

FCC RF Exposure Evaluation

Report Number:

F221817E7

Equipment under Test (EUT):

CTP3NA

Applicant:

Robert Bosch GmbH

Manufacturer:

Robert Bosch GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

References

CFR 47 Rule part 1 Practice and Procedure

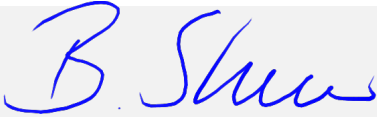
CFR 47 Rule part 2 Frequency Allocations and Radio Treaty Matters; General Rules and Regulations

KDB 447498 D01 General RF Exposure Guidance v06

Assessed and
written by:

Signature

Reviewed and
approved by:

 Bernd STEINER
05.03.2024

Signature

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1. Identification

1.1. Applicant

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1.3. Factory

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1.4. Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
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Accredited by *Deutsche Akkreditierungsstelle GmbH* in compliance with
DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-06.

1.5. EUT (Equipment under Test)

Test object: *	Telematic Control Unit
Model name: *	CTP3NA
Model number: *	CTP3NA Ext
Order number: *	-

	EUT number
	1
Serial number: *	1150003406
PCB identifier: *	8157-01
Hardware version: *	C2
Software version: *	DAIMLER_CTP3_ISTANBUL_RC2_S.010
Type Plate	

* Declared by the applicant

1.6. Technical Data of Equipment

General			
Power supply EUT: *	DC		
Supply voltage EUT: *	$U_{nom} = 12 / 24 \text{ V DC}$	$U_{min} = 8 \text{ V DC}$	$U_{max} = 32 \text{ V DC}$
Temperature range: *	-40 °C to +60 °C		
Highest internal frequency: *	radio frequency: WiFi 5GHz: 5825 MHz internal clock frequency: 125MHz		

* Declared by the applicant

WLAN part 2.4 / 5 Ghz (> 5725 MHz (SRD part))	
Fulfils WLAN specification: *	802.11b/g/n/ac/ax 802.11a/n/ac/ax
Operating frequency range: *	2412 to 2472MHz for 802.11b/g/n/ac/ax 2.4GHz (20/40 MHz) 5180 to 5825MHz for 802.11a/n/ac/ax 5GHz (20/40/80 MHz)
Number of channels: *	IEEE 802.11 b/g/n20/ax20: 13 IEEE 802.11 n40/ax40: 9 IEEE 802.11a/n20/axc20/ax20 5 IEEE 802.11n40/ac40/ax40 2 IEEE 802.11/ac80/ax80 1
Type of modulation: *	IEEE 802.11 b: DSSS (1Mbps DBPSK, 2Mbps DQPSK, 5.5/11Mbps CCK) IEEE 802.11 g: OFDM (6/9Mbps BPSK, 12/18Mbps QPSK, 24/36Mbps 16-QAM, 48/54Mbps 64-QAM) IEEE 802.11n (HT20): OFDM (BPSK, QPSK, 16-QAM, 64-QAM) IEEE 802.11n (HT40): OFDM (BPSK, QPSK, 16-QAM, 64-QAM) IEEE 802.11ax (HE20): OFDM (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM) IEEE 802.11ax (HE40): OFDM (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM) IEEE 802.11ax80 (HE80) BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM
Power supply WLAN module: *	DC
Supply voltage WLAN module: *	3.3 V & 1.8 V
Antenna type / name: *	External antenna (refer to antennas)

* Declared by the applicant

Bluetooth part	
Fulfils Bluetooth specification: *	Bluetooth 5.0 / Bluetooth Low Energy (BLE) 5.0
Operating frequency range: *	2402 to 2480 MHz
Number of channels: *	Bluetooth: 79 BLE: 40
Type of modulation: *	Bluetooth: 1 Mbps: GFSK, 2 Mbps: $\pi/4$ -DQPSK, 3 Mbps: 8DPSK BLE: GFSK (1 Mbit/s; 2 Mbit/s; 500 kbit/s; 125 kbit/s)
Power supply WLAN module: *	DC
Supply voltage WLAN module: *	3.3 V & 1.8 V
Antenna type / name: *	External antenna (refer to antennas)

* Declared by the applicant

Cellular part:			
Manufacturer: *	WNC (Module), MTK (Core)		
Model name: *	MT2731 (UMC-MT2731CDJ)		
Power supply module: *	DC by host		
Supply voltage module: *	$U_{nom} = 4.0 \text{ V DC}$	$U_{min} = 3.8 \text{ V DC}$	$U_{max} = 4.2 \text{ V DC}$
Hardware version: *	n.a.		
Firmware version: *	RX.40/41.12		
Supported bands: *	GSM/GPRS/EDGE: 850/1900 MHz LTE FDD**: Band 2, 4, 5, 7, 12, 14, 17, 25, 26, 66		
Max. output power: *	GSM/GPRS/EDGE: Class 4 (33 dBm) @ 900 MHz Class 1 (30 dBm) @ 1800 MHz LTE FDD: Class 3 (23 dBm)		
Antenna type / name: *	External antenna (refer to antennas)		

* Declared by the applicant

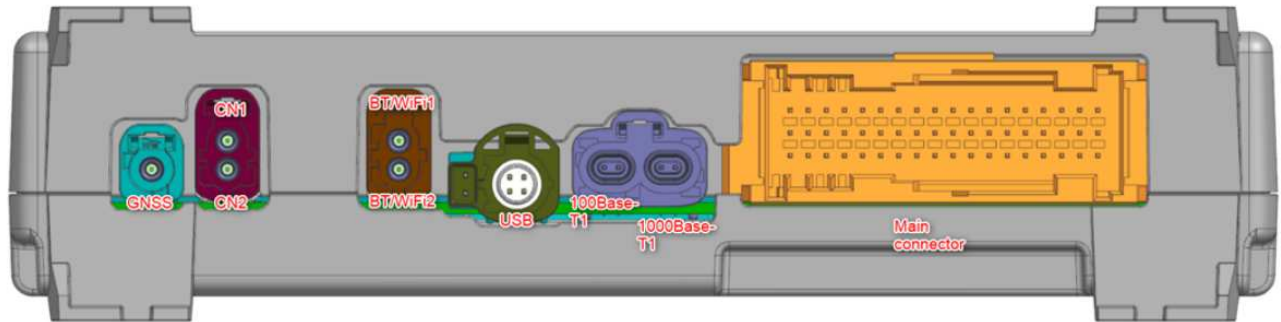
** Not all bands are used in the end application.

GNSS part			
GNSS module type: *	UBX-M9140-KA		
Power supply GNSS module: *	DC		
Supply voltage GNSS module: *	$U_{nom} = 3.3 \text{ V DC}$	$U_{min} = 1.65 \text{ V DC}$	$U_{max} = 3.6 \text{ V DC}$
Hardware version: *	Product revision: C1100A		
Firmware version: *	EXT Core 4.04 (7f89f7)		
Supported GNSS: *	GPS L1C/A, GLONASS L1OF, Galileo E1-B/C		
Antenna type / name: *	External antenna (refer to antennas)		

* Declared by the applicant

Used antennas	
Antenna 1	
Antenna type	Rooftop combined antenna
Antenna Model / Brand	LU Antenne F GNSS WLAN Bluetooth GSM (A 006 820 39 75)
Antenna gain	Cellular: 698 - 960 MHz: 3.4 dBi; 1444 - 1551 MHz: 4.0 dBi; 1710 - 2690 MHz: 5.0 dBi; 3300 - 4200 MHz: 6.1 dBi; 4400 - 5000 MHz: 5.7 dBi; WLAN & BT: 2400 - 2480 MHz: 6.2 dBi; 5150 - 5835 MHz: 8.2 dBi
Connector	3x Fakra male (GNSS coding C, cellular coding D, WLAN & BT coding I)
Antenna 2	
Antenna type	dashboard antenna BT & WiFi
Antenna Model / Brand	ZB Antenne WLAN (A 006 820 82 75)
Antenna gain	WLAN & BT: 2400 - 2480 MHz: 1dBi; 5150 - 5835 MHz: 6 dBi
Connector	Fakra male coding K
Antenna 3	
Antenna type	CN RX diversity antenna
Antenna Model / Brand	LU Antenne F GSM (A 006 820 40 75)
Antenna gain	Cellular: 698 - 960 MHz: 0 dBi; 1444 - 1551 MHz: - dBi; 1710 - 2690 MHz: 3 dBi; 3300 - 4200 MHz: 2 dBi; 4400 - 5000 MHz: 2 dBi
Connector	Fakra female coding D

* Declared by the applicant



Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
Main Connector	54 Pin Connector	Customized	Appr. 3 m	No
GNSS	Fakra HFM single coding C	Fakra (Antenna)	Appr. 2 m	Yes
CN1 / CN2	Fakra HFM double coding D	2 x Fakra (Antenna)	Appr. 2 m	Yes
BT/ WiFi 1 / BT/ WiFi 1	Fakra HFM double coding F	2 x Fakra (Antenna)	Appr. 2 m	Yes
USB	HSD+2 coding C	USB	Appr. 2 m	Yes
100 base T1 / 1000 Base T1	H-MTD	Customized	Appr. 2 m	Yes

Antenna	illustration	B- sample FAKRA Code	C- sample FAKRA Code	TE
GNSS +CN1+WiFi/BT		GNSS: C (Blue) CN: D (Bordeaux) WiFi/Bt: I (Beige)	GNSS: C (Blue) CN: D (Bordeaux) WiFi/Bt: I (Beige)	new Part Number-1
CN2		CN2: N (Pastell Green)	CN2: D (Bordeaux)	new Part Number-2
WiFi2		WiFi2: K (Curry)	WiFi2: K (Curry)	A1779052902

2. Subject of Investigation

According to the CFR47 §2.1091 the device as declared by the applicant is a mobile device which is used at least at 26 cm separation distance between the device and the users.

This document includes the RF-Exposure evaluation for a host integrating one Cellular Module with the FCC ID: NKRUMC-MT2731CBN, and one WLAN/BT Modul with the FCC ID: YZP-ATC6NPL002

3. MPE evaluation limits

3.1. Stand alone MPE evaluation limits

The human exposure to RF emissions from such devices could be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and / or power density. The limits for General Population / Uncontrolled Exposure are given in the following table from §1.1310(e)1:

Frequency Range [MHz]	Electric Field Strength (E) [V/m]	Magnetic Field Strength (H) [A/m]	Power Density (S) [mW/cm ²]	Averaging Time E ² , H ² or S [min]
0.3 – 1.34	614	1.63	(100)*	30
1.34 – 30	824/f	2.19/f	(180/f)*	30
30 – 300	27.5	0.073	0.2	30
300 – 1500			f/1500	30
1500 – 100,000			1.0	

Limits for General Population / Uncontrolled Exposure.

Note: f = frequency in MHz; * Plane – wave equivalent power density

3.2. Simultaneous transmission MPE requirements

According to the RF exposure KDB 447498 D01 General RF Exposure Guidance v06 in chapter 7.2:

For mobile exposure host platform devices to qualify for simultaneous transmission MPE test exclusion, all transmitters and antennas in the host must either be evaluated for MPE compliance, by measurement or computational modelling, or qualify for the standalone MPE test exclusion in 7.1.

When modular transmitters are used, the minimum test separation distance required for each simultaneously transmitting antenna installed in the host device must satisfy MPE compliance for both standalone and simultaneous transmission operations. When simultaneous transmission MPE test exclusion applies, transmitter modules may be incorporated in host devices according to Class I permissive change requirements to document the test exclusion conditions.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is

≤ 1.0, according to calculated/estimated, numerically modelled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

4. MPE evaluation

The power density is calculated as follows:

$$\text{Power density} = \frac{P \cdot D \cdot G}{4 \cdot \pi \cdot R^2}$$

Where:

P: conducted power [mW]

D: Duty cycle (linear)

G: Antenna gain (linear)

R: minimum separation distance from antenna to the user [cm]

4.1. Stand-alone MPE results

Band	Frequency [MHz]	Highest RF conducted output power [dBm]	Power + Tune up tol. [dBm]	Duty cycle [dB]	Antenna Gain [dBi]	Distance [cm]	Power Density [mW/cm ²]	Limit of Power Density [mW/cm ²]	Reference
Bluetooth classic	2402	0.2	4.2	-	6.2	26	0.00129	1.0	Current filing
Bluetooth LE	2402	0.1	4.3	-	6.2	26	0.00132	1.0	Current filing
WLAN 2.4 GHz	2412	16.7	20.7 ^{*6}	-	6.4 ^{*5}	26	0.05506	1.0	Current filing
WLAN 5GHz	5580	10.6	14.6 ^{*6}	-	9.6 ^{*5}	26	0.03096	1.0	Current filing
GSM850	824	30.98	35	-3*	3.4	26	0.40818	0.549	module report ^{*1}
PCS1900	1850	28.35	32	-3*	5.0	26	0.29570	1.0	module report ^{*2}
LTE Bd 5	824	23.44	25	-	3.4	26	0.08144	0.549	module report ^{*1}
LTE Bd 26	814	23.54	25	-	3.4	26	0.08144	0.543	module report ^{*1}
LTE Bd 2	1850	22.94	25	-	5.0	26	0.11772	1.0	module report ^{*2}
LTE Bd 25	1850	22.93	25	-	5.0	26	0.11772	1.0	module report ^{*2}
LTE Bd 4	1710	22.88	25	-	5.0	26	0.11772	1.0	module report ^{*3}
LTE Bd 7	2505	22.79	25	-	6.1	26	0.15165	1.0	module report ^{*3}
LTE Bd 12	699	23.31	25	-	3.4	26	0.08144	0.466	module report ^{*3}
LTE Bd 17	704	23.32	25	-	3.4	26	0.08144	0.471	module report ^{*3}
LTE Bd 66	1710	22.95	25	-	5.0	26	0.11772	1.0	module report ^{*3}
LTE Bd 14	788	23.17	25	-	3.4	26	0.08144	0.527	module report ^{*4}

^{*1} Module report RFBHKI-WTW-P21120244 issued by BV Taiwan 2022-06-09

^{*2} Module report RFBHKI-WTW-P21120244-1 issued by BV Taiwan 2022-06-09

^{*3} Module report RFBHKI-WTW-P21120244-2 issued by BV Taiwan 2022-06-09

^{*4} Module report RFBHKI-WTW-P21120244-3 issued by BV Taiwan 2022-06-09

^{*5} Combined gain of both antennas

^{*6} Combined conducted power of both antenna ports

4.2. Simultaneous MPE results

The worst case MPE ratios of the stand-alone modules are calculated in the following:

For the Bluetooth module:

$$BT_{ratio} = \frac{0.00132 \text{ mW/cm}^2}{1.0 \text{ mW/cm}^2} = 0.00132$$

For the WLAN 2.4 GHz module:

$$WLAN2.4GHz_{ratio} = \frac{0.05506 \text{ mW/cm}^2}{1.0 \text{ mW/cm}^2} = 0.05506$$

For the WLAN 5 GHz module:

$$WLAN5GHz_{ratio} = \frac{0.03096 \text{ mW/cm}^2}{1.0 \text{ mW/cm}^2} = 0.03096$$

For the Cellular module:

$$Cellular_{ratio} = \frac{0.40818 \text{ mW/cm}^2}{0.549 \text{ mW/cm}^2} = 0.74351$$

The Sum of the MPE ratios for the simultaneous transmission is:

$$\text{Sum} = 0.00132 + 0.05506 + 0.03096 + 0.74351$$

$$\text{Sum} = 0.83085 < 1.0$$

5. Conclusion

As the sum of the MPE ratios is less than 1.0, the device is excluded from the simultaneous transmission MPE test.

A safety statement concerning the minimum separation distance from enclosure of the device has to be integrated in the user's manual to provide end-users with transmitter operating conditions for satisfying RF exposure compliance.

6. Report History

Report Number	Date	Comment
F221817E7	05.03.2024	Initial Test Report
-	-	-
-	-	-