

RF EXPOSURE EVALUATION REPORT

FCC ID : GKRRMLN1
Equipment : 5G LGA Module
Brand Name : COMPAL
Model Name : RML-N1
Marketing Name : 5G LGA Module
Applicant : Compal Electronics, Inc.
No.581 & 581-1, Ruiguang Rd., Neihu District, Taipei,
(114) Taiwan
Manufacturer : Compal Electronics, Inc.
No.581 & 581-1, Ruiguang Rd., Neihu District, Taipei,
(114) Taiwan
Standard : 47 CFR Part 2.1091

We, SPORTON INTERNATIONAL INC has been evaluated this product in accordance with 47 CFR Part 2.1091 and it complies with applicable limit.

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC evaluation.

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Approved by: Cona Huang / Deputy Manager



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History of this test report

Report No.	Version	Description	Issued Date
FA133040-04	Rev. 01	Initial issue of report	Nov. 30, 2021



1. Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT Type	5G LGA Module
Brand Name	COMPAL
Model Name	RML-N1
Marketing Name	5G LGA Module
FCC ID	GKRRMLN1
Wireless Technology and Frequency Range	LTE Band 2: 1850 MHz ~ 1910 MHz LTE Band 4: 1710 MHz ~ 1755 MHz LTE Band 5: 824 MHz ~ 849 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 13: 777 MHz ~ 787 MHz LTE Band 17: 704 MHz ~ 716 MHz LTE Band 25: 1850 MHz ~ 1915 MHz LTE Band 26: 814 MHz ~ 849 MHz LTE Band 30: 2305 MHz ~ 2315 MHz LTE Band 41: 2496 MHz ~ 2690 MHz LTE Band 48: 3550 MHz ~ 3700 MHz LTE Band 66: 1710 MHz ~ 1780 MHz LTE Band 71: 663 MHz ~ 698 MHz 5G NR n2 : 1850 MHz ~ 1910 MHz 5G NR n5 : 824 MHz ~ 849 MHz 5G NR n12 : 699 MHz ~ 716 MHz 5G NR n25 : 1850 MHz ~ 1915 MHz 5G NR n30 : 2305 MHz ~ 2315 MHz 5G NR n41 : 2496 MHz ~ 2690 MHz 5G NR n66 : 1710 MHz ~ 1780 MHz 5G NR n71 : 663 MHz ~ 698 MHz 5G NR n77: 3300 MHz ~ 4200 MHz 5G NR n78: 3300 MHz ~ 3800 MHz
Mode	LTE: QPSK, 16QAM, 64QAM, 256QAM 5G NR: DFT-s-OFDM/CP-OFDM, Pi/2 BPSK/QPSK/16QAM/64QAM/256QAM
General Note:	
1. The device support LTE UL CA, 5G NR uplink MIMO and 5G NR EN-DC mode with DPS (dynamic power share), when these mode active which the total power is less than or equal to the standalone mode also the PD calculation result will be less than standalone mode, therefore, for the MPE calculation is using standalone maximum power to show compliance.	

Reviewed by: Jason Wang

Report Producer: Carlie Tsai

2. Maximum RF average output power among production units

<Standalone Maximum Power>

Mode		Maximum Transmit Power Level (dBm)
FDD LTE	Band 2	25.00
	Band 4	25.00
	Band 5	25.00
	Band 12	25.00
	Band 13	25.00
	Band 17	25.00
	Band 25	25.00
	Band 26	25.00
	Band 30	25.00
	Band 66	25.00
TDD LTE	Band 41_HPUE	28.00
	Band 48	25.00
FDD FR1	n2	25.50
	n5	26.00
	n12	25.00
	n25	25.00
	n30	25.00
	n66	25.50
	n71	25.00
TDD FR1	n41_HPUE	28.00
	n77	28.50
	n78	28.00

<LTE UL CA Total Power>

Mode		Maximum Transmit Power Level (dBm)
LTE	Band 2	25.00
	Band 4	25.00
	Band 5	25.00
	Band 12	25.00
	Band 13	25.00
	Band 17	25.00
	Band 25	25.00
	Band 26	25.00
	Band 30	25.00
	Band 41	25.00
	Band 48	25.00
	Band 66	25.00
	Band 71	25.00

<NR Uplink MIMO Total Power>

Mode		Maximum Transmit Total Power Level (dBm)
FR1	n41_HPUE	28.00

<NR EN-DC Total Power>

Mode		Maximum Transmit Total Power Level (dBm)
FR1	n2	25.50
	n5	26.00
	n25	25.00
	n41	25.00
	n66	25.50
	n71	25.00
	n77	25.00
	n78	25.00



3. RF Exposure Limit Introduction

According to ANSI/IEEE C95.1-1992, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1310.

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

The MPE was calculated at 20 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = Power Density

P = Output Power at Antenna Terminals

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna

4. Radio Frequency Radiation Exposure Evaluation

4.1. Standalone Power Density Calculation

Antenna	Band	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum ERP (dBm)	Maximum ERP (W)	Maximum EIRP (dBm)	Maximum EIRP (W)	Maximum Output Power Limit (W)	Average EIRP (mW)	Power Density at 20cm (mW/cm ²)	Limit (mW/cm ²)	Power Density / Limit
Ant 0	LTE Band 2	7.50	25.00	30.350	1.084	32.500	1.778	2.000	1778.279	0.354	1.000	0.354
	LTE Band 4	4.50	25.00	27.350	0.543	29.500	0.891	1.000	891.251	0.177	1.000	0.177
	LTE Band 5	8.40	25.00	31.250	1.334	33.400	2.188	7.000	2187.762	0.435	0.549	0.793
	LTE Band 12	8.60	25.00	31.450	1.396	33.600	2.291	3.000	2290.868	0.456	0.466	0.979
	LTE Band 13	9.10	25.00	31.950	1.567	34.100	2.570	3.000	2570.396	0.512	0.518	0.988
	LTE Band 17	8.70	25.00	31.550	1.429	33.700	2.344	3.000	2344.229	0.467	0.469	0.994
	LTE Band 25	7.50	25.00	30.350	1.084	32.500	1.778	2.000	1778.279	0.354	1.000	0.354
	LTE Band 26	8.40	25.00	31.250	1.334	33.400	2.188	7.000	2187.762	0.435	0.543	0.802
	LTE Band 30	-1.10	25.00	21.750	0.150	23.900	0.245	0.250	245.471	0.049	1.000	0.049
	LTE Band 66	4.50	25.00	27.350	0.543	29.500	0.891	1.000	891.251	0.177	1.000	0.177
	LTE Band 71	8.40	25.00	31.250	1.334	33.400	2.188	3.000	2187.762	0.435	0.442	0.985
	FR1 n2	7.50	25.50	30.850	1.216	33.000	1.995	2.000	1995.262	0.397	1.000	0.397
	FR1 n5	8.40	26.00	32.250	1.679	34.400	2.754	7.000	2754.229	0.548	0.549	0.998
	FR1 n12	8.60	25.00	31.450	1.396	33.600	2.291	3.000	2290.868	0.456	0.466	0.979
	FR1 n25	7.50	25.00	30.350	1.084	32.500	1.778	2.000	1778.279	0.354	1.000	0.354
	FR1 n30	-1.10	25.00	21.750	0.150	23.900	0.245	0.250	245.471	0.049	1.000	0.049
	FR1 n41	5.00	28.00	30.850	1.216	33.000	1.995	2.000	1995.262	0.397	1.000	0.397
FR1 n66	4.50	25.50	27.850	0.610	30.000	1.000	1.000	1000.000	0.199	1.000	0.199	
FR1 n71	8.40	25.00	31.250	1.334	33.400	2.188	3.000	2187.762	0.435	0.442	0.985	
Ant 2	LTE Band 30	-1.10	25.00	21.750	0.150	23.900	0.245	0.250	245.471	0.049	1.000	0.049
	LTE Band 41	5.00	28.00	30.850	1.216	33.000	1.995	2.000	1995.262	0.397	1.000	0.397
	FR1 n41	5.00	28.00	30.850	1.216	33.000	1.995	2.000	1995.262	0.397	1.000	0.397
Ant 3	LTE Band 13	9.10	25.00	31.950	1.567	34.100	2.570	3.000	2570.396	0.512	0.518	0.988
Ant 4	LTE Band 2	7.50	25.00	30.350	1.084	32.500	1.778	2.000	1778.279	0.354	1.000	0.354
	LTE Band 4	4.50	25.00	27.350	0.543	29.500	0.891	1.000	891.251	0.177	1.000	0.177
	LTE Band 25	7.50	25.00	30.350	1.084	32.500	1.778	2.000	1778.279	0.354	1.000	0.354
	LTE Band 66	4.50	25.00	27.350	0.543	29.500	0.891	1.000	891.251	0.177	1.000	0.177
	FR1 n2	7.50	25.50	30.850	1.216	33.000	1.995	2.000	1995.262	0.397	1.000	0.397
	FR1 n66	4.50	25.50	27.850	0.610	30.000	1.000	1.000	1000.000	0.199	1.000	0.199
Ant 5	LTE Band 48	-2.00	25.00	20.850	0.122	23.000	0.200	0.200	199.526	0.040	1.000	0.040
	FR1 n77	1.50	28.50	27.850	0.610	30.000	1.000	1.000	1000.000	0.199	1.000	0.199
	FR1 n78	2.00	28.00	27.850	0.610	30.000	1.000	1.000	1000.000	0.199	1.000	0.199



4.2. Collocated Power Density Calculation

General Note:

1. This MPE analysis is applicable to any collocated transmitters with transmit power for WLAN is less than or equal to 26dBm and for Bluetooth is less than or equal to 15dBm.
2. A maximum antenna gain of 5 dBi for WLAN/BT has been assumed for all collocated antennas.

Antenna	Band	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	Maximum EIRP (W)	Average EIRP (mW)	Power Density at 20cm (mW/cm ²)	Limit (mW/cm ²)	Power Density / Limit
Ant 0	LTE Band 2	7.50	25.00	32.500	1.778	1778.279	0.354	1.000	0.354
	LTE Band 4	4.50	25.00	29.500	0.891	891.251	0.177	1.000	0.177
	LTE Band 5	7.00	25.00	32.000	1.585	1584.893	0.315	0.549	0.574
	LTE Band 12	7.00	25.00	32.000	1.585	1584.893	0.315	0.466	0.677
	LTE Band 13	7.70	25.00	32.700	1.862	1862.087	0.371	0.518	0.716
	LTE Band 17	7.30	25.00	32.300	1.698	1698.244	0.338	0.469	0.720
	LTE Band 25	7.50	25.00	32.500	1.778	1778.279	0.354	1.000	0.354
	LTE Band 26	7.00	25.00	32.000	1.585	1584.893	0.315	0.543	0.581
	LTE Band 30	-1.10	25.00	23.900	0.245	245.471	0.049	1.000	0.049
	LTE Band 66	4.50	25.00	29.500	0.891	891.251	0.177	1.000	0.177
	LTE Band 71	7.00	25.00	32.000	1.585	1584.893	0.315	0.442	0.714
	FR1 n2	7.50	25.50	33.000	1.995	1995.262	0.397	1.000	0.397
	FR1 n5	7.00	26.00	33.000	1.995	1995.262	0.397	0.549	0.723
	FR1 n12	7.00	25.00	32.000	1.585	1584.893	0.315	0.466	0.677
	FR1 n25	7.50	25.00	32.500	1.778	1778.279	0.354	1.000	0.354
	FR1 n30	-1.10	25.00	23.900	0.245	245.471	0.049	1.000	0.049
	FR1 n41	5.00	28.00	33.000	1.995	1995.262	0.397	1.000	0.397
FR1 n66	4.50	25.50	30.000	1.000	1000.000	0.199	1.000	0.199	
FR1 n71	7.00	25.00	32.000	1.585	1584.893	0.315	0.442	0.714	
Ant 2	LTE Band 30	-1.10	25.00	23.900	0.245	245.471	0.049	1.000	0.049
	LTE Band 41	5.00	28.00	33.000	1.995	1995.262	0.397	1.000	0.397
	FR1 n41	5.00	28.00	33.000	1.995	1995.262	0.397	1.000	0.397
Ant 3	LTE Band 13	7.70	25.00	32.700	1.862	1862.087	0.371	0.518	0.716
Ant 4	LTE Band 2	7.50	25.00	32.500	1.778	1778.279	0.354	1.000	0.354
	LTE Band 4	4.50	25.00	29.500	0.891	891.251	0.177	1.000	0.177
	LTE Band 25	7.50	25.00	32.500	1.778	1778.279	0.354	1.000	0.354
	LTE Band 66	4.50	25.00	29.500	0.891	891.251	0.177	1.000	0.177
	FR1 n2	7.50	25.50	33.000	1.995	1995.262	0.397	1.000	0.397
	FR1 n66	4.50	25.50	30.000	1.000	1000.000	0.199	1.000	0.199
Ant 5	LTE Band 48	-2.00	25.00	23.000	0.200	199.526	0.040	1.000	0.040
	FR1 n77	1.50	28.50	30.000	1.000	1000.000	0.199	1.000	0.199
	FR1 n78	2.00	28.00	30.000	1.000	1000.000	0.199	1.000	0.199
WLAN2.4GHz Band		5.0	26.0	31.0	1.26	1258.93	0.251	1.000	0.251
WLAN5GHz Band		5.0	26.0	31.0	1.26	1258.93	0.251	1.000	0.251
Bluetooth		5.0	15.0	20.0	0.10	100.00	0.020	1.000	0.020

WWAN Power Density / Limit	WLAN Power Density / Limit	Bluetooth Power Density / Limit	Σ (Power Density / Limit) of WWAN+WLAN+Bluetooth
0.723	0.251	0.020	0.994

Note:

1. Σ (Power Density / Limit): This is a summation of [(power density for each transmitter/antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for WWAN + WLAN + Bluetooth.
2. Considering the LTE/NR collocation with the WLAN + Bluetooth transmitter of the EIRP performance listed in the table above, the aggregated (power density /limit) is smaller than 1, and MPE of 4 collocated transmitters is compliant



Conclusion:

Based on FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, the analysis concludes that this product when transmitting in standalone within a host device, is compliant with the FCC RF exposure requirements in mobile exposure condition, provided the conducted power and antenna gain do not exceed the limits for each given frequency band per wireless technology as follow table:

Device	Technology	Band	Maximum Conducted Power (dBm)	Standalone Maximum Antenna Gain (dBi)	Collocated Maximum Antenna Gain (dBi)
RML-N1	LTE	LTE Band 2	25.0	7.5	7.5
		LTE Band 4	25.0	4.5	4.5
		LTE Band 5	25.0	8.4	7.0
		LTE Band 12	25.0	8.6	7.0
		LTE Band 13	25.0	9.1	7.7
		LTE Band 17	25.0	8.7	7.3
		LTE Band 25	25.0	7.5	7.5
		LTE Band 26	25.0	8.4	7.0
		LTE Band 30	25.0	-1.1	-1.1
		LTE Band 41	28.0	5.0	5.0
		LTE Band 48	25.0	-2.0	-2.0
		LTE Band 66	25.0	4.5	4.5
	LTE Band 71	25.0	8.4	7.0	
	NR	FR1 n2	25.5	7.5	7.5
		FR1 n5	26.0	8.4	7.0
		FR1 n12	25.0	8.6	7.0
		FR1 n25	25.0	7.5	7.5
		FR1 n30	25.0	-1.1	-1.1
		FR1 n41	28.0	5.0	5.0
		FR1 n66	25.5	4.5	4.5
FR1 n71		25.0	8.4	7.0	
FR1 n77	28.5	1.5	1.5		
FR1 n78	28.0	2.0	2.0		