



RF TEST REPORT

No. 160500840SHA-001

Applicant : Telehems Labs Corporation

45401 Research Ave,Suite 208,Fremont,CA 94539

Manufacturer : Ningbo Ruiming Electric Co., Ltd

18 Beihai Road 239 Long, Jiangbei, Ningbo, Zhejiang,
China

Product Name : Telehems Smart Switch

Type/Model : HEMS-F2-15US

TEST RESULT : PASS

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 (2015): Radio Frequency Devices

ANSI C63.10 (2013): American National Standard for Testing Unlicensed Wireless Devices

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FCC ID: 2AIKN-HEMSF215US

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1. General Information

1.1 Applicant Information

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Manufacturer : Ningbo Ruiming Electric Co., Ltd
18 Beihai Road 239 Long, Jiangbei, Ningbo, Zhejiang, China

1.2 Identification of the EUT

Product description : Telehems Smart Switch
Type/model : HEMS-F2-15US
Operation Frequency : 2402~2480 MHz
Band
EUT Modes of : BT4.0 BLE
Modulation
Type of Modulation : GFSK
Transfer Rate : 1Mbps
Power Class : Class II
Channel Number : 40 (0-39)
Antenna : 0dBi Internal antenna
Port identification : AC output *1
Rating : 120V AC 60Hz 15A
Declared Temperature : 0°C ~ 45°C
range
Category of EUT : Class B
EUT type : ☒ Table top ☐ Floor standing
Sample received date : 2016.05.10
Sample Identification : *0160510-02-001*
No
Date of test : 2016.05.10 ~ 2016.6.13

1.3 Mode of operation during the test / Test peripherals used

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.

Radiated test mode:

Mode 1: EUT transmitted signal with BT antenna;

Conducted test mode:

Mode 2: EUT transmitted signal from BT RF port connected to SPA directly;

Channel 0,19,39 was choose for the test.

Frequency Band (MHz)				2402 ~ 2480			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

Test peripherals used:

Item No	Description	Band and Model	S/No
1	Laptop computer	HP ProBook 6470b	NA
Note: The accessories are used for configuration only and not used during test.			

2. Test Specification

2.1 Instrument list

Selected	Equipment	Type	Manu.	Internal no.	Cal. Date	Due date
☒	PXA Analyzer	N9030A	Agilent	EC5338	2016/3/4	2017/3/3
☒	Vector SG	N5182B	Agilent	EC5175	2016/3/4	2017/3/3
☒	Power sensor	U2021XA	Agilent	EC5338-1	2016/3/4	2017/3/3
☒	MXG Analog SG	N5181A	Agilent	EC5338-2	2016/3/4	2017/3/3
☒	Power meter	N1911A/N1921A	Agilent	EC4318	2016/4/10	2017/4/9
☒	EMI Receiver	ESCS 30	R&S	EC 2107	2015/10/20	2016/10/19
☒	A.M.N.	ESH2-Z5	R&S	EC 3119	2015/12/16	2017/12/15
☒	I.S.N.	FCC-TLISN-T8-02	FCC	EC3756	2016/2/16	2017/2/15
☒	EMI chamber	3m	Albatross	EC 3048	2016/5/5	2017/5/4
☒	Test Receiver	ESIB 26	R&S	EC 3045	2015/10/20	2016/10/19
☒	Test Receiver	ESCI 7	R&S	EC4501	2016/2/24	2017/2/23
☒	Antenna	HL 562	R&S	EC 3046-1	2015/12/18	2016/12/17
☒	Horn antenna	HF 906	R&S	EC 3049	2015/9/12	2016/9/11
☒	Horn antenna	HAP18-26W	TOYO	EC 4792-3	2014/6/12	2017/6/11
☒	Pre-amplifier	Pre-amp 18	R&S	EC 5262	2014/5/25	2016/5/24
☒	Pre-amplifier	Tpa0118-40	R&S	EC 4792-2	2016/4/11	2017/4/10
☒	Shielded room	-	Zhongyu	EC 2838	2016/1/9	2017/1/8

2.2 Test Standard

47CFR Part 15 (2015)
ANSI C63.10 (2013)

2.3 Test Summary

This report applies to tested sample only. This report shall not be reproduced in part without written approval of Intertek Testing Service Shanghai Limited.

TEST ITEM	FCC REFERENCE	RESULT
Radiated emission	15.249 & 15.209	Pass
Assigned bandwidth (20dB bandwidth)	15.215(c)	Pass
Power line conducted emission	15.207	Pass

3. Radiated emission

Test result: PASS

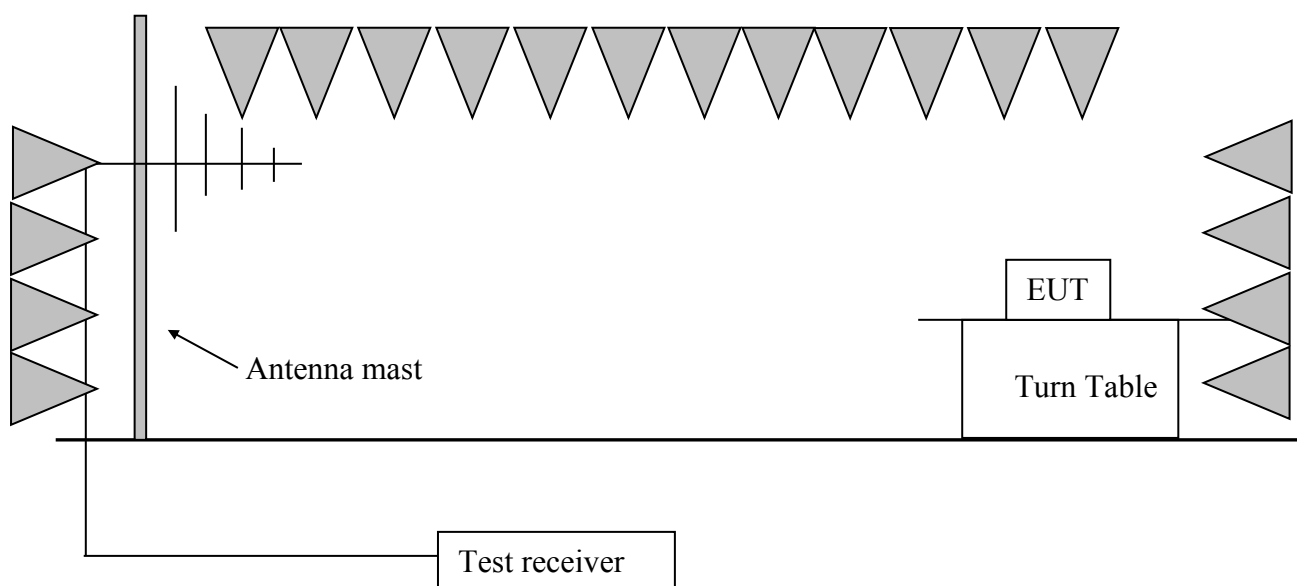
3.1 Test limit

Fundamental Frequency (MHz)	Fundamental limit (dBuV/m)	Harmonic limit (dBuV/m)
☐ 902 - 928	94	54
☒ 2400 - 2483.5	94	54
☐ 5725 - 5875	94	54
☐ 24000 - 24250	108	68

The radiated emissions which fall outside allocated band (2400-2483.5MHz), must also comply with the radiated emission limits specified in §15.209(a) showed as below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

3.2 Test Configuration



3.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, if applied, the pre-amplifier would be equipped just at the output terminal of the antenna.

Tabletop devices shall be placed on a non-conducting platform with nominal top surface dimensions 1 m by 1.5 m. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m.

The turntable rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.

The radiated emission was measured using the Spectrum Analyzer with the resolutions bandwidth set as:

RBW=300 Hz, VBW=1 kHz (9 kHz~150 kHz);

RBW=10 kHz, VBW=30 kHz (150 kHz~30 MHz);

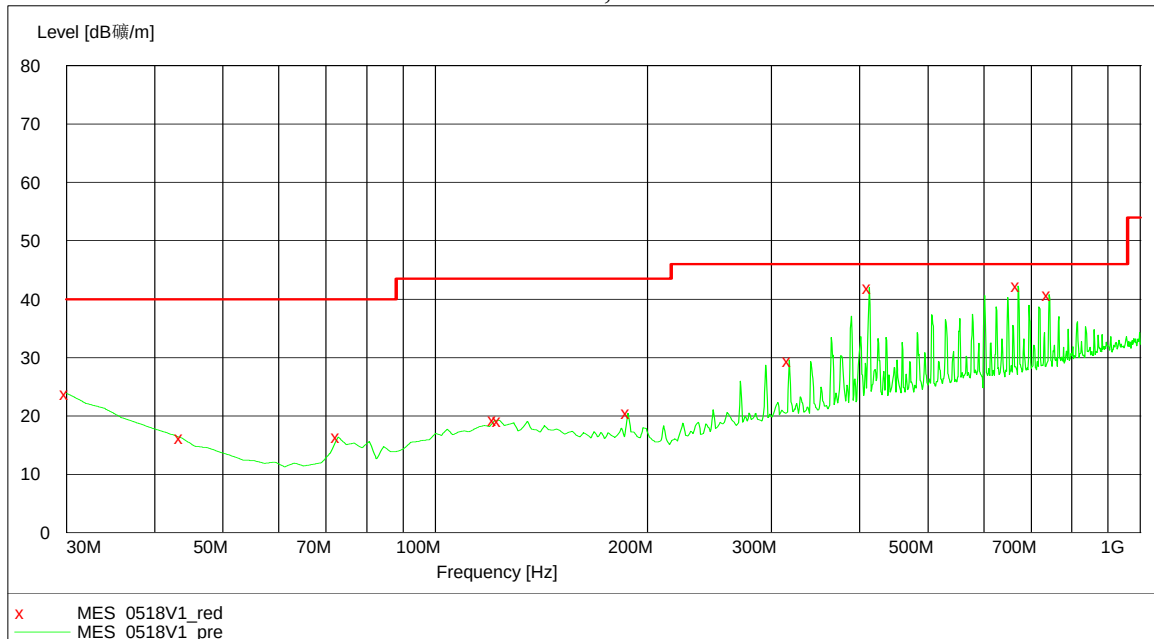
RBW = 100 kHz, VBW = 300 kHz (30MHz~1GHz for PK);

RBW = 1MHz, VBW = 3MHz (>1GHz for PK);

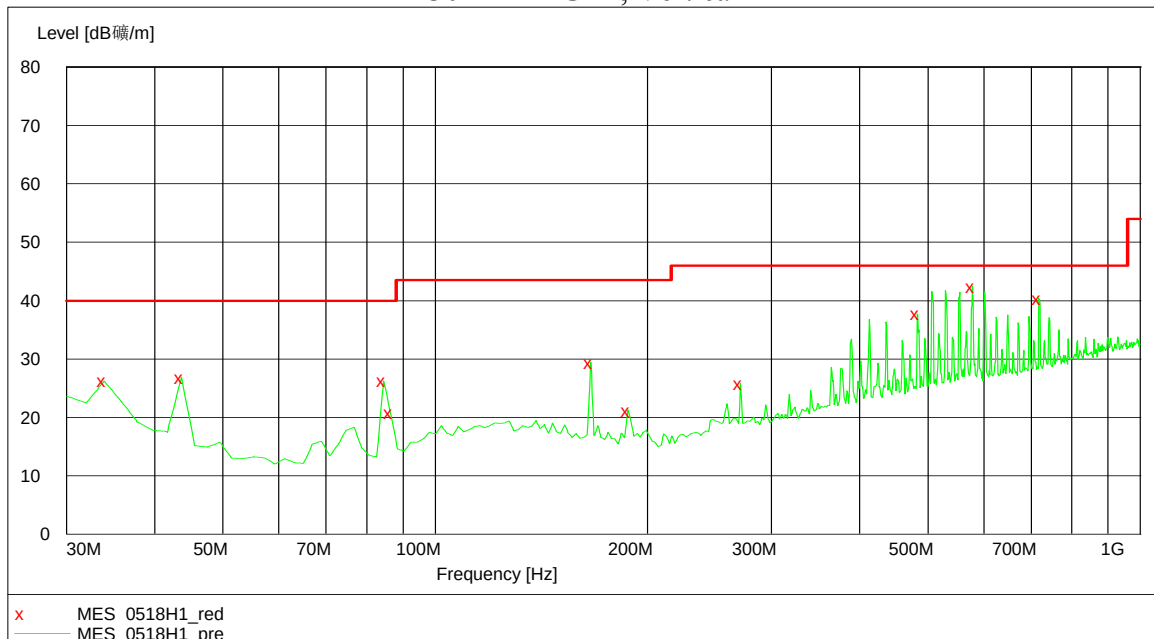
3.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

30MHz~1GHz, Horizontal



30MHz~1GHz, Vertical



Test data at 30MHz~1GHz (Channel H):

Polarization	Frequency (MHz)	Measured level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Detector
H	30.00	23.9	40.0	16.1	PK
	43.61	16.2	40.0	23.8	PK
	72.77	16.4	40.0	23.6	PK
	121.36	19.3	43.5	24.2	PK
	123.31	19.2	43.5	24.3	PK
	187.45	20.5	43.5	23.0	PK
	317.70	29.5	46.0	16.5	PK
	412.95	42.0	46.0	4.0	PK
	671.48	42.3	46.0	3.7	PK
	743.41	40.8	46.0	5.2	PK
V	33.89	26.2	40.0	13.8	PK
	43.61	26.8	40.0	13.2	PK
	84.43	26.2	40.0	13.8	PK
	86.37	20.7	40.0	19.3	PK
	166.07	29.4	43.5	14.1	PK
	187.45	21.2	43.5	22.3	PK
	271.04	25.8	46.0	20.2	PK
	482.93	37.7	46.0	8.3	PK
	578.18	42.4	46.0	3.6	PK
	718.14	40.4	46.0	5.6	PK

Note:

1: The test result (30MHz to 1GHz) of channel H (2480MHz) chosen to list in the report as representative.

2: The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line and not reported.

Test result above 1GHz:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2402MHz	H	2402.0	1.3	104.5	114.0	9.5	PK
	H	2402.0	1.3	90.3	94.0	3.7	AV
	H	2390.0	1.4	50.1	74.0	23.9	PK
	H	4804.0	-1.1	56.7	74.0	17.3	PK
	H	4804.0	-1.1	47.7	54.0	6.3	AV
	V	2402.0	1.3	103.5	114.0	10.5	PK
	V	2402.0	1.3	89.6	94.0	4.4	AV
	V	2390.0	1.4	50.3	74.0	23.7	PK
	V	4804.0	-1.1	57.7	74.0	16.3	PK
	V	4804.0	-1.1	46.2	54.0	7.8	AV
2440MHz	H	2440.0	0.9	103.9	114.0	10.1	PK
	H	2440.0	0.9	89.4	94.0	4.6	AV
	H	4880.0	-0.6	54.0	74.0	20.0	PK
	H	4880.0	-0.6	43.1	54.0	10.9	AV
	V	2440.0	0.9	103.8	114.0	10.2	PK
	V	2440.0	0.9	88.8	94.0	5.2	AV
	V	4880.0	-0.6	54.9	74.0	19.1	PK
	V	4880.0	-0.6	44.2	54.0	9.8	AV
2480MHz	H	2480.0	0.5	103.8	114.0	10.2	PK
	H	2480.0	0.5	89.1	94.0	4.9	AV
	H	2483.5	0.5	50.2	74.0	23.8	PK
	H	4960.0	-0.2	52.5	74.0	21.5	PK
	H	4960.0	-0.2	43.4	54.0	10.6	AV
	V	2480.0	0.5	103.0	114.0	11.0	PK
	V	2480.0	0.5	88.4	94.0	5.6	AV
	V	2483.5	0.5	50.2	74.0	23.8	PK
	V	4960.0	-0.2	54.6	74.0	19.4	PK
	V	4960.0	-0.2	43.6	54.0	10.4	AV

Test result above 1GHz (With WIFI connect mode):

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2402MHz	H	2402.0	1.3	104.4	114.0	9.6	PK
	H	2402.0	1.3	90.2	94.0	3.8	AV
	H	2390.0	1.4	50.2	74.0	23.8	PK
	H	4804.0	-1.1	56.8	74.0	17.2	PK
	H	4804.0	-1.1	47.7	54.0	6.3	AV
	V	2402.0	1.3	103.5	114.0	10.5	PK
	V	2402.0	1.3	89.8	94.0	4.2	AV
	V	2390.0	1.4	50.7	74.0	23.3	PK
	V	4804.0	-1.1	57.5	74.0	16.5	PK
	V	4804.0	-1.1	46.3	54.0	7.7	AV
2440MHz	H	2440.0	0.9	103.3	114.0	10.7	PK
	H	2440.0	0.9	89.7	94.0	4.3	AV
	H	4880.0	-0.6	54.6	74.0	19.4	PK
	H	4880.0	-0.6	43.6	54.0	10.4	AV
	V	2440.0	0.9	103.4	114.0	10.6	PK
	V	2440.0	0.9	88.7	94.0	5.3	AV
	V	4880.0	-0.6	54.4	74.0	19.6	PK
	V	4880.0	-0.6	44.7	54.0	9.3	AV
2480MHz	H	2480.0	0.5	103.5	114.0	10.5	PK
	H	2480.0	0.5	89.4	94.0	4.6	AV
	H	2483.5	0.5	50.4	74.0	23.6	PK
	H	4960.0	-0.2	52.3	74.0	21.7	PK
	H	4960.0	-0.2	43.3	54.0	10.7	AV
	V	2480.0	0.5	103.6	114.0	10.4	PK
	V	2480.0	0.5	88.2	94.0	5.8	AV
	V	2483.5	0.5	50.5	74.0	23.5	PK
	V	4960.0	-0.2	54.2	74.0	19.8	PK
	V	4960.0	-0.2	43.2	54.0	10.8	AV

Remark:

1. For fundamental emission test, no pre-amplifier is employed;
2. Correct Factor = Antenna Factor + Cable Loss (-Amplifier, is employed);
3. Corrected Reading = Original Receiver Reading + Correct Factor;
4. Margin = limit – Corrected Reading;
5. If the PK reading is lower than AV limit, the AV test can be elided;
6. The shaded data is the fundamental emission;
7. Both emissions on “horizontal” and “vertical” axes were assessed and the worse test data was listed in this report;

Example:

Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV,
Then Correct Factor = $30.20 + 2.00 - 32.00 = 0.20\text{dB/m}$,
Corrected Reading = $10\text{dBuV} + 0.20\text{dB/m} = 10.20\text{dBuV/m}$,
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m,
Then Margin = $54 - 10.20 = 43.80\text{dBuV/m}$.

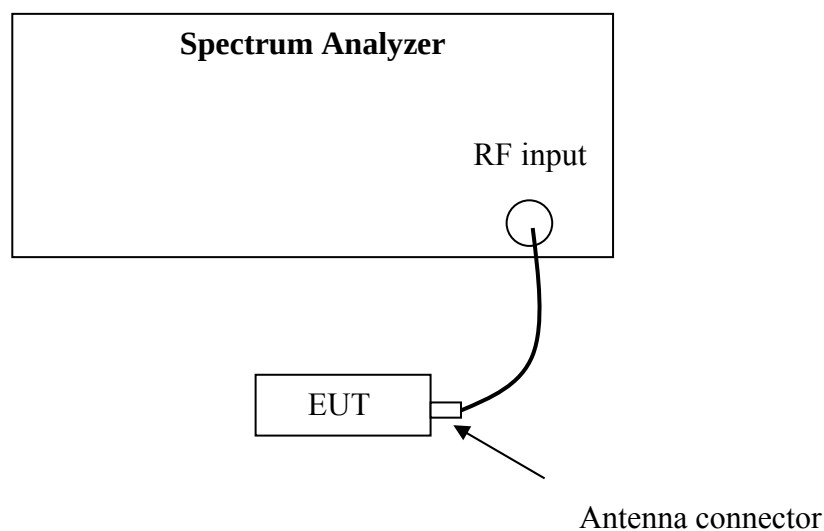
4. Assigned bandwidth (20dB bandwidth)

Test result: PASS

4.1 Limit

Intentional radiators must be designed to ensure that the 20 dB bandwidth of the emission is contained within the allocated frequency band as clause 3.1 shows.

4.2 Test Configuration



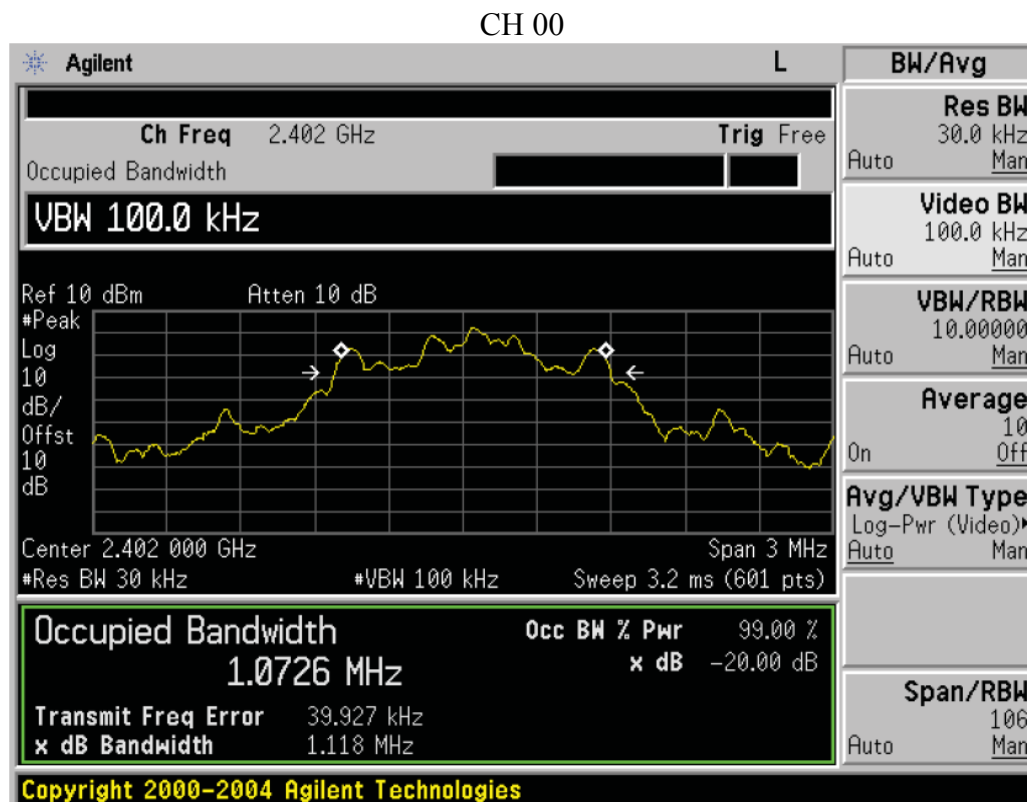
4.3 Test procedure and test setup

The 20dB Bandwidth per FCC § 15.215(c) is measured using the Spectrum Analyzer. Set Span = 2 to 3 times the 20 dB bandwidth, $RBW \geq 1\%$ of the 20 dB bandwidth, $VBW \geq RBW$, Sweep = auto, Detector = peak, Trace = max hold. The test was performed at 3 channels (lowest, middle and highest channel).

4.4 Test protocol

Temperature : 25°C
Relative Humidity : 55 %

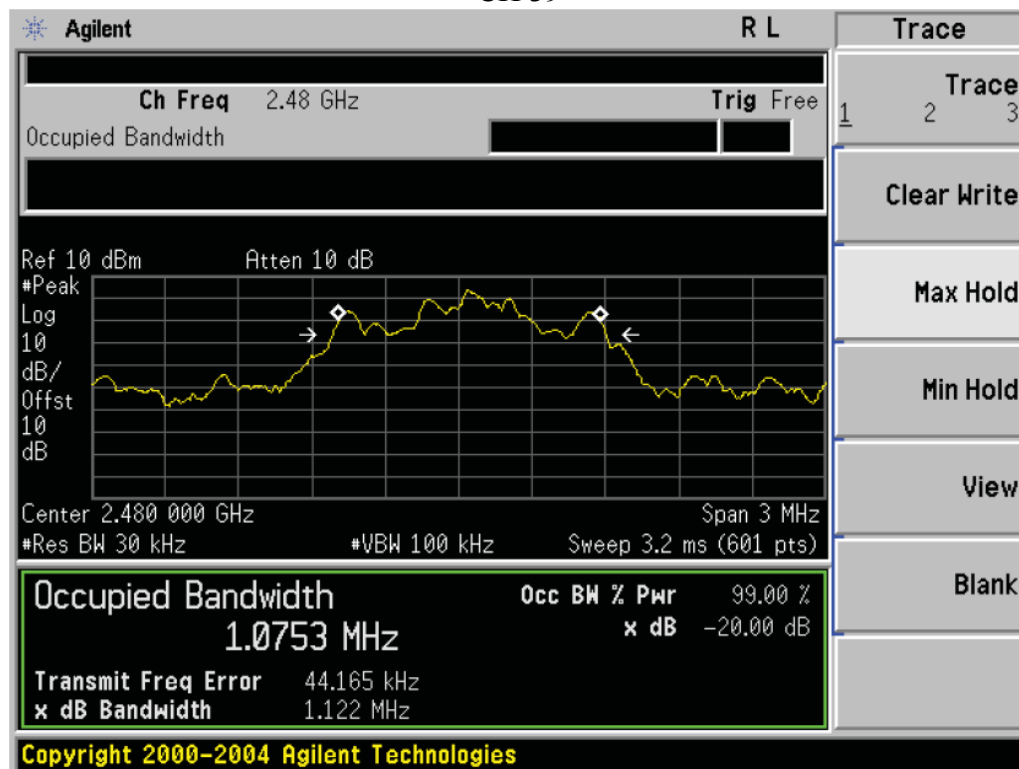
Channel No.	Frequency	20dB Bandwidth (MHz)
00	2402MHz	1.118
19	2440MHz	1.120
39	2480MHz	1.122



CH 19



CH 39



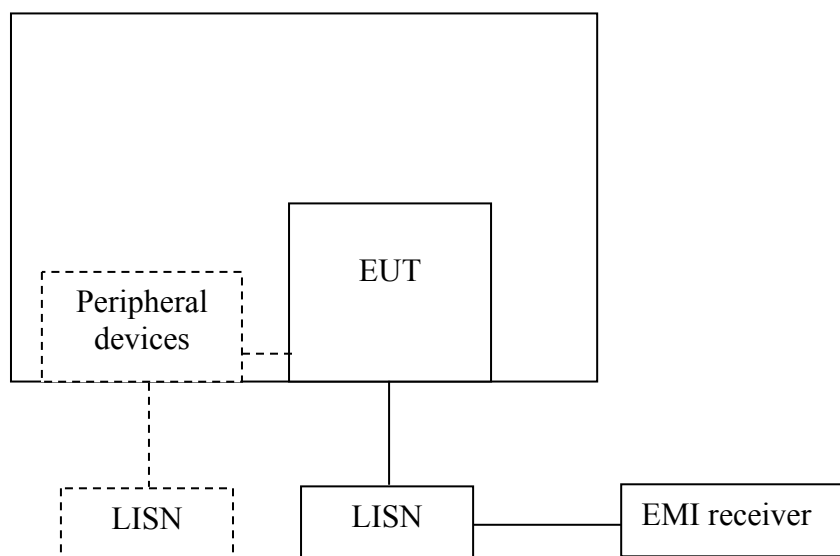
5. Power line conducted emission

Test result: **PASS**

5.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
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.		

5.2 Test configuration



☒ For table top equipment, wooden support is 0.8m height table

☐ For floor standing equipment, wooden support is 0.1m height rack.

5.3 Test procedure and test set up

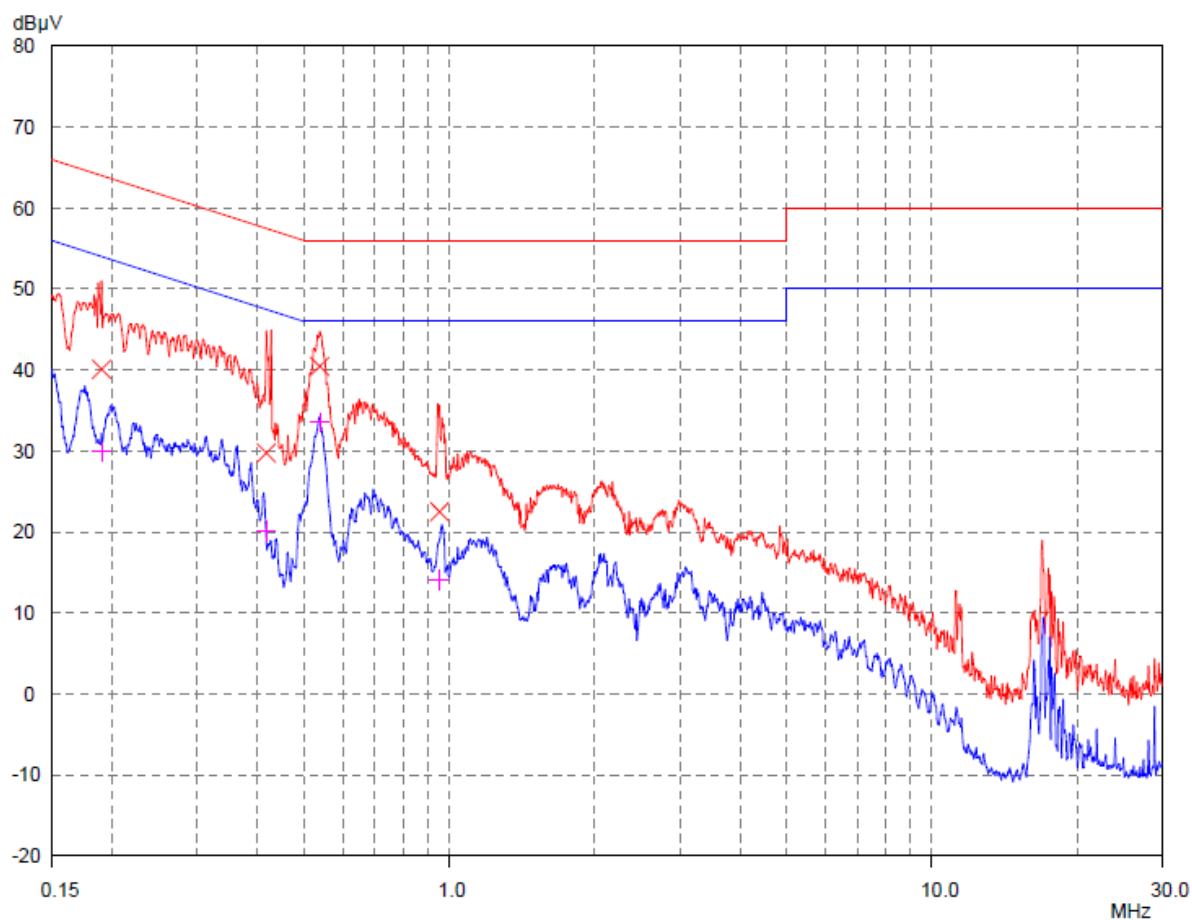
The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a $50\Omega/50\mu\text{H}$ coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a $50\Omega/50\mu\text{H}$ coupling impedance with 50Ω termination.

Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4 on conducted measurement. The bandwidth of the test receiver is set at 9 kHz.

5.4 Test protocol

Temperature : 25°C
Relative Humidity : 55 %

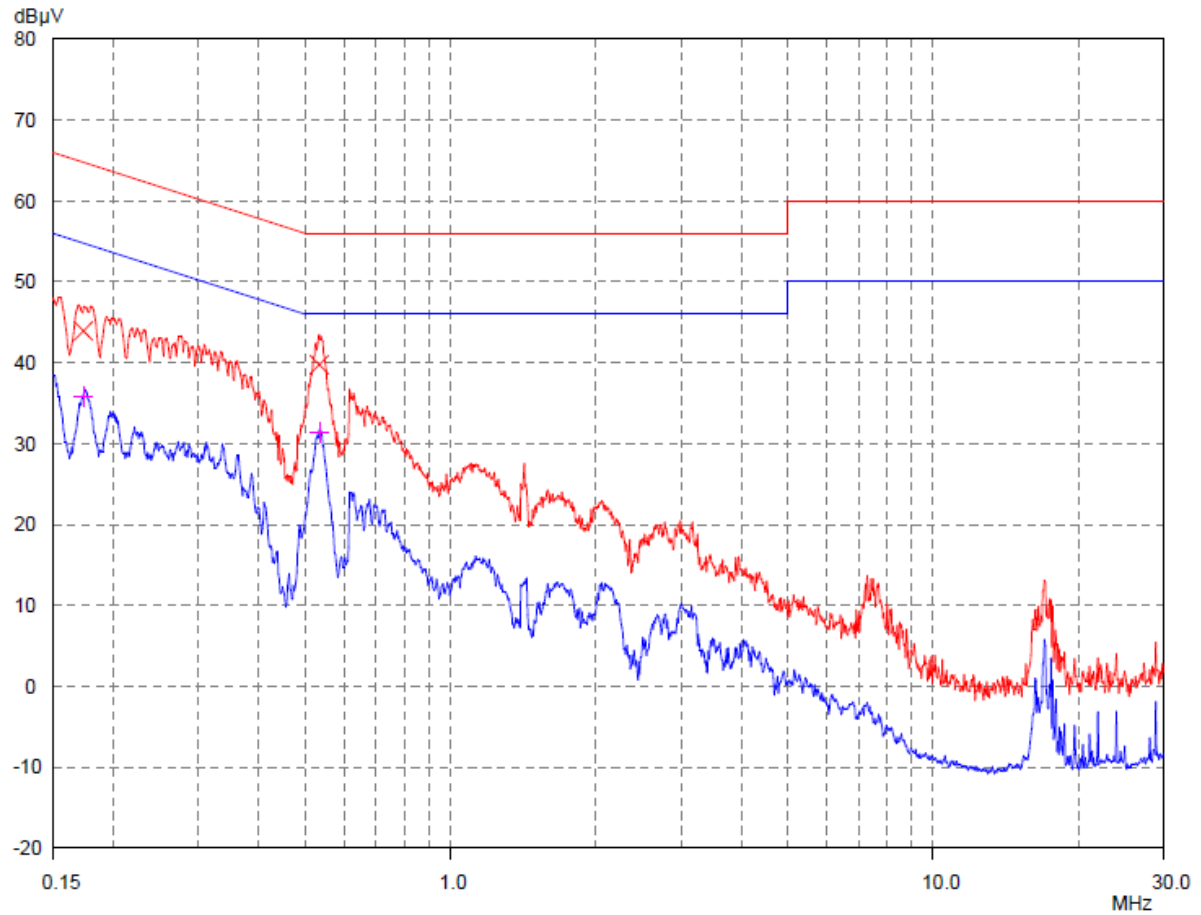
L line



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(μV)	Limit dB(μV)	Margin (dB)	level dB(μV)	limit dB(μV)	Margin (dB)
0.190	40.10	64.04	23.94	29.93	54.04	24.11
0.417	29.76	57.51	27.75	20.12	47.51	27.39
0.538	40.47	56.00	15.53	33.51	46.00	12.49
0.952	22.51	56.00	33.49	14.07	46.00	31.93

N line



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(µV)	Limit dB(µV)	Margin (dB)	level dB(µV)	limit dB(µV)	Margin (dB)
0.173	43.94	64.81	20.87	35.86	54.81	18.95
0.534	39.78	56.00	16.22	31.42	46.00	14.58