

FCC
RF
TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.



FOR
Bluetooth Headphone

ISSUED TO
D&M Holdings Inc.

D&M Building, 2-1 Nisshin-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa,
210-8569, Japan



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Date: *Oct 27, 2014*
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Date: *Oct 27, 2014*



Report No.: BL-SZ1490080-602
EUT Type: Bluetooth Headphone
Model Name: AH-GC20
Brand Name: DENON
Test Standard: 47 CFR Part 15 Subpart C
FCC ID: BV2-AHGC20

Test conclusion: PASS
Test Date: Jul 15, 2014 ~ Oct 20, 2014
Date of Issue: Oct 27, 2014

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Revision History

Version	Issue Date	Revisions
<u>Rev. 01</u>	<u>Oct 27, 2014</u>	<u>Initial Issue</u>

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1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6683 3402
Fax Number	+86 755 6182 4271

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory has been listed by US Federal Communications Commission to perform electromagnetic emission measurements. The recognition numbers of test site are 832625. The laboratory has met the requirements of the IAS Accreditation Criteria for Testing Laboratories (AC89), has demonstrated compliance with ISO/IEC Standard 17025:2005. The accreditation certificate number is TL-588. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Test Environment Condition

Ambient Temperature	23 to 26°C
Ambient Relative Humidity	45 to 55%
Ambient Pressure	90 to 92 kPa

1.4 Announce

- (1) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
- (2) The test report is invalid if there is any evidence and/or falsification.
- (3) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.
- (4) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.
- (5) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant

Applicant	D&M Holdings Inc.
Address	D&M Building, 2-1 Nisshin-cho, Kawasaki-ku, Kawasaki-shi, Kanagawa, 210-8569, Japan

2.2 Manufacturer

Manufacturer	Zhongshan Wata Electronics co., Ltd
Address	No 142, South Tanshen Road, Tanzhou, Zhongshan, Guangdong, P. R. China

2.3 General Description for Equipment under Test (EUT)

EUT Type	Bluetooth Headphone
Model Name	AH-GC20
Hardware Version	V1.4
Software Version	V2.4
Network and Wireless connectivity	Bluetooth 3.0, Bluetooth 4.0 Low Energy (BLE)
About the Product	The equipment is Bluetooth Headphone, it contains Bluetooth 3.0 and Bluetooth 4.0 Low Energy (BLE) operating at 2.4GHz ISM band. Only the Bluetooth 4.0 Low Energy (BLE) was tested in this report.

2.4 Technical Information

Modulation Technology	FHSS
Modulation Type	GFSK
Transfer Rate	1Mbps
Frequency Range	The frequency range used is 2402MHz - 2480MHz; The frequency block is 2400MHz to 2483.5MHz.
Number of channel	40 (at intervals of 2MHz)
Tested Channel	0 (2402MHz), 19 (2440MHz), 39 (2480MHz).
Antenna Type	Ceramic Chip Antenna
Antenna Gain	1.03dBi

Note: The above EUT information in section 2.3 and 2.4 was declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.5 Ancillary Equipment

Ancillary Equipment 1	Battery	
	Brand Name	N/A
	Model No	6SP383450
	Serial No	(N/A. marked #1 by test site)
	Capacitance	600mAh
	Rated Voltage	3.7V
	Extreme Voltage	Low: 3.3V / High: 4.2V
Ancillary Equipment 2	Audio Line	
Ancillary Equipment 3	USB Cable	

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C (12-30-13 Edition)	Miscellaneous Wireless Communications Services
2	KDB Publication 558074 D01v03r02	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
3	ANSI C63.4-2014	American National Standard for Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
4	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

3.2 Verdict

No.	Description	FCC Part No.	Test Result	Verdict
1	Antenna Requirement	15.203 15.247(b)	Note1	PASS
2	Output Power	15.247(b)	ANNEX A.1	PASS
3	6dB Bandwidth	15.247(a)	ANNEX A.2	PASS
4	Conducted Spurious Emission	15.247(d)	ANNEX A.3	PASS
5	Conducted Emission	15.207	ANNEX A.4	PASS
6	Radiated Spurious Emission	15.209 15.247(d)	ANNEX A.5	PASS
7	Band Edge	15.247(d)	ANNEX A.6	PASS
8	Power spectral density (PSD)	15.247(e)	ANNEX A.7	PASS
Note 1: Please refer to section 5.1				

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity (%)	30 -60	
Atmospheric Pressure (kPa)	86-106	
Temperature	NT (Normal Temperature)	+20°C to +25°C
	LT (Low Temperature)	-20°C
	HT (High Temperature)	+55°C
Working Voltage of the EUT	NV (Normal Voltage)	3.7V
	LV (Low Voltage)	3.3V
	HV (High Voltage)	4.2V

4.2 Test Equipment List

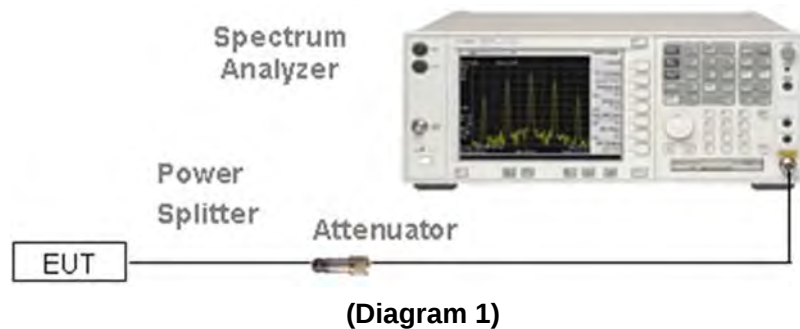
Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	AGILENT	E4440A	MY45304434	2014.07.07	2015.07.06
Spectrum Analyzer	ROHDE&SCHWARZ	FSL3	103640/003	2014.07.07	2015.07.06
Power Splitter	KMW	DCPD-LDC	1305003215	2014.07.07	2015.07.06
Power Sensor	ROHDE&SCHWARZ	NRP-Z21	103971	2014.07.07	2015.07.06
Attenuator (20dB)	KMW	ZA-S1-201	110617091	--	--
Attenuator (6dB)	KMW	ZA-S1-61	1305003189	--	--
DC Power Supply	ROHDE&SCHWARZ	HMP2020	018141664	2014.07.07	2015.07.06
Temperature Chamber	ANGELANTIONI SCIENCE	NTH64-40A	1310	2014.07.07	2015.07.06
Test Antenna-Loop(9kHz-30MHz)	SCHWARZBECK	FMZB 1519	1519-037	2013.07.02	2015.07.01
Test Antenna-Bi-Log(30MHz-3G Hz)	SCHWARZBECK	VULB 9163	9163-624	2013.07.03	2015.07.02
Test Antenna-Horn(1-18GHz)	SCHWARZBECK	BBHA 9120D	9120D-1148	2013.07.02	2015.07.01
Test Antenna-Horn(15-26.5GHz)	SCHWARZBECK	BBHA 9170	9170-305	2013.07.02	2015.07.01
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2014.10.07	2015.10.06

4.3 Test Configurations

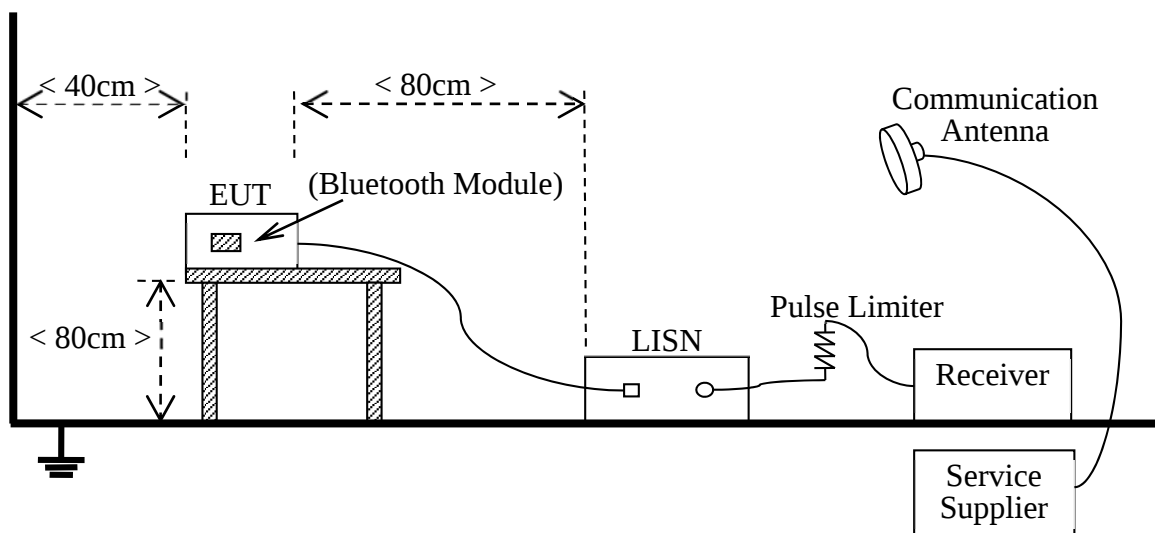
Test Configurations (TC) NO.	Description	
	Signal Description	Operating Frequency
Transmitter		
TC01	FHSS modulation, GFSK	Ch No. 0/ 2402MHz
TC02	FHSS modulation, GFSK	Ch No.19/ 2440MHz
TC03	FHSS modulation, GFSK	Ch No. 39/ 2480MHz

4.4 Description of Test Setup

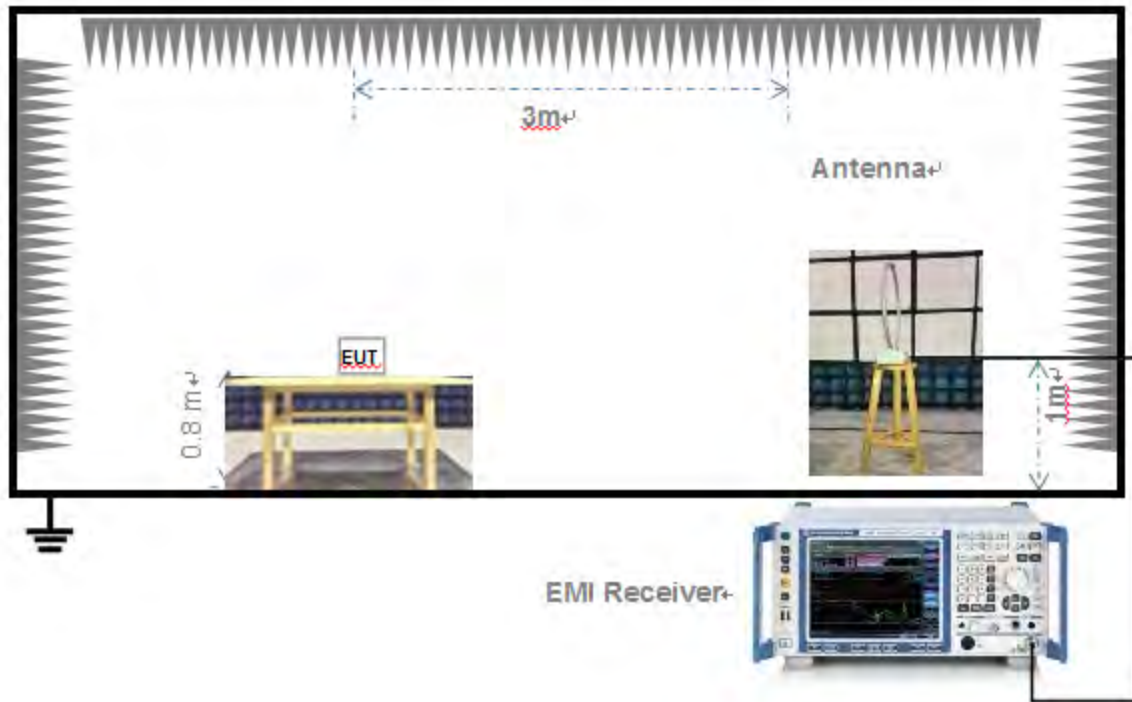
4.4.1 For Antenna Port Test



4.4.2 For AC Power Supply Port Test

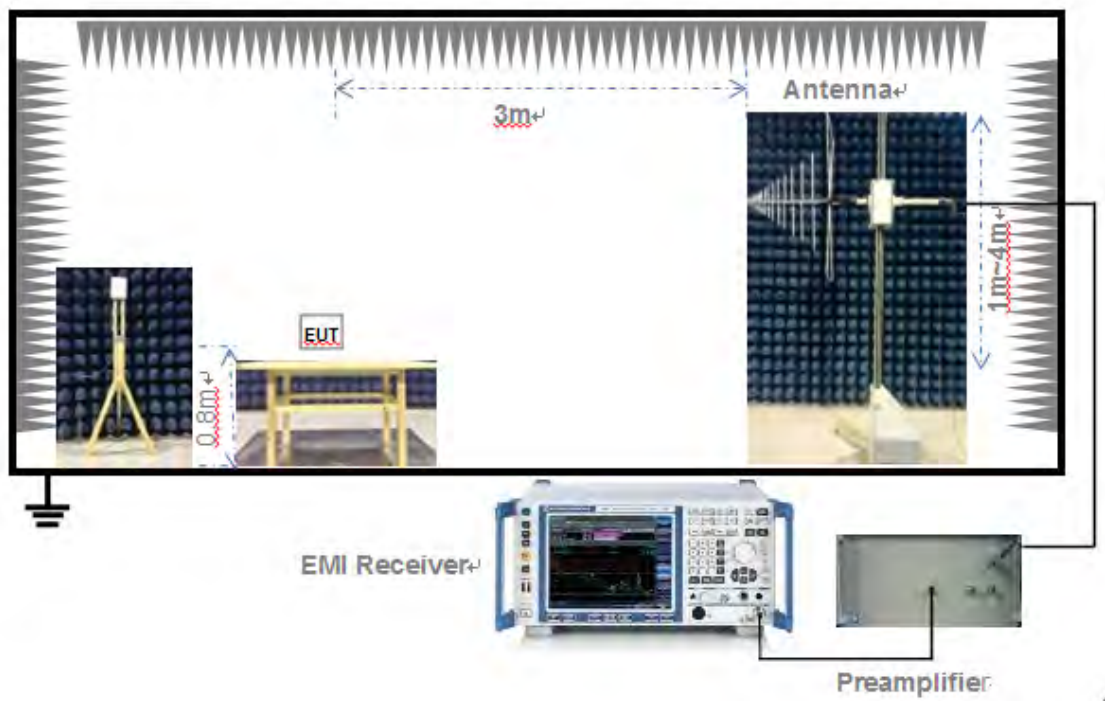


4.4.3 For Radiated Test (Below 30MHz)



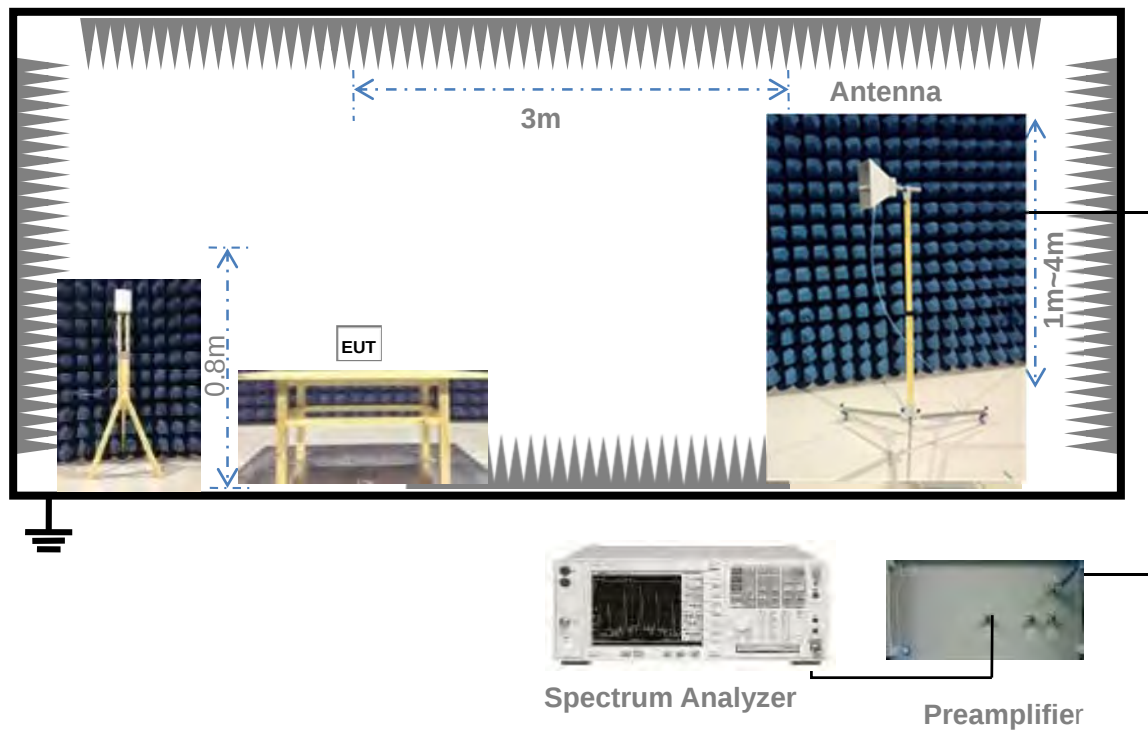
(Diagram 3)

4.4.4 For Radiated Test (30MHz-1GHz)



(Diagram 4)

4.4.5 For Radiated Test (Above 1GHz)



(Diagram 5)

4.5 Test Conditions

Test Case	Test Conditions		
	Test Env.	Test Setup ^{Note 1}	Test Configuration ^{Note 2}
Peak Output Power	NTNV	Test Setup 1	TC01~TC03
Occupied Bandwidth	NTNV	Test Setup 1	TC01~TC03
Conducted Spurious Emission	NTNV	Test Setup 1	TC01~TC03
Conducted Emission	NTNV	Test Setup 2	TC01~TC03
Radiated Spurious Emission	NTNV	Test Setup 3 Test Setup 4 Test Setup 5	TC01~TC03
Band Edge	NTNV	Test Setup 1	TC01, TC03
Power spectral density (PSD)	NTNV	Test Setup 2	TC01~TC03
Note: 1. Please refer to section 4.4 for test setup details. 2. Please refer to section 4.3 for test setup details.			

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Standard Applicable

FCC §15.203 & 15.247(b)

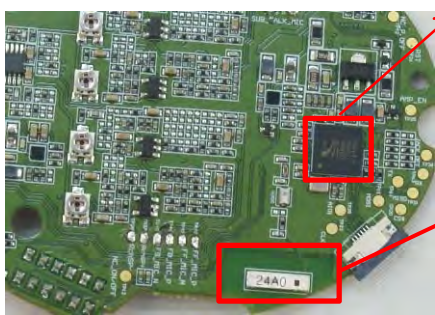
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is An embedded-in	An embedded-in antenna design is used.

Reference Documents	Item
Photo	

5.1.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Output Power

5.2.1 Test Limit

FCC § 15.247(b)

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements.

5.2.2 Test Procedure

Maximum peak conducted output power

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

Set the RBW $\geq$ DTS bandwidth.

Set VBW $\geq 3 \times$ RBW.

Set span $\geq 3 \times$ RBW

Sweep time = auto couple.

Detector = peak.

Trace mode = max hold.

Allow trace to fully stabilize.

Use peak marker function to determine the peak amplitude level.

Measurements of duty cycle

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

Set the center frequency of the instrument to the center frequency of the transmission.

Set RBW $\geq$ OBW if possible; otherwise, set RBW to the largest available value.

Set VBW $\geq$ RBW. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are $> 50/T$ and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if $T \leq 16.7$ microseconds.)

5.3 6dB Bandwidth

5.3.1 Limit

FCC §15.247(a)

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW. The 6 dB bandwidth must be greater than 500 kHz.

5.3.2 Test Procedure

Use the following spectrum analyzer settings:

Set RBW = 100 kHz.

Set the video bandwidth (VBW) ≥ 3 RBW.

Detector = Peak.

Trace mode = max hold.

Sweep = auto couple.

Allow the trace to stabilize.

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

5.4 Conducted Spurious Emission

5.4.1 Limit

FCC §15.247(d)

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

5.4.2 Test Procedure

The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

- a) If the maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).
- b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).
- c) In either case, attenuation to levels below the 15.209 general radiated emissions limits is not required.

The following procedures shall be used to demonstrate compliance to these limits. Note that these procedures can be used in either an antenna-port conducted or radiated test set-up. Radiated tests must conform to the test site requirements and utilize maximization procedures defined herein.

Reference level measurement

Establish a reference level by using the following procedure:

Set instrument center frequency to DTS channel center frequency.

Set the span to ≥ 1.5 times the DTS bandwidth.

Set the RBW = 100 kHz.

Set the VBW $\geq 3 \times$ RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum PSD level.

Emission level measurement

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

Set the RBW = 100 kHz.

Set the VBW $\geq 3 \times$ RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

5.5 Conducted Emission

5.5.1 Limit

FCC §15.207

For an intentional radiator 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 within the band 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dB μ V)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

5.5.2 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

5.6 Radiated Spurious Emission

5.6.1 Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength ($\mu\text{V/m}$)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. For Above 1000MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
2. For above 1000MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.6.2 Test Procedure

Since the emission limits are specified in terms of radiated field strength levels, measurements performed to demonstrate compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for demonstrating compliance to the specified limits; however antenna-port conducted measurements are also now acceptable to demonstrate compliance (see below for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 shall be followed.

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

General Procedure for conducted measurements in restricted bands

- a) Measure the conducted output power (in dBm) using the detector specified (see guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
- b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see guidance on determining the applicable antenna gain)
- c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB

for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

$$E = \text{EIRP} - 20\log D + 104.8$$

where:

E = electric field strength in dB μ V/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

f) Compare the resultant electric field strength level to the applicable limit.

g) Perform radiated spurious emission test.

Quasi-Peak measurement procedure

The specifications for measurements using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

Peak power measurement procedure

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 1.

b) VBW $\geq 3 \times$ RBW.

c) Detector = Peak.

d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Table 1—RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent), then the following procedure shall be used:

- a) The EUT shall be configured to operate at the maximum achievable duty cycle.
- b) Measure the duty cycle, x , of the transmitter output signal as described in section 6.0.
- c) RBW = 1 MHz (unless otherwise specified).
- d) VBW $\geq 3 \times$ RBW.
- e) Detector = RMS, if $\text{span}/(\# \text{ of points in sweep}) \leq (\text{RBW}/2)$. Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
- f) Averaging type = power (i.e., RMS).
 - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
 - 2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
- g) Sweep time = auto.
- h) Perform a trace average of at least 100 traces.
- i) A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
 - 1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is $10 \log(1/x)$, where x is the duty cycle.
 - 2) If linear voltage averaging mode was used in step f), then the applicable correction factor is $20 \log(1/x)$, where x is the duty cycle.
 - 3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

NOTE: Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.

Determining the applicable transmit antenna gain

A conducted power measurement will determine the maximum output power associated with a restricted band emission; however, in order to determine the associated EIRP level, the gain of the transmitting antenna (in dBi) must be added to the measured output power (in dBm).

Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.

See KDB 662911 for guidance on calculating the additional array gain term when determining the effective antenna gain for a EUT with multiple outputs occupying the same or overlapping frequency ranges in the same band.

Radiated spurious emission test

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.

The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

5.7 Band Edge

5.7.1 Limit

FCC §15.209&15.247(d)

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

5.7.2 Test Procedure

The following procedures may be used to determine the peak or average field strength or power of an unwanted emission that is within 2 MHz of the authorized band edge. If a peak detector is utilized, use the procedure described in 13.2.1. Use the procedure described in 13.2.2 when using an average detector and the EUT can be configured to transmit continuously (i.e., duty cycle $\geq 98\%$). Use the procedure described in 13.2.3 when using an average detector and the EUT cannot be configured to transmit continuously but the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent). Use the procedure described in 13.2.4 when using an average detector for those cases where the EUT cannot be configured to transmit continuously and the duty cycle is not constant (duty cycle variations equal or exceed 2 percent).

When using a peak detector to measure unwanted emissions at or near the band edge (within 2 MHz of the authorized band), the following integration procedure can be used.

Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).

Set span to 2 MHz

RBW = 100 kHz.

VBW $\geq 3 \times$ RBW.

Detector = peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweep to continue until the trace stabilizes (required measurement time may increase for low duty cycle applications)

Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency (f_{emission}) ± 0.5 MHz. If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by f_{emission} ± 0.5 MHz.

5.8 Power Spectral density (PSD)

5.8.1 Limit

FCC §15.247(e)

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used.

5.8.2 Test Procedure

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.

Set the VBW $\geq 3 \text{ RBW}$.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

ANNEX A TEST RESULT

A.1 Output Power

Duty Cycle

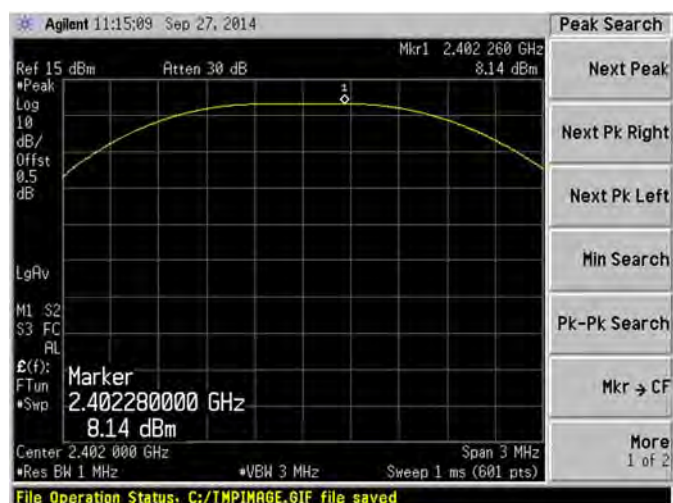
Band	Duty Cycle(%)	T(ms)	1/T(kHz)
GFSK	61.54	0.400	2.5

Peak Power Test Data

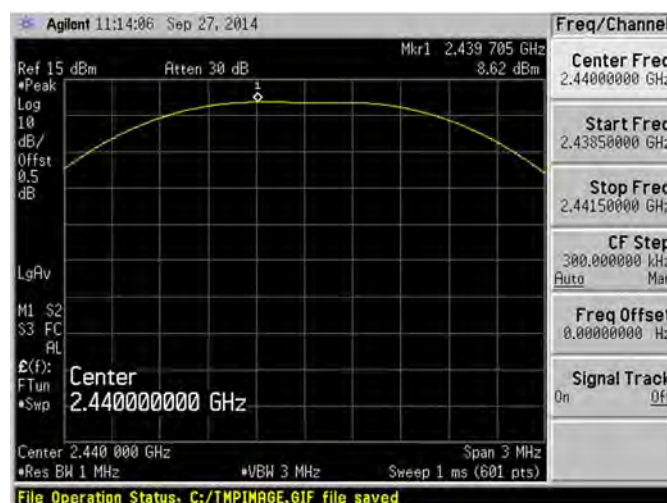
Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
Low	8.14	6.52	30	1000	PASS
Middle	8.62	7.28			PASS
High	9.03	8.00			PASS

Peak Power Test Plots

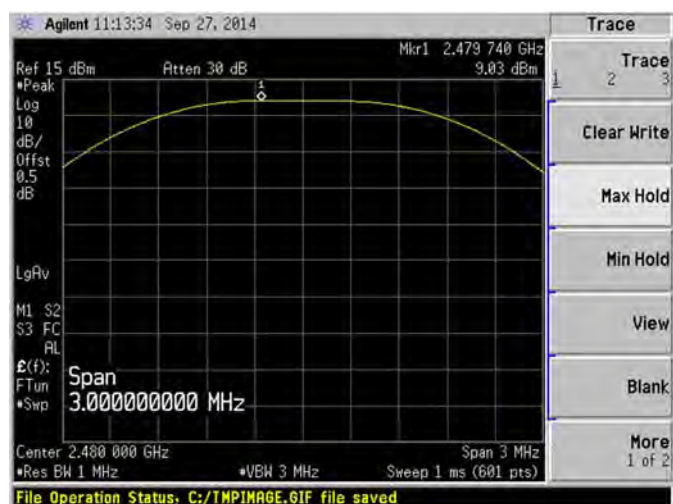
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL



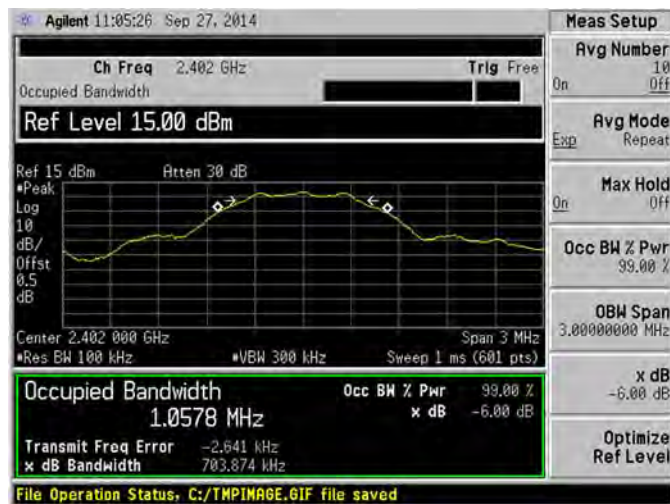
A.2 Bandwidth

Test Data

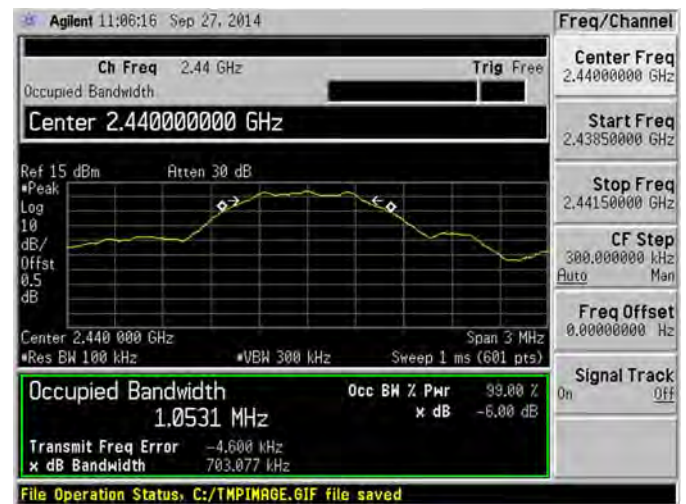
Channel	6 dB Bandwidth (kHz)	Limits (kHz)
Low	703.874	≥ 500
Middle	703.077	≥ 500
High	692.991	≥ 500

Test plots

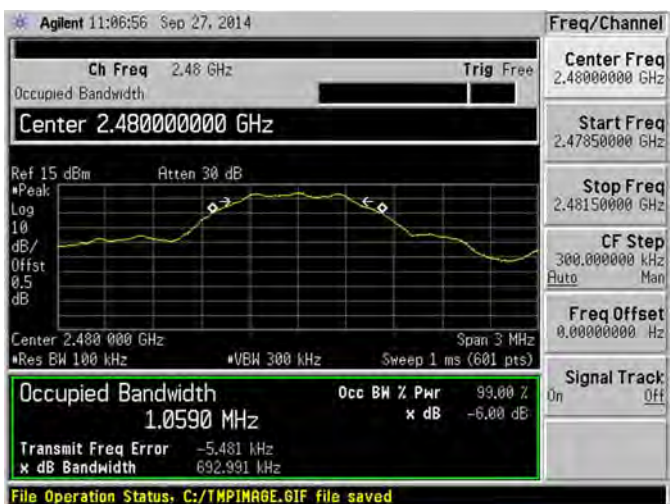
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL



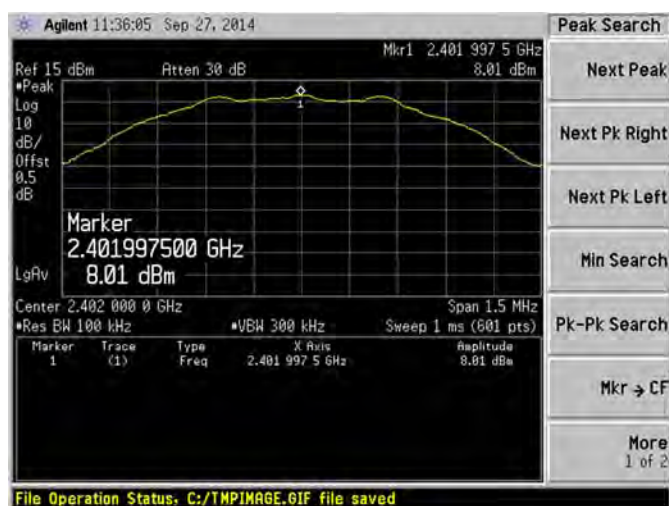
A.3 Conducted Spurious Emissions

Test Data

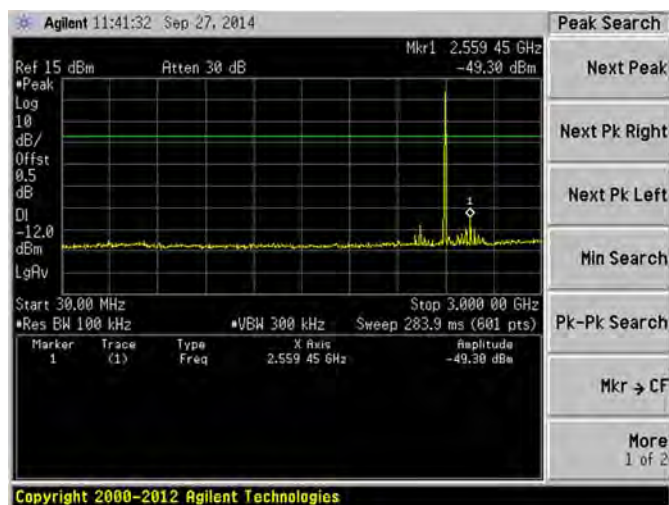
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-49.30	8.01	-12.0	PASS
Middle	-51.41	8.50	-11.5	PASS
High	-48.33	8.88	-11.1	PASS

Test Plots

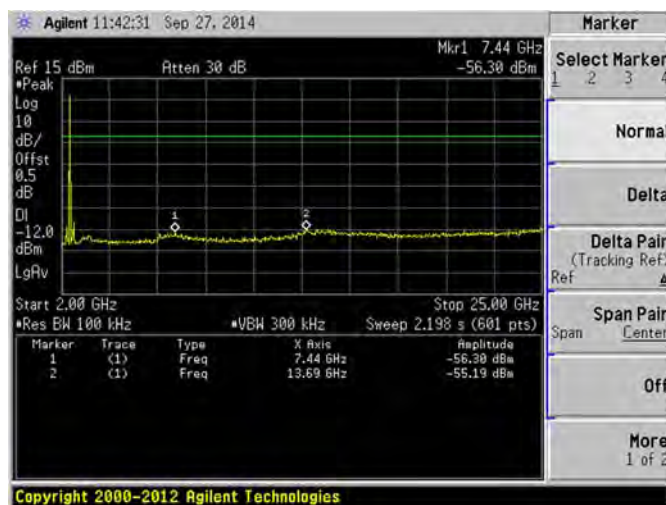
LOW CHANNEL CARRIER LEVEL



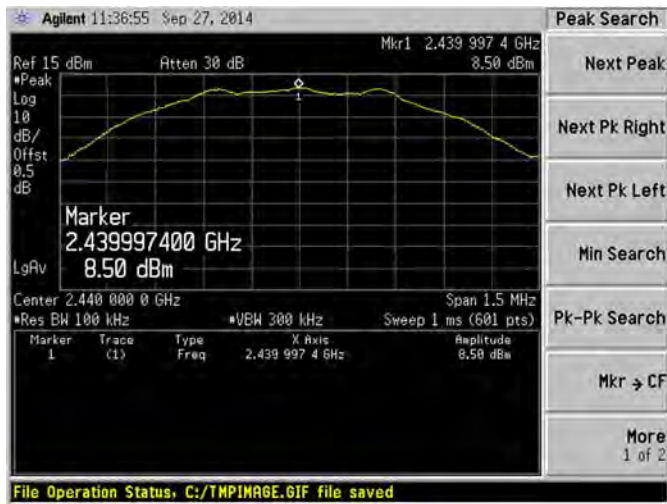
LOW CHANNEL, SPURIOUS 30MHz~3GHz



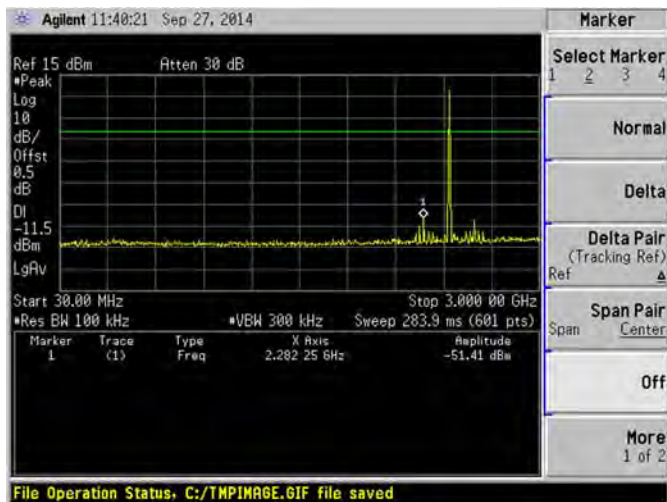
LOW CHANNEL, SPURIOUS 2GHz~25GHz



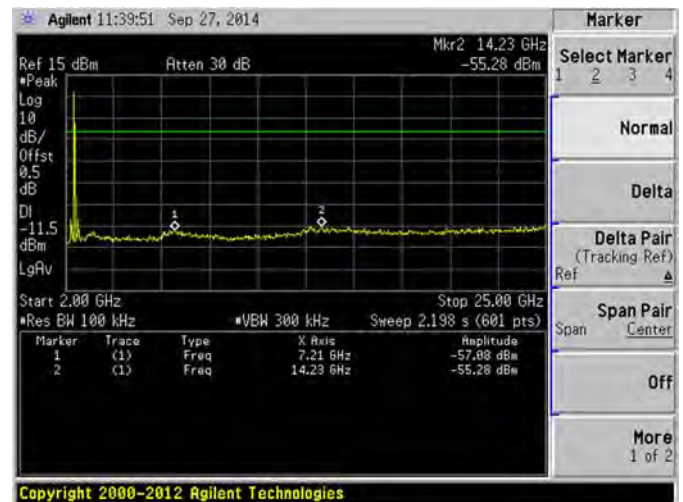
MID CHANNEL CARRIER LEVEL



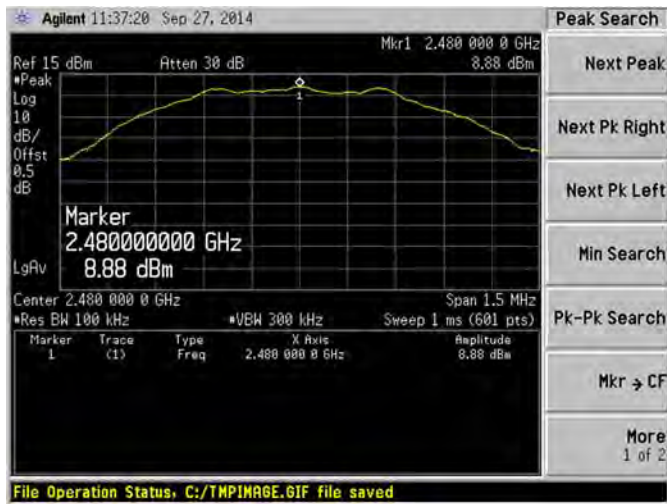
MID CHANNEL, SPURIOUS 30MHz~3GHz



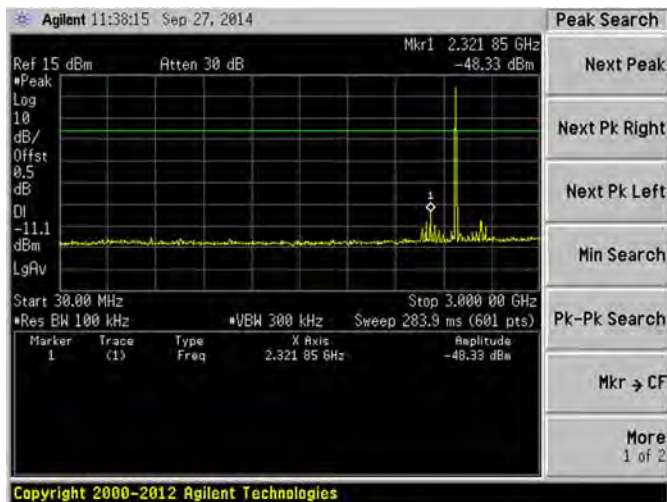
MID CHANNEL, SPURIOUS 2GHz~25GHz



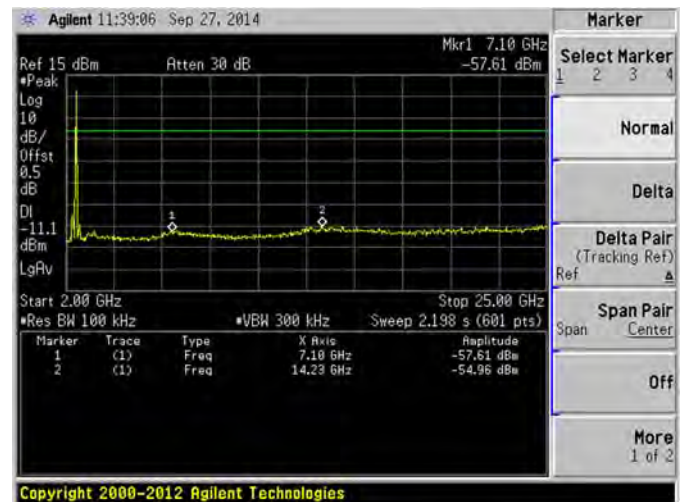
HIGH CHANNEL CARRIER LEVEL



HIGH CHANNEL, SPURIOUS 30MHz~3GHz



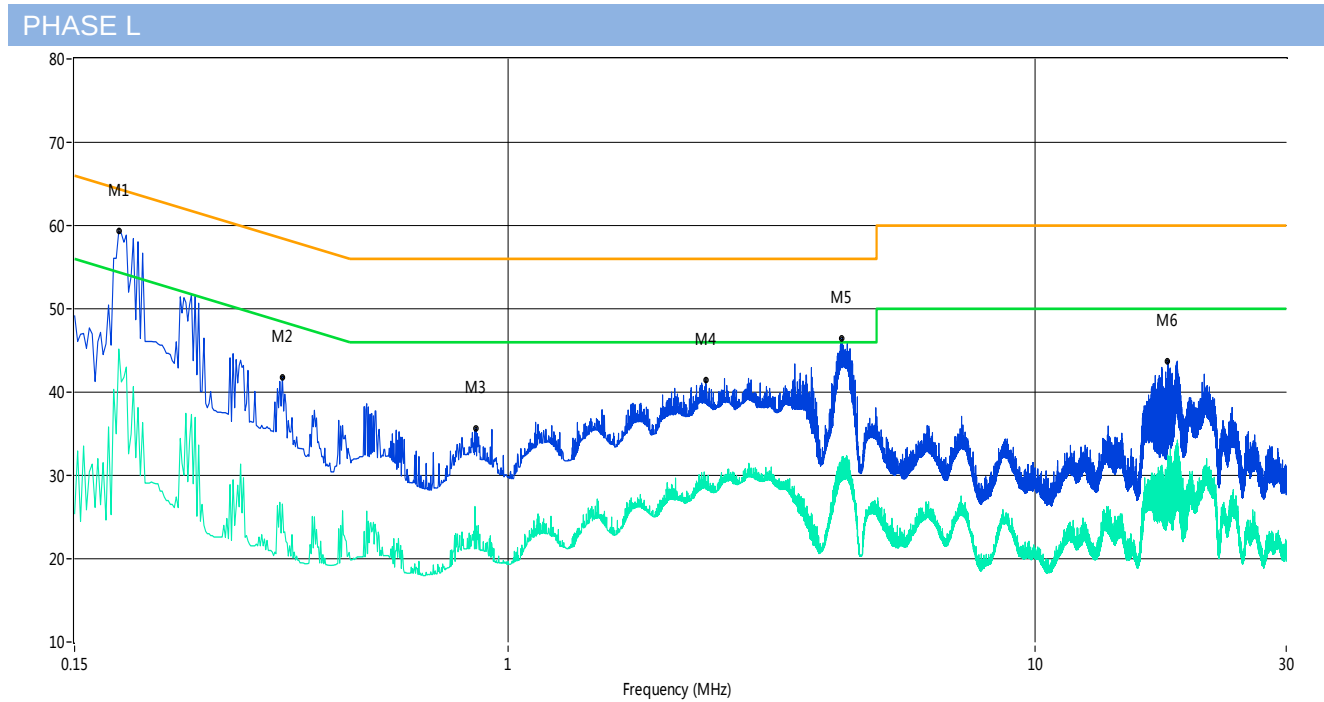
HIGH CHANNEL, SPURIOUS 2GHz~25GHz



A.4 Conducted Emissions

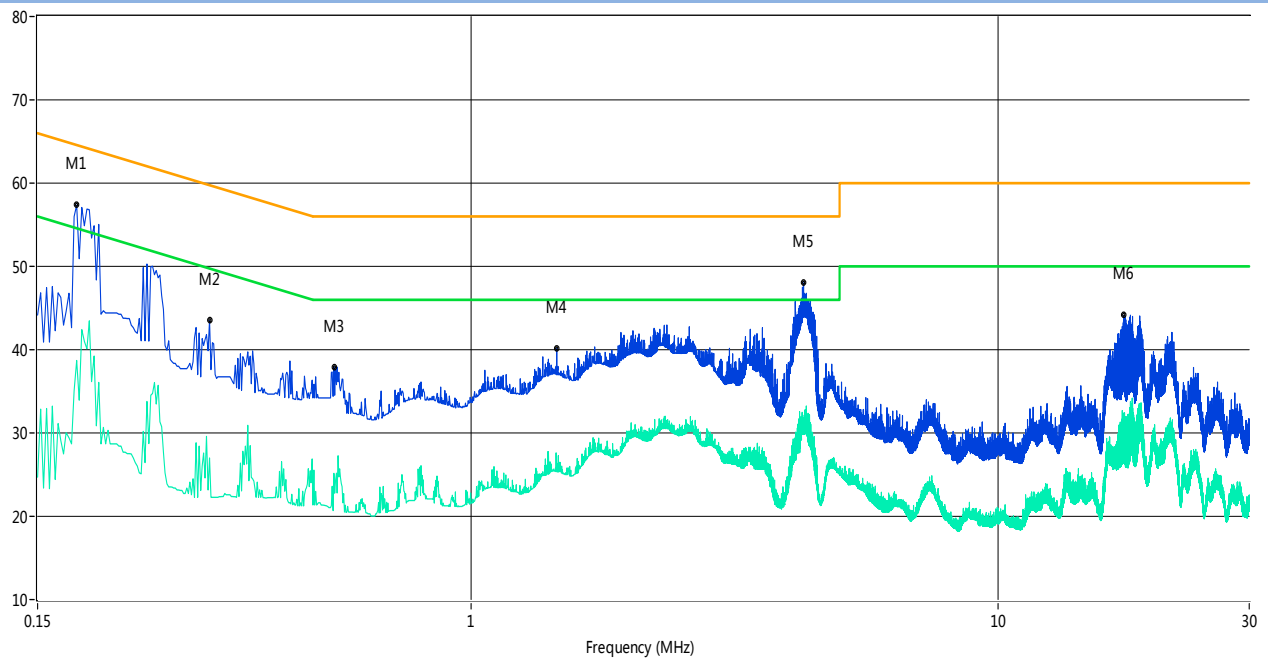
Note: All configurations have been tested, only the worst configuration (GFSK High Channel) shown here.

Test Data and Test Plots



Frequency (MHz)	Peak Level (dBuV)	Q-peak Level (dBuV)	Average Level (dBuV)	Factor (dB)	QP Limit (dBuV)	AV Limit (dBuV)	Margin (dB)	Line	Verdict
0.18	59.4	--	45.2	10.00	65.1	55.1	9.90	L Line	PASS
0.37	41.8	--	26.6	10.00	59.7	49.7	23.10	L Line	PASS
0.87	35.7	--	23.9	10.00	56.0	46.0	22.10	L Line	PASS
2.37	41.5	--	29.9	10.00	56.0	46.0	16.10	L Line	PASS
4.30	46.5	--	32.3	10.00	56.0	46.0	13.70	L Line	PASS
17.86	43.8	--	32.4	10.00	60.0	50.0	17.60	L Line	PASS

PHASE N



Frequency (MHz)	Peak Level (dBuV)	Q-peak Level (dBuV)	Average Level (dBuV)	Factor (dB)	QP Limit (dBuV)	AV Limit (dBuV)	Margin (dB)	Line	Verdict
0.18	57.4	--	38.7	10.00	65.2	55.2	16.50	N Line	PASS
0.32	43.5	--	27.0	10.00	61.2	51.2	24.20	N Line	PASS
0.55	38.0	--	25.2	10.00	56.0	46.0	20.80	N Line	PASS
1.45	40.2	--	26.4	10.00	56.0	46.0	19.60	N Line	PASS
4.27	48.0	--	29.9	10.00	56.0	46.0	16.10	N Line	PASS
17.31	44.1	--	32.4	10.00	60.0	50.0	17.60	N Line	PASS

A.5 Radiated Emission

Antenna-port Conducted test data

$$E = \text{EIRP} - 20\log D + 104.8$$

where:

E = electric field strength in dB μ V/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

EIRP= Measure Conducted output power Value(dBm) + Maximum transmit antenna gain(dBi) + The appropriate maximum ground reflection factor(dB)

Note 1: The frequency is fundamental signal which can be ignored.

Note 2: Which frequency is not within a restricted band, and its limit line is 20dB below the highest emission level.

Note 3: Average measurement was not performed if peak level went lower than the average limit.

Note 4: The harmonic (3th, 4th, 5th, etc.) and other spurious are not reported, because those levels are lower than average limit line and background noise.

GFSK: LOW CHANNEL

Frequency (MHz)	Value (dBm)	Ground Reflection Factor (dB)	D (m)	Max gain (dBi)	Detector	E (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Remark	Verdict
0.00992	-89.49	6	3	2	QP	13.77	83.11	69.34	Note 2	PASS
0.172	-85.72	6	3	2	QP	17.54	83.11	65.57	Note 2	PASS
231.4	-78.53	4.7	3	2	QP	23.43	83.11	59.68	Note 2	PASS
814	-80.14	4.7	3	2	QP	21.82	83.11	61.29	Note 2	PASS
4803	-44.16	0	3	2	PK	53.10	74.00	20.90	--	PASS
	N/A		3	2	AV	N/A	54.00	N/A	Note 3	PASS
1636.9	-44.78	0	3	2	PK	52.48	83.11	30.63	Note 2	PASS
	N/A		3	2	AV	N/A	63.11	N/A	Note 3	PASS
2407	5.85	0	3	2	PK	103.11	N/A	N/A	Note 1	N/A
	N/A		3	2	AV	N/A	N/A	N/A		N/A

Test Plots

LOW CHANNEL, SPURIOUS 9kHz~150kHz



Date: 27 OCT. 2014 03:19:20

LOW CHANNEL, SPURIOUS 150kHz~30MHz



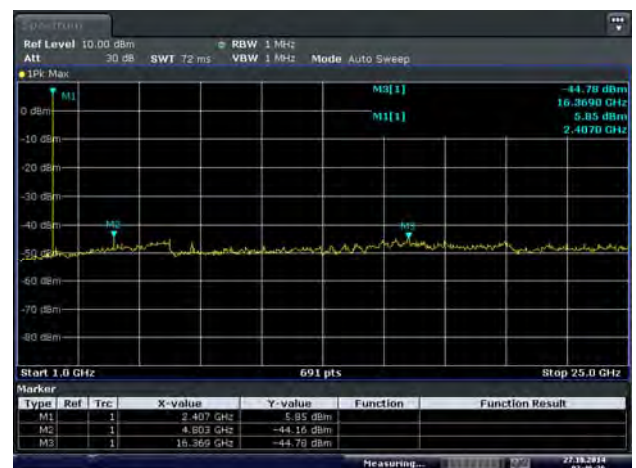
Date: 27 OCT. 2014 03:29:58

LOW CHANNEL, SPURIOUS 30MHz~1GHz



Date: 27 OCT. 2014 03:32:32

LOW CHANNEL, SPURIOUS 1GHz~25GHz



Date: 27 OCT. 2014 03:46:27

Note 1: The frequency is fundamental signal which can be ignored.

Note 2: Which frequency is not within a restricted band, and its limit line is 20dB below the highest emission level.

Note 3: Average measurement was not performed if peak level went lower than the average limit.

Note 4: The harmonic (2th, 3th, 4th, etc.) and other spurious are not reported, because those levels are lower than average limit line and background noise.

GFSK: MIDDLE CHANNEL

Frequency (MHz)	Value (dBm)	Ground Reflection Factor (dB)	D (m)	Max gain (dBi)	Detector	E (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Remark	Verdict
0.00992	-89.81	6	3	2	QP	13.45	83.59	70.14	Note 2	PASS
0.172	-85.73	6	3	2	QP	17.53	83.59	66.06	Note 2	PASS
242.7	-80.03	4.7	3	2	QP	21.93	74.00	52.07	Note 2	PASS
979.6	-78.94	4.7	3	2	QP	23.02	74.00	50.98	Note 2	PASS
6644	-44.78	0	3	2	PK	52.48	83.59	31.11	Note 2	PASS
	N/A		3	2	AV	N/A	63.59	N/A	Note 3	PASS
1636.9	-43.93	0	3	2	PK	53.33	83.59	30.26	Note 2	PASS
	N/A		3	2	AV	N/A	63.59	N/A	Note 3	PASS
2441	6.33	0	3	2	PK	103.59	N/A	N/A	Note 1	N/A
	N/A		3	2	AV	N/A	N/A	N/A		N/A

Test Plots

MIDDLE CHANNEL, SPURIOUS 9kHz~150kHz



Date: 27 OCT 2014 03:20:34

MIDDLE CHANNEL, SPURIOUS 150kHz~30MHz



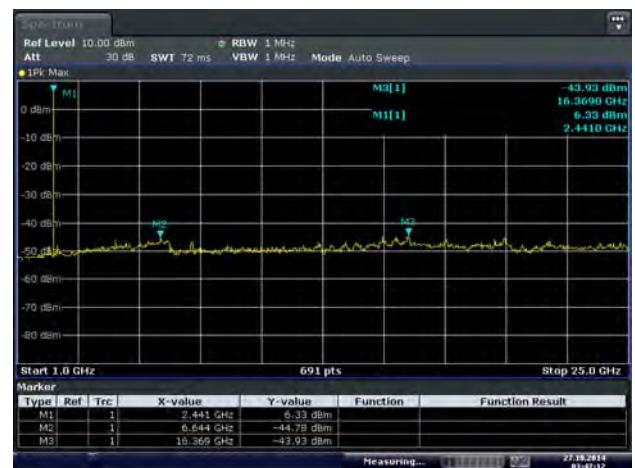
Date: 27 OCT 2014 03:29:25

MIDDLE CHANNEL, SPURIOUS 30MHz~1GHz



Date: 27 OCT 2014 03:33:10

MIDDLE CHANNEL, SPURIOUS 1GHz~25GHz



Date: 27 OCT 2014 03:47:13

Note 1: The frequency is fundamental signal which can be ignored.

Note 2: Which frequency is not within a restricted band, and its limit line is 20dB below the highest emission level.

Note 3: Average measurement was not performed if peak level went lower than the average limit.

Note 4: The harmonic (3th, 4th, 5th, etc.) and other spurious are not reported, because those levels are lower than average limit line and background noise.

GFSK: HIGH CHANNEL

Frequency (MHz)	Value (dBm)	Ground Reflection Factor (dB)	D (m)	Max gain (dBi)	Detector	E (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Remark	Verdict
0.00992	-89.7	6	3	2	QP	13.56	84.13	70.57	Note 2	PASS
0.172	-85.35	6	3	2	QP	17.91	84.13	66.22	Note 2	PASS
238.5	-79.5	4.7	3	2	QP	22.46	84.13	61.67	Note 2	PASS
442	-78.6	4.7	3	2	QP	23.36	84.13	60.77	Note 2	PASS
4977	-45.8	0	3	2	PK	51.46	74.00	22.54	--	PASS
	N/A		3	2	AV	N/A	54.00	N/A	Note 3	PASS
16300	-44.48	0	3	2	PK	52.78	84.13	31.35	Note 2	PASS
	N/A		3	2	AV	N/A	64.13	N/A	Note 3	PASS
2476	6.87	0	3	2	PK	104.13	N/A	N/A	Note 1	N/A
	N/A		3	2	AV	N/A	N/A	N/A		N/A

Test Plots

HIGH CHANNEL, SPURIOUS 9kHz~150kHz



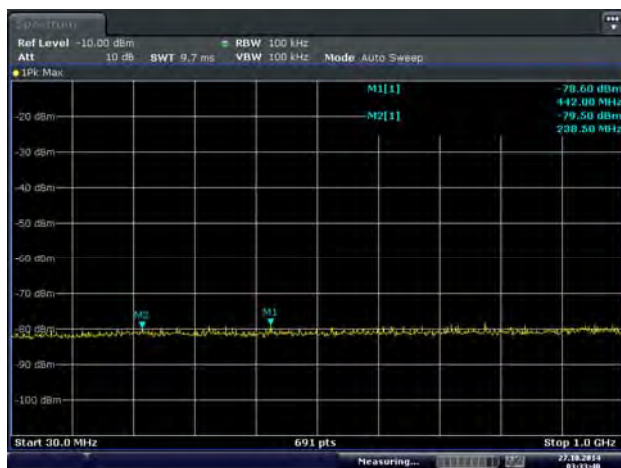
Date: 27 OCT 2014 03:20:56

HIGH CHANNEL, SPURIOUS 150kHz~30MHz



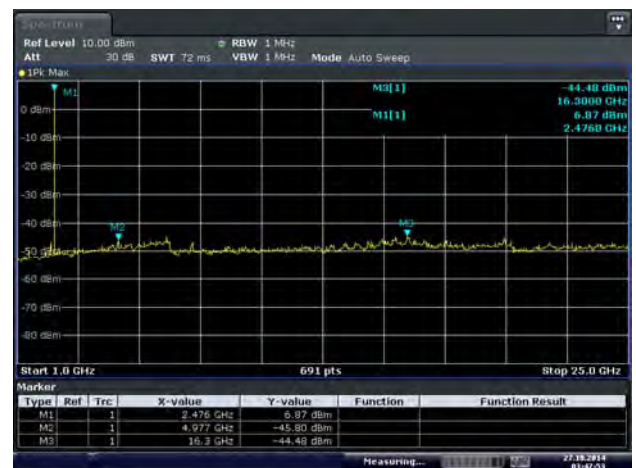
Date: 27 OCT 2014 03:26:37

HIGH CHANNEL, SPURIOUS 30MHz~1GHz



Date: 27 OCT 2014 03:33:40

HIGH CHANNEL, SPURIOUS 1GHz~25GHz



Date: 27 OCT 2014 03:47:53

Cabinet Radiated spurious emission test

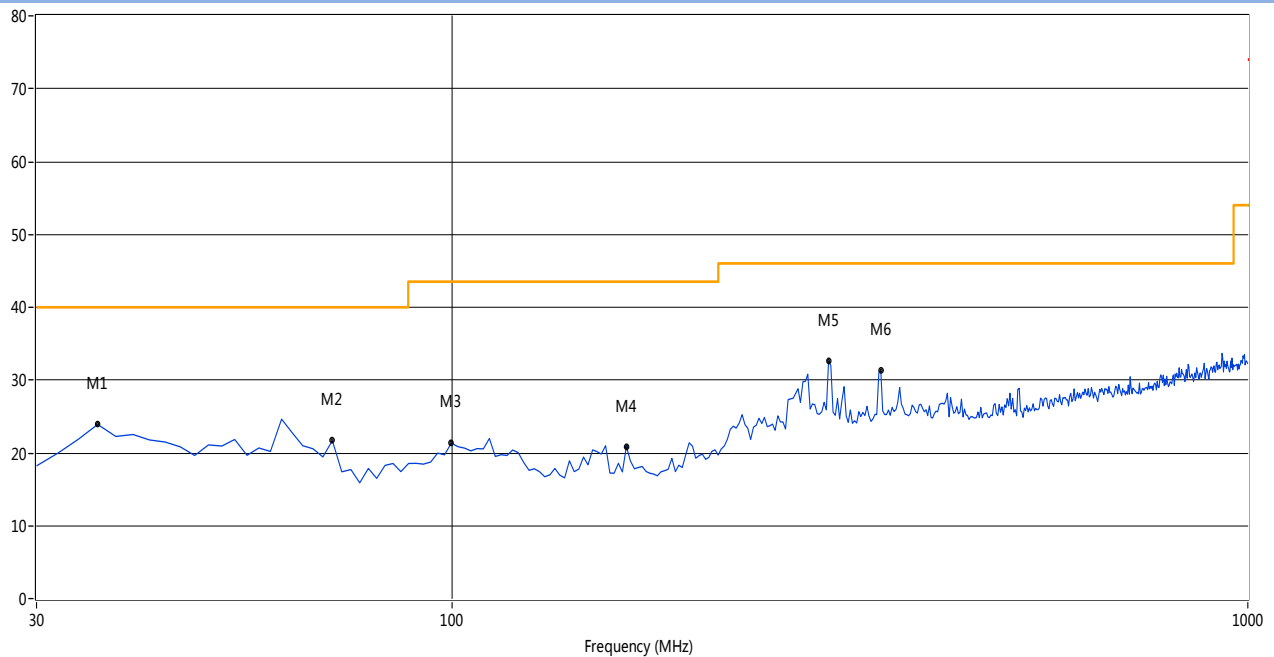
Note 1: The symbol of "--" in the table which means not application.

Note 2: For the test data above 1GHz, According the ANSI C63.4-2014, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note 3: The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

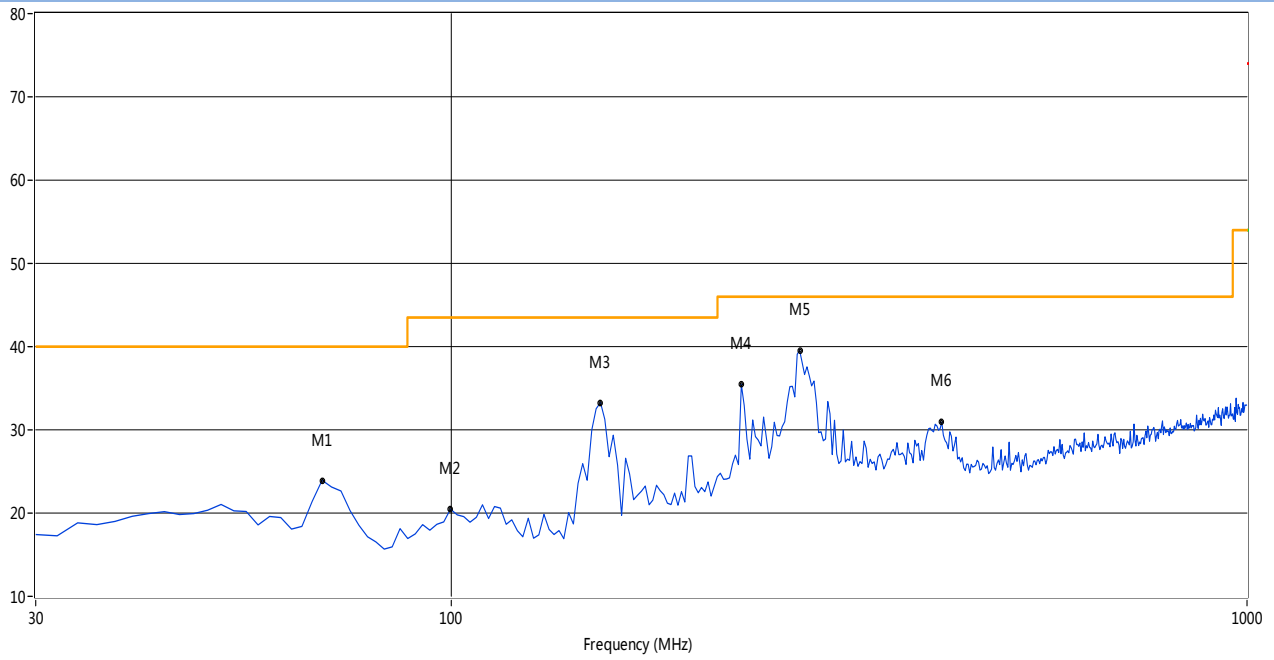
Note 4: All configurations have been tested, only the worst configuration (GFSK High Channel) shown here.

30MHz to 1GHz, ANT V



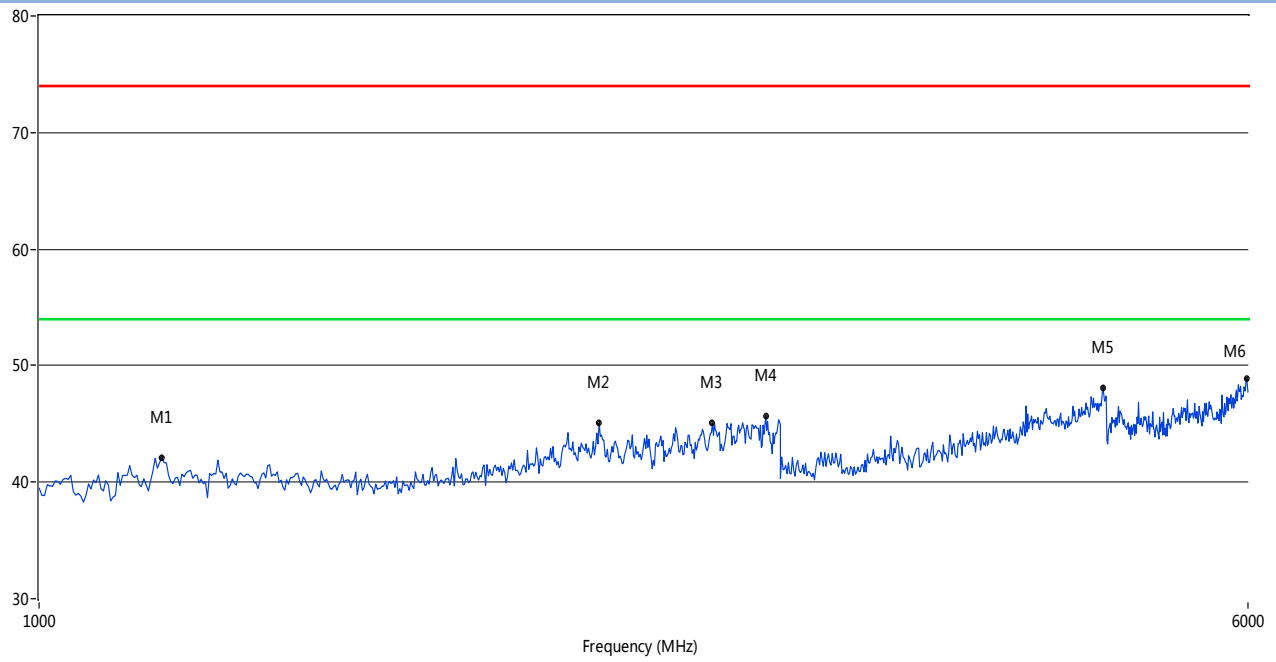
Frequency (MHz)	Peak Level (dBuV/m)	Q-peak Level (dBuV/m)	Average Level (dBuV/m)	Factor (dB)	PK Limit (dBuV/m)	QP Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Table (o)	Height (cm)	ANT	Verdict
35.81	--	23.92	--	-20.45	--	40.0	--	16.08	256.80	100	Vertical	PASS
70.66	--	21.69	--	-22.30	--	40.0	--	18.31	261.30	100	Vertical	PASS
99.70	--	21.35	--	-19.60	--	43.5	--	22.15	99.10	100	Vertical	PASS
165.53	--	20.91	--	-22.21	--	43.5	--	22.59	188.70	100	Vertical	PASS
297.19	--	32.61	--	-17.18	--	46.0	--	13.39	8.90	100	Vertical	PASS
345.59	--	31.38	--	-15.74	--	46.0	--	14.62	0.00	100	Vertical	PASS

30MHz to 1GHz, ANT H



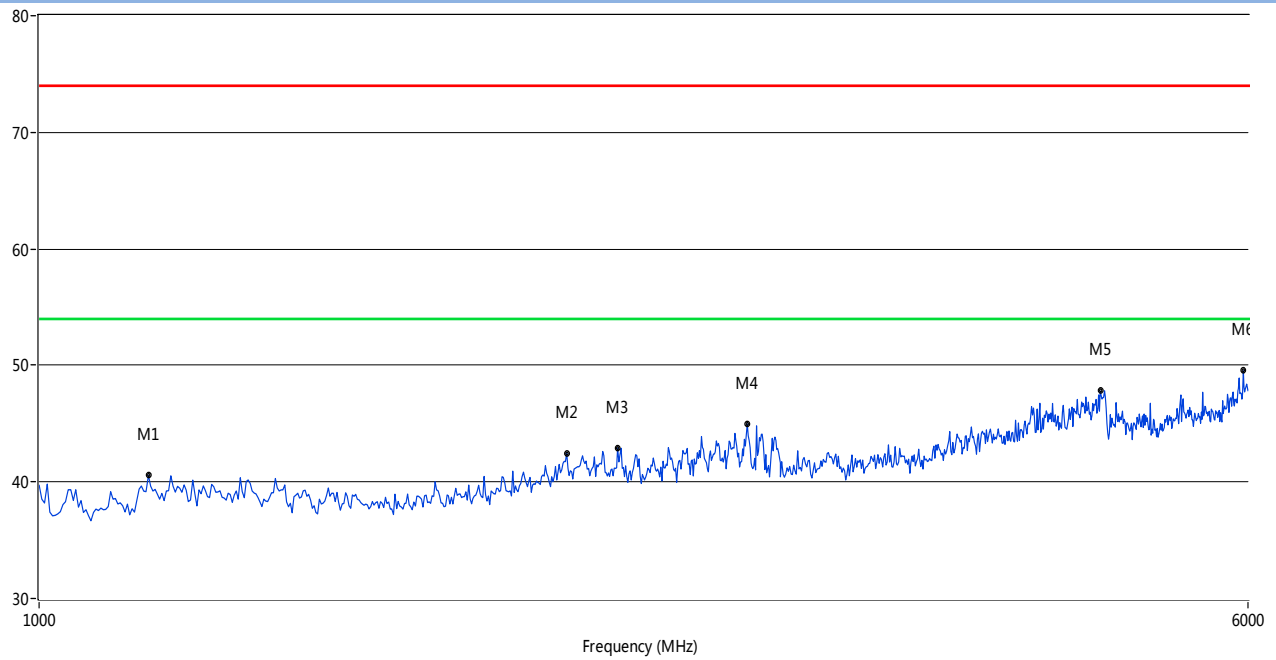
Frequency (MHz)	Peak Level (dBuV/m)	Q-peak Level (dBuV/m)	Average Level (dBuV/m)	Factor (dB)	PK Limit (dBuV/m)	QP Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Table (o)	Height (cm)	ANT	Verdict
68.72	--	23.93	--	-21.50	--	40.0	--	16.07	358.60	100	Horizontal	PASS
99.70	--	20.48	--	-19.60	--	43.5	--	23.02	212.10	100	Horizontal	PASS
153.91	--	33.29	--	-22.79	--	43.5	--	10.21	86.70	100	Horizontal	PASS
231.36	--	35.43	--	-19.02	--	46.0	--	10.57	248.10	100	Horizontal	PASS
273.95	--	39.58	--	-17.84	--	46.0	--	6.42	243.60	100	Horizontal	PASS
413.35	--	30.93	--	-14.45	--	46.0	--	15.07	306.30	100	Horizontal	PASS

1GHz to 6GHz, ANT V



Frequency (MHz)	Peak Level (dBuV/m)	Q-peak Level (dBuV/m)	Average Level (dBuV/m)	Factor (dB)	PK Limit (dBuV/m)	QP Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Table (o)	Height (cm)	ANT	Verdict
1199.60	42.14			-4.15	74.0	--	54.0	11.86	4.50	100	Vertical	PASS
2293.41	45.09			-0.58	74.0	--	54.0	8.91	246.00	100	Vertical	PASS
2712.57	45.07			1.16	74.0	--	54.0	8.93	18.70	100	Vertical	PASS
2936.13	45.67			2.28	74.0	--	54.0	8.33	268.60	100	Vertical	PASS
4838.32	48.13			13.06	74.0	--	54.0	5.87	187.40	100	Vertical	PASS
5988.02	48.94			15.12	74.0	--	54.0	5.06	10.10	100	Vertical	PASS

1GHz to 6GHz, ANT H



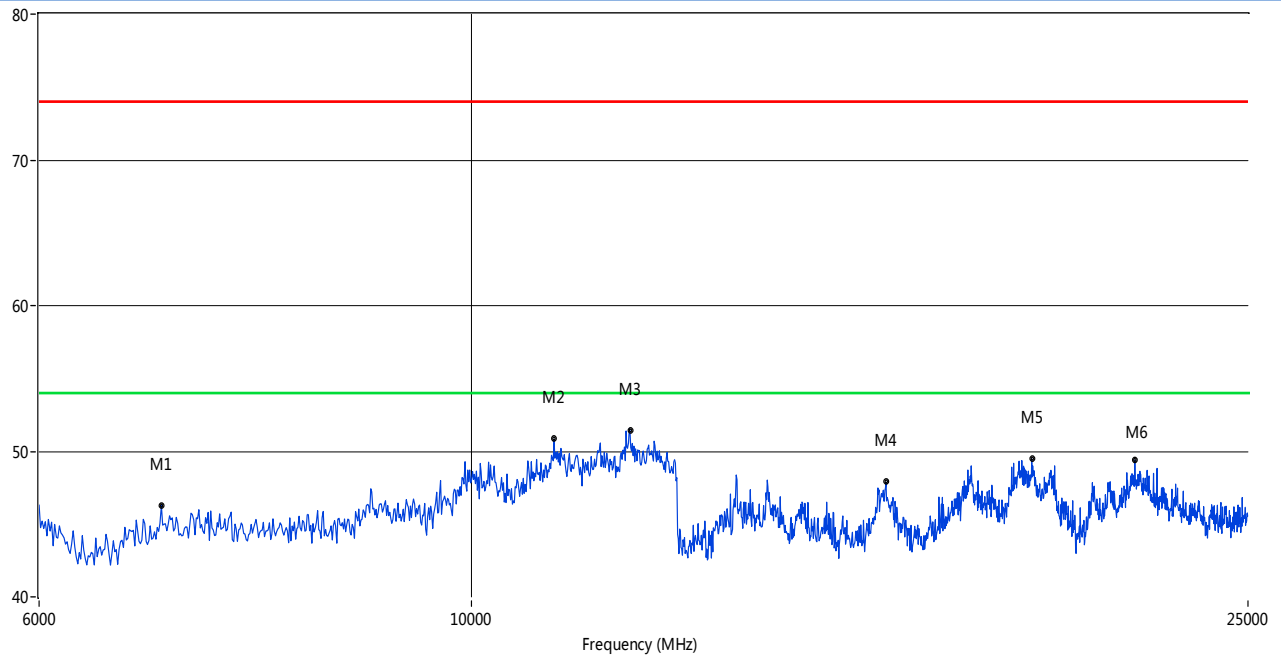
Frequency (MHz)	Peak Level (dBuV/m)	Q-peak Level (dBuV/m)	Average Level (dBuV/m)	Factor (dB)	PK Limit (dBuV/m)	QP Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Table (o)	Height (cm)	ANT	Verdict
1175.65	40.57			-4.53	74.0	--	54.0	13.43	59.30	100	Horizontal	PASS
2185.63	42.46			-0.64	74.0	--	54.0	11.54	212.90	100	Horizontal	PASS
2357.28	42.92			-0.60	74.0	--	54.0	11.08	156.30	100	Horizontal	PASS
2856.29	44.99			2.38	74.0	--	54.0	9.01	138.90	100	Horizontal	PASS
4820.36	47.80			12.57	74.0	--	54.0	6.20	201.90	100	Horizontal	PASS
5958.08	49.54			15.06	74.0	--	54.0	4.46	356.70	100	Horizontal	PASS

6GHz to 25GHz, ANT V



Frequency (MHz)	Peak Level (dBuV/m)	Q-peak Level (dBuV/m)	Average Level (dBuV/m)	Factor (dB)	PK Limit (dBuV/m)	QP Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Table (o)	Height (cm)	ANT	Verdict
7673.46	45.87			14.45	74.0	--	54.0	8.13	237.10	100	Vertical	PASS
11166.39	50.29			20.21	74.0	--	54.0	3.71	76.10	100	Vertical	PASS
12053.66	51.91			20.82	74.0	--	54.0	2.09	269.70	100	Vertical	PASS
16327.37	48.43			11.70	74.0	--	54.0	5.57	157.30	100	Vertical	PASS
19309.48	50.49			13.46	74.0	--	54.0	3.51	57.40	100	Vertical	PASS
21885.19	49.68			12.61	74.0	--	54.0	4.32	325.20	100	Vertical	PASS

6GHz to 25GHz, ANT H



Frequency (MHz)	Peak Level (dBuV/m)	Q-peak Level (dBuV/m)	Average Level (dBuV/m)	Factor (dB)	PK Limit (dBuV/m)	QP Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Table (o)	Height (cm)	ANT	Verdict
6932.20	46.28			14.23	74.0	--	54.0	7.72	205.80	100	Horizontal	PASS
11020.38	50.83			20.14	74.0	--	54.0	3.17	285.90	100	Horizontal	PASS
12053.66	51.91			20.82	74.0	--	54.0	2.09	269.70	100	Horizontal	PASS
16306.57	47.88			11.64	74.0	--	54.0	6.12	243.80	100	Horizontal	PASS
19369.38	49.48			13.09	74.0	--	54.0	4.52	-0.00	100	Horizontal	PASS
21875.21	49.40			12.63	74.0	--	54.0	4.60	89.00	100	Horizontal	PASS

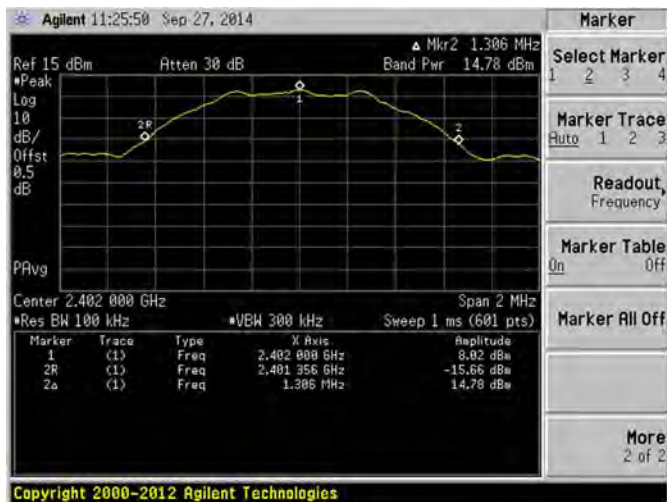
A.6 Band Edge

Test Data

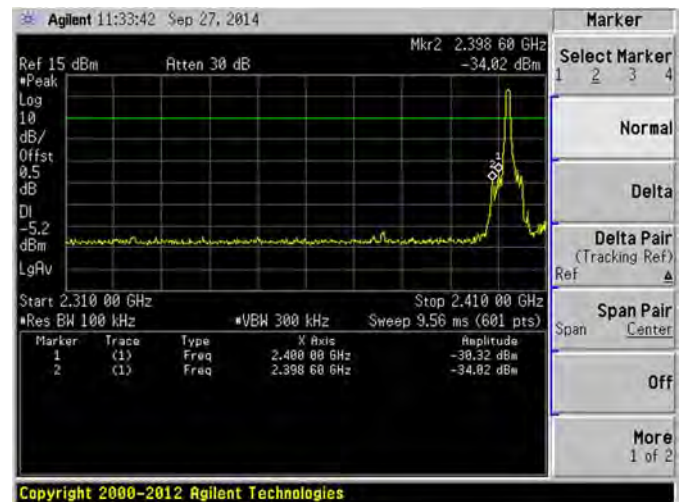
The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

Test Plots

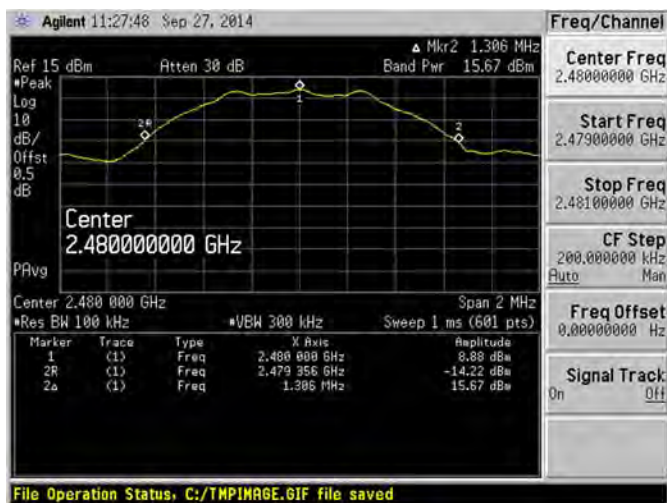
LOW CHANNEL, Reference level



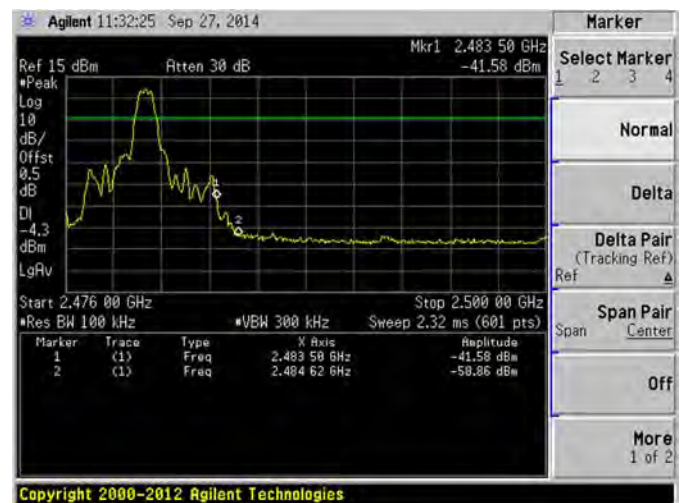
LOW CHANNEL, Band Edge



HIGH CHANNEL, Reference level



HIGH CHANNEL, Band Edge



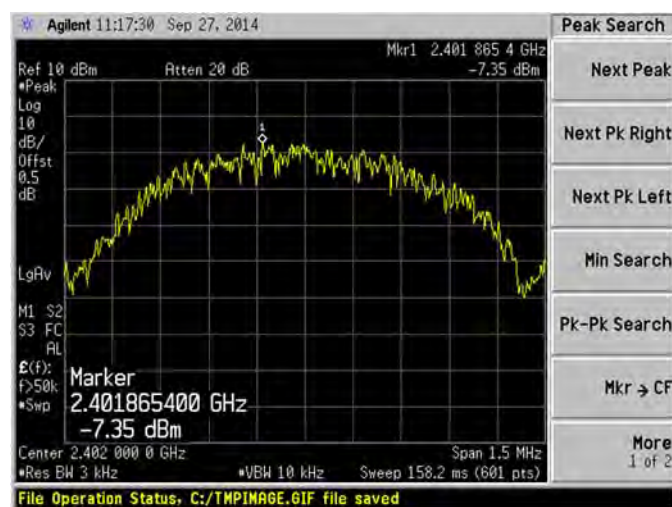
A.7 Power Spectral Density (PSD)

Test Data

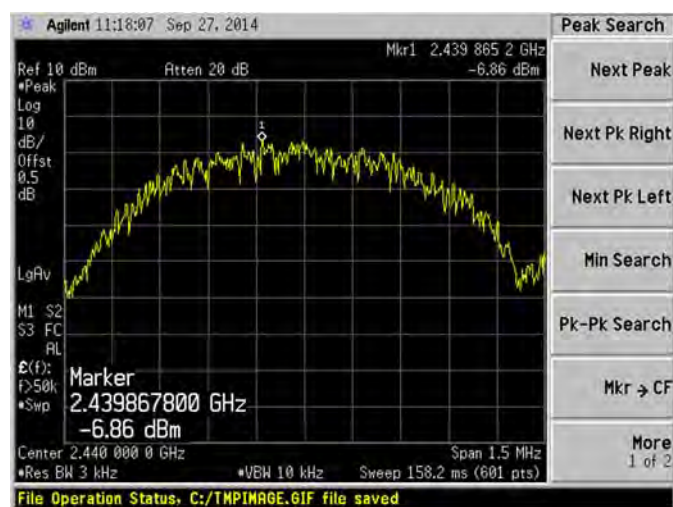
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low	-7.35	8	PASS
Middle	-6.86	8	PASS
High	-6.61	8	PASS

Test plots

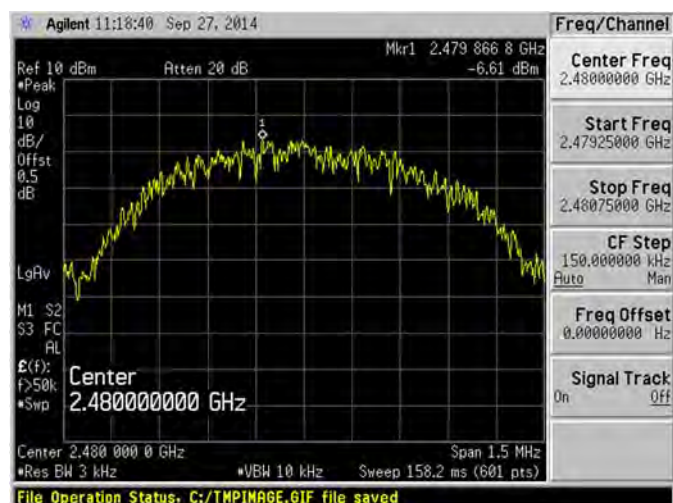
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL



ANNEX B TEST SETUP PHOTOS

B.1 Conducted Test Photo



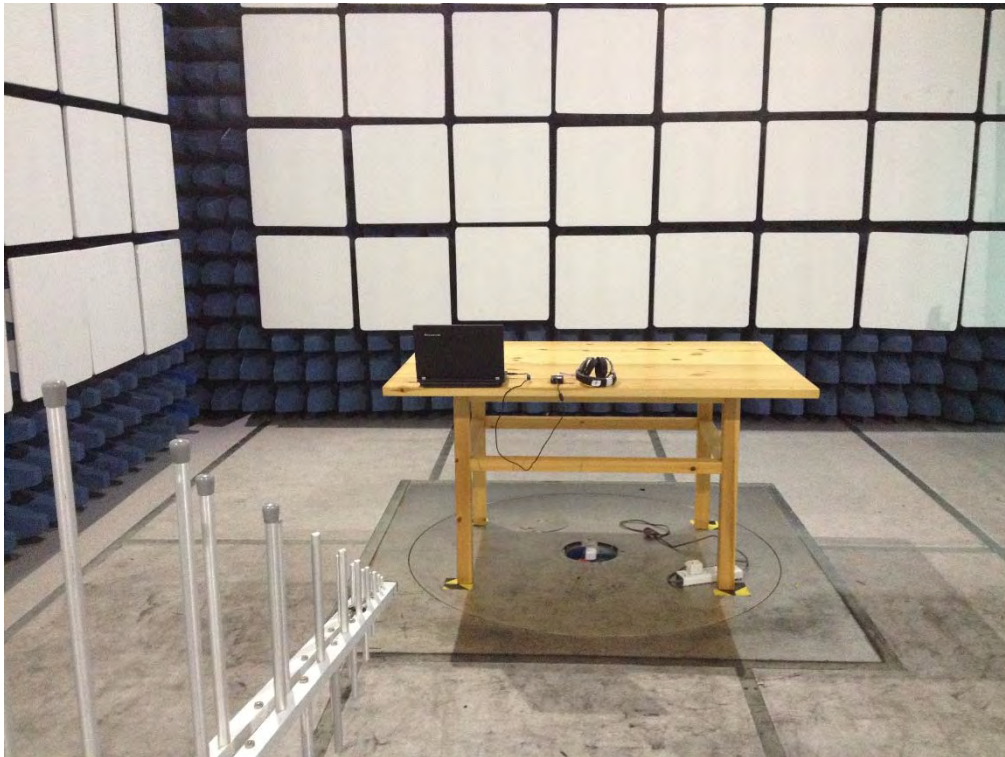
B.2 Conducted Emissions Test Photo



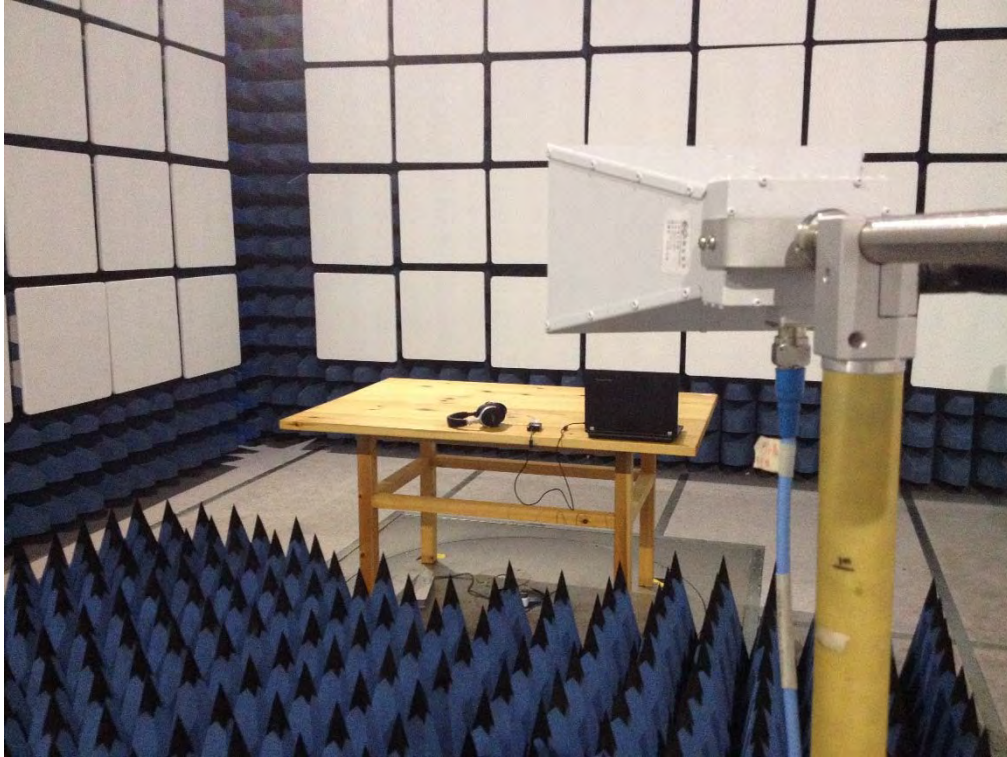
B.3 Radiated Test Photo



Below 30MHz



30MHz to 1GHz



Above 1GHz

ANNEX C EUT PHOTOS

C.1 Appearance of the EUT



THE FRONT OF EUT



THE BACK OF EUT



THE LEFT OF EUT



THE RIGHT OF EUT



THE UP OF EUT



THE DOWN OF EUT



THE AUDIO LINE



THE USB CABLE

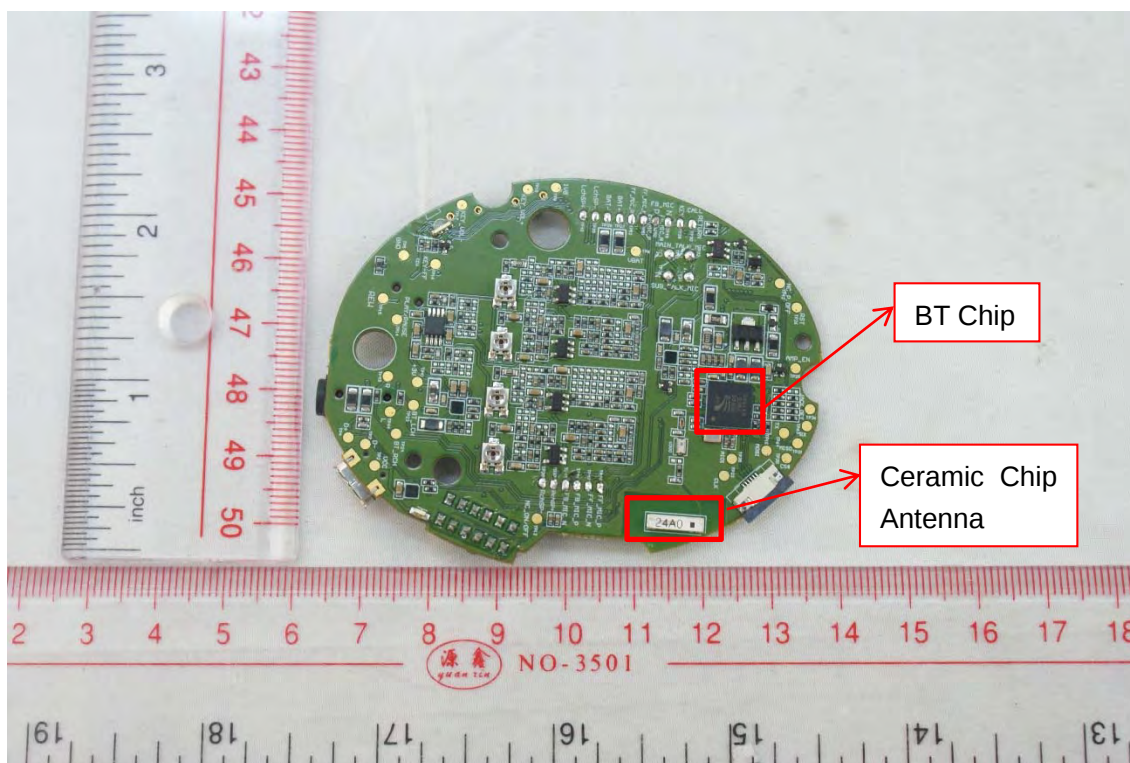
C.2 Inside of the EUT



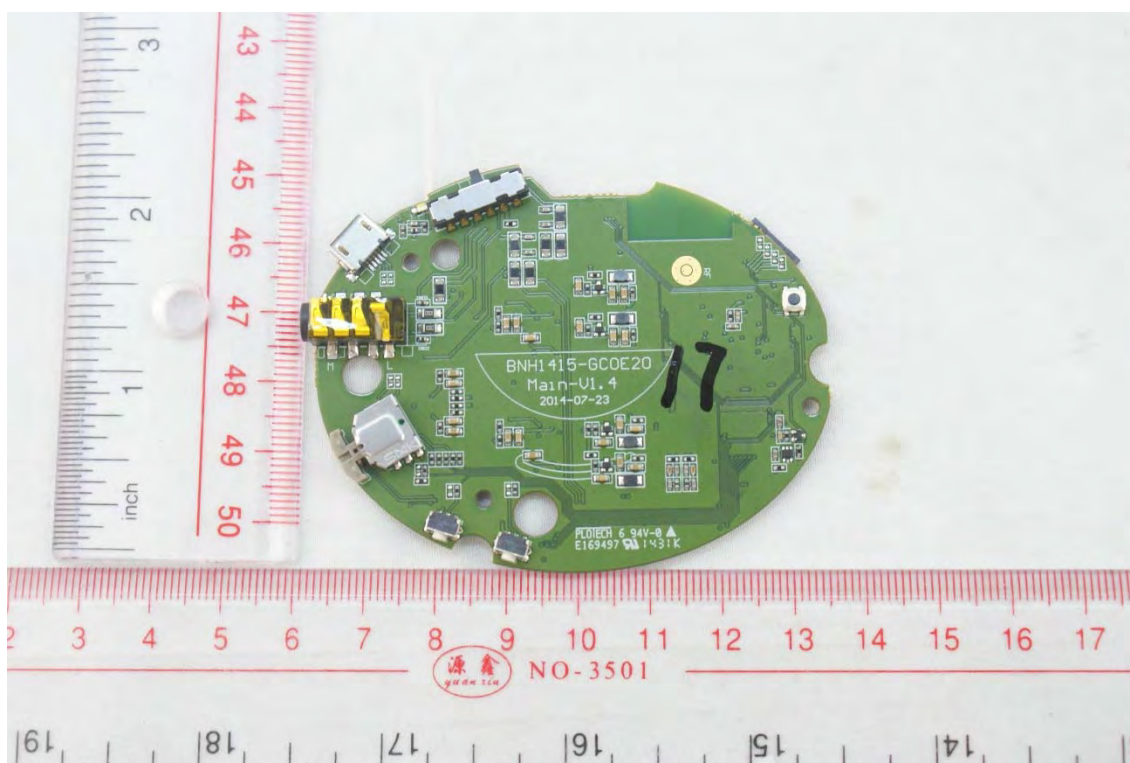
OPEN THE EUT PHOTO 1



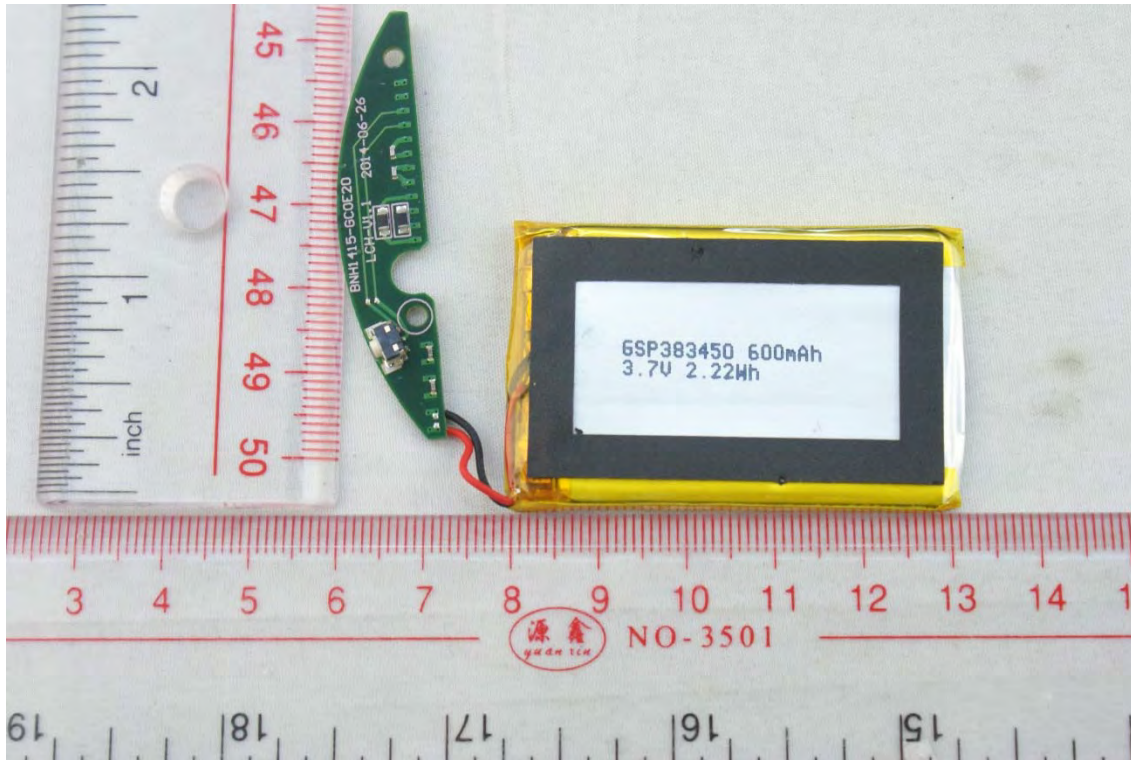
OPEN THE EUT PHOTO 2



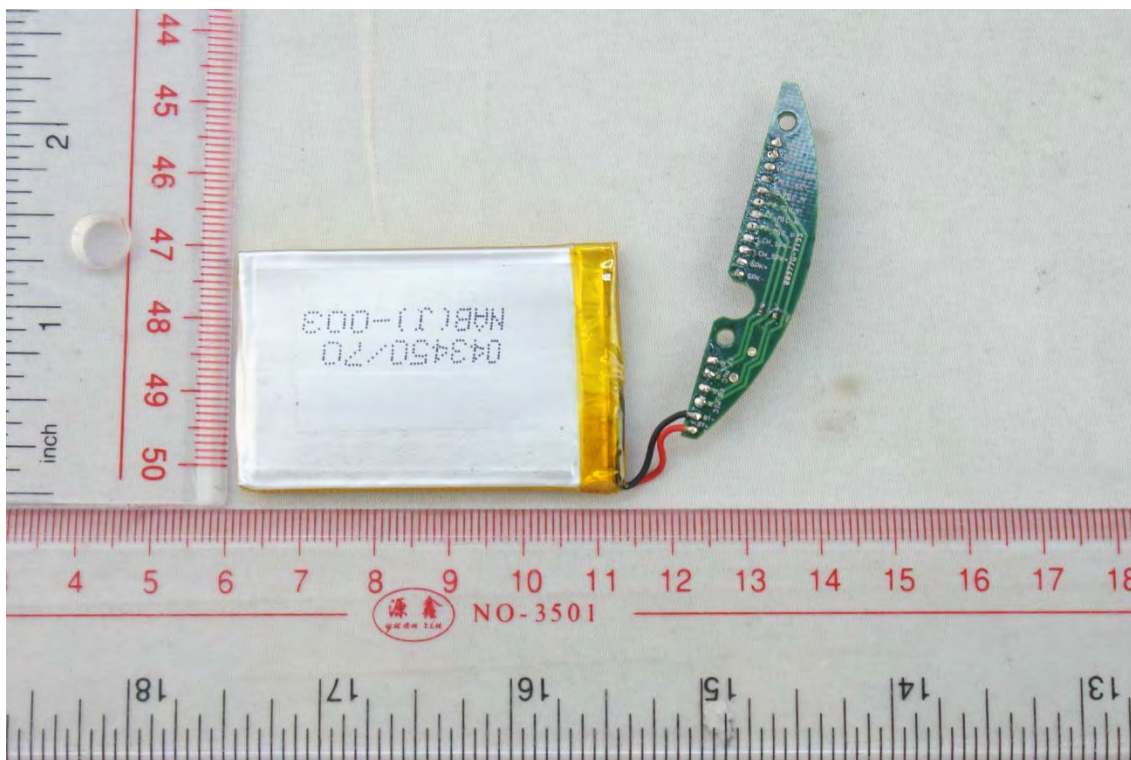
EUT INTERNAL BOARD 1



EUT INTERNAL BOARD 2



THE INTERNAL BATTERY 1



THE INTERNAL BATTERY 2

--END OF REPORT--