

TEST REPORT

Applicant Name & Address : Guangzhou MCOHome Technology Co., Ltd.
Room 202, Hi-tech Innovation Plaza, Panyu Hi-tech Ecological Park,
Guangzhou, China

Sample Description

Product : Mini Energy Dimmer/Switch
ID : 2ACTJMH210001
Model No. : MH-P210-US, MH-S210-US
Electrical Rating : 120 Vac, 60Hz
2.5A max output for MH-P210-US, 3A max output for MH-S210-US

Date Received : 06 March 2016
Date Test Conducted : 10 March 2016 – 24 March 2016
Test standards : **47 CFR PART 15 Subpart C: 2014 section 15.249**

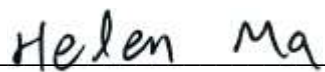
Test Result : Pass

Conclusion : The submitted samples complied with the above rules/standards.


Remark : None.

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Prepared and Checked By:


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28 March 2016 ***Date***

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1.0 Summary of Test

TEST	TEST REQUIREMENT	TEST METHOD	RESULT
Antenna Requirement	FCC PART 15 C Section 15.203	FCC PART 15 C Section 15.203	PASS
Occupied Bandwidth	FCC PART 15 C section 15.215(c)	ANSI C63.10: Clause 6.9	PASS
Radiated Emission	FCC PART 15 C section 15.249 (a), (d)	ANSI C63.10: Clause 6.4, 6.5 & 6.6	PASS
Band Edges Measurement	FCC PART 15 C section 15.249 (d)	ANSI C63.10: Clause 6.10	PASS
Conducted Emissions at Mains Terminals	FCC PART 15 C section 15.207	ANSI C63.10: Clause 6.2	PASS
Remark: N/A: not applicable. Refer to the relative section for the details. EUT: In this whole report EUT means Equipment Under Test. Tx: In this whole report Tx (or tx) means Transmitter. Rx: In this whole report Rx (or rx) means Receiver. RF: In this whole report RF means Radio Frequency. ANSI C63.10: the detail version is ANSI C63.10:2013 in the whole report.			



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2.0 General Description

2.1 Product Description

Operating Frequency	908.42 MHz
Type of Modulation:	FSK
Number of Channels	1 Channel
Channel Separation:	N/A
Antenna Type	Wire antenna
Antenna gain:	1 dBi
Speciality:	Z - wave
Function:	The product is a Z-Wave enabled module that can be set in existing in-wall switches. It supports basic command class, which can report immediate voltage, current, watt, and energy consumption. It also can act as a repeater in the Z-Wave network.
Power Supply:	AC 120V,60Hz
Power cord:	1.1 m x 2 wires unscreened AC supply cable supplied by test lab.
EUT modulation and data packet during test:	
The EUT has been tested on the FSK with 9.6 kbps data rate.	

The two models MH-P210-US and MH-S210-US have similar schematic and PCB layout, the difference between them is that MH-P210-US has dimmer function while MH-S210-US has not.



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2.2 Related Submittal(s) Grants

This is an application for certification of:
DXX- Part 15 Low Power Communications Device Transmitter.

Remaining portions are subject to the following procedures:

1. Receiver portion: Verification Procedure.

2.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10:2013. Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans and final tests were performed in the semi-anechoic chamber to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise.

2.4 Test Facility

All of the tests are performed at:
Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City,
GETDD Guangzhou, China.

This test facility and site measurement data have been fully placed on file with the FCC, test firm registration number is 549654.



3.0 System Test Configuration

3.1 Justification

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, AC power line was manipulated to produce worst case emissions. It was powered by AC 120V/60Hz supply.

The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. The spurious emissions more than 20 dB below the permissible value are not reported.

For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in the following table:

Frequency range of radiated emission measurements

Lowest frequency generated in the device	Upper frequency range of measurement
9 kHz to below 10 GHz	10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower
At or above 10 GHz to below 30 GHz	5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower
At or above 30 GHz	5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified



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3.2 EUT Exercising Software

No special software used during test.

3.3 Special Accessories

No special accessories used during test.

3.4 Measurement Uncertainty

When determining of the test conclusion, the Measurement Uncertainty of test has been considered.

Uncertainty and Compliance – Unless the standard specifically states that measured values are to be extended by the measurement uncertainty in determining compliance, all compliance determinations are based on the actual measured value.

3.5 Equipment Modification

Any modifications installed previous to testing by Guangzhou MCOHome Technology Co., Ltd will be incorporated in each production model sold / leased in the United States.

No modifications were installed by Intertek Testing Services Shenzhen Ltd. Guangzhou Branch.

3.6 Support Equipment List and Description

N/A

4.0 Measurement Results

4.1 Antenna Requirement:

Standard requirement

15.203 requirement:

For intentional device. According to 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.

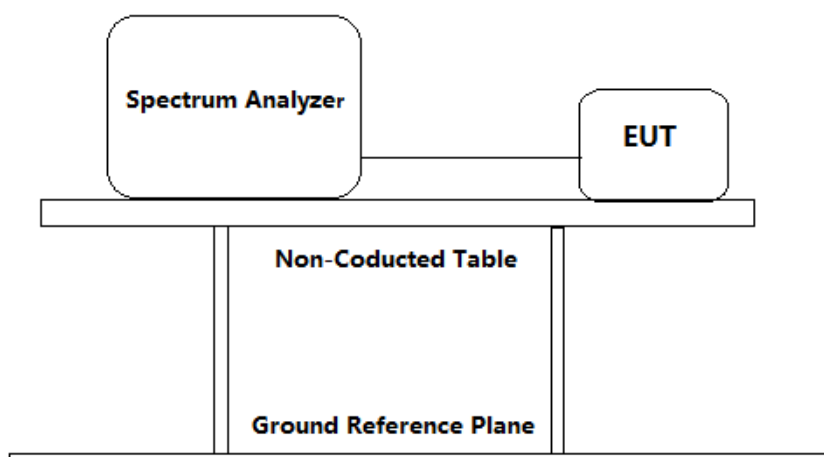
EUT Antenna

The antenna is an wire antenna and no consideration of replacement. The best case gain of the antenna is 1 dBi.



4.2 Occupied Bandwidth:

Test Requirement:	FCC PART 15 C section 15.215(c) (c) 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 Method:	ANSI C63.10: Clause 6.9
Test Status:	Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). The highest, middle and the lowest channels were selected for the final test as listed below.
Test Configuration:	



Test Procedure:

The transmitter was operated at its maximum carrier power measured under normal test conditions.

- The instrument center frequency was set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer was between 1.5 times and 5.0 times the OBW(20 dB Bandwidth).
- The nominal IF filter bandwidth (3 dB RBW) was in the range of 1% to 5% of the OBW, and VBW was approximately three times the RBW.

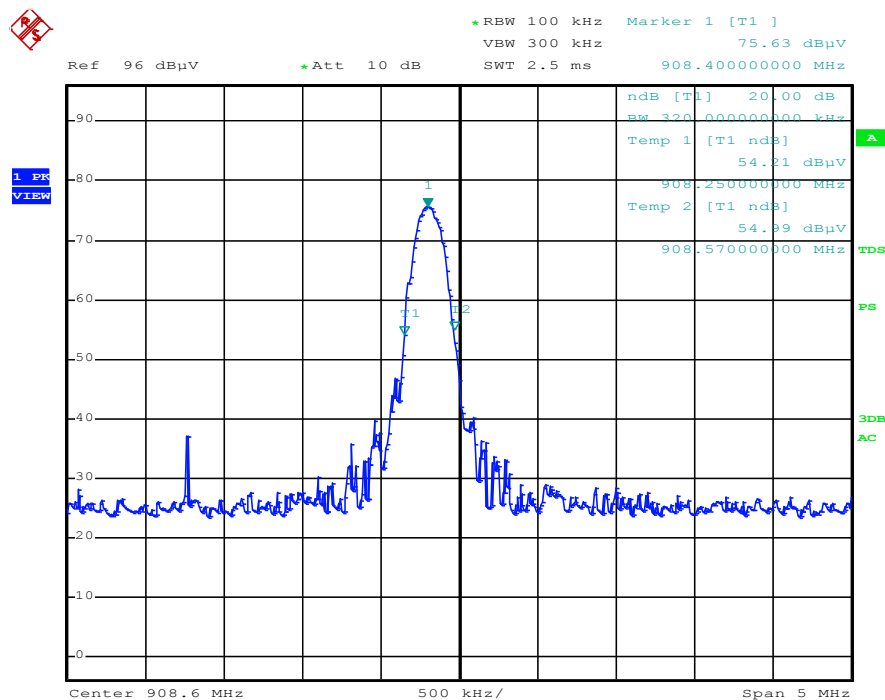
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope was more than $[10 \log (\text{OBW}/\text{RBW})]$ below the reference level.
- d) Step a) through step c) might require iteration to adjust within the specified range.
- e) The dynamic range of the instrument at the selected RBW was more than 10 dB below the target “-20 dB down” requirement; that is, if the requirement calls for measuring the -20 dB OBW, the instrument noise floor at the selected RBW was at least 30 dB below the reference value.
- f) Peak detection and max hold mode (until the trace stabilizes) was used.
- g) Used the 20dB bandwidth function of the instrument and reported the measured bandwidth.
- h) The occupied bandwidth was reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division was clearly labeled. Tabular data was reported in addition to the plot(s).

20 dB bandwidth:

Frequency (MHz)	Measured 20dB bandwidth (kHz)	Limit (kHz)	Result
908.42	320.00	/	Pass

20dB bandwidth:

Result plot as follows:



4.7 Radiated Emission

Test Requirement:

FCC PART 15 C section 15.249 (a), (d)

(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 (MHz)	Field Strength of Fundamental (dB μ V/m @ 3m)	Field Strength of Harmonics (dB μ V/m @ 3m)
902 to 928	94.0	54.0
2400 to 2483.5	94.0	54.0
5725 to 5875	94.0	54.0

Note: The limits shown in the above table are based on measurements using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, which is based on measurements using a CISPR quasi-peak detector.

(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 Method:

ANSI C63.10: Clause 6.4, 6.5 and 6.6

Test Status:

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

Test site:

Measurement Distance: 3m (Semi-Anechoic Chamber)

Limit:

The field strength of radiated emission outside of the specified frequency bands, except for harmonics at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Field Strength (dB μ V/m @ 3m)
30-88	40.0
88-216	43.5
216-960	46.0
Above 960	54.0

Detector:

For Peak and Quasi-Peak value:
200 Hz for 9 kHz to 150 kHz
9 kHz for 150 kHz to 30 MHz

120 kHz for 30 MHz to 1GHz

RBW = 1 MHz for $f \geq 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak for $f \geq 1$ GHz, QP for $f < 1$ GHz

Trace = max hold

According 15.35(c), when the field strength (or envelope power) is not constant or it is in pulses, and an average detector is specified to be used, the value of field strength or power shall be determined by averaging over one complete pulse train, including blanking intervals within the pulse train, as long as the pulse train does not exceed 0.1 seconds. In cases where the pulse train exceeds 0.1 second, the average value of field strength or output power shall be determined during a 0.1 second interval during which the field strength or power is at its maximum value.

The average correction factor was computed by analyzing the on time in 100ms over one complete pulse train. Analysis of the remote transmitter on time in one complete pulse train, therefore the average value of fundamental frequency was: Average = Peak value + $20\log$ (Duty cycle), where the duty factor is calculated from following formula:

The duration of one cycle = 499.2ms

Effective period of the cycle = 21.2 ms

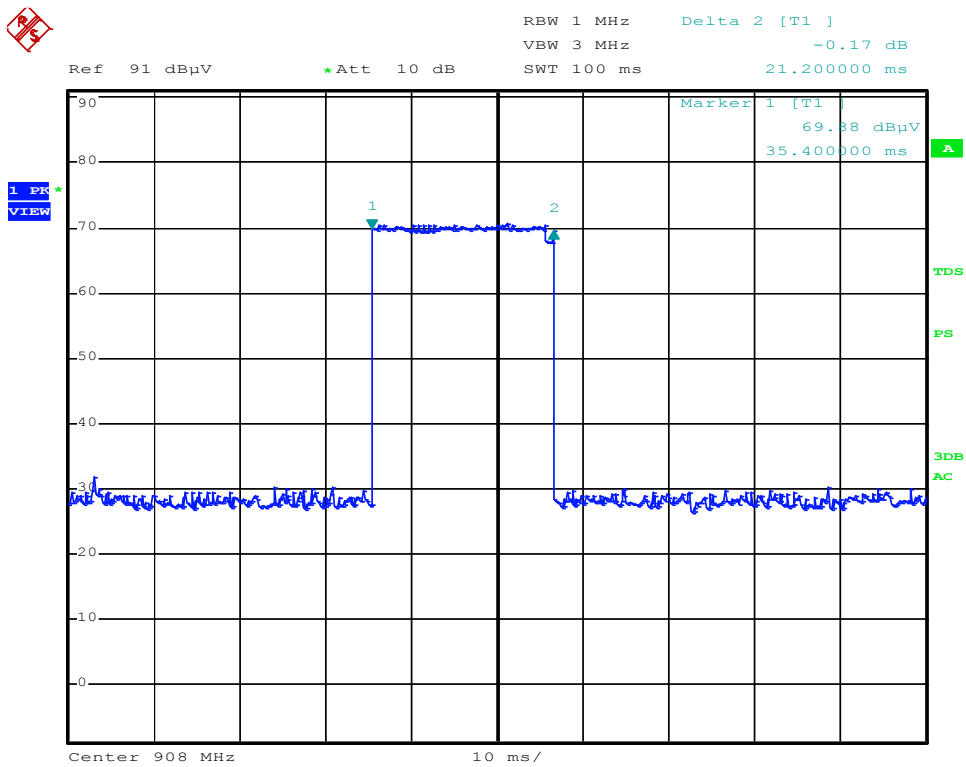
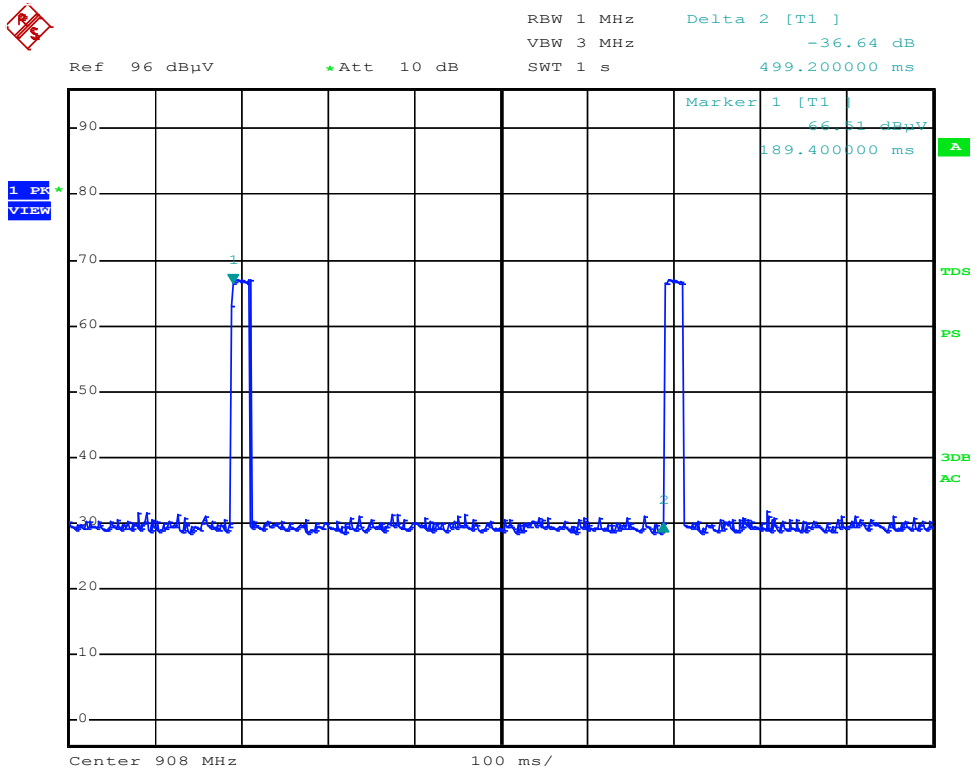
DC = $21.2/100=0.212$ or 21.2%

Therefore, the averaging factor is found by $20\lg 0.212=-13.5$

Please refer to below plots for more details.



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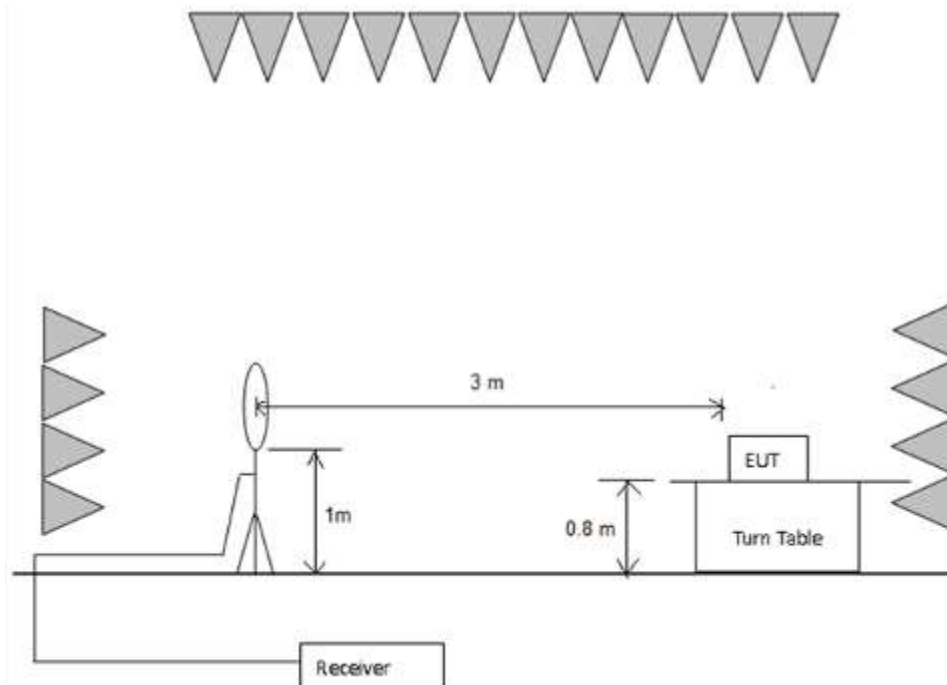


Section 15.205 Restricted bands of operation.

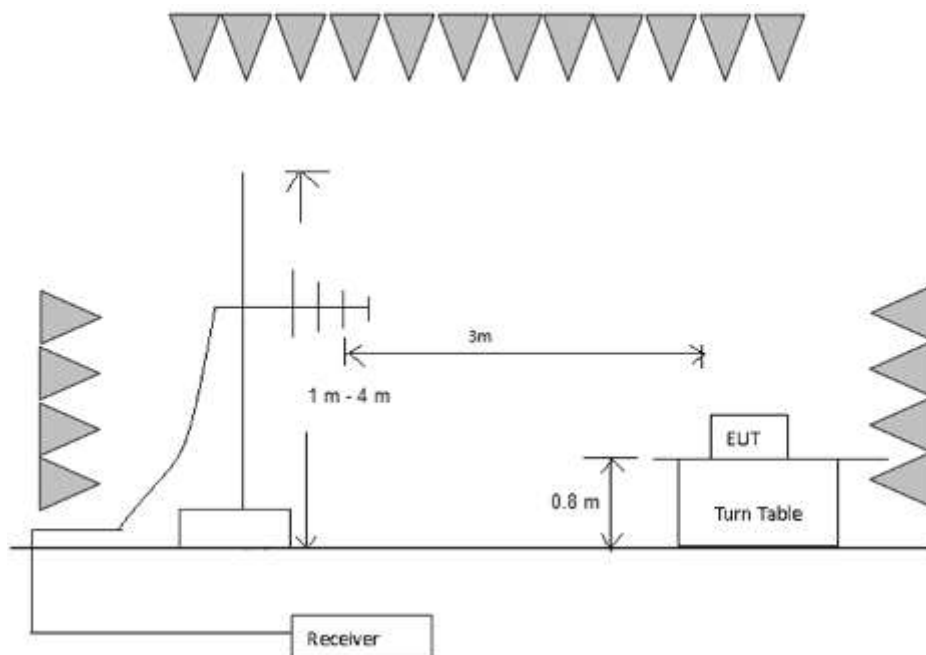
MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.69475 -	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.69525	960 - 1240	7.25 - 7.75
4.125 - 4.128	16.80425 -	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	16.80475	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	25.5 - 25.67	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	37.5 - 38.25	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	73 - 74.6	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	74.8 - 75.2	2200 - 2300	14.47 - 14.5
8.291 - 8.294	108 - 121.94	2310 - 2390	15.35 - 16.2
8.362 - 8.366	123 - 138	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	149.9 - 150.05	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.52475 -	3260 - 3267	23.6 - 24.0
12.29 - 12.293	156.52525	3332 - 3339	31.2 - 31.8
12.51975 -	156.7 - 156.9	3345.8 - 3358	36.43 - 36.5
12.52025	162.0125 - 167.17	3600 - 4400	
12.57675 -	167.72 - 173.2		
12.57725	240 - 285		
13.36 - 13.41	322 - 335.4		

Test Configuration:

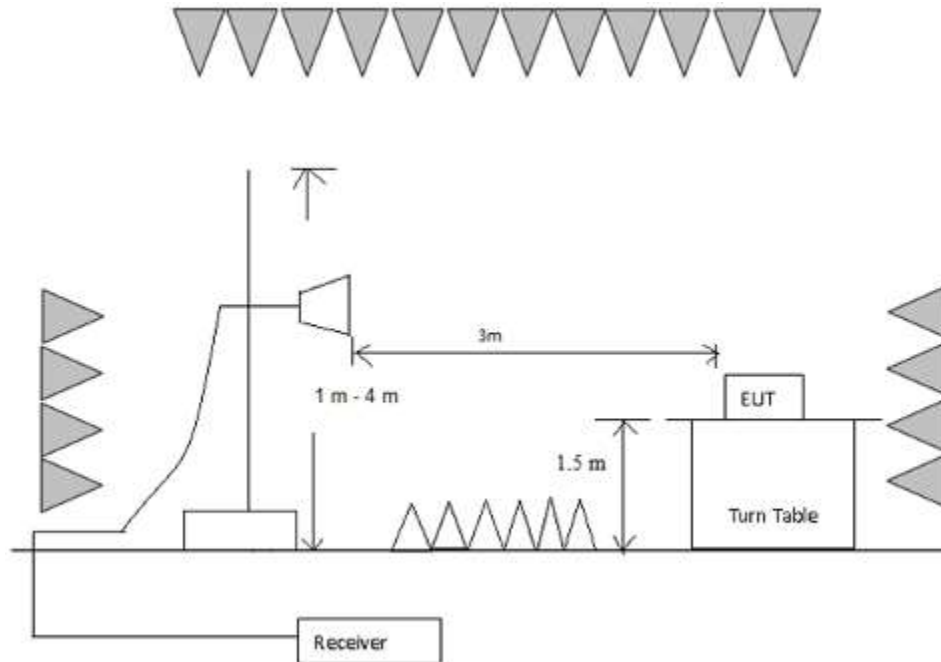
1) 9 kHz to 30 MHz emissions:



2) 30 MHz to 1 GHz emissions:



3) 1 GHz to 40 GHz emissions:



Test Procedure:

1) 9 kHz to 30 MHz emissions:

For testing performed with the loop antenna. The centre of the loop was positioned 1 m above the ground and positioned with its plane vertical at the special distance from the EUT. During testing the loop was rotated about its vertical axis for maximum response at each azimuth and also investigated with the loop positioned in the horizontal plane.

2) 30 MHz to 1 GHz emissions:

For testing performed with the bi-log type antenna. The measurement is performed with the EUT rotated 360 °; the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurement for both the horizontal and vertical antenna polarizations.

3) 1 GHz to 25 GHz emissions:

Test site with RF absorbing material covering the ground plane that met the site validation criterion called out in CISPR 16-1-4:2007 was used to perform radiated emission test above 1 GHz.

For testing performed with the horn antenna. The measurement is performed with the EUT rotated 360 °; the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurement for both the horizontal and vertical antenna polarizations.

4) The receiver was scanned from 9 kHz to 25 GHz. When an emission was found, the table was rotated to produce the maximum signal strength. An initial pre-scan was performed for in peak detection mode using the receiver. The EUT was measured for both the Horizontal and Vertical polarities and performed a pre-test. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. The worst case emissions were reported.

9 kHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement
 The measurements with active loop antenna were greater than 20dB below the limit, so the test data were not recorded in the test report.

Radiated Emissions (Below 1GHz)

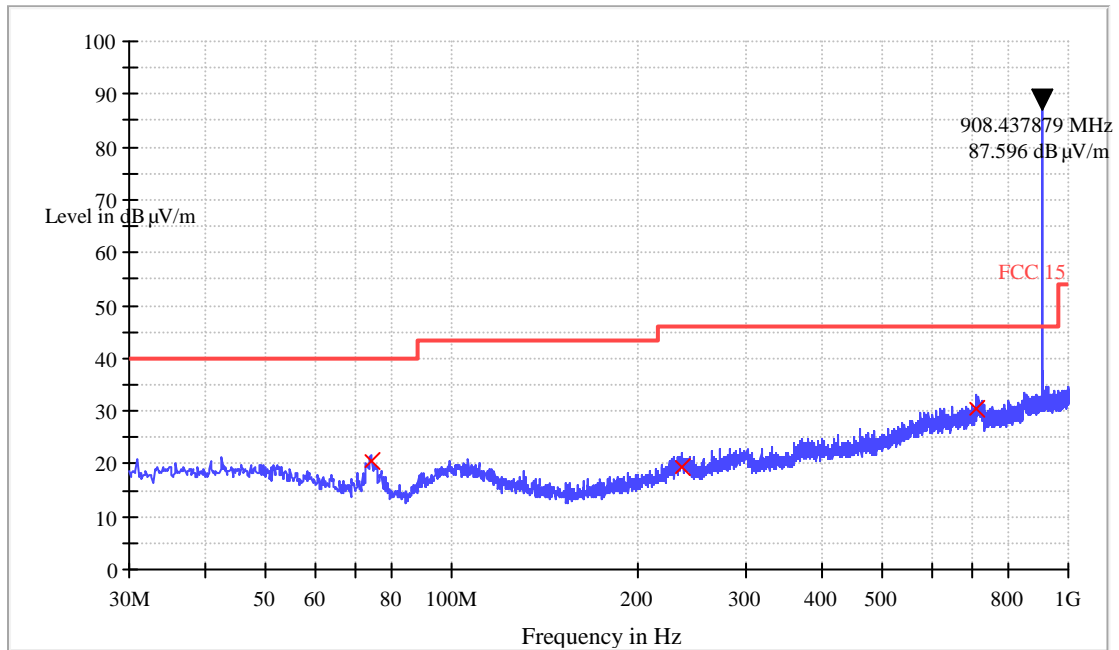
Polarization	Frequency (MHz)	QP Reading (dBμV)	Correction Factor (dB)	QP Net at 3m (dBμV/m)	QP Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	73.960	12.6	8.0	20.6	40.0	-19.4
Horizontal	235.760	7.5	11.9	19.4	46.0	-26.6
Vertical	30.000	18.7	11.7	30.4	40.0	-9.6
Vertical	73.640	21.7	8.1	29.8	40.0	-10.2

Polarization	Frequency (MHz)	PK Reading (dBμV)	Correction Factor (dB)	PK Net at 3m (dBμV/m)	AV Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	908.438	65.3	22.3	87.6	94.0	-6.4
Vertical	908.438	56.9	22.3	79.2	94.0	-14.8

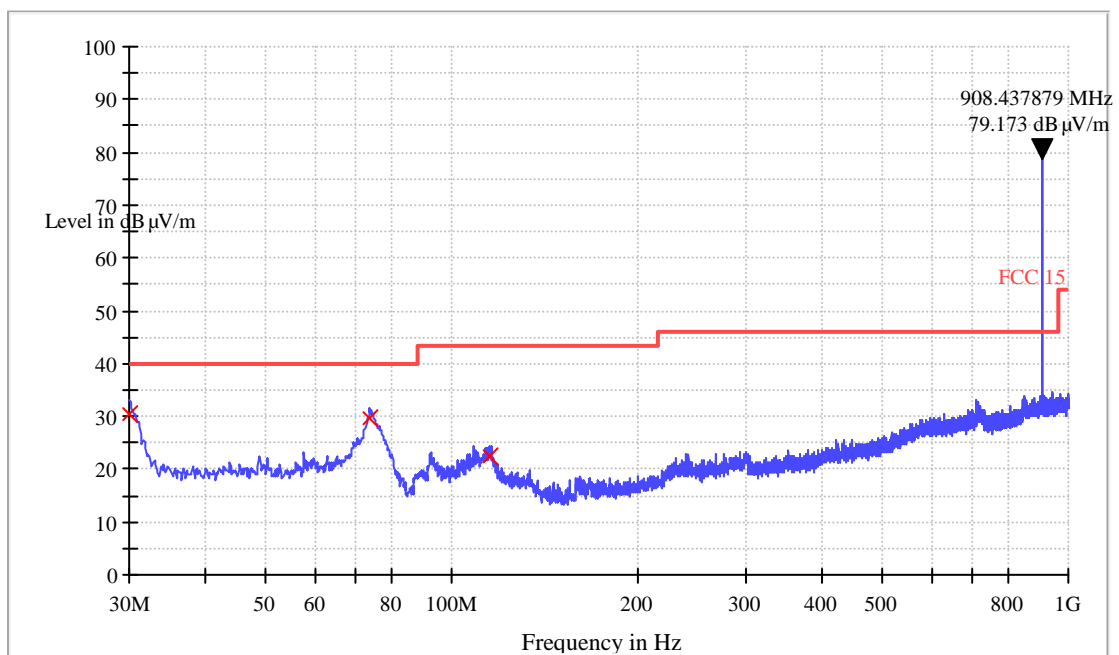


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Test Curve:
Horizontal:



Vertical:





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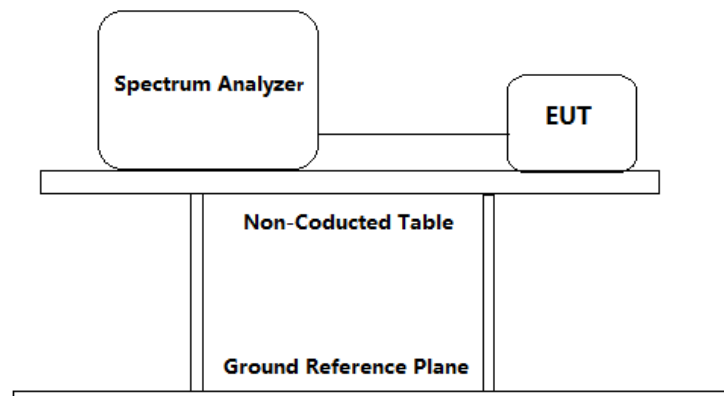
Radiated Emissions (Above 1GHz)

Polarization	Frequency (MHz)	PK Reading (dB μ V)	Correction Factor (dB)	PK Net at 3m (dB μ V/m)	Average Limit at 3m (dB μ V/m)	Margin (dB)
Horizontal	1816.750	62.9	-14.8	48.1	54.0	-5.9
Horizontal	2453.500	45.8	-12.7	33.1	54.0	-20.9
Horizontal	6178.000	43.3	-7.2	36.1	54.0	-17.9
Vertical	1816.400	49.5	-14.8	34.7	54.0	-19.3
Vertical	2591.593	45.8	-12.3	33.5	54.0	-20.5
Vertical	4534.800	43.0	-8.7	34.3	54.0	-19.7

- Notes:
1. All measurements were made at 3 meter.
 2. Negative value in the margin column shows emission below limit.
 3. Horn antenna is used for the emission over 1000MHz.
 4. When Peak emission level was below AV limit, the AV emission level was not recorded.

4.8 Band Edges Requirement

Test Requirement:	FCC PART 15 C section 15.249 (d) (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.
Frequency Band:	2400 MHz to 2483.5 MHz
Test Method:	ANSI C63.10: Clause 6.10
Test Status:	Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). The lowest, middle and the highest channels were selected for the final test as listed below.
Test Configuration:	

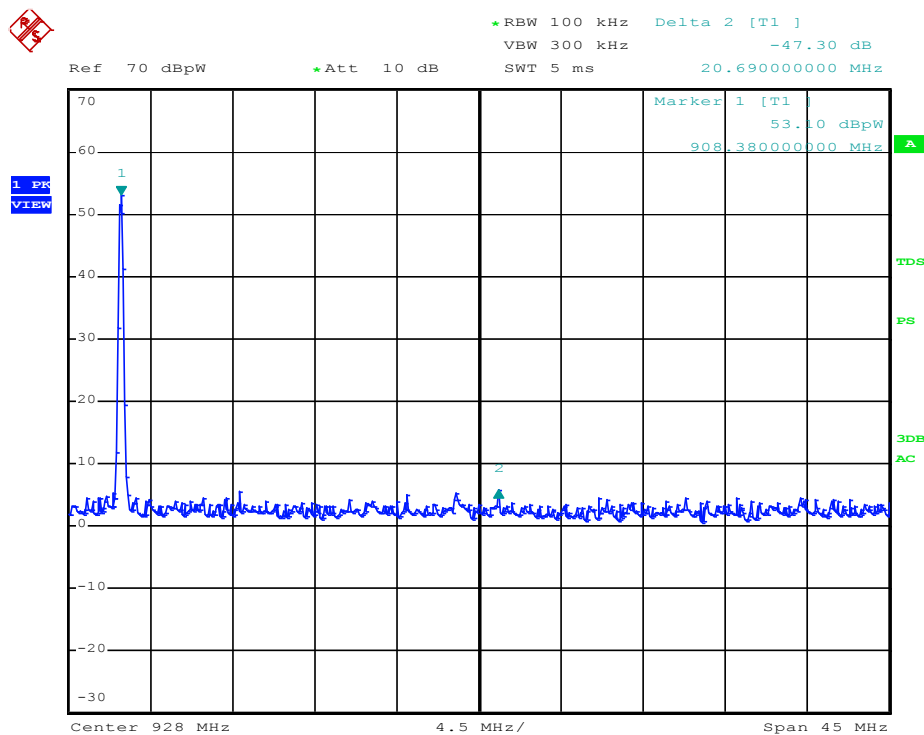
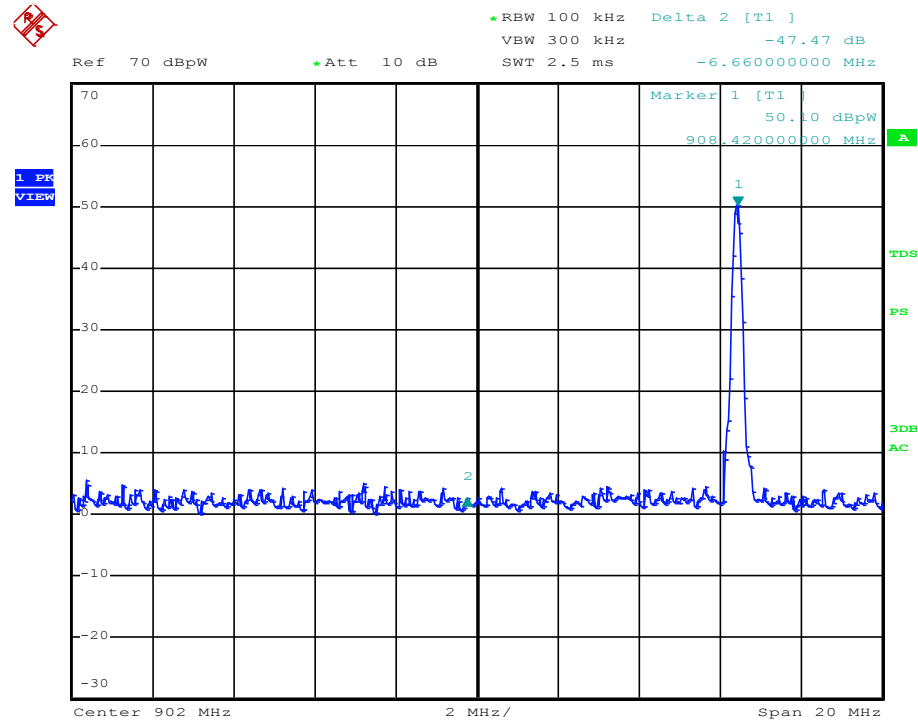




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Test result with plots as follows:

Result plot as follows:



Peak Measurement

Band-edge compliance is determined by applying marker-delta method, i.e (Band-edge Plot).

(i) Lower band-edge:

Peak Resultant field strength

=Fundamental emissions (peak value) – delta from the band-edge plot

= 87.6dB μ V/m – 47.47dB

= 40.13dB μ V/m

(ii) Upper band-edge:

Peak Resultant field strength

=Fundamental emissions (peak value) – delta from the band-edge plot

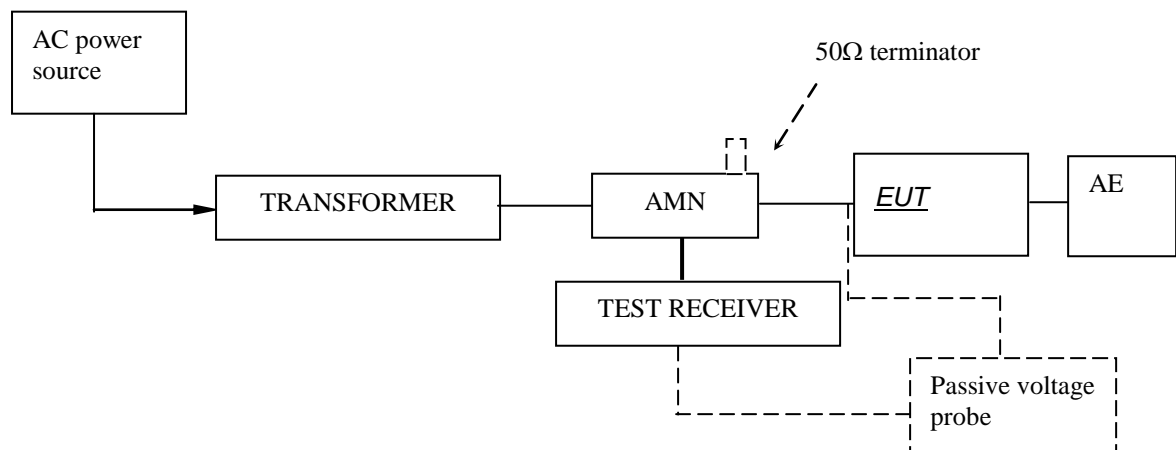
= 87.6dB μ V/m – 47.30dB

= 40.30dB μ V/m

The Peak resultant field strength meets the general radiated emission AV limit 54dB μ V/m in RSS-Gen, so it complies with the requirement.

4.9 Conducted Emissions at Mains Terminals

Test Configuration:



Test Setup and Procedure

Test was performed according to ANSI C63.10 Clause 6.2. The EUT was set to achieve the maximum emission level. The mains terminal disturbance voltage was measured with the EUT in a shielded room. The EUT was connected to AC power source through an Artificial Mains Network which provides a 50Ω linear impedance. Artificial hand is used if appropriate (for handheld apparatus). The load/control terminal disturbance voltage was measured with passive voltage probe if appropriate.

The table-top EUT was placed on a 0.8m high non-metallic table above earthed ground plane (Ground Reference Plane). And for floor standing EUT, was placed on a 0.1m high non-metallic supported on GRP. The EUT keeps a distance of at least 0.8m from any other of the metallic surface. The Artificial Mains Network is situated at a distance of 0.8m from the EUT.

During the test, mains lead of EUT excess 0.8m was folded back and forth parallel to the lead so as to form a horizontal bundle with a length between 0.3m and 0.4m.

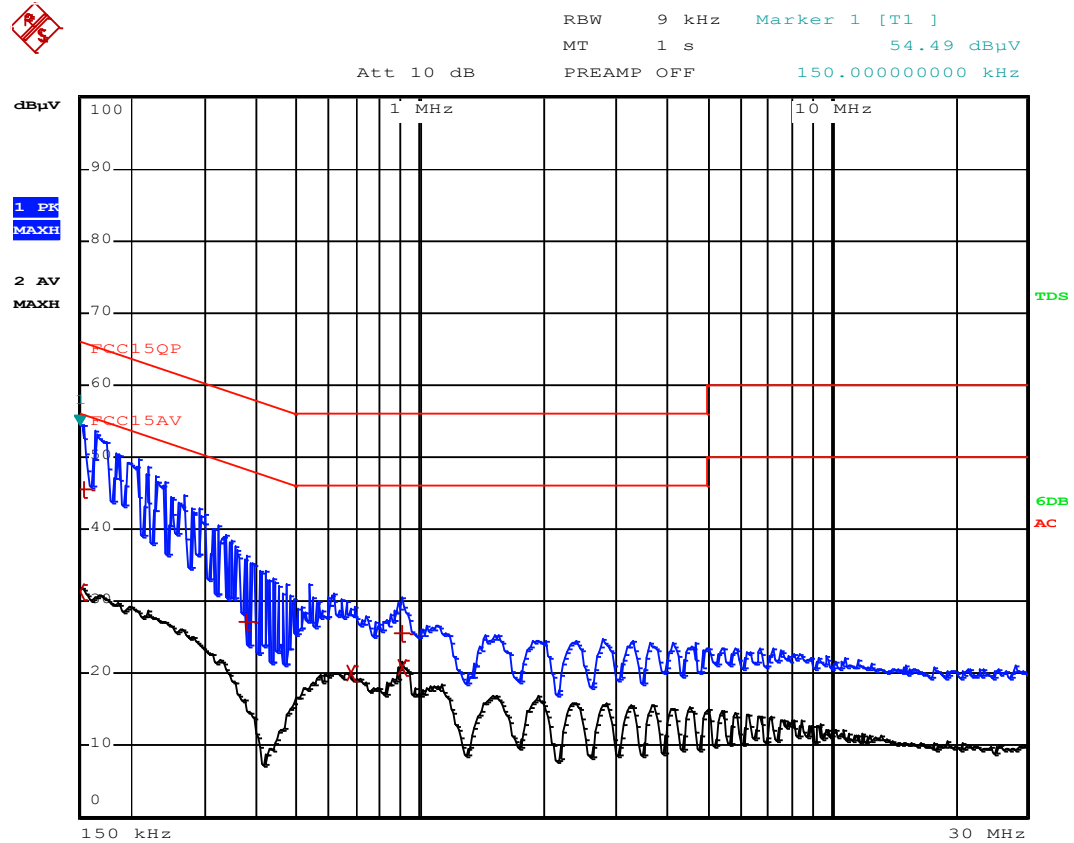
The bandwidth of test receiver was set at 9 kHz. The frequency range from 150 kHz to 30MHz was checked.

Test Data

At main terminal: Pass

Tested Wire: Live

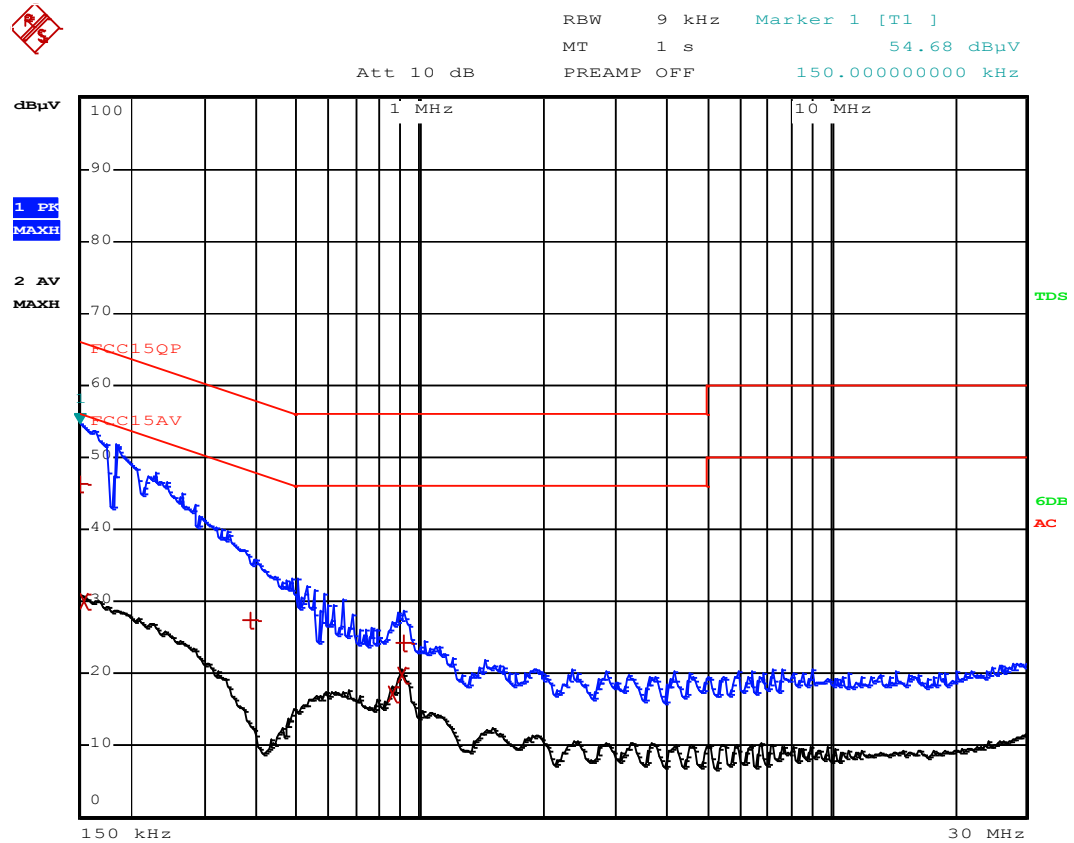
Operation Mode: transmitting mode



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	FCC15QP			
Trace2:	FCC15AV			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBμV		DELTA LIMIT dB
2 Average	150 kHz	31.38	L1	-24.61
1 Quasi Peak	154 kHz	45.54	L1	-20.23
1 Quasi Peak	378 kHz	27.11	L1	-31.21
2 Average	678 kHz	19.94	L1	-26.05
1 Quasi Peak	906 kHz	25.63	L1	-30.36
2 Average	906 kHz	20.93	L1	-25.06

Tested Wire: Neutral

Operation Mode: Transmitting mode



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	FCC15QP			
Trace2:	FCC15AV			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBμV		DELTA LIMIT dB
1 Quasi Peak	150 kHz	46.30 L1		-19.69
2 Average	154 kHz	30.04 L1		-25.73
1 Quasi Peak	386 kHz	27.41 L1		-30.73
2 Average	854 kHz	17.27 L1		-28.72
2 Average	906 kHz	19.70 L1		-26.29
1 Quasi Peak	910 kHz	24.17 L1		-31.82



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10.0 Test Equipment List

Radiated Emission

Equipment No.	Equipment	Model	Manufacturer	Cal. Due date (YYYY-MM-DD)	Calibration Interval
EM030-01	3m Semi-Anechoic Chamber	9×6×6 m ³	ETS•LINDGREN	2016-04-02	1Y
EM030-02	Control room for 3m Semi-Anechoic Chamber	4×4×3 m ³	ETS•LINDGREN		
EM031-02	EMI Test Receiver (9 kHz~7 GHz)	R&S ESR7	R&S	2016-06-03	1Y
EM031-03	Signal and Spectrum Analyzer (10 Hz~40 GHz)	R&S FSV40	R&S	2016-06-03	1Y
EM011-04	Loop antenna (9 kHz-30 MHz)	HFH2-Z2	R&S	2016-05-25	1Y
EM061-03	TRILOG Super Broadband test Antenna (30 MHz-1.5 GHz)	VULB 9161	SCHWARZBECK	2016-05-25	1Y
EM033-02	Bouble-Ridged Waveguide Horn Antenna (800 MHz-18 GHz)	R&S HF907	R&S	2016-05-25	1Y
EM033-04	High Frequency Antenna & preamplifier (26 GHz-40 GHz)	R&S SCU- 40	R&S	2016-05-25	1Y
EM031-02-01	Coaxial cable(9 kHz-1 GHz)	/	R&S	2016-06-03	1Y
EM033-02-02	Coaxial cable(1 GHz-18 GHz)	/	R&S	2016-06-09	

Conducted emission at the mains terminals test

Equipment No.	Equipment	Model	Manufacturer	Cal.Due date (YYYY-MM-DD)	Calibration Interval
EM080-05	EMI receiver	ESCI	R&S	2016-08-04	1Y
EM006-05	LISN	ENV216	R&S	2016-09-12	1Y
EM006-06-01	Coaxial cable	/	R&S	2016-04-12	1Y
EM004-04	EMC shield Room	8m×3m×3m	Zhongyu	2016-08-04	1Y