



## 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

Date of issue: June 14, 2016

Prepared by:

Wade Zhang (*Project Engineer*)

Reviewed by:

Daniel Zhao (*Reviewer*)



**FCC ID: 2AIKN-HEMSF215US**

## **Description of Test Facility**

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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)
<b>0</b>	<b>2402</b>	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	<b>19</b>	<b>2440</b>	29	2460	<b>39</b>	<b>2480</b>

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
<input checked="" type="checkbox"/>	PXA Analyzer	N9030A	Agilent	EC5338	2016/3/4	2017/3/3
<input checked="" type="checkbox"/>	Vector SG	N5182B	Agilent	EC5175	2016/3/4	2017/3/3
<input checked="" type="checkbox"/>	Power sensor	U2021XA	Agilent	EC5338-1	2016/3/4	2017/3/3
<input checked="" type="checkbox"/>	MXG Analog SG	N5181A	Agilent	EC5338-2	2016/3/4	2017/3/3
<input checked="" type="checkbox"/>	Power meter	N1911A/N1921A	Agilent	EC4318	2016/4/10	2017/4/9
<input checked="" type="checkbox"/>	EMI Receiver	ESCS 30	R&S	EC 2107	2015/10/20	2016/10/19
<input checked="" type="checkbox"/>	A.M.N.	ESH2-Z5	R&S	EC 3119	2015/12/16	2017/12/15
<input checked="" type="checkbox"/>	I.S.N.	FCC-TLISN-T8-02	FCC	EC3756	2016/2/16	2017/2/15
<input checked="" type="checkbox"/>	EMI chamber	3m	Albatross	EC 3048	2016/5/5	2017/5/4
<input checked="" type="checkbox"/>	Test Receiver	ESIB 26	R&S	EC 3045	2015/10/20	2016/10/19
<input checked="" type="checkbox"/>	Test Receiver	ESCI 7	R&S	EC4501	2016/2/24	2017/2/23
<input checked="" type="checkbox"/>	Antenna	HL 562	R&S	EC 3046-1	2015/12/18	2016/12/17
<input checked="" type="checkbox"/>	Horn antenna	HF 906	R&S	EC 3049	2015/9/12	2016/9/11
<input checked="" type="checkbox"/>	Horn antenna	HAP18-26W	TOYO	EC 4792-3	2014/6/12	2017/6/11
<input checked="" type="checkbox"/>	Pre-amplifier	Pre-amp 18	R&S	EC 5262	2014/5/25	2016/5/24
<input checked="" type="checkbox"/>	Pre-amplifier	Tpa0118-40	R&S	EC 4792-2	2016/4/11	2017/4/10
<input checked="" type="checkbox"/>	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**

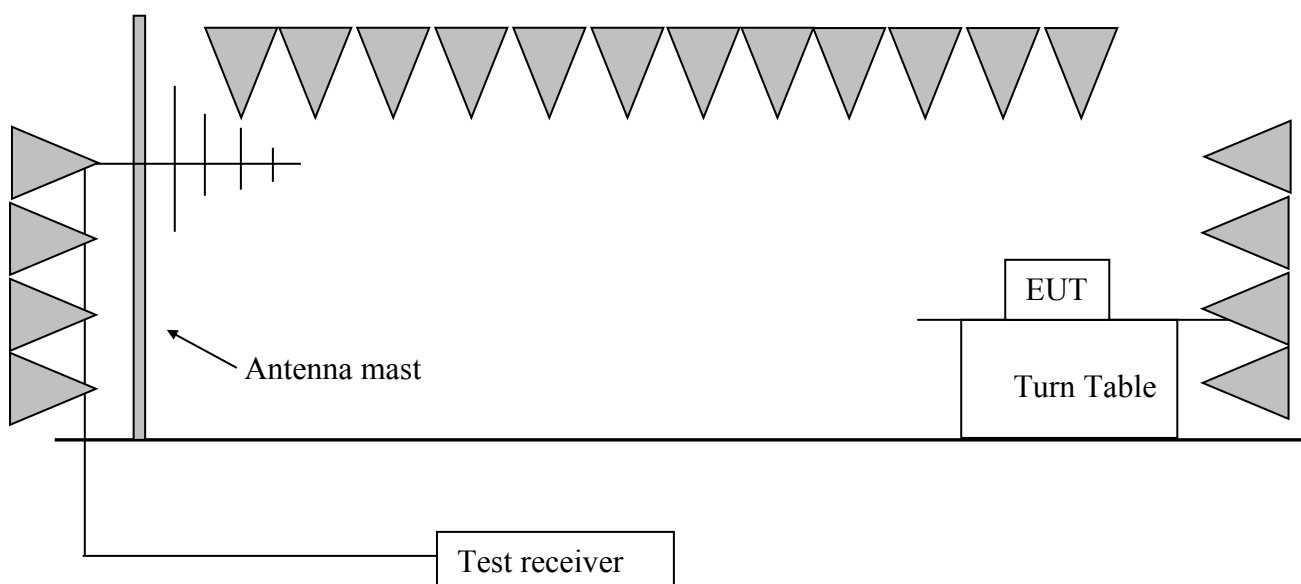
#### 3.1 Test limit

Fundamental Frequency (MHz)	Fundamental limit (dBuV/m)	Harmonic limit (dBuV/m)
<input type="checkbox"/> 902 - 928	94	54
<input checked="" type="checkbox"/> 2400 - 2483.5	94	54
<input type="checkbox"/> 5725 - 5875	94	54
<input type="checkbox"/> 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);

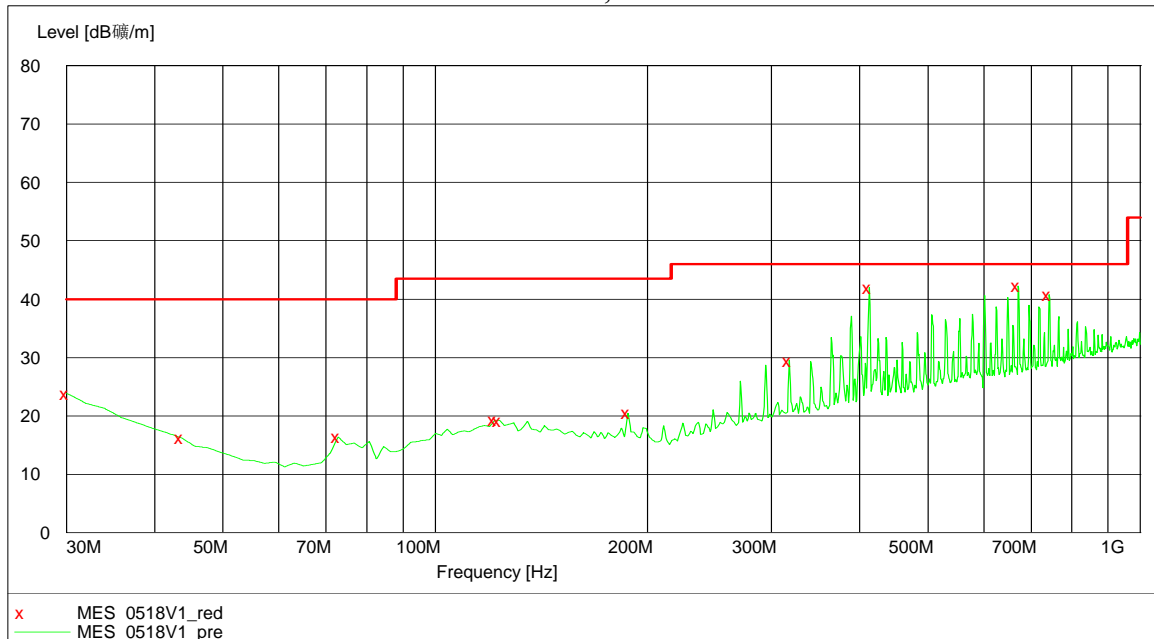
RBW = 100 kHz, VBW = 300 kHz (30MHz~1GHz for PK);

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

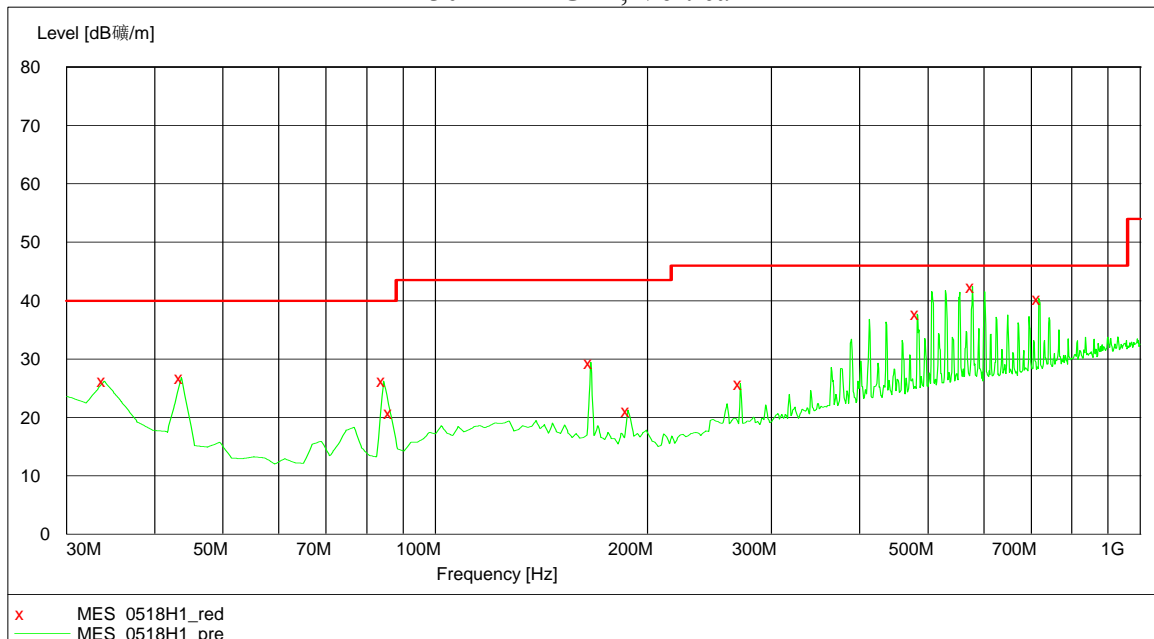
### 3.4 Test protocol

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 $\mu$ V/m)	Limits (dB $\mu$ 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 = 0.20dB/m,  
Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m,  
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m,  
Then Margin = 54 -10.20 = 43.80dBuV/m.

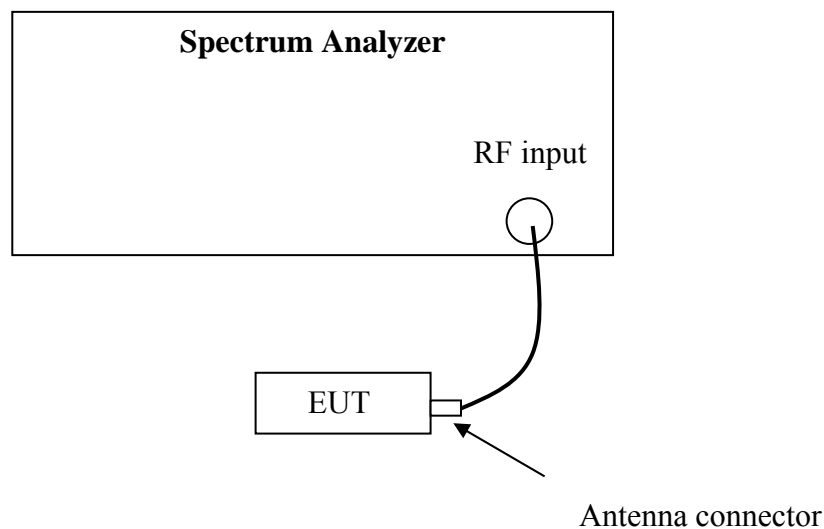
#### 4. Assigned bandwidth (20dB bandwidth)

**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



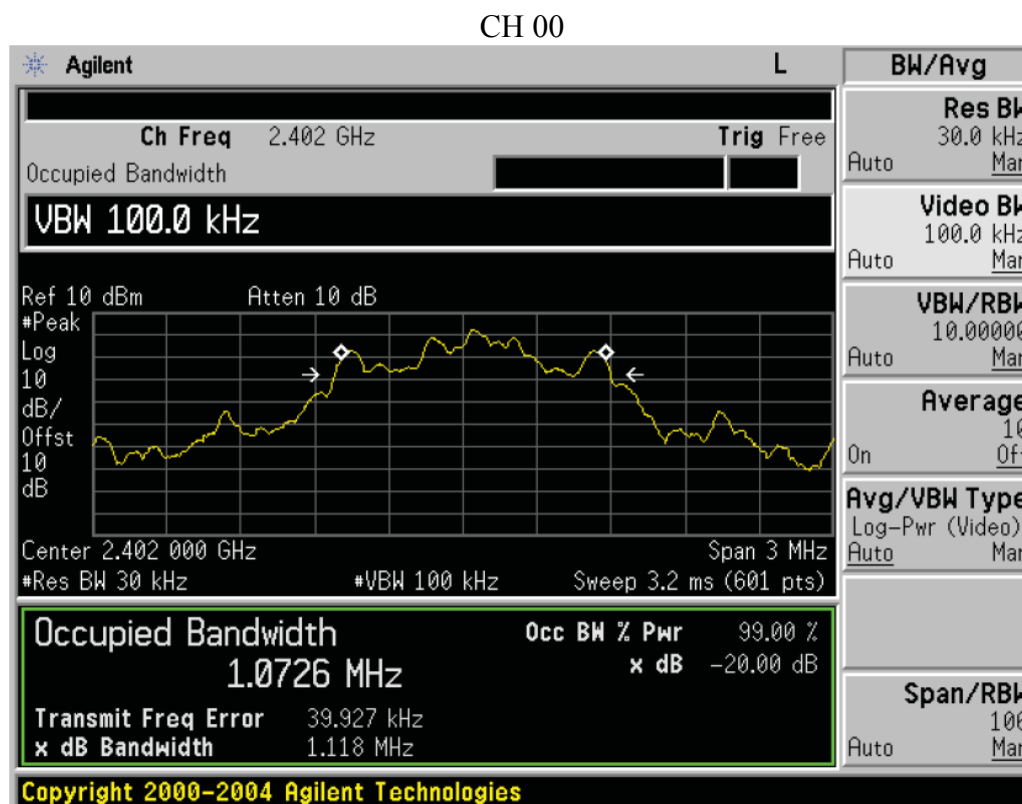
##### 4.3 Test procedure and test setup

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

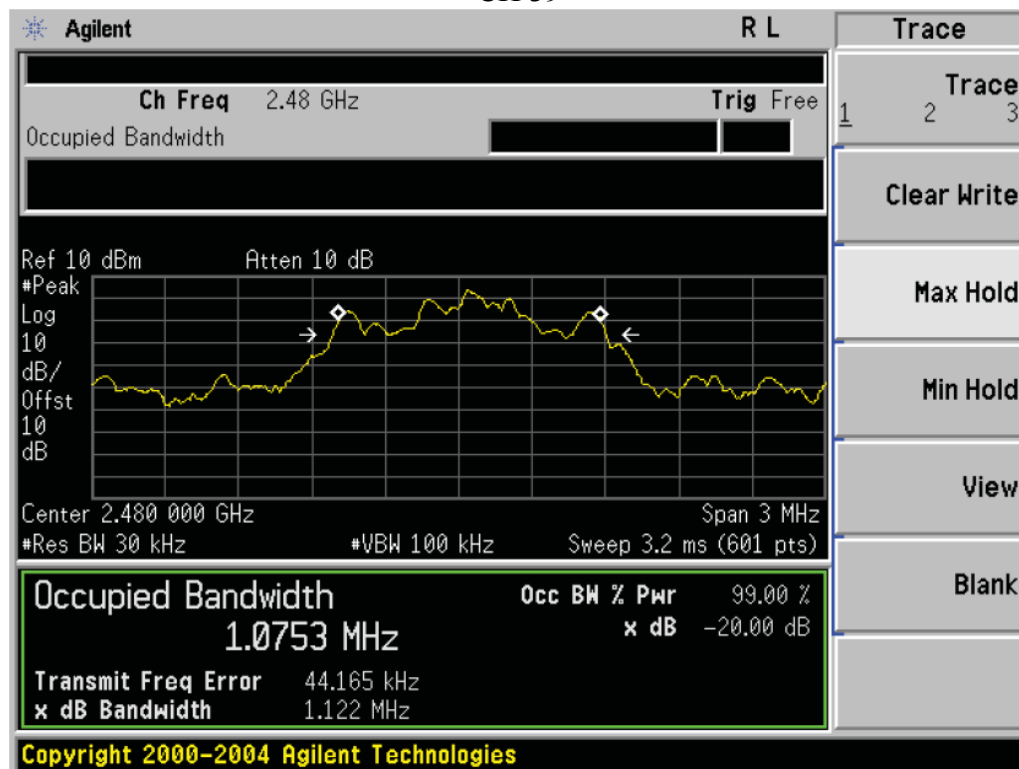




CH 19



CH 39



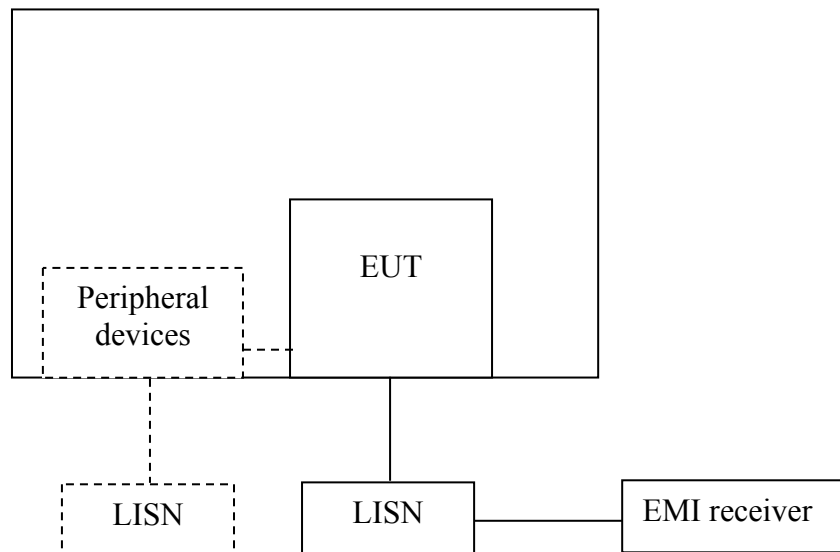
## 5. Power line conducted emission

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

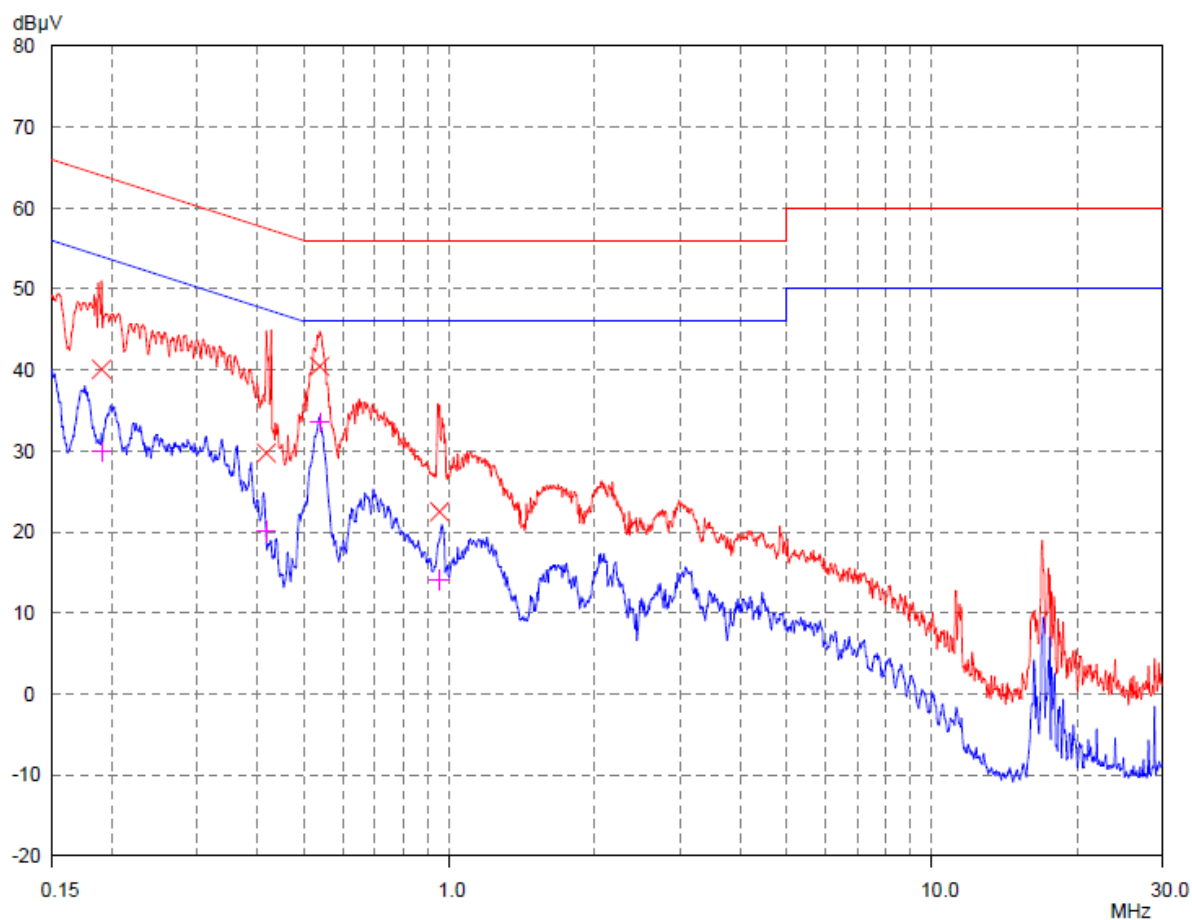
The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a  $50\Omega/50\mu\text{H}$  coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a  $50\Omega/50\mu\text{H}$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

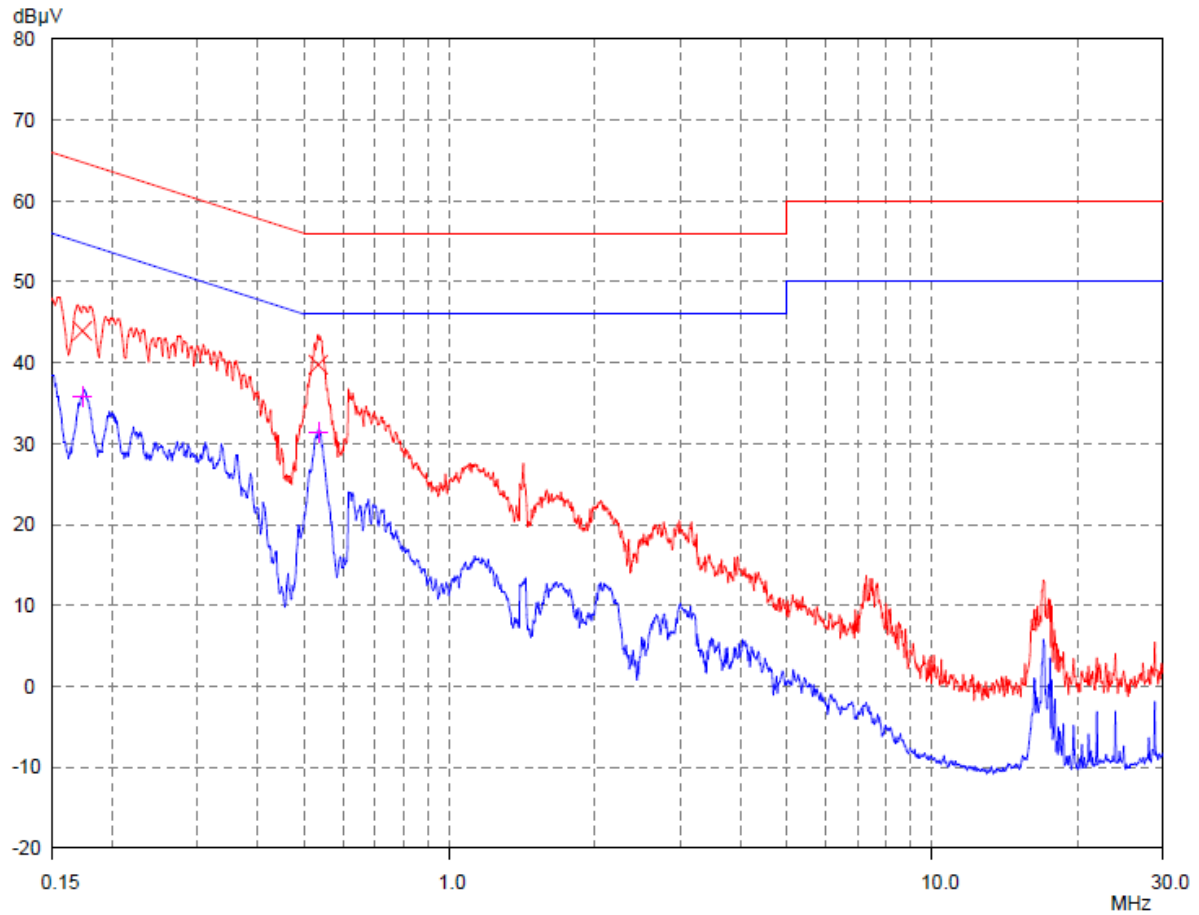
L line



### 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