FCC RF Test Report

APPLICANT	:	Honeywell International Inc.
EQUIPMENT	:	Dolphin CT60
BRAND NAME	:	Honeywell
MODEL NAME	:	CT60L0N
FCC ID	:	HD5-CT60L0N
STANDARD	:	FCC Part 15 Subpart E §15.407
CLASSIFICATION	:	(NII) Unlicensed National Information Infrastructure

This is a variant report. We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

Jason Jia

Reviewed by: Jason Jia / Supervisor

James Huang

Approved by: James Huang / Manager

ACCREDITED
Cert #5145.02

Sporton International (Kunshan) Inc.
No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China

TABLE OF CONTENTS

REVISION HISTORY **3**

SUMMARY OF TEST RESULT **4**

1 GENERAL DESCRIPTION **5**

1.1 Applicant 5
1.2 Manufacturer 5
1.3 Product Feature of Equipment Under Test 5
1.4 Product Specification of Equipment Under Test 7
1.5 Modification of EUT 7
1.6 Testing Location 7
1.7 Test Software 8
1.8 Applicable Standards 8
1.9 Re-use of Measured Data 9

2 TEST CONFIGURATION OF EQUIPMENT UNDER TEST **10**

2.1 Test Mode 10
2.2 Connection Diagram of Test System 11
2.3 Support Unit used in test configuration and system 12
2.4 EUT Operation Test Setup 12

3 TEST RESULT **13**

3.1 AC Conducted Emission Measurement 13
3.2 Automatically Discontinue Transmission 15
3.3 Antenna Requirements 16

4 LIST OF MEASURING EQUIPMENT **17**

5 UNCERTAINTY OF EVALUATION **18**

APPENDIX A. AC CONDUCTED EMISSION TEST RESULT

APPENDIX B. SETUP PHOTOGRAPHS

APPENDIX C. REFERENCE REPORT

REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR042406C	Rev. 01	Initial issue of report	Jun. 11, 2020

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 12.71 dB at 0.474 MHz
3.2	15.407(c)	Automatically Discontinue Transmission	Discontinue Transmission	Pass	-
3.3	15.203 & 15.407(a)	Antenna Requirement	N/A	Pass	-

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Applicant

Honeywell International Inc.
9680 Old Bailes Road, Fort Mill, SC 29707 USA

1.2 Manufacturer

Honeywell International Inc.
9680 Old Bailes Road, Fort Mill, SC 29707 USA

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Dolphin CT60
Brand Name	Honeywell
Model Name	CT60L0N
FCC ID	HD5-CT60L0N
EUT supports Radios application	WLAN 2.4GHz 802.11b/g/n HT20/HT40 WLAN 2.4GHz 802.11ac VHT20/VHT40 WLAN 5GHz 802.11a/n HT20/HT40 WLAN 5GHz802.11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE NFC
HW Version	V1.0
HW P/N	DVT
SW Version	OS.03.003-HON.02.001
SW P/N	88.00.00-DEBUG(0579)
EUT Stage	Identical Prototype

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. This is a variant report for CT60L0N (Original FCC ID: HD5-CT60L0N, Model: CT60L0N), for change note, please refer to the change list as below.
3. The CT60L0N share the same part with CT60L1N for BT/WIFI part , CT60L0N data re-use the test results from CT60L1N, the verify data could be referred to the Section 1.9 and the conduction test item was re-tested.

Original and Variant product are list in the following table:

Object	Original	Variant	Remark
Carrier Board	Scanner N6703 imager	Scanner change to N6803 imager	

CT60L0N have the following new parts:

RF Module	Under fill Modified
RF Module	LPDDR4x Layout Optimization
RF Module	Wi-Fi Layout Optimization
RF Module	SOM PAD Mask Optimization
RF Module	Change DC regulator and WLAN amplifier DC power
RF Module	BOM Change for Optimization **
RF Module	Add New power inductor in BOM
RF Module	Remove un-used CLK trace WCN_CLK
Carrier Board	Add 1F/2.7V supercap
Carrier Board	Add MAX38888 DC/DC for supercap charge/ change discharge circuit
Carrier Board	Add low battery protection circuit
Carrier Board	Change speaker and add a connector for it
Carrier Board	Change ADS1014 to ADS1015 to add supercap voltage detection
Carrier Board	AUX antenna tuner circuit change placement location
Carrier Board	Upgrade the SOM to SOM4
Carrier Board	Add new model battery
Carrier Board	Add WIFI-AUX layout, RF WIFI AUX Matching
Carrier Board	Modify two n-PTH to PTH to reduce RSE issue.
Carrier Board	Upgrade to gen 8 scanner, adjust 2 spring contacts' location.
Carrier Board	Add a high-G sensor.
WIFI 11b	Power reduction from 18+/-1.5 dB to 17.5+/-1.5 dB

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Channel Frequency Range	5745 MHz ~ 5825 MHz
Antenna Type / Gain	<Ant. 1> : PIFA Antenna with gain 1.14 dBi <Ant. 2> : Monopole Antenna with gain 2.10 dBi
Type of Modulation	802.11a/n : OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ac : OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM)

1.5 Modification of EUT

No modifications are made to the EUT during all test items.

1.6 Testing Location

Sporton International (Kunshan) Inc. is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sporton International (Kunshan) Inc.		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	CO01-KS 03CH04-KS	CN1257	314309

1.7 Test Software

Item	Site	Manufacture	Name	Version
1.	03CH04-KS	AUDIX	E3	6.2009-8-24a
2.	CO01-KS	AUDIX	E3	6.2009-8-24

1.8 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 15 Subpart E
- FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

1.9 Re-use of Measured Data

1.9.1 Introduction Section

This application re-uses data collected on a similar device. The subject device of this application (Model: CT60L0N, FCC ID: HD5-CT60L0N) is electrically identical to the reference device (Model: CT60L1N, FCC ID: HD5-CT60L1N) for the portions of the circuitry corresponding to the data being re-used, as treated by KDB Publication 484596 D01.

1.9.2 Difference Section

For details concerning the similarity with respect to component placement, mechanical/electrical design etc., please refer to the Product Equality Declaration.

The re-used RF data includes the following bands provided in Appendix C (Sporton RF Report No. FR042407C for the reference device Model: CT60L1N, FCC ID: HD5-CT60L1N).

1.9.3 Reference detail Section:

Equipment Class	Reference FCC ID	Folder Test	Report Title/Section
NII (B1~3)	HD5-CT60L1N	Part15E(FR042407B)	All sections applicable except for AC Conducted Emission
NII (B4)	HD5-CT60L1N	Part15E(FR042407C)	All sections applicable except for AC Conducted Emission
NII (DFS)	HD5-CT60L1N	Part15E(FZ042407)	All sections applicable

1.9.4 Spot Check Verification Data Section

In order to confirm hardware similarity of the subject device with the reference device, spot check measurements were performed on the subject device for the following test items, the test result were consistent with FCC ID: HD5-CT60L1N.

Assertions concerning the similarity of these devices are based on representations by the applicant. The applicant accepts full responsibility for the validity of the similarity claim, and for the determination that verification test data are sufficient to support it.

Test Item	Mode	HD5-CT60L1N Worst Result	HD5-CT60L0N Worst Result	Difference (dB)
Radiated Spurious Emission (Band Edge. Haromic) (dBuV/m)	802.11ac VHT40_CH62	51.88	49.47	2.41
	802.11acVHT80_CH155	57.8	55.08	2.72

2 Test Configuration of Equipment Under Test

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz),

b. AC power line Conducted Emission was tested under maximum output power.

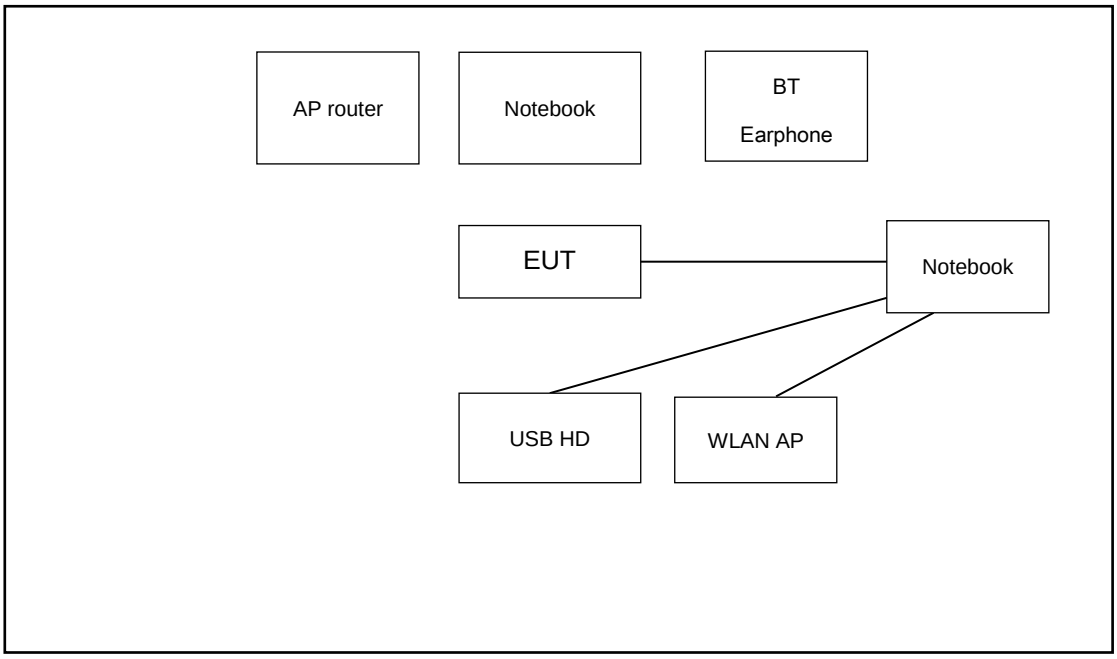
2.1 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

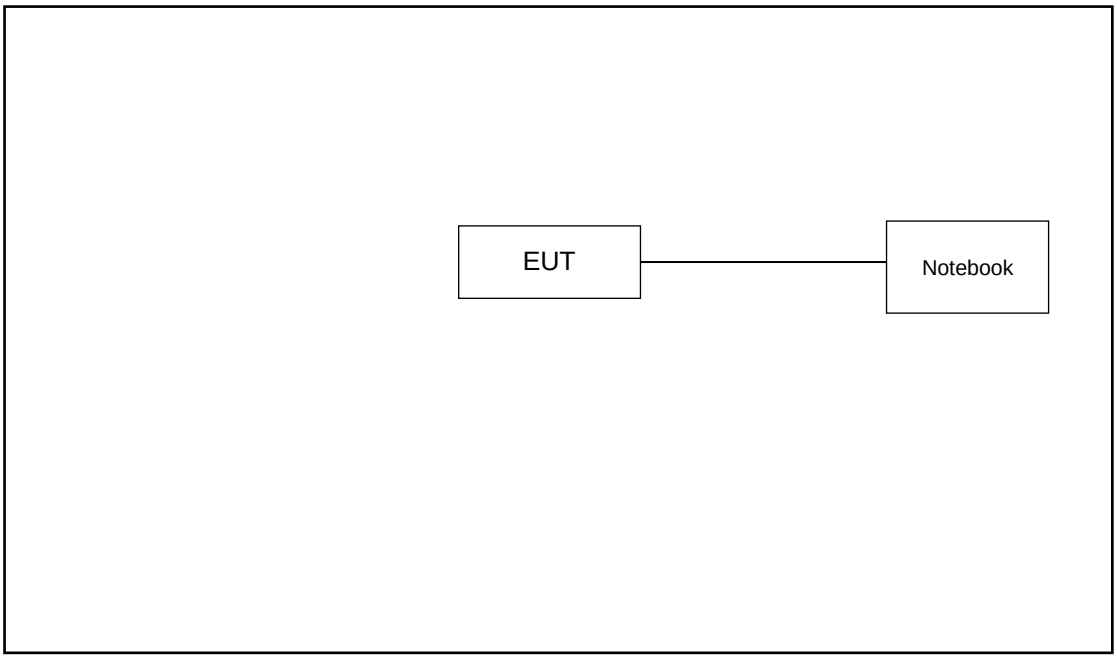
Test Cases	
AC Conducted Emission	Mode 1 : Bluetooth Link + WLAN Link(5G) + USB Cable(Data Link with Notebook) + snap on Adapter

2.2 Connection Diagram of Test System

For Conducted Emission:



For Radiation:



2.3 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Bluetooth Earphone	Lenovo	LBH308	N/A	N/A	Unshielded, 1.8m
2.	WLAN AP	D-link	DIR-655	KA21R655B1	N/A	Unshielded, 1.8m
3.	Notebook	Lenovo	G480	QDS-BRCM1050I	N/A	AC I/P: Unshielded, 1.8 m DC O/P: Shielded, 1.8 m
4.	Hard Disk	Lenovo	F310	DoC	Shielded, 1.2m	N/A
5.	SD Card	Kingston	8GB	N/A	N/A	N/A

2.4 EUT Operation Test Setup

For WLAN RF test items, an engineering test program was provided and enabled to make EUT continuous transmit/receive.

For AC power line conducted emissions, the EUT was set to connect with the WLAN AP under large package sizes transmission.

3 Test Result

3.1 AC Conducted Emission Measurement

3.1.1 Limit of AC Conducted Emission

For equipment that 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 the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

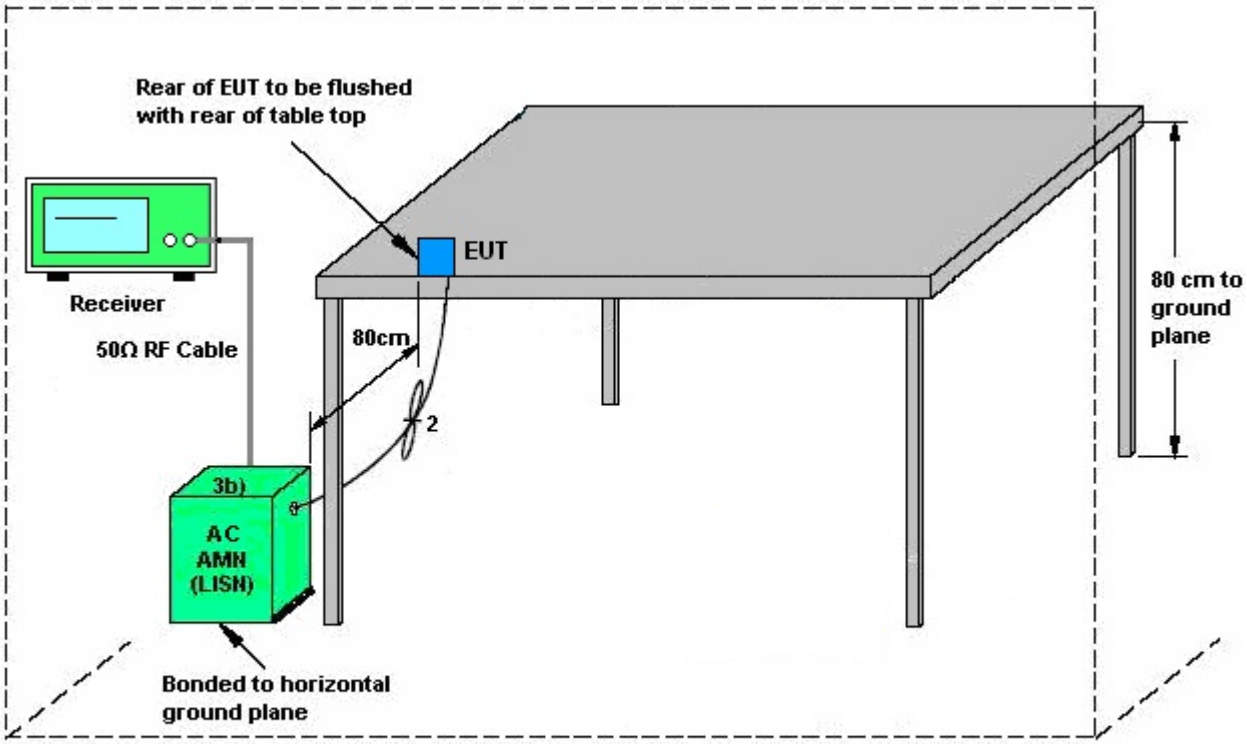
3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode.

3.1.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.1.5 Test Result of AC Conducted Emission

Please refer to Appendix A.

3.2 Automatically Discontinue Transmission

3.2.1 Limit of Automatically Discontinue Transmission

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization to describe how this requirement is met.

3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Result of Automatically Discontinue Transmission

While the EUT is not transmitting any information, the EUT can automatically discontinue transmission and become standby mode for power saving. The EUT can detect the controlling signal of ACK message transmitting from remote device and verify whether it shall resend or discontinue transmission.

3.3 Antenna Requirements

3.3.1 Standard Applicable

If transmitting antenna directional gain is greater than 6 dBi, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.3.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.3.3 Antenna Gain

<CDD Modes >

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For CDD transmissions, directional gain is calculated as

Directional gain = GANT + Array Gain, where Array Gain is as follows.

For power spectral density (PSD) measurements on all devices,

Array Gain = 10 log(NANT/NSS=1) dB.

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for NANT ≤ 4.

Directional gain may be calculated by using the formulas applicable to equal gain antennas with GANT set equal to the gain of the antenna having the highest gain;

The EUT supports CDD mode.

For power, the directional gain GANT is set equal to the antenna having the highest gain, i.e., F)2)f)i).

For PSD, the directional gain calculation is following F)2)f)ii) of KDB 662911 D01 v02r01.

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain “DG” is calculated as following table.

<CDD Modes>

	Ant. 1 (dBi)	Ant. 2 (dBi)	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
Band I	1.14	2.10	2.10	4.64	0.00	0.00
Band II	1.14	2.10	2.10	4.64	0.00	0.00
Band III	1.14	2.10	2.10	4.64	0.00	0.00

Power limit reduction = Composite gain – 6dBi, (min = 0)

PSD limit reduction = Composite gain + PSD Array gain – 6dBi, (min = 0)

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
EMI Test Receiver	Keysight	N9038A	MY57290151	3Hz~8.5GHz;Max 30dBm	Jul. 18, 2019	May 13, 2020	Jul. 17, 2020	Radiation (03CH04-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY55150244	10Hz-44G,MAX 30dB	Apr. 15, 2020	May 13, 2020	Apr. 14, 2021	Radiation (03CH04-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Nov. 10, 2019	May 13, 2020	Nov. 09, 2020	Radiation (03CH04-KS)
Bilog Antenna	TeseQ	CBL6111D	49922	30MHz-1GHz	May 30, 2019	May 13, 2020	May 29, 2020	Radiation (03CH04-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	75957	1GHz~18GHz	Nov. 10, 2019	May 13, 2020	Nov. 09, 2020	Radiation (03CH04-KS)
SHF-EHF Horn	Com-power	AH-840	101115	18GHz~40GHz	Nov. 10, 2019	May 13, 2020	Nov. 09, 2020	Radiation (03CH04-KS)
Amplifier	Burgeon	BPA-530	102219	0.01MHz ~3000MHz	Nov. 02, 2019	May 13, 2020	Nov 01, 2020	Radiation (03CH04-KS)
Amplifier	MITEQ	EM18G40GGA	060728	18~40GHz	Jan. 08, 2020	May 13, 2020	Jan. 07, 2021	Radiation (03CH04-KS)
high gain Amplifier	MITEQ	AMF-7D-00101800-30-10P	2025788	1Ghz-18Ghz	Aug. 16, 2019	May 13, 2020	Aug. 15, 2020	Radiation (03CH04-KS)
Amplifier	Keysight	83017A	MY57280106	500MHz~26.5GHz	Oct. 15, 2019	May 13, 2020	Oct. 14, 2020	Radiation (03CH04-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	May 13, 2020	NCR	Radiation (03CH04-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	May 13, 2020	NCR	Radiation (03CH04-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	May 13, 2020	NCR	Radiation (03CH04-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	Apr. 14, 2020	May 12, 2020	Apr. 13, 2021	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 18, 2019	May 12, 2020	Oct. 17, 2020	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060105	9kHz~30MHz	Oct. 28, 2019	May 12, 2020	Oct. 27, 2020	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 18, 2019	May 12, 2020	Oct. 17, 2020	Conduction (CO01-KS)

NCR: No Calibration Required.

5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**2.9dB**

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

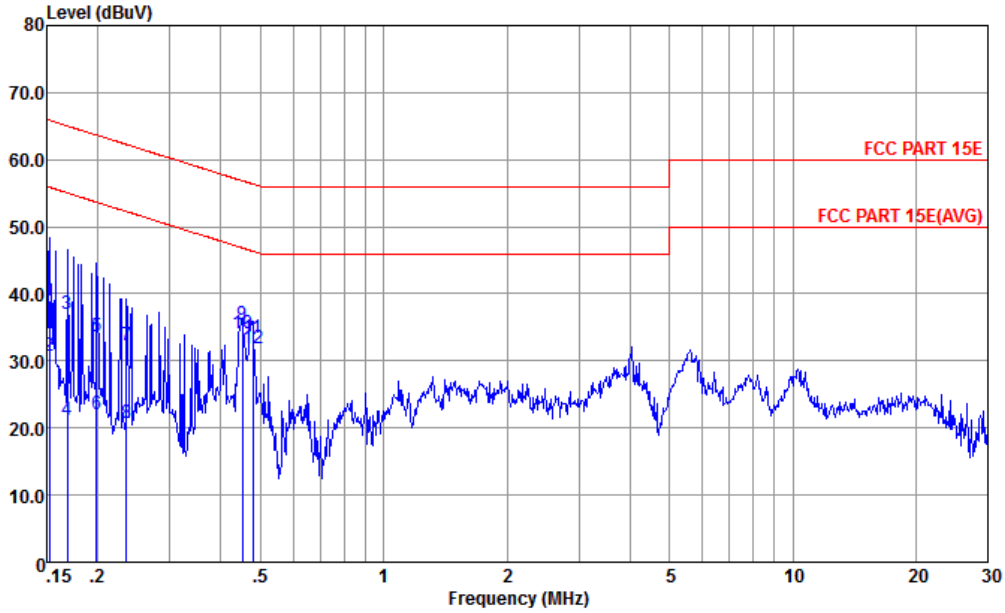
Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.1dB**

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.1dB**

Appendix A. AC Conducted Emission Test Results

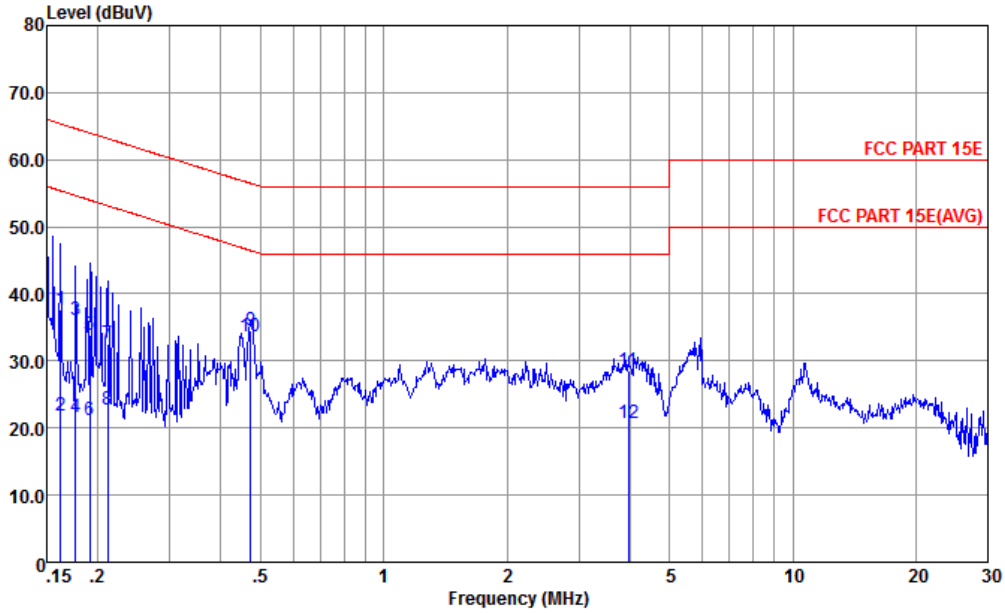
Test Engineer :	Amos Zhang	**Temperature :**	24.2~25.6℃
		Relative Humidity :	37~39%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line



Site : CO01-KS
Condition : FCC PART 15E LISN-L-191028-060105 LINE

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.152	39.10	-26.77	65.87	28.60	0.03	10.47	QP
2	0.152	30.80	-25.07	55.87	20.30	0.03	10.47	Average
3	0.169	37.07	-27.96	65.03	26.61	0.03	10.43	QP
4	0.169	21.07	-33.96	55.03	10.61	0.03	10.43	Average
5	0.199	33.61	-30.06	63.67	23.20	0.04	10.37	QP
6	0.199	22.01	-31.66	53.67	11.60	0.04	10.37	Average
7	0.235	32.29	-29.97	62.26	21.91	0.04	10.34	QP
8	0.235	20.69	-31.57	52.26	10.31	0.04	10.34	Average
9	0.452	35.51	-21.34	56.85	25.20	0.06	10.25	QP
10 *	0.452	34.01	-12.84	46.85	23.70	0.06	10.25	Average
11	0.479	33.50	-22.86	56.36	23.20	0.06	10.24	QP
12	0.479	31.90	-14.46	46.36	21.60	0.06	10.24	Average

Test Engineer :	Amos Zhang	**Temperature :**	24.2~25.6℃
		Relative Humidity :	37~39%
Test Voltage :	120Vac / 60Hz	**Phase :**	Neutral



Site : CO01-KS
Condition : FCC PART 15E LISN-N-191028-060105 NEUTRAL

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.162	37.73	-27.61	65.34	27.20	0.08	10.45	QP
2	0.162	21.83	-33.51	55.34	11.30	0.08	10.45	Average
3	0.177	35.99	-28.65	64.64	25.50	0.08	10.41	QP
4	0.177	21.69	-32.95	54.64	11.20	0.08	10.41	Average
5	0.191	33.76	-30.22	63.98	23.30	0.08	10.38	QP
6	0.191	21.06	-32.92	53.98	10.60	0.08	10.38	Average
7	0.212	32.64	-30.50	63.14	22.20	0.08	10.36	QP
8	0.212	22.64	-30.50	53.14	12.20	0.08	10.36	Average
9	0.474	34.54	-21.91	56.45	24.20	0.10	10.24	QP
10 *	0.474	33.74	-12.71	46.45	23.40	0.10	10.24	Average
11	3.964	28.60	-27.40	56.00	18.20	0.15	10.25	QP
12	3.964	20.70	-25.30	46.00	10.30	0.15	10.25	Average

Note:

1. Level(dBμV) = Read Level(dBμV) + LISN Factor(dB) + Cable Loss(dB)
2. Over Limit(dB) = Level(dBμV) – Limit Line(dBμV)

Appendix C. Reference Report

Please refer to Sporton report number FR042407C which are issued separately.