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RF exposure analysis for the equipment FCC ID: PD93165NG and FCC ID: PD93165NGU; IC: 1000M-3165NG

The device (FCC ID: PD93165NG and FCC ID: PD93165NGU; IC: 1000M-3165NG) is designed as module to be installed in and used in a mixed mobile and portable exposure host platform. Portable exposure conditions are evaluated in a separate exhibit. The analysis provided in this document only covers mobile exposure conditions and for that the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all the persons and must not be co-located or operating in conjunction with any other antenna or transmitter except in the conditions described in this document.

MPE exposure limits

The table below is excerpted from Table 1B of 47 CFR 1.1310 titled Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure:

Frequency Range (MHz)	Power density (mW/cm ²)	Averaging time (minutes)
300 – 1500	f (MHz) /1500	30
1500 – 100.000	1,0	30

The table below is excerpted from RSS-102, Issue 4, 4.2, titled “RF Limits for Devices used by the General Public”:

Frequency Range (MHz)	Power density (W/m ²)	Averaging time (minutes)
300 – 1500	f (MHz) /150	6
1500 – 100.000	10	6

As all the operating frequencies of this device are higher than 1500 MHz, the applicable maximum permissive exposure is: 1 mW/cm².

Using the equation $S = \frac{PG}{4\pi R^2}$ to calculate the exposure to electromagnetic fields

where: S = power density (in appropriate units, e.g. mW/cm²)
P = power input to the antenna (in appropriate units, e.g., mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Compliance with FCC and IC maximum permissive exposure limits is demonstrated based on the following calculations.

1. Standalone operations analysis

DSS GRANT (Bluetooth Basic and EDR)																			
Frequency band (MHz)	Mode	BW (MHz)	Channel / Freq.	Data Rate	CONDUCTED OUTPUT POWER					ANTENNA GAIN		Duty cycle (%)	Evaluation distance (cm)	Power density (mW/cm ²)	FCC/IC MPE limit (mW/cm ²)	MPE RATIO			
					SISO Chain A Measured Value (dBm)	SISO Chain A Measured Value (mW)	SISO Chain B Measured Value (dBm)	SISO Chain B Measured Value (mW)	Worst Case Conducted Output Power (mW)	Antenna gain (dBi)	Antenna gain (numerical)								
2400-2483,5	Bluetooth BR (Modulation: GFSK)	1	0 / 2402	1 Mbps	n/a	n/a	5.11	3.243	3.443	3.24	2.11	100%	20	0.002	1.000	0.002			
			40 / 2441		n/a	n/a	5.34	3.420	3.443	3.24	2.11	100%	20	0.002	1.000	0.002			
			79 / 2480		n/a	n/a	5.37	3.443	3.443	3.24	2.11	100%	20	0.002	1.000	0.002			
		2 Mbps	0 / 2402	n/a	n/a	3.97	2.495	2.742	3.24	2.11	100%	20	0.002	1.000	0.002				
			40 / 2441	n/a	n/a	4.23	2.649	2.742	3.24	2.11	100%	20	0.002	1.000	0.002				
	Bluetooth EDR (Modulation: Π/4-DQPSK)	1.5	79 / 2480	n/a	n/a	4.38	2.742	2.742	3.24	2.11	100%	20	0.002	1.000	0.002				
			0 / 2402	n/a	n/a	3.35	2.163	2.296	3.24	2.11	100%	20	0.001	1.000	0.001				
			40 / 2441	n/a	n/a	3.61	2.296	2.296	3.24	2.11	100%	20	0.001	1.000	0.001				
		3 Mbps	79 / 2480	n/a	n/a	3.55	2.265	2.265	3.24	2.11	100%	20	0.001	1.000	0.001				
			DTS GRANT (Bluetooth Low Energy operation + WLAN operation in 2400-2483,5 MHz and 5725-5850 MHz frequency bands)																
Frequency band (MHz)	Mode	BW (MHz)	Channel / Freq.	Data Rate	CONDUCTED OUTPUT POWER					ANTENNA GAIN		Duty cycle (%)	Evaluation distance (cm)	Power density (mW/cm ²)	FCC/IC MPE limit (mW/cm ²)	MPE RATIO			
					SISO Chain A Measured Value (dBm)	SISO Chain A Measured Value (mW)	SISO Chain B Measured Value (dBm)	SISO Chain B Measured Value (mW)	Worst Case Conducted Output Power (mW)	Antenna gain (dBi)	Antenna gain (numerical)								
2400-2483,5	Bluetooth Low Energy (Modulation: GFSK)	1	0 / 2402	200 kbps	n/a	n/a	3.29	2.133	2.133	3.24	2.11	100%	20	0.001	1.000	0.001			
			40 / 2441		n/a	n/a	3.51	2.244	2.244	3.24	2.11	100%	20	0.001	1.000	0.001			
			79 / 2480		n/a	n/a	3.44	2.208	2.208	3.24	2.11	100%	20	0.001	1.000	0.001			
			802.11b		20	1 / 2412	16.12	0.041	16.33	42.954	42.954	3.24	2.11	100%	20	0.019	1.000	0.019	
			6 / 2437		17.21	0.053	17.31	53.827	53.827	3.24	2.11	100%	20	0.023	1.000	0.023			
2400-2483,5	802.11g	20	11 / 2462	1 Mbps	16.55	0.045	16.20	41.687	41.687	3.24	2.11	100%	20	0.018	1.000	0.018			
			1 / 2412		13.91	0.025	14.37	30.353	30.353	3.24	2.11	100%	20	0.012	1.000	0.012			
			6 / 2437		17.19	0.052	17.60	57.544	57.544	3.24	2.11	100%	20	0.025	1.000	0.025			
			11 / 2462		12.13	0.016	12.64	18.365	18.365	3.24	2.11	100%	20	0.008	1.000	0.008			
			1 / 2412		13.76	0.024	14.65	29.174	29.174	3.24	2.11	100%	20	0.013	1.000	0.013			
	802.11n	20	6 / 2437	6 Mbps	17.19	0.052	17.64	50.814	50.814	3.24	2.11	100%	20	0.026	1.000	0.026			
			11 / 2462		12.15	0.016	12.18	16.520	16.520	3.24	2.11	100%	20	0.007	1.000	0.007			
			3 / 2422		13.27	0.021	13.54	22.594	22.594	3.24	2.11	100%	20	0.01	1.000	0.01			
			6 / 2437		17.25	0.053	17.34	54.200	54.200	3.24	2.11	100%	20	0.023	1.000	0.023			
			9 / 2452		12.29	0.027	12.48	38.428	38.428	3.24	2.11	100%	20	0.008	1.000	0.008			
5725-5850	802.11a	20	149 / 5745	6 Mbps	15.27	0.034	15.02	31.769	31.769	4.97	3.14	100%	20	0.02	1.000	0.02			
			157 / 5785		15.67	0.037	14.70	29.512	29.512	4.97	3.14	100%	20	0.019	1.000	0.019			
			165 / 5825		15.42	0.035	15.35	34.277	34.277	4.97	3.14	100%	20	0.022	1.000	0.022			
			149 / 5745		15.49	0.035	15.13	32.584	32.584	4.97	3.14	100%	20	0.021	1.000	0.021			
			157 / 5785		15.26	0.034	14.89	30.761	30.761	4.97	3.14	100%	20	0.02	1.000	0.02			
	802.11n	20	165 / 5825	HT4	15.36	0.034	14.89	30.832	30.832	4.97	3.14	100%	20	0.02	1.000	0.02			
			151 / 5755		16.29	0.043	16.21	41.783	41.783	4.97	3.14	100%	20	0.027	1.000	0.027			
			802.11n		40	159 / 5795	HT4	16.29	0.043	16.15	41.210	41.210	4.97	3.14	100%	20	0.026	1.000	0.026
			802.11ac		80	155 / 5775	VHT6	16.42	0.044	16.63	46.026	46.026	4.97	3.14	100%	20	0.029	1.000	0.029
			U-NII GRANT (WLAN operation in 5150-5250 MHz, 5250-5350 MHz, 5470-5725 and 5725-5825 MHz frequency bands)																
Frequency band (MHz)	Mode	BW (MHz)	Channel / Freq.	Data Rate	CONDUCTED OUTPUT POWER					ANTENNA GAIN		Duty cycle (%)	Evaluation distance (cm)	Power density (mW/cm ²)	FCC/IC MPE limit (mW/cm ²)	MPE RATIO			
					SISO Chain A Measured Value (dBm)	SISO Chain A Measured Value (mW)	SISO Chain B Measured Value (dBm)	SISO Chain B Measured Value (mW)	Worst Case Conducted Output Power (mW)	Antenna gain (dBi)	Antenna gain (numerical)								
5150-5250	802.11a	20	36 / 5180	6 Mbps	14.10	0.026	13.79	23.933	23.933	3.64	2.31	100%	20	0.012	1.000	0.012			
			40 / 5200		14.45	0.028	14.45	27.861	27.861	3.64	2.31	100%	20	0.013	1.000	0.013			
			48 / 5240		14.38	0.027	14.47	27.990	27.990	3.64	2.31	100%	20	0.013	1.000	0.013			
			36 / 5180		13.73	0.024	13.91	24.604	24.604	3.64	2.31	100%	20	0.012	1.000	0.012			
			40 / 5200		14.38	0.027	14.54	28.445	28.445	3.64	2.31	100%	20	0.014	1.000	0.014			
	802.11n	20	48 / 5240	HT4	14.53	0.028	14.49	28.119	28.119	3.64	2.31	100%	20	0.013	1.000	0.013			
			38 / 5190		11.73	0.015	13.12	20.512	20.512	3.64	2.31	100%	20	0.01	1.000	0.01			
			46 / 5230		16.40	0.044	16.20	41.687	41.687	3.64	2.31	100%	20	0.02	1.000	0.02			
			802.11ac		80	42 / 5210	VHT6	13.69	0.023	13.79	23.933	23.933	3.64	2.31	100%	20	0.012	1.000	0.012
			5250-5350		802.11a	20	52 / 5260	6 Mbps	15.49	0.035	15.30	38.905	38.905	3.73	2.36	100%	20	0.019	1.000
60 / 5300	15.33	0.034		15.70			37.154		37.154	3.73	2.36	100%	20	0.018	1.000	0.018			
64 / 5320	13.18	0.021		13.21			20.941		20.941	3.73	2.36	100%	20	0.01	1.000	0.01			
52 / 5260	15.28	0.034		15.81			38.107		38.107	3.73	2.36	100%	20	0.018	1.000	0.018			
60 / 5300	15.67	0.037		15.81			38.107		38.107	3.73	2.36	100%	20	0.018	1.000	0.018			
802.11n	20	64 / 5320		HT4	13.28	0.021	13.21	20.941	20.941	3.73	2.36	100%	20	0.01	1.000	0.01			
		54 / 5270			16.21	0.042	16.21	41.783	41.783	3.73	2.36	100%	20	0.02	1.000	0.02			
		62 / 5310			13.21	0.021	13.15	20.654	20.654	3.73	2.36	100%	20	0.01	1.000	0.01			
		802.11ac			80	58 / 5290	VHT6	13.20	0.021	13.32	21.478	21.478	3.73	2.36	100%	20	0.011	1.000	0.011
		5470-5725			802.11a	20	100 / 5500	6 Mbps	13.58	0.023	13.18	20.797	20.797	4.77	3.00	100%	20	0.013	1.000
120 / 5600	15.44		0.035	15.71			37.259		37.259	4.77	3.00	100%	20	0.023	1.000	0.023			
140 / 5700	13.00		0.020	13.14			20.606		20.606	4.77	3.00	100%	20	0.013	1.000	0.013			
100 / 5500	13.30		0.021	13.29			21.330		21.330	4.77	3.00	100%	20	0.013	1.000	0.013			
120 / 5600	15.44		0.035	16.22			41.879		41.879	4.77	3.00	100%	20	0.025	1.000	0.025			
5725-5825: Only Channels 138, 142, 144 that straddle 5725 MHz limit of U-NII-2 frequency band	802.11n		20	140 / 5700	HT4	12.71	0.019	12.82	19.143	19.143	4.77	3.00	100%	20	0.012	1.000	0.012		
				102 / 5510		13.22	0.021	13.21	20.941	20.941	4.77	3.00	100%	20	0.013	1.000	0.013		
				118 / 5590		16.17	0.041	16.20	41.687	41.687	4.77	3.00	100%	20	0.025	1.000	0.025		
				134 / 5570		16.22	0.042	16.73	47.098	47.098	4.77	3.00	100%	20	0.029	1.000	0.029		
				144 / 5720 (*)		15.47	0.035	16.37	43.378	43.378	4.77	3.00	100%	20	0.026	1.000	0.026		
802.11ac	40	142 / 5710 (C)	VHT6	16.22	0.042	16.39	43.568	43.568	4.77	3.00	100%	20	0.026	1.000	0.026				
		106 / 5530		13.52	0.022	13.67	23.281	23.281	4.77	3.00	100%	20	0.014	1.000	0.014				
		122 / 5610		16.50	0.045	16.55	45.186	45.186	4.77	3.00	100%	20	0.027	1.000	0.027				
802.11ac	80	138 / 5690 (C)	VHT6	16.41	0.044	16.42	43.891	43.891	4.77	3.00	100%	20	0.027	1.000	0.027				
(*) Total output power of the channel calculated by summing mathematically the power integrated in each sub-band in linear power units.																			

(*): Total output power of the channel calculated by summing mathematically the power integrated in each sub-band in linear power units

Under all conditions the equipment complies with the FCC/IC MPE limits and the maximum MPE ratio obtained is **0.029**.



2. Co-location analysis

2.1. Co-location with other transmitter in mobile exposure conditions

According to KDB 447498 D01 General RF Exposure Guidance v05r02, 7.2:

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density, is ≤ 1.0 .

As the maximum calculated MPE ratio for the device is **0,029**, the product can be co-located with other antennas providing that the sum of the MPE ratios for all the other simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density is $\leq 1.0 - 0,029 = 0,971$.

2.2. Co-location with other transmitter in mixed mobile and portable host platform exposure conditions

According to KDB 447498 D01 General RF Exposure Guidance v05r02, 7.2:

When one of the following test exclusion conditions is satisfied for all combinations of simultaneous transmission configurations, further equipment approval is not required to incorporate transmitter modules in host devices that operate in the mixed mobile and portable host platform exposure conditions. The grantee is responsible for documenting this according to Class I permissive change requirements. Antennas that qualify for standalone SAR test exclusion must apply the estimated standalone SAR to determine simultaneous transmission test exclusion.

- The $[\Sigma \text{ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg}] + [\Sigma \text{ of MPE ratios}]$ is ≤ 1.0 .
- The SAR to peak location separation ratios of all simultaneous transmitting antenna pairs operating in portable exposure conditions are all ≤ 0.04 and the $[\Sigma \text{ of MPE ratios}]$ is ≤ 1.0 .

As the maximum calculated MPE ratio for the device is **0,029**, the equipment can be co-located with other transmitters in a mixed mobile and portable conditions providing that the exposure of the co-located transmitter complies with:

- The $[\Sigma \text{ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg}] + [\Sigma \text{ of MPE ratios}]$ is $\leq 1.0 - 0,029 = 0,971$

OR

- The SAR to peak location separation ratios of all simultaneous transmitting antenna pairs operating in portable exposure conditions are all ≤ 0.04 and the $[\Sigma \text{ of MPE ratios}]$ is $\leq 1.0 - 0,029 = 0,971$

Sincerely,

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