz	
	Modulation method	Impulse radio	
	-10 dB RF bandwidth	Approx. 500 MHz	
	Max. radiated spectral power density	-41.3 dBm / MHz	
	Mode of operation	Half duplex	
	Antenna	Integrated PCB-Antenna	
BLE	Standard	Bluetooth Low Energy 6	
	Number of RF-channels	40 according to BT 6.0 standard	
	Frequency range	2400 MHz... 2483.5 MHz	
	RF channel spacing	2 MHz	
	Modulation method	GFSK	
	Radiated power (EIRP)	Max: + 10 dBm	
	Max. data rate	1 Mbit/s	
	Mode of operation	Half duplex	
	Antenna	Integrated PCB-Antenna	

- (1) For detailed country list see separate document
- (2) Selection of Channel 8 and 9 will be controlled by vehicle ECU based on country specific regulations.
- (3) Not all channels may be used for every mode of operation.
- (4) Other variants with less population in digital circuit may exist. The RF part in all variants remain the same.
- (5) **The software version number can range from 01 to 99, and none of these versions have any impact on the RF performance of the device.**

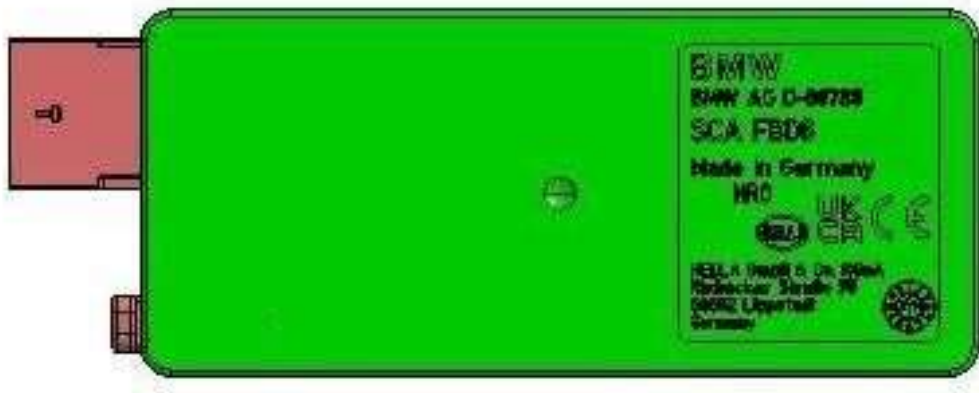
ANTENNA	ANTENNA GAIN
BLE - Ant	-1.0 dBi
UWB - Ant 1	2.8 dBi
UWB - Ant 2	1.0 dBi
UWB - Ant 3	5.0 dBi

4 FBD6 pictures

The following illustrations show the exterior view of the FBD6 devices.



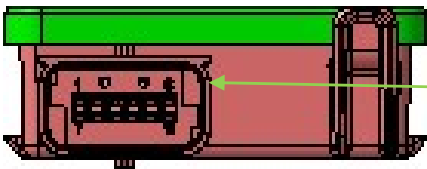
Picture 1: FBD6 3D View



Picture 2: FBD6 bottom view



Picture 3: FBD6 side view 1

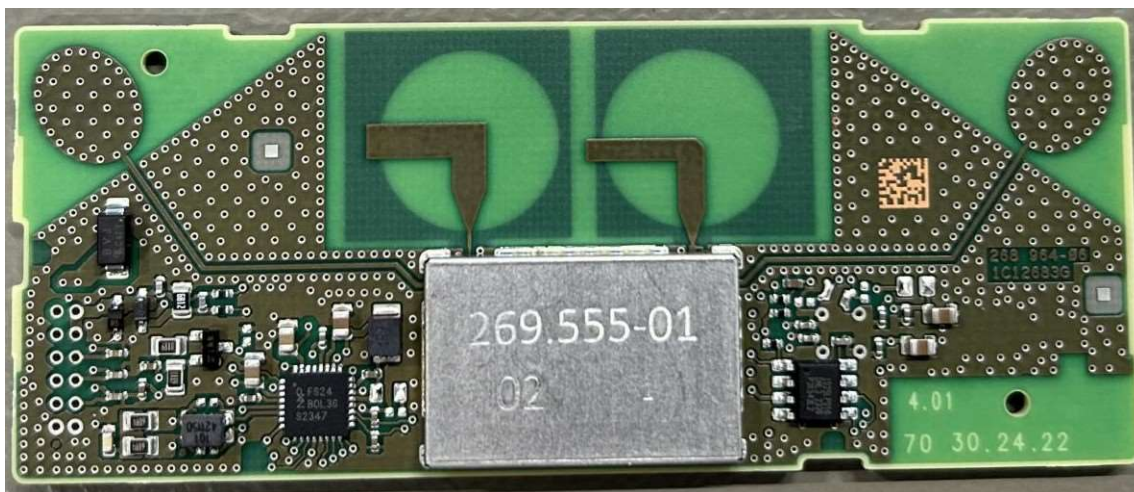


Connector pins

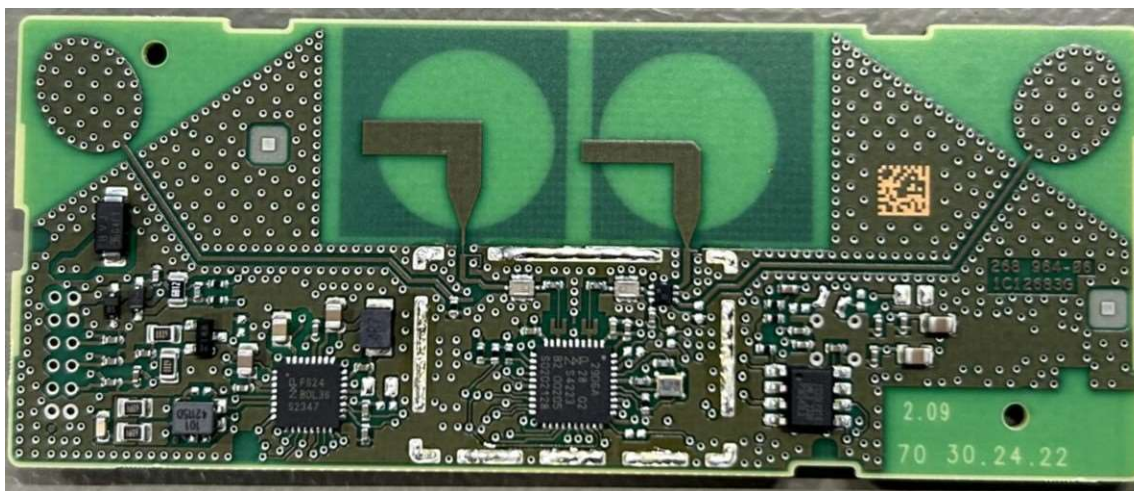
Picture 4: FBD6 side view 2

5 FBD6 PCB photographs

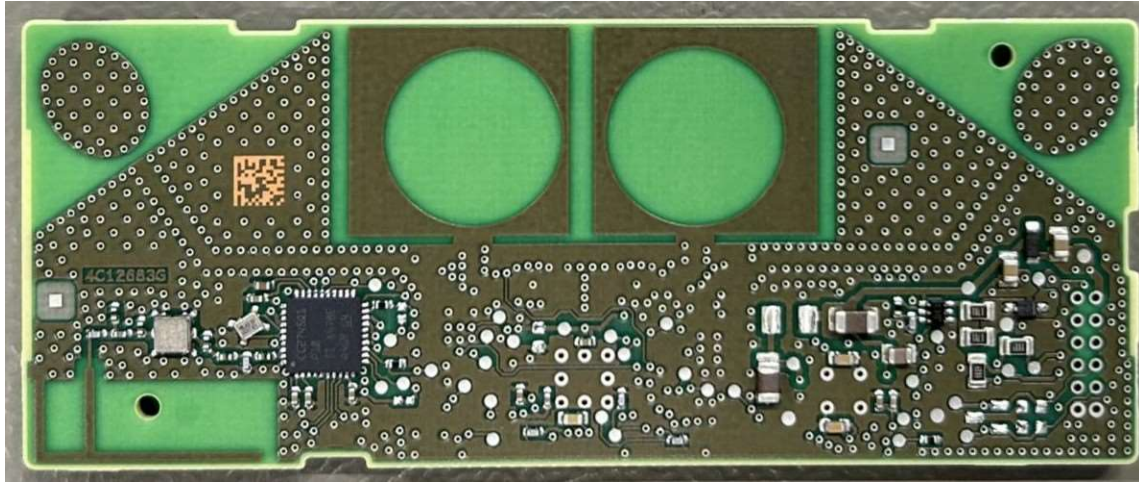
The following photograph shows the printed circuit board of the FBD6 devices with all its components.



Picture 5: FBD6 PCB top photo



Picture 6: FBD6 PCB top photo without Tuner Box



Picture 7: FBD6 PCB bottom photo

6 FBD6 electrical circuit block diagram

The following figure shows the electrical circuit block diagram of the FBD6 devices with all its sections.

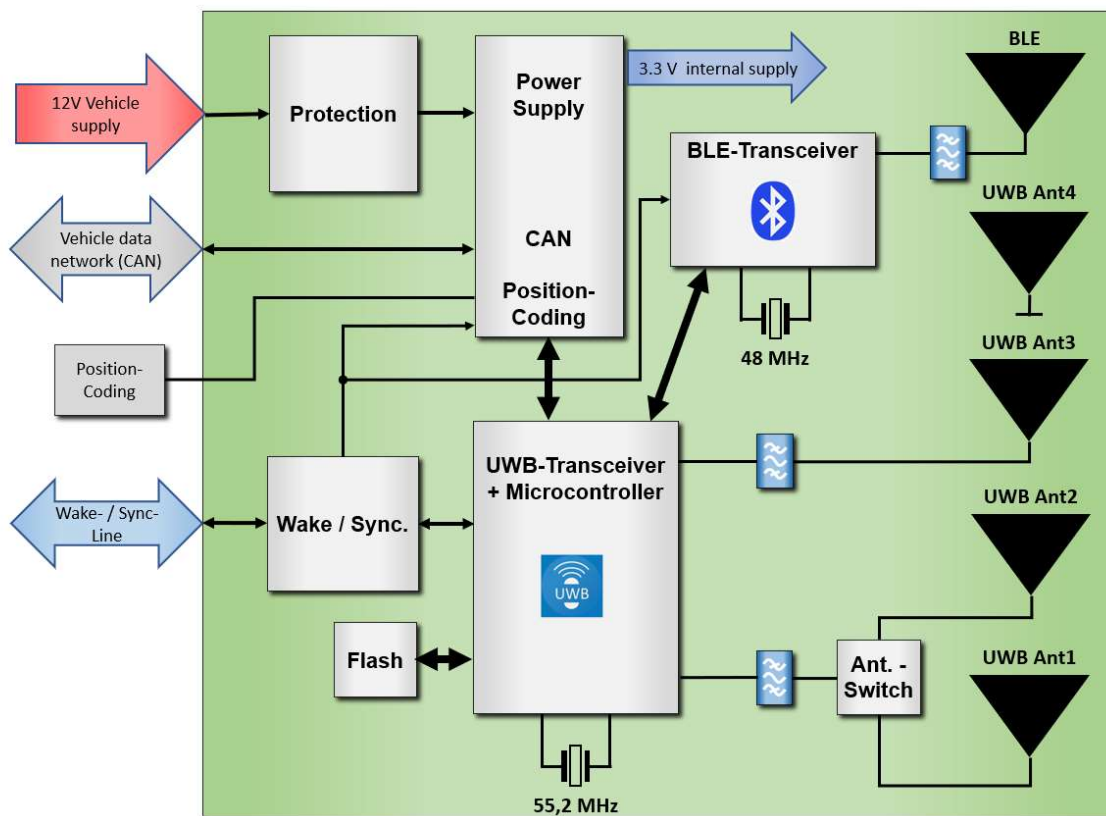


Figure 1: FBD6 block diagram

The individual modules and their functions are explained in the following subchapters.

Antennas mounted on outdoor structures such as antennas mounted on the outside of a building or on a telephone pole, or any fixed outdoor infrastructure are prohibited for use with this device.

6.1 Power Supply section

This section realizes the power supply of the entire FBD6 device. The power supply of 3.3 V is generated out of the power lines (12 V Supply voltage and GND) of the vehicle in which the FBD6 device is mounted.

This section also provides CAN and SPI interface for communication.

This section is also used for coding different vehicle mounting positions of the FBD6 device. The position is detected by reading out the voltage level of the input terminals.

6.2 UWB-Transceiver + Microcontroller section

The UWB section consists of a fully integrated transceiver for ultra-wide band secure ranging with mobile device and radar applications for Vital Sign Detection for example Child Presence Detection (CPD). The UWB section consists of two bandpass filter that is both part of the RX and TX signal path and an external Antenna Switch to switch the TRx function between Ranging and CPD.

The integrated PCB-Antennas serves for radiating and receiving the UWB signal.

- Ant1- TRx. Used for CPD functionality at Channel 8 and Channel 9
- Ant2- TRx. Used for Ranging and localization function at Channel 9 (with Smart Phone and key fob) and Channel 8 (with key fob)
- Ant3- Rx. Used for Ranging and CPD functionality at Channel 8 and Channel 9
- Ant4- Not used. Connected to ground.

The inbuilt microcontroller in this section also takes central control of the devices. The microcontroller is the central processing unit for the entire FBD6 device. It executes the sequence control of all communication activities.

6.3 Flash section:

This section contains an EEPROM for non-volatile data storage.

6.4 BLE-Transceiver section:

The BLE Transceiver offers full support for Bluetooth Low Energy (5.3 and the upcoming version 6.0) for automotive applications to enable radio communication between FBD6 and mobile devices. The section is mainly used for device pairing, activate UWB based ranging and data transfer for diagnostic and configuration according CCC 3.0.

The BLE section consists of a bandpass filter that is both part of the RX and TX signal path and an integrated PCB-Antennas serves for radiating and receiving the BLE signal.

7 FBD6 Modes of operation

The following chapter describes the mode of operation that can be carried out by the FBD6 devices.

7.1 Ranging mode

7.1.1 Ranging with mobile devices (Smart Phone)

The fastest Ranging-Cycle is 96ms, but can be a multiple of 96ms (will be negotiated between smartphone and vehicle). FBD6 is only transmitting STS frames. Those are 140µs long and have a max. power of -41,3 dB/MHz because the mitigation technique according to ETSI is used (trigger before transmit).

FBD6 is using only channel 9 for CCC function.

7.1.2 Ranging With Key fob

The key fob typically will use Channel 8 or channel 9 and will send UWB-Frames only on user demand (entry-authentication). The frame type doesn't have to be CCC-compliant, hence even shorter UWB-frames are used to save energy in the key fob.

The ranging with key fob is not under the scope because the PSD is lower than the Ranging with mobile devices.

7.2 Vital Sign Detection (VSD)

This feature is using UWB-Frames as radar for up to three interior UWB-Nodes to detect living beings in the vehicle. This VSD UWB-frames are cyclically triggered (e.g. 48 or 96 ms). The frame type and used UWB-channel don't have to be CCC-compliant, so anything what is beneficial can be used, e.g. longer frames, other UWB-channel. Vital sign detection will only take place after car locking event. Transmission Timeout is 7s (typical value).

VSD can use both UWB channel 8 or 9.

8 Test sample overview

FBD6 test setup are equipped with two FBD6 connectors, two for the power supply and one DB9 connector for CAN.

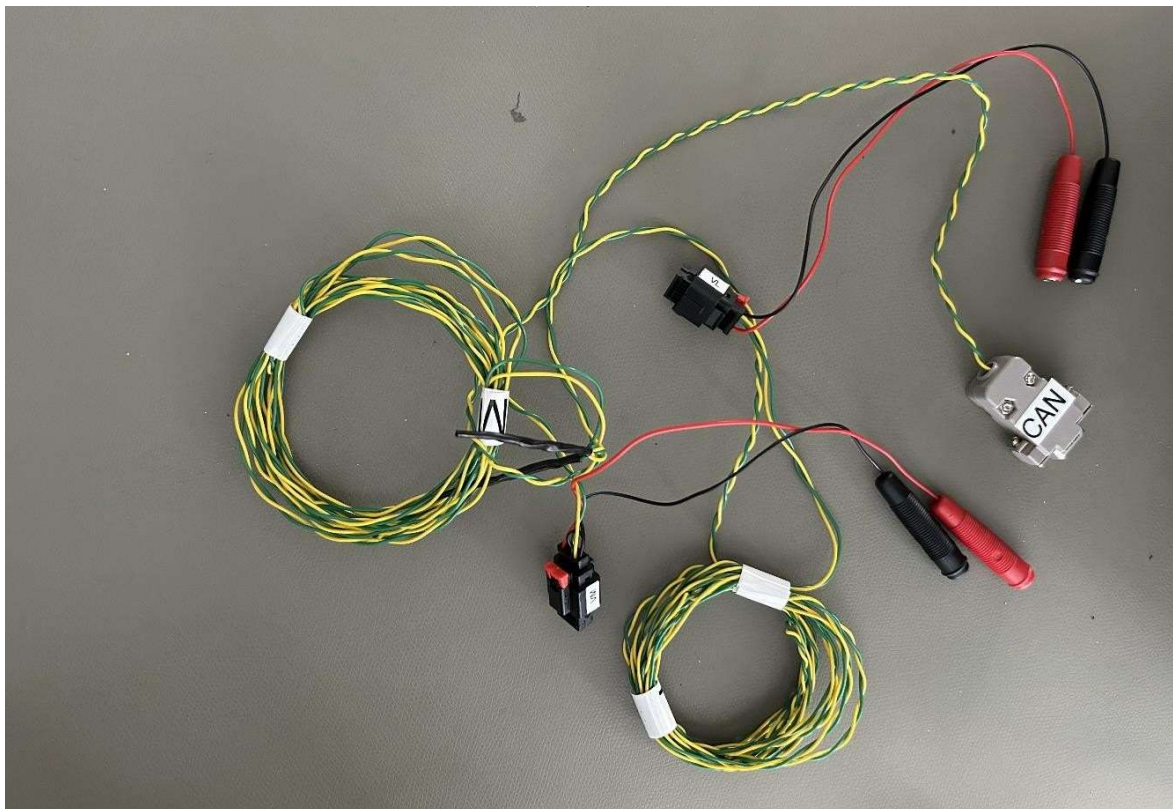
The following pictures show the exterior and interior view of the test samples:



Picture 8: FBD6 test sample top



Picture 9: FBD6 test sample bottom

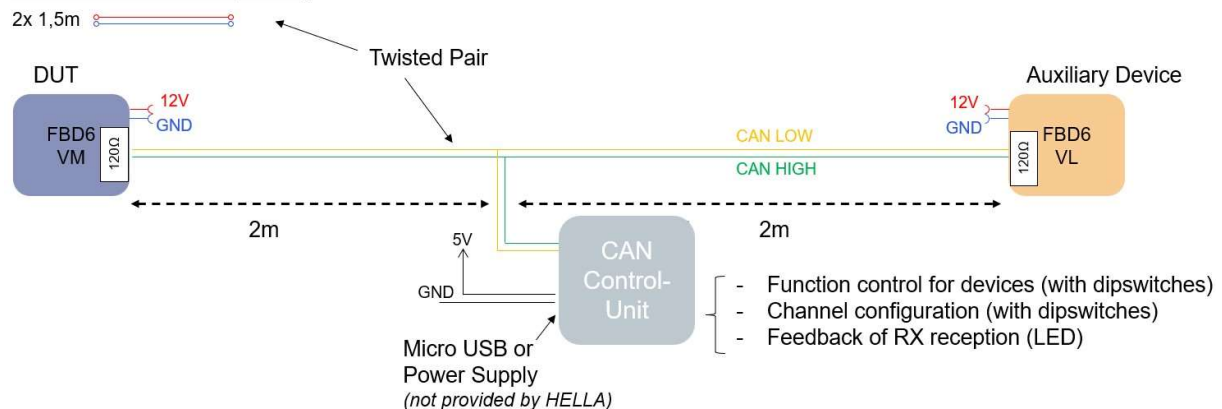


Picture 10: Connector for FBD6 test samples

8.1 FBD6 test setup

The setup can include two samples (Test device VM and auxiliary/signal source device VL) which can be configured to perform Box to Box UWB communication and BLE communication to show the regular behaviour of the FBD6 devices. Additionally, the test device can be configured to special test modes using CAN controlled unit as per the test requirement.

Power/Ground harnesses per setup



Test #	UWB Test Mode
1	UWB continuous frame TX mode with max. possible repetition rate
2	UWB continuous frame TX mode with series-like repetition rate
3	UWB RX mode
4	UWB Ranging mode
5	UWB Continuous Wave mode (CW)
Test #	BLE Test Mode
1	BLE Channel Selection
2	BLE TX mode Payload
3	BLE RX mode
4	BLE continuous wave mode (CW)

Note: After every measurement you need to consider a Power On Reset

The following devices test modes can be configured using the mentioned setup. The detailed test instruction is mentioned in additional document "FBD6: UWB / BLE Sample Description".

8.1.1 FBD6 photo sample

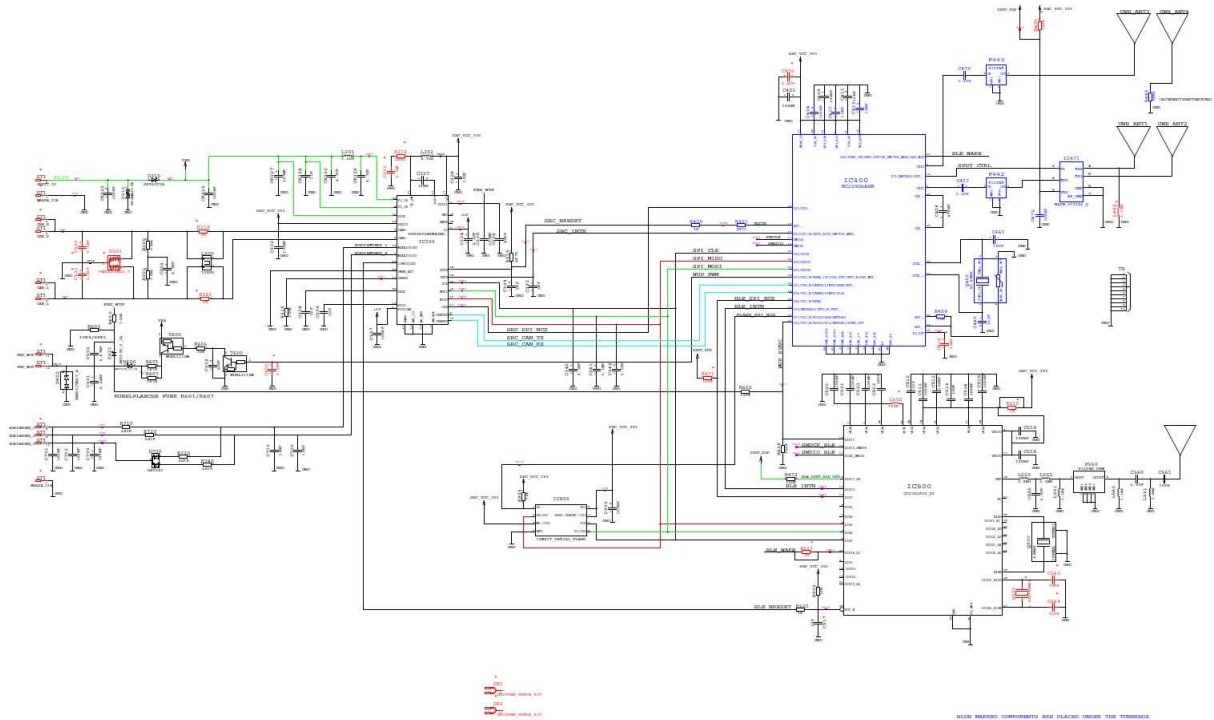
The FBD6 photo sample is a dismountable FBD6 device with no electrical function. This is used for documentation and photographic visualization only.



Picture 11: FBD6 photo sample disassembled

9 FBD6 circuit diagram

The following picture shows the circuit diagram of the FBD6 devices.



Picture 12: FBD6 circuit diagram

10 FBD6 bill of material

The following table shows the BOM of FBD6 devices.

Designator	Value
ST1	Connector
TB	KONTAKTELEMENT (TUNERBOX)
C300*	100pF
C301*	100pF
C302	4,7nF
C327	33nF
C328	10µF
C329	1nF
C330	1nF
C331*	100pF
C332	100nF
C334	2,2µF
C335	100nF
C336	47nF
C337	100nF
C338	1µF
C339	1µF
C340	100pF
C341	100pF
C342	100pF
CK323	100nF
CK325	100nF
CK327	100nF
CK328	1µF
CK329	4,7µF
CK330	4,7µF
D303*	DIODE
D310	DIODE
D311	DIODE
IC300	SFS2400
L300	100 µH
L301	1,5 µH
L302	4,7 µH
R300	60,4 Ohm

R301	60,4 Ohm
R315	4,75 kOhm
R316	100 kOhm
R318*	RES JUMP
R319*	22,6 Ohm
R323*	RES JUMP 0
C400*	2,2µF
C403	100nF
C404	100nF
C406	470nF
C409	100nF
C410	10nF
C411	10nF
C412	10nF
C417	3,3pF
C419*	10nF
C460	10pF
C461	10pF
C470	3,3pF
C472	100nF
F442	Band Pass FILTER
F443	Band Pass FILTER
IC400	NCJ29D6AHN
IC471	MASW-011186-Q
L442*	0,0022 µH
Q400	QUARZ 55,2 MHz
R400	1 kOhm
R401	4,75 kOhm
R409	10 kOhm
R445	56,2 Ohm
R470*	100 Ohm
R471*	100 Ohm
R472	100 Ohm
C500	100nF
C501	100nF
C503	10µF
C510	1µF
C511	100nF
C512	100nF
C514	100nF

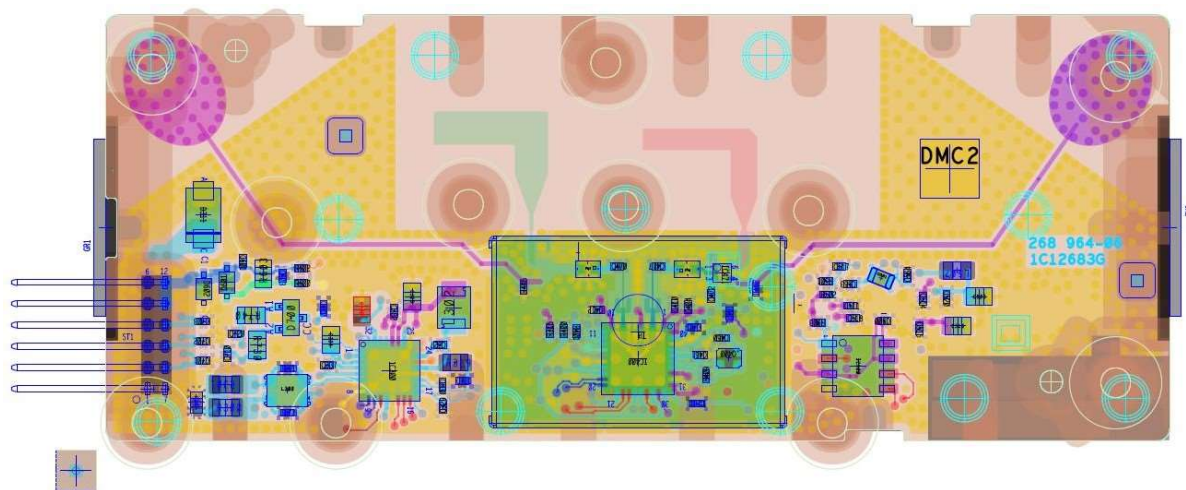
C515	100nF
C516	10µF
C517	1µF
C518	100nF
C519	100nF
C520	100nF
C550	0,5pF
C560	5,6pF
C561	10pF
C563*	12pF
C564*	15pF
F550	FILTER OFW
IC500	CC2745R10
L502*	10 µH
L550	0,0022 µH
L551	0,0051 µH
L552	0,0033 µH
L560	0,0051 µH
L561	0,0039 µH
Q500	QUARZ 48 MHz
Q501*	QUARZ 0,032768 MHz
R501	1 kOhm
R502	10 kOhm
R510*	RES JUMP
R511*	RES JUMP
C600*	100pF
C601	220pF
C602	22pF
C603	470pF
D600	DIODE
D601	DIODE
D602	DIODE
R600	100 kOhm
R601	1,78 kOhm
R602	100 kOhm
R603	10,5 kOhm/68,1 kOhm
R605	10 kOhm
R607	1,78 kOhm
R608	150 kOhm
T600	TRANSISTOR MUN5311DW

C701	100nF
C702	100nF
C703	100nF
C710	10nF
C720	10nF
D700	DIODE
R710	681 Ohm
R720	681 Ohm
R730	681 Ohm
R740	681 Ohm
C900	100nF
IC900	MEMORY 16MBIT SERIAL FLASH
R903	10 kOhm

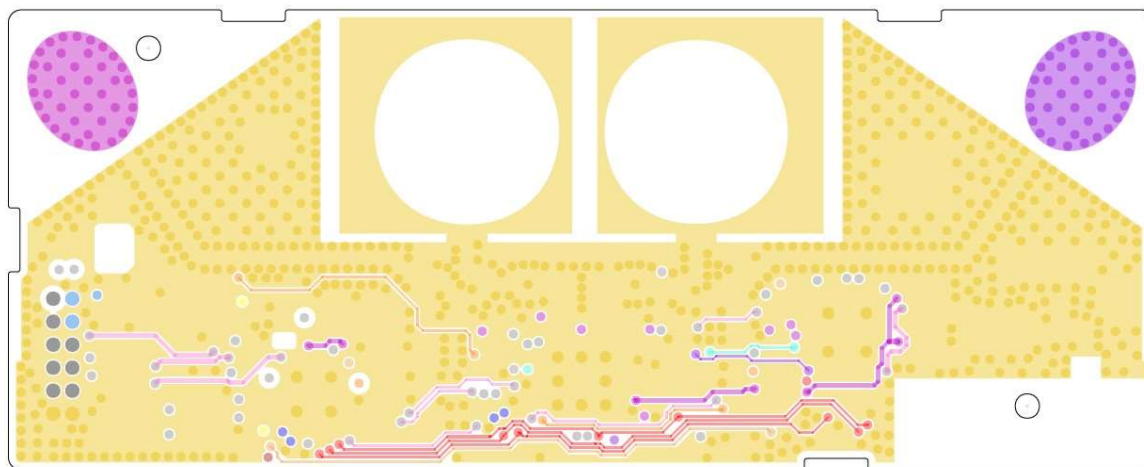
Part values marked with (*) are depopulated

11 FBD6 printed circuit board layout

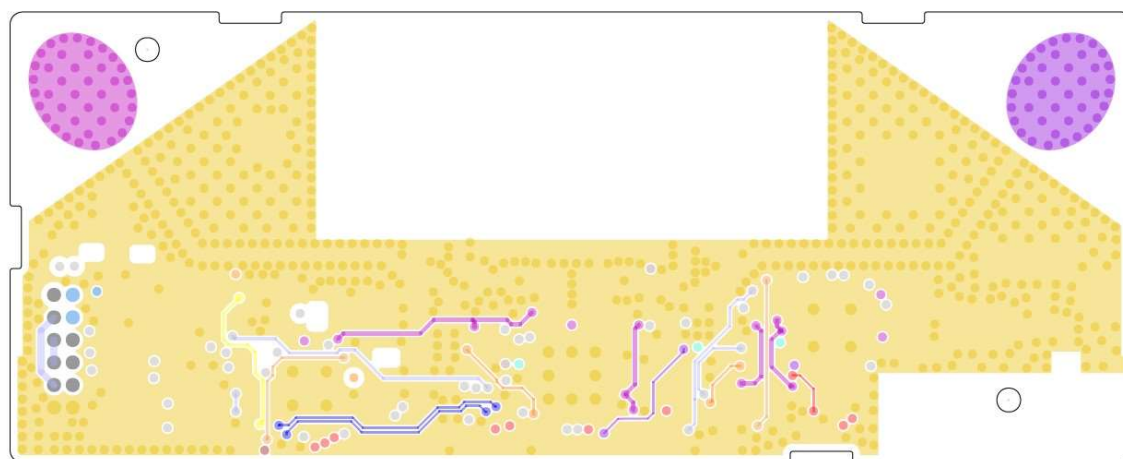
The following pictures show the printed circuit board layout of the FBD6 devices.



Picture 13: FBD6 PCB top layer

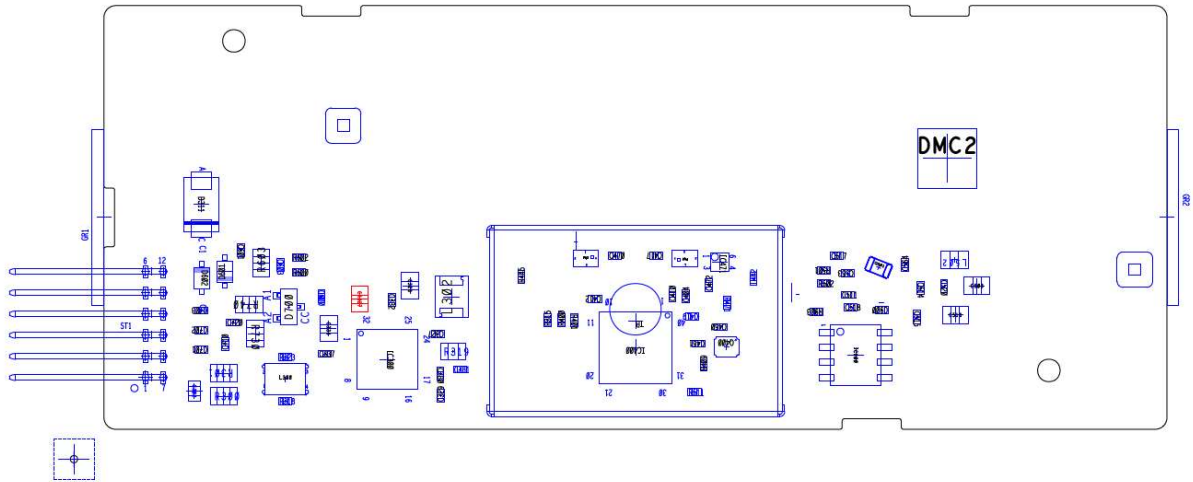


Picture 14: FBD6 PCB inner layer #1

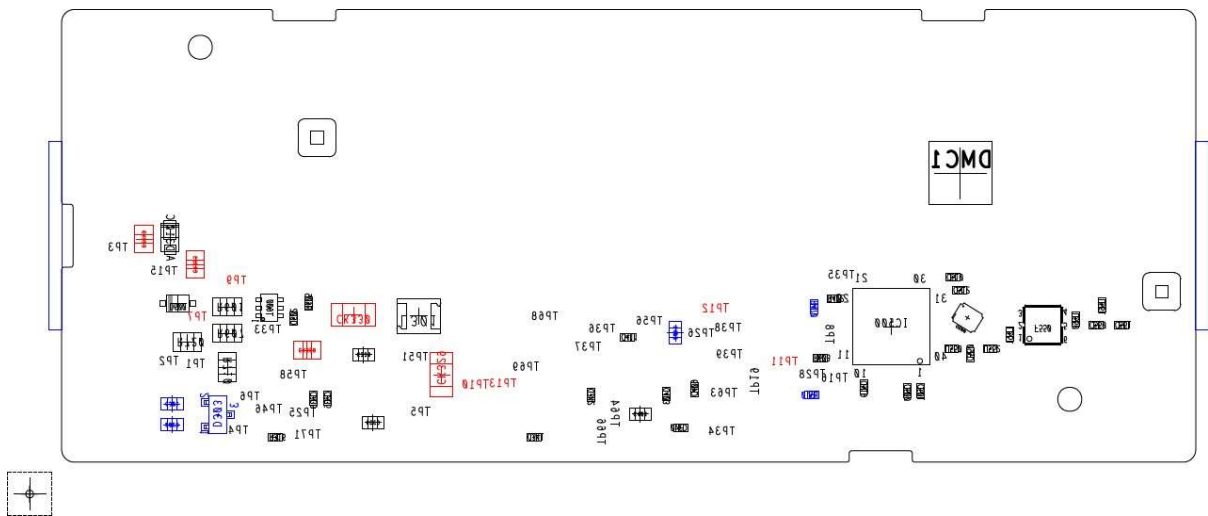


Picture 15: FBD6 PCB inner layer #2





Picture 18: FBD6 PCB top placement



Picture 19: FBD6 PCB bottom placement