

RF EXPOSURE EVALUATION

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency(RF) Radiation as specified in §1.1307(b)

FCC ID: 2BVVH260015ASTD

EUT Specification

EUT	Solar Luminaire Controller		
Frequency (Operating)	band	BLE: 2.402GHz-2.480GHz	
	4G Band	TX (MHz)	Rx (MHz)
	NB-IoT Band5	824~ 849	869~894
	NB-IoT Band 2	1850 ~ 1910	1930 ~ 1990
	NB-IoT Band 25	1850 ~ 1915	1930 ~ 1995
	NB-IoT Band 4	1710 ~ 1755	2110~ 2155
	NB-IoT Band 12	699 ~ 716	729~ 746
	NB-IoT Band 13	777~787	746 ~ 756
	NB-IoT Band 17	704~716	734~ 746
	NB-IoT Band 66	1710~1780	2110~2180
	LTE eMTC Band 26	824~ 849	869~894
	LTE eMTC Band 2	1850 ~ 1910	1930 ~ 1990
	LTE eMTC Band 25	1850 ~ 1915	1930 ~ 1995
	LTE eMTC Band 4	1710 ~ 1755	2110~ 2155
	LTE eMTC Band 12	699 ~ 716	729~ 746
	LTE eMTC Band 13	777~787	746 ~ 756
	LTE eMTC Band 66	1710~1780	2110~2180
	LTE eMTC Band 26	814~ 824	859~869
	LTE eMTC Band 5	824~ 849	869~894
Device category	☐ Portable (<20cm separation) ☒ Mobile (>20cm separation)		
Exposure classification	☐ Occupational/Controlled exposure (S = 5mW/cm ²) ☒ General Population/Uncontrolled exposure (S=1mW/cm ²)		
Antenna diversity	☐ Single antenna ☒ Multiple antennas ☐ Tx diversity ☐ Rx diversity ☐ Tx/Rx diversity		
Evaluation applied	☒ MPE Evaluation ☐ SAR Evaluation		

Limits for Maximum Permissible Exposure(MPE)

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density(mW/cm ²)	Average Time
(A) Limits for Occupational/Control Exposures				
300-1500	--	--	F/300	6
1500-100000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300-1500	--	--	F/1500	6
1500-100000	--	--	1	30

Friis transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where

P_d = Power density in mW/cm², P_{out} =output power to antenna in mW.

G = gain of antenna in linear scale, $\pi=3.1416$

R = distance between observation point and center of the radiator in cm=20cm

P_d the limit of MPE, 1mW/cm². If we know the maximum gain of the antenna and total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

For multiple RF sources: Multiple RF sources are exempt if:

in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation

$$\sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

$Evaluated_k$: the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

$Exposure Limit_k$: either the general population/uncontrolled maximum permissible exposure (MPE) or specific Absorption rate (SAR) limit for each fixed, mobile, or portable RF source k .

Measurement Result

4G:

Band	Maximum Conducted Output Power (dBm)	
	(dBm)	(mW)
LTE eMTC Band 2	25.70	371.535
LTE eMTC Band 4	25.70	371.535
LTE eMTC Band 5	25.70	371.535
LTE eMTC Band 12	25.70	371.535
LTE eMTC Band 13	25.70	371.535
LTE eMTC Band 25	25.70	371.535
LTE eMTC Band 26	25.70	371.535
LTE eMTC Band 66	25.70	371.535
NB-IoT Band 2	25.70	371.535
NB-IoT Band 4	25.70	371.535
NB-IoT Band 5	25.70	371.535
NB-IoT Band 12	25.70	371.535
NB-IoT Band 13	25.70	371.535
NB-IoT Band 17	25.70	371.535
NB-IoT Band 25	25.70	371.535
NB-IoT Band 66	25.70	371.535

Note:

Numeric gain (G)= $10^{(\text{antenna gain}/10)}$

The numeric gain (G) of the antenna with a gain specified in dB is determined by

Band	The maximum permissible exposure (mW/cm ²)
LTE eMTC Band 2	1.000
LTE eMTC Band 4	1.000
LTE eMTC Band 5	0.566
LTE eMTC Band 12	0.477
LTE eMTC Band 13	0.525
LTE eMTC Band 25	1.000
LTE eMTC Band 26	0.566
LTE eMTC Band 66	1.000
NB-IoT Band 2	1.000
NB-IoT Band 4	1.000
NB-IoT Band 5	0.566
NB-IoT Band 12	0.477
NB-IoT Band 13	0.525
NB-IoT Band 17	0.469
NB-IoT Band 25	1.000
NB-IoT Band 66	1.000

Note: The maximum permissible exposure for 300~1500 MHz is $f/1500$, for 1500~100,000MHz.

Band	Maximum Conducted Output Power (dBm)	EIRP Limit (dBm)	Margin1 (dB)	Power density Limit		Margin2 (dB)	Final Margin (dB)	Gain (dBi)
LTE eMTC Band 2	25.70	33.000	7.300	1.000	37.013	11.313	7.300	7.300
LTE eMTC Band 4	25.70	30.000	4.300	1.000	37.013	11.313	4.300	4.300
LTE eMTC Band 5	25.70	40.600	14.900	0.566	34.541	8.841	8.841	8.841
LTE eMTC Band 12	25.70	36.850	11.150	0.477	33.798	8.098	8.098	8.098
LTE eMTC Band 13	25.70	36.850	11.150	0.525	34.214	8.514	8.514	8.514
LTE eMTC Band 25	25.70	33.000	7.300	1.000	37.013	11.313	7.300	7.300
LTE eMTC Band 26	25.70	40.600	14.900	0.566	34.541	8.841	8.841	8.841
LTE eMTC Band 66	25.70	30.000	4.300	1.000	37.013	11.313	4.300	4.300
NB-IoT Band 2	25.70	33.000	7.300	1.000	37.013	11.313	7.300	7.300
NB-IoT Band 4	25.70	30.000	4.300	1.000	37.013	11.313	4.300	4.300
NB-IoT Band 5	25.70	40.600	14.900	0.566	34.541	8.841	8.841	8.841
NB-IoT Band 12	25.70	36.850	11.150	0.477	33.798	8.098	8.098	8.098
NB-IoT Band 13	25.70	36.850	11.150	0.525	34.214	8.514	8.514	8.514
NB-IoT Band 17	25.70	36.850	11.150	0.469	33.724	8.024	8.024	8.024
NB-IoT Band 25	25.70	33.000	7.300	1.000	37.013	11.313	7.300	7.300
NB-IoT Band 66	25.70	30.000	4.300	1.000	37.013	11.313	4.300	4.300

Note:

1. The Maximum allowed antenna gain per Band should be less than or equal to the Final Margin which is the allowable maximum gain value to comply with limits for maximum permissible exposure (MPE).
2. The Final Margin is determined and selected to the worst-case of Margin1 and Margin2.
3. $\text{Margin1} = \text{EIRP Limit (dBm)} - \text{Maximum Conducted Power (dBm)}$. EIRP limit reference standard part22/part24/part27 and part90 for each band, $\text{EIRP} = \text{ERP} + 2.15 \text{ (dB)}$.
4. $\text{Margin2} = \text{Power density Limit (dBm)} - \text{Maximum Conducted Power (dBm)}$. Power density Limit (dBm): The max. obtained by MPE with 20cm.

IMPORTANT NOTE: To comply with the FCC RF exposure compliance requirements, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. No change to the antenna or the device is permitted. Any change to the antenna or the device could result in the device exceeding the RF exposure requirements and void user's authority to operate the device.

Band	PG (mW)	Test Result (mW/cm ²)	Limit Value (mW/cm ²)	Conclusion
LTE eMTC Band 2	1995.262	0.397	1.000	Pass
LTE eMTC Band 4	1000.000	0.199	1.000	Pass
LTE eMTC Band 5	2845.116	0.566	0.566	Pass
LTE eMTC Band 12	2397.728	0.477	0.477	Pass
LTE eMTC Band 13	2638.761	0.525	0.525	Pass
LTE eMTC Band 25	1995.262	0.397	1.000	Pass
LTE eMTC Band 26	2845.116	0.566	0.566	Pass
LTE eMTC Band 66	1000.000	0.199	1.000	Pass
NB-IoT Band 2	1995.262	0.397	1.000	Pass
NB-IoT Band 4	1000.000	0.199	1.000	Pass
NB-IoT Band 5	2845.116	0.566	0.566	Pass
NB-IoT Band 12	2397.728	0.477	0.477	Pass
NB-IoT Band 13	2638.761	0.525	0.525	Pass
NB-IoT Band 17	2357.219	0.469	0.469	Pass
NB-IoT Band 25	1995.262	0.397	1.000	Pass
NB-IoT Band 66	1000.000	0.199	1.000	Pass

Note: For transmitters, minimum separation distance is 20cm, even if calculations indicate MPE distance is less.

BLE:

Mode	Max Measured Power (dBm)	Tune up tolerance (dBm)	Max tune up conducted power(dBm)	Output Peak power (mW)	Ant. Gain (dBi)	Ant. Gain (numeric)	Power density at 20cm (mW/ cm ²)	Power density Limits (mW/ cm ²)
BLE	4.579	5±1	6	3.981	-1	0.794	0.000629	1

Maximum Simultaneous transmission MPE Ratio for 4G & 2.4G BLE

Maximum MPE ratio (4G)	Maximum MPE ratio (2.4G BLE)	Σ MPE ratios	Limit	Results
0.566	0.000629	0.566629	1.000	Pass

Signature:



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