FCC 47 CFR PART 15 SUBPART B

TEST REPORT

Capricorn Electronics Ltd

Wireless Tank Monitor

Model No.: TM1

Prepared for	:	Capricorn Electronics Ltd
Address	:	Workshop No. A7, 5th Floor, Block A, Proficient Industrial Centre, 6 Wang Kwun Road, Kowloon Bay, Hong Kong
Prepared by	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
Address	:	1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China
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Mail	:	webmaster@LCS-cert.com
Date of receipt of test sample	:	December 19, 2018
Number of tested samples	:	1
Serial number	:	Prototype
Date of Test	:	December 19, 20188 ~ December 20, 2018
Date of Report	:	December 21, 2018

FCC TEST REPORT

FCC 47 CFR PART 15 SUBPART B

Report Reference No.	**:**	**LCS181219059AEA**
Date Of Issue.....	:	December 21, 2018
Testing Laboratory Name.....	**:**	**Shenzhen LCS Compliance Testing Laboratory Ltd.**
Address	:	1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China
Testing Location/ Procedure	:	Full application of Harmonised standards ■ Partial application of Harmonised standards □ Other standard testing method □
Applicant's Name	**:**	**Capricorn Electronics Ltd**
Address	:	Workshop No. A7, 5th Floor, Block A, Proficient Industrial Centre, 6 Wang Kwun Road, Kowloon Bay, Hong Kong
Test Specification		
Standard.....	:	FCC 47 CFR Part 15 Subpart B, ANSI C63.4 -2014
Test Report Form No.....	:	LCSEMC-1.0
TRF Originator.....	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
Master TRF.....	:	Dated 2011-03

Test Item Description.....	**:**	**Wireless Tank Monitor**
Trade Mark	:	N/A
Model/ Type Reference.....	:	TM1
Ratings	:	DC 3.0V from battery
Result	:	**Positive**

Compiled by:	**Supervised by:**	**Approved by:**
Ace Chai / File administrators	Calvin Weng / Technique principal	Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : LCS181219059AEA	December 21, 2018 Date of issue

Type / Model.....	: TM1
EUT.....	: Wireless Tank Monitor
Applicant.....	**: Capricorn Electronics Ltd**
Address.....	: Workshop No. A7, 5th Floor, Block A, Proficient Industrial Centre, 6 Wang Kwun Road, Kowloon Bay, Hong Kong
Telephone.....	: /
Fax.....	: /
Manufacturer.....	**: Capricorn Electronics Ltd**
Address.....	: Workshop No. A7, 5th Floor, Block A, Proficient Industrial Centre, 6 Wang Kwun Road, Kowloon Bay, Hong Kong
Telephone.....	: /
Fax.....	: /
Factory.....	: **Capricorn Electronics Ltd**
Address.....	: Workshop No. A7, 5th Floor, Block A, Proficient Industrial Centre, 6 Wang Kwun Road, Kowloon Bay, Hong Kong
Telephone.....	: /
Fax.....	: /

Test Result	**Positive**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

Revision History

Revision	Issue Date	Revisions	Revised By
000	December 21, 2018	Initial Issue	Gavin Liang

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Test Report Description Page

1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT : Wireless Tank Monitor
Test Model : TM1
Power Supply : DC 3.0V from battery
Hardware Version : -/-
Software Version : /-

1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
Dell	Keyboard	L100	CN-0RH656-65890-14C-02L S REV A04	DoC
Brother	Printer	HL-2140	E65602M0J161141	DoC
Dell	Mouse	MS111-P	CN-011D3V-71581-0BM	DoC
Dell	Mainframe	XPS 8920-R1AN8S	-/-	DoC
Dell	LCD Monitor	E2014Hf	50642E20LB01H07(A)JL-3	DoC

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
Mini USB Port	1	N/A

1.4. Description of Test Facility

FCC Registration Number. is 254912.
Industry Canada Registration Number. is 9642A-1.
ESMD Registration Number. is ARCB0108.
UL Registration Number. is 100571-492.
TUV SUD Registration Number. is SCN1081.
TUV RH Registration Number. is UA 50296516-001
NVLAP Registration Code is 600167-0.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

1.5. Statement of the Measurement Uncertainty

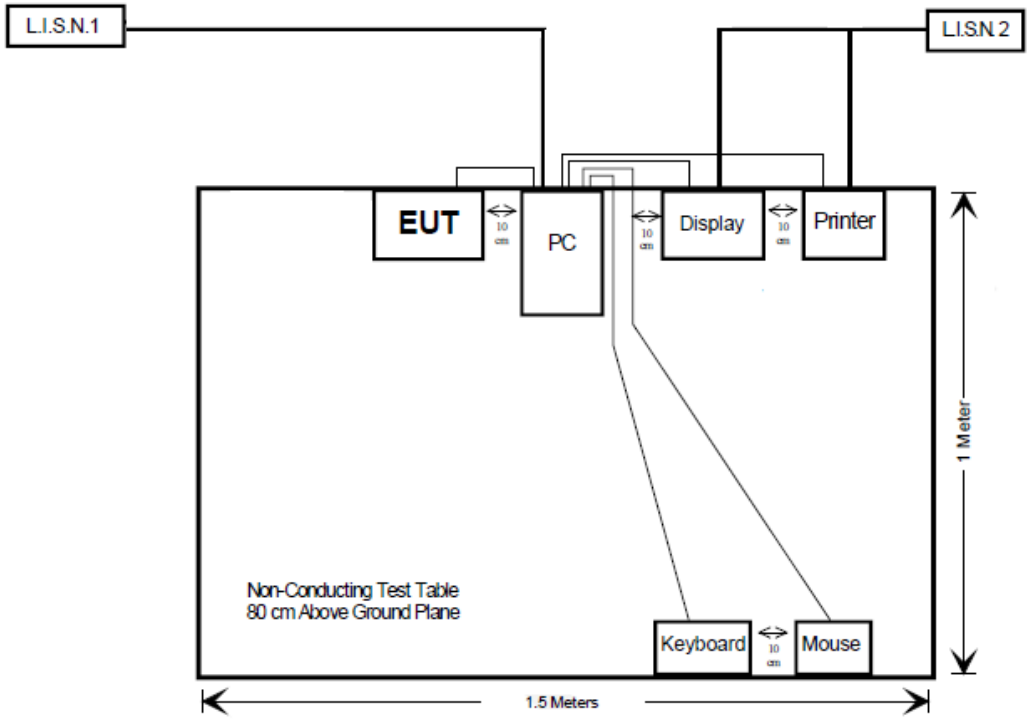
The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. To CISPR 16 – 4 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements" and is documented in the LCS quality system acc. To DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

1.6. Measurement Uncertainty

Test Item		Frequency Range	Uncertainty	Note
Radiation Uncertainty	:	9KHz~30MHz	±3.10dB	(1)
		30MHz~200MHz	±2.96dB	(1)
		200MHz~1000MHz	±3.10dB	(1)
		1GHz~26.5GHz	±3.80dB	(1)
		26.5GHz~40GHz	±3.90dB	(1)
Conduction Uncertainty	:	150kHz~30MHz	±1.63dB	(1)
Power disturbance	:	30MHz~300MHz	±1.60dB	(1)

(1). This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.6. Description of Test Setup Block Diagram



1.7. Description of Test Modes

Test Configuration (TC) No.	Test Mode Description	Test Item Description	Worst Case Recorded in Test Report
TC01	EUT + PC + Display + Mouse + Keyboard + Printer + LTE module RX	Conducted Emission	☒
TC02	EUT + PC + Display + Mouse + Keyboard + Printer + LTE module RX	Radiated Emission	☒
TC03	EUT + PC + Display + Mouse + Keyboard + Printer	Conducted Emission	☐
TC04	EUT + PC + Display + Mouse + Keyboard + Printer	Radiated Emission	☐

2. SUMMARY OF TEST RESULTS

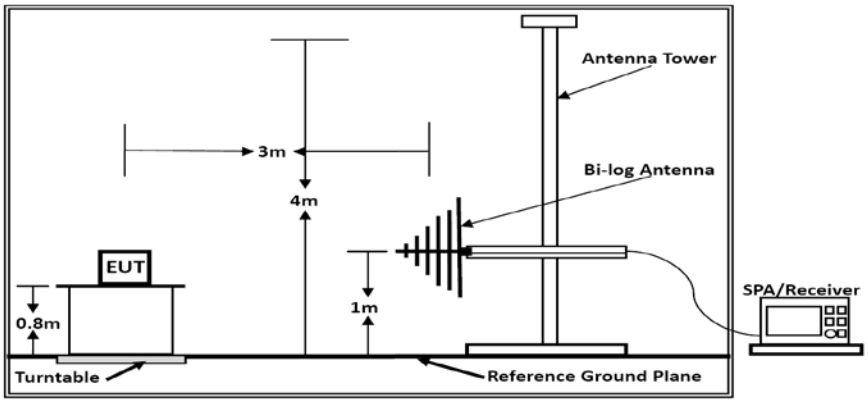
Applied Standard: FCC Part 15 Subpart B			
FCC Rules	Description of Test	Result	Remark
§15.107	AC Conducted Emissions	Compliant	N/A
§15.109	Radiated Emissions	Compliant	N/A

3. Radiated emission Measurement

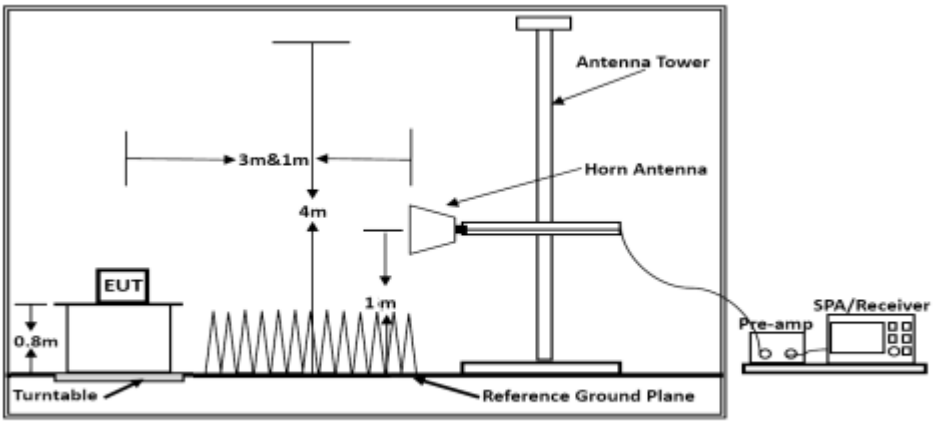
3.1. Test Equipment

Item	Equipment	Manufacturer	Model No.	Serial No.	Cal. Day	Cal. Due Day
1	3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	2018-06-17	2019-06-16
2	EMI Test Receiver	R&S	ESR 7	101181	2018-06-17	2019-06-16
3	Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	2018-07-16	2019-07-15
4	Log per Antenna	SCHWARZBECK	VULB9163	9163-470	2018-06-09	2019-06-08
5	EMI Test Software	AUDIX	E3	N/A	N/A	N/A
6	Positioning Controller	MF	MF-7082	/	N/A	N/A
7	RF Cable	Hubersuhner	Sucoflex104	FP2RX2	2018-06-17	2019-06-16
8	Horn Antenna	EMCO	3115	6741	2018-06-09	2019-06-08
9	RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	2018-06-17	2019-06-16
10	Amplifier	SCHAFFNER	COA9231A	18667	2018-06-17	2019-06-16
11	Amplifier	Agilent	8449B	3008A02120	2018-06-17	2019-06-16
12	Amplifier	MITEQ	AMF-6F-260400	9121372	2018-06-17	2019-06-16

3.2. Block Diagram of Test Setup



Below 1GHz



Above 1GHz

3.3. Radiated Emission Limit (Class B)

According to §15.109 (b): The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the following:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

Remark:

(1) Emission level (dB)μV = 20 log Emission level μV/m

(2) The smaller limit shall apply at the cross point between two frequency bands.

(3) Distance is the distance in meters between the measuring instrument, antenna and the closest point of any part of the device or system.

3.4. EUT Configuration on Measurement

The following equipment are installed on Radiated Emission Measurement to meet the commission requirements and operating regulations in a manner which tends to maximize its emission characteristics in normal application.

3.5. Operating Condition of EUT

3.5.1. Setup the EUT as shown in Section 3.2.

3.5.2. Let the EUT work in test mode (ON) and measure it.

3.6. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	5th highest work frequency
RB / VB	1MHz / 1MHz for Peak, 1 MHz / 10 Hz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

3.7. Test Procedure

1) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 4 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

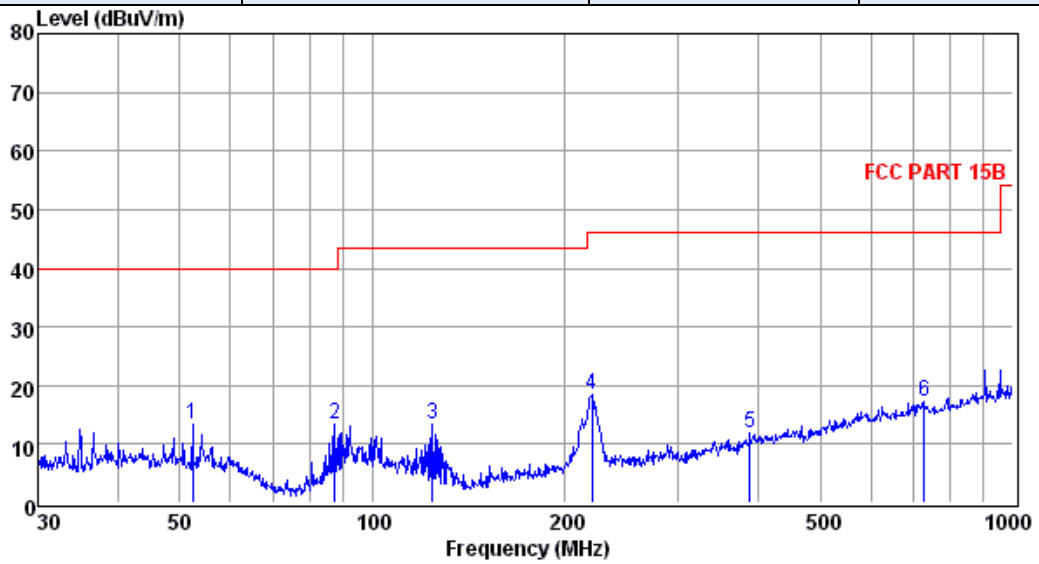
--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3.8. Radiated Emission Noise Measurement Result

PASS.

The scanning waveforms refer to the following page.

Model No.	TM1	Test Mode	TC02
Environmental Conditions	23.5℃, 53.1% RH	Detector Function	Quasi-peak
Pol	Vertical	Distance	3m
Test Engineer	Jayden Zhuo		

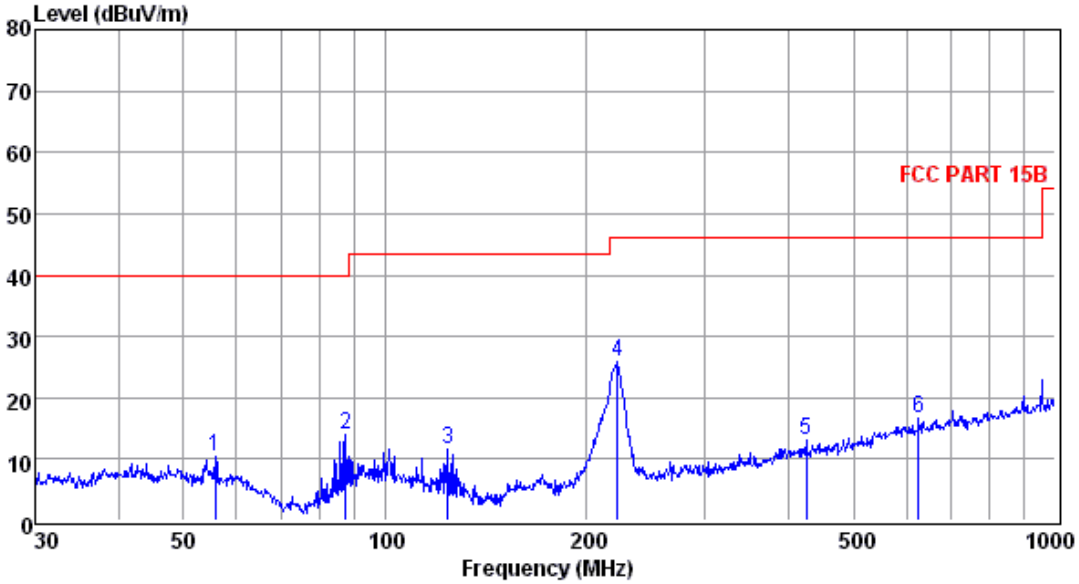


pol: VERTICAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	52.39	-0.27	0.46	13.14	13.33	40.00	-26.67	QP
2	87.42	1.93	0.47	11.08	13.48	40.00	-26.52	QP
3	124.13	2.98	0.71	9.84	13.53	43.50	-29.97	QP
4	219.84	6.24	0.95	11.20	18.39	46.00	-27.61	QP
5	387.99	-4.04	1.17	14.78	11.91	46.00	-34.09	QP
6	726.81	-3.68	1.70	19.15	17.17	46.00	-28.83	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that are 20db below the official limit are not reported

Model No.	TM1	Test Mode	TC02
Environmental Conditions	23.5℃, 53.1% RH	Detector Function	Quasi-peak
Pol	Horizontal	Distance	3m
Test Engineer	Jayden Zhuo		



pol: HORIZONTAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	55.80	-3.18	0.47	12.97	10.26	40.00	-29.74	QP
2	87.42	2.39	0.47	11.08	13.94	40.00	-26.06	QP
3	124.13	0.93	0.71	9.84	11.48	43.50	-32.02	QP
4	222.17	13.64	0.95	11.30	25.89	46.00	-20.11	QP
5	425.03	-3.54	1.16	15.49	13.11	46.00	-32.89	QP
6	625.08	-3.37	1.49	18.54	16.66	46.00	-29.34	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that are 20db below the official limit are not reported

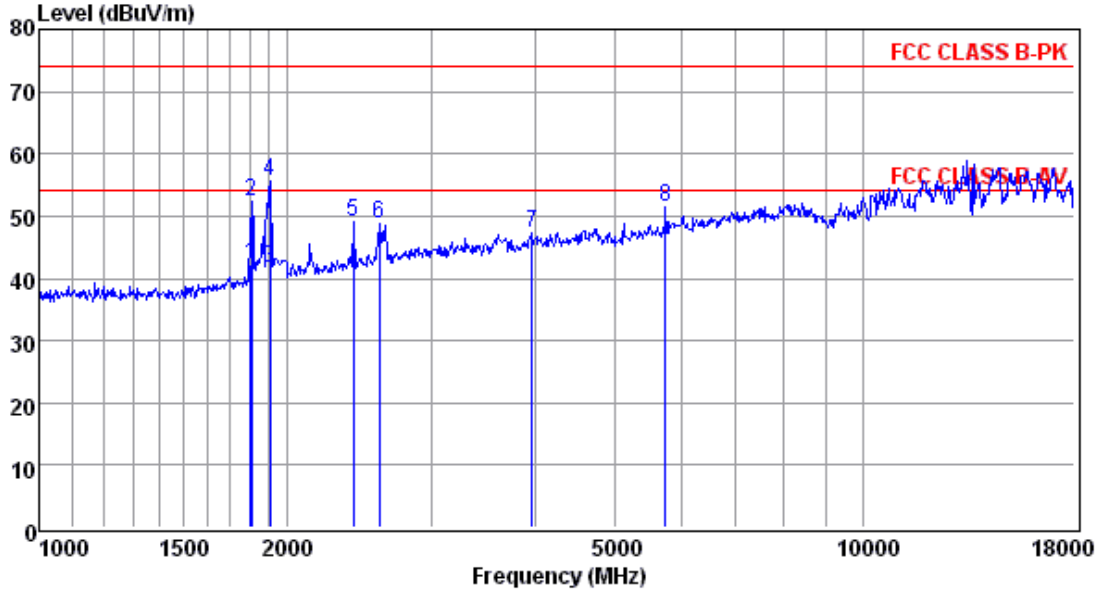
Note:

Pre-scan all modes and recorded the worst case results in this report.

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level = Level.

Model No.	TM1	Test Mode	TC02
Environmental Conditions	23.5℃, 53.1% RH	Detector Function	Peak
Pol	Vertical	Distance	3m
Test Engineer	Jayden Zhuo		

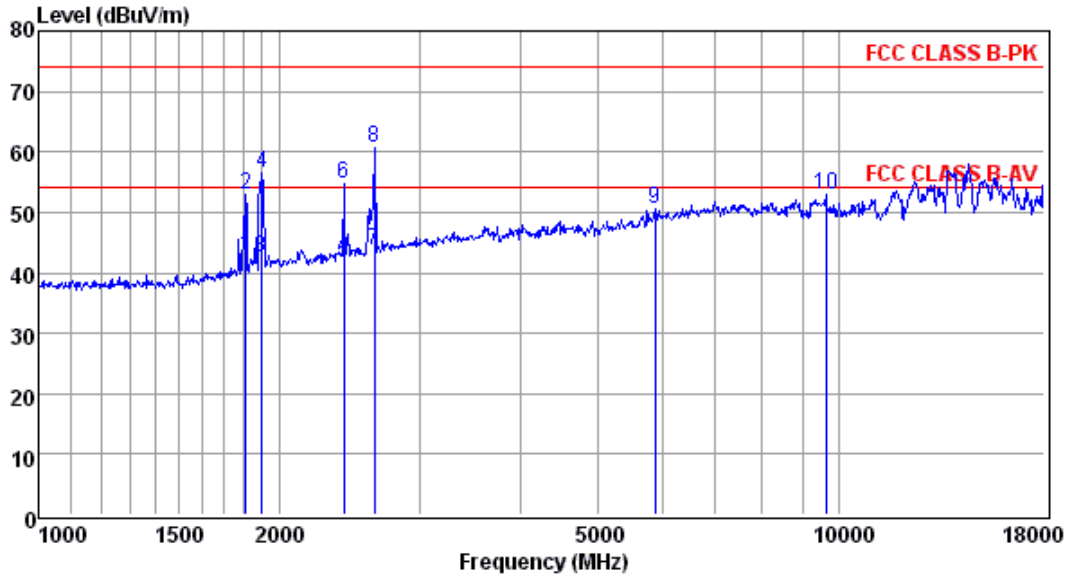


pol: VERTICAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	1807.55	44.05	4.46	30.75	42.24	54.00	-11.76	Average
2	1808.55	54.04	4.46	30.76	52.24	74.00	-21.76	Peak
3	1904.14	42.80	4.48	31.43	41.67	54.00	-12.33	Average
4	1905.14	56.79	4.48	31.44	55.67	74.00	-18.33	Peak
5	2407.70	48.14	5.07	32.92	49.03	74.00	-24.97	Peak
6	2588.12	47.31	5.32	33.24	48.76	74.00	-25.24	Peak
7	3958.31	42.55	7.15	34.38	47.25	74.00	-26.75	Peak
8	5746.98	43.64	8.62	35.90	51.38	74.00	-22.62	Peak

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that are 20db below the official limit are not reported

Model No.	TM1	Test Mode	TC02
Environmental Conditions	23.5℃, 53.1% RH	Detector Function	Peak
Pol	Horizontal	Distance	3m
Test Engineer	Jayden Zhuo		



pol: HORIZONTAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	1812.79	44.66	4.46	30.79	42.89	54.00	-11.11	Average
2	1813.79	54.65	4.46	30.80	52.89	74.00	-21.11	Peak
3	1898.54	43.60	4.48	31.39	42.43	54.00	-11.57	Average
4	1899.64	57.59	4.48	31.40	56.43	74.00	-17.57	Peak
5	2406.70	40.76	5.07	32.91	41.64	54.00	-12.36	Average
6	2407.70	53.75	5.07	32.92	54.64	74.00	-19.36	Peak
7	2624.79	42.08	5.37	33.30	43.65	54.00	-10.35	Average
8	2625.80	59.07	5.38	33.30	60.65	74.00	-13.35	Peak
9	5881.42	42.41	8.77	36.11	50.50	74.00	-23.50	Peak
10	9613.43	39.91	9.98	38.22	52.80	74.00	-21.20	Peak

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that are 20db below the official limit are not reported

Notes:

1. Radiated emissions measured in frequency range from 9 KHz~10th harmonic were made with an instrument using Peak detector mode.

2. Data of measurement within this frequency range shown "---" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

3. Average values no need if peak values lower than average limit.

4. AC Power line conducted emissions

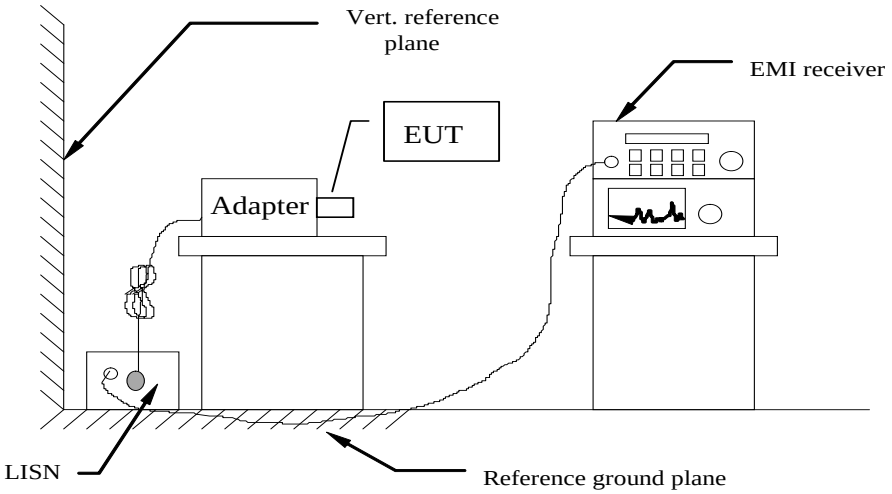
4.1 Standard Applicable

According to §15.107 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

4.2 Block Diagram of Test Setup



4.2 Test Equipment

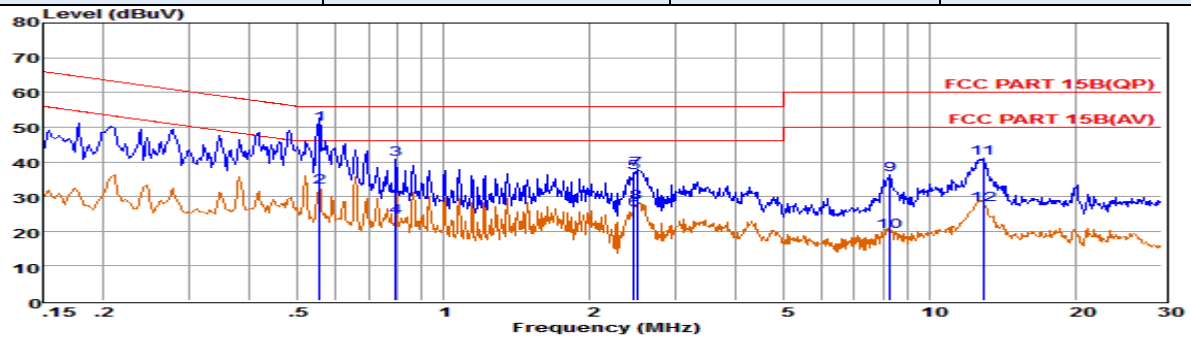
Item	Equipment	Manufacturer	Model No.	Serial No.	Cal. Day	Cal. Due Day
1	EMI Test Receiver	R&S	ESR 7	101181	2018-06-17	2019-06-16
2	10dB Attenuator	SCHWARZBECK	MTS-IMP136	261115-001-0032	2018-06-17	2019-06-16
3	Artificial Mains	R&S	ENV216	101288	2018-06-17	2019-06-16
4	EMI Test Software	AUDIX	E3	N/A	N/A	N/A
5	RF Cable	Harbour Industries	1452	N/A	2018-06-17	2019-06-16

4.3 Test Results

PASS

The test data please refer to following page.

Model No.	TM1	Test Mode	TC01
Environmental Conditions	23.5℃, 53.1% RH	Detector Function	Quasi-peak
Pol	Line	Distance	3m
Test Engineer	Jayden Zhuo		

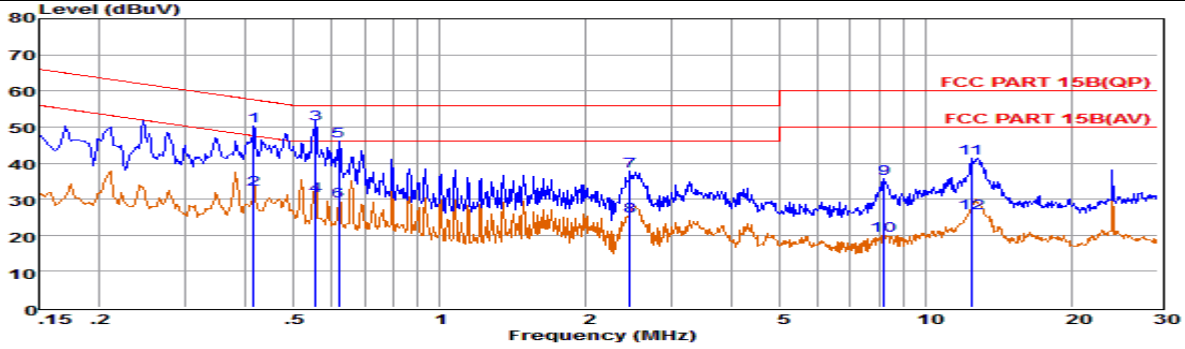


Pol: LINE

	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dBuV	dBuV	dB	
1	0.56	31.05	9.63	0.04	10.00	50.72	56.00	-5.28	QP
2	0.56	13.13	9.63	0.04	10.00	32.80	46.00	-13.20	Average
3	0.80	20.99	9.64	0.04	10.00	40.67	56.00	-15.33	QP
4	0.80	4.53	9.64	0.04	10.00	24.21	46.00	-21.79	Average
5	2.46	17.31	9.64	0.05	10.00	37.00	56.00	-19.00	QP
6	2.46	6.47	9.64	0.05	10.00	26.16	46.00	-19.84	Average
7	2.50	18.09	9.64	0.05	10.00	37.78	56.00	-18.22	QP
8	2.50	8.68	9.64	0.05	10.00	28.37	46.00	-17.63	Average
9	8.28	16.41	9.68	0.07	10.00	36.16	60.00	-23.84	QP
10	8.28	0.15	9.68	0.07	10.00	19.90	50.00	-30.10	Average
11	12.85	21.21	9.70	0.09	10.00	41.00	60.00	-19.00	QP
12	12.85	7.96	9.70	0.09	10.00	27.75	50.00	-22.25	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

Model No.	TM1	Test Mode	Mode 1
Environmental Conditions	23.5℃, 53.1% RH	Detector Function	Quasi-peak
Pol	Neutral	Distance	3m
Test Engineer	Jayden Zhuo		



Pol: NEUTRAL

	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dBuV	dBuV	dB	
1	0.41	30.46	9.61	0.04	10.00	50.11	57.55	-7.44	QP
2	0.41	13.13	9.61	0.04	10.00	32.78	47.55	-14.77	Average
3	0.56	31.24	9.62	0.04	10.00	50.90	56.00	-5.10	QP
4	0.56	11.32	9.62	0.04	10.00	30.98	46.00	-15.02	Average
5	0.62	26.32	9.63	0.04	10.00	45.99	56.00	-10.01	QP
6	0.62	9.72	9.63	0.04	10.00	29.39	46.00	-16.61	Average
7	2.46	18.11	9.64	0.05	10.00	37.80	56.00	-18.20	QP
8	2.46	5.54	9.64	0.05	10.00	25.23	46.00	-20.77	Average
9	8.19	15.91	9.70	0.07	10.00	35.68	60.00	-24.32	QP
10	8.19	0.24	9.70	0.07	10.00	20.01	50.00	-29.99	Average
11	12.38	21.57	9.73	0.09	10.00	41.39	60.00	-18.61	QP
12	12.38	6.29	9.73	0.09	10.00	26.11	50.00	-23.89	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

Note: Pre-Scan all mode, Thus record worse case mode result in this report.

5. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separated files for Test Setup Photos of the EUT.

6. EXTERIOR PHOTOGRAPHS OF EUT

Please refer to separated files for External Photos of the EUT.

7. INTERIOR PHOTOGRAPHS OF EUT

Please refer to separated files for Internal Photos of the EUT.

---------- THE END OF TEST REPORT ----------