



FCC PART 15.249

TEST REPORT

For

Xeleum Lighting LLC

225 W 36th St Suite 706 New York United States

FCC ID: 2APEA-XCM-001

Report Type: Original Report	Product Type: XCM (Xi-Fi Communication Module)
Report Number: <u>RSZ171120551-00B</u>	
Report Date:	2018-08-15
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Note: This test report is prepared for the customer shown above and for the equipment described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp.

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

The *Xeleum Lighting LLC*'s product, model number: *XCM-001 (FCC ID: 2APEA-XCM-001)* (or the "EUT") in this report was a *XCM (Xi-Fi Communication Module)*, which was measured approximately: 60 mm (L) * 42 mm (W) * 25 mm (H), rated with input voltage: DC 12 V.

**All measurement and test data in this report was gathered from production sample serial number: 1710079 (Assigned by BACL, Shenzhen). The EUT supplied by the applicant was received on 2017-11-20.*

Objective

This type approval report is prepared on behalf of *Xeleum Lighting LLC*. in accordance with Part 2-Subpart J, and Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.249 rules.

Related Submittal(s)/Grant(s)

FCC PART 15.231 DSR submissions with FCC ID: 2APEA-XCM-001.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
Radiated emission	30MHz~1 GHz	±5.91 dB
	Above 1 GHz	±4.92 dB
AC Power Lines Conducted Emissions		±1.95dB
Occupied Bandwidth		±0.5 kHz
Temperature		±1.0 °C
Humidity		±6 %

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

SYSTEM TEST CONFIGURATION

Justification

The system was configured for testing by manufacture.

EUT Exercise Software

No software was used.

Equipment Modifications

No modifications were made to the unit tested.

Support Equipment List and Details

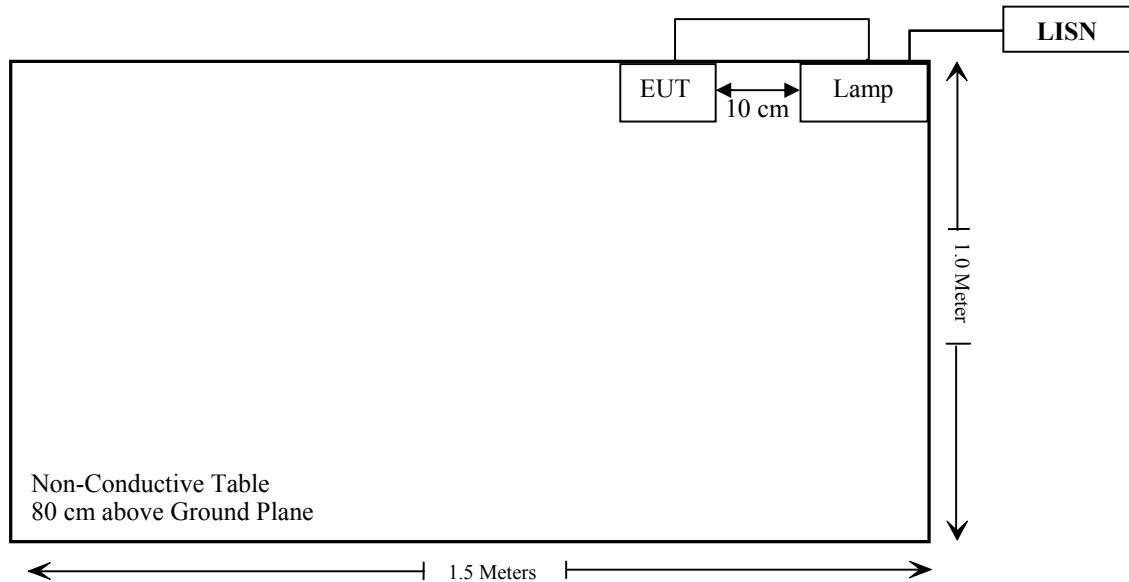
Manufacturer	Description	Model	Serial Number
Xeleum	Lamp	N/A	N/A

External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielding Un-Detachable AC Power Cable	1.2	Lamp	LISN

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.203	Antenna Requirement	Compliance
§15.207(a)	Conduction Emissions	Compliance
15.205, §15.209, §15.249(d)	Radiated Emissions& Outside of Band Emission	Compliance
§15.215 (c)	20 dB Bandwidth	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
AC Line Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	100176	2017-08-04	2018-08-04
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2017-12-21	2018-12-21
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2018-05-21	2018-11-19
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Unknown	Conducted Emission Cable	78652	UF A210B-1-0720-504504	2018-05-12	2018-11-12
Radiated Emission Test					
A.H.System	Horn Antenna	SAS-200/571	135	2015-08-18	2018-08-17
Rohde & Schwarz	Signal Analyzer	FSEM	845987/005	2018-06-23	2019-06-23
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017-12-22	2020-12-21
Sonoma instrument	Amplifier	310 N	186238	2018-05-12	2018-11-12
COM-POWER	Pre-amplifier	PA-122	181919	2018-08-01	2019-02-01
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2018-01-11	2019-01-11
UTiFLEX MICRO-C0AX	RF Cable	UFA147A-2362-100100	MFR64639 231029-003	2018-08-01	2019-02-01
Ducommun technologies	RF Cable	104PEA	218124002	2018-05-21	2018-11-21
Ducommun technologies	RF Cable	RG-214	1	2018-05-21	2018-11-19
Ducommun technologies	RF Cable	RG-214	2	2018-05-22	2018-11-22
Heatsink Required	Amplifier	QLW-18405536-J0	15964001002	2018-08-01	2019-02-01
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Agilent	Spectrum Analyzer	8564E	3943A01781	2018-01-04	2019-01-04
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-04	2017-12-29	2020-12-28
Ducommun Technologies	Horn Antenna	ARH-2823-02	1007726-04	2017-12-29	2020-12-28

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Antenna Connector Construction

The EUT has one external antenna arrangement, which used a unique coupling to this product. And the antenna gain is 2.0 dBi, fulfill the requirement of this section. Please refer to EUT photos.

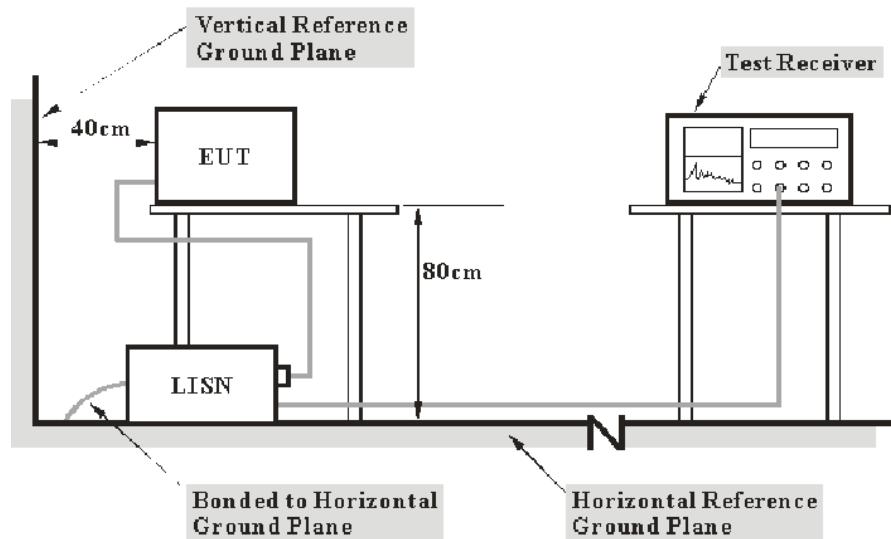
Result: Compliance.

FCC §15.207 – AC LINE CONDUCTED EMISSIONS

Applicable Standard

According to FCC §15.207

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with per ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN/ISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207,

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level is in compliance with the limit if

$$L_m + U_{(Lm)} \leq L_{\text{lim}} + U_{\text{cispr}}$$

In BACL., $U_{(Lm)}$ is less than U_{cispr} , if L_m is less than L_{lim} , it implies that the EUT complies with the limit.

Test Data

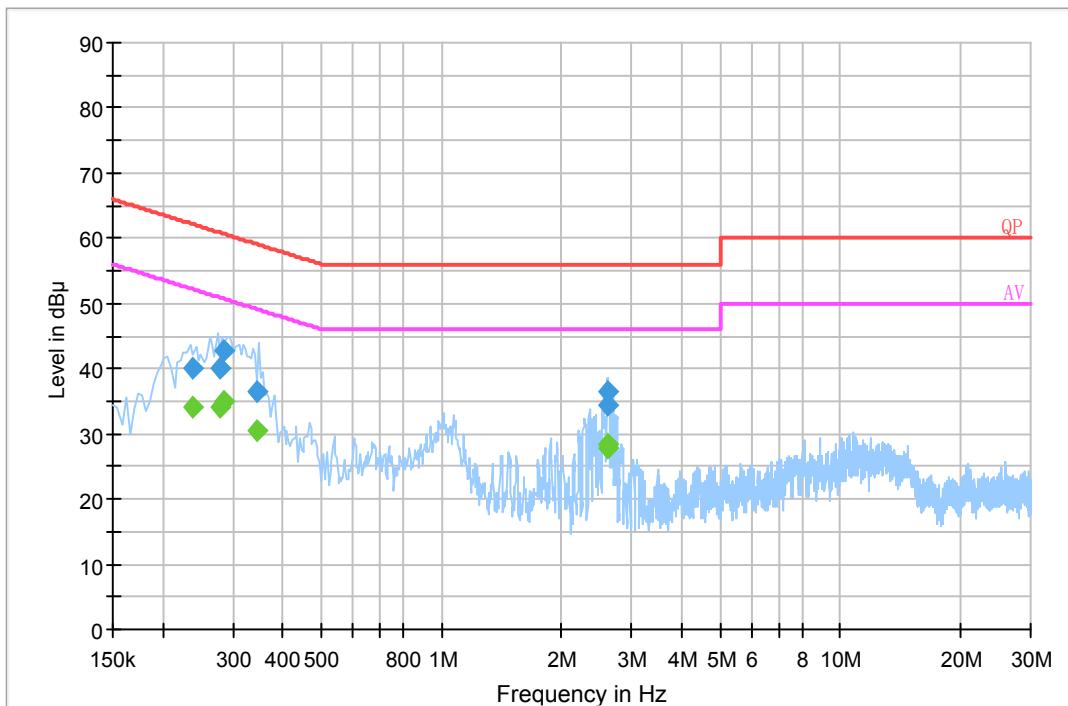
Environmental Conditions

Temperature:	26 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

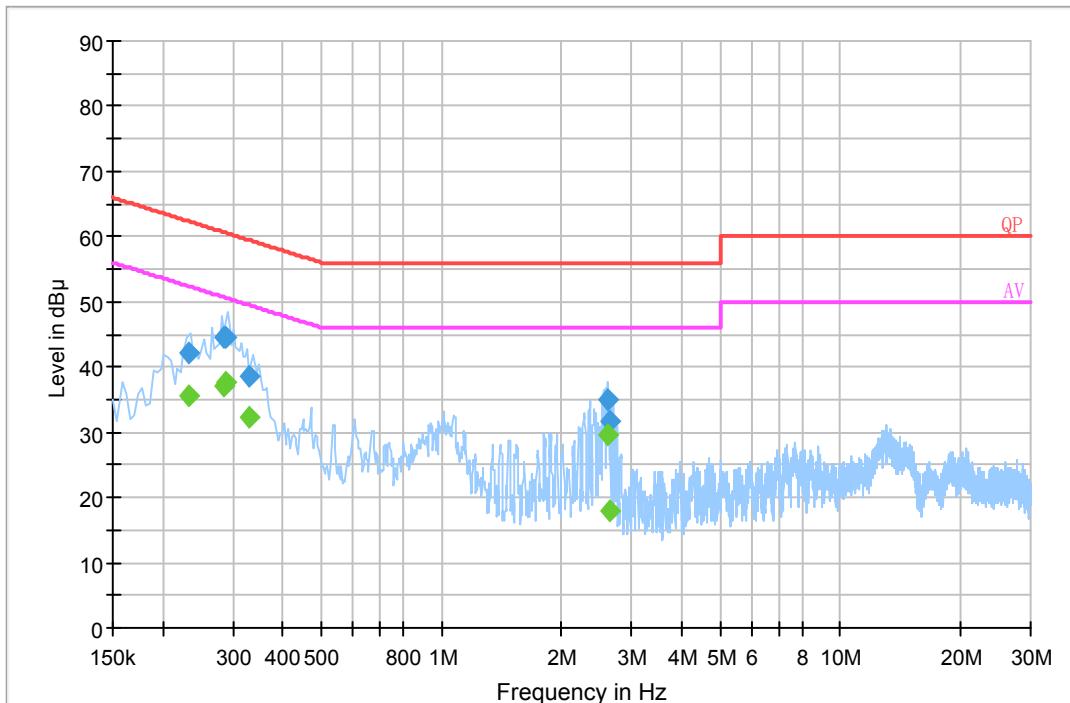
The testing was performed by Hill He on 2018-08-02.

EUT Operation Mode: Transmitting

AC 120V/60 Hz, Line:



Frequency (MHz)	Corrected Amplitude (dB μ V)	Corrected Factor (dB)	Limit (dB μ V)	Margin (dB)	Remark (PK/QP/Ave.)
0.237500	40.2	19.7	62.2	22.0	QP
0.277500	40.2	19.8	60.9	20.7	QP
0.285500	42.7	19.8	60.7	18.0	QP
0.344750	36.4	19.7	59.1	22.7	QP
2.598610	34.5	19.9	56.0	21.5	QP
2.606730	36.4	19.9	56.0	19.6	QP
0.237500	34.2	19.7	52.2	18.0	Ave.
0.277500	34.0	19.8	50.9	16.9	Ave.
0.285500	35.0	19.8	50.7	15.7	Ave.
0.344750	30.6	19.7	49.1	18.5	Ave.
2.598610	28.3	19.9	46.0	17.7	Ave.
2.606730	27.8	19.9	46.0	18.2	Ave.

AC 120V/60 Hz, Neutral

Frequency (MHz)	Corrected Amplitude (dB μ V)	Corrected Factor (dB)	Limit (dB μ V)	Margin (dB)	Remark (PK/QP/Ave.)
0.233500	42.2	19.7	62.3	20.1	QP
0.285500	44.4	19.8	60.7	16.3	QP
0.289500	44.6	19.8	60.5	15.9	QP
0.329110	38.5	19.7	59.5	21.0	QP
2.622610	35.1	19.9	56.0	20.9	QP
2.634790	31.8	19.9	56.0	24.2	QP
0.233500	35.7	19.7	52.3	16.6	Ave.
0.285500	37.0	19.8	50.7	13.7	Ave.
0.289500	37.8	19.8	50.5	12.7	Ave.
0.329110	32.3	19.7	49.5	17.2	Ave.
2.622610	29.6	19.9	46.0	16.4	Ave.
2.634790	17.8	19.9	46.0	28.2	Ave.

Note:

- 1) Correction Factor = LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
The corrected factor has been input into the transducer of the test software.
- 2) Corrected Amplitude = Reading + Correction Factor
- 3) Margin = Limit – Corrected Amplitude

FCC§15.205, §15.209 & §15.249(d) - RADIATED EMISSIONS**Applicable Standard**

As per FCC§15.249 (a), except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400–2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0–24.25 GHz	250	2500

As per FCC§15.249 (c), Field strength limits are specified at a distance of 3 meters.

As per FCC§15.249 (d), Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

Test Equipment Setup

The spectrum analyzer or receiver is set as:

Below 1000MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

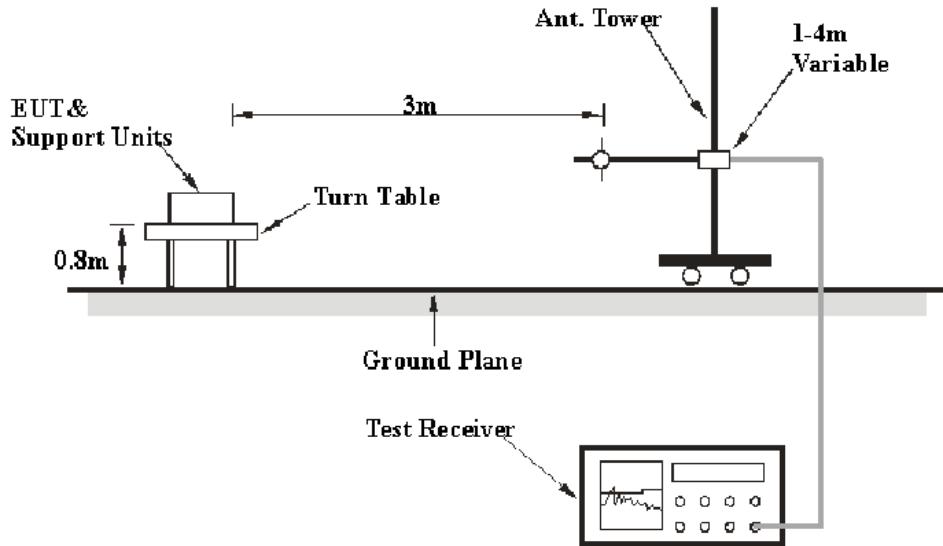
Above 1000MHz:

Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto

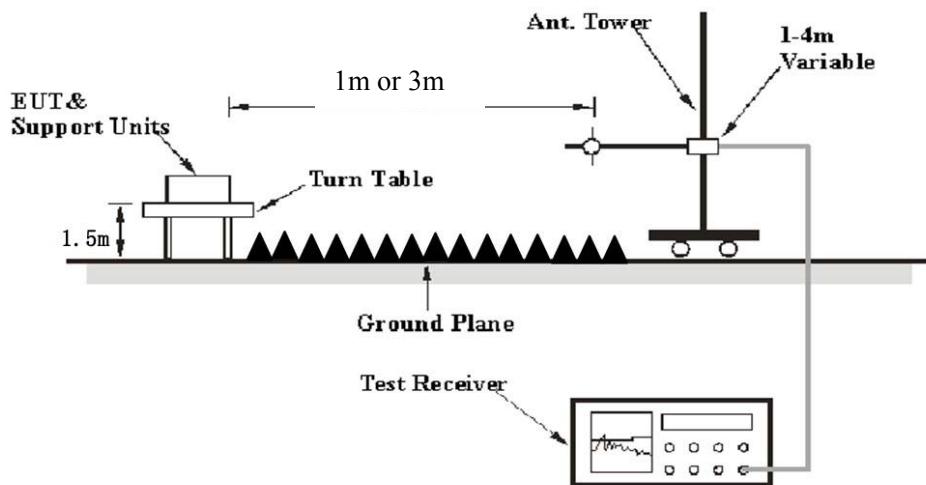
Average: RBW = 1MHz / VBW = 10Hz / Sweep = Auto

EUT Setup

Below 1 GHz:



Above 1 GHz:



The radiated emission and out of band emission tests were performed in the 3 meters chamber test site for below 18GHz and 1meter for above 18GHz, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209/15.205 and FCC 15.249 limits.

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT is set 3 meter away from the testing antenna, which is varied from 1-4 meter, and the EUT is placed on a turntable, which is 0.8 meter above ground plane for below 1GHz or 1.5 meter for above 1GHz, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1GHz, peak and Average detection modes for frequencies above 1GHz.

According to ANSI C63.10-2013,9.4: For field strength measurements made at other than the distance at which the applicable limit is specified, extrapolate the measured field strength to the field strength at the distance specified by the limit using an inverse distance correction factor (20 dB/decade of distance). In some cases, a different distance correction factor may be required;

$$E_{\text{SpecLimit}} = E_{\text{Meas}} + 20 \log \left(\frac{d_{\text{Meas}}}{d_{\text{SpecLimit}}} \right)$$

where

$E_{\text{SpecLimit}}$ is the field strength of the emission at the distance specified by the limit, in dB μ V/m

E_{Meas} is the field strength of the emission at the measurement distance, in dB μ V/m

d_{Meas} is the measurement distance, in m

$d_{\text{SpecLimit}}$ is the distance specified by the limit, in m

So the extrapolation factor of 1m is $20 * \log(1/3) = -9.54$ dB

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Results Summary

According to the data in the following table, the EUT complied with the FCC Part 15.205, 15.209 & §15.249

Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{lim} + U_{cisp}$$

In BACL, $U_{(Lm)}$ is less than U_{cisp} , if L_m is less than L_{lim} , it implies that the EUT complies with the limit.

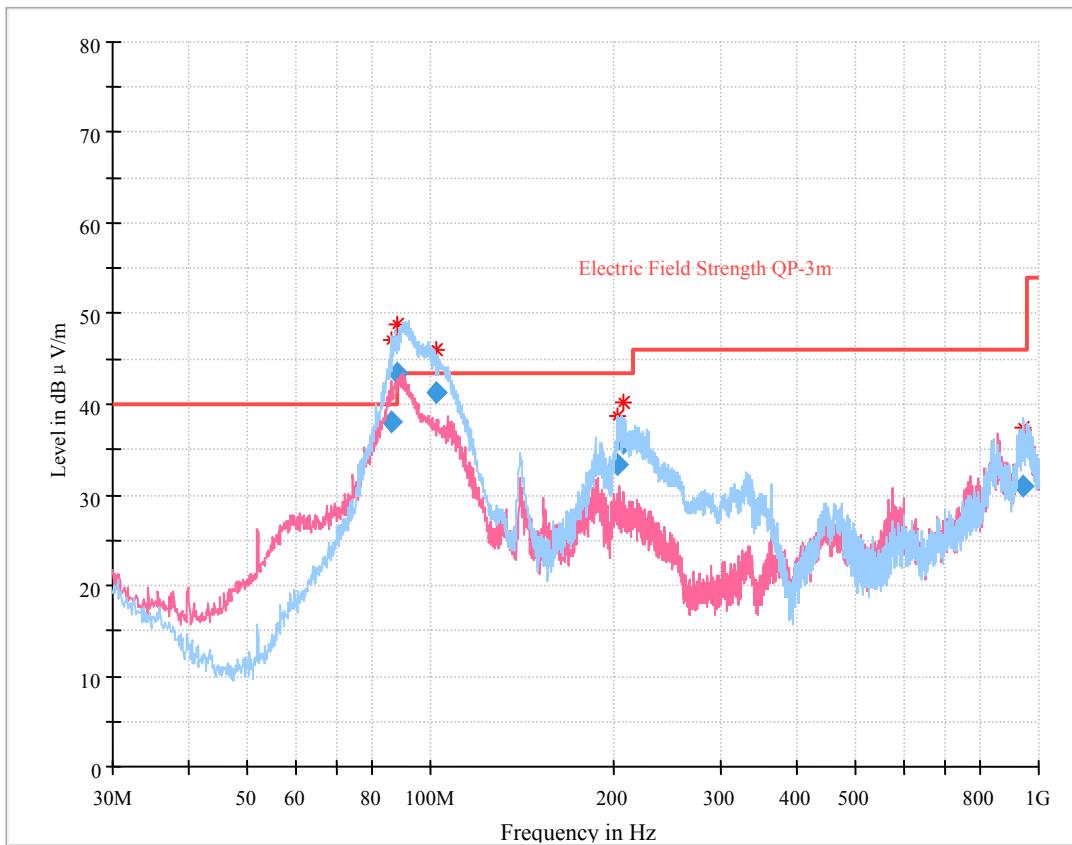
Test Data

Environmental Conditions

Temperature:	26 °C
Relative Humidity:	51 %
ATM Pressure:	101.0 kPa

The testing was performed by Hill He on 2018-08-11.

Test Mode: Transmitting

30MHz – 1 GHz @3m:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBuV/m)	FCC Part 15.249&15.209	
	Reading (dB μ V)	PK/QP/Ave.		Height (cm)	Polar (H / V)			Limit (dBuV/m)	Margin (dB)
86.017125	57.41	QP	182.0	400.0	H	-19.4	38.01	40.00	1.99
88.024250	62.58	QP	177.0	213.0	H	-19.2	43.38	43.50	0.12
102.195000	58.01	QP	192.0	277.0	H	-16.8	41.21	43.50	2.29
203.448750	47.1	QP	174.0	160.0	H	-13.8	33.30	43.50	10.20
208.003375	49.56	QP	181.0	166.0	H	-13.9	35.66	43.50	7.84
943.486625	21.85	QP	347.0	221.0	H	9.2	31.05	46.00	14.95

1 GHz ~ 18 GHz @3m:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB μ V/m)	FCC Part 15.249&15.209	
	Reading (dB μ V)	Detector (PK/QP/Ave.)		Height (m)	Polar (H/V)			Limit (dB μ V/m)	Margin (dB)
5739	48.39	PK	330	1.4	H	42.15	90.54	114	23.46
5739	48.21	Ave.	330	1.4	H	42.15	90.36	94	3.64
5739	48.88	PK	311	1.2	V	42.15	91.03	114	22.97
5739	47.58	Ave.	311	1.2	V	42.15	89.73	94	4.27
5656.71	40.24	PK	82	2.0	H	7.75	47.99	54*	6.01
5700.56	38.22	PK	182	1.9	H	7.75	45.97	54*	8.03
5721.36	39.46	PK	205	1.3	H	7.75	47.21	54*	6.79
5853.84	40.40	PK	90	1.6	H	8.05	48.45	54*	5.55
5870.63	39.77	PK	315	1.2	H	8.05	47.82	54*	6.18
5897.34	40.54	PK	205	1.4	H	8.05	48.59	54*	5.41
11479.24	42.97	PK	278	2.1	H	18.92	61.89	74	12.11
11479.24	34.54	Ave.	278	2.1	H	18.92	53.46	54	0.54

Note 1:

Corrected Amplitude = Corrected Factor + Reading

Corrected Factor=Antenna factor (RX) +cable loss – amplifier factor

Margin = Limit- Corr. Amplitude

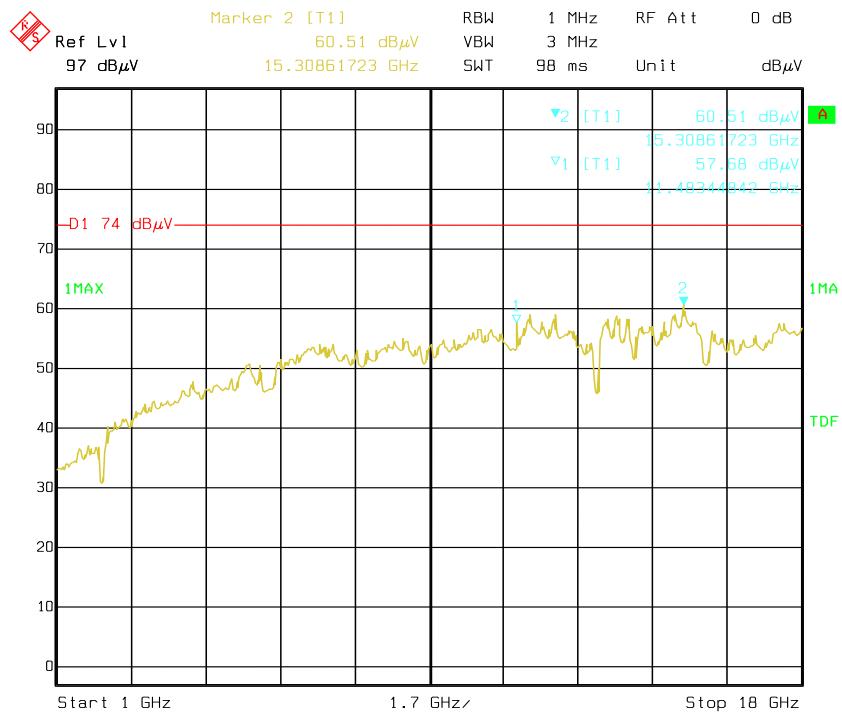
Note 2:

“*” means peak test value meets average limit.

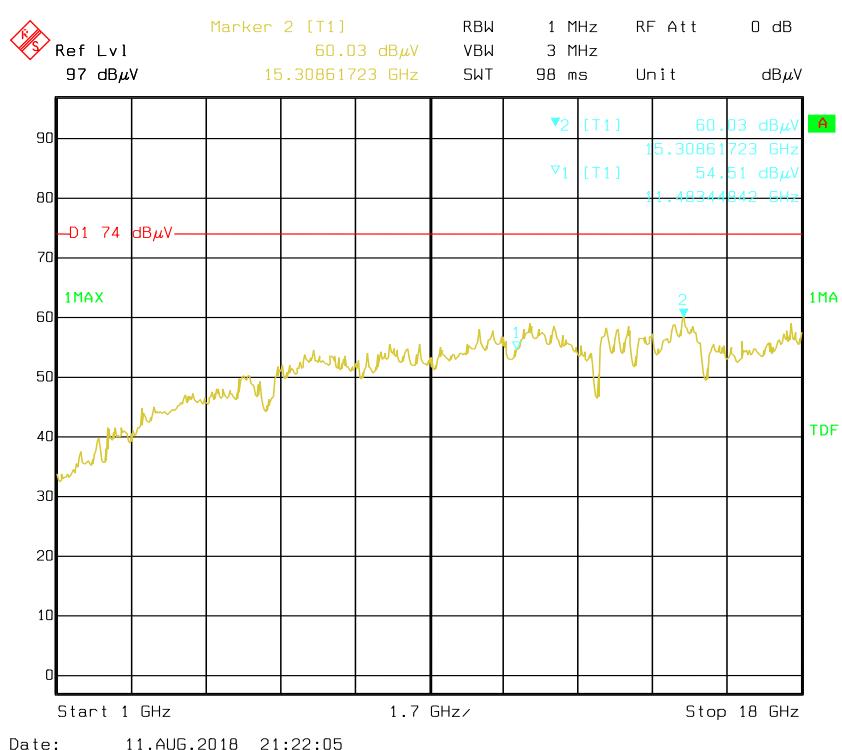
Note 3:

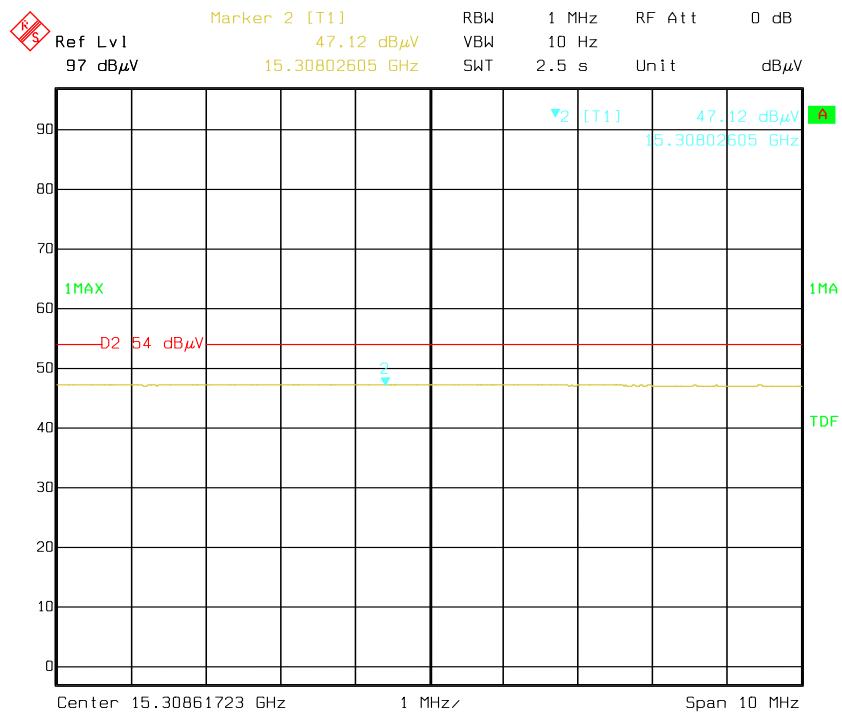
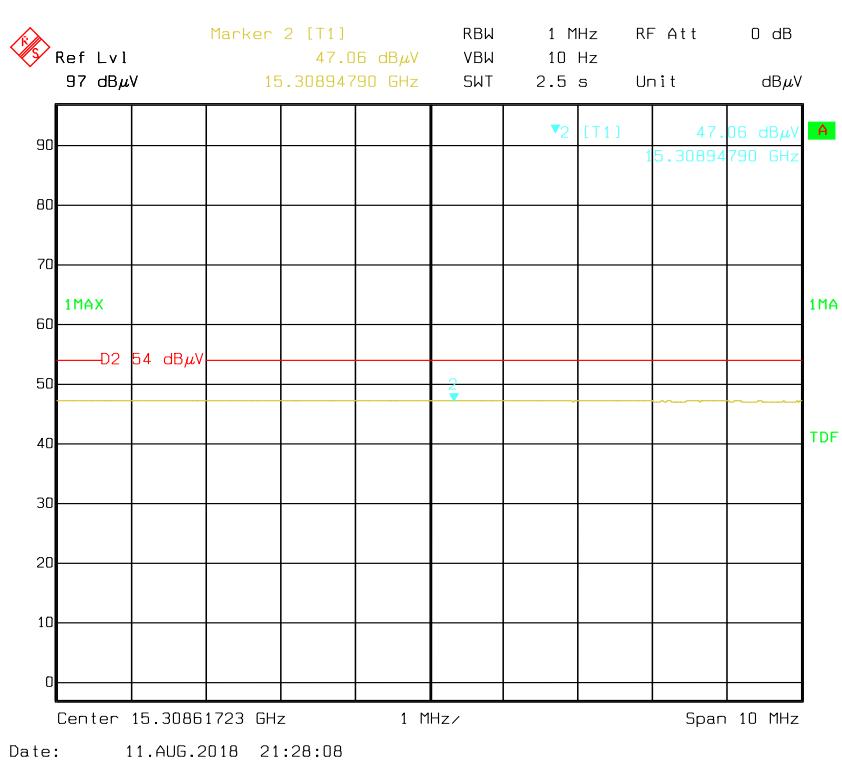
The emission more than 20dB below the limit was not required to be recorded.

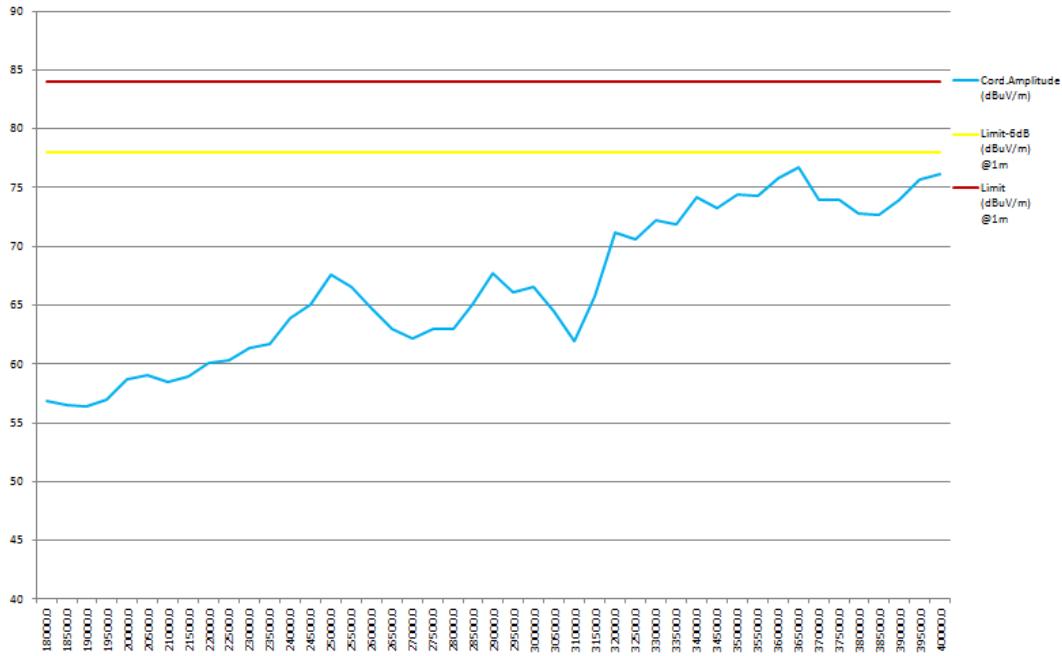
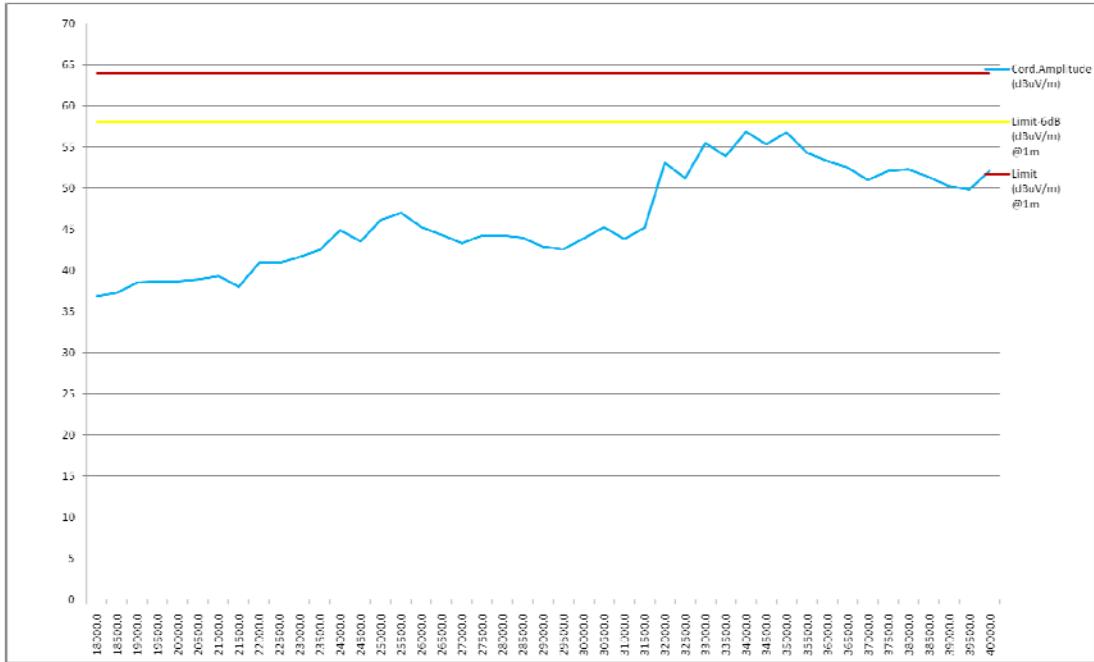
Pre-scan with Peak - Horizontal



Pre-scan with Peak - Vertical



Pre-scan with Average - Horizontal**Pre-scan with Average - Vertical**

System noise floor level for above 18GHz @1m, for Peak**System noise floor level for above 18GHz @1m, for Average**

FCC§15.215(c) - 20dB EMISSION BANDWIDTH

Applicable Standard

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in § 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that indicated 20dB bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

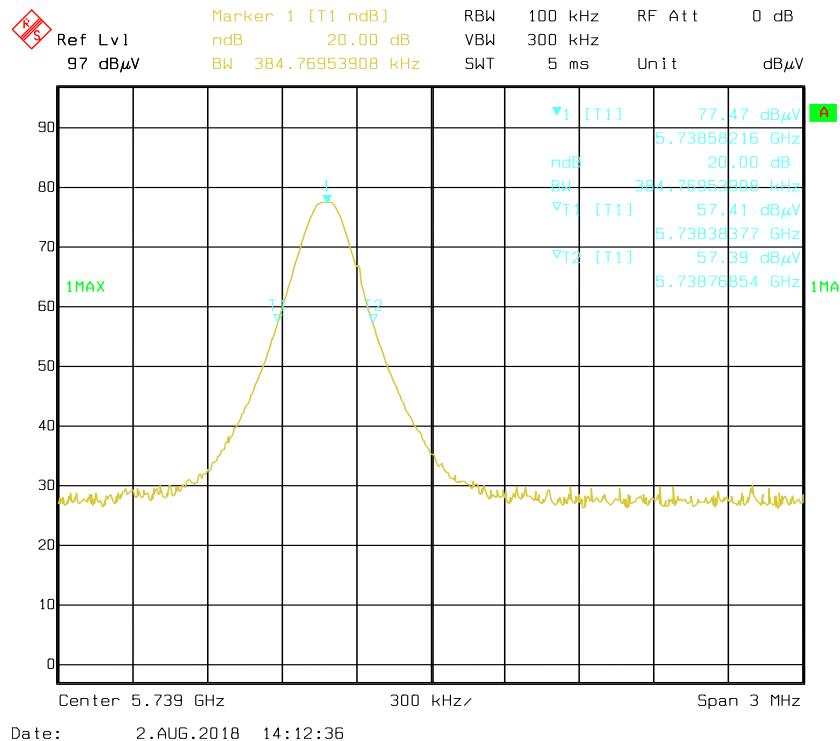
Temperature:	26 °C
Relative Humidity:	51 %
ATM Pressure:	101.0 kPa

The testing was performed by Hill He on 2018-08-02.

Test Mode: Transmitting

Please refer to the following table and plots.

Frequency (MHz)	20dB Bandwidth (kHz)	Limit (MHz)
5738.38377 – 5738.76854	385	5725-5875



***** END OF REPORT *****