

# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

## INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

<b>Product Name:</b>	<b>Vehicle Mount Computer</b>
<b>Brand Name:</b>	<b>Honeywell</b>
<b>Marketing Name:</b>	<b>Thor VM3</b>
<b>Model No.:</b>	<b>VM3WWANUS</b>
<b>Model Difference:</b>	<b>N/A</b>
<b>FCC ID:</b>	<b>HD5-VM3WWANA</b>
<b>Report No.:</b>	<b>ER/2015/20027</b>
<b>Issue Date:</b>	<b>Apr. 07, 2015</b>
<b>FCC Rule Part:</b>	<b>§15.247, Cat: DSS</b>
<b>Prepared for:</b>	<b>Honeywell International Inc., Honeywell Scanning and Mobility 9680 Old Bailes Road, Fort Mill, SC 29707, USA</b>
<b>Prepared by:</b>	<b>SGS Taiwan Ltd. Electronics &amp; Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803</b>



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**VERIFICATION OF COMPLIANCE**

**Applicant:** Honeywell International Inc.,  
Honeywell Scanning and Mobility  
9680 Old Bailes Road, Fort Mill, SC 29707, USA

**Product Name:** Vehicle Mount Computer

**Brand Name:** Honeywell

**Marketing Name:** Thor VM3

**Model No.:** VM3WWANUS

**Model Difference:** N/A

**FCC ID:** HD5-VM3WWANA

**File Number:** ER/2015/20027

**Date of test:** Feb. 04, 2015 ~ Apr. 07, 2015

**Date of EUT Received:** Feb. 04, 2015

**We hereby certify that:**

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

**Test By:****Date:**

Apr. 07, 2015

*Marcus Tseng / Engineer***Prepared By:****Date:**

Apr. 07, 2015

*Karen Huang / Clerk***Approved By:****Date:**

Apr. 07, 2015

*Jim Chang / Asst. Manager*

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## Revision History

Report Number	Revision	Description	Issue Date
ER/2015/20027	Rev.00	Initial creation of document	Apr. 07, 2015

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## 1. GENERAL INFORMATION

### 1.1. Product description

General:

Product Name:	Vehicle Mount Computer		
Brand Name:	Honeywell		
Marketing Name:	Thor VM3		
Model No.:	VM3WWANUS		
Model Difference:	N/A		
Product SW/HW version:	(a)Win7: 99.01.00.0002 (b)Win8: 99.01.00.0004 / ALXH48		
Radio SW/HW version:	HCI version 6.8891 / LMP version 6.8891		
Test SW Version:	CSR 2.3		
RF power setting in TEST SW:	MAX setting , BR-63 , EDR-105		
Power Supply:	7.3Vdc form Rechargeable Li-ion Battery or 15Vdc from adapter		
	Battery:	Part No.:L3-52301624-R / OVT270L1R00 / 50121692-001, Supplier: TOTEX	
	Adapter:	Model No.:GT-81081-6015-T3 Supplier: GlobTek, Inc.	

Bluetooth\_BR+EDR:

Bluetooth Version:	V4.0 dual mode
Channel number:	79 channels
Modulation type:	GFSK + $\pi/4$ DQPSK + 8DPSK
Transmit Power:	0.58dBm
Frequency Range:	2.402GHz – 2.480GHz
Emission Designation:	1M21F1D
Antenna Designation:	Monopole chip Antenna, Gain: 0.5dBi Model No.: BT111, Supplier: Bluegiga Technologies

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## 1.2. Product Feature of Equipment Under Test

The equipment under Test (Hereafter Called: EUT) is Vehicle Mount Computer supporting, GSM / WCDMA / CDMA / LTE, Wi-Fi 802.11abgn, Bluetooth with GPS features, and below is details of information.

Product Feature	
Product Name:	Vehicle Mount Computer
Brand Name:	Honeywell
Marketing Name:	Thor VM3
Model No.:	VM3WWANUS
Model Difference:	N/A
FCC ID	HD5-VM3WWANA
GSM Operating Band(s)	GSM 850/1900MHz
GPRS / EGPRS Multi Slot Class	GPRS Class 10 / Class 12
CDMA / EVDO	BC0 / BC1 / BC10
WCDMA Operating Band(s)	FDD Band II / IV / V
WCDMA Rel. Version	Rel.8
LTE Operating Band(s)	FCC Band 2 / 4 / 5 / 13 / 17 / 25
LTE Rel. Version	Rel.9
Wi-Fi Specification	802.11a/b/g/n
Bluetooth Version	V4.0 dual mode

**Note:** The above EUT information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

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### 1.3. Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 DTS Meas. Guidance V03r02

ANSI C63.10:2013

Note:

1. All test items have been performed and record as per the above standards.
2. The composite system is compliance with FCC Subpart B is authorized under the certification procedure.
3. The EUT was placed 1.5m height for frequency above 1GHz in accordance with ANSI C63. 10 :2013

### 1.4. Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan. (TAF code 0513)

FCC Registration Numbers are: 990257

Canada Registration Number: 4620A-4.

### 1.5. Special Accessories

There is no special accessory used while test was conducted.

### 1.6. Equipment Modifications

There was no modification incorporated into the EUT.

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## 2. SYSTEM TEST CONFIGURATION

### 2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

### 2.2. EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

### 2.3. Test Procedure

#### 2.3.1 Conducted Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed according to §15.107. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

#### 2.3.2 Radiated Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

### 2.4. Measurement Results Explanation Example

#### For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

#### Note:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Following shows an offset computation example with cable loss 2.1 dB.

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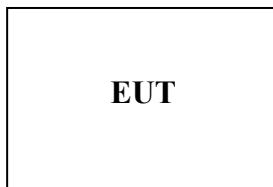
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## 2.5. Configuration of Tested System

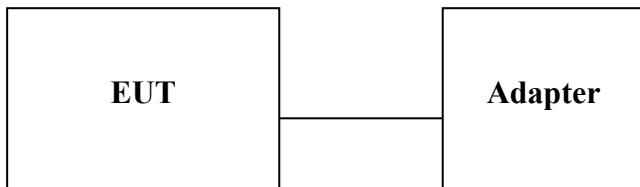
**Fig. 2-1 Radiated Emission & Conducted (Antenna Port) Configuration**



**Table 2-1 Equipment Used in Tested System**

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	CSR 2.3	N/A	N/A	N/A	N/A

**Fig. 2-2 AC Power Line Conducted Emission**



**Table 2-2 Equipment Used in Tested System**

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Bluetooth Test Software	CSR 2.3	N/A	N/A	N/A	N/A

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### 3. SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(a)(2)	20dB Bandwidth & 99% Power Bandwidth	Compliant
§15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency	Compliant
§15.247(a)(1)(iii)	Time of Occupancy	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

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## 4. DESCRIPTION OF TEST MODES

### 4.1. Operated in 2400 ~ 2483.5MHz Band

79 channels are provided for Bluetooth

CH	FREQUENCY	CH	FREQUENCY	CH	FREQUENCY	CH	FREQUENCY
0	2402 MHz	20	2422 MHz	40	2442 MHz	70	2462 MHz
1	2403 MHz	21	2423 MHz	41	2443 MHz	71	2463 MHz
2	2404 MHz	22	2424 MHz	42	2444 MHz	72	2464 MHz
3	2405 MHz	23	2425 MHz	43	2445 MHz	73	2465 MHz
4	2406 MHz	24	2426 MHz	44	2446 MHz	74	2466 MHz
5	2407 MHz	25	2427 MHz	45	2447 MHz	75	2467 MHz
6	2408 MHz	26	2428 MHz	46	2448 MHz	76	2468 MHz
7	2409 MHz	27	2429 MHz	47	2449 MHz	77	2469 MHz
8	2410 MHz	28	2430 MHz	48	2450 MHz	78	2470 MHz
9	2411 MHz	29	2431 MHz	49	2451 MHz	79	2471 MHz
10	2412 MHz	30	2432 MHz	50	2452 MHz	70	2472 MHz
11	2413 MHz	31	2433 MHz	51	2453 MHz	71	2473 MHz
12	2414 MHz	32	2434 MHz	52	2454 MHz	72	2474 MHz
13	2415 MHz	33	2435 MHz	53	2455 MHz	73	2475 MHz
14	2416 MHz	34	2436 MHz	54	2456 MHz	74	2476 MHz
15	2417 MHz	35	2437 MHz	55	2457 MHz	75	2477 MHz
16	2418 MHz	36	2438 MHz	56	2458 MHz	76	2478 MHz
17	2419 MHz	37	2439 MHz	57	2459 MHz	77	2479 MHz
18	2420 MHz	38	2440 MHz	58	2460 MHz	78	2480 MHz
19	2421 MHz	39	2441 MHz	59	2461 MHz		

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## 4.2. The Worst Test Modes and Channel Details

- 1 The EUT has been tested under operating condition.
- 2 Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
- 3 Investigation has been done on all the possible configurations for searching the worst case.

### RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE	ANTENNA PORT
Bluetooth	0 to 78	0,39,78	GFSK	DH5	MAIN
RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE	ANTENNA PORT
Bluetooth	0 to 78	0,39,78	GFSK	DH5	MAIN

#### Note:

The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth BR+EDR Transmitter for channel Low, Mid and High, the worst case E1 position was reported.

### ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST					
Peak Output Power, 20dB Band Width					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE	ANTENNA PORT
Bluetooth	0 to 78	0,39,78	GFSK	DH5	MAIN
	0 to 78	0,39,78	/4-DQPSK	DH5	MAIN
	0 to 78	0,39,78	8-DPSK	DH5	MAIN
Band Edge					
Bluetooth	0 to 78	0,78	GFSK	DH5	MAIN
Frequency Separation					
Bluetooth	0 to 78	0,1,2	GFSK	DH5	MAIN
Number of hopping frequency					
Bluetooth	0 to 78	0 to 78	GFSK	DH5	MAIN
Time of Occupancy (Dwell time)					
Bluetooth	0 to 78	0,39,78	GFSK	DH1/DH3/DH5	MAIN
Bluetooth	0 to 78	39	/4-DQPSK	DH1/DH3/DH5	MAIN
Bluetooth	0 to 78	39	8-DPSK	DH1/DH3/DH5	MAIN

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## 5. MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
20dB/ 99% Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 1.55 dB
Frequency Separation	+/- 51.33 Hz
Number of hopping frequency	+/- 51.33 Hz
Time of Occupancy	+/- 51.33 Hz
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC= +/- 0.2%

Radiated Spurious Emission:

Measurement uncertainty (Polarization : <b>Vertical</b> )	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB

Measurement uncertainty (Polarization : <b>Horizontal</b> )	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

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

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## 6. CONDUCTED EMISSION TEST

### 6.1. Standard Applicable

Frequency within 150 kHz to 30MHz shall not exceed the limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

#### Note

1. The lower limit shall apply at the transition frequencies

2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

### 6.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI7	100760	05/26/2014	05/25/2015
LISN	Rolf-Heine	NNB-2/16Z	99012	03/26/2014	03/25/2015
LISN	FCC	FCC-LISN-50/250-25-2-01	04034	03/19/2014	03/18/2015
Coaxial Cables	N/A	WK CE Cable	N/A	11/26/2014	11/25/2015

### 6.3. EUT Setup

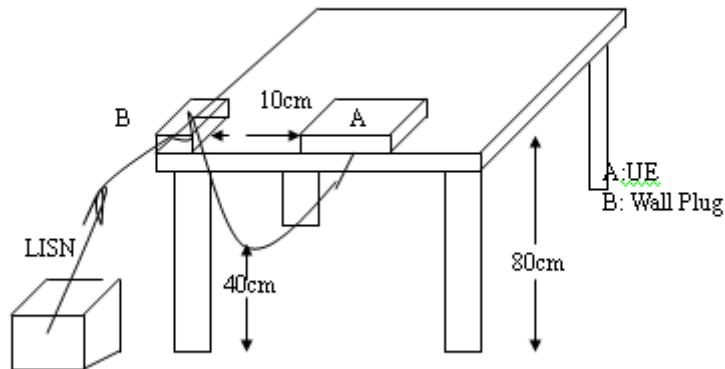
1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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#### 6.4. Test SET-UP (Block Diagram of Configuration)



#### 6.5. Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

#### 6.6. Measurement Result

Note: Refer to next page for measurement data and plots.

Note2: The \* reveals the worst-case results that closet to the limit

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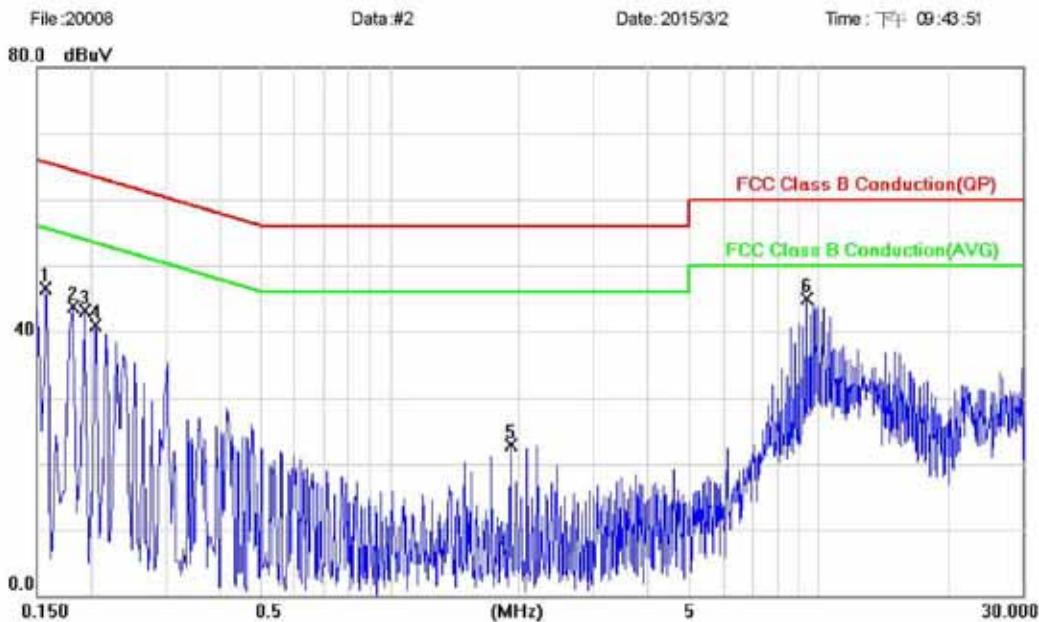
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## AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Operation mode			Test Date:	Mar. 02, 2015
Temperature:	24	Humidity:	66 %	Test By:	Tin

Site: ConductionRoom  
 Phase: **L1**  
 Temperature: 24 °C  
 Limit: FCC Class B Conduction(QP)  
 Power: AC 120V/60Hz  
 Humidity: 66%  
 Mode: Operation  
 Note: Adapter:GT-81081-6015-T3

## Conducted Emission



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dB	Detector	Comment
1		0.1580	46.36	0.05	46.41	65.57	-19.16	peak
2		0.1820	43.57	0.06	43.63	64.39	-20.76	peak
3		0.1940	42.95	0.06	43.01	63.86	-20.85	peak
4		0.2060	40.83	0.06	40.89	63.37	-22.48	peak
5		1.9100	22.87	0.12	22.99	56.00	-33.01	peak
6 *		9.3740	44.54	0.32	44.86	60.00	-15.14	peak

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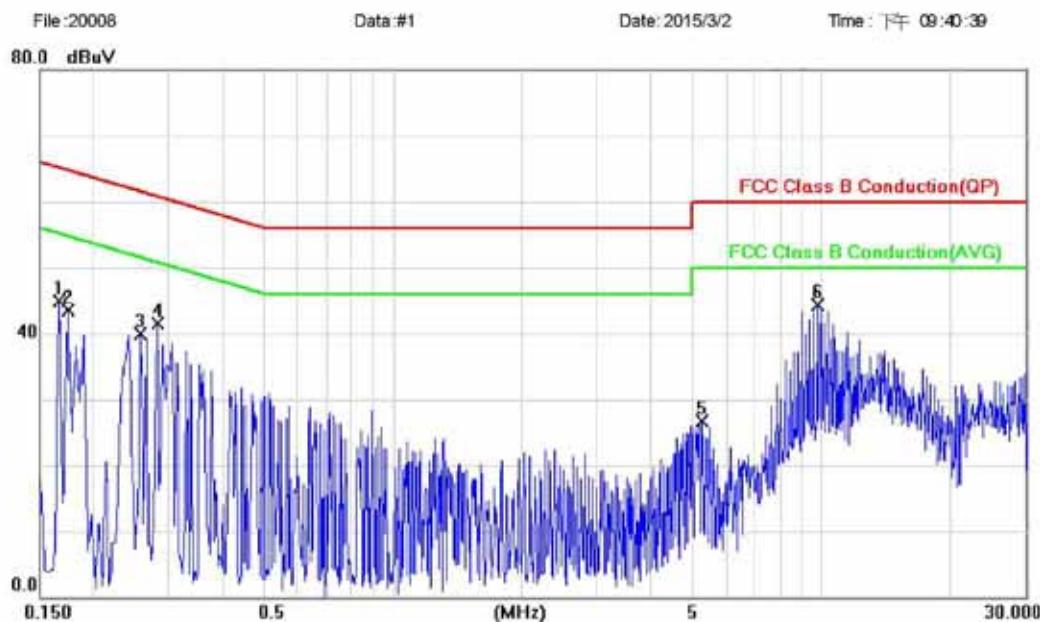
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Site: ConductionRoom  
 Limit: FCC Class B Conduction(QP)  
 Mode: Operation  
 Note: Adapter:GT-81081-6015-T3

Phase: **N**  
 Power: AC 120V/60Hz

Temperature: 24 °C  
 Humidity: 66%

### Conducted Emission



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Detector	Comment
			Level	Factor	ment				
		MHz	dBuV	dB	dBuV				
1		0.1660	44.90	0.05	44.95	65.16	-20.21	peak	
2		0.1740	43.49	0.05	43.54	64.77	-21.23	peak	
3		0.2580	39.87	0.06	39.93	61.50	-21.57	peak	
4		0.2820	41.47	0.06	41.53	60.76	-19.23	peak	
5		5.2500	26.57	0.20	26.77	60.00	-33.23	peak	
6 *		9.7740	44.06	0.34	44.40	60.00	-15.60	peak	

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## 7. PEAK OUTPUT POWER MEASUREMENT

### 7.1. Standard Applicable

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, The Limit: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: The Limit: 0.125 Watts. The power limit for 1Mbps is 1watt, and 2Mbps, 3Mbps and AFH mode are 0.125 watts.

### 7.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

### 7.3. Test Set-up:



### 7.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW >=20dB bandwidth)
4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

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## 7.5. Measurement Result

GFSK (1 Mbps)				
Channel	Frequency (MHz)	Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402.00	0.56	1.13763	1000
39	2441.00	<b>0.58</b>	1.14288	1000
78	2480.00	-1.77	0.66527	1000
<b><math>\pi/4</math>-DQPSK (2 Mbps)</b>				
Channel	Frequency (MHz)	Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402.00	-0.73	0.84528	125
39	2441.00	-0.62	0.86696	125
78	2480.00	-3.05	0.49545	125
<b>8-DPSK (3 Mbps)</b>				
Channel	Frequency (MHz)	Output Power (dBm)	Output Power (mW)	Limit (mW)
0	2402.00	-0.51	0.88920	125
39	2441.00	-0.37	0.91833	125
78	2480.00	-2.78	0.52723	125

*NOTE: cable loss as 2.1dB that offsets in the spectrum*

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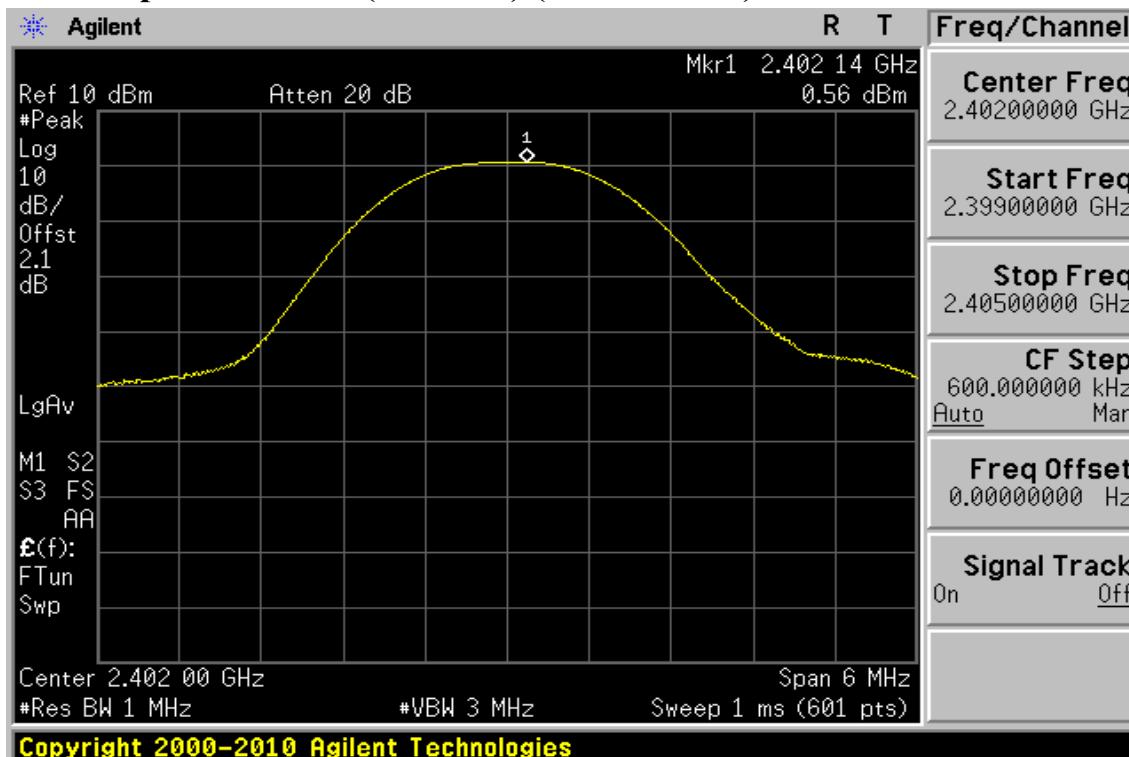
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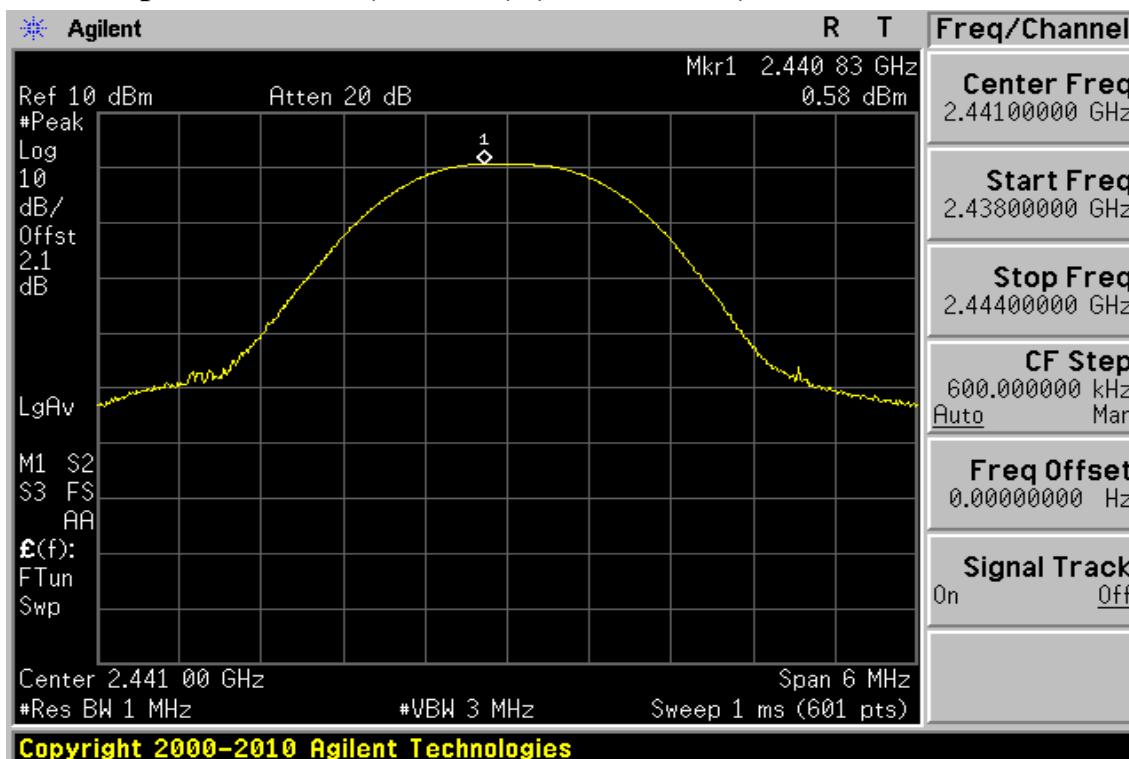
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## Peak Power Output Data Plot (CH Low) (GFSK mode)



## Peak Power Output Data Plot (CH Mid) (GFSK mode)



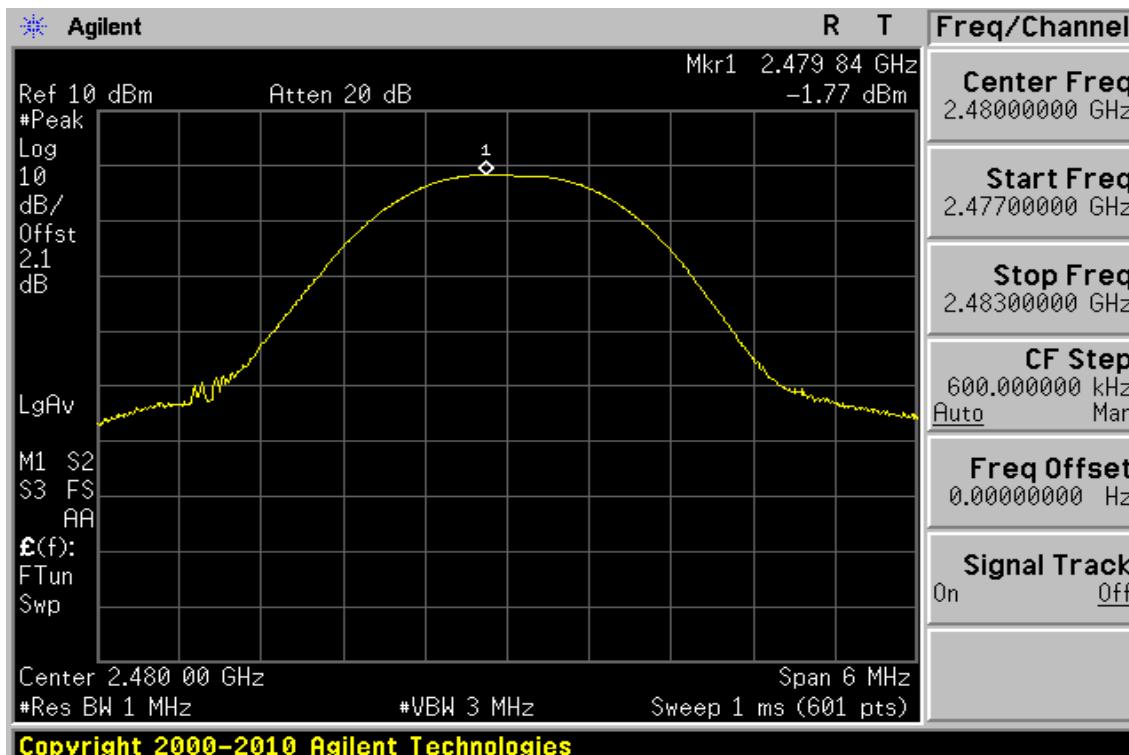
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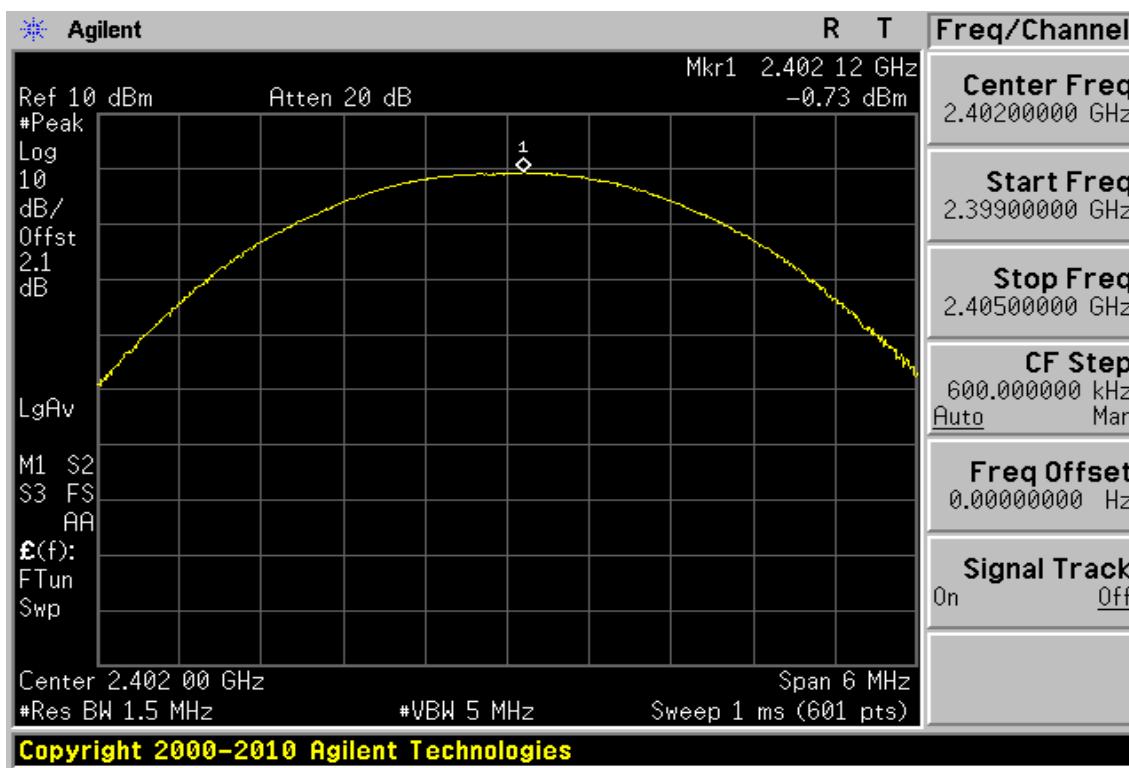
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## Peak Power Output Data Plot (CH High) (GFSK mode)



## Peak Power Output Data Plot (CH Low) ( /4-DQPSK mode)



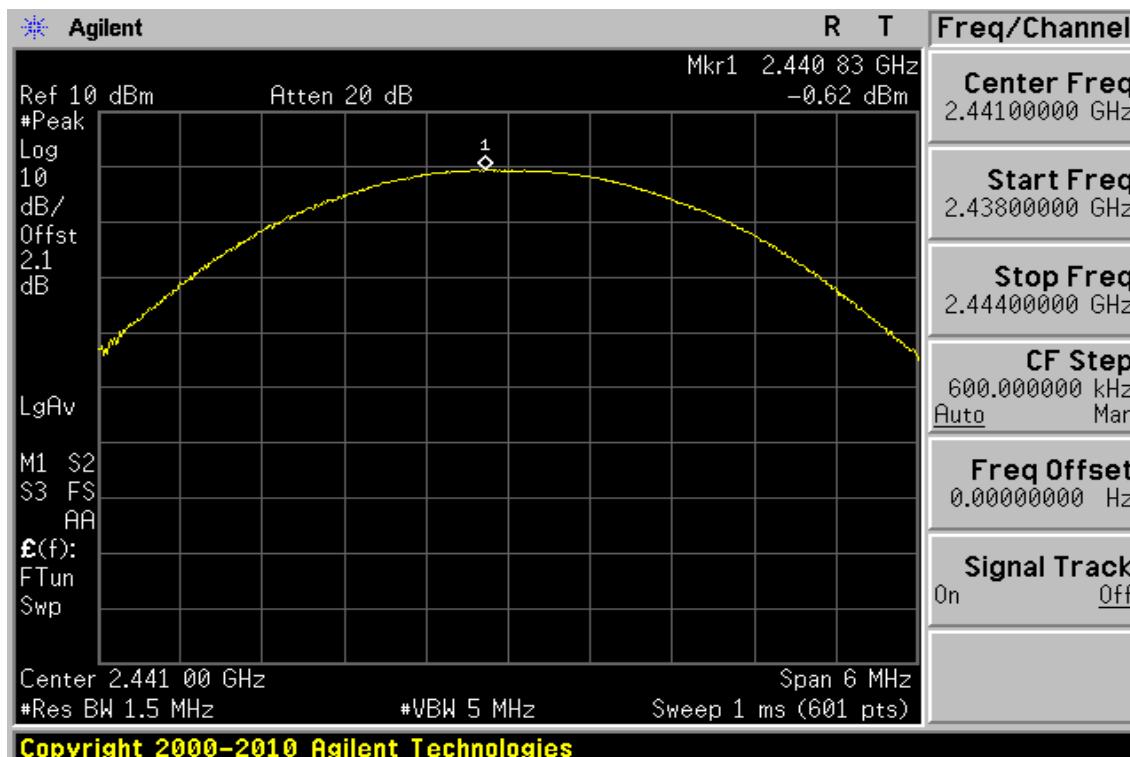
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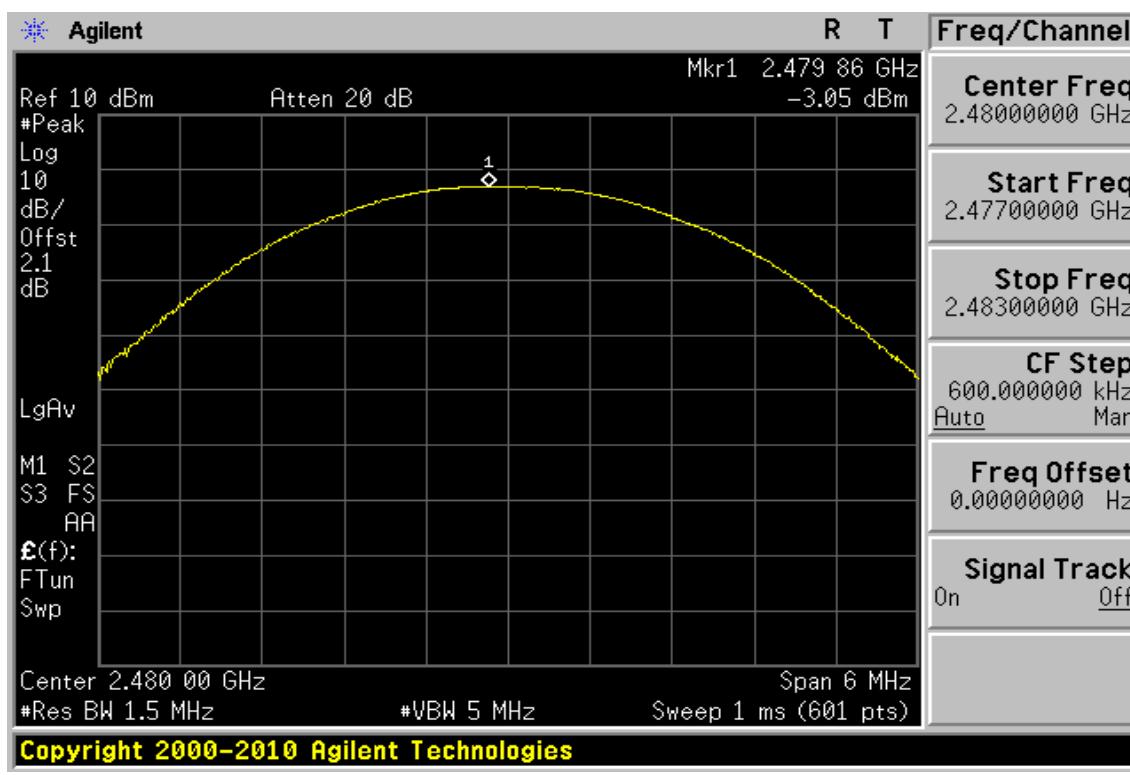
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## Peak Power Output Data Plot (CH Mid) ( 1/4-DQPSK mode)



## Peak Power Output Data Plot (CH High) ( 1/4-DQPSK mode)



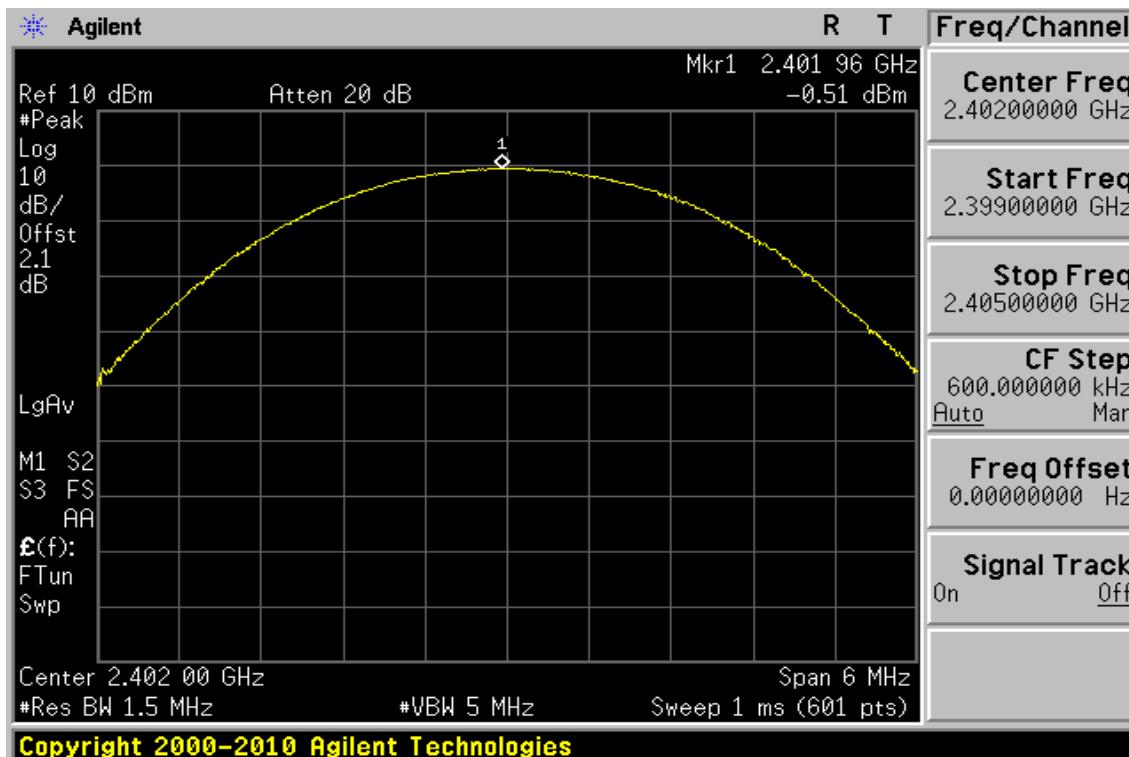
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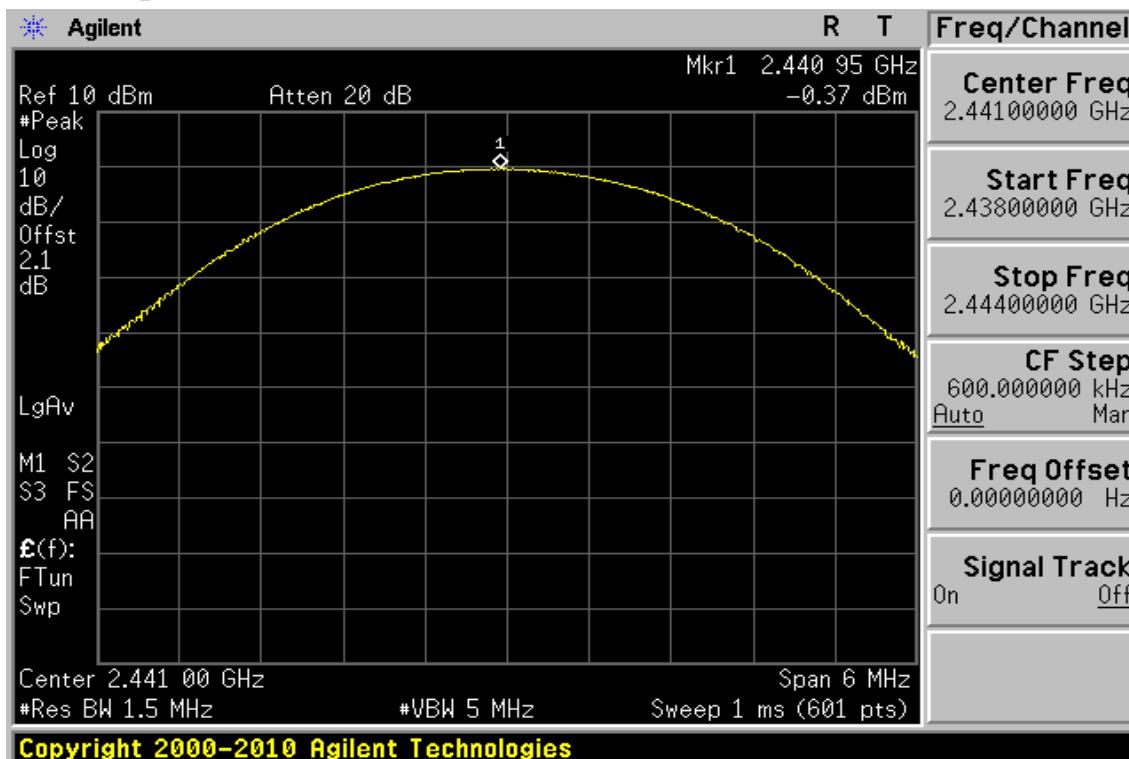
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## Peak Power Output Data Plot (CH Low) (8-DPSK mode)



## Peak Power Output Data Plot (CH Mid) (8-DPSK mode)



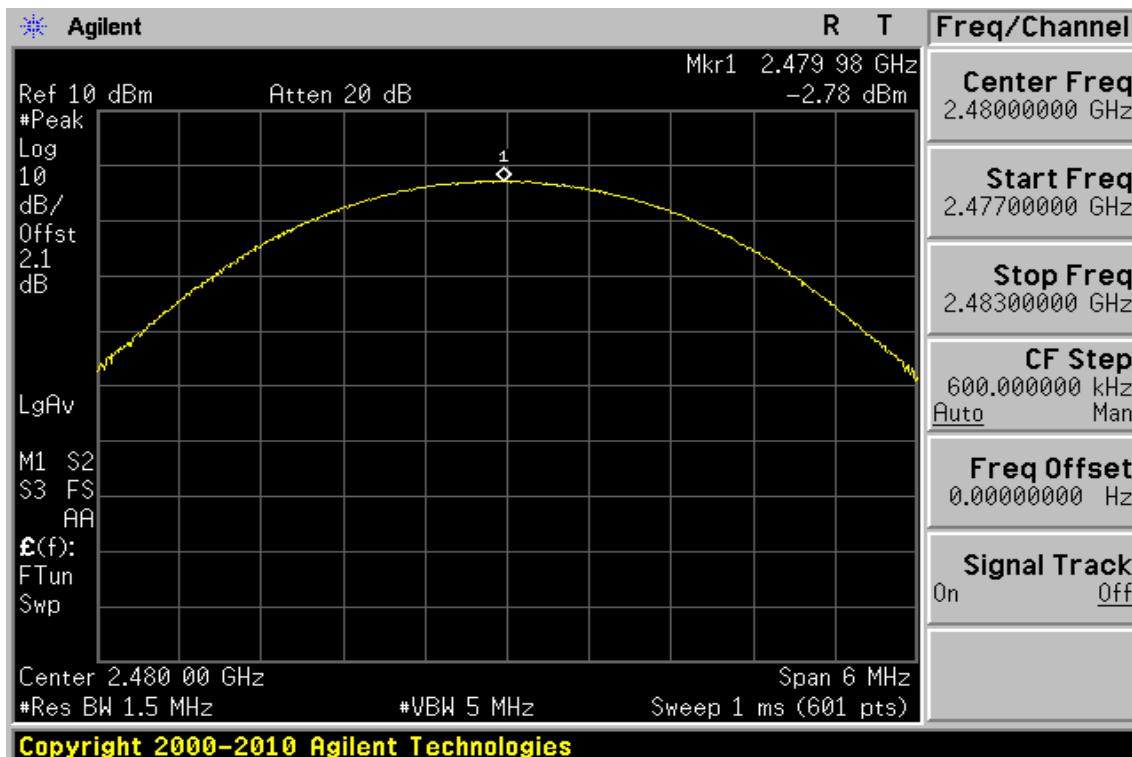
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## Peak Power Output Data Plot (CH High) (8-DPSK mode)



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## 8. 20dB BANDWIDTH MEASUREMENT

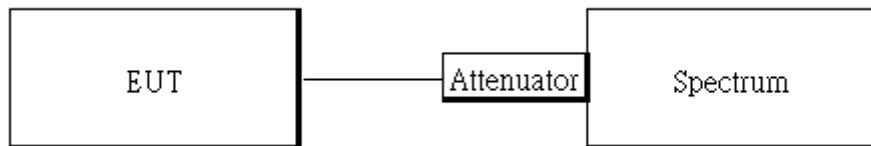
### 8.1. Standard Applicable

For frequency hopping systems operating in the 2400MHz-2483.5 MHz no limit for 20dB bandwidth.

### 8.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

### 8.3. Test Set-up



### 8.4. Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set the spectrum analyzer as RBW=10 kHz (1 % of 20 dB Bandwidth.), VBW = 30 kHz, Span= 3MHz, Sweep=auto, Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and -20dB (upper and lower) frequency
6. Repeat above procedures until all test default channel is completed

#### NOTE:

1. cable loss as 2.1dB that offsets in the spectrum
2. For the plot of bandwidth measurement, the marker of the 20dB BW is arrow-mark

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## 8.5. Measurement Result

GFSK			
Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	2/3 Bandwidth (MHz)
0	2402	0.970	-
39	2441	0.971	-
78	2480	0.925	-

/4-DQPSK			
Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	2/3 Bandwidth (MHz)
0	2402	1.322	0.881
39	2441	1.315	0.877
78	2480	1.320	0.880

8-DPSK			
Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	2/3 Bandwidth (MHz)
0	2402	1.269	0.846
39	2441	1.316	0.877
78	2480	1.513	1.009

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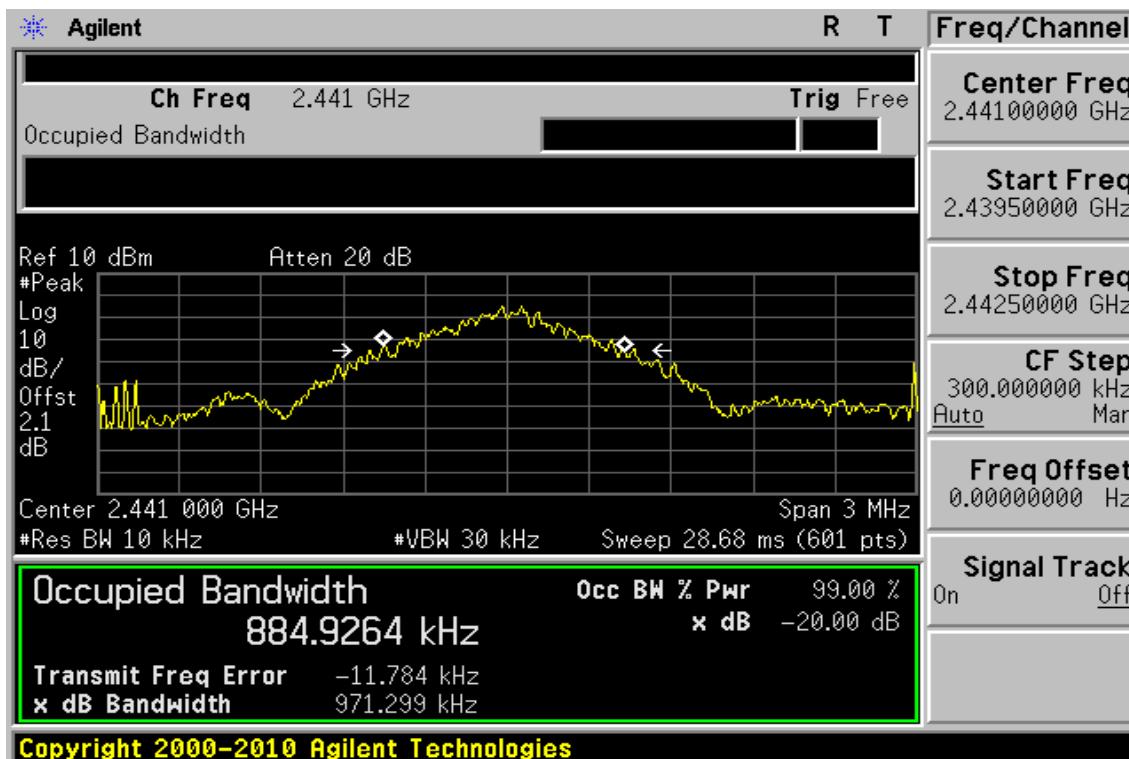
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## 20dB Band Width Test Data CH-Low (GFSK mode)



## 20dB Band Width Test Data CH-Mid (GFSK mode)

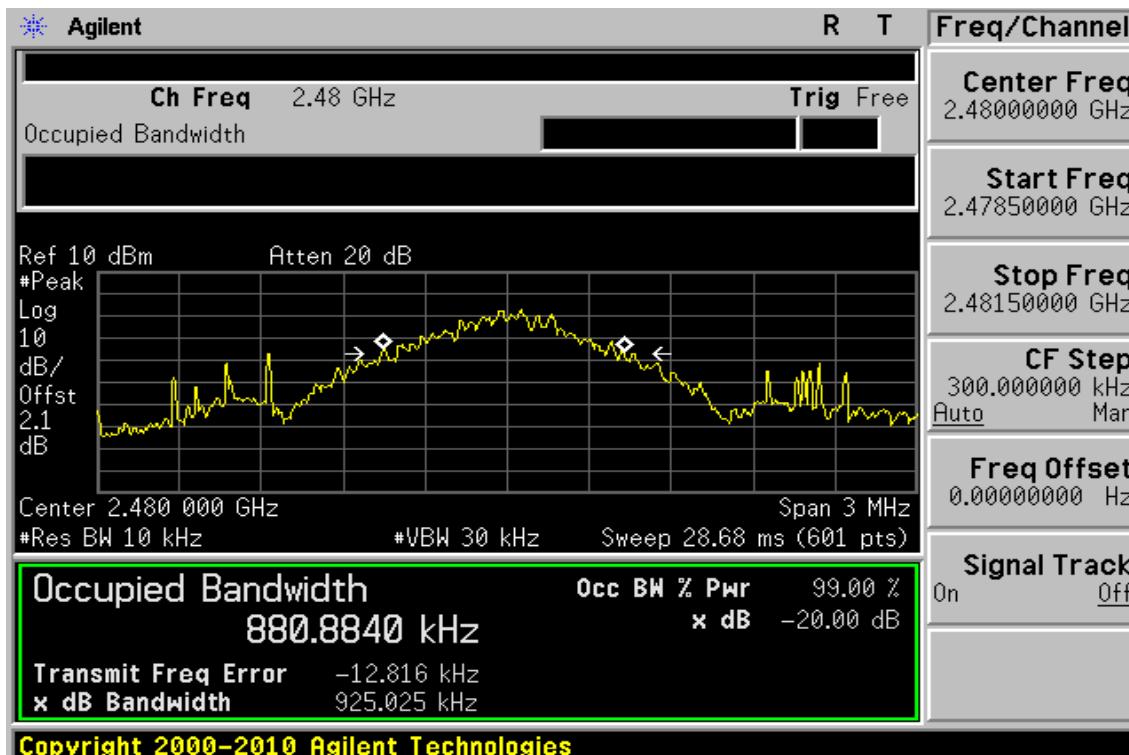


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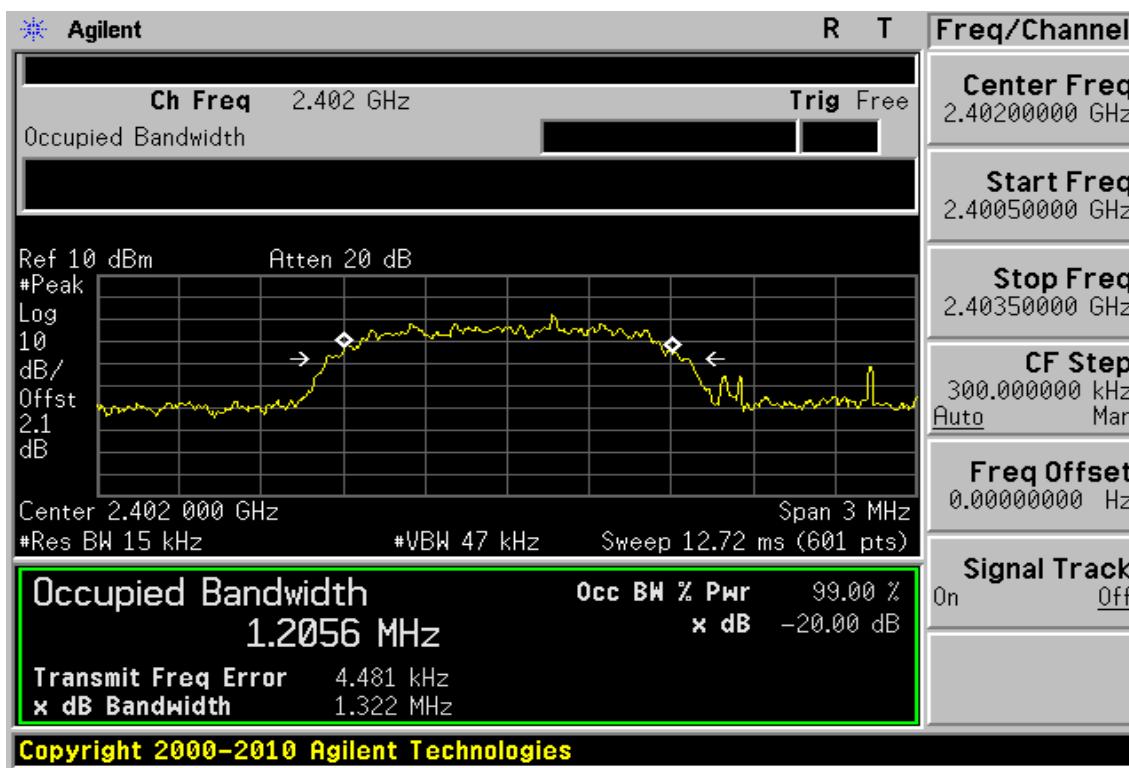
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## 20dB Band Width Test Data CH-High (GFSK mode)



## 20dB Band Width Test Data CH-Low ( /4-DQPSK mode)



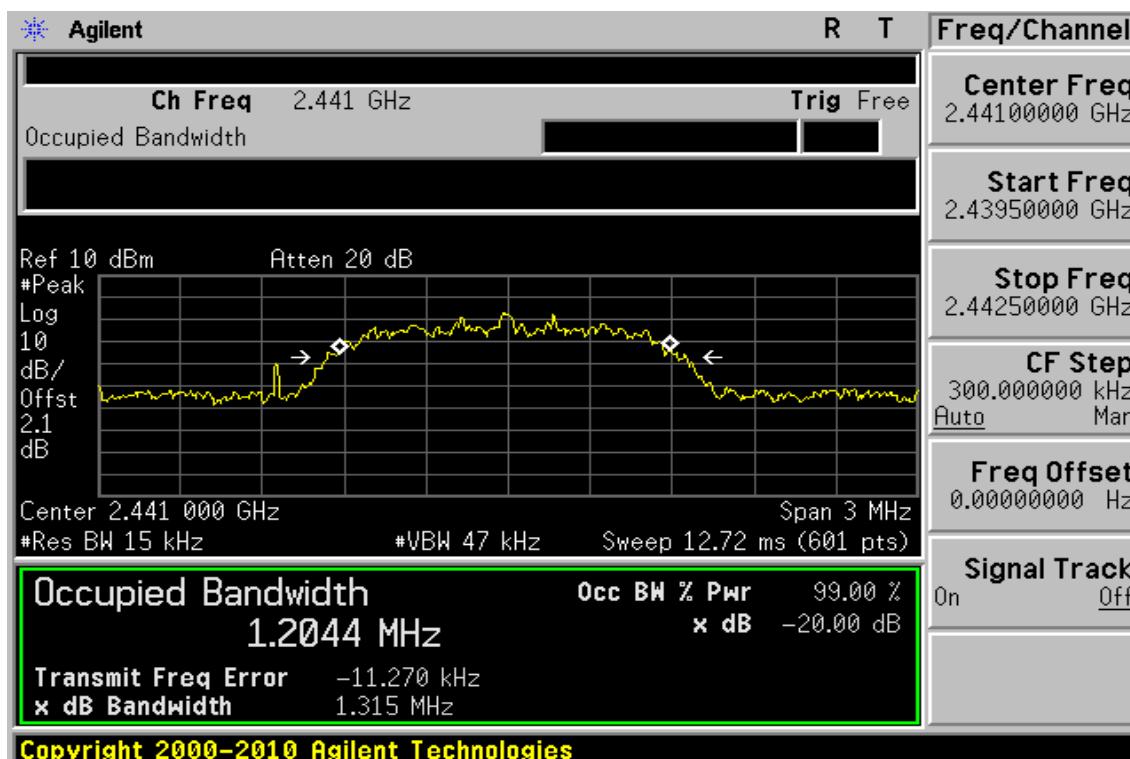
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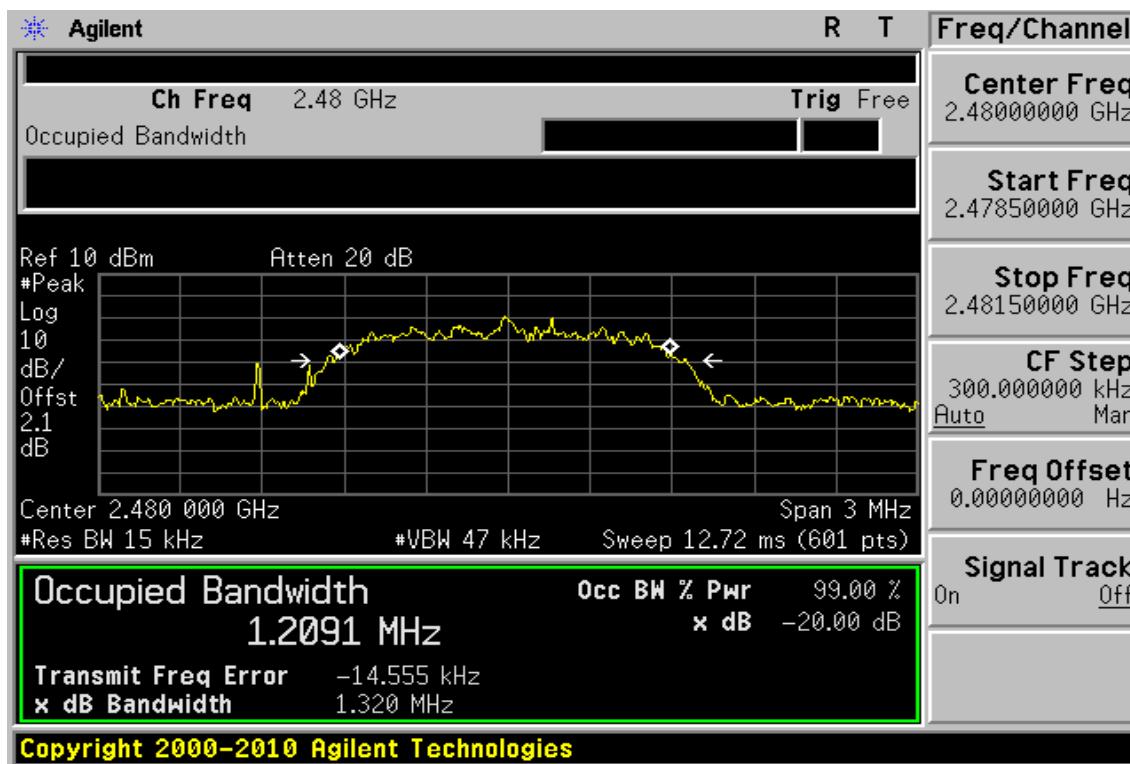
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## 20dB Band Width Test Data CH-Mid ( /4-DQPSK mode)



## 20dB Band Width Test Data CH-High ( /4-DQPSK mode)



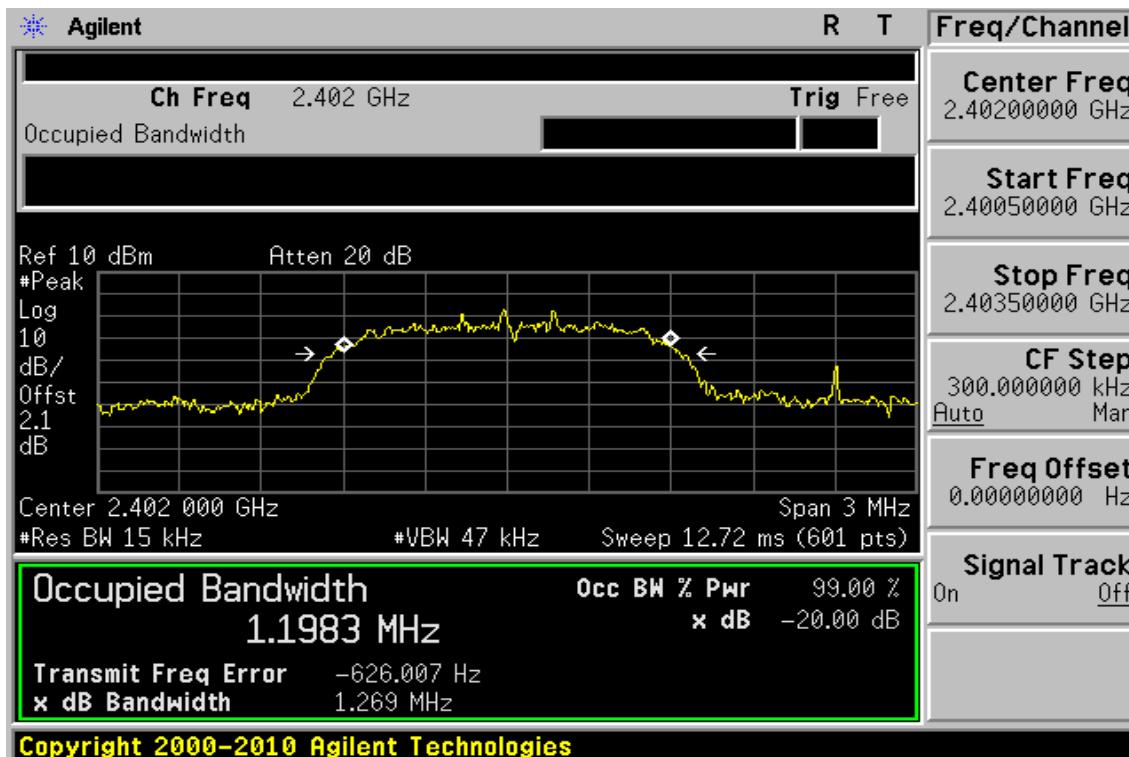
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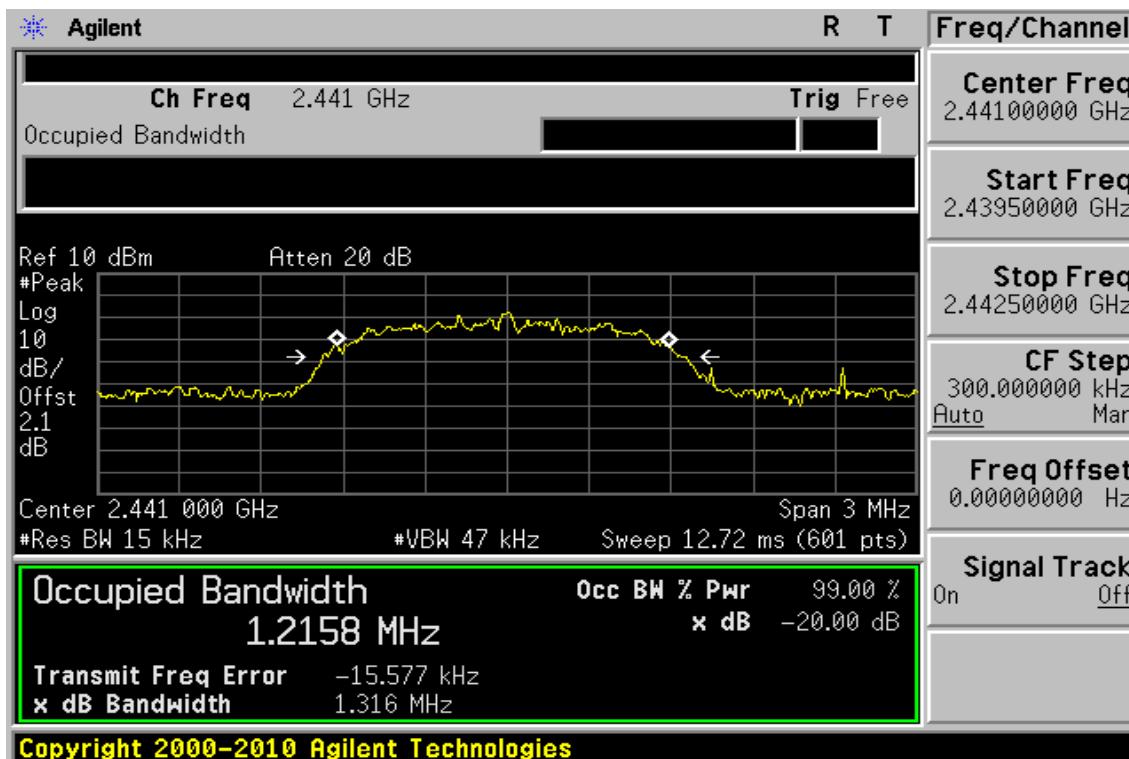
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## 20dB Band Width Test Data CH-Low (8-DPSK mode)



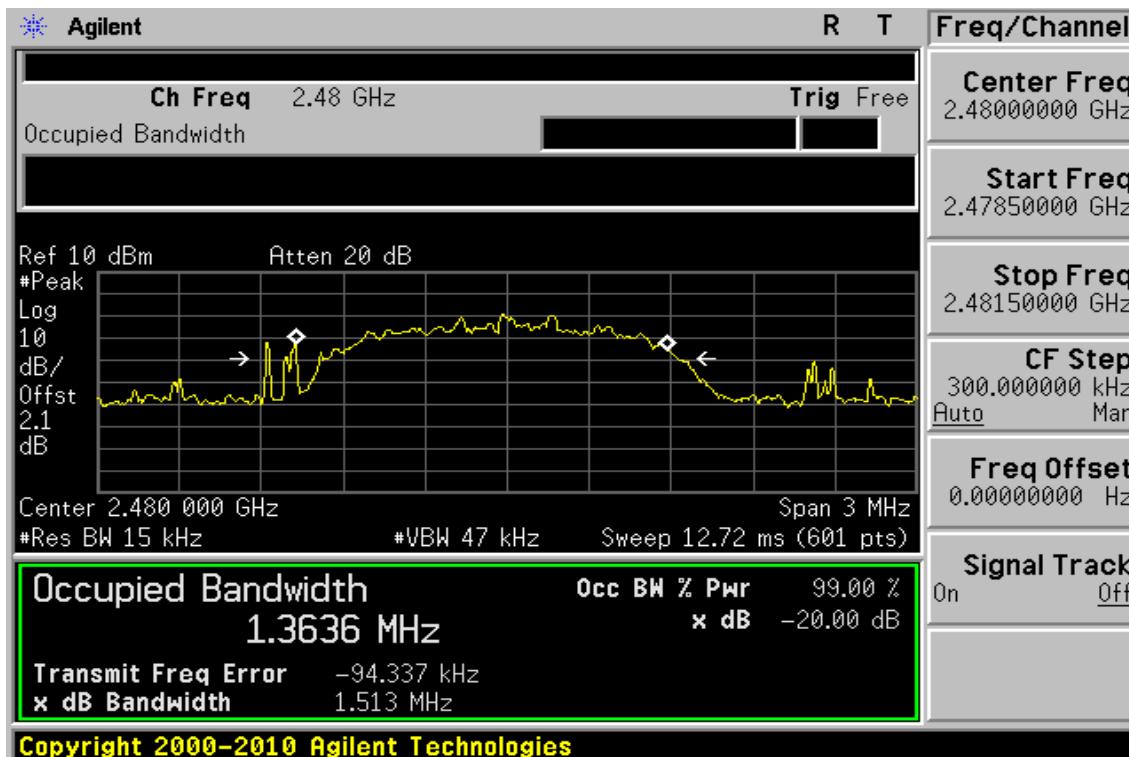
## 20dB Band Width Test Data CH-Mid (8-DPSK mode)



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**20dB Width Test Data CH-High (8-DPSK mode)**

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## 9. CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

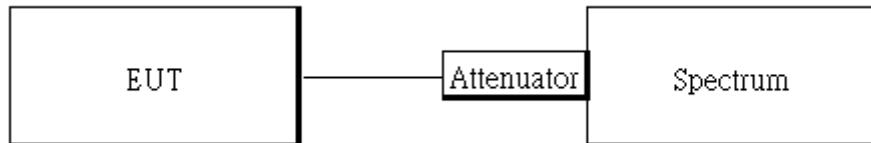
### 9.1. Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

### 9.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

### 9.3. Test SET-UP



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## 9.4. Measurement Procedure

### Conducted Band Edge:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=300 kHz, Sweep = auto
6. Mark Peak, 2.390GHz and 2.4835GHz and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

### Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Set RBW = 100K & VBW = 300K, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

## 9.5. Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

### NOTE:

1. Cable loss as 2.1dB that offsets in the spectrum
2. The occurrence of the spike on the conducted emission is the signal of the fundamental emission.

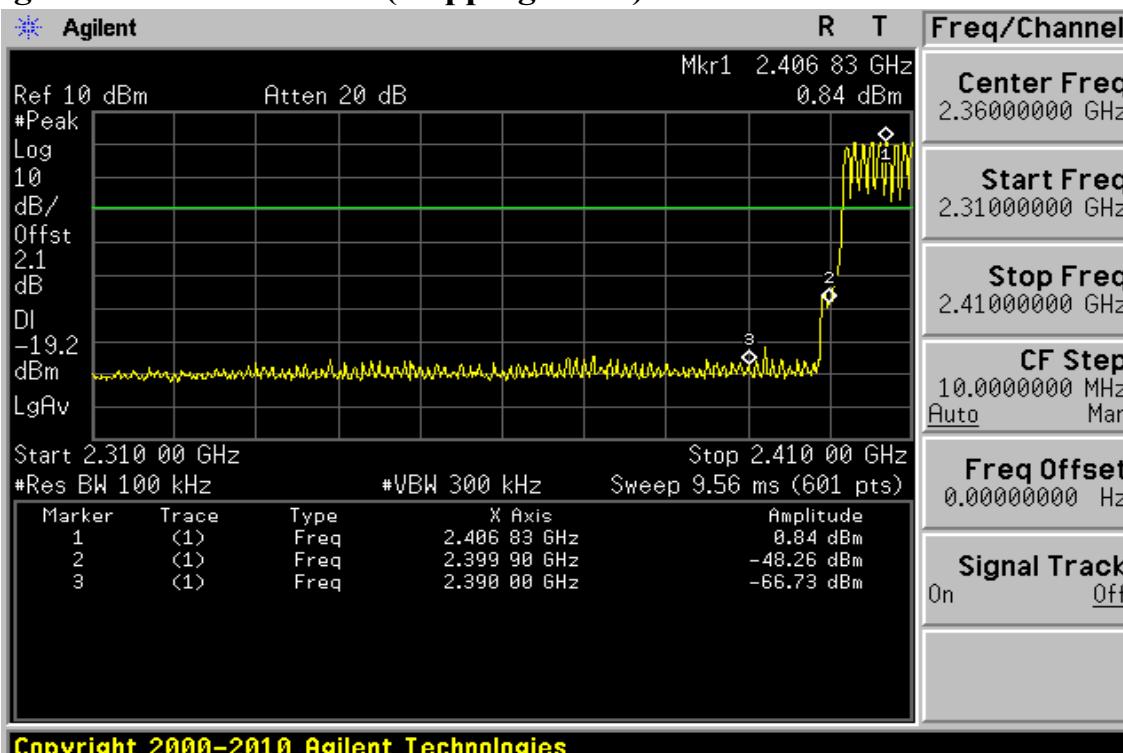
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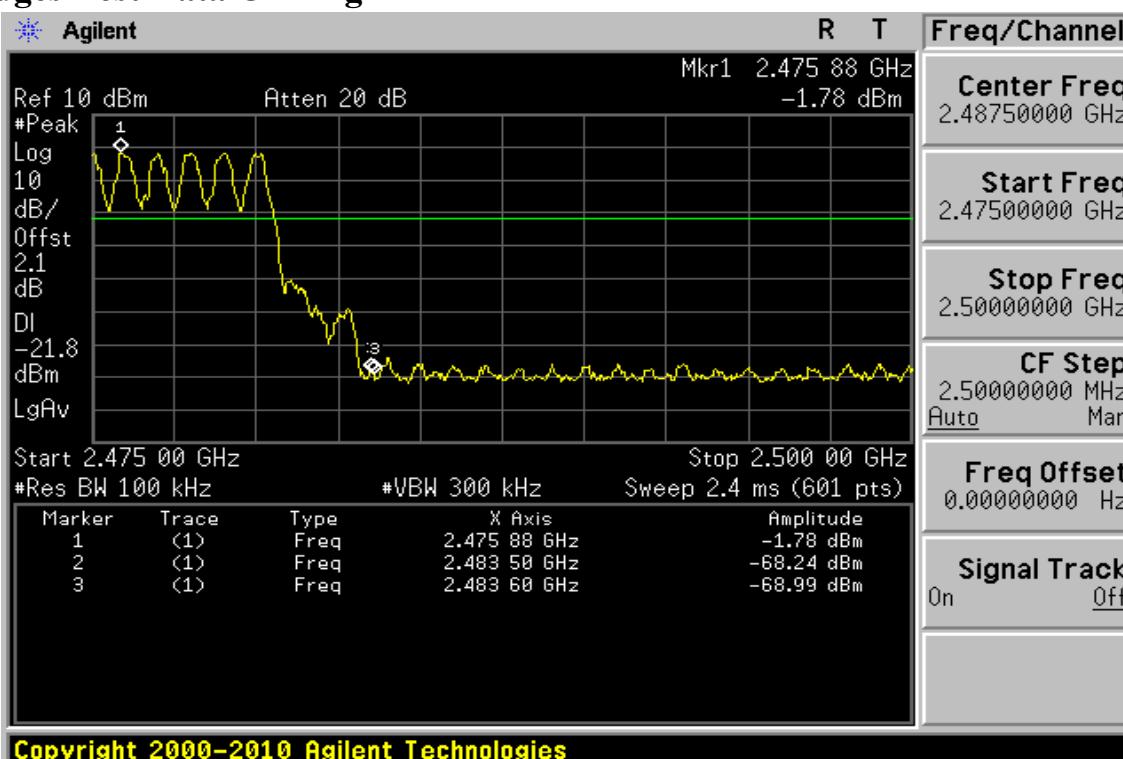
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## Band Edges Test Data CH-Low (Hopping mode)



## Band Edges Test Data CH-High



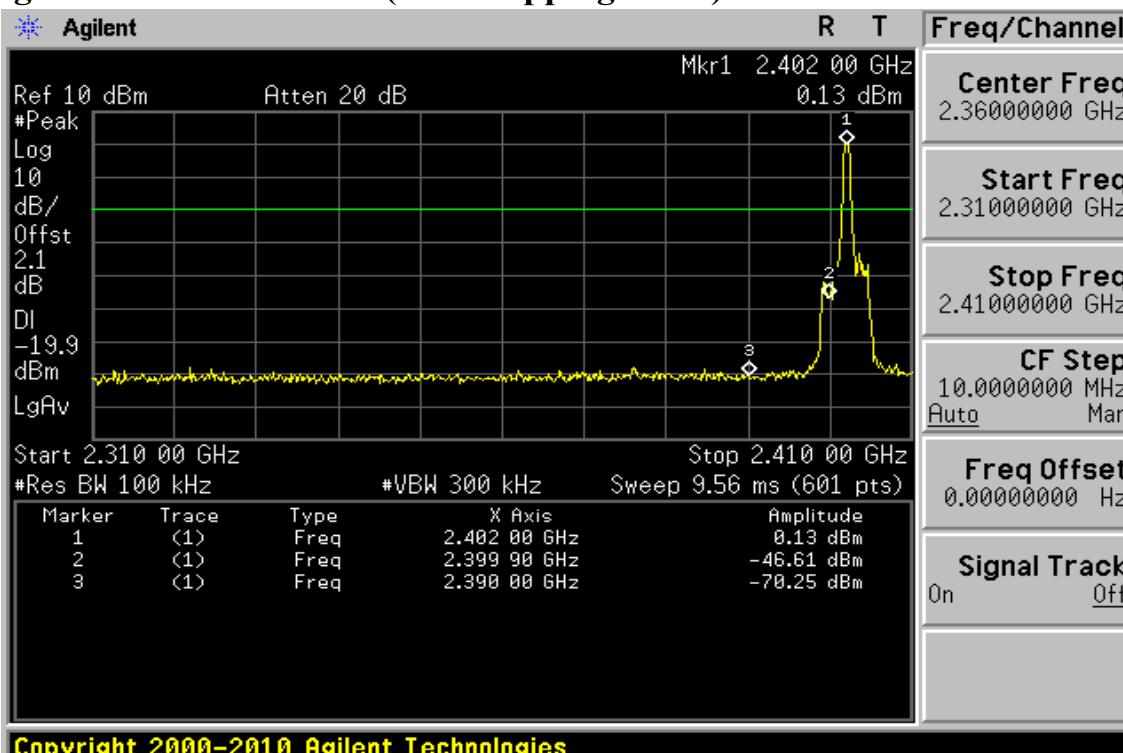
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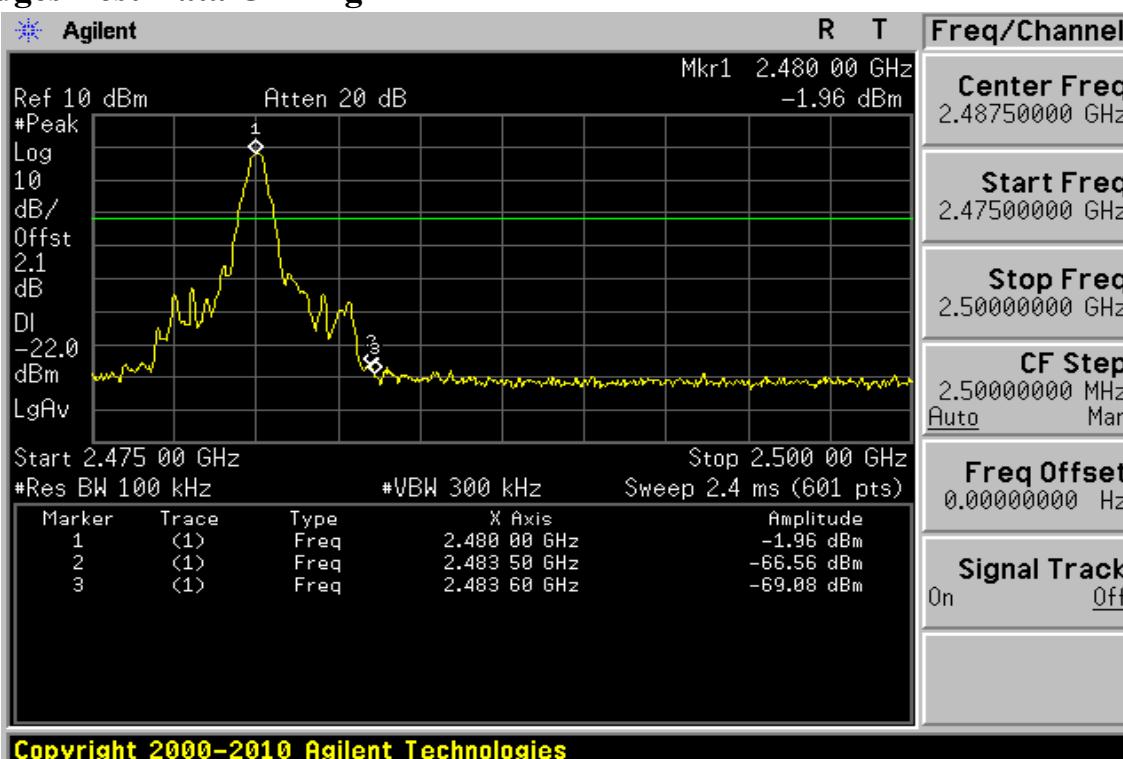
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## Band Edges Test Data CH-Low (Non-Hopping mode)



## Band Edges Test Data CH-High



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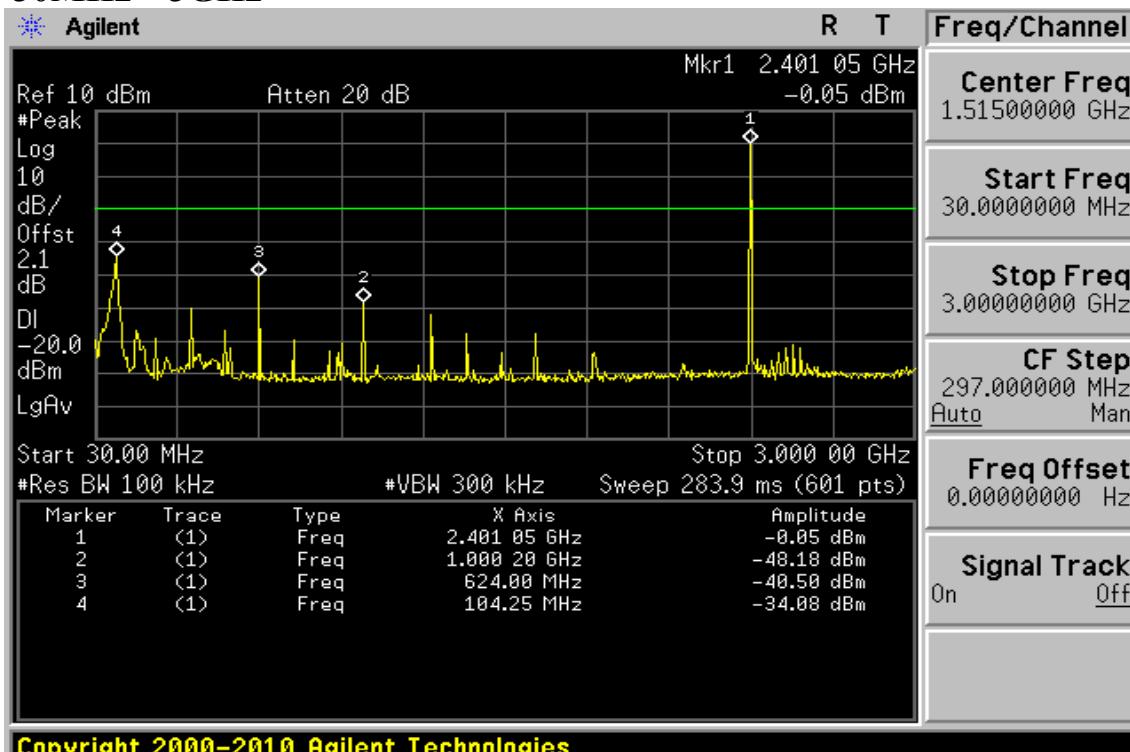
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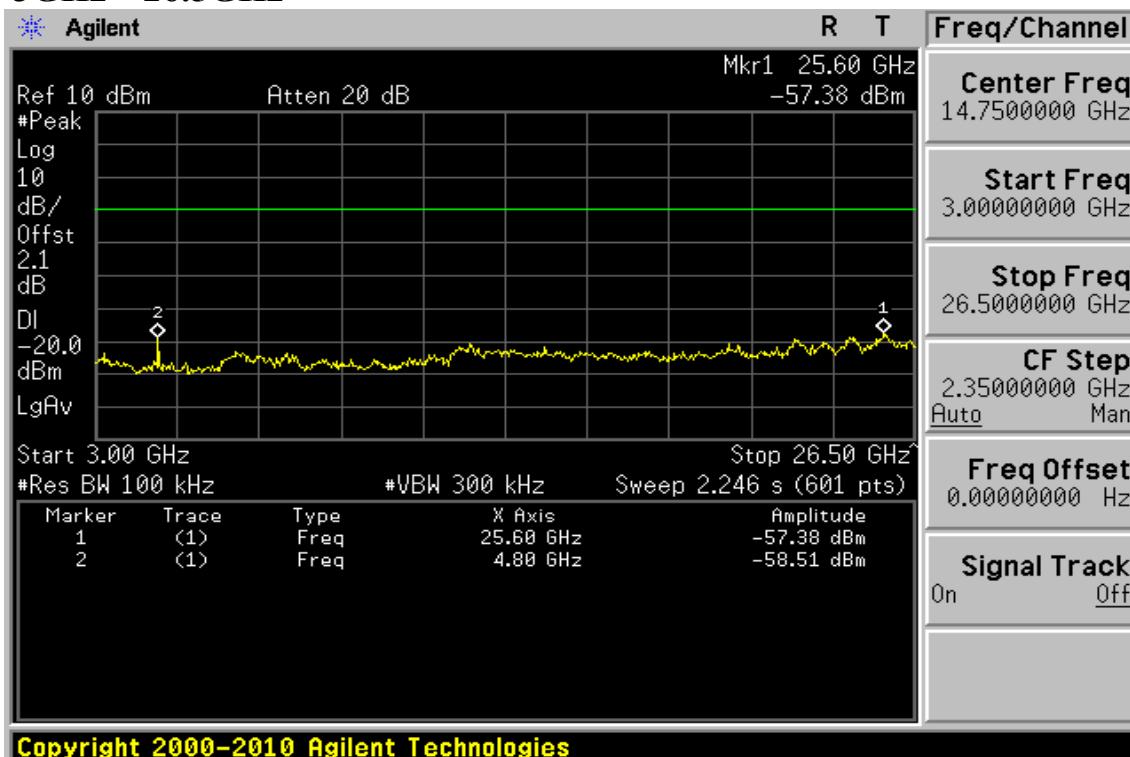
## Conducted Spurious Emission Measurement Result

### Ch Low 30MHz – 3GHz



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### Ch Low 3GHz – 26.5GHz



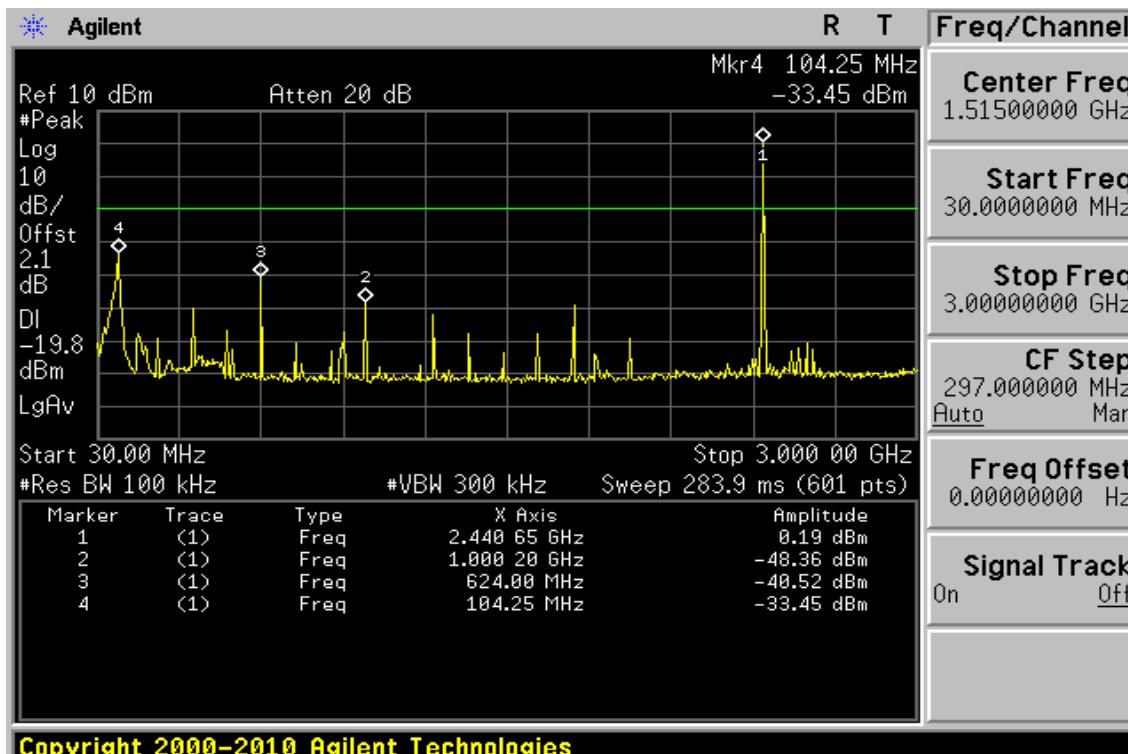
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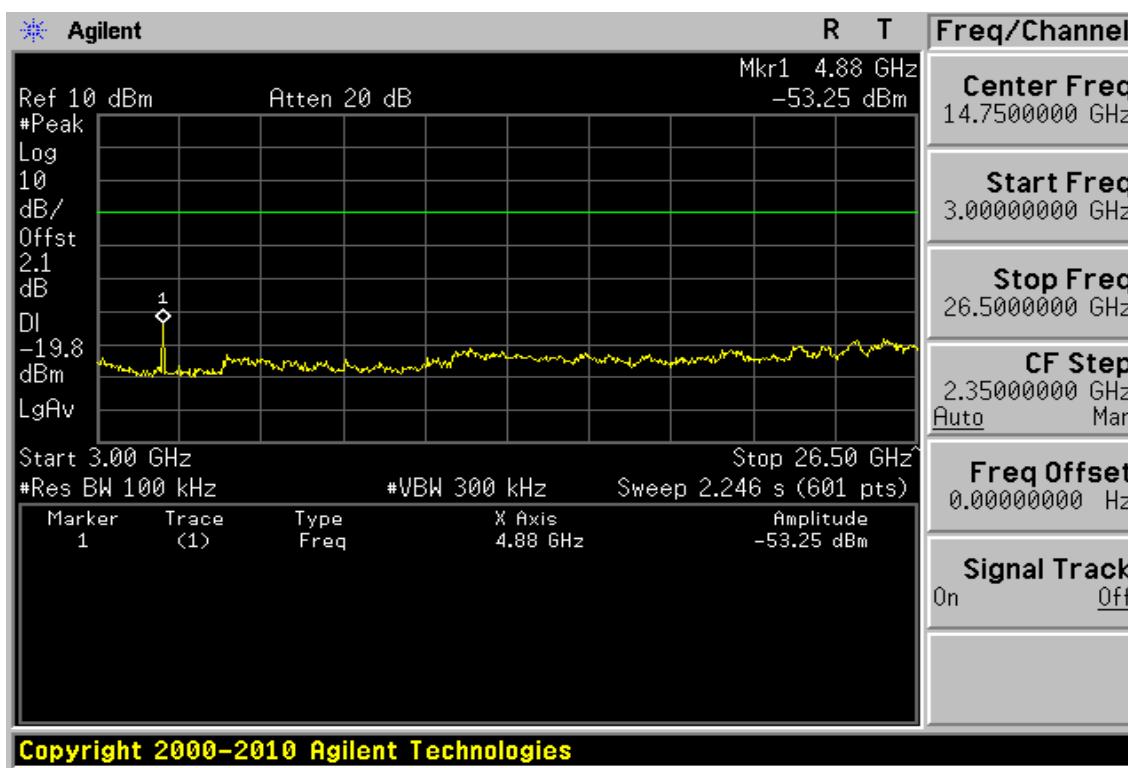
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## Ch Mid 30MHz – 3GHz



## Ch Mid 3GHz – 26.5GHz



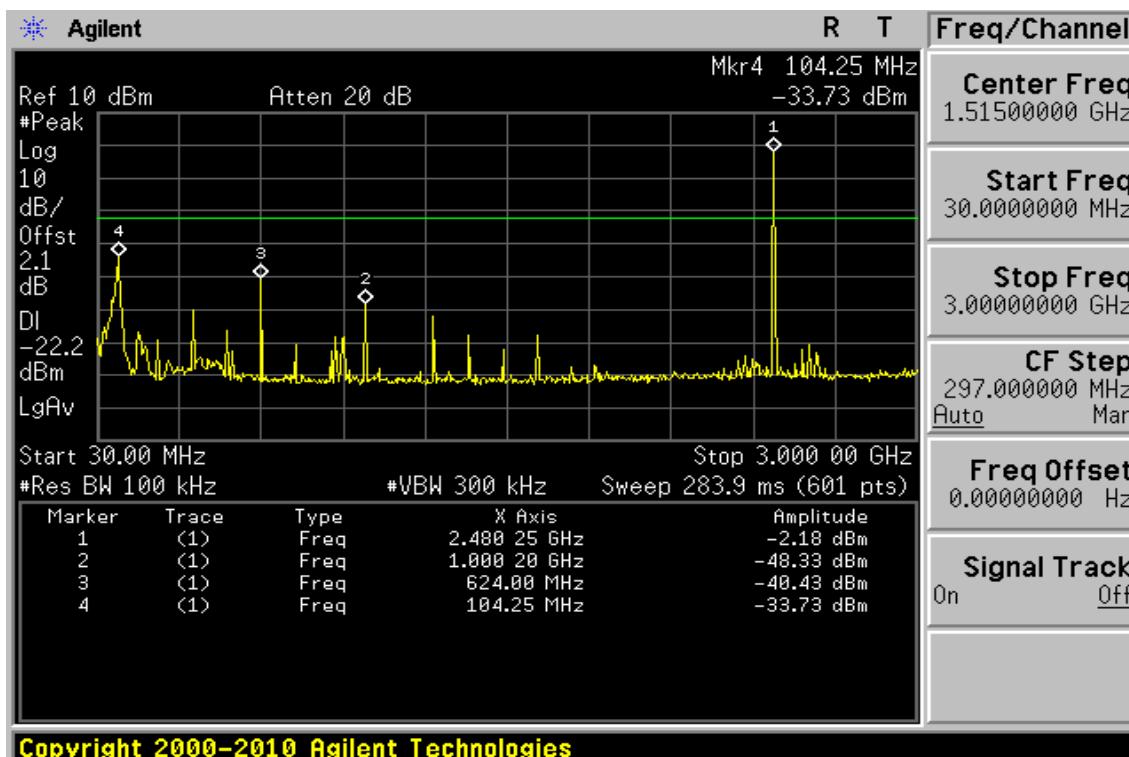
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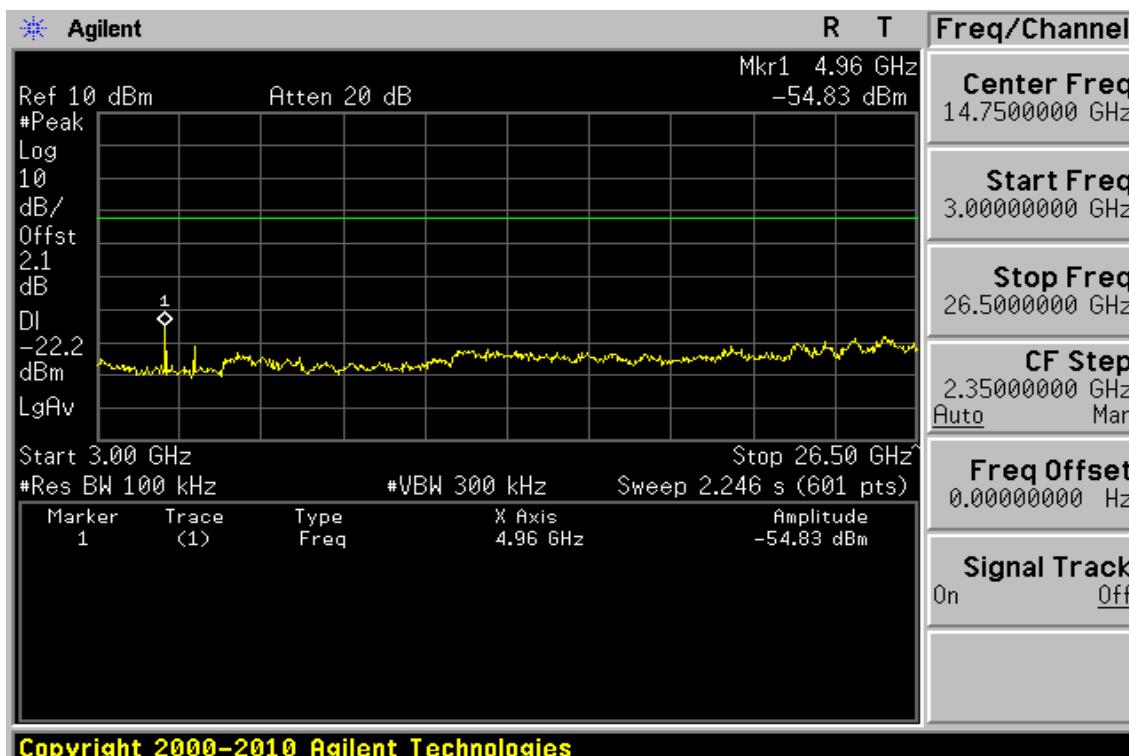
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## Ch High 30MHz – 3GHz



## Ch High 3GHz – 26.5GHz



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## 10. RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

### 10.1. Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 limit as below.

And according to §15.33(a) (1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

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

**Note:**

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dB $\mu$ V/m) = 20 log Emission level (dB $\mu$ V/m)

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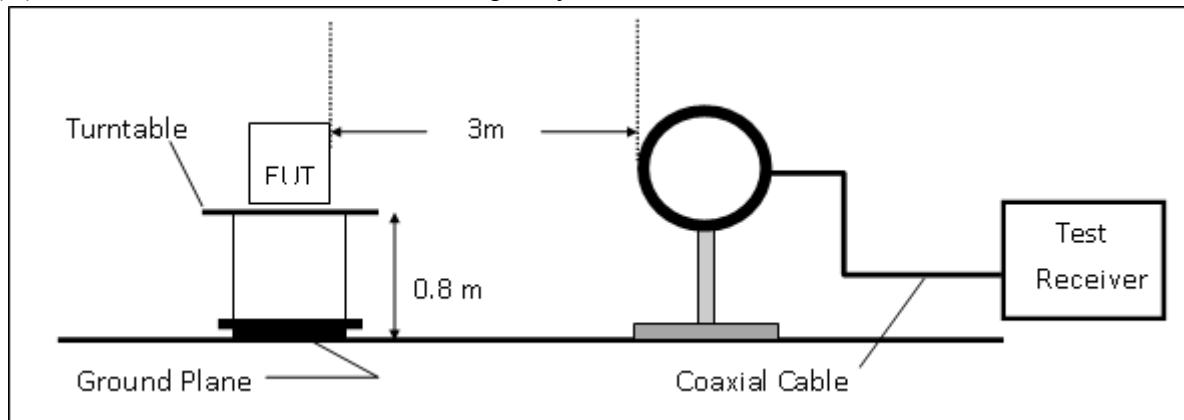
## 10.2. Measurement Equipment Used

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI7	100760	05/26/2014	05/25/2015
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	12/22/2014	12/21/2015
Loop Antenna	ETS.LINDGREN	6502	00148045	07/03/2014	07/02/2015
Bilog Antenna	SCHWAZBECK	VULB9168	378	12/23/2014	12/22/2015
Horn antenna	ETS.LINDGREN	3117	123995	05/19/2014	05/18/2015
Horn Antenna	Schwarzbeck	BBHA9170	184	12/25/2014	12/24/2015
Pre-Amplifier	Agilent	8447D	2944A07676	01/02/2015	01/01/2016
Pre-Amplifier	Agilent	8449B	3008A00578	01/02/2015	01/01/2016
Pre-Amplifier	EMC Instruments Corp.	EMC184045	980135	01/02/2015	01/01/2016
Filter 2400-2483.5 MHz	EWT	EWT-14-0166	M2	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	004	01/02/2015	01/01/2016
Turn Table	HD	DT420	N/A	N.C.R	N.C.R
Antenna Tower	HD	MA240-N	240/657	N.C.R	N.C.R
Controller	HD	HD100	N/A	N.C.R	N.C.R
Low Loss Cable	Huber Suhner	966_Rx	9	01/02/2015	01/01/2016

NOTE: N.C.R refers to Not Calibrated Required.

## 10.3. Test SET-UP

(A) Radiated Emission Test Set-UP Frequency Below 30MHz.

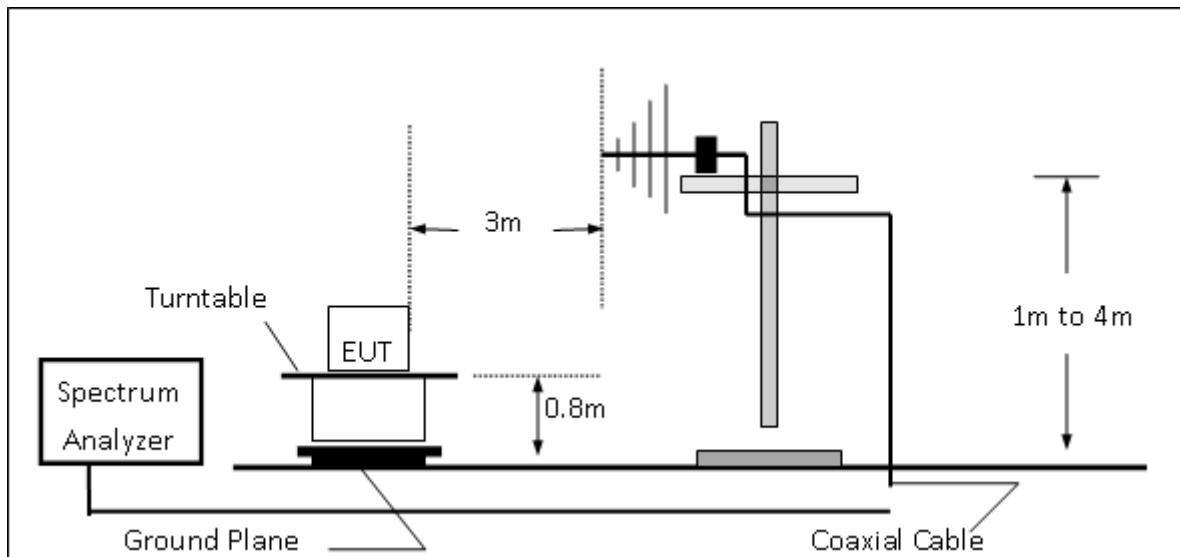


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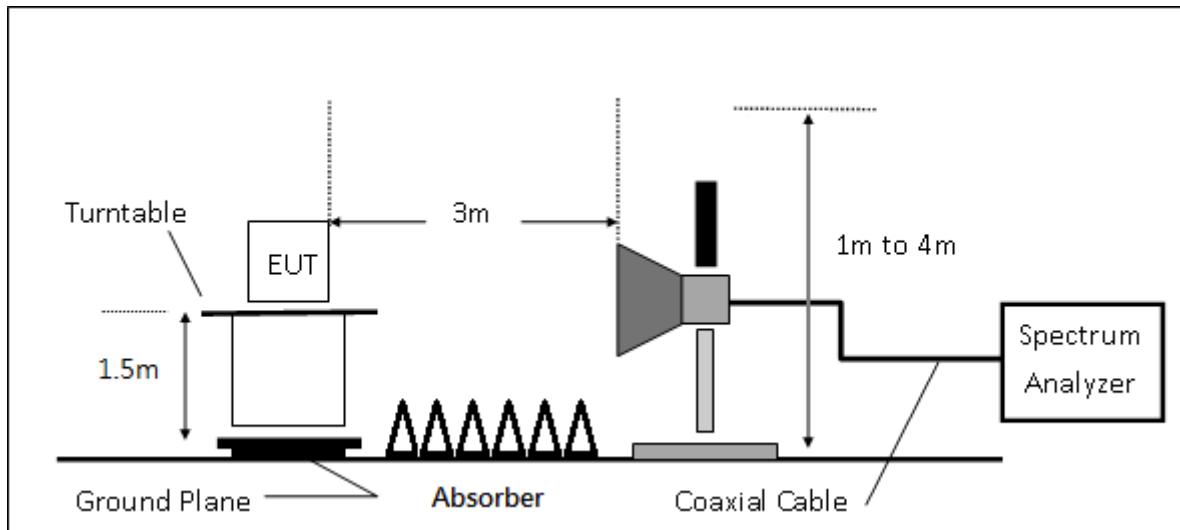
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(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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## 10.4. Measurement Procedure

### Radiated Emission

1. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Use the follow spectrum analyzer setting:
  - (1) Span = wide enough to fully capture the emission being measured
  - (2) RBW = 1 MHz for  $f \geq 1$  GHz, 100 kHz for  $f < 1$  GHz, VBW  $\geq$  RBW, Sweep = auto, Detector function = peak, Trace = max hold
  - (3) For average measurement: use duty cycle correction factor method per 15.35(c)  
Duty Cycle = On time/100 milliseconds  
On time =  $N_1 \cdot L_1 = N_2 \cdot L_2 + \dots + N_{(n-1)} \cdot L_{(n-1)} + N(n) \cdot L(n)$   
Where  $N_1$  is number of type 1 pulses,  $L_1$  is length of type 1 pulses, etc.  
Average Emission Level = Peak Emission Level +  $20 \cdot \log(\text{duty Cycle})$
6. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
7. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
8. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
9. Repeat above procedures until all frequency of the interest measured were complete.

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## 10.5. Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

The limit of the emission level is expressed in dB $\mu$ V/m, which converts  $20 * \log(\mu\text{V}/\text{m})$

Actual FS(dB $\mu$ V/m) = SPA. Reading level(dB $\mu$ V) + Factor(dB)

Factor(dB) = Antenna Factor(dB $\mu$ V/m) + Cable Loss(dB) - Pre\_Amplifier Gain(dB)

### Note :

“F” : denotes Fundamental Frequency. ; “H” : denotes Harmonic Frequency.

“E” : denotes Band Edge Frequency. ; “S” : denotes Spurious Frequency.

## 10.6. Test Results of Radiated Spurious Emissions from 9 KHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

## 10.7. Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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**Radiated Band Edge Measurement Result: (Hopping Mode)**

Operation Band	:BR+Hopping	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23 deg_C / 62 RH
Operation Mode	:Band Edge LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			dB $\mu$ V					
2390.00	E	Average	30.31	5.16	35.47	54.00	-18.53	
2390.00	E	Peak	41.97	5.16	47.13	74.00	-26.87	

Operation Band	:BR+Hopping	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23 deg_C / 62 RH
Operation Mode	:Band Edge LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:HORIZONTAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			dB $\mu$ V					
2390.00	E	Average	30.24	5.16	35.40	54.00	-18.60	
2390.00	E	Peak	41.16	5.16	46.32	74.00	-27.68	

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Operation Band :BR+Hopping  
 Fundamental Frequency :2480 MHz  
 Operation Mode :Band Edge HIGH  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :VERTICAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
						dB $\mu$ V/m	dB $\mu$ V/m
2483.50	E	Average	30.24	6.01	36.25	54.00	-17.75
2483.50	E	Peak	41.86	6.01	47.87	74.00	-26.13

Operation Band :BR+Hopping  
 Fundamental Frequency :2480 MHz  
 Operation Mode :Band Edge HIGH  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :HORIZONTAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
						dB $\mu$ V/m	dB $\mu$ V/m
2483.50	E	Average	30.02	6.01	36.03	54.00	-17.97
2483.50	E	Peak	42.96	6.01	48.97	74.00	-25.03

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**10.6.2 Radiated Emission – Band Edge (Non-Hopping Mode):**

Operation Band	:BR	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23 deg_C / 62 RH
Operation Mode	:Band Edge LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
						FS dB $\mu$ V/m	Margin dB
2390.00	E	Average	30.32	5.16	35.48	54.00	-18.52
2390.00	E	Peak	42.32	5.16	47.48	74.00	-26.52

Operation Band	:BR	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23 deg_C / 62 RH
Operation Mode	:Band Edge LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:HORIZONTAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
						FS dB $\mu$ V/m	Margin dB
2390.00	E	Average	30.36	5.16	35.52	54.00	-18.48
2390.00	E	Peak	42.06	5.16	47.22	74.00	-26.78

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Operation Band :BR Test Date :2015-02-24  
 Fundamental Frequency :2480 MHz Temp./Humi. :23 deg\_C / 62 RH  
 Operation Mode :Band Edge HIGH Engineer :Curry  
 EUT Pol. :H Plane Measurement Antenna Pol. :VERTICAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
						FS dB $\mu$ V/m	Margin dB
2483.50	E	Average	31.39	6.01	37.40	54.00	-16.60
2483.50	E	Peak	42.34	6.01	48.35	74.00	-25.65

Operation Band :BR Test Date :2015-02-24  
 Fundamental Frequency :2480 MHz Temp./Humi. :23 deg\_C / 62 RH  
 Operation Mode :Band Edge HIGH Engineer :Curry  
 EUT Pol. :H Plane Measurement Antenna Pol. :HORIZONTAL

Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
						FS dB $\mu$ V/m	Margin dB
2483.50	E	Average	32.92	6.01	38.93	54.00	-15.07
2483.50	E	Peak	46.52	6.01	52.53	74.00	-21.47

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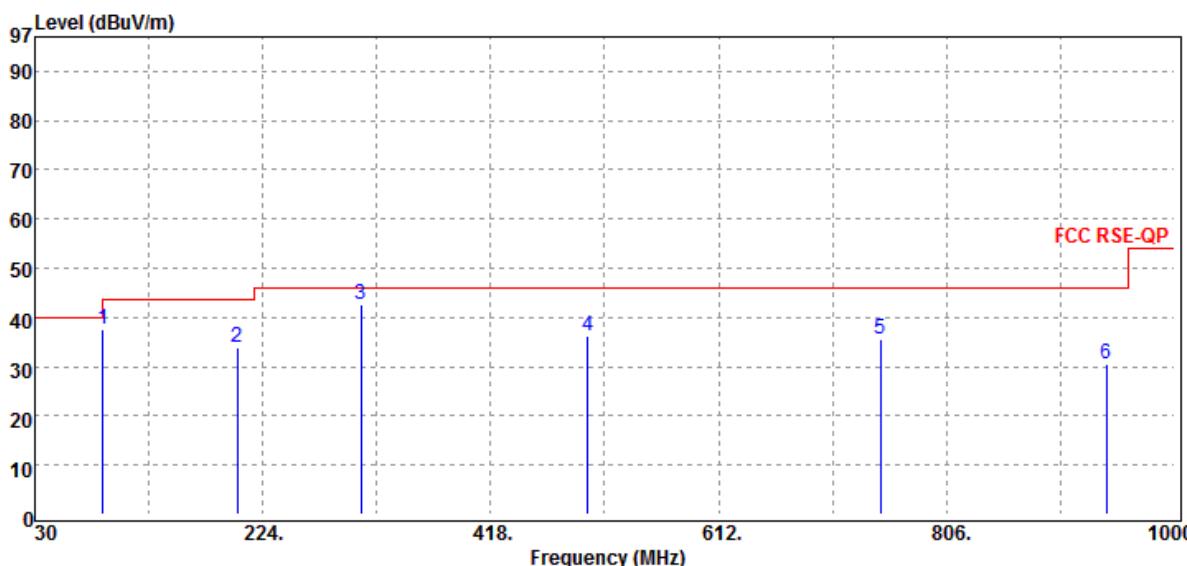
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## Radiated Spurious Emission Measurement Result: For Frequency form 30MHz to 1000MHz

Operation Band	:BR	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23 deg_C / 62 RH
Operation Mode	:TX LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Note	Detector	Spectrum		Factor	Actual	Limit	Margin
			Mode	Reading Level				
MHz	F/H/E/S	PK/QP/AV	dB $\mu$ V	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB	
88.20	S	Peak	52.63	-15.13	37.50	43.50	-6.00	
202.66	S	Peak	45.63	-11.63	34.00	43.50	-9.50	
307.42	S	Peak	50.39	-7.72	42.67	46.00	-3.33	
500.45	S	Peak	40.73	-4.34	36.39	46.00	-9.61	
749.74	S	Peak	35.14	0.27	35.41	46.00	-10.59	
941.80	S	Peak	27.62	2.97	30.59	46.00	-15.41	

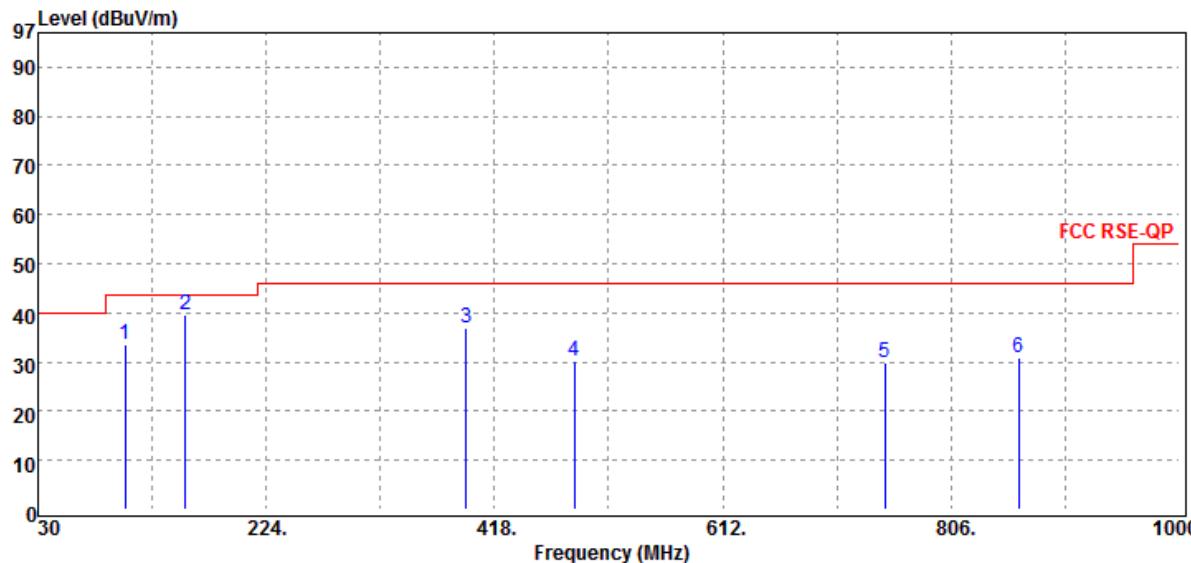
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Operation Band :BR  
 Fundamental Frequency :2402 MHz  
 Operation Mode :TX LOW  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			PK/QP/AV	Reading Level dB $\mu$ V				
103.72	S	Peak	46.91	-13.49	33.42	43.50	43.50	-10.08
155.13	S	Peak	48.74	-9.03	39.71	43.50	43.50	-3.79
393.75	S	Peak	43.01	-6.09	36.92	46.00	46.00	-9.08
485.90	S	Peak	34.56	-4.37	30.19	46.00	46.00	-15.81
749.74	S	Peak	29.72	0.27	29.99	46.00	46.00	-16.01
863.23	S	Peak	28.63	2.30	30.93	46.00	46.00	-15.07

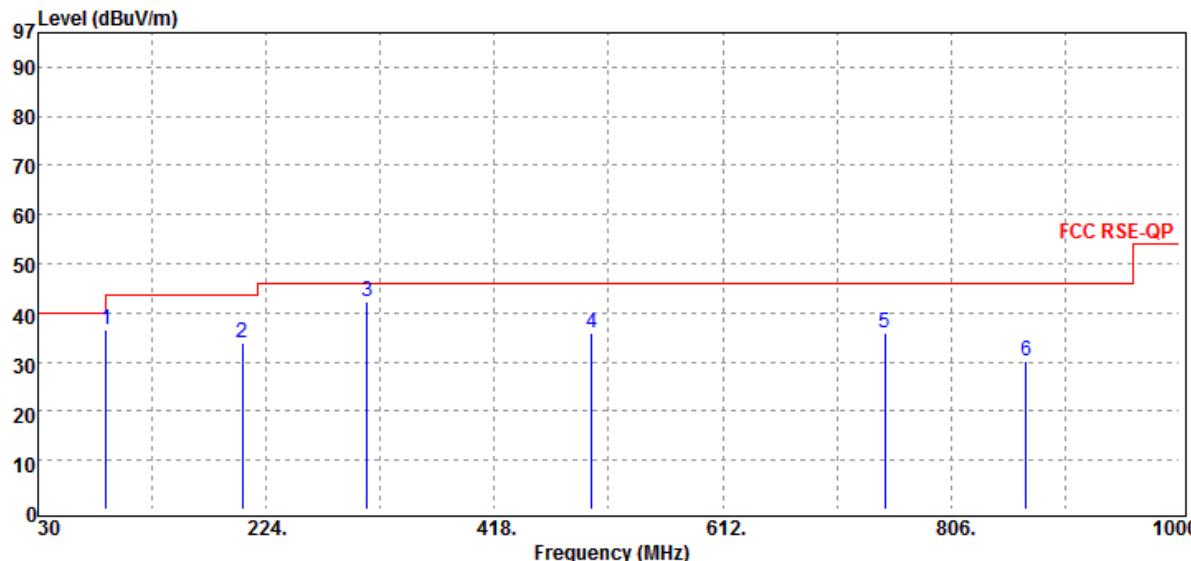
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Operation Band :BR  
 Fundamental Frequency :2441 MHz  
 Operation Mode :TX MID  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level		Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			PK/QP/AV	dB $\mu$ V				
88.20	S	Peak	51.86	-15.13	36.73	43.50	-6.77	
203.63	S	Peak	45.51	-11.57	33.94	43.50	-9.56	
309.36	S	Peak	50.00	-7.67	42.33	46.00	-3.67	
500.45	S	Peak	40.41	-4.34	36.07	46.00	-9.93	
749.74	S	Peak	35.60	0.27	35.87	46.00	-10.13	
870.02	S	Peak	27.53	2.54	30.07	46.00	-15.93	

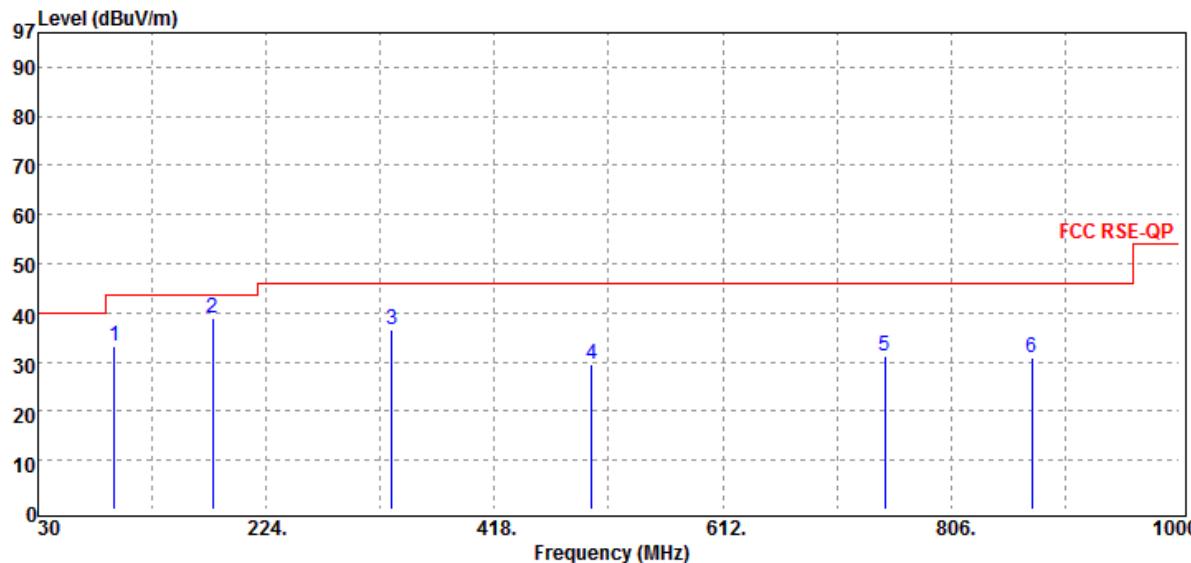
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Operation Band :BR  
 Fundamental Frequency :2441 MHz  
 Operation Mode :TX MID  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			PK/QP/AV	Reading Level dB $\mu$ V				
94.99	S	Peak	48.14	-14.90	33.24	43.50	-10.26	
178.41	S	Peak	49.31	-10.33	38.98	43.50	-4.52	
330.70	S	Peak	44.15	-7.69	36.46	46.00	-9.54	
500.45	S	Peak	33.77	-4.34	29.43	46.00	-16.57	
749.74	S	Peak	31.09	0.27	31.36	46.00	-14.64	
874.87	S	Peak	28.46	2.44	30.90	46.00	-15.10	

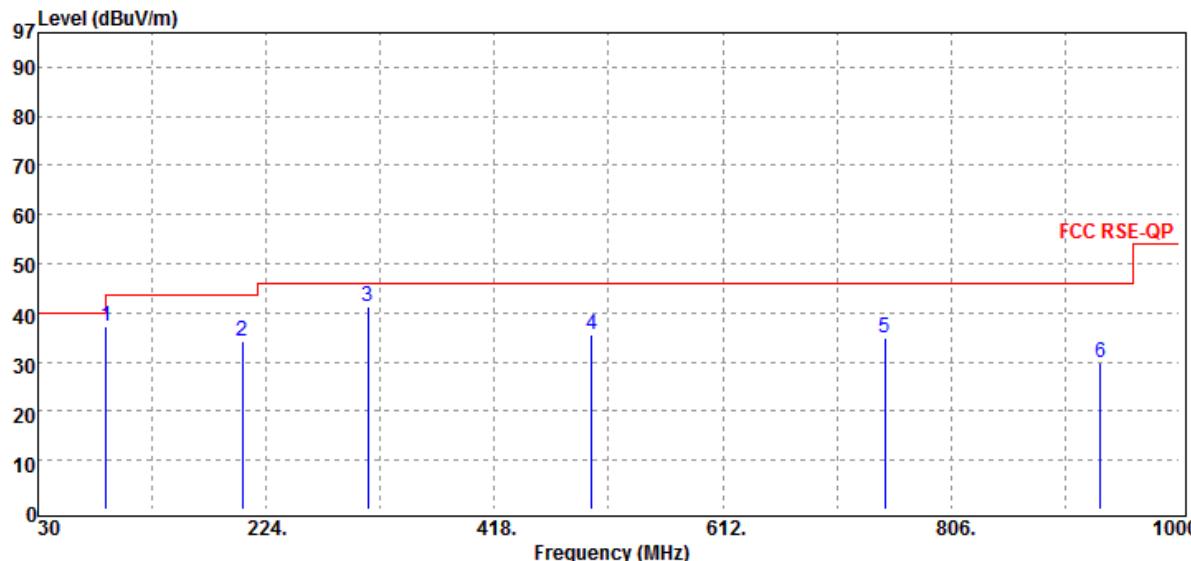
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Operation Band :BR  
 Fundamental Frequency :2480 MHz  
 Operation Mode :TX HIGH  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			PK/QP/AV	Reading Level dB $\mu$ V				
88.20	S	Peak	52.55	-15.13	37.42	43.50	-6.08	
203.63	S	Peak	45.89	-11.57	34.32	43.50	-9.18	
310.33	S	Peak	49.08	-7.64	41.44	46.00	-4.56	
500.45	S	Peak	39.86	-4.34	35.52	46.00	-10.48	
749.74	S	Peak	34.51	0.27	34.78	46.00	-11.22	
933.07	S	Peak	27.00	2.79	29.79	46.00	-16.21	

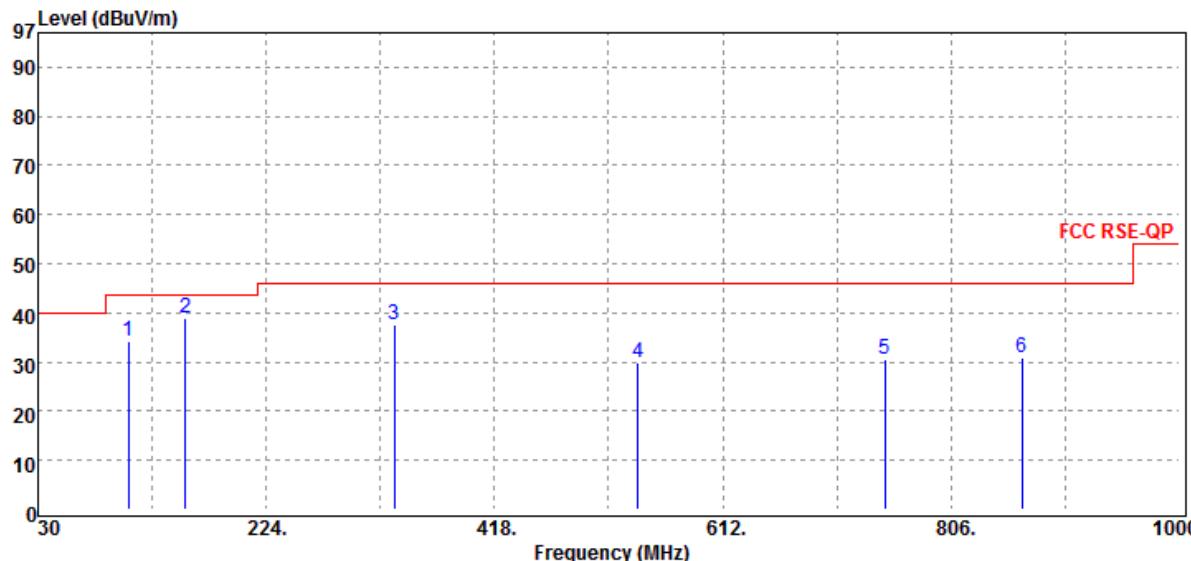
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Operation Band :BR  
 Fundamental Frequency :2480 MHz  
 Operation Mode :TX HIGH  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level		Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			PK/QP/AV	dB $\mu$ V				
106.63	S	Peak	46.96	-12.83	34.13	43.50	-9.37	
155.13	S	Peak	47.88	-9.03	38.85	43.50	-4.65	
332.64	S	Peak	45.31	-7.67	37.64	46.00	-8.36	
540.22	S	Peak	33.90	-4.01	29.89	46.00	-16.11	
749.74	S	Peak	30.13	0.27	30.40	46.00	-15.60	
866.14	S	Peak	28.37	2.46	30.83	46.00	-15.17	

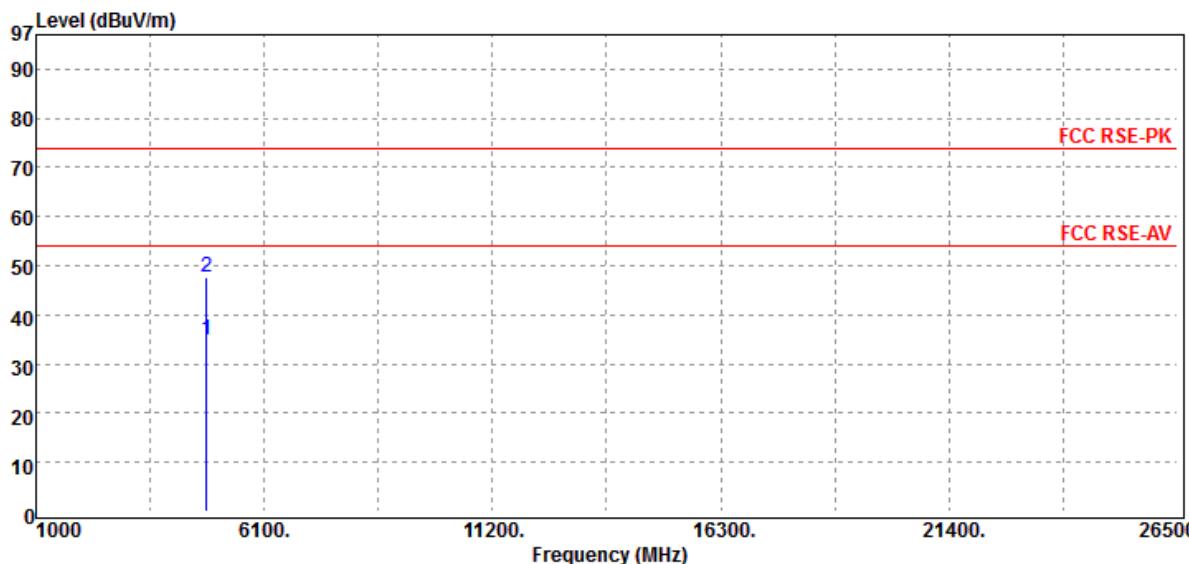
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**Radiated Spurious Emission Measurement Result:  
For Frequency over 1GHz**

Operation Band	:BR	Test Date	:2015-02-24
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23 deg_C / 62 RH
Operation Mode	:TX LOW	Engineer	:Curry
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			dB $\mu$ V				
4804.00	H	Average	25.39	9.56	34.95	54.00	-19.05
4804.00	H	Peak	38.11	9.56	47.67	74.00	-26.33

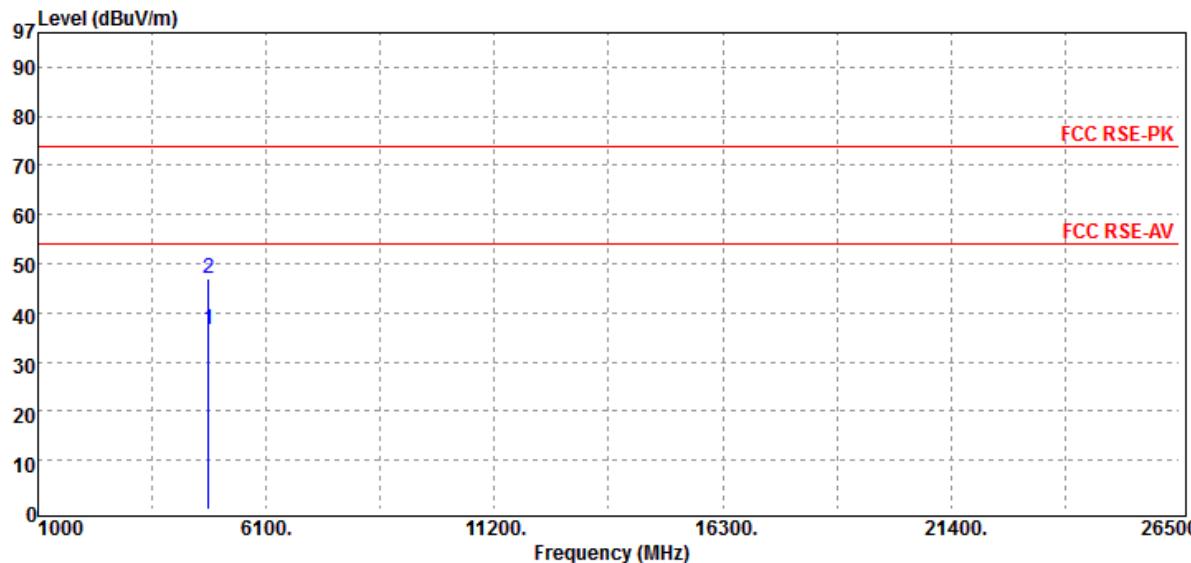
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Operation Band :BR  
 Fundamental Frequency :2402 MHz  
 Operation Mode :TX LOW  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading	Factor	Actual FS	Limit @3m	Margin
						dB $\mu$ V/m	dB $\mu$ V/m
4804.00	H	Average	27.05	9.56	36.61	54.00	-17.39
4804.00	H	Peak	37.46	9.56	47.02	74.00	-26.98

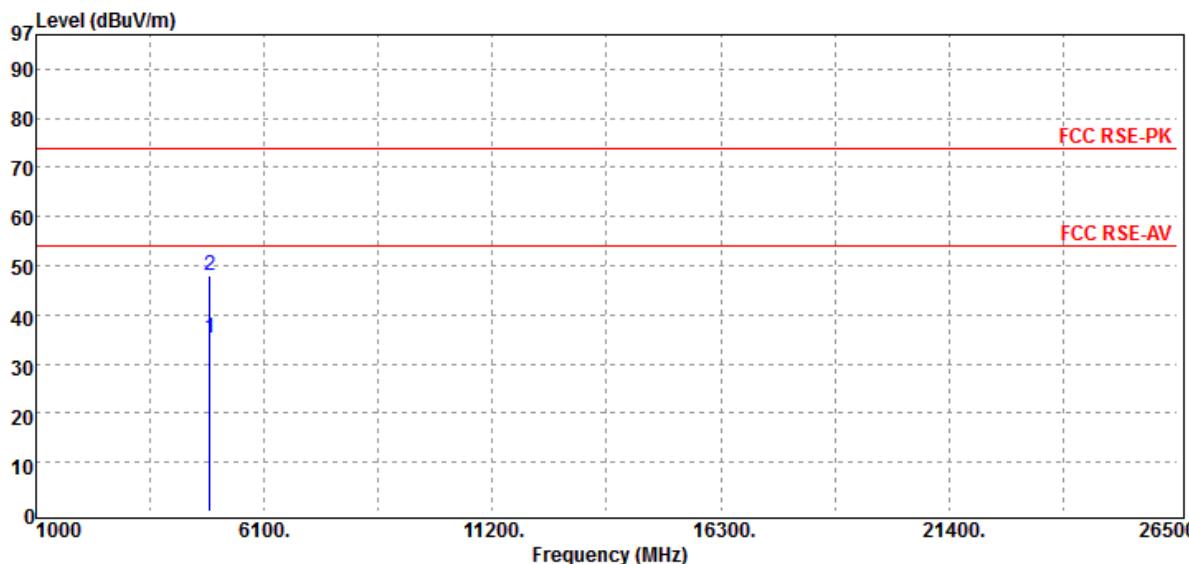
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Operation Band :BR  
 Fundamental Frequency :2441 MHz  
 Operation Mode :TX MID  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
			PK/QP/AV	Reading Level dB $\mu$ V				
4882.00	H	Average	25.55	9.85	35.40	54.00	-18.60	
4882.00	H	Peak	38.13	9.85	47.98	74.00	-26.02	

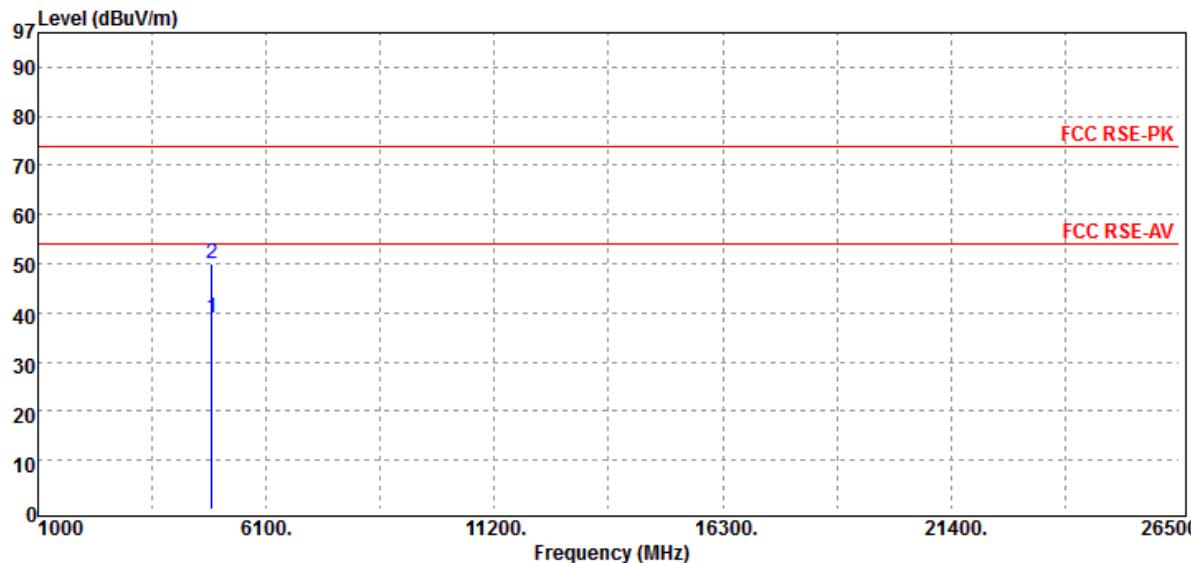
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Operation Band :BR  
Fundamental Frequency :2441 MHz  
Operation Mode :TX MID  
EUT Pol. :H Plane

Test Date :2015-02-24  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Curry  
Measurement Antenna Pol. :HORIZONTAL



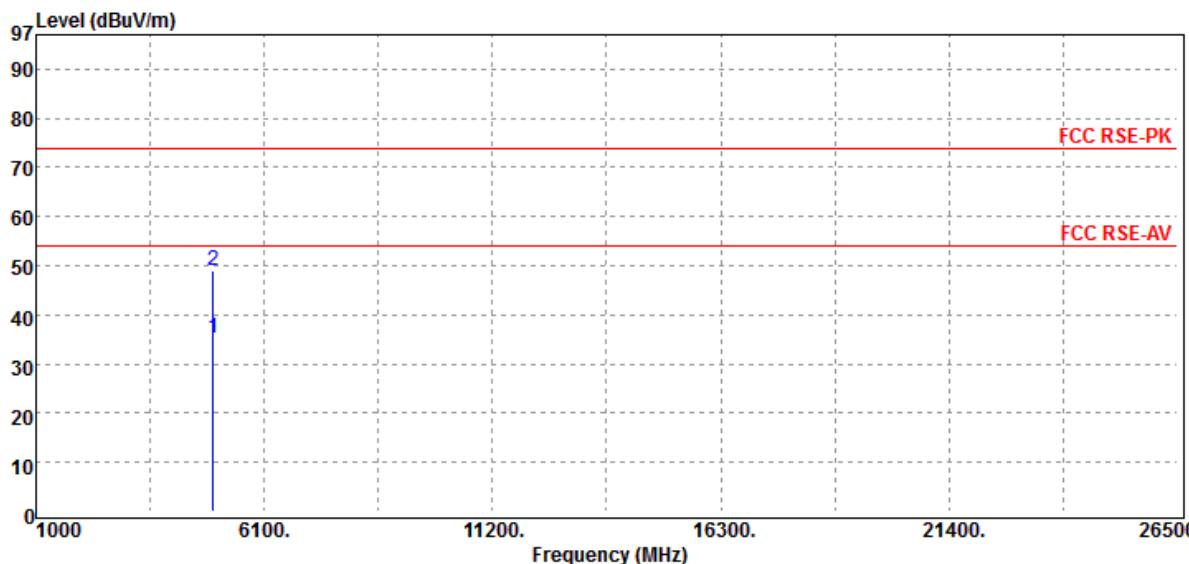
Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading	Factor	Actual FS	Limit @3m	Margin
						dB $\mu$ V/m	dB $\mu$ V/m
4882.00	H	Average	29.07	9.85	38.92	54.00	-15.08
4882.00	H	Peak	40.16	9.85	50.01	74.00	-23.99

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Operation Band :BR  
Fundamental Frequency :2480 MHz  
Operation Mode :TX HIGH  
EUT Pol. :H Plane  
Test Date :2015-02-24  
Temp./Humi. :23 deg\_C / 62 RH  
Engineer :Curry  
Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading	Factor	Actual FS	Limit @3m	Margin
						dBuV/m	dBuV/m
4960.00	H	Average	25.24	9.86	35.10	54.00	-18.90
4960.00	H	Peak	39.22	9.86	49.08	74.00	-24.92

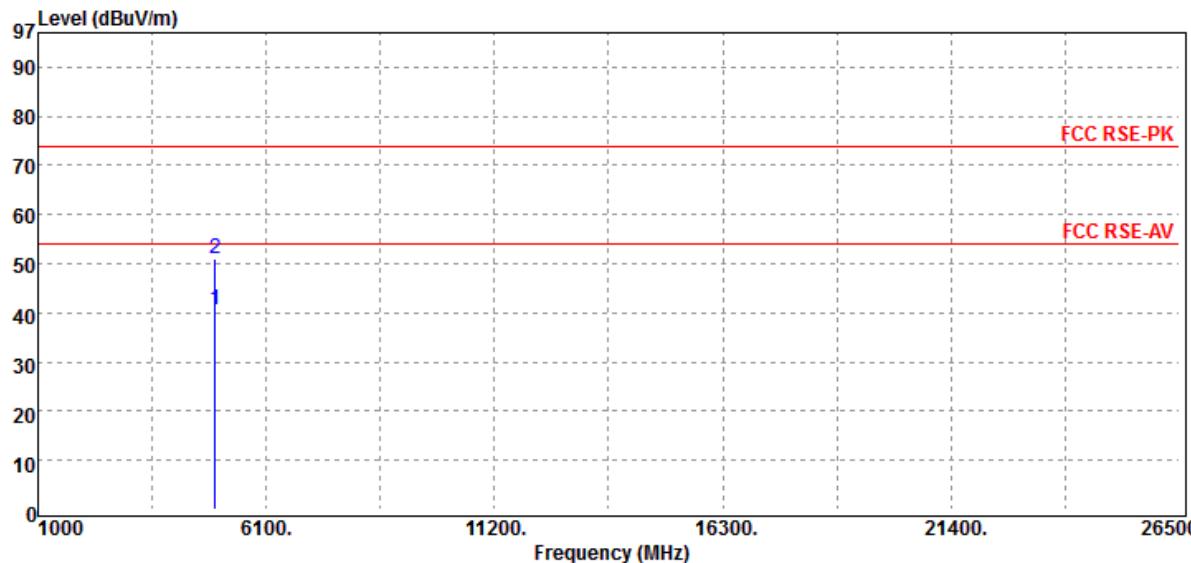
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Operation Band :BR  
 Fundamental Frequency :2480 MHz  
 Operation Mode :TX HIGH  
 EUT Pol. :H Plane

Test Date :2015-02-24  
 Temp./Humi. :23 deg\_C / 62 RH  
 Engineer :Curry  
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
						dB $\mu$ V/m	dB $\mu$ V/m
4960.00	H	Average	30.80	9.86	40.66	54.00	-13.34
4960.00	H	Peak	41.16	9.86	51.02	74.00	-22.98

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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## 11. FREQUENCY SEPARATION

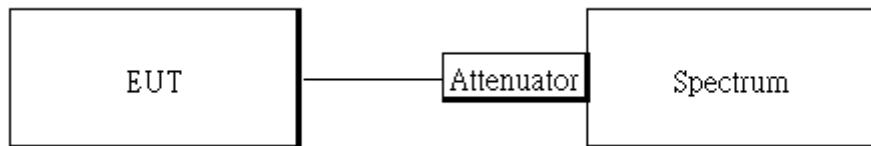
### 11.1. Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the 2/3\*20dB bandwidth of the hopping channel, whichever is greater.

### 11.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

### 11.3. Test Set-up



### 11.4. Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = middle of hopping channel.
5. Set the spectrum analyzer as RBW, VBW=100 kHz, Adjust Span to 5MHz, Sweep = auto.
6. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

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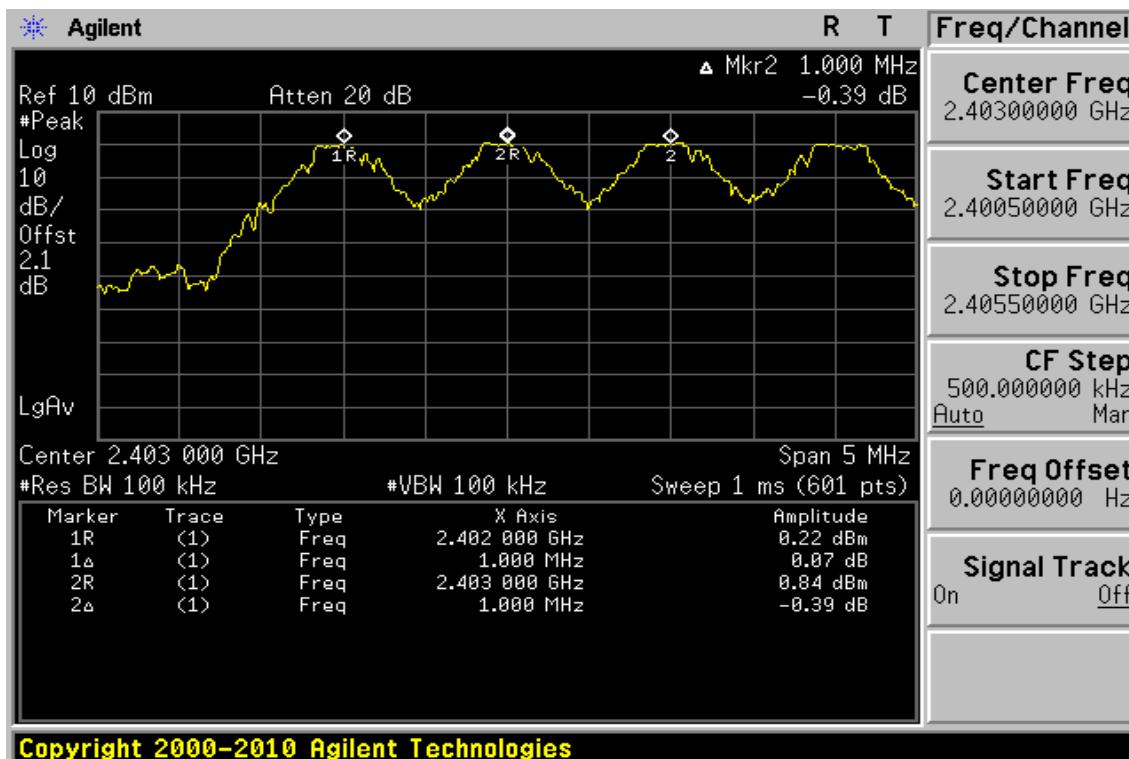
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## 11.5. Measurement Result

Channel separation (MHz)	Limit	Result
1	>=25 kHz or 2/3 times 20dB bandwidth	PASS

## Frequency Separation Test Data



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## 12. NUMBER OF HOPPING FREQUENCY

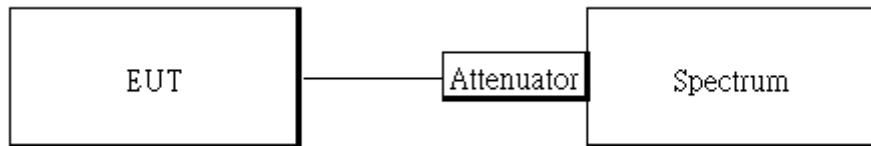
### 12.1. Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

### 12.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

### 12.3. Test Set-up



### 12.4. Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set spectrum analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.
5. Set the spectrum analyzer as RBW=430 kHz, VBW=1.5MHz., Detector = Peak
6. Max hold, view and count how many channel in the band.

### 12.5. Measurement Result

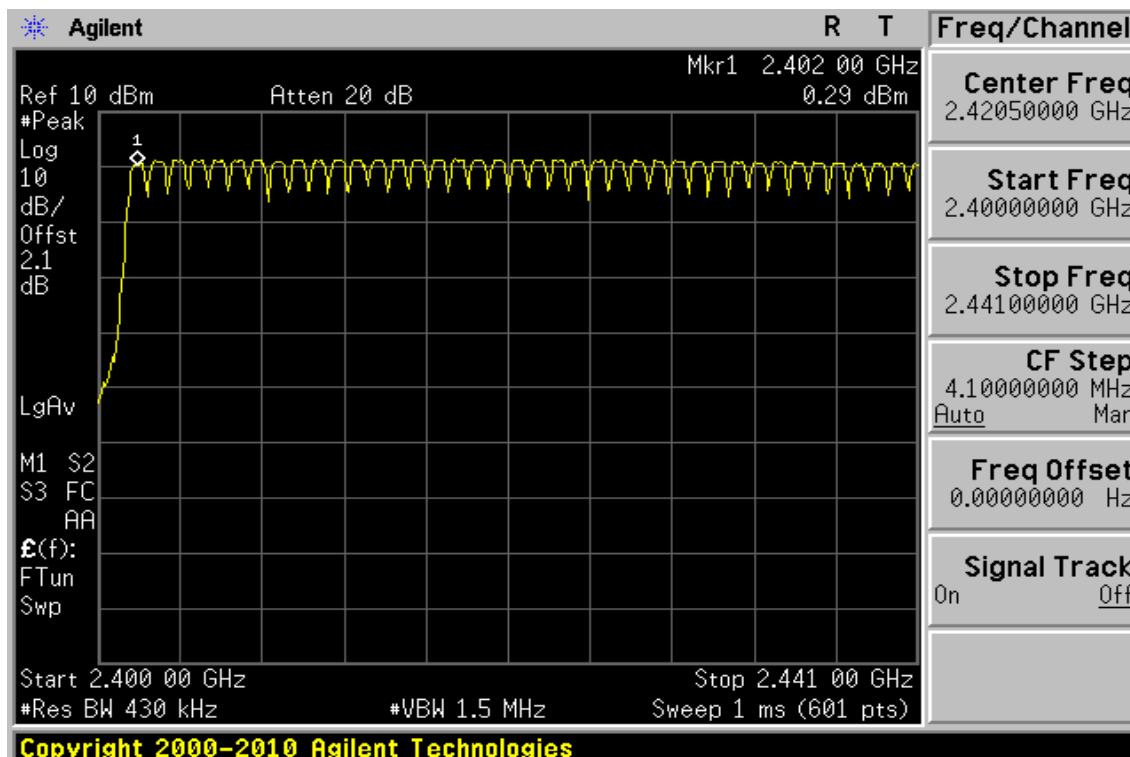
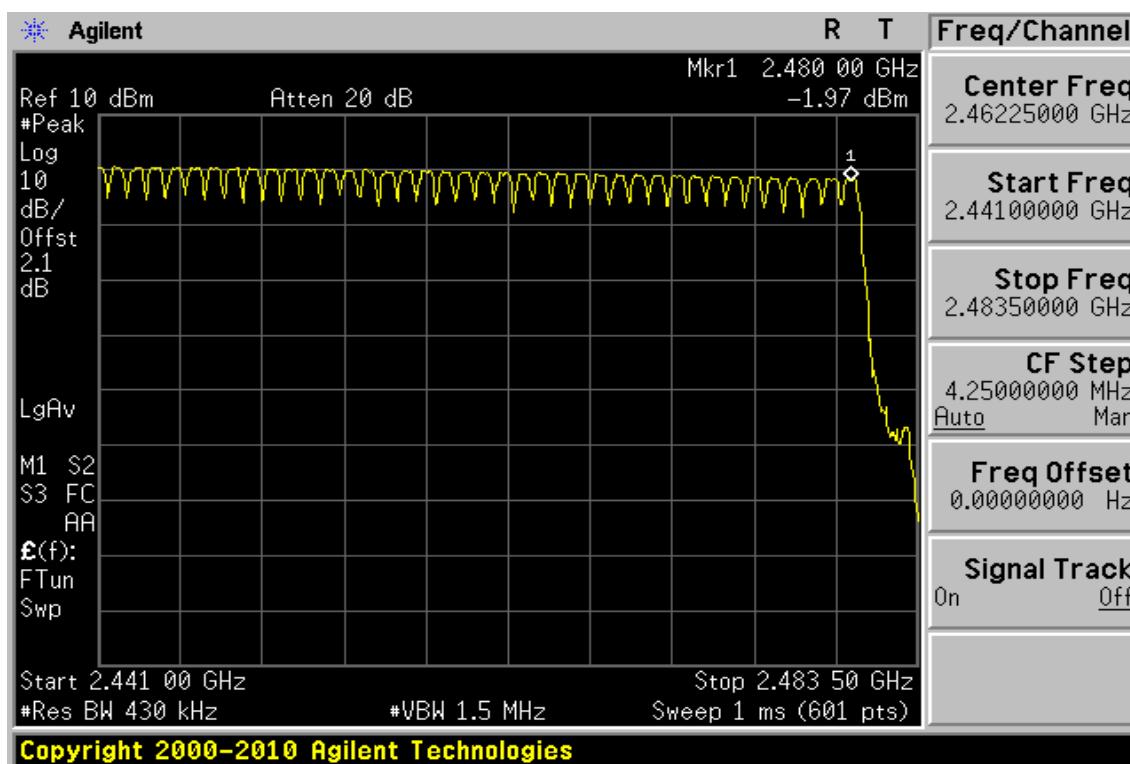
#### Tabular Data of Total Channel Number

	Channel Number	Limit
2.4 GHz - 2.441GHz	40	>15
2.441 GHz - 2.4835GHz	39	
2.4GHz ~2.4835GHz	(40+39) = 79	

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**Channel Number****2.4 GHz - 2.441GHz****2.441 GHz - 2.4835GHz**

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## 13. TIME OF OCCUPANCY (DWELL TIME)

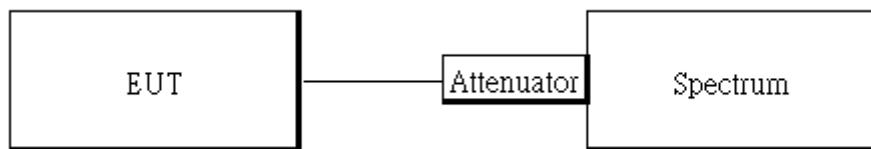
### 13.1. Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 seconds multiplied by the number of hopping channel employed.

### 13.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

### 13.3. Test Set-up



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### 13.4. Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=1MHz, 3MHz, Span = 0Hz , Detector = Peak, Adjust Sweep = 2~8ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

Formula Deduced: time occupancy of one time slot X Hopping rate / total slot in one channel / total channel that hops X period of working channels.

Where, standard hopping rate is 1600 hops/s, slot in one channel for DH1, DH3, and DH5 is 2, 4, and 6, respectively.

DH1 consists of single time slot of the uplink, and one slot of the downlink Total Slot: 2

DH3 consists of three time slot of the uplink, and one slot of the downlink. Total Slot: 4

DH5 consists of five time slot of the uplink, and one slot of the downlink. Total Slot: 6

Note: the result of the complete test default channel at 1Mbps is recorded on the test report, 2Mbps, and 3Mbps only records the measurement result at middle channel that reveals no much deviation.

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**13.5. Tabular Result of the Measurement**

<b>GFSK (1Mbps)</b>			
<b>Channel</b>	<b>PACKET TYPE</b>	<b>Measurement Result (ms)</b>	<b>Limit (ms)</b>
0	DH1	121.60	400ms
	DH3	261.28	400ms
	DH5	307.52	400ms
39	DH1	121.60	400ms
	DH3	261.28	400ms
	DH5	307.52	400ms
78	DH1	121.60	400ms
	DH3	261.28	400ms
	DH5	307.52	400ms
<b>/4 DQPSK (2Mbps)</b>			
<b>Channel</b>	<b>PACKET TYPE</b>	<b>Measurement Result (ms)</b>	<b>Limit (ms)</b>
0	DH1	121.60	400ms
	DH3	261.28	400ms
	DH5	307.52	400ms
<b>8-DPSK (3Mbps)</b>			
<b>Channel</b>	<b>PACKET TYPE</b>	<b>Measurement Result (ms)</b>	<b>Limit (ms)</b>
0	DH1	121.60	400ms
	DH3	261.28	400ms
	DH5	307.52	400ms

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A period time = 0.4 (s) \* 79 = 31.6 (s)

**GFSK (1Mbps):**

CH Low      DH1 time slot = 0.380 (ms) \* (1600/2/79) \* 31.6 = 121.60 (ms)

                DH3 time slot = 1.633 (ms) \* (1600/4/79) \* 31.6 = 261.28 (ms)

                DH5 time slot = 2.883 (ms) \* (1600/6/79) \* 31.6 = 307.52 (ms)

CH Mid      DH1 time slot = 0.380 (ms) \* (1600/2/79) \* 31.6 = 121.60 (ms)

                DH3 time slot = 1.633 (ms) \* (1600/4/79) \* 31.6 = 261.28 (ms)

                DH5 time slot = 2.883 (ms) \* (1600/6/79) \* 31.6 = 307.52 (ms)

CH High      DH1 time slot = 0.380 (ms) \* (1600/2/79) \* 31.6 = 121.60 (ms)

                DH3 time slot = 1.633 (ms) \* (1600/4/79) \* 31.6 = 261.28 (ms)

                DH5 time slot = 2.883 (ms) \* (1600/6/79) \* 31.6 = 307.52 (ms)

**/4 -DQPSK (2Mbps):**

CH Mid      2DH1 time slot = 0.380 (ms) \* (1600/2/79) \* 31.6 = 121.60 (ms)

                2DH3 time slot = 1.633 (ms) \* (1600/4/79) \* 31.6 = 261.28 (ms)

                2DH5 time slot = 2.883 (ms) \* (1600/6/79) \* 31.6 = 307.52 (ms)

**8-DPSK (3Mbps):**

CH Mid      3DH1 time slot = 0.380 (ms) \* (1600/2/79) \* 31.6 = 121.60 (ms)

                3DH3 time slot = 1.633 (ms) \* (1600/4/79) \* 31.6 = 261.28 (ms)

                3DH5 time slot = 2.883 (ms) \* (1600/6/79) \* 31.6 = 307.52 (ms)

## 13.6. Measurement Result

Note: Refer to next page for plots.

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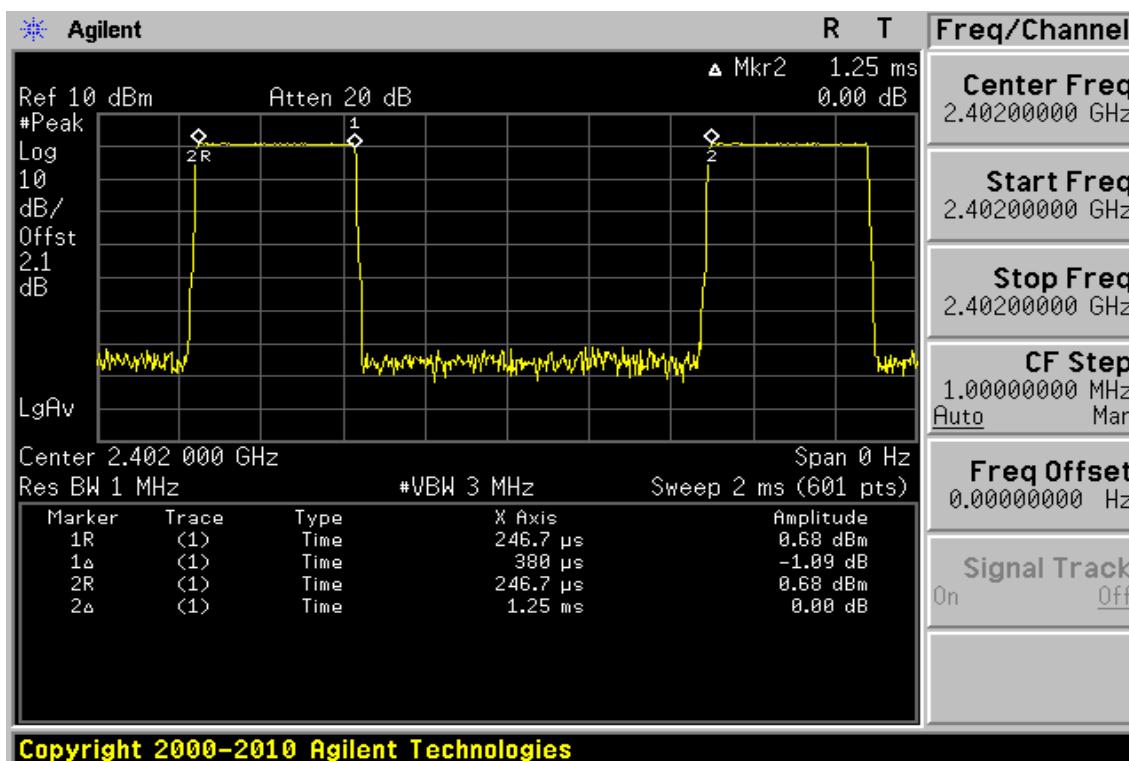
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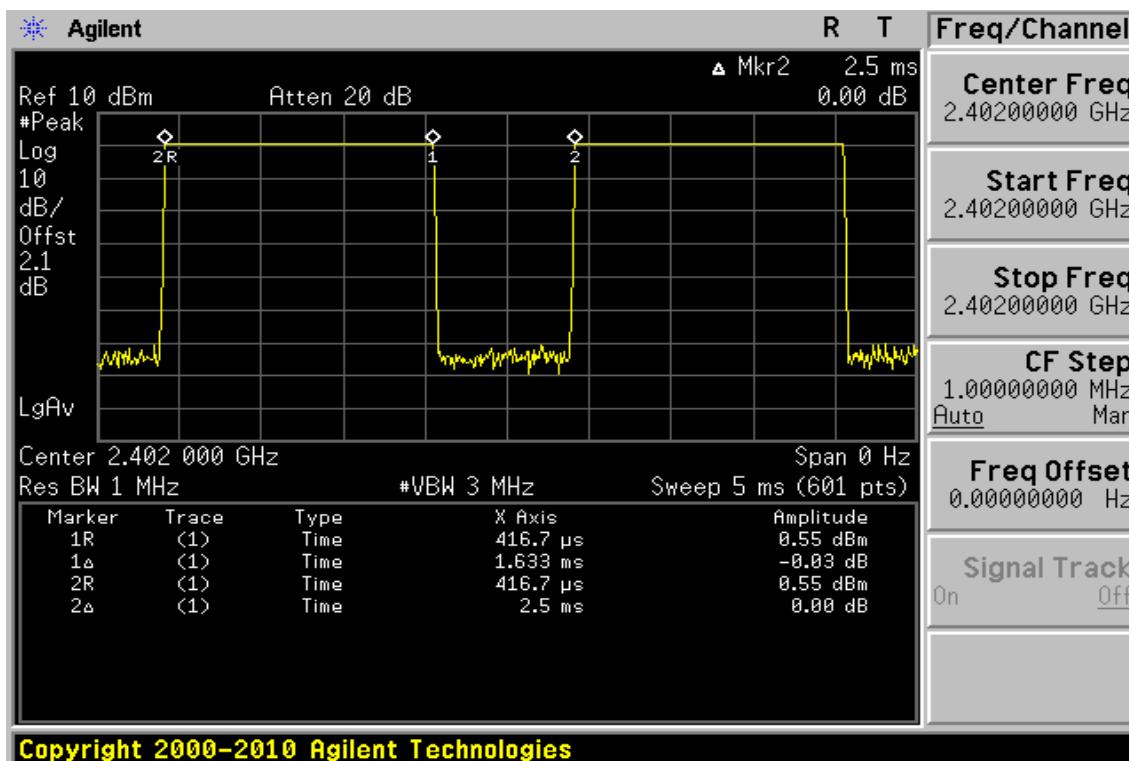
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## CH-Low

### DH1



### DH3



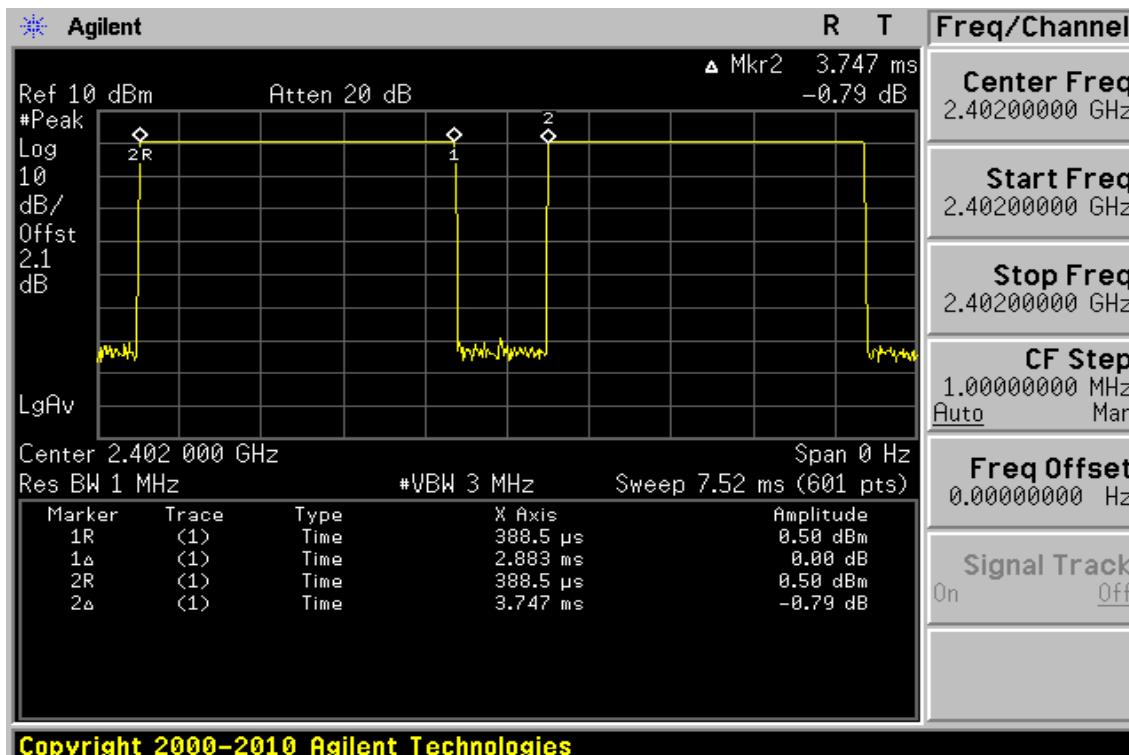
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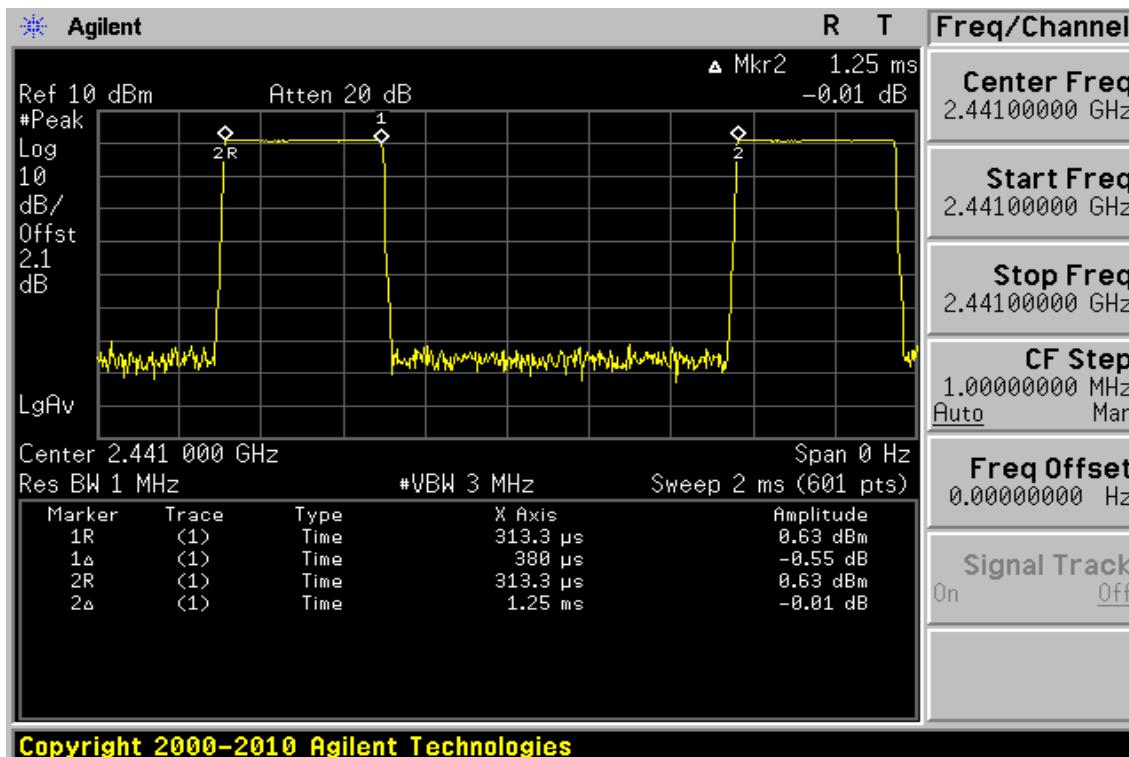
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DH5



CH-Mid

DH1



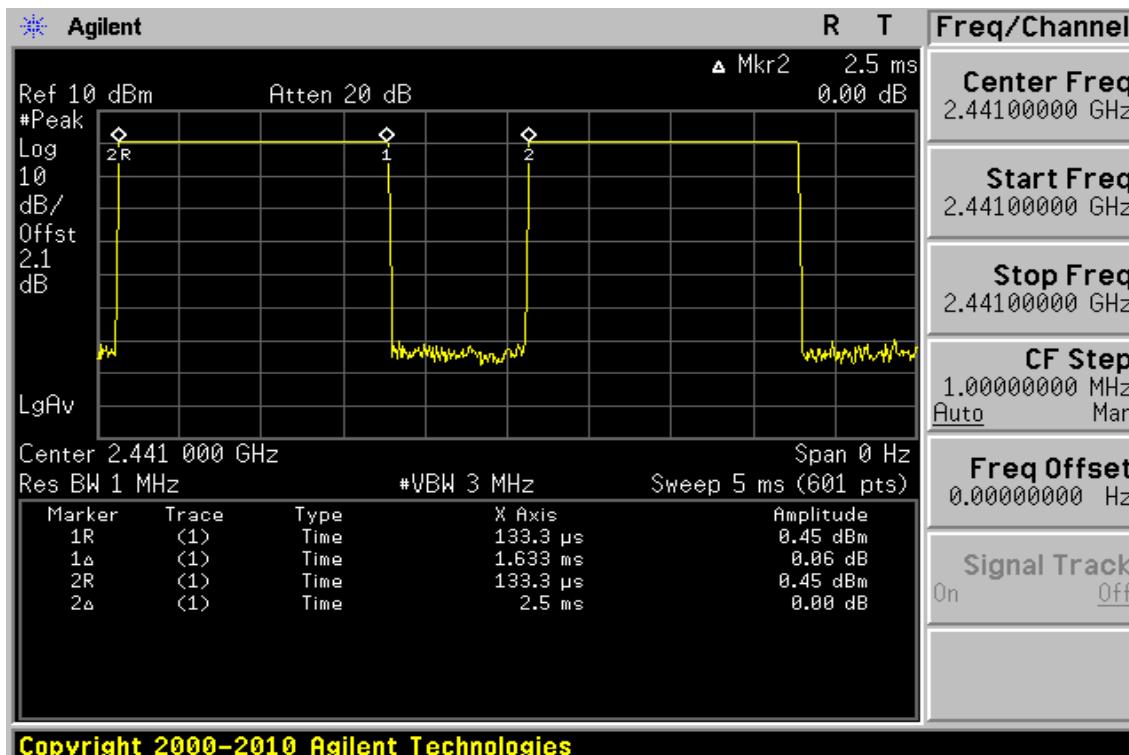
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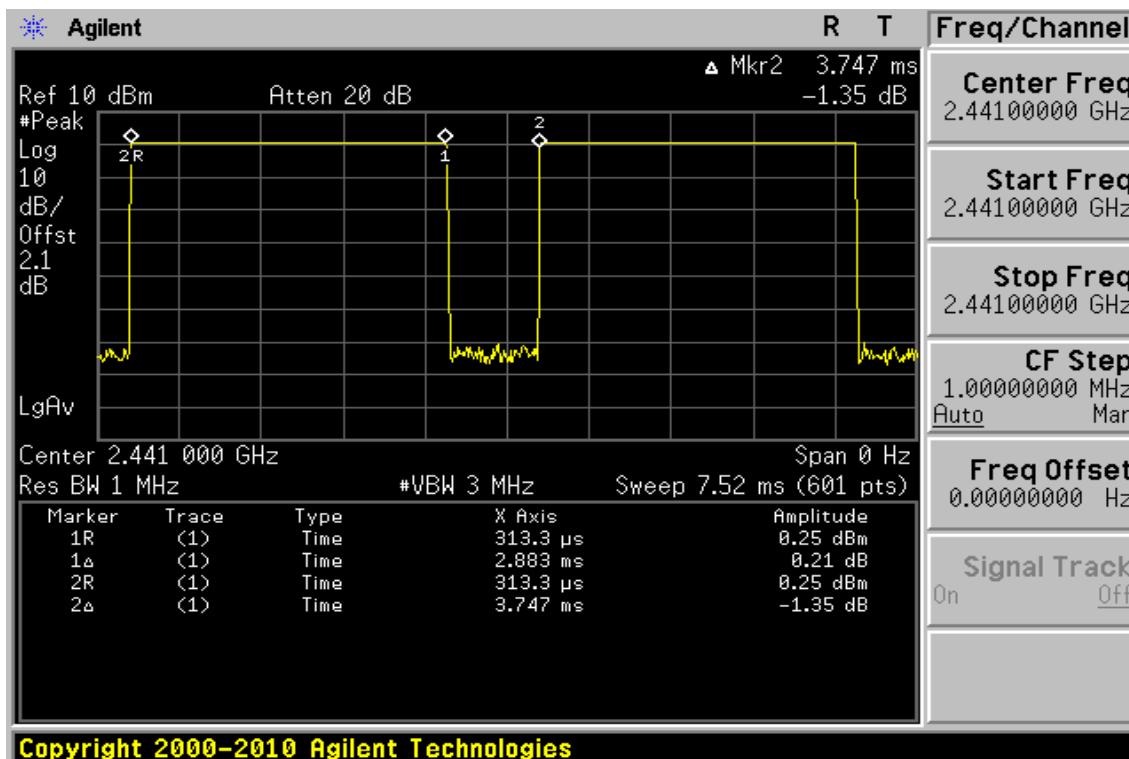
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## DH3



## DH5



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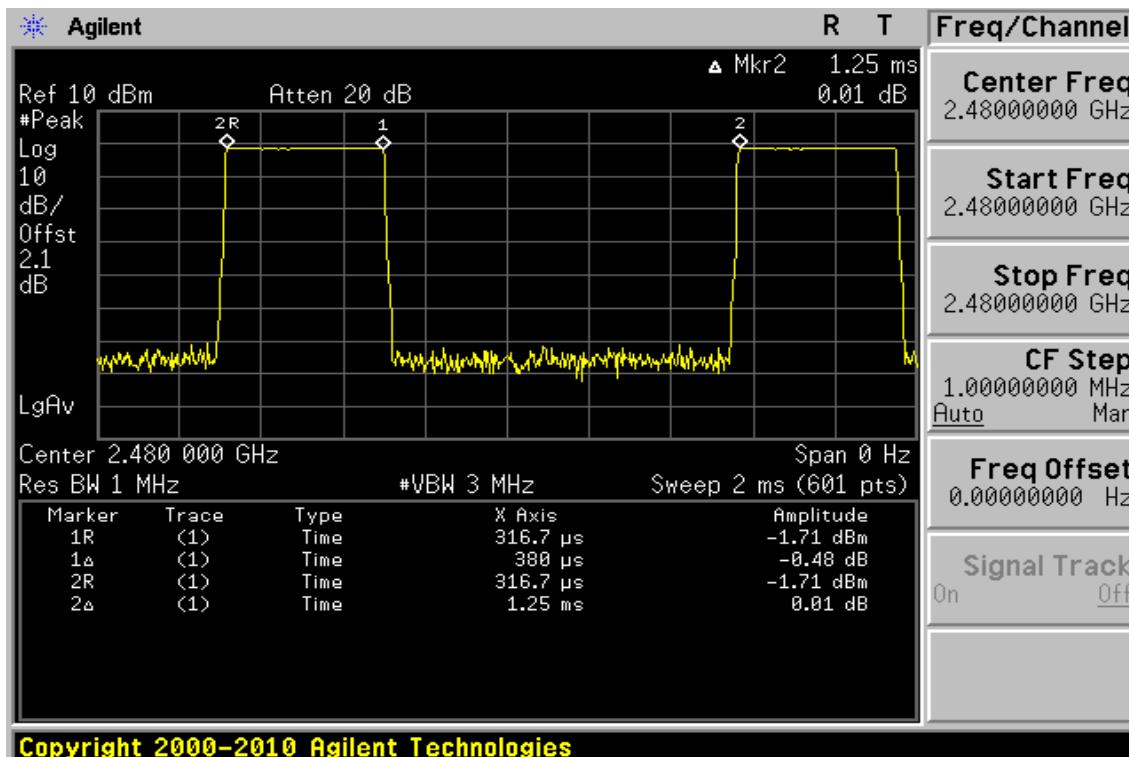
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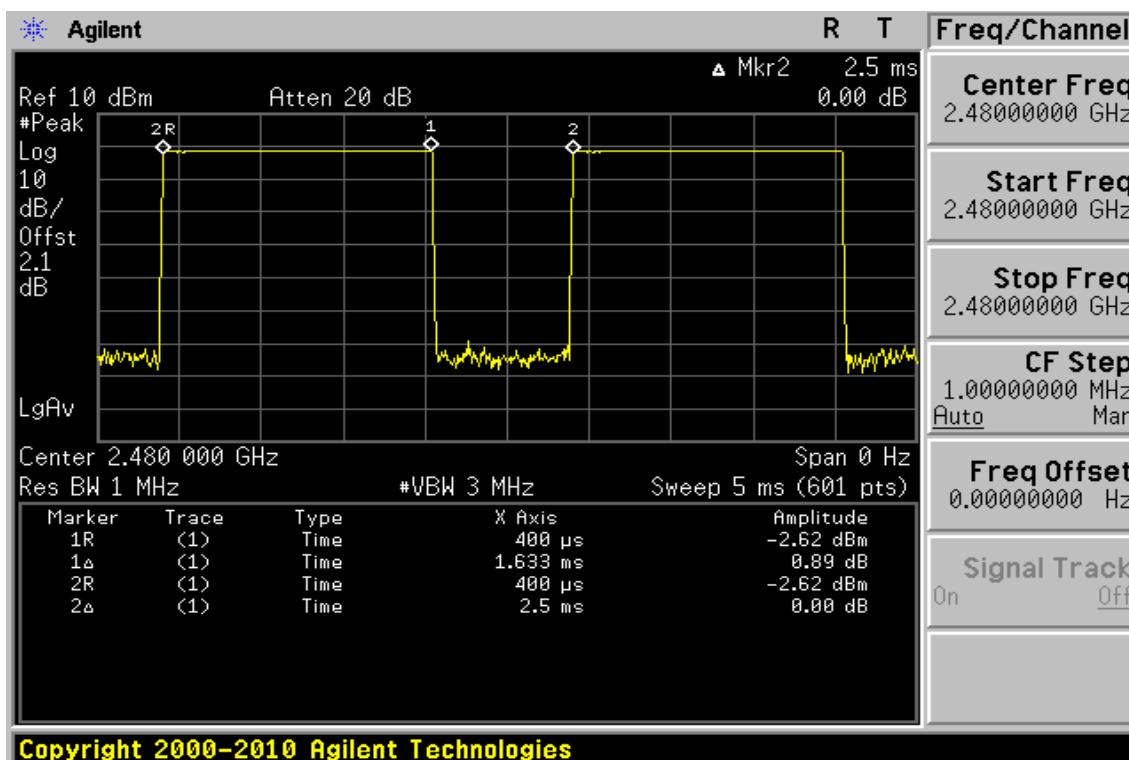
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## CH-High

## DH1



## DH3

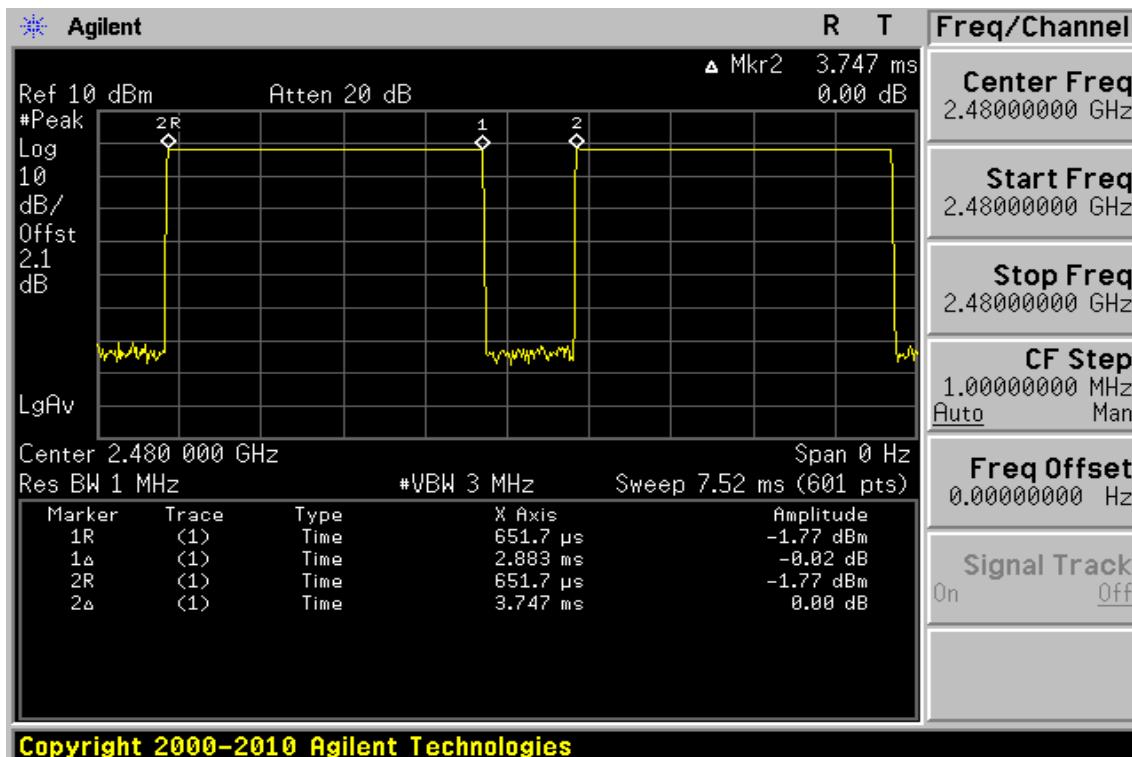


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**DH5**

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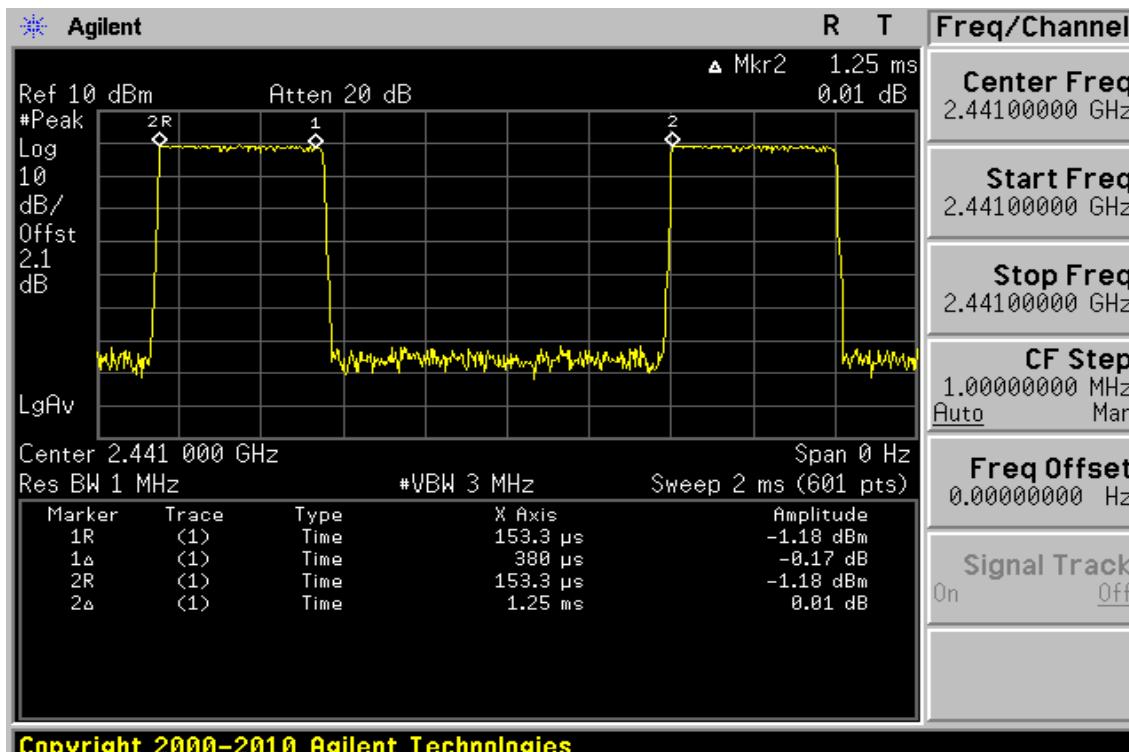
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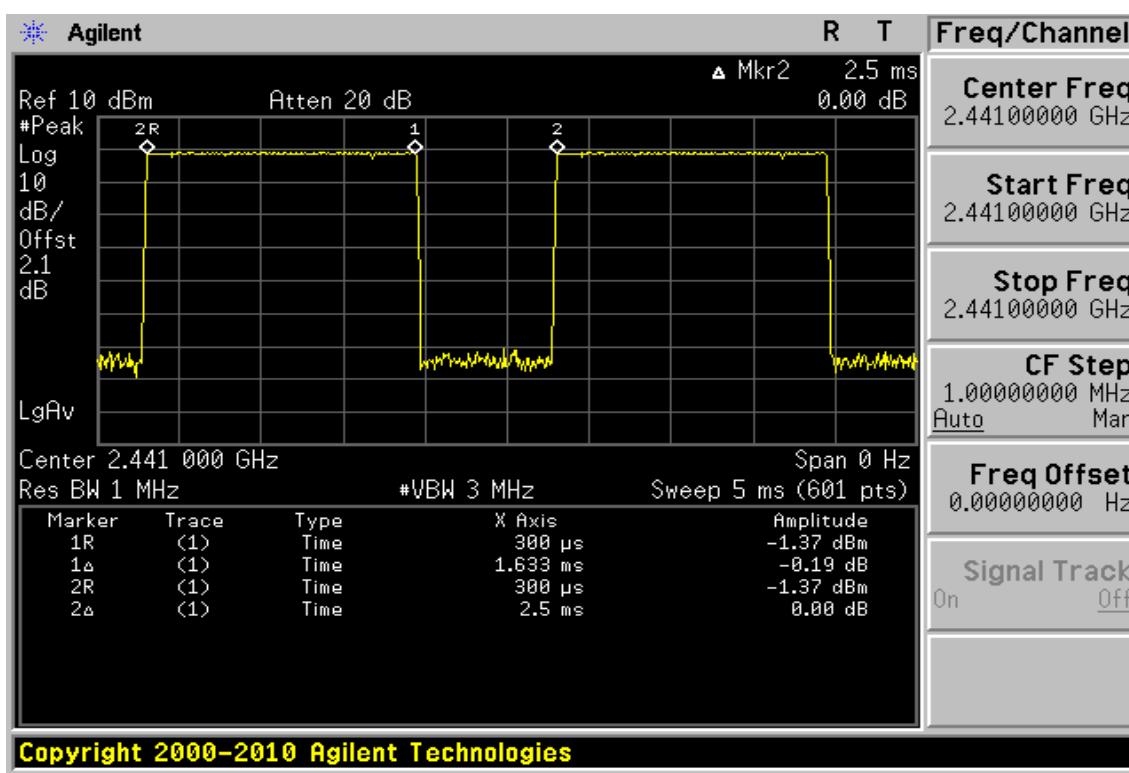
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CH-Mid

2DH1



2DH3



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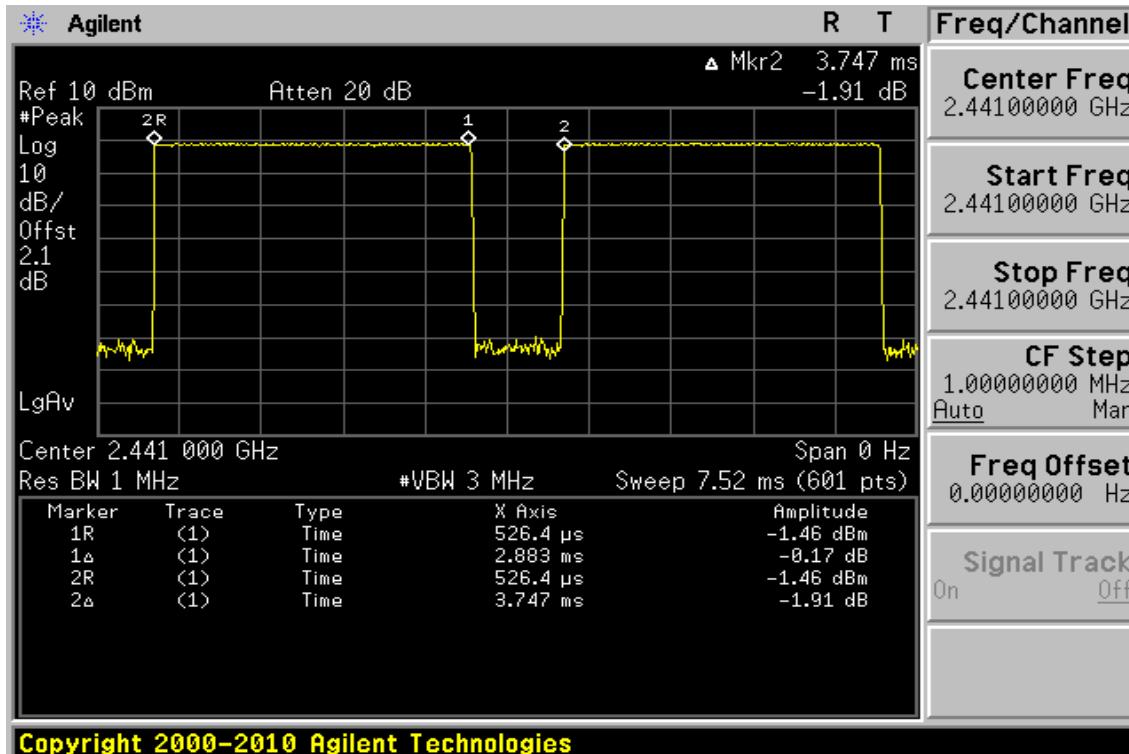
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**2DH5**

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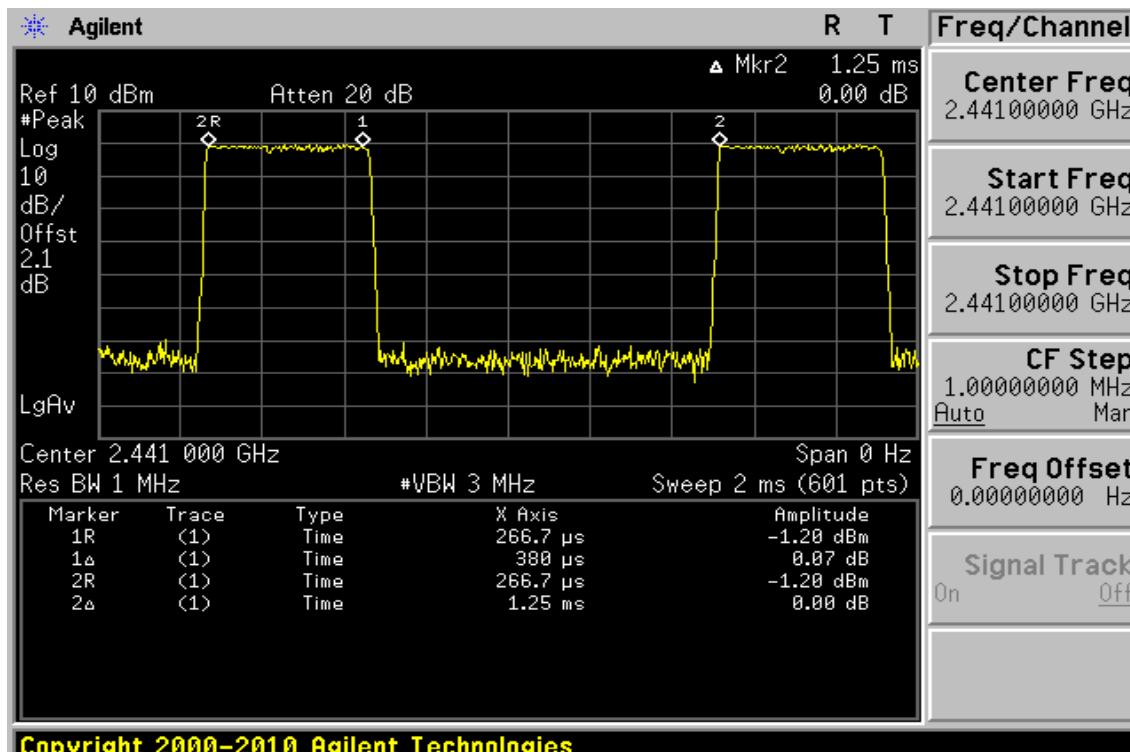
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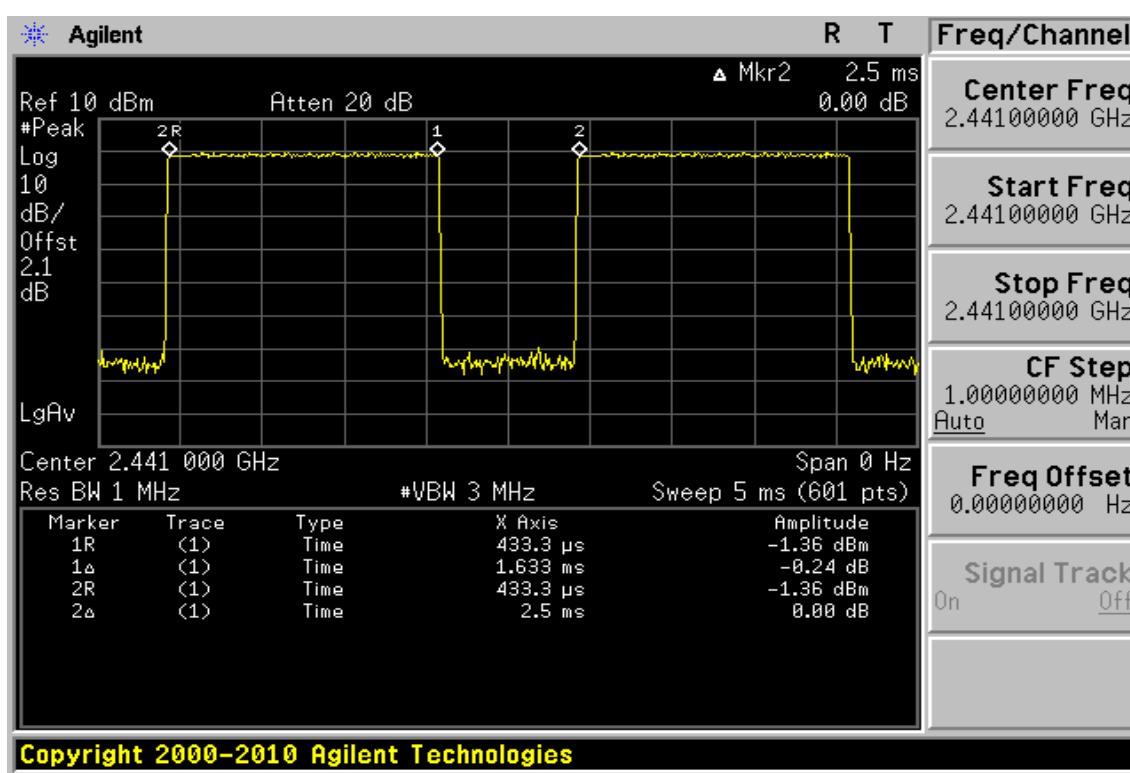
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CH-Mid

3DH1



3DH3

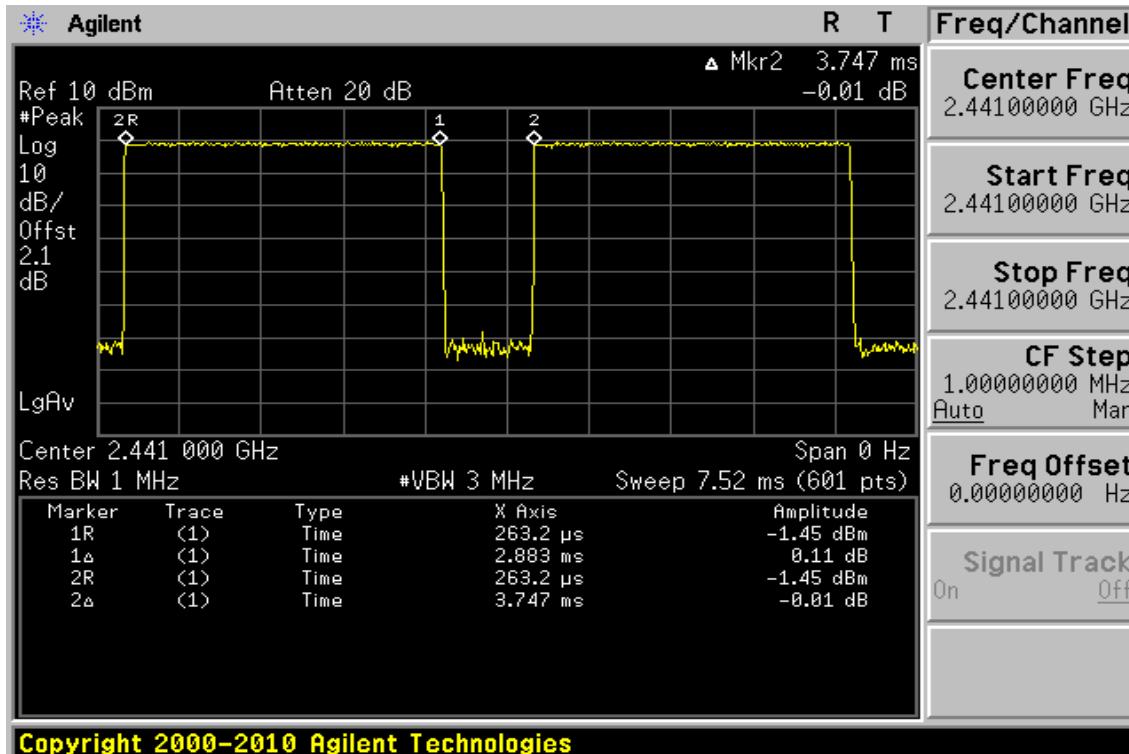


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**3DH5**

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## 14. ANTENNA REQUIREMENT

### 14.1. Standard Applicable

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

### 14.2. Antenna Connected Construction

An embedded-in antenna design is used.

The antenna connector is designed with unique type RF connector and no consideration of replacement. Please see EUT photo and antenna spec. for details.

The antenna gain is less than 6dBi. Therefore, it is not necessary to reduce maximum output power limit.

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## 15. MAXIMUM PERMISSIBLE EXPOSURE (MPE)

### 15.1. Standard Applicable

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

This is a Mobile device, the MPE is required.

According to §1.1310 and §2.1093 RF exposure is calculated.

Limits for Maximum Permissive Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

F = frequency in MHz

\* = Plane-wave equipment power density

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## 15.2. Maximum Permissible Exposure (MPE) Evaluation

Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)
2402	0.56	0.0011	1
2441	<b>0.58</b>	0.0011	1
2480	-1.77	0.0007	1

### MPE Prediction (BT Mode)

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4 \pi R^2$$

Where: S = Power density

P = Power input to antenna

G = Power gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	<b>0.58</b>	(dBm)
Maximum peak output power at antenna input terminal:	1.14287833	(mW)
Duty cycle:	<b>77</b>	(%)
Maximum Pav :	0.88001632	(mW)
Antenna gain (Maximum):	<b>0.5</b>	(dBi)
Antenna gain (linear):	1.12201845	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	<b>2441</b>	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm <sup>2</sup> )
Power density at predication frequency at 20 (cm)	0.0001965	(mW/cm <sup>2</sup> )

### Measurement Result

The predicted power density level at 20 cm is 0.0001965 mW/cm<sup>2</sup>. This is below the uncontrolled exposure limit of 1 mW/cm<sup>2</sup> at 2441MHz.

*Remark: For RF exposure potentially generating from Co-located transmitter, please reference to the section of collocated MPE analysis, Report No.: ER/2015/20030.*

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