



Radio Test Report

Report No.: RJ180605C12-2

Test Model: ZX1

Received Date: Jun. 05, 2018

Test Date: Jul. 03 ~ Jul. 04, 2018

Issued Date: Jul. 13, 2018

Applicant: Carl Zeiss AG

Address: Carl-Zeiss-Str. 22,D-73447 Oberkochen,Germany

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

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Table of Contents

Release Control Record	3
1 Certificate of Conformity	4
2 Summary of Test Results	5
2.1 Test Instruments	6
2.2 Measurement Uncertainty	6
2.3 Modification Record	6
3 General Information	7
3.1 General Description of EUT	7
3.2 Description of Test Modes	8
3.3 Test Conditions	8
3.4 Assembly	8
3.5 Antenna Specifications	9
3.5.1 Antenna Gain	9
3.5.2 Antenna Pattern	9
4 Test Results	10
4.1 Frequency Tolerance Measurement	10
4.1.1 Limits of Frequency Tolerance Measurement	10
4.1.2 Test Setup	10
4.1.3 Test Results	11
4.2 Occupied Bandwidth Measurement (99% power bandwidth)	14
4.2.1 Limits of Occupied Bandwidth Measurement	14
4.2.2 Test Setup	14
4.2.3 Test Results	15
4.3 Spreading Bandwidth Measurement (90% power bandwidth)	18
4.3.1 Limits of Spreading Bandwidth and Spreading Factor Measurement	18
4.3.2 Test Setup	18
4.3.3 Test Results	19
4.4 Spurious Emissions for Transmitter Measurement	22
4.4.1 Limits of Spurious Emissions	22
4.4.2 Test Setup	22
4.4.3 Test Results	23
4.5 Antenna Power Measurement	34
4.5.1 Limits of Antenna Power	34
4.5.2 Test Setup	34
4.5.3 Test Results	34
4.6 Spurious Emissions for Receiver	35
4.6.1 Limits of Spurious Emissions For Receiver	35
4.6.2 Test Setup	35
4.6.3 Test Result	36
4.7 Interference Prevention Function	40
4.7.1 Limits of Interference Prevention Function	40
4.7.2 Test Setup	40
4.7.3 Test Results	40
5 Photographs of the Test Configuration	41
Appendix - Information on the Testing Laboratories	42



Release Control Record

Issue No.	Description	Date Issued
RJ180605C12-2	Original release	Jul. 13, 2018



1 Certificate of Conformity

Product: Digital Camera

Brand: ZEISS

Test Model: ZX1

Sample Status: Engineering sample

Applicant: Carl Zeiss AG

Test Date: Jul. 03 ~ Jul. 04, 2018

Standards: ARIB STD-T66 (V3.7), MIC notice 88 Appendix 43
Certification Ordinance Article 2-1-19

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 RF characteristics under the conditions specified in this report.

Prepared by : Celine Chou, **Date:** Jul. 13, 2018
Celine Chou / Specialist

Approved by : Bruce Chen, **Date:** Jul. 13, 2018
Bruce Chen / Project Engineer



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)	4.4	Spurious emissions	C
Transmitting Equipment				
F	--	4.5	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)	4.6	Spurious emissions of receiver	C
--	--	--	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)	4.5	Antenna power	C
--	3.6 (2)	4.5	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)	4.3	Spreading bandwidth	C
--	3.2 (9)	4.3	Spreading factor	C
--	3.2 (11)	--	Frequency retention time (FH employed)	NA
--	3.4.1(1)	4.7	Interference Prevention Function	C
Note: C = Conform NC = Not Conform NT = Not Tested NA = Not Applicable				



2.1 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date of Calibration	Calibration Authority
Spectrum Analyzer Rohde & Schwarz	FSV40	100980	Apr. 17, 2018	Apr. 16, 2019	ETC
Signal Generator / Anritsu	E4438C	MY49071692	Sep. 20, 2017	Sep. 19, 2018	ETC
Power Meter / Anritsu	ML2495A	0824012	Aug. 18, 2017	Aug. 17, 2018	ETC
Power Sensor / Anritsu	MA2411B	0738171	Aug. 18, 2017	Aug. 17, 2018	ETC
DC power supply / Keysight	U8002A	MY56330015	Sep. 22, 2017	Sep. 21, 2018	NA

Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.

2.2 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	491.896Hz
Spurious emissions	3.508dB
Output power density	2.889dB
Out of band radiated power	3.93dB
Frequency Tolerance	6805.18Hz

2.3 Modification Record

There were no modifications required for compliance.



3 General Information

3.1 General Description of EUT

Product	Digital Camera
Brand	ZEISS
Test Model	ZX1
Status of EUT	Engineering sample
Nominal Voltage	5Vdc from adapter or host equipment 7.2Vdc from battery
Modulation Type	GFSK
Transfer Rate	1Mbps
Operating Frequency	2402 ~ 2480MHz
Number of Channel	40
Rated RF Output Power Density	2.00mW
Conducted RFOutput Power Density	2.159mW
Radiated RF Output Power Density	1.453mW
Antenna Type	Refer to note
Antenna Connector	Refer to note
Accessory Device	Adapter, Battery
Data Cable Supplied	0.95m shielded USB type C cable without core

Note:

1. The EUT consumes power from the following Adapter & Battery.

Adapter	
Brand	ZEISS
Model	EA1045SJR
Input Power	100-240Vac, 50/60Hz, 1.5A
Output Power	5Vdc, 3A or 9Vdc, 3A or 15Vdc, 3A or 20Vdc, 2.25A

Battery	
Brand	ZEISS
Model	DD-PS1E
Rating	7.2Vdc, 3190mAh, 22.9Wh

2. The following antennas were provided to the EUT.

No.	Brand	Model	Type	Connector	Gain (dBi)	
					2.4G	5G
1	LYNwave	ALA160-221033-000000	PCB	IPEX4	-1.72	1.69
2	LYNwave	ALA160-222040-000000	PCB	IPEX4L	-2.40	3.09



3.2 Description of Test Modes

40 channels are provided to this EUT:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

Note: 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 (QRCT) provided by manufacture, the power levels during the tests were set according to the following codes:

Modulation Type: GFSK	
Channel	Power Setting
0	default
19	default
39	default

3.3 Test Conditions

Test Conditions	Voltage (Vdc)
Vnormal	7.20
Vmax.	8.36
Vmin.	6.00

3.4 Assembly

The modulation section, preamplifier, RF component etc, are shielded in the inside of the black plastic housing, and used the tenon and the glue on the PCB. Therefore, it is not capable of being open easily.

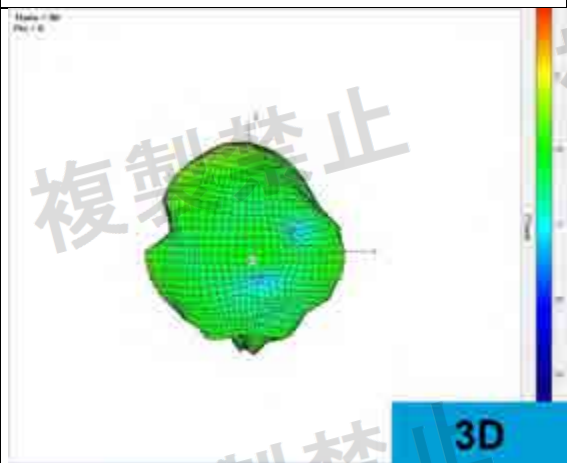
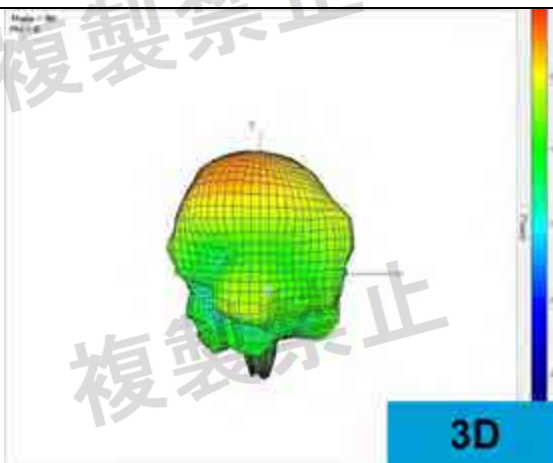
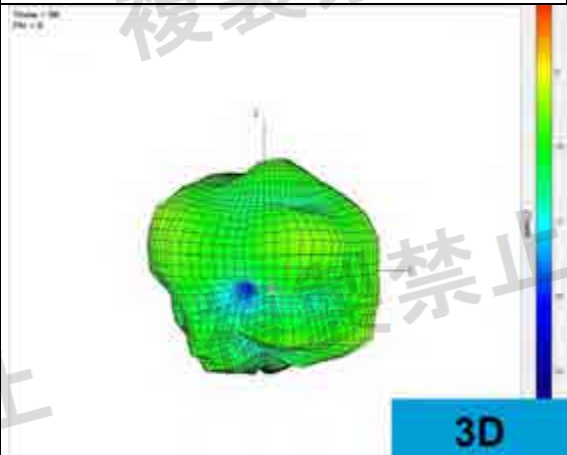
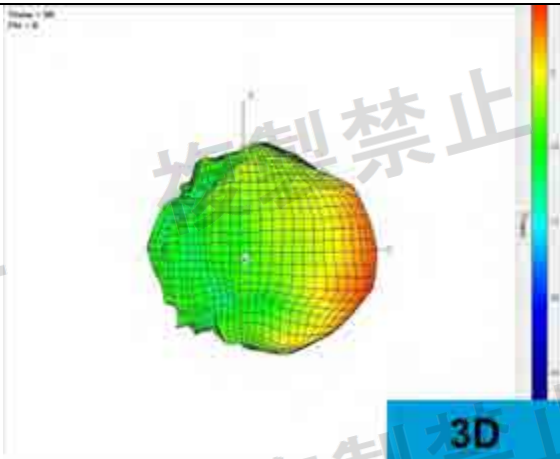


3.5 Antenna Specifications

3.5.1 Antenna Gain

No.	Brand	Model	Type	Connector	Gain (dBi)	
					2.4G	5G
1	LYNwave	ALA160-221033-000000	PCB	IPEX4	-1.72	1.69
2	LYNwave	ALA160-222040-000000	PCB	IPEX4L	-2.40	3.09

3.5.2 Antenna Pattern

Ant. No.	Antenna Pattern	
1	2.4G	5G
		
2	2.4G	5G
		



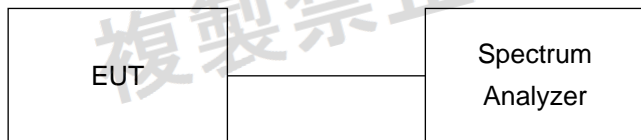
4 Test Results

4.1 Frequency Tolerance Measurement

4.1.1 Limits of Frequency Tolerance Measurement

Tolerance of frequency shall be +/- 50ppm

4.1.2 Test Setup

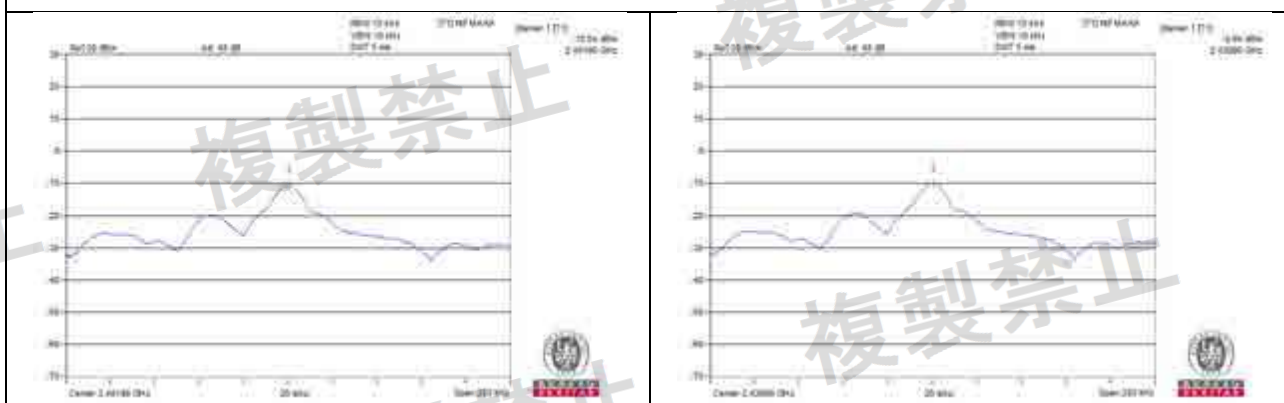




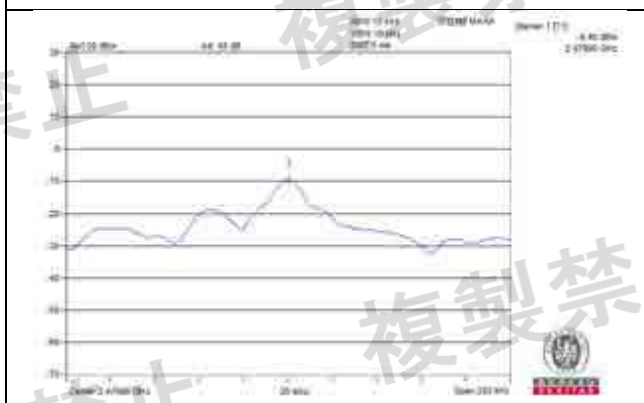
4.1.3 Test Results

Environmental Conditions		25 deg.C, 68% RH					
Channel	Frequency (MHz)	Vnormal		Vmax.		Vmin.	
		Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)
0	2402	2401.990400	-3.996	2401.990800	-3.830	2401.990800	-3.830
19	2440	2439.990800	-3.770	2439.990800	-3.770	2439.990800	-3.770
39	2480	2479.990800	-3.709	2479.990800	-3.709	2479.990800	-3.709

Vnormal



Channel 0



Channel 19

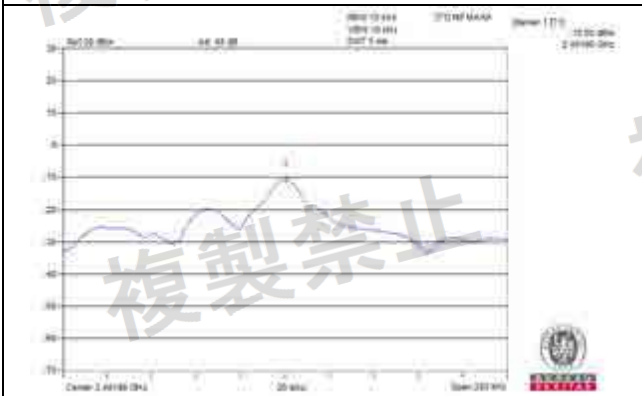


Channel 39

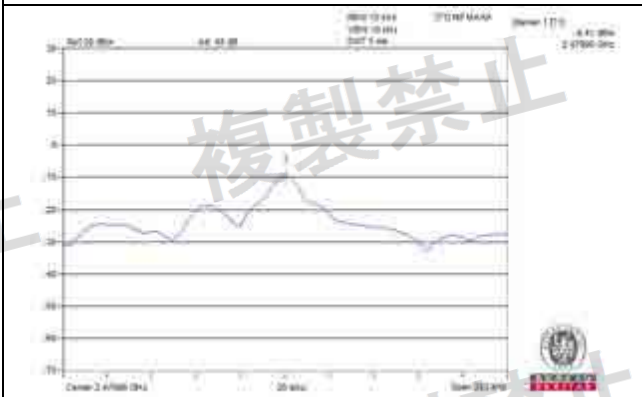
Measurement uncertainty: ± 206.50 Hz



V_{max}.



Channel 0



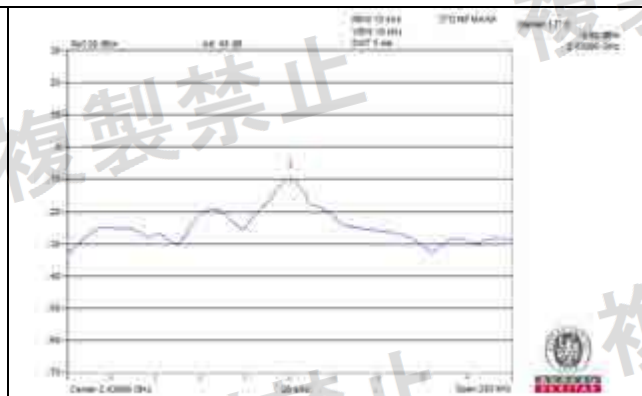
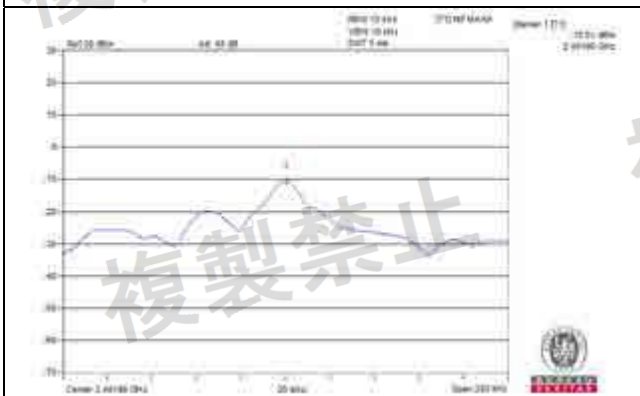
Channel 19

Channel 39

Measurement uncertainty: ± 206.50 Hz

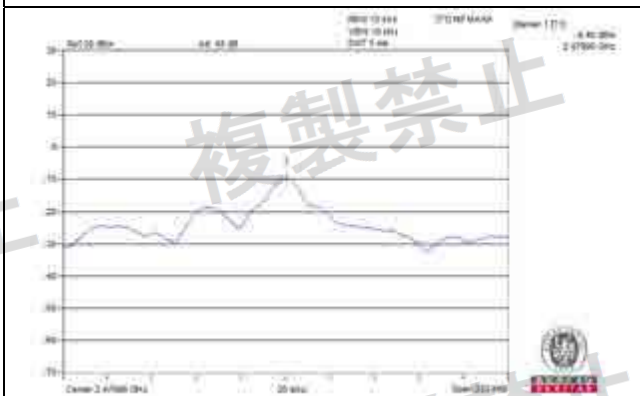


Vmin.



Channel 0

Channel 19



Channel 39

Measurement uncertainty: ± 206.50 Hz

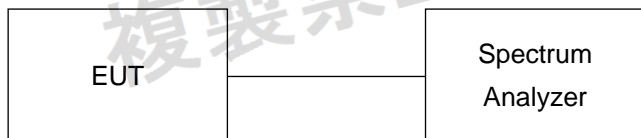


4.2 Occupied Bandwidth Measurement (99% power bandwidth)

4.2.1 Limits of Occupied Bandwidth Measurement

Item	Limit
Occupied bandwidth	<26MHz

4.2.2 Test Setup



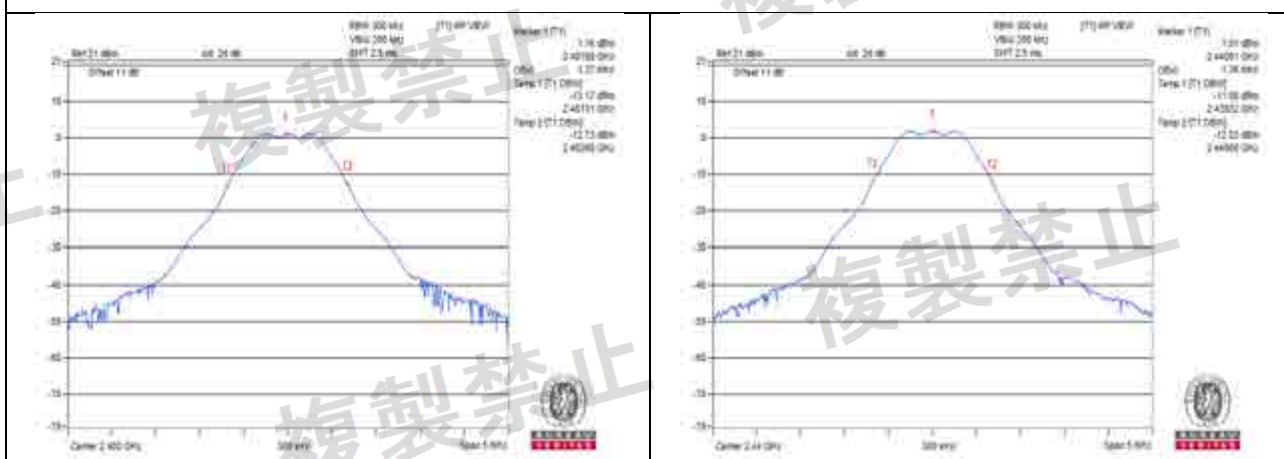


4.2.3 Test Results

Environmental Conditions		25 deg.C, 68% RH		
Channel	Frequency (MHz)	Vnormal	Vmax.	Vmin.
		Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
0	2402	1.37	1.37	1.36
19	2440	1.36	1.36	1.36
39	2480	1.36	1.36	1.36

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

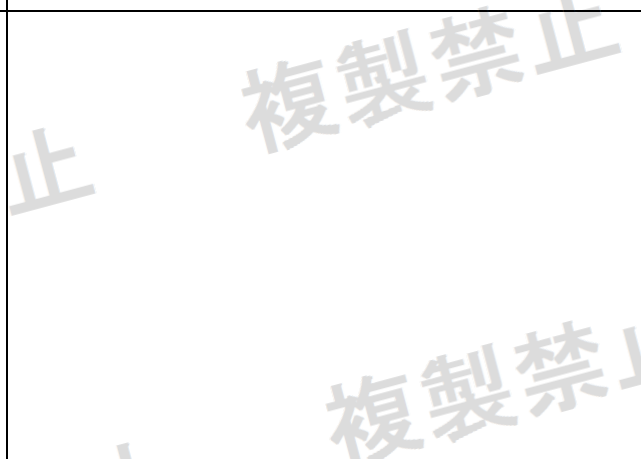
Vnormal



Channel 0



Channel 19

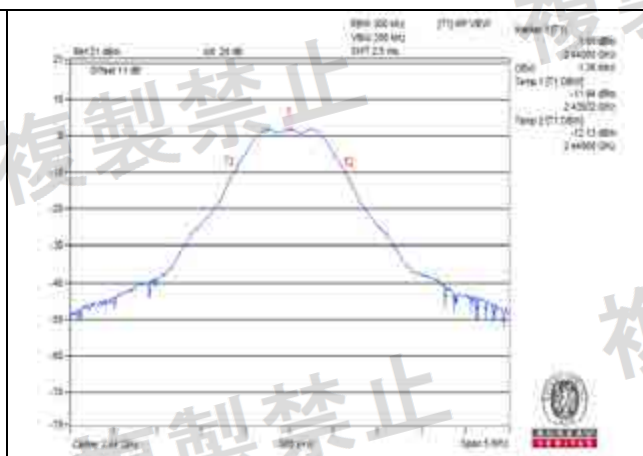
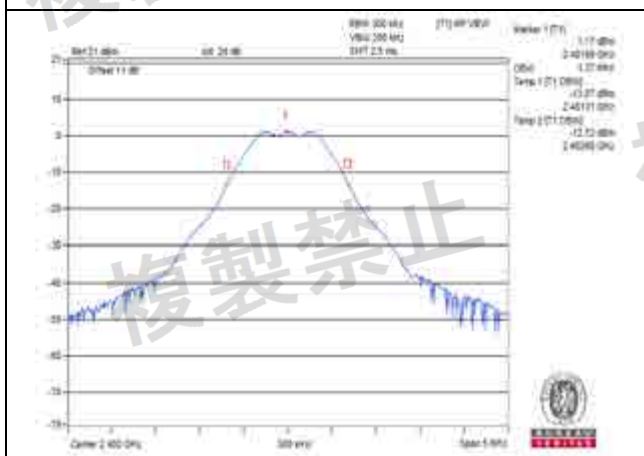


Channel 39

Measurement uncertainty: ± 206.50 Hz

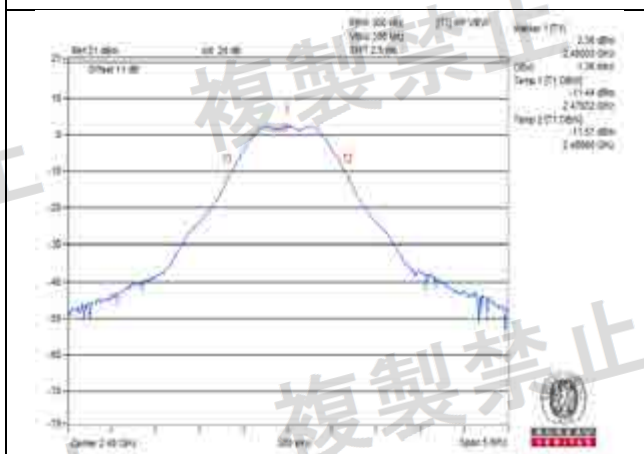


Vmax.



Channel 0

Channel 19

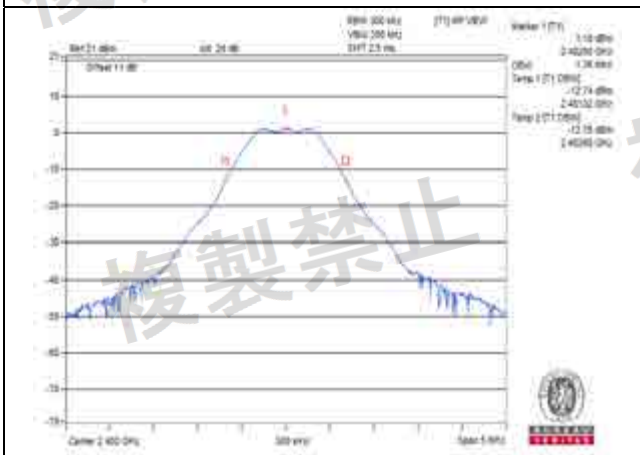


Channel 39

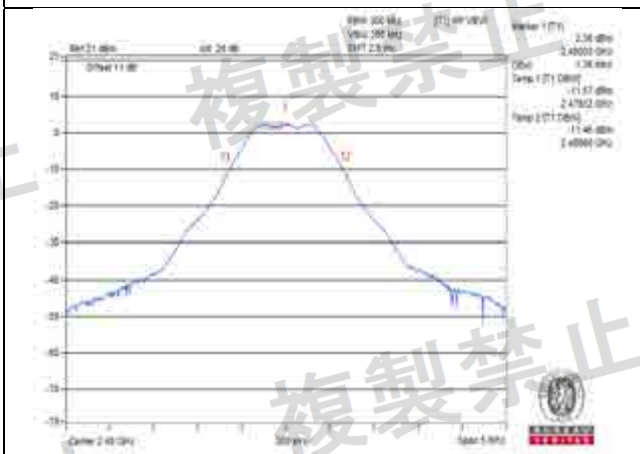
Measurement uncertainty: ± 206.50 Hz



Vmin.

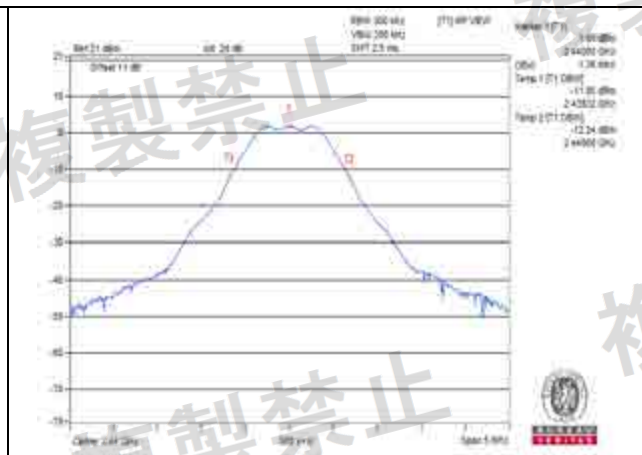


Channel 0



Channel 39

Measurement uncertainty: ± 206.50 Hz



Channel 19



4.3 Spreading Bandwidth Measurement (90% power bandwidth)

4.3.1 Limits of Spreading Bandwidth and Spreading Factor Measurement

Item	Limit	Remark
Spreading Bandwidth	$\geq 500\text{kHz}$	
Spreading Factor	≥ 5	Operating frequency 2400 to 2483.5MHz

4.3.2 Test Setup





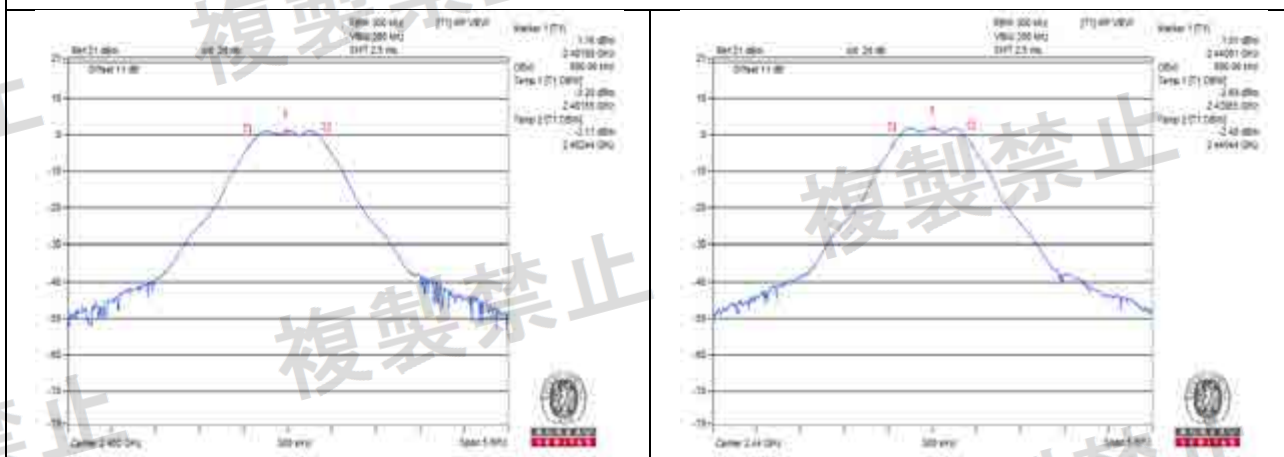
4.3.3 Test Results

Environmental Conditions		25 deg.C, 68% RH					
Channel	Frequency (MHz)	Vnormal		Vmax.		Vmin.	
		Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
0	2402	0.89	14.24	0.89	14.24	0.89	14.24
19	2440	0.89	14.24	0.89	14.24	0.89	14.24
39	2480	0.89	14.24	0.89	14.24	0.89	14.24

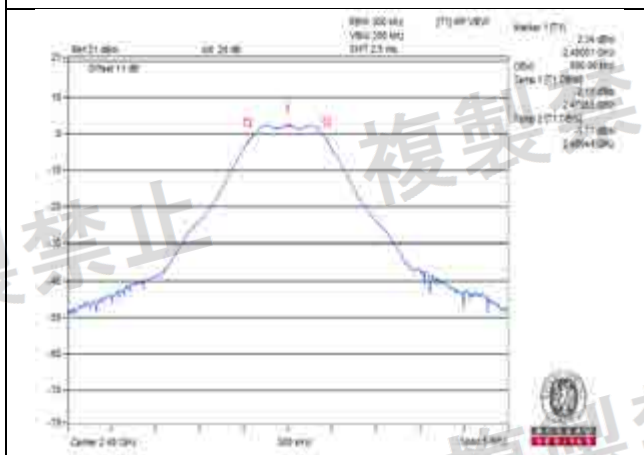
Note: 1. For the test plots please refer to the below pages.

2. Spreading Factor: 90% channel power bandwidth / 0.0625.

Vnormal



Channel 0



Channel 19

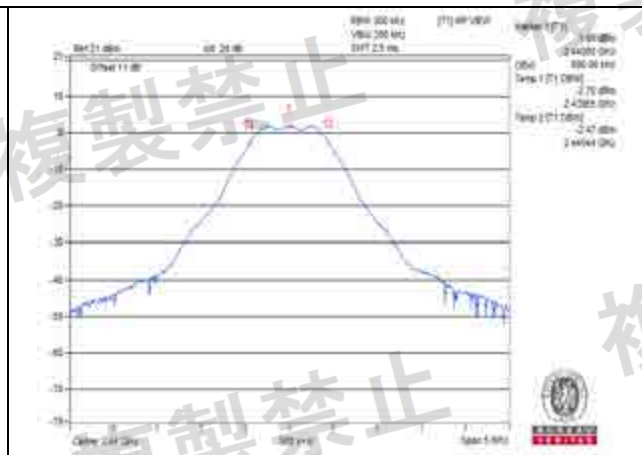
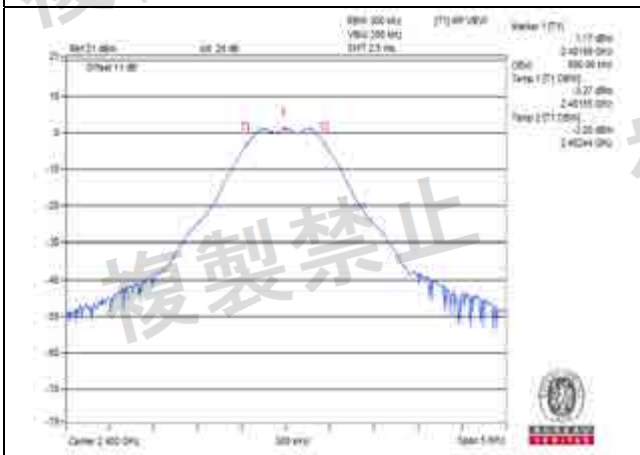


Channel 39

Measurement uncertainty: ± 206.50 Hz

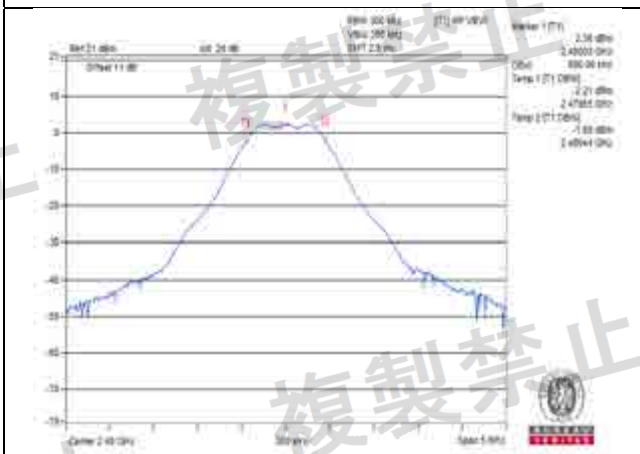


Vmax.



Channel 0

Channel 19

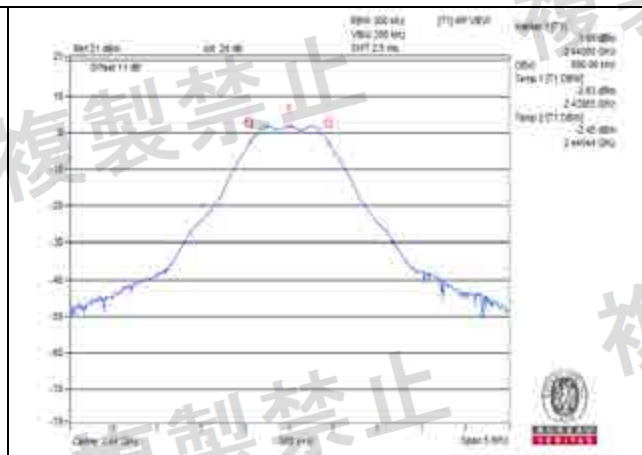
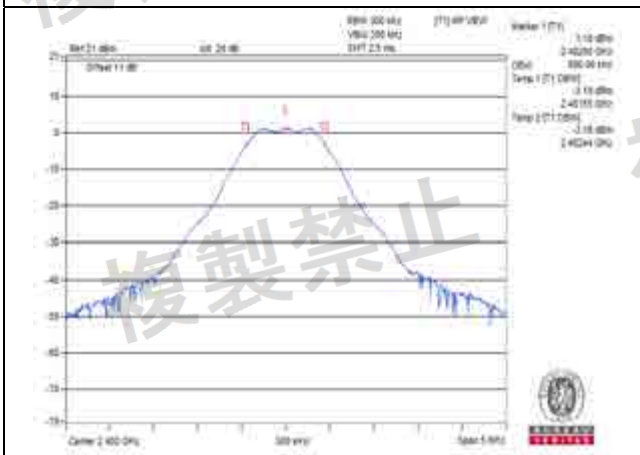


Channel 39

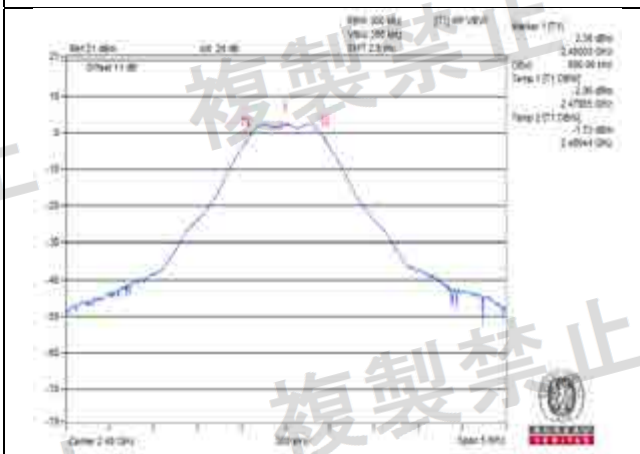
Measurement uncertainty: ± 206.50 Hz



Vmin.



Channel 0



Channel 19

Channel 39

Measurement uncertainty: ± 206.50 Hz



4.4 Spurious Emissions for Transmitter Measurement

4.4.1 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	$\leq 2.5 \text{ uW/MHz}$

4.4.2 Test Setup





4.4.3 Test Results

Environmental Conditions		25 deg.C, 68% RH					
Test Channel		CH 0 (2402MHz)		CH 19 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
Vnormal	30.0MHz to 1000.0MHz	99.840	0.020512uW	792.420	0.017824uW	0.25uW	Pass
	1000.0MHz to 2387MHz	1632.470	0.007211uW	2245.520	0.007499uW	2.5uW	Pass
	2387.0MHz to 2400.0MHz	2400.000	7.379042uW	2396.300	0.007674uW	25uW	Pass
	2483.5MHz to 2496.5MHz	2489.010	0.007516uW	2491.530	0.007745uW	25uW	Pass
	2496.5MHz to 12500.0MHz	9278.870	0.053088uW	10519.300	0.048978uW	2.5uW	Pass
Vmax.	30.0MHz to 1000.0MHz	747.800	0.018578uW	301.600	0.019454uW	0.25uW	Pass
	1000.0MHz to 2387MHz	1712.910	0.015382uW	1610.280	0.007311uW	2.5uW	Pass
	2387.0MHz to 2400.0MHz	2400.000	7.328245uW	2395.130	0.008453uW	25uW	Pass
	2483.5MHz to 2496.5MHz	2496.130	0.00859uW	2487.990	0.008831uW	25uW	Pass
	2496.5MHz to 12500.0MHz	10699.370	0.052723uW	3016.680	0.047863uW	2.5uW	Pass
Vmin.	30.0MHz to 1000.0MHz	305.480	0.019543uW	788.540	0.016982uW	0.25uW	Pass
	1000.0MHz to 2387MHz	2387.000	0.007534uW	1712.910	0.009057uW	2.5uW	Pass
	2387.0MHz to 2400.0MHz	2400.000	7.379042uW	2398.510	0.010889uW	25uW	Pass
	2483.5MHz to 2496.5MHz	2492.440	0.00877uW	2485.110	0.008072uW	25uW	Pass
	2496.5MHz to 12500.0MHz	9278.870	0.049545uW	12459.980	0.047973uW	2.5uW	Pass

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

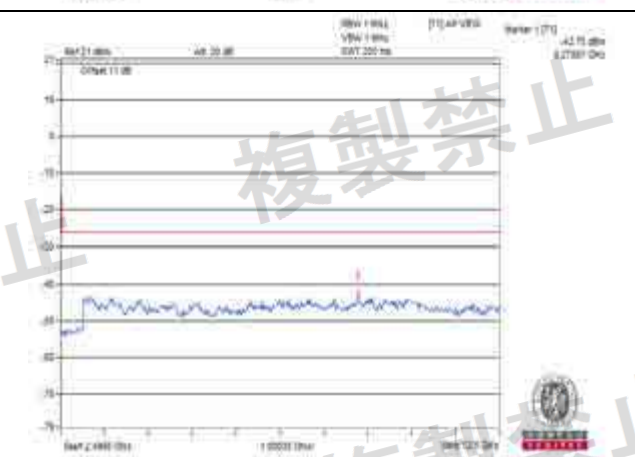
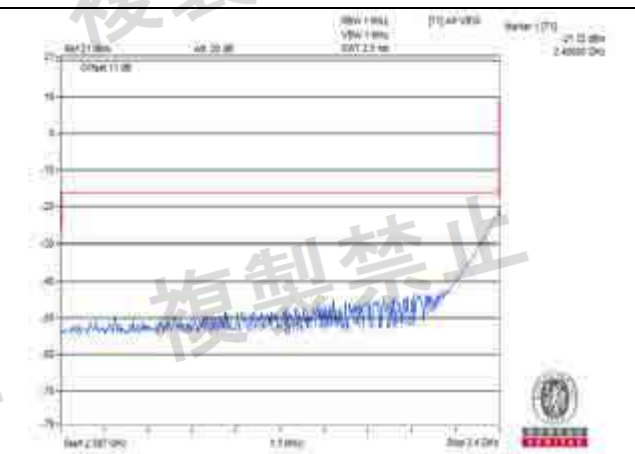
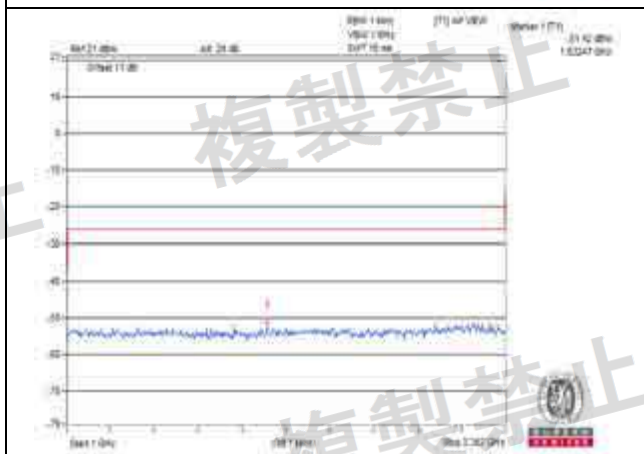
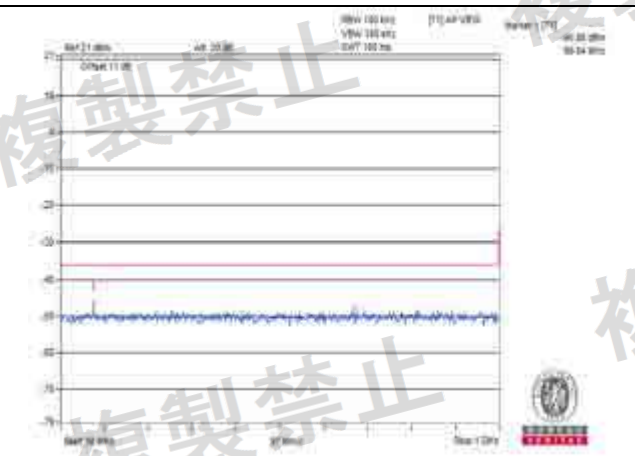
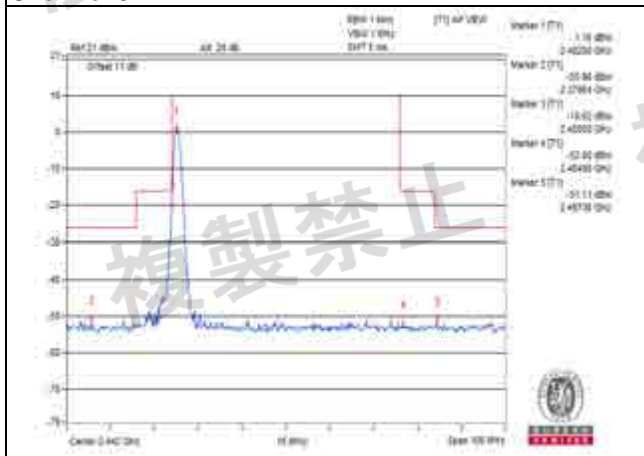


Environmental Conditions		25 deg.C, 68% RH			
Test Channel		CH 39 (2480MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value		
Vnormal	30.0MHz to 1000.0MHz	914.640	0.015631uW	0.25uW	Pass
	1000.0MHz to 2387MHz	2176.170	0.007568uW	2.5uW	Pass
	2387.0MHz to 2400.0MHz	2398.620	0.00875uW	25uW	Pass
	2483.5MHz to 2496.5MHz	2483.500	0.254097uW	25uW	Pass
	2496.5MHz to 12500.0MHz	10099.160	0.056234uW	2.5uW	Pass
Vmax.	30.0MHz to 1000.0MHz	499.480	0.017378uW	0.25uW	Pass
	1000.0MHz to 2387MHz	1724.010	0.013366uW	2.5uW	Pass
	2387.0MHz to 2400.0MHz	2387.960	0.006761uW	25uW	Pass
	2483.5MHz to 2496.5MHz	2483.500	0.252348uW	25uW	Pass
	2496.5MHz to 12500.0MHz	3176.730	0.044463uW	2.5uW	Pass
Vmin.	30.0MHz to 1000.0MHz	992.240	0.01875uW	0.25uW	Pass
	1000.0MHz to 2387MHz	1305.140	0.008299uW	2.5uW	Pass
	2387.0MHz to 2400.0MHz	2390.560	0.008492uW	25uW	Pass
	2483.5MHz to 2496.5MHz	2483.500	0.253513uW	25uW	Pass
	2496.5MHz to 12500.0MHz	2996.670	0.052966uW	2.5uW	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.



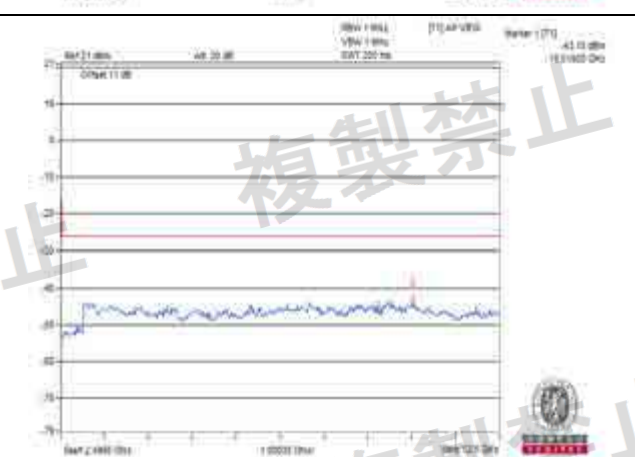
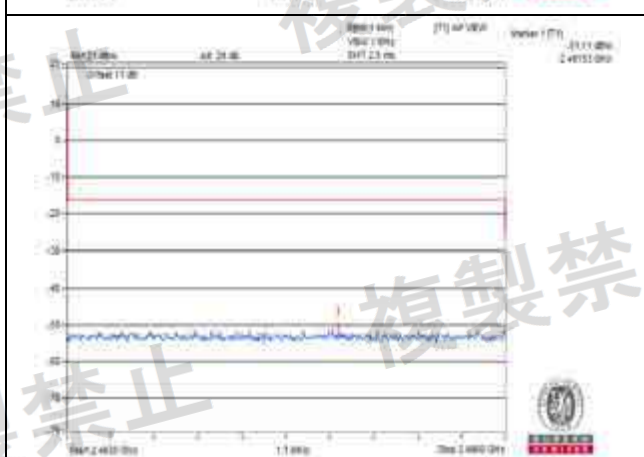
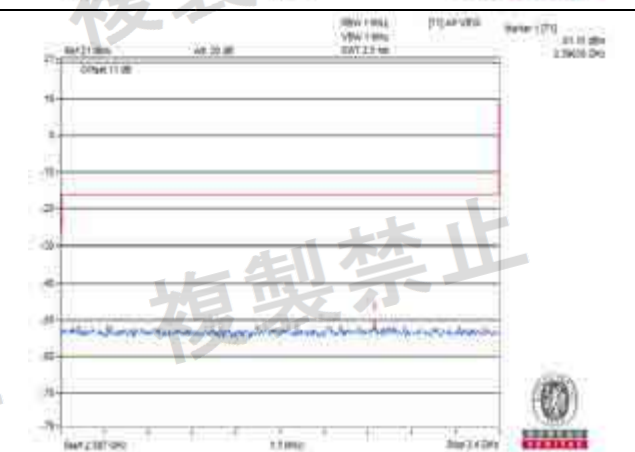
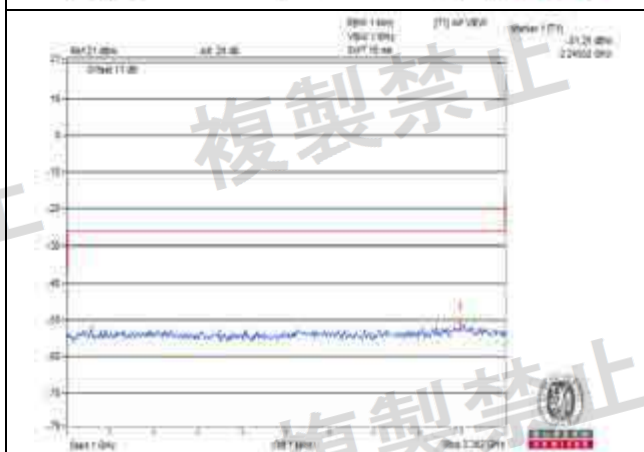
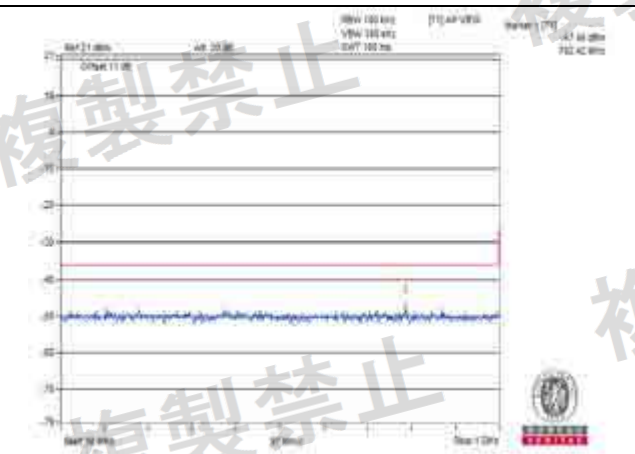
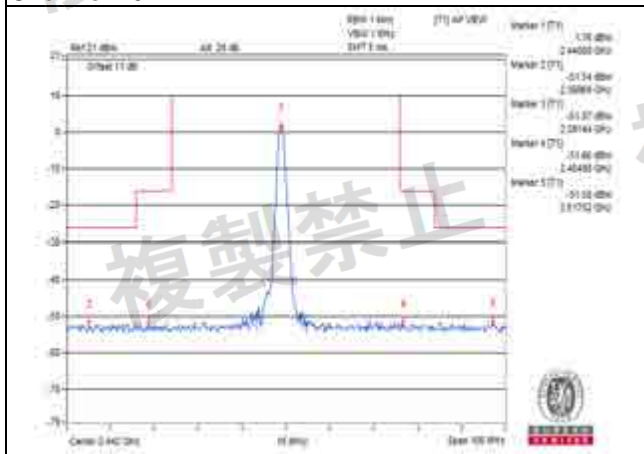
Vnormal
Channel 0



Measurement uncertainty: $\pm 3.93\text{dB}$



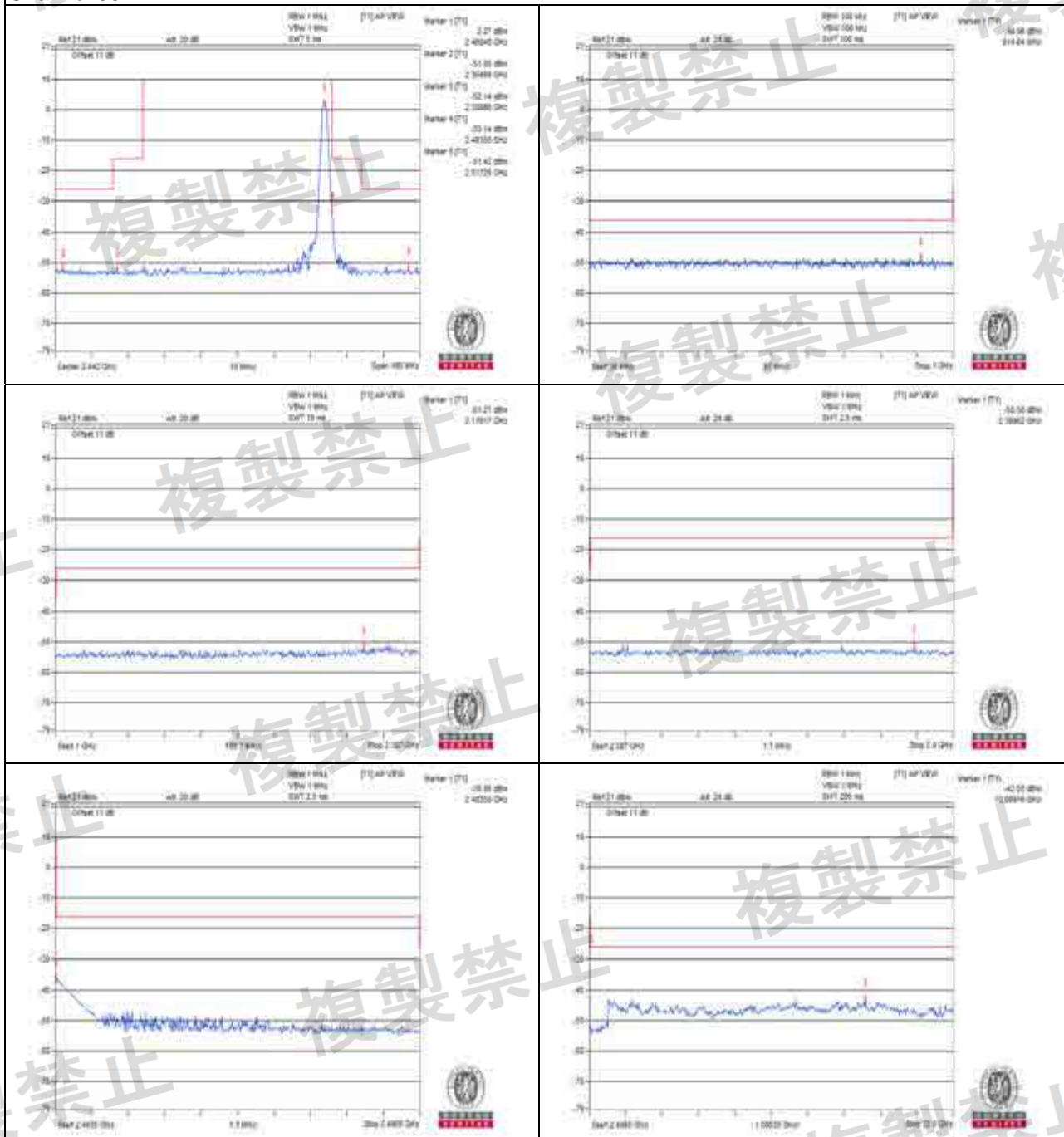
Vnormal
Channel 19



Measurement uncertainty: $\pm 3.93\text{dB}$



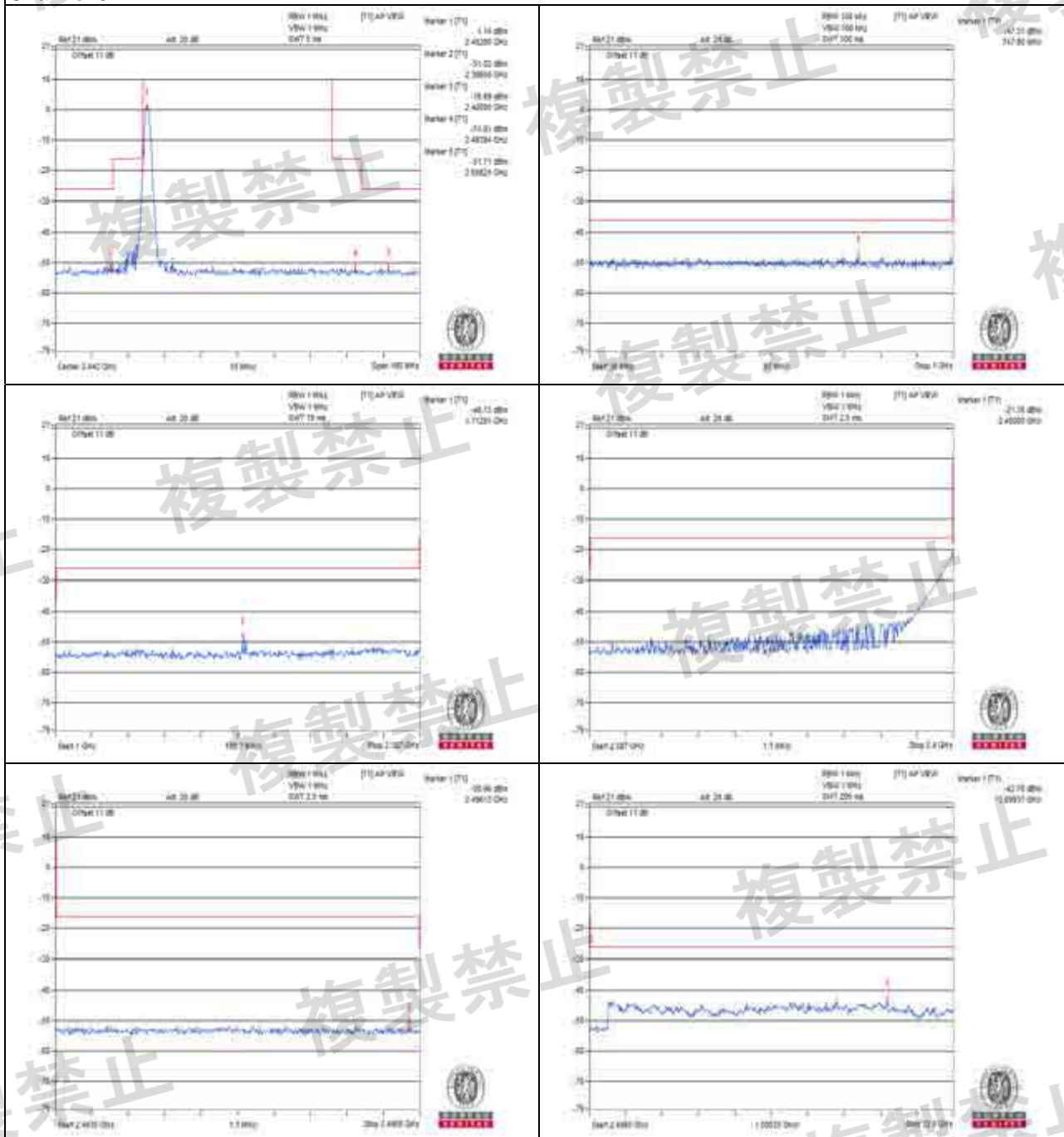
Vnormal
Channel 39



Measurement uncertainty: $\pm 3.93\text{dB}$



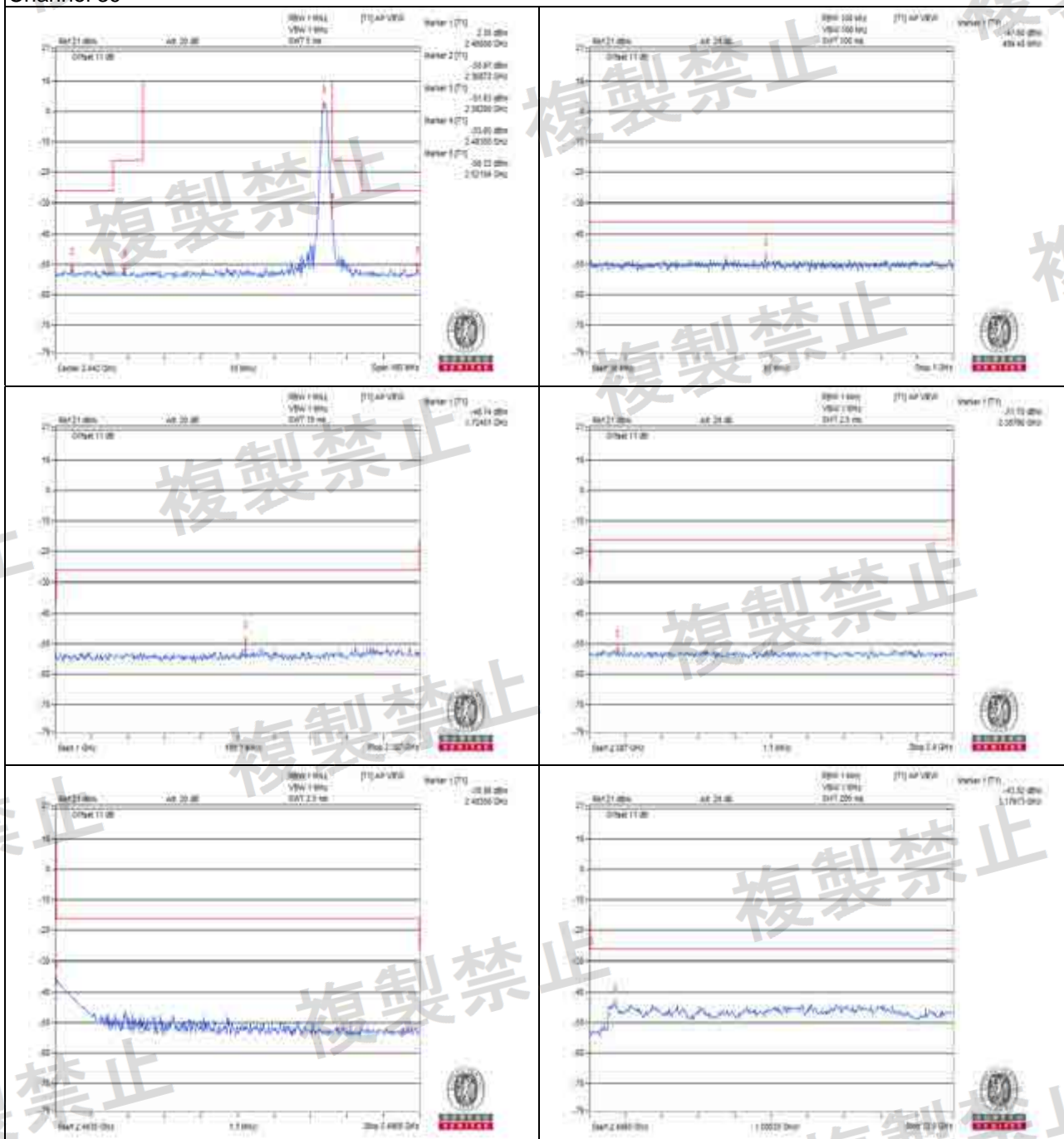
Vmax.
Channel 0



Measurement uncertainty: $\pm 3.93\text{dB}$



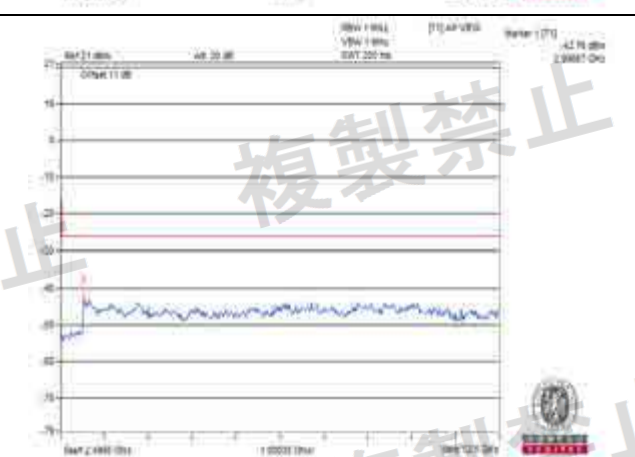
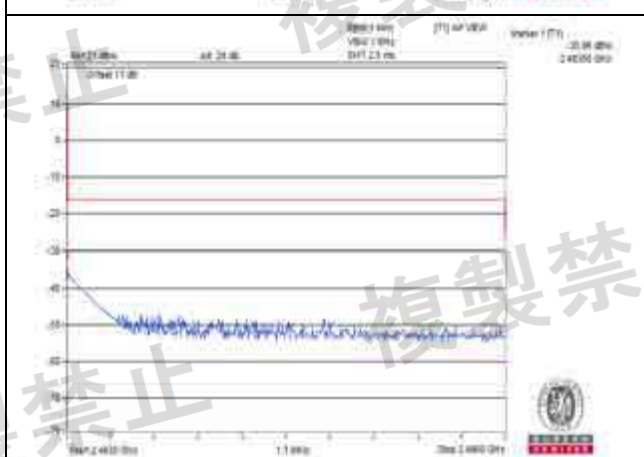
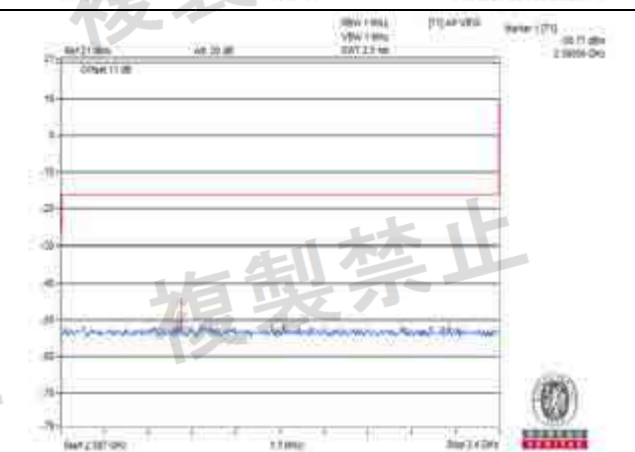
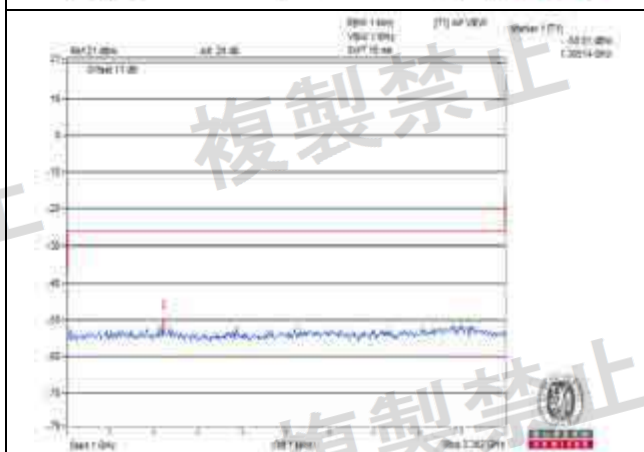
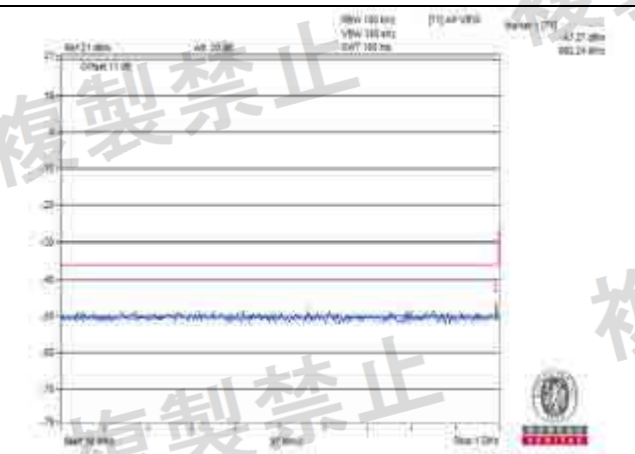
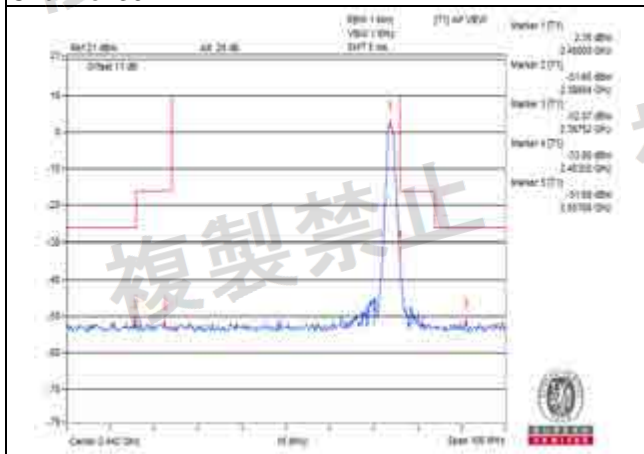
Vmax.
Channel 39



Measurement uncertainty: $\pm 3.93\text{dB}$



Vmin.
Channel 39



Measurement uncertainty: $\pm 3.93\text{dB}$



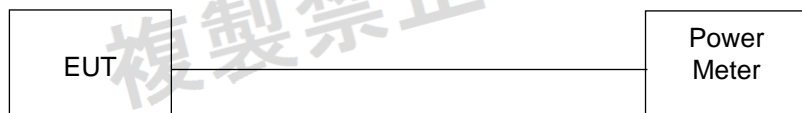
4.5 Antenna Power Measurement

4.5.1 Limits of Antenna Power

Antenna power shall be 10mW or less.

Tolerance of antenna power shall be +20% (upper value) and -80% (lower value).

4.5.2 Test Setup



4.5.3 Test Results

Environmental Conditions	25 deg.C, 68% RH			
Test Condition	Conducted RF Output Power Density (mW/MHz)			
	Channel 0 2402MHz	Channel 19 2440MHz	Channel 39 2480MHz	Max. Limit (mW/MHz)
Vnormal	1.702	1.986	2.143	10
Vmax.	1.711	2.000	2.159	10
Vmin.	1.684	1.959	2.110	10
Rated Power	2.0mW			
Tolerance of Antenna Power	0.4mW ~ 2.4mW			
Measurement uncertainty	± 1.11dB			

PCB antenna with -1.72dBi gain

Environmental Conditions	25 deg.C, 68% RH			
Test Condition	Radiated RF Output Power Density (mW/MHz)			
	Channel 0 2402MHz	Channel 19 2440MHz	Channel 39 2480MHz	Max. Limit (mW/MHz)
Vnormal	1.146	1.337	1.442	16.368
Vmax.	1.152	1.346	1.453	16.368
Vmin.	1.133	1.318	1.420	16.368
Measurement uncertainty	± 1.11dB			

- 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.



4.6 Spurious Emissions for Receiver

4.6.1 Limits of Spurious Emissions For Receiver

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

4.6.2 Test Setup





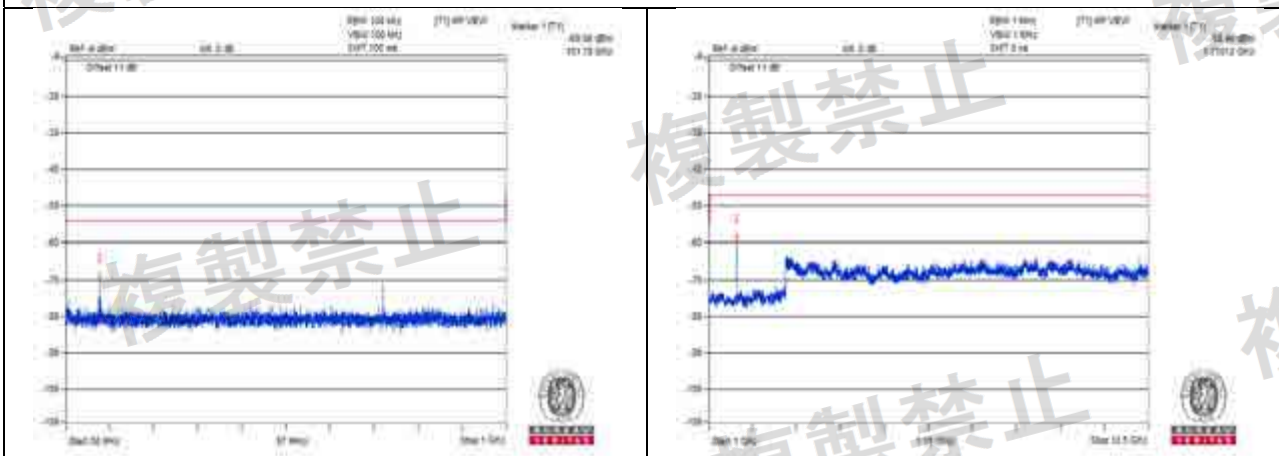
4.6.3 Test Result

Environmental Conditions		25 deg.C, 68% RH					
Test Channel		CH0 (2402MHz)		CH19 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
Vnormal	Below 1GHz	101.780	0.123595nW	101.530	0.041591nW	4nW	Pass
	Above 1GHz	1710.120	1.425608nW	3127.500	0.465586nW	20nW	Pass
Vmax.	Below 1GHz	101.780	0.09977nW	103.230	0.039628nW	4nW	Pass
	Above 1GHz	1710.120	5.636377nW	10159.750	0.446684nW	20nW	Pass
Vmin.	Below 1GHz	101.530	0.070632nW	101.780	0.039719nW	4nW	Pass
	Above 1GHz	1721.620	3.198895nW	3130.370	0.548277nW	20nW	Pass
Test Channel		CH39(2480MHz)				Limit	Result
Test Condition	Frequency Range	Frequency (MHz)		Measured Value			
Vnormal	Below 1GHz	101.780		0.060534nW		4nW	Pass
	Above 1GHz	8147.250		0.514044nW		20nW	Pass
Vmax.	Below 1GHz	729.120		0.257632nW		4nW	Pass
	Above 1GHz	9898.120		0.469894nW		20nW	Pass
Vmin.	Below 1GHz	747.070		0.709578nW		4nW	Pass
	Above 1GHz	3127.500		0.533335nW		20nW	Pass

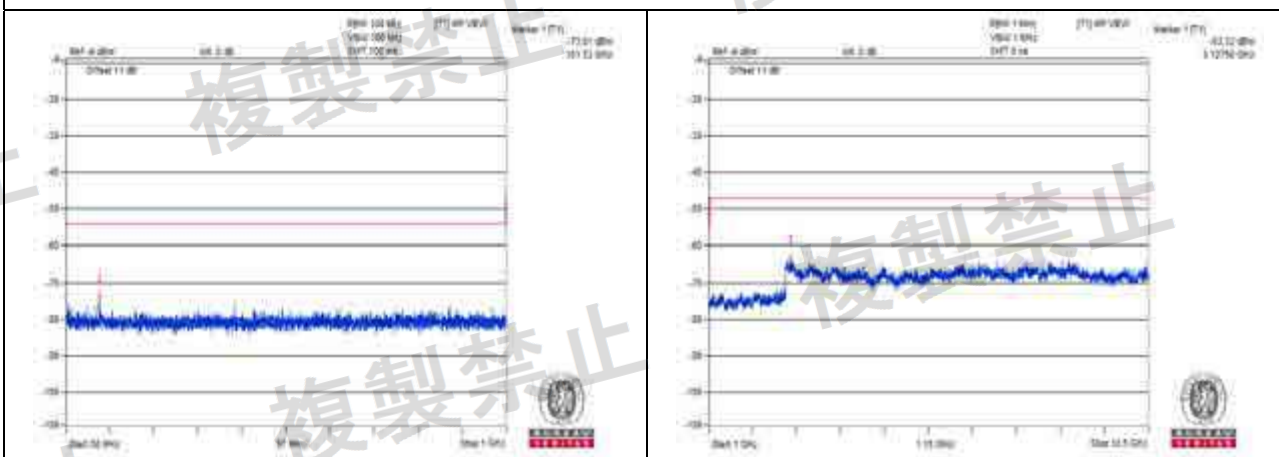
- Note:
1. The worst value in each frequency range v.s. each channel has been marked by boldface.
 2. The spectrum plots are attached on the following pages.



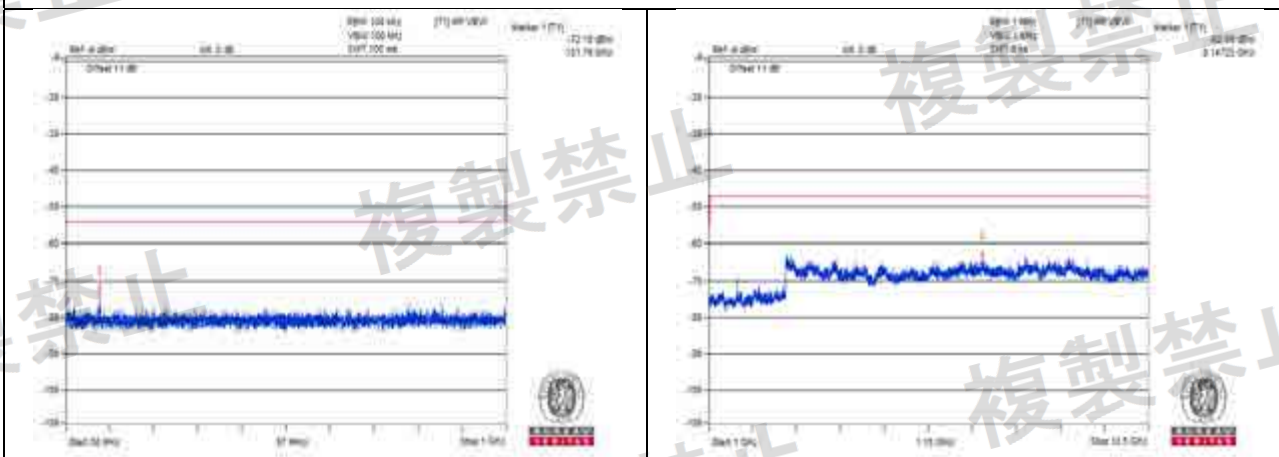
Vnormal



Channel 0



Channel 19

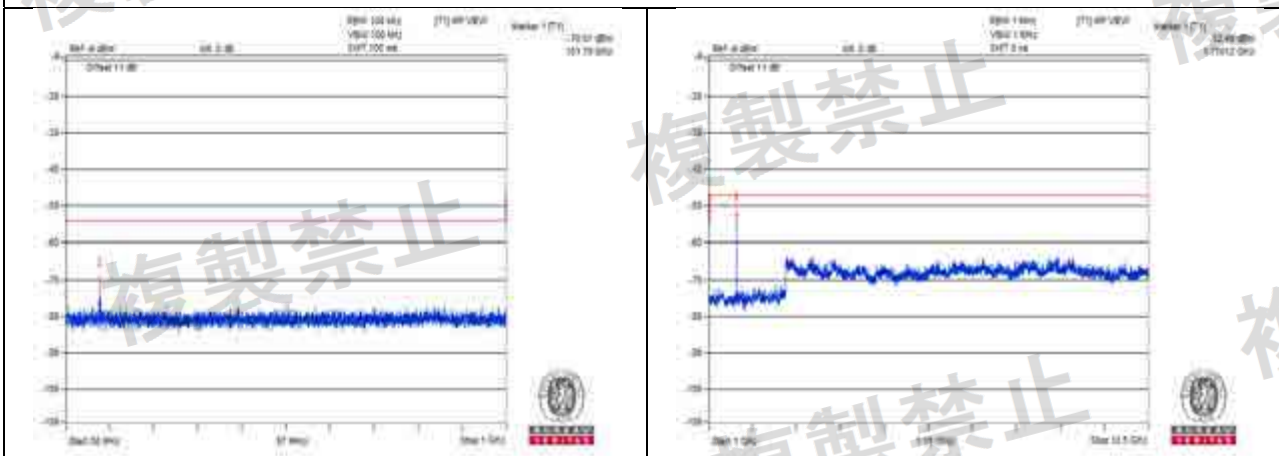


Channel 39

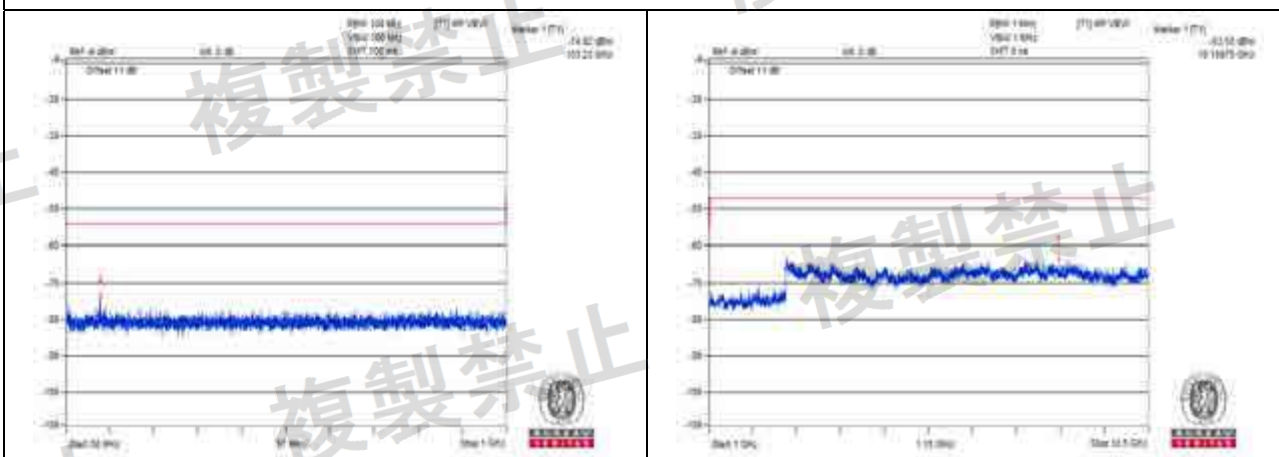
Measurement uncertainty: $\pm 3.93\text{dB}$



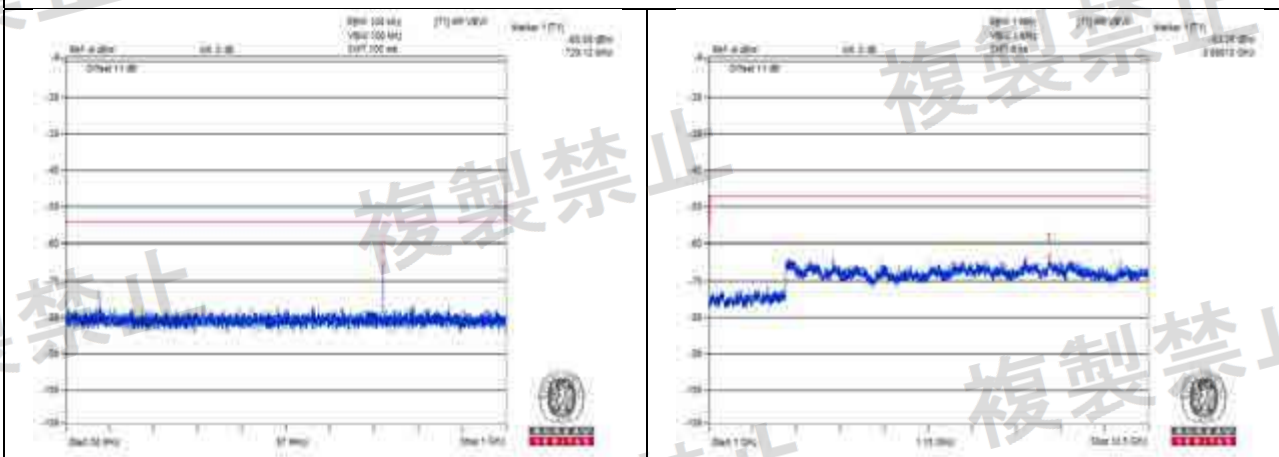
Vmax.



Channel 0



Channel 19

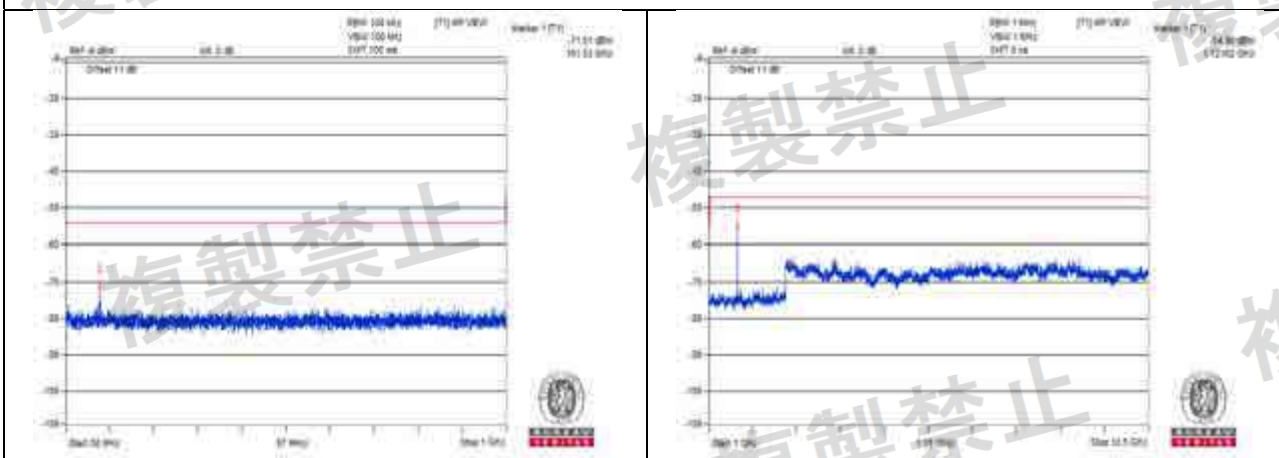


Channel 39

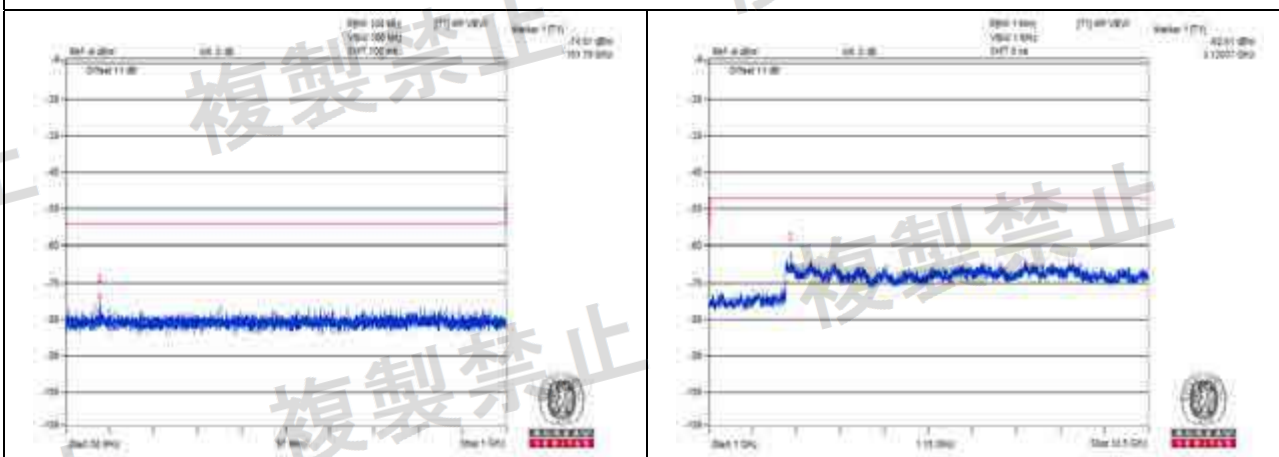
Measurement uncertainty: $\pm 3.93\text{dB}$



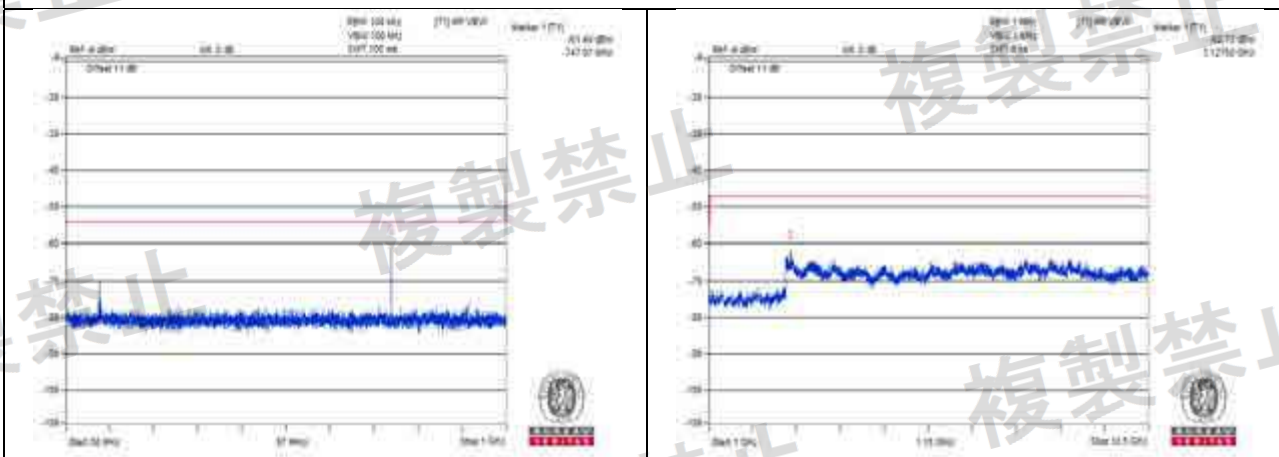
Vmin.



Channel 0



Channel 19



Channel 39

Measurement uncertainty: $\pm 3.93\text{dB}$

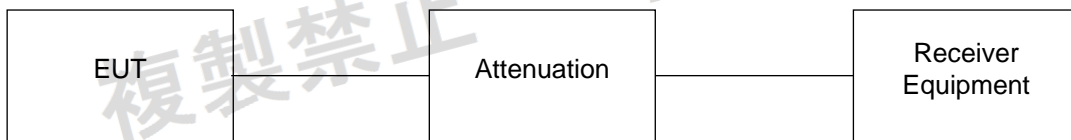


4.7 Interference Prevention Function

4.7.1 Limits of Interference Prevention Function

NA

4.7.2 Test Setup



4.7.3 Test Results

Environmental Conditions	25 deg.C, 68% RH
Link Mode	Test Result
Bluetooth LE	Pass

5 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 FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

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

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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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