

Radio Test Report (Zigbee)

Report No.: RJ171208E04B-5

Test Model: WHW03 V2

Series Model: A03 V2

Received Date: Mar. 01, 2018

Test Date: Mar. 02, 2018

Issued Date: Apr. 20, 2018

Applicant: Belkin International, Inc.

Address: 12045 East Waterfront Drive, Playa Vista, CA. 90094, USA

Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
Hsin Chu Laboratory

Lab Address: E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300,
Taiwan R.O.C.

Test Location: E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300,
Taiwan R.O.C.



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Release Control Record

Issue No.	Description	Date Issued
RJ171208E04B-5	Original release.	Apr. 20, 2018

1 Certificate of Conformity

Product: WHOLE HOME WI-FI

Brand: Linksys

Test Model: WHW03 V2

Series Model: A03 V2

Sample Status: ENGINEERING SAMPLE

Applicant: Belkin International, Inc.

Test Date: Mar. 02, 2018

Standards: ARIB STD-T66 (V3.7), MIC notice 88 Appendix 43

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by :

Mary Ko
Mary Ko / Specialist

Date:

Apr. 20, 2018

Approved by :

May Chen
May Chen / Manager

Date:

Apr. 20, 2018

2 Summary of Test Results

The EUT has been tested according to the following specifications:

Notice 88 Appendix 43 Reference	ARIB STD-T66 Ref.	Report Reference	Parameter	Test Results (Note)
General Provisions				
C	3.2 (4)	4.1	Frequency tolerance	C
D	3.2 (7)	4.2	Occupied bandwidth	C
E	3.2 (6)	4.3	Spurious emissions	C
Transmitting Equipment				
F	--	4.4	Antenna power	C
--	--	--	SAR	NA
Transmitting Antenna				
--	--	3.5	Type, configuration, etc. of transmitting antenna	C
--	--	3.5	Direction pattern of transmitting antenna	C
Receiving Equipment				
G	3.3 (1)	4.5	Spurious emissions of receiver	C
--	--	3.5	Refer to all articles for transmitting antenna	C
Operating Frequency 2400 to 2483.5MHz				
--	3.7 (1)	3.4	High Frequency / Modulation section cannot be opened easily	C
--	3.1 (1)	3.1	Communication method	C
--	3.2 (1)a	3.1	Modulation method	C
--	3.2 (1)a	3.1	Spread spectrum method	C
--	3.2 (2)	4.4	Antenna power	C
--	3.6 (2)	4.4	Absolute gain of transmitting antenna	C
--	3.6 (2)	--	Angular width of principal radiation (AWPR)	NA
--	3.2 (10)	--	Number of carriers within 1 MHz bandwidth in OFDM	NA
--	3.2 (8)	--	Spreading bandwidth	NA
--	3.2 (9)	--	Spreading factor	NA
--	3.2 (11)	--	Frequency retention time (FH employed)	NA
--	3.4.1(1)	4.6	Interference Prevention Function	C
--	3.4.1(3)	--	Carrier Sense Capability	NA
Note: C = Conform NC = Not Conform NT = Not Tested NA = Not Applicable				

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in TR 100 028-1.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

Parameter	Uncertainty
Occupied Bandwidth	703.56 Hz
Spurious emissions	2.52 dB
Output power density	1.37 dB
Out of band radiated power	2.52 dB
Frequency Tolerance	703.56 Hz

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT (Zigbee)

Product	WHOLE HOME WI-FI
Brand	Linksys
Test Model	WHW03 V2
Series Model	A03 V2
Driver version	2.1.2.187415
Status of EUT	ENGINEERING SAMPLE
Nominal Voltage	12Vdc from power adapter
Modulation Type	O-QPSK
Modulation Technology	DSSS
Transfer Rate	250kbps
Operating Frequency	2405 ~ 2480MHz
Number of Channel	16
Rated RF Output Power	10 mW
Conducted RF Output Power	9.817 mW
Radiated RF Output Power	11.939 mW
Antenna Type	Refer to section 3.5
Antenna Connector	Refer to section 3.5
Accessory Device	Adapter x1
Data Cable Supplied	NA

Note:

- There are WLAN, Bluetooth and Zigbee technology used for the EUT. The EUT has below radios as following table:

Radio 1	Radio 2	Radio 3	Radio 4
WLAN 2.4GHz + 5GHz (low band)	WLAN 5GHz (high band)	Bluetooth	Zigbee

- The EUT has below model names, which are identical to each other in all aspects except for the following table:

Brand	Model Name	Different
Linksys	WHW03 V2	For marketing request
	A03 V2	

From the above models, model: **WHW03 V2** was selected as representative model for the test and its data was recorded in this report.

- Simultaneously transmission condition.

Condition	Technology				
1	WLAN 2.4GHz	WLAN 5GHz (low band)	WLAN 5GHz (high band)	Bluetooth	Zigbee

- The EUT must be supplied with a power adapter as following table:

Brand	Model No.	Spec.
Ktec	KSA-24H-120200HU	Input: 100-240Vac, 0.7A, 50-60Hz Output: 12Vdc, 2A DC output cable (Unshielded, 1.8m)

5. The DDR3 Memory of EUT as following table

Item	Brand	Model No.	Different
Main source	SK HYNIX	H5TC4G63CFR-PBA	1. For maketing request. 2. DDR3 Memory.
Second source	NANYA	NT5CC256M16EP-EK	

Note: From the above models, the worst case was found in **Main source**. Therefore only the test data of the modes were recorded in this report.

6. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

16 channels are provided to the EUT:

Channel	Frequency	Channel	Frequency
11	2405	19	2445
12	2410	20	2450
13	2415	21	2455
14	2420	22	2460
15	2425	23	2465
16	2430	24	2470
17	2435	25	2475
18	2440	26	2480

Note:

1. The channels which were indicated in bold type of the above channel list were selected as representative test channel. Therefore only the data of the test channels were recorded in this report.

By means of test software (Command) provided by manufacture, the power levels during the tests were set according to the following codes:

Channel	Power Setting
11	-5
18	-6
26	-7

3.3 Test Conditions

Test Conditions	Voltage (Vdc)
V_{normal}	12
$V_{+10\%}$	13.2
$V_{-10\%}$	10.8

3.4 Assembly

The RF circuits was located inside of the EUT. The plastic enclosure was assembled by one screw and covered by mylar rubbers patch with glue, the screw can not be observed directly. Also it won't be easy to be opened.

3.5 Antenna Specifications

3.5.1 Antenna Gain

Bluetooth						
Ant No.	Brand	Model	Antenna Net Gain (dBi)	Frequency rang (GHz)	Antenna type	Connector type
1	Aristotle	RFA-BT-9267	1.69	2.4~2.4835	Dipole	i-pex(MHF)
Zigbee						
Ant No.	Brand	Model	Antenna Net Gain (dBi)	Frequency rang (GHz)	Antenna type	Connector type
1	Aristotle	RFA-ZB-9267	0.85	2.4~2.4835	Dipole	i-pex(MHF)
WLAN						
Ant No.	Brand	Model	Antenna Net Gain (dBi)	Frequency rang (GHz)	Antenna type	Connector type
1	Aristotle	RFA-05-9267-L	3.55	5.5~5.825	Dipole	i-pex(MHF)
2	Aristotle	RFA-05-9267-R	3.87	5.5~5.825	Dipole	i-pex(MHF)
3	Aristotle	RFA-25-9267-B-V2	3.12	2.4~2.4835	Dipole	i-pex(MHF)
			3.77	5.18~5.320		
4	Aristotle	RFA-25-9267-F-V2	3.26	2.4~2.4835	Dipole	i-pex(MHF)
			3.68	5.18~5.320		

3.5.2 Antenna Pattern

Please refer to the attached file (Antenna pattern).

4 Test Results

4.1 Frequency Tolerance Measurement

4.1.1 Limits of Frequency Tolerance Measurement

Tolerance of frequency shall be +/- 50ppm

4.1.2 Test Setup



4.1.3 Test Results

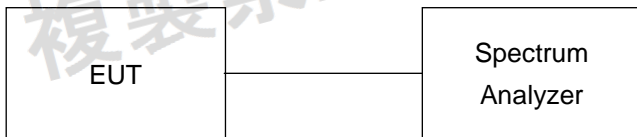
Environmental Conditions		25 deg.C, 60% RH					
Channel	Frequency (MHz)	Voltage normal		Voltage +10%		Voltage -10%	
		Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)
11	2405	2405.001210	0.503	2405.001221	0.508	2405.001215	0.505
18	2440	2440.001215	0.498	2440.001218	0.499	2440.001222	0.501
26	2480	2480.001228	0.495	2480.001228	0.495	2480.001223	0.493

4.2 Occupied Bandwidth Measurement (99% power bandwidth)

4.2.1 Limits of Occupied Bandwidth Measurement

Occupied bandwidth shall be 26MHz or less.

4.2.2 Test Setup

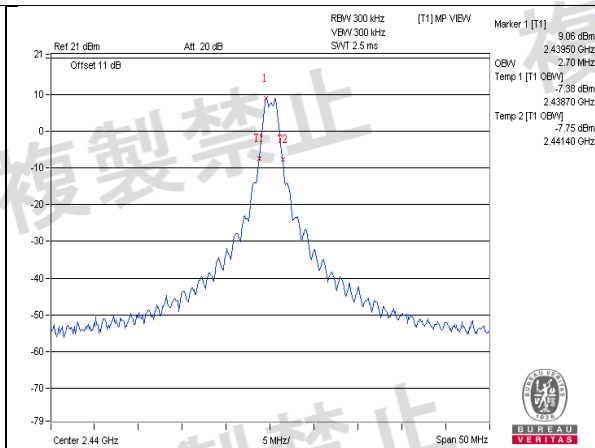
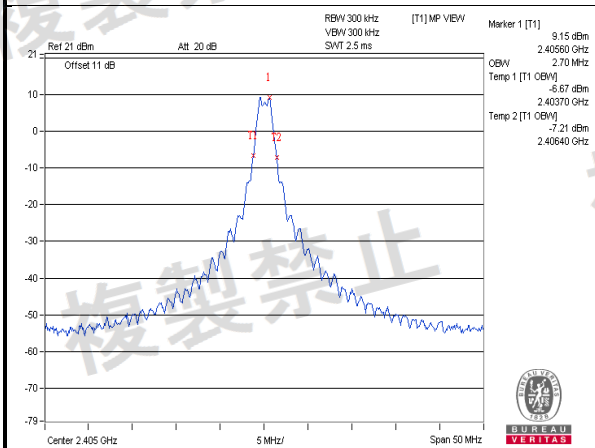


4.2.3 Test Results

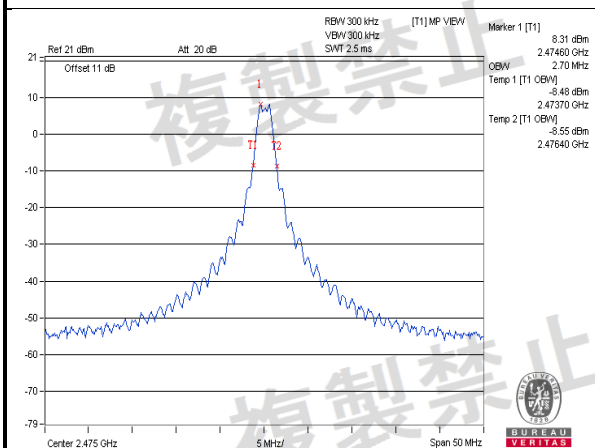
Environmental Conditions		25 deg.C, 60% RH		
Channel	Frequency (MHz)	V _{normal}	V _{+10%}	V _{-10%}
		Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
11	2405	2.70	2.70	2.70
18	2440	2.70	2.70	2.70
26	2480	2.70	2.70	2.70

Note: 1. For the test plots please refer to the below pages.

Vnormal



Channel 11



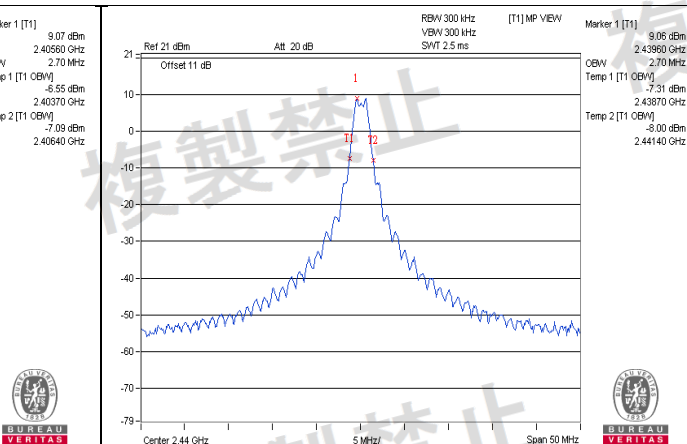
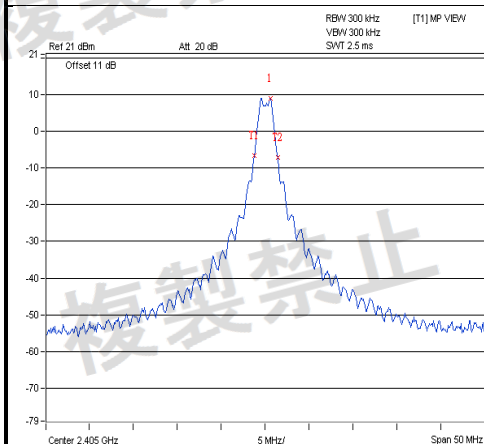
Channel 18



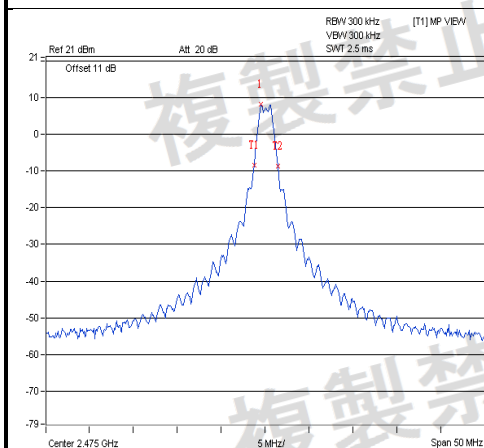
Channel 25

Measurement uncertainty: ± 206.50 Hz

V+10%



Channel 11

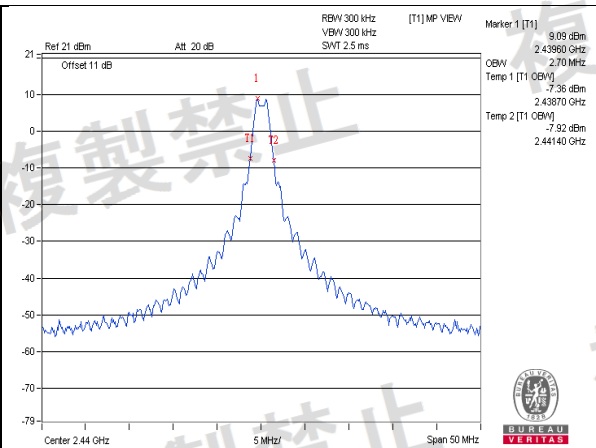
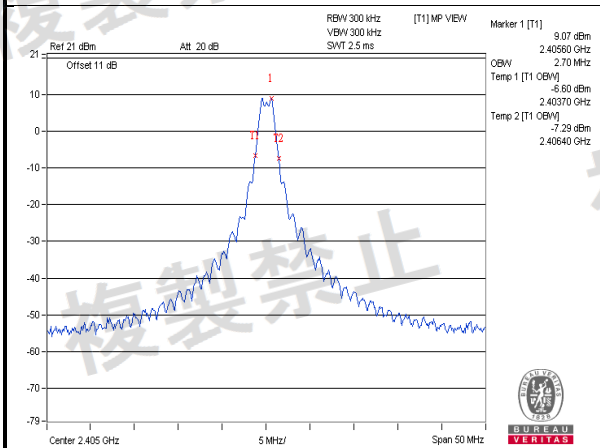


Channel 18

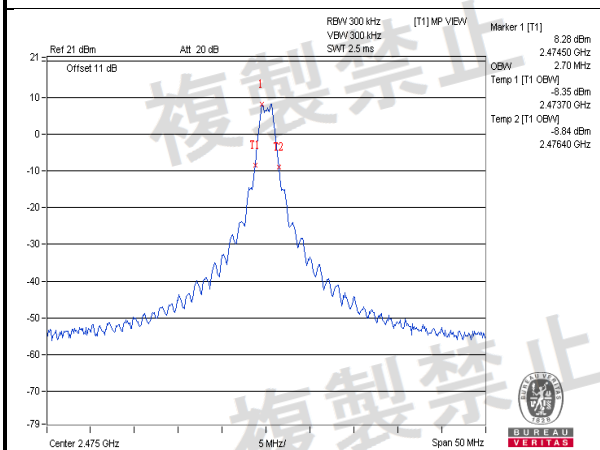
Channel 25

Measurement uncertainty: ± 206.50 Hz

V-10%



Channel 11



Channel 18

Channel 25

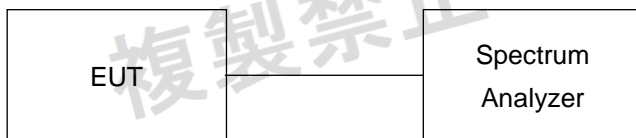
Measurement uncertainty: ± 206.50 Hz

4.3 Spurious Emissions for Transmitter Measurement

4.3.1 Limits of Spurious Emissions

Frequencies (MHz)	Limit
Operating frequency 2400 to 2483.5MHz	
30.0MHz to 1000.0MHz	$\leq 0.25 \text{ uW/100kHz}$
1000.0MHz to 2387MHz	$\leq 2.5 \text{ uW/MHz}$
2387.0MHz to 2400.0MHz	$\leq 25 \text{ uW/MHz}$
2483.5MHz to 2496.5MHz	$\leq 25 \text{ uW/MHz}$
2496.5MHz to 12500.0MHz	$\leq 2.5 \text{ uW/MHz}$

4.3.2 Test Setup



4.3.3 Test Results

Environmental Conditions		25 deg.C, 60% RH					
Test Channel		CH11 (2405MHz)		CH18 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
V _{normal}	30.0MHz to 1000.0MHz	643.76	0.02uW	711.06	0.02uW	0.25 uW/ 100kHz	PASS
	1000.0MHz to 2387MHz	2264.59	0.032uW	2184.67	0.02uW	2.5 uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2399.99	2.013uW	2394.17	0.041uW	25 uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2486.55	0.041uW	2488.95	0.052uW	25 uW/MHz	PASS
	2496.5MHz to 12500.0MHz	9725.27	0.032uW	2511.5	0.049uW	2.5 uW/MHz	PASS
V _{+10%}	30.0MHz to 1000.0MHz	75.1	0.017uW	729.73	0.032uW	0.25 uW/ 100kHz	PASS
	1000.0MHz to 2387MHz	2379.02	0.026uW	2343.48	0.023uW	2.5 uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2399.93	1.774uW	2392.28	0.038uW	25 uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2494.58	0.044uW	2485.39	0.054uW	25 uW/MHz	PASS
	2496.5MHz to 12500.0MHz	4811.05	0.036uW	3079.2	0.03uW	2.5 uW/MHz	PASS
V _{-10%}	30.0MHz to 1000.0MHz	399.69	0.024uW	378.71	0.018uW	0.25 uW/ 100kHz	PASS
	1000.0MHz to 2387MHz	2386.47	0.054uW	2298.4	0.035uW	2.5 uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2399.99	1.949uW	2398.63	0.042uW	25 uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2490.76	0.046uW	2483.65	0.066uW	25 uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3090.45	0.028uW	4878.58	0.073uW	2.5 uW/MHz	PASS

Note: The worst value in each frequency range v.s. each channel has been marked by boldface.

Environmental Conditions		25 deg.C, 60% RH			
Test Channel		CH26 (2480MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value		
V _{normal}	30.0MHz to 1000.0MHz	683.78	0.018uW	0.25 uW/ 100kHz	PASS
	1000.0MHz to 2387MHz	2207.9	0.016uW	2.5 uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2388.77	0.041uW	25 uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.6	10.495uW	25 uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3157.98	0.025uW	2.5 uW/MHz	PASS
V _{+10%}	30.0MHz to 1000.0MHz	589.56	0.02uW	0.25 uW/ 100kHz	PASS
	1000.0MHz to 2387MHz	2317.99	0.021uW	2.5 uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2396.5	0.037uW	25 uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.51	10.447uW	25 uW/MHz	PASS
	2496.5MHz to 12500.0MHz	7441.98	0.031uW	2.5 uW/MHz	PASS
V _{-10%}	30.0MHz to 1000.0MHz	365.49	0.017uW	0.25 uW/ 100kHz	PASS
	1000.0MHz to 2387MHz	2222.29	0.017uW	2.5 uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2396.32	0.039uW	25 uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.54	11.22uW	25 uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3135.47	0.027uW	2.5 uW/MHz	PASS

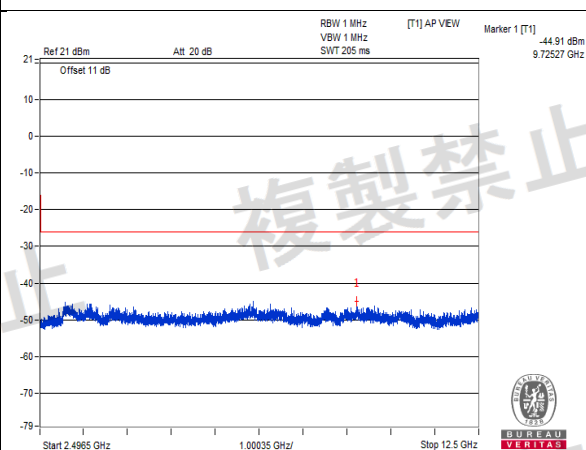
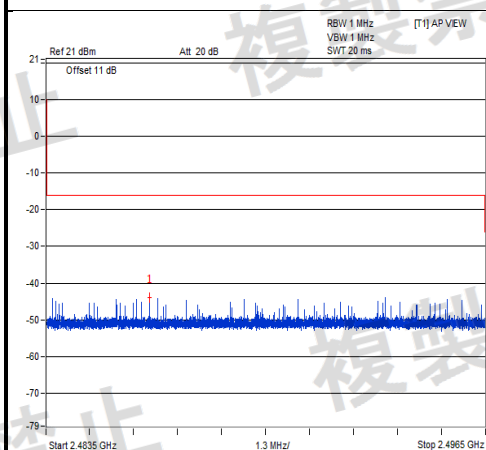
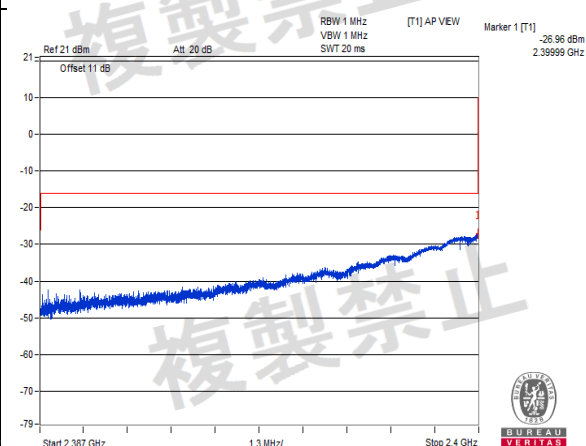
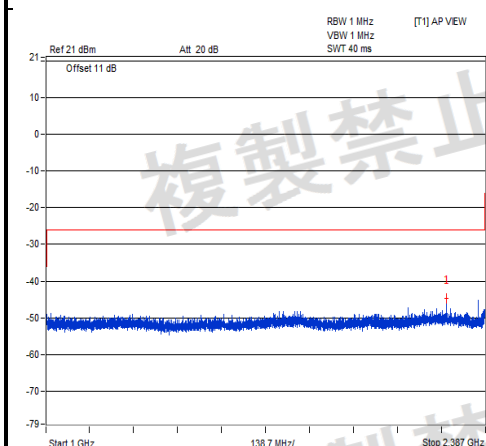
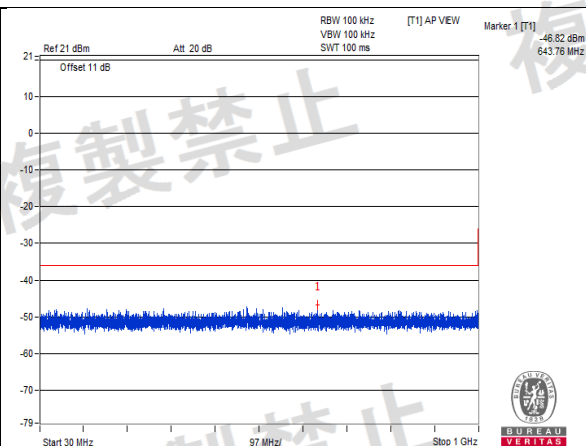
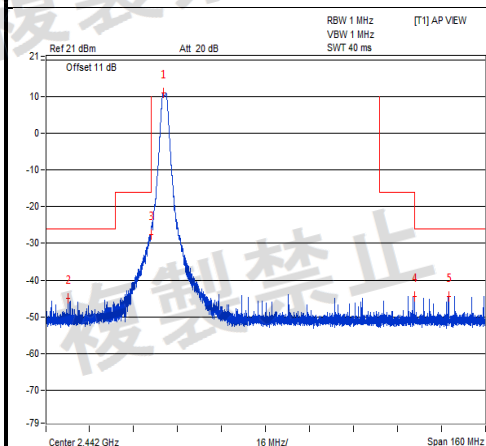
Note: 1. The worst value in each frequency range v.s. each channel has been marked by boldface.

2. The spectrum plots are attached on the following pages.



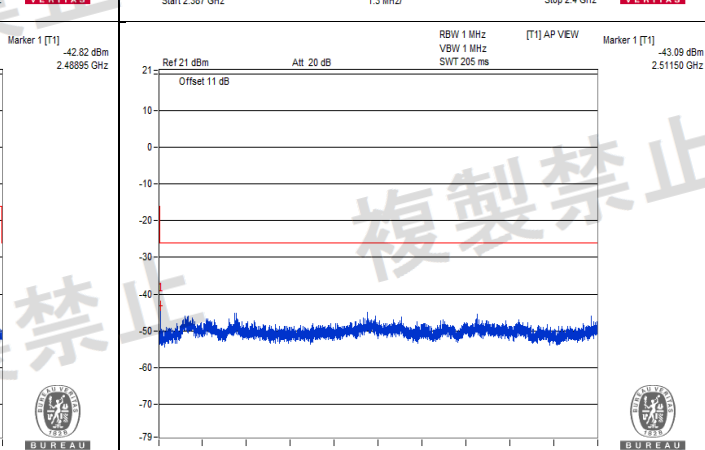
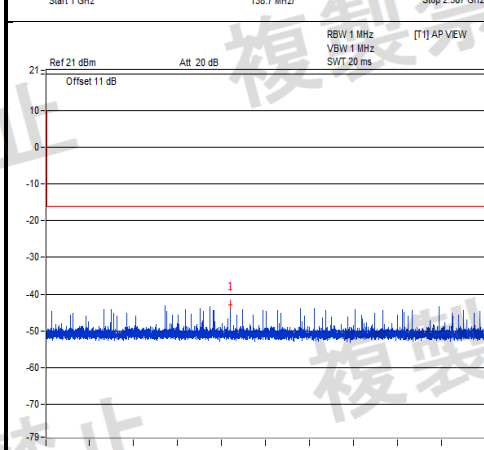
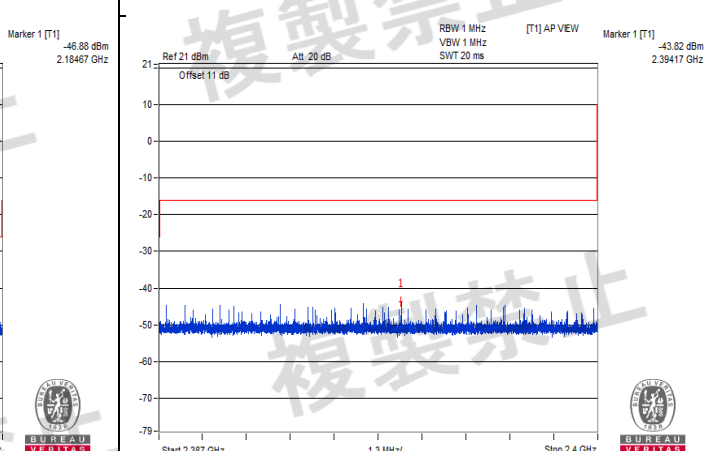
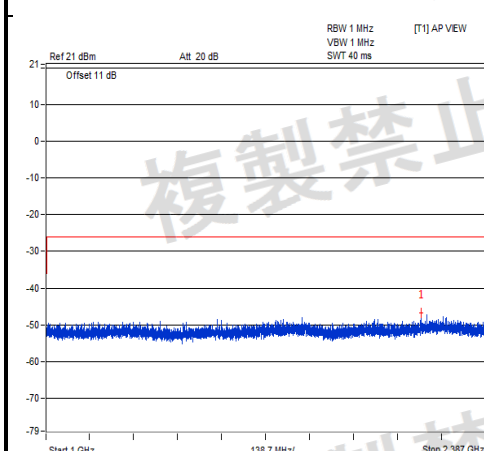
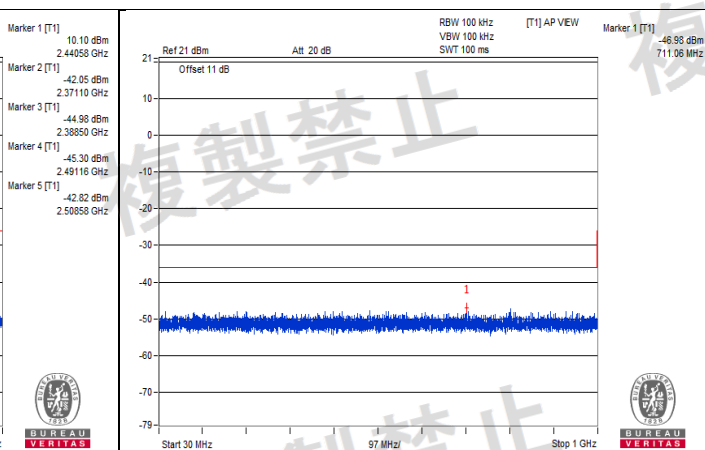
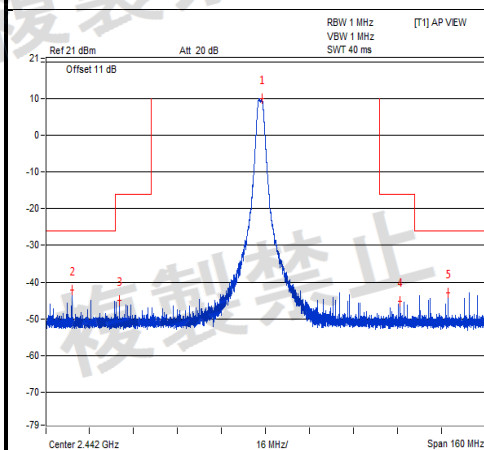
BUREAU
VERITAS

V normal



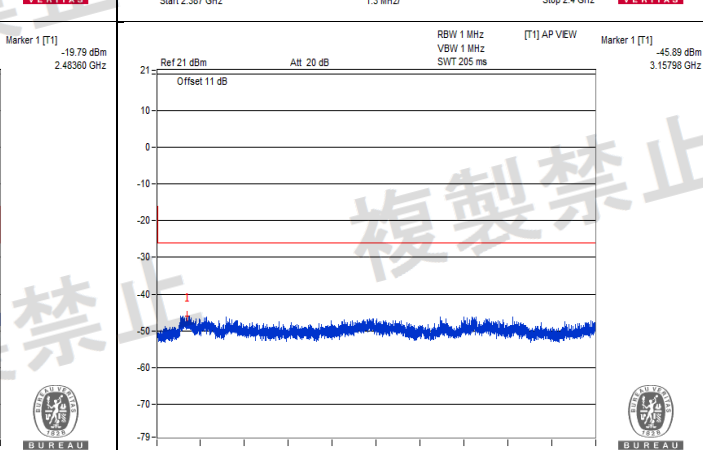
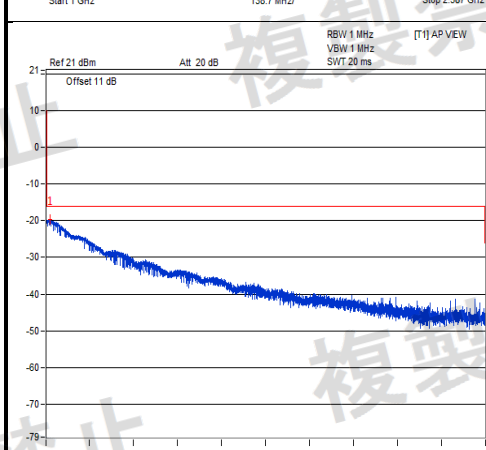
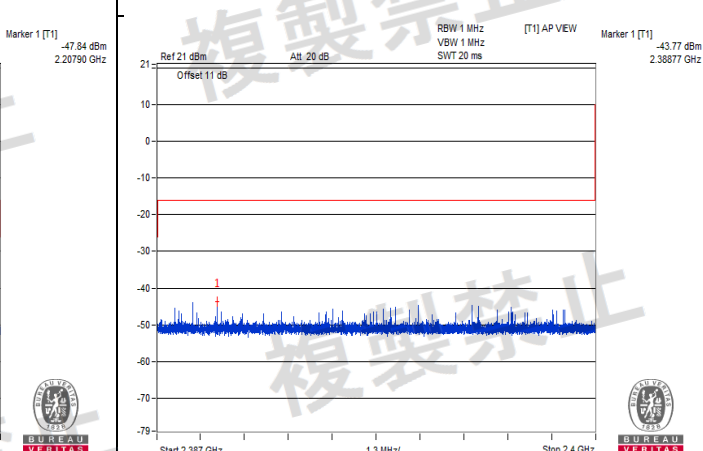
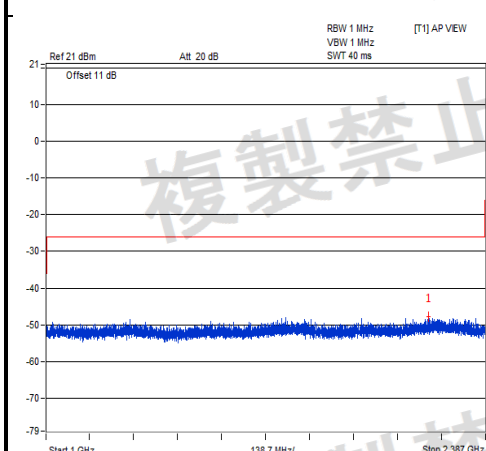
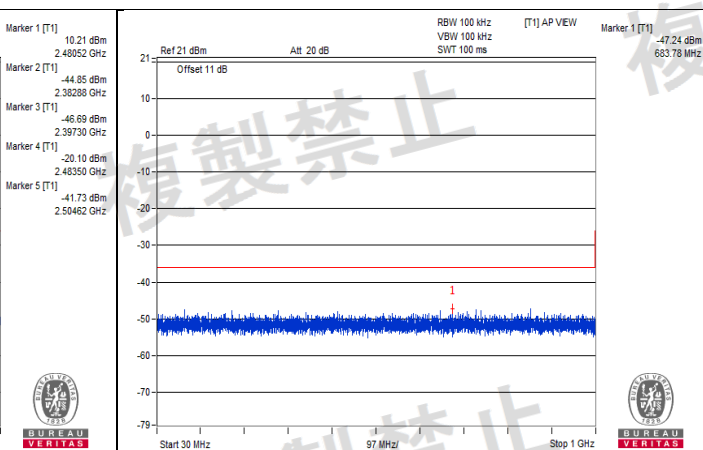
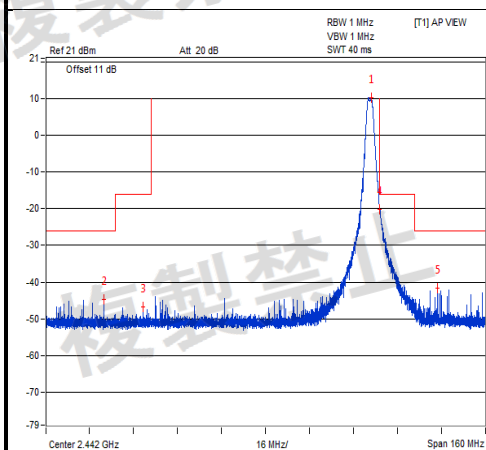
Channel 11

V normal



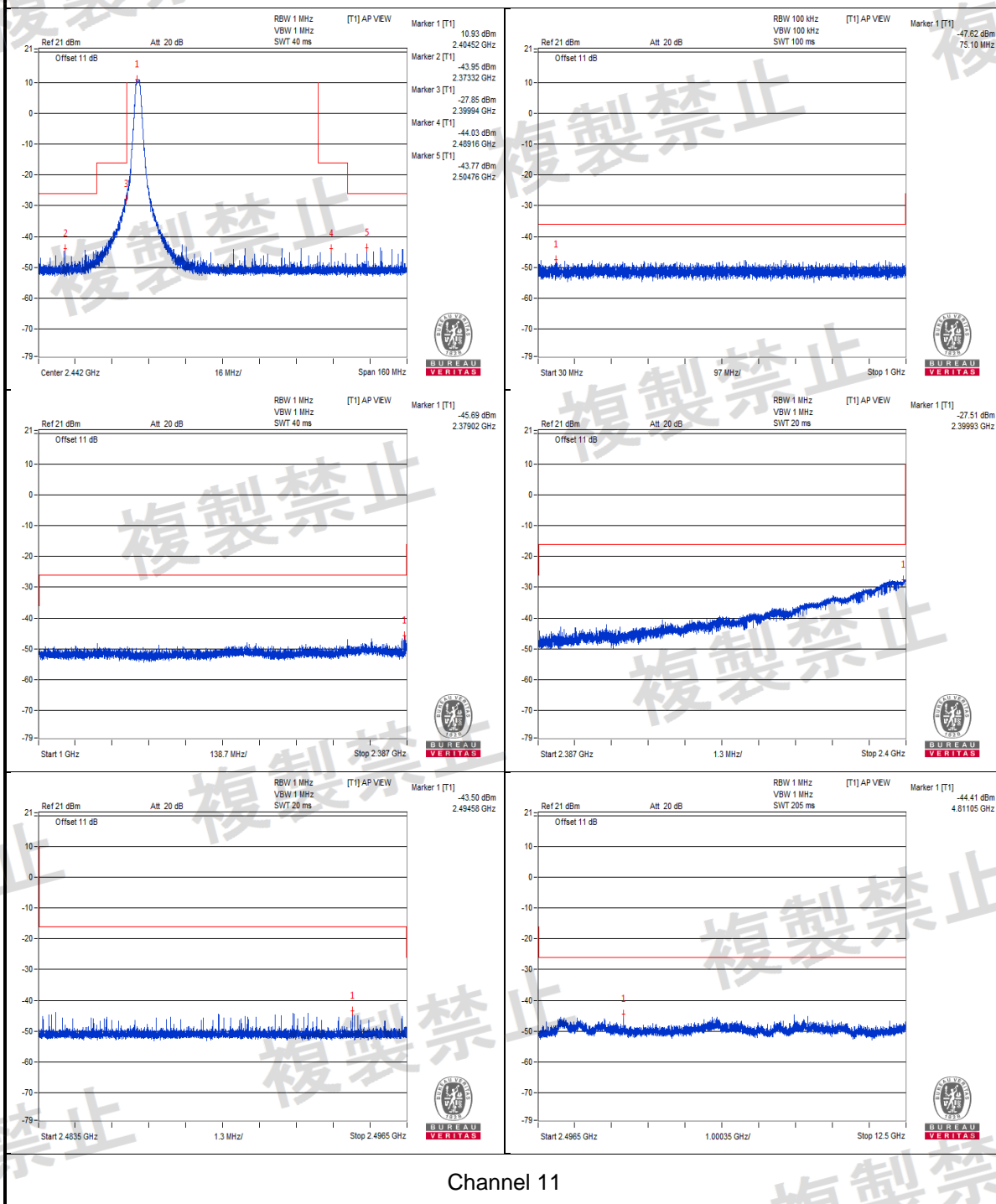
Channel 18

V normal

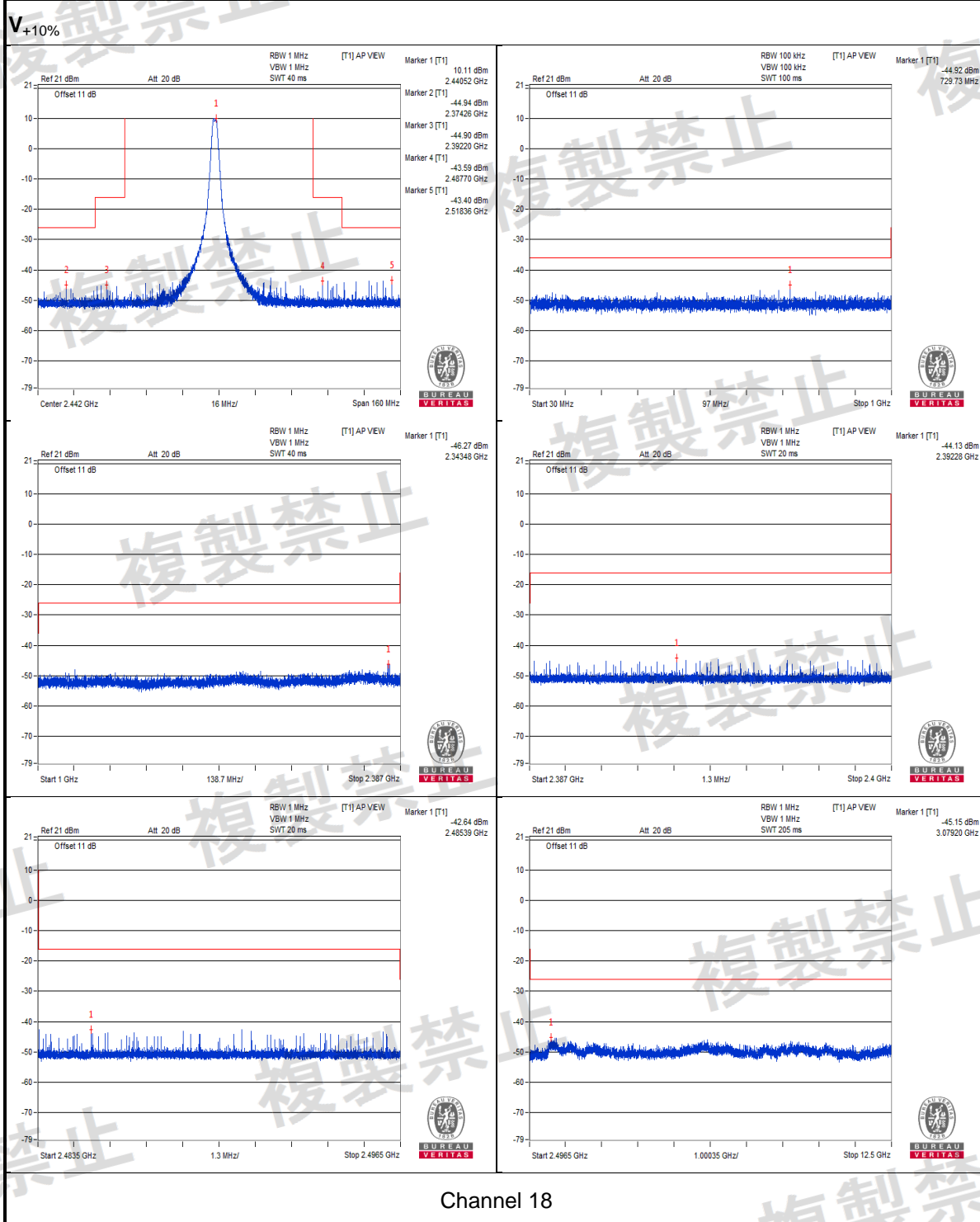


Channel 26

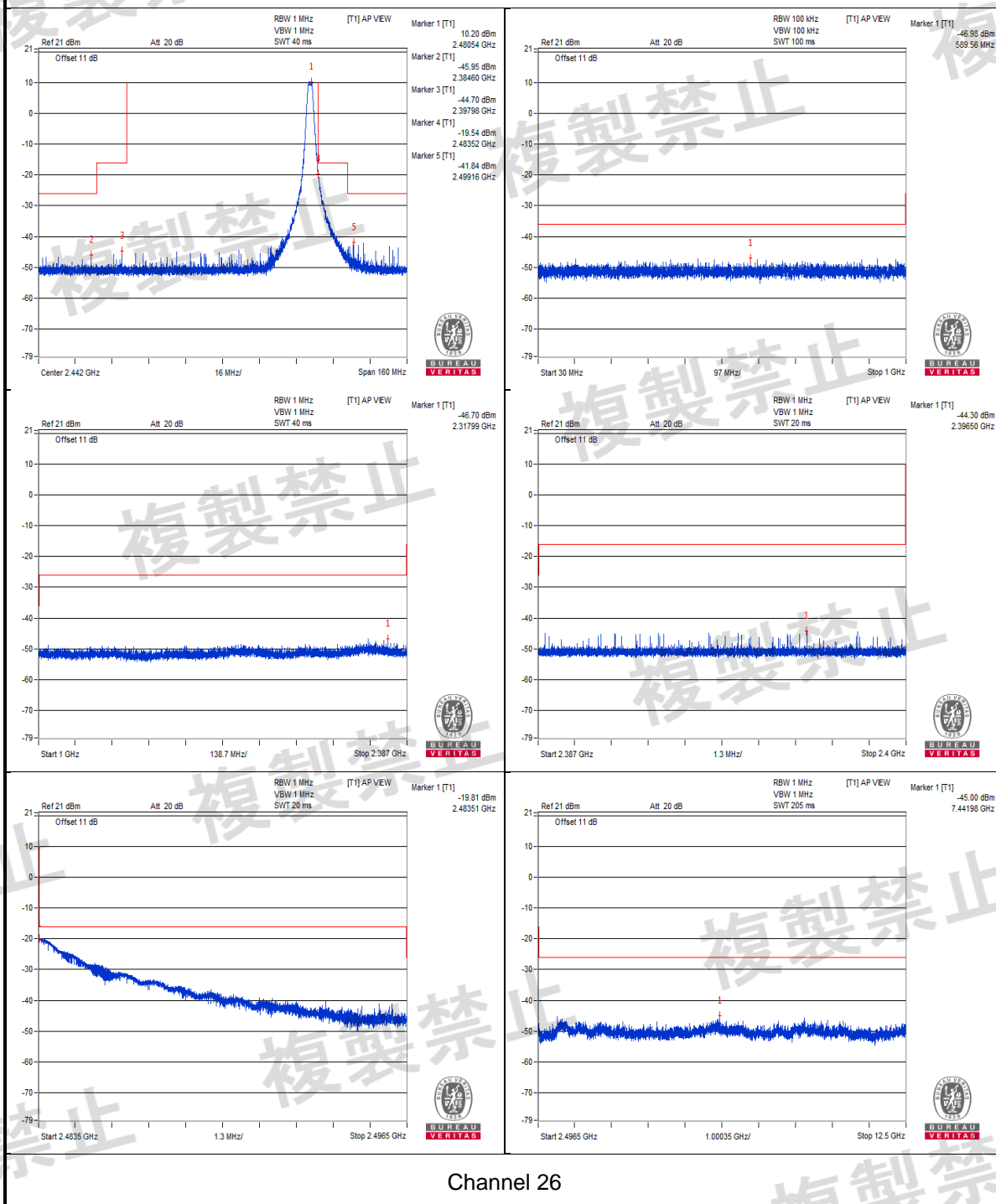
V+10%



Channel 11



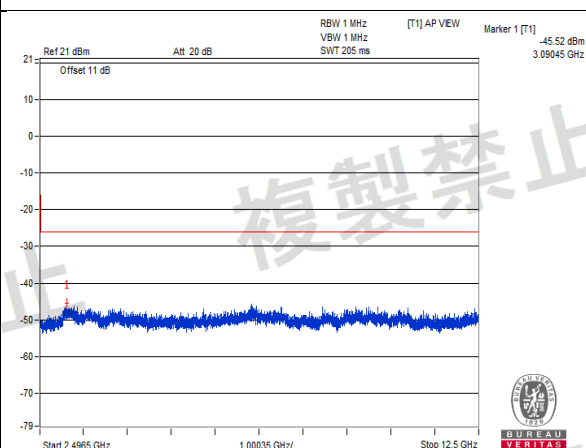
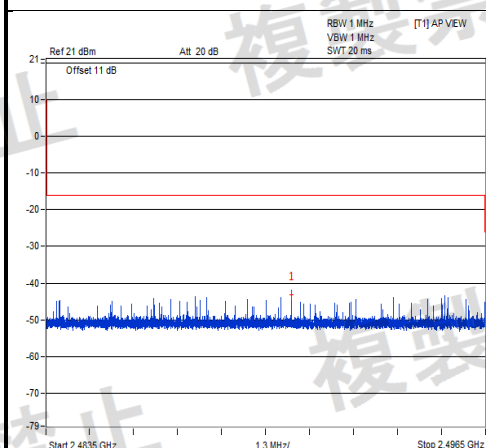
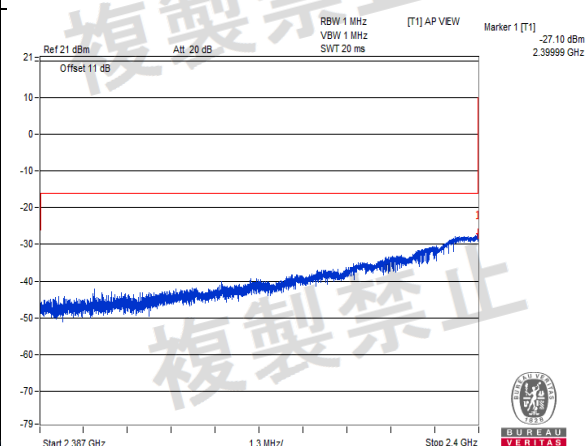
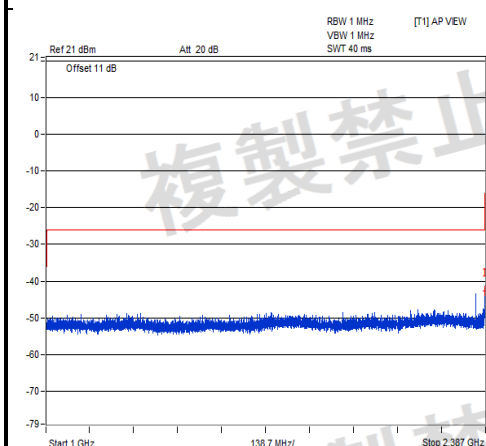
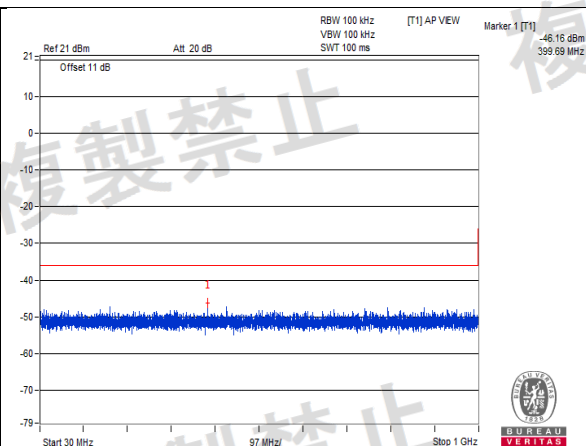
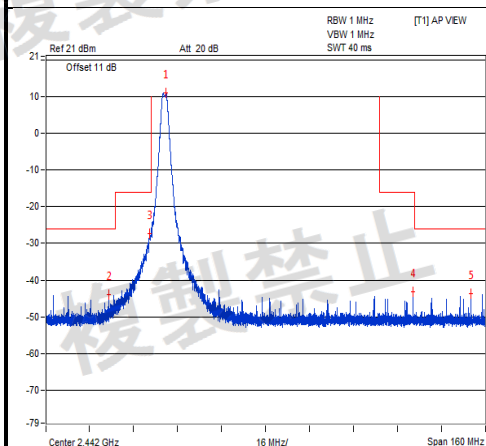
V+10%





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V-10%

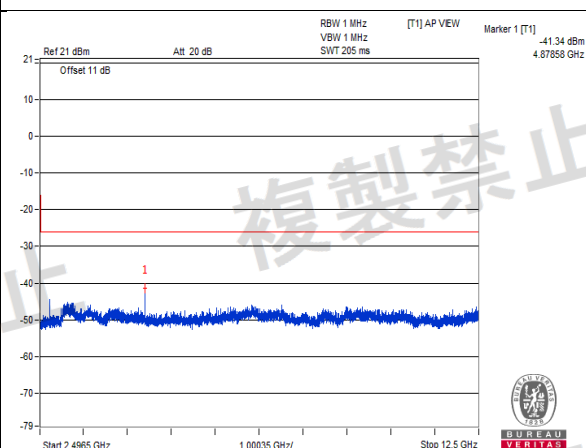
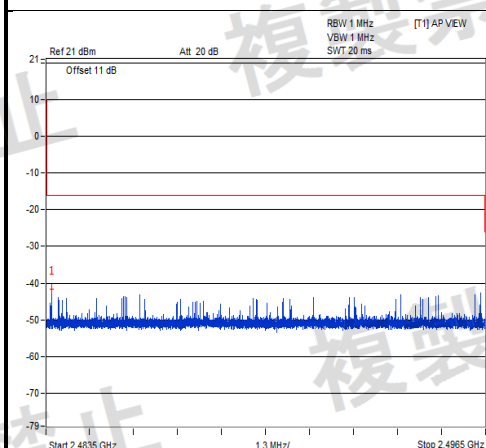
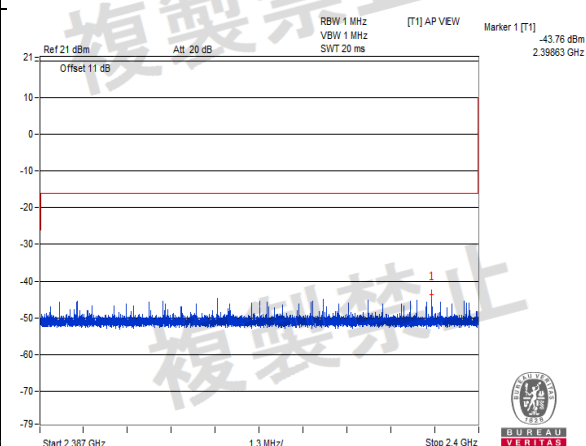
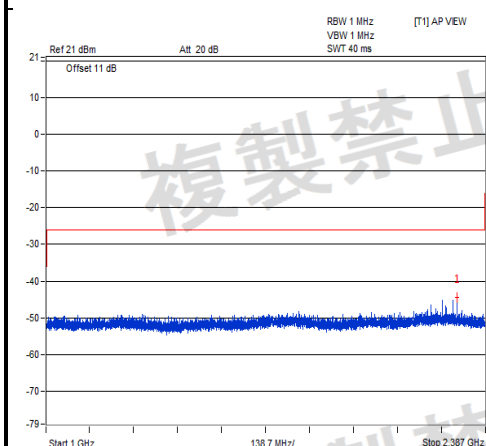
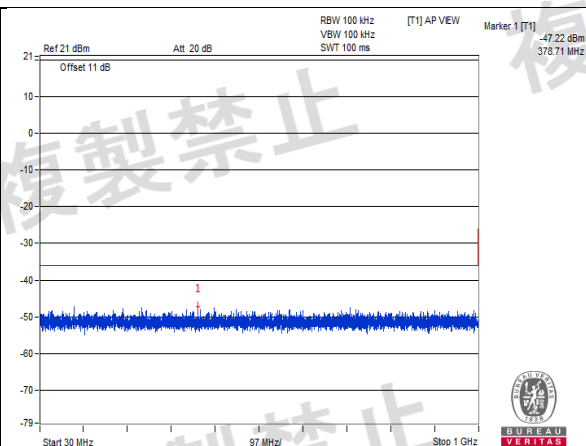
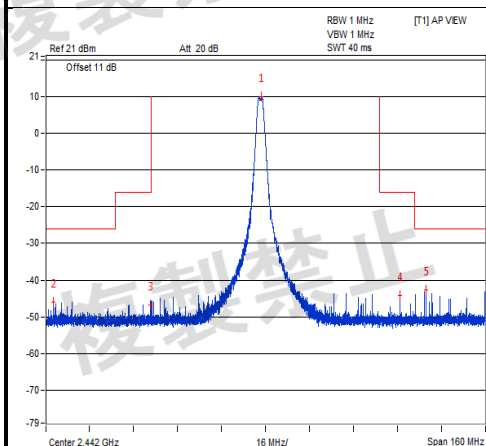


Channel 11



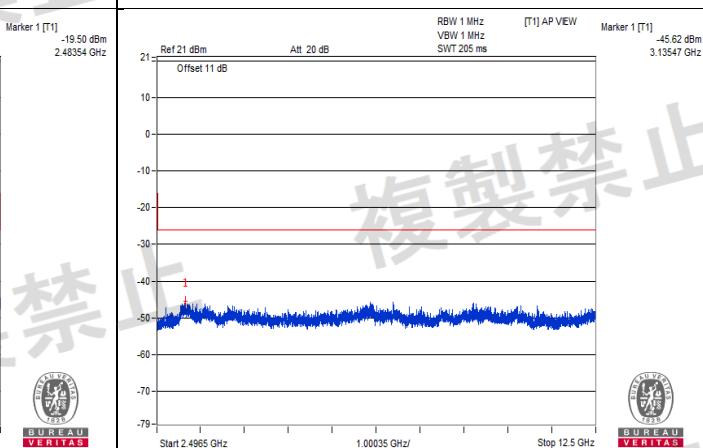
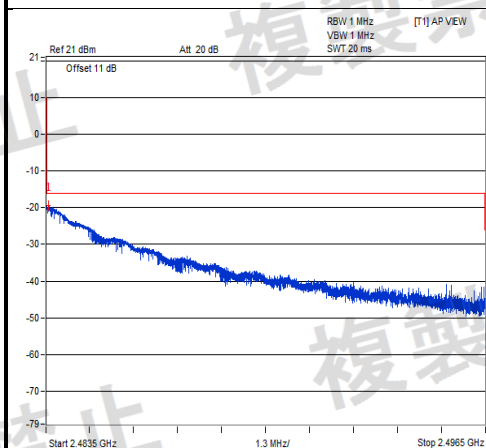
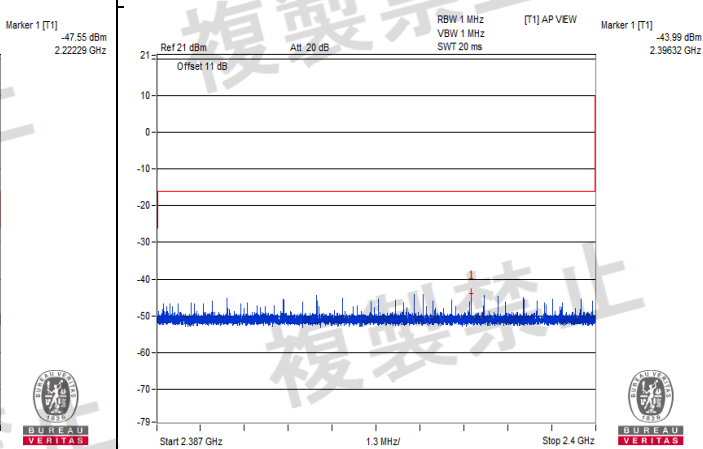
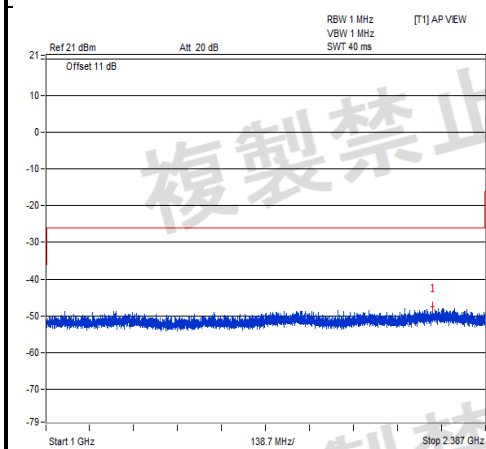
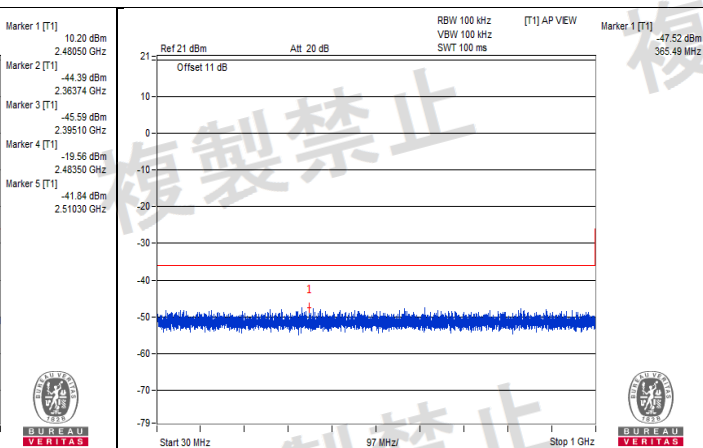
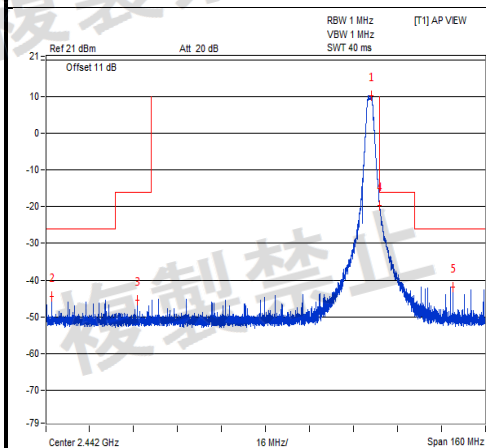
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V-10%



Channel 18

V-10%



Channel 26

4.4 Antenna Power Measurement

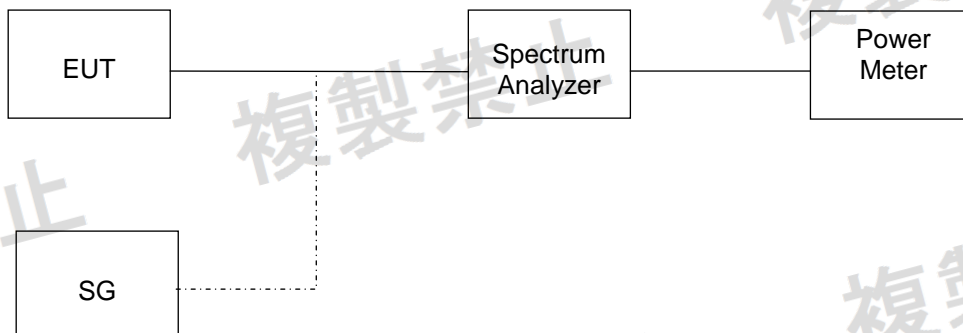
4.4.1 Limits of Antenna Power

Modulation System	Frequency Band Used	Antenna Power (Max.)	EIRP (Max.)	
			Omni-Directional Case	Directional Case
DS	2400 – 2483.5 MHz	10mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
OFDM (Note 1)	2400 – 2483.5 MHz	10mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
OFDM (Note 2)	2400 – 2483.5 MHz	5mW/MHz	9.14 dBm/MHz (8.203 mW/MHz)	19.14 dBm/MHz (82.03 mW/MHz)
Other than the above	2400 – 2483.5 MHz	10 mW	12.14 dBm (16.368 mW)	22.14 dBm (163.68 mW)

Note:

1. Occupied bandwidth is less than 26MHz
2. Occupied bandwidth is more than 26MHz and less than 38MHz
3. The half-power beam width for directional antenna shall be 360/A degrees or less, where A is a ratio which causes the EIRP concerned to exceed the omnidirectional EIRP upper limit.
4. Tolerance of antenna power shall be +20% (upper value) and –80% (lower value).

4.4.2 Test Setup



4.4.3 Test Results

Environmental Conditions	25 deg.C, 60% RH			
Channel Number	Frequency (MHz)	Conducted RF Output Power Density (mW/MHz)		
		V _{normal}	V _{max}	V _{min}
11	2405	9.419	9.268	9.183
18	2440	9.484	9.75	9.462
26	2480	9.817	9.638	9.594
Max. Limit (mW/MHz)		10		
Rated Power		10		
Tolerance of Antenna Power		2~12		

Dipole antenna with antenna gain: 0.85dBi

Environmental Conditions	25 deg.C, 60% RH			
Channel Number	Frequency (MHz)	Radiated RF Output Power Density (mW/MHz)		
		V _{normal}	V _{max}	V _{min}
11	2405	11.455	11.272	11.168
18	2440	11.534	11.858	11.508
26	2480	11.939	11.722	11.668
Max. Limit (mW/MHz)		16.368		

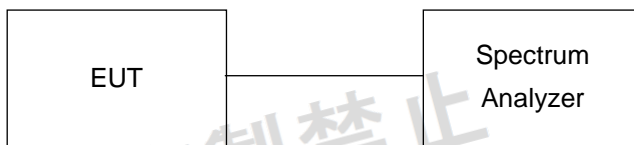
Note: 1. The radiated RF output power density is a “calculated” value derived from the conducted value.
 2. Formula: Radiated RF output power density = Conducted RF output power density + Antenna Gain.

4.5 Spurious Emissions for Receiver

4.5.1 Limits of Spurious Emissions for Receiver

Frequencies (MHz)	Limit
Below 1GHz	$\leq 4\text{nW}$ (-54dBm)
Above 1GHz	$\leq 20\text{nW}$ (-47dBm)

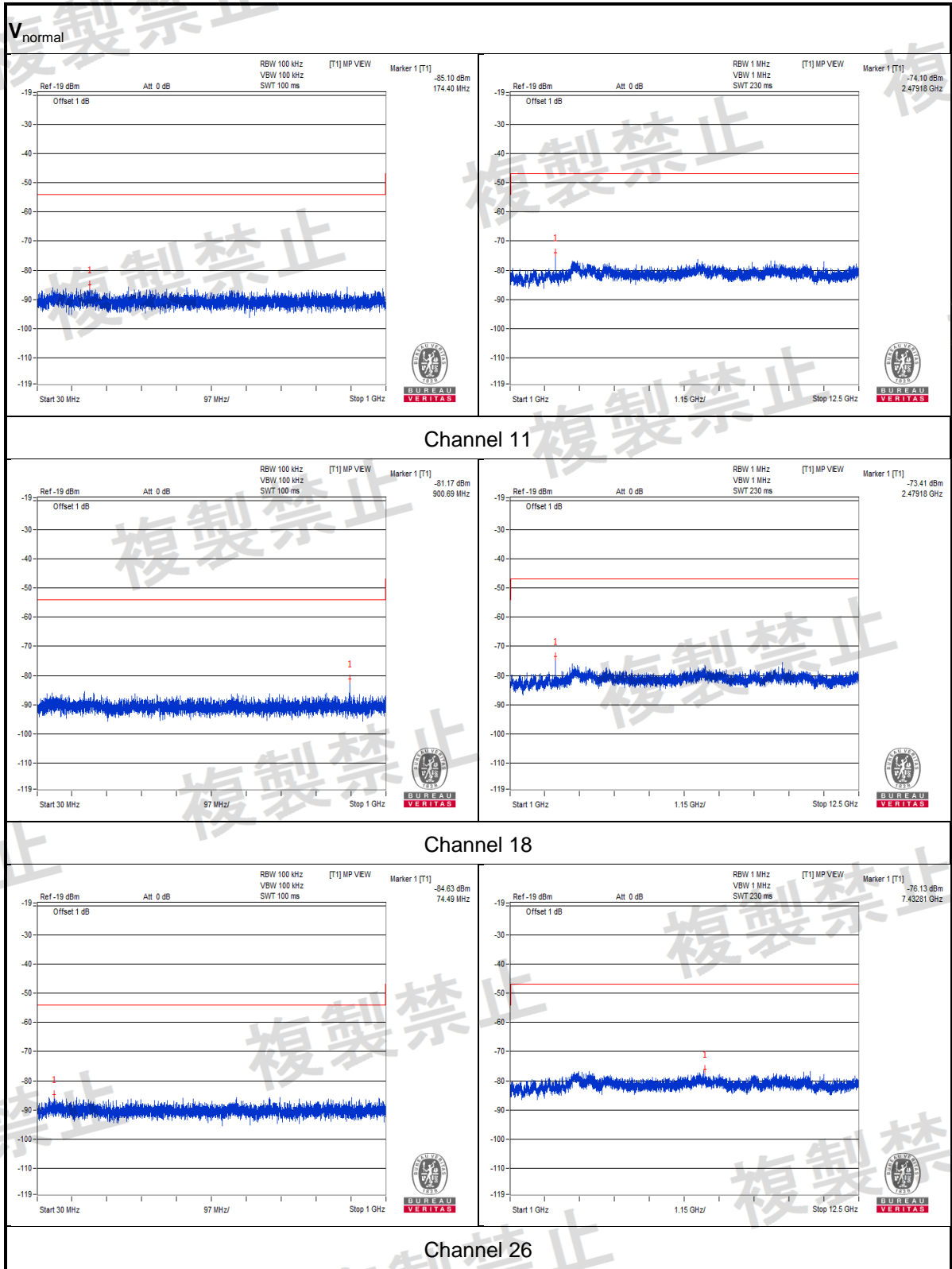
4.5.2 Test Setup



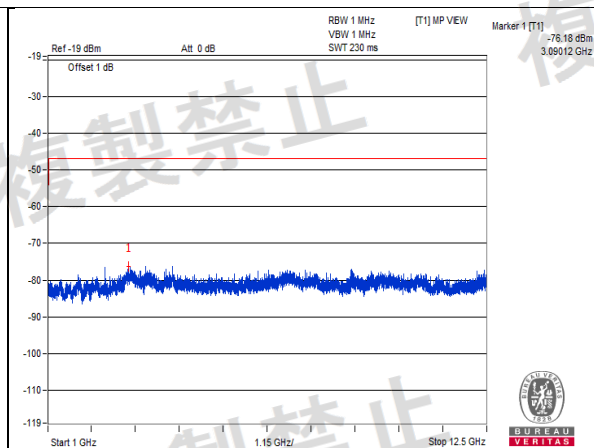
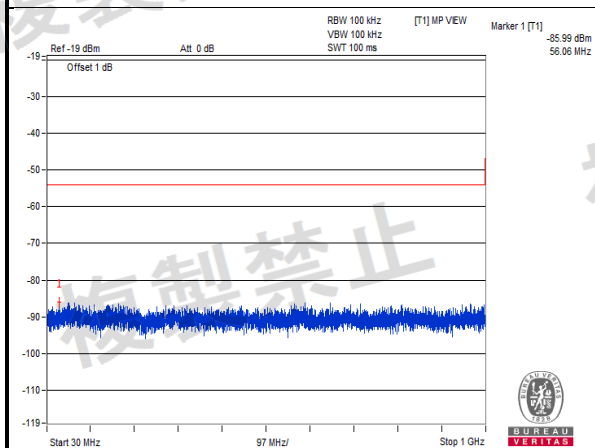
4.5.3 Test Result

Environmental Conditions		25 deg.C, 60% RH					
Test Channel		Channel 11 (2405MHz)		Channel 18 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
V _{normal}	Below 1GHz	174.4	0.00309nW	900.69	0.007638nW	4nW	PASS
	Above 1GHz	2479.18	0.038905nW	2479.18	0.045604nW	20nW	PASS
V _{+10%}	Below 1GHz	56.06	0.002518nW	93.29	0.002483nW	4nW	PASS
	Above 1GHz	3090.12	0.024099nW	2479.18	0.051642nW	20nW	PASS
V _{-10%}	Below 1GHz	307.17	0.003724nW	419.81	0.002924nW	4nW	PASS
	Above 1GHz	6836.25	0.023988nW	2479.18	0.038548nW	20nW	PASS
Test Channel		Channel 26 (2480MHz)				Limit	Result
Test Condition	Frequency Range	Frequency (MHz)		Measured Value			
V _{normal}	Below 1GHz	74.49		0.003443nW		4nW	PASS
	Above 1GHz	7432.81		0.024378nW		20nW	PASS
V _{+10%}	Below 1GHz	178.53		0.002748nW		4nW	PASS
	Above 1GHz	2479.18		0.031117nW		20nW	PASS
V _{-10%}	Below 1GHz	329.24		0.003451nW		4nW	PASS
	Above 1GHz	2479.18		0.035237nW		20nW	PASS

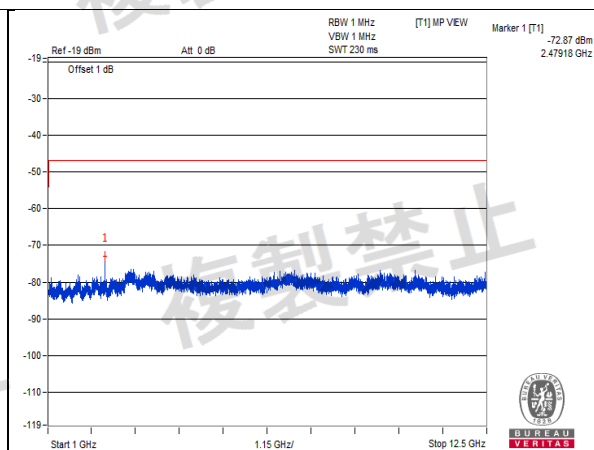
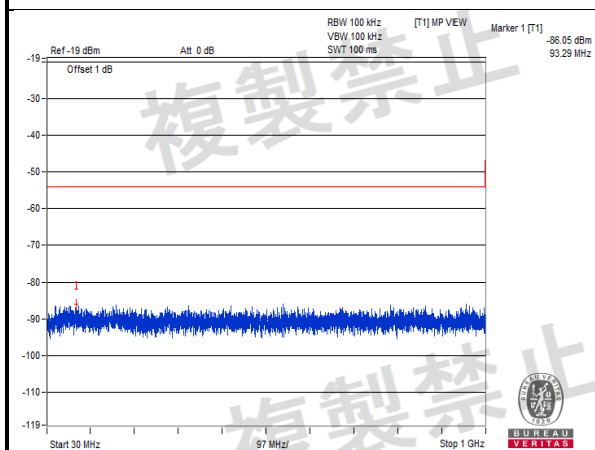
Note: 1. The worst value in each frequency range v.s. each channel has been marked by boldface.
2. The spectrum plots are attached on the following pages.



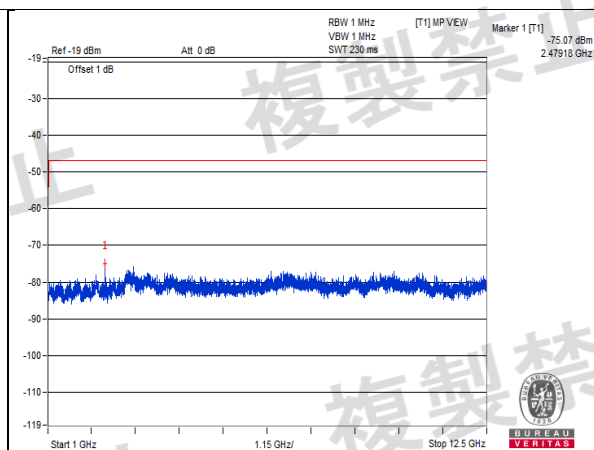
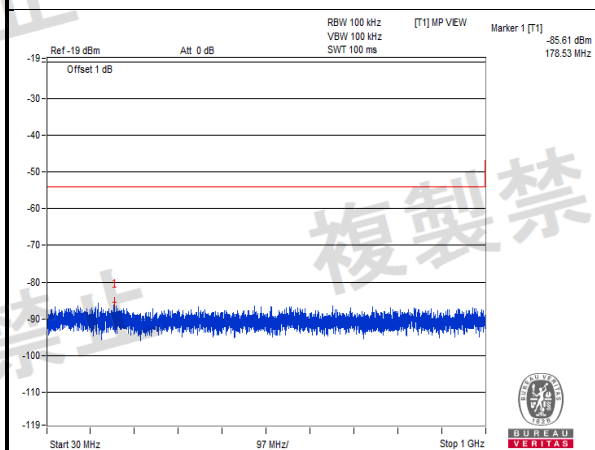
V+10%



Channel 11



Channel 18

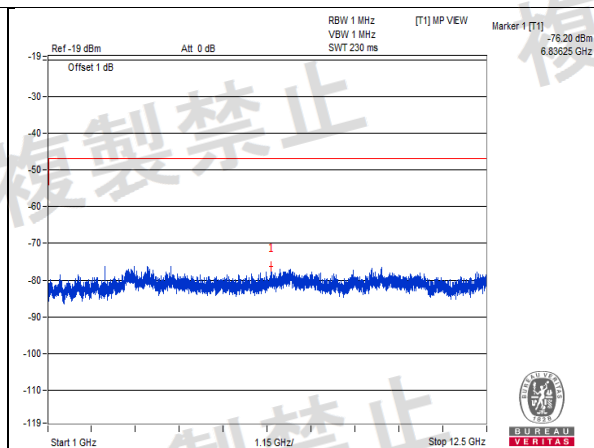
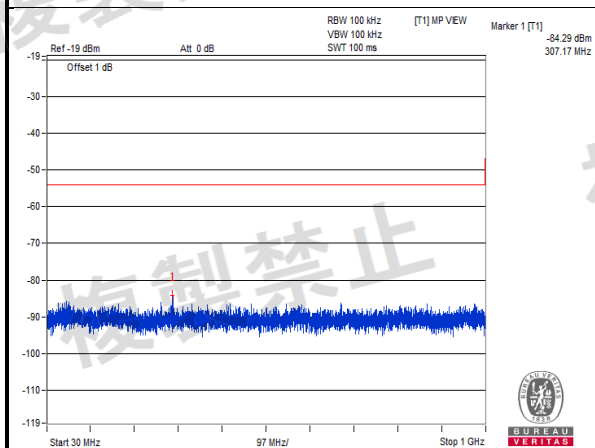


Channel 26

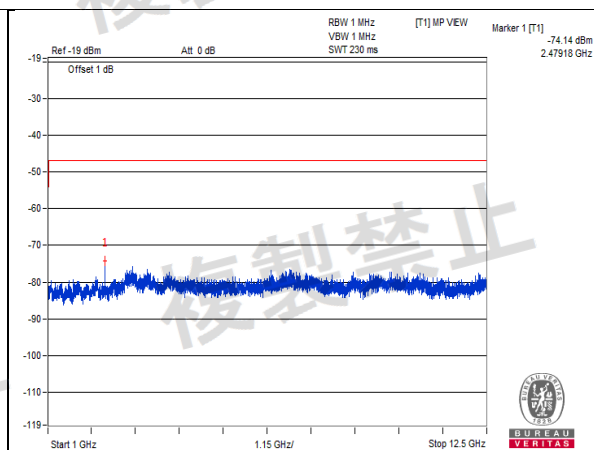
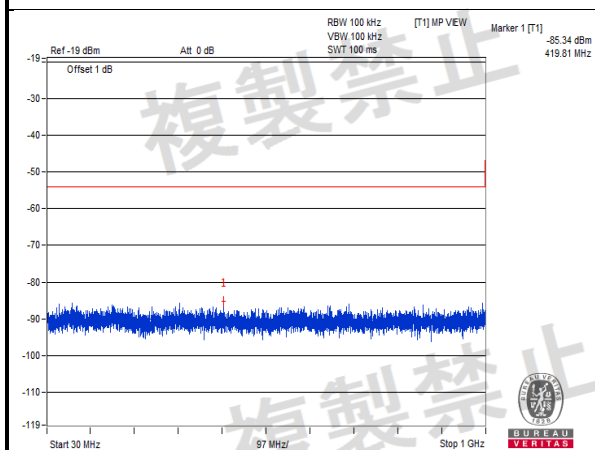


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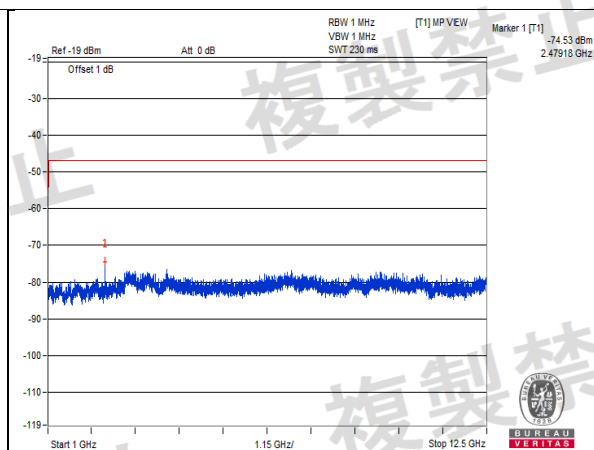
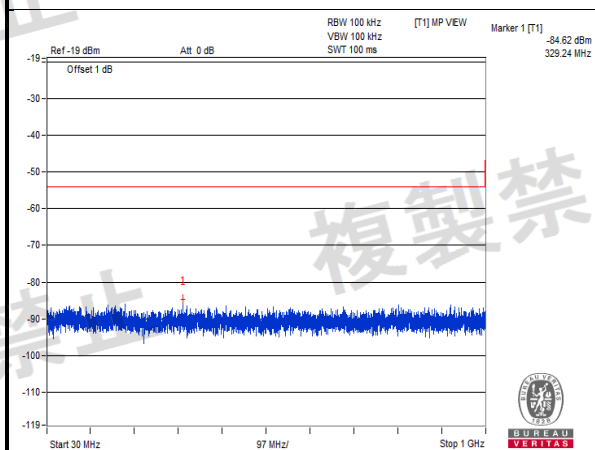
V-10%



Channel 11



Channel 18



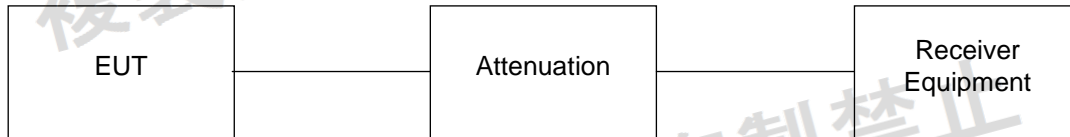
Channel 26

4.6 Interference Prevention Function

4.6.1 Limits of Interference Prevention Function

Radio equipment used mainly on the same premises and automatically transmits or receives identification code.

4.6.2 Test Setup



4.6.3 Test Results

Environmental Conditions	25 deg.C, 60% RH
Link Mode	Test Result
Zigbee	PASS

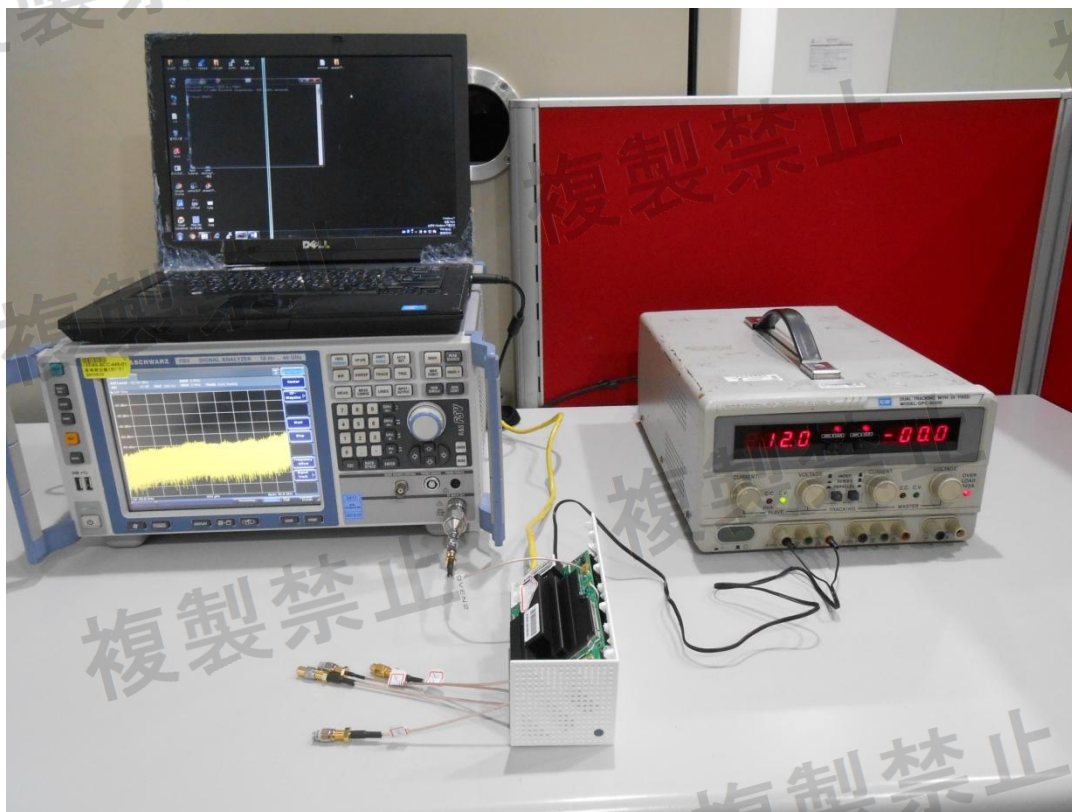
5 Test Instruments

Description & Manufacturer	Model no.	Serial No.	Calibrated DATE	Calibrated Until	Calibration Authority
Spectrum Analyzer R&S	FSV40	100964	July 1, 2017	June 30, 2018	ETC
ESG Vector signal generator Agilent	E4438C	MY47271330.506 602 UNJ	Oct, 11, 2017	Oct. 10, 2018	ETC
Detector Narda	4503A	0306	NA	NA	NA
Power Meter Anritsu	ML2495A	1014008	MAY 11, 2017	MAY 10, 2018	ETC
Power Sensor Anritsu	MA2411B	0917122	MAY 11, 2017	MAY 10, 2018	ETC
Digital Oscilloscope R&S	RTO1012	300053	June 28, 2017	June 27, 2018	ETC
DC Power Supply Topward	6603D	795558	NA	NA	NA
AC Power Source Exttech Electronics	6205	1440452	NA	NA	NA
True RMS Clamp Meter FLUKE	325	31130711WS	May 29, 2017	May 28, 2018	ETC

NOTE:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. Tested Date: Mar. 02, 2018.

6 Photographs of the Test Configuration



Appendix - Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Linko EMC/RF Lab

Tel: 886-2-26052180

Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab

Tel: 886-3-6668565

Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety Lab

Tel: 886-3-3183232

Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com

Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

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