

EMI TEST REPORT

FCC CERTIFICATION

Applicant:

LG Electronics MobileComm U.S.A., Inc.
1000 Sylvan Avenue, Englewood Cliffs NJ 07632
United States

Date of Receipt: March 08, 2018**Date of Issue: March 23, 2018****Test Report No. HCT-EM-1803-FC023****FCC ID :****ZNFL713DL**

Rule Part(s) / Standard(s) : FCC CFR 47 PART 15 Subpart B Class B
FCC Classification : JAB (Part 15B – Class B Digital Device)
EUT Type : Multi-band GSM/WCDMA/LTE/CDMA Phone with BT and WLAN
Model Name : LML713DL
Additional Model Name : L713DL
TA Information: : Model Name: MCS-V01WD, Manufacturer: DONGDO
Date of Test : March 14, 2018 – March 16, 2018

The device bearing the trade name and model specified above, has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.4-2014. (See Test Report if any modifications were made for compliance)

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

HCT certifies that no party to application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C 862

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REVISION HISTORY

The revision history for this document is shown in table.

Report No.	Issue Date	Information About Changes
HCT-EM-1803-FC023	March 23, 2018	Initial Release



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1. GENERAL INFORMATION

1.1 Description of EUT

Its basic purpose is used for communications.

FCC ID	ZNFL713DL
Model	LML713DL
Additional Model	L713DL
EUT Type	Multi-band GSM/WCDMA/LTE/CDMA Phone with BT and WLAN
TX Frequency	824.70 MHz to 848.31 MHz (CDMA BC0) 1 851.25 MHz to 1 908.75 MHz (CDMA BC1) 824.20 MHz to 848.80 MHz (GSM 850) 1 850.20 MHz to 1 909.80 MHz (GSM 1 900) 1 852.4 MHz to 1 907.6 MHz (WCDMA B2) 1712.4 MHz to 1752.6 MHz (WCDMA B4) 826.40 MHz to 846.60 MHz (WCDMA B5) 1 850.7 MHz to 1 909.3 MHz (LTE B2) 1 710 MHz to 1 755 MHz (LTE B4) 824 MHz to 849 MHz (LTE B5) 699 MHz to 716 MHz (LTE B12) 777 MHz to 787 MHz (LTE B13) 1 710 MHz to 1 780 MHz (LTE B66) 663 MHz to 698 MHz (LTE B71) 2 402 MHz to 2 480 MHz (Bluetooth) 2 412 MHz to 2 462 MHz (WiFi 2.4 GHz)
RX Frequency	869.70 MHz to 893.31 MHz (CDMA BC0) 1 931.25 MHz to 1 988.75 MHz (CDMA BC1) 869.20 MHz to 893.80 MHz (GSM 850) 1 930.20 MHz to 1 989.80 MHz (GSM 1 900) 1 932.4 MHz to 1 987.6 MHz (WCDMA B2) 2 112.4 MHz to 2 152.6 MHz (WCDMA B4) 871.40 MHz to 891.60 MHz (WCDMA B5) 1 930 MHz to 1 990 MHz (LTE B2) 2 110 MHz to 2 155 MHz (LTE B4) 869 MHz to 894 MHz (LTE B5) 729 MHz to 746 MHz (LTE B12) 746 MHz to 756 MHz (LTE B13) 2 110 MHz to 2 200 MHz (LTE B66) 617 MHz to 652 MHz (LTE B71) 2 402 MHz to 2 480 MHz (Bluetooth) 2 412 MHz to 2 462 MHz (WiFi 2.4 GHz)

1.2 Related Submittal(s) / Grant(s)

Original submittal only.



1.3 Test Facility

Test site is located at 74, SEOICHEON-RO, 578BEON-GIL, MAJANG-MYEON, ICHEON-SI, GYEONGGI-DO, SOUTH KOREA. Those measurement facilities are constructed in conformance with the requirements of ANSI C63.4-2014. The Normalized site attenuations (30 MHz to 1GHz) and Site validation (1 GHz to 18 GHz) were performed in accordance with the standard in ANSI C63.4-2014

Measurement Facilities	Registration Number
Radiated Field strength measurement facility 3 m Semi Anechoic chamber	90661
Radiated Field strength measurement facility 10 m Semi Anechoic chamber	

1.4 Calibration of Measuring Instrument

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturers recommendations for utilizing calibration equipments, which is traceable to recognized national standards.

Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).



1.5 Tested System Details

All equipment descriptions used in the tested system (including inserted cards) are:

Device Type	Model Name	Serial Number	Manufacturer	FCC ID / DoC
EUT	LML713DL	-	LG	ZNFL713DL
Data cable	EAD64746103	-	Ningbo Broad	-
Earphone	EAB64468444	-	CRESYN	-
Travel adaptor	MCS-V01WD	-	DONGDO	-
Micro SD card	256 GB EVO+UHS-I microSDXC U1	-	SAMSUNG	-

1.6 Cable Description

Product Name	Port	Power Cord Shielded (Y/N)	I/O Cable Shielded (Y/N)	Length (m)
EUT	USB Type C	Y	Y	(P)1.0
	Earphone	N/A	Y	(D)1.2

* The marked “(D)” means the data cable and “(P)” means the power cable.

1.7 Noise Suppression Parts on Cable. (I/O Cable)

Product Name	Port	Ferrite Bead (Y/N)	Location	Metal Hood (Y/N)	Location
EUT	USB Type C	N	N/A	Y	Both End
	Earphone	N	N/A	Y	EUT End



2. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (dB)
Conducted Emission (0.15 MHz to 30 MHz)	1.82 dB ($k = 2$)
Radiated Emissions (30 MHz to 1 GHz)	5.20 dB ($k = 2$)
Radiated Emissions (1 GHz to 18 GHz)	5.24 dB ($k = 2$)
Radiated Emissions (18 GHz to 40 GHz)	5.40 dB ($k = 2$)



3. DESCRIPTION OF TEST

3.1 Measurement of Conducted Emission

The test procedure was in accordance with ANSI C63.4-2014, Clause 7.3

- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN).
If the EUT is connected to the PC through USB, the AC power-line adapter of the PC is directly connected to a line impedance stabilization network (LISN).
Other support units were connected to the power mains through another LISN. The two LISNs provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both conducted lines are measured in Quasi-Peak and Average mode, including the worst-case data points for each tested configuration.
- c. The frequency range from 150 kHz to 30 MHz was searched.

[Conducted Emission Limits]

Frequency (MHz)	Resolution Bandwidth (kHz)	Quasi-Peak (dB(μV))	Average (dB(μV))
0.15 to 0.5	9	66 to 56*	56 to 46*
0.5 to 5	9	56	46
5 to 30	9	60	50

**Decreases with the logarithm of the frequency.*



3.2 Measurement of Radiated Emission

The test procedure was in accordance with ANSI C63.4-2014, Clause 8.3

- a. The EUT was placed on the top of a turn table 0.8 meters above the ground at a semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 m away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna height is varied from 1 m to 4 m above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 m to 4 m and the turn table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to Peak and Average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz.
- g. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response.(1 GHz to 40 GHz)

[Radiated Emission Limits]

Frequency (MHz)	Antenna Distance (m)	Field Strength ($\mu\text{V}/\text{m}$)	Quasi-Peak ($\text{dB}(\mu\text{V})/\text{m}$)
30 to 88	3	100	40.0
88 to 216	3	150	43.5
216 to 960	3	200	46.0
Above 960	3	500	54.0
Frequency (MHz)	Antenna Distance (m)	Peak ($\text{dB}(\mu\text{V})/\text{m}$)	Average ($\text{dB}(\mu\text{V})/\text{m}$)
Above 1 000	3	74	54



3.2.1 Frequency Range of Radiated Measurements

An unintentional radiator, including a digital device, the spectrum shall be investigated from the lowest radio frequency signal generated or used in the device, without going below the lowest frequency for which a Radiated Emission limit is specified, up to the frequency shown in the following table

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705 to 108	1 000
108 to 500	2 000
500 to 1 000	5 000
Above 1 000	5 th harmonic of the highest frequency or 40 GHz, whichever is lower

3.3 Configuration of Tested System



Non-Conductive Table
Power Line: 120 VAC



4. PRELIMINARY TEST

4.1 Conducted Emission Test

It was tested Data Communication mode, after connecting all peripheral devices.

Operation Mode: ☒ Camera (Front) & MP3 mode
☒ Camera (Rear) & FM Radio mode
☒ Idle mode

NOTE. The worst-case emissions are reported.

4. 2 Radiated Emission Test

It was tested Data Communication mode, after connecting all peripheral devices.

Operation Mode: ☒ Camera (Front) & MP3 mode
☒ Camera (Rear) & FM Radio mode
☒ Idle mode

NOTE. The worst-case emissions are reported.



5. CONDUCTED AND RADIATED EMISSION TEST SUMMARY

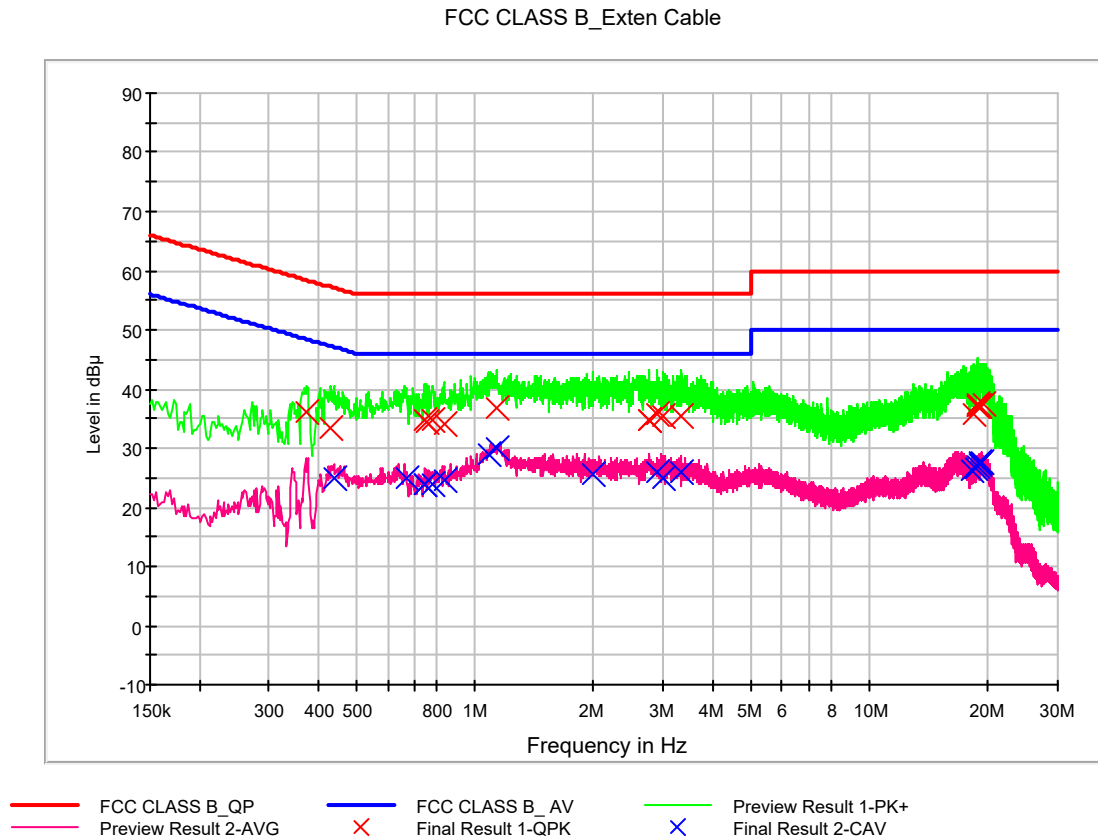
5.1 Conducted Emission Test

The test results of conducted emission at mains ports provide the following information:

Rule Part / Standard	FCC PART 15 Subpart B Class B
Detector	Quasi-Peak, CISPR-Average
Bandwidth	9 kHz (6 dB)
Worst Case of Operation Mode	Camera (Front) & MP3 mode
Kind of Test Site	Shielded Room
Temperature	23.0 °C
Relative Humidity	36.3 %
Test Date	March 14, 2018

- Calculation Formula:

1. Conductor L1 = Hot, Conductor N = Neutral
2. Corr. = LISN Factor + Cable Loss
3. QuasiPeak or CAverage= Receiver Reading + Corr.
4. Margin = Limit – QuasiPeak or CAverage

**Figure 1: Conducted Emission, AC Main Port, Line (L1)**



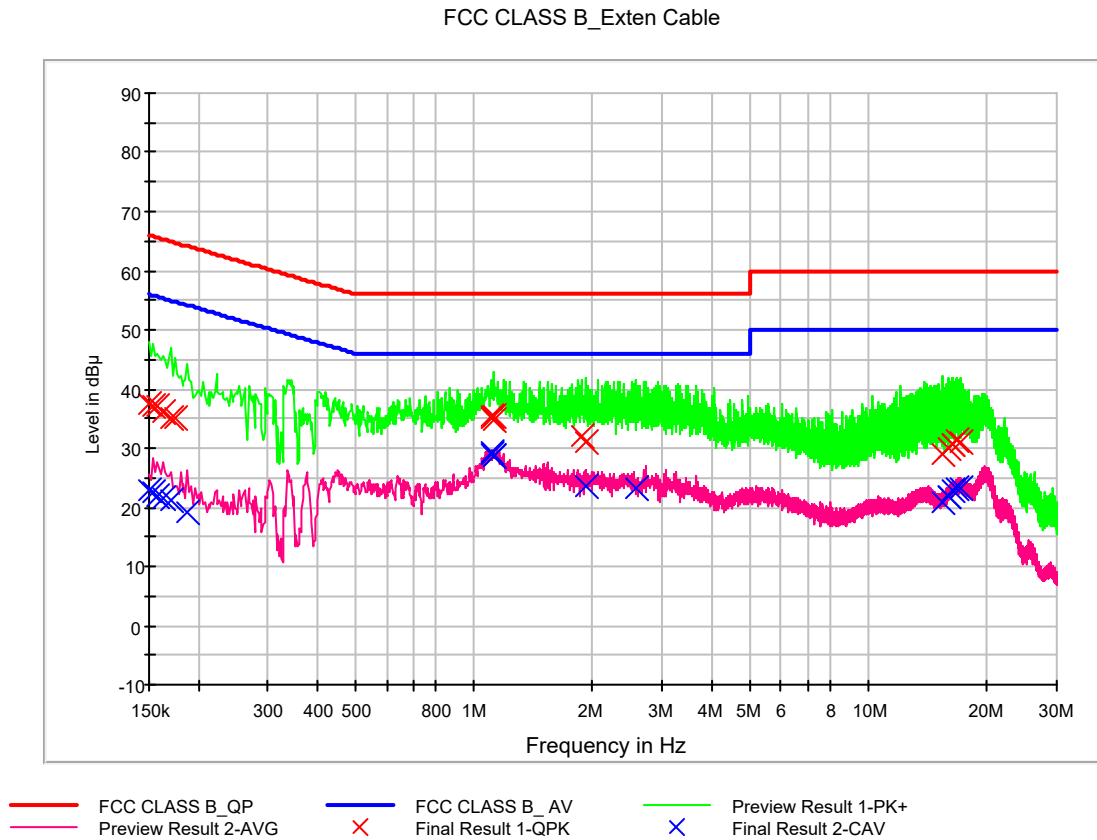
QuasiPeak Final Result, Line (L1)

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.374000	36.0	9.000	L1	9.7	22.4	58.4
0.432000	33.3	9.000	L1	9.7	23.9	57.2
0.744000	34.9	9.000	L1	9.7	21.1	56.0
0.750000	34.4	9.000	L1	9.7	21.6	56.0
0.782000	34.9	9.000	L1	9.7	21.1	56.0
0.834000	34.2	9.000	L1	9.7	21.8	56.0
1.136000	36.6	9.000	L1	9.8	19.4	56.0
2.762000	34.8	9.000	L1	9.9	21.2	56.0
2.766000	34.9	9.000	L1	9.9	21.1	56.0
2.896000	35.7	9.000	L1	9.9	20.3	56.0
2.996000	35.4	9.000	L1	9.9	20.6	56.0
3.332000	35.4	9.000	L1	9.9	20.6	56.0
18.434000	35.8	9.000	L1	10.3	24.2	60.0
18.700000	37.1	9.000	L1	10.3	22.9	60.0
18.764000	37.2	9.000	L1	10.3	22.8	60.0
18.894000	37.4	9.000	L1	10.3	22.6	60.0
19.070000	37.3	9.000	L1	10.3	22.7	60.0
19.518000	37.5	9.000	L1	10.4	22.5	60.0



CAverage Final Result, Line (L1)

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.438000	25.0	9.000	L1	9.7	22.1	47.1
0.668000	24.9	9.000	L1	9.7	21.1	46.0
0.744000	23.8	9.000	L1	9.7	22.2	46.0
0.748000	24.0	9.000	L1	9.7	22.0	46.0
0.782000	23.7	9.000	L1	9.7	22.3	46.0
0.834000	24.7	9.000	L1	9.7	21.3	46.0
1.078000	28.9	9.000	L1	9.8	17.1	46.0
1.136000	30.1	9.000	L1	9.8	15.9	46.0
1.980000	25.5	9.000	L1	9.8	20.5	46.0
2.896000	25.9	9.000	L1	9.9	20.2	46.0
2.996000	24.9	9.000	L1	9.9	21.1	46.0
3.332000	25.9	9.000	L1	9.9	20.1	46.0
18.240000	26.3	9.000	L1	10.3	23.7	50.0
18.560000	26.6	9.000	L1	10.3	23.4	50.0
18.700000	26.8	9.000	L1	10.3	23.2	50.0
18.940000	27.4	9.000	L1	10.3	22.6	50.0
19.070000	27.5	9.000	L1	10.3	22.5	50.0
19.222000	27.7	9.000	L1	10.4	22.3	50.0

**Figure 2: Conducted Emission, AC Main Port, Line (N)**



QuasiPeak Final Result, Line (N)

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	37.5	9.000	N	9.7	28.5	66.0
0.154000	37.2	9.000	N	9.7	28.5	65.8
0.158000	37.3	9.000	N	9.7	28.3	65.6
0.162000	36.0	9.000	N	9.7	29.3	65.4
0.170000	35.0	9.000	N	9.7	30.0	65.0
0.174000	34.9	9.000	N	9.7	29.8	64.8
1.102000	35.1	9.000	N	9.8	21.0	56.0
1.110000	35.5	9.000	N	9.8	20.5	56.0
1.120000	35.5	9.000	N	9.8	20.5	56.0
1.128000	34.9	9.000	N	9.8	21.1	56.0
1.878000	32.1	9.000	N	9.8	23.9	56.0
1.922000	31.0	9.000	N	9.8	25.0	56.0
15.356000	28.9	9.000	N	10.5	31.1	60.0
15.878000	29.9	9.000	N	10.5	30.1	60.0
16.400000	30.8	9.000	N	10.5	29.2	60.0
16.410000	30.8	9.000	N	10.5	29.2	60.0
16.758000	31.2	9.000	N	10.5	28.8	60.0
17.200000	30.9	9.000	N	10.6	29.1	60.0



CAverage Final Result, Line (N)

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	22.9	9.000	N	9.7	33.1	56.0
0.154000	22.6	9.000	N	9.7	33.2	55.8
0.158000	21.7	9.000	N	9.7	33.8	55.6
0.162000	21.6	9.000	N	9.7	33.8	55.4
0.170000	21.2	9.000	N	9.7	33.8	55.0
0.188000	19.2	9.000	N	9.7	35.0	54.1
1.102000	28.9	9.000	N	9.8	17.1	46.0
1.110000	29.2	9.000	N	9.8	16.8	46.0
1.120000	28.6	9.000	N	9.8	17.4	46.0
1.128000	28.5	9.000	N	9.8	17.5	46.0
1.922000	23.6	9.000	N	9.8	22.4	46.0
2.558000	23.4	9.000	N	9.9	22.6	46.0
15.356000	20.8	9.000	N	10.5	29.2	50.0
15.878000	21.9	9.000	N	10.5	28.1	50.0
15.898000	21.9	9.000	N	10.5	28.2	50.0
16.400000	22.9	9.000	N	10.5	27.1	50.0
16.758000	23.3	9.000	N	10.5	26.7	50.0
17.200000	23.1	9.000	N	10.6	26.9	50.0



5.2 Radiated Emission Test

The test results of radiated emission provide the following information:

-For Measurement Below 1 GHz

Rule Part / Standard	FCC PART 15 Subpart B Class B
Detector	Quasi-Peak
Bandwidth	120 kHz (6 dB)
Worst Case of Operation Mode	Camera (Front) & MP3 mode
Kind of Test Site	3 m semi anechoic chamber
Temperature	23.4 °C
Relative Humidity	38.6 %
Test Date	March 15, 2018

Frequency (MHz)	Quasi Peak (dBμV/m)	Antenna Height (cm)	POL. (H/V)	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
38.624800	22.1	99.8	V	79.0	19.5	18.0	40.0
45.764000	23.6	99.7	V	132.0	20.0	16.4	40.0
80.788800	22.9	99.8	V	184.0	15.5	17.1	40.0
161.668800	26.7	99.9	V	67.0	20.1	16.8	43.5
647.711200	27.9	166.7	V	1.0	28.0	18.1	46.0
907.820800	31.1	249.7	V	17.0	31.2	14.9	46.0

- Calculation Formula:

1. POL. H = Horizontal, POL. V = Vertical
2. QuasiPeak = Reading (Receiver Reading) + Corr.
3. Corr. (Correction Factor) = Antenna Factor + Cable Loss
4. Margin = Limit - QuasiPeak



-For Measurement Above 1 GHz

Rule Part / Standard	FCC PART 15 Subpart B Class B
Detector	Peak mode: Peak (RBW: 1 MHz, VBW: 3 MHz) CISPR-Average mode: Peak (RBW: 1 MHz, VBW: 10 Hz)
Highest Operating Frequency	2 480 MHz
Upper Frequency	1 GHz to 12.4 GHz
Worst Case of Operation Mode	Camera (Front) & MP3 mode
Kind of Test Site	3 m semi anechoic chamber
Temperature	23.6 °C
Relative Humidity	39.0 %
Test Date	March 16, 2018

Frequency (MHz)	Peak (dBμV/m)	Antenna Height (cm)	POL. (H/V)	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1500.120000	37.5	99.8	V	75.0	-28.3	36.5	74.0
3228.560000	33.1	99.7	V	128.0	-22.6	40.9	74.0
5970.960000	37.2	197.6	V	126.0	-16.6	36.8	74.0
6624.030000	38.9	198.4	H	254.0	-14.6	35.1	74.0
7444.070000	41.5	139.7	V	136.0	-12.3	32.5	74.0
9652.495000	43.0	217.5	H	294.0	-10.5	31.0	74.0

Frequency (MHz)	CAverage (dBμV/m)	Antenna Height (cm)	POL. (H/V)	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1500.120000	21.3	99.8	V	75.0	-28.3	32.7	54.0
3228.560000	20.5	99.7	V	128.0	-22.6	33.5	54.0
5970.960000	24.7	197.6	V	126.0	-16.6	29.3	54.0
6624.030000	26.0	198.4	H	254.0	-14.6	28.0	54.0
7444.070000	28.8	139.7	V	136.0	-12.3	25.2	54.0
9652.495000	30.3	217.5	H	294.0	-10.5	23.7	54.0

- Calculation Formula:

1. POL. H = Horizontal, POL. V = Vertical
2. Peak or CAverage = Reading (Receiver Reading) + Corr.
3. Corr. (Correction Factor) = Antenna Factor+ Cable Loss –Amplifier Gain
4. Margin = Limit - Peak or CAverage



6. LIST OF TEST EQUIPMENT

<u>Type</u>	<u>Manufacturer</u>	<u>Model Name</u>	<u>Serial Number</u>	<u>Calibration Cycle</u>	<u>CAL Date</u>
<u>Conducted Emission</u>					
☐ EMI Test Receiver	Rohde & Schwarz	ESCI	100584	1 year	06.20.2017
☒ EMI Test Receiver	Rohde & Schwarz	ESCI	100033	1 year	06.27.2017
☒ LISN	Rohde & Schwarz	ENV216	102245	1 year	12.20.2017
☐ LISN	Rohde & Schwarz	ESH3-Z5	100282	1 year	05.22.2017
☐ LISN	Rohde & Schwarz	ENV216	100073	1 year	07.18.2017
☒ Software	Rohde & Schwarz	EMC32 VER8.54.0	-	-	-
<u>Radiated Emission</u>					
-For measurement below 1 GHz					
☒ EMI Test Receiver	Rohde & Schwarz	ESU40	100524	1 year	08.16.2017
☒ Trilog Antenna	Schwarzbeck	VULB 9168	760	2 year	04.06.2017
☒ Antenna master	INNCO Systems	MA4000-XP-ET	-	N/A	-
☒ Antenna master controller	INNCO Systems	CO 3000	CO 3000/870/ 35990515/L	N/A	-
☒ Turn Table	INNCO Systems	-	-	N/A	-
☒ Turn Table controller	INNCO Systems	CO2000	-	N/A	-
☐ EMI Test Receiver	Rohde & Schwarz	ESU26	100241	1 year	08.16.2017
☐ Antenna master	INNCO Systems	MA4000-EP	MA4000/283	N/A	-
☐ Turn Table	INNCO Systems	DT3000-3T	DT3000/69	N/A	-
☒ Software	Rohde & Schwarz	EMC32 VER8.40.0	-	-	-
-For measurement above 1 GHz					
☒ EMI Test Receiver	Rohde & Schwarz	ESU40	100524	1 year	08.16.2017
☒ Antenna master	INNCO Systems	MA4000-XP-ET	-	N/A	-
☒ Antenna master controller	INNCO Systems	CO 3000	CO 3000/870/ 35990515/L	N/A	-
☒ Turn Table	INNCO Systems	-	-	N/A	-
☒ Turn Table controller	INNCO Systems	CO2000	-	N/A	-
☒ Horn Antenna	Schwarzbeck	BBHA 9120D	296	2 year	10.12.2016
☒ Low Noise Amplifier	TESTEK	TK-PA18H	170034-L	1 year	03.06.2018
☐ Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170#786	2 year	12.05.2017
☐ Power Amplifier	TESTEK	TK-PA1840H	170030-L	1 year	12.20.2017
☐ Antenna master controller	HD GmbH	HD 100	100/637	N/A	-
☐ Power Amplifier	CERNEX	CBLU1183540	21691	1 year	06.28.2017
☐ Antenna master	HD GmbH	MA240	240/520	N/A	-
☐ Horn Antenna	Schwarzbeck	BBHA 9120D	1300	2 year	06.30.2017
☐ EMI Test Receiver	Rohde & Schwarz	ESU26	100241	1 year	08.16.2017
☐ Turn Table	INNCO Systems	DT3000-3T	DT3000/69	N/A	-
☒ Software	Rohde & Schwarz	EMC32 VER8.40.0	-	-	-



7. CONCLUSION

The data collected shows that the **EUT Type: Multi-band GSM/WCDMA/LTE/CDMA Phone with BT and WLAN, Model: LML713DL, FCC ID: ZNFL713DL** complies with §15.107 and §15.109 of the FCC rules



8. APPENDIX A. TEST SETUP PHOTOGRAPHS

Please refer to Appendix A