

MPE / SAR exemption letter according Interim procedure KDB 447498 D04

Customer	Product	Model	Type	HW Status	SW status	FCC ID
Robert Bosch GmbH Robert-Bosch-Straße 200 31139 Hildesheim Germany	Telematics Control Unit Generation 2	TCU2 NA IP67	--	5968H04	23.04.S.010.4	2AUXS- TCU2NAIP67

Declared minimum distance to human body according to customer ≥ 20 cm according external customer's document "20240430_MPE Information Requirements TCU2 NA IP67_v11_FCC_new".

The customer thus declares that the device is not body-worn.

RF Exposure Test Exemptions for Single Source

MPE-based Exemption

According 1.1307(b)(3)(i)(C) Option C – ERP at frequencies above 300 kHz but at distances $R > \lambda/2\pi$ can be exempted as follows:

TABLE B.1—THRESHOLDS FOR SINGLE RF SOURCES
SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source Frequency			Minimum Distance			Threshold ERP
f_L MHz		f_H MHz	$\lambda_L / 2\pi$		$\lambda_H / 2\pi$	W
0.3	–	1.34	159 m	–	35.6 m	1,920 R ²
1.34	–	30	35.6 m	–	1.6 m	3,450 R ² /f ²
30	–	300	1.6 m	–	159 mm	3.83 R ²
300	–	1,500	159 mm	–	31.8 mm	0.0128 R ² f
1,500	–	100,000	31.8 mm	–	0.5 mm	19.2R ²

Subscripts L and H are low and high; λ is wavelength.
From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.

SAR-based Exemption

According 1.1307(b)(3)(i)(B) Option B – Available maximum time-averaged power or effective radiated power (ERP) at frequencies above 300 kHz and below 6 GHz, but with distances from 0.5 cm to 40 cm may be exempted as follows:

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases} \quad (\text{B.1})$$

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}}(d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases} \quad (\text{B.2})$$

11/29/2021

where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right)$$

Table B.2—Example Power Thresholds (mW)

Frequency (MHz)	Distance (mm)									
	5	10	15	20	25	30	35	40	45	50
300	39	65	88	110	129	148	166	184	201	217
450	22	44	67	89	112	135	158	180	203	226
835	9	25	44	66	90	116	145	175	207	240
1900	3	12	26	44	66	92	122	157	195	236
2450	3	10	22	38	59	83	111	143	179	219
3600	2	8	18	32	49	71	96	125	158	195
5800	1	6	14	25	40	58	80	106	136	169

Calculation based on external document
 “20240430_MPE Information Requirements TCU2 NA IP67_v11_FCC_new”,
 provided by customer.

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LTE

MPE-based Exemption

Exemption acc. TABLE 1 TO § 1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION																
Band	Technology	Frequency	$\lambda/2\pi$	R	$R \geq \lambda/2\pi$ fulfilled	Maximum Rated Conducted Output Power (dBm)	Maximum Tolerance (dB)	Minimum Path Loss to Antenna connector (dB)	Minimum Path Loss in Antenna cable (dB)	Maximum Antenna Gain (dBi)	Duty Cycle (%)	EIRP (dBm)	ERP (dBm)	ERP (W)	Threshold ERP (W)	MPE Exemption fulfilled
		(MHz)	(m)	(m)												
B71	LTE	663.0	0.072	0.200	yes	22.7	0.0	0.8	0.20	-0.1	100	21.6	19.5	0.088	0.339	yes
		680.5	0.070	0.200	yes							21.6	19.5	0.088	0.348	yes
		698.0	0.068	0.200	yes							21.6	19.5	0.088	0.357	yes
B12	LTE	699.0	0.068	0.200	yes	22.6	0.0	0.8	0.20	0.3	100	21.9	19.8	0.094	0.358	yes
		707.5	0.067	0.200	yes							21.9	19.8	0.094	0.362	yes
		716.0	0.067	0.200	yes							21.9	19.8	0.094	0.367	yes
B26	LTE	814.0	0.059	0.200	yes	22.7	0.0	0.7	0.20	-0.2	100	21.6	19.5	0.088	0.417	yes
		831.5	0.057	0.200	yes							21.6	19.5	0.088	0.426	yes
		849.0	0.056	0.200	yes							21.6	19.5	0.088	0.435	yes
B66	LTE	1710.0	0.028	0.200	yes	22.7	0.0	1.3	0.40	5.3	100	26.3	24.2	0.260	0.768	yes
		1745.0	0.027	0.200	yes							26.3	24.2	0.260	0.768	yes
		1780.0	0.027	0.200	yes							26.3	24.2	0.260	0.768	yes
B25	LTE	1850.0	0.026	0.200	yes	22.7	0.0	1.4	0.40	5.4	100	26.3	24.2	0.260	0.768	yes
		1882.5	0.025	0.200	yes							26.3	24.2	0.260	0.768	yes
		1915.0	0.025	0.200	yes							26.3	24.2	0.260	0.768	yes
B7	LTE	2500.0	0.019	0.200	yes	22.7	0.0	1.5	0.40	7.7	100	28.5	26.4	0.432	0.768	yes
		2535.0	0.019	0.200	yes							28.5	26.4	0.432	0.768	yes
		2570.0	0.019	0.200	yes							28.5	26.4	0.432	0.768	yes

Remark: Only worst case cable and antenna combination is shown.

Bluetooth and BLE

MPE-based Exemption

Exemption acc. TABLE 1 TO § 1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION																
Band	Technology	Frequency	$\lambda/2\pi$	R	$R \geq \lambda/2\pi$ fulfilled	Maximum Rated Conducted Output Power (dBm)	Maximum Tolerance (dB)	Minimum Path Loss to Antenna connector (dB)	Minimum Path Loss in Antenna cable (dB)	Maximum Antenna Gain (dBi)	Duty Cycle (%)	EIRP (dBm)	ERP (dBm)	ERP (W)	Threshold ERP (W)	MPE Exemption fulfilled
		(MHz)	(m)	(m)												
2.4 GHz	Bluetooth	2402.0	0.020	0.200	yes	4.0	4.0	1.0	0.0	5.1	100	12.1	10.0	0.010	0.768	yes
		2442.0	0.020	0.200	yes							12.1	10.0	0.010	0.768	yes
		2480.0	0.019	0.200	yes							12.1	10.0	0.010	0.768	yes
2.4 GHz	Bluetooth LE	2402.0	0.020	0.200	yes	4.0	4.0	1.0	0.0	5.1	100	12.1	10.0	0.010	0.768	yes
		2442.0	0.020	0.200	yes							12.1	10.0	0.010	0.768	yes
		2480.0	0.019	0.200	yes							12.1	10.0	0.010	0.768	yes

WLAN 2.4 GHz

MPE-based Exemption

Exemption acc. TABLE 1 TO § 1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION																	
Band	Technology	Frequency	$\lambda/2\pi$	R	$R \geq \lambda/2\pi$ fulfilled	Maximum Rated Conducted Output Power (dBm)	Maximum Tolerance (dB)	Minimum Path Loss to Antenna connector (dB)	Minimum Path Loss in Antenna cable (dB)	2x2 MIMO (dB)	Maximum Antenna Gain (dBi)	Duty Cycle (%)	EIRP (dBm)	ERP (dBm)	ERP (W)	Threshold ERP (W)	MPE Exemption fulfilled
		(MHz)	(m)	(m)													
2.4 GHz	WLAN	2412.0	0.020	0.200	yes	16.0	2.0	1.0	0.0	0.0	5.1	100	22.1	20.0	0.099	0.768	yes
		2440.0	0.020	0.200	yes								22.1	20.0	0.099	0.768	yes
		2462.0	0.019	0.200	yes								22.1	20.0	0.099	0.768	yes
2.4 GHz	WLAN	2412.0	0.020	0.200	yes	16.0	2.0	1.0	0.0	3.0	5.1	100	25.1	23.0	0.197	0.768	yes
		2440.0	0.020	0.200	yes								25.1	23.0	0.197	0.768	yes
		2462.0	0.019	0.200	yes								25.1	23.0	0.197	0.768	yes

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WLAN 5 GHz

MPE-based Exemption

Exemption acc. TABLE 1 TO § 1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION																	
Band	Technology	Frequency	$\lambda/2\pi$	R	R $\geq \lambda/2\pi$ fulfilled	Maximum Rated Conducted Output Power (dBm)	Maximum Tolerance (dB)	Minimum Path Loss to Antenna connector (dB)	Minimum Path Loss in Antenna cable (dB)	2x2 MIMO (dB)	Maximum Antenna Gain (dBi)	Duty Cycle (%)	EIRP (dBm)	ERP (dBm)	ERP (W)	Threshold ERP (W)	MPE Exemption fulfilled
5.1 GHz	WLAN	5180.0	0.009	0.200	yes	9.5	2.0	1.9	0.0	3.0	3.7	100	16.3	14.2	0.026	0.768	yes
		5200.0	0.009	0.200	yes								16.3	14.2	0.026	0.768	yes
		5240.0	0.009	0.200	yes								16.3	14.2	0.026	0.768	yes
5.2 GHz	WLAN	5240.0	0.009	0.200	yes	9.5	2.0	1.9	0.0	3.0	3.7	100	16.3	14.2	0.026	0.768	yes
		5300.0	0.009	0.200	yes								16.3	14.2	0.026	0.768	yes
		5350.0	0.009	0.200	yes								16.3	14.2	0.026	0.768	yes
5.4 GHz	WLAN	5470.0	0.009	0.200	yes	9.5	2.0	1.9	0.0	3.0	3.7	100	16.3	14.2	0.026	0.768	yes
		5600.0	0.009	0.200	yes								16.3	14.2	0.026	0.768	yes
		5725.0	0.008	0.200	yes								16.3	14.2	0.026	0.768	yes
5.8 GHz	WLAN	5745.0	0.008	0.200	yes	9.5	2.0	1.9	0.0	3.0	3.7	100	16.3	14.2	0.026	0.768	yes
		5805.0	0.008	0.200	yes								16.3	14.2	0.026	0.768	yes
		5825.0	0.008	0.200	yes								16.3	14.2	0.026	0.768	yes

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Simultaneous Transmission

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

Two transmitter active at the same time:

		WLAN 2.4 GHz	WLAN 5 GHz	Bluetooth	Bluetooth LE
	Ratio of Value/Limit	0.256826	0.033856	0.012872	0.012872
LTE B7	0.561874	0.818700	0.595730	0.574746	0.574746
LTE B12	0.263787	0.520613	0.297643	0.276658	0.276658
LTE B25	0.338562	0.595388	0.372419	0.351434	0.351434
LTE B26	0.211400	0.468226	0.245257	0.224272	0.224272
LTE B66	0.338562	0.595388	0.372419	0.351434	0.351434
LTE B71	0.259547	0.516373	0.293404	0.272419	0.272419

Remark: only maximum value in band / mode is shown

Maximum Value	=	0.818700
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One cellular transmitter and all other possible worst case transmitters are active:

	Cellular	WLAN 2.4 GHz	WLAN 5 GHz
Maximum Value	0.561874	0.256826	0.033856

Remark: only maximum value in band / mode is shown

Total Value	=	0.852556
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MPE / SAR exemption letter TR23-1-0041314T005c

Conclusion

MPE-/ SAR Based Exemption fulfilled

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Timo Franke

Version	Applied changes	Date of release
--	Initial release	2024-Jul-08