MPE Calculation

Applicant:	Neutron Holdings, Inc.
Address:	85 2nd St, San Francisco, CA 94105 USA
Product:	CCU
FCC ID:	2APB2-LIME-CCU23
Model No.:	Lime-CCU23
Reference RF report #	709502403822-00A, 709502403822-00C, 709502403822-00D, 709502403822-00E, 709502403822-00F, 709502403822-00G, 202415010745

According to subpart 15.247(i) and subpart §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
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
300–1,500	/	/	f/1500	30
1,500–100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:
Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);

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, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

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5G Wi-Fi Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	14.57
Maximum peak output power at antenna input terminal (mW):	28.64
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	3.52
Maximum Antenna Gain (numeric):	2.25
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.01282
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

The max power density 0.01282 (mW/cm2) < 1 (mW/cm2)

2.4G Wi-Fi Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	20.26
Maximum peak output power at antenna input terminal (mW):	106.17
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	1.96
Maximum Antenna Gain (numeric):	1.5704
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.03317
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

The max power density 0.03317 (mW/cm2) < 1 (mW/cm2)

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2.4G BLE for 709502403822-00D Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	-2.06
Maximum peak output power at antenna input terminal (mW):	0.62
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	1.96
Maximum Antenna Gain (numeric):	1.5704
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.00019
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

The max power density 0.00019 (mW/cm2) < 1 (mW/cm2)

2.4G EDR for 709502403822-00E Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	0.71
Maximum peak output power at antenna input terminal (mW):	1.18
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	1.96
Maximum Antenna Gain (numeric):	1.5704
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.00037
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

The max power density 0.00037 (mW/cm2) < 1 (mW/cm2)

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2.4G BLE for 709502403822-00F Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	-6.98
Maximum peak output power at antenna input terminal (mW):	0.20
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	3.16
Maximum Antenna Gain (numeric):	2.0701
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.00008
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

The max power density 0.00008 (mW/cm2) < 1 (mW/cm2)

2.4G EDR for 709502403822-00G Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	-7.22
Maximum peak output power at antenna input terminal (mW):	0.19
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	3.16
Maximum Antenna Gain (numeric):	2.0701
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.00008
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

The max power density 0.00008 (mW/cm2) < 1 (mW/cm2)

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WCDMA Band2 (1907.6MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.8
Maximum peak output power at antenna input terminal (mW):	190.55
tune-up conducted power(dBm):	24
tune-up conducted power(mW):	251.19
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	4.2
Maximum Antenna Gain (numeric):	2.6303
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.13144
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

Note: *The tune-up conducted power (24 dBm) was declared by the manufacturer.*
The max power density 0.13144 (mW/cm2) < 1 (mW/cm2)

WCDMA Band4 (1732.6MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	23.7
Maximum peak output power at antenna input terminal (mW):	234.42
tune-up conducted power(dBm):	24
tune-up conducted power(mW):	251.19
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.8
Maximum Antenna Gain (numeric):	1.9055
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.09522
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1.00

Note: *The tune-up conducted power (24 dBm) was declared by the manufacturer.*
The max power density 0.09522 (mW/cm2) < 1 (mW/cm2)

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WCDMA Band5 (846.6MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.9
Maximum peak output power at antenna input terminal (mW):	194.98
tune-up conducted power(dBm):	24
tune-up conducted power(mW):	251.19
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.8
Maximum Antenna Gain (numeric):	1.9055
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.09522
MPE limit for general population exposure at prediction frequency (mW/cm^2):	0.5644

Note: *The tune-up conducted power (24 dBm) was declared by the manufacturer.*
The max power density 0.09522 (mW/cm2) < 0.5644 (mW/cm2)

LTE Band2 for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	21.5
Maximum peak output power at antenna input terminal (mW):	141.25
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	4.2
Maximum Antenna Gain (numeric):	2.6303
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.09305
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.09305 (mW/cm2) < 1 (mW/cm2)

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LTE Band4 for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	21.7
Maximum peak output power at antenna input terminal (mW):	147.91
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.8
Maximum Antenna Gain (numeric):	1.9055
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.06741
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.06741 (mW/cm2) < 1 (mW/cm2)

LTE Band5 (824MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	21.9
Maximum peak output power at antenna input terminal (mW):	154.88
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.8
Maximum Antenna Gain (numeric):	1.9055
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.06741
MPE limit for general population exposure at prediction frequency (mW/cm^2):	0.54933

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.06741 (mW/cm2) < 0.54933 (mW/cm2)

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LTE Band7 for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.3
Maximum peak output power at antenna input terminal (mW):	169.82
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.2
Maximum Antenna Gain (numeric):	1.6596
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.05871
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.05871 (mW/cm2) < 1 (mW/cm2)

LTE Band12 (699MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.0
Maximum peak output power at antenna input terminal (mW):	158.49
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	1.9
Maximum Antenna Gain (numeric):	1.5488
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.05479
MPE limit for general population exposure at prediction frequency (mW/cm^2):	0.466

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.05479 (mW/cm2) < 0.466 (mW/cm2)

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LTE Band13 (777MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.2
Maximum peak output power at antenna input terminal (mW):	165.96
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.5
Maximum Antenna Gain (numeric):	1.7783
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.06291
MPE limit for general population exposure at prediction frequency (mW/cm^2):	0.518

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.06291 (mW/cm2) < 0.518 (mW/cm2)

LTE Band25 for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	21.7
Maximum peak output power at antenna input terminal (mW):	147.91
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	4.2
Maximum Antenna Gain (numeric):	2.6303
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.09305
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.09305 (mW/cm2) < 1 (mW/cm2)

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LTE Band26 (814MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.0
Maximum peak output power at antenna input terminal (mW):	158.49
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.8
Maximum Antenna Gain (numeric):	1.9055
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.06741
MPE limit for general population exposure at prediction frequency (mW/cm^2):	0.54267

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.06741 (mW/cm2) < 0.54267 (mW/cm2)

LTE Band26 (824MHz) for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.3
Maximum peak output power at antenna input terminal (mW):	169.82
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.8
Maximum Antenna Gain (numeric):	1.9055
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.06741
MPE limit for general population exposure at prediction frequency (mW/cm^2):	0.54933

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.06741 (mW/cm2) < 0.54933 (mW/cm2)

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LTE Band38 for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.0
Maximum peak output power at antenna input terminal (mW):	158.49
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.4
Maximum Antenna Gain (numeric):	1.7378
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.06148
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.06148 (mW/cm2) < 1 (mW/cm2)

LTE Band41 for 202415010745 Calculated Data: FPC antenna

Maximum peak output power at antenna input terminal (dBm):	22.0
Maximum peak output power at antenna input terminal (mW):	158.49
tune-up conducted power(dBm):	22.5
tune-up conducted power(mW):	177.83
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	2.4
Maximum Antenna Gain (numeric):	1.7378
The worst case is power density at predication frequency at 20 cm (mW/cm^2):	0.06148
MPE limit for general population exposure at prediction frequency (mW/cm^2):	1

Note: *The tune-up conducted power (22.5 dBm) was declared by the manufacturer.*
The max power density 0.06148 (mW/cm2) < 1 (mW/cm2)

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Co-Located Transmitters transmission table:

Transmitter type	Transmitter type that can transmit at the same time
5G Wi-Fi or 2.4G Wi-Fi or BLE for 709502403822-00D or EDR for 709502403822-00E	WCDMA Band 2 or WCDMA Band 4 or WCDMA Band 5 or LTE Band 2 or LTE Band 4 or LTE Band 5 or LTE Band 7 or LTE Band 12 or LTE Band 13 or LTE Band 25 or LTE Band 26 (814-824MHz) or LTE Band 26 (824-849MHz) or LTE Band 38 or LTE Band 41 and BLE for 709502403822-00F or EDR for 709502403822-00G
BLE for 709502403822-00F or EDR for 709502403822-00G	WCDMA Band 2 or WCDMA Band 4 or WCDMA Band 5 or LTE Band 2 or LTE Band 4 or LTE Band 5 or LTE Band 7 or LTE Band 12 or LTE Band 13 or LTE Band 25 or LTE Band 26 (814-824MHz) or LTE Band 26 (824-849MHz) or LTE Band 38 LTE Band 41 and 5G Wi-Fi or 2.4G Wi-Fi or BLE for 709502403822-00D or EDR for 709502403822-00E
WCDMA Band 2 or WCDMA Band 4 or WCDMA Band 5 or LTE Band 2 or LTE Band 4 or LTE Band 5 or LTE Band 7 or LTE Band 12 or LTE Band 13 or LTE Band 25 or LTE Band 26 (814-824MHz) or LTE Band 26 (824-849MHz) or LTE Band 38 or LTE Band 41	5G Wi-Fi or 2.4G Wi-Fi or BLE for 709502403822-00D or EDR for 709502403822-00E and BLE for 709502403822-00F or EDR for 709502403822-00G

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Simultaneous Transmission MPE:

Frequency Band	MPE (mw/cm2)	Limit (mw/cm2)	Evaluated Distance (cm)	Worst-Case MPE Ratios	Worst-Case Transmitter type MPE Ratios	Worst-Case Sum of MPE Ratios	Limit	Result
Worst Case								
5 GHz Wi-Fi	0.01282	1	20	1.28%	3.32%	20.20%	100%	Pass
2.4G Wi-Fi	0.03317	1	20	3.32%				
BLE for 709502403822-00D	0.00019	1	20	0.02%				
EDR for 709502403822-00E	0.00037	1	20	0.04%				
BLE for 709502403822-00F	0.00008	1	20	0.01%	0.01%			
EDR for 709502403822-00G	0.00008	1	20	0.01%				
WCDMA Band 2	0.13144	1	20	13.14%	16.87%			
WCDMA Band 4	0.09522	1	20	9.52%				
WCDMA Band 5	0.09522	0.5644	20	16.87%				
LTE Band 2	0.09305	1	20	9.31%				
LTE Band 4	0.06741	1	20	6.74%				
LTE Band 5	0.06741	0.54933	20	12.27%				
LTE Band 7	0.05871	1	20	5.87%				
LTE Band 12	0.05479	0.466	20	11.76%				
LTE Band 13	0.06291	0.518	20	12.14%				
LTE Band 25	0.09305	1	20	9.31%				
LTE Band 26 (814-824MHz)	0.06741	0.54267	20	12.42%				
LTE Band 26 (824-849MHz)	0.06741	0.54933	20	12.27%				
LTE Band 38	0.06148	1	20	6.15%				
LTE Band 41	0.06148	1	20	6.15%				

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Reviewed by:	Prepared by:	Tested by:
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EMC Section Manager	EMC Project Engineer	EMC Test Engineer
Date: Nov. 07, 2024	Date: Nov. 07, 2024	Date: Nov. 07, 2024

----------End of Test Report----------