

EXHIBIT 1. RF EXPOSURE REQUIREMENTS [§§ 15.247(i), 1.1310 & 2.1091]

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

1.1. Method of Measurements

Calculation Method of Power Density/RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where,

P: power input to the antenna in mW

EIRP: Equivalent (effective) isotropic radiated power.

S: power density mW/cm²

G: numeric gain of antenna relative to isotropic radiator

r: distance to centre of radiation in cm

1.2. RF Evaluation

Pursuant to KDB 447498 D01 General RF Exposure Guidance v06, Section 7.2:

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 modeled, or measured field strengths or power density.

The EUT is subject to co-location MPE evaluation, below table are the possible options:

Source Option	Lyngsoe Systems WiFi and Bluetooth Module (FCC ID: PQG-XREADER)	Impinj, Inc., RFID Reader Module, (FCC ID: TWYIPJREV)	JADAK, a business unit of Novanta Corporation (FCC ID: QV5MERCURY6E-M)	Quectel Wireless Solutions Co., Ltd. LTE Module (FCC ID: XMR201906EG21G)	Telit Communications S.p.A. LTE Module, (FCC ID: RI7LE910CXNF)
1	X	X		X	
2	X	X			X
3	X	X			
4	X		X	X	
5	X		X		X
6	X		X		
7	X			X	
8	X				X

Co-location evaluation is evaluated at a separation distance of 55 cm. The table below is the calculation for all the possible options and the sum of the MPE ratios from all sources.

Source Option	Maximum MPE Ratio					Sum of the MPE ratios from all sources
	Lyngsoe Systems WiFi and Bluetooth Module (FCC ID: PQG- XREADER)	Impinj, Inc., RFID Reader Module, (FCC ID: TWYIPJREV)	JADAK, a business unit of Novanta Corporation (FCC ID: QV5MERCURY6E-M)	Quectel Wireless Solutions Co., Ltd. LTE Module (FCC ID: XMR201906EG21G)	Telit Communications S.p.A. LTE Module, (FCC ID: RI7LE910CXNF)	
1	0.008	0.174	--	0.223	--	0.405
2	0.008	0.174	--	--	0.069	0.251
3	0.008	0.174	--	--	--	0.182
4	0.008	--	0.174	0.223	--	0.405
5	0.008	--	0.174	--	0.069	0.251
6	0.008	--	0.174	--	--	0.182
7	0.008	--	--	0.223	--	0.231
8	0.008	--	--	--	0.069	0.077

The sum of the MPE ratios from all sources is < 1 . Thus, in compliant with general public (uncontrolled environment) MPE limit.

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For detailed MPE ratios calculation, refer to the following tables.

Calculated MPE Ratio for Lyngsoe Systems WiFi and Bluetooth Module									
Band	Frequency (MHz)	² Antenna Gain (dBi)	¹ Maximum Power (dBm)	¹ Maximum EIRP (dBm)	¹ Maximum EIRP (W)	¹ Average EIRP (mW)	Power Density at 55cm (mW/cm ²)	MPE Limit (mW/cm ²)	MPE Ratio
Bluetooth	2402	3.2	12.5	15.7	0.037	37.154	0.001	1.000	0.001
2.4GHz WLAN	2412	3.2	17.5	20.7	0.117	117.49	0.003	1.000	0.003
5GHz WLAN	5180	4.5	19.5	24	0.251	251.189	0.007	1.000	0.007
Sum of MPE Ratios from Bluetooth and 5GHz WLAN:									0.008
¹ Data derived from Texas Instruments WiFi and Bluetooth Module MPE test report, Test Report No. FA741330.									
² Maximum permitted antenna gain.									

Calculated MPE Ratio for Impinj, Inc. RFID Reader								
Operating Band (MHz)	Frequency (MHz)	¹ Power (dBm)	² Ant Type/ Gain (dBi)	¹ EIRP (dBm)	Distance (cm)	MPE (mW/cm ²)	MPE Limit (mW/cm ²)	MPE Ratio
902-928	902.75	30	6	36	55	0.105	0.602	0.174
¹ Data derived from Impinj, Inc., RFID Reader MPE test report, Test Report No. 101403-9.								
² Maximum permitted antenna gain.								

Calculated MPE Ratio for JADAK, a business unit of Novanta Corporation RFID Reader								
Operating Band (MHz)	Frequency (MHz)	¹ Power (dBm)	² Ant Type/ Gain (dBi)	¹ EIRP (dBm)	Distance (cm)	MPE (mW/cm ²)	MPE Limit (mW/cm ²)	MPE Ratio
902-928	902.75	30	6	36	55	0.105	0.602	0.174
¹ Data derived from JADAK, a business unit of Novanta Corporation, RFID Reader MPE test report, Test Report No. N/A								
² Maximum permitted antenna gain.								

Calculated MPE Ratio for Quectel LTE Module										
Operating Band	Frequency (MHz)	¹ Max Conducted Average Output Power (dBm)	¹ Output Power to Antenna (dBm)	² Max Gain Allowed (dBi)	Max. E.I.R.P. (dBm)	Max. E.I.R.P. (W)	Evaluation Distance (m)	Power Density (W/m ²)	MPE Limit (W/m ²)	MPE Ratio
GSM850	824.2	25.81	25.95	8.60	34.55	2851.018	55	0.075	0.549	0.137
GSM1900	1850.2	22.81	24.40	10.19	34.59	2877.398	55	0.076	1.000	0.076
WCDMA B2	1852.4	25.00	26.59	8.00	34.59	2877.398	55	0.076	1.000	0.076
WCDMA B4	1712.4	25.00	27.00	5.00	32.00	1584.893	55	0.042	1.000	0.042
WCDMA B5	826.4	25.00	25.14	9.42	34.56	2857.591	55	0.075	0.551	0.136
LTE B2	1850.7	25.00	26.59	8.00	34.59	2877.398	55	0.076	1.000	0.076
LTE B4	1710.7	25.00	27.00	5.00	32.00	1584.893	55	0.042	1.000	0.042
LTE B5	824.7	25.00	25.14	9.41	34.55	2851.018	55	0.075	0.550	0.136
LTE B7	2502.5	25.00	28.00	8.00	36.00	3981.072	55	0.105	1.000	0.105
LTE B12	699.7	25.00	26.11	8.70	34.81	3026.913	55	0.080	0.466	0.172
LTE B13	779.5	25.00	27.30	9.16	36.46	4425.884	55	0.116	0.520	0.223
LTE B25	1850.7	25.00	26.59	8.00	34.59	2877.398	55	0.076	1.000	0.076
LTE B26(814-824)	814.7	25.00	25.38	9.36	34.74	2978.516	55	0.078	0.543	0.144
LTE B26(824-849)	824.7	25.00	25.38	9.41	34.79	3013.006	55	0.079	0.550	0.144
LTE B38	2572.5	25.00	27.06	8.00	35.06	3206.269	55	0.084	1.000	0.084
LTE B41	2498.5	25.00	28.00	8.00	36.00	3981.072	55	0.105	1.000	0.105
¹ Data derived from Quectel LTE Module MPE test report, Test Report No. HR/2019/10016E-0102.										
² Maximum permitted antenna gain.										

Calculated MPE Ratio for Telit Communications S.p.A. WCDMA and LTE Cellular Wireless Module										
Band	Frequency (MHz)	¹ Maximum conducted output power (per tune-up) (dBm)	Duty Cycle (%)	² Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm ²)	FCC MPE Limit (mW/cm ²)	MPE Ratio
FDD 71	663.0	25.00	100,0%	5.63	30.63	1156.11	55	0.030	0.442	0.069
FDD 12	699.0	25.00	100,0%	5.63	30.63	1156.11	55	0.030	0.466	0.065
FDD 13	777.0	25.00	100,0%	5.94	30.94	1241.65	55	0.033	0.518	0.063
FDD 14	788.0	25.00	100,0%	5.94	30.94	1241.65	55	0.033	0.525	0.062
WCDMA Band V	826.4	25.00	100,0%	6.12	31.12	1294.20	55	0.034	0.551	0.062
FDD 5	824.0	25.00	100,0%	6.12	31.12	1294.20	55	0.034	0.549	0.062
FDD 4	1710.0	25.00	100,0%	5.00	30.00	1000.00	55	0.026	1.0	0.026
FDD 66	1710.0	25.00	100,0%	5.00	30.00	1000.00	55	0.026	1.0	0.026
WCDMA Band IV	1710.0	25.00	100,0%	5.00	30.00	1000.00	55	0.026	1.0	0.026
WCDMA Band II	1850.0	25.00	100,0%	8.01	33.01	1999.86	55	0.053	1.0	0.053
FDD 2	1850.0	25.00	100,0%	8.01	33.01	1999.86	55	0.053	1.0	0.053
¹ Data derived from Telit LTE Module MPE test report, Test Report No. 57536_LE910C4-NF.										
² Maximum permitted antenna gain.										

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