5.4. RF EXPOSURE REQUIRMENTS [§§ 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.

5.4.1. 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/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

5.4.2. 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 option(s):

Source / Option	Lyngsoe Systems Ltd. Active RFID Reader	Lyngsoe Systems Ltd. WiFi and Bluetooth Module (FCC ID: Z64-WL18DBMOD)	Lyngsoe Systems Ltd. UHF RFID Reader Module (FCC ID: PQG-MERCURY6E-M)	Telit Communications S.p.A. Data Terminal Module (FCC ID: RI7LE910CXWWX)
1	X	X	X	--
2	X	X	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.

	Maximum MPE Ratio				Sum of MPE ratios from all sources
Source / Option	Lyngsoe Systems Ltd. Active RFID Reader	Lyngsoe Systems Ltd. WiFi and Bluetooth Module (FCC ID: Z64-WL18DBMOD)	Lyngsoe Systems Ltd. UHF RFID Reader Module (FCC ID: PQG-MERCURY6E-M)	Telit Communications S.p.A. Data Terminal Module (FCC ID: RI7LE910CXWWX)	
1	0.00007	0.008	0.169	--	**0.177**
2	0.00007	0.008	0.169	0.133	**0.310**

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

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

Calculated MPE Ratio for Lyngsoe Systems Ltd. Active RFID Reader					
Frequency (MHz)	***EUT EIRP (mW)**	**Evaluation Distance (cm)**	**Power Density (mW/cm^2)**	**MPE Limit (mW/cm^2)**	**MPE Ratio**
0.125	--	--	--	--	**--**
433.92	0.589	55	0.00002	0.289	**0.00007**

*EIRP is calculated from the measured field strength and measurement distance using formula: EIRP = $(E \times d)^2/30$, where: E = electric field strength in V/m and d = measurement distance in meters (m).

Measured max. field strength for 433.92 MHz Tx at 3m = 92.93 dBuV/m = 0.04431 V/m
EIRP = $(E \times d)^2/30 = (0.04431 \times 3)^2/30 = 0.000589$ W = 0.589 mW

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Calculated MPE Ratio for Texas Instruments 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 RF exposure evaluation test report, Test Report No. FA741330.
[2] Maximum permitted antenna gain.

Calculated MPE Ratio for Lyngsoe Systems Ltd. UHF RFID Reader Module								
Frequency (MHz)	**[1] Maximum Conducted Power (dBm)**	**[1] Antenna Gain (dBi)**	**EIRP (dBm)**	**EIRP (mW)**	**Distance (cm)**	**MPE (mW/cm^2)**	**Limit (mW/cm^2)**	**MPE Ratio**
902.625	29	6.9	35.9	3890.451	55	0.102	0.602	**0.169**

[1] Data derived from Lyngsoe Systems Ltd., UHF RFID Reader Module test report, Test Report No. 23LYI-213_FCC15C247

Calculated MPE Ratio for Telit Communications S.p.A. Data Terminal Module							
Band / Mode	**Frequency (MHz)**	**[1] Max Power (dBm)**	**[1] Maximum Permissive Antenna Gain (dBi)**	**Evaluation Distance (cm)**	**Power Density (mW/cm^2)**	**MPE Limit (mW/cm^2)**	**MPE Ratio**
GSM/GPRS Cell	824.2 - 848.8	27.5	6.91	55	0.073	0.549	**0.133**
EDGE Cell	824.2 - 848.9	22	12.41	55	0.073	0.549	**0.133**
GSM/GPRS PCS	1850.2 - 1909.8	24.5	8.51	55	0.053	1.000	0.053
EDGE PCS	1850.2 - 1909.8	21	12.01	55	0.053	1.000	0.053
WCDMA Cell	826.4 - 846.6	24.5	9.92	55	0.073	0.551	0.132
WCDMA AWS	1712.4 - 1752.6	24.5	5.50	55	0.026	1.000	0.026
WCDMA PCS	1852.4 - 1907.6	24.5	8.51	55	0.053	1.000	0.053
LTE BAND25/2	1850.7 -1914.3	24	9.01	55	0.053	1.000	0.053
LTE BAND4	1710.7 - 1754.3	24	6.00	55	0.026	1.000	0.026
LTE BAND26/5	824.7 - 848.3	24	10.41	55	0.073	0.550	**0.133**
LTE BAND7	2502.5 - 2567.5	24	9.01	55	0.053	1.000	0.053
LTE BAND8	898.2 - 899.8	24	10.79	55	0.079	0.599	0.132
LTE BAND12	699.7 - 715.3	24	9.70	55	0.062	0.466	**0.133**
LTE BAND13	779.5 - 784.5	24	10.17	55	0.069	0.520	**0.133**
LTE BAND14	790.5 - 795.5	24	10.23	55	0.070	0.527	**0.133**
LTE Band26(Part.90)	814.7 - 823.3	24	10.36	55	0.072	0.543	**0.133**

[1] Data derived from Telit Data Terminal Module MPE test report, Test Report No. 1M2106040065-03.RI7.