

Radio Test Report (Zigbee)

Report No.: RJBEAD-WTW-P20060161

Test Model: EPD-023B2

Series Model: EPD023B2 (Refer to item 3.1 for the more details)

Received Date: Jun. 30, 2020

Test Date: Jul. 25, 2020

Issued Date: Jul. 29, 2020

Applicant: ADVANTECH CO., LTD

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

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33383, TAIWAN



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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	10
4.2 Occupied Bandwidth Measurement (99% power bandwidth)	11
4.2.1 Limits of Occupied Bandwidth Measurement	11
4.2.2 Test Setup	11
4.2.3 Test Results	12
4.3 Spreading Bandwidth Measurement (90% power bandwidth)	15
4.3.1 Limits of Spreading Bandwidth and Spreading Factor Measurement	15
4.3.2 Test Setup	15
4.3.3 Test Results	15
4.4 Spurious Emissions for Transmitter Measurement	19
4.4.1 Limits of Spurious Emissions	19
4.4.2 Test Setup	19
4.4.3 Test Results	20
4.5 Antenna Power Measurement	31
4.5.1 Limits of Antenna Power	31
4.5.2 Test Setup	31
4.5.3 Test Results	32
4.6 Spurious Emissions for Receiver	33
4.6.1 Limits of Spurious Emissions for Receiver	33
4.6.2 Test Setup	33
4.6.3 Test Result	34
4.7 Interference Prevention Function	38
4.7.1 Limits of Interference Prevention Function	38
4.7.2 Test Setup	38
4.7.3 Test Results	38
5 Photographs of the Test Configuration	39
Appendix - Information of the Testing Laboratories	40

Release Control Record

Issue No.	Description	Date Issued
RJBEAD-WTW-P20060161	Original release	Jul. 29, 2020

1 Certificate of Conformity

Product: 2.9" Epd control system device

Brand: ADVANTECH

Test Model: EPD-023B2

Series Model: EPD023B2 (Refer to item 3.1 for the more details)

Sample Status: Engineering Sample

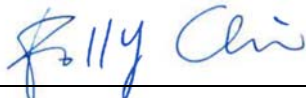
Applicant: ADVANTECH CO., LTD

Test Date: Jul. 25, 2020

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 :



Polly Chien / Specialist

Date:

Jul. 29, 2020

Approved by :



Bruce Chen / Senior Project Engineer

Date:

Jul. 29, 2020

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
--	--	3.6	Refer to all articles for transmitting antenna	C
Operating Frequency 2400 to 2483.5MHz				
--	3.7 (1)	3.2	High Frequency	C
--	3.7 (1)	3.4	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)	3.5.2	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
Note: C = Conform NC = Not Conform NT = Not Tested NA = Not Applicable				

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date of Calibration	Calibration Authority	Cal. Method
Spectrum Analyzer / Rohde & Schwarz	FSP40	100039	Jun. 12, 2020	Jun. 11, 2021	Electronics Testing Center, Taiwan	c)
Signal Generator / Agilent	E4438C	MY45094468	Nov. 14, 2019	Nov. 13, 2020	Electronics Testing Center, Taiwan	c)
Power Meter / Anritsu	ML2495A	1232003	Dec. 30, 2019	Dec. 29, 2020	Electronics Testing Center, Taiwan	c)
Power Sensor / Anritsu	MA2411B	1207333	Dec. 30, 2019	Dec. 29, 2020	Electronics Testing Center, Taiwan	c)
Power Splitter / Agilent	11667B	52805	NA	NA	NA	d)
Power Splitter / Agilent	11667B	11628	NA	NA	NA	d)
DC Power Supply / Topward	6306A	727263	NA	NA	NA	d)
True RMS Clamp Meter / Fluke	325	31130711WS	Jun. 06, 2020	Jun. 05, 2021	Electronics Testing Center, Taiwan	c)

NOTE: Calibration Method

a) : Calibration conducted by the National Institute of Information and Communications Technology~NICT~ or a designated calibration agency under Article 102-18 paragraph (1)~ TELEC EngineeringCenter, Intertek Japan K.K., Keysight Technologies, Inc~.

b) : Correction conducted pursuant to the provisions of Article 135 or Article 144 of the MeasurementLaw (Law No. 51 of 1992)~Japan Calibration Service Syste~

c) : Calibration conducted in foreign countries, which shall be equivalent to the calibration conducted bythe NICT or a designated calibration agency under Article 102-18 paragraph (1)~ TELEC EngineeringCenter, Intertek Japan K.K., Keysight Technologies, Inc~.

d) : Calibration conducted by using other equipment that listed above from a) to c)

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	2.208dB
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	2.9" Epd control system device
Brand	ADVANTECH
Model	EPD-023B2
Series Model	EPD023B2
Model Difference	Refer to Note for the more details
Status of EUT	Engineering Sample
Nominal Voltage	3Vdc from battery
Modulation Type	O-QPSK
Operating Frequency	2405 ~ 2480MHz
Number of Channel	16
Rated RF Output Power	3.00mW
Conducted RF Output Power	2.851mW
Radiated RF Output Power	2.692mW
Antenna Type	Refer to note
Antenna Connector	Refer to note
Accessory Device	NA
Data Cable Supplied	NA

Note:

1. All models are listed as below. Model: EPD-023B2 was chosen for the final tests.

Brand	Product	Model	Display Size	Antenna
ADVANTECH	2.9" Epd control system device	EPD-023B2	2.3	Chip antenna
		EPD023B2B2		

2. The following antennas were provided to the EUT.

Ant. Type	Chip antenna		
Connector	NA		
Frequency (GHz)	2.40	2.45	2.50
Gain (dBi)	-3.13	-1.36	-0.25

*The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

3. The EUT contains following accessory devices.

Product	Brand	Model	Description
Battery	Panasonic	CR2450	3 Vdc, 620 mAh

3.2 Description of Test Modes

16 channels are provided to this EUT:

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

By means of test software (smartrftm_studio-2.7.0), the power levels during the tests were set according to the following codes:

Modulation type: O-QPSK	
Channel	Power Setting
11	default
18	default
26	default

3.3 Test Conditions

Test Conditions	Voltage (Vdc)
V_{normal}	3.0
$V_{max.}$	3.3
$V_{min.}$	2.7

3.4 Assembly

The EUT is constructed as a standalone unit. The EUT used a kind of particular screw, which could not operated by a tool bought in the market. Only means of brute force will be able to open.

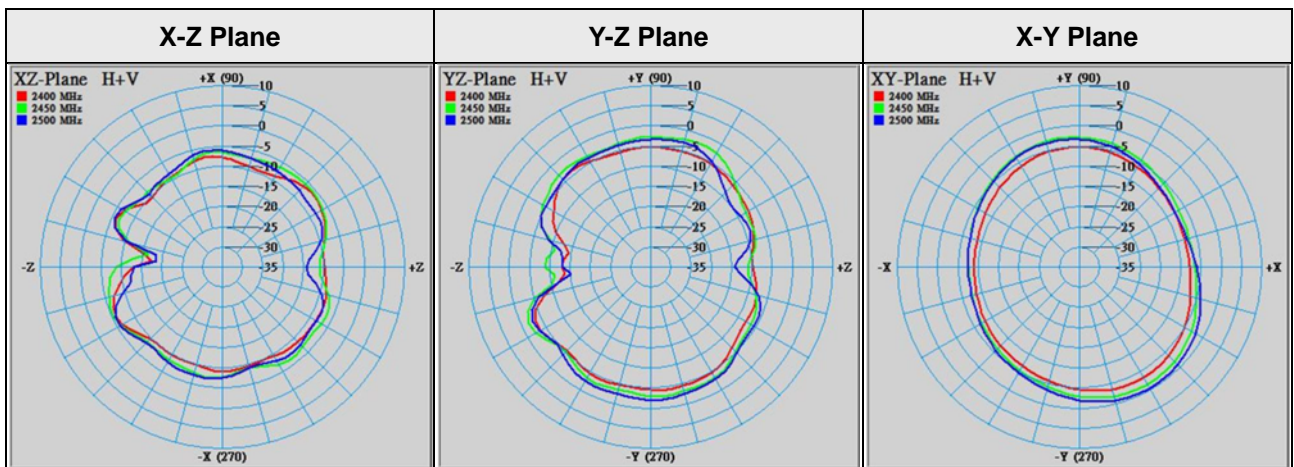
3.5 Antenna Specifications

3.5.1 Antenna Gain

Ant. Type	Chip antenna		
Connector	NA		
Frequency (GHz)	2.40	2.45	2.50
Gain (dBi)	-3.13	-1.36	-0.25

*The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.

3.5.2 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)	V _{normal}		V _{max.}		V _{min.}	
		Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)
11	2405	2404.918000	-34.095	2404.917600	-34.261	2404.917600	-34.261
18	2440	2439.915600	-34.590	2439.915600	-34.590	2439.915600	-34.590
26	2480	2479.915200	-34.193	2479.915200	-34.193	2479.915600	-34.032

4.2 Occupied Bandwidth Measurement (99% power bandwidth)

4.2.1 Limits of Occupied Bandwidth Measurement

Item	Limit
Occupied bandwidth	<26MHz

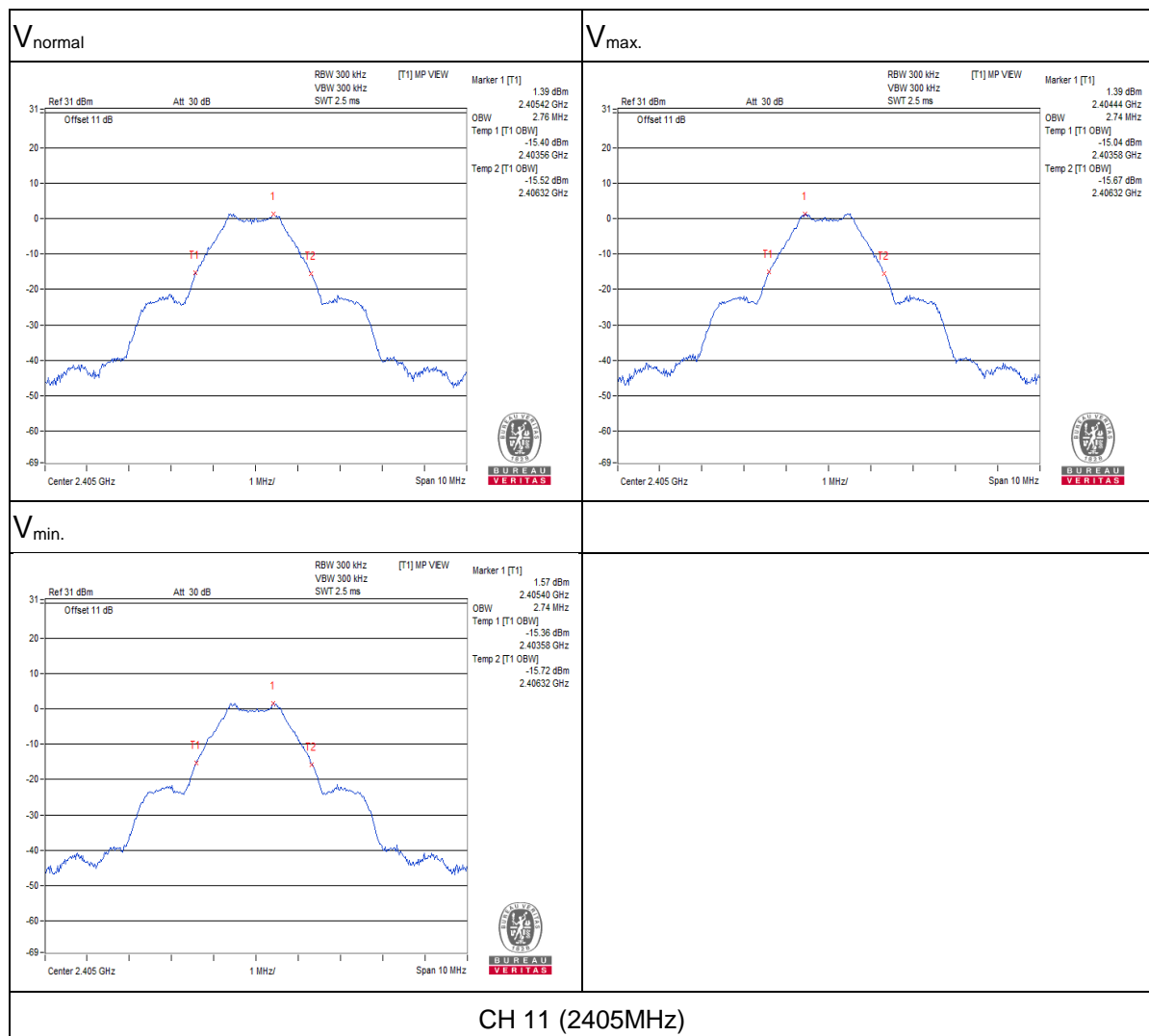
4.2.2 Test Setup



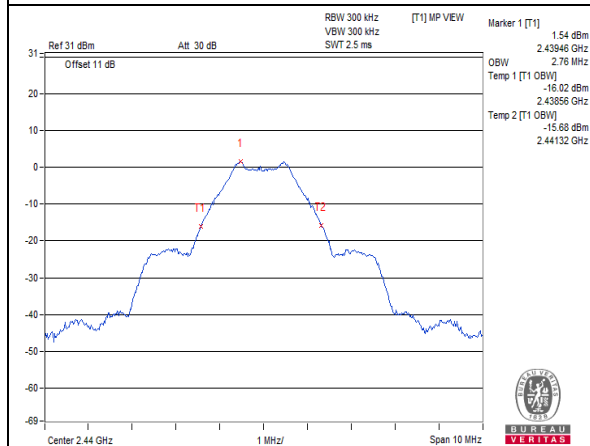
4.2.3 Test Results

Environmental Conditions		25 deg.C, 60% RH		
Channel	Frequency (MHz)	V _{normal}	V _{max}	V _{min.}
		Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
11	2405	2.76	2.74	2.74
18	2440	2.76	2.76	2.76
26	2480	2.72	2.74	2.74

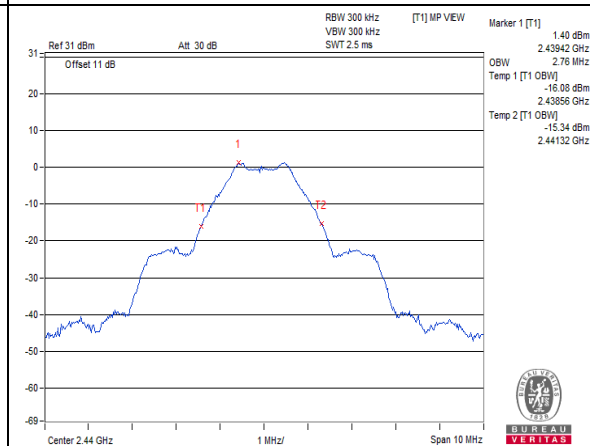
Note: 1. For the test plots please refer to the below pages.



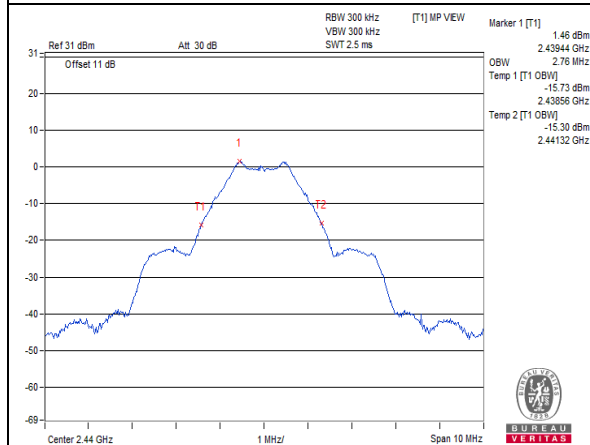
V_{normal}



V_{max}

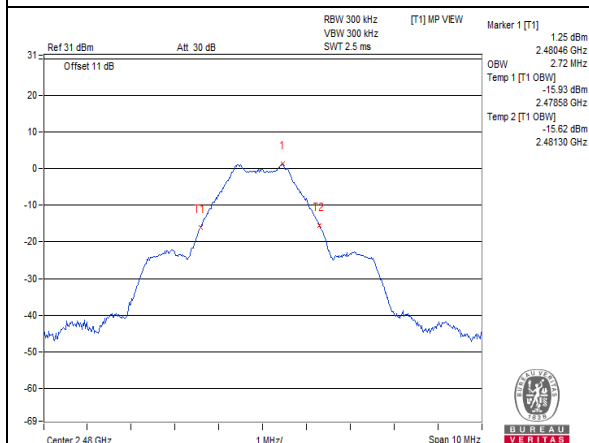


V_{min}

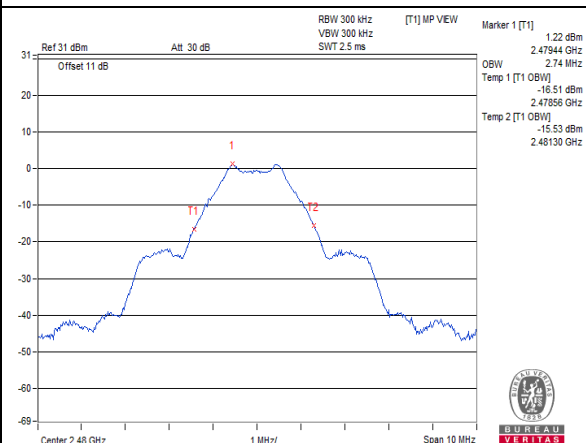


CH 18 (2440MHz)

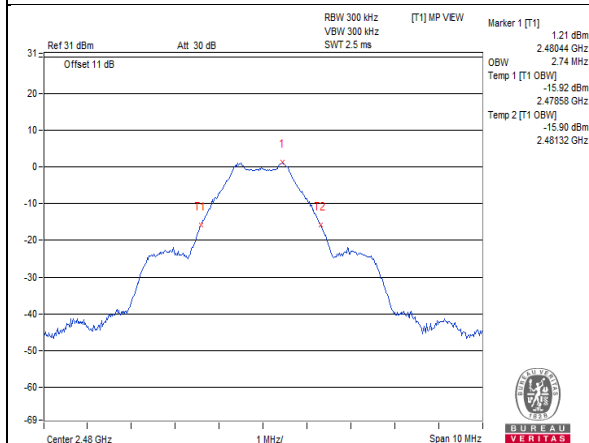
V_{normal}



V_{max.}



V_{min.}



CH 26 (2480MHz)

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

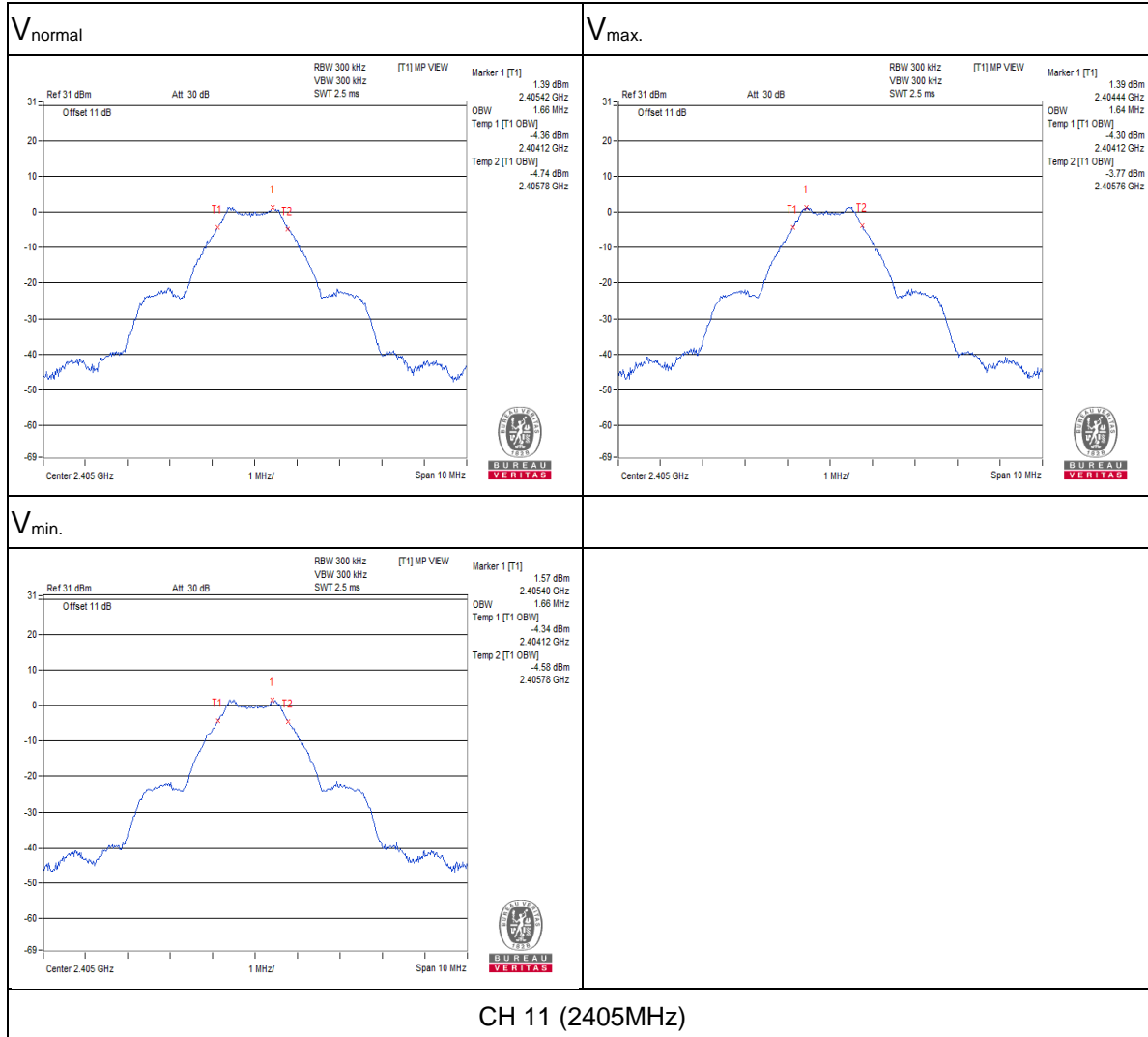
4.3.2 Test Setup



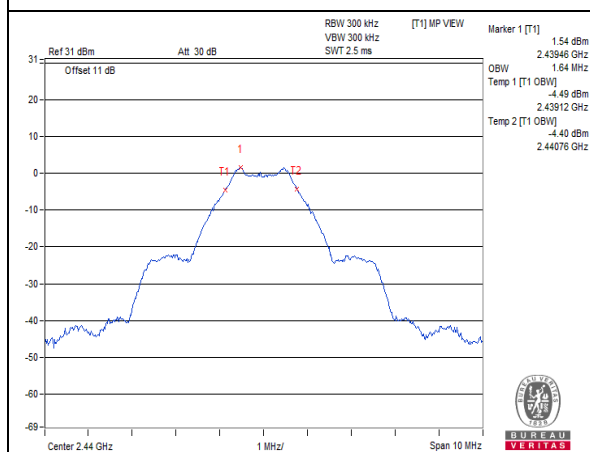
4.3.3 Test Results

Environmental Conditions		25 deg.C, 60% RH					
Channel	Frequency (MHz)	V _{normal}		V _{+10%}		V _{-10%}	
		Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
11	2405	1.66	26.56	1.64	26.24	1.66	26.56
18	2440	1.64	26.24	1.64	26.24	1.64	26.24
26	2480	1.64	26.24	1.64	26.24	1.64	26.24

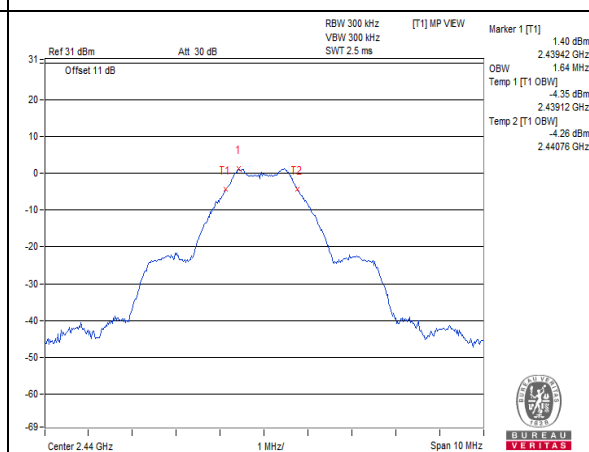
- Note: 1. For the test plots please refer to the below pages.
 2. Spreading Factor: 90% channel power bandwidth / 0.0625



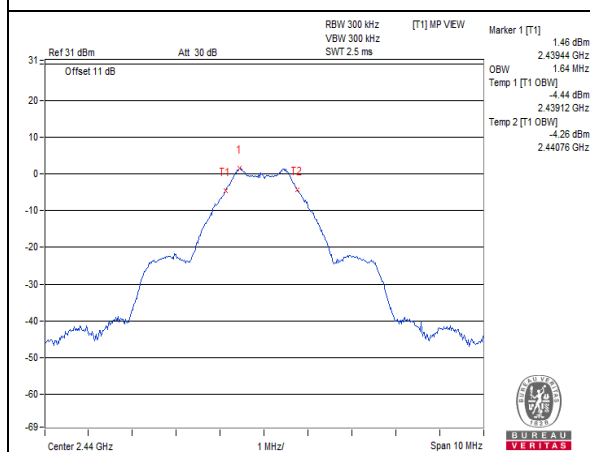
V_{normal}



V_{max.}

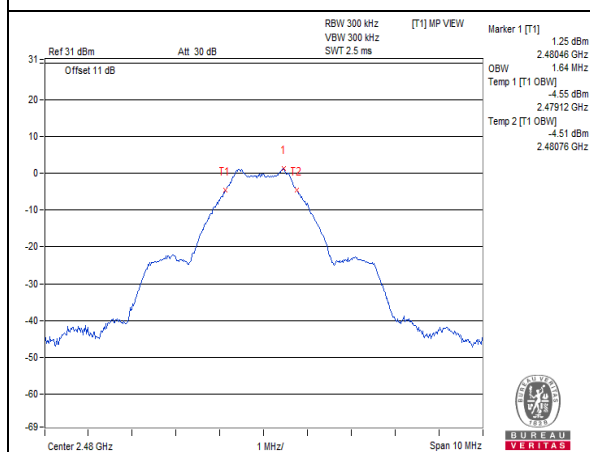


V_{min.}

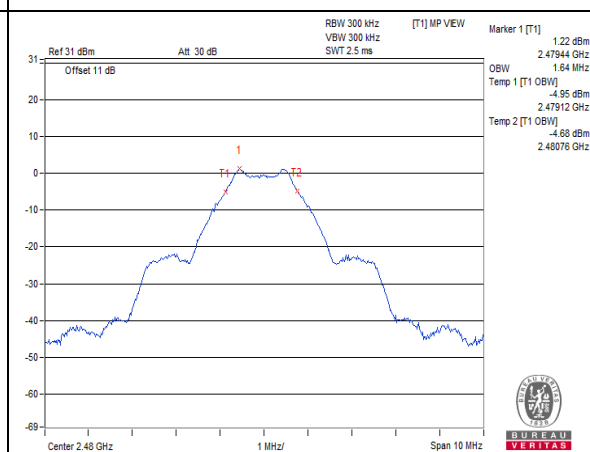


CH 18 (2440MHz)

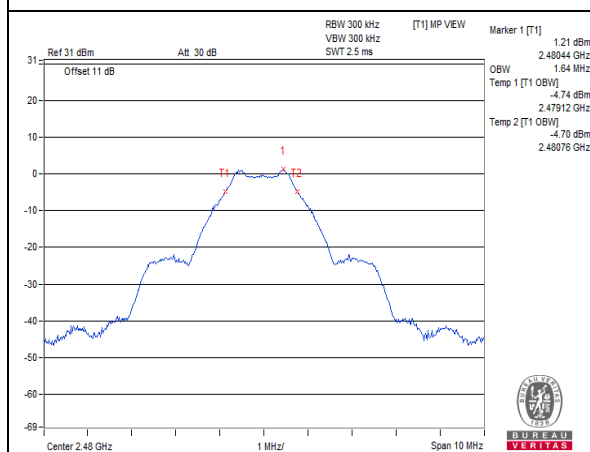
V_{normal}



V_{max.}



V_{min.}



CH 26 (2480MHz)

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

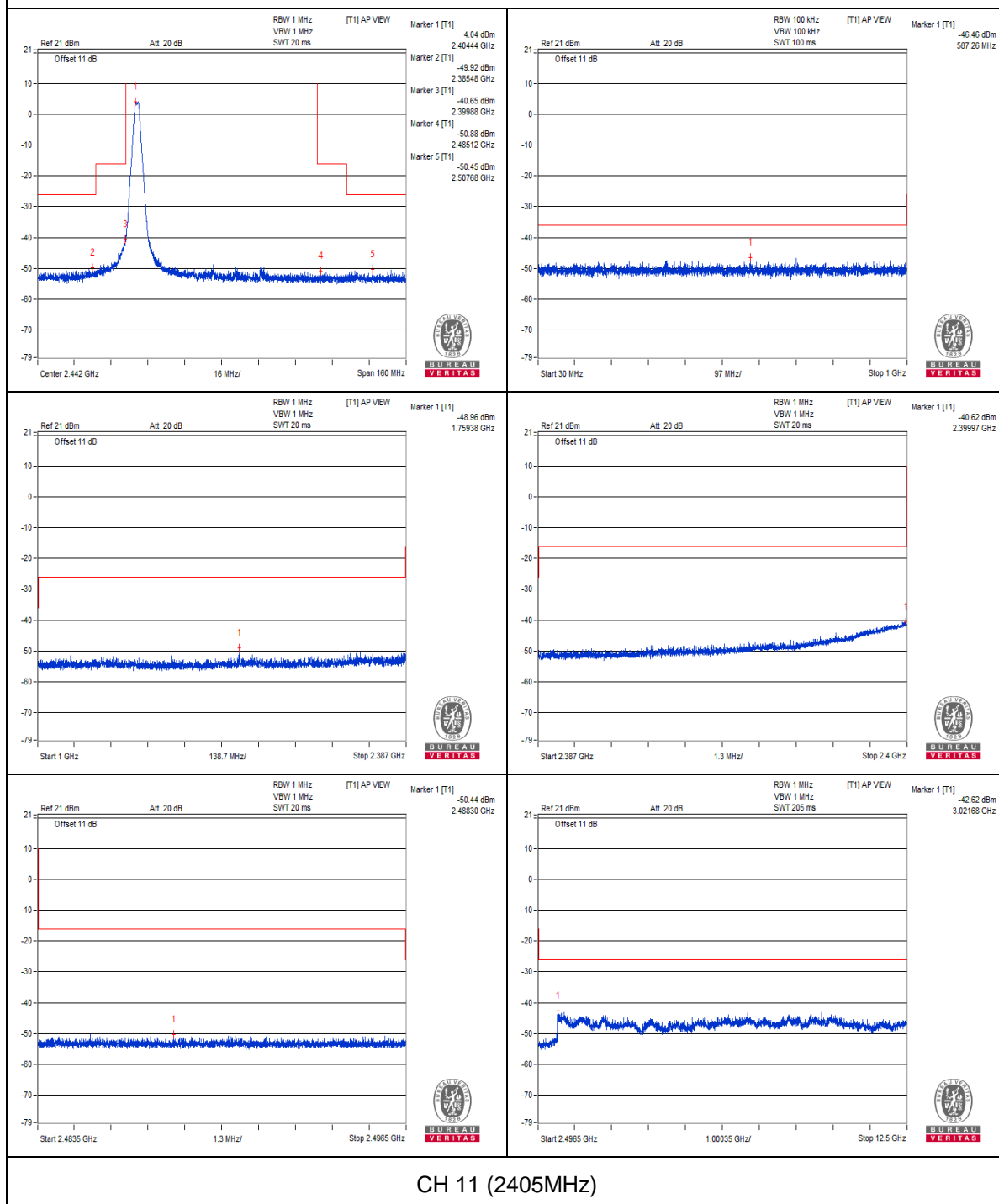
Environmental Conditions		25 deg.C, 60% RH					
Test Channel		CH 11 (2405MHz)		CH 18 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
V_{normal}	30.0MHz to 1000.0MHz	587.260	0.022594	166.040	0.020091	0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	1759.380	0.012706	2374.510	0.007499	2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2399.970	0.086696	2396.220	0.011776	25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2488.300	0.009036	2483.590	0.009954	25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3021.680	0.054702	8175.980	0.047973	2.5uW/MHz	PASS
V_{max.}	30.0MHz to 1000.0MHz	365.370	0.018793	387.200	0.019770	0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	2262.510	0.009141	2244.830	0.007834	2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2399.970	0.096383	2396.450	0.009750	25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2494.540	0.008810	2494.600	0.009016	25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3141.720	0.066681	3611.890	0.047863	2.5uW/MHz	PASS
V_{min.}	30.0MHz to 1000.0MHz	708.510	0.019724	493.660	0.021184	0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	1752.790	0.016106	1745.850	0.010423	2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2399.890	0.087297	2398.730	0.009550	25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.760	0.008750	2492.410	0.008810	25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	10489.290	0.049091	3124.210	0.047973	2.5uW/MHz	PASS

Note: 1. The spectrum plots are attached on the following pages.
2. (No.): The value was tested under Measuring Mode *Zero Span.

Environmental Conditions		25 deg.C, 60% RH			
Test Channel		CH 26 (2480MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value		
V_{normal}	30.0MHz to 1000.0MHz	121.420	0.021038	0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	1737.190	0.077983	2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2393.900	0.009162	25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.500	1.442115	25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	9901.590	0.058210	2.5uW/MHz	PASS
V_{max}	30.0MHz to 1000.0MHz	417.510	0.025351	0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	1736.840	0.024717	2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2392.470	0.010351	25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.510	1.412538	25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3649.400	0.051404	2.5uW/MHz	PASS
V_{min.}	30.0MHz to 1000.0MHz	531.000	0.019999	0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	1736.840	0.013122	2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2387.490	0.010093	25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.500	1.465548	25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3164.230	0.052481	2.5uW/MHz	PASS

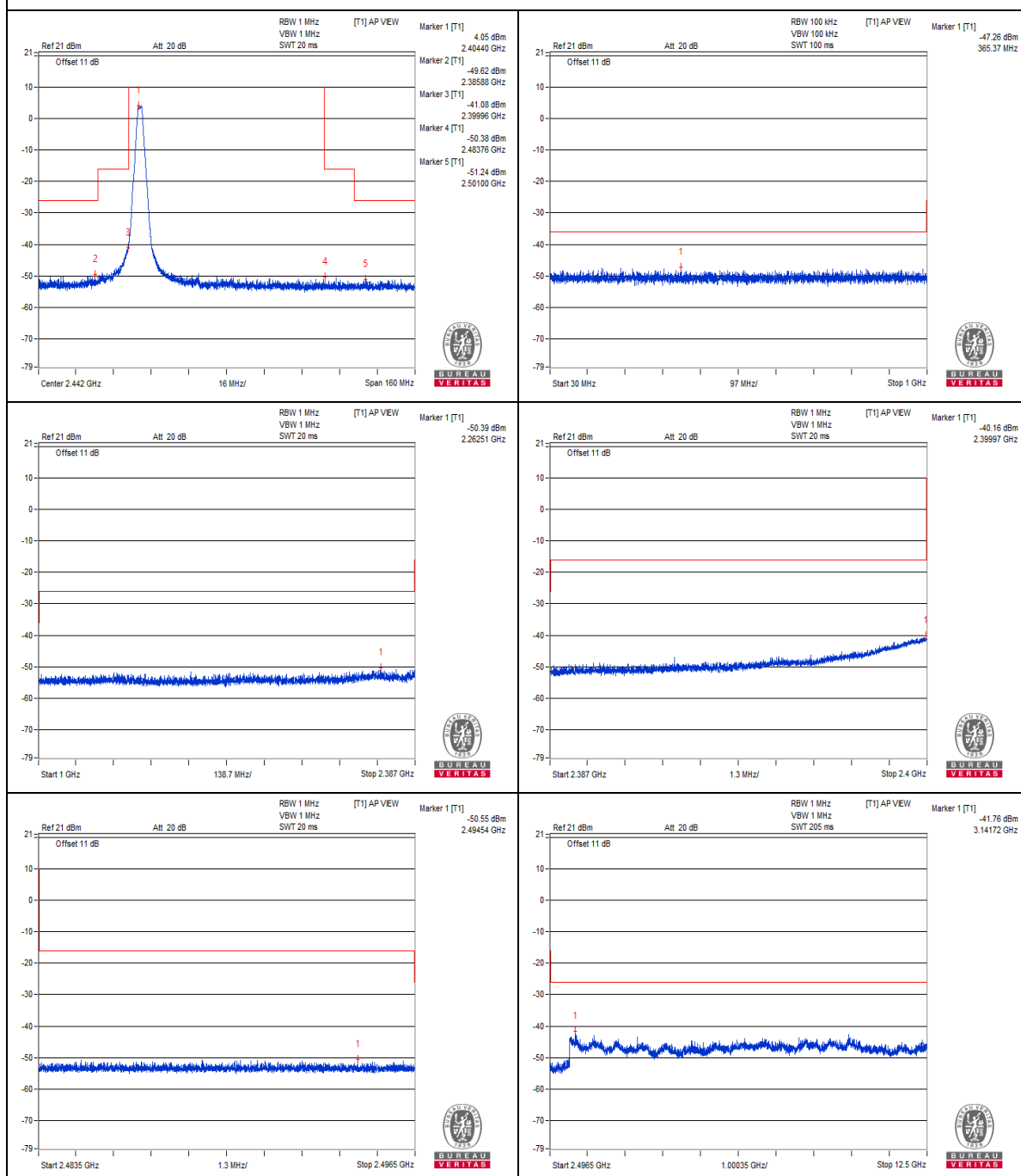
Note: 1. The spectrum plots are attached on the following pages.
2. (No.): The value was tested under Measuring Mode *Zero Span.

V_{normal}



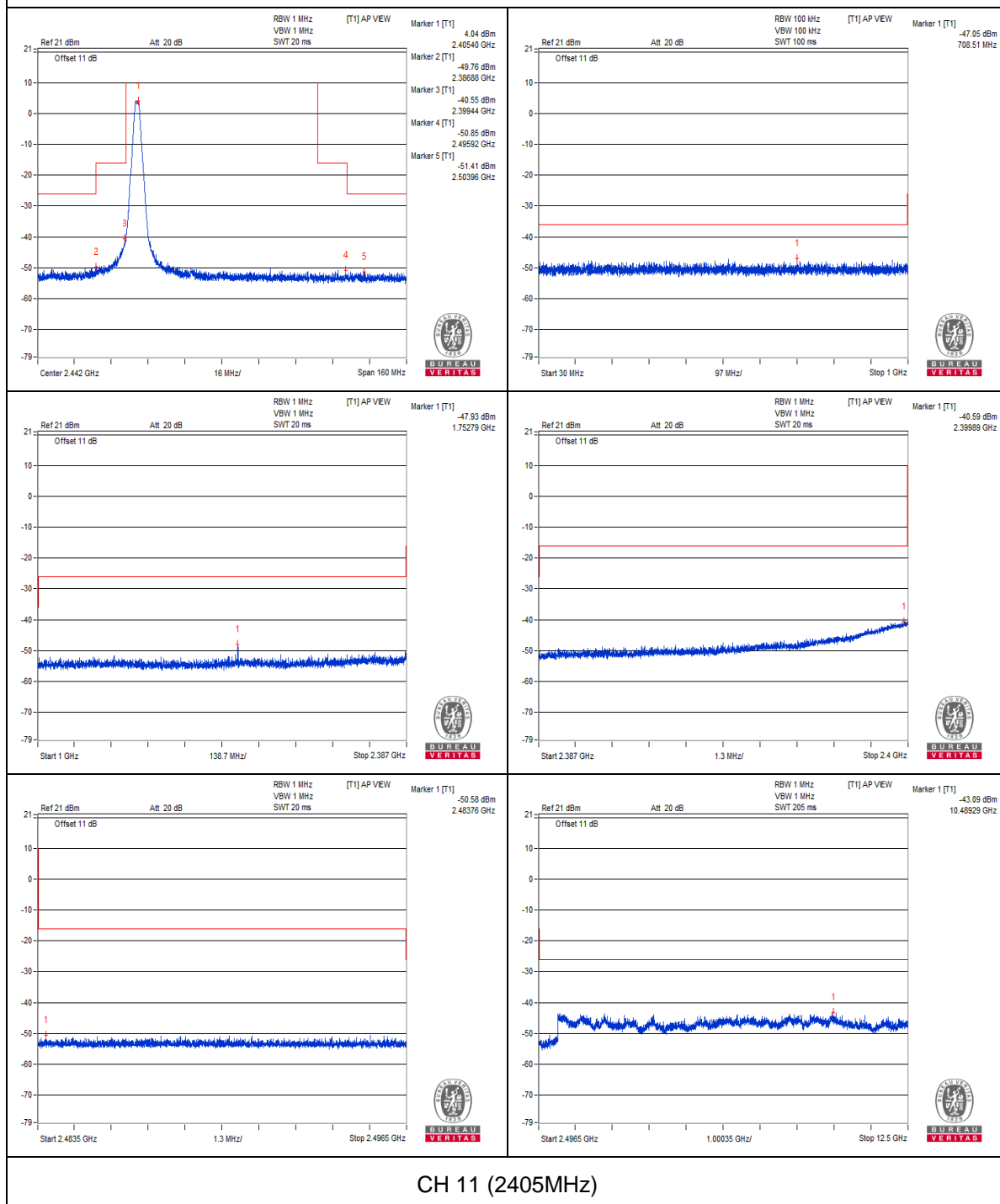
CH 11 (2405MHz)

V_{max}.

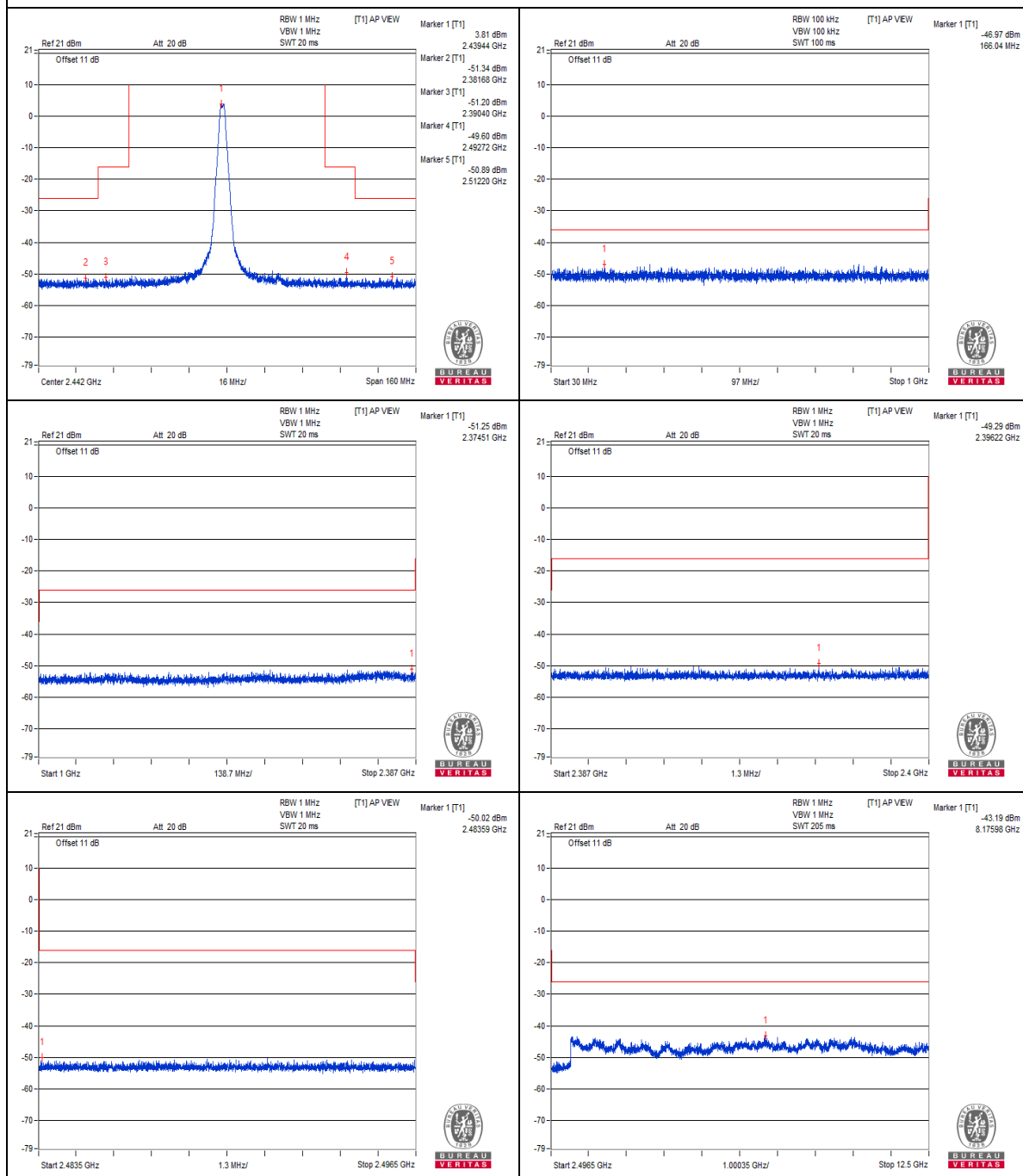


CH 11 (2405MHz)

V_{min}.

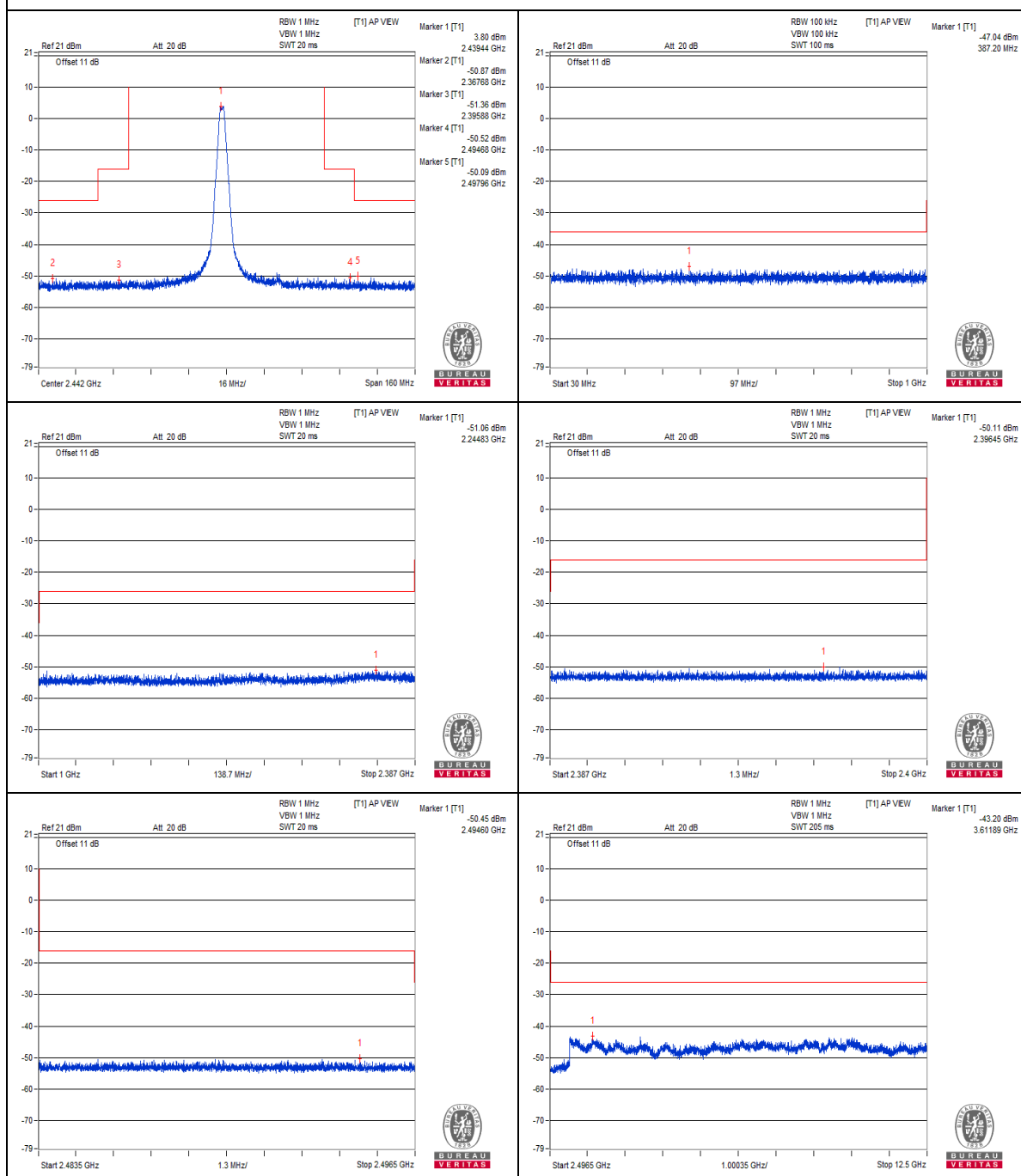


V_{normal}



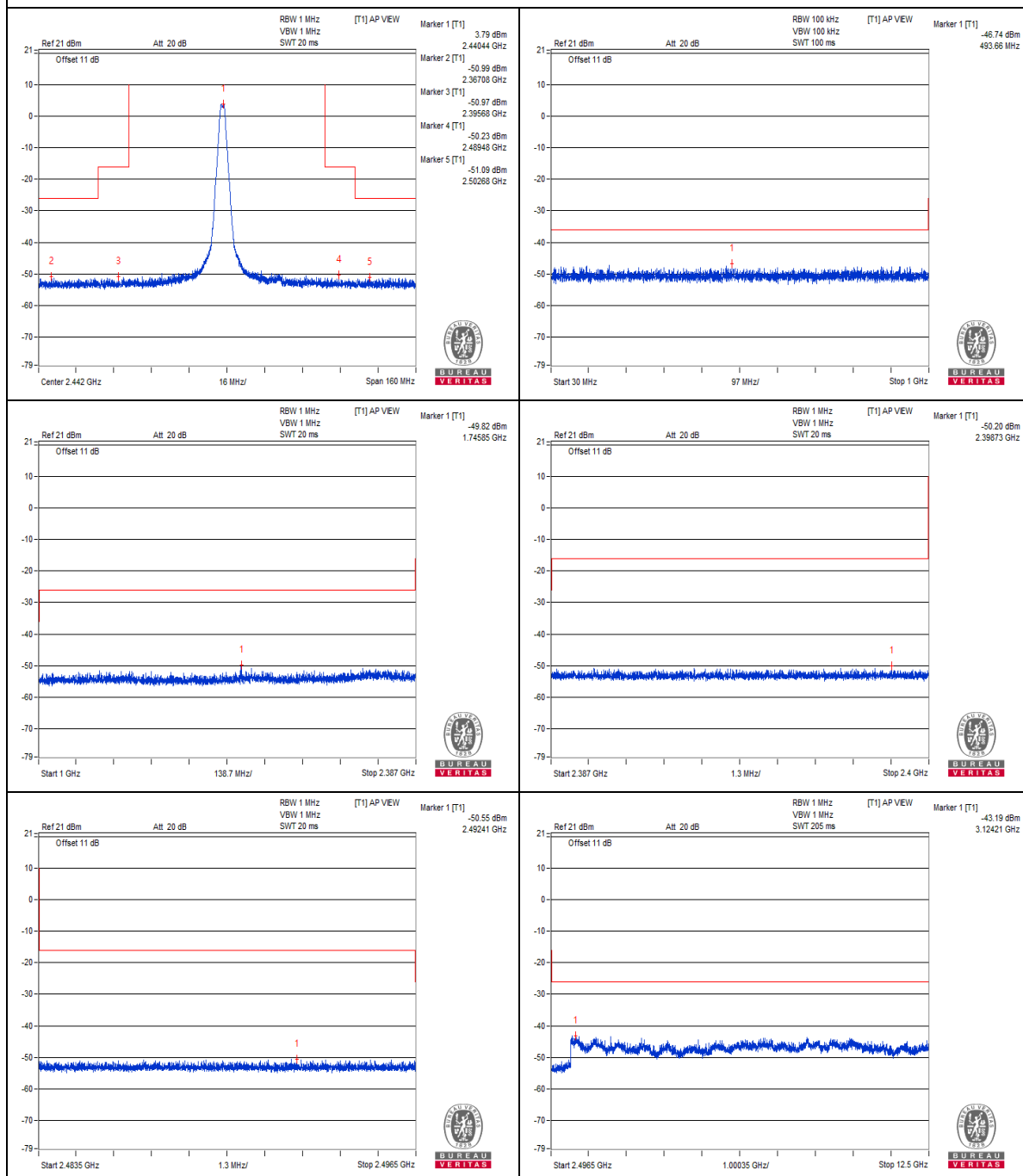
CH 18 (2440MHz)

V_{max}.



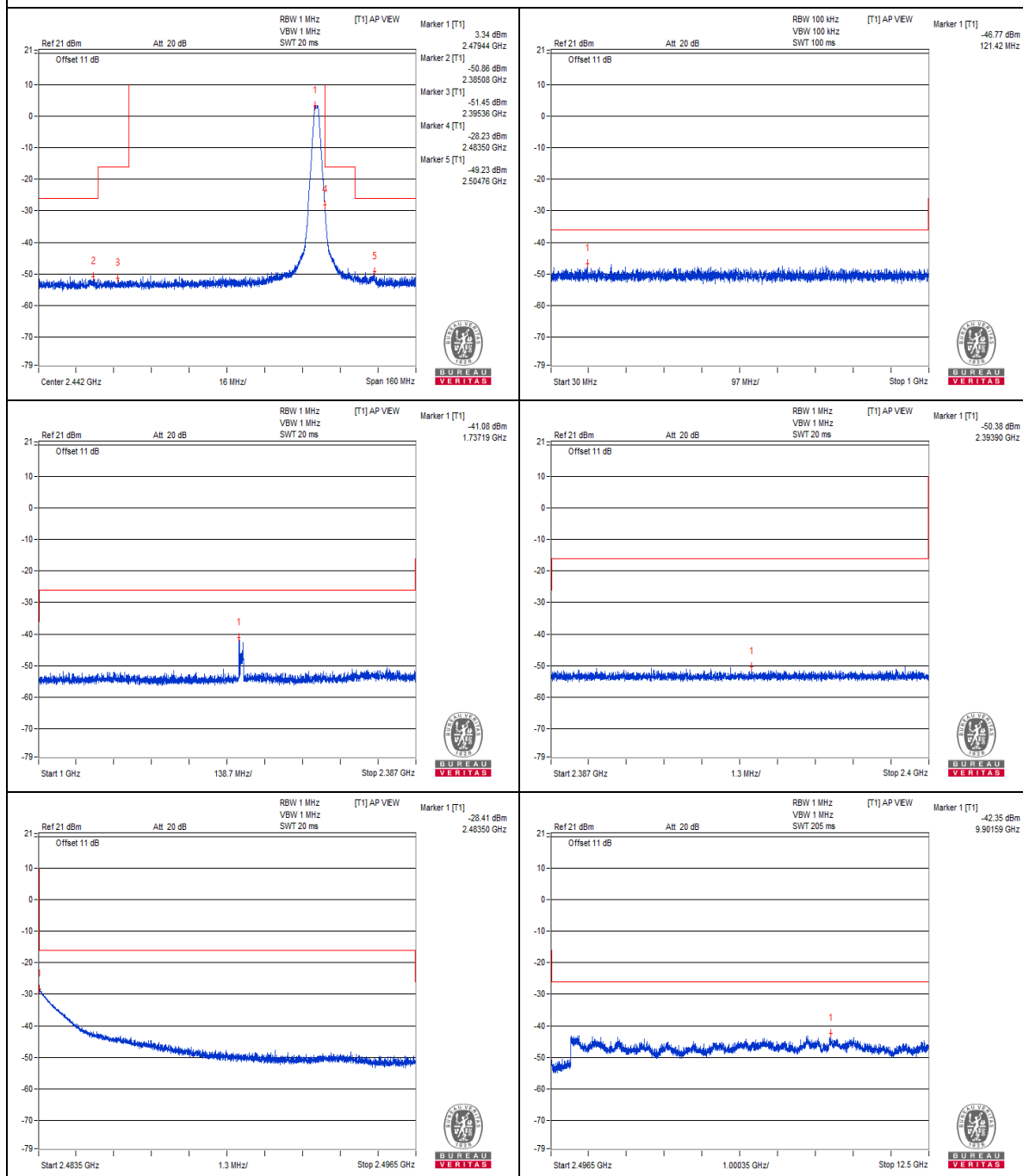
CH 18 (2440MHz)

V_{min}.



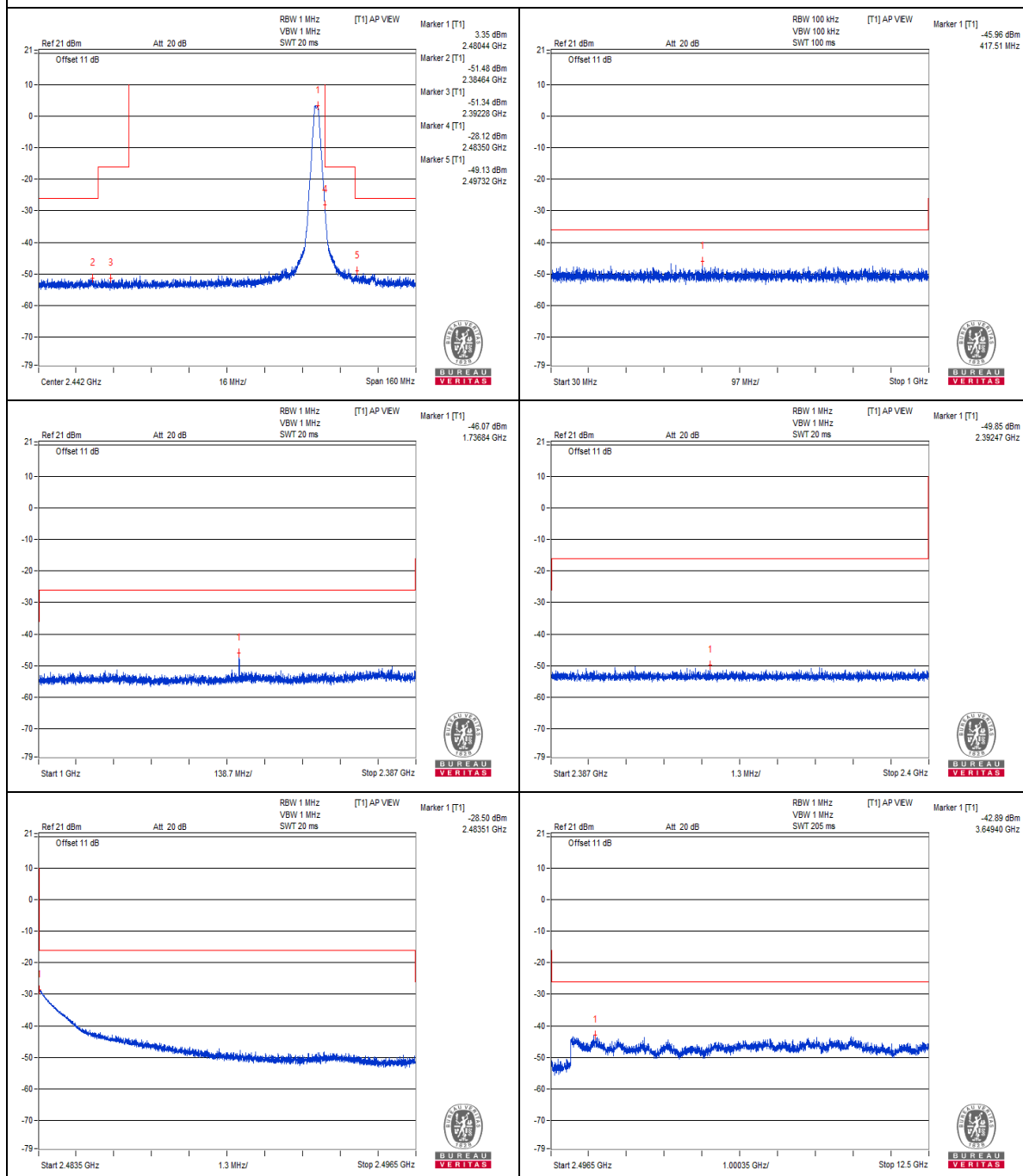
CH 18 (2440MHz)

V_{normal}



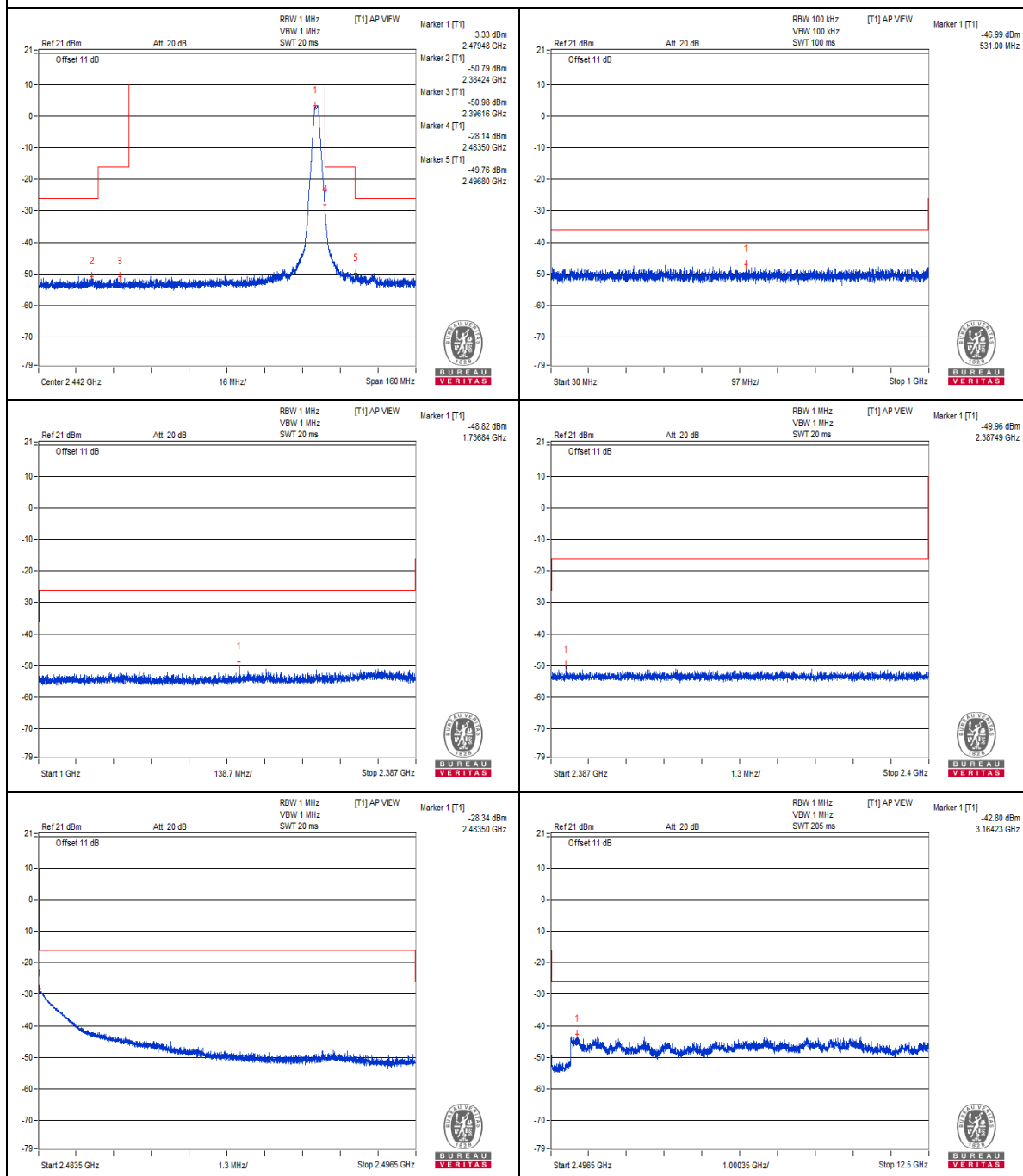
CH 26 (2480MHz)

V_{max}.



CH 26 (2480MHz)

V_{min}.



CH 26 (2480MHz)

4.5 Antenna Power Measurement

4.5.1 Limits of Antenna Power

Modulation System	Frequency Band Used	Antenna Power (Max.)	EIRP (Max.)	
			Omni-Directional Case	Directional Case
DS	2400 – 2483.5 MHz	10 mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
OFDM (Note 1)	2400 – 2483.5 MHz	10 mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
OFDM (Note 2)	2400 – 2483.5 MHz	5 mW/MHz	9.14d Bm/MHz (8.20 mW/MHz)	19.14 dBm/MHz (82.03 mW/MHz)
Other than the above	2400 – 2483.5 MHz	10 mW	12.14 dBm	22.14 dBm

Note:

1. Occupied bandwidth is less than 26MHz
2. Occupied bandwidth is more that 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 omni directional EIRP upper limit.
4. 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, 60% RH			
Channel Number	Frequency (MHz)	Conducted RF Output Power Density (mW)			
		Normal Voltage	Max. Voltage	Min. Voltage	Max. Limit (mW)
		3.0Vdc	3.3Vdc	2.7Vdc	
11	2405	2.818	2.825	2.851	10
18	2440	2.754	2.649	2.799	10
26	2480	2.570	2.483	2.529	10
Rated power		3.00mW/MHz			
Tolerance of antenna power		0.60mW/MHz ~ 3.60mW/MHz			

Chip antenna with -0.25dBi gain

Environmental Conditions		25 deg.C, 60% RH			
Channel Number	Frequency (MHz)	Radiated RF Output Power Density (mW)			
		Normal Voltage	Max. Voltage	Min. Voltage	Max. Limit (mW)
		3.0Vdc	3.3Vdc	2.7Vdc	
11	2405	2.660	2.667	2.692	16.368
18	2440	2.600	2.501	2.642	16.368
26	2480	2.426	2.344	2.388	16.368

Note: 1. The radiated RF output power is a "calculated" value derived from the conducted value.

2. Radiated RF output power = Conducted RF output power + 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

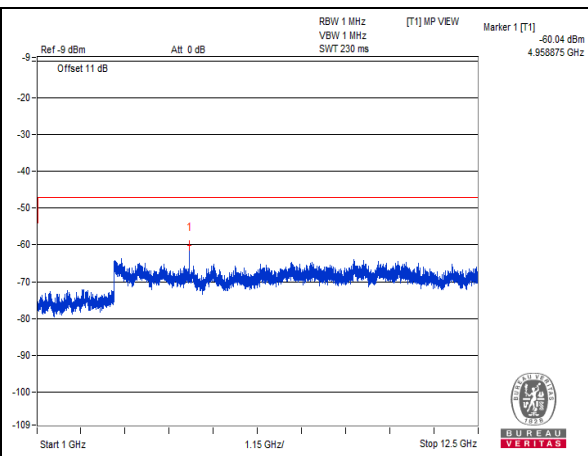
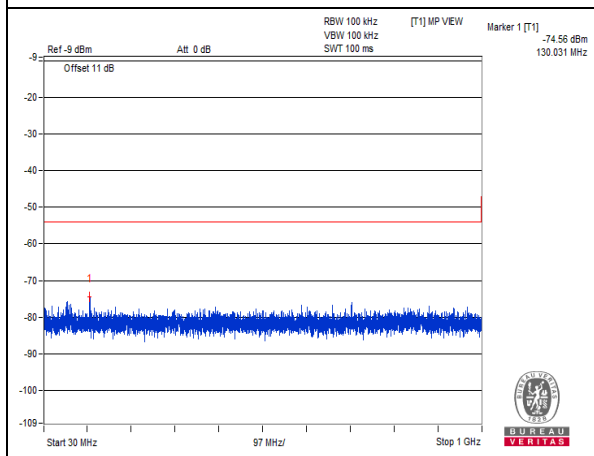


4.6.3 Test Result

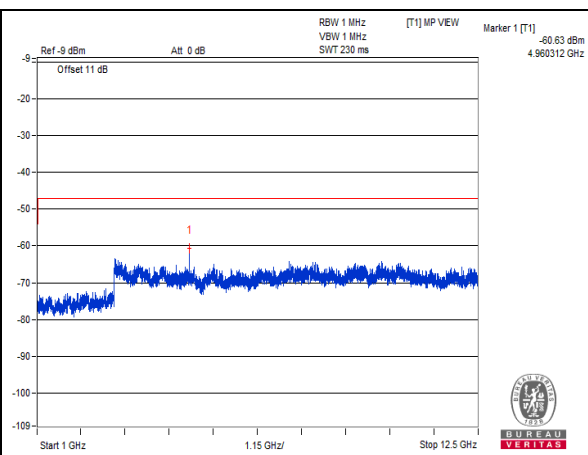
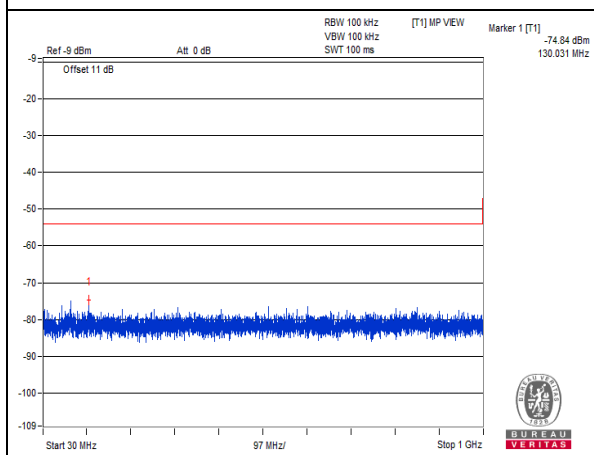
Environmental Conditions		25 deg.C, 60% RH					
Test Channel		CH11 (2405MHz)		CH18 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value (nW)	Frequency (MHz)	Measured Value (nW)		
V _{normal}	Below 1GHz	130.031	0.034995	90.018	0.034041	4nW/100kHz	Pass
	Above 1GHz	4958.875	0.990832	4960.312	0.706318	20nW/MHz	Pass
V _{max}	Below 1GHz	130.031	0.032810	130.031	0.036983	4nW/100kHz	Pass
	Above 1GHz	4960.312	0.864968	4960.312	0.887156	20nW/MHz	Pass
V _{min.}	Below 1GHz	129.910	0.047206	130.031	0.038815	4nW/100kHz	Pass
	Above 1GHz	4960.312	0.933254	4958.875	0.939723	20nW/MHz	Pass
Test Channel		CH26(2480MHz)				Limit	Result
Test Condition	Frequency Range	Frequency (MHz)		Measured Value (nW)			
V _{normal}	Below 1GHz	130.031		0.031769		4nW/100kHz	Pass
	Above 1GHz	4958.875		0.785236		20nW/MHz	Pass
V _{max}	Below 1GHz	130.031		0.031046		4nW/100kHz	Pass
	Above 1GHz	4958.875		0.803526		20nW/MHz	Pass
V _{min.}	Below 1GHz	130.031		0.041115		4nW/100kHz	Pass
	Above 1GHz	4960.312		1.023293		20nW/MHz	Pass

Note: The spectrum plots are attached on the following pages.

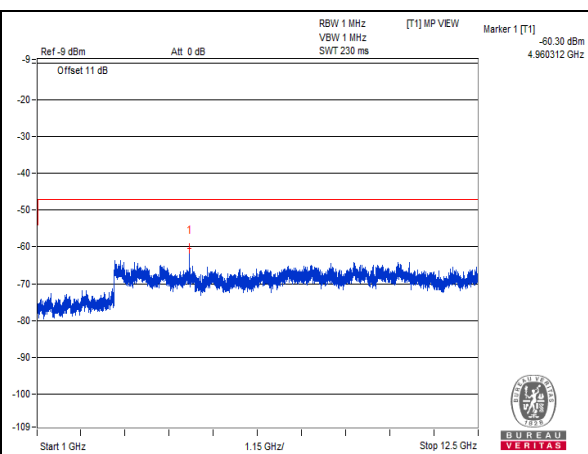
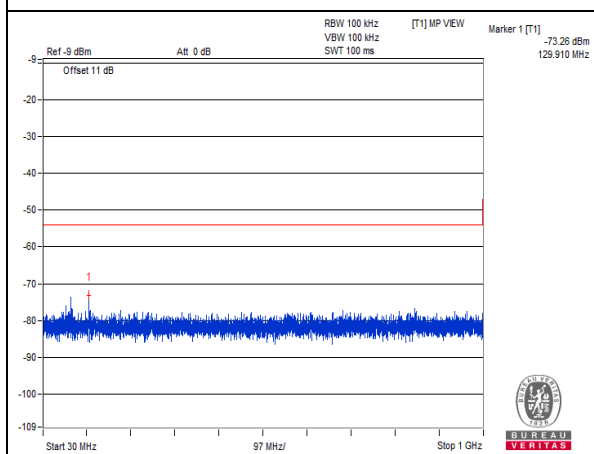
V_{normal}



V_{max}

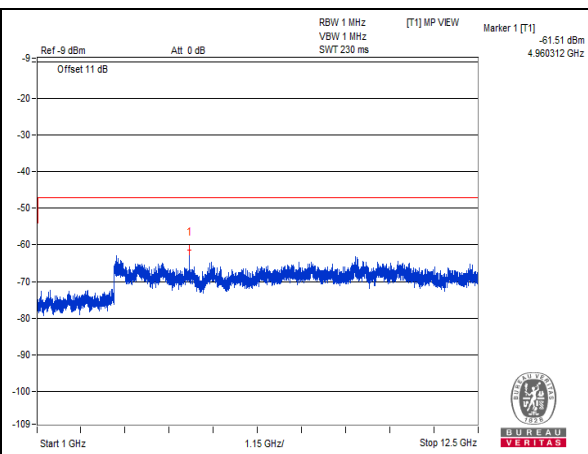
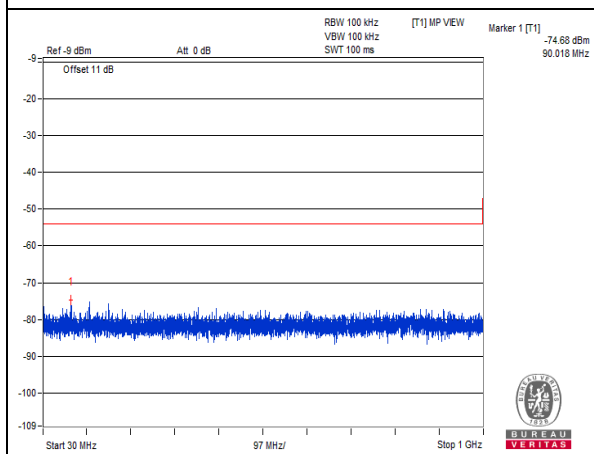


V_{min}

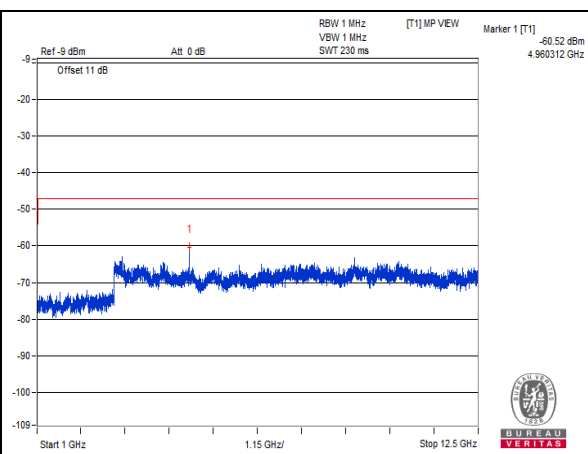
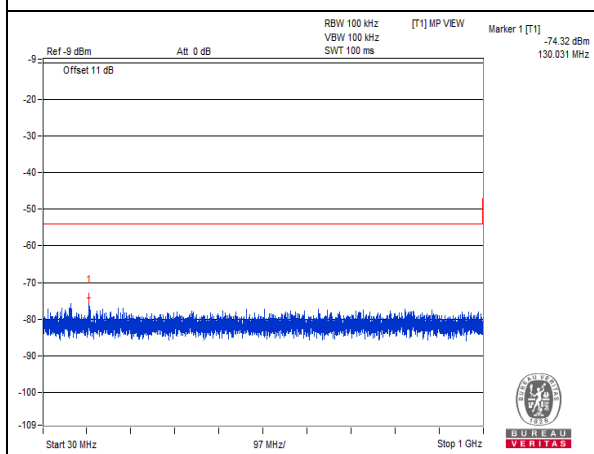


CH 11 (2405MHz)

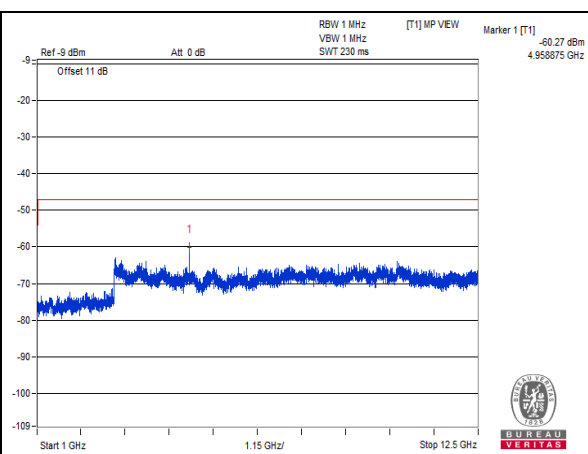
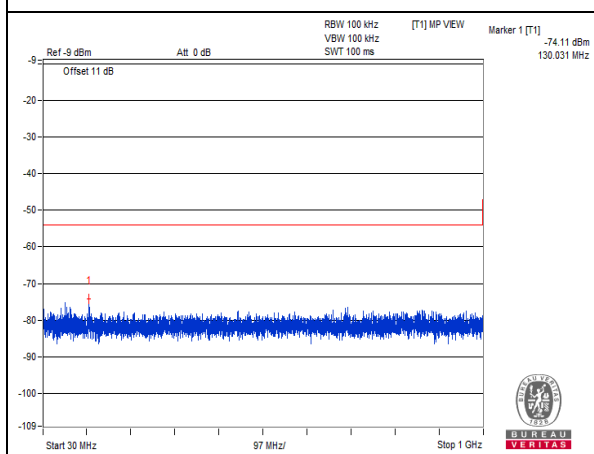
V_{normal}



V_{max}

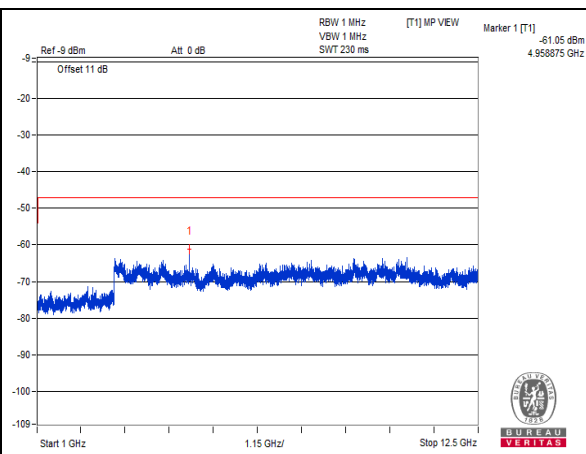
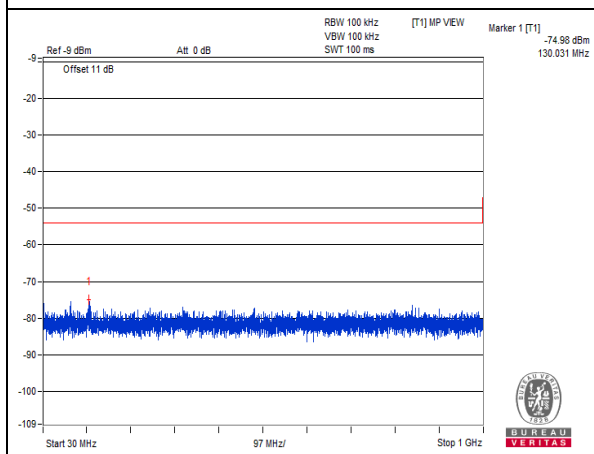


V_{min}

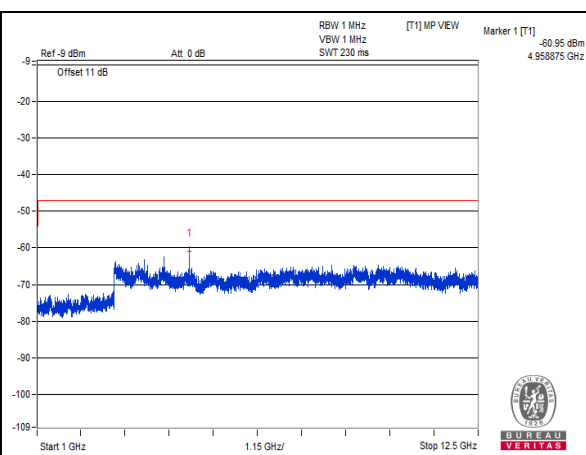
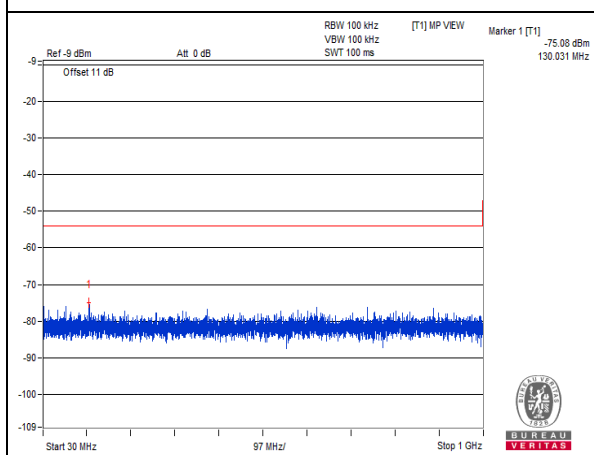


CH 18 (2440MHz)

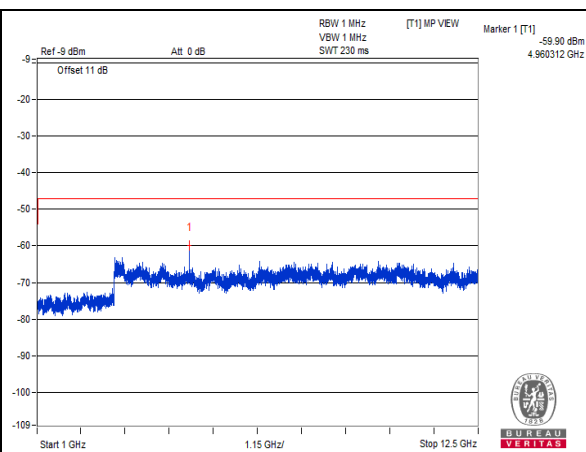
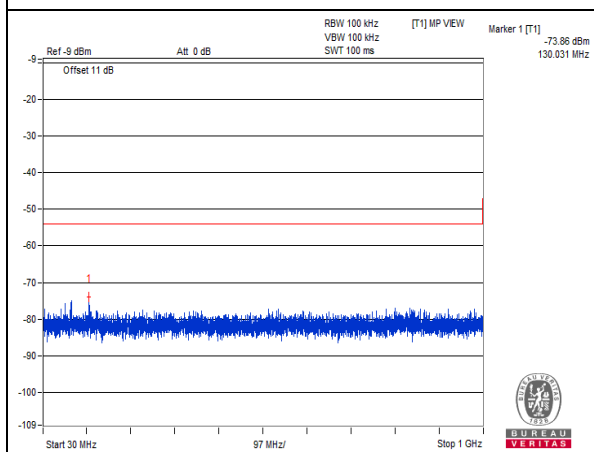
V_{normal}



V_{max}



V_{min}



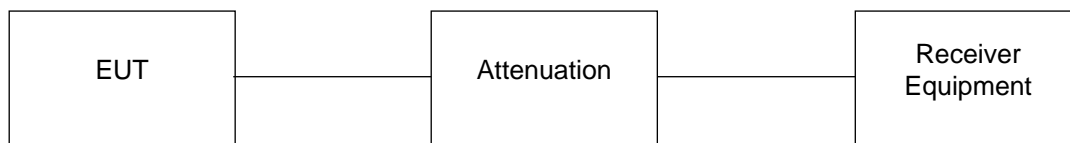
CH 26 (2480MHz)

4.7 Interference Prevention Function

4.7.1 Limits of Interference Prevention Function

NA

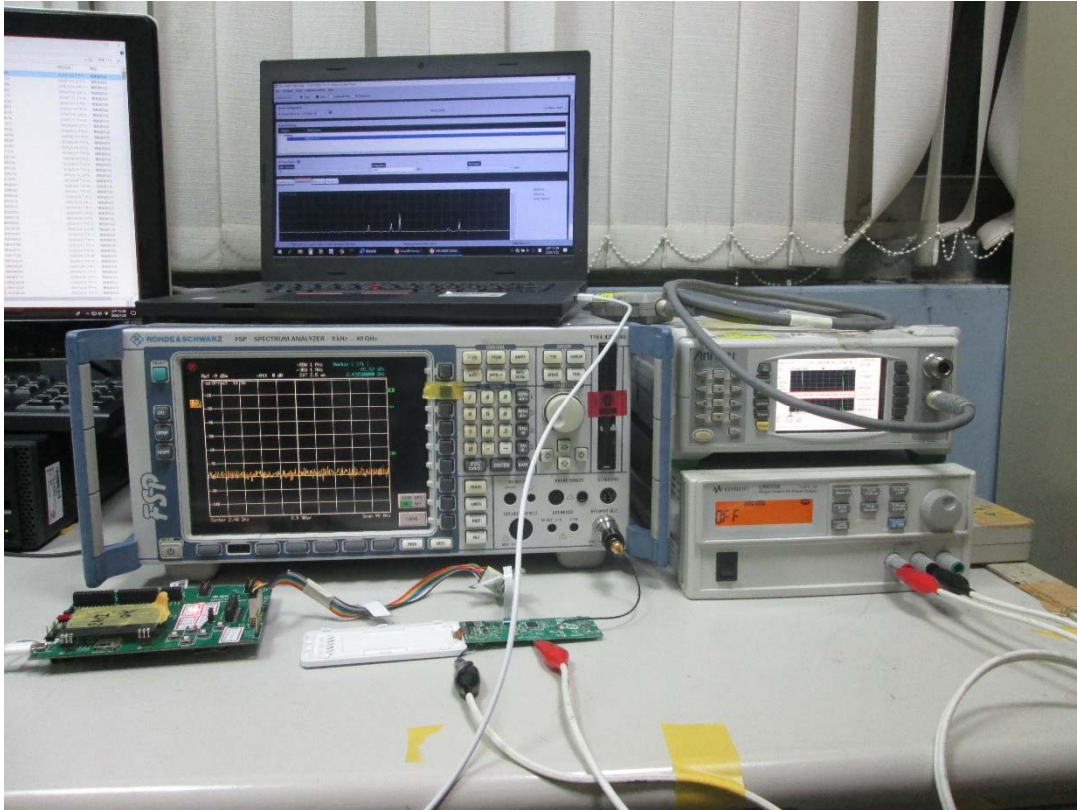
4.7.2 Test Setup



4.7.3 Test Results

Environmental Conditions	25 deg.C, 60% RH
Link Mode	Test Result
Normal	Pass

5 Photographs of the Test Configuration



Appendix - Information of 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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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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