RF Exposure Assessment

On

NetModule AG

VCUpro/NB800/NB1601/TC-Router

contains FCC ID: XPYUBX21BEO1 (Cellular)
contains FCC ID: POR-WL18DBMOD (Wifi and BLE)

Assessment Reference: MDE_NETMO_2205_MPE_02

Date: 2023-11-29

Test Laboratory:
7layers GmbH
Borsigstraße 11
40880 Ratingen
Germany

Contents

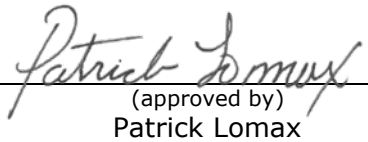
1 Summary

The RF-exposure assessment according to KDB 447498 D01 General RF Exposure Guidance v06 shows, that the worst-case RF exposure values of the assessed radio technologies and bands are below the Limits for General Population/Uncontrolled Exposure:

- Table 1 (II) to § 1.1310(E)(1) of 47 CFR Ch. I (10–1–21 Edition).

COMMENTS:

- Assessment limited to supported North American frequency bands
- Prediction Distance R = 40 cm



(approved by)
Patrick Lomax

(responsible for report)
Andreas Tübel

2 Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2023-11-29	--	valid
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3 Administrative Data

3.1 Testing Laboratory

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany
Report Template Version:	2022-10-21

3.2 Project Data

Responsible for report:	Andreas Tübel
Date of Report:	2023-11-29

3.3 Applicant Data

Company Name:	NetModule AG
Address:	Maulbeerstrasse 10, 3011 Bern Switzerland
Contact Person	Reto Schrotberger
Phone	+41 31 985 25 06
Email	reto.schrotberger@netmodule.com

3.4 Manufacturer Data

Company Name:	please see Applicant Data
Address:	
Contact Person:	

4 Test object Data

Declared EUT data by the supplier	
Kind of Device product description	Router with Ethernet port and optional extensions. Wireless technologies optional include LTE/UMTS/GSM,WLAN, Bluetooth Low Energy and GNSS.
Product name(s)	NB800; NB1601; NG800/VCU Pro; TC Router
Type(s)	NB800-LWWt*; NB800-LjWWt* NB1601-LWWt*; NB1601-LjWWt* NG800-LWWt*; NG800-LjWWt* VCU-LWWt* TC Router 4x02T-4G EU WLAN
Integrated transmitter	
Cellular Radio Module uBlox LARA-L6004/L6004D Module	
supported Radio technologies	2G/3G/4G
Supplied document(s)	MDE_UBLOX_2029_MPE_01_rev02, 2022-11-24
WLAN BLE Radio Module Texas Instruments WL1837MOD	
supported Radio technologies	WLAN 2.4 GHz and 5 GHz, BLE
Supplied document(s)	RF Exposure Evaluation Report, FA741330, Rev.01, 2018-03-23

5 Assessment

5.1 Assessment method and subject of assessment

Calculation of power density and comparison with reference levels for general public exposure.
Applicability area and limitations: Power density can be calculated in far field region.

Applied Standards:

- IEEE Std C95.3-2021, D.4.2 Antennas – Main beam on-axis, general method for determining the power density at points in the radiating near-field and far-field antenna regions.
- IEEE Std C95.1-2019, D.2 Multifrequency exposures (exposures to multiple sources)

Specific information:

- Values used for calculation are based on supplied documents and supplied RF exposure reports.
- Output power values are based on the supplied RF exposure reports.

Worst case considerations:

- Main beams of the antennas are directed to the same point in the prediction distance.
- Output power values are based on the module manufacturer MPE calculations
- Antenna gain values are based on values declared by the manufacturer.
- Cable loss of internal antenna cables set to 0.
- Duty cycle factor BLE 2.4 GHz = 1.
- Duty cycle factor WLAN 2.4 GHz and 5GHz = 1.
- Duty cycle factor GSM = 0.5
- Duty cycle factor UMTS = 1.
- Duty cycle factor LTE = 1.
- The radio modules can transmit independently from each other:
  (1 cellular band + WLAN 2,4 GHz + BLE).
  (1 cellular band + WLAN 5 GHz + BLE).
- Selected bands for multi frequency exposure calculations:
  worst case of each cellular technology + WLAN 2.4 GHz + BLE and + worst case of each cellular technology + WLAN 5 GHz + BLE
- Cellular LTE/UMTS/GSM module is uBlox-LARA-L6004/L6004D
- WiFi module TI WL1837MOD (WiFi 2.4 GHz and WiFi 5GHz cannot transmit together on the same time slot).

5.2 Exposure limits

Extract of

- Table 1 (II) to § 1.1310(E)(1) of 47 CFR Ch. I (10–1–21 Edition).

Frequency range	*Power density*	*Power density*
MHz	*W/m²*	*mW/cm²*
300 – 1500	f/150	f/1500
1500 - 100000	10	1

Note:
f in MHz

5.3 Formulas used for calculation

5.3.1 Single-frequency exposures (exposures to one source)

Table D.2—Determining power density on antenna main beam axis

$$S_{FF} = \frac{G_i P_{in}}{4\pi d^2}$$

In this report is the power density S_i at frequency i calculated in mW/cm^2.
G_i is the (isotropic) far-field antenna gain (power ratio) at frequency i.
P_{in} is the power into the antenna in mW => P_{mW}.
d is the distance to the antenna in cm.

5.3.2 Multi-frequency exposures (exposures to multiple sources)

Summation based on IEEE Std C95.1-2019, D.2

$$\sum_{i=1}^{n} \frac{exposure_i}{ERL_i} < 1$$

In this report is the power density calculated. In the tables below is "*exposure*" = S_i = power density at frequency i.
ERL_i is the corresponding exposure reference level at frequency i.

IEEE Std C95.1-2019:
exposure reference level (ERL): The maximum exposure level relative to ambient electric and/or magnetic field strength or power density, induced and/or contact current, or contact voltage.
NOTE 1— ERLs provide an adequate margin of safety against established adverse health effects.
NOTE 6— In some documents, ERLs are called reference levels, derived limits, permissible exposure limits, maximum permissible exposure values, action levels, or investigation levels.

5.4 Module(s) single-frequency exposures used for multi-frequency calculation

5.4.1 Cellular Single-frequency exposures - Module uBlox LARA-L6004/L6004D Module and Module Texas Instruments WL1837MOD

Prediction Distance d in cm =>	**40**	TX frequ. band	Prediction frequ.	Average (temporal) power (log.)	Average (temporal) power (lin.)	Max. Gain (log.)	Gain (lin.)	Power density at distance d	Power density limit at frequency f_i	Ratio to exposure reference level	Sum of S_i / ERL_i	Compliance, if Sum of S_i / ERL_i < 1
		f_{Band}	f_i	P_{dBm}	**P_{mW}**	g_{dBi}	**G_i**	S_i	ERL_i	S_i / ERL_i	-	-
Radio technology	Band	MHz	MHz	dBm	mW	dBi	-	mW/cm²	mW/cm²	-	-	-
GSM	GSM 850	824 - 849	824.2	33.5	1119.44	9.00	7.94	0.442	0.549	**0.805**	0.805	Pass
GSM	GSM 1900	1850 - 1910	1850.2	30.5	561.05	14.00	25.12	0.701	1.000	0.701	0.701	Pass
UMTS	FDD II	1850 - 1910	1852.4	24	251.19	14.00	25.12	0.314	1.000	**0.314**	0.314	Pass
UMTS	FDD V	824 - 849	826.4	24	251.19	9.00	7.94	0.099	0.551	0.180	0.180	Pass
LTE	eFDD2	1850 - 1910	1850.7	24	251.19	14.00	25.12	0.314	1.000	**0.314**	0.314	Pass
LTE	eFDD4	1710 - 1755	1710.7	24	251.19	14.00	25.12	0.314	1.000	**0.314**	0.314	Pass
LTE	eFDD5	824 - 849	824.7	24	251.19	9.00	7.94	0.099	0.550	0.180	0.180	Pass
LTE	eFDD7	2500 - 2570	2502.5	23.5	223.87	14.00	25.12	0.280	1.000	0.280	0.280	Pass
LTE	eFDD8	880 - 915	898	24	251.19	9.00	7.94	0.099	0.599	0.166	0.166	Pass
LTE	eFDD12	699 - 716	699.7	24	251.19	9.00	7.94	0.099	0.466	0.213	0.213	Pass
LTE	eFDD13	777 - 787	779.5	24	251.19	9.00	7.94	0.099	0.520	0.191	0.191	Pass
LTE	eFDD26 Part 90	814 - 824	814.7	24	251.19	9.00	7.94	0.099	0.543	0.183	0.183	Pass
LTE	eFDD26	824 - 849	824.7	24	251.19	9.00	7.94	0.099	0.550	0.180	0.180	Pass
LTE	eTDD38	2570 - 2620	2572.5	24	251.19	14.00	25.12	0.314	1.000	**0.314**	0.314	Pass
Bluetooth	2.4 GHz ISM	2402 - 2480	2402	12.5	17.78	14.00	25.12	0.022	1.000	**0.022**	0.022	Pass
WLAN 2.4 GHz	2.4 GHz ISM	2412 - 2472	2412	17.5	56.23	14.00	25.12	0.070	1.000	**0.070**	0.070	Pass
WLAN 5 GHz	5 GHz ISM	5180 - 5240 5260 - 5320 5500 - 5720 5745 - 5825	5180	19.5	89.13	14.00	25.12	0.111	1.000	**0.111**	0.111	Pass

Bold marked = worst case band of the radio technology
Information: 10 W m-2 = 1 mW cm-2

5.5 Calculation

5.5.1 Calculation of multi-frequency exposures

Prediction Distance d in cm =>	**40**	TX frequ. band	Prediction frequ.	Average (temporal) power (log.)	Average (temporal) power (lin.)	Max. Gain (log.)	Gain (lin.)	Power density at distance d	Power density limit at frequency f_i	Ratio to exposure reference level	Sum of S_i / ERL_i	Compliance, if Sum of S_i / ERL_i < 1
		f_{Band}	f_i	P_{dBm}	P_{mW}	g_{dBi}	G_i	S_i	ERL_i	S_i / ERL_i	-	-
Radio technology	Band	MHz	MHz	dBm	mW	dBi	-	mW/cm²	mW/cm²	-	-	-
GSM	GSM 850	824 - 849	824.2	33.5	1119.44	9.00	7.94	0.442	0.549	0.805	0.897	Pass
Bluetooth	2.4 GHz ISM	2402 - 2480	2402	12.5	17.78	14.00	25.12	0.022	1.000	0.022		
WLAN 2.4 GHz	2.4 GHz ISM	2412 - 2472	2412	17.50	56.23	14.00	25.12	0.070	1.000	0.070		
GSM	GSM 850	824 - 849	824.2	33.5	1119.44	9.00	7.94	0.442	0.549	0.805	0.938	Pass
Bluetooth	2.4 GHz ISM	2402 - 2480	2402	12.5	17.78	14.00	25.12	0.022	1.000	0.022		
WLAN 5 GHz	5 GHz ISM	5180 - 5240 5260 - 5320 5500 - 5720 5745 - 5825	5180	19.50	89.13	14.00	25.12	0.111	1.000	0.111		
UMTS	FDD II	1850 - 1910	1852.4	24	251.19	14.00	25.12	0.314	1.000	0.314	0.406	Pass
Bluetooth	2.4 GHz ISM	2402 - 2480	2402	12.5	17.78	14.00	25.12	0.022	1.000	0.022		
WLAN 2.4 GHz	2.4 GHz ISM	2412 - 2472	2412	17.50	56.23	14.00	25.12	0.070	1.000	0.070		
UMTS	FDD II	1850 - 1910	1852.4	24	251.19	14.00	25.12	0.314	1.000	0.314	0.447	Pass
Bluetooth	2.4 GHz ISM	2402 - 2480	2402	12.5	17.78	14.00	25.12	0.022	1.000	0.022		
WLAN 5 GHz	5 GHz ISM	5180 - 5240 5260 - 5320 5500 - 5720 5745 - 5825	5180	19.50	89.13	14.00	25.12	0.111	1.000	0.111		
LTE	eTDD38	2570 - 2620	2572.5	24	251.19	14.00	25.12	0.314	1.000	0.314	0.406	Pass
Bluetooth	2.4 GHz ISM	2402 - 2480	2402	12.5	17.78	14.00	25.12	0.022	1.000	0.022		
WLAN 2.4 GHz	2.4 GHz ISM	2412 - 2472	2412	17.50	56.23	14.00	25.12	0.070	1.000	0.070		

Prediction Distance d in cm =>	**40**	TX frequ. band	Prediction frequ.	Average (temporal) power (log.)	Average (temporal) power (lin.)	Max. Gain (log.)	Gain (lin.)	Power density at distance d	Power density limit at frequency f_i	Ratio to exposure reference level	Sum of S_i / ERL_i	Compliance, if Sum of S_i / ERL_i < 1
		f_{Band}	f_i	P_{dBm}	$\mathbf{P_{mW}}$	g_{dBi}	$\mathbf{G_i}$	S_i	ERL_i	S_i / ERL_i	-	-
Radio technology	Band	MHz	MHz	dBm	mW	dBi	-	mW/cm²	mW/cm²	-	-	-
LTE	eTDD38	2570 - 2620	2572.5	24	251.19	14.00	25.12	0.314	1.000	0.314	0.447	Pass
Bluetooth	2.4 GHz ISM	2402 - 2480	2402	12.5	17.78	14.00	25.12	0.022	1.000	0.022		
WLAN 5 GHz	5 GHz ISM	5180 - 5240 5260 - 5320 5500 - 5720 5745 - 5825	5180	19.50	89.13	14.00	25.12	0.111	1.000	0.111		

Information: 10 W m^{-2} = 1 mW cm^{-2}

END OF REPORT