LP0002-2018

TEST REPORT

For

Kinestral Technologies Inc

3955 Trust Way, Hayward, CA 94545-3723
Brand: HALIO

Model: DR200

Report Type:	**Product Type:**
Original Report	Driver

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Report Number:	R1910021	
Report Date:	2019-11-13	
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ACCREDITED
CERTIFICATE #3297.02

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* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" (Rev.2)

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1910021	Original Report	-

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Kinestral Technologies Inc*, and their product model: *DR200*, Brand: *HALIO* or the "EUT" as referred to in this report.

1.2 Objective

This report is prepared on behalf of *Kinestral Technologies Inc* in accordance with LP0002-2018.

The objective is to determine compliance with LP0002-2018 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

Model Number	DR200
Operating Frequency	2405MHz - 2475MHz
Modulation	O-QPSK
Chip Type Antenna Gain	1.3 dBi

1.3 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 DTS Meas Guidance v05r2: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

1.4 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Parameter	**Measurement uncertainty**
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.57 dB
Power Spectral Density, conducted	±1.48dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ^{o} C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %

1.5 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.6 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- ***An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3279.02),*** in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.03)*** to certify

- For the USA (Federal Communications Commission):
  1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
  2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
  3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
  1 All Scope 1-Licence-Exempt Radio Frequency Devices;
  2 All Scope 2-Licensed Personal Mobile Radio Services;
  3 All Scope 3-Licensed General Mobile & Fixed Radio Services;
  4 All Scope 4-Licensed Maritime & Aviation Radio Services;
  5 All Scope 5-Licensed Fixed Microwave Radio Services
  6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
  1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2

2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2

- For the Hong Kong Special Administrative Region:
  1 All Radio Equipment, per KHCA 10XX-series Specifications;
  2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
  3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
  1 MIC Telecommunication Business Law (Terminal Equipment):
    - All Scope A1 - Terminal Equipment for the Purpose of Calls;
    - All Scope A2 - Other Terminal Equipment
  2 Radio Law (Radio Equipment):
    - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
    - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
    - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.01)*** to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

1 Electronics and Office Equipment:
- for Telephony (ver. 3.0)
- for Audio/Video (ver. 3.0)
- for Battery Charging Systems (ver. 1.1)
- for Set-top Boxes & Cable Boxes (ver. 4.1)
- for Televisions (ver. 6.1)
- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)

2 Commercial Food Service Equipment
- for Commercial Dishwashers (ver. 2.0)
- for Commercial Ice Machines (ver. 2.0)
- for Commercial Ovens (ver. 2.1)
- for Commercial Refrigerators and Freezers

3 Lighting Products
- For Decorative Light Strings (ver. 1.5)
- For Luminaires (including sub-components) and Lamps (ver. 1.2)
- For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
- For Integral LED Lamps (ver. 1.4)

4 Heating, Ventilation, and AC Products
- for Residential Ceiling Fans (ver. 3.0)
- for Residential Ventilating Fans (ver. 3.2)

5 Other
- For Water Coolers (ver. 3.0)

D- ***A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:***

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;

- Canada: (Innovation, Science and Economic development Canada - ISEDC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
    - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
    - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
    - EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
    - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
    - Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
    - ENERGY STAR Recognized Test Laboratory – US EPA
    - Telecommunications Certification Body (TCB) – US FCC;
    - Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013.

The EUT was tested in a testing mode to represent worst-case results during the final qualification test.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PPSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

The test software used was CoolTerm, the software is compliant with the standard requirements being tested against.

Modulation	Frequency (MHz)	Power Setting
O-QPSK	2405	19
	2440	19
	2475	19

2.3 Duty Cycle Correction Factor

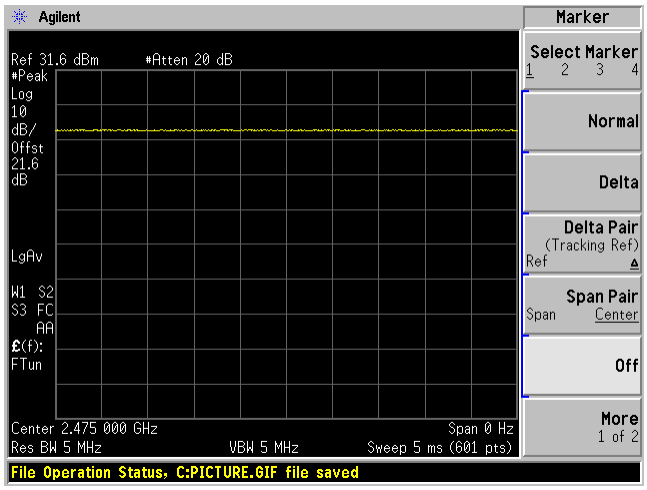
According to KDB 558074 D01 DTS Meas Guidance v05r02 section 6.0:

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data is being acquired (i.e., no transmitter off-time is to be considered).

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
2.4GHz	-	-	100	0

Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = 10*log(1/Duty Cycle)

Please refer to the following plot.



2.4 Equipment Modifications

A hole was cut in the side of the EUT with a RF cable coming out to connect antenna ports to power spectrum analyzer.

2.5 Local Support Equipment

Manufacturer	Description	Model	Serials Number
Dell	Laptop	Latitude E4610	GB1ZVM1
Meanwell	Power Supply	HEP-600C-48	-
Kinestral	Serials port connector	-	-

2.6 Interface Ports and Cabling

Cable Description	Brand	Model Name	To	From
Serials Cable	BACL	BACL-Serials	Laptop	EUT
RF Cable	BACL	BACL-RCL	EUT	PSA

3 Summary of Test Results

Results reported relate only to the product tested.

Rules	Description of Test	Results
LP0002-2018 §2.2	Antenna Requirement	Compliant
LP0002-2018 §2.3	AC Line Conducted Emissions	N/A*
LP0002-2018 §5.20	RF Exposure	Compliant
LP0002-2018 §3.10	Spurious Emissions at Antenna Port	Compliant
LP0002-2018 §3.10	Radiated Spurious Emissions	Compliant
LP0002-2018 §3.10	6 dB and 99% Emission Bandwidth	Compliant
LP0002-2018 §3.10	Maximum Peak Output Power	Compliant
LP0002-2018 §3.10	100 kHz Bandwidth of Frequency Band Edge	Compliant
LP0002-2018 §3.10	Power Spectral Density	Compliant

Note: EUT is DC powered, the AC Line Conducted Emissions is not required.

4 LP0002-2018 §2.2 - Antenna Requirements

4.1 Applicable Standards

According to LP0002-2018 §2.2,

Antenna requirement: Low-power radio frequency transmitter or transceiver (receiver) shall utilize a permanently, semi-permanently attached antenna or uses a unique coupling of the antenna and at any cable connector between the transmitter and the antenna. The antenna shall be an omni-directional type. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector or other than authorized is prohibited. Such standard connectors are for example: BNC, F type, N type, M type, UG type, RCA, SMA, SMB, and other standard type antenna connectors.

4.2 Antenna Description

The antennas used by the EUT are permanent attached antennas.

Antenna Type	Brand	Model	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
Chip Antenna	JOHANSON TECHNOLOGY	2450AT43B100	2400-2483.5	1.3

5 LP0002-2018 §5.20.2.2 – RF Exposure

5.1 Applicable Standards

According to LP0002-2018 §5.20.2.2

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* (100)	30
1.34-30	824/f	2.19/f	* ($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

5.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

5.3 MPE Results

Maximum output power at antenna input terminal (dBm):	15.21
Tune-up Maximum output power at antenna input terminal (dBm):	16.21
Tune-up Maximum output power at antenna input terminal (mW):	41.78
Prediction distance (cm):	20
Prediction frequency (MHz):	2405
Maximum Antenna Gain, typical (dBi):	1.3
Maximum Antenna Gain (numeric):	1.35
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.011221
MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.011mW/cm^2. Limit is 1.0 mW/cm^2.

6 LP0002-2018 §3.10 - Spurious Radiated Emissions

6.1 Applicable Standards

As Per LP0002-2018 §2.7 Additional regulations shall apply except for this standard. The fundamental frequency of any low-power radio-frequency devices shall be restricted in any of the operation bands listed below; spurious emissions shall be permitted in any of frequency band listed below and shall meet the field strength requirement of 2.8:

Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
0.090 ~ 0.110	322.00 ~ 335.40	3500.0 ~ 4400.0
0.490 ~ 0.510	399.90 ~ 410.00	4500.0 ~ 5250.0
2.172 ~ 2.198	485.00 ~ 510.00	5350.0 ~ 5460.0
3.013 ~ 3.033	608.00 ~ 614.00	7250.0 ~ 7750.0
4.115 ~ 4.198	703.00 ~ 748.00	8025.0 ~ 8500.0
5.670 ~ 5.690	758.00 ~ 803.00	9000.0 ~ 9200.0
6.200 ~ 6.300	825.00 ~ 915.00	9300.0 ~ 9500.0
8.230 ~ 8.400	930.00 ~ 1240.0	10600 ~ 12700
12.265 ~ 12.600	1300.0 ~ 1427.0	13250 ~ 13400
13.340 ~ 13.430	1435.0 ~ 1626.5	14470 ~ 14500
14.965 ~ 15.020	1660.0 ~ 1785.0	15350 ~ 16200

16.700 ~ 16.755	1805.0 ~ 1880.0	17700 ~ 21400
19.965 ~ 20.020	1885.0 ~ 1900.0	22010 ~ 23120
25.500 ~ 25.700	1905.0 ~ 1985.0	23600 ~ 24000
37.475 ~ 38.275	2010.0 ~ 2025.0	31200 ~ 31800
73.500 ~ 75.400	2110.0 ~ 2170.0	36430 ~ 36500
108.00 ~ 138.00	2200.0 ~ 2300.0	38600 +
149.90 ~ 150.05	2310.0 ~ 2390.0	
156.70 ~ 156.90	2483.5 ~ 2900.0	
162.01 ~ 167.17	3260.0 ~ 3267.0	
167.72 ~ 173.20	3332.0 ~ 3339.0	
240.00 ~ 285.00	3345.8 ~ 3358.0	)

As per LP0002-2018 §2.8, 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 (micro volts/meter)	Measurement Distance (meters)
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

The field strength radio frequency 9-90 kHz, 110-490 kHz and 1000 MHz above stipulated in the above table shall be measured according to an average detector and comply with Section 5.15.2, while others shall be measured using a CISPR quasi-peak detector. Those not specified above shall comply with Section 5.5 and the frequency bands measurement of radiated emission shall accord with Section 5.14

6.2 Test Setup

The radiated emissions tests were performed in the Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the LP0002-2018 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

6.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords was connected to the DC Power Source.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT was set 3 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000 MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
(2) Average: RBW = 1MHz / VBW = 10Hz or 1/T/ Sweep = Auto

6.4 Corrected Amplitude and Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

Margin = Corrected Amplitude - Limit

6.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	100338	2018-07-05	2 year
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
Sunol Science Corp	System Controller	SC99V	011003-1	N/R	N/R
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2018-02-26	2 year
Sunol Sciences	Antenna, Horn	DRH-118	A052704	2019-04-02	2 years
Wisewave	Antenna, Horn	ARH-4223-02	10555-01	2018-01-18	2 years
Agilent	Amplifier, Pre	8447D	2944A10187	2019-09-27	1 year
HP	Pre-Amplifier	8449B	3008A01978	2019-09-27	1year
Insulted Wire Corp.	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1571AN-3960-KPS	DC 1917	2019-05-08	1 Year
-	SMA cable	-	C0002	Each time[1]	N/A
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL *attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.*

6.6 Test Environmental Conditions

Temperature:	23 ºC
Relative Humidity:	42 %
ATM Pressure:	102.7 kPa

The testing was performed by Christian McCaig from 2019-10-02 to 2019-10-14 in 5m3 chamber.

6.7 Summary of Test Results

According to the data hereinafter, the EUT complied with LP0002-2018§3.10 standard's radiated emissions limits, and had the worst margin of:

30-1000 MHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Detector Mode**
-2.57	225.66125	Horizontal	Quasi Peak

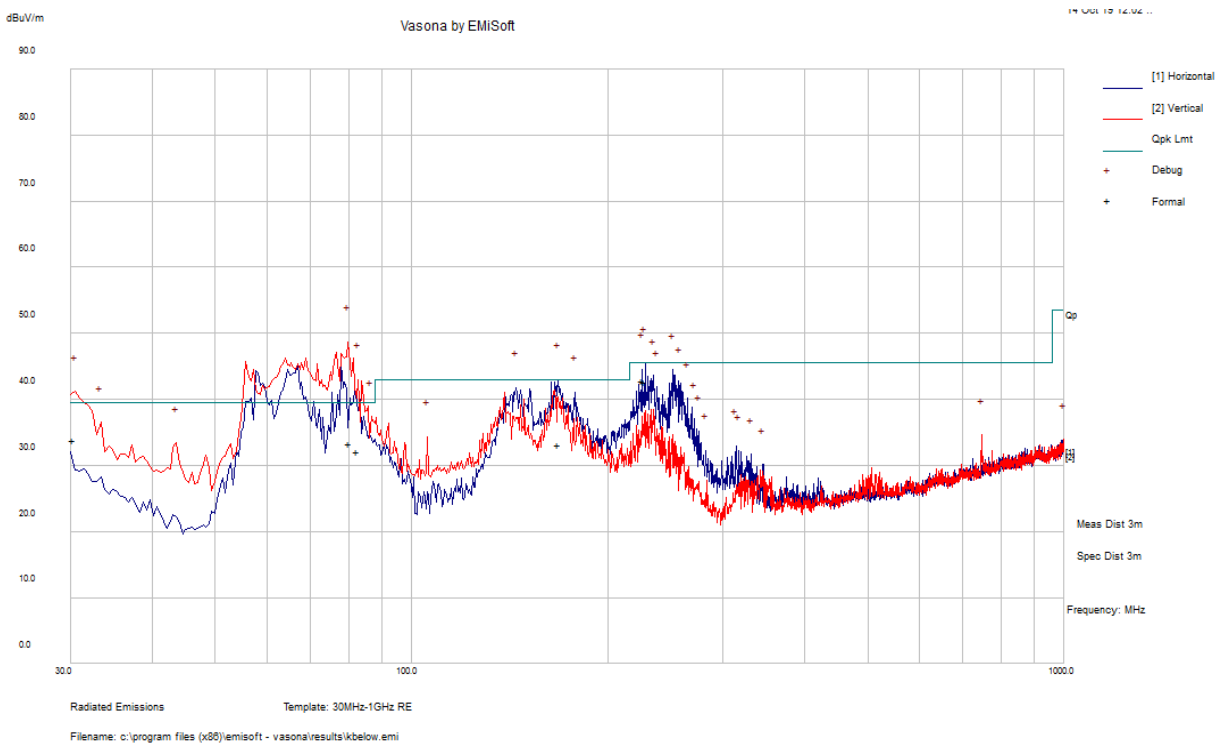
1-26.5 GHz:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Detector Mode**
-11.86	4950	Vertical	Average

Please refer to the following table and plots for specific test result details.

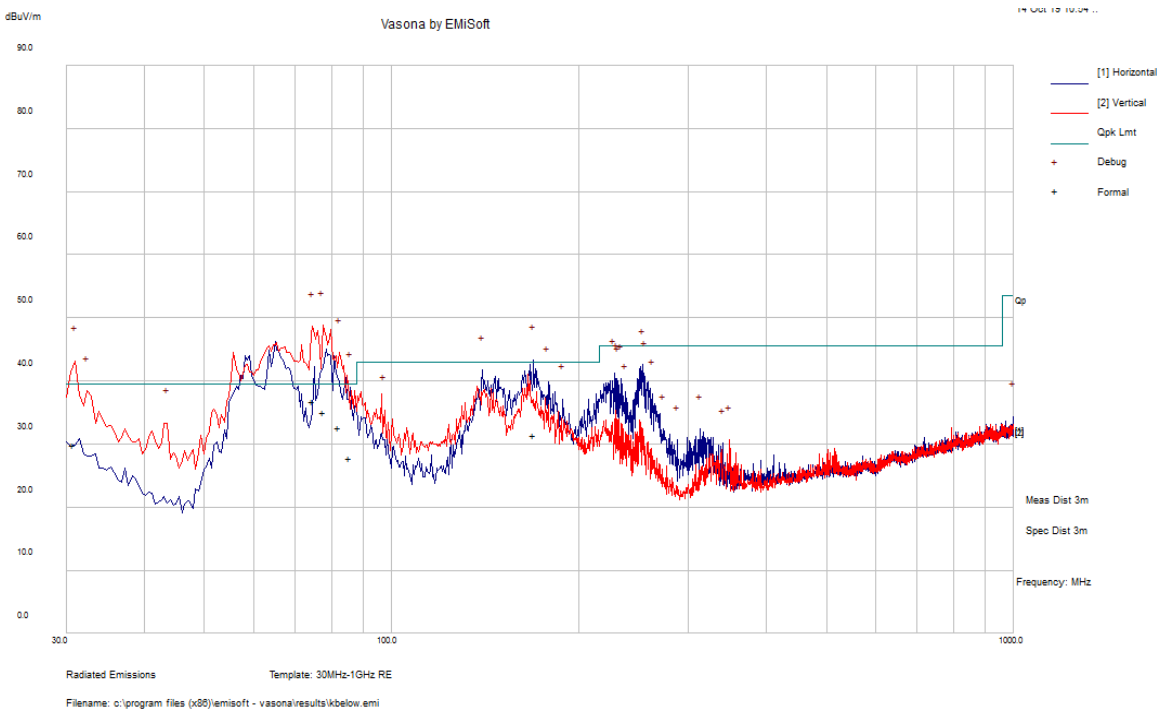
6.8 Radiated Emissions Test Results

1) 30 MHz – 1 GHz Transmitting Mode Worst Case, Measured at 3 meters



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
80.08925	33.32	195	V	38	39.5	-6.18	QP
82.63475	32.12	149	V	0	39.5	-7.38	QP
30.2525	33.8	111	V	13	39.5	-5.7	QP
167.59	33.09	187	H	313	43	-9.91	QP
228.0365	42.66	155	H	294	45.5	-2.84	QP
225.66125	42.93	117	H	292	45.5	-2.57	QP

2) 30 MHz – 1 GHz Receiving Mode, Measured at 3 meters



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
77.6835	35.11	202	V	192	39.5	-4.39	QP
74.728	36.79	136	V	173	39.5	-2.71	QP
82.2615	32.63	110	V	52	39.5	-6.87	QP
30.76675	29.81	114	V	167	39.5	-9.69	QP
169.4055	31.5	197	H	265	43	-11.5	QP
85.64375	27.8	222	H	256	39.5	-11.7	QP

3) 1–25 GHz Measured at 3 meters

TX Mode

Freq. (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)			Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low channel 2405MHz											
2390	47.61	342	178	H	28.87	5.73	36.162	46.04	74.00	-27.96	PK
2390	34.52	342	178	H	28.87	5.73	36.162	32.95	54.00	-21.05	AV
2390	47.33	198	130	V	28.89	5.73	36.162	45.79	74.00	-28.21	PK
2390	34.14	198	130	V	28.89	5.73	36.162	32.60	54.00	-21.40	AV
4810	48.32	298	280	H	32.46	8.40	35.902	53.27	74.00	-20.73	PK
4810	37.13	298	280	H	32.46	8.40	35.902	42.08	54.00	-11.92	AV
4810	47.79	295	109	V	32.45	8.40	35.902	52.74	74.00	-21.26	PK
4810	36.24	295	109	V	32.45	8.40	35.902	41.19	54.00	-12.81	AV
Mid channel 2440MHz											
4880	47.14	279	235	H	32.46	8.40	35.902	52.09	74.00	-21.91	PK
4880	34.72	279	235	H	32.46	8.40	35.902	39.67	54.00	-14.33	AV
4880	47.83	295	179	V	32.45	8.40	35.902	52.78	74.00	-21.22	PK
4880	35.99	295	179	V	32.45	8.40	35.902	40.94	54.00	-13.06	AV
High channel 2475MHz											
2483.5	54.62	23	298	H	29.17	5.85	36.15	53.49	74.00	-20.51	PK
2483.5	40.98	23	298	H	29.17	5.85	36.15	39.85	54.00	-14.15	AV
2483.5	52.35	360	299	V	29.10	5.85	36.15	51.15	74.00	-22.86	PK
2483.5	39.69	360	299	V	29.10	5.85	36.15	38.49	54.00	-15.52	AV
4950	46.57	279	235	H	32.84	8.40	35.732	52.08	74.00	-21.92	PK
4950	34.28	279	235	H	32.84	8.40	35.732	39.79	54.00	-14.21	AV
4950	47.13	289	220	V	32.79	8.40	35.732	52.59	74.00	-21.41	PK
4950	36.68	289	220	V	32.79	8.40	35.732	42.14	54.00	-11.86	AV

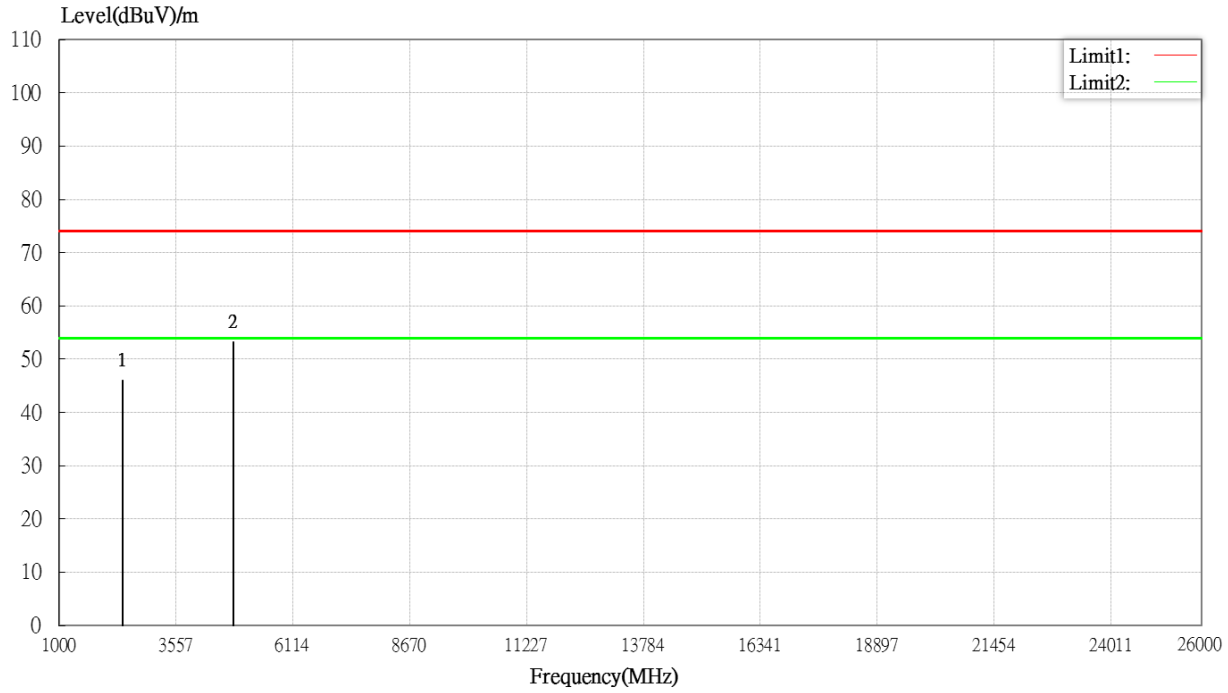
Freq. (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)			Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
RX mode											
2397	47.54	0	100	H	28.87	5.73	36.162	45.97	74.00	-28.03	PK
2397	33.79	0	100	H	28.87	5.73	36.162	32.22	54.00	-21.78	AV
2397	46.87	0	100	V	28.89	5.73	36.162	45.33	74.00	-28.67	PK
2397	33.26	0	100	V	28.89	5.73	36.162	31.72	54.00	-22.28	AV

TX Mode

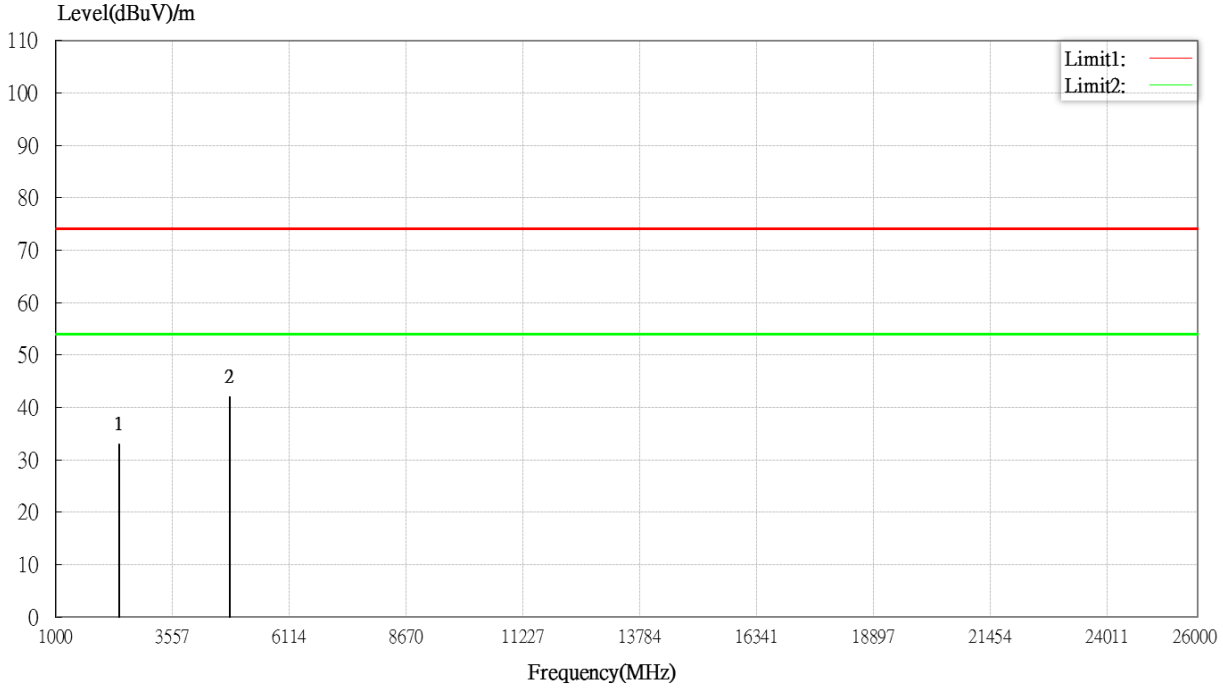
Low Freq.

Horizontal Polarization

Peak



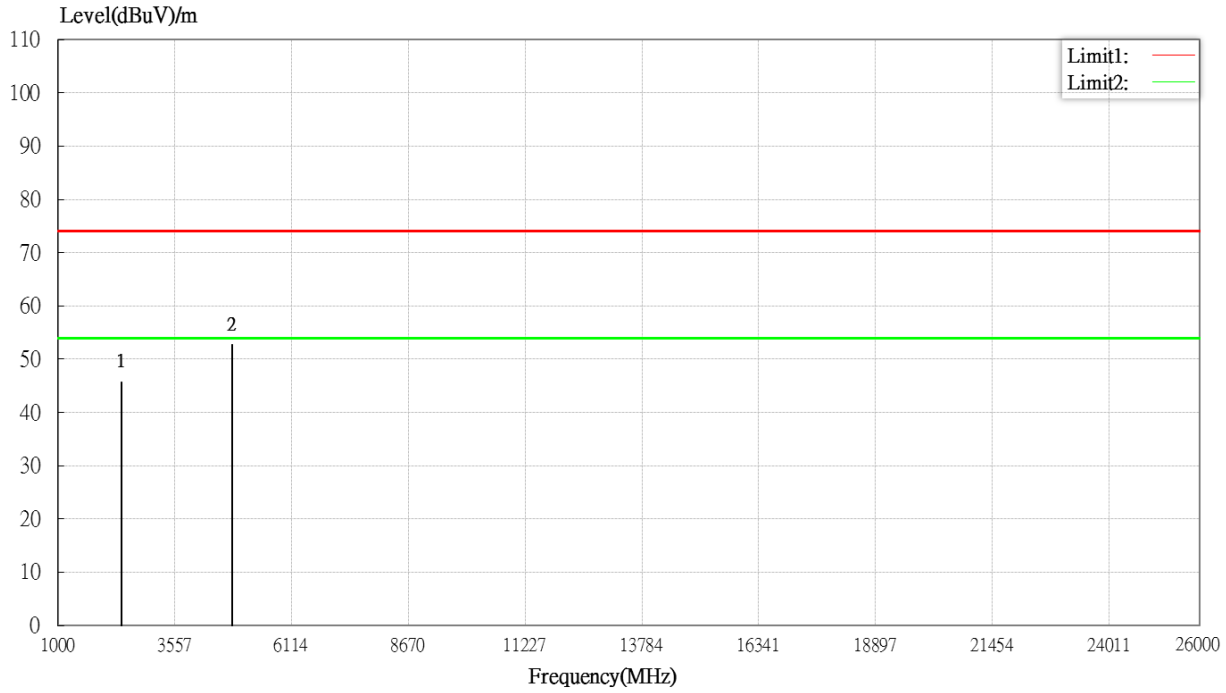
Avg.



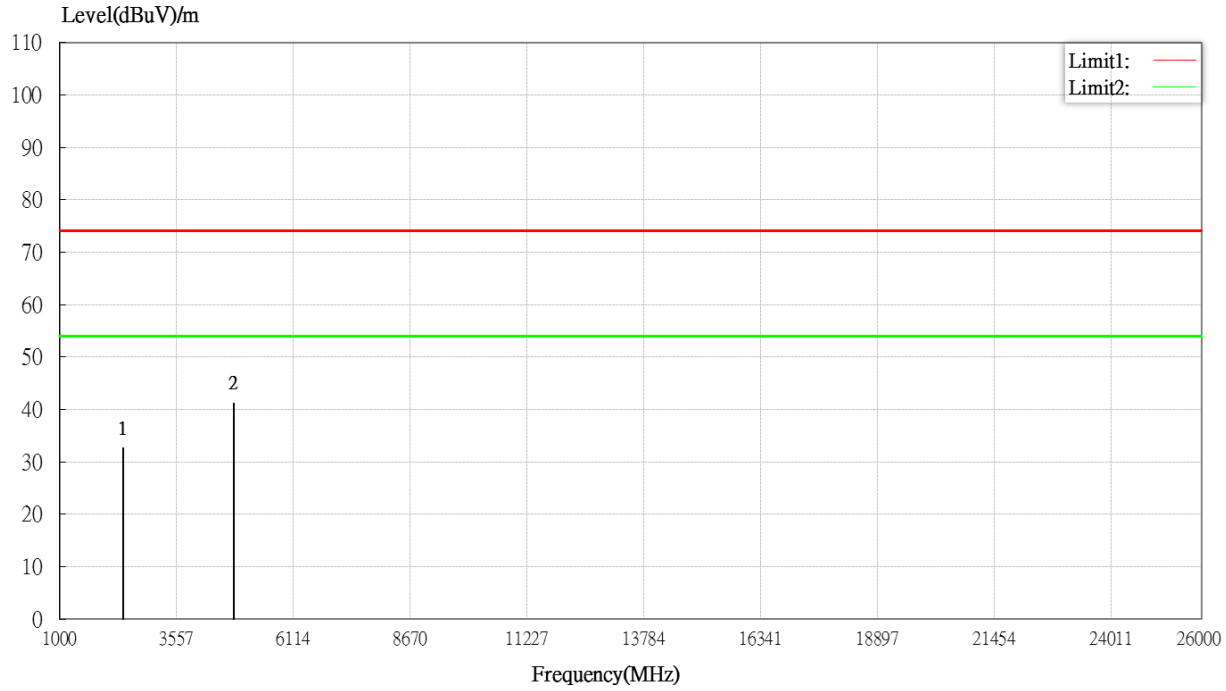
Low Freq.

Vertical Polarization

Peak



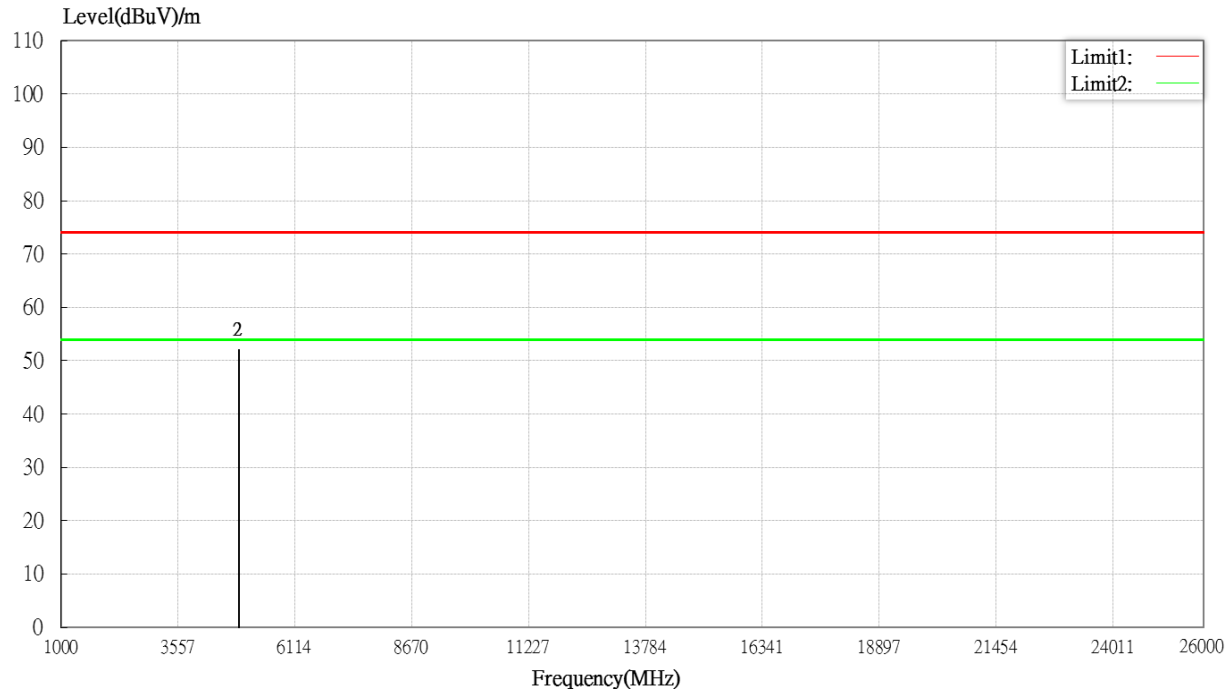
Avg.



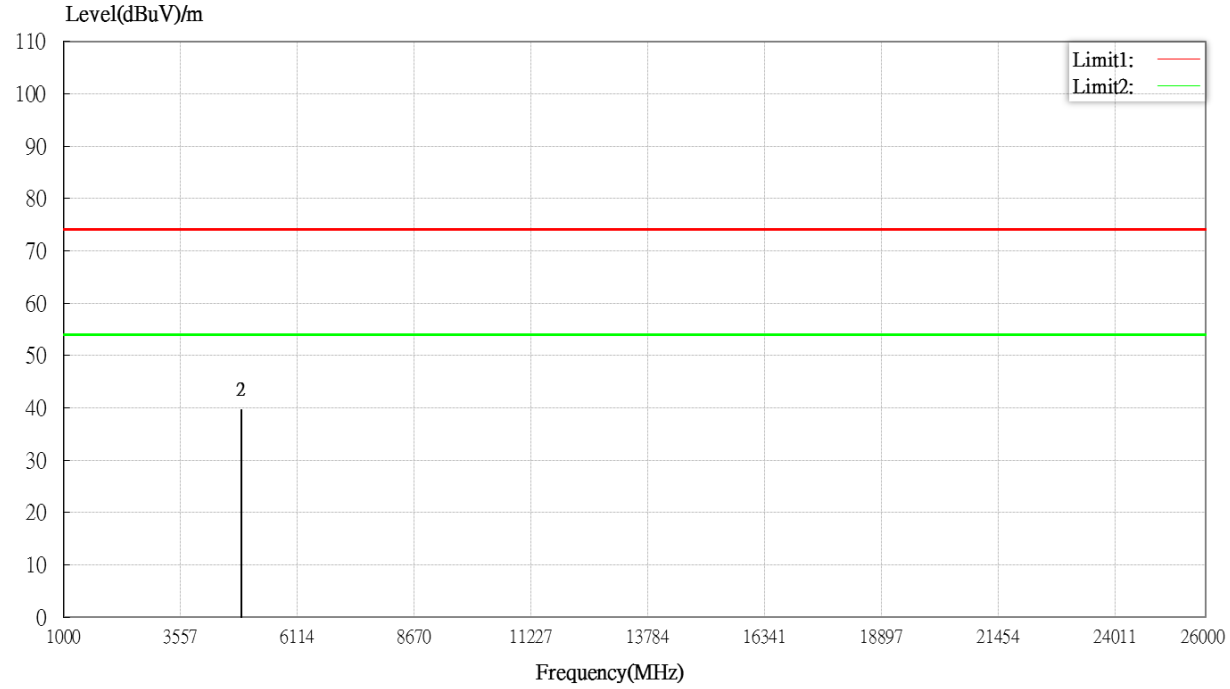
Mid Freq.

Horizontal Polarization

Peak



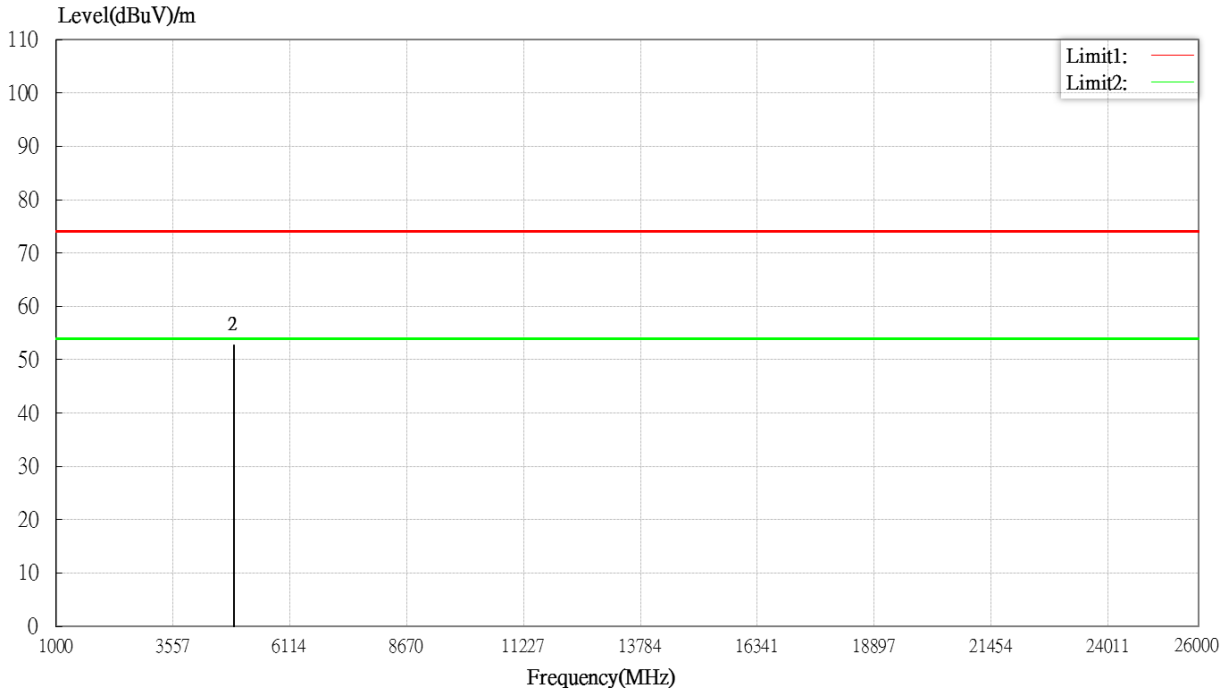
Avg.



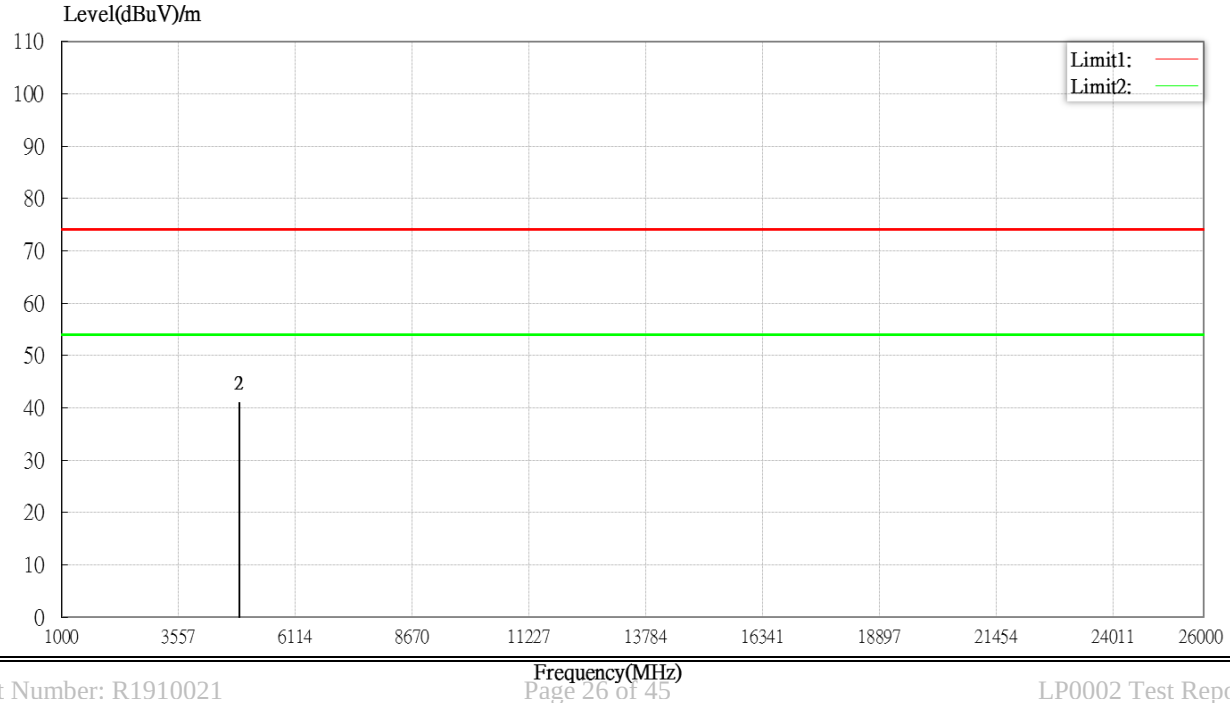
Mid Freq.

Vertical Polarization

Peak



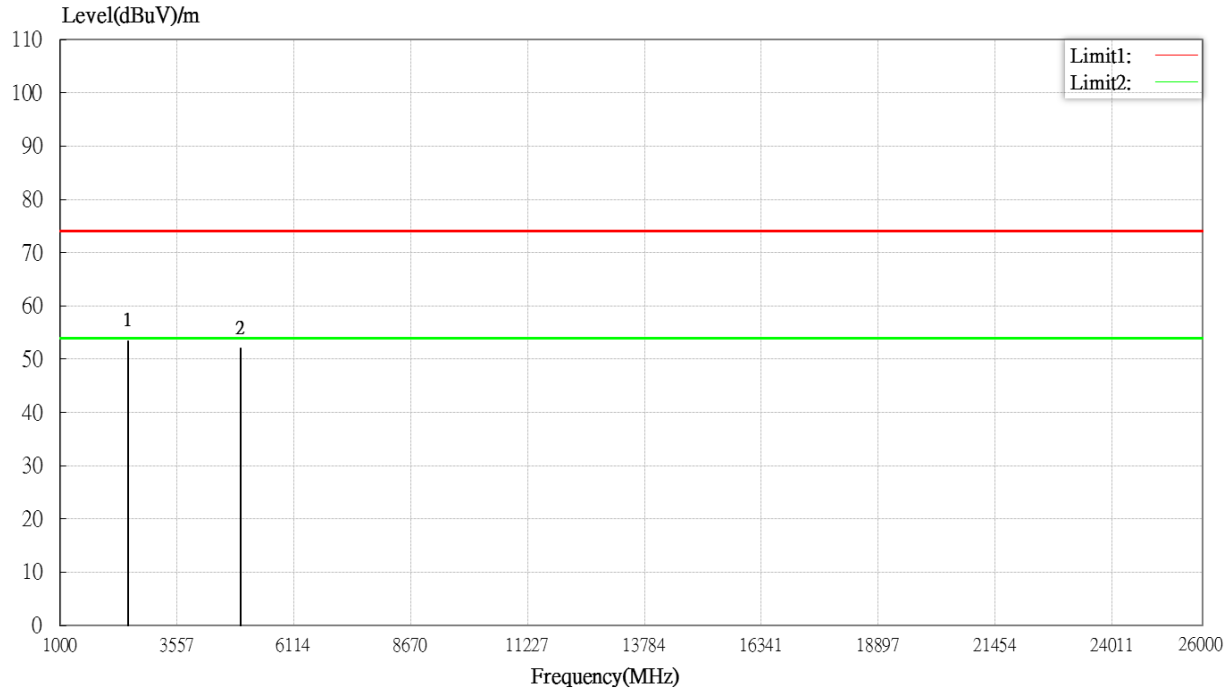
Avg.



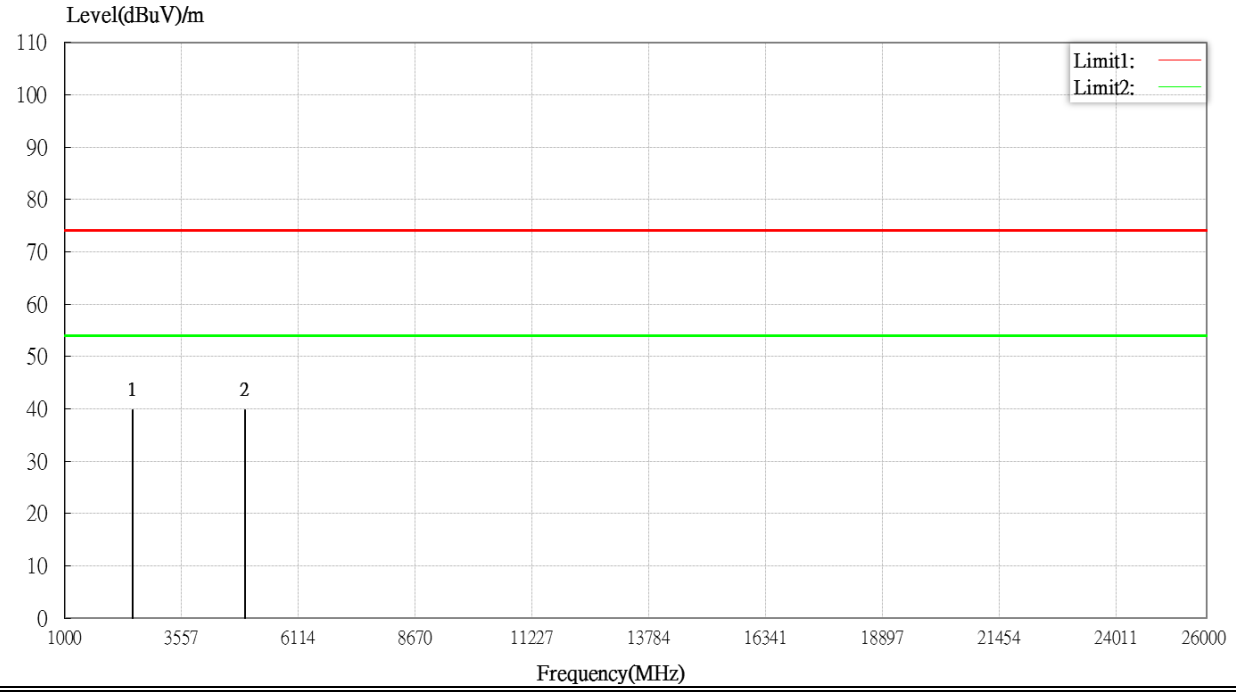
High Freq.

Horizontal Polarization

Peak



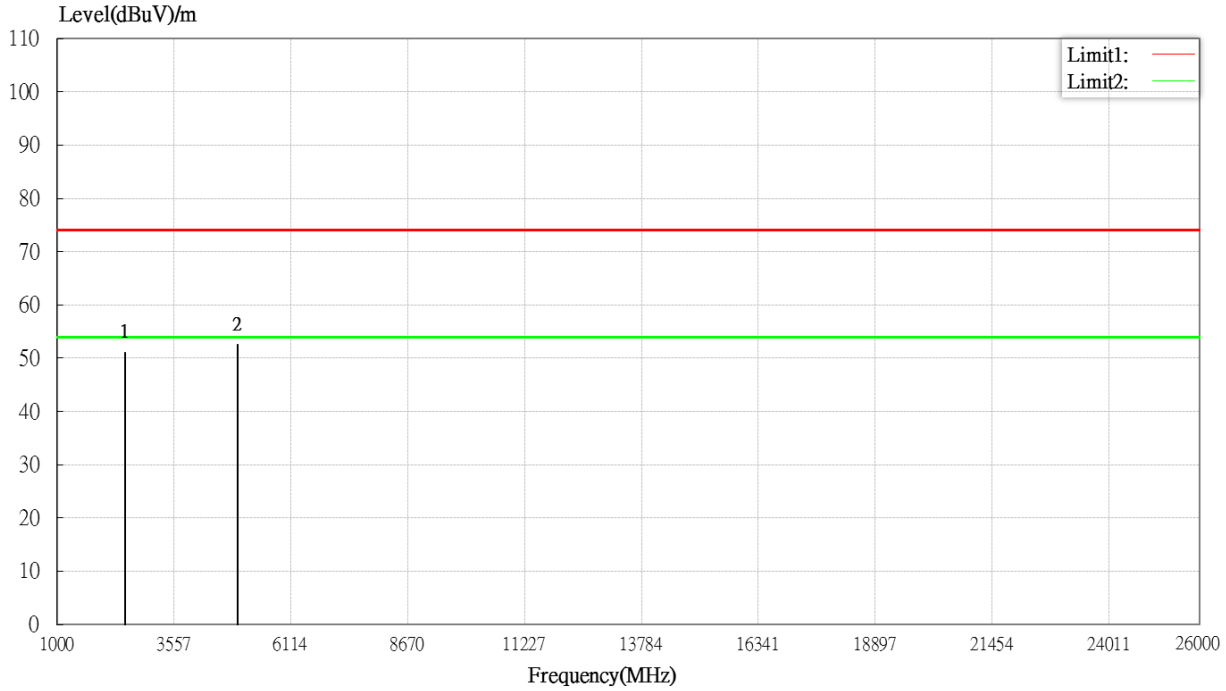
Avg.



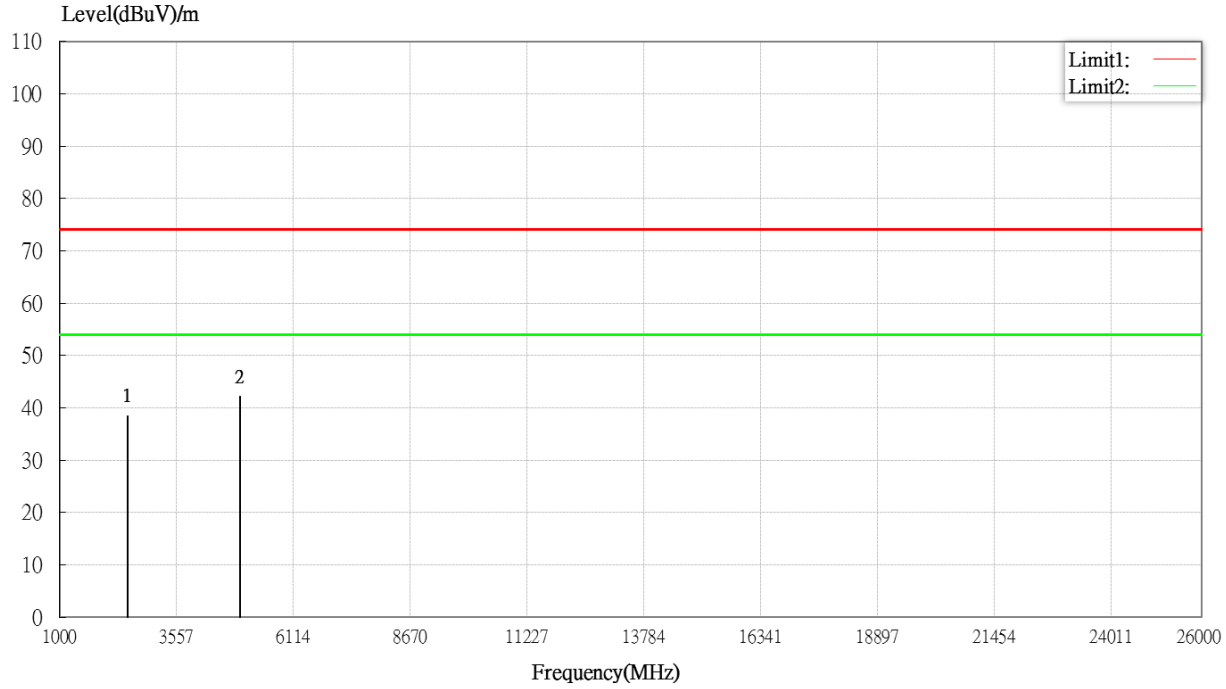
High Freq.

Vertical Polarization

Peak



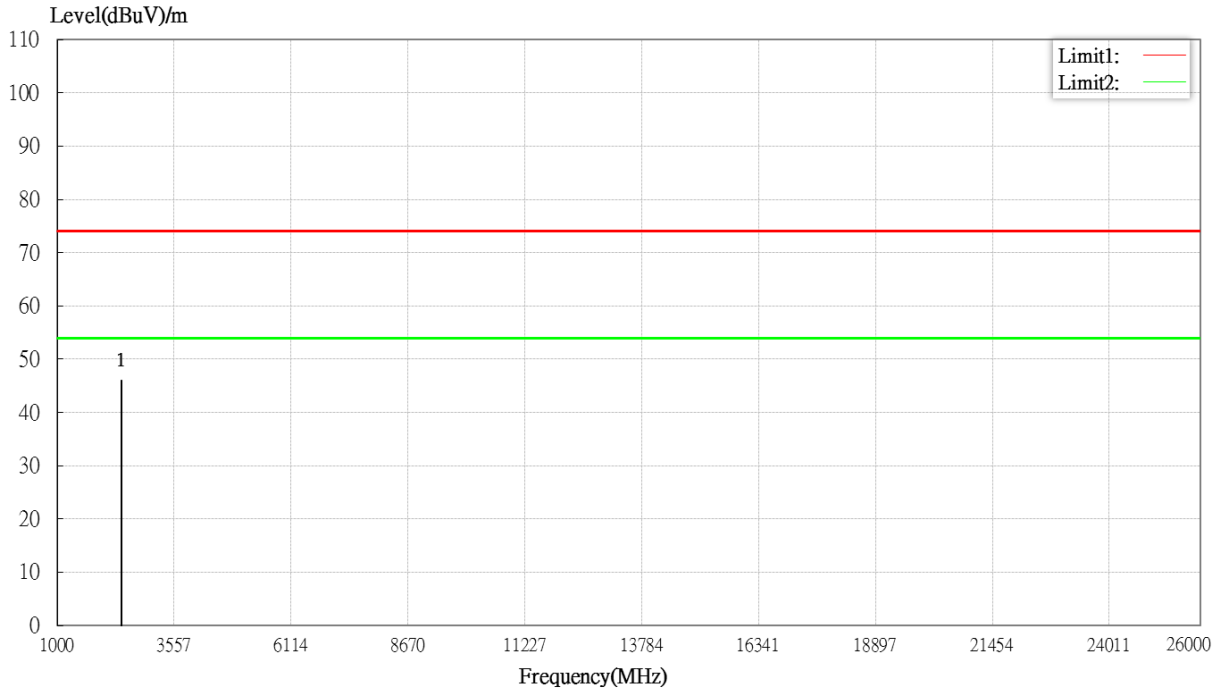
Avg.



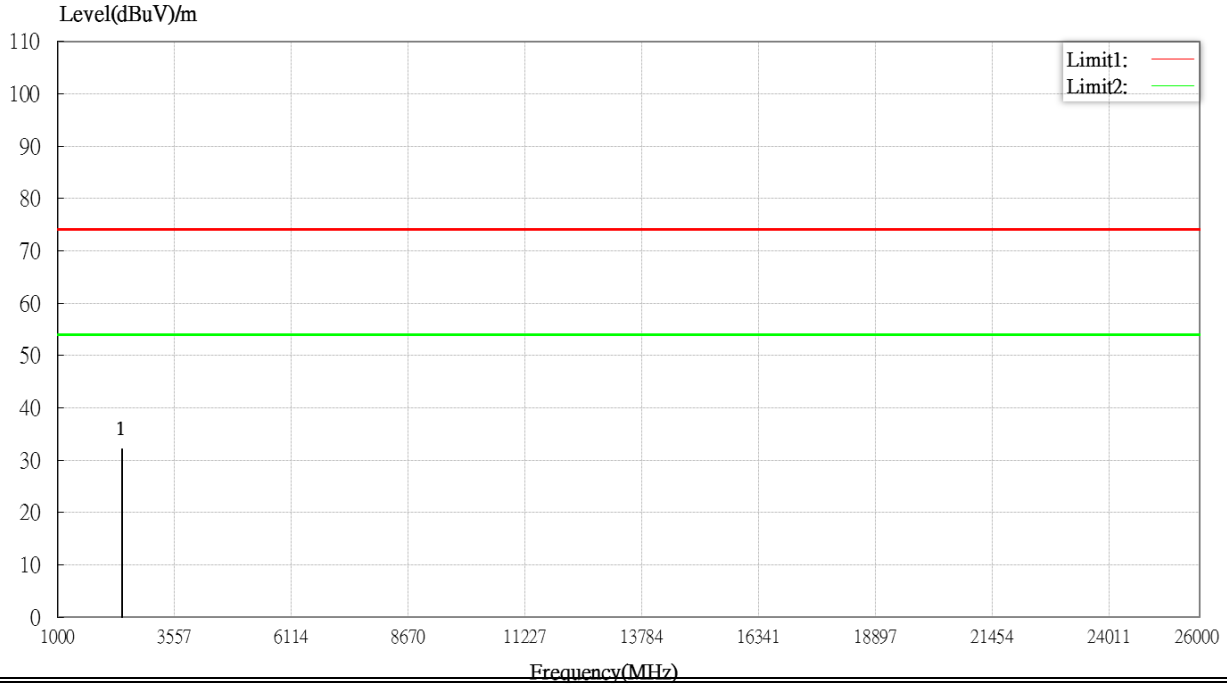
Receiving Mode

Horizontal Polarization

Peak



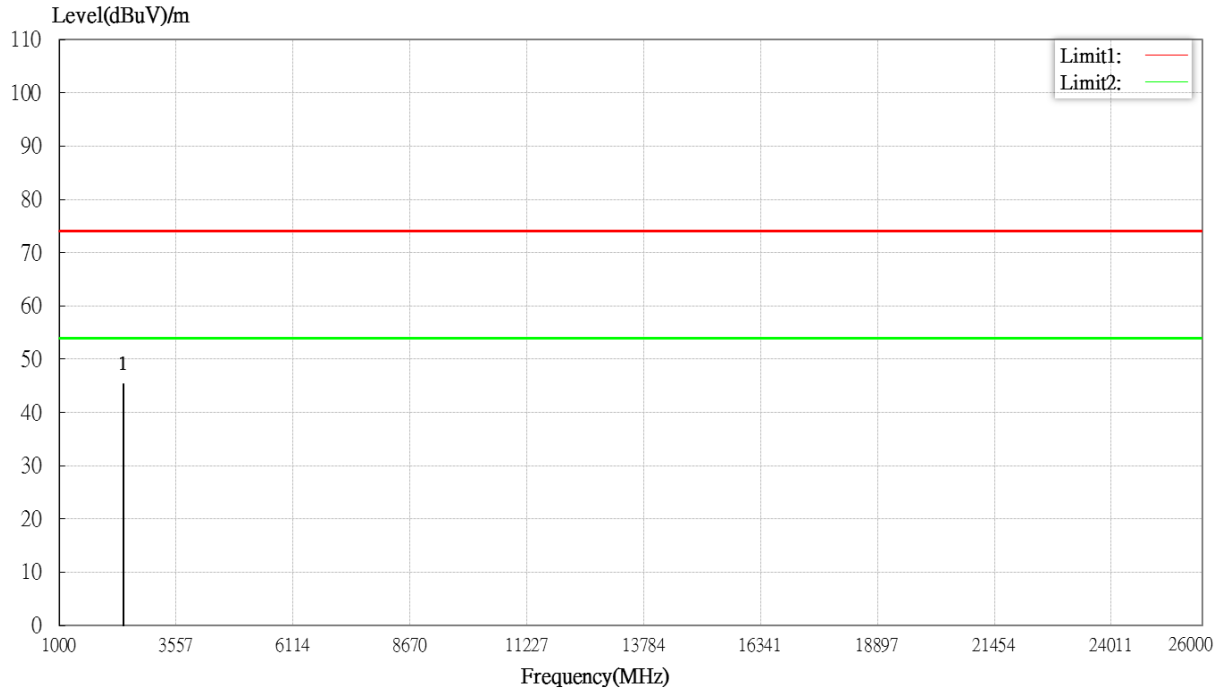
Avg.



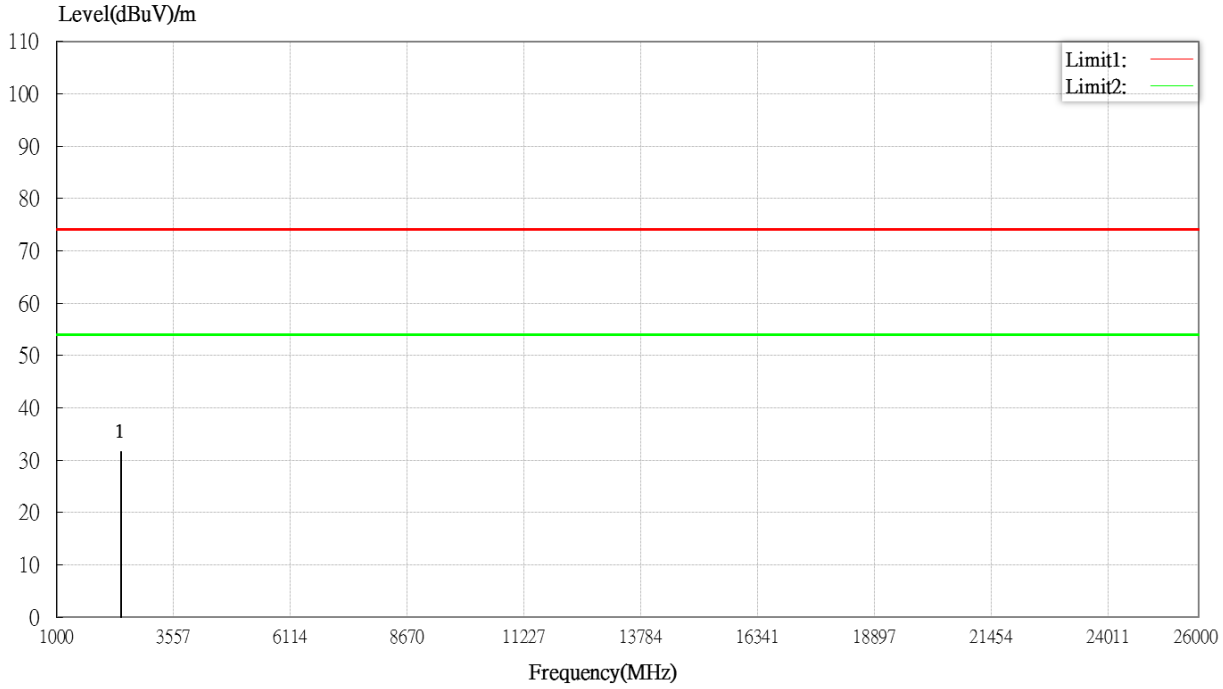
Receiving Mode

Vertical Polarization

Peak



Avg.



7 LP0002-2018 §3.10 -Emission Bandwidth

7.1 Applicable Standards

According to LP0002-2018 §3.10, systems using digital modulation techniques may operate in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz

7.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth

7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
-	RF cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

7.4 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Zhao Zhao on 2019-10-08 at RF site.

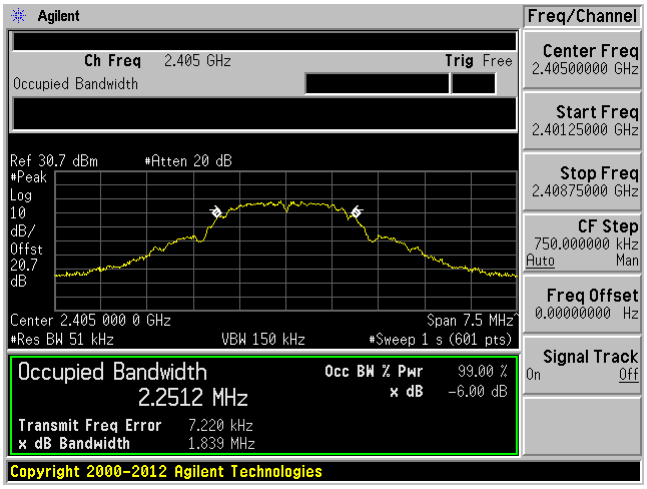
7.5 Test Results

Channel	Frequency (MHz)	99% OBW (kHz)	6 dB BW (kHz)	6 dB OBW limit (kHz)
Low	2405	2251.2	1691	500
Middle	2440	2258.5	1696	500
High	2475	2258.2	1690	500

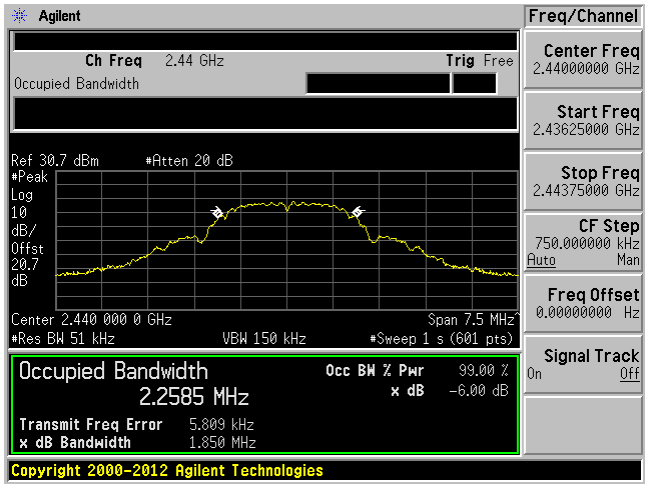
Please refer to the following plots for detailed test results.

99% OBW

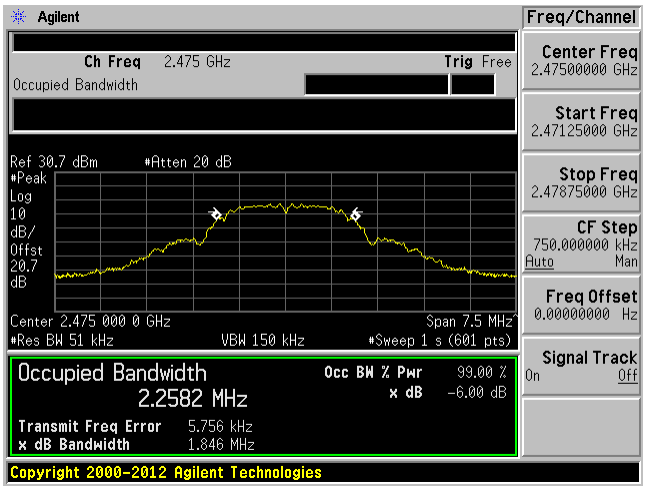
Low Channel 2405 MHz



Middle Channel 2440 MHz

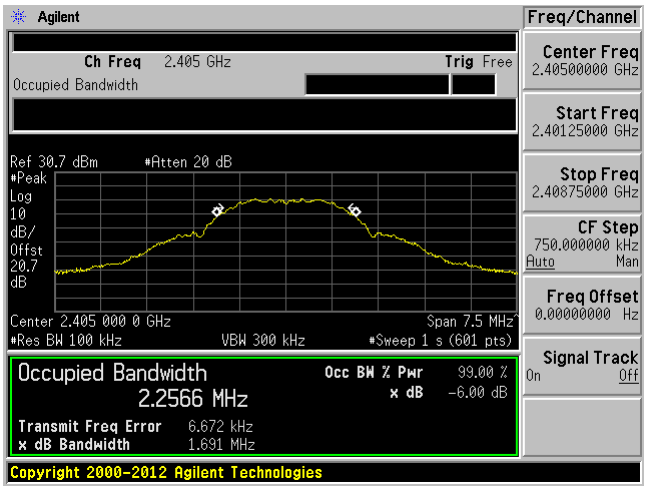


High Channel 2475 MHz

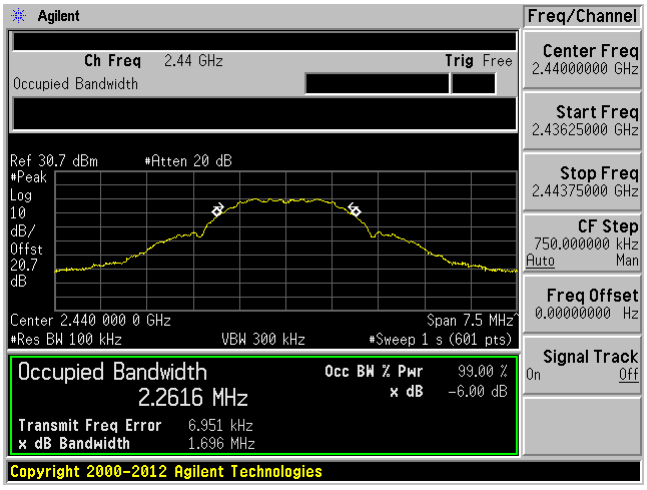


6dB Bandwidth

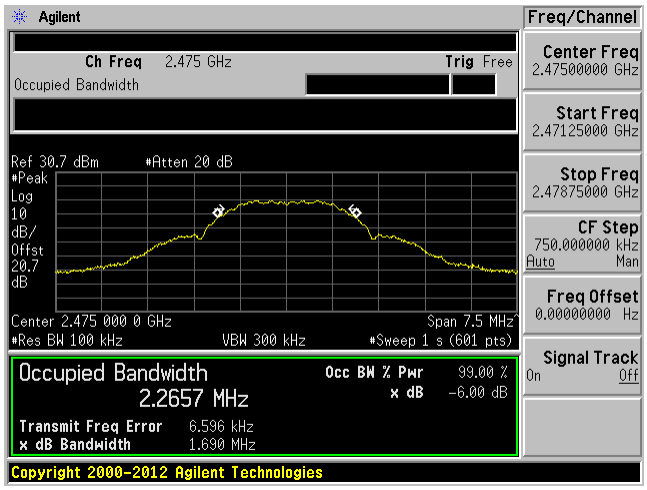
Low Channel 2405 MHz



Middle Channel 2440 MHz



High Channel 2475 MHz



8 LP0002-2018 §3.10 - Output Power Measurement

8.1 Applicable Standards

According to LP0002-2018 §3.10 for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

8.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 9: Fundamental emission output power

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
-	RF Cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

8.4 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Zhao Zhao on 2019-10-08 at RF site.

8.5 Test Results

Peak Output Power

Channel	Frequency (MHz)	Conducted Peak Power (dBm)	Limit (dBm)
Low	2405	15.21	30
Middle	2440	14.52	30
High	2475	14.17	30

9 LP0002-2018 §3.10 – 100 kHz Bandwidth of Band Edges

9.1 Applicable Standards

According to LP0002-2018§3.10, in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

9.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 13: Band-edge measurements

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
-	RF Cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

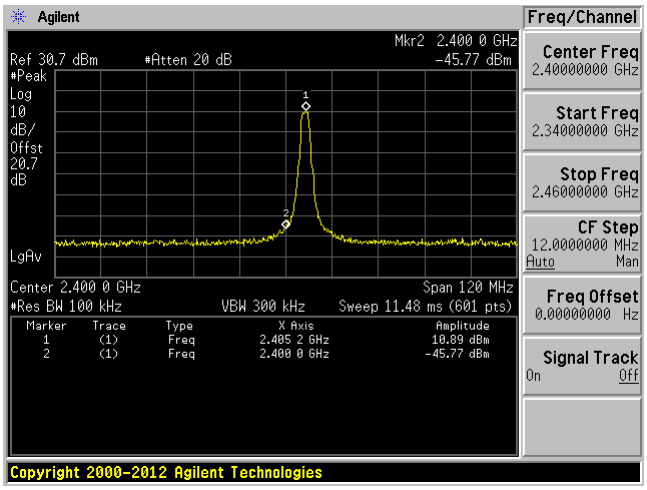
9.4 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

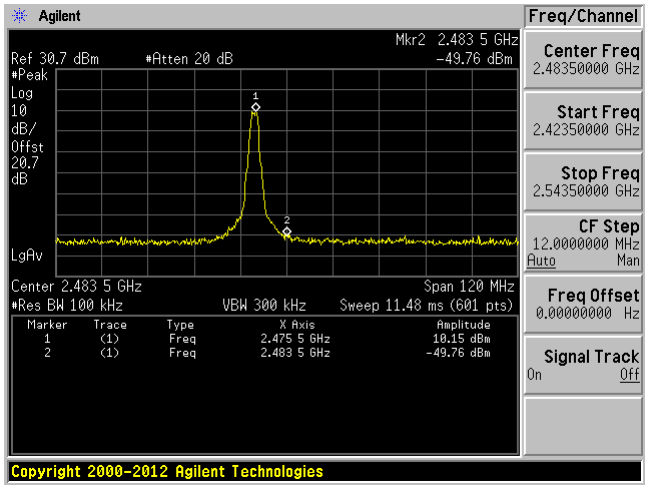
The testing was performed by Zhao Zhao on 2019-10-08 at RF site.

9.5 Test Results

Low Channel 2405 MHz



High Channel 2475 MHz



10 LP0002-2018 §3.10– Power Spectral Density

10.1 Applicable Standards

According to LP0002-2018 §3.10 , for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

10.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under LP0002-2018 §3.10: Maximum power spectral density level in the fundamental emission.

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
-	RF Cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

10.4 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

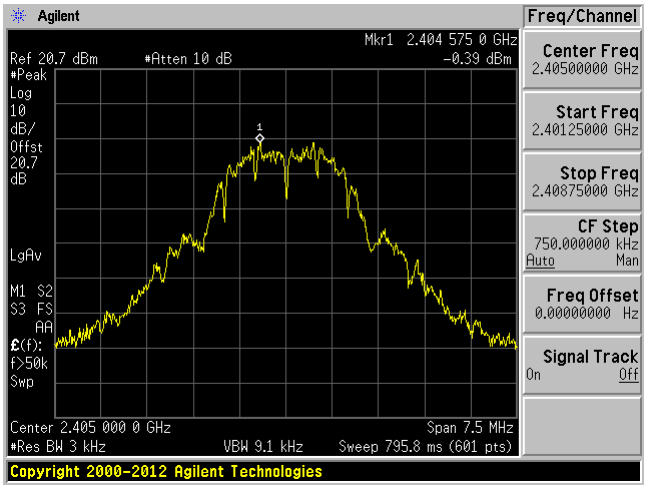
The testing was performed by Zhao Zhao on 2019-10-08 at RF site.

10.5 Test Results

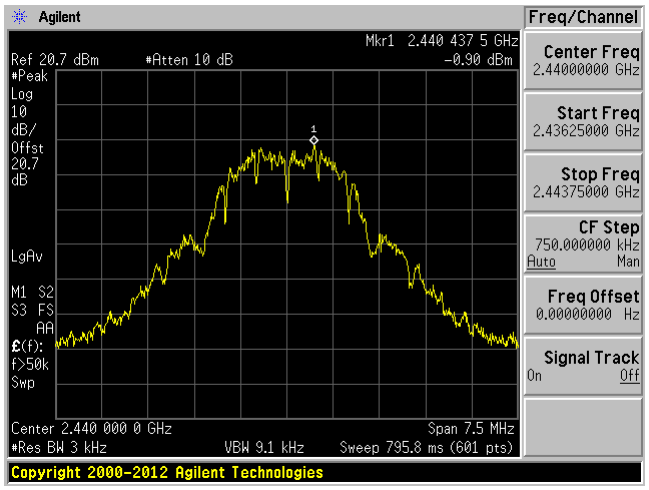
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2405	-0.39	8
Middle	2440	-0.90	8
High	2475	-1.06	8

Please refer to the following plots for detailed test results.

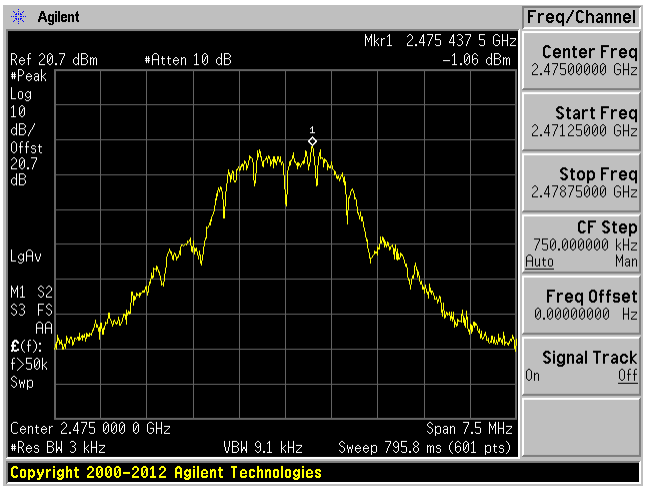
Low Channel 2405 MHz



Middle Channel 244 MHz



High Channel 2475 MHz



11 LP0002-2018 §3.10– Spurious Emissions at Antenna Terminals

11.1 Applicable Standards

As per LP0002-2018 §3.10, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB.

11.2 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
-	RF Cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

11.4 Test Environmental Conditions

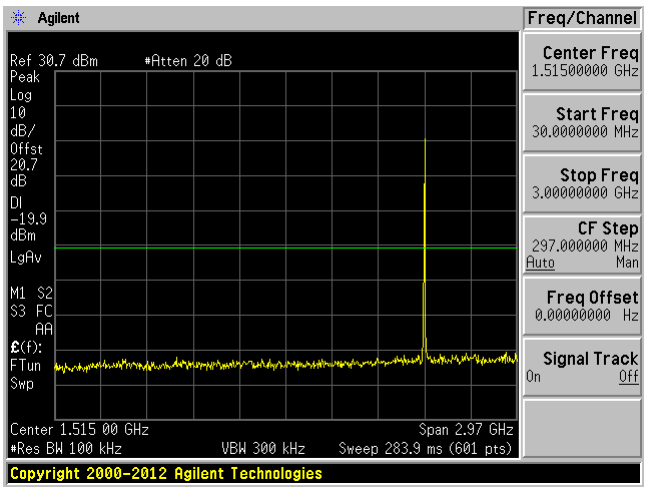
Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Zhao Zhao on 2019-10-08 at RF site.

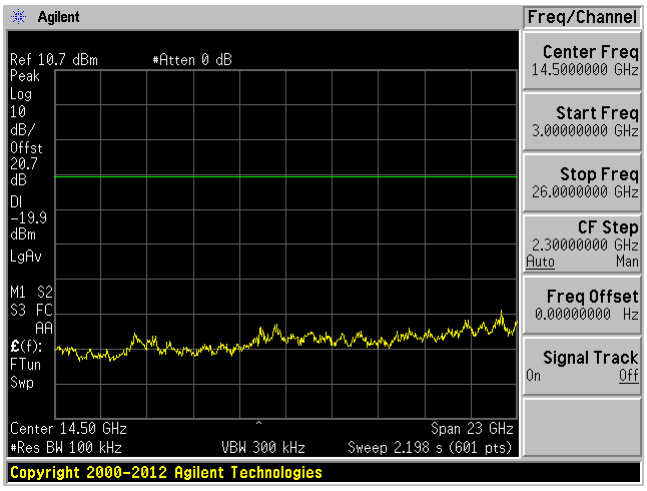
11.5 Test Results

Please refer to following plots.

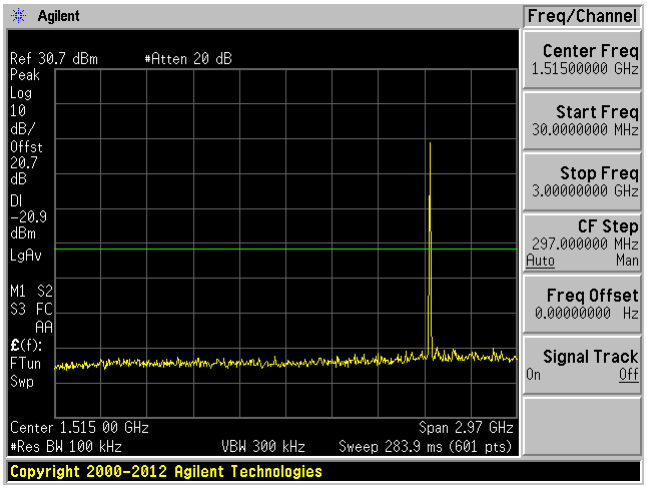
Low Channel 30 MHz – 3 GHz



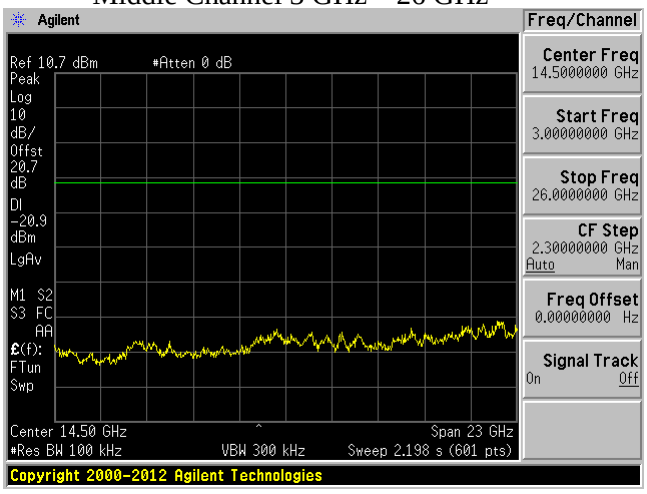
Low Channel 3 GHz – 26 GHz



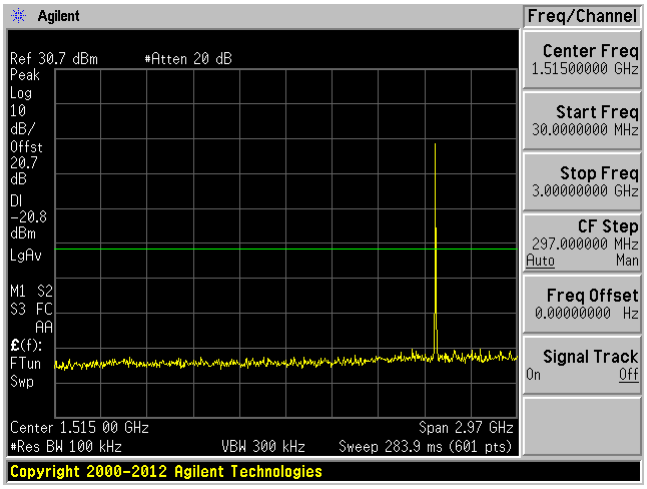
Middle Channel 30 MHz – 3 GHz



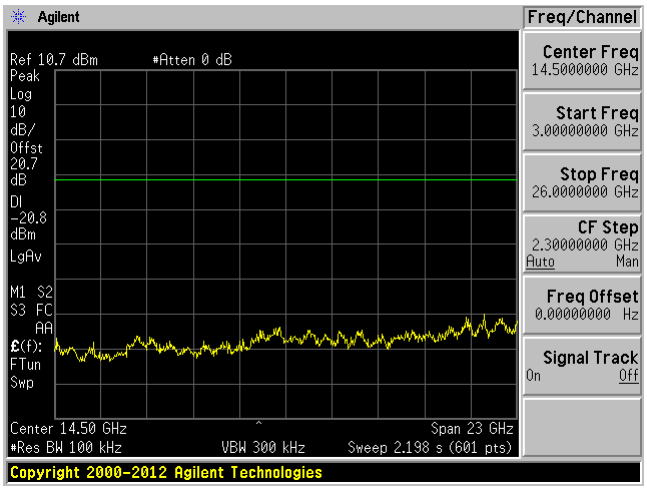
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz



High Channel 3 GHz – 26 GHz



12 Annex A – EUT Test Setup Photographs

Please refer to the attachment.

13 Annex B – EUT Photographs

Please refer to the attachment.

14 Annex C (Normative) - A2LA Electrical Testing Certificate

Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets A2LA R222 - *Specific Requirements EPA ENERGY STAR Accreditation Program*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 2nd day of October 2018.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2020
Revised June 5, 2019

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

Please follow the web link below for a full ISO 17025 scope

https://www.a2la.org/scopepdf/3297-02.pdf

--- END OF REPORT ---