



# FCC Radio Test Report FCC ID: TE7E4 This report concerns: Original Grant : 1812C106 Project No. Equipment : AC1200 Whole Home Mesh Wi-Fi System Test Model : Deco E4R Series Model : Deco W2400 : TP-Link Technologies Co., Ltd. Applicant Address : Building 24(floors1,3,4,5) and 28(floors1-4) Central Science and Technology Park, Shennan Rd, Nanshan, Shenzhen, China Date of Receipt : Dec. 18, 2018 Date of Test : Dec. 18, 2018 ~ Jan. 10, 2019 Issued Date : Feb. 27, 2019 Tested by : BTL Inc. 1/in cent. Tan Testing Engineer (Vincent Tan) **Technical Manager** (David Mao) **Authorized Signatory** (Steven Lu) BTL INC No.3, Jinshagang 1st Road, Shixia, Dalang Town, Dongguan, Guangdong, China. TEL: +86-769-8318-3000 FAX: +86-769-8319-6000 ac-MRA ACCREDITED 11 July Certificate #5123.02

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For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.





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# **REPORT ISSUED HISTORY**

Report Version	Description	Issued Date
R00	Original Issue.	Jan. 25, 2019
R01	Modified the comments of TCB.	Feb. 19, 2019
R02	Added the description of Section 3.2 note 2.	Feb. 27, 2019



## **1. GENERAL SUMMARY**

	AC1200 Whole Home Mesh Wi-Fi System
Brand Name :	tp-link
Test Model :	Deco E4R
Series Model :	Deco W2400
Applicant :	TP-Link Technologies Co., Ltd.
Manufacturer :	TP-Link Technologies Co., Ltd.
Address :	Building 24(floors1,3,4,5) and 28(floors1-4) Central Science and Technology
	Park, Shennan Rd, Nanshan, Shenzhen, China
Factory :	TP-Link Technologies Co., Ltd.
Address :	Building 24(floors1,3,4,5) and 28(floors1-4) Central Science and Technology
	Park, Shennan Rd, Nanshan, Shenzhen, China
Date of Test :	Dec. 18, 2018 ~ Jan. 10, 2019
Test Sample :	Engineering Sample No.: D181211652
Standard(s) :	FCC Part15, Subpart E(15.407)
	ANSI C63.10-2013

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc..

The test data, data evaluation, and equipment configuration contained in our test report (Ref No. BTL-FCCP-2-1812C106) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of A2LA according to the ISO/IEC 17025 quality assessment standard and technical standard(s).

#### Test results included in this report are only for the RLAN 5G UNII-1 and UNII-3 part.



# 2. SUMMARY OF TEST RESULTS

Test procedures	according	to the	technical	standard/	<u>ر م</u>	
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FCC Part15, Subpart E(15.407)								
Standard(s) Section	Test Item	Test Result	Judgement	Remark				
15.207 15.407(b)	AC Power Line Conducted Emissions	AC Power Line Conducted Emissions APPENDIX A PASS						
15.205 15.407(b)								
15.407(a) 15.407(e)	S / ISOPCIUM BADOWIOID		PASS					
15.407(a)	Maximum Output Power	APPENDIX F	PASS					
15.407(a)	15.407(a) Power Spectral Density		PASS					
15.407(g)	15.407(g) Frequency Stability		PASS					
15.203	15.203 Antenna Requirements		PASS					
15.407(c)	Automatically Discontinue Transmission		PASS	NOTE (2)				

#### Note:

- (1) "N/A" denotes test is not applicable in this test report.
- (2) During no any information transmission, the EUT can automatically discontinue transmission and become standby mode for power saving. the EUT can detect the controlling signal of ACK message transmitting from remote device and verify whether it shall resend or discontinue transmission.
- (3) For UNII-1 this device was functioned as a
  - $\square$  Access point device  $\square$  Client device



### 2.1 TEST FACILITY

The test facilities used to collect the test data in this report is at the location of No.3, Jinshagang 1st Road, Shixia, Dalang Town, Dongguan, Guangdong, China. BTL's Test Firm Registration Number for FCC: 357015 BTL's Designation Number for FCC: CN1240

#### 2.2 MEASUREMENT UNCERTAINTY

The measurement uncertainty figures shall be calculated according the methods described in the ETSI TR 100 028 and shall correspond to an expansion factor (coverage factor) k=1.96 or k=2(which provide confidence levels of respectively 90% and 95.45% in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Measurement Uncertainty for a Level of Confidence of 95 %, U=2xUc(y).

The BTL measurement uncertainty as below table:

A. AC power line conducted emissions Measurement:

Test Site Method Measurement Frequency Range			
DG-C02	02 CISPR 150 KHz ~ 30 MHz		2.32

B. Radiated Measurement:

Test Site	Method	ethod Measurement Frequency Range		U, (dB)		
		9 kHz~30 MHz	V	3.79		
		9 kHz~30 MHz	Н	3.57		
DG-CB03 CIS		30 MHz~200 MHz	V	3.82		
		30 MHz~200 MHz	Н	3.60		
	CISPR	200 MHz~1,000 MHz	V	3.86		
		200 MHz~1,000 MHz	Н	3.94		
		1 GHz~18 GHz	V	3.12		
		1 GHz~18 GHz	Н	3.68		
		18 GHz~40 GHz	V	4.15		
		18 GHz~40 GHz	Н	4.14		

Note: Unless specifically mentioned, the uncertainty of measurement has not been taken into account to declare the compliance or non-compliance to the specification.



# **3. GENERAL INFORMATION**

#### 3.1 GENERAL DESCRIPTION OF EUT

Equipment	AC1200 Whole Home Mesh Wi-Fi System			
Brand Name	tp-link			
Test Model	Deco E4R			
Series Model	Deco W2400			
Model Difference(s)	Only differ in model name.			
Power Source	DC voltage supplied from AC/DC adapter. Model: T120100-2B1			
Power Rating	I/P: 100-240V~ 50/60Hz 0.3A O/P: 12V === 1A			
Operation FrequencyUNII-1: 5150 MHz to 5250 MHz UNII-3: 5725 MHz to 5850 MHz				
Modulation Type OFDM				
Bit Rate of Transmitter Up to 866.7 Mbps				
Maximum Output Power for UNII-1	IEEE 802.11a: 22.78 dBm (0.1899 W) IEEE 802.11n (HT20): 22.90 dBm (0.1948 W) IEEE 802.11n (HT40): 22.33 dBm (0.1712 W) IEEE 802.11ac (VHT20): 22.61 dBm (0.1824 W) IEEE 802.11ac (VHT40): 22.25 dBm (0.1680 W) IEEE 802.11ac (VHT80): 17.62 dBm (0.0579 W)			
IEEE 802.11a: 22.83 dBm (0.1918 W)   Maximum Output Power IEEE 802.11n (HT20): 22.33 dBm (0.1710 W)   IEEE 802.11n (HT40): 22.77 dBm (0.1893 W) IEEE 802.11ac (VHT20): 22.70 dBm (0.1860 W)   IEEE 802.11ac (VHT20): 22.81 dBm (0.1908 W) IEEE 802.11ac (VHT40): 21.23 dBm (0.1326 W)				

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.

## 2. Channel List:

**BI**L

IEEE 802.11a IEEE 802.11n (HT20) IEEE 802.11ac (VHT20)		IEEE 802.1 IEEE 802.11	11n (HT40) Iac (VHT40)	IEEE 802.	11ac (VHT80)
UNII-1		UNII-1		UNII-1	
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
36	5180	38	5190	42	5210
40	5200	46	5230		
44	5220				
48	5240				

IEEE 802.11a IEEE 802.11n (HT20) IEEE 802.11ac (VHT20)		IEEE 802.11n (HT40) IEEE 802.11ac (VHT40)		IEEE 802.11ac (VHT80)	
UNII-3		UNII-3		L	INII-3
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
149	5745	151	5755	155	5775
153	5765	159	5795		
157	5785				
161	5805				
165	5825				

### 3. Table for Filed Antenna:

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)
1	<b>TP-LINK</b>	N/A	PCB	N/A	0.89
2	<b>TP-LINK</b> °	N/A	PCB	N/A	0.96

Note:

This EUT supports MIMO 2X2, any transmit signals are correlated with each other, so Directional gain = $10\log[(10^{G1/20}+10^{G2/20}+...10^{GN/20})^2/N]dBi$ . Then, Directional gain= $10\log[(10^{0.89/20}+10^{0.96/20})^2/2]dBi = 3.94$ .

#### 4. Table for Antenna Configuration:

Operating Mode	TV Mada	2TX
	TX Mode	
IEEE 802.11a		V (Ant. 1 + Ant. 2)
IEEE 802.11n (HT	20)	V (Ant. 1 + Ant. 2)
IEEE 802.11n (HT40)		V (Ant. 1 + Ant. 2)
IEEE 802.11ac (VH	T20)	V (Ant. 1 + Ant. 2)
IEEE 802.11ac (VH	T40)	V (Ant. 1 + Ant. 2)
IEEE 802.11ac (VH	T80)	V (Ant. 1 + Ant. 2)



## 3.2 TEST MODES

The test system was pre-tested based on the consideration of all possible combinations of EUT operation mode.

Pretest Mode	Description
Mode 1	TX A Mode / CH36, CH40, CH48 (UNII-1)
Mode 2	TX N (HT20) Mode / CH36, CH40, CH48 (UNII-1)
Mode 3	TX N (HT40) Mode / CH38, CH46 (UNII-1)
Mode 4	TX AC (VHT20) Mode / CH36, CH40, CH48 (UNII-1)
Mode 5	TX AC (VHT40) Mode / CH38, CH46 (UNII-1)
Mode 6	TX AC (VHT80) Mode / CH42 (UNII-1)
Mode 7	TX A Mode / CH149,CH157,CH165 (UNII-3)
Mode 8	TX N (HT20) Mode / CH149,CH157,CH165 (UNII-3)
Mode 9	TX N (HT40) Mode / CH151,CH159 (UNII-3)
Mode 10	TX AC (VHT20) Mode / CH149,CH157,CH165 (UNII-3)
Mode 11	TX AC (VHT40) Mode / CH151,CH159 (UNII-3)
Mode 12	TX AC (VHT80) Mode / CH155 (UNII-3)
Mode 13	TX N(HT20) Mode / CH40 (UNII-1)

Following mode(s) as (were) found to be the worst case(s) and selected for the final test.

AC power line conducted emissions test					
Final Test Mode	Description				
Mode 13	TX N(HT20) Mode / CH40 (UNII-1)				
	Radiated emissions test				
Final Test Mode	Description				
Mode 1	TX A Mode / CH36, CH40, CH48 (UNII-1)				
Mode 2	TX N (HT20) Mode / CH36, CH40, CH48 (UNII-1)				
Mode 3	TX N (HT40) Mode / CH38, CH46 (UNII-1)				
Mode 4	TX AC (VHT20) Mode / CH36, CH40, CH48 (UNII-1)				
Mode 5	TX AC (VHT40) Mode / CH38, CH46 (UNII-1)				
Mode 6	TX AC (VHT80) Mode / CH42 (UNII-1)				
Mode 7	TX A Mode / CH149,CH157,CH165 (UNII-3)				
Mode 8	TX N (HT20) Mode / CH149,CH157,CH165 (UNII-3)				
Mode 9	TX N (HT40) Mode / CH151,CH159 (UNII-3)				
Mode 10	TX AC (VHT20) Mode / CH149,CH157,CH165 (UNII-3)				
Mode 11	TX AC (VHT40) Mode / CH151,CH159 (UNII-3)				
Mode 12	TX AC (VHT80) Mode / CH155 (UNII-3)				



	Conducted test					
Test Mode	Description					
Mode 1	TX A Mode / CH36, CH40, CH48 (UNII-1)					
Mode 2	Mode 2 TX N (HT20) Mode / CH36, CH40, CH48 (UNII-1)					
Mode 3	TX N (HT40) Mode / CH38, CH46 (UNII-1)					
Mode 4	TX AC (VHT20) Mode / CH36, CH40, CH48 (UNII-1)					
Mode 5	TX AC (VHT40) Mode / CH38, CH46 (UNII-1)					
Mode 6	TX AC (VHT80) Mode / CH42 (UNII-1)					
Mode 7	TX A Mode / CH52, CH60, CH64 (UNII-2A)					
Mode 8	TX N (HT20) Mode / CH52, CH60, CH64 (UNII-2A)					
Mode 9	TX N (HT40) Mode / CH54, CH62 (UNII-2A)					
Mode 10	TX AC (VHT20) Mode / CH52, CH60, CH64 (UNII-2A)					
Mode 11	TX AC (VHT40) Mode / CH54, CH62 (UNII-2A)					
Mode 12	TX AC (VHT80) Mode / CH58 (UNII-2A)					
Mode 13	TX A Mode / CH100, CH116, CH140 (UNII-2C)					
Mode 14	TX N (HT20) Mode / CH100, CH116, CH140 (UNII-2C)					
Mode 15	TX N (HT40) Mode / CH102, CH110, CH134 (UNII-2C)					
Mode 16	TX AC (VHT20) Mode / CH100, CH116, CH140 (UNII-2C)					
Mode 17	TX AC (VHT40) Mode / CH102, CH110, CH134 (UNII-2C)					
Mode 18	TX AC (VHT80) Mode / CH106, CH122 (UNII-2C)					
Mode 19	TX A Mode / CH149,CH157,CH165 (UNII-3)					
Mode 20	TX N (HT20) Mode / CH149,CH157,CH165 (UNII-3)					
Mode 21	TX N (HT40) Mode / CH151,CH159 (UNII-3)					
Mode 22	TX AC (VHT20) Mode / CH149,CH157,CH165 (UNII-3)					
Mode 23	TX AC (VHT40) Mode / CH151,CH159 (UNII-3)					
Mode 24	TX AC (VHT80) Mode / CH155 (UNII-3)					

Note :

(1) For radiated emission below 1 GHz test, the IEEE 802.11a is found to be the worst case and recorded.

(2) For radiated emission above 1 GHz test, 1GHz~26.5GHz and 26.5GHz~40GHz have been pre-tested and in this report only recorded the worst case. The remaining spurious points are all below the limit value of 20dB.

## 3.3 PARAMETERS OF TEST SOFTWARE

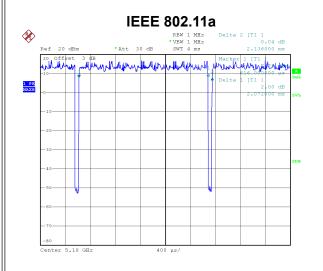
UNII-1				
Test Software Version		QRCT		
Test Frequency (MHz)	5180	5200	5240	
IEEE 802.11a	17.5	19.5	20	
IEEE 802.11n (HT20)	17.5	20.5	20.5	
IEEE 802.11ac (VHT20)	17.5	20	21	
Test Frequency (MHz)	5190	5230		
IEEE 802.11n (HT40)	14.5	19		
IEEE 802.11ac (VHT40)	14.5	19		
Test Frequency (MHz)	5210			
IEEE 802.11ac (VHT80)	14			

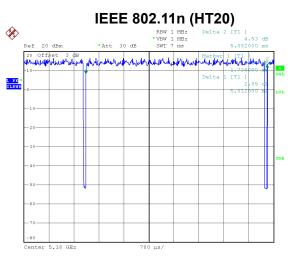
UNII-3				
Test Software Version		QRCT		
Test Frequency (MHz)	5745	5785	5825	
IEEE 802.11a	20	21	21	
IEEE 802.11n (HT20)	20.5	21	21	
IEEE 802.11ac (VHT20)	21	21	21.5	
Test Frequency (MHz)	5755	5795		
IEEE 802.11n (HT40)	21	21		
IEEE 802.11ac (VHT40)	21	21		
Test Frequency (MHz)	5775			
IEEE 802.11ac (VHT80)	18.5			



## 3.4 DUTY CYCLE

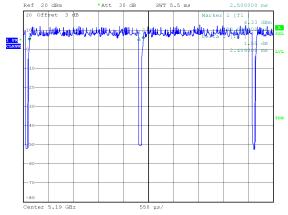
If duty cycle is  $\geq$  98 %, duty factor is not required. If duty cycle is < 98 %, duty factor shall be considered.





Date: 25.DEC.2018 10:42:06

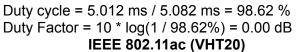
Duty cycle = 2.072 ms / 2.136 ms = 97.00 % Duty Factor =  $10 * \log(1 / 97.00\%) = 0.13 \text{ dB}$ IEEE 802.11n (HT40)  $\bigotimes$ RBW 1 MHz \*VBW 1 MHz SWT 5.5 ms 20 dBm \* 2++ 30 dB Rof

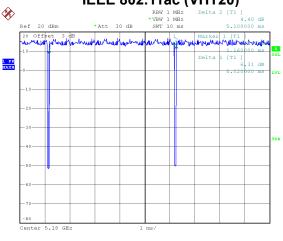


Date: 25.DEC.2018 10:46:21

Duty cycle = 2.409 ms / 2.508 ms = 96.05 % Duty cycle = 5.020 ms / 5.100 ms = 98.43 % Duty Factor = 10 \* log(1 / 96.05%) = 0.17 dB Duty Factor = 10 \* log(1 / 98.43%) = 0.00 dB

Date: 25.DEC.2018 10:43:59

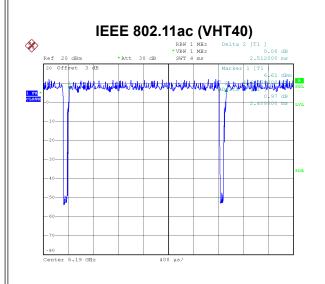


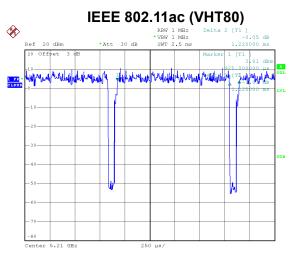


Date: 25.DEC.2018 10:45:33









Date: 25.DEC.2018 10:47:00

Date: 25.DEC.2018 10:47:35

Duty cycle = 2.408 ms / 2.512 ms = 95.86 % Duty cycle = 1.125 ms / 1.220 ms = 92.21 % Duty Factor = 10 \* log(1 / 95.86%) = 0.18 dB Duty Factor = 10 \* log(1 / 92.21%) = 0.35 dB

#### NOTE:

For IEEE 802.11a:

For radiated emissions frequency above 1 GHz, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz (Duty cycle < 98%).

For IEEE 802.11n (HT40) and IEEE 802.11ac (VHT40):

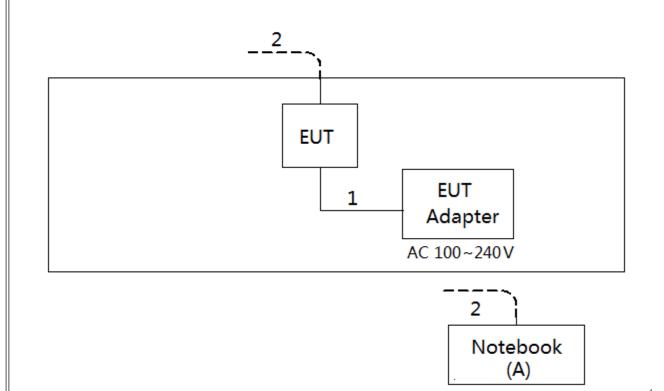
For radiated emissions frequency above 1 GHz, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 2 kHz (Duty cycle < 98%). For IEEE 802.11ac (VHT80):

For radiated emissions frequency above 1 GHz, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 kHz (Duty cycle < 98%).





## 3.5 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED



#### 3.6 SUPPORT UNITS

Item	Equipment		Mfr/Brand	Model/Type No.	Series No.
А	Notebook		Lenovo	INSPIRON 1420 N/A	
Item	Shielded Type	Ferrite Core	Length	Note	
1	NO	NO	1.5m	DC Cable	
2	NO	NO	10m	RJ45 Cable	



# 4. AC POWER LINE CONDUCTED EMISSIONS TEST

## 4.1 LIMIT

Frequency	Limit (dBµV)	
(MHz)	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46 *
0.50 - 5.0	56	46
5.0 - 30.0	60	50

NOTE:

(1) The tighter limit applies at the band edges.

(2) The limit of " \* " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

(3) The test result calculated as following:

Measurement Value = Reading Level + Correct Factor

Correct Factor = Insertion Loss + Cable Loss + Attenuator Factor (if use)

Margin Level = Measurement Value – Limit Value

Sample calculations: (Refer to page 38, test result No.1.)

,				
Reading Level		Correct Factor		Measurement Value
38.66	+	9.82	Ι	48.48

Measurement Value		Limit Value		Margin Level
48.48	-	65.52	=	-17.04

#### The following table is the setting of the receiver

Receiver Parameter	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 KHz

#### 4.2 TEST PROCEDURE

- a. The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipment powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- d. LISN at least 80 cm from nearest part of EUT chassis.
- e. For the actual test configuration, please refer to the related Item -EUT Test Photos.

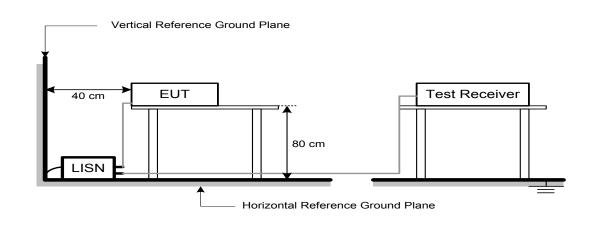
## 4.3 DEVIATION FROM STANDARD

No deviation





# 4.4 TEST SETUP



## 4.5 EUT OPERATING CONDITIONS

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

The EUT was programmed to be in continuously transmitting/TX Mode mode.

#### 4.6 EUT TEST CONDITIONS

Temperature: 25°C Relative Humidity: 53% Test Voltage: AC 120V/60Hz

#### 4.7 TEST RESULTS

Please refer to the APPENDIX A.



# 5. RADIATED EMISSION TEST

#### **5.1 LIMIT**

In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

#### LIMITS OF RADIATED EMISSIONS MEASUREMENT (9 kHz to 1000 MHz)

Frequency	Field Strength	Measurement Distance
(MHz)	(microvolts/meter)	(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

#### LIMITS OF UNWANTED EMISSION OUT OF THE RESTRICTED BANDS.

Frequency	EIRP Limit	Equivalent Field Strength at 3m	
(MHz)	(dBm/MHz)	(dBµV/m)	
5150-5250	-27	68.3	
5725-5850	-27 NOTE (2)	68.3	
	10 NOTE (2)	105.3	
	15.6 NOTE (2)	110.9	
	27 NOTE (2)	122.3	

## NOTE:

- (1) The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength:  $E = \frac{1000000\sqrt{30P}}{1000000\sqrt{30P}}$ 
  - $\mu$ V/m, where P is the eirp (Watts)
- (2) According to FCC 16-24, all emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
- (3) The test result calculated as following: Measurement Value = Reading Level + Correct Factor Correct Factor = Insertion Loss + Cable Loss + Attenuator Factor (if use) Margin Level = Measurement Value – Limit Value Sample calculations: (Refer to nage 41, test result No.1.)

Sample calculations. (Refer to page 41, test result No. 1.)				
Reading Level Correct Factor Measurement Value				
36.50	+ 20.75		Η	57.25

Measurement Value		Limit Value		Margin Level
57.25	-	124.20	II	-66.95



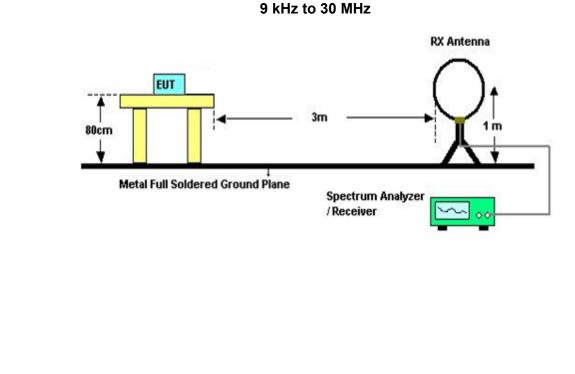
## 5.2 TEST PROCEDURE

- a. The measuring distance of 3 m shall be used for measurements. The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(below 1GHz)
- b. The measuring distance of 3 m shall be used for measurements. The EUT was placed on the top of a rotating table 1.5 meter above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(above 1GHz)
- c. The height of the equipment or of the substitution antenna shall be 0.8m or 1.5m; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights find the maximum reading (used Bore sight function).
- e. The receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz.
- f. The initial step in collecting radiated emission data is a receiver peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- g. All readings are Peak unless otherwise stated QP in column of Note. Peak denotes that the Peak reading compliance with the QP Limits and then QP Mode measurement didn't perform. (below 1 GHz)
- h. All readings are Peak Mode value unless otherwise stated AVG in column of Note. If the Peak Mode Measured value compliance with the Peak Limits and lower than AVG Limits, the EUT shall be deemed to meet both Peak & AVG Limits and then only Peak Mode was measured, but AVG Mode didn't perform. (above 1 GHz)
- i. For the actual test configuration, please refer to the related Item –EUT Test Photos.

## 5.3 DEVIATION FROM STANDARD

No deviation

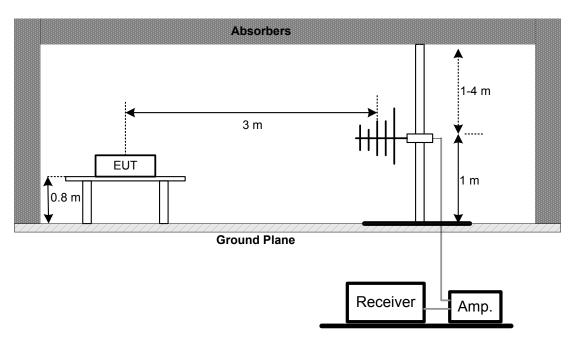
#### 5.4 TEST SETUP



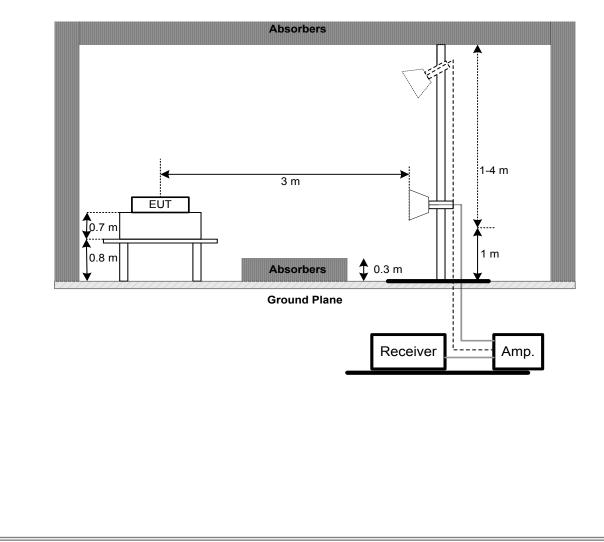




#### 30 MHz to 1 GHz



## Above 1 GHz



Report No.: BTL-FCCP-2-1812C106





## 5.5 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of 4.5 unless otherwise a special operating condition is specified in the follows during the testing.

#### 5.6 EUT TEST CONDITIONS

Temperature: 23°C Relative Humidity: 48% Test Voltage: AC 120V/60Hz

#### 5.7 TEST RESULTS - 9 kHz To 30 MHz

Please refer to the APPENDIX B Remark:

- (1) The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.
- (2) Distance extrapolation factor = 40 log (specific distance / test distance) (dB).
- (3) Limit line = specific limits (dBuV) + distance extrapolation factor.

#### 5.8 TEST RESULTS - 30 MHz TO 1000 MHz

Please refer to the APPENDIX C.

#### 5.9 TEST RESULTS - ABOVE 1000 MHz

Please refer to the APPENDIX D.

Remark:

(1) No limit: This is fundamental signal, the judgment is not applicable. For fundamental signal judgment was referred to Peak output test.



# 6. BANDWIDTH

### 6.1 LIMIT

FCC Part15, Subpart E (15.407)				
Section	Test Item	Limit	Frequency Range (MHz)	
15.407(a)	26 dB Bandwidth	-	5150-5250	
15.407(e)	6 dB Bandwidth	Minimum 500 kHz	5725-5850	

## 6.2 TEST PROCEDURE

- a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below
- b. a. Spectrum Setting:

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> 26 dB Bandwidth
RBW	300 kHz (Bandwidth 20 MHz)
	1 MHz (Bandwidth 40 MHz and 80 MHz)
VBW	1 MHz (Bandwidth 20 MHz)
VBVV	3 MHz (Bandwidth 40 MHz and 80 MHz)
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	6 dB Bandwidth
RBW	100 kHz
VBW	300 kHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

c. Measured the spectrum width with power higher than 26 dB below carrier

## 6.3 DEVIATION FROM STANDARD

No deviation.





## 6.4 TEST SETUP



## 6.5 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

#### 6.6 EUT TEST CONDITIONS

Temperature: 22.6°C Relative Humidity: 46.9% Test Voltage: AC 120V/60Hz

#### 6.7 TEST RESULTS

Please refer to the APPENDIX E.



# 7. MAXIMUM OUTPUT POWER

## 7.1 LIMIT

FCC Part15, Subpart E (15.407)				
Section	Test Item	Limit	Frequency Range (MHz)	
15.407(a)	Maximum Output Power	AP device: 1 Watt (30 dBm) Client device: 250 mW (24 dBm)	5150-5250	
		1 Watt (30dBm)	5725-5850	

#### Note:

- a. For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).
- b. For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10log B, where B is the 26dB Bandwidth in megahertz.

## 7.2 TEST PROCEDURE

- a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
- b. Used spectrum analyzer band power measurement function.
- C. Spectrum Setting

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	Encompass the entire emissions bandwidth (EBW) of the signal
RBW	= 1 MHz.
VBW	≥ 3 MHz.
Sweep points	≥ 2 x span / RBW
Detector	RMS
Trace	Trace average at least 100 traces in power averaging(rms) mode.
Sweep Time	auto

c. Test test was performed in accordance with method of FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.

#### 7.3 DEVIATION FROM STANDARD

No deviation.





# 7.4 TEST SETUP

EUT	SPECTRUM
	ANALYZER

### 7.5 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

#### 7.6 EUT TEST CONDITIONS

Temperature: 22.6°C Relative Humidity: 46.9% Test Voltage: AC 120V/60Hz

## 7.7 TEST RESULTS

Please refer to the APPENDIX F.



# 8. POWER SPECTRAL DENSITY TEST

## 8.1 LIMIT

FCC Part15, Subpart E (15.407)				
Section	Test Item	Limit	Frequency Range (MHz)	
15.407(a) Power Spectral Density		AP device: 17 dBm/MHz Client device: 11 dBm/MHz	5150-5250	
		30 dBm/500 kHz	5725-5850	

## 8.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.

#### b. Spectrum Setting

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	Encompass the entire emissions bandwidth (EBW) of the signal
RBW	= 1 MHz.
VBW	≥ 3 MHz.
Detector	RMS
Trace average	100 trace
Sweep Time	Auto

Note:

- 1. For UNII-3, according to KDB publication 789033 D02 General UNII Test Procedures New Rules v01r02, section II.F.5., it is acceptable to set RBW at 1 MHz and VBW at 3 MHz if the spectrum analyzer does not have 500 kHz RBW.
- The value measured with RBW=1 MHz is to be added with 10log(500 kHz/1 MHz) which is -3 dB. For example, if the measured value is +10dBm using RBW=1 MHz (that is +10 dBm/MHz), then the converted value will be +7dBm/500kHz.

## 8.3 DEVIATION FROM STANDARD

No deviation.





# 8.4 TEST SETUP



### 8.5 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

#### 8.6 UT TEST CONDITIONS

Temperature: 22.6°C Relative Humidity: 46.9% Test Voltage: AC 120V/60Hz

#### 8.7 TEST RESULTS

Please refer to the APPENDIX H.



# 9. FREQUENCY STABILITY MEASUREMENT

## 9.1 LIMIT

FCC Part15, Subpart E (15.407)					
Section Test Item		Limit Frequency F (MHz)			
15.407(g)	Frequency Stability	Specified in the user's manual	5150-5250 5725-5850		

## 9.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.

#### b. Spectrum Setting:

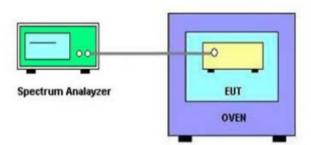
Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	Entire absence of modulation emissions
Span Frequency	bandwidth
RBW	10 kHz
VBW	10 kHz
Sweep Time	Auto

- c. The test extreme voltage is to change the primary supply voltage from 85 to 115 percent of the nominal value.
- d. User manual temperature is 0°C~40°C.

## 9.3 DEVIATION FROM STANDARD

No deviation.

## 9.4 TEST SETUP



## 9.5 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

#### 9.6 EUT TEST CONDITIONS

Temperature: 22.6°C Relative Humidity: 46.9% Test Voltage: AC 120V/60Hz

#### 9.7 TEST RESULTS

Please refer to the APPENDIX I.

## **10. MEASUREMENT INSTRUMENTS LIST**

AC Power Line Conducted Emissions						
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until	
1	EMI Test Receiver	R&S	ESCI	100382	Mar. 11, 2019	
2	LISN	EMCO	3816/2	52765	Mar. 11, 2019	
3	50Ω Terminator	SHX	TF2-3G-A	8122901	Mar. 11, 2019	
4	TWO-LINE V-NETWORK	R&S	ENV216	101447	Mar. 11, 2019	
5	Measurement Software	Farad	EZ-EMC Ver.NB-03A1-01	N/A	N/A	
6	Cable	N/A	RG223	12m	Mar. 23, 2019	

Radiated Emissions - 9 kHz to 30 MHz						
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until	
1	Loop Antenna	EM	EM-6876-1	230	Feb. 07, 2019	
2	Cable	N/A	RG 213/U	C-102	Jun. 01, 2019	
3	EMI Test Receiver	R&S	ESCI	100382	Mar. 11, 2019	
4	Measurement Software	Farad	EZ-EMC Ver.NB-03A1-01	N/A	N/A	

Radiated Emissions - 30 MHz to 1 GHz					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Antenna	Schwarzbeck	VULB9160	9160-3232	Mar. 11, 2019
2	Amplifier	HP	8447D	2944A09673	Aug. 11, 2019
3	Receiver	Agilent	N9038A	MY52130039	Aug. 11, 2019
4	Cable	emci	LMR-400(30MHz- 1GHz)(8m+5m)	N/A	May 25, 2019
5	Controller	СТ	SC100	N/A	N/A
6	Controller	MF	MF-7802	MF780208416	N/A
7	Measurement Software	Farad	EZ-EMC Ver.NB-03A1-01	N/A	N/A

Radiated Emissions - Above 1 GHz					
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Double Ridged Guide Antenna	ETS	3115	75789	Mar. 11, 2019
2	Broad-Band Horn Antenna	Schwarzbeck	BBHA 9170	9170319	Jun. 30, 2019
3	Amplifier	Agilent	8449B	3008A02274	Mar. 11, 2019
4	Microwave Preamplifier With Adaptor	EMC INSTRUMENT	EMC2654045	980039 & HA01	Mar. 11, 2019
5	Receiver	Agilent	N9038A	MY52130039	Aug. 11, 2019
6	Controller	СТ	SC100	N/A	N/A
7	Controller	MF	MF-7802	MF780208416	N/A
8	Cable	mitron	B10-01-01-12M	18072744	Jul. 30, 2019
9	Measurement Software	Farad	EZ-EMC Ver.NB-03A1-01	N/A	N/A
10	Microwave Preamplifier With Adaptor	EMC INSTRUMENT	EMC2654045	980039 & HA01	Mar. 11, 2019





Bandwidth						
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until	
1	Spectrum Analyzer	R&S	FSP40	100185	Aug. 11, 2019	
			Output Power			
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until	
1	Spectrum Analyzer	R&S	FSP40	100185	Aug. 11, 2019	
Power Spectral Density						
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until	
1	Spectrum Analyzer	R&S	FSP40	100185	Aug. 11, 2019	
Frequency Stability						
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until	
1	Spectrum Analyzer	R&S	FSP40	100185	Aug. 11, 2019	
2	Precision Oven Tester	Bell	BTH-50C	20170306001	Mar. 11, 2019	

REMARK: "N/A" denotes no model name, no serial no. or no calibration specified. All calibration period of equipment list is one year.





# **11. EUT TEST PHOTOS**

## AC Power Line Conducted Emissions Test Photos





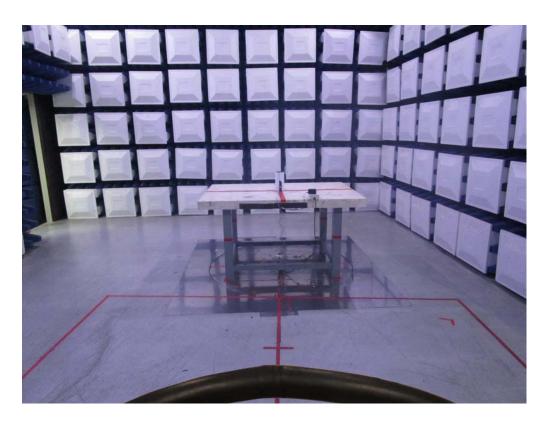




## **Radiated Emissions Test Photos**

9 kHz to 30 MHz





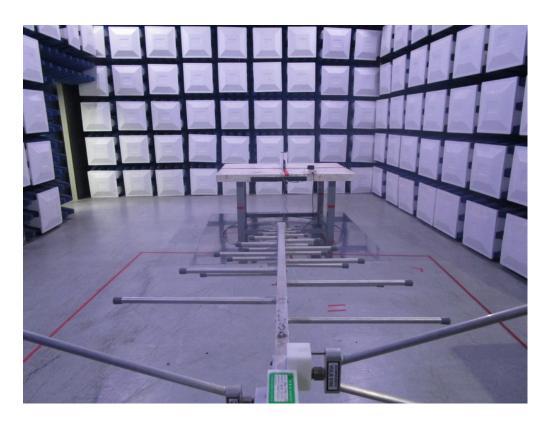




#### **Radiated Emissions Test Photos**

30 MHz to 1 GHz



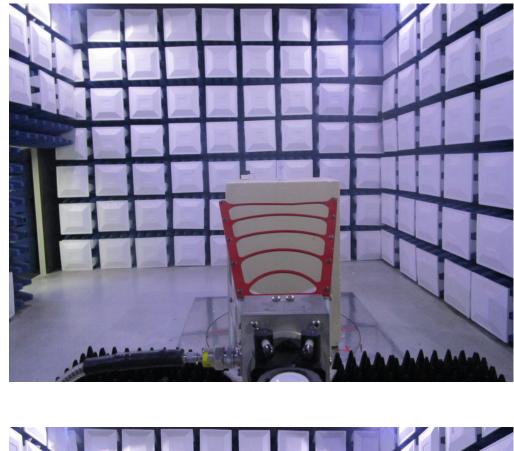


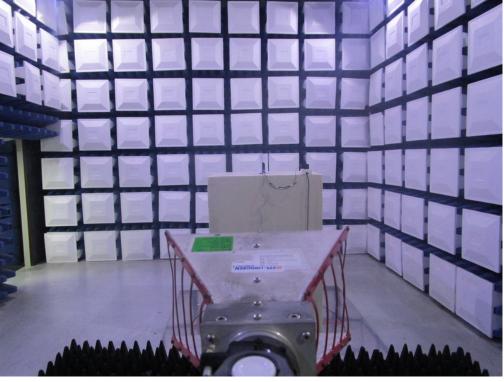




### **Radiated Emissions Test Photos**

Above 1 GHz









#### **APPENDIX A - AC POWER LINE CONDUCTED EMISSIONS**

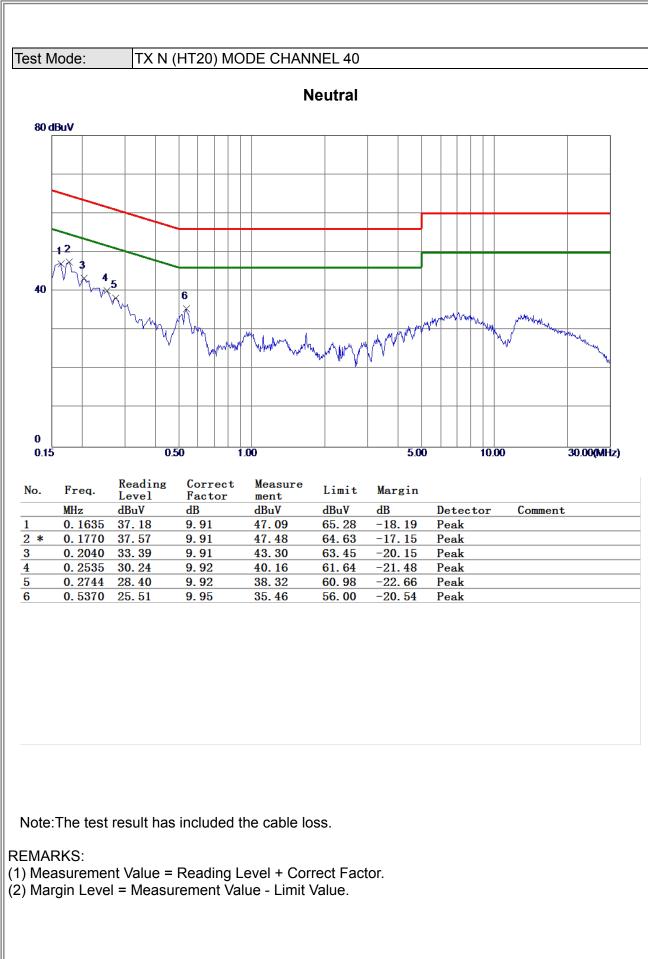




Test Mode: TX N (HT20) MODE CHANNEL 40 Line 80 dBuV 34 40 6 Martin hangest 0 0.50 0.15 1.00 5.00 10.00 30.00(MHz) Reading Correct Measure No. Freq. Limit Margin Level Factor ment MHz dBuV Comment dBuV dB dBuV dB Detector -17.04 0.1590 38.66 9.82 48.48 65.52 Peak 1 2 0.1815 36.37 9.82 46.19 64.42 -18.23 Peak 3 0.2085 34.81 9.82 44.63 63.26 -18.63 Peak 0.2220 33.50 9.82 43.32 62.74 -19.42 Peak 4 31.61 -14.59 5 \* 0.5190 9.80 41.41 56.00 Peak 0.9960 23.71 9.92 33.63 56.00 -22.37 Peak 6 Note: The test result has included the cable loss. **REMARKS**: (1) Measurement Value = Reading Level + Correct Factor. (2) Margin Level = Measurement Value - Limit Value.











#### **APPENDIX B - RADIATED EMISSION - 9 KHZ TO 30 MHZ**





Test Mode: **TX A MODE CHANNEL** Ant 0° 160.0 dBu∀/m 150 140 130 120 110 100 90 80 Marine Marin 70 60 50 40 30 20 10 0.0 0.009 (MHz) 0.150 Reading Correct Measure-No. Mk. Limit Margin Freq. Level Factor ment MHz dBuV dB dBuV/m dBuV/m dB Detector Comment 20.75 0.0148 36.50 57.25 124.20 -66.95 AVG 1 2 0.0456 29.40 19.60 49.00 114.43 -65.43 AVG 0.0686 47.26 AVG 3 \* 28.10 19.16 110.88 -63.62 **REMARKS**: (1) Measurement Value = Reading Level + Correct Factor. (2) Margin Level = Measurement Value - Limit Value.





Test Mode: **TX A MODE CHANNEL** Ant 0° 160.0 dBuV/m 150 140 130 120 110 100 90 80 70 60 50 4 3 × 40 30 20 10 0.0 30.000 0.150 0.5 (MHz) 5 Reading Correct Measure-No. Mk. Freq. Level Factor Limit Margin ment MHz dBuV/m dB dBuV dB dBuV/m Detector Comment 1 0.2548 25.50 17.06 42.56 99.48 -56.92 AVG 2.2015 17.00 49.90 2 32.90 69.54 -19.64 QP \* 6.5573 23.20 14.90 69.54 QP 3 38.10 -31.44

REMARKS:

(1) Measurement Value = Reading Level + Correct Factor.

(2) Margin Level = Measurement Value - Limit Value.





Test Mode: TX A MODE CHANNEL Ant 90° 160.0 dBu∀/m 150 140 130 120 110 100 90 80 70 man all the man of the share of the state of 60 50 40 30 20 10 0.0 0.009 (MHz) 0.150 Reading Correct Measure-No. Mk. Limit Margin Freq. Level Factor ment MHz dBuV dB dBuV/m dBuV/m dB Detector Comment 1 \* 0.0194 33.20 20.10 53.30 121.85 -68.55 AVG 2 0.0365 26.80 19.76 46.56 116.36 -69.80 AVG 3 0.0690 22.90 19.15 42.05 110.83 -68.78 AVG

**REMARKS**:

(1) Measurement Value = Reading Level + Correct Factor.(2) Margin Level = Measurement Value - Limit Value.





Test Mode: **TX A MODE CHANNEL** Ant 90° 160.0 dBuV/m 150 140 130 120 110 100 90 80 70 60 50 40 ALMAN N 30 20 10 0.0 30.000 0.5 (MHz) 5 0.150 Correct Reading Measure-Limit Margin No. Mk. Freq. Level Factor ment MHz dBuV dB dBuV/m dBuV/m dB Detector Comment 0.3465 29.10 17.02 46.12 96.81 -50.69 AVG 1 2 \* 1.0050 27.90 16.60 44.50 67.56 -23.06 QP 3 2.2015 25.20 17.00 42.20 69.54 QP -27.34

**REMARKS**:

(1) Measurement Value = Reading Level + Correct Factor.

(2) Margin Level = Measurement Value - Limit Value.





#### **APPENDIX C - RADIATED EMISSION - 30 MHZ TO 1 GHZ**

# **B**TL



Test Mode: **TX A MODE CHANNEL 149** Vertical 80 dBuV/m 40 6  $\times$ 5 4  $\times$ 2 3 X 0 30.00 127.00 224.00 321.00 418.00 515.00 612.00 709.00 806.00 1000.00 (MHz) Reading Correct Measure Limit No. Freq. Margin Level Factor ment dBuV/m MHz dBuV/m dB dBuV/m dB Detector Comment 1 \* 50. 3700 29.93 40.00 -10.07 -14.81 44.74 Peak 125.0600 36.04 -14.03 22.01 43.50 -21.49 Peak 2 3 240.0050 36.41 -14.67 21.74 46.00 -24.26 Peak 629.9450 34.14 28.52 4 -5.62 46.00 -17.48 Peak 5 801.6350 30.02 -1.07 28.95 46.00 -17. **0**5 Peak 6 941.8000 32.67 1.08 33.75 46.00 -12.25 Peak **REMARKS**: (1) Measurement Value = Reading Level + Correct Factor. (2) Margin Level = Measurement Value - Limit Value.

# **B**TL



Test Mode: **TX A MODE CHANNEL 149** Horizontal 80 dBuV/m 40 6 × 5 đ. 3 2 X  $\times$  $\times$ 0 515.00 612.00 709.00 30.00 127.00 224.00 321.00 418.00 806.00 1000.00 (MHz) Reading Correct Measure Limit Margin No. Freq. Level Factor ment MHz dBuV/m dB dBuV/m dBuV/m dB Detector Comment 1 320.0300 31.60 -10.65 20.95 46.00 -25.05 Peak 2 453.4050 31.18 -7.48 23.70 46.00 -22.30 Peak 3 557.6800 29.48 -5.59 23.89 46.00 -22.11 Peak 4 695.4200 29.49 -2.97 26.52 46.00 -19.48 Peak 799.6950 29.98 -1.06 28.92 46.00 -17.08 Peak 5 941.8000 32.07 46.00 -12.85 Peak 6 \* 1.08 33.15 **REMARKS**: (1) Measurement Value = Reading Level + Correct Factor. (2) Margin Level = Measurement Value - Limit Value.

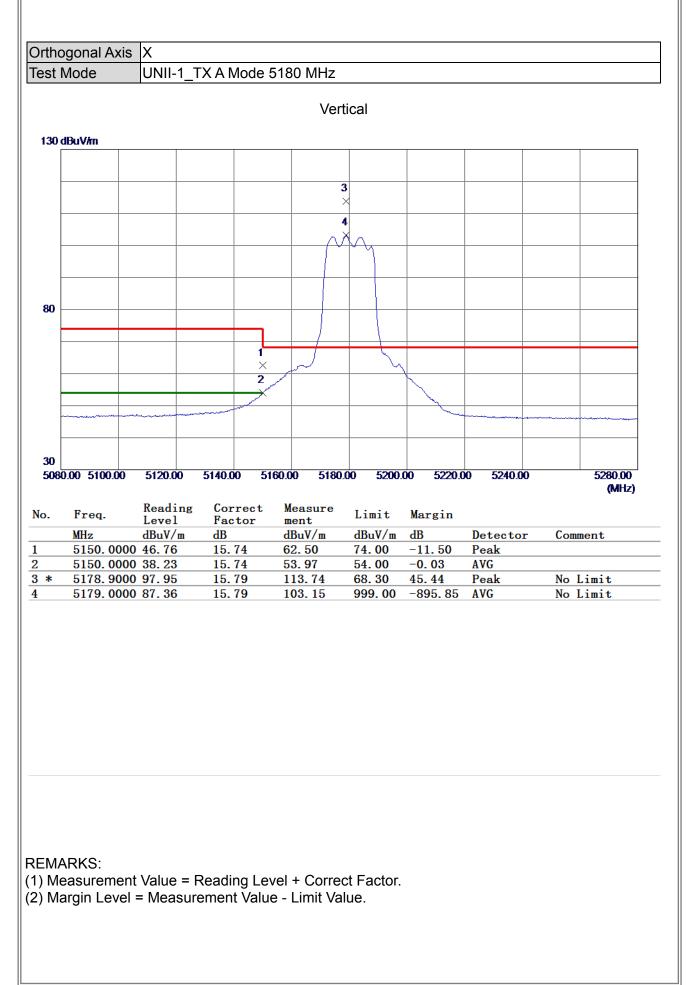




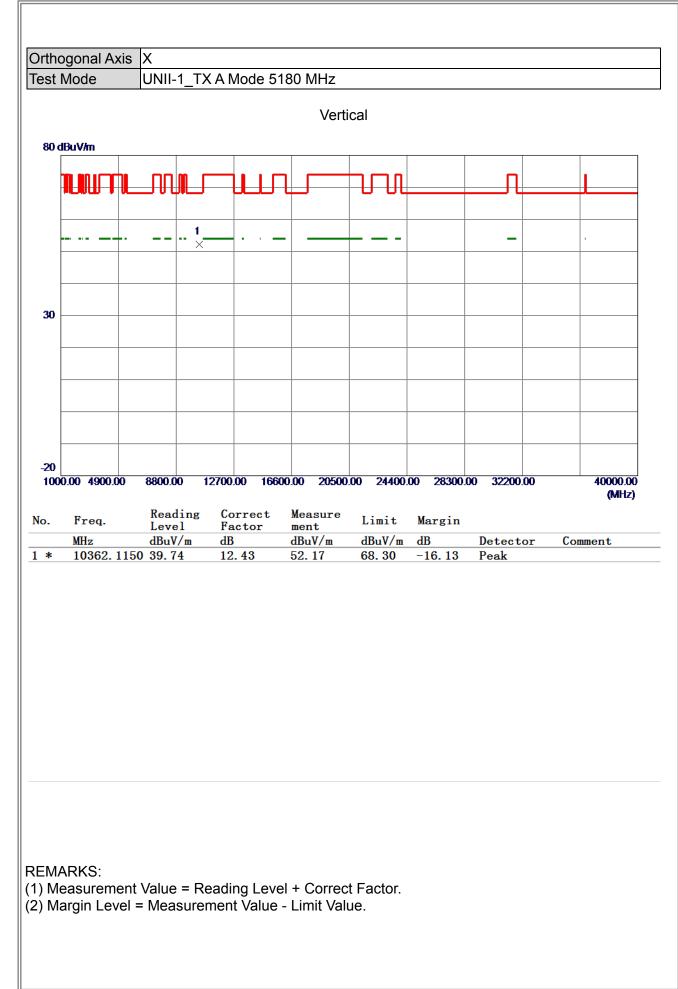
#### **APPENDIX D - RADIATED EMISSION - ABOVE 1000 MHZ**





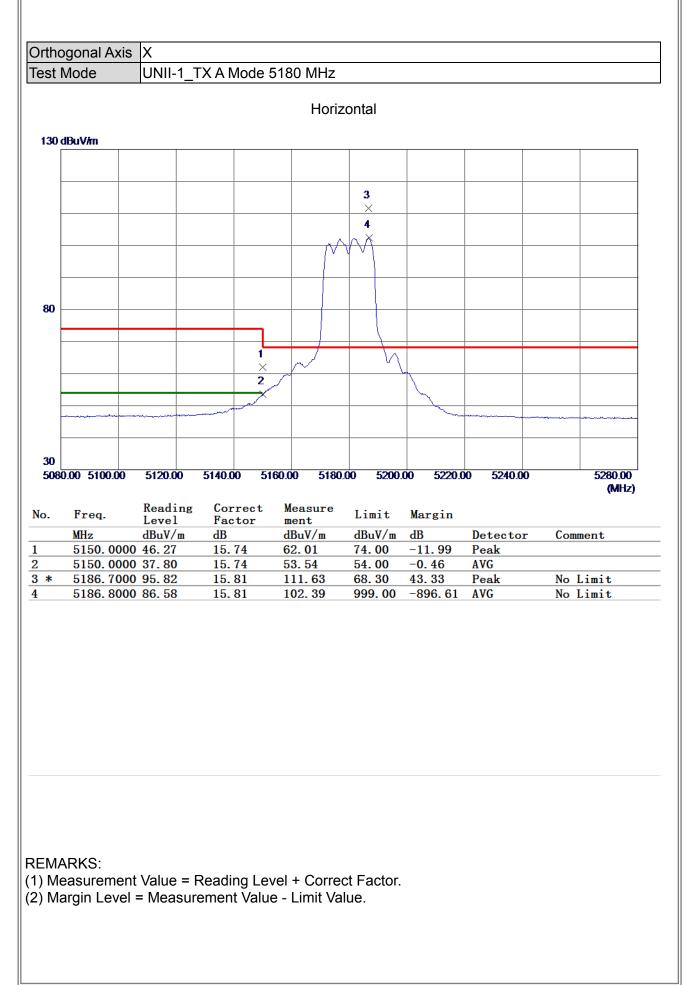




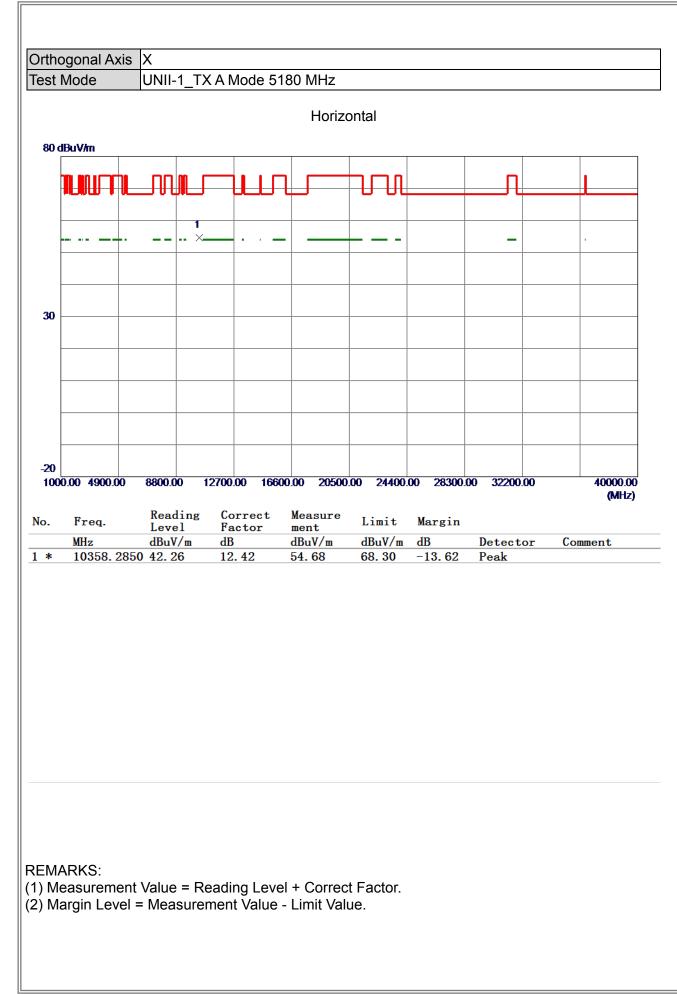






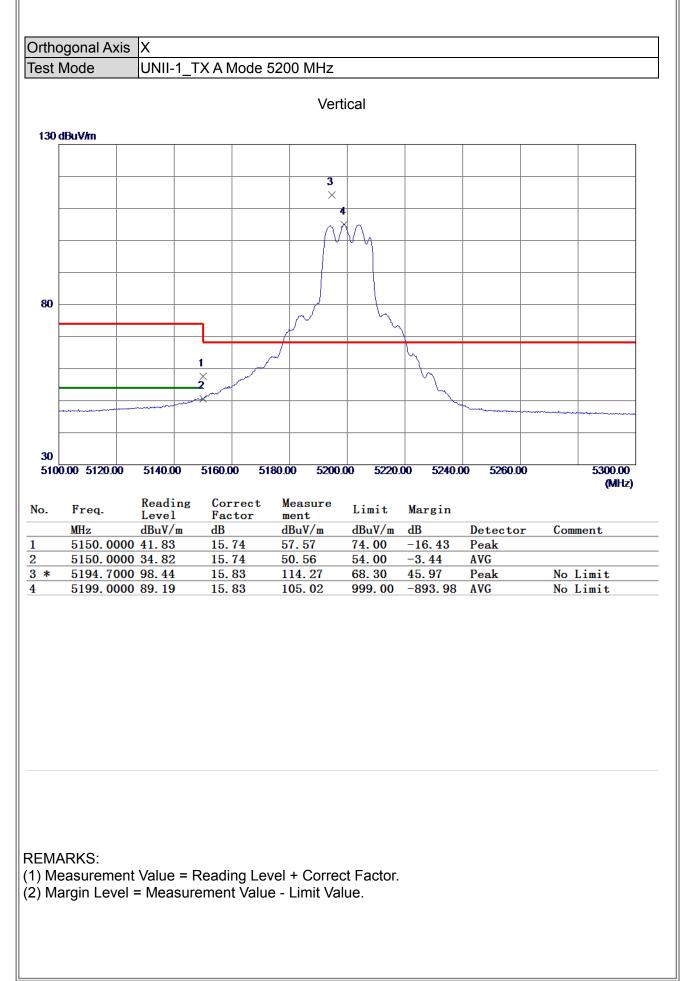




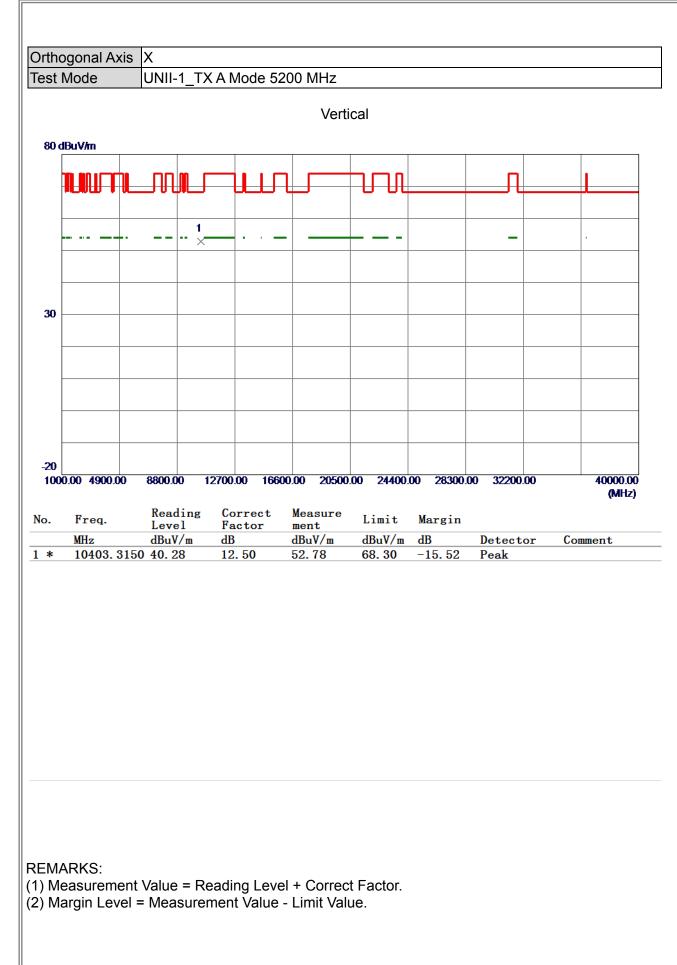


# <u>3TL</u>



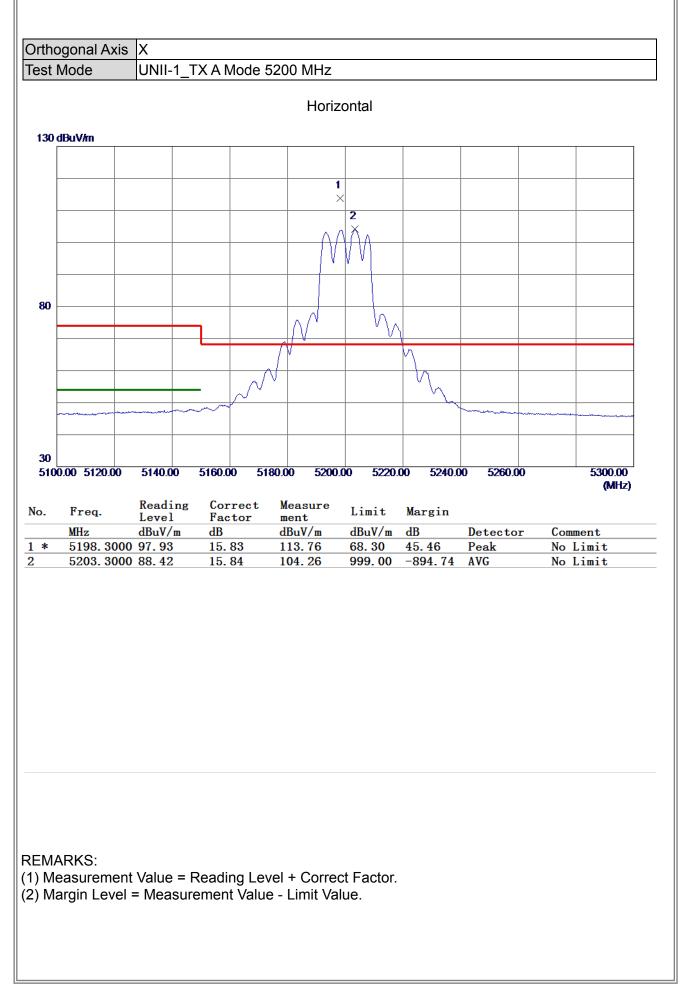




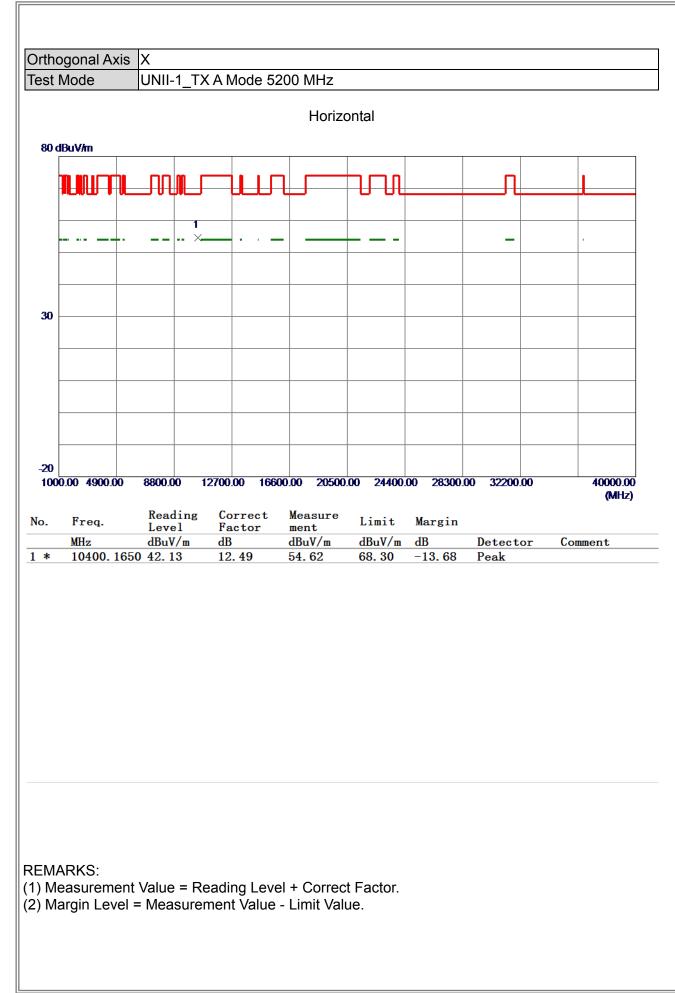






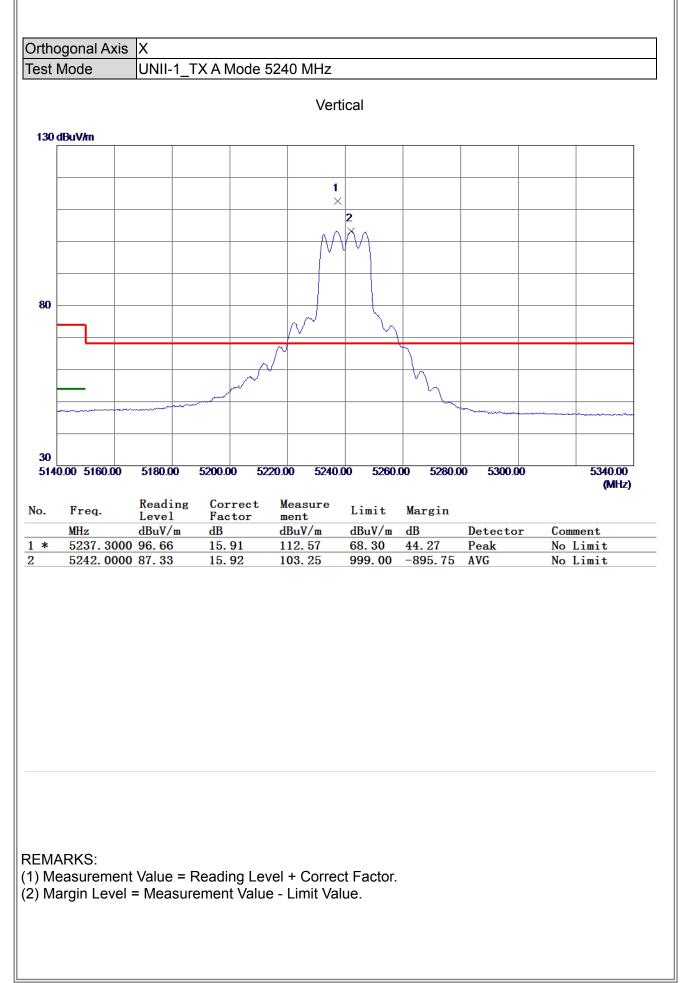




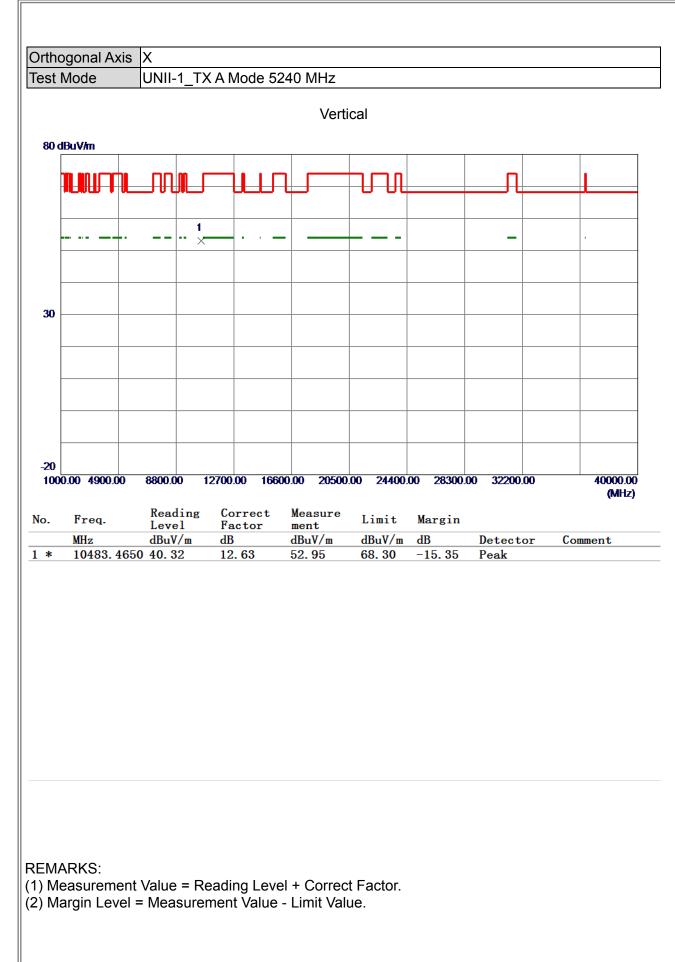






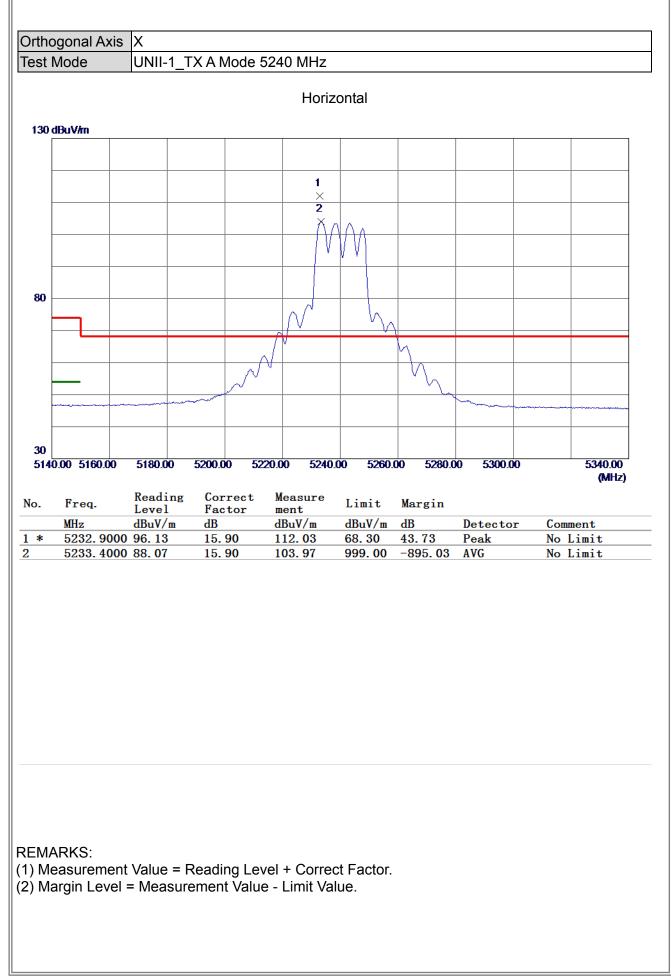




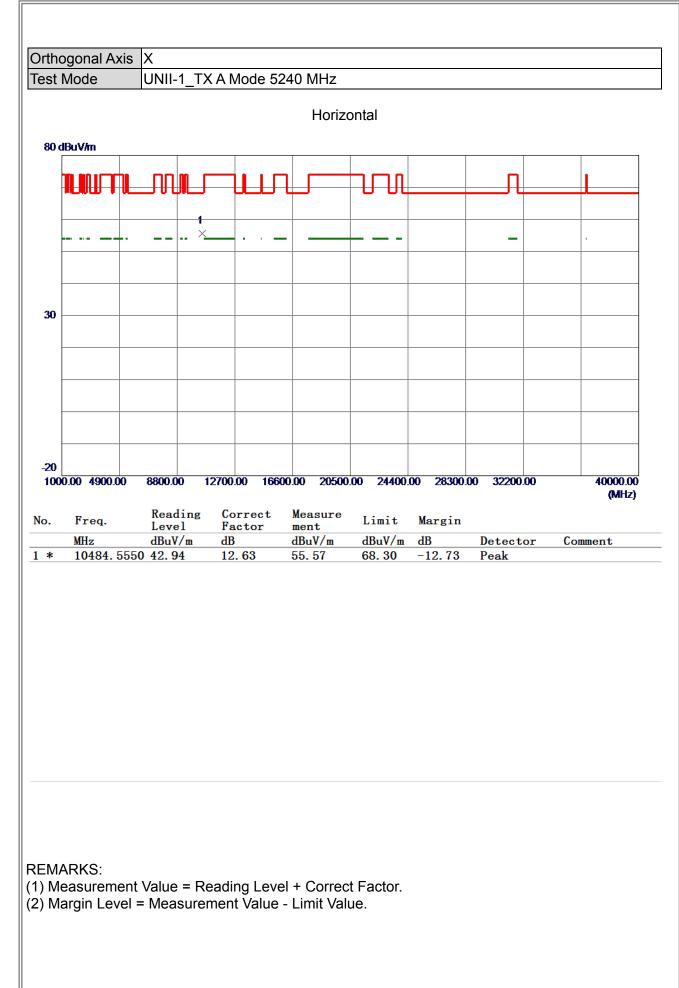


# **B**L



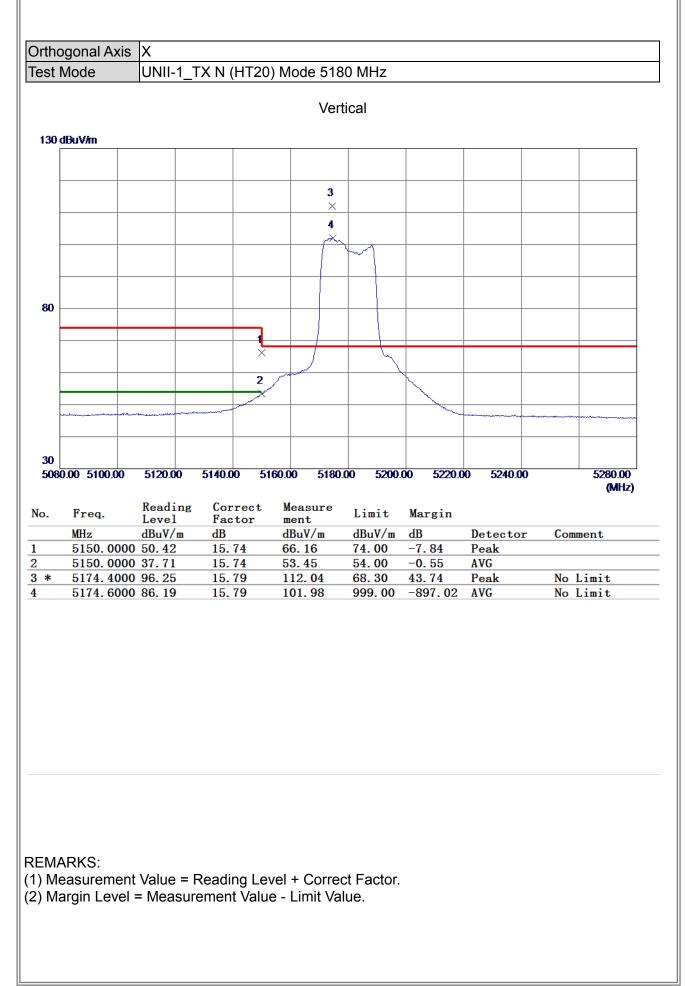




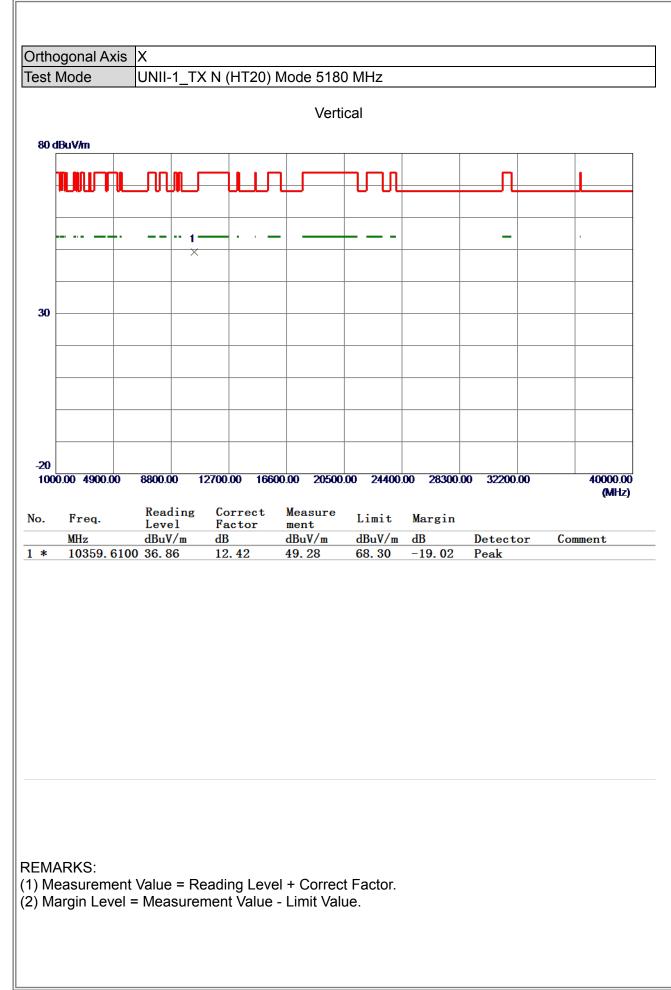






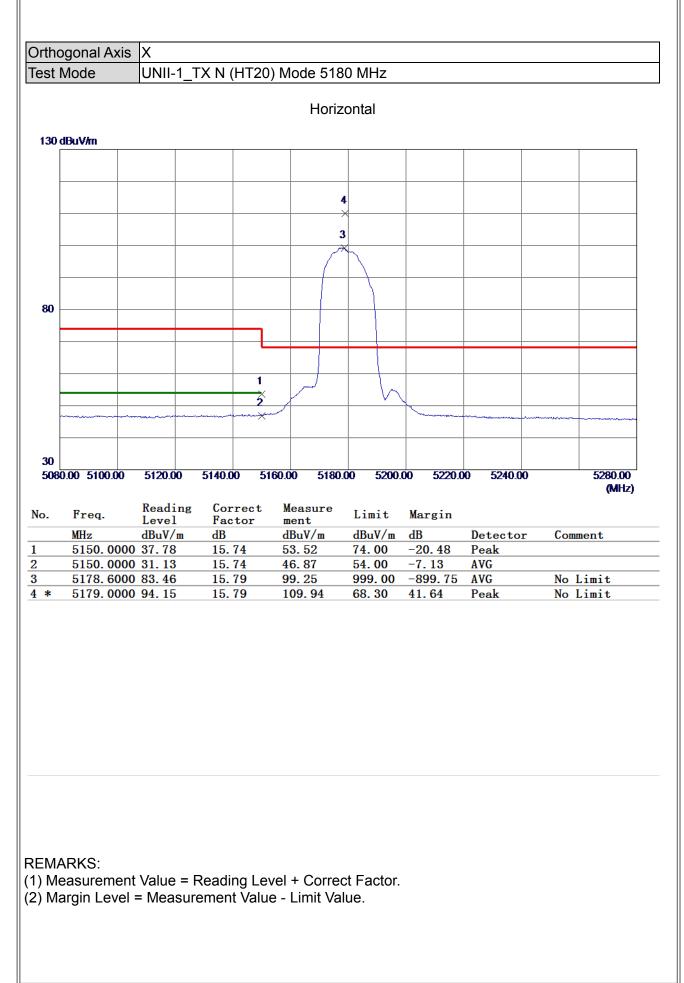




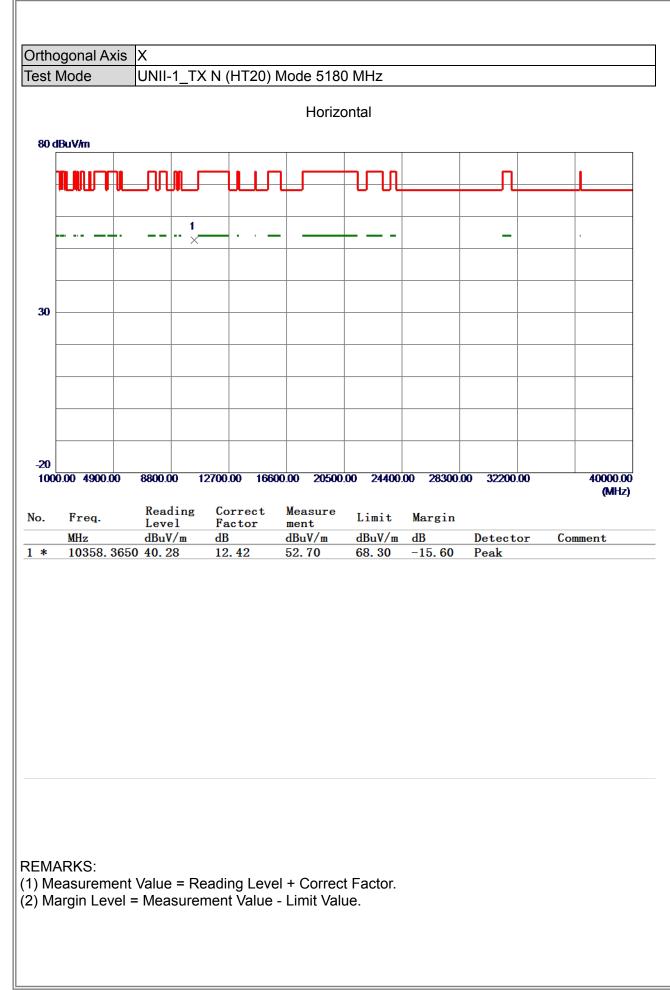






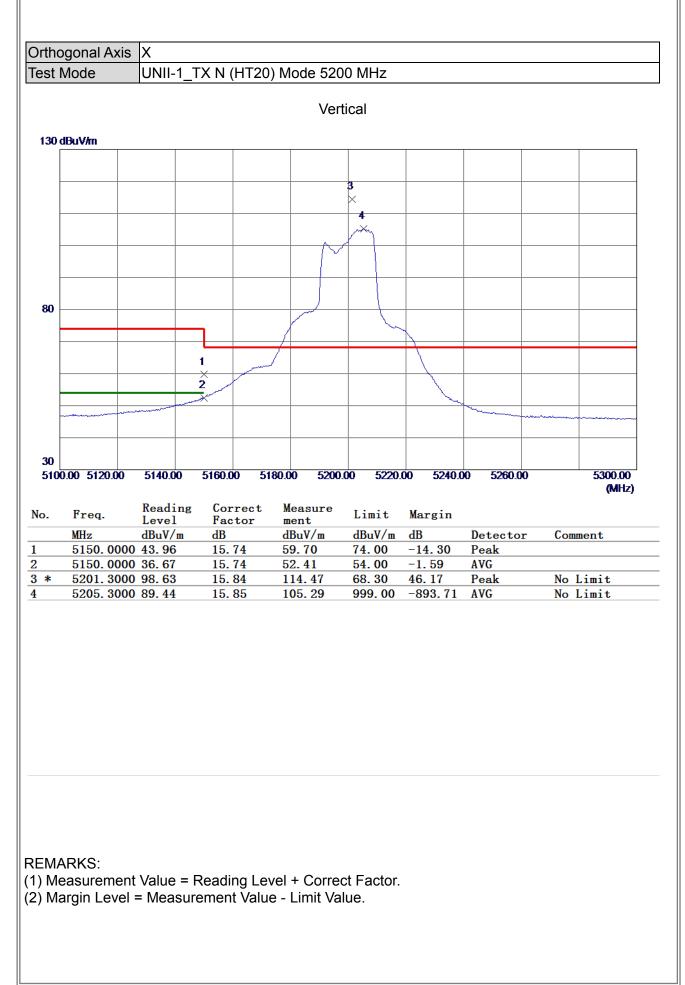




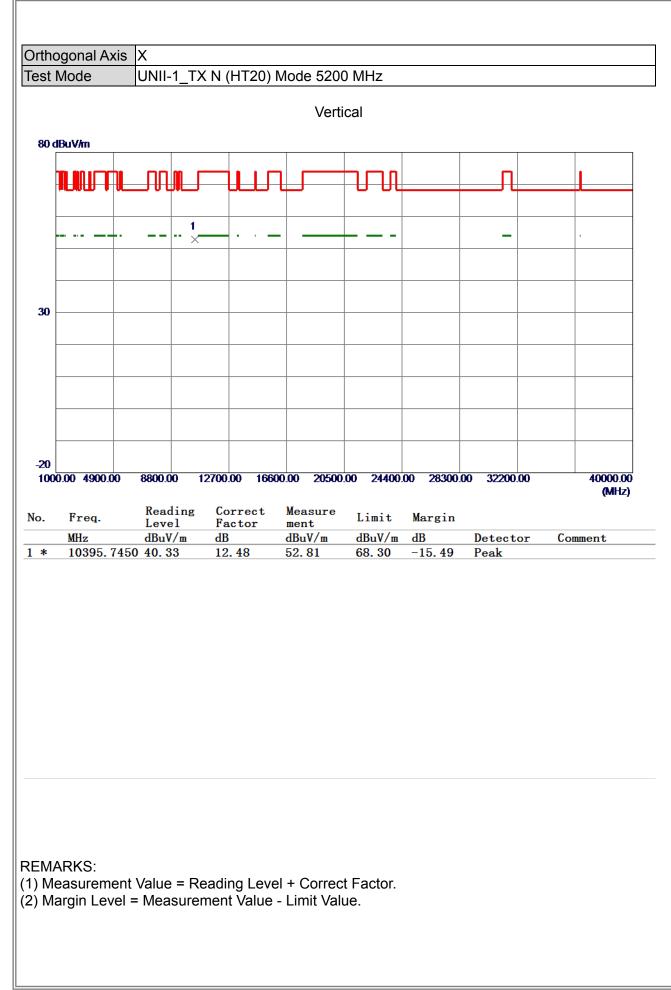






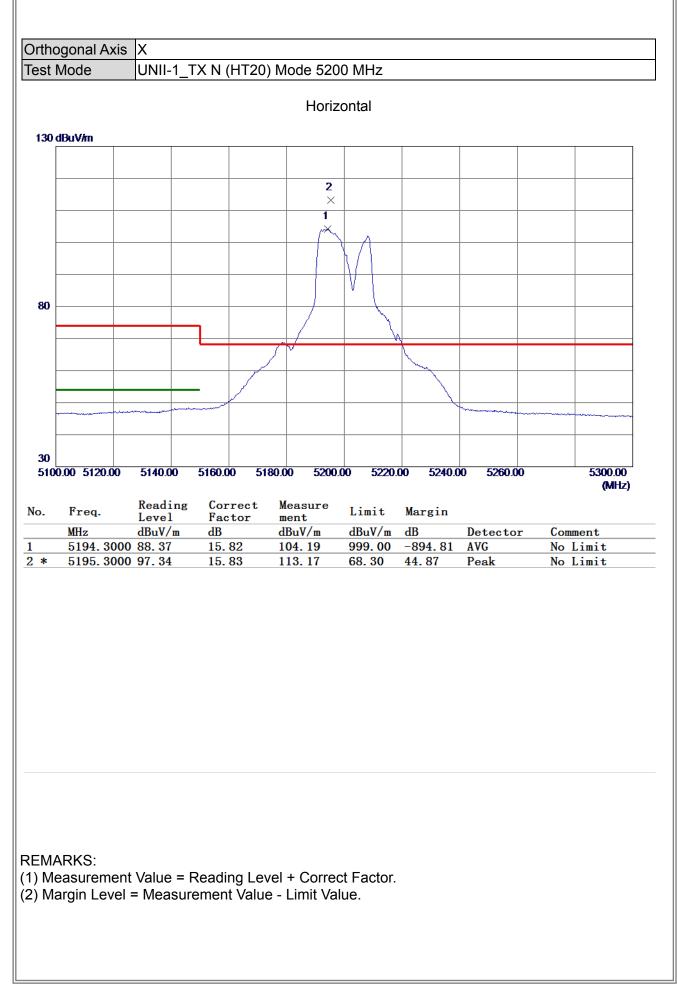




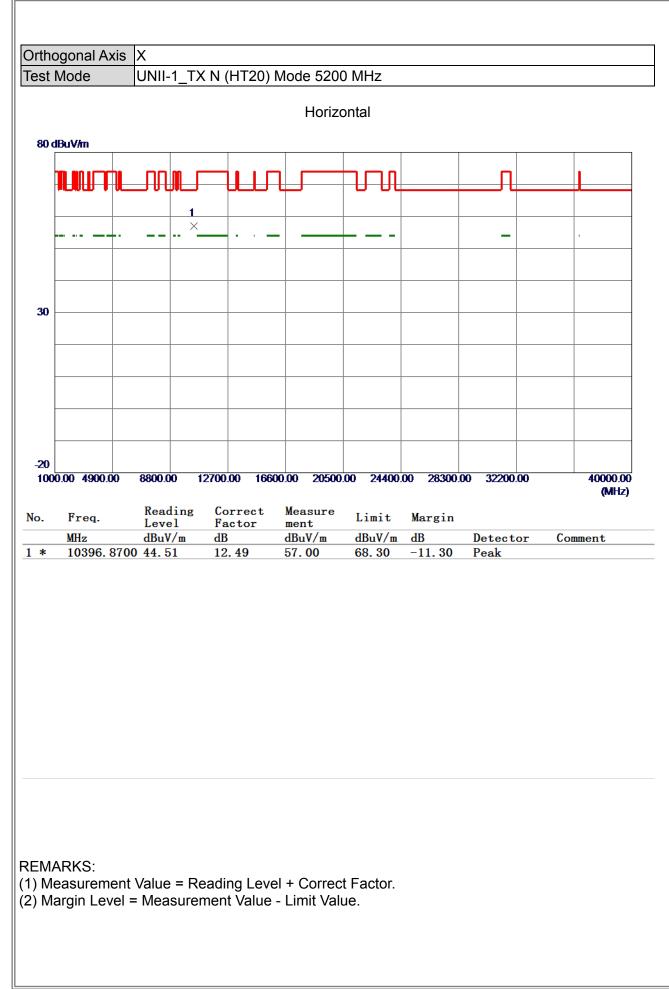








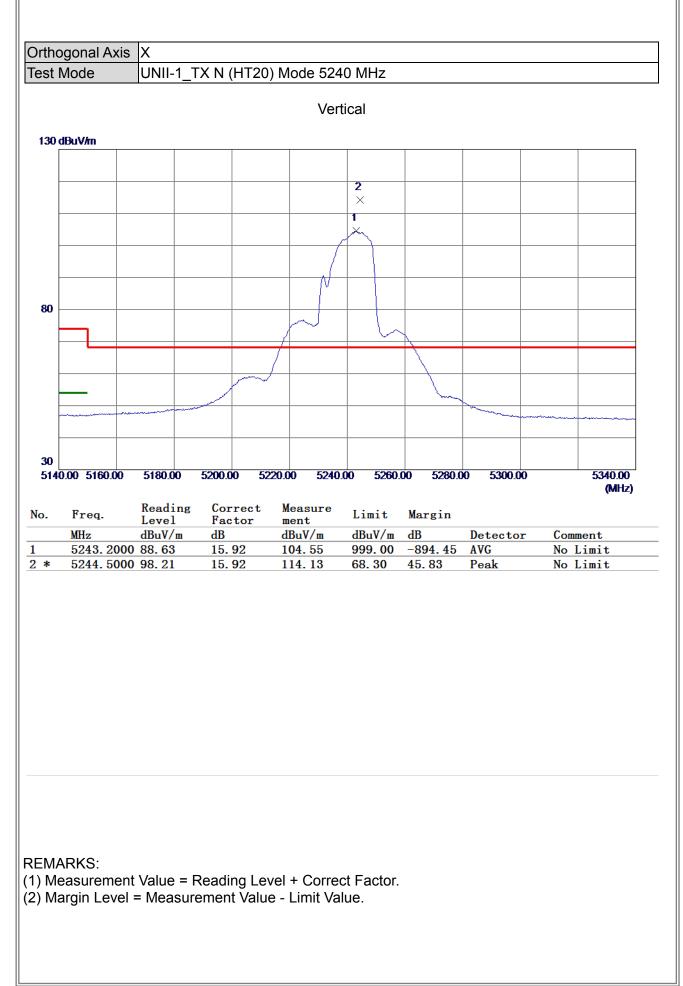




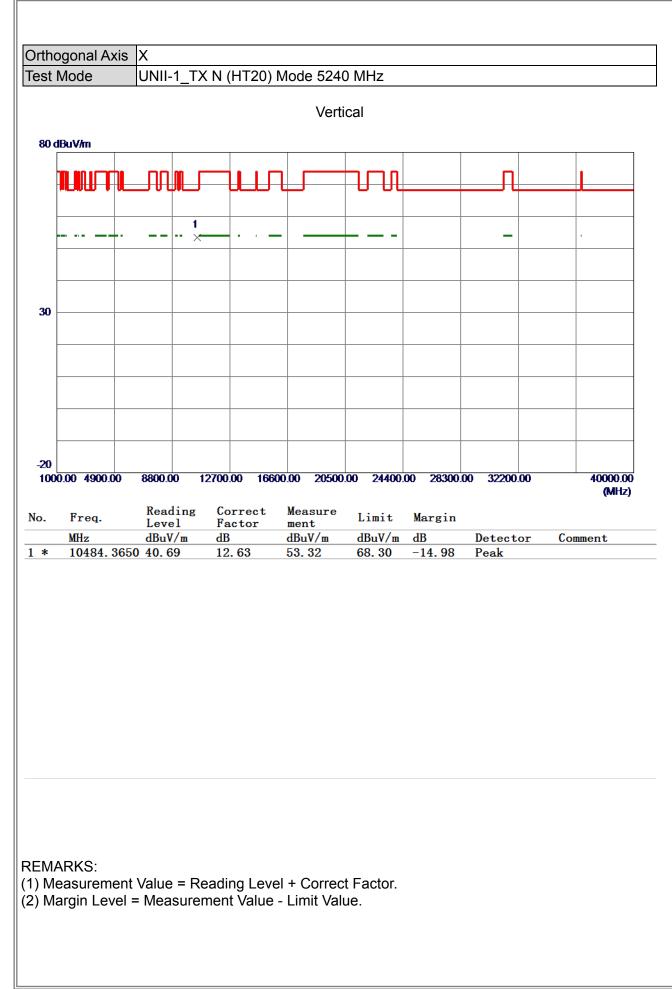
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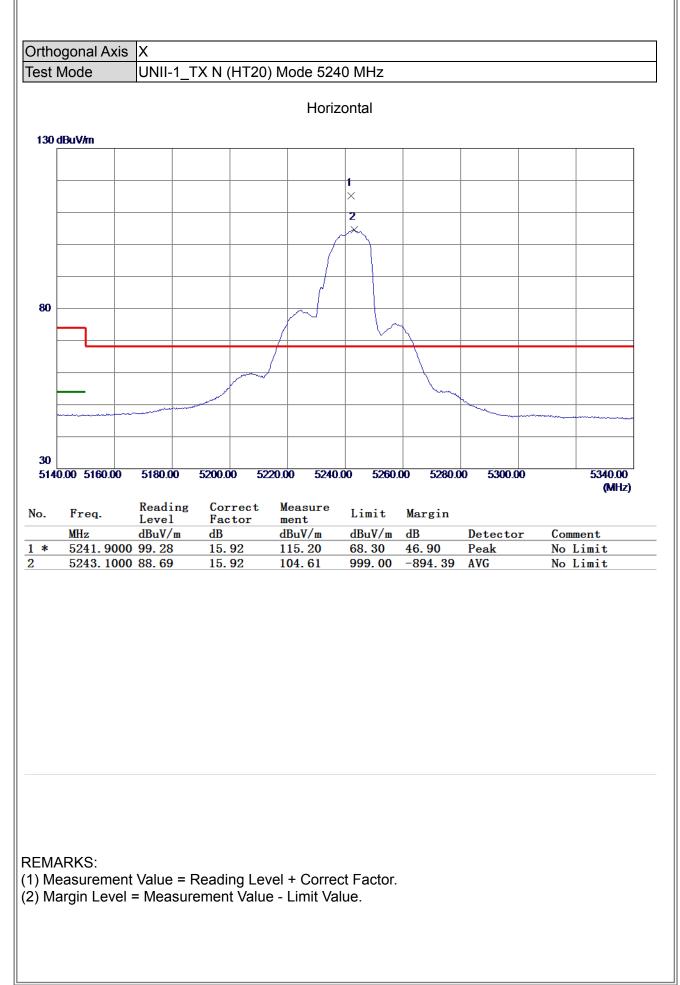




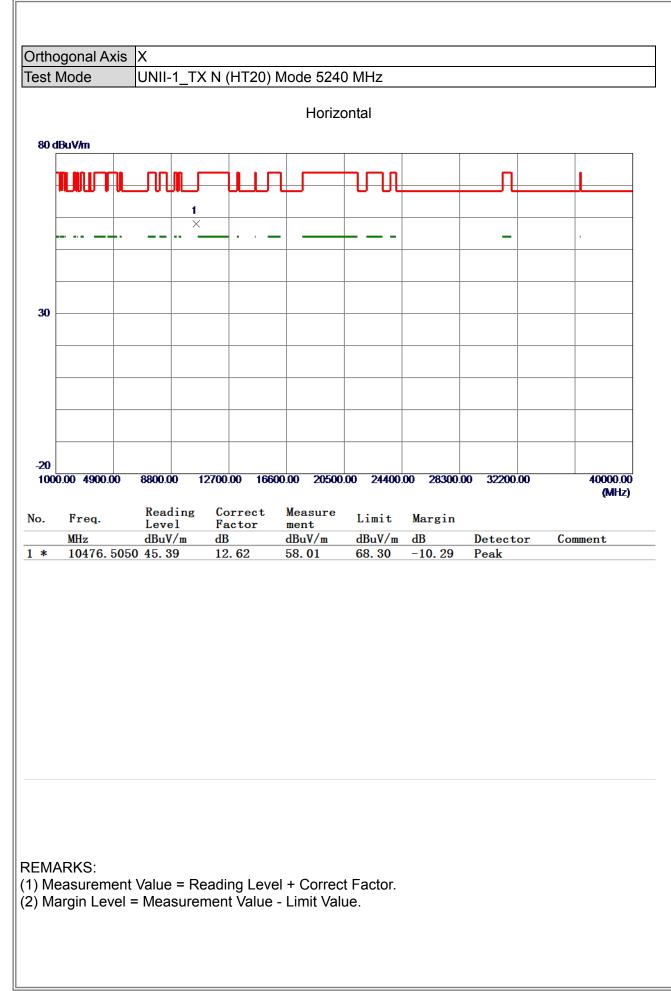






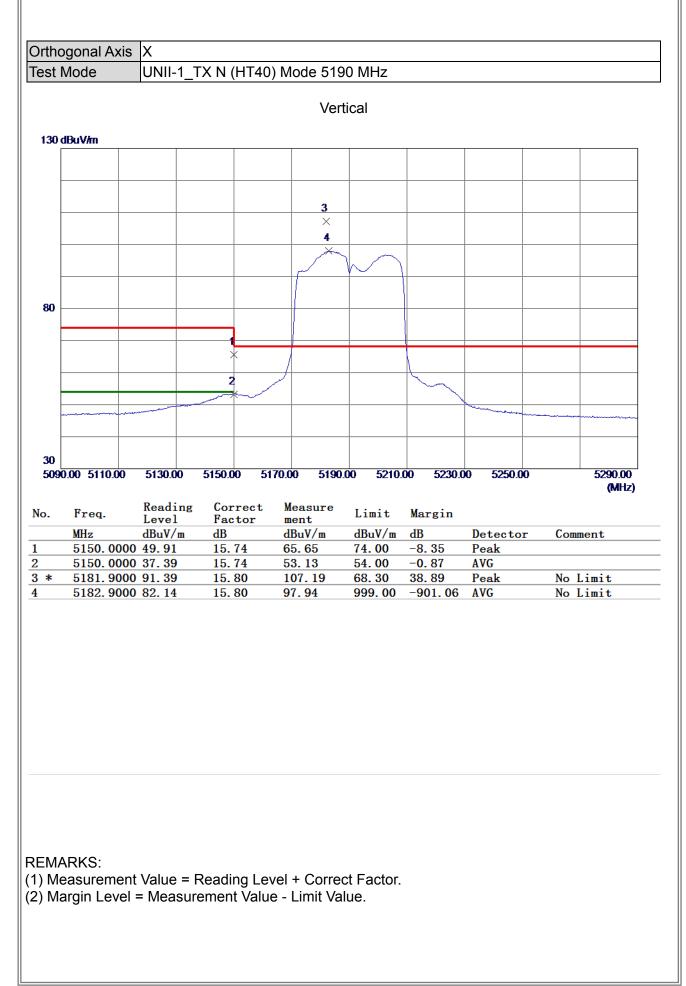




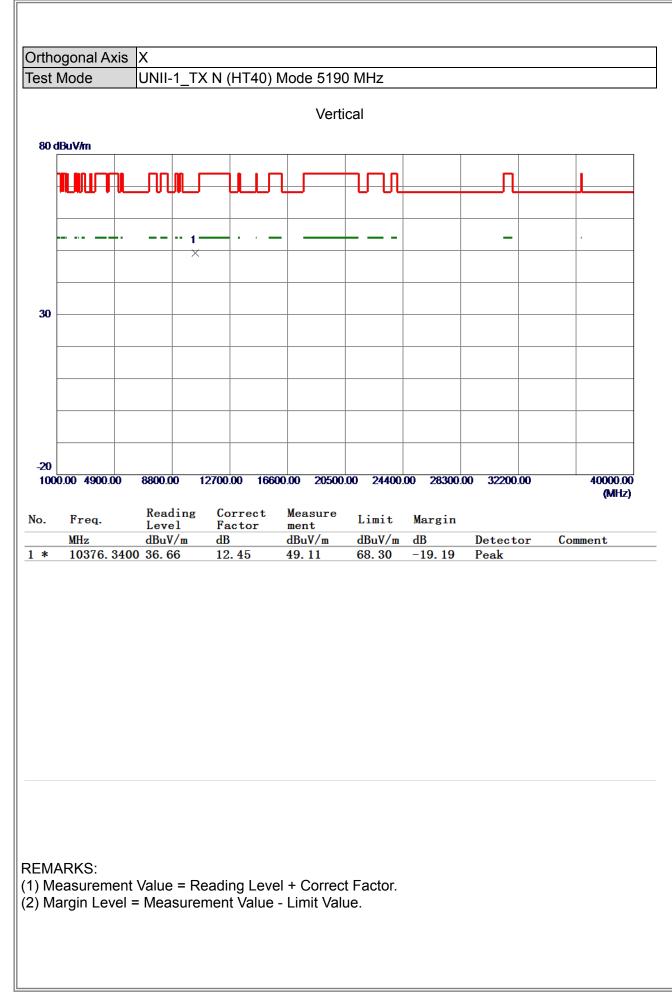






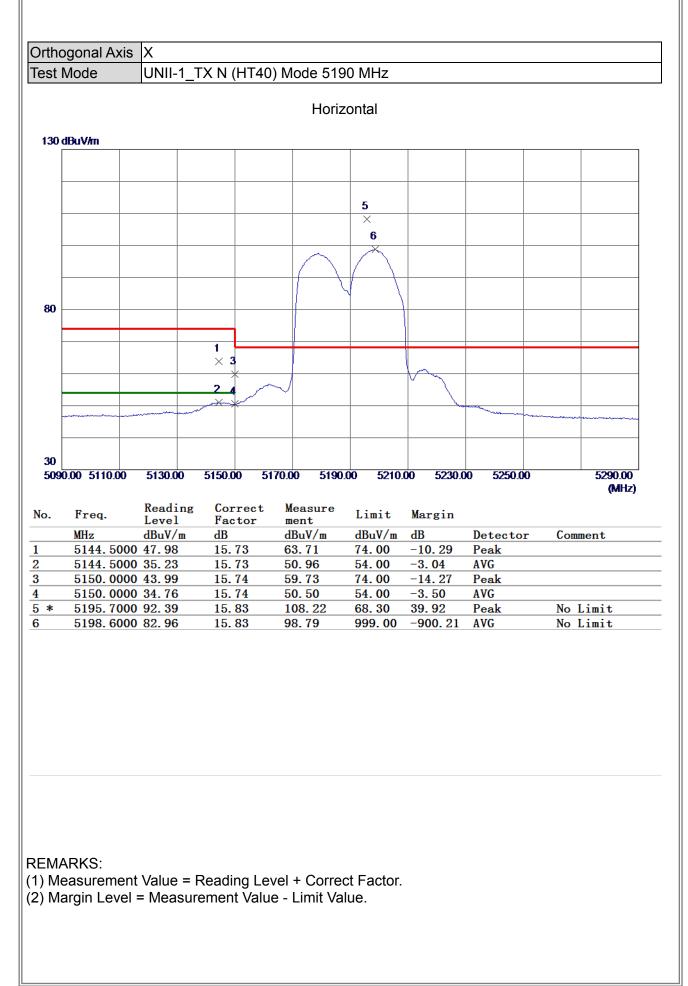




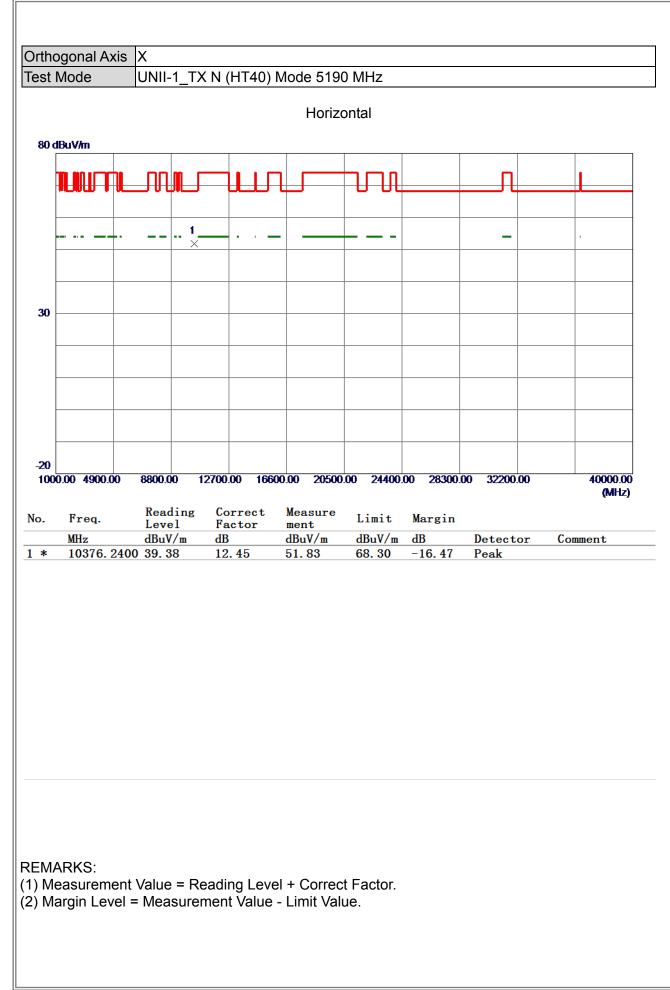






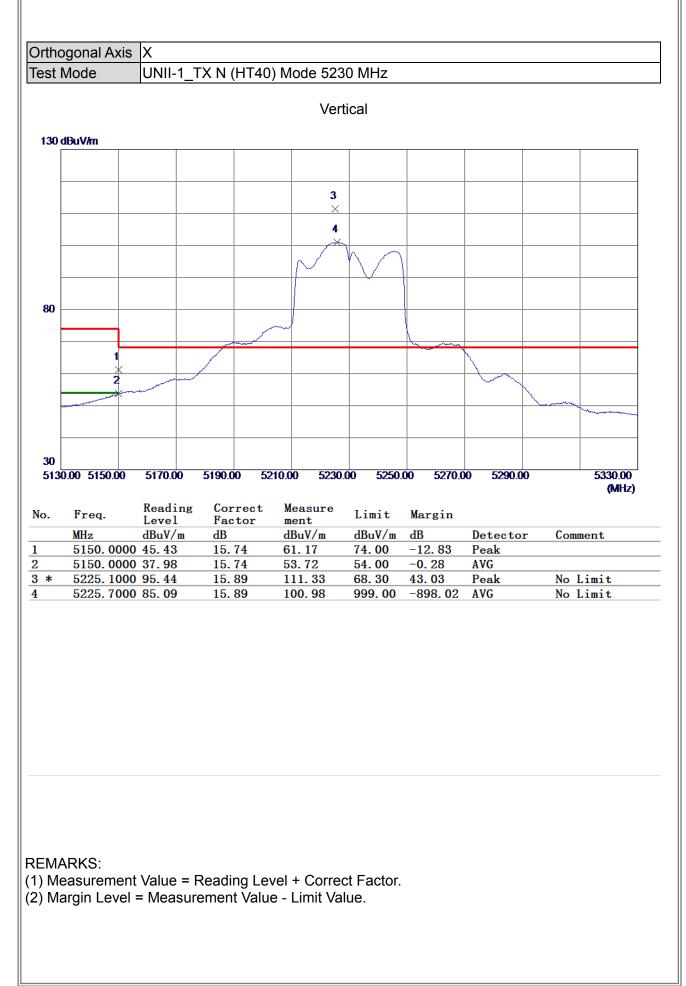




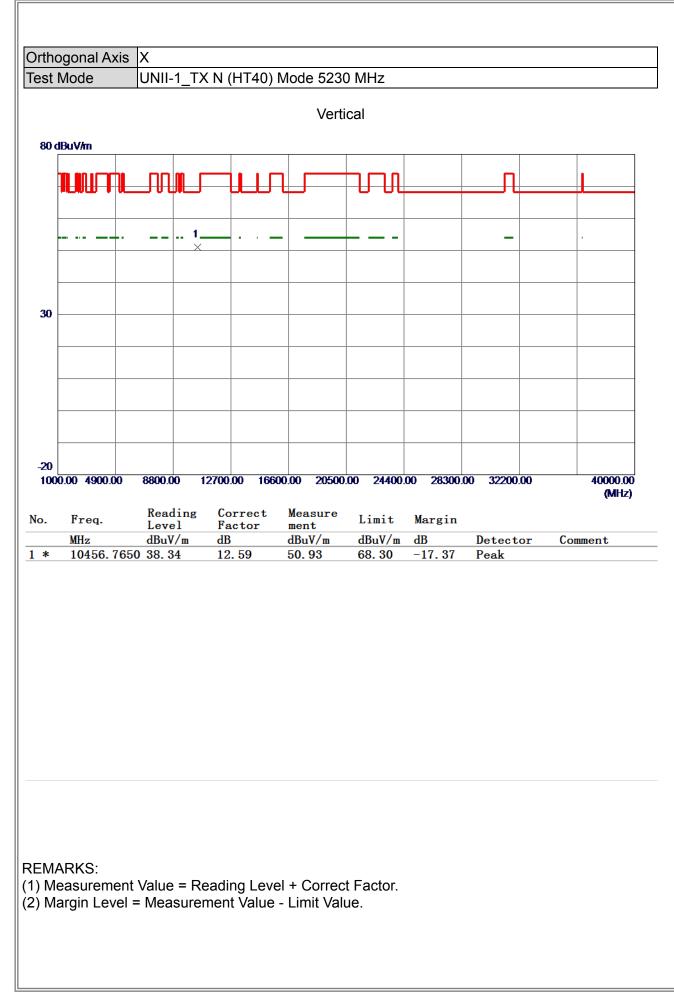






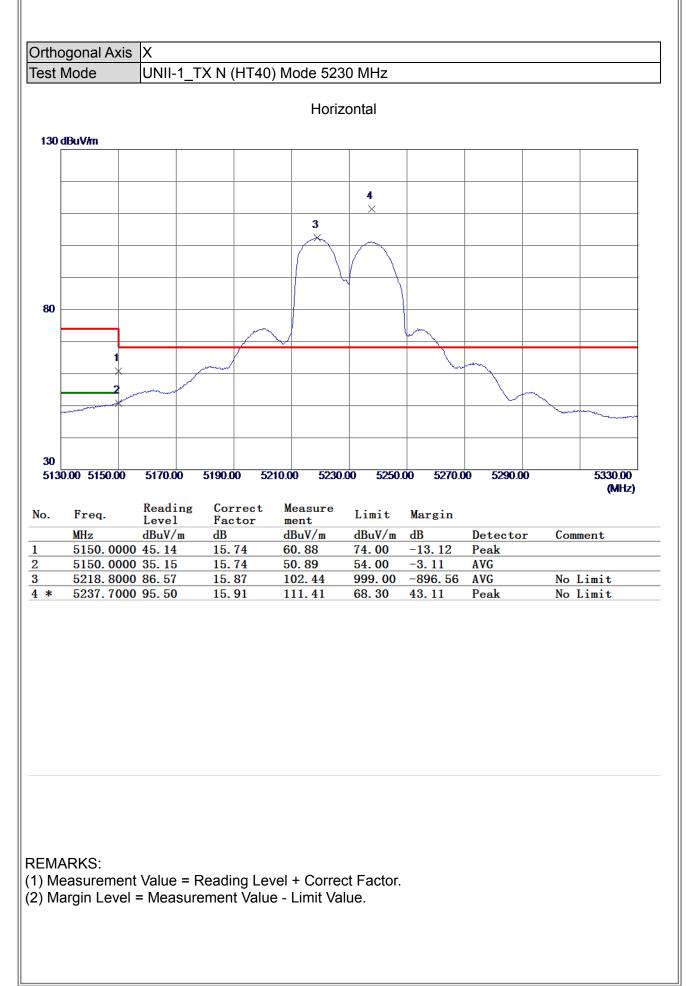




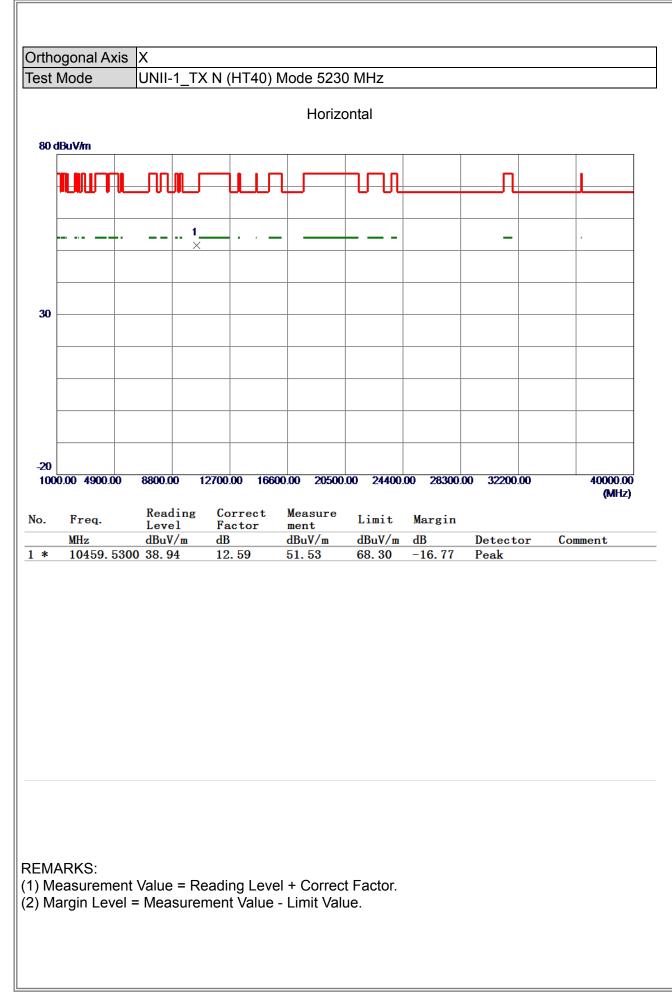






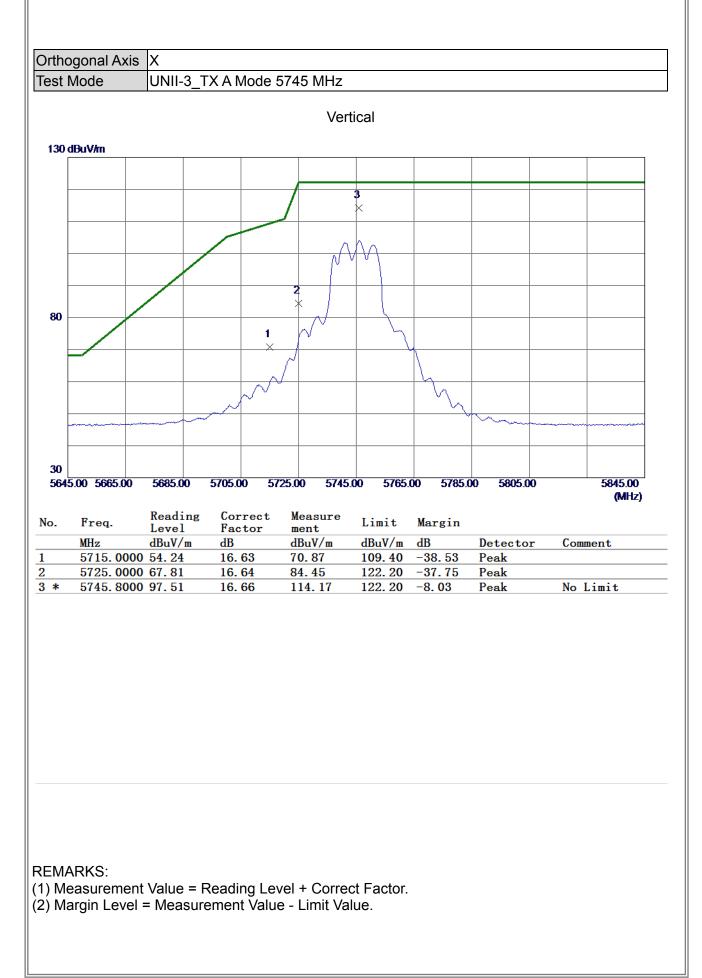






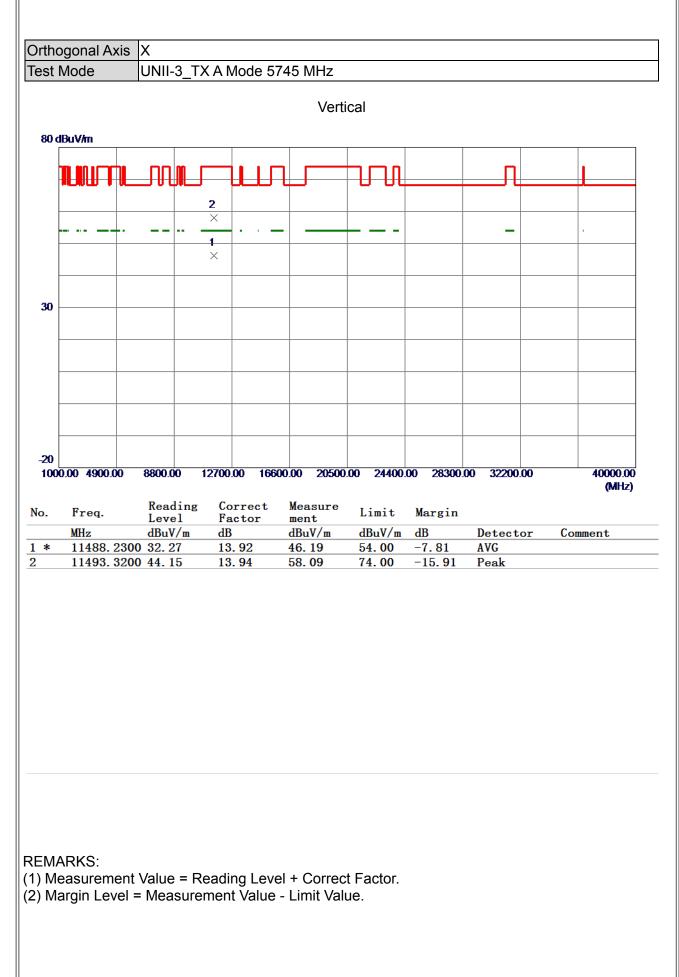




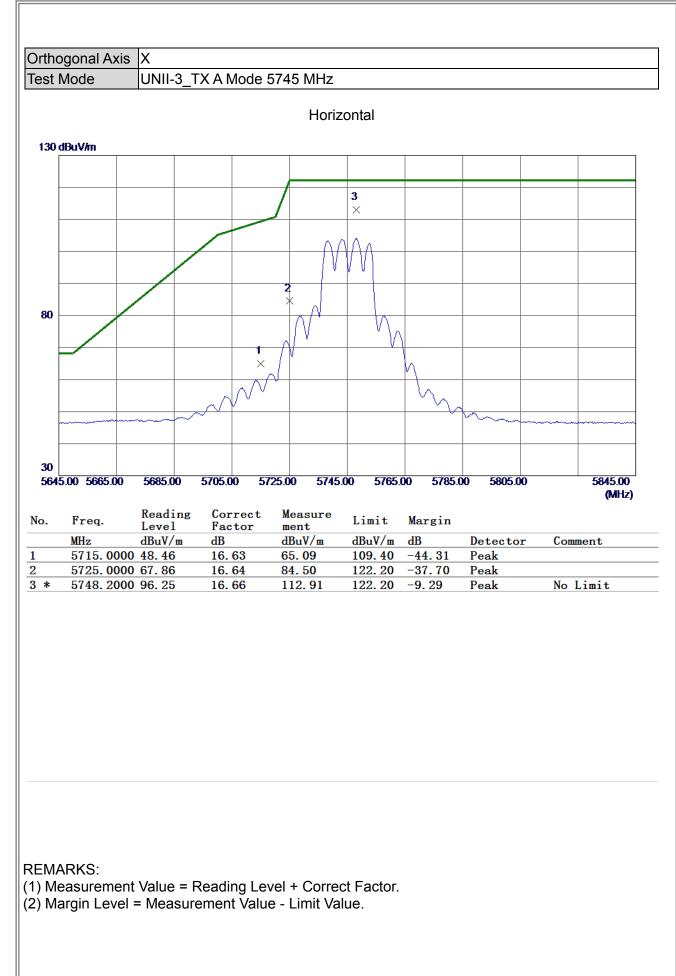






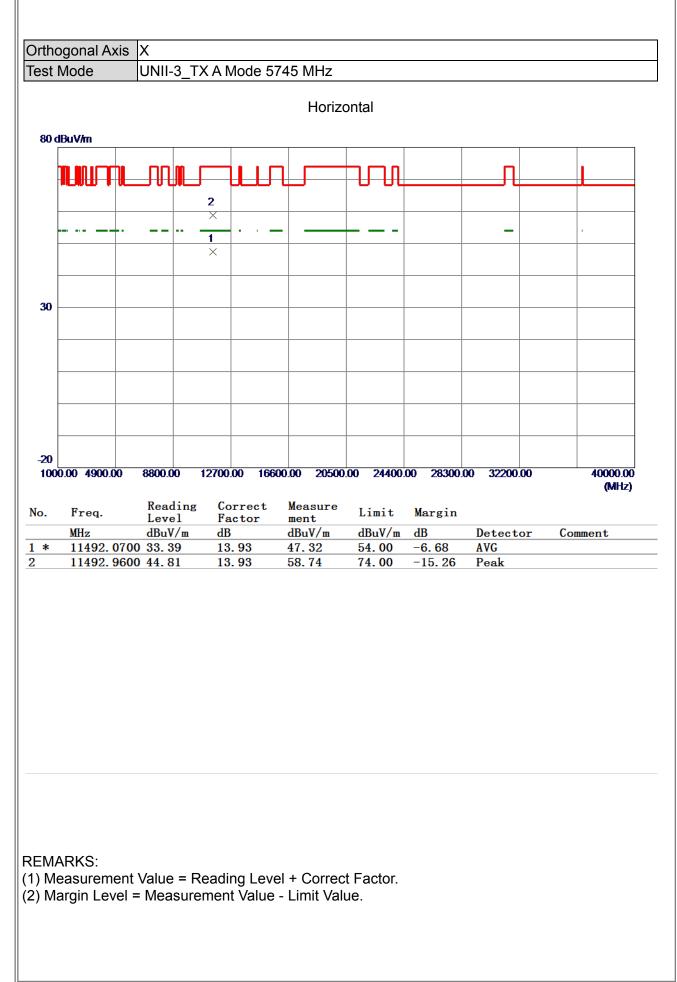




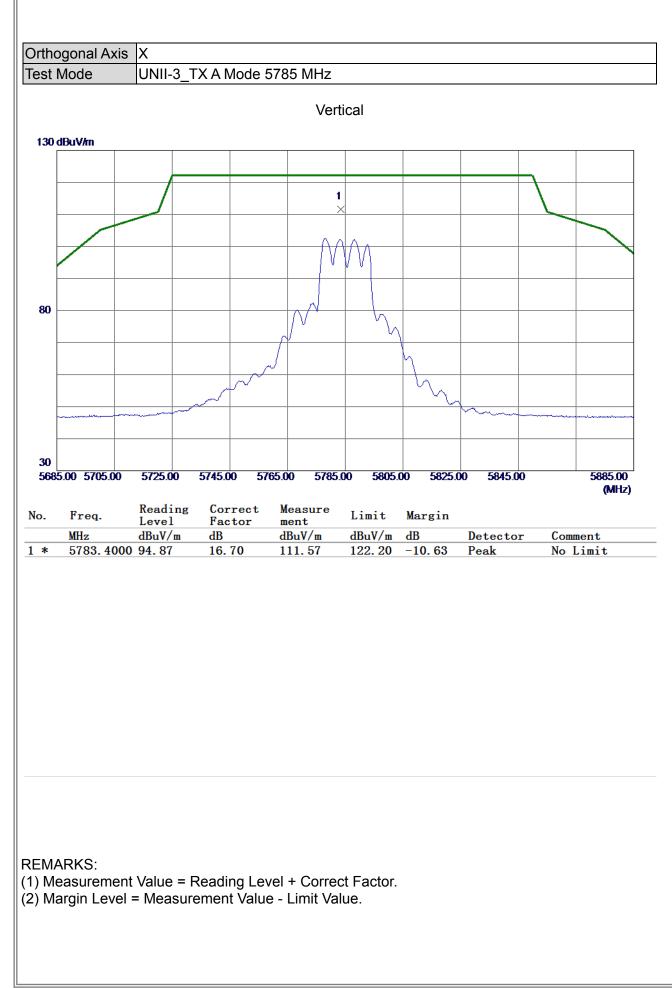




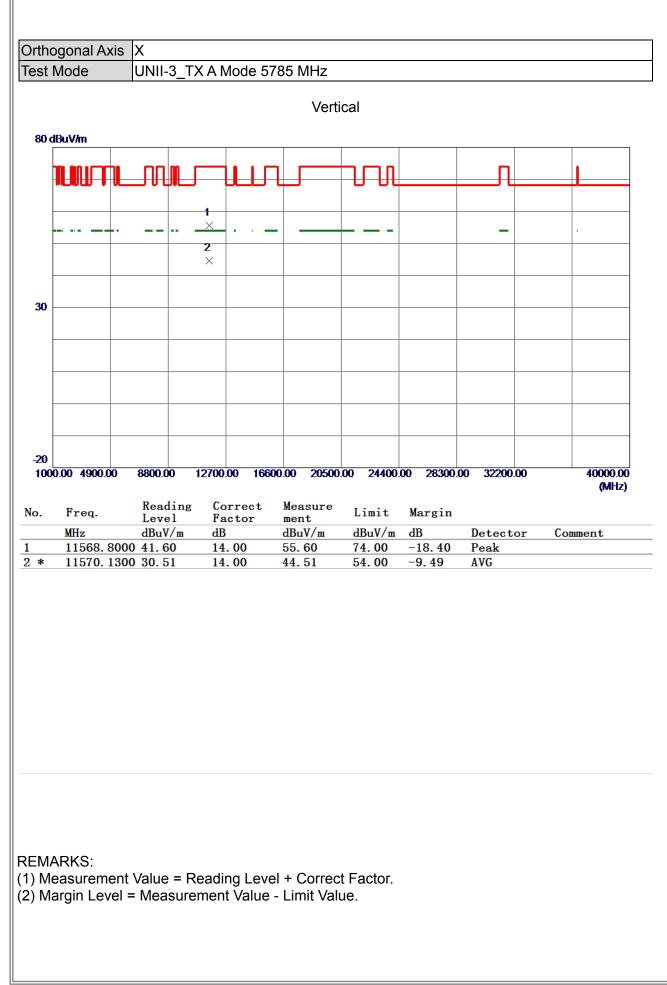




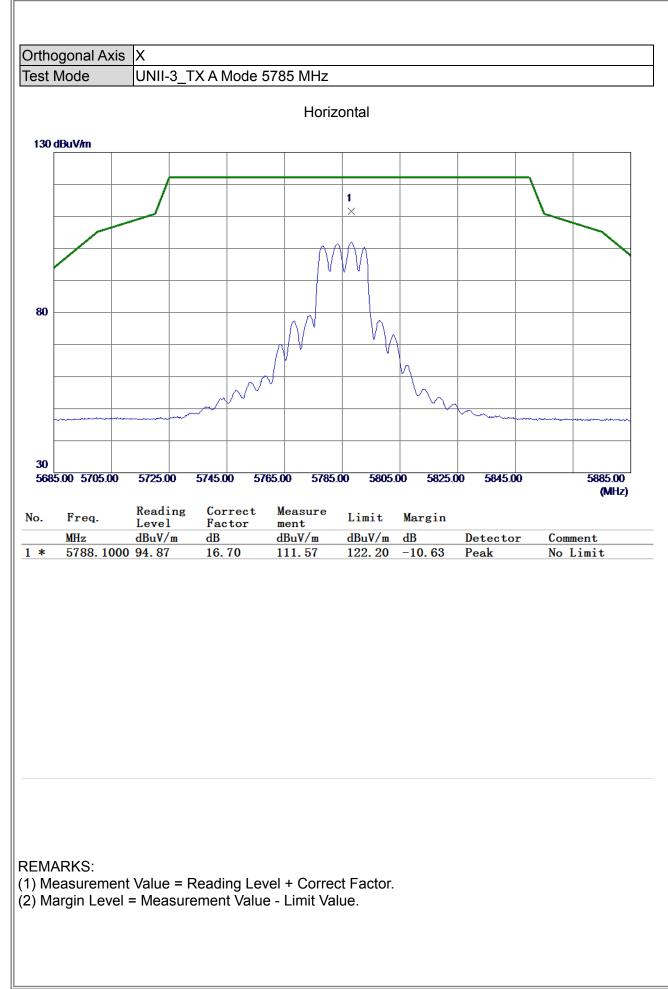






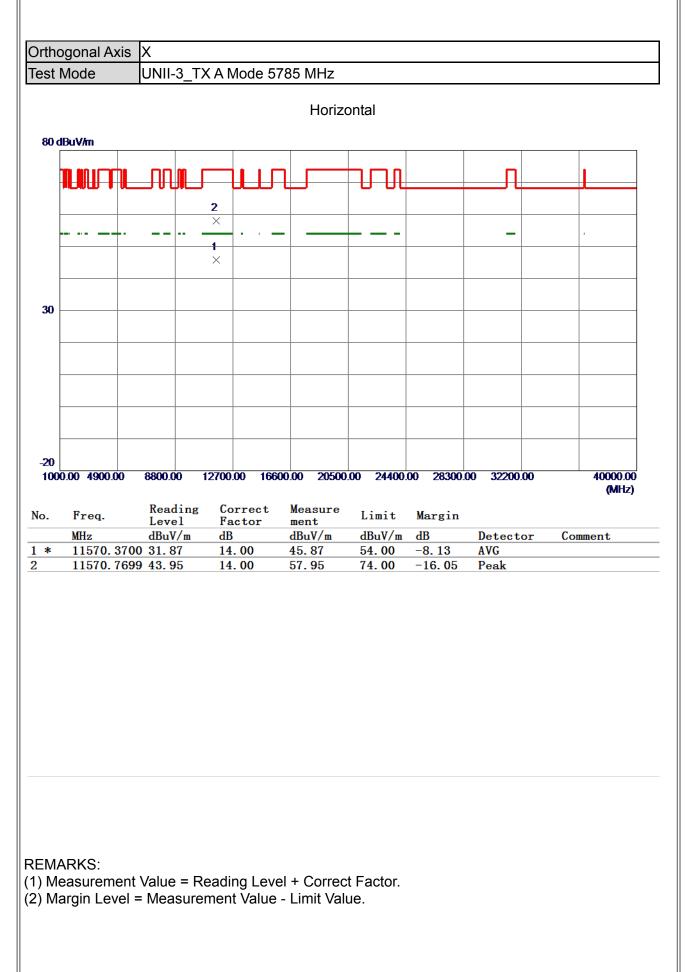






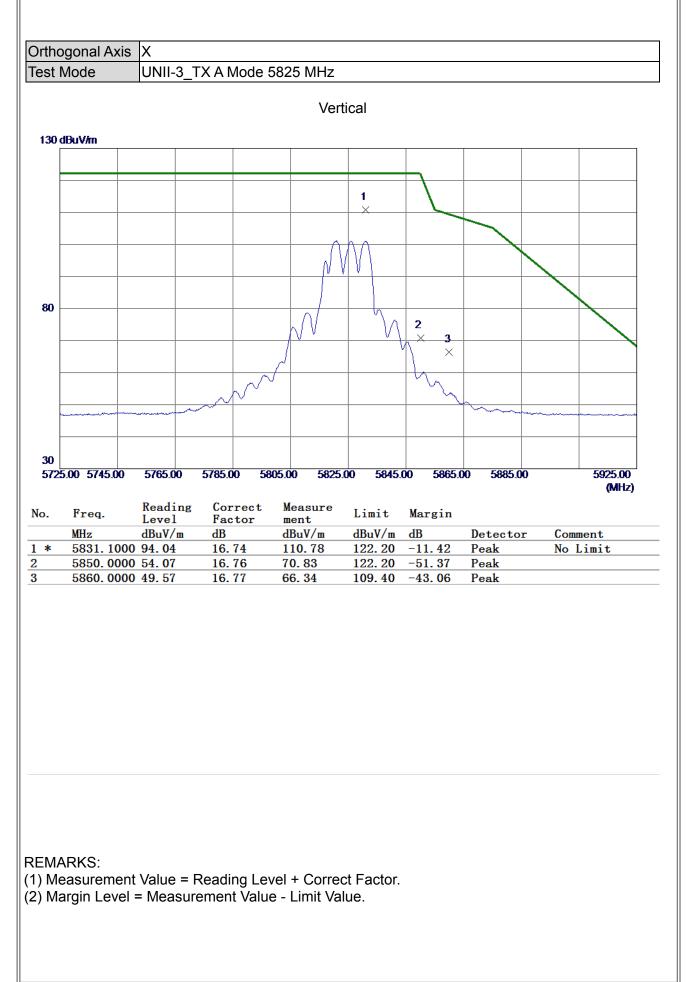




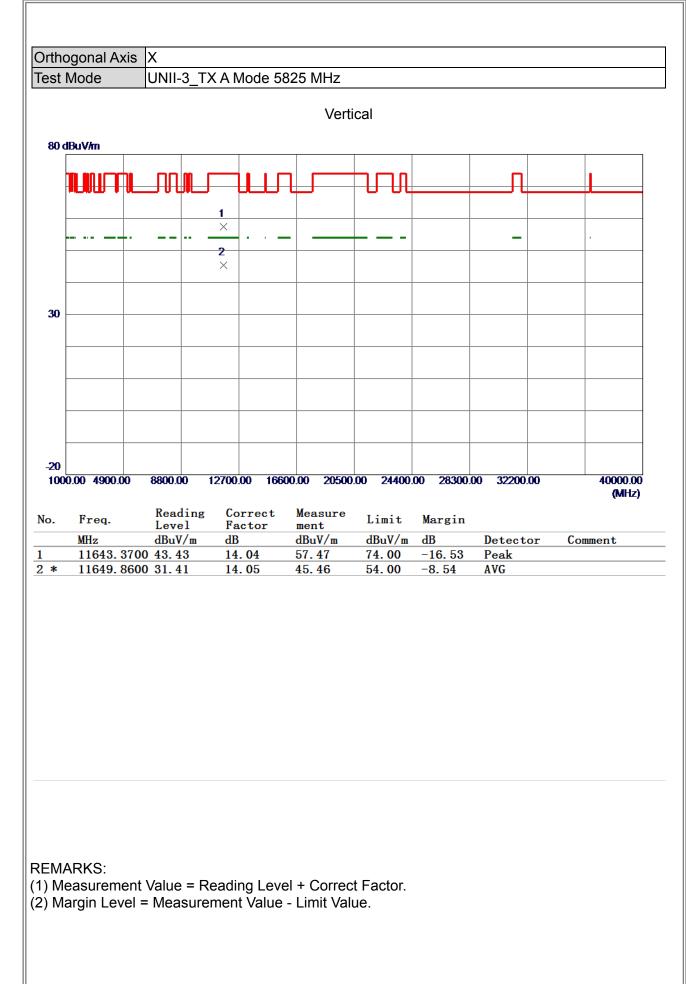






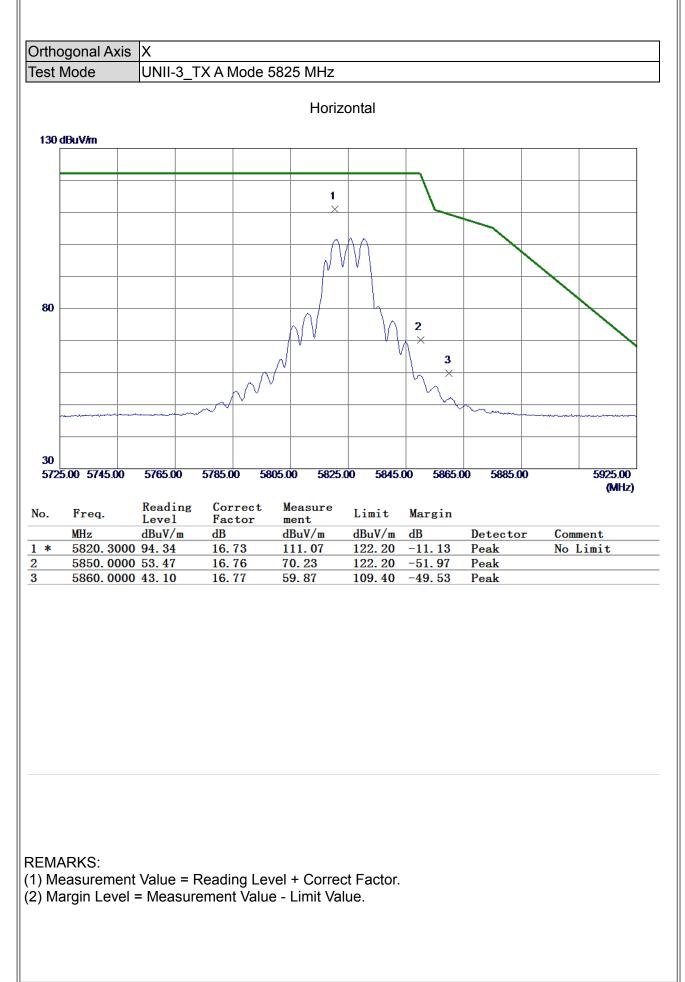




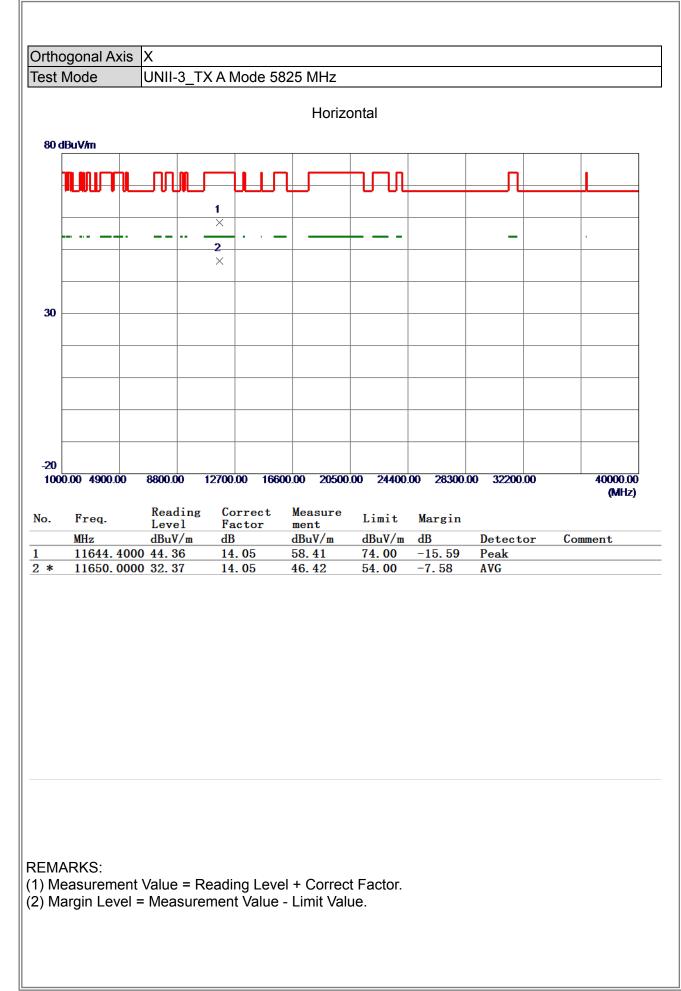




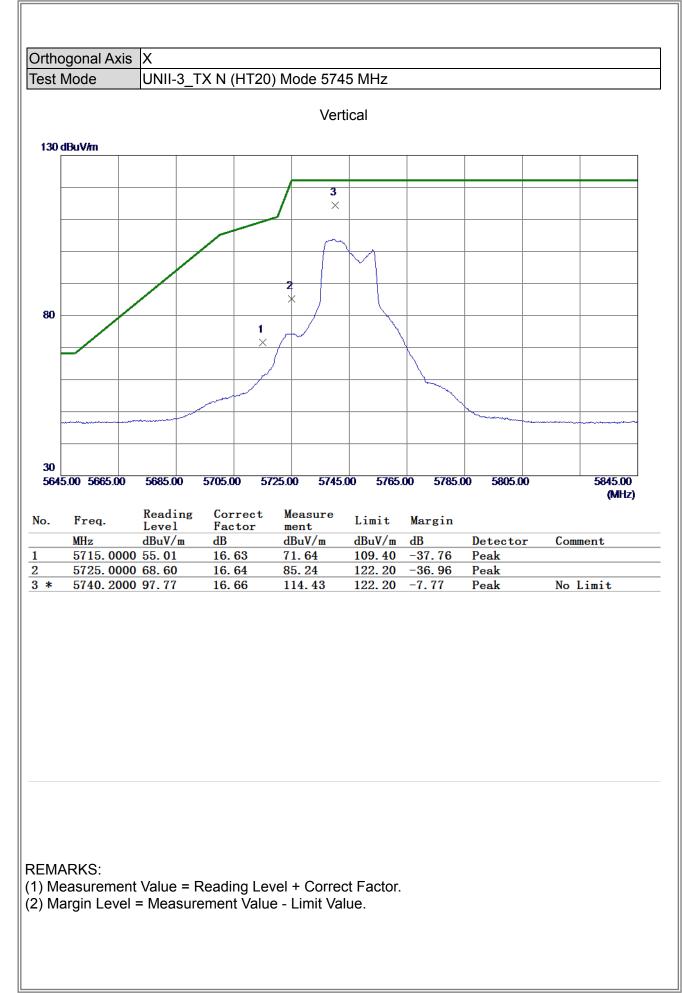




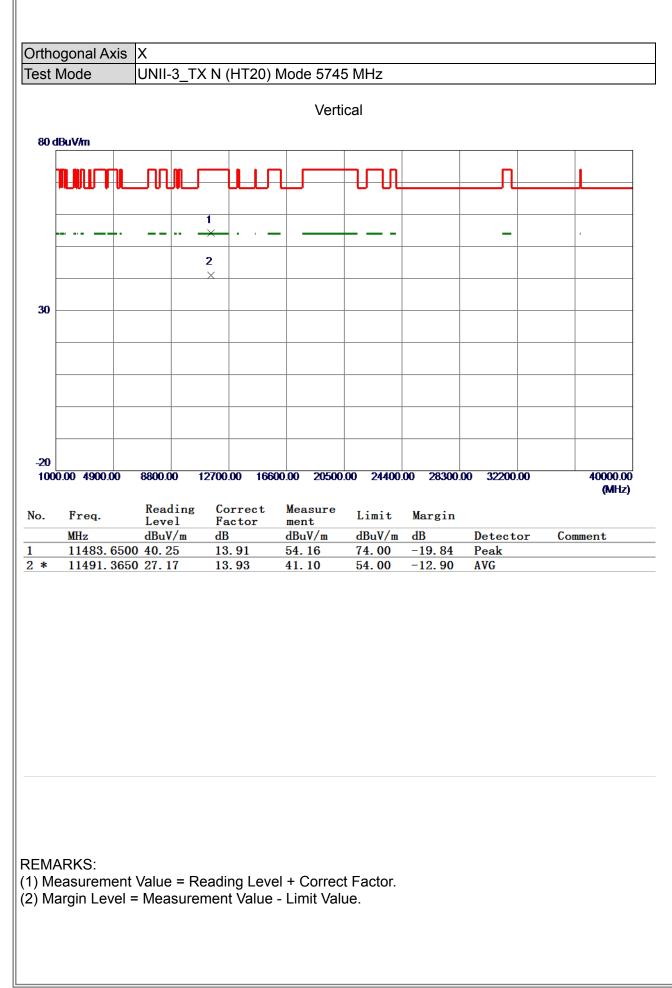




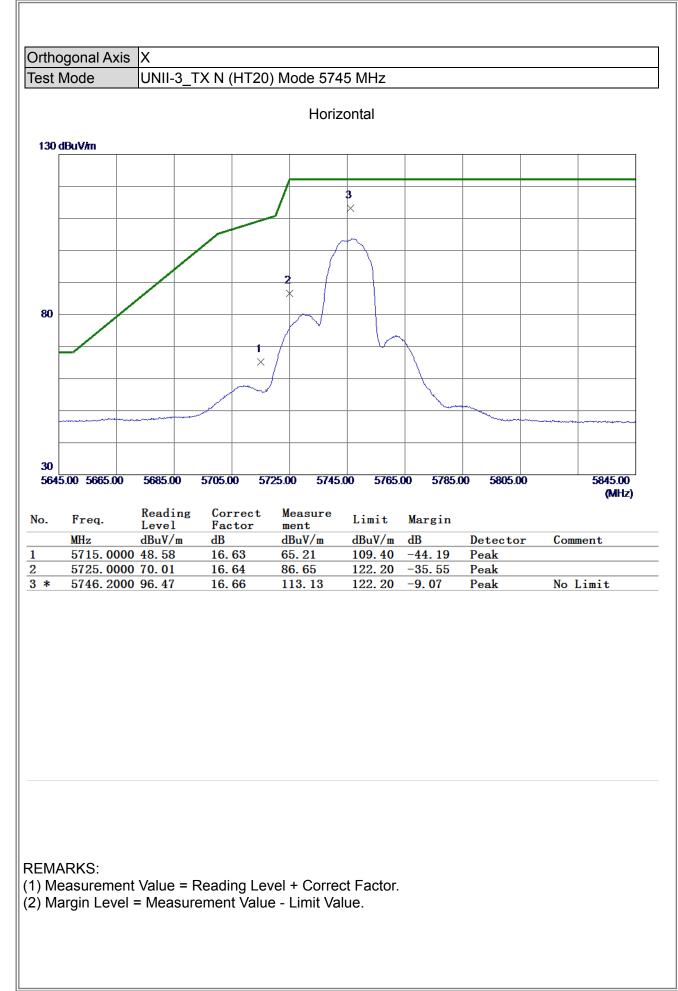




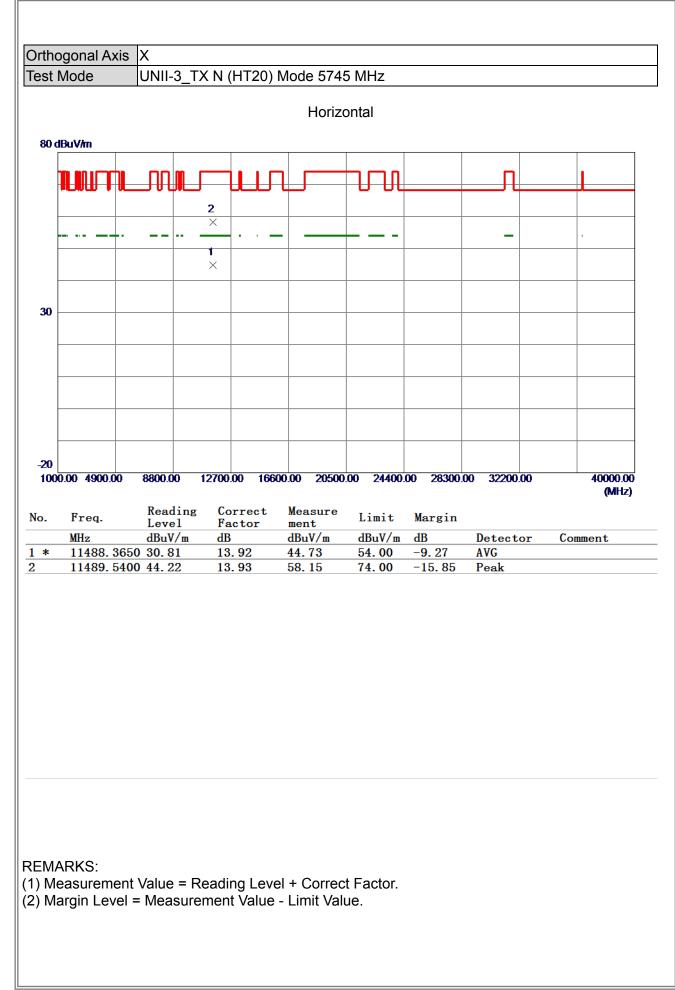




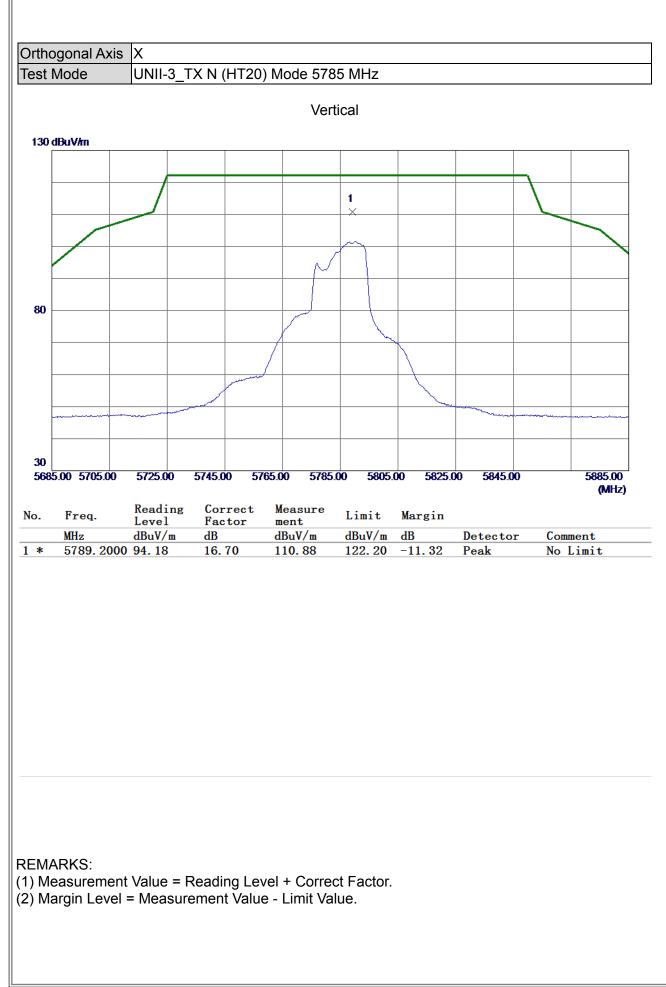




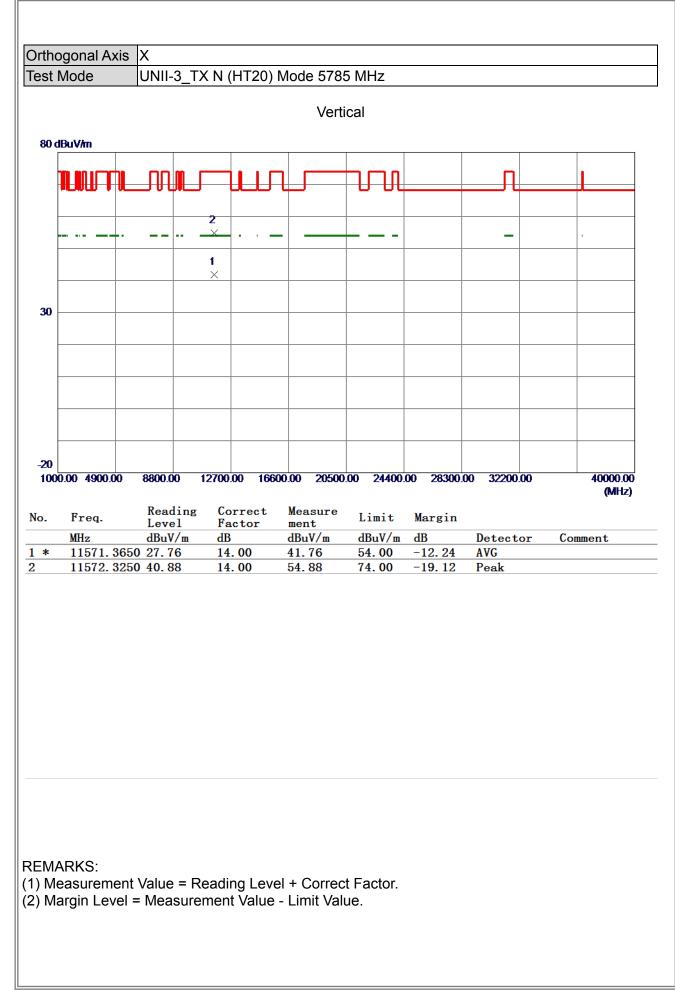




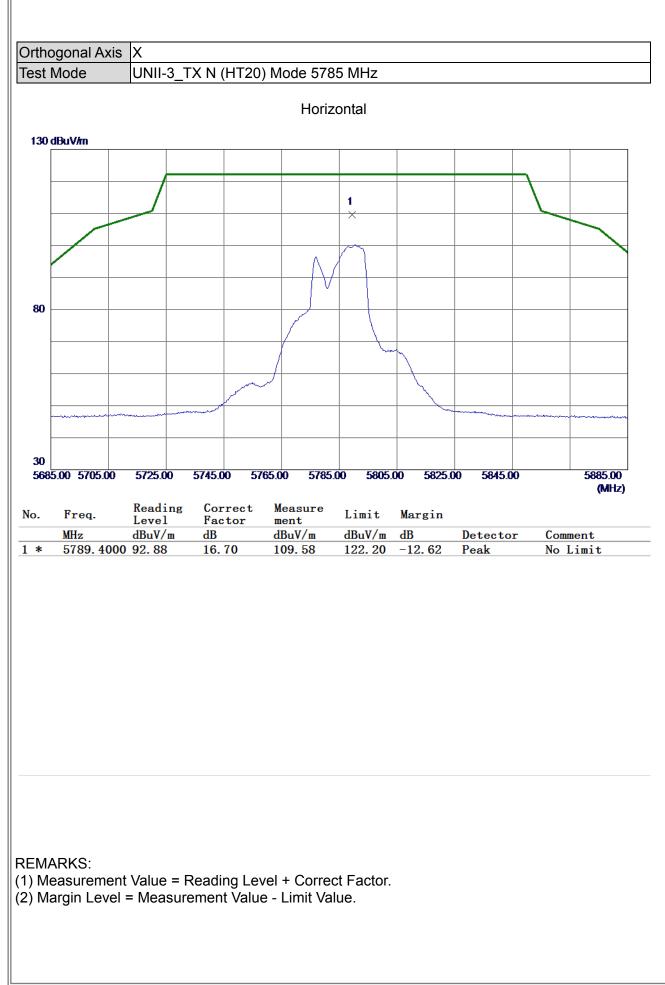




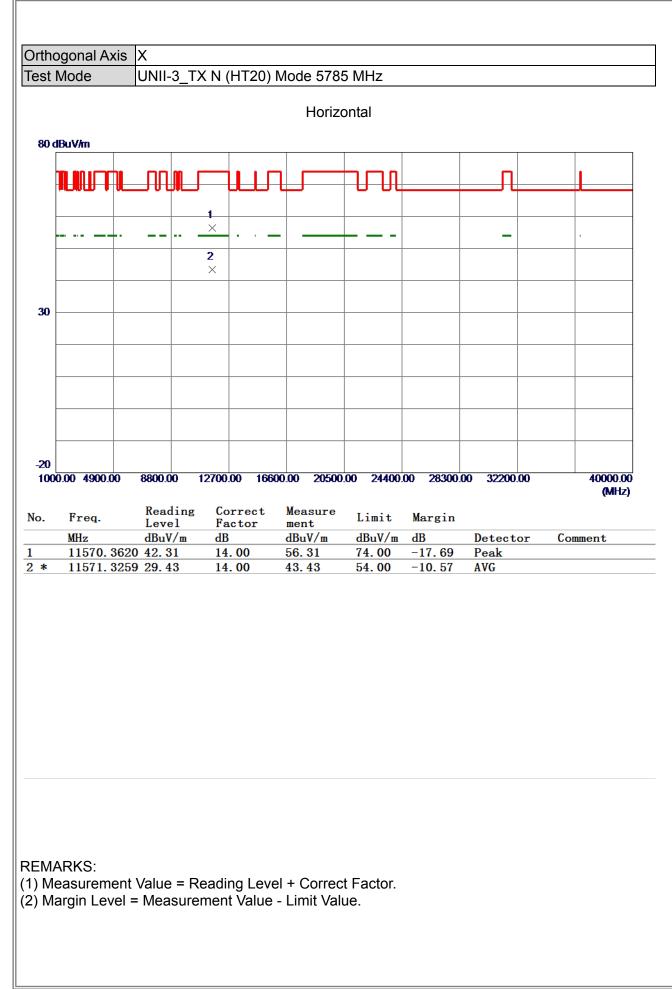




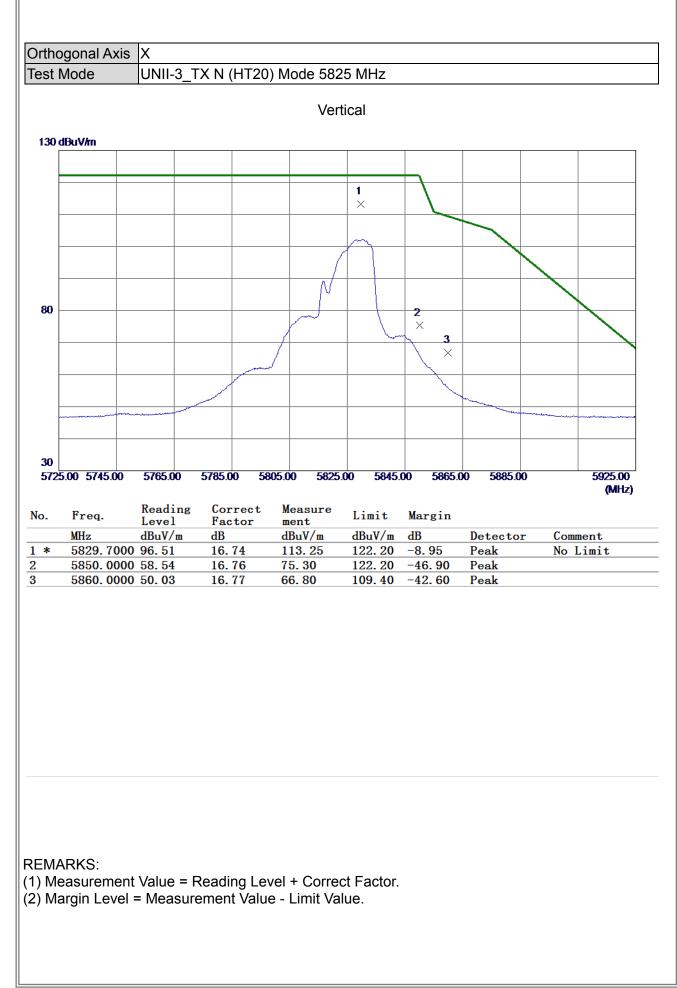




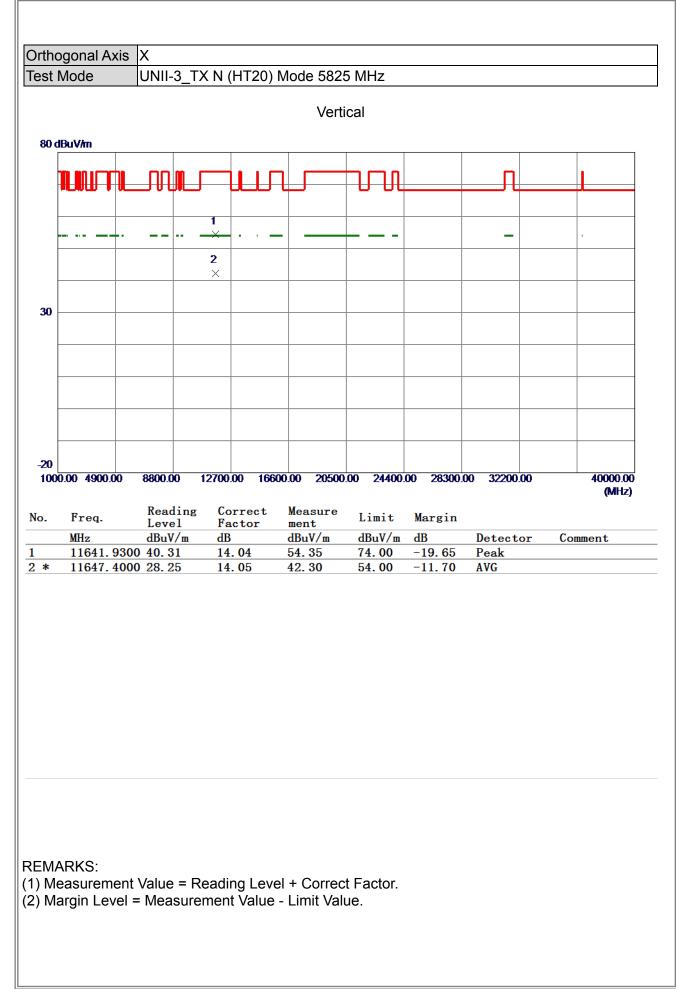






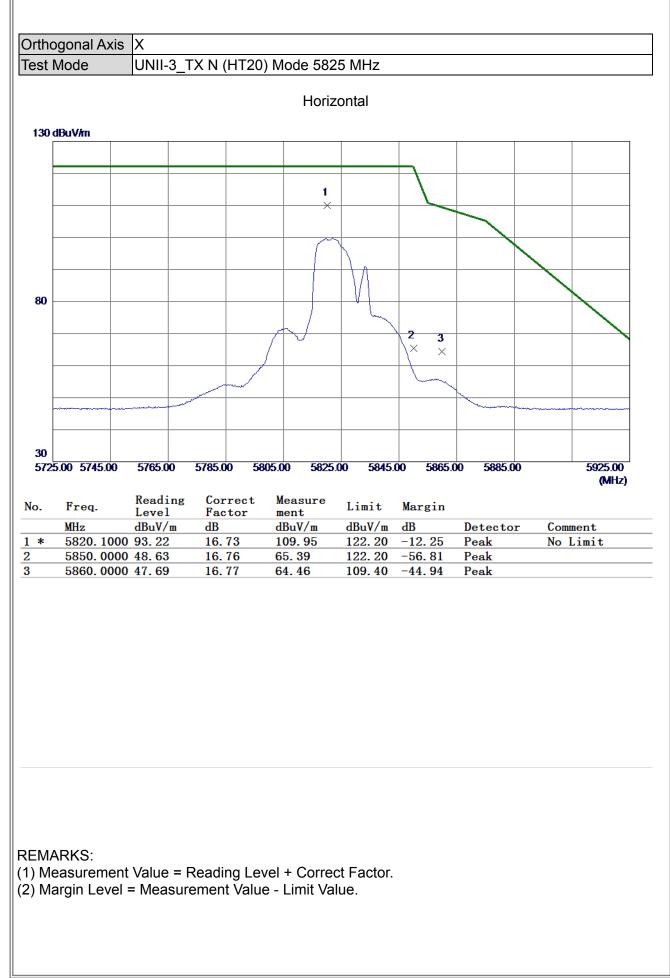




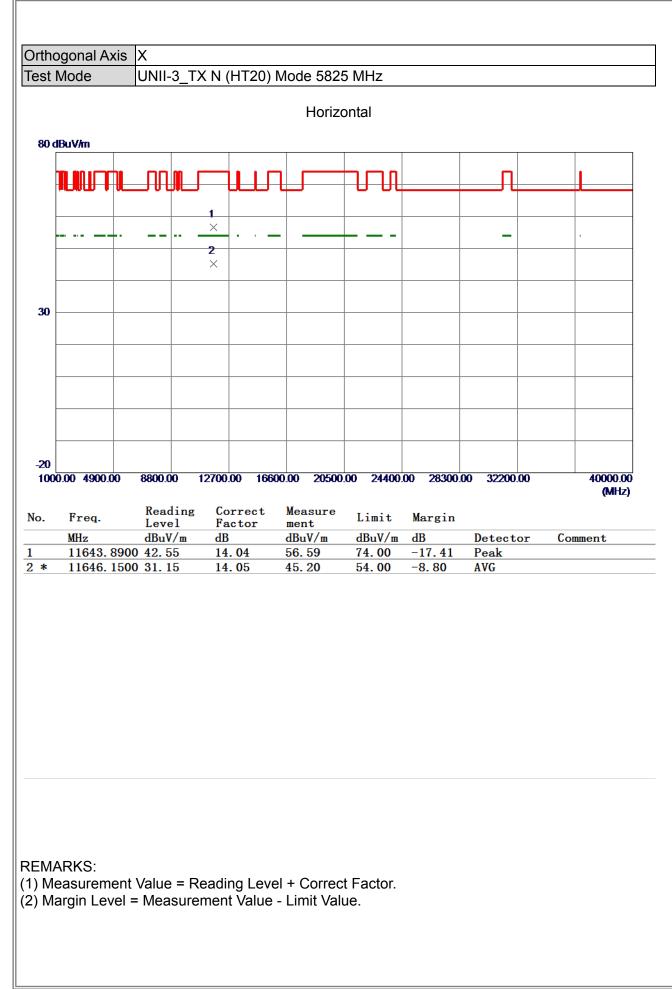






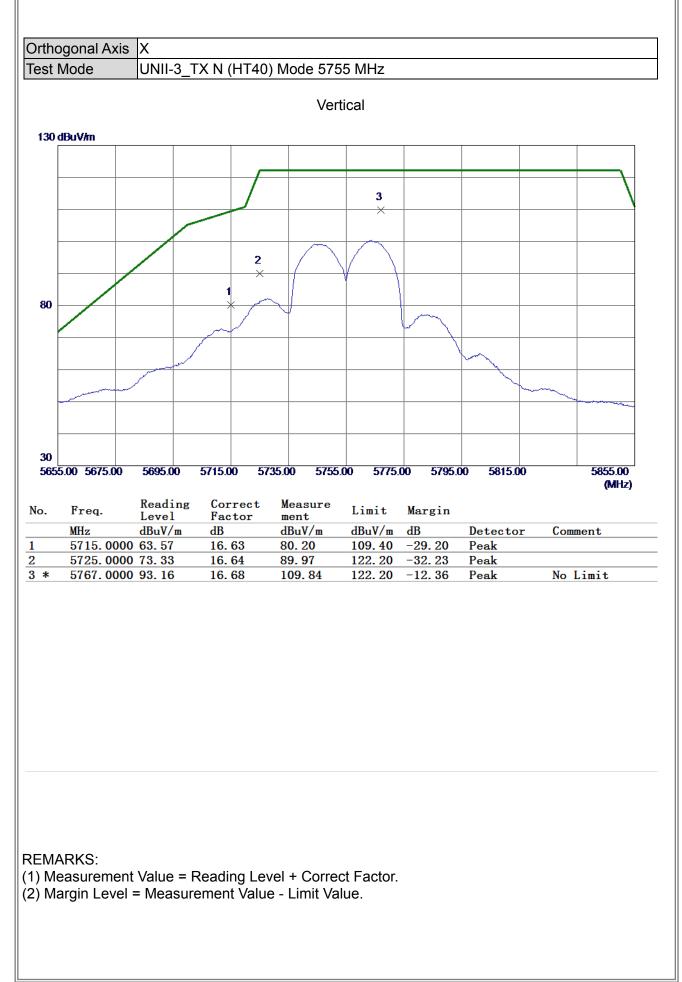




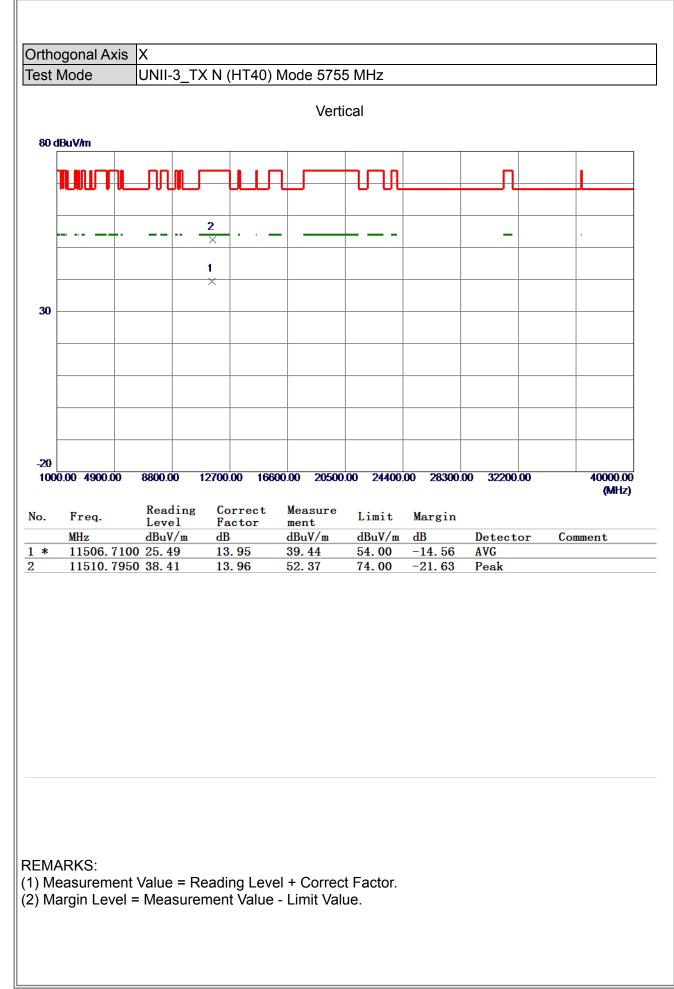






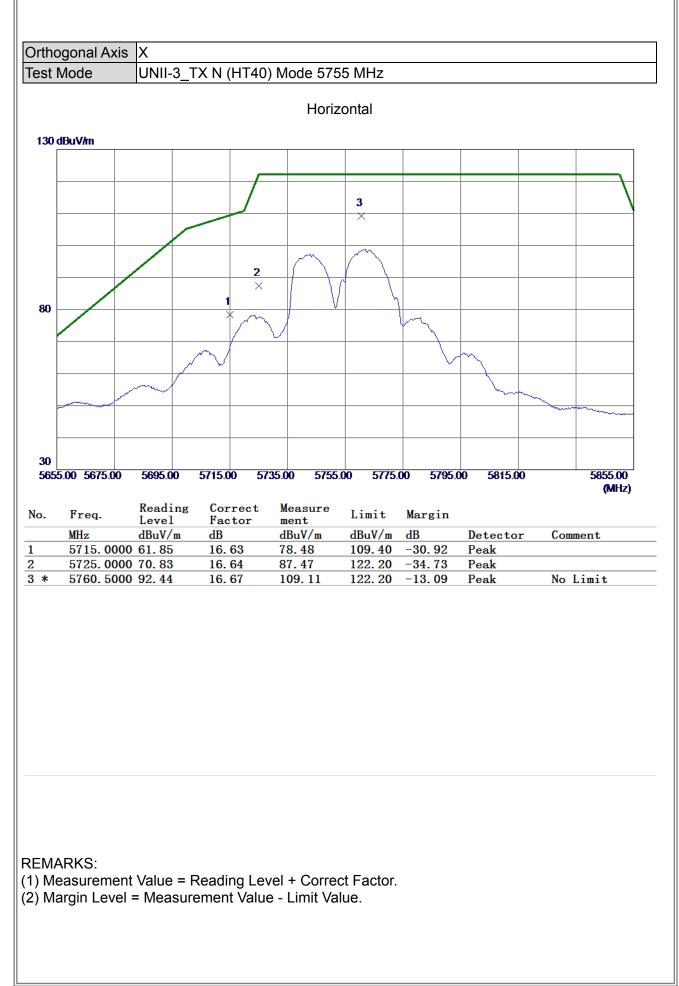




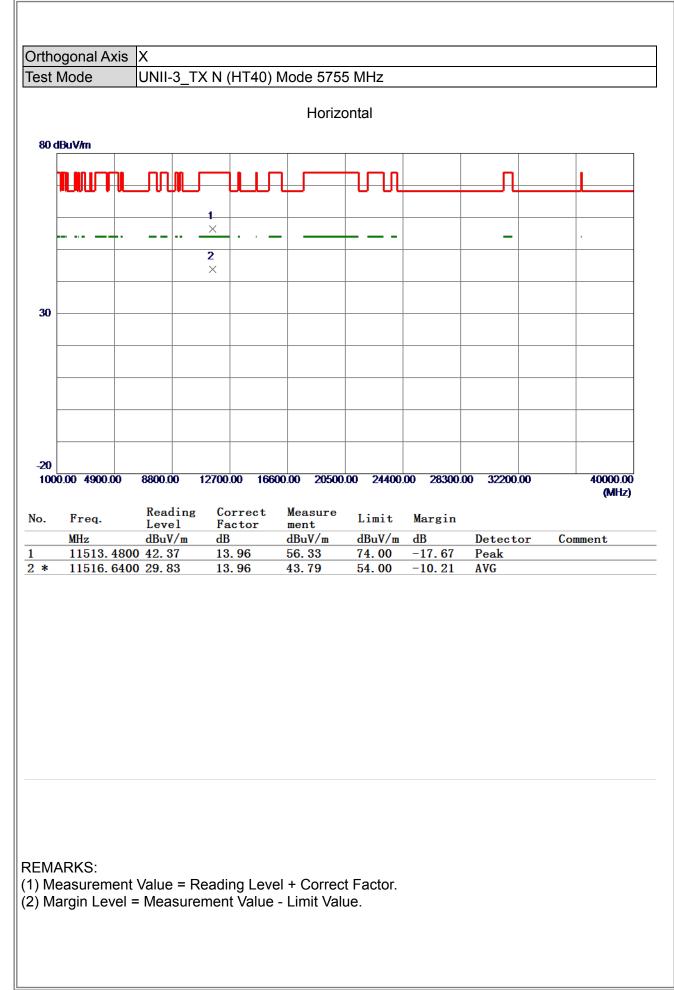






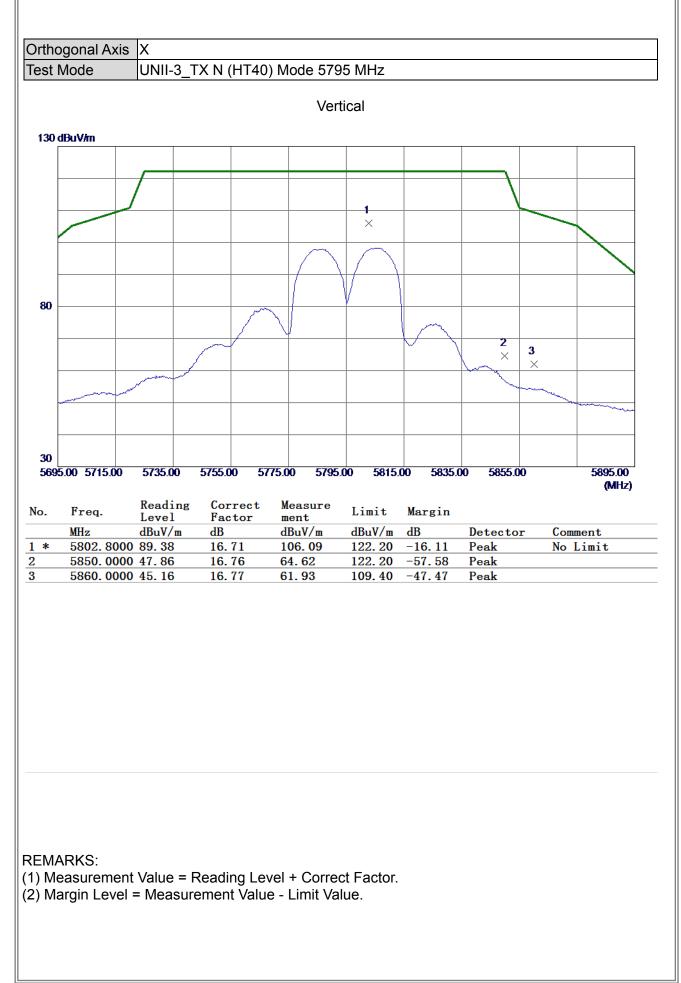




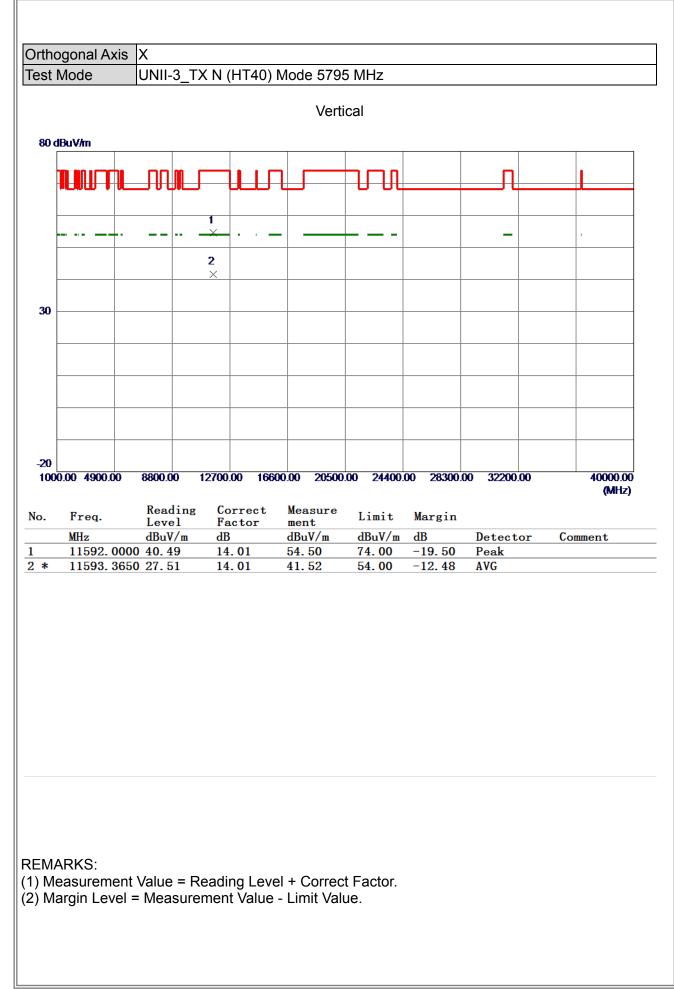








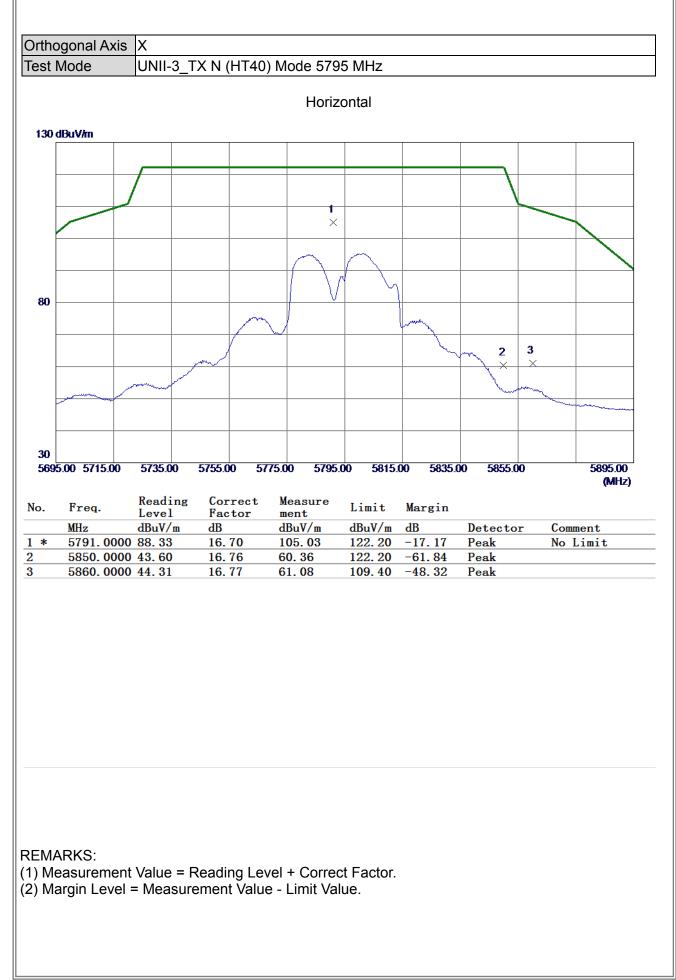




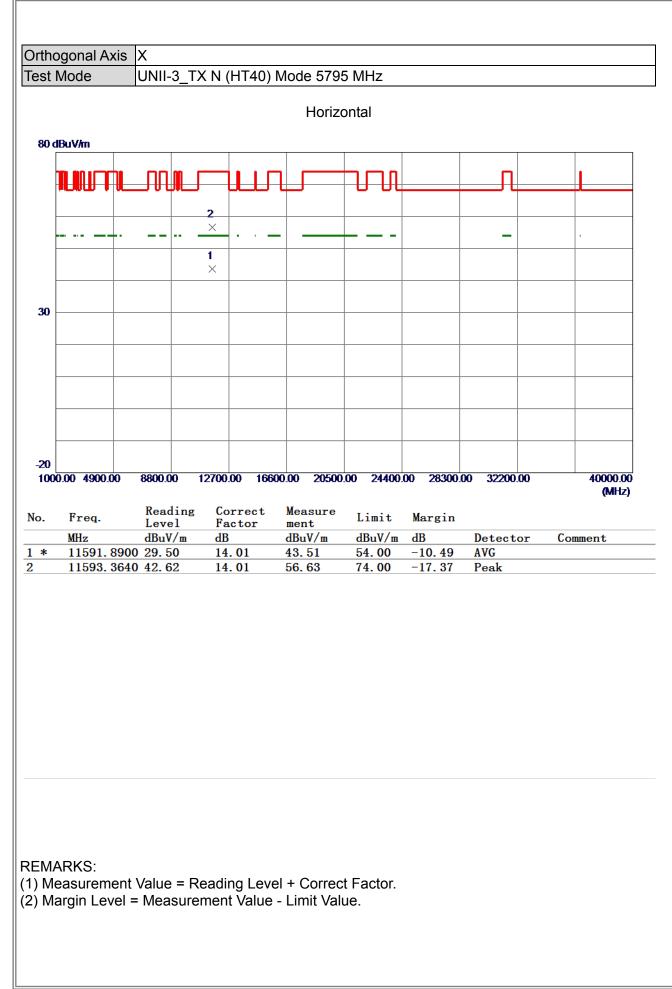
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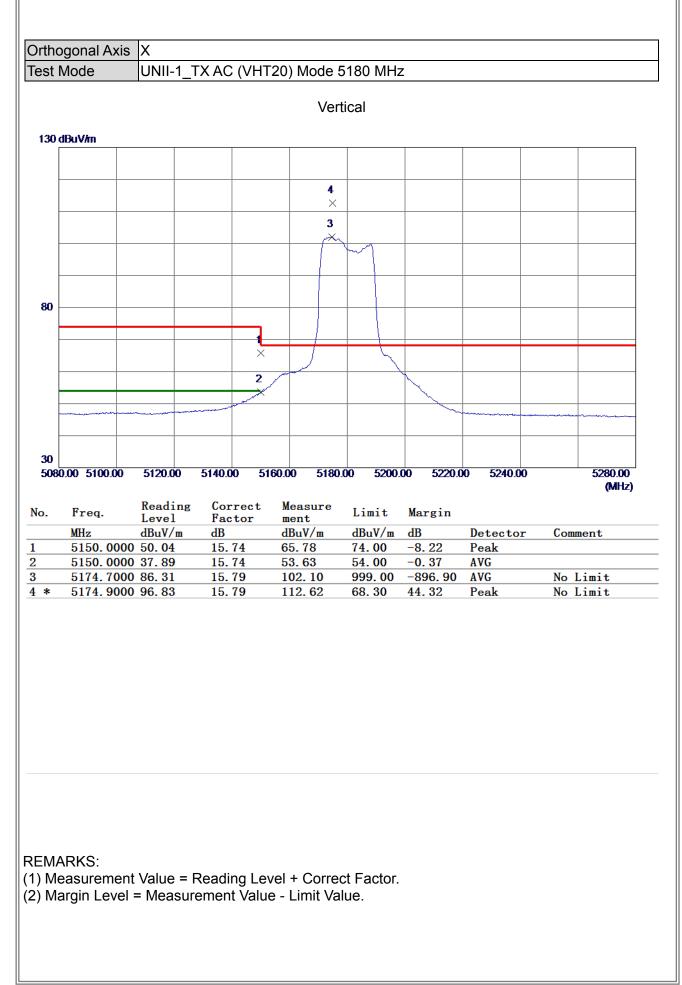




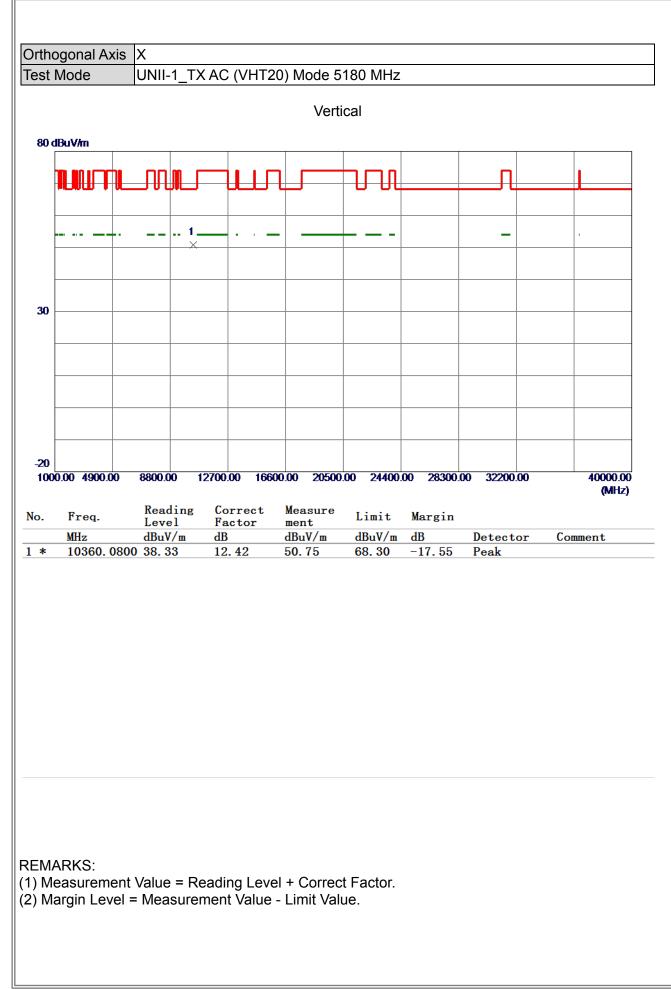






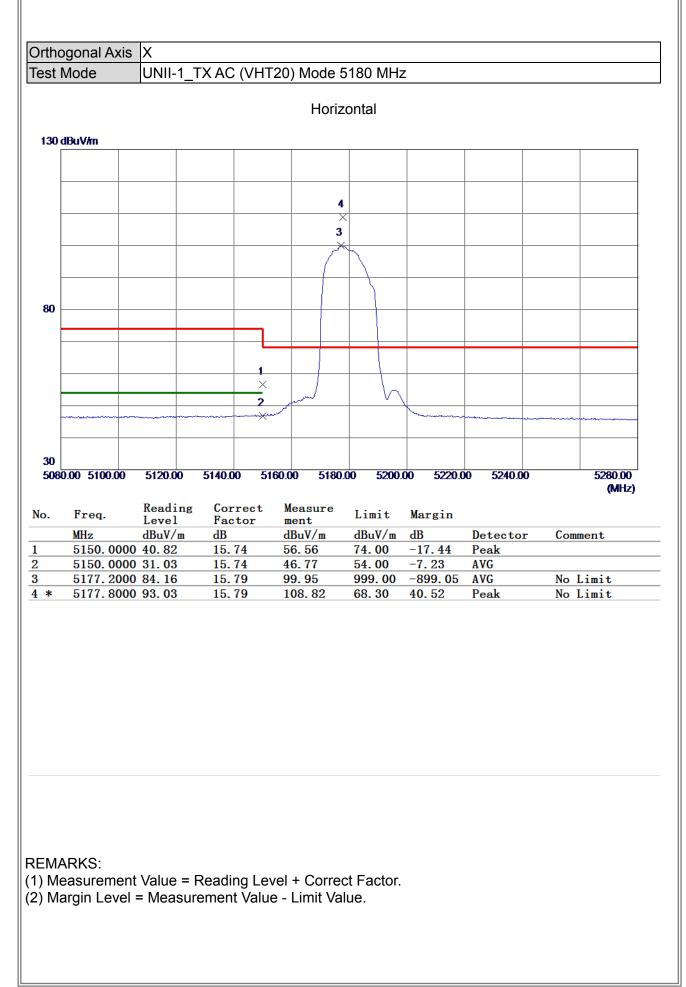




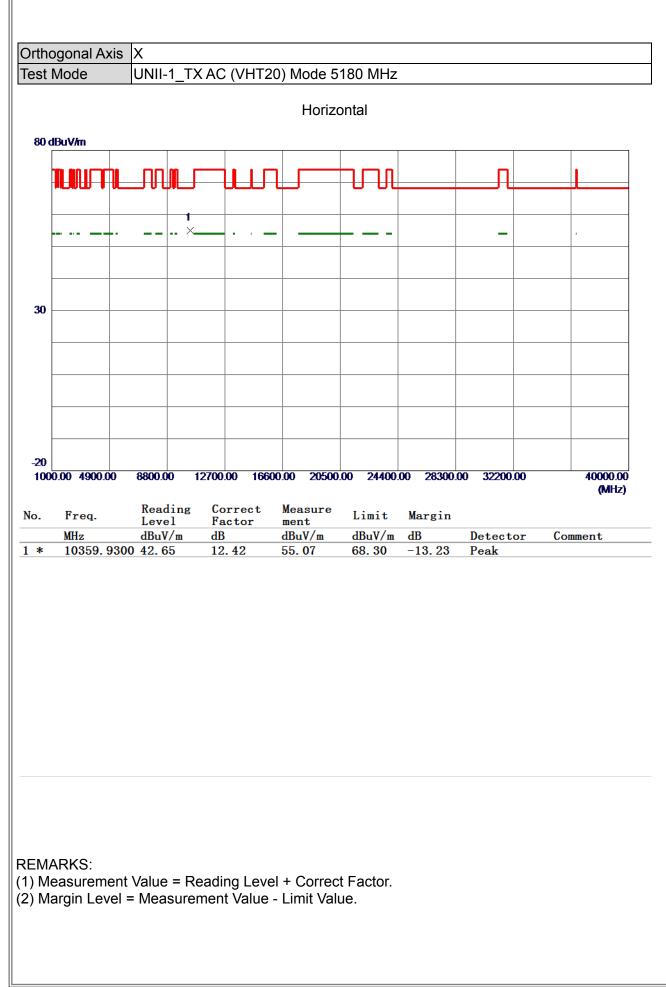






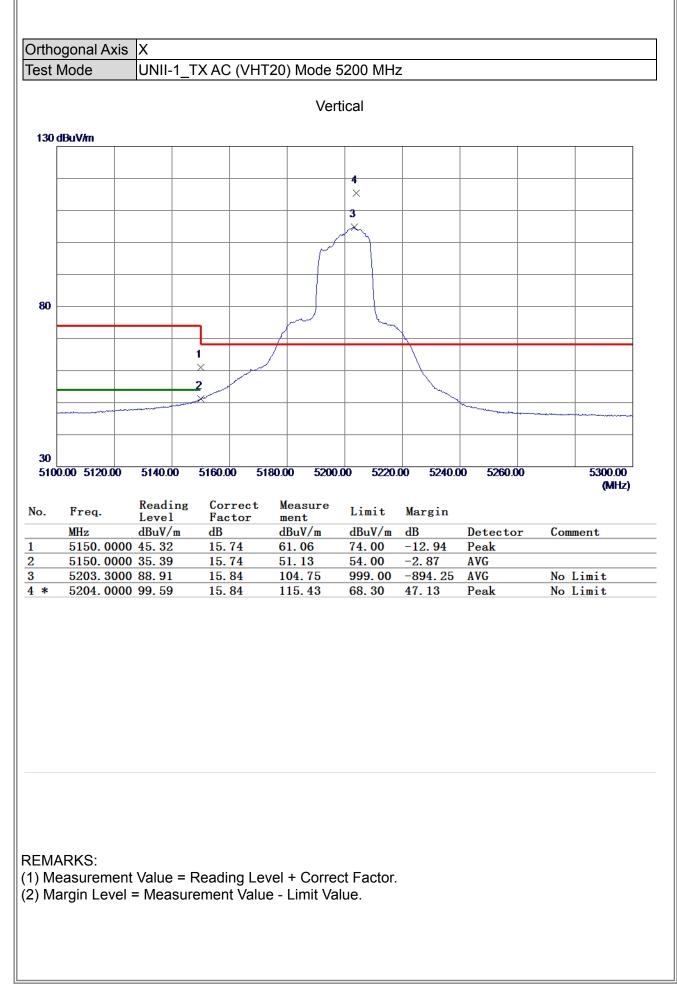




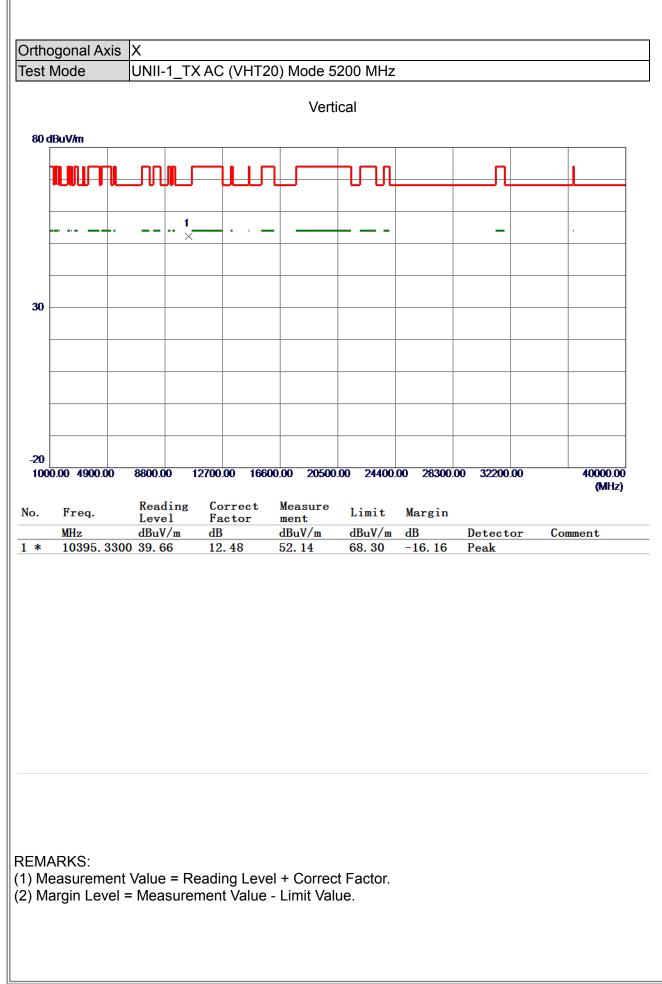






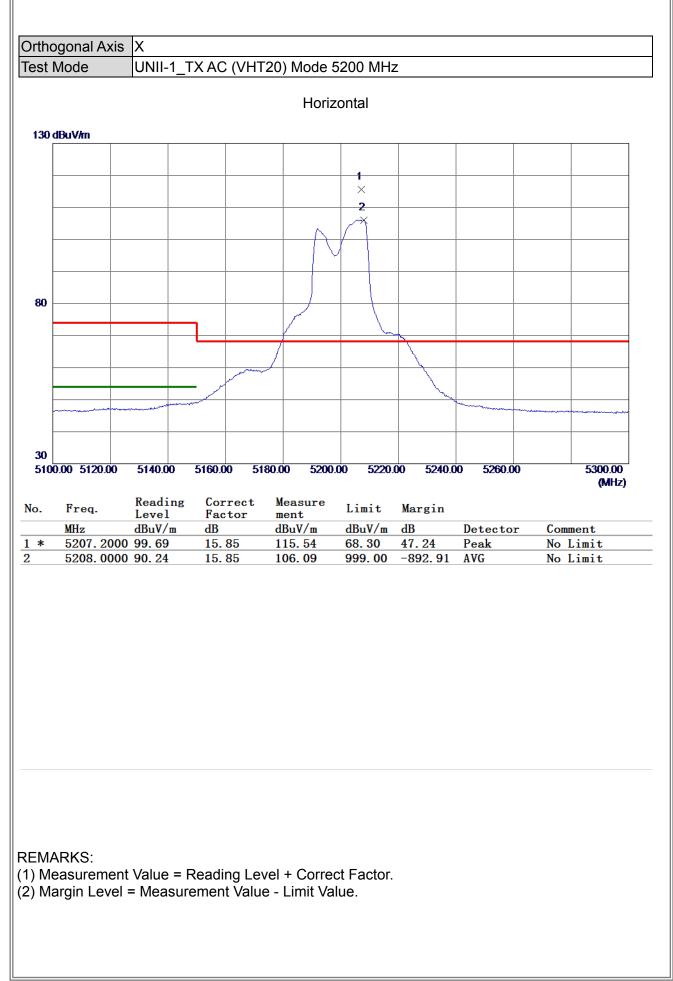




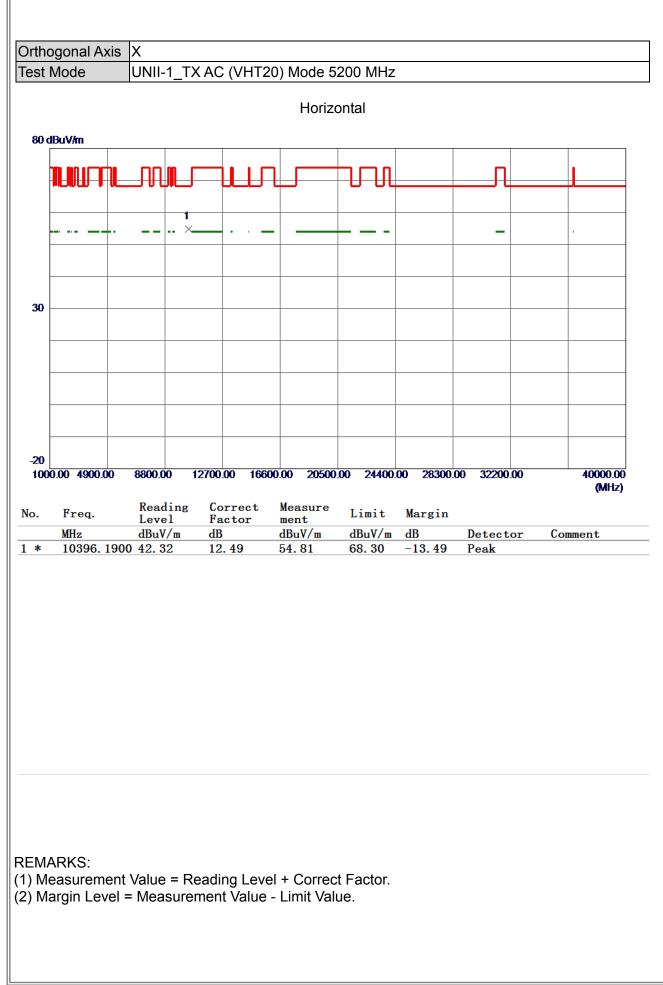






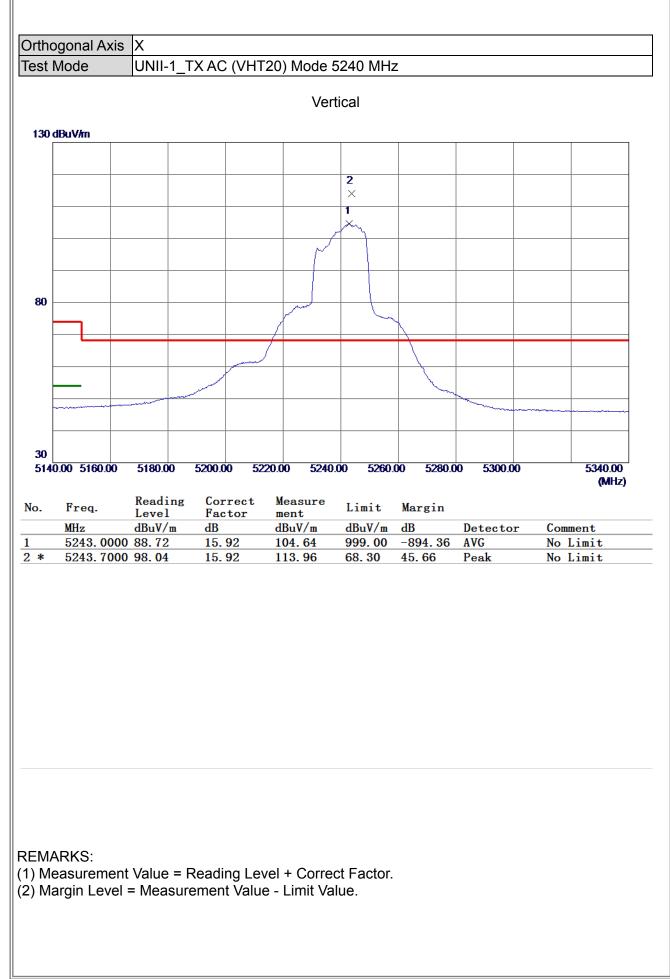




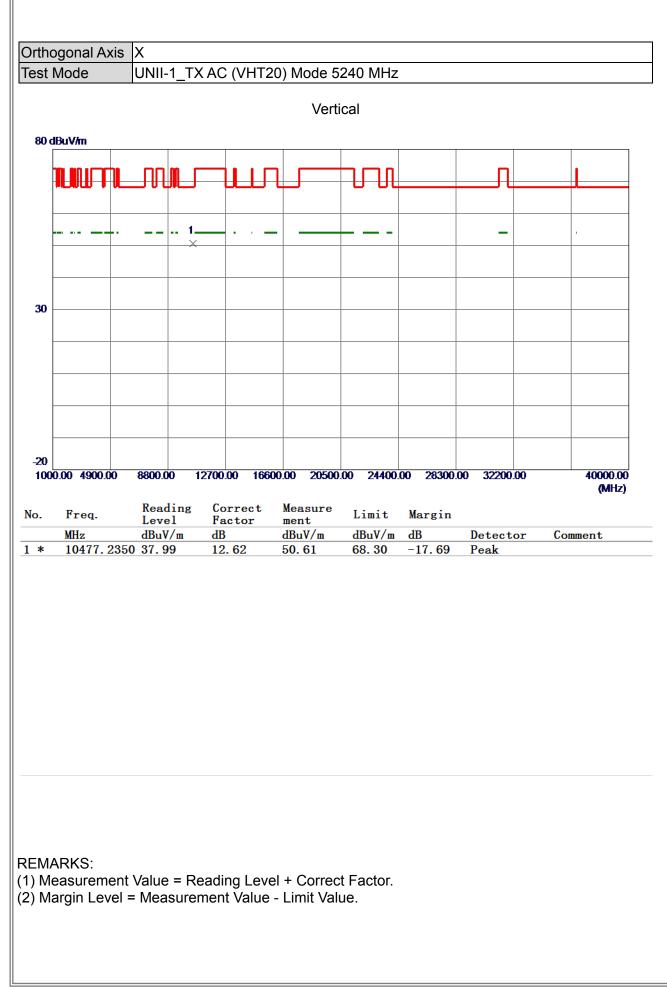






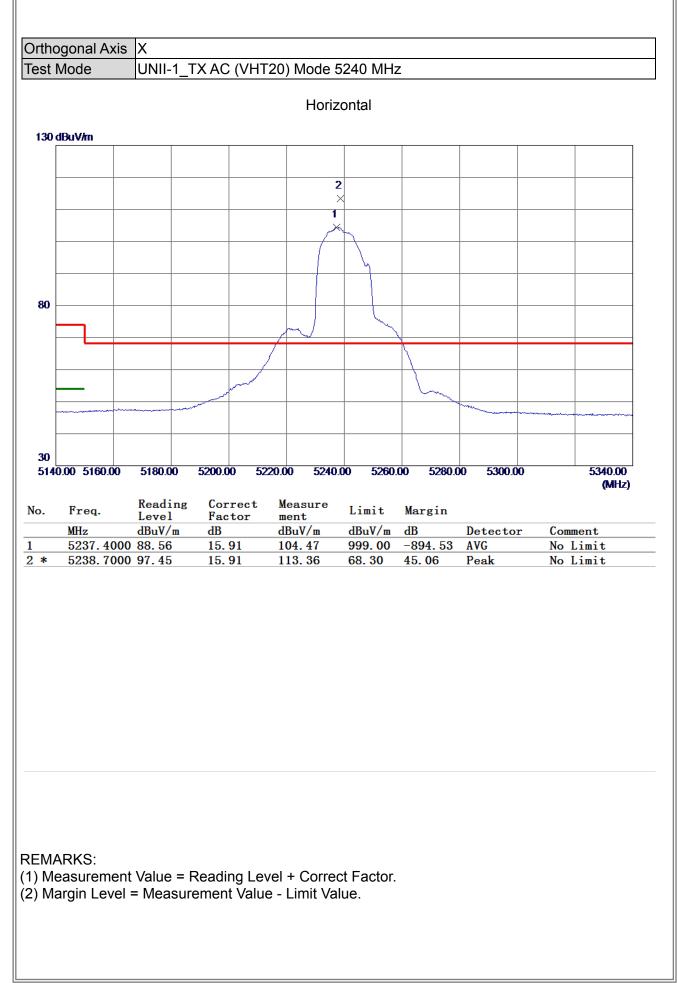




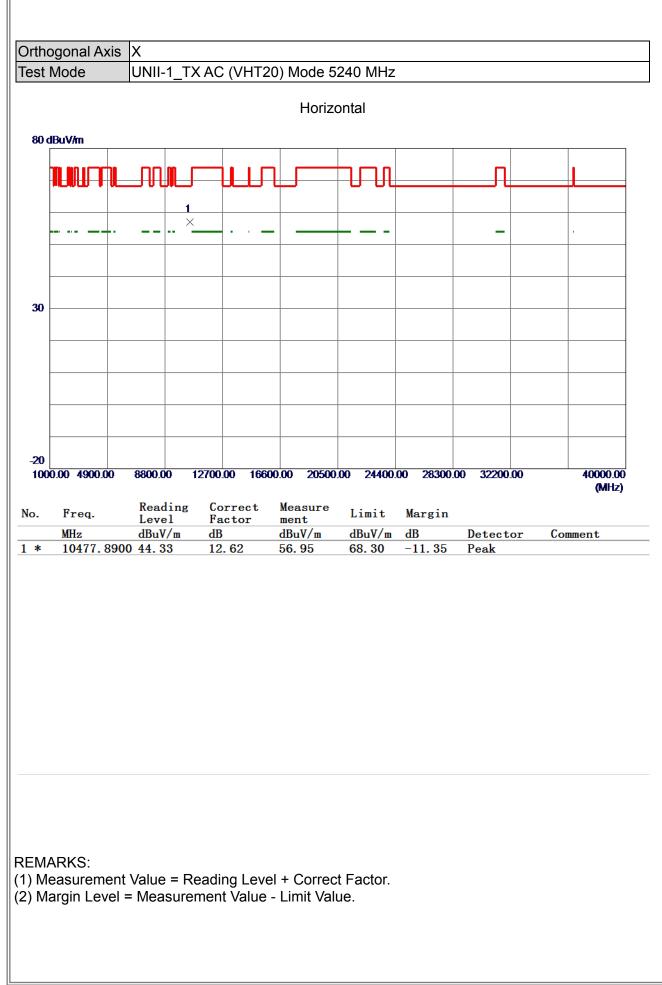






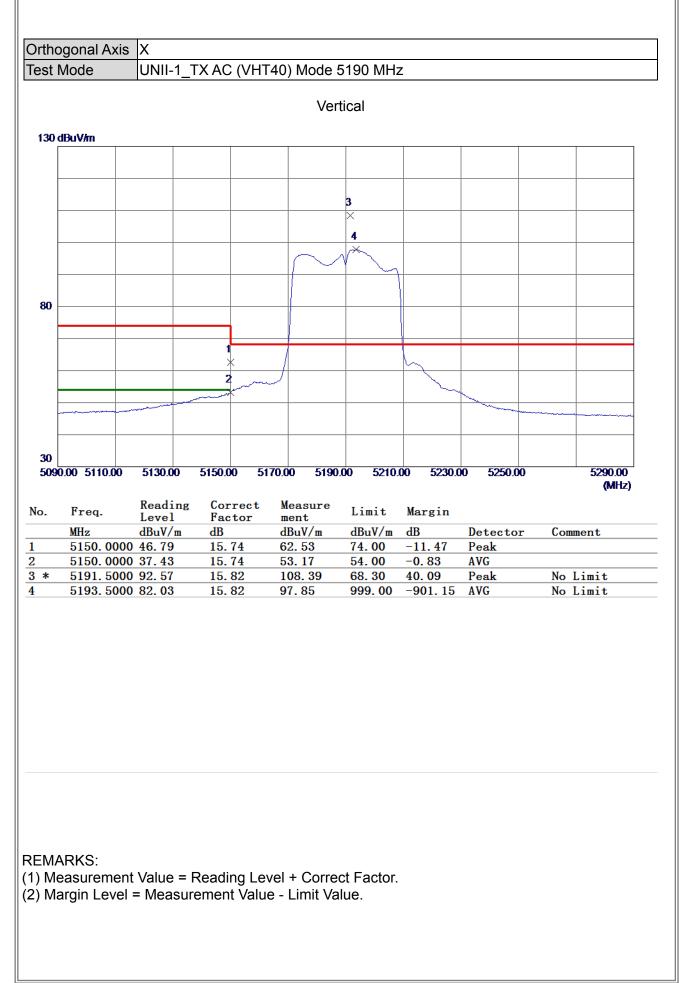




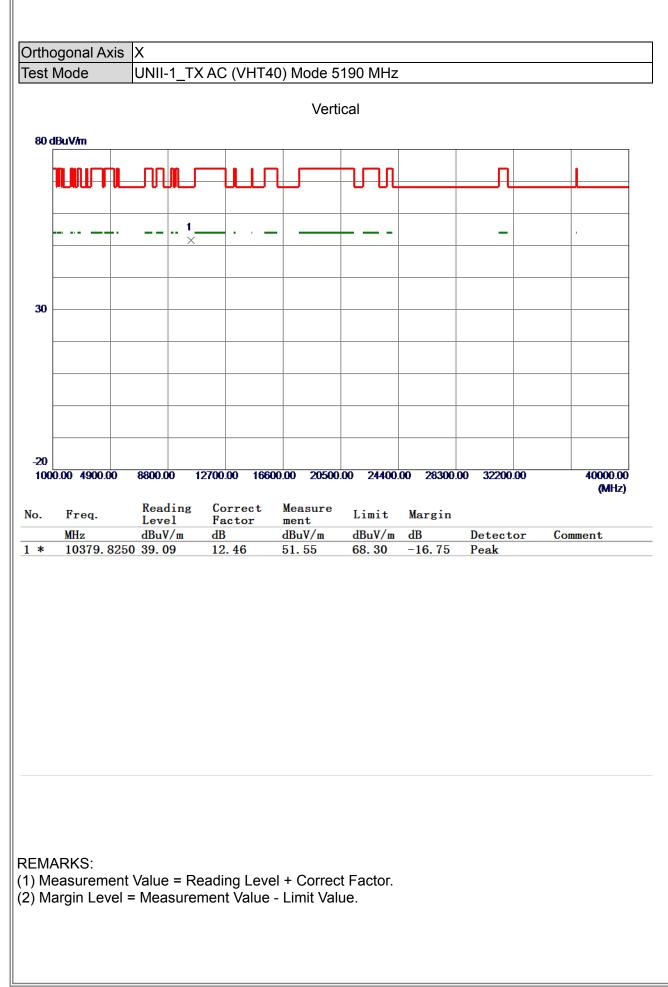






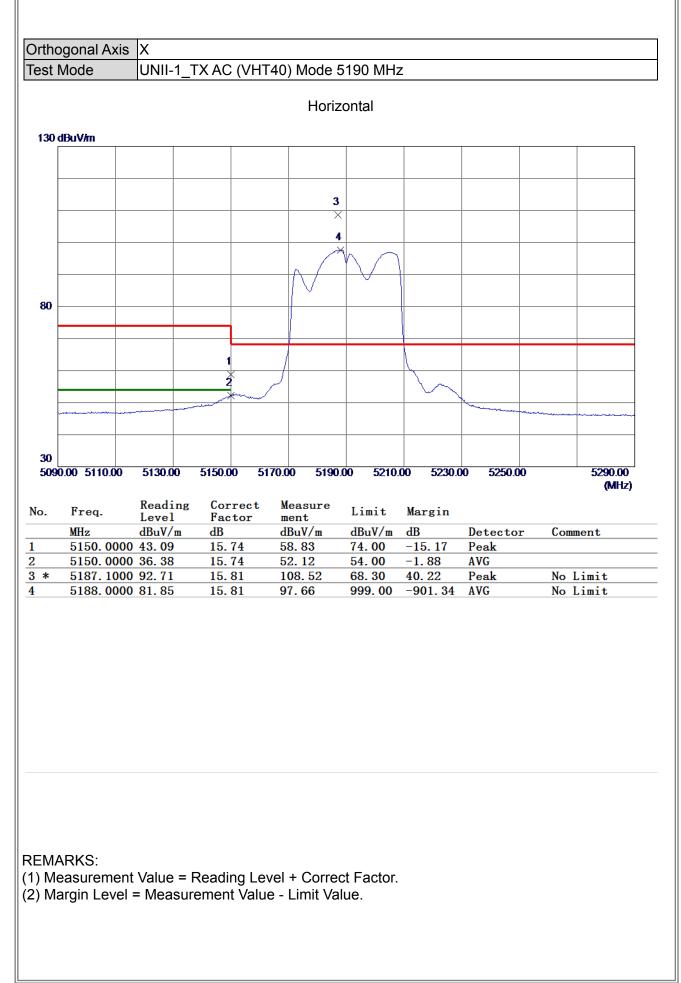




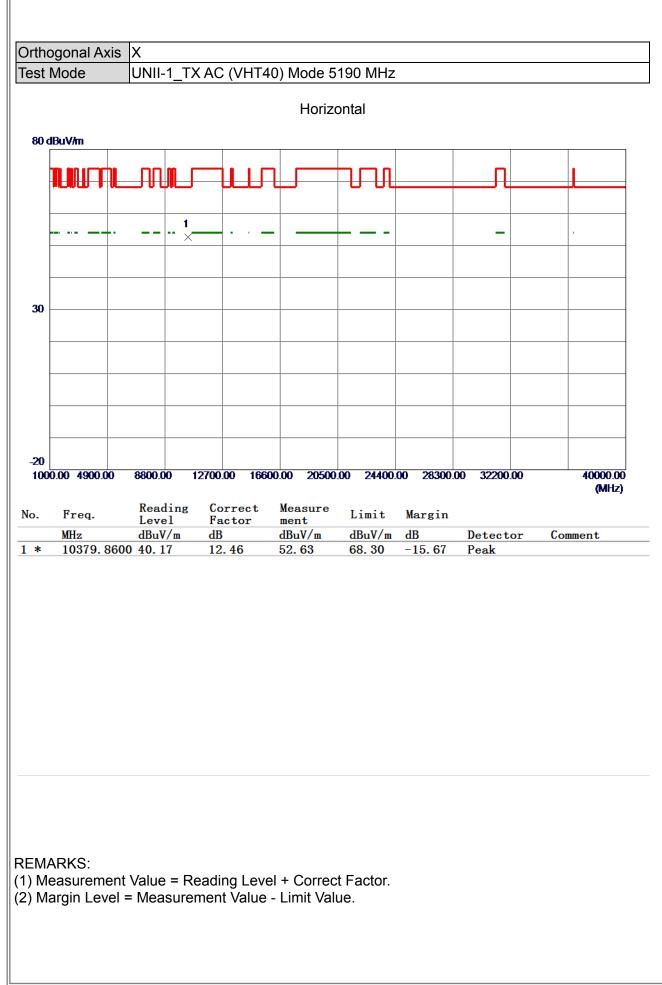






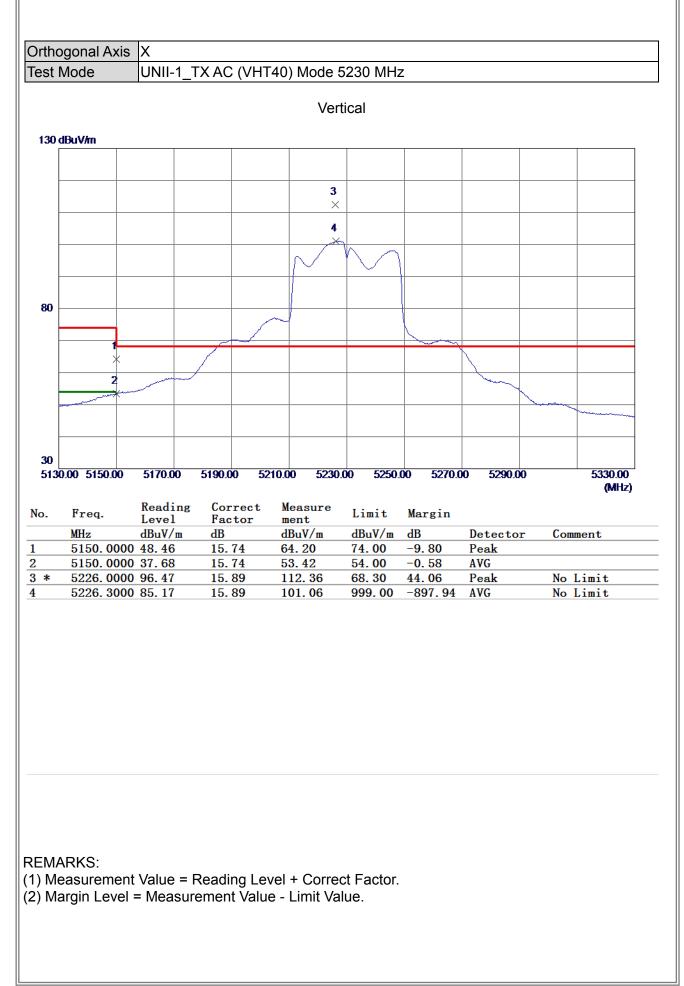




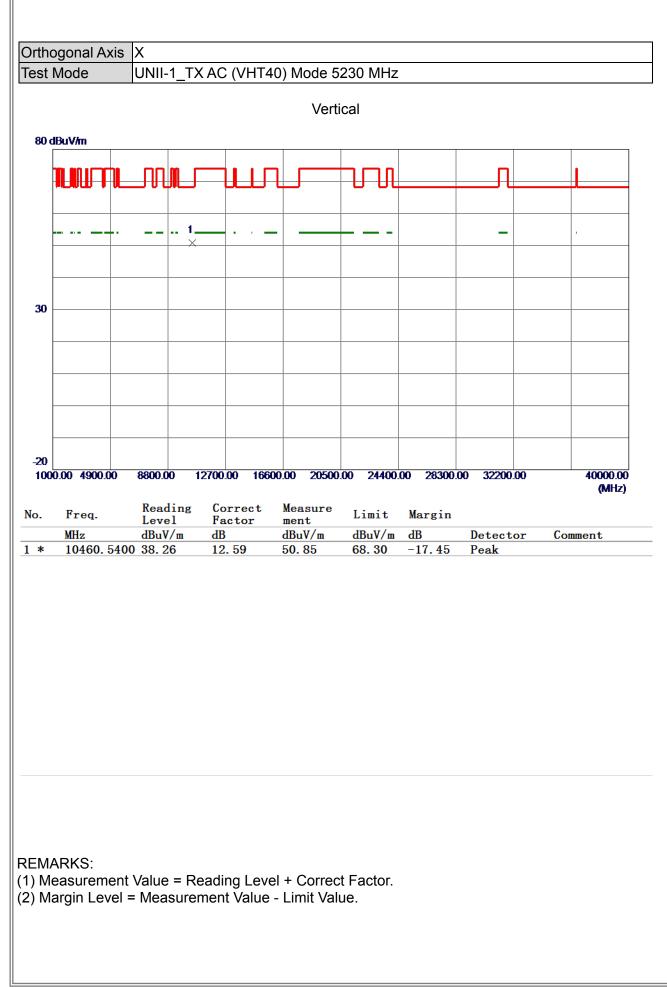






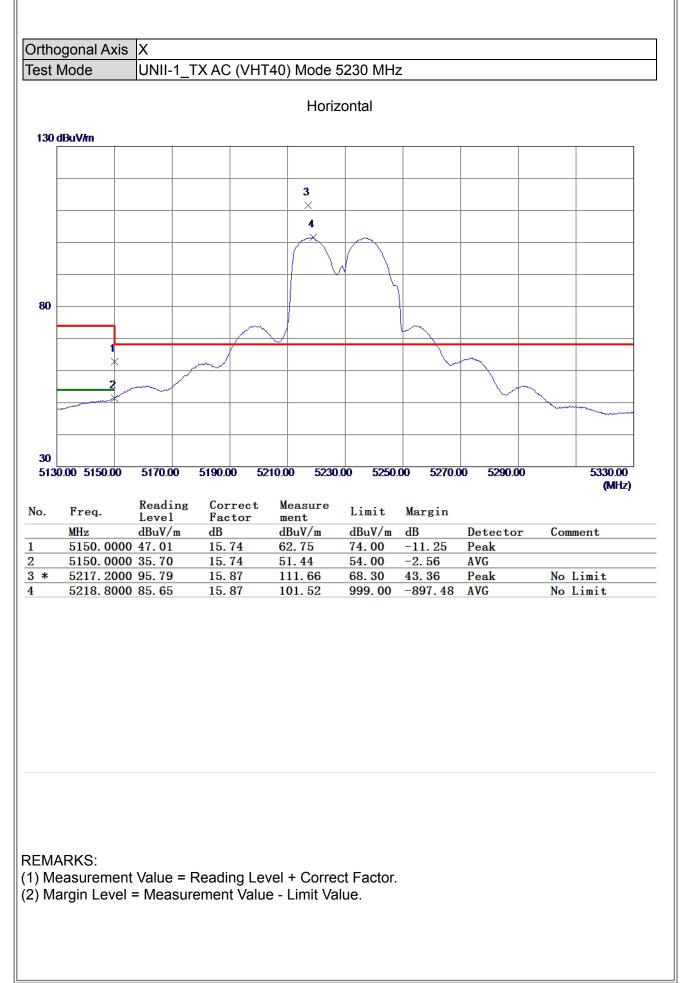




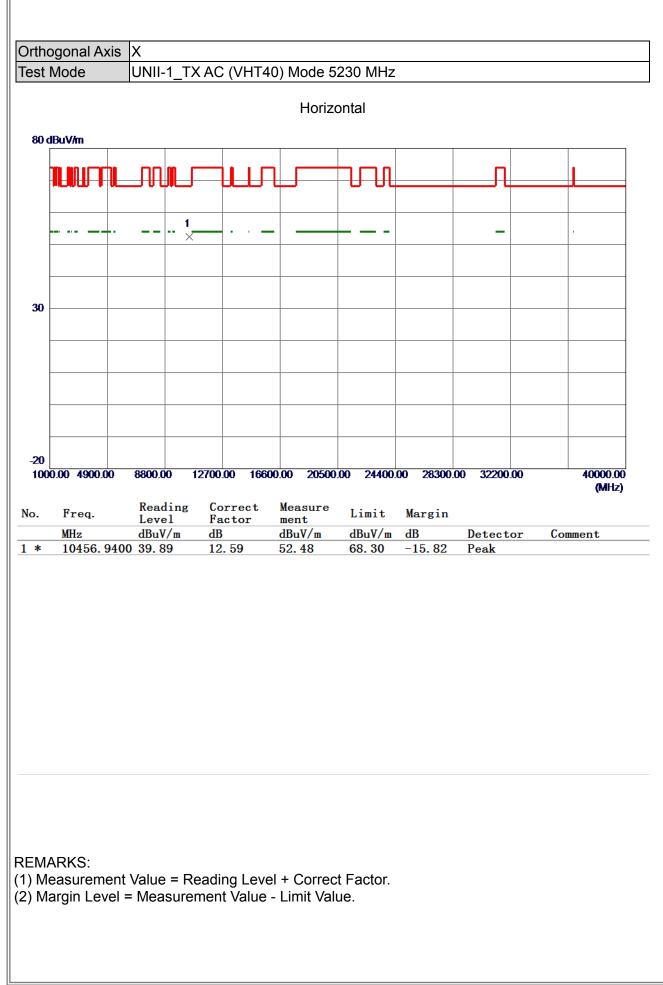






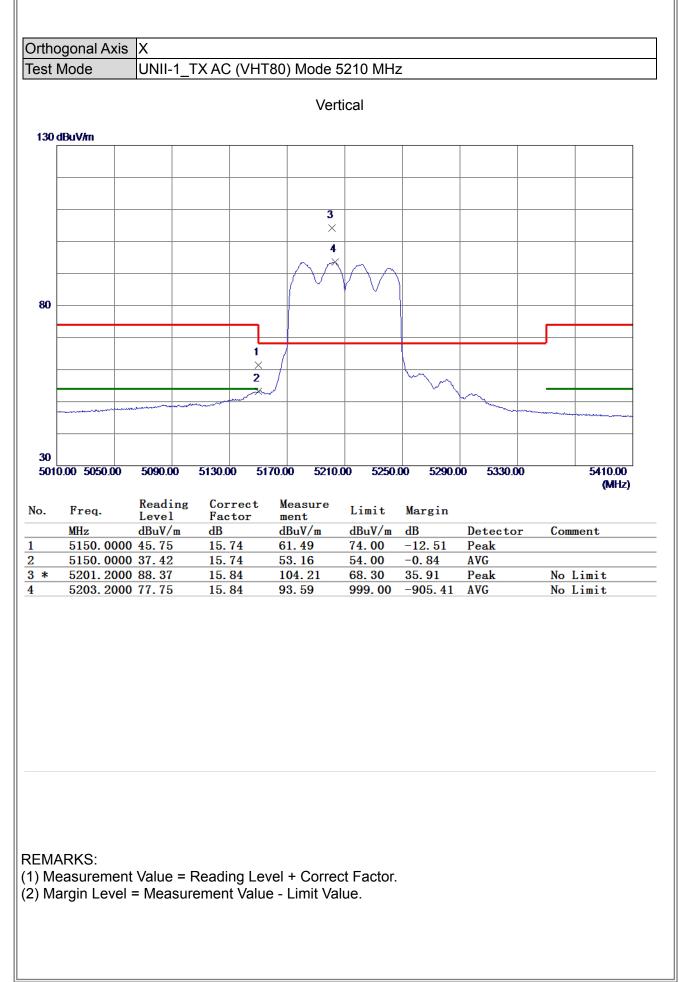




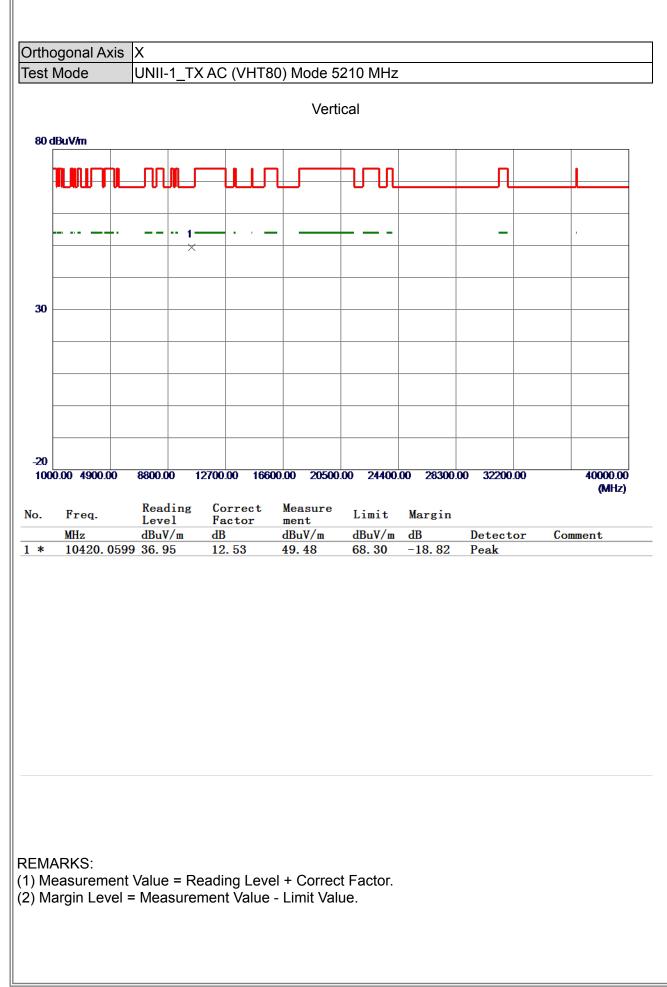






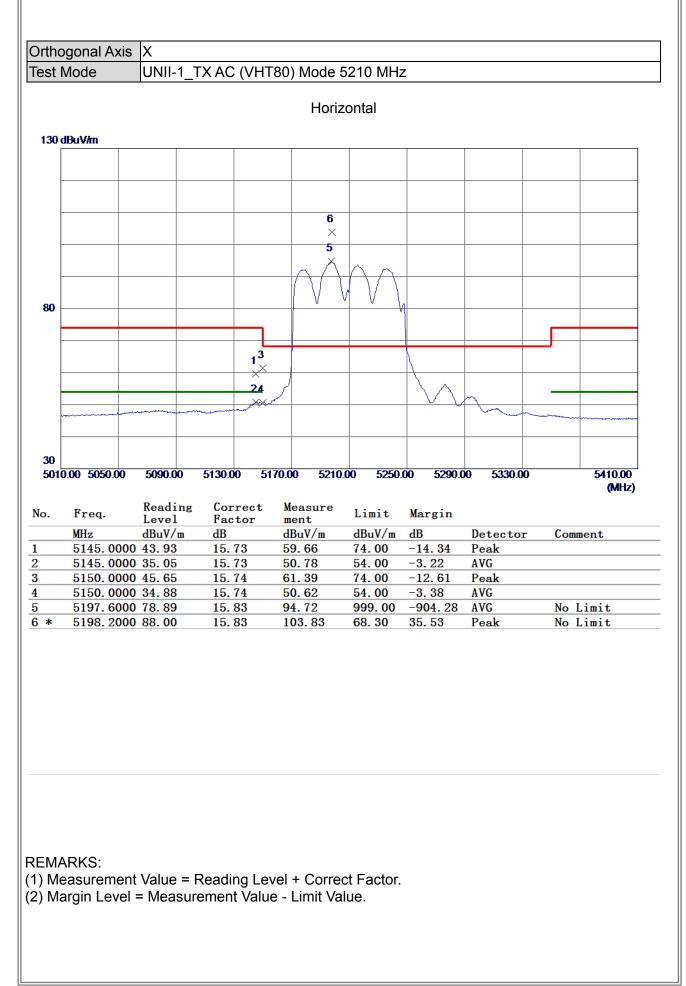




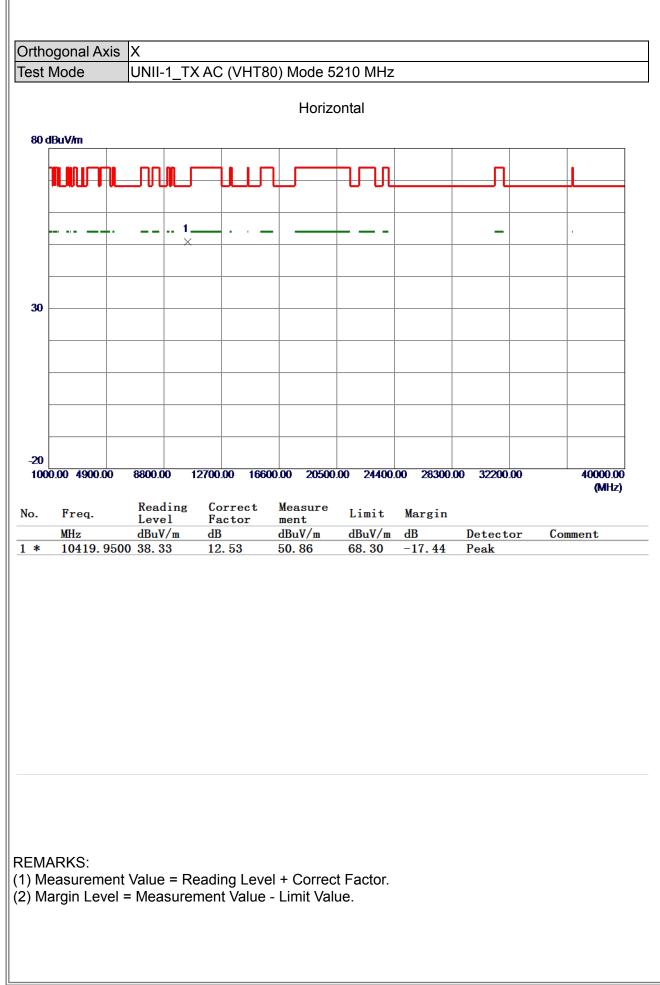






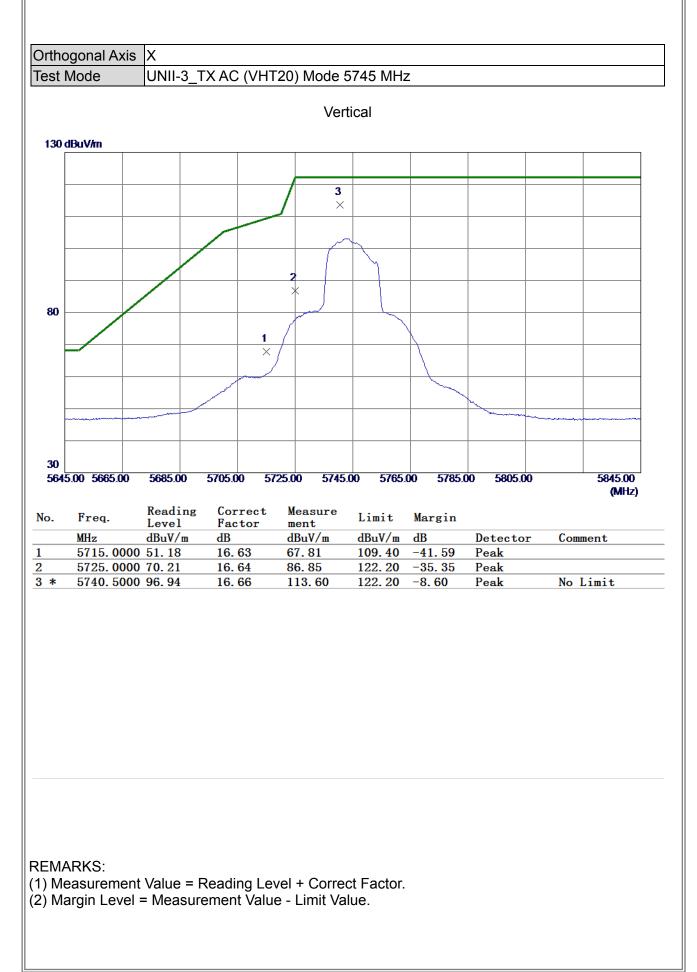




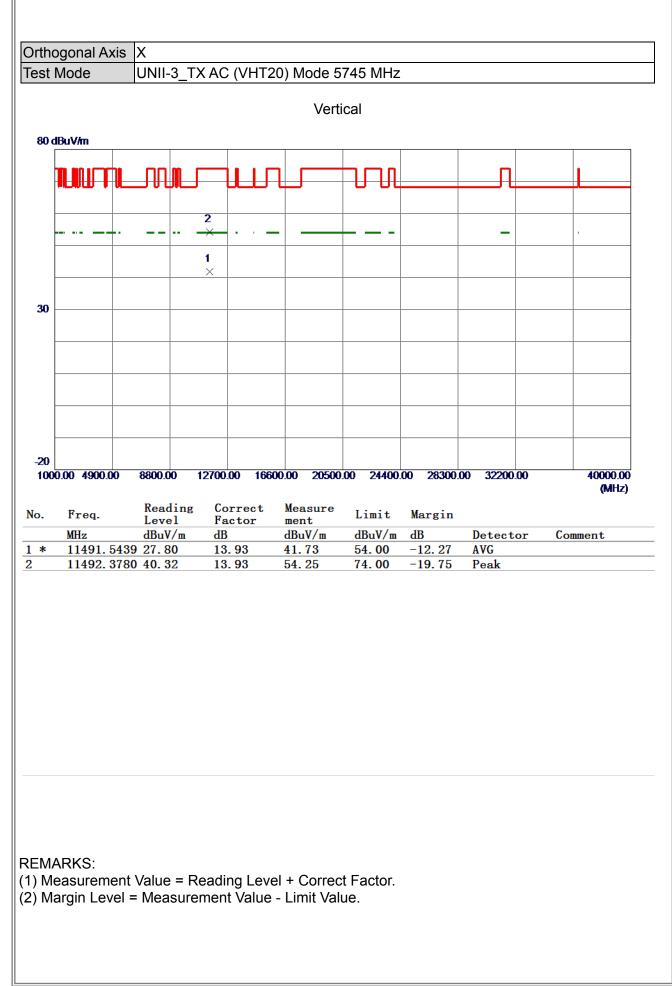




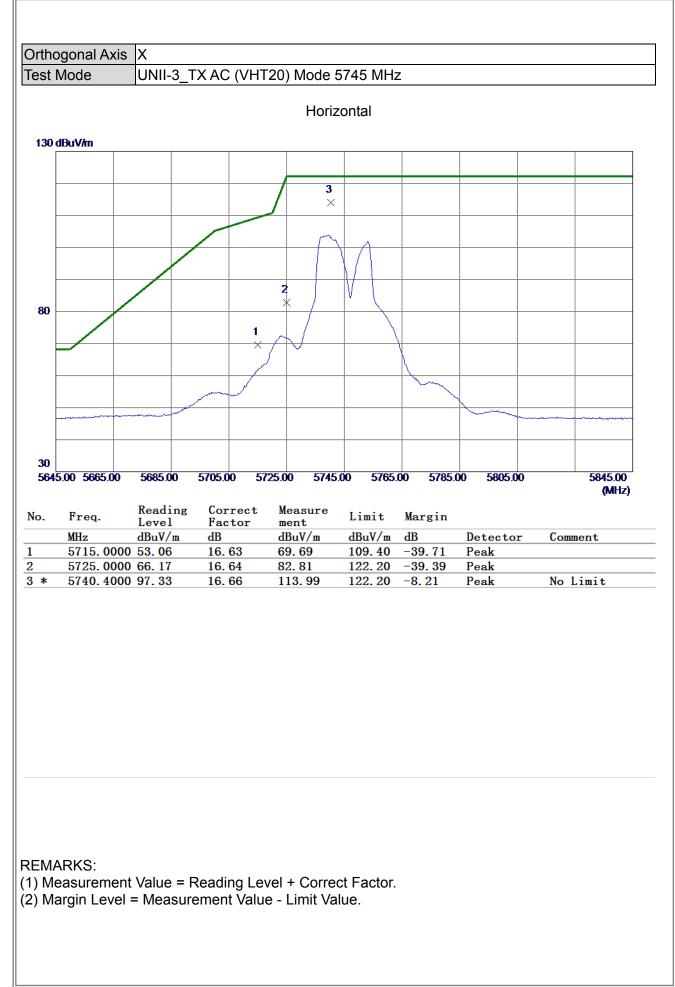






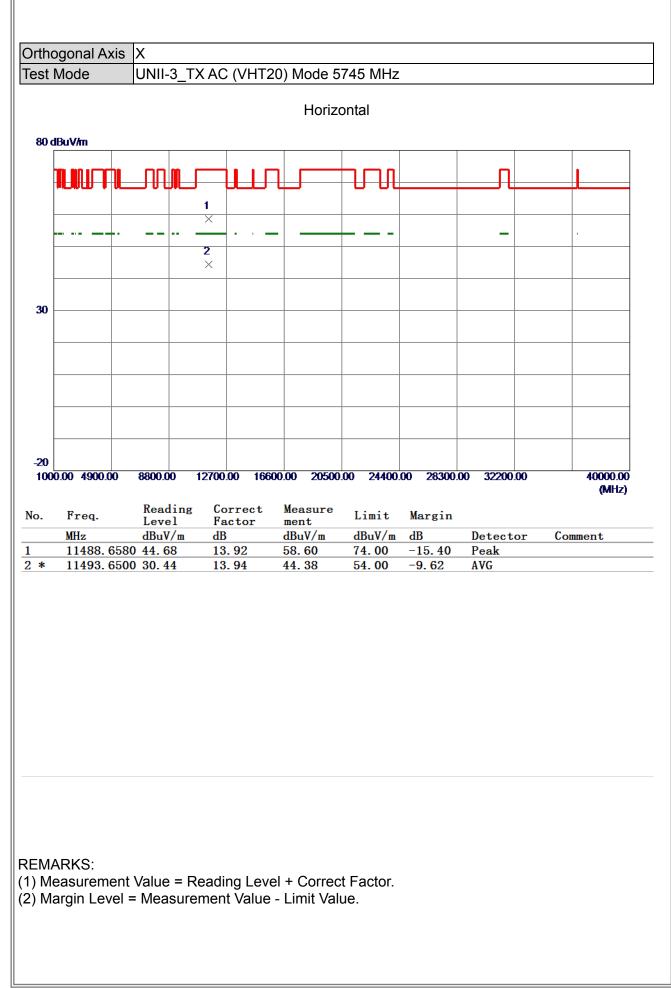




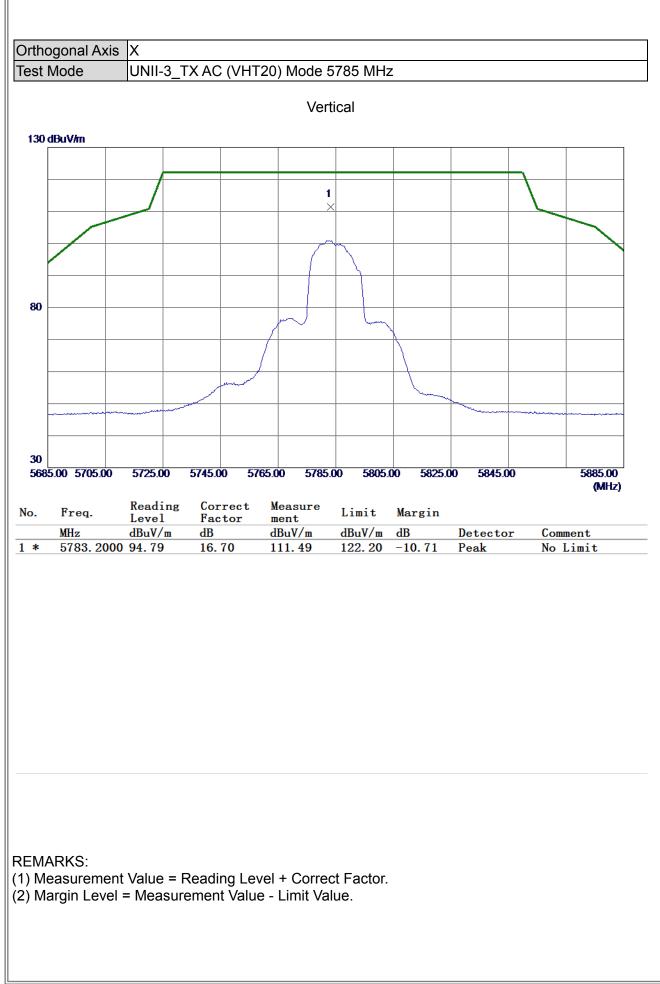


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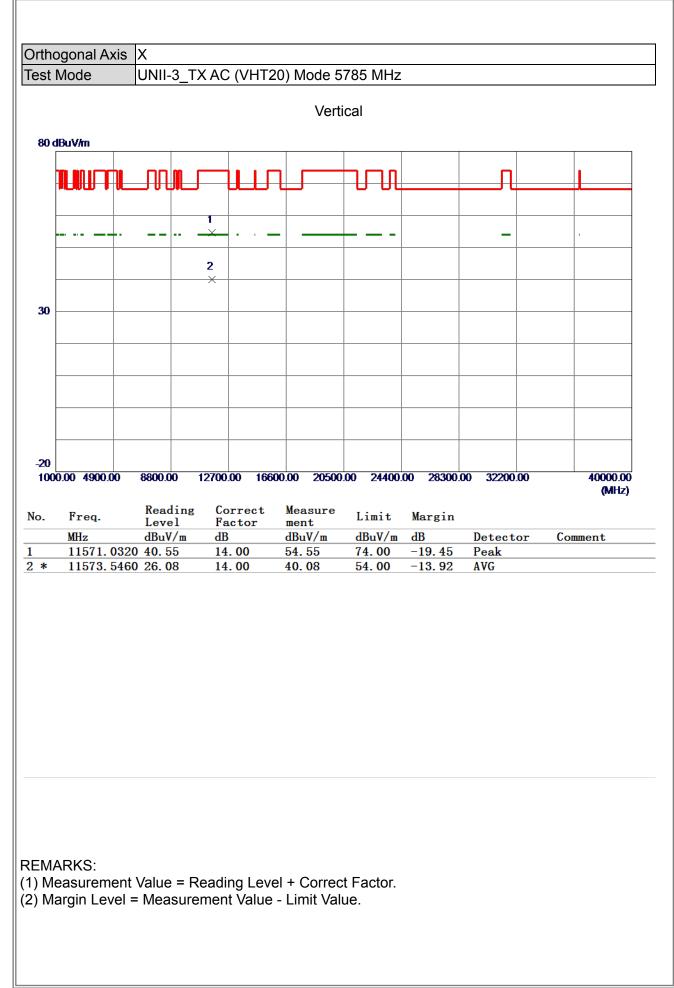




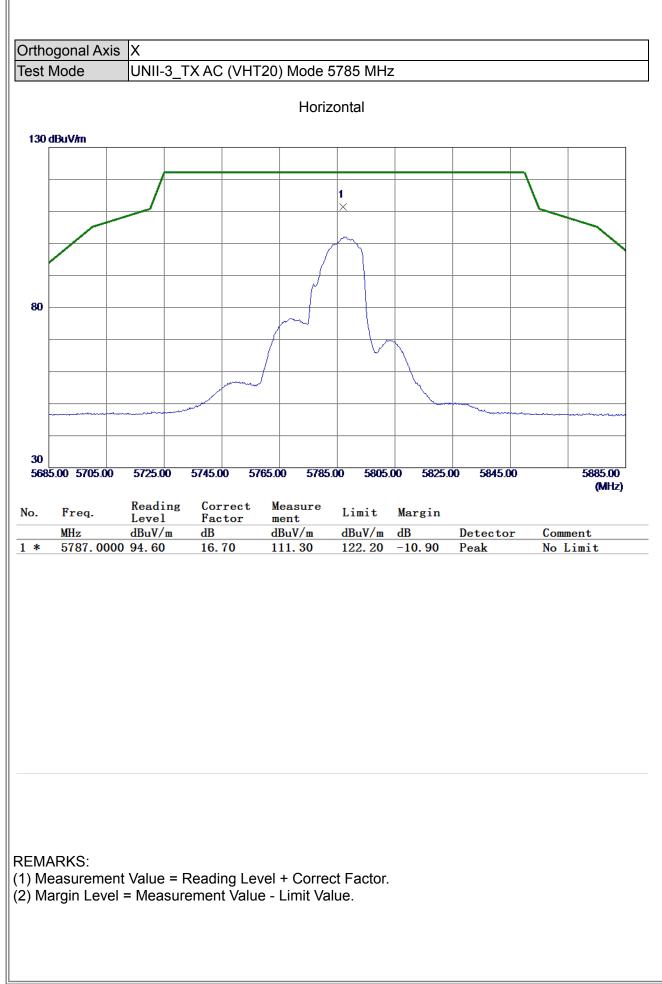


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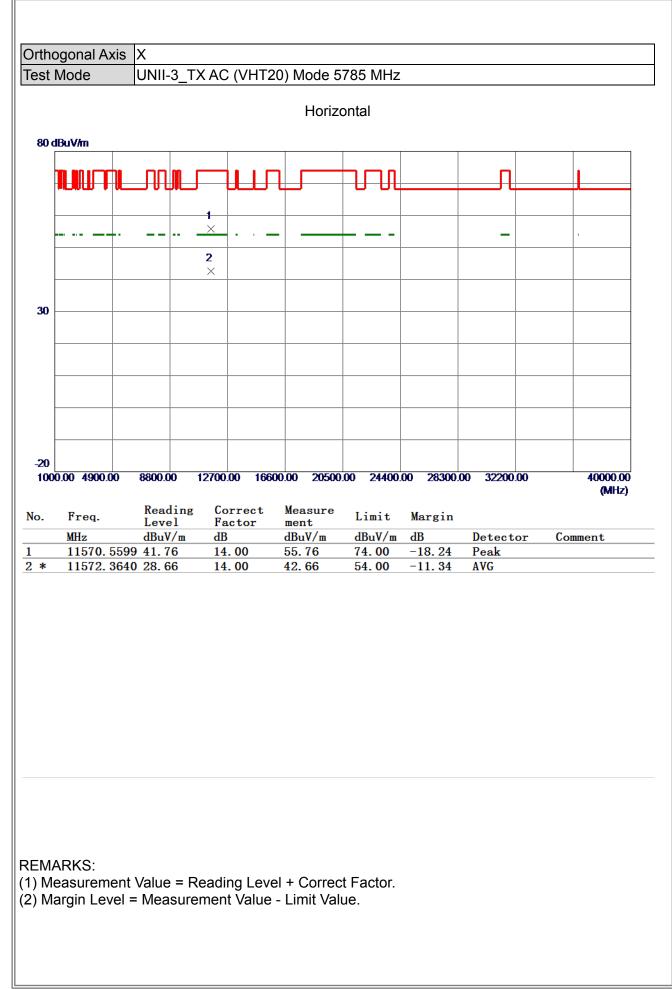




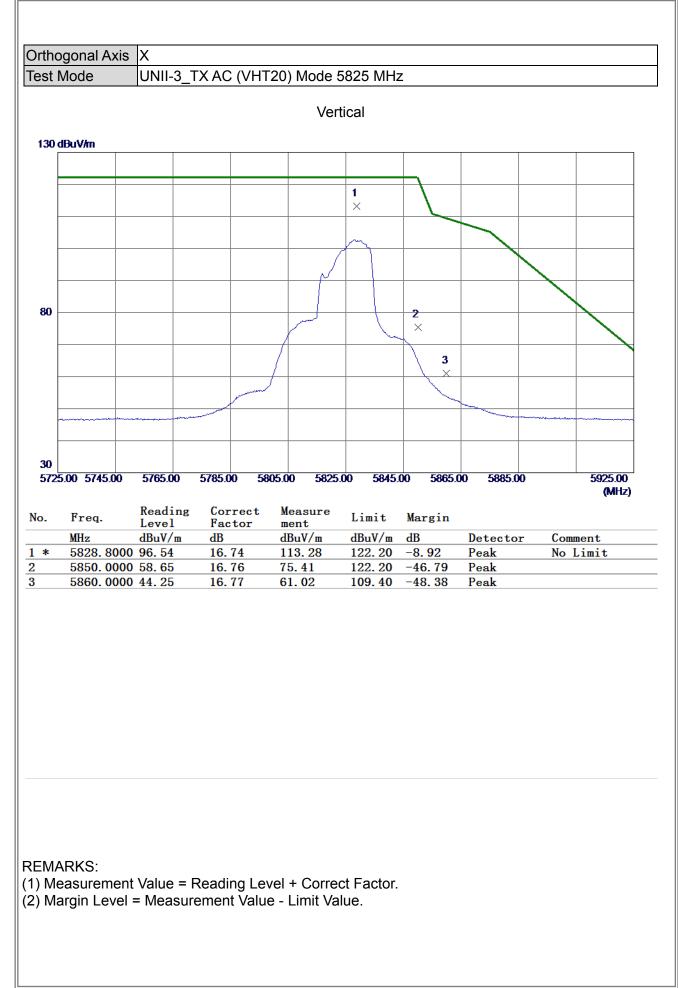


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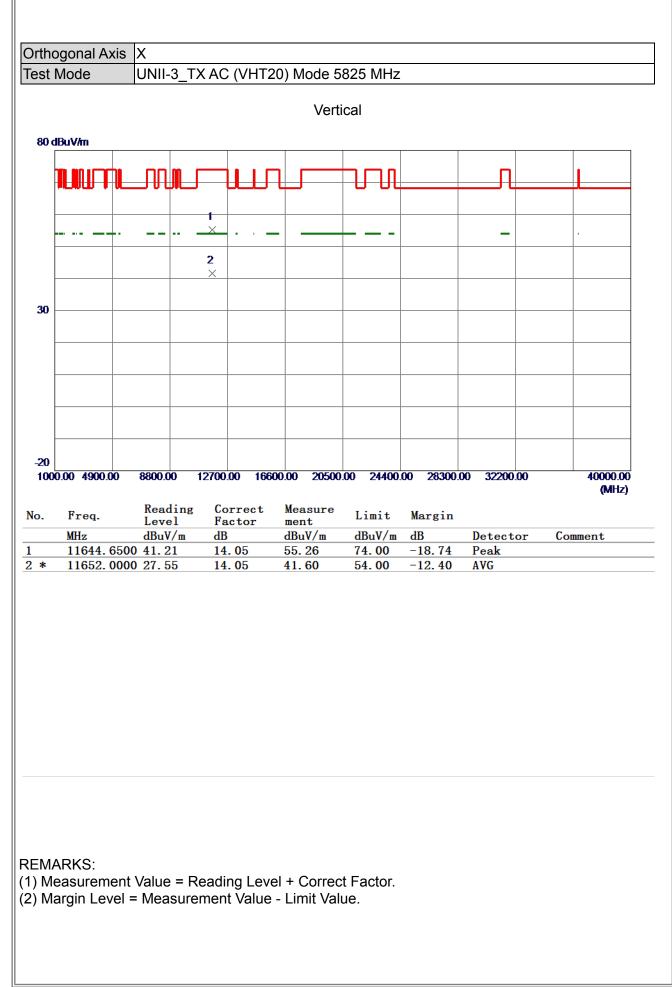






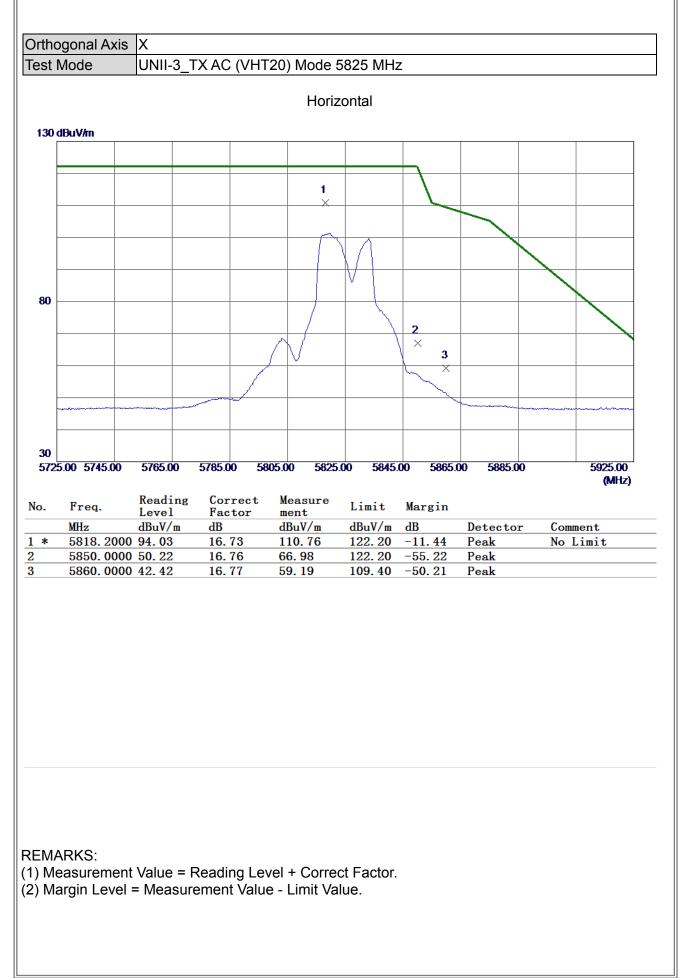




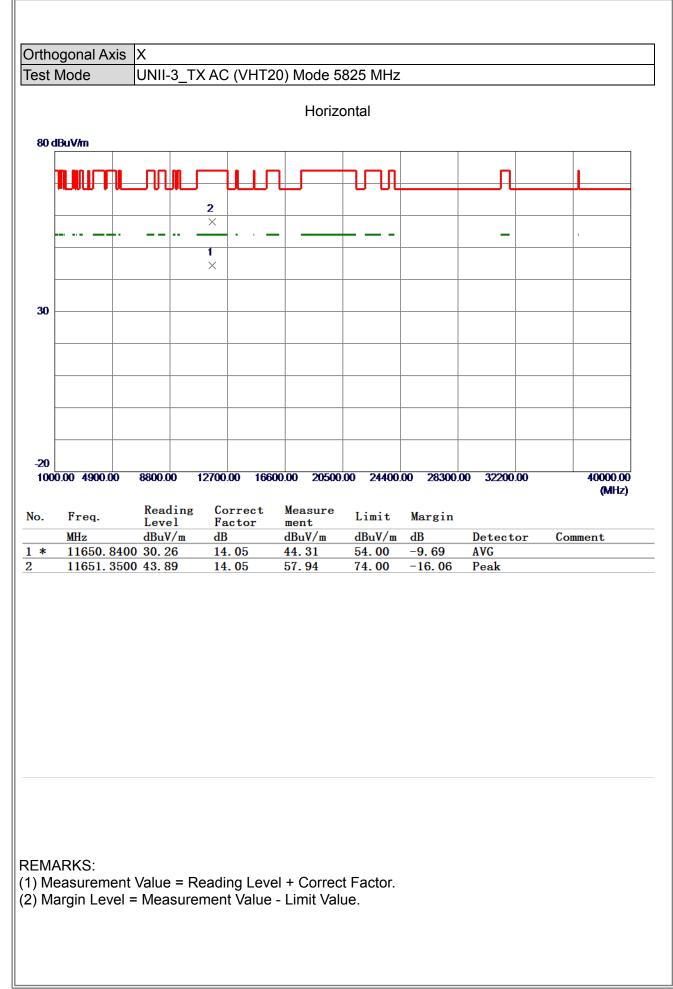




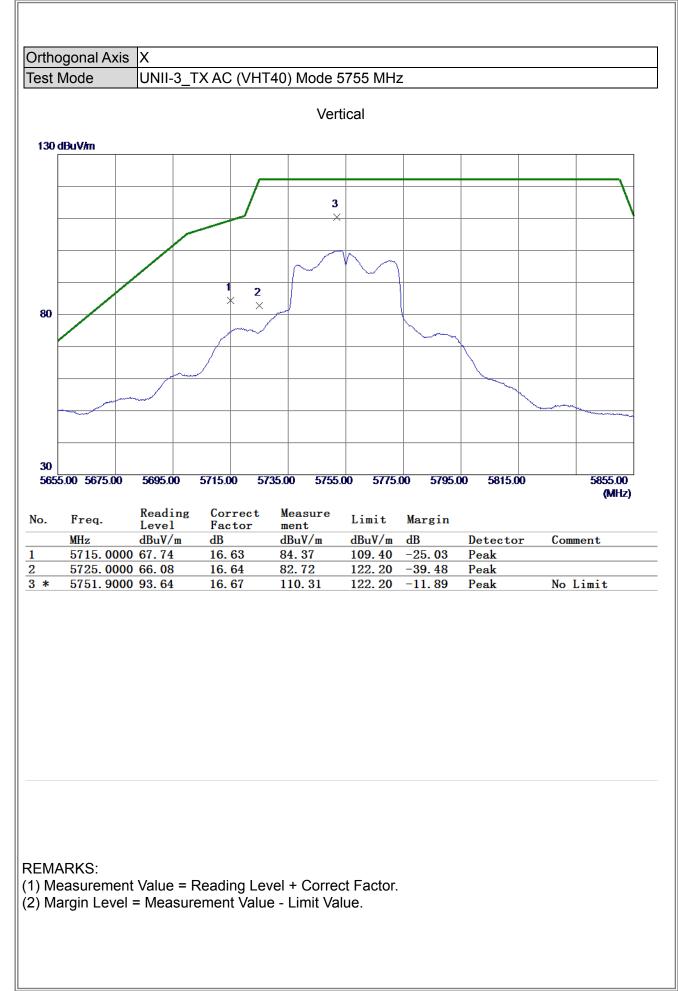




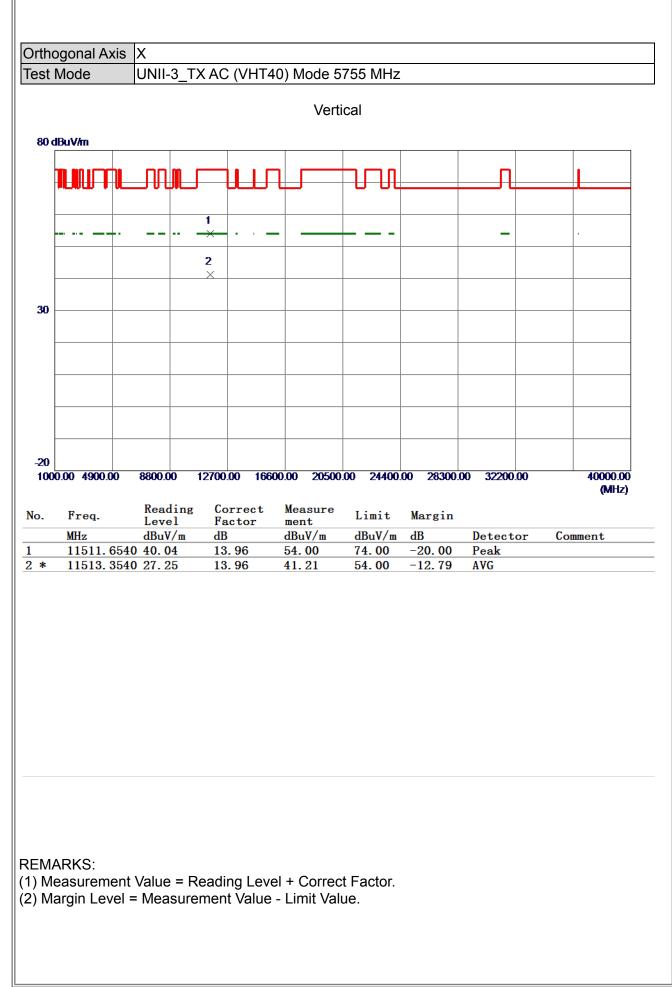




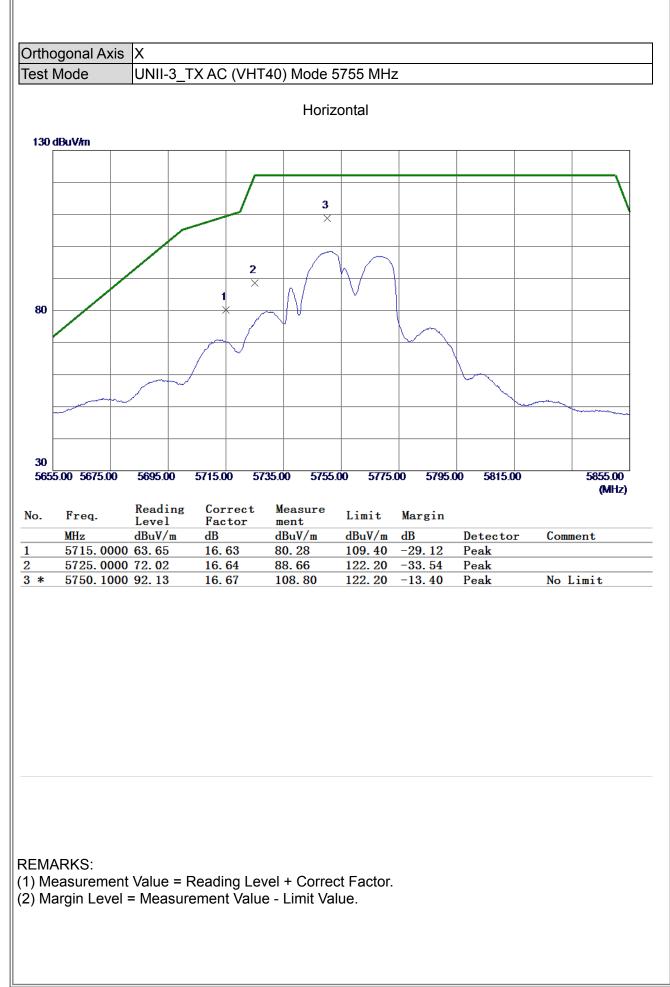




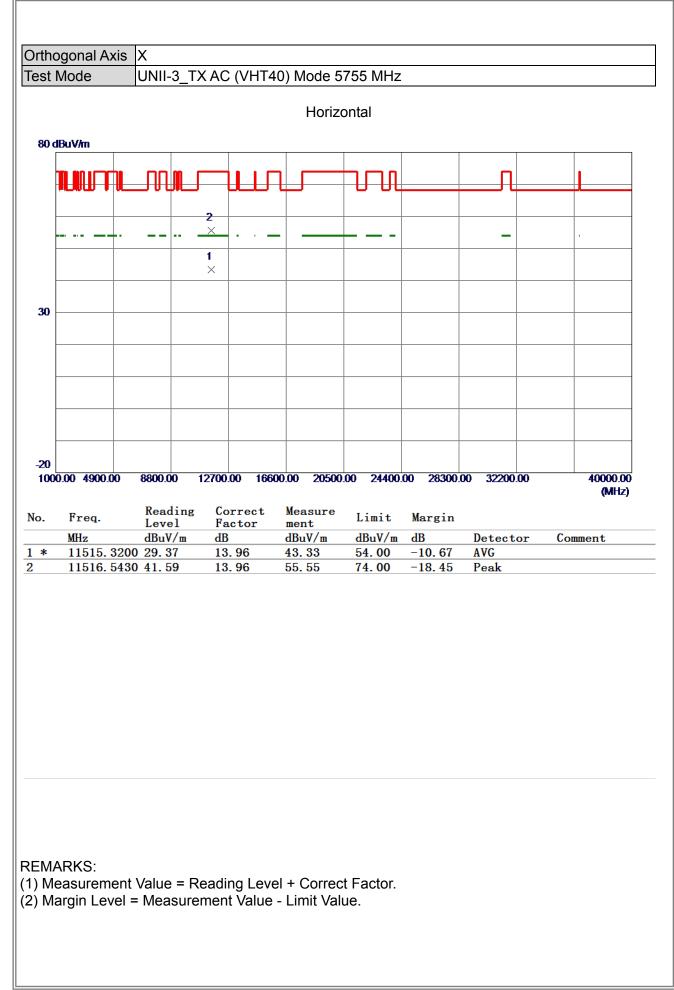




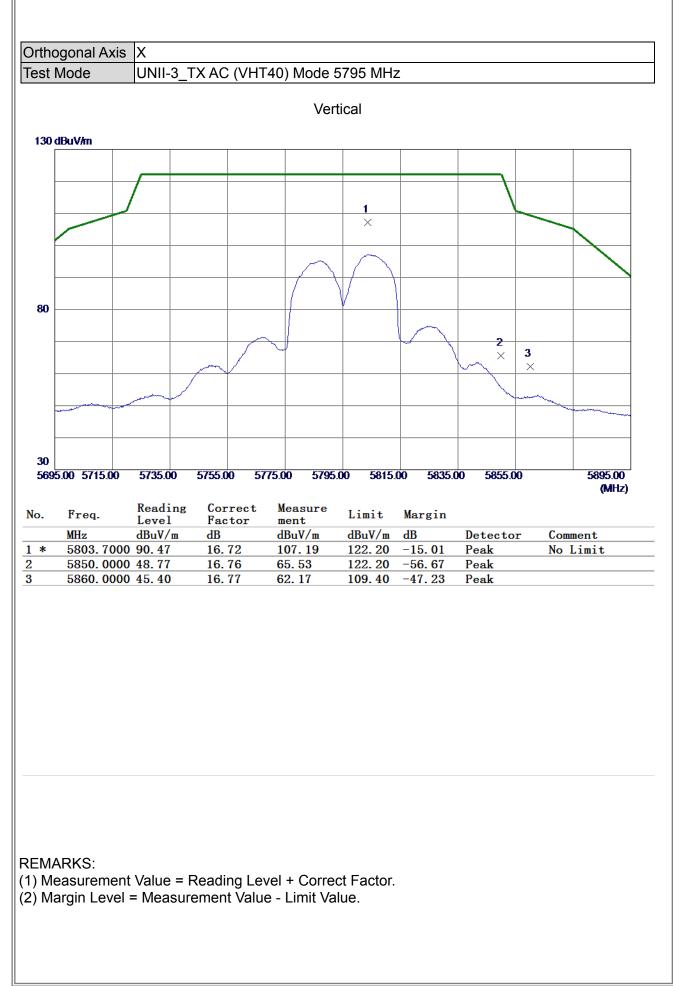




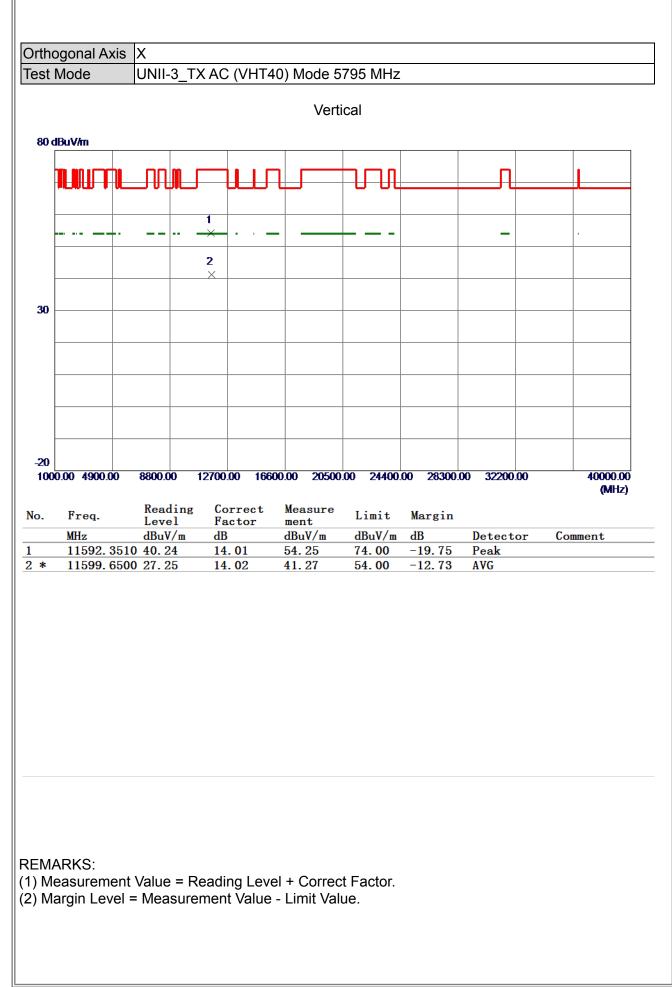




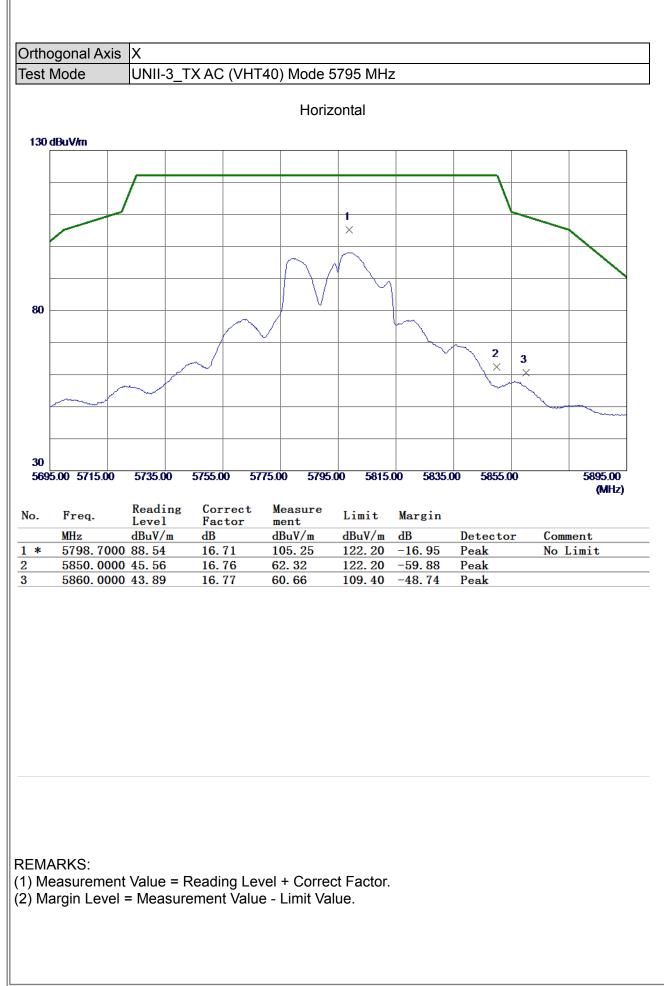




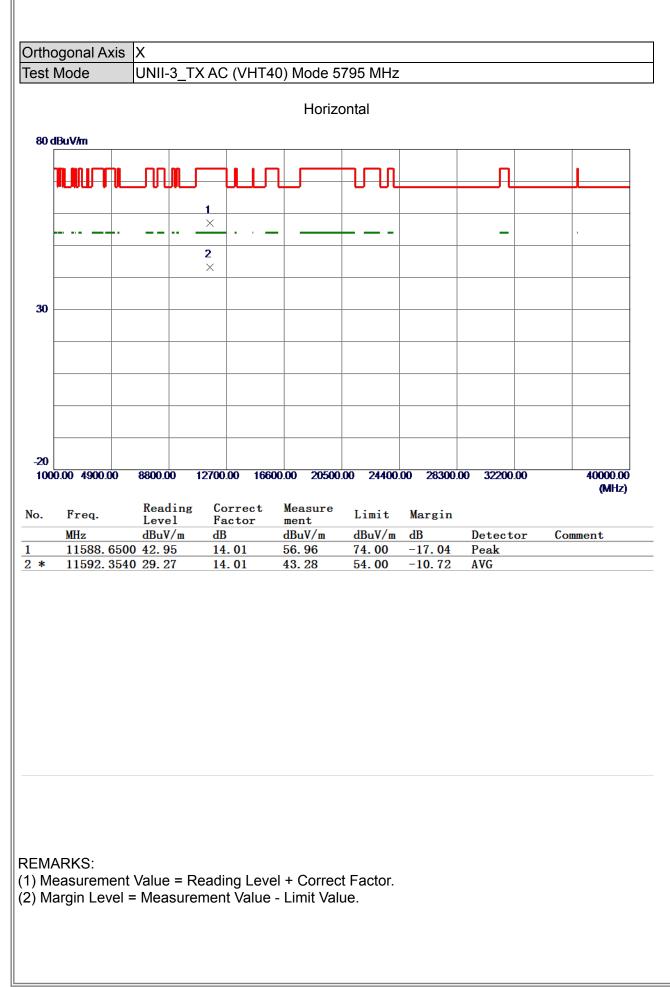




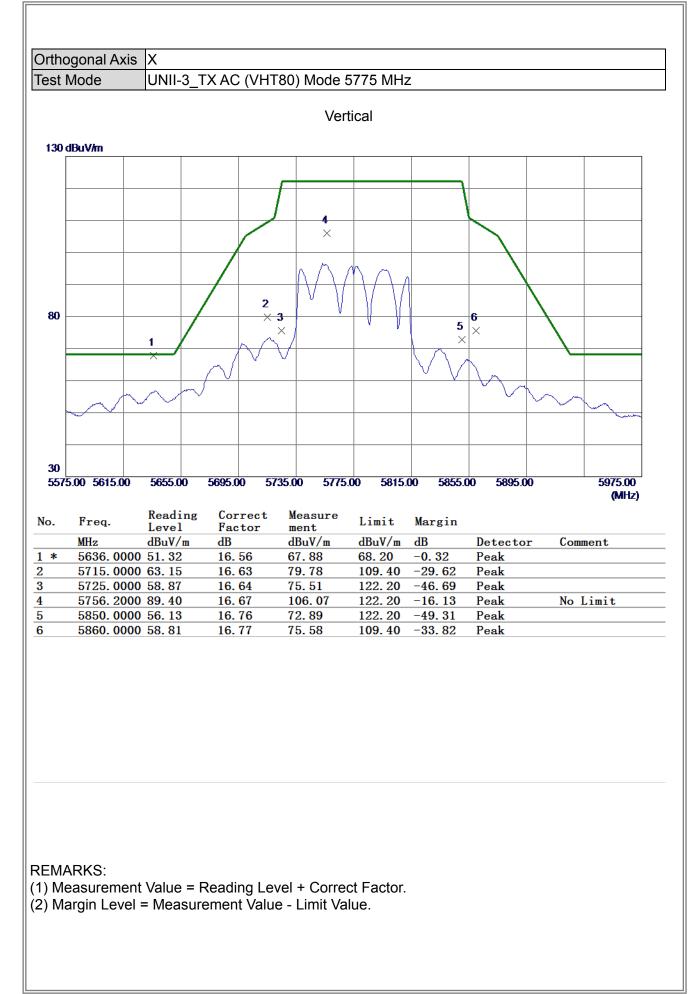




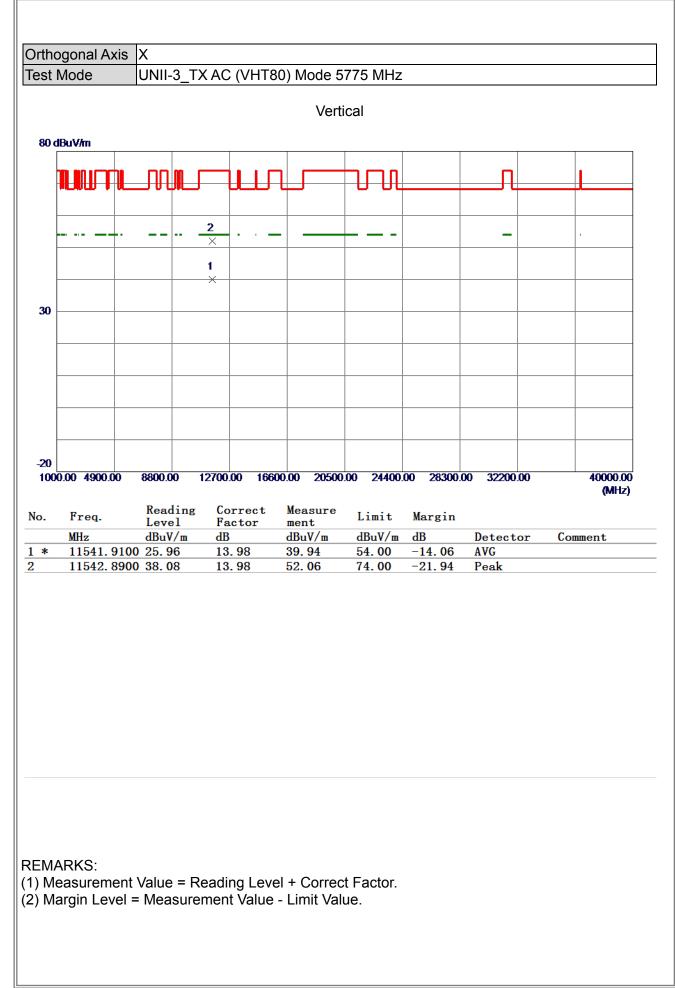




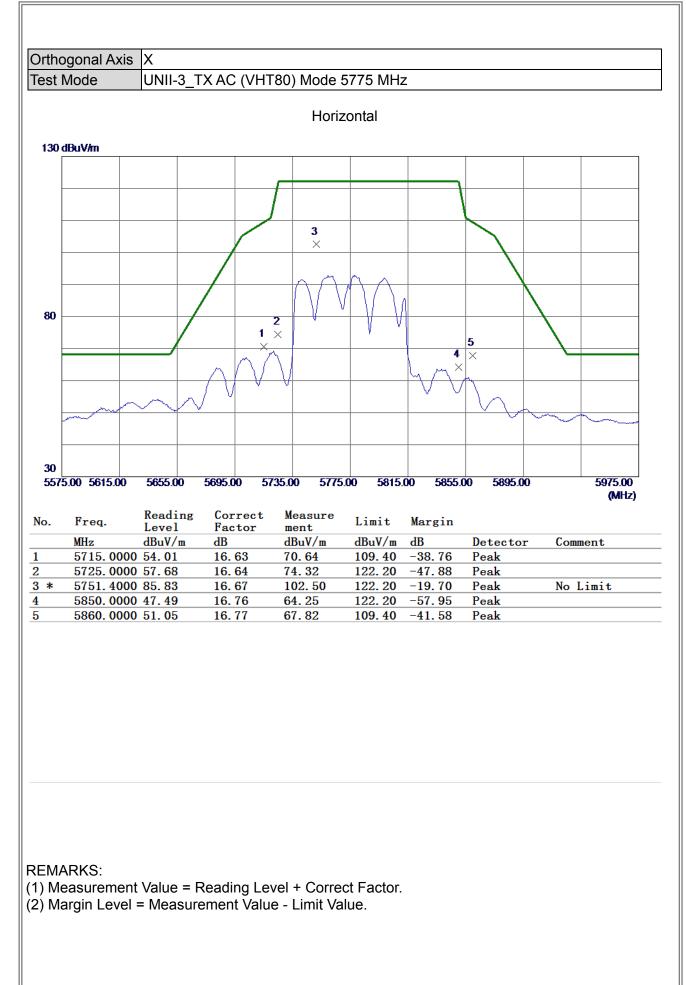




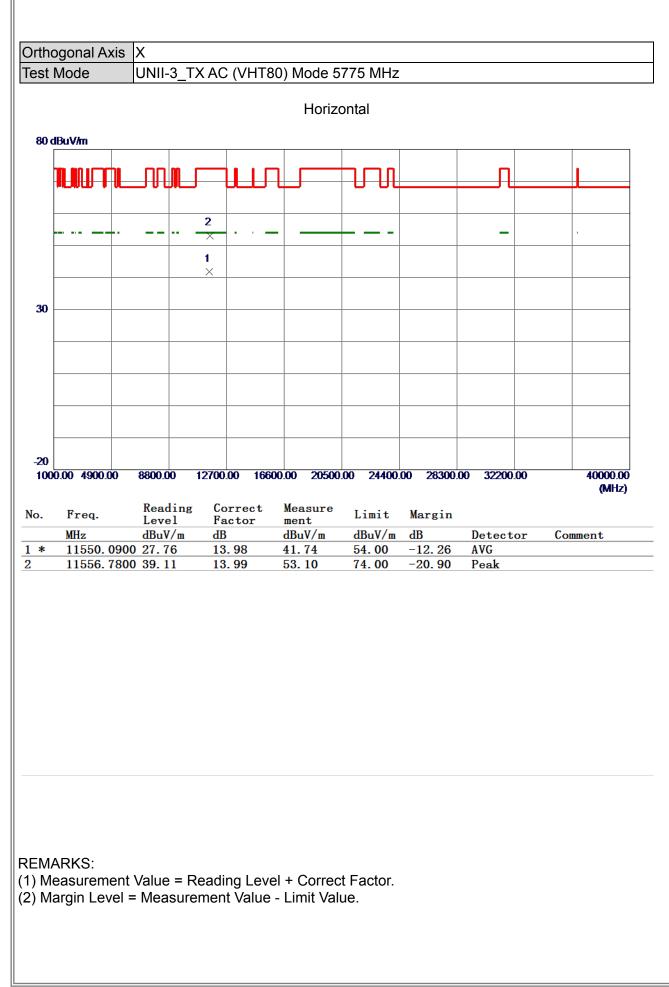
















## **APPENDIX E - BANDWIDTH**