

## Radio Test Report (BT-EDR)

**Report No.:** RJ171204E07F-2

**Test Model:** WHW01

**Series Model:** A01

**Received Date:** June 06, 2018

**Test Date:** June 08, 2018

**Issued Date:** June 28, 2018

**Applicant:** Belkin International, Inc.

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**Issued By:** Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch  
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**Test Location:** E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300,  
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# Release Control Record

Issue No.	Description	Date Issued
RJ171204E07F-2	Original release.	June 28, 2018



## 1 Certificate of Conformity

**Product:** Velop

**Brand:** Linksys

**Test Model:** WHW01

**Series Model:** A01

**Sample Status:** ENGINEERING SAMPLE

**Applicant:** Belkin International, Inc.

**Test Date:** June 08, 2018

**Standards:** ARIB STD-T66 (V3.7), MIC notice 88 Appendix 43  
Article 2 Paragraph 1 of Item 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 EMC characteristics under the conditions specified in this report.

**Prepared by :**

Mary Ko  
Mary Ko / Specialist

**Date:**

June 28, 2018

**Approved by :**

May Chen  
May Chen / Manager

**Date:**

June 28, 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)
<b>General Provisions</b>				
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
<b>Transmitting Equipment</b>				
F	--	4.5	Antenna power	C
--	--	--	SAR	NA
<b>Transmitting Antenna</b>				
--	--	3.5	Type, configuration, etc. of transmitting antenna	C
--	--	3.5	Direction pattern of transmitting antenna	C
<b>Receiving Equipment</b>				
G	3.3 (1)	4.6	Spurious emissions of receiver	C
--	--	3.5	Refer to all articles for transmitting antenna	C
<b>Operating Frequency 2400 to 2483.5MHz</b>				
--	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)	4.7	Frequency retention time (FH employed)	C
--	3.4.1 (1)	4.8	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 (BT-EDR)

Product	Velop
Brand	Linksys
Test Model	WHW01
Series Model	A01
Driver version	1.1.6.189522
Status of EUT	ENGINEERING SAMPLE
Nominal Voltage	12Vdc from power adapter
Modulation Type	GFSK, $\pi/4$ -DQPSK, 8DPSK
Modulation Technology	FHSS
Transfer Rate	Up to 3Mbps
Operating Frequency	2.402 ~ 2.480GHz
Number of Channel	79
Rated RF Output Power Density	Refer to Note
Conducted RF Output Power Density	Refer to Note
Radiated RF Output Power Density	Refer to Note
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 and Bluetooth technology used for the EUT.
- 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	WHW01	For marketing request
	A01	

From the above models, model: **WHW01** 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	Bluetooth

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

Brand	Model No.	Spec.
APD	WB-12G12FU	Input: 100-240Vac, 0.3A, 50-60Hz Output: 12V, 1A Output cable: Unshielded, 1.5m

5. The power table as below table:

	Rated output power density (mW/MHz)	Conducted RF output power density (mW/MHz)	Radiated RF output power density (mW/MHz)
<b>Normal mode</b>			
<b>GFSK</b>	0.1	0.081695	0.114867
<b><math>\pi/4</math>-DQPSK</b>	0.1	0.037389	0.052571
<b>8DPSK</b>	0.1	0.036351	0.051111
<b>Enable AFH function</b>			
<b>GFSK</b>	0.4	0.322216	0.453051
<b><math>\pi/4</math>-DQPSK</b>	0.4	0.147478	0.207361
<b>8DPSK</b>	0.4	0.142995	0.201058

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

### 3.2 Description of Test Modes

79 channels are provided for BT-EDR mode:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461		

**NOTE 1:** By means of test software (Hyper terminal paste 171205\_BT+BLE command.txt) provided by manufacture, the power levels during the tests were set according to the following codes:

Modulation type: GFSK		Modulation type: $\pi/4$ -DQPSK		Modulation type: 8DPSK	
Channel	Power setting	Channel	Power setting	Channel	Power setting
0	4	0	4	0	4
39	4	39	4	39	4
78	4	78	4	78	4

**NOTE 2:** The EUT was tested under following test modes, and the test data was recorded in this report:

Normal mode	Enable AFH function
GFSK	GFSK
$\pi/4$ -DQPSK	$\pi/4$ -DQPSK
8DPSK	8DPSK

\* For AFH function only tested occupied bandwidth, spreading bandwidth, Antenna power and dwell time.

### 3.3 Test Conditions

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

### 3.4 Assembly

The EUT is constructed as a Velop. The housing consists of two parts, the parts was fixed together by special type screws. Separating the two parts was only possible by special tools.

### 3.5 Antenna Specifications

#### 3.5.1 Antenna Gain

WLAN						
Ant No.	Brand	Model	Antenna Gain (dBi)	Frequency rang (GHz)	Antenna type	Connector type
1	ARISTOTLE	AP571-P11-P2	2.4	2.4~2.4835	PCB	i-pex(MHF)
			3.6	5.15~5.85		
2	ARISTOTLE	AP571-P22-P5	1.36	2.4~2.4835	PCB	i-pex(MHF)
			3.5	5.15~5.85		
Bluetooth						
Ant No.	Brand	Model	Antenna Gain (dBi)	Frequency rang (GHz)	Antenna type	Connector type
1	ARISTOTLE	AP571-BT-1	1.48	2.4~2.4835	PCB	i-pex(MHF)

#### 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



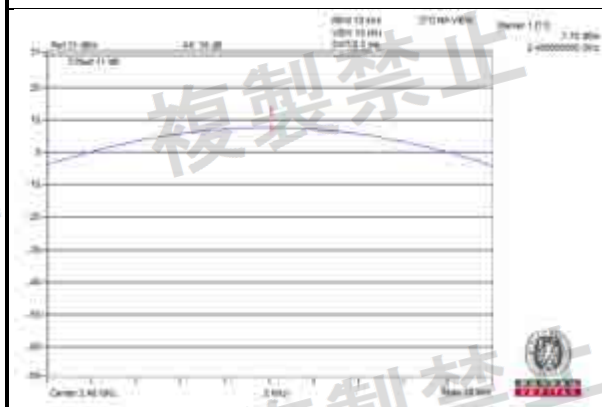
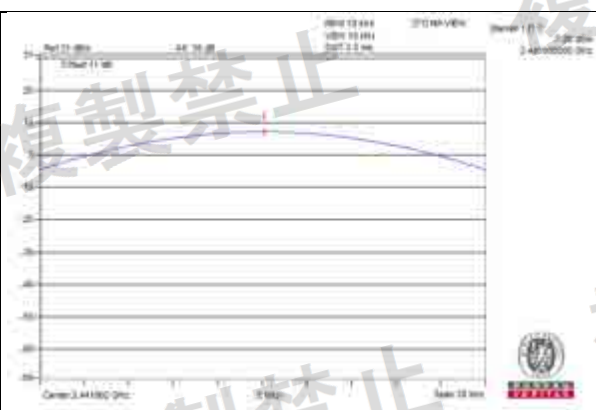
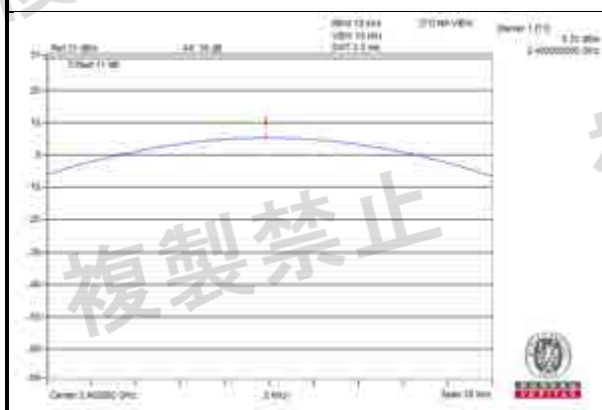
#### 4.1.3 Test Results

Modulation: GFSK

Environmental Conditions		25 deg.C, 60% RH					
Channel	Frequency (MHz)	V <sub>normal</sub>		V <sub>max.</sub>		V <sub>min.</sub>	
		Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)	Carrier frequency (MHz)	Frequency tolerance (ppm)
0	2402	2402.002080	0.865	2402.002000	0.832	2402.002000	0.832
39	2441	2441.002000	0.819	2441.002000	0.819	2441.001880	0.770
78	2480	2480.000480	0.193	2480.000400	0.161	2480.000360	0.145

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

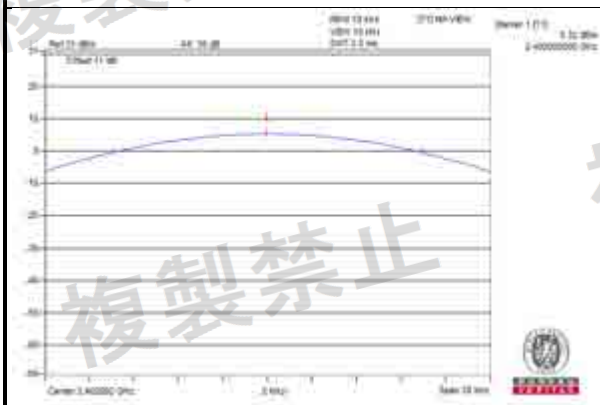
**V** normal



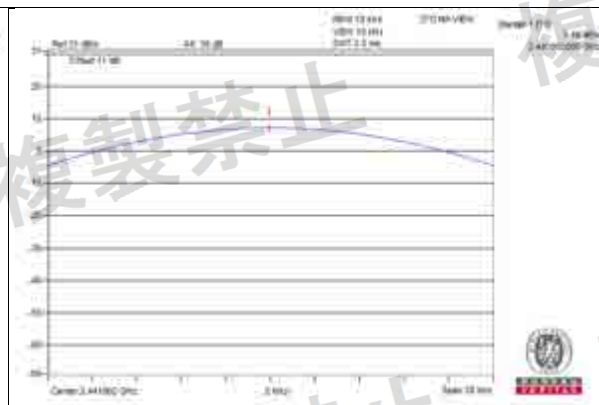


Channel 78

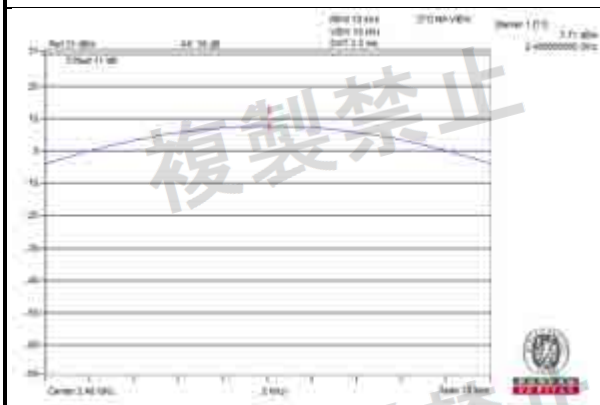
$V_{min}$



Channel 0



Channel 39



Channel 78

## 4.2 Occupied Bandwidth Measurement (99% power bandwidth)

### 4.2.1 Limits of Occupied Bandwidth Measurement

Item	Limit
Occupied bandwidth	<83.5 MHz

### 4.2.2 Test Setup



### 4.2.3 Test Results

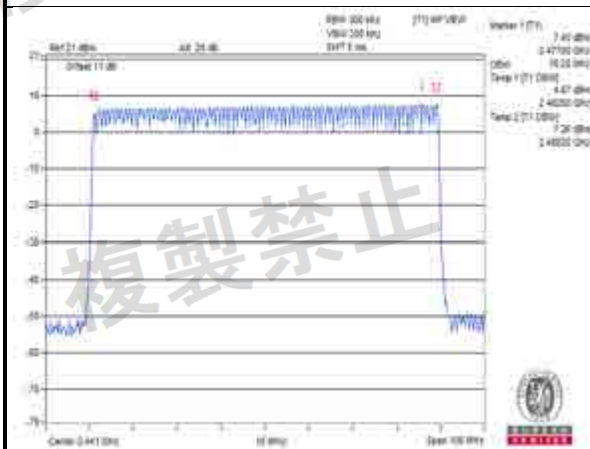
Modulation: GFSK

Normal Mode:

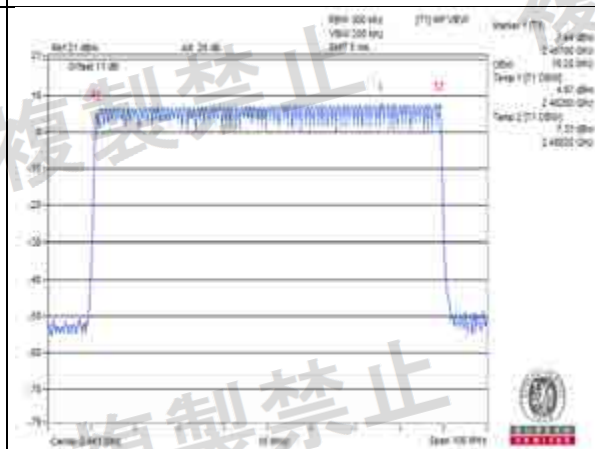
Environmental Conditions	25 deg.C, 60% RH	
$V_{\text{normal}}$	$V_{\text{max.}}$	$V_{\text{min.}}$
Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
78.20	78.20	78.20

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

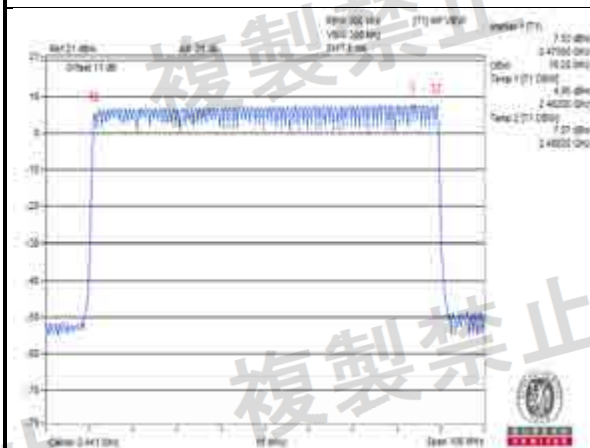
V<sub>normal</sub>



V<sub>max.</sub>

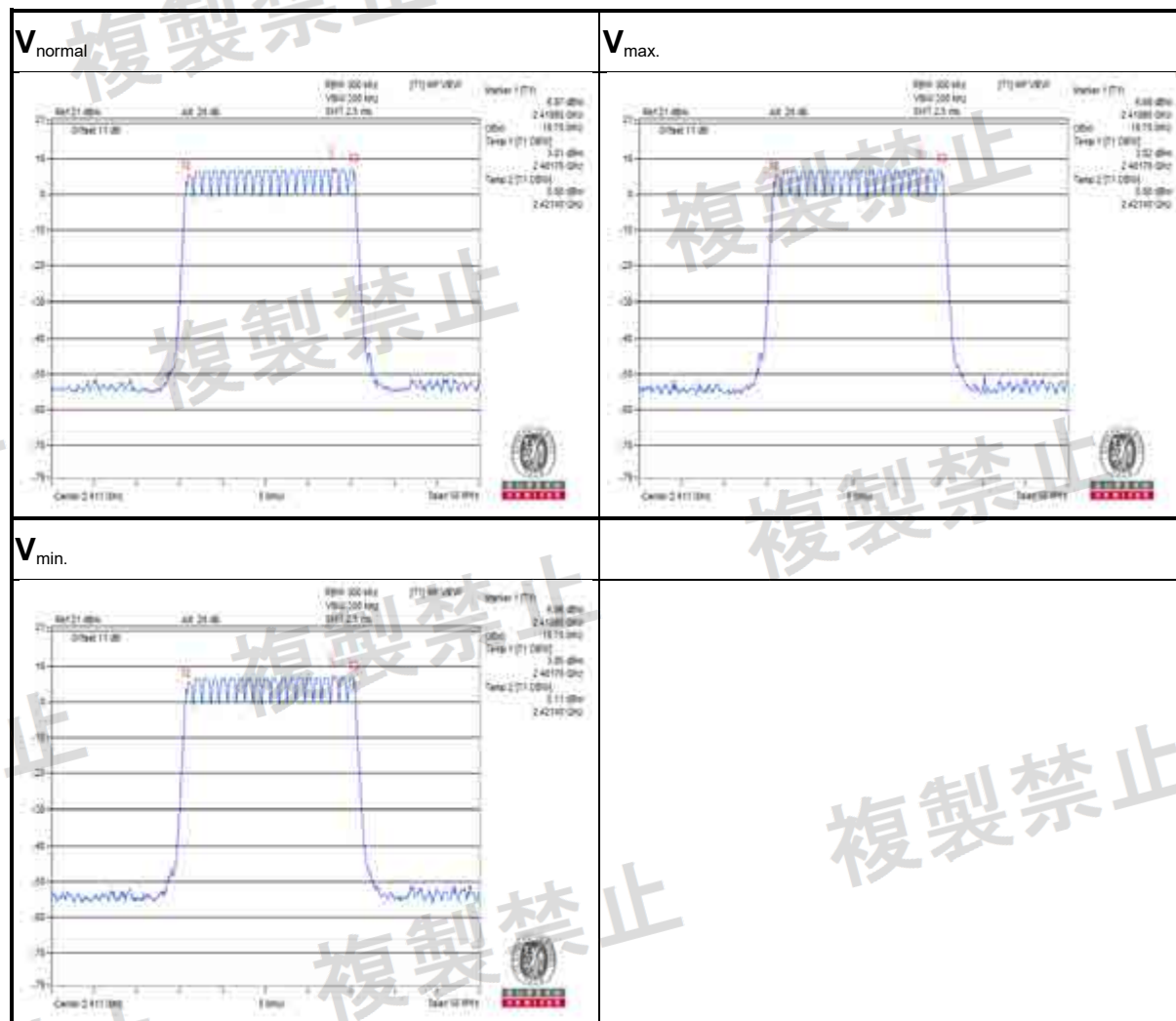


V<sub>min.</sub>



# AFH Mode:

Environmental Conditions	25 deg.C, 60% RH	
$V_{normal}$	$V_{max.}$	$V_{min.}$
Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
19.70	19.70	19.70

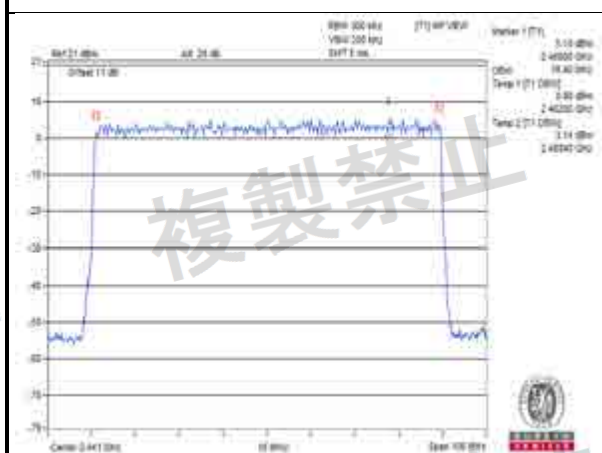


Modulation:  $\pi/4$ -DQPSK

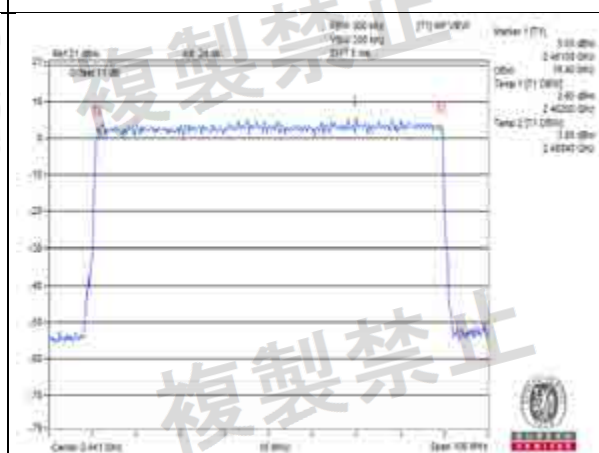
Normal Mode:

Environmental Conditions	25 deg.C, 60% RH	
$V_{\text{normal}}$	$V_{\text{max.}}$	$V_{\text{min.}}$
Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
78.40	78.40	78.40

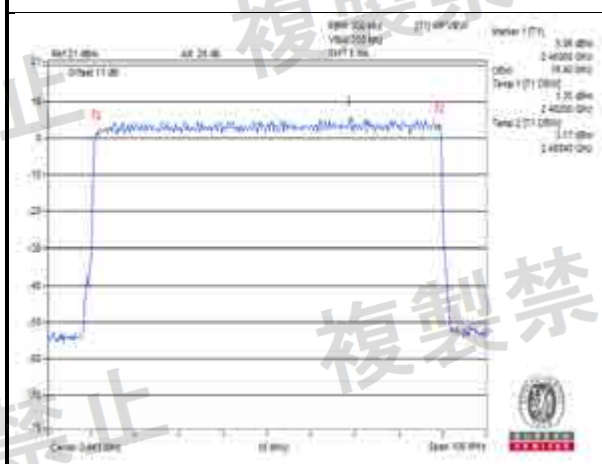
$V_{\text{normal}}$



$V_{\text{max.}}$

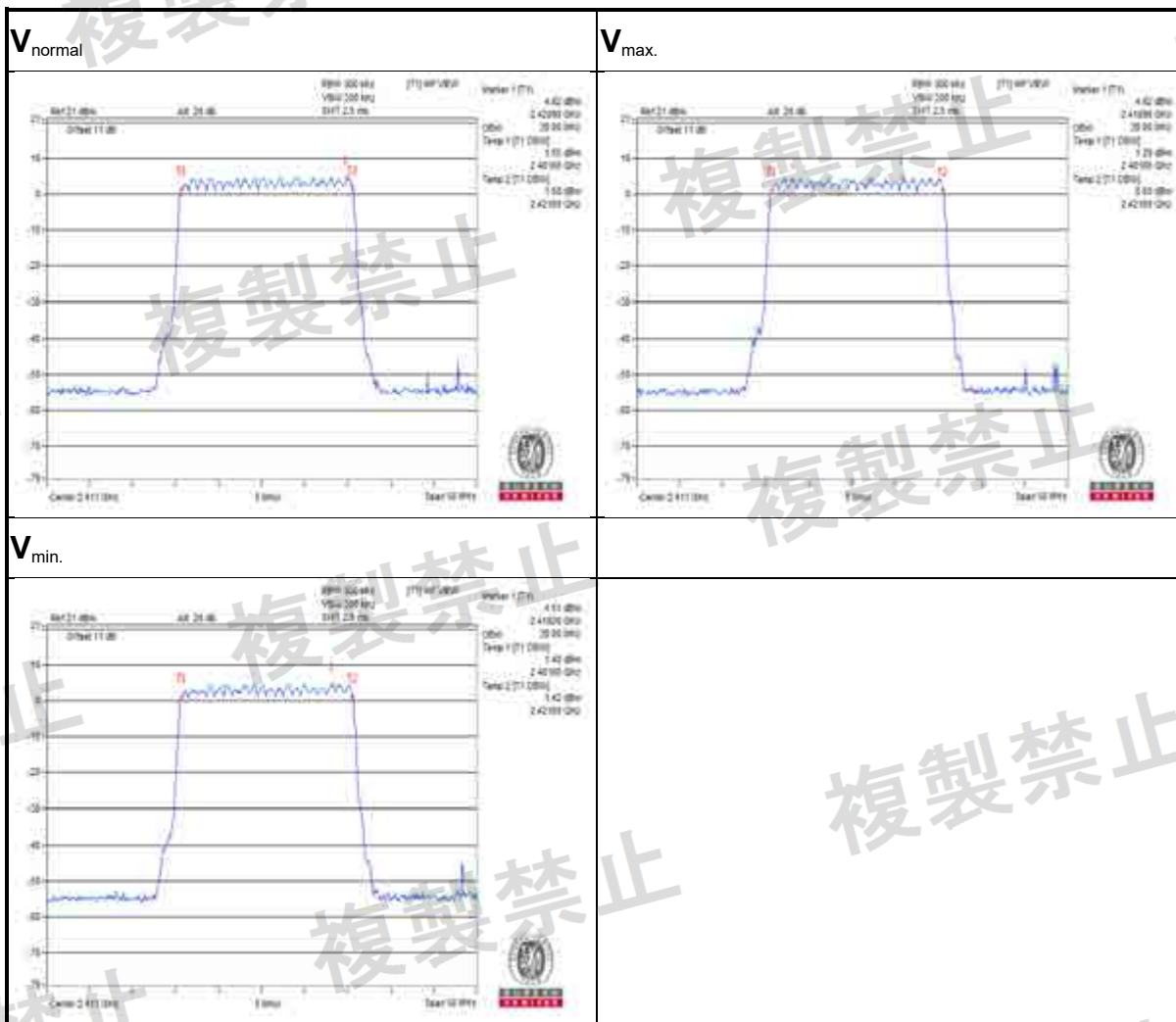


$V_{\text{min.}}$



# AFH Mode:

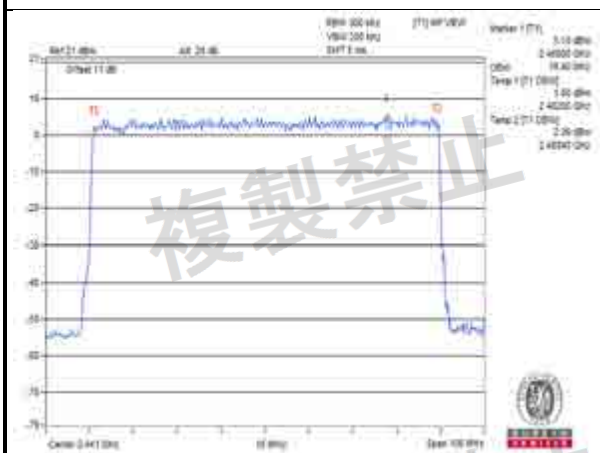
Environmental Conditions		25 deg.C, 60% RH	
$V_{normal}$		$V_{max.}$	$V_{min.}$
Occupied Bandwidth (MHz)		Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
20.00		20.00	20.00



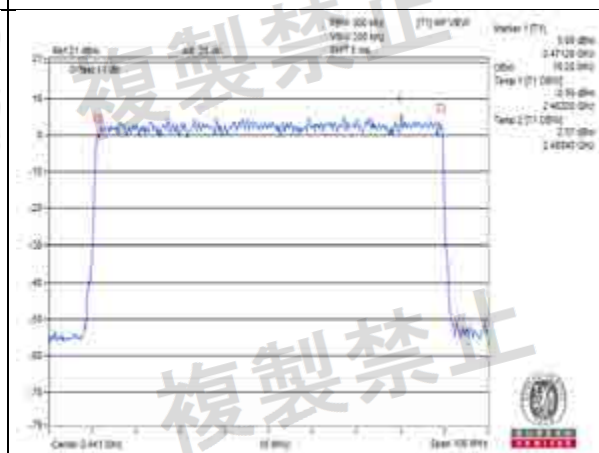
Modulation: 8DPSK  
Normal Mode:

Environmental Conditions	25 deg.C, 60% RH	
$V_{normal}$	$V_{max.}$	$V_{min.}$
Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
78.40	78.20	78.40

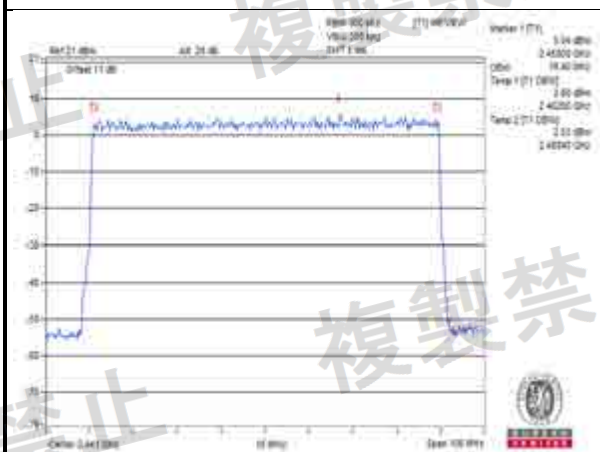
$V_{normal}$



$V_{max.}$

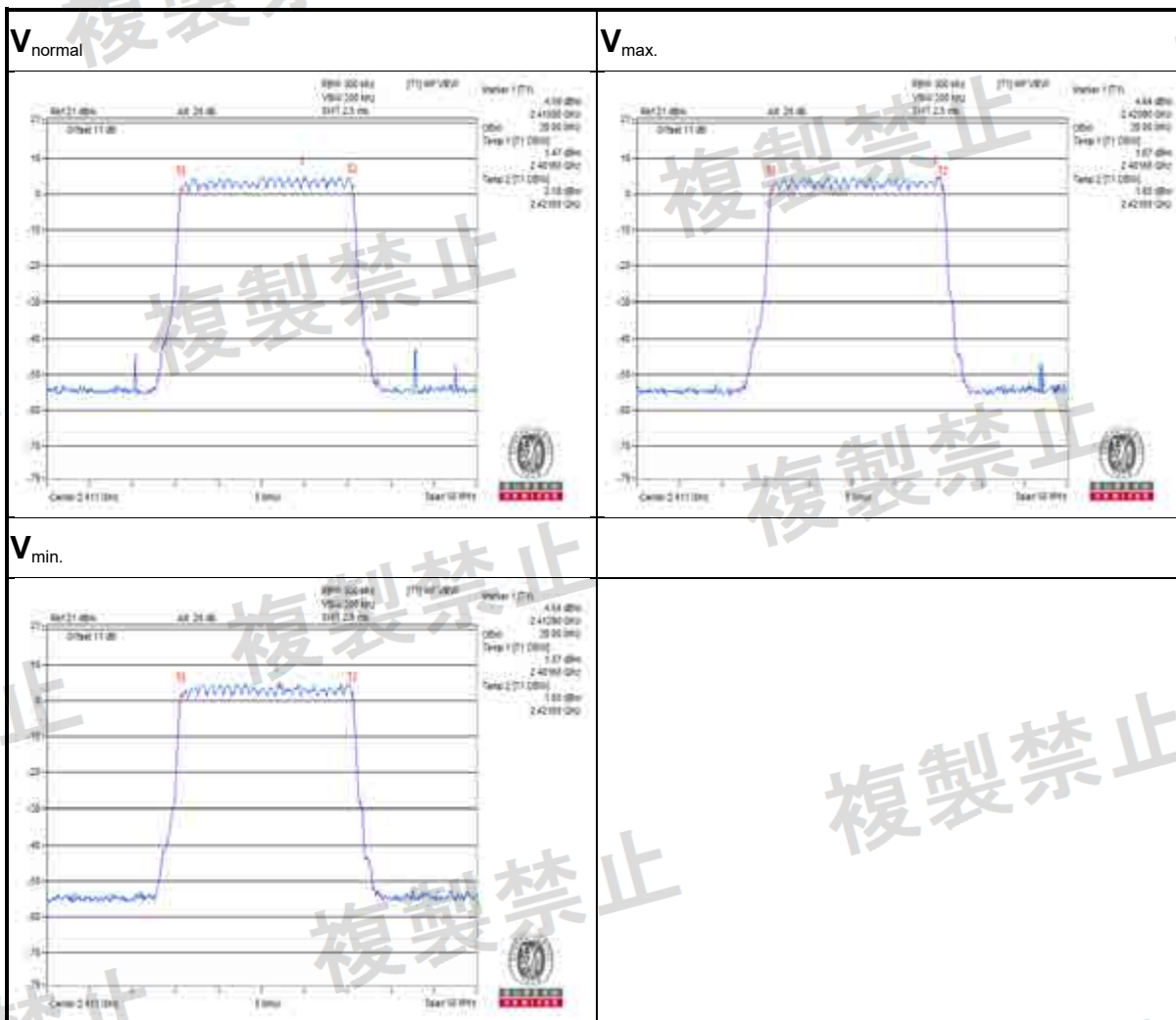


$V_{min.}$



# AFH Mode:

Environmental Conditions	25 deg.C, 60% RH	
$V_{normal}$	$V_{max.}$	$V_{min.}$
Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)	Occupied Bandwidth (MHz)
20.00	20.00	20.00



### 4.3 Spreading Bandwidth Measurement (90% power bandwidth)

#### 4.3.1 Limits of Spreading Bandwidth and Spreading Factor Measurement

Item	Limit	Remark
Spreading Bandwidth	$\geq 500\text{kHz}$	(For DSSS, FHSS)
Spreading Factor	$\geq 5$	Operating frequency 2400 to 2483.5MHz

#### 4.3.2 Test Setup



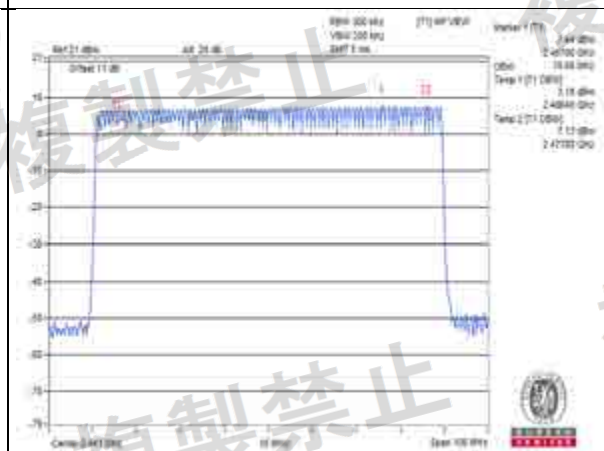
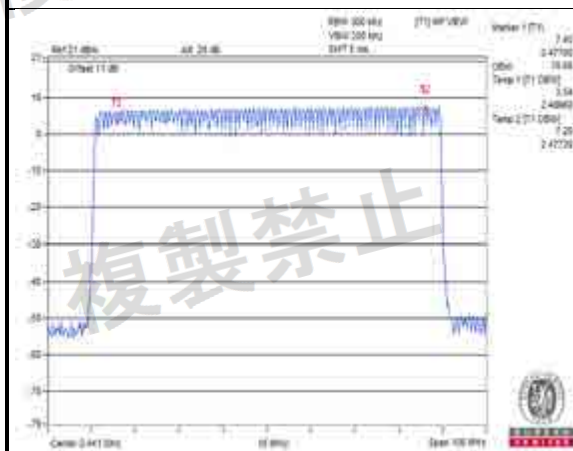
#### 4.3.3 Test Results

Modulation: GFSK

Normal Mode:

Environmental Conditions		25 deg.C, 60% RH			
$V_{\text{normal}}$		$V_{\text{max.}}$		$V_{\text{min.}}$	
Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
70.60	70.60	70.60	70.60	70.60	70.60

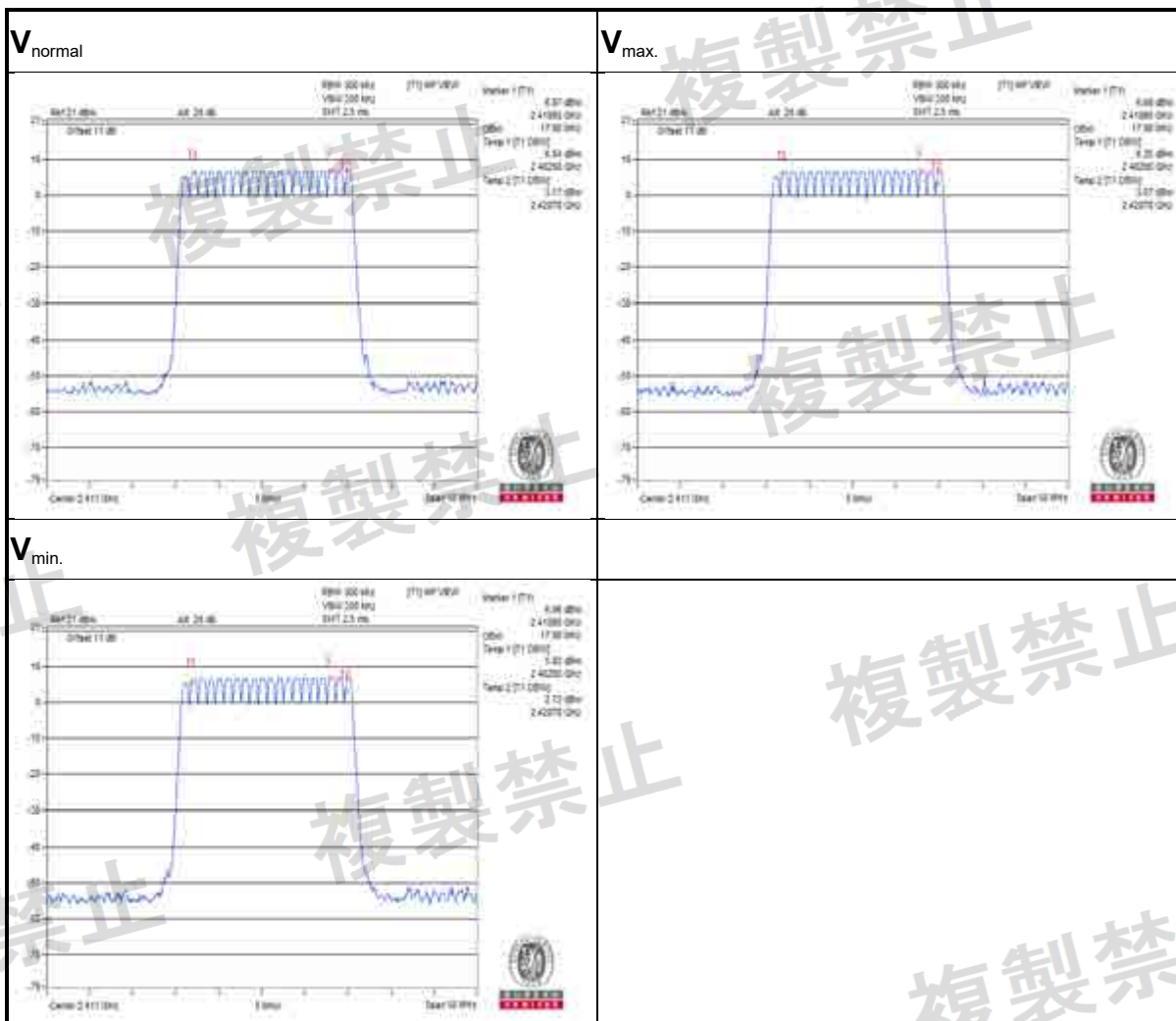
Note: 1. Spreading Factor: 90% channel power bandwidth / 1.  
2. For the test plots please refer to the below pages.



# AFH Mode:

Environmental Conditions		25 deg.C, 60% RH			
V <sub>normal</sub>		V <sub>max.</sub>		V <sub>min.</sub>	
Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
17.80	17.80	17.90	17.90	17.90	17.90

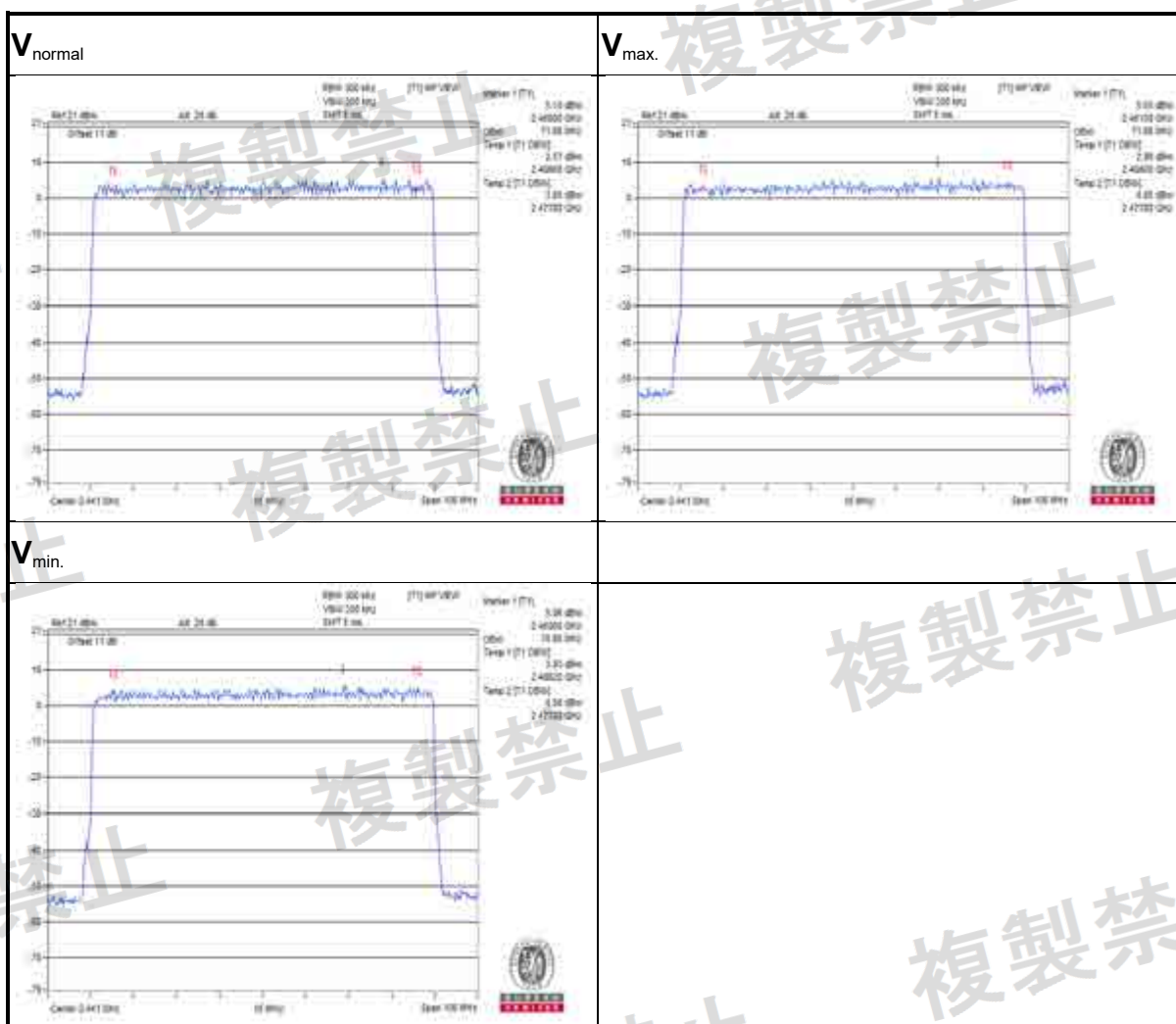
Note: 1. Spreading Factor: 90% channel power bandwidth / 1.



Modulation:  $\pi/4$ -DQPSK  
Normal Mode:

Environmental Conditions		25 deg.C, 60% RH			
$V_{normal}$		$V_{max.}$		$V_{min.}$	
Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
71.00	71.00	71.00	71.00	70.80	70.80

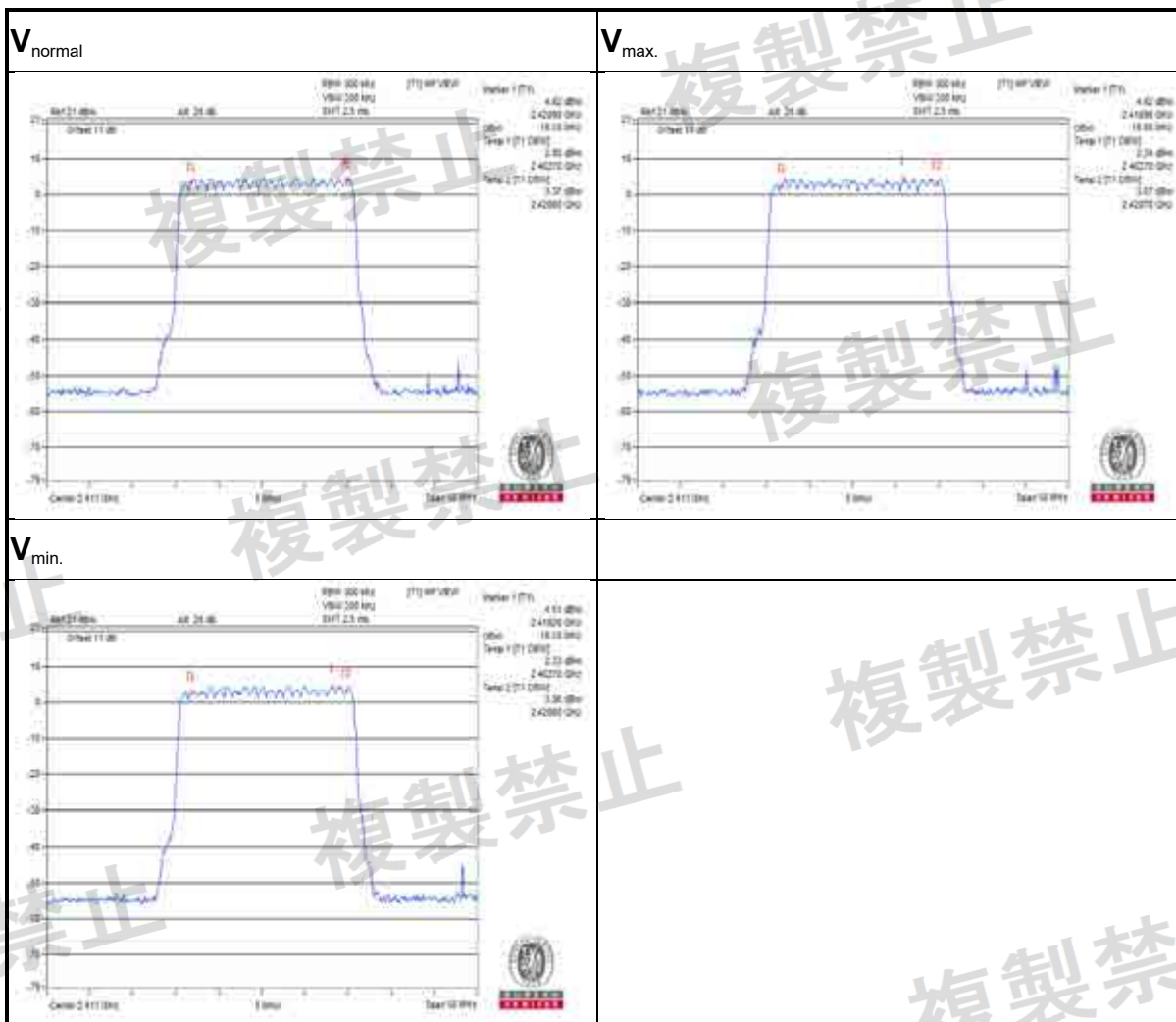
Note: 1. Spreading Factor: 90% channel power bandwidth / 1.



# AFH Mode:

Environmental Conditions		25 deg.C, 60% RH			
V <sub>normal</sub>		V <sub>max.</sub>		V <sub>min.</sub>	
Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
18.10	18.10	18.00	18.00	18.10	18.10

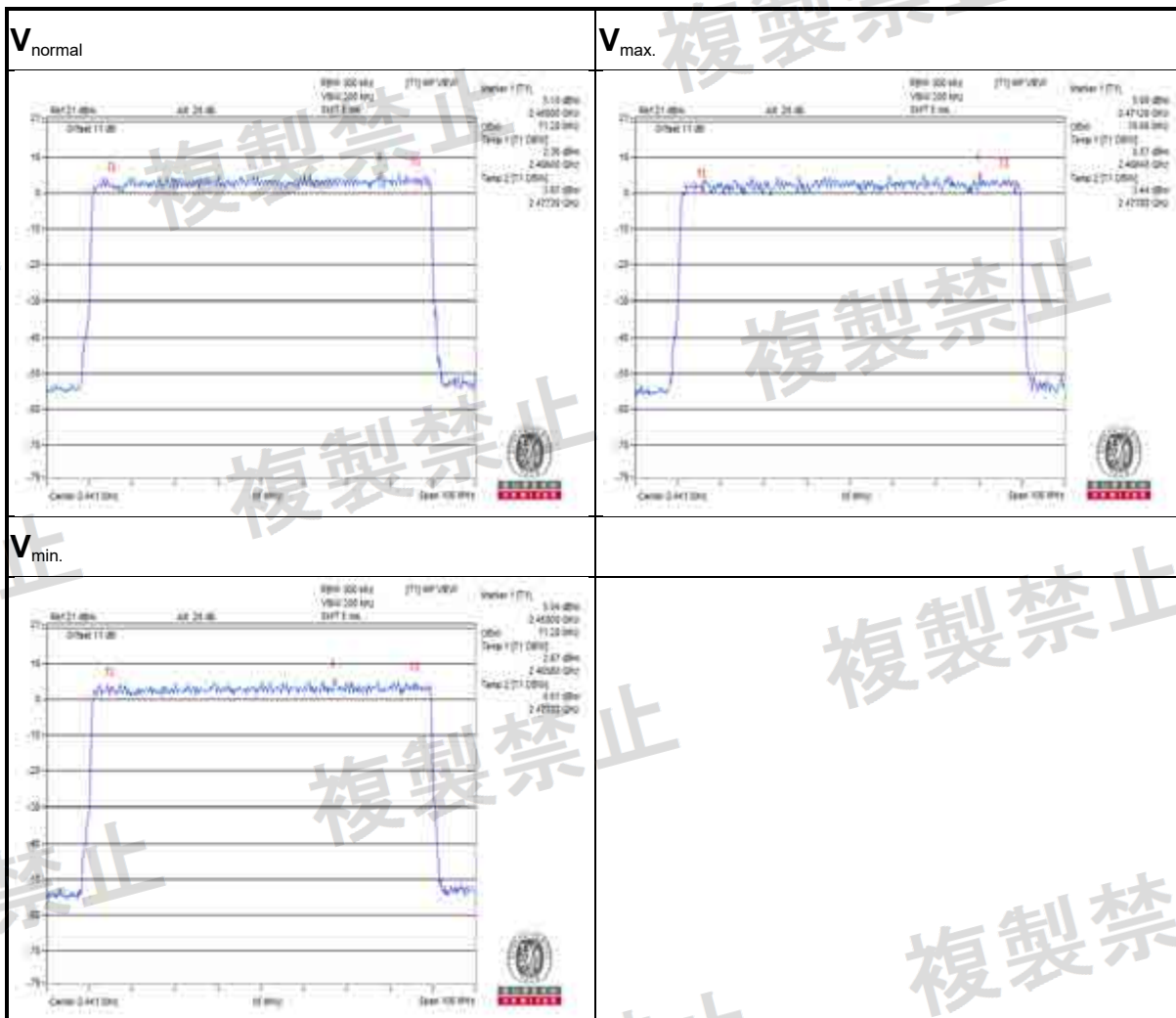
Note: 1. Spreading Factor: 90% channel power bandwidth / 1.



Modulation: 8DPSK  
Normal Mode:

Environmental Conditions		25 deg.C, 60% RH			
$V_{normal}$		$V_{max.}$		$V_{min.}$	
Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
71.20	71.20	70.60	70.60	71.20	71.20

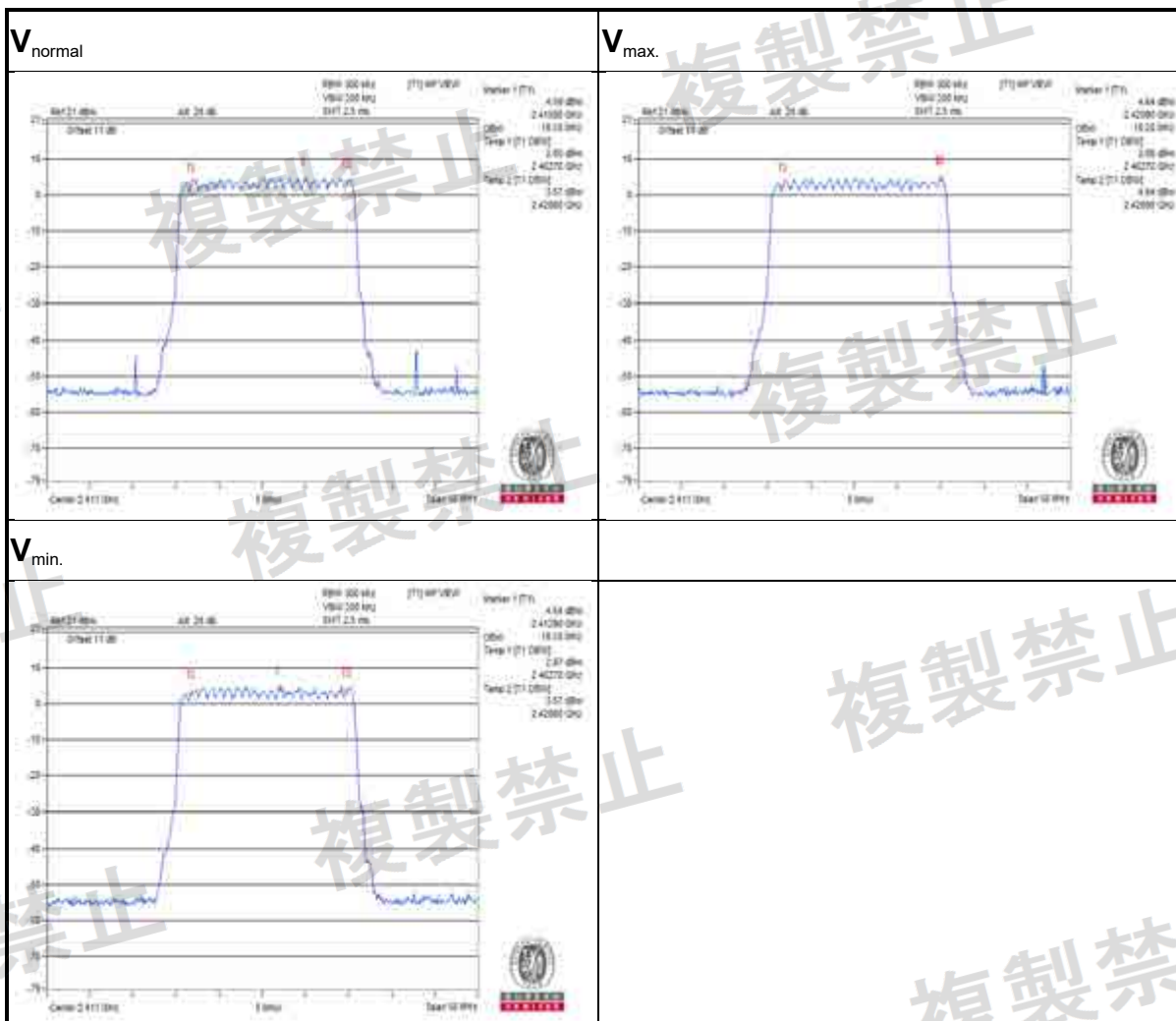
Note: 1. Spreading Factor: 90% channel power bandwidth / 1.



# AFH Mode:

Environmental Conditions		25 deg.C, 60% RH			
V <sub>normal</sub>		V <sub>max.</sub>		V <sub>min.</sub>	
Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor	Occupied Bandwidth (MHz)	Spreading Factor
18.10	18.10	18.20	18.20	18.10	18.10

Note: 1. Spreading Factor: 90% channel power bandwidth / 1.

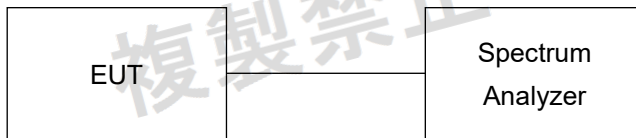


#### 4.4 Spurious Emissions for Transmitter Measurement

##### 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

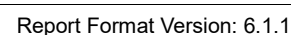


#### 4.4.3 Test Results

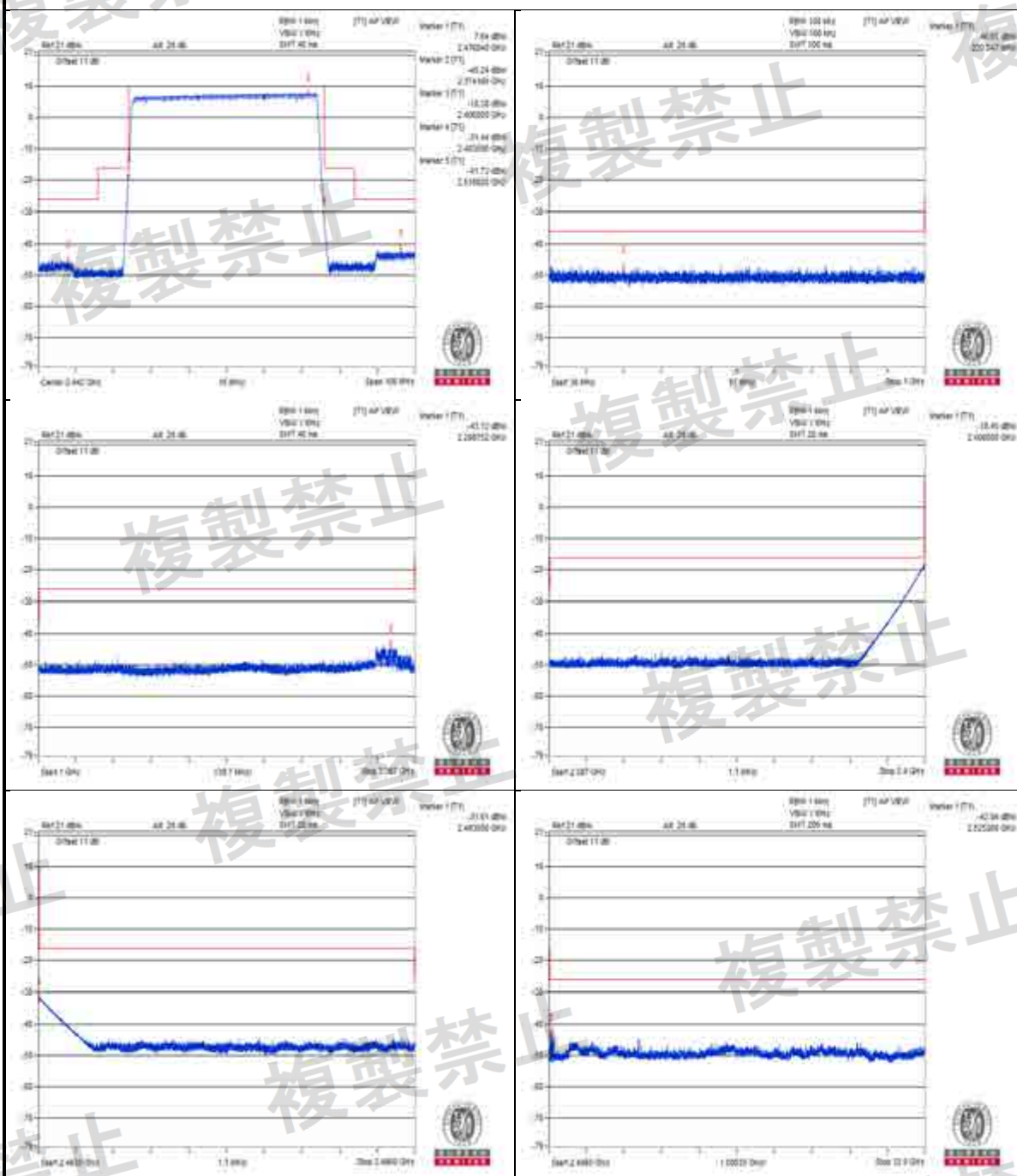
Modulation: GFSK

Environmental Conditions		25 deg.C, 60% RH			
Test Channel		Hopping Mode		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value		
V <sub>normal</sub>	30.0MHz to 1000.0MHz	744.526	0.019679uW	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2298.232	0.043451uW	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2400.000	14.157938uW	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.500	0.679204uW	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2514.006	0.050234uW	2.5 uW/MHz	Pass
V <sub>max.</sub>	30.0MHz to 1000.0MHz	220.847	0.020184uW	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2298.752	<b>0.048753uW</b>	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2400.000	14.28894uW	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.500	0.69024uW	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2525.260	<b>0.052uW</b>	2.5 uW/MHz	Pass
V <sub>min.</sub>	30.0MHz to 1000.0MHz	731.916	<b>0.024889uW</b>	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2317.303	0.039174uW	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2399.998	<b>14.421154uW</b>	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.503	<b>0.691831uW</b>	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2575.277	0.05035uW	2.5 uW/MHz	Pass

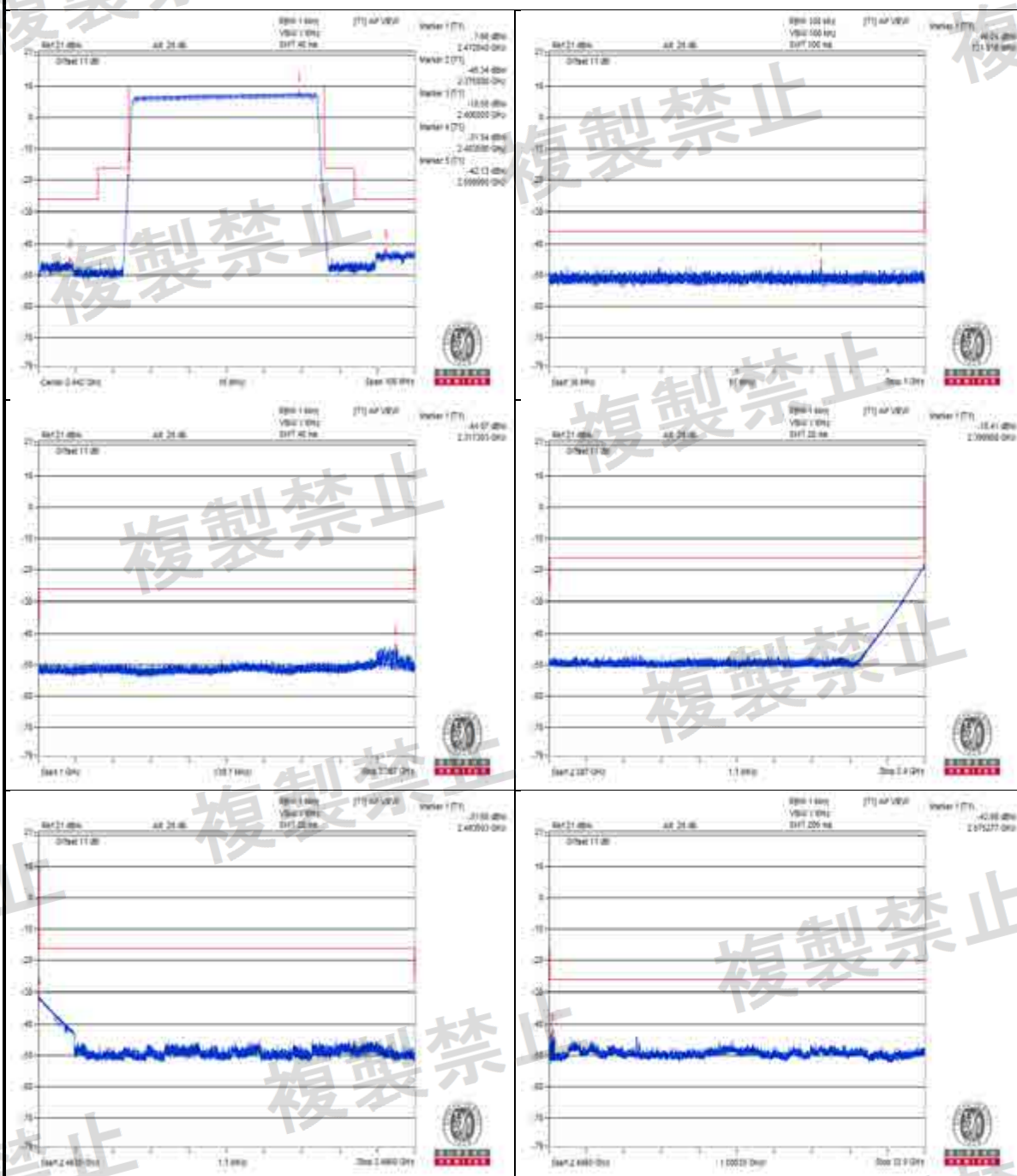
**NOTE:** 1. The worst value in each Frequency range v.s. each channel has been marked by boldface.  
2. The spectrum plots are attached on the following pages.



V<sub>max</sub>.



V<sub>min</sub>.



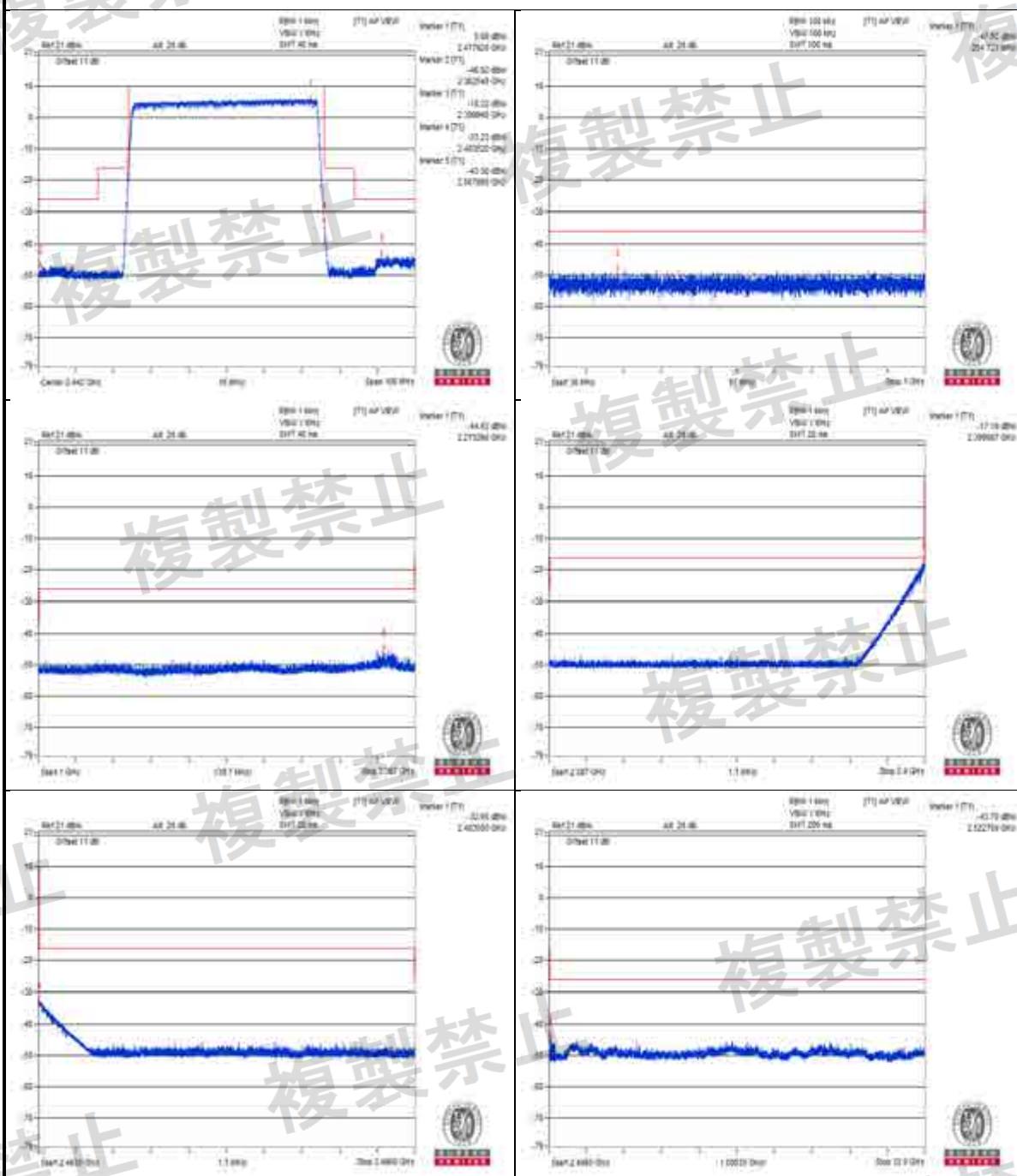
Modulation:  $\pi/4$ -DQPSK

Environmental Conditions		25 deg.C, 60% RH			
Test Channel		Hopping Mode		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value		
$V_{normal}$	30.0MHz to 1000.0MHz	746.466	0.020045uW	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2271.879	0.028054uW	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2400.000	<b>20.276827uW</b>	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.500	0.526017uW	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2514.006	0.035156uW	2.5 uW/MHz	Pass
$V_{max.}$	30.0MHz to 1000.0MHz	204.721	0.016218uW	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2273.266	<b>0.034435uW</b>	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2399.987	19.098533uW	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.500	0.506991uW	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2522.759	<b>0.042658uW</b>	2.5 uW/MHz	Pass
$V_{min.}$	30.0MHz to 1000.0MHz	30.606	<b>0.022336uW</b>	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2301.526	0.027416uW	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2399.983	18.071741uW	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.501	<b>0.555904uW</b>	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2531.512	0.034754uW	2.5 uW/MHz	Pass

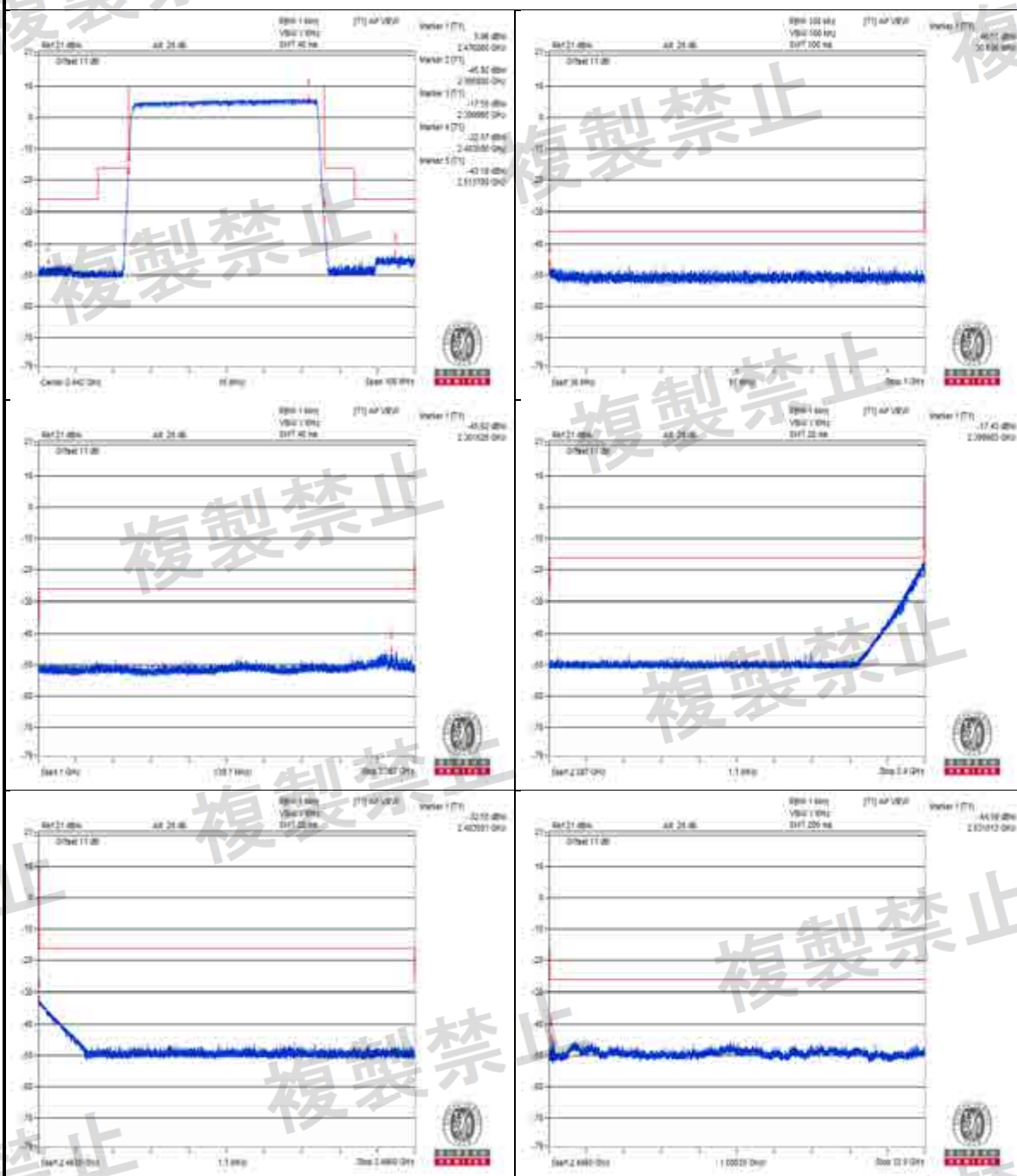
**NOTE:** 1. The worst value in each Frequency range v.s. each channel has been marked by boldface.  
2. The spectrum plots are attached on the following pages.



V<sub>max</sub>



V<sub>min</sub>.

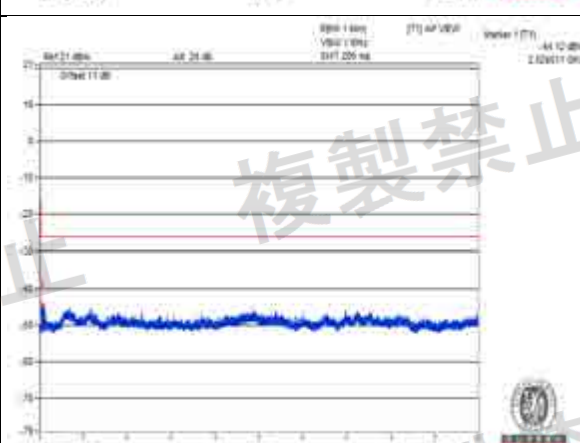
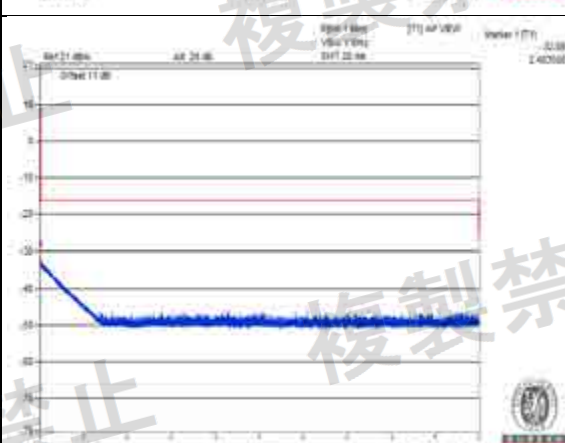
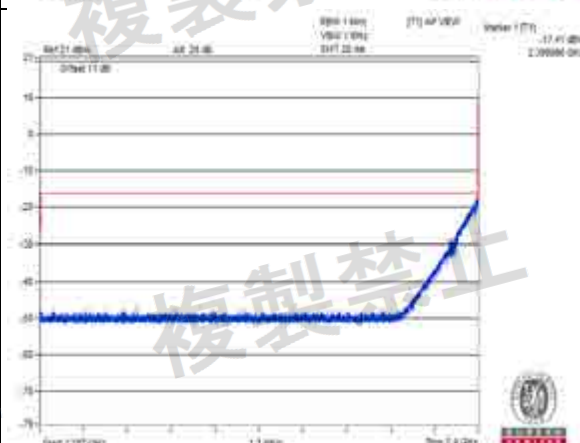
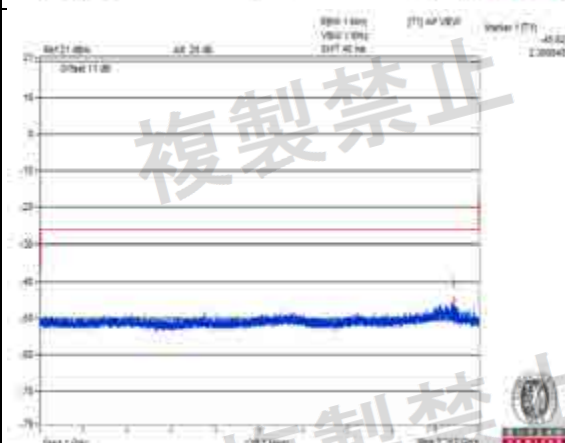
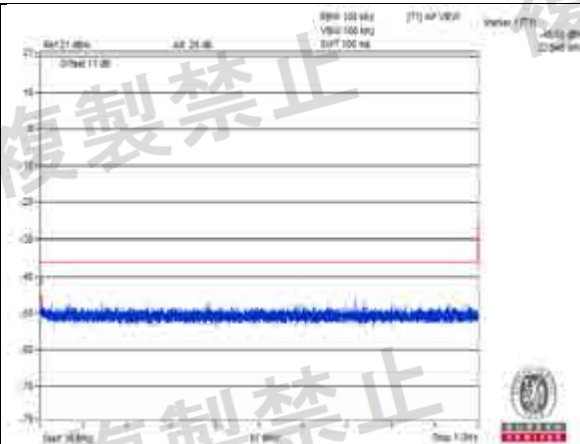
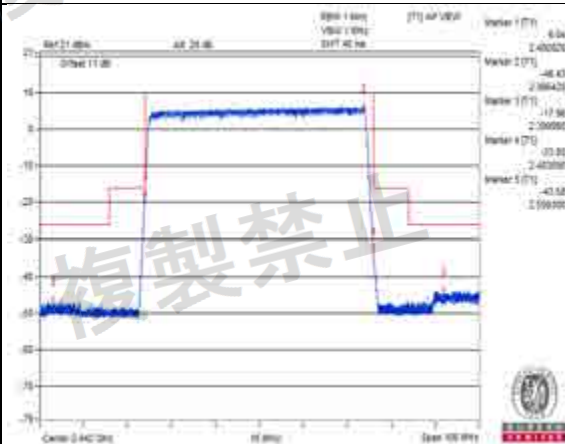


# Modulation: 8DPSK

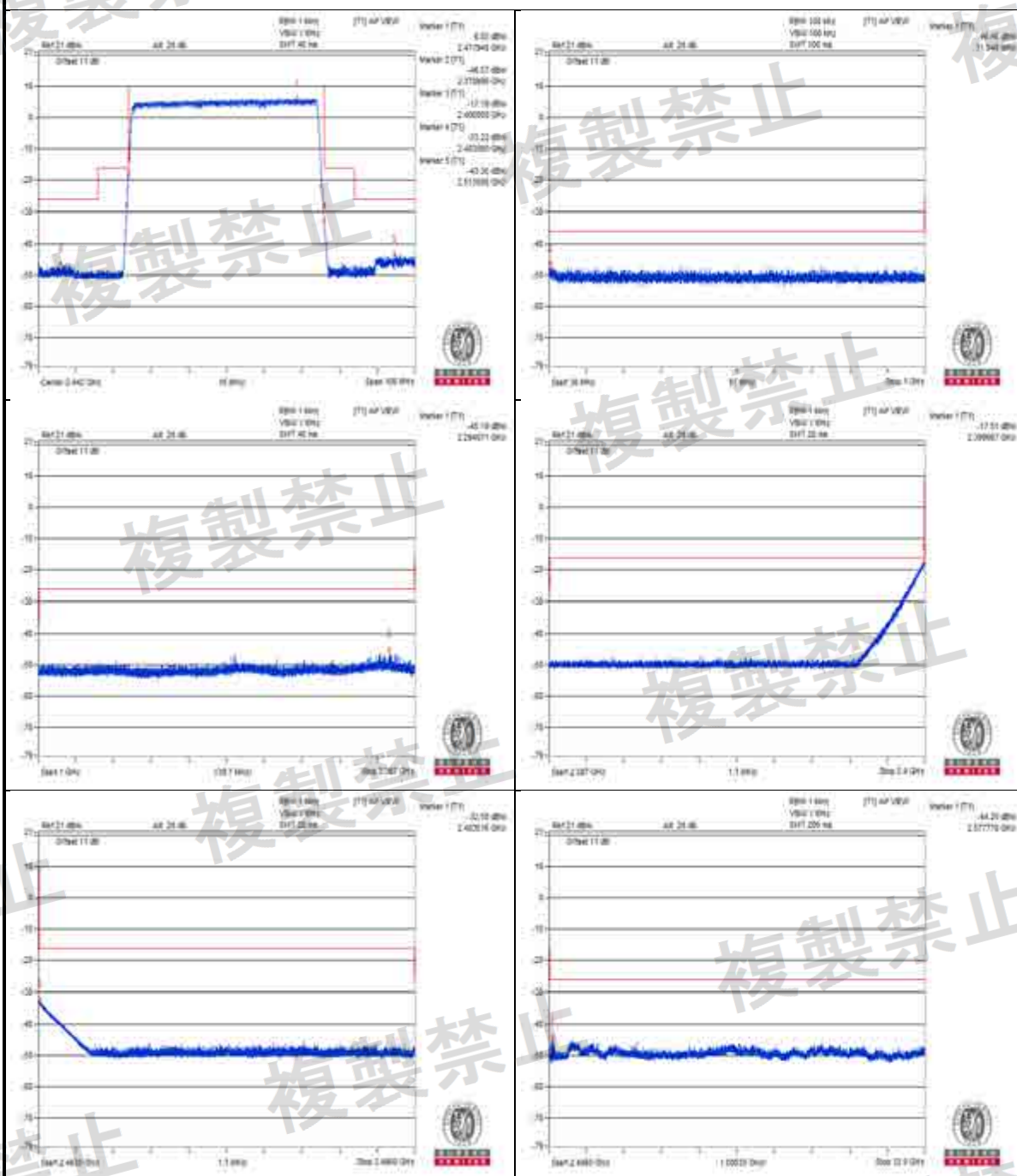
Environmental Conditions		25 deg.C, 60% RH			
Test Channel		Hopping Mode		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value		
V <sub>normal</sub>	30.0MHz to 1000.0MHz	32.546	<b>0.025823uW</b>	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2309.848	0.027416uW	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2399.996	<b>18.155157uW</b>	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.508	0.514044uW	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2529.011	0.038726uW	2.5 uW/MHz	Pass
V <sub>max.</sub>	30.0MHz to 1000.0MHz	31.940	0.022594uW	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2294.071	<b>0.030269uW</b>	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2399.987	17.741895uW	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.516	<b>0.552077uW</b>	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	2577.778	0.038019uW	2.5 uW/MHz	Pass
V <sub>min.</sub>	30.0MHz to 1000.0MHz	30.727	0.024322uW	0.25 uW/100kHz	Pass
	1000.0MHz to 2387MHz	2289.736	0.023335uW	2.5 uW/MHz	Pass
	2387.0MHz to 2400.0MHz	2399.995	17.741895uW	25 uW/MHz	Pass
	2483.5MHz to 2496.5MHz	2483.513	0.542001uW	25 uW/MHz	Pass
	2496.5MHz to 12500.0MHz	3060.447	<b>0.047206uW</b>	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.

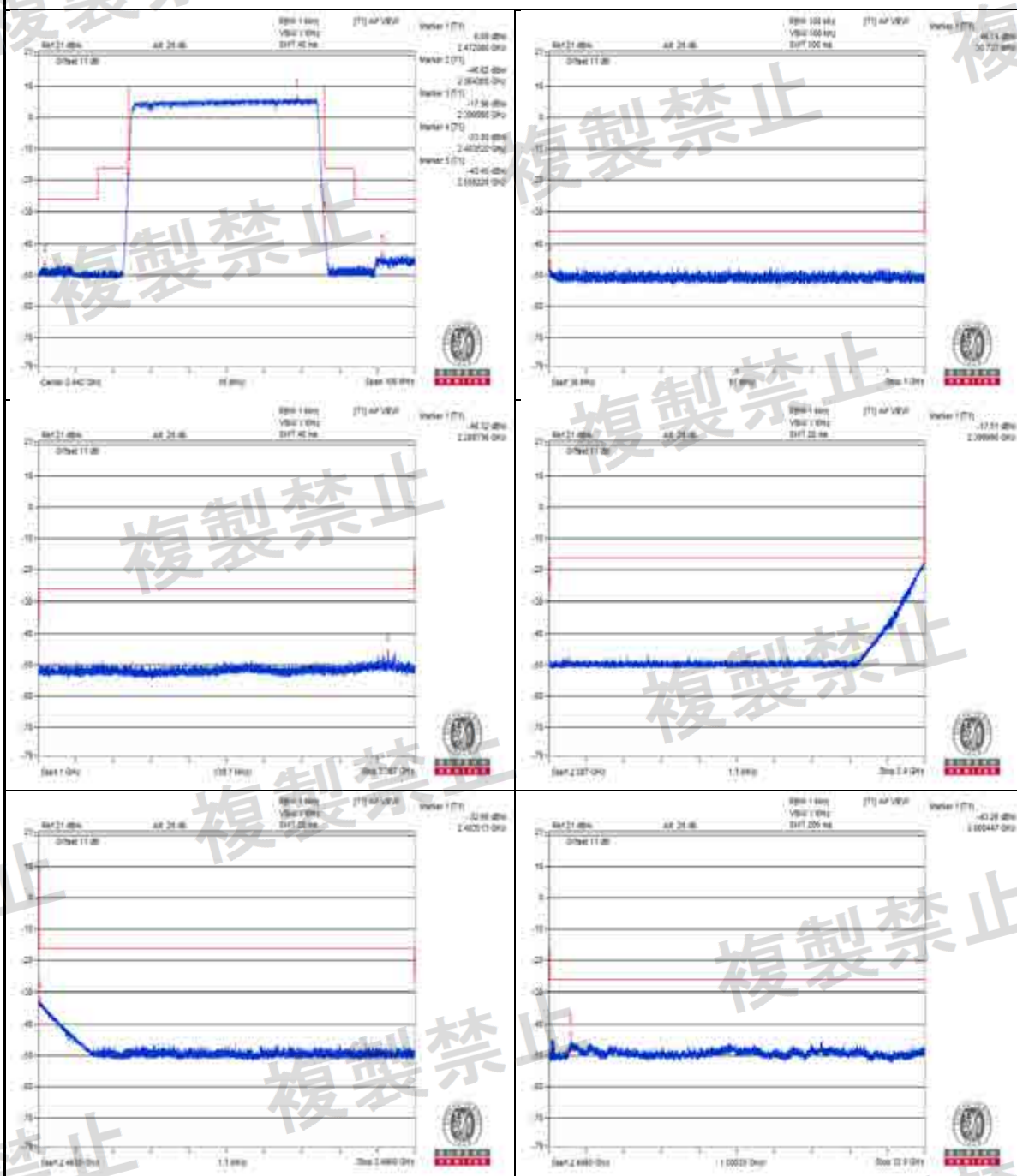
V normal



V<sub>max</sub>



V<sub>min</sub>.



## 4.5 Antenna Power Measurement

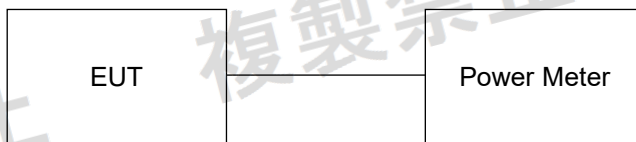
### 4.5.1 Limits of Antenna Power

Modulation System	Frequency Band Used	Antenna Power (Max.)	EIRP (Max.)	
			Omni-Directional Case	Directional Case
<b>DS</b>	2400 – 2483.5 MHz	10 mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
<b>OFDM (Note 1)</b>	2400 – 2483.5 MHz	10 mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
<b>OFDM (Note 2)</b>	2400 – 2483.5 MHz	5 mW/MHz	9.14 dBm/MHz (8.203mW/MHz)	19.14 dBm/MHz (82.03 mW/MHz)
<b>FH</b>	2400 – 2483.5 MHz	3 mW/MHz	6.91 dBm/MHz (4.909 mW/MHz)	16.91 dBm/MHz (49.09 mW/MHz)
<b>Other than the above</b>	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).

### 4.5.2 Test Setup



Output Power Density (mW/MHz) = Total Output Power (mW) / Spread Bandwidth (MHz)

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

#### 4.5.3 Test Results

##### Normal Mode:

Environmental Conditions		25 deg.C, 60% RH		
Modulation Type	Data Rate Type	Conducted RF Output Power Density (mW/MHz)		
		V <sub>normal</sub>	V <sub>max.</sub>	V <sub>min.</sub>
GFSK	DH5	0.07983	0.077481	0.081695
DQPSK	2DH5	0.035958	0.037389	0.035316
8DPSK	3DH5	0.035772	0.034769	0.036351
Max. Limit (mW/MHz)		3		
Rated Power		0.1		
Tolerance of Antenna Power		0.02 ~ 0.12		

##### PCB antenna with antenna gain: 1.48 dBi

Environmental Conditions		25 deg.C, 60% RH		
Modulation Type	Data Rate Type	Radiated RF Output Power Density (mW/MHz)		
		V <sub>normal</sub>	V <sub>max.</sub>	V <sub>min.</sub>
GFSK	DH5	0.112245	0.108942	0.114867
DQPSK	2DH5	0.050559	0.052571	0.049656
8DPSK	3DH5	0.050297	0.048887	0.051111
EIRP Max. Limit (mW/MHz)		4.909		

- 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 + Maximum Antenna Gain

#### AFH Mode:

Environmental Conditions		25 deg.C, 60% RH		
Modulation Type	Data Rate Type	Conducted RF Output Power Density (mW/MHz)		
		V <sub>normal</sub>	V <sub>max.</sub>	V <sub>min.</sub>
GFSK	DH5	0.316629	0.305596	0.322216
DQPSK	2DH5	0.14105	0.147478	0.138141
8DPSK	3DH5	0.140718	0.134874	0.142995
Max. Limit (mW/MHz)		3		
Rated Power		0.4		
Tolerance of Antenna Power		0.08 ~ 0.48		

#### PCB antenna with antenna gain: 1.48 dBi

Environmental Conditions		25 deg.C, 60% RH		
Modulation Type	Data Rate Type	Radiated RF Output Power Density (mW/MHz)		
		V <sub>normal</sub>	V <sub>max.</sub>	V <sub>min.</sub>
GFSK	DH5	0.445195	0.429682	0.453051
DQPSK	2DH5	0.198323	0.207361	0.194233
8DPSK	3DH5	0.197856	0.189639	0.201058
EIRP Max. Limit (mW/MHz)		4.909		

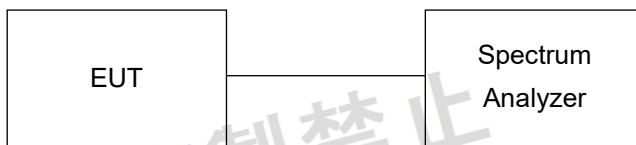
- Note: 1. The radiated RF output power density is a "calculated" value derived from the conducted value.  
 2. Formula: Radiated RF output power density = Conducted RF output power density + Maximum Antenna Gain

#### 4.6 Spurious Emissions for Receiver

##### 4.6.1 Limits of Spurious Emissions for Receiver

Frequencies (MHz)	Limit
Below 1GHz	$\leq 4\text{nW}/100\text{kHz}$ (-54dBm)
Above 1GHz	$\leq 20\text{nW}/\text{MHz}$ (-47dBm)

##### 4.6.2 Test Setup

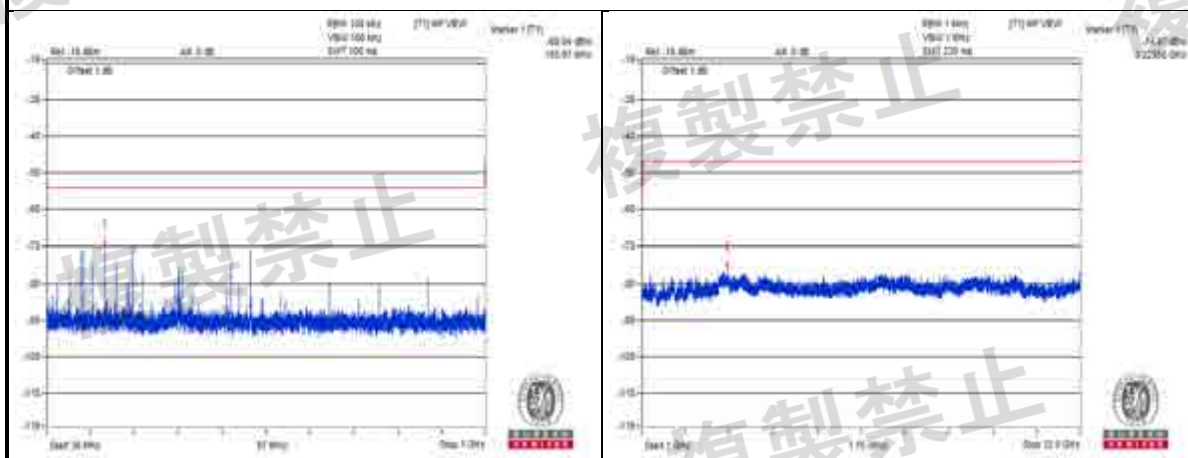


#### 4.6.3 Test Result

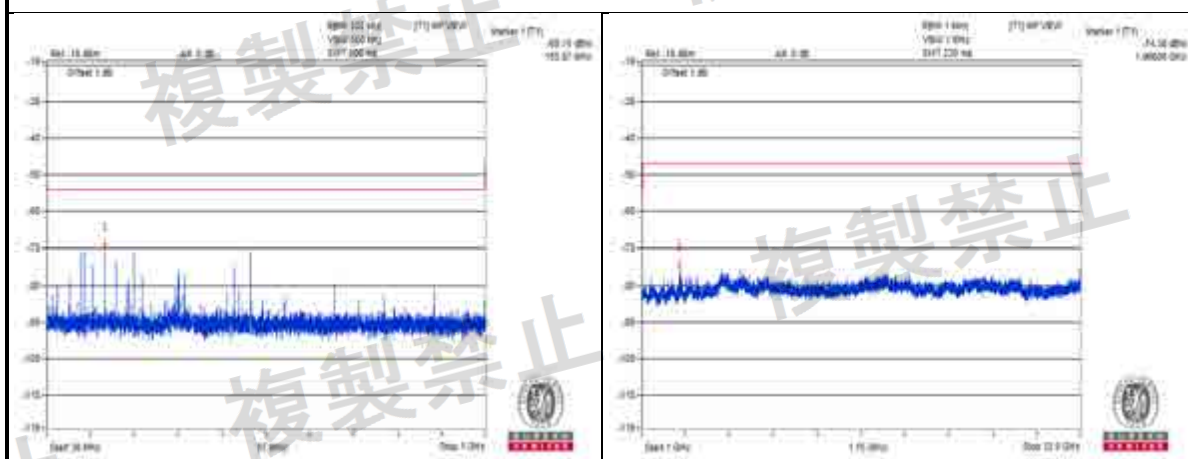
Environmental Conditions		25 deg.C, 60% RH					
Test Channel		Channel 0 (2402MHz)		Channel 39 (2441MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
V <sub>normal</sub>	Below 1GHz	155.970	0.130617nW	155.970	0.121619nW	4nW/100kHz	Pass
	Above 1GHz	3229.560	0.031842nW	1966.000	0.036475nW	20nW/MHz	Pass
V <sub>max.</sub>	Below 1GHz	155.970	0.126474nW	155.970	0.125026nW	4nW/100kHz	Pass
	Above 1GHz	7418.430	0.027164nW	3606.180	0.02729nW	20nW/MHz	Pass
V <sub>min.</sub>	Below 1GHz	155.970	0.12735nW	155.970	0.119124nW	4nW/100kHz	Pass
	Above 1GHz	9738.560	0.027733nW	3659.370	0.024491nW	20nW/MHz	Pass
Test Channel		CH 78 (2480MHz)				Limit	Result
Test Condition	Frequency Range	Frequency (MHz) Measured Value		Measured Value			
V <sub>normal</sub>	Below 1GHz	155.970		0.11508nW		4nW/100kHz	Pass
	Above 1GHz	12500.000		0.027479nW		20nW/MHz	Pass
V <sub>max.</sub>	Below 1GHz	155.970		0.111944nW		4nW/100kHz	Pass
	Above 1GHz	12500.000		0.024099nW		20nW/MHz	Pass
V <sub>min.</sub>	Below 1GHz	155.970		0.108143nW		4nW/100kHz	Pass
	Above 1GHz	12500.000		0.023933nW		20nW/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.

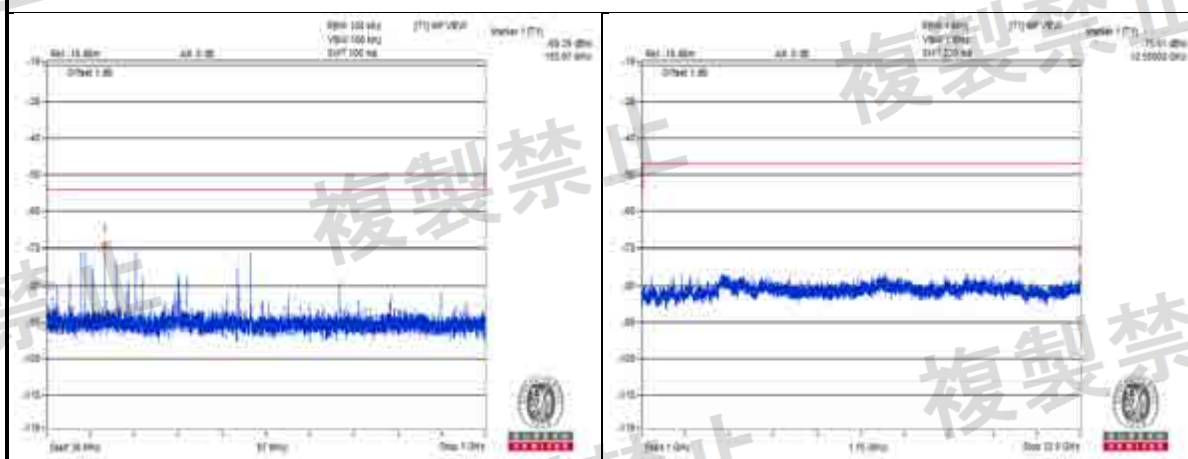
V<sub>normal</sub>



Channel 0

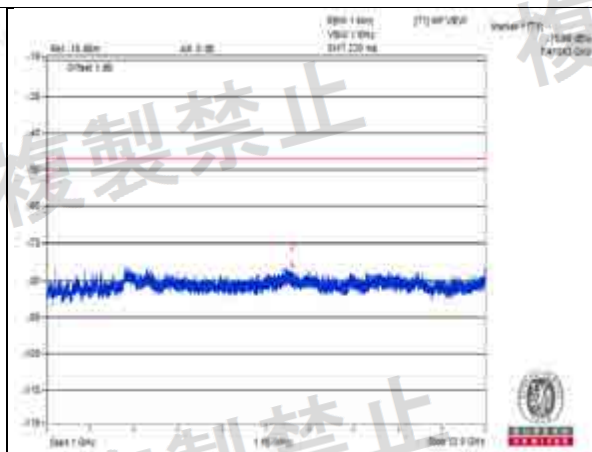
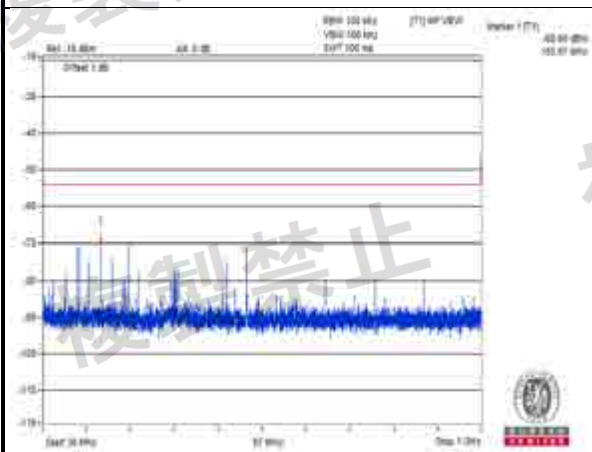


Channel 39

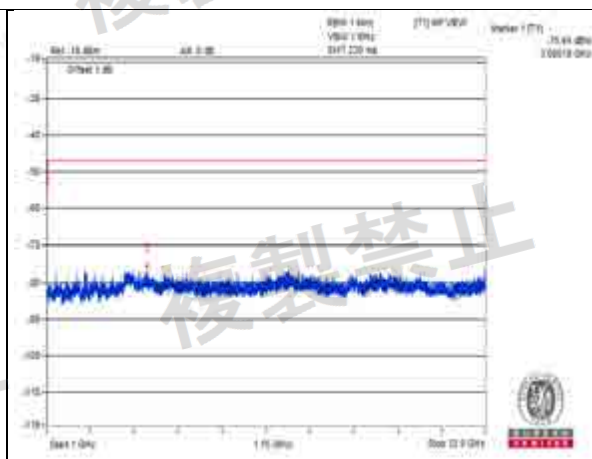
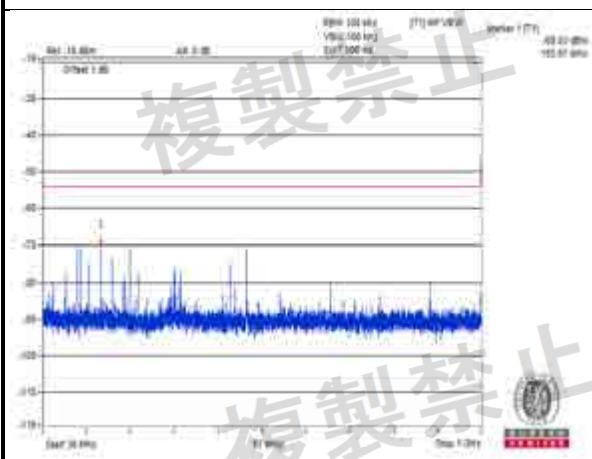


Channel 78

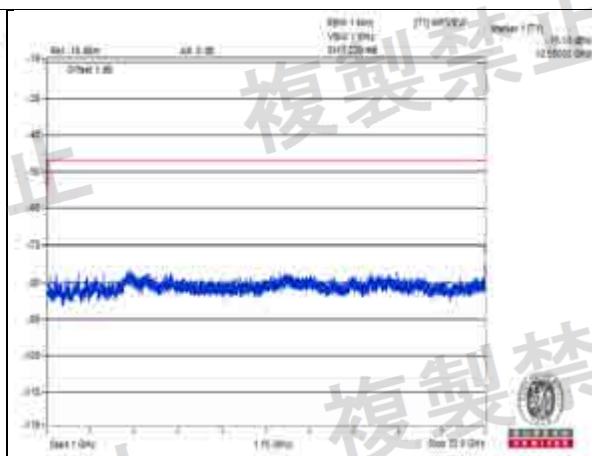
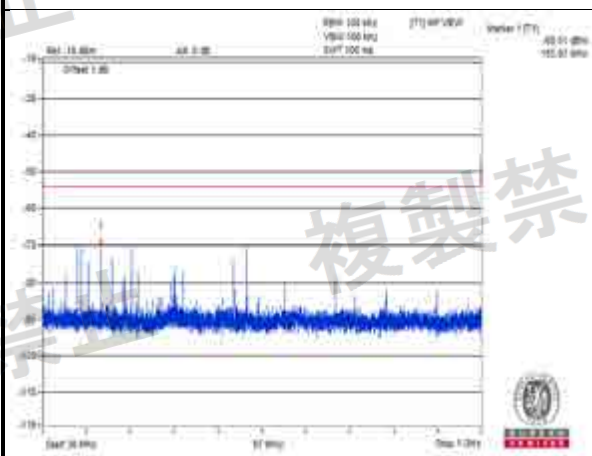
V<sub>max</sub>.



Channel 0

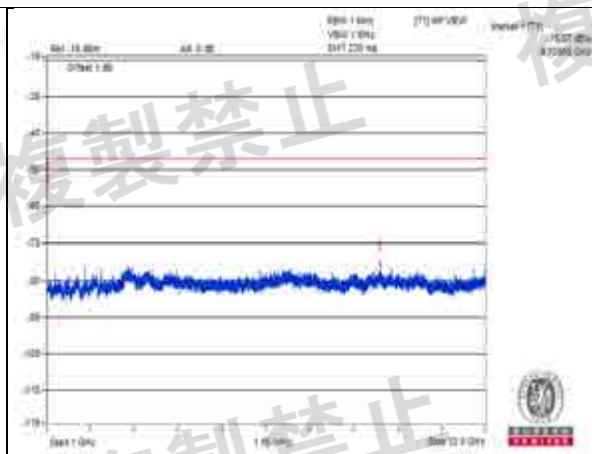
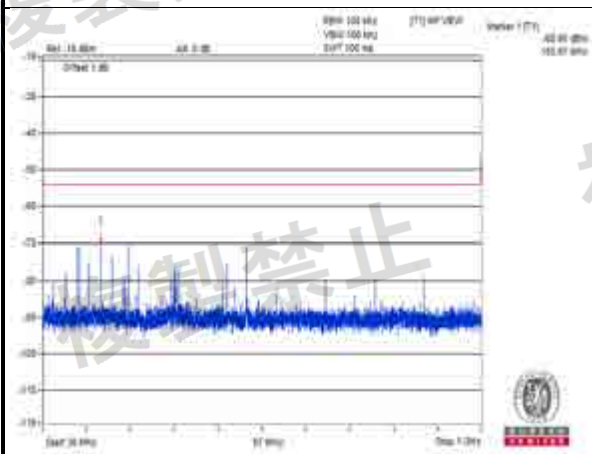


Channel 39

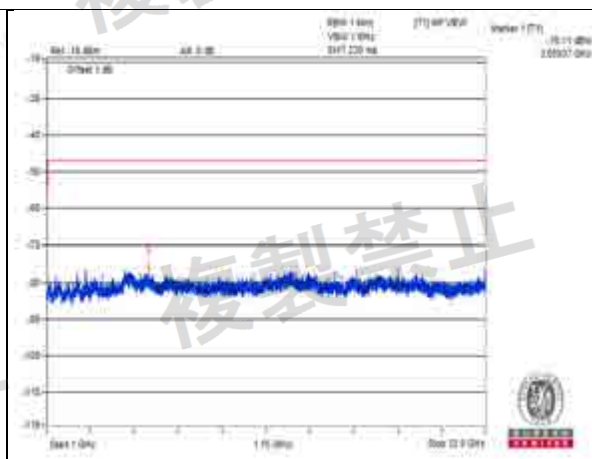
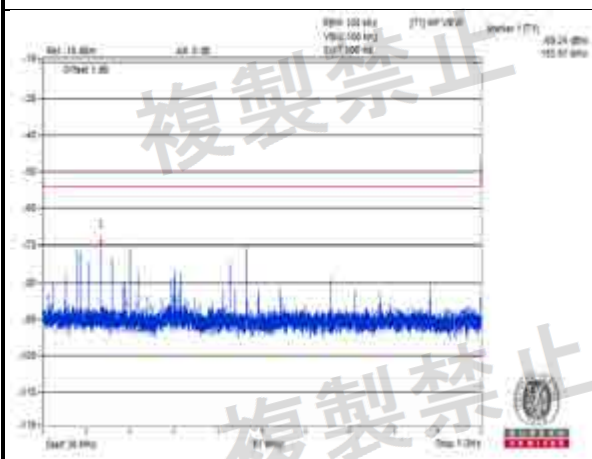


Channel 78

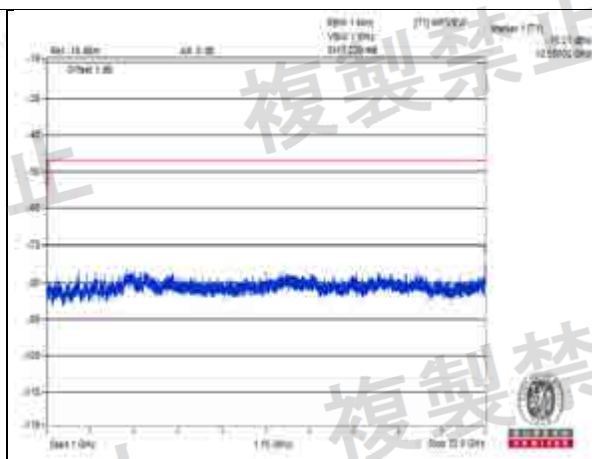
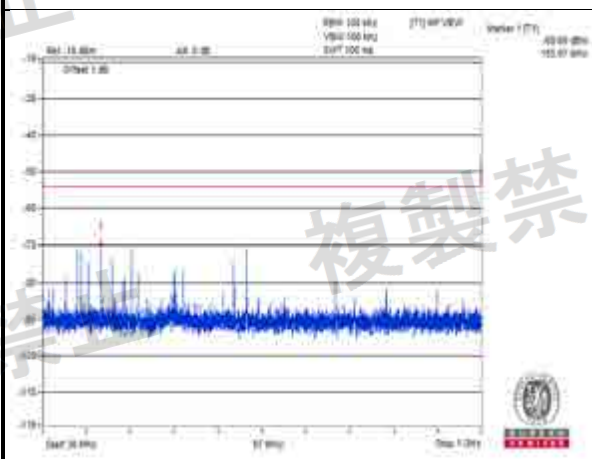
V<sub>min</sub>.



Channel 0



Channel 39



Channel 78

#### 4.7 Dwell Time

##### 4.7.1 Limits of Dwell Time

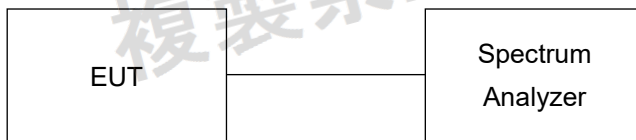
The frequency retention time in the frequency hopping method shall be 0.4 second or less. The total sum of the frequency retention time in any frequency within the time obtained by multiplying the diffusion rate by 0.4 second shall be 0.4 second or shorter.

Formula:

(Normal mode) dwell time = [diffusion rate/ 79] x duty-cycle x 0.4 seconds

(AFH mode) dwell time = [diffusion rate/20] x duty-cycle x 0.4 sec

##### 4.7.2 Test Setup



#### 4.7.3 Test Result

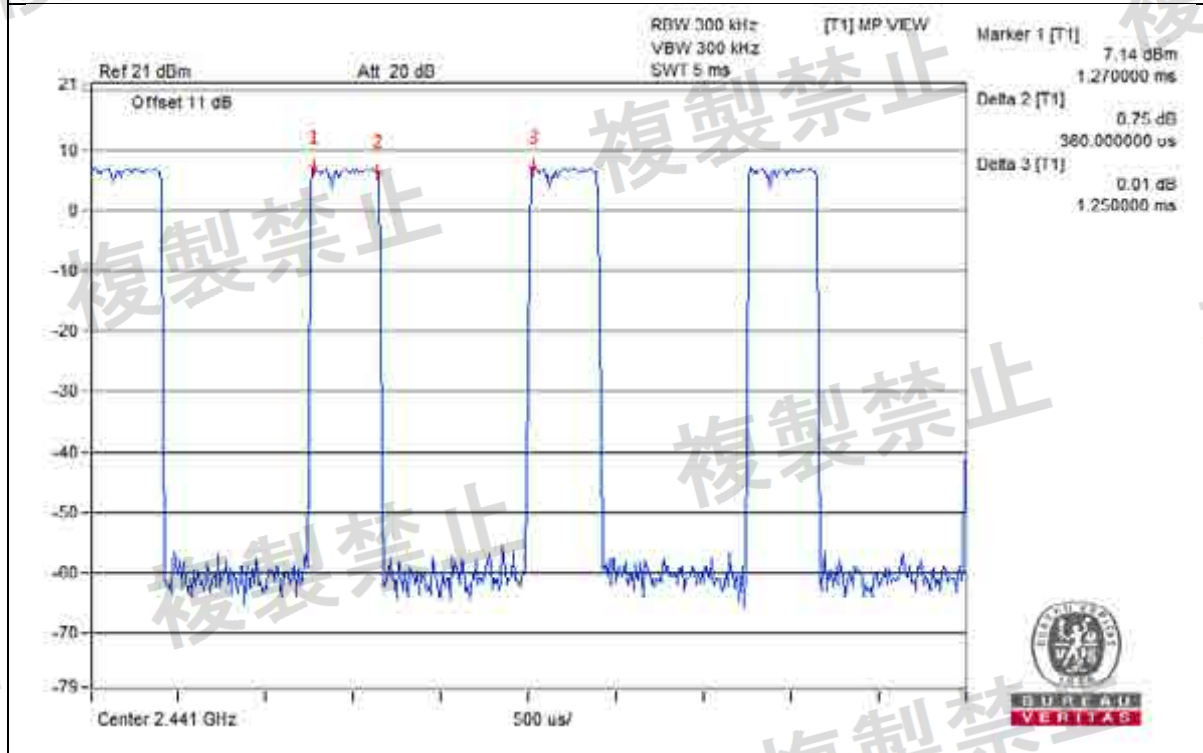
Modulation: GFSK

Normal Mode:

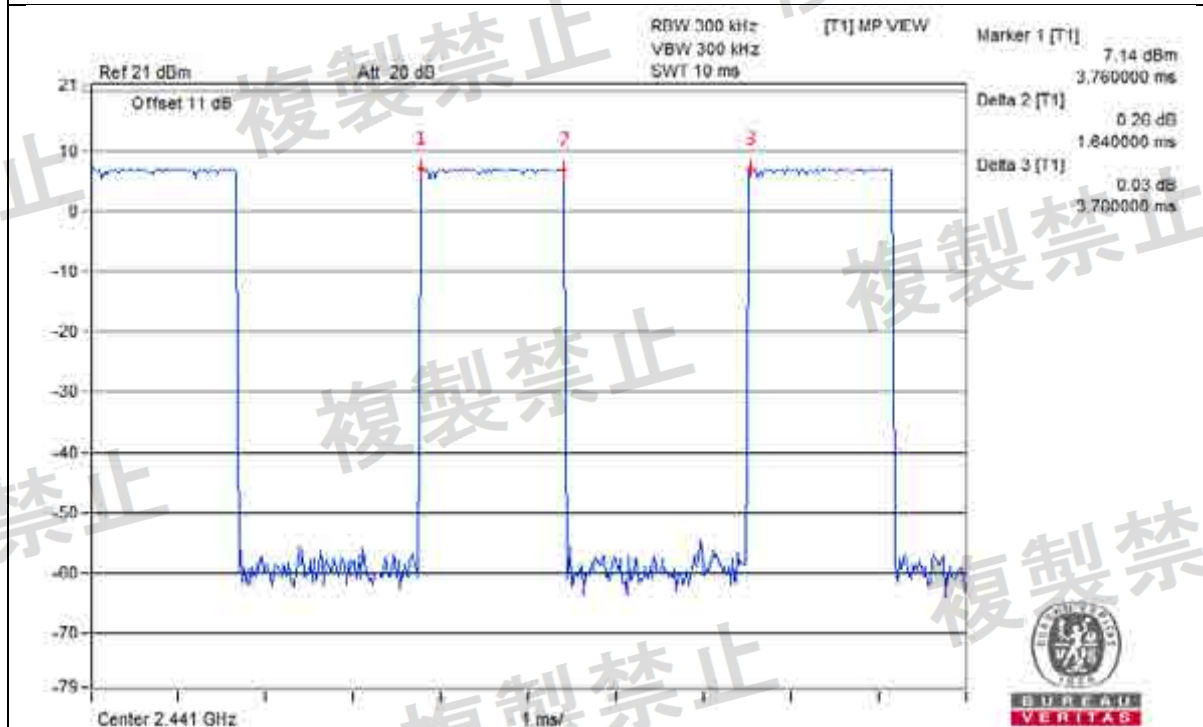
Test Condition	Mode	Spreading Rate	[Spreading Rate/79]*0.4	Duty Cycle	Result (msec)	Limit (msec)
V <sub>normal</sub>	DH1	70.60	0.357	0.288	102.816	400
	DH3	70.60	0.357	0.433	154.581	400
	DH5	70.60	0.357	0.459	163.863	400
V <sub>max.</sub>	DH1	70.60	0.357	0.288	102.816	400
	DH3	70.60	0.357	0.433	154.581	400
	DH5	70.60	0.357	0.459	163.863	400
V <sub>min.</sub>	DH1	70.60	0.357	0.293	104.601	400
	DH3	70.60	0.357	0.428	152.796	400
	DH5	70.60	0.357	0.459	163.863	400

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

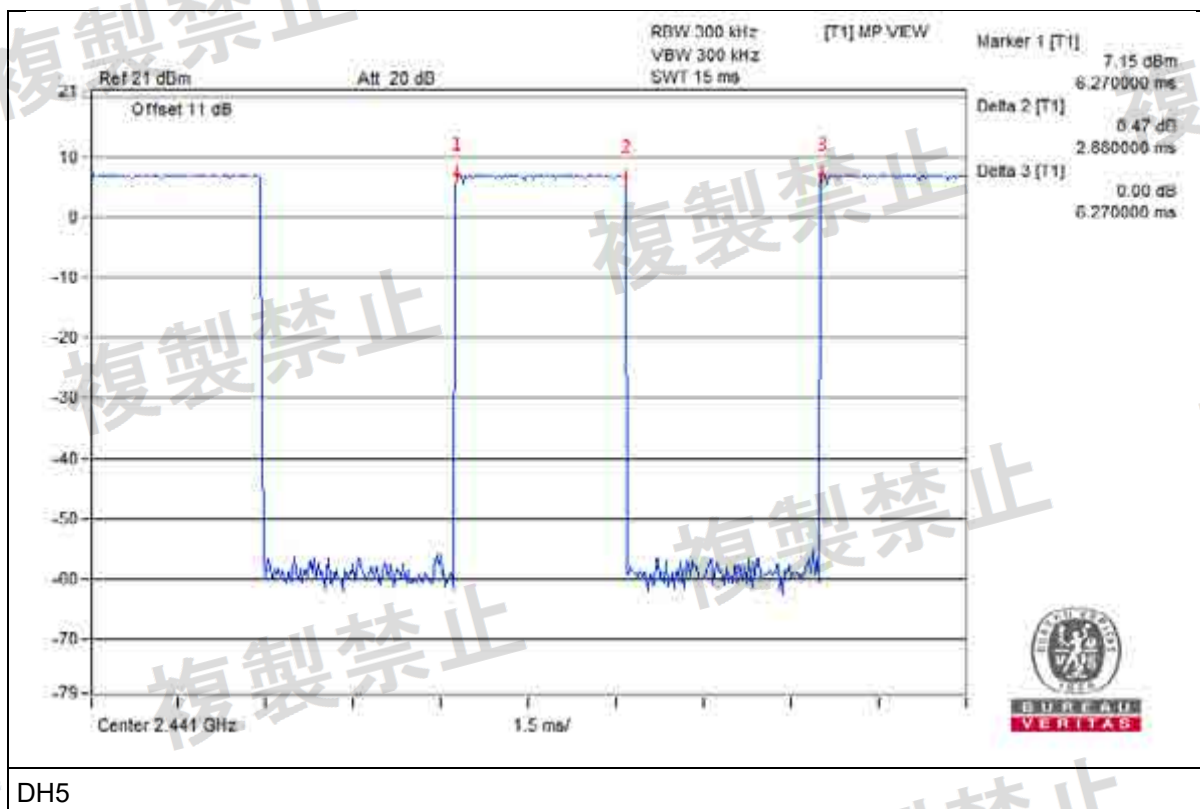
V<sub>normal</sub>



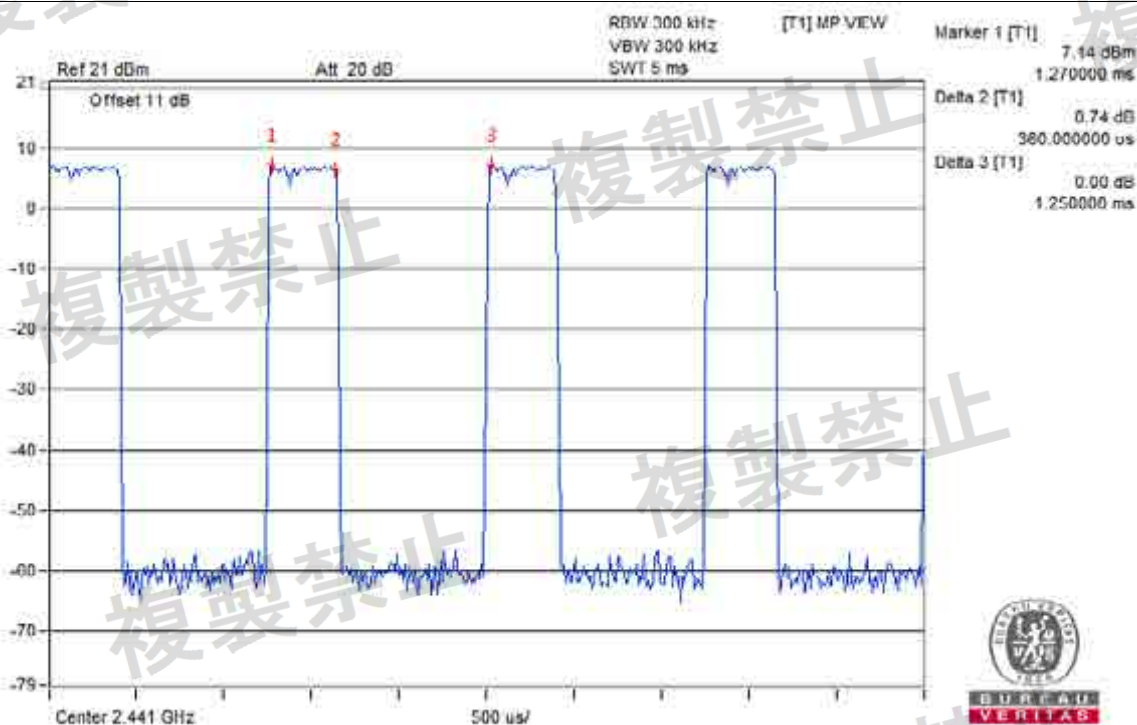
DH1



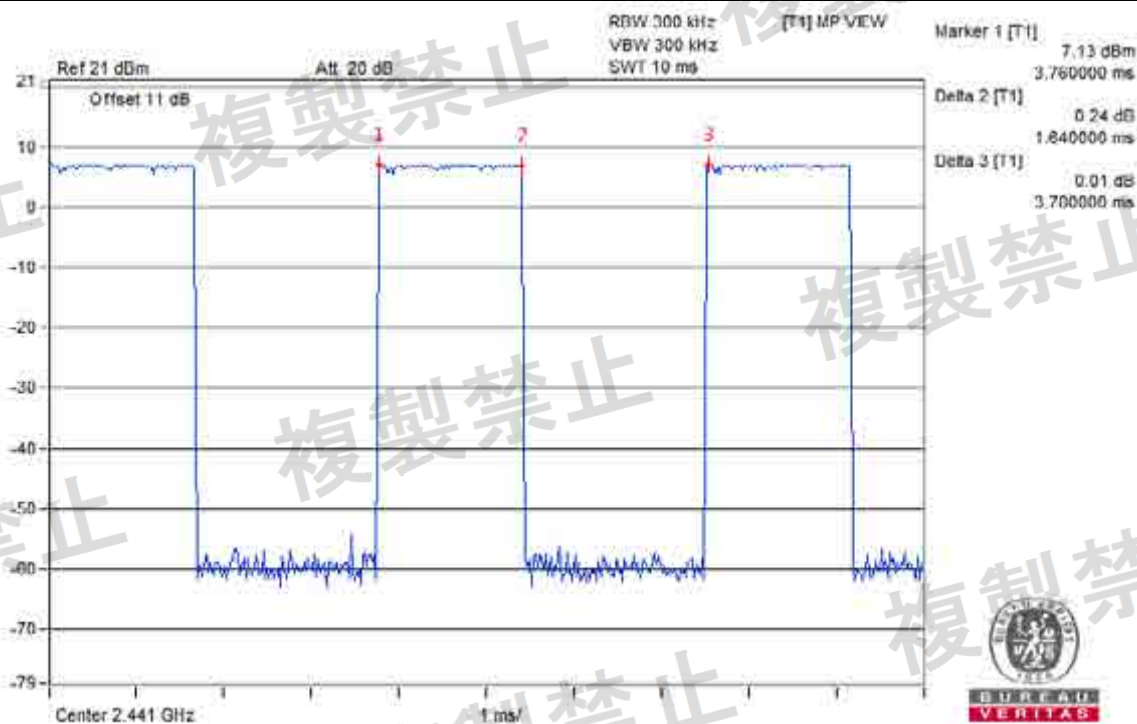
DH3



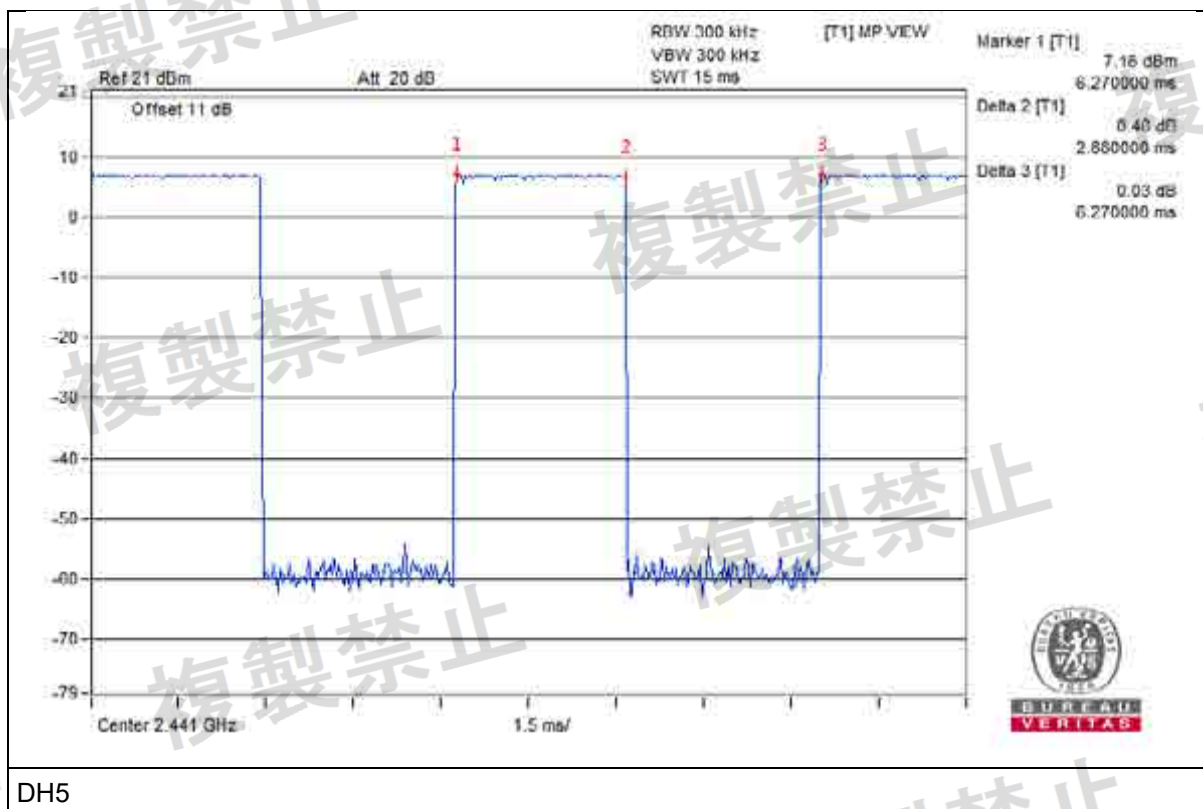
V<sub>max</sub>.



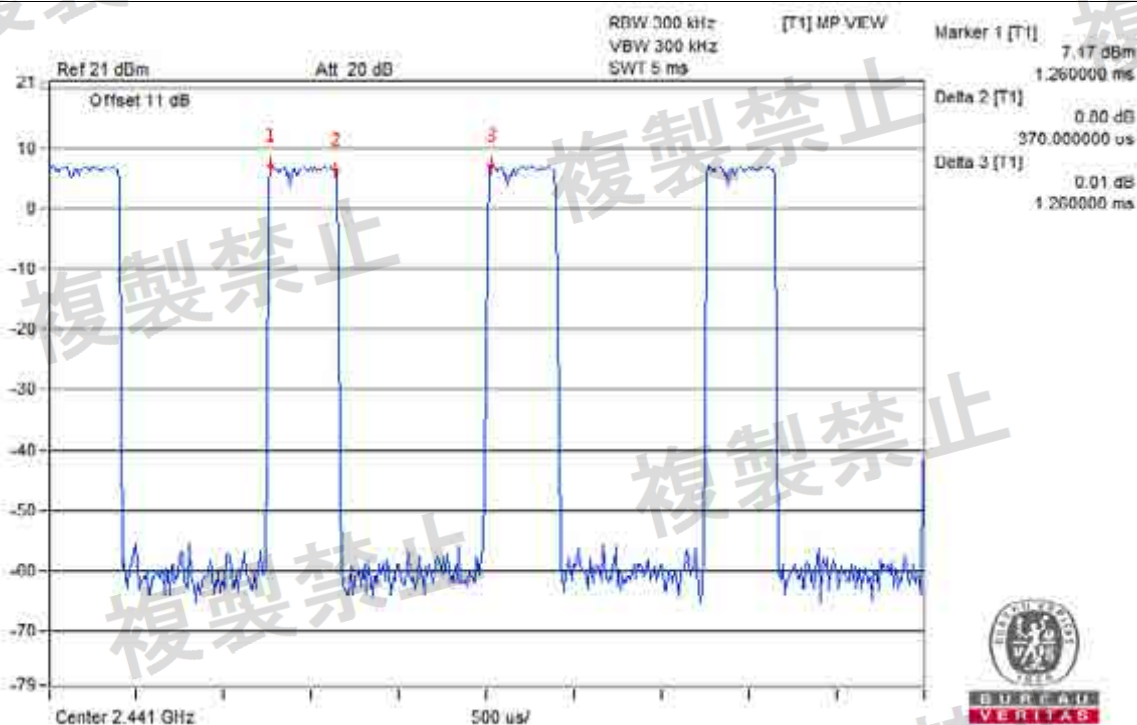
DH1



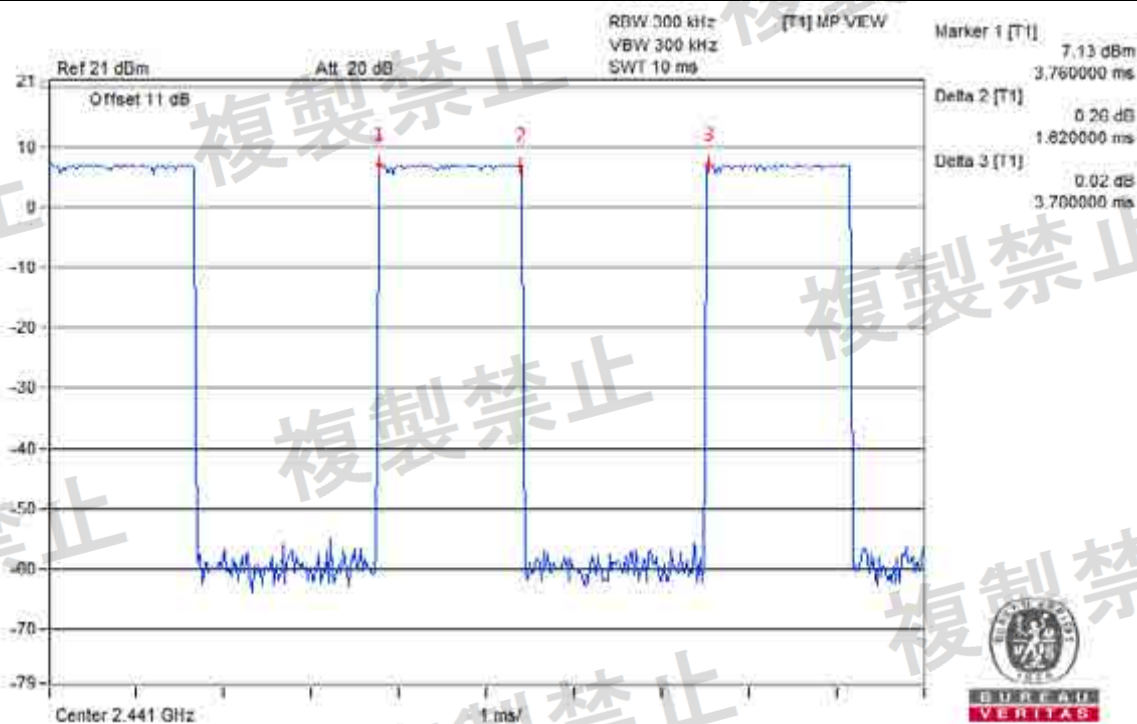
DH3



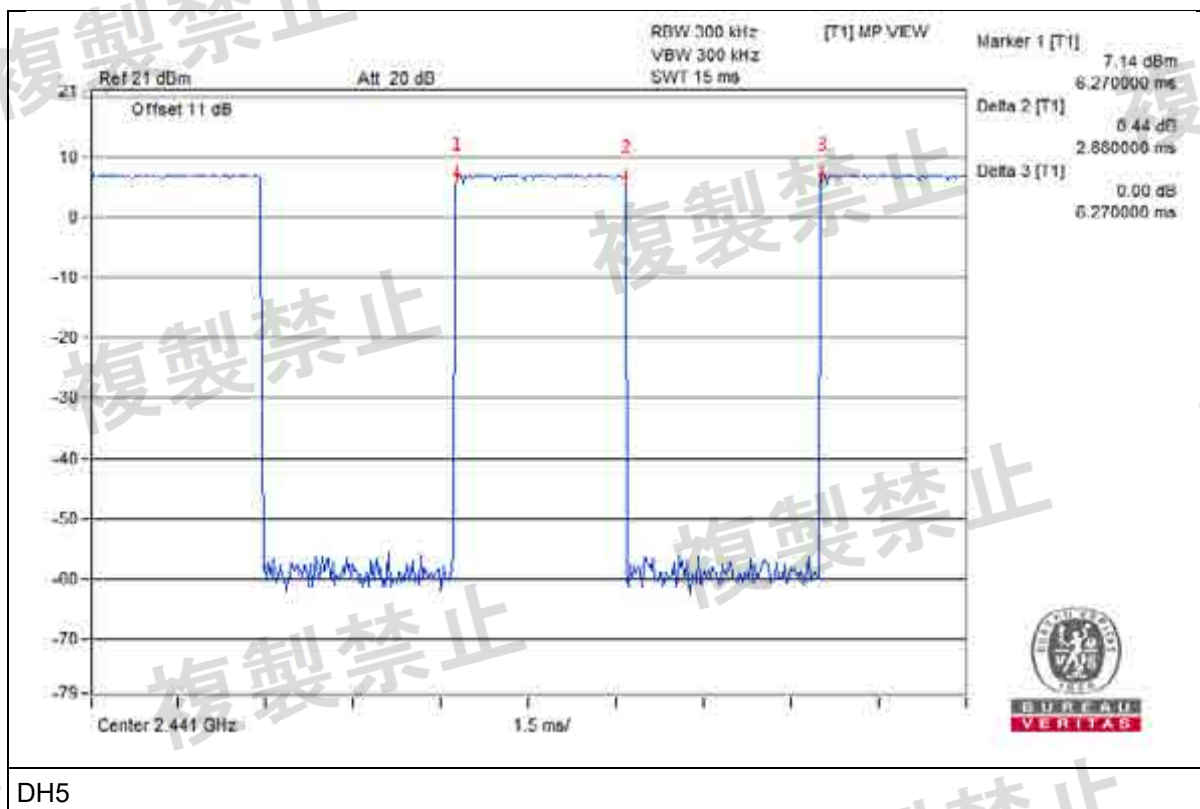
V<sub>min</sub>.



DH1



DH3

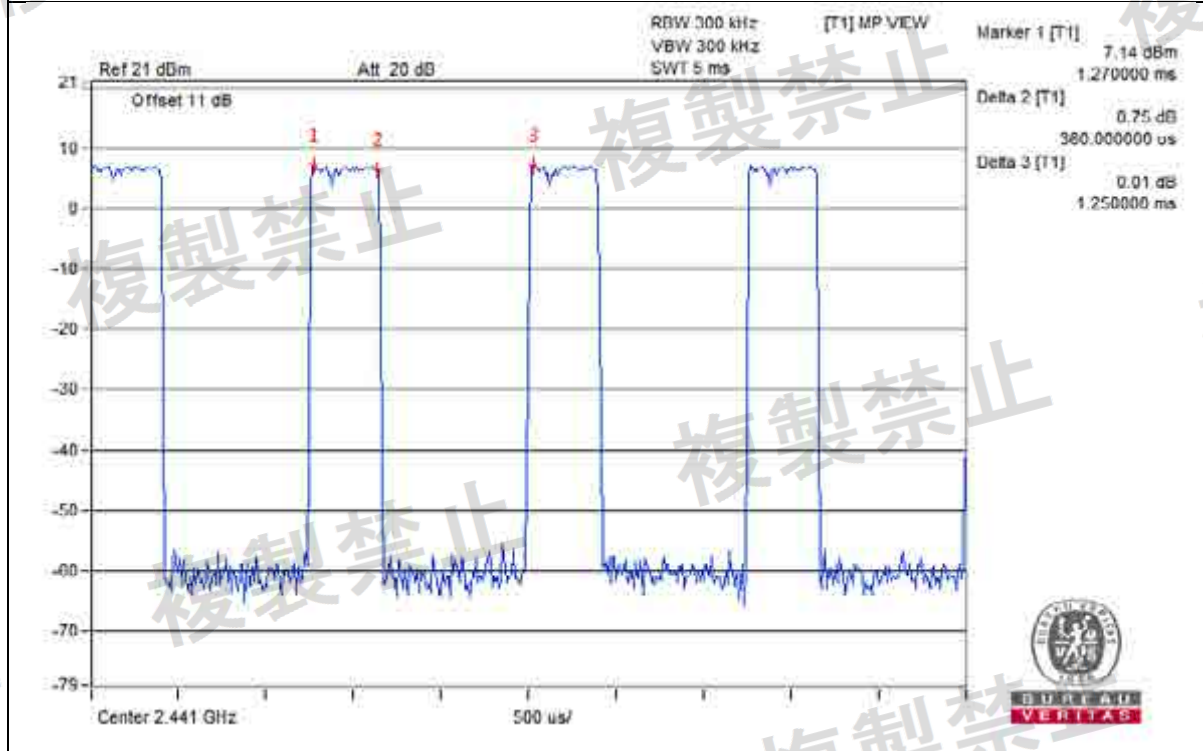


**AFH Mode:**

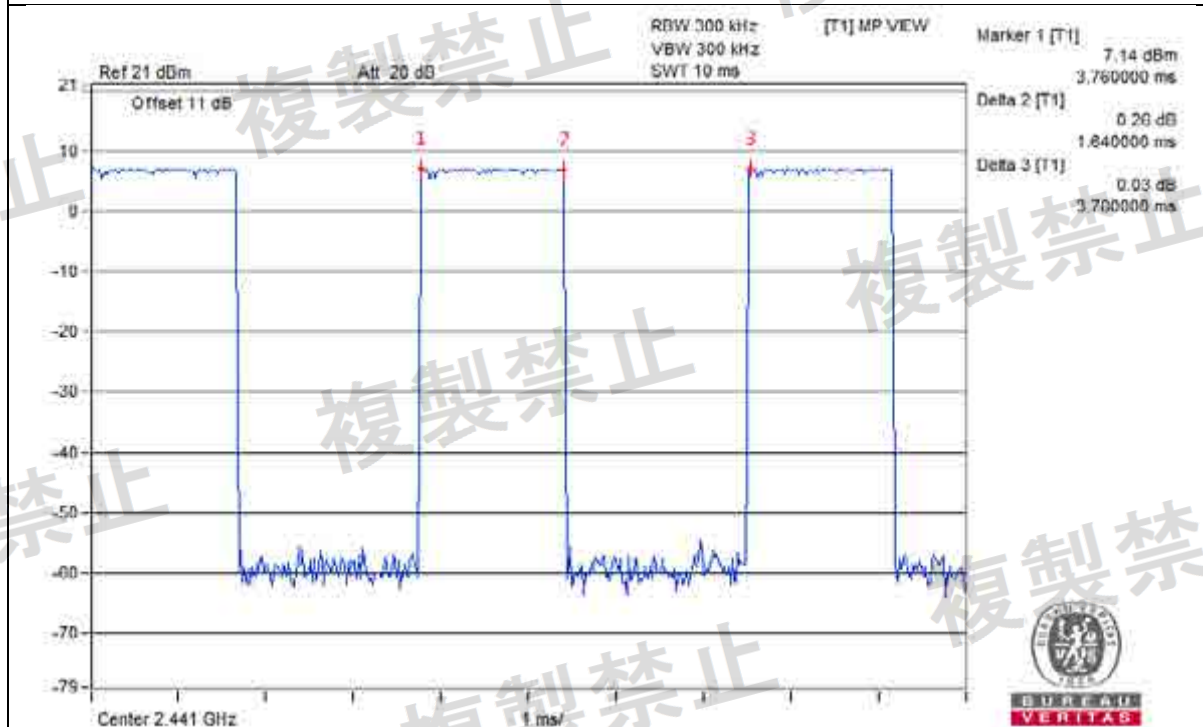
Test Condition	Mode	Spreading Rate	[Spreading Rate/20]*0.4	Duty Cycle	Result (msec)	Limit (msec)
V <sub>normal</sub>	DH1	17.80	0.356	0.288	102.528	400
	DH3	17.80	0.356	0.433	154.148	400
	DH5	17.80	0.356	0.459	163.404	400
V <sub>max.</sub>	DH1	17.90	0.358	0.288	103.104	400
	DH3	17.90	0.358	0.433	155.014	400
	DH5	17.90	0.358	0.459	164.322	400
V <sub>min.</sub>	DH1	17.90	0.358	0.293	104.894	400
	DH3	17.90	0.358	0.428	153.224	400
	DH5	17.90	0.358	0.459	164.322	400

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

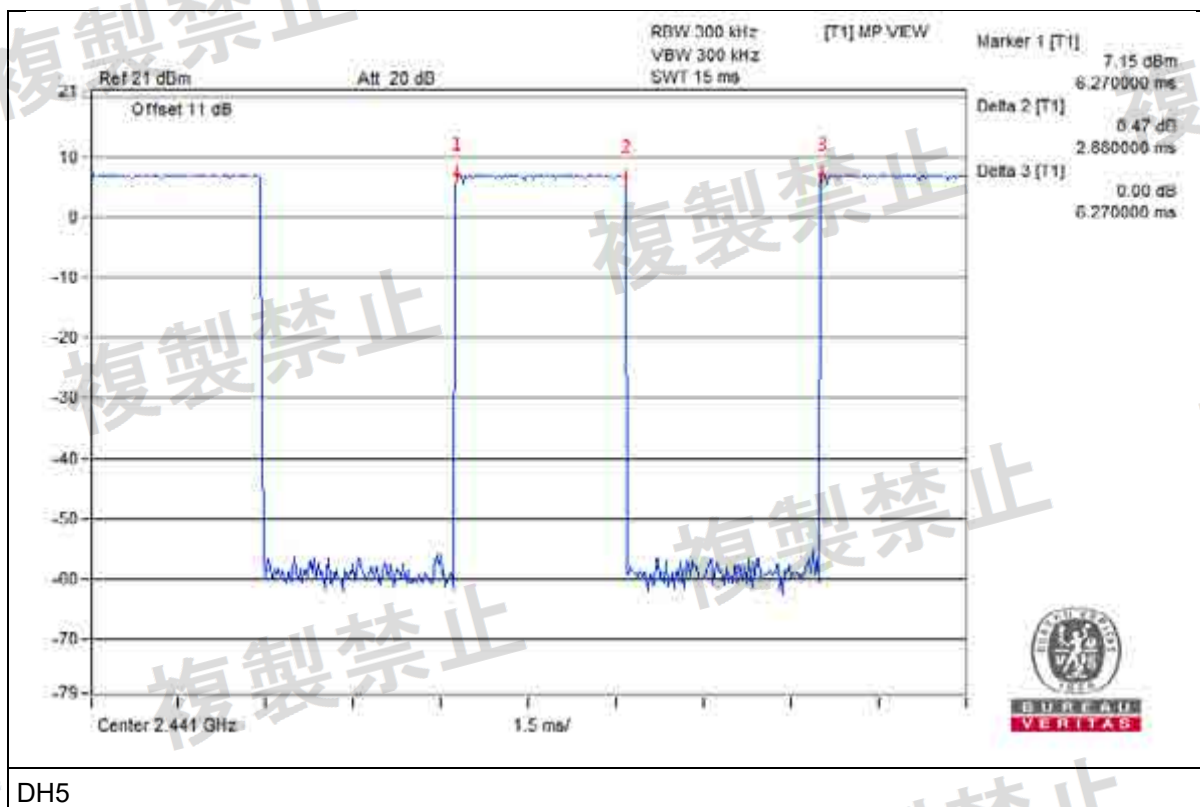
V<sub>normal</sub>



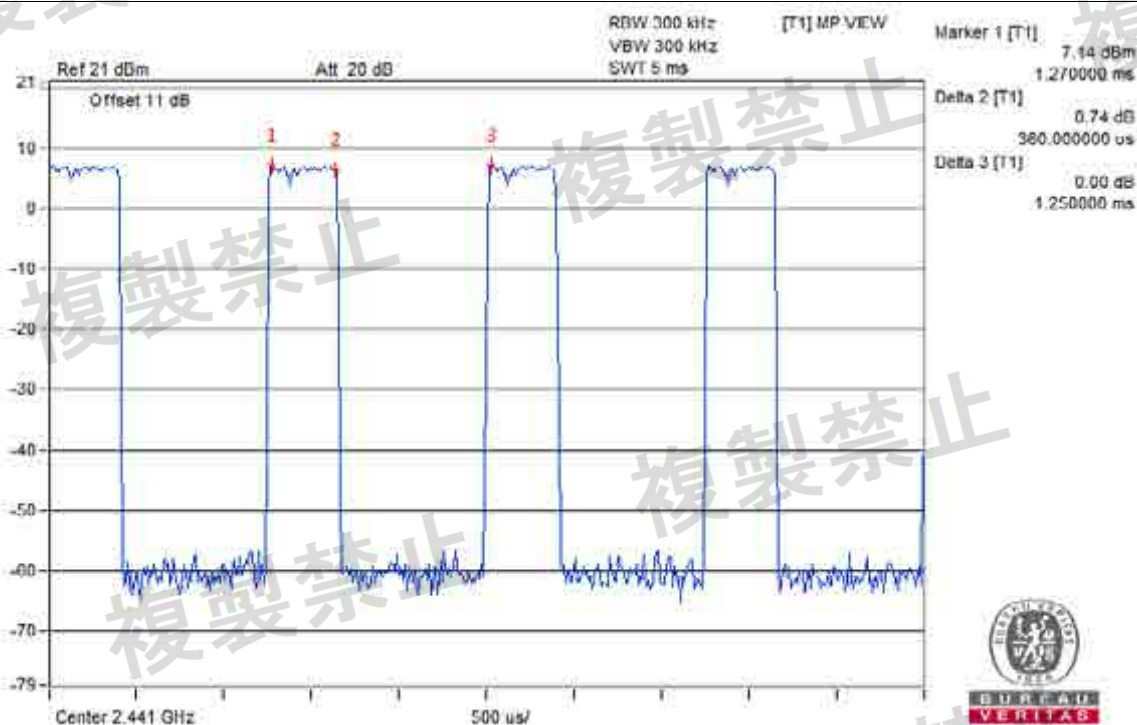
DH1



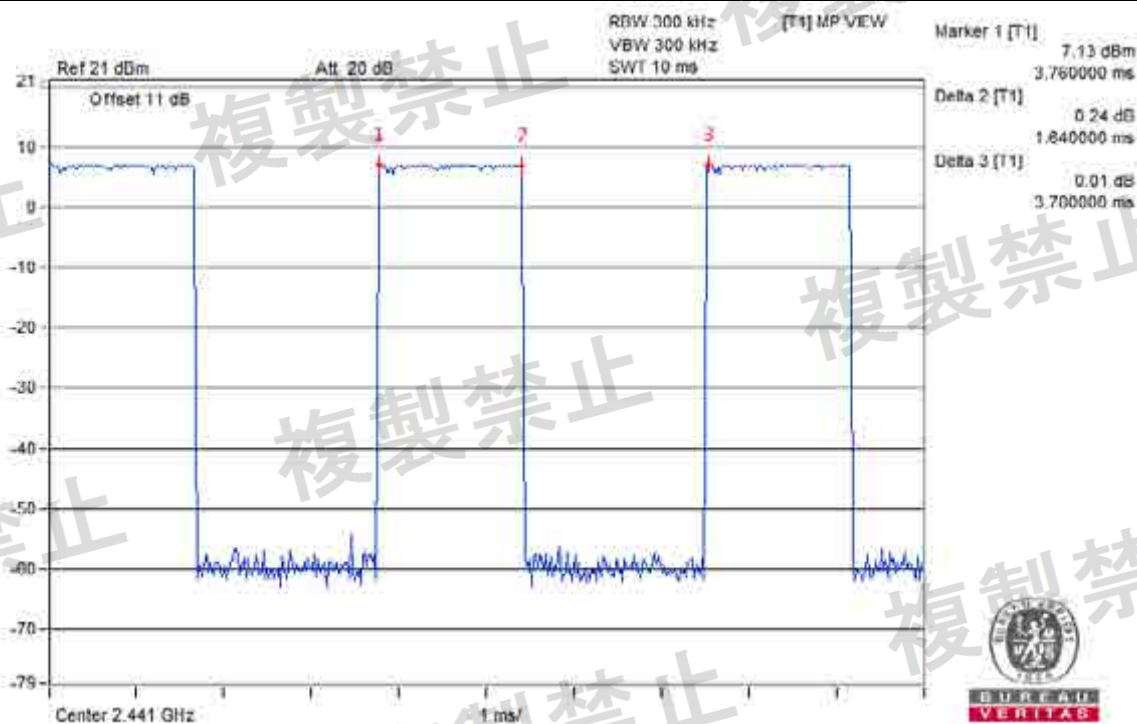
DH3



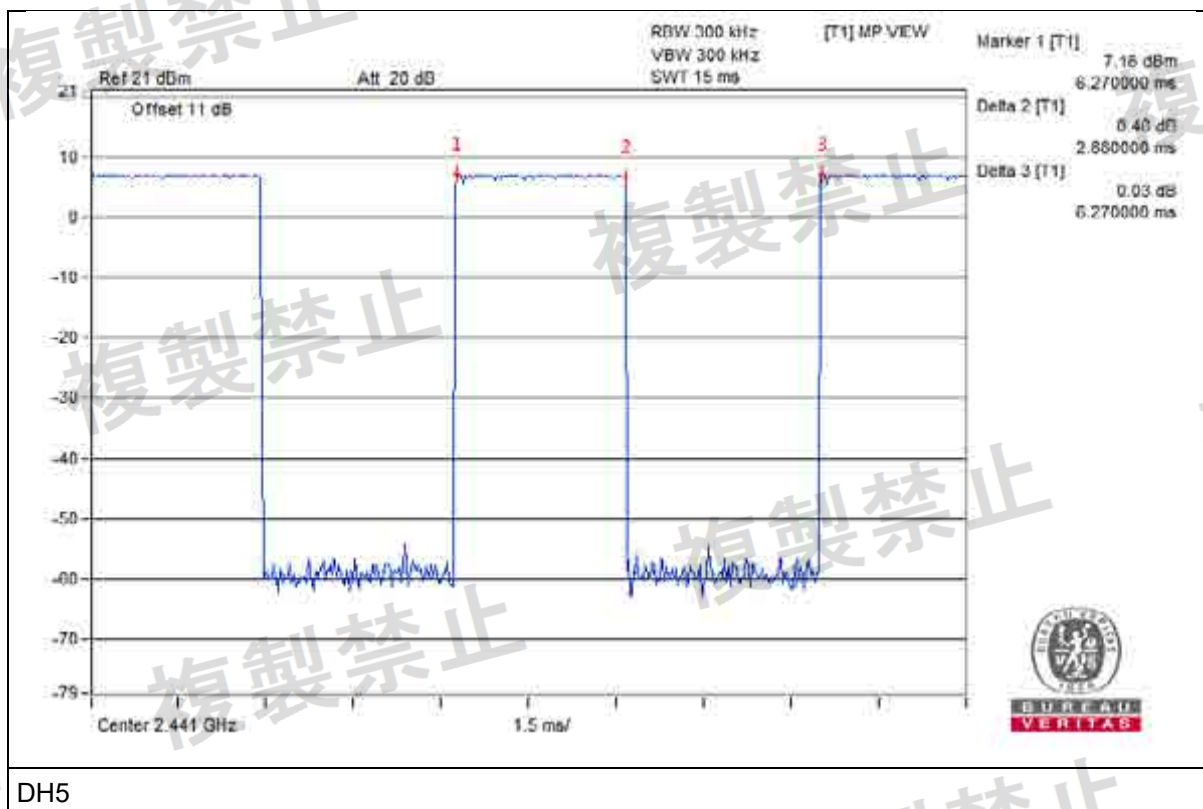
V<sub>max</sub>.



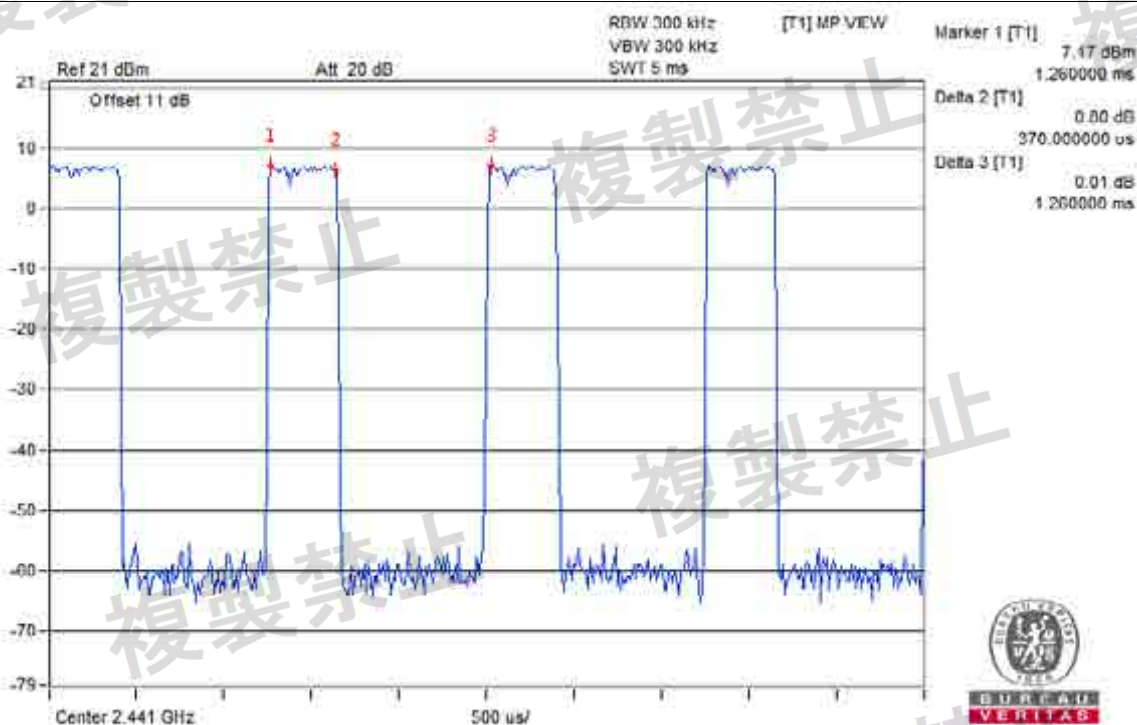
DH1



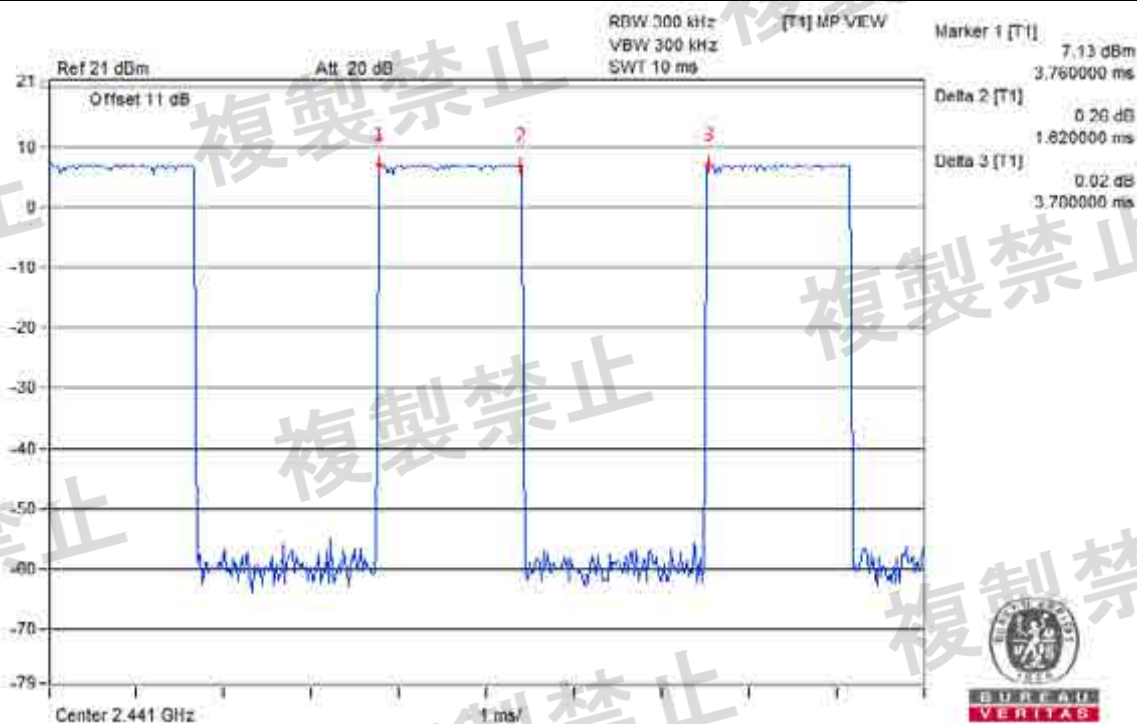
DH3



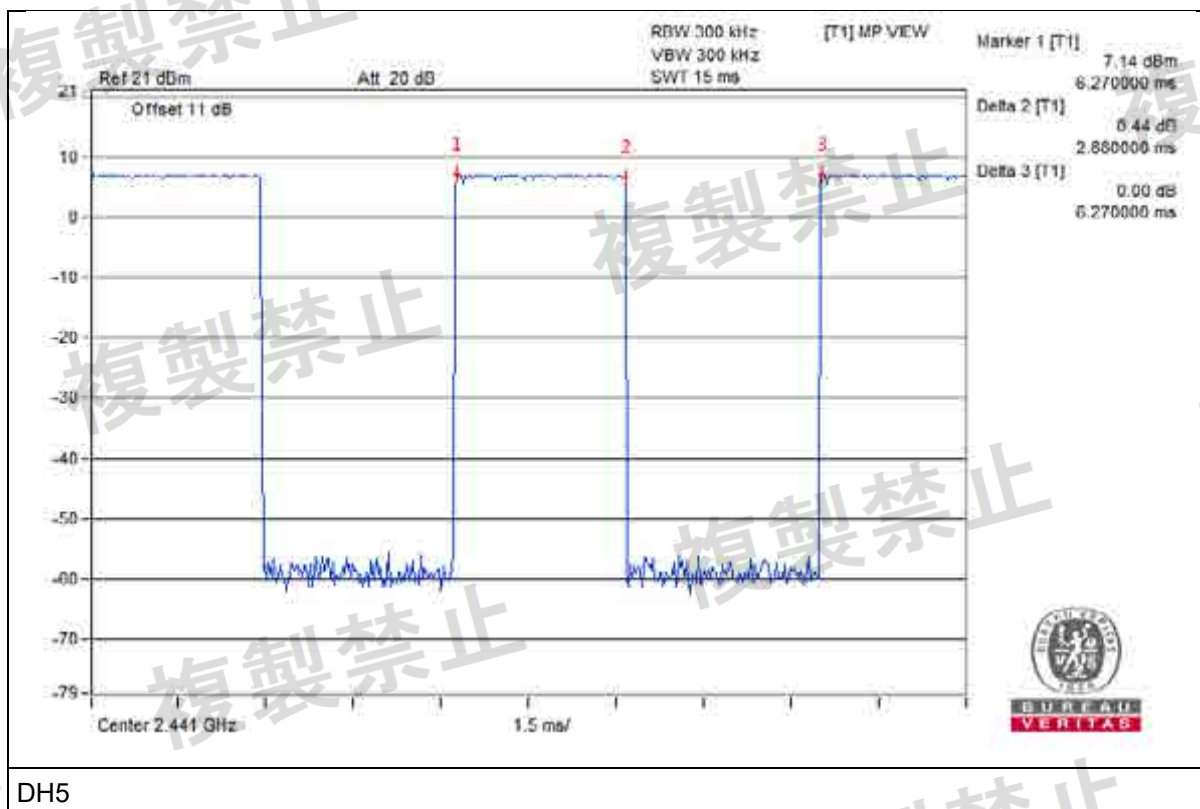
V<sub>min</sub>.



DH1



DH3



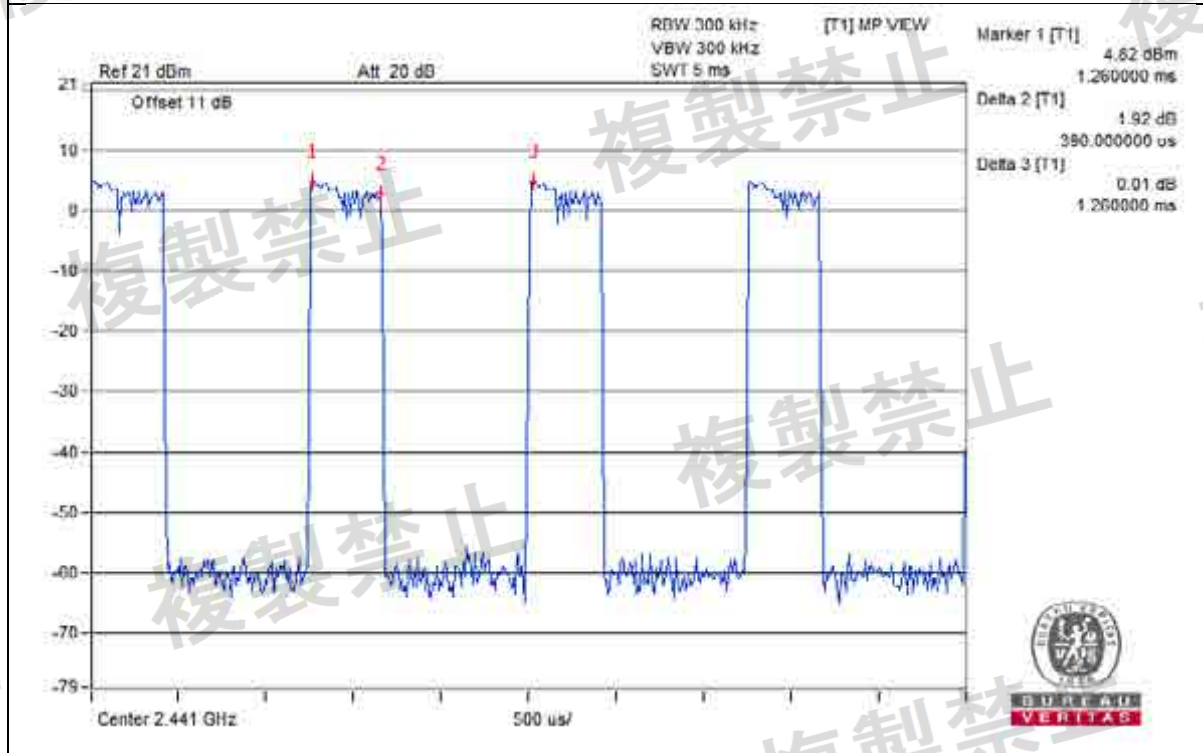
DH5

Modulation:  $\pi/4$ -DQPSK  
Normal Mode:

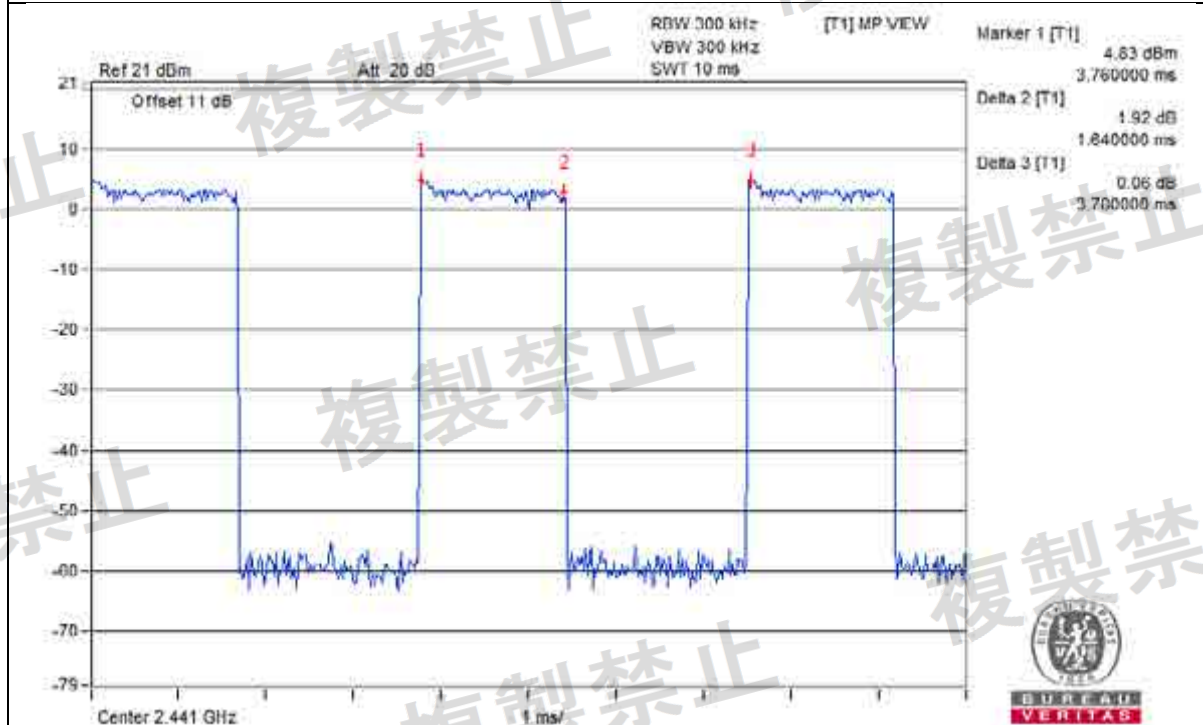
Test Condition	Mode	Spreading Rate	[Spreading Rate/79]*0.4	Duty Cycle	Result (msec)	Limit (msec)
$V_{\text{normal}}$	2DH1	71.00	0.359	0.309	110.931	400
	2DH3	71.00	0.359	0.433	155.447	400
	2DH5	71.00	0.359	0.459	164.781	400
$V_{\text{max.}}$	2DH1	71.00	0.359	0.309	110.931	400
	2DH3	71.00	0.359	0.433	155.447	400
	2DH5	71.00	0.359	0.459	164.781	400
$V_{\text{min.}}$	2DH1	70.80	0.358	0.309	110.622	400
	2DH3	70.80	0.358	0.433	155.014	400
	2DH5	70.80	0.358	0.459	164.322	400

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

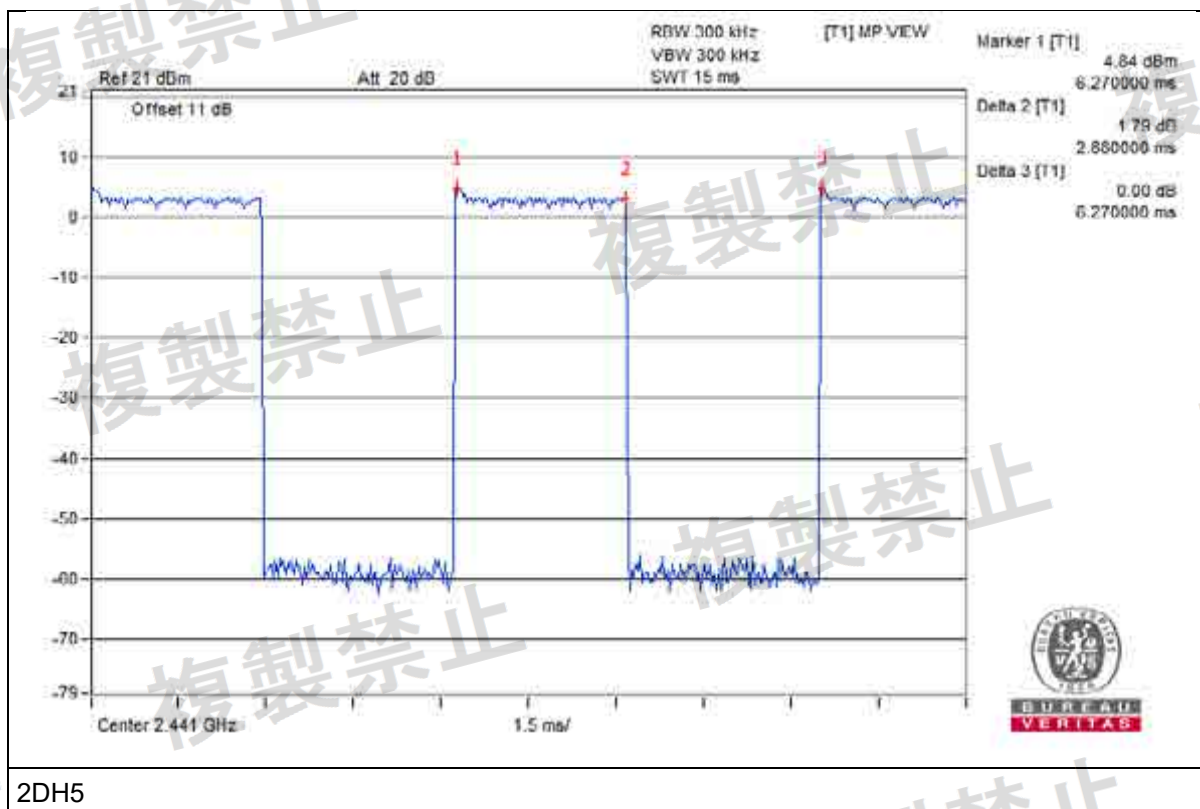
V<sub>normal</sub>



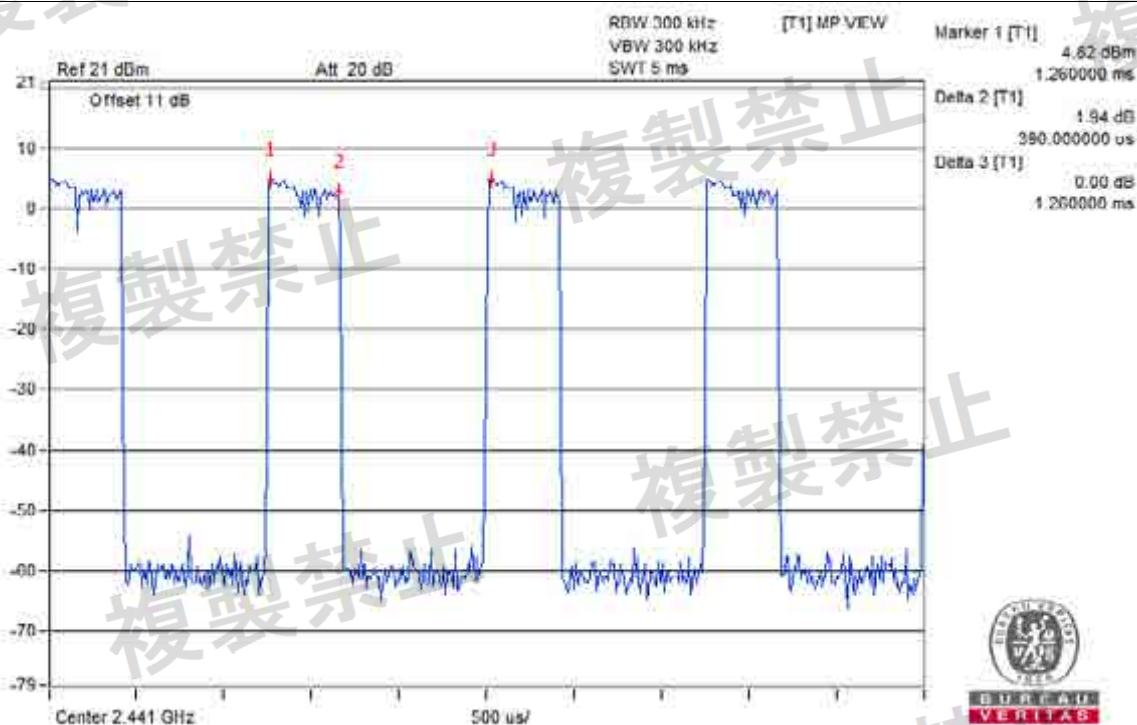
2DH1



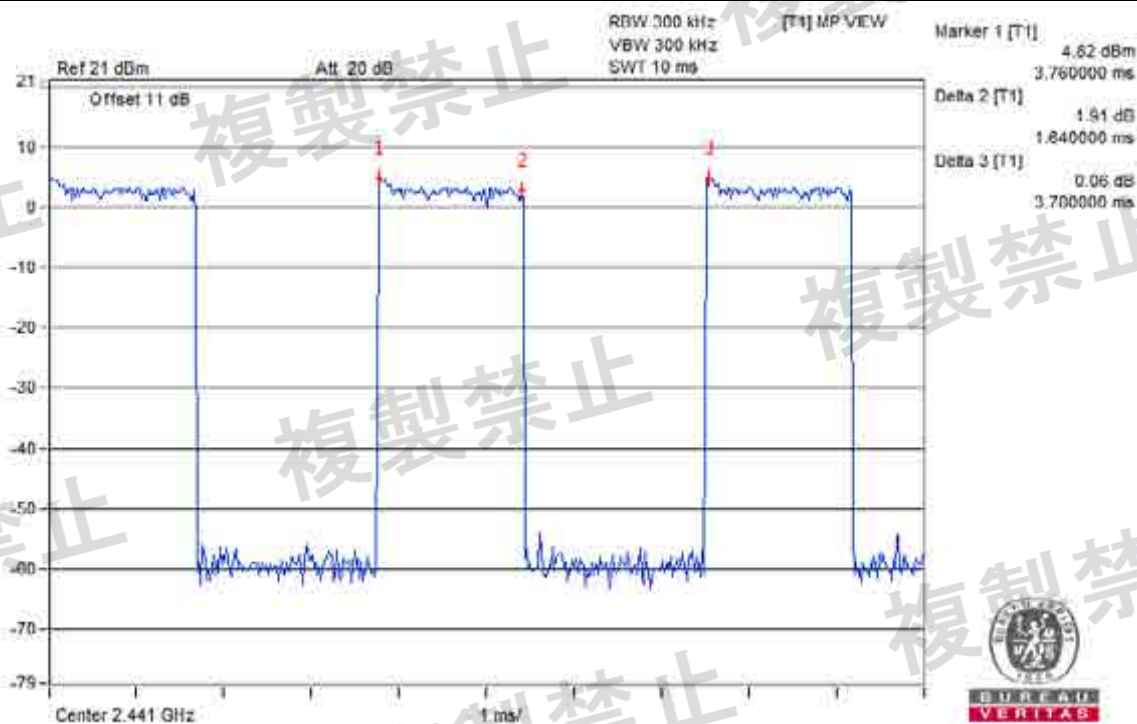
2DH3



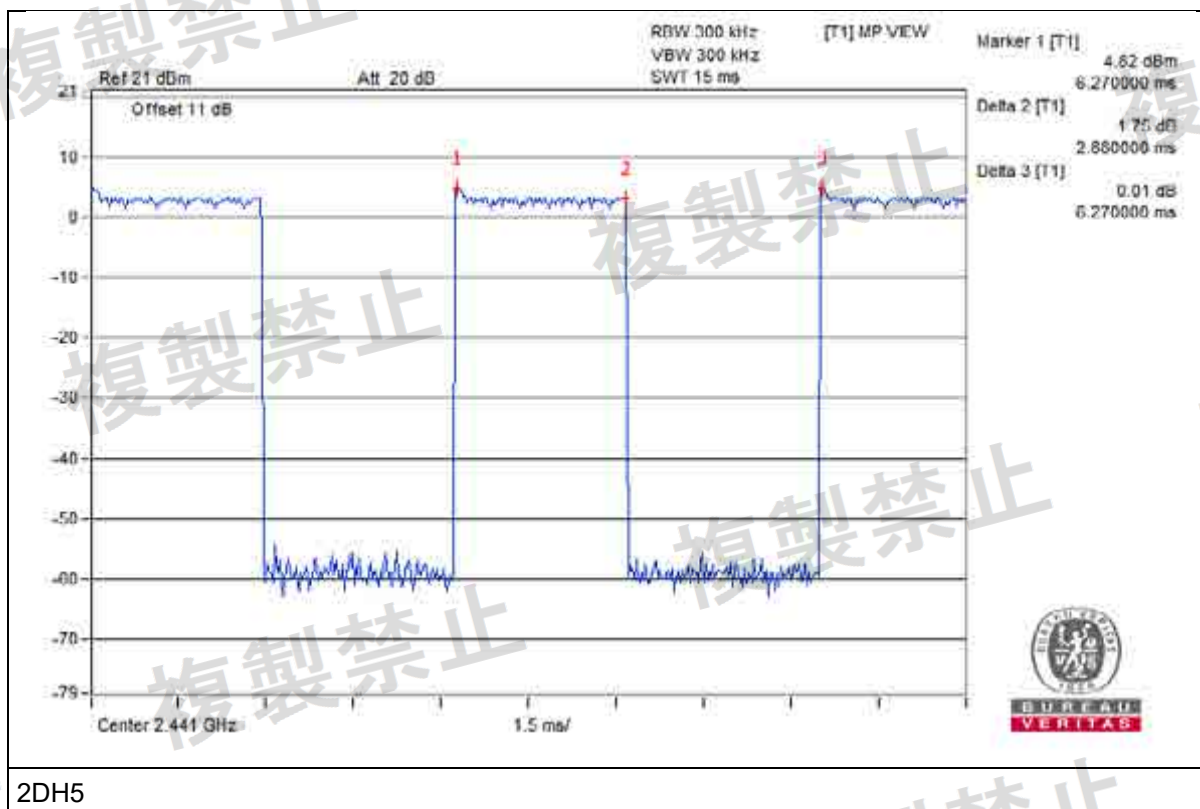
V<sub>max</sub>.



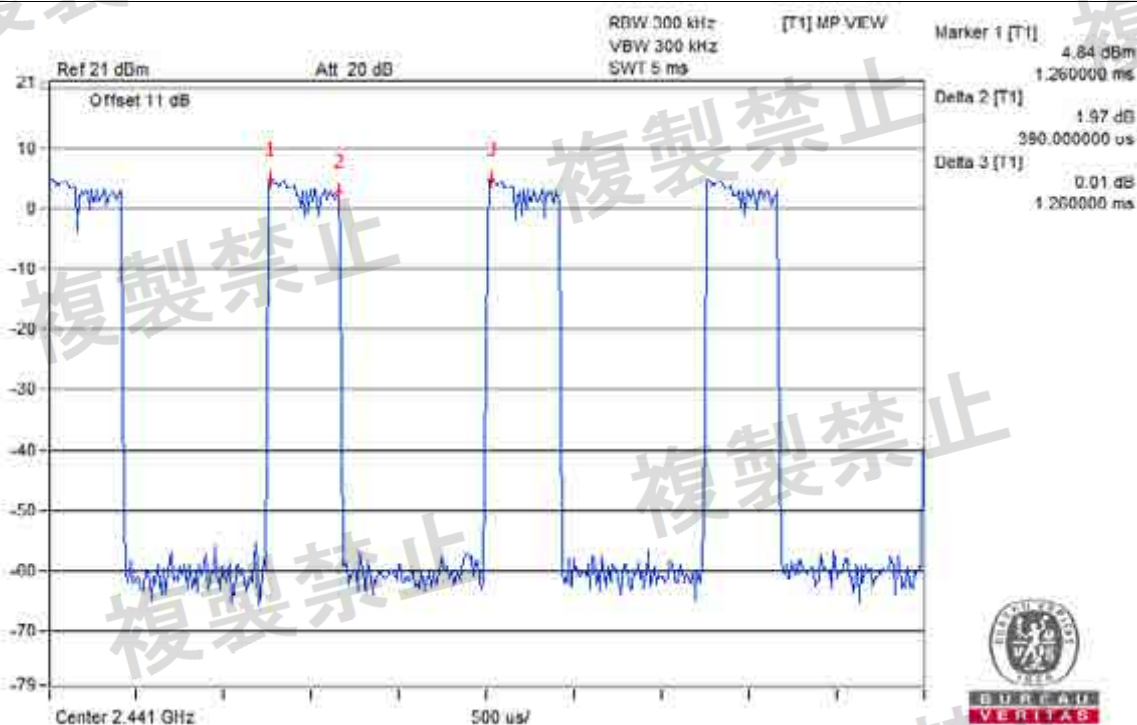
2DH1



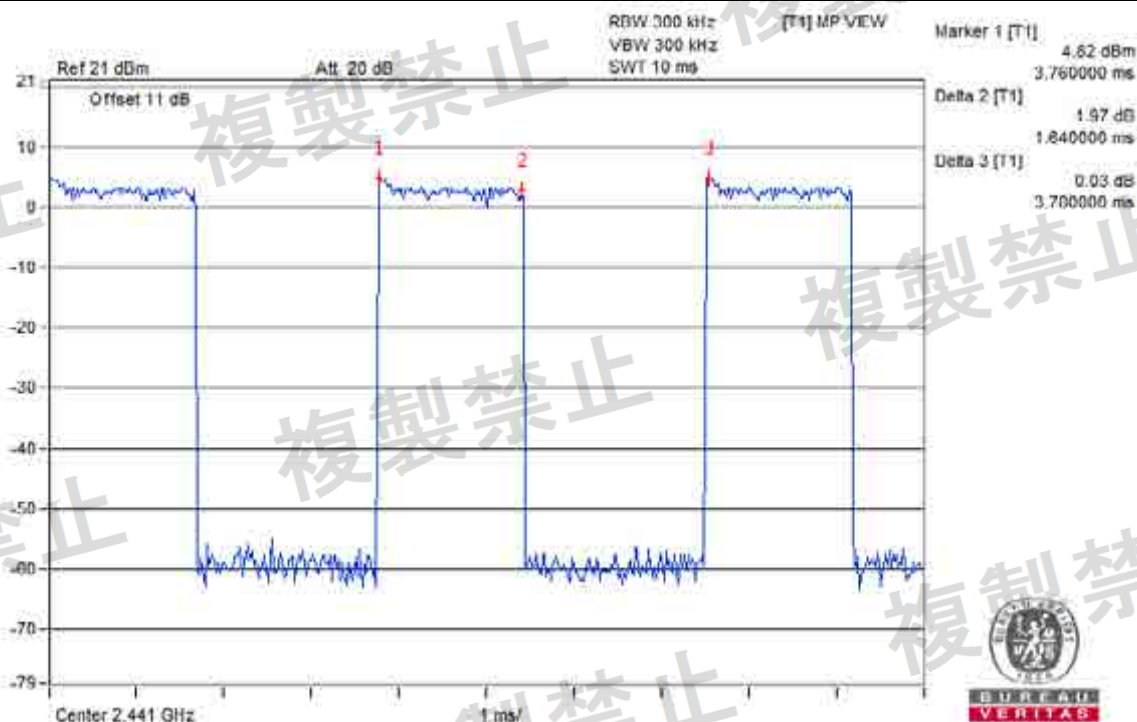
2DH3



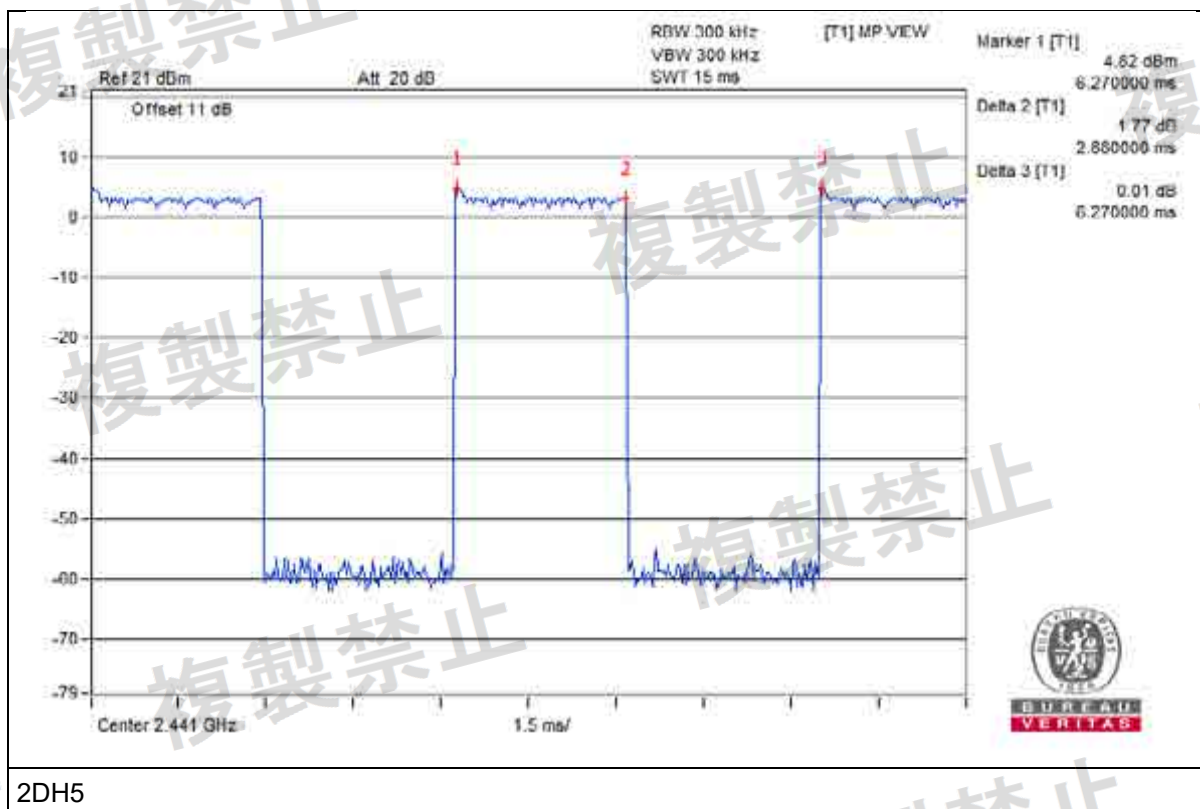
V<sub>min</sub>.



2DH1



2DH3

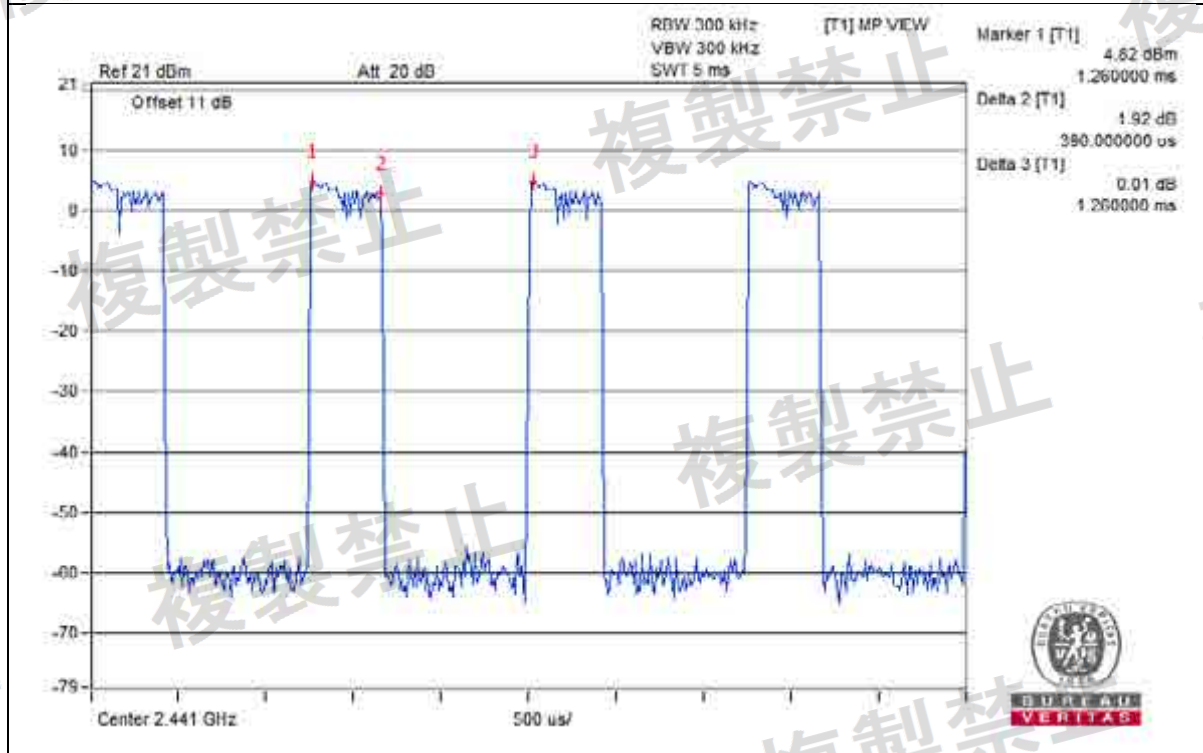


**AFH Mode:**

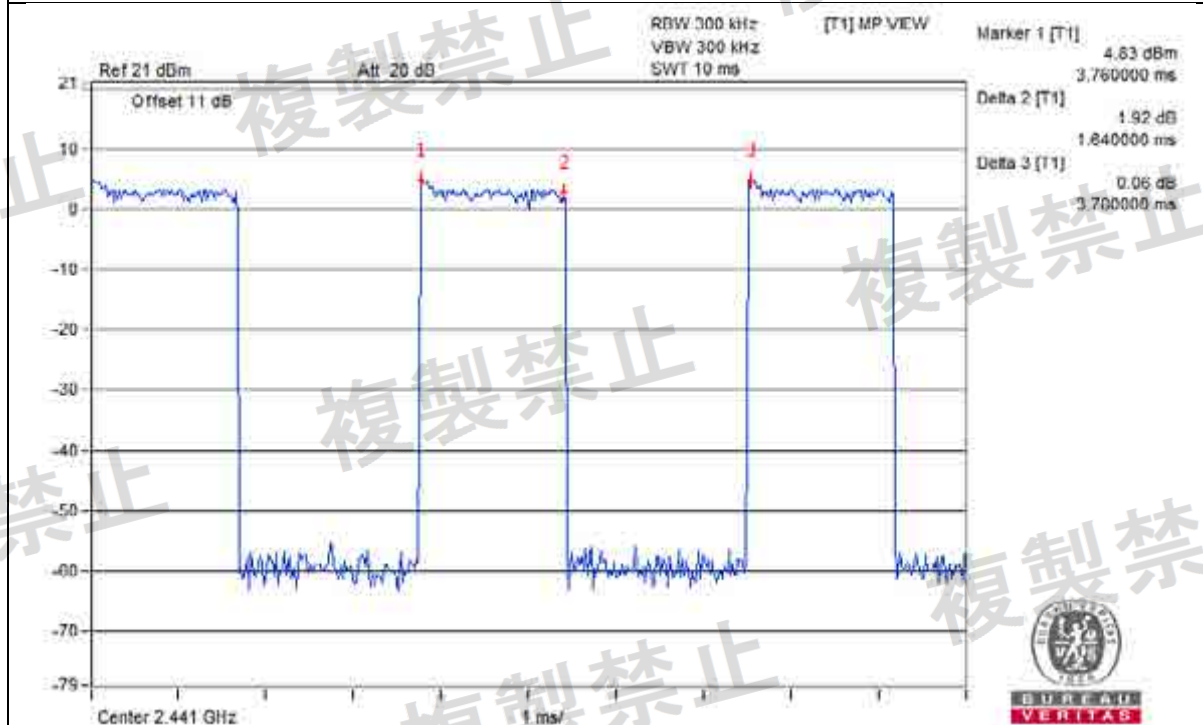
Test Condition	Mode	Spreading Rate	[Spreading Rate/20]*0.4	Duty Cycle	Result (msec)	Limit (msec)
V <sub>normal</sub>	2DH1	18.10	0.362	0.309	111.858	400
	2DH3	18.10	0.362	0.433	156.746	400
	2DH5	18.10	0.362	0.459	166.158	400
V <sub>max.</sub>	2DH1	18.00	0.360	0.309	111.240	400
	2DH3	18.00	0.360	0.433	155.880	400
	2DH5	18.00	0.360	0.459	165.240	400
V <sub>min.</sub>	2DH1	18.10	0.362	0.309	111.858	400
	2DH3	18.10	0.362	0.433	156.746	400
	2DH5	18.10	0.362	0.459	166.158	400

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

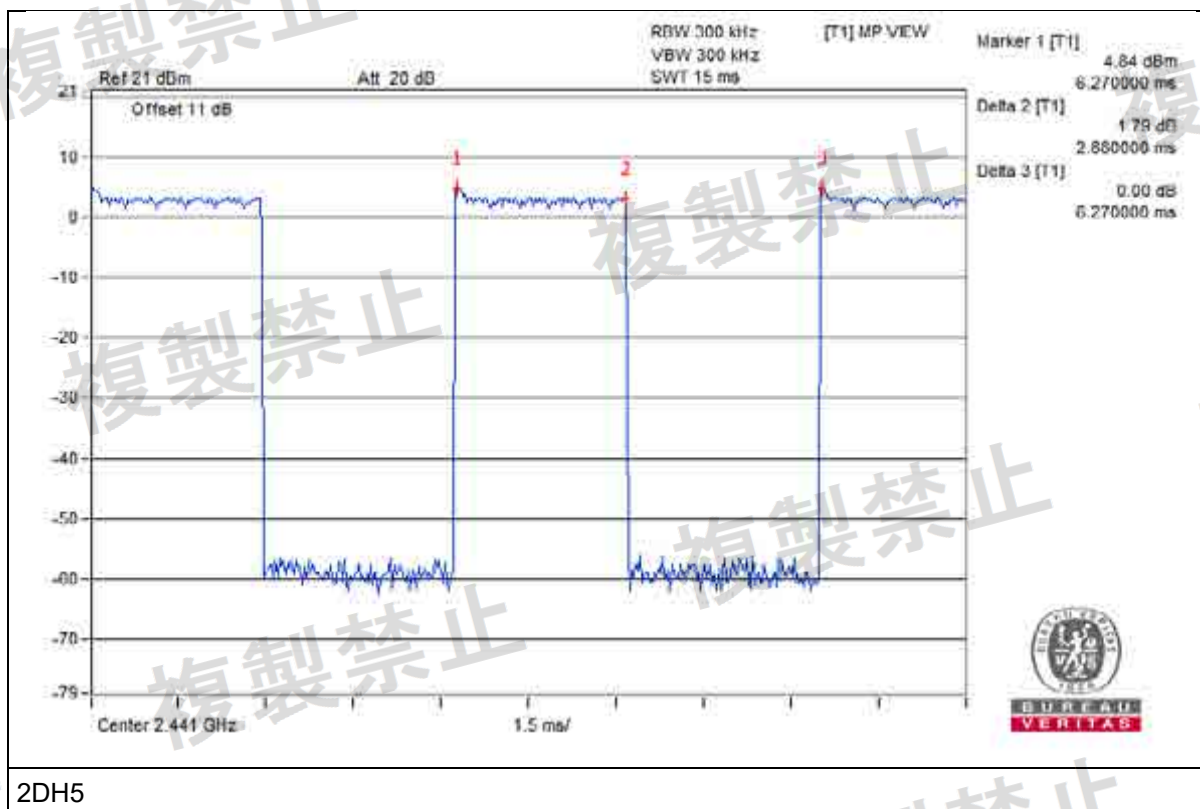
V<sub>normal</sub>



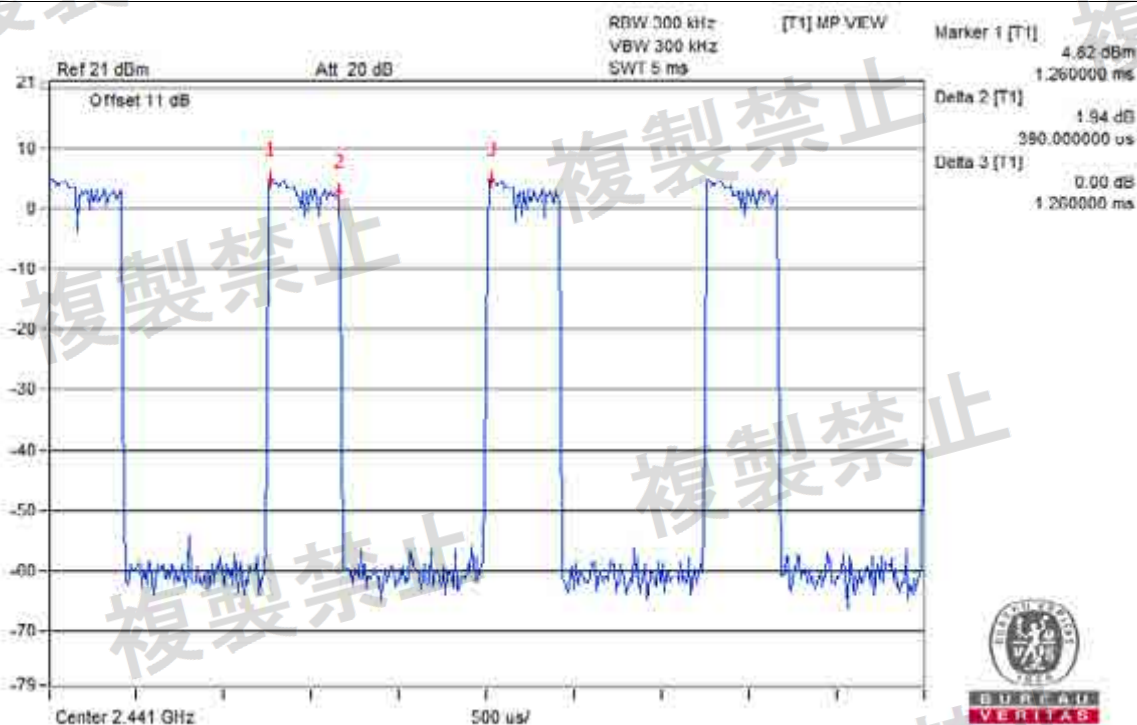
2DH1



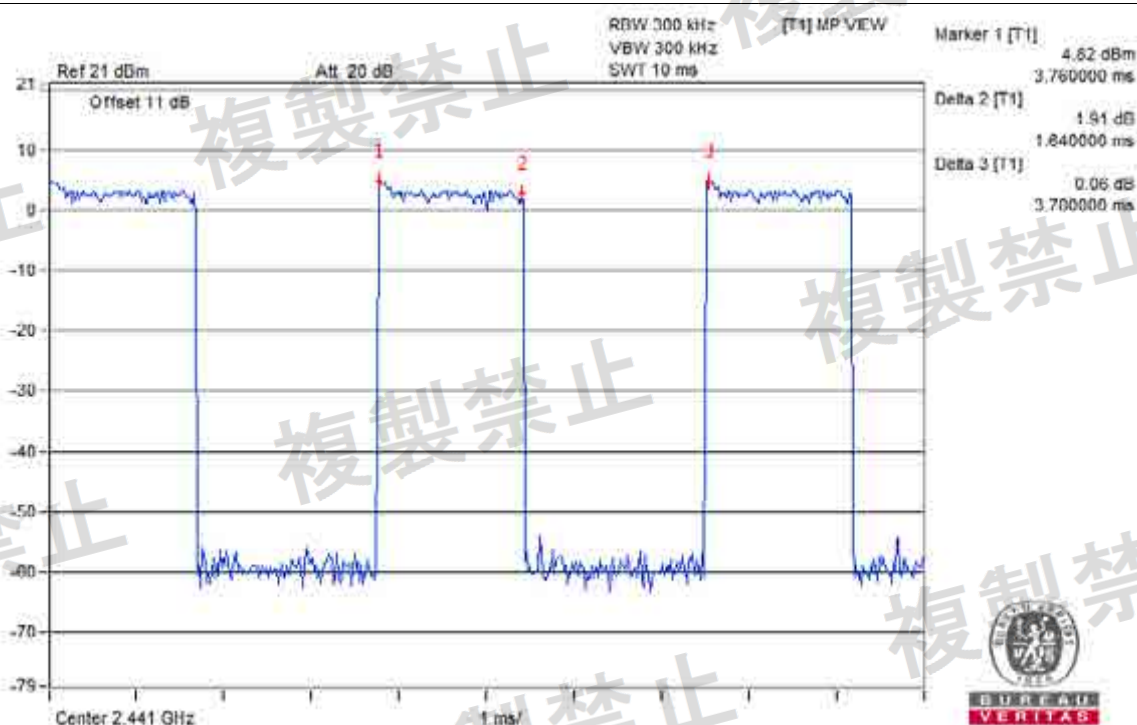
2DH3



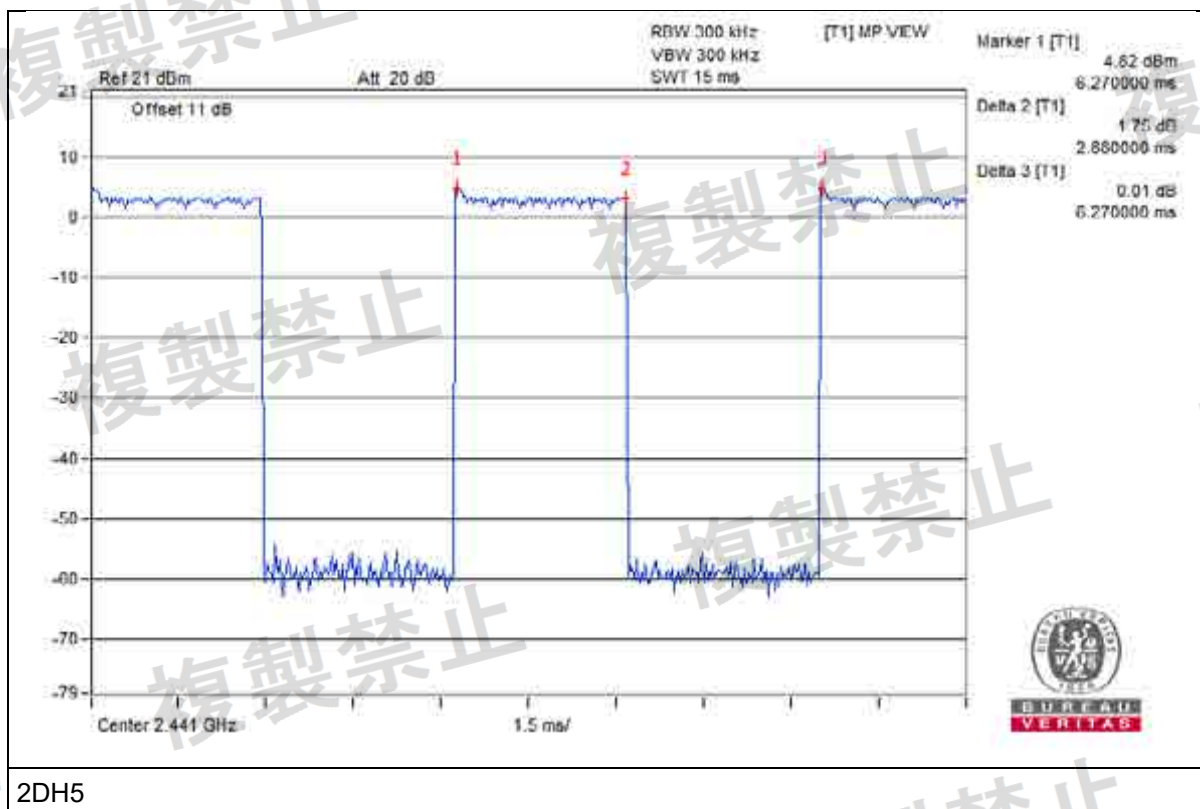
V<sub>max</sub>.



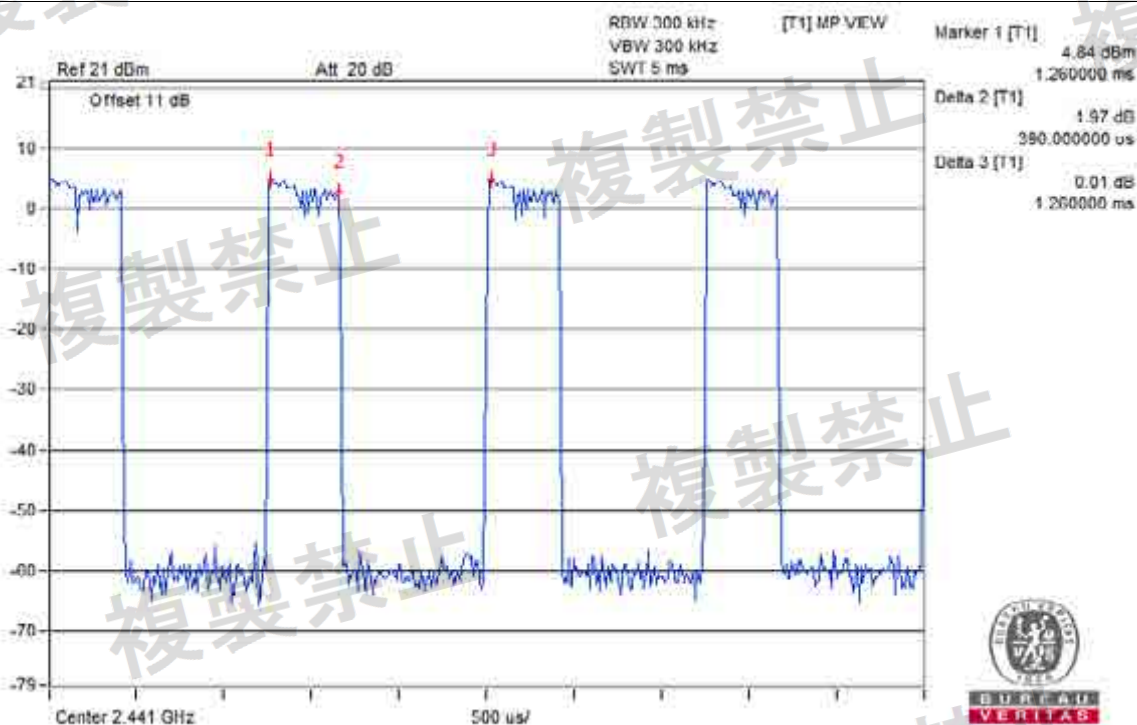
2DH1



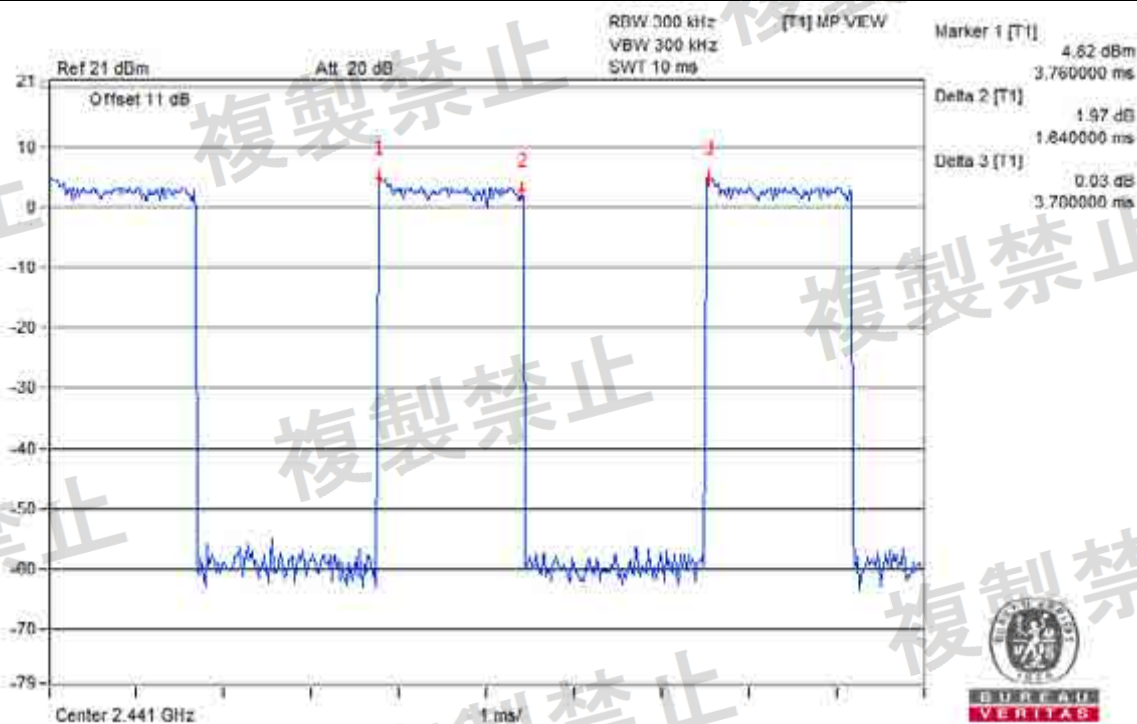
2DH3



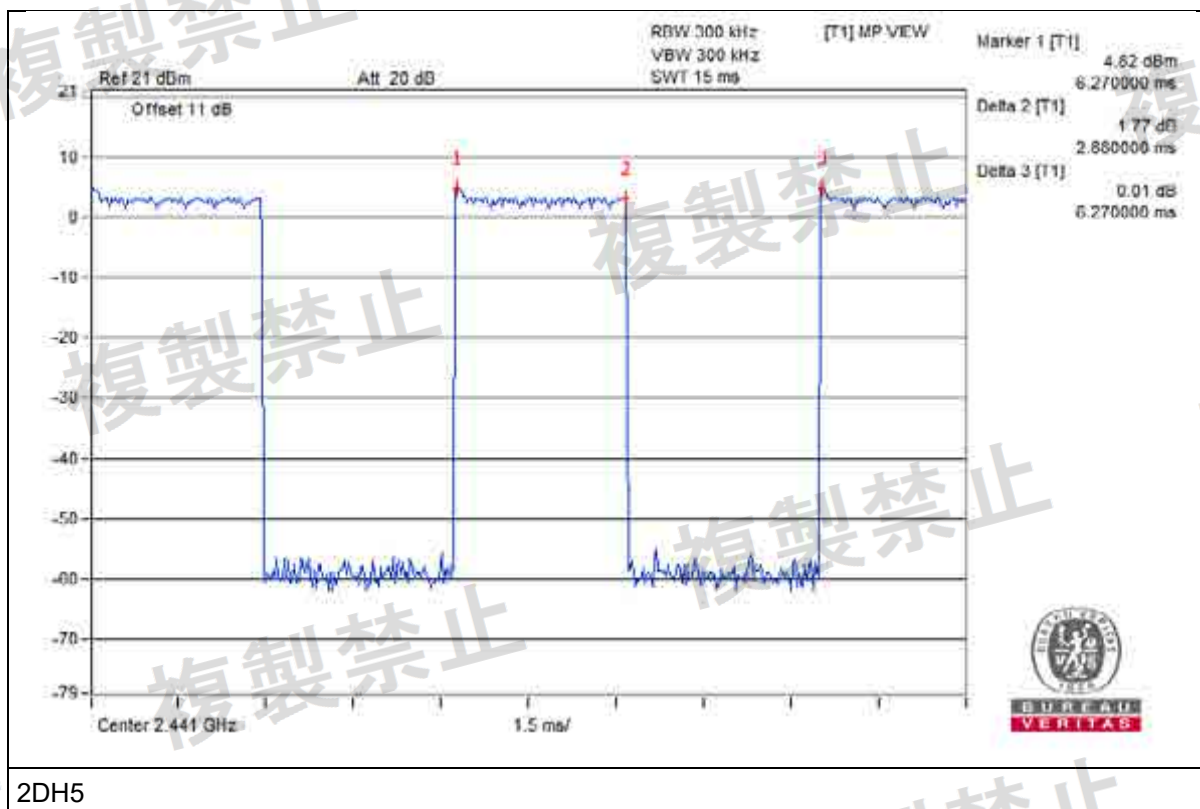
V<sub>min</sub>.



2DH1



2DH3

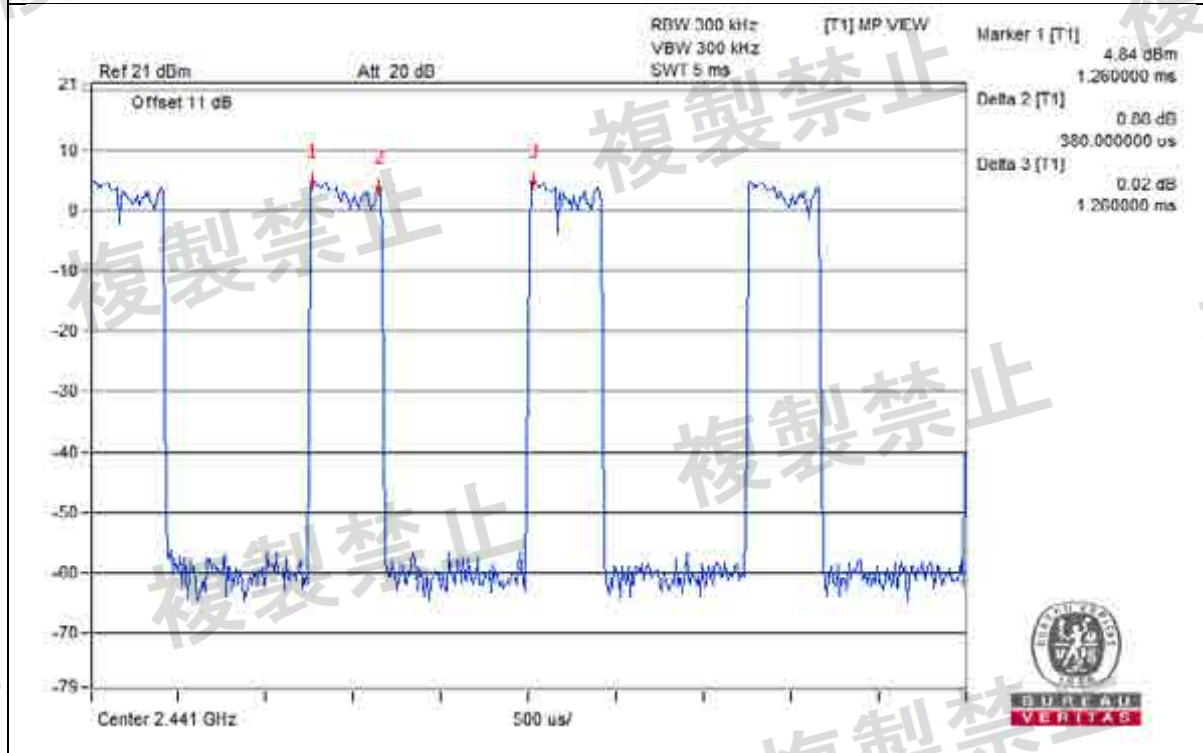


Modulation: 8DPSK  
Normal Mode:

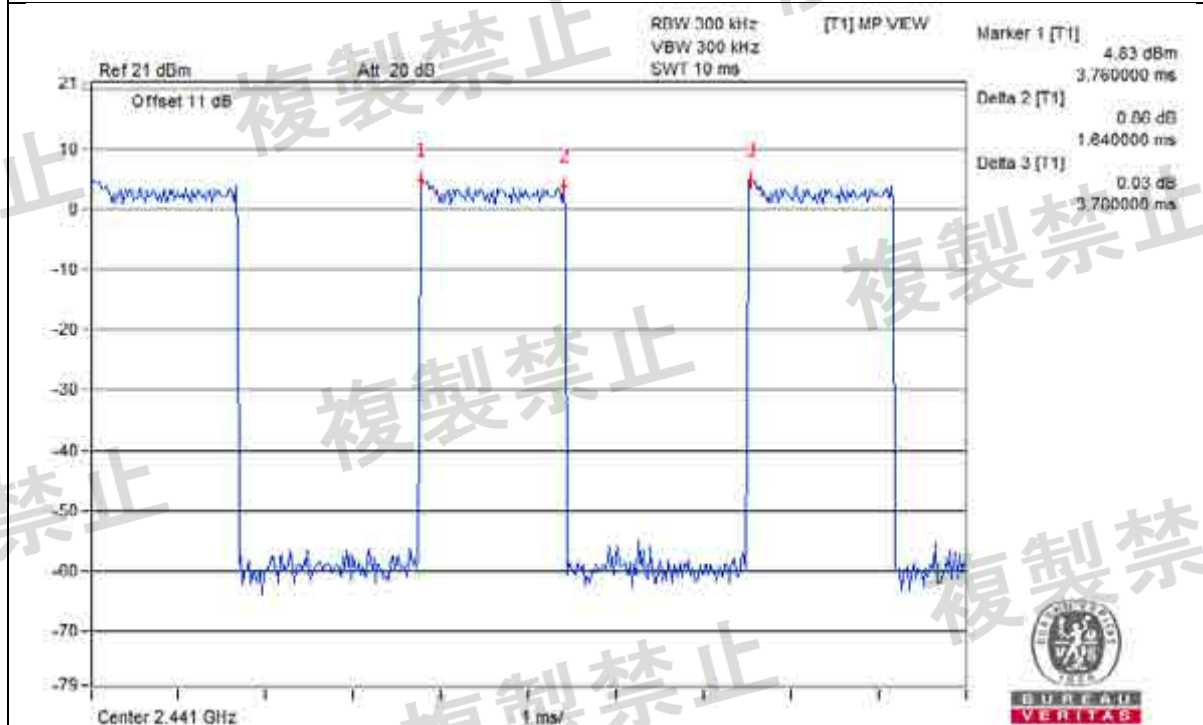
Test Condition	Mode	Spreading Rate	[Spreading Rate/79]*0.4	Duty Cycle	Result (msec)	Limit (msec)
V <sub>normal</sub>	3DH1	71.20	0.360	0.301	108.360	400
	3DH3	71.20	0.360	0.433	155.880	400
	3DH5	71.20	0.360	0.459	165.240	400
V <sub>max.</sub>	3DH1	70.60	0.357	0.309	110.313	400
	3DH3	70.60	0.357	0.433	154.581	400
	3DH5	70.60	0.357	0.459	163.863	400
V <sub>min.</sub>	3DH1	71.20	0.360	0.309	111.240	400
	3DH3	71.20	0.360	0.433	155.880	400
	3DH5	71.20	0.360	0.459	165.240	400

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

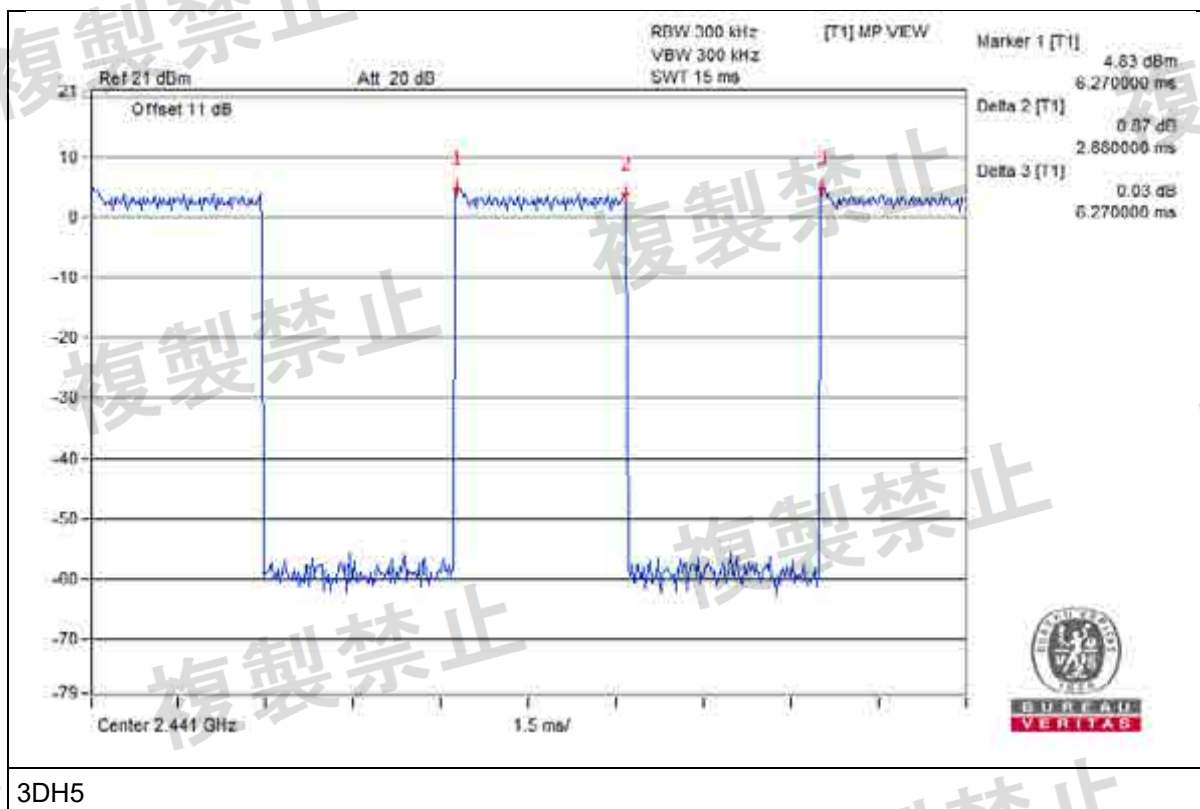
V<sub>normal</sub>



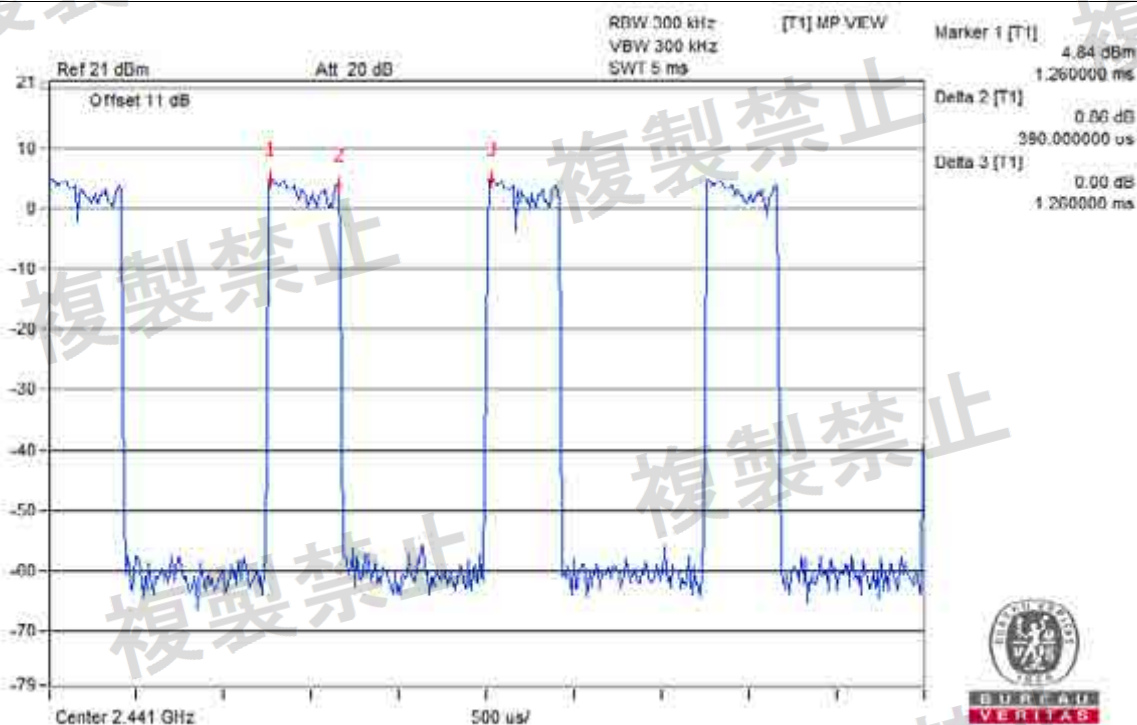
3DH1



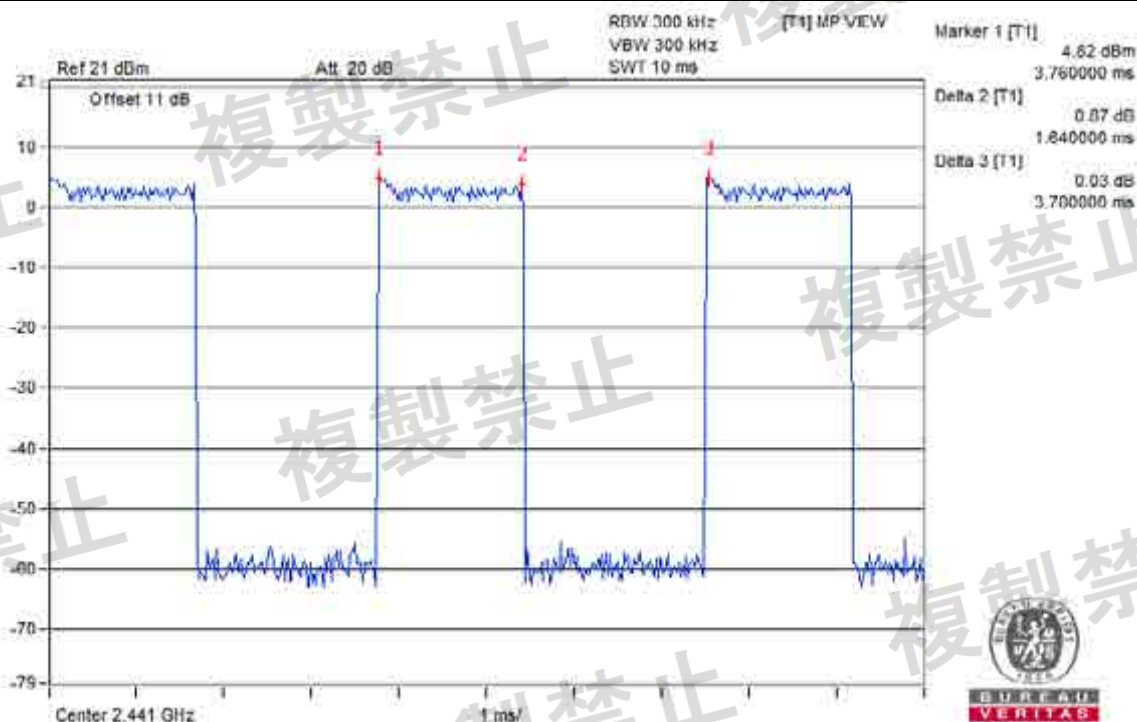
3DH3



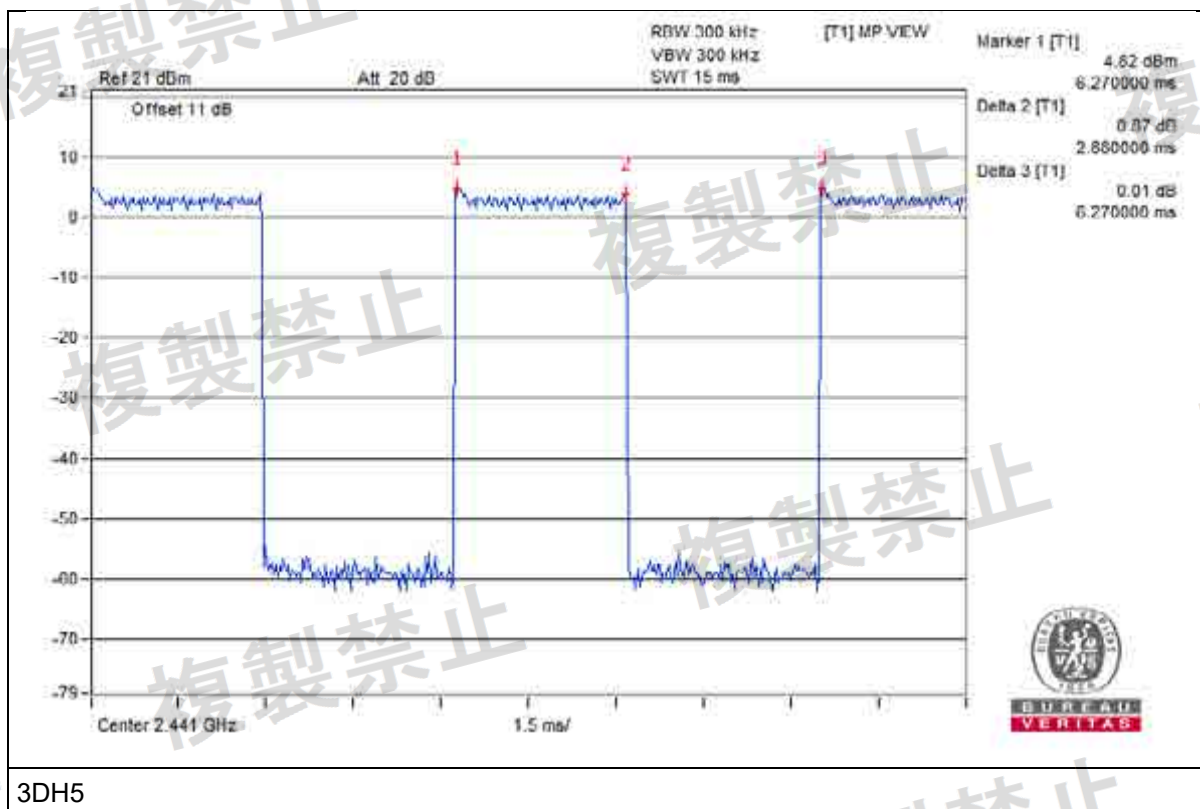
V<sub>max</sub>.



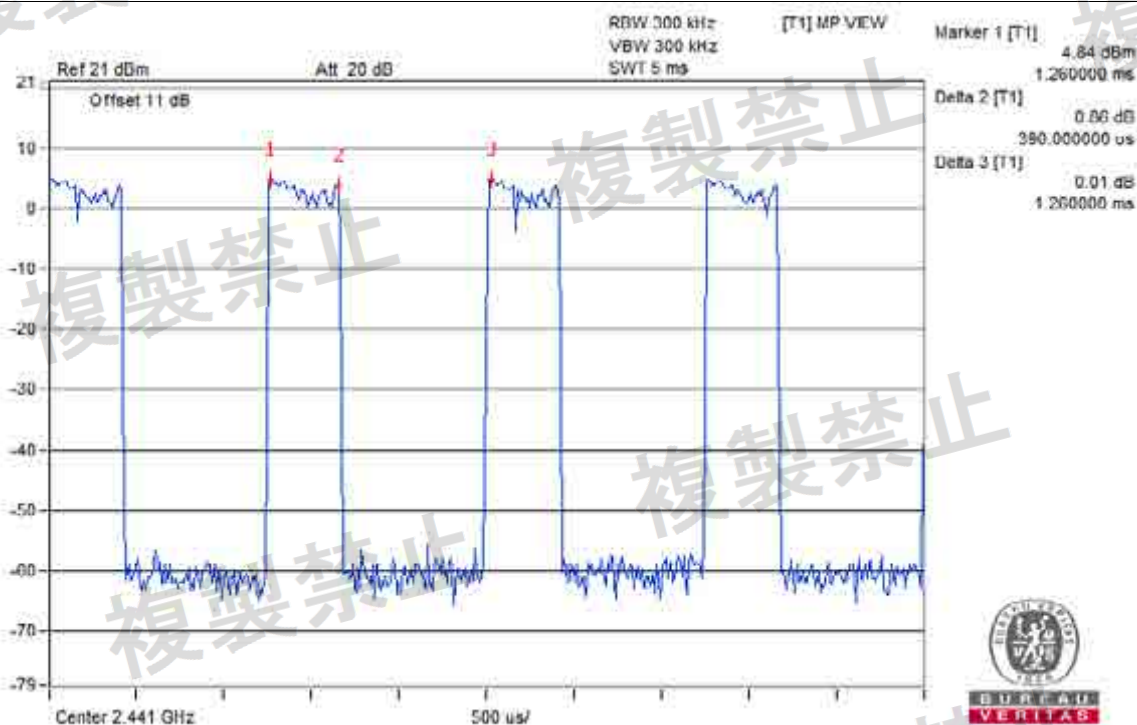
3DH1



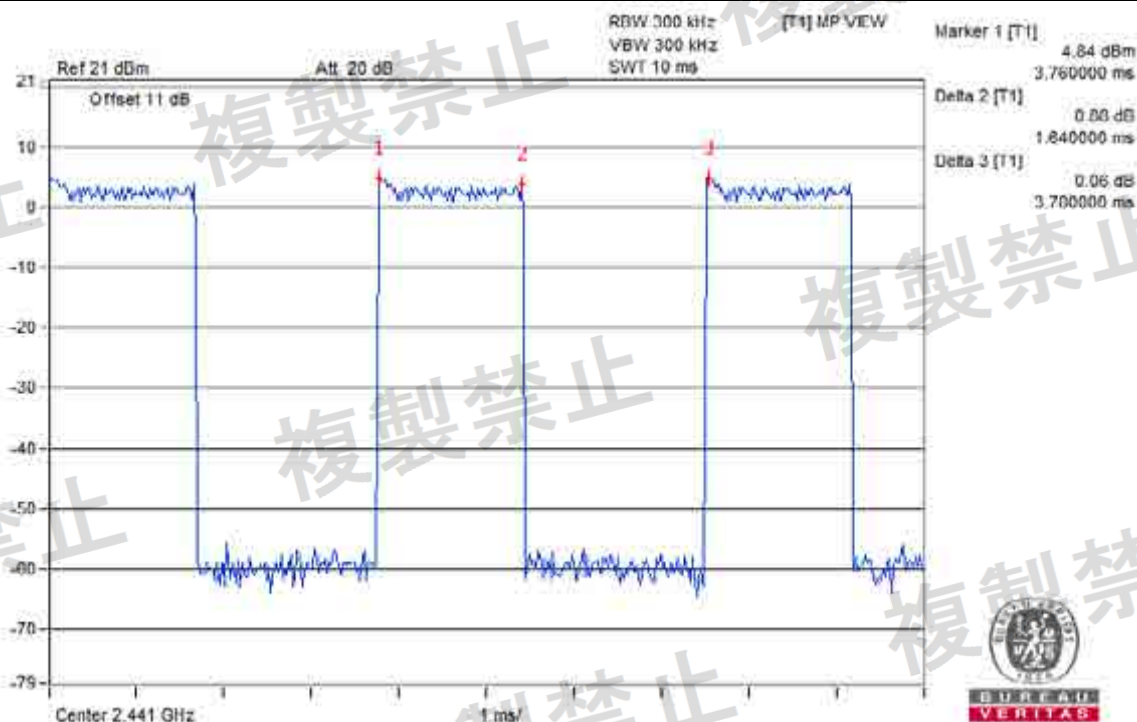
3DH3



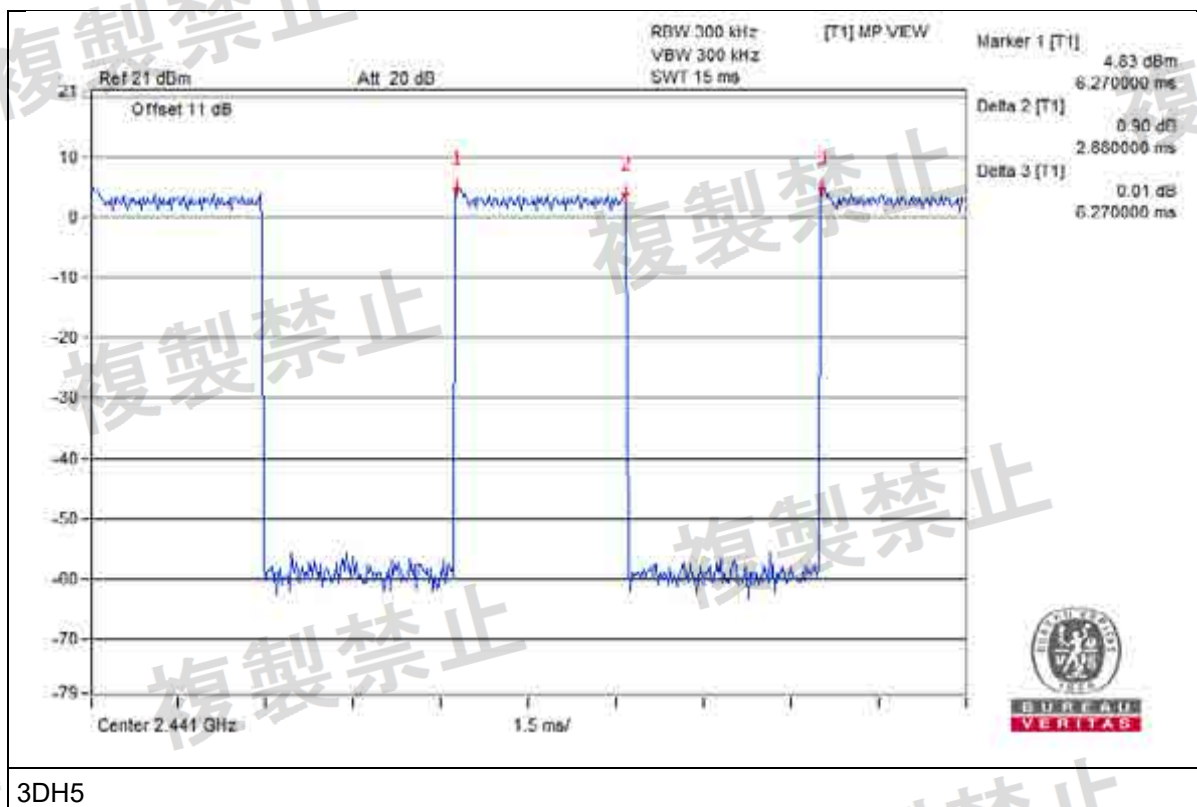
V<sub>min</sub>.



3DH1



3DH3

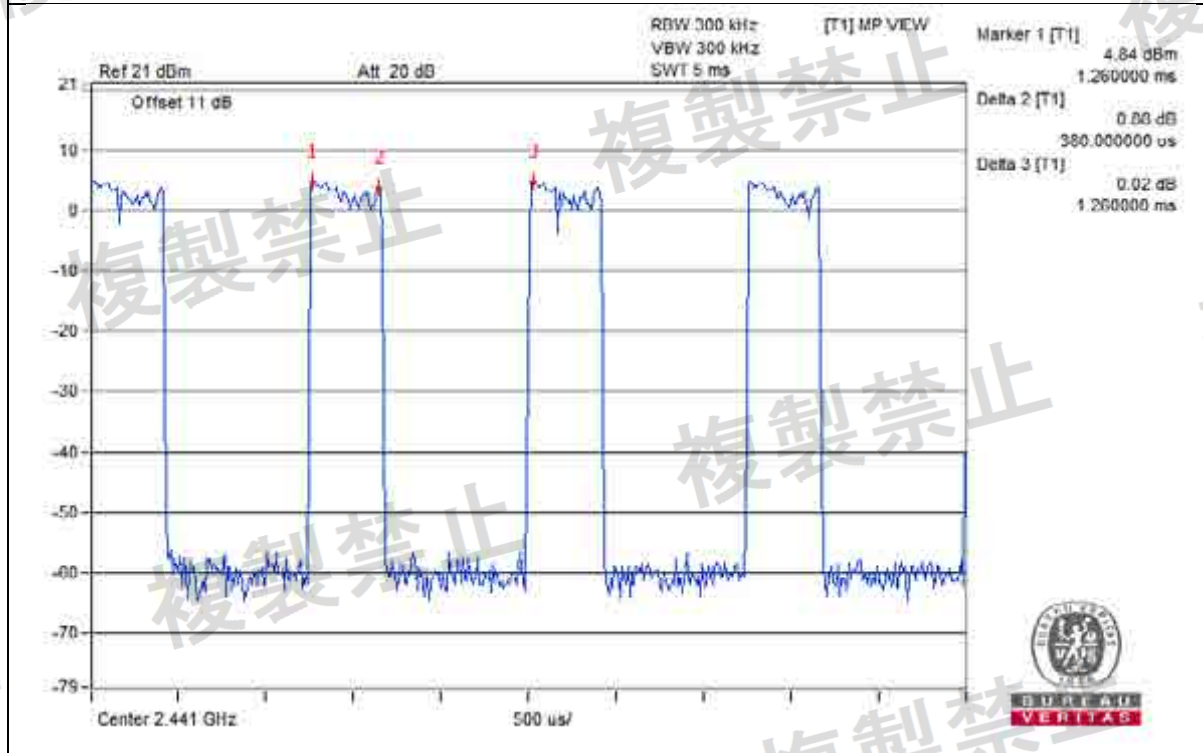


#### AFH Mode:

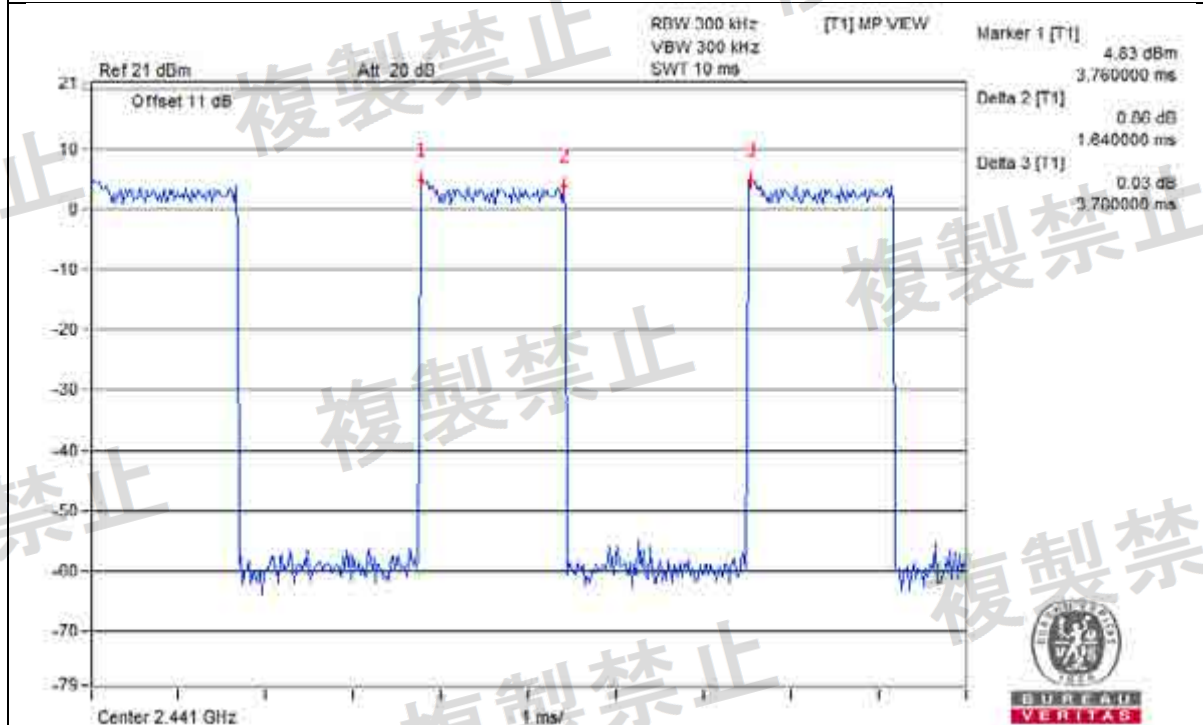
Test Condition	Mode	Spreading Rate	[Spreading Rate/20]*0.4	Duty Cycle	Result (msec)	Limit (msec)
$V_{normal}$	3DH1	18.10	0.362	0.301	108.962	400
	3DH3	18.10	0.362	0.433	156.746	400
	3DH5	18.10	0.362	0.459	166.158	400
$V_{max.}$	3DH1	18.20	0.364	0.309	112.476	400
	3DH3	18.20	0.364	0.433	157.612	400
	3DH5	18.20	0.364	0.459	167.076	400
$V_{min.}$	3DH1	18.10	0.362	0.309	111.858	400
	3DH3	18.10	0.362	0.433	156.746	400
	3DH5	18.10	0.362	0.459	166.158	400

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

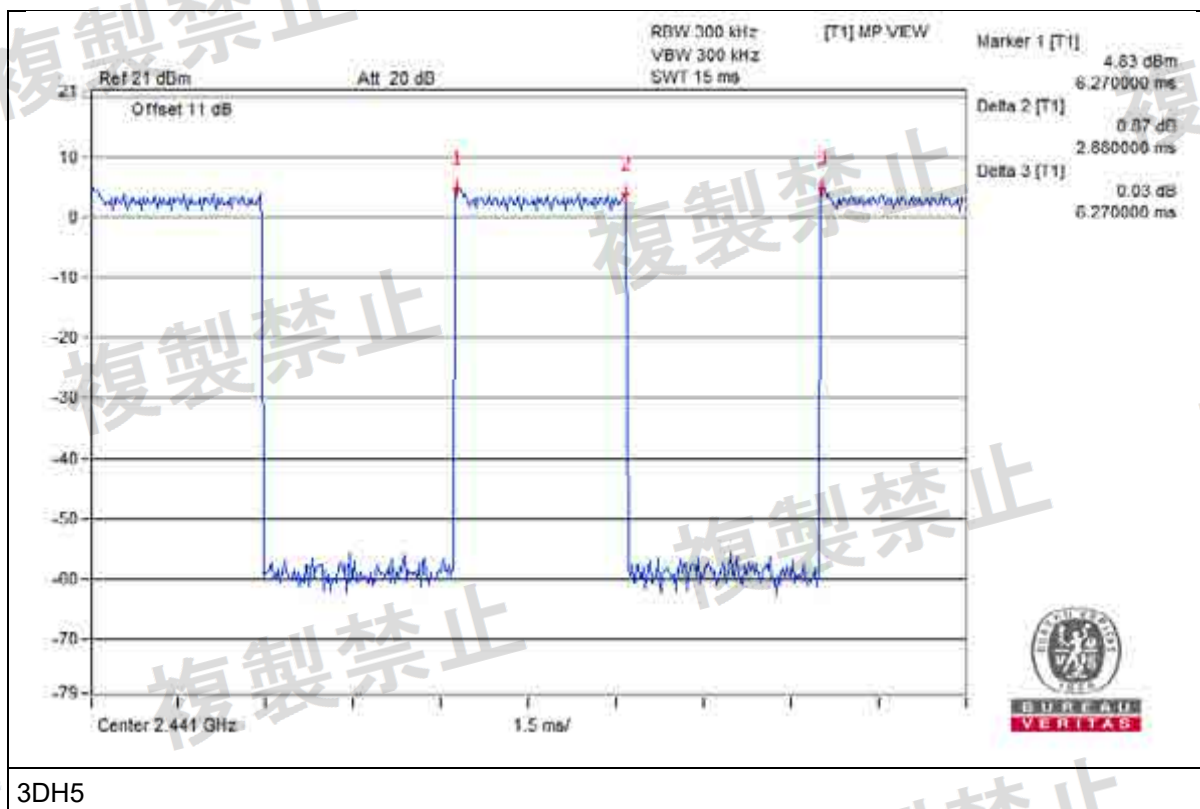
V<sub>normal</sub>

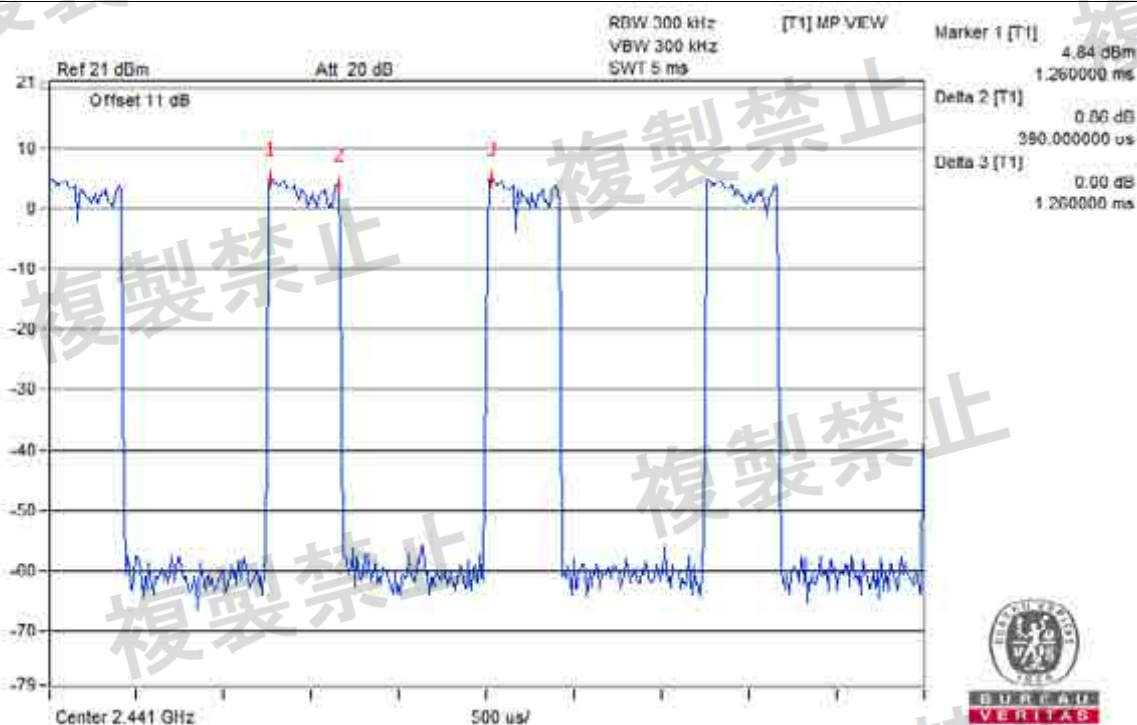


3DH1

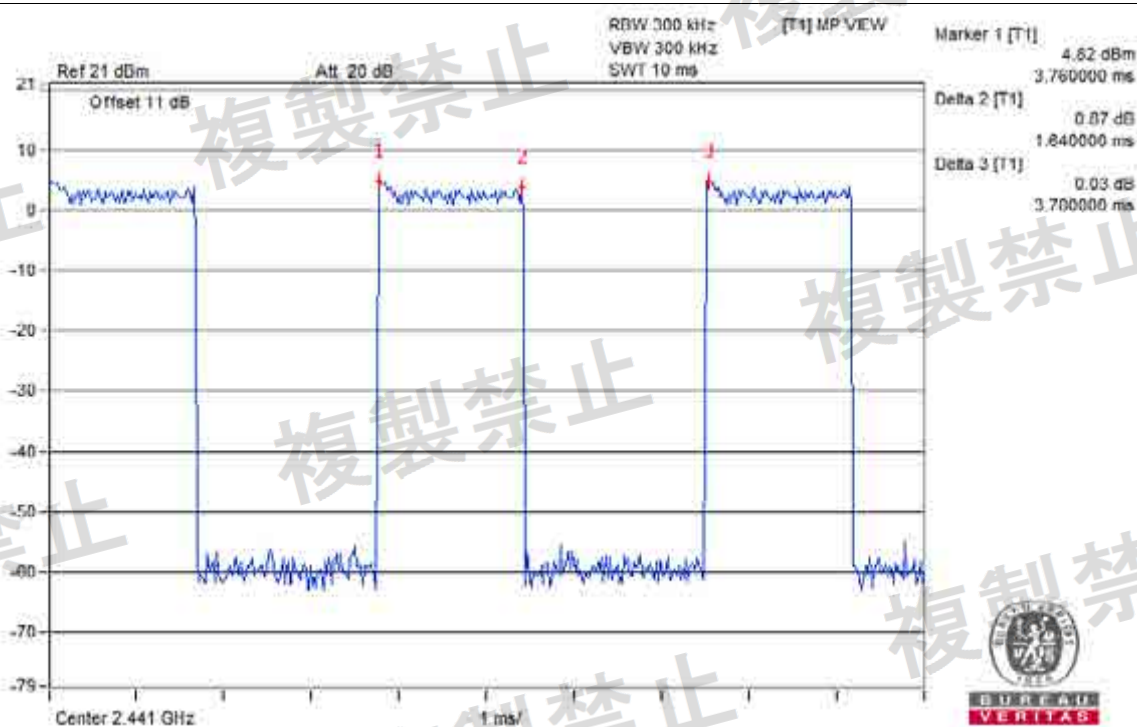


3DH3

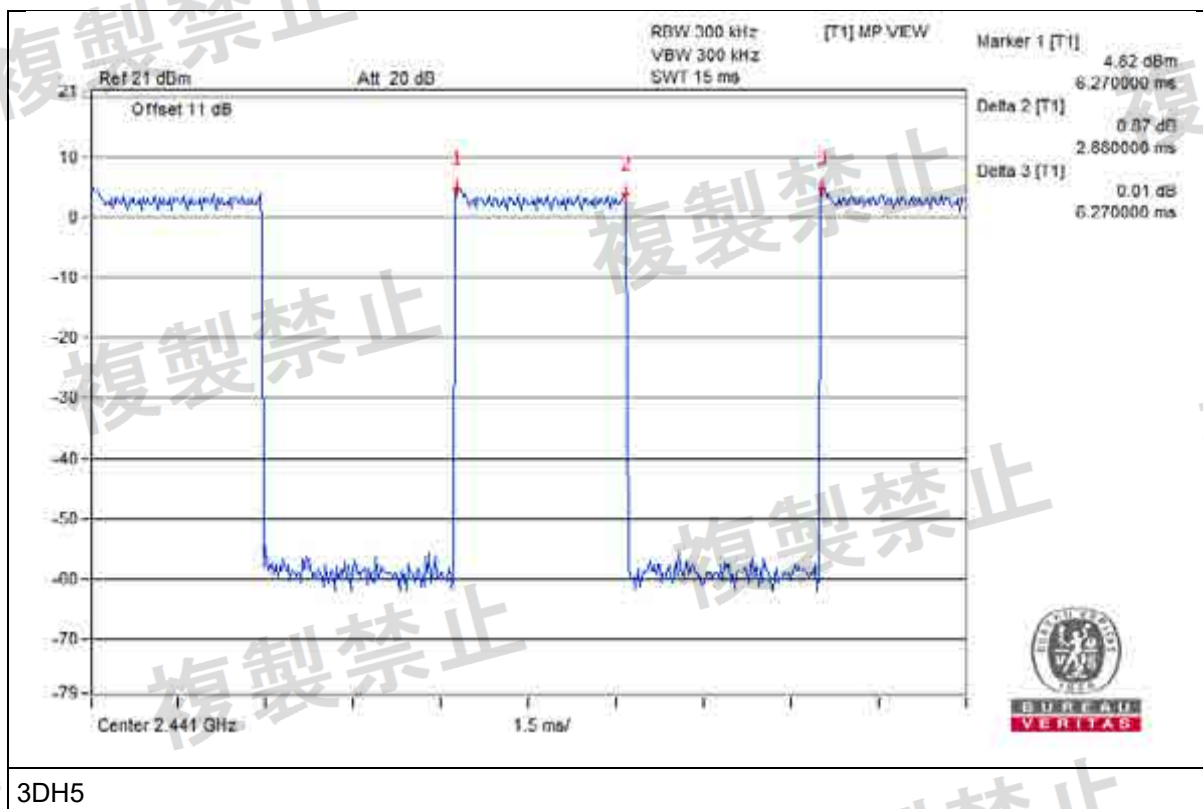


$V_{\max}$ 

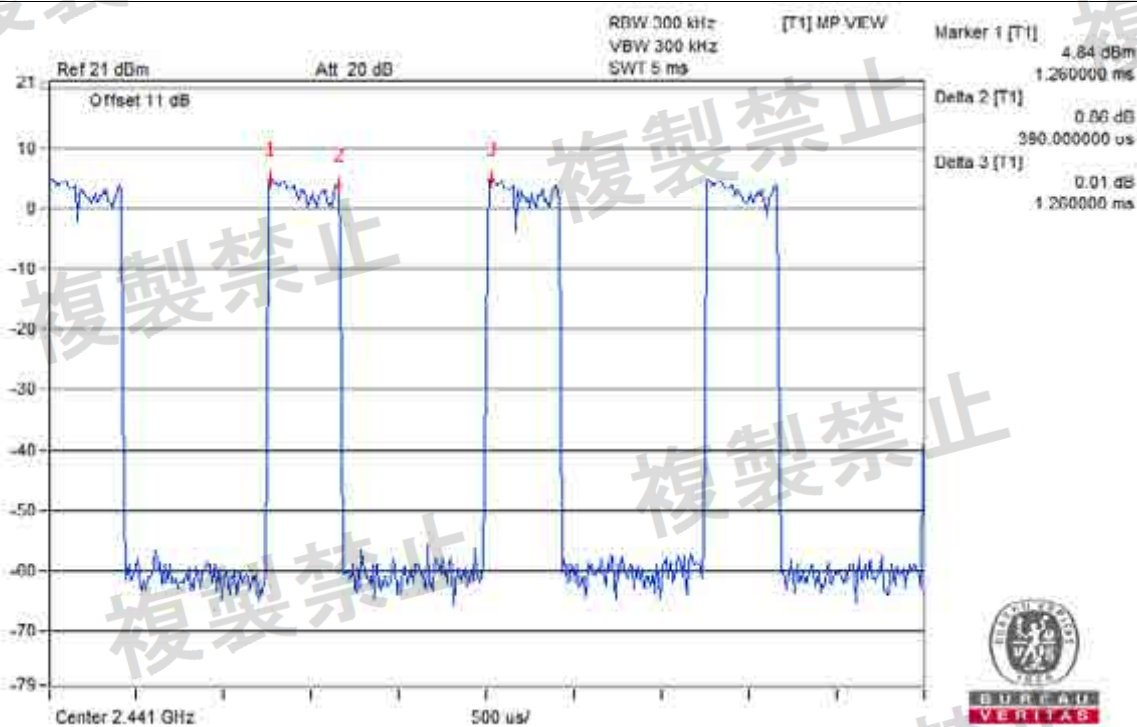
3DH1



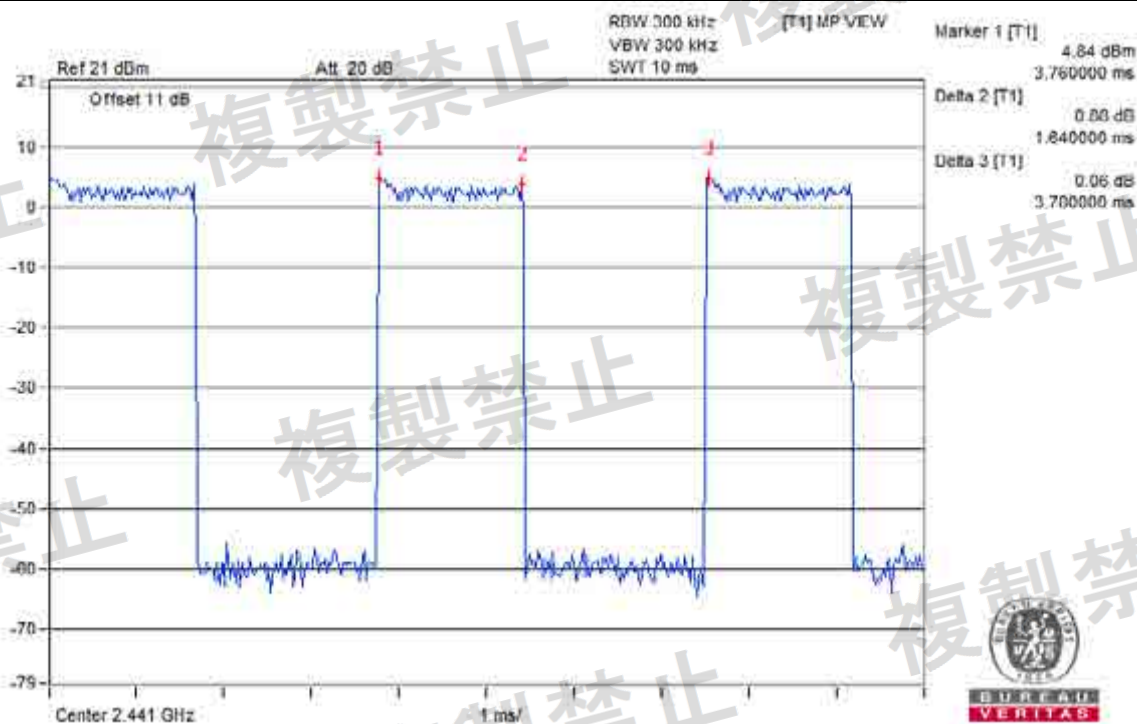
3DH3



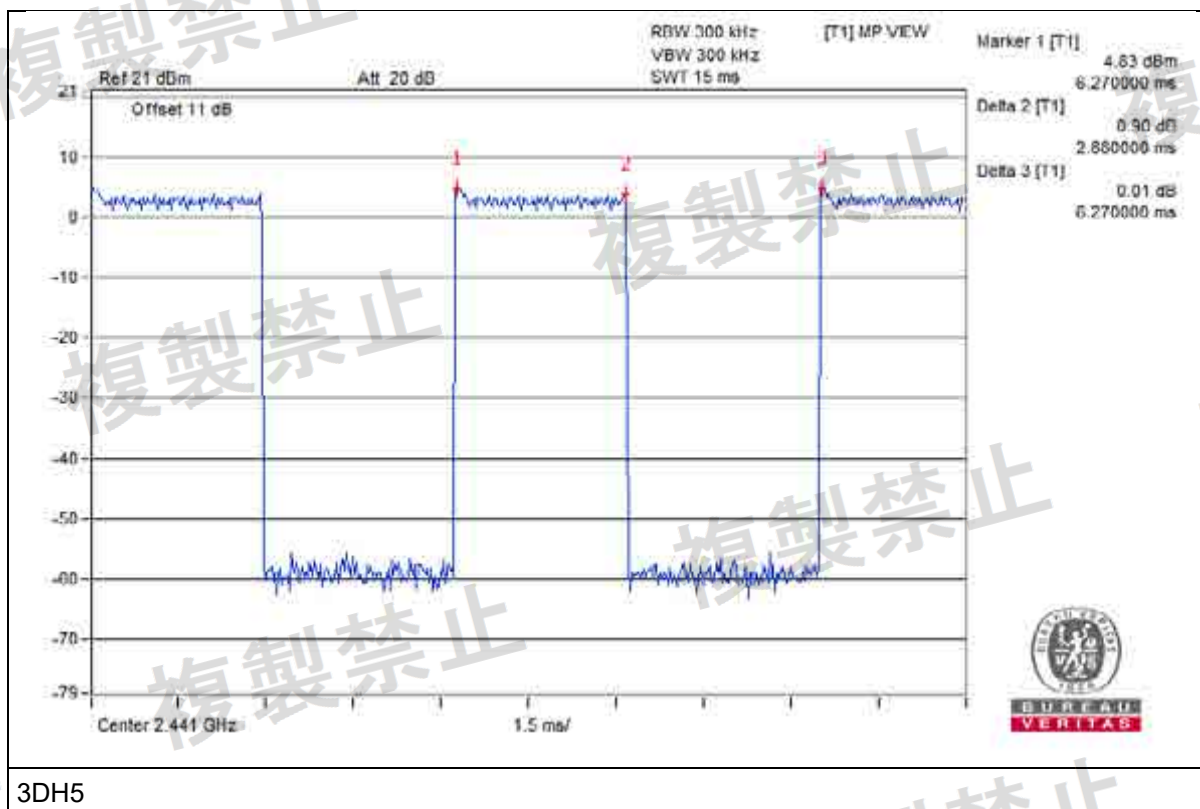
V<sub>min</sub>.



3DH1



3DH3

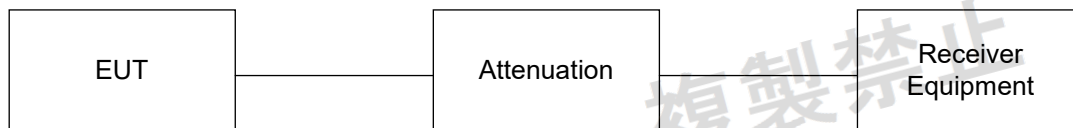


#### 4.8 Interference Prevention Function

##### 4.8.1 Limits of Interference Prevention Function

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

##### 4.8.2 Test Setup



##### 4.8.3 Test Results

Environmental Conditions	25 deg.C, 60% RH
Link Mode	Test Result
BT-EDR	Pass

## 5 Test Instruments

Description & Manufacturer	Model no.	Serial No.	Calibrated Date	Calibrated Until	Calibration Authority
Spectrum Analyzer R&S	FSV40	100964	July 01, 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 09, 2018	May 08, 2019	ETC
Power Sensor Anritsu	MA2411B	0917122	May 09, 2018	May 08, 2019	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 Extech Electronics	6205	1440452	NA	NA	NA
True RMS Clamp Meter FLUKE	325	31130711WS	May 22, 2018	May 21, 2019	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: June 08, 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.

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**Web Site:** [www.bureauveritas-adt.com](http://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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