

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT**INTENTIONAL RADIATOR CERTIFICATION TO
FCC PART 15 SUBPART C REQUIREMENT**

OF

Product Name: OPN2005

Brand Name: Opticon

Model No.: OPN2005

Model Difference: N/A

FCC ID: Q2Q-OPN2005

Report No.: EF/2013/40006

Issue Date: May 10, 2013

Rule Part: §15.247, Cat: DSS

Prepared for: Opticon Sensors Europe B.V.
Opaallaan 35, 2132 XV Hoofddorp, The Netherlands

Prepared by: SGS Taiwan Ltd.
Electronics & Communication Laboratory
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CERTIFICATION OF COMPLIANCE

Applicant: Opticon Sensors Europe B.V.
Opaallaan 35, 2132 XV Hoofddorp, The Netherlands

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FCC ID: Q2Q-OPN2005

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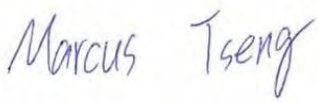
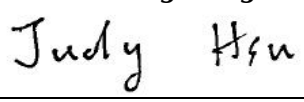
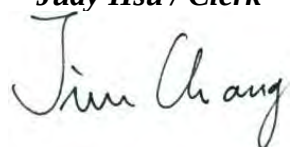
Date of test: Apr. 12, 2013 ~ May 07, 2013

Date of EUT Received: Apr. 12, 2013

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.4 2009 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits of FCC Rules Part 15C, §15.247.

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

Test By:		Date:	May 10, 2013
	Marcus Tseng / Engineer		
Prepared By:		Date:	May 10, 2013
	Judy Hsu / Clerk		
Approved By:		Date:	May 10, 2013
	Jim Chang / Supervisor		

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Version

Version No.	Date	Description
00	May 10, 2013	Initial creation of document

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1. GENERAL INFORMATION

1.1. Product Description

General:

Product Name:	OPN2005	
Brand Name:	Opticon	
Model No.:	OPN2005	
Model Difference:	N/A	
Hardware Version:	OF1OPN2005.01	
Software Version:	RBLV0016	
USB Cable:	Model No.: N/A; Supplier: N/A	
Power Supply:	3.7Vdc Rechargeable Lithium-Ion battery	
	Battery:	Model No.: 5811-M3TTPS241A Supplier: Power Source Energy CO., LTD.

Bluetooth:

Bluetooth Version:	V2.1 (GFSK)
Frequency Range:	2402 – 2480MHz
Channel number:	79 channels max.
Transmit Power:	-0.85 dBm (Peak)
Modulation type:	Frequency Hopping Spread Spectrum
Dwell Time:	<= 0.4s
Operating Mode:	Point-to-Point
Antenna Designation:	Chip Antenna, Gain: 1.9 dBi

The EUT is compliance with Bluetooth V2.1 (GFSK) standard.

This test report applies for Bluetooth function.

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1.2. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: Q2Q-OPN2005** filing to comply with Section 15.247 of the FCC Part 15C, Subpart C Rules. The composite system (digital device) is compliance with Subpart B is authorized under a Doc procedure.

1.3. Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4 2009. Radiated testing was performed at an antenna to EUT distance 3 meters.

Tested in accordance with FCC Public Notice DA 00-705

1.4. Test Facility

The measurement facilities used to collect the 3m Radiated Emission and AC power line conducted data are located on the address of SGS Taiwan Ltd. No. 134, Wu Kung Rd., Wuku Industrial Zone, Taipei Country, Taiwan which are constructed and calibrated to meet the FCC requirements in documents ANSI C63.4: 2009. FCC Registration Number are: 990257 and 236194, Canada Registration Number: 4620A-4.

The 10 m Open Area Test Sites located on the address of SGS Taiwan Ltd. No. 29, Pau-Tou-Tsuo Valley Chia-Pau Tsuen, Linkou Hsiang, Taipei county, which is constructed and calibrated to meet the CISPR 22/EN 55022 requirements. SGS Site No. 1(3 & 10 meters) and FCC Registration Number: 94644.

1.5. Special Accessories

Not available for this EUT intended for grant.

1.6. Equipment Modifications

Not available for this EUT intended for grant.

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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

The EUT (Transmitter) was tested with a test program to fix the Tx/RX frequency that was for the purpose of the measurements. For more information please see test data and APPENDIX 1 for set-up photographs.

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. According to the requirements in Section 7, 13 of ANSI C63.4-2009, conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-Peak and Average detector mode.

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. according to the requirements in Section 8 and 13 of ANSI C63.4-2009 and DA 00-705.

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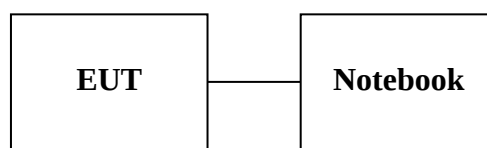
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2.4. Configuration of Tested System

Fig. 2-1 Configuration of Tested System

Radiated Emission



Remote side

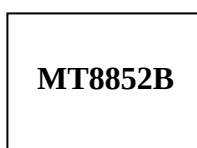


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Notebook	DELL	E5400	3704625136	shield	Un-shield
2.	Bluetooth Test Set	Anritsu	MT8852B	6k00006107	shield	Un-shield

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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)(1)	Peak Output Power	Compliant
§15.247(d)	100 KHz Bandwidth Of Frequency Band Edges	Compliant
§15.247(c)	Spurious Emission	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency	Compliant
§15.247(a)(1)(ii)	Time of Occupancy	Compliant
§15.247	Peak Power Density	Compliant
§15.247(a)(1)	20dB Bandwidth	Compliant
§15.203, §15.247(c)	Antenna Requirement	Compliant

4. DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition.

Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Channel low (2402MHz) 、mid (2441MHz) and high (2480MHz) with BR mode is chosen for full testing.

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5. MEASUREMENT UNCERTAINTY FOR FIELD STRENGTH OF SPURIOUS RADIATION

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

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

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6. AC POWER LINE CONDUCTED EMISSION TEST

6.1. Standard Applicable:

According to §15.207, frequency range within 150KHz 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	100759	05/20/2011	05/19/2013
EMI Receiver	R&S	ESCS 30	828985/004	09/23/2012	09/22/2013
LISN	Rolf-Heine	NNB-2/16Z	99012	03/23/2013	03/22/2014
LISN	FCC	FCC-LISN-50/250-25-2-01	04034	03/23/2013	03/22/2014
Coaxial Cables	N/A	WK CE Cable	N/A	01/05/2013	01/04/2014

6.3. EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.4-2009.
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. 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.

6.5. Measurement Result:

The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. Significant peaks are then marked as shown on the following data page, and these signals are then quasi-peaked.

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

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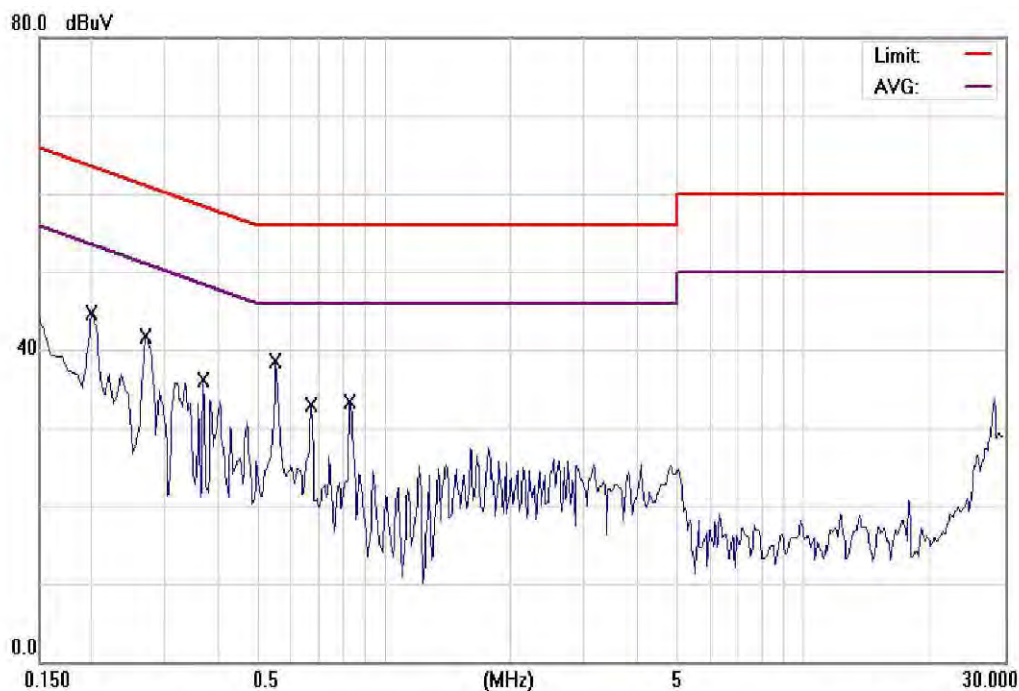
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Bluetooth Mode			Test Date:	Apr. 22, 2013
Temperature:	23 °C	Humidity:	57 %	Test By:	Marucs



Site	ConductionRoom	Phase:	L1	Temperature:	24 °C
Limit:	FCC Class B Conduction(QP)	Power:	AC 120V/60Hz	Humidity:	60%
EUT:	OPN2005	Distance:			
M/N:	OPN2005				
Mode:	Operationmode				
Note:					

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Detector	Comment
		MHz	dBuV	dB	dBuV	dBuV	dB		
1		0.2000	44.55	0.12	44.67	63.61	-18.94	QP	
2		0.2700	41.56	0.12	41.68	61.12	-19.44	QP	
3		0.3700	35.98	0.12	36.10	58.50	-22.40	QP	
4	*	0.5500	38.37	0.12	38.49	56.00	-17.51	QP	
5		0.6700	32.81	0.12	32.93	56.00	-23.07	QP	
6		0.8300	33.10	0.12	33.22	56.00	-22.78	QP	

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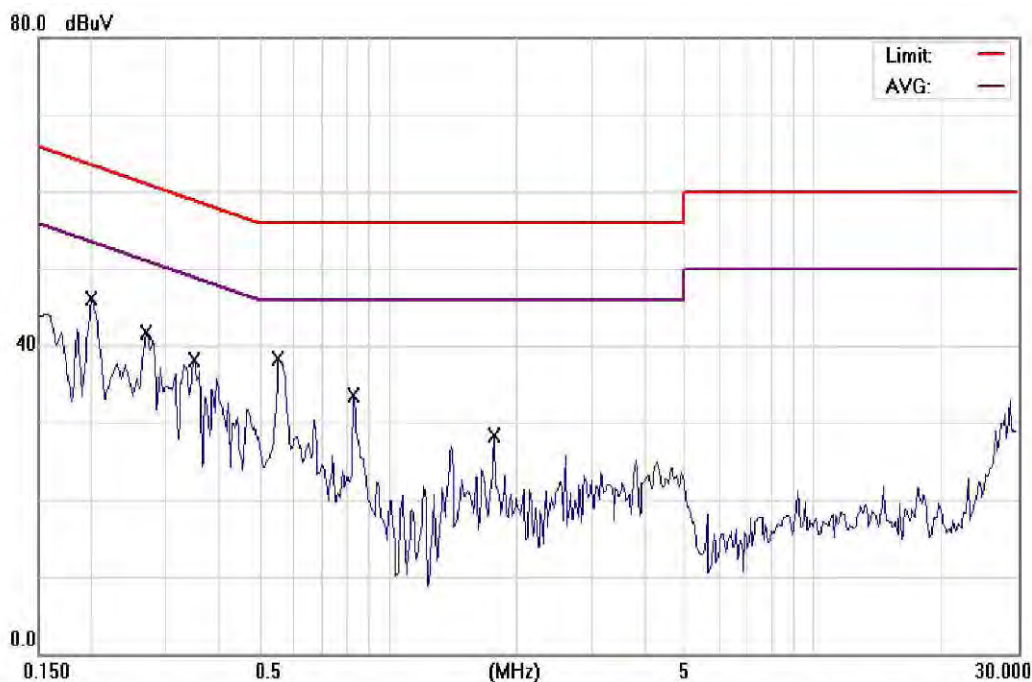
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Site ConductionRoom

Phase: **N**

Temperature: 24 °C

Limit: FCC Class B Conduction(QP)

Power: AC 120V/60Hz

Humidity: 60%

EUT: OPN2005

Distance:

M/N: OPN2005

Mode: Operationmode

Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.2000	45.98	0.13	46.11	63.61	-17.50	QP	
2		0.2700	41.48	0.13	41.61	61.12	-19.51	QP	
3		0.3500	38.05	0.12	38.17	58.96	-20.79	QP	
4		0.5500	38.17	0.12	38.29	56.00	-17.71	QP	
5		0.8300	33.28	0.13	33.41	56.00	-22.59	QP	
6		1.7800	28.06	0.15	28.21	56.00	-27.79	QP	

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7. PEAK OUTPUT POWER MEASUREMENT

7.1. Standard Applicable:

According to §15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850MHz band: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: 0.125 Watts.

7.2. Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Sensor	Anritsu	ML2495A	1005007	02/08/2012	02/07/2014
Power Meter	Anritsu	MA2411B	917032	02/08/2012	02/07/2014
Spectrum Analyzer	Agilent	E4446A	MY51100003	04/15/2013	04/14/2014
Spectrum Analyzer	Agilent	E4440A	MY45304525	03/15/2013	03/14/2014
DC Block	Mini-Circuits	BLK-18-S+	1	02/28/2013	02/27/2014
Low Loss Cable	HUBER+SUHNER	SUCOFLEX 104PEA	N/A	01/05/2013	01/04/2014
Attenuator	Mini-Circuit	BW-S10W2+	002	02/28/2013	02/27/2014
Splitter	Agilent	11636B	N/A	02/28/2013	02/27/2014

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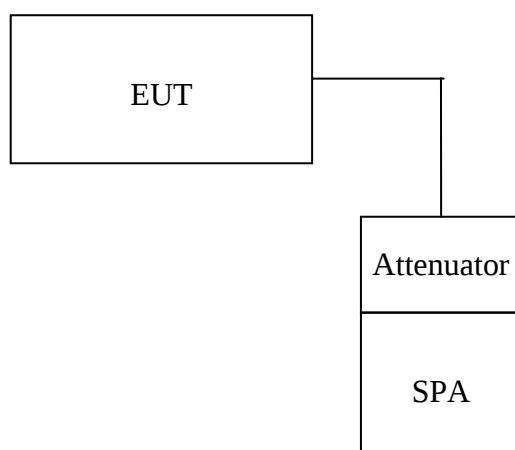
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7.3. Test Set-up:



7.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. 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 peak function, RBW> 20dB bandwidth, VBW>RBW)
3. Record the max. reading.
4. Repeat above procedures until all frequency measured were complete.

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7.5. Measurement Result:

BR mode (GFSK):

Frequency (MHz)	Reading Power (dBm)	Output Power (dBm)	Output Power (W)	Limit (W)
2402.00	-3.75	-3.75	0.00042	1
2441.00	-1.70	-1.70	0.00068	1
2480.00	-0.85	-0.85	0.00082	1

Offset: 4.2dB

Note: Refer to next page for plots.

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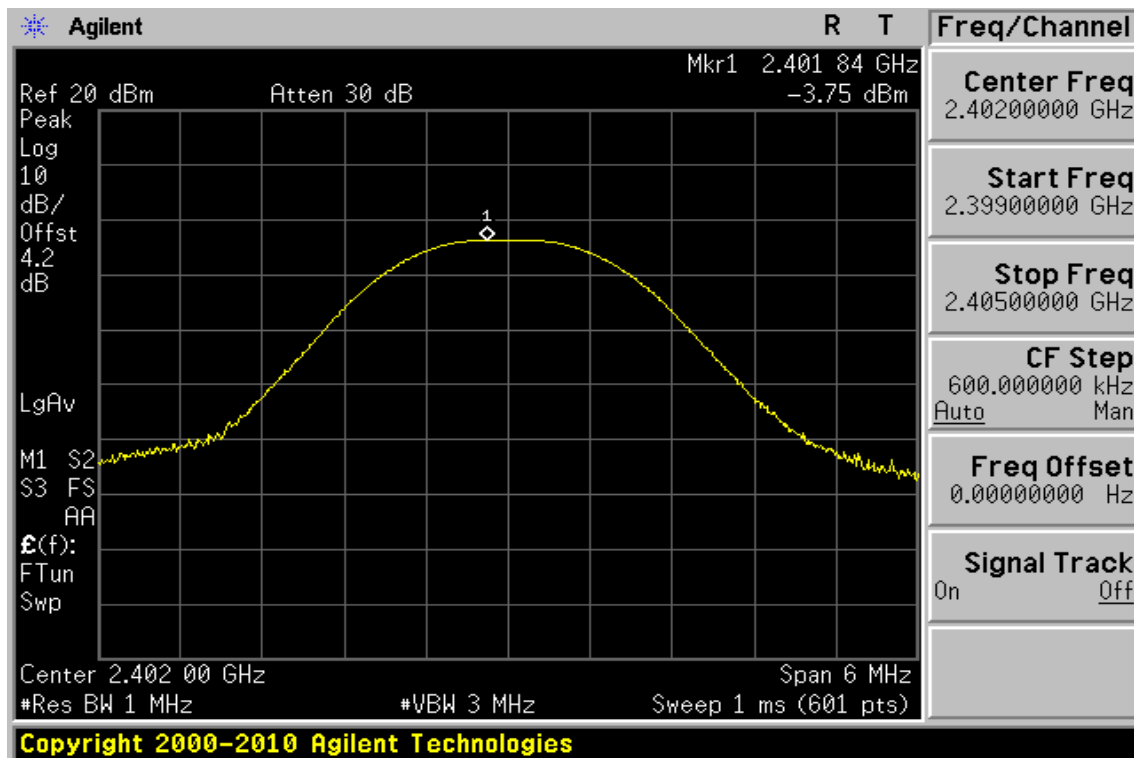
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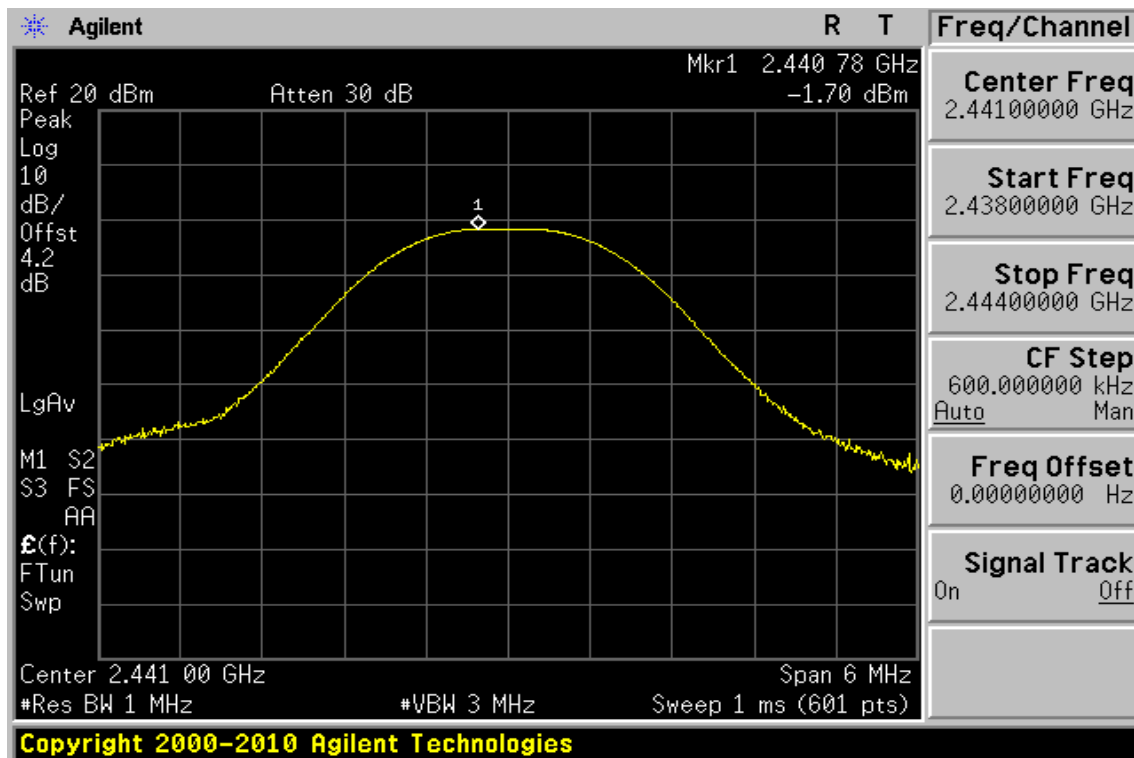
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Peak Power Output Data Plot (CH Low) (BR mode GFSK)



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



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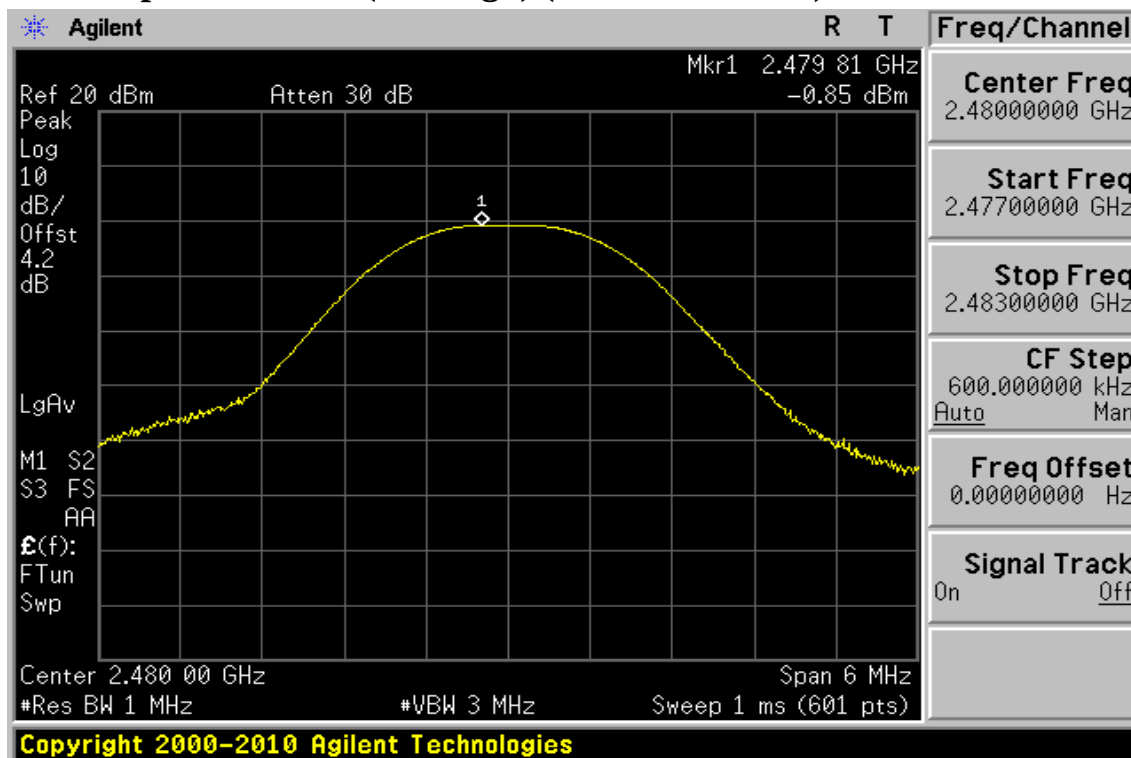
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Peak Power Output Data Plot (CH High) (BR mode GFSK)



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8. 100KHz BANDWIDTH OF BAND EDGES MEASUREMENT

8.1. Standard Applicable:

According to §15.247(d), in any 100 KHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power. 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).

8.2. Measurement Equipment Used:

8.2.1. Conducted Emission at antenna port:

Refer to section 7.2 for details.

8.2.2. Radiated emission:

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESC17	100759	05/20/2011	05/19/2013
Spectrum Analyzer	Agilent	E4446A	MY51100003	04/15/2013	04/14/2014
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	02/06/2013	02/07/2014
Spectrum Analyzer	R&S	FSV-30	101398	10/18/2011	10/17/2013
Bilog Antenna	SCHWAZBECK	VULB9168	378	01/10/2012	01/09/2014
Horn antenna	ETS.LINDGREN	3117	123995	05/19/2011	05/18/2013
Horn Antenna	Schwarzbeck	BBHA9170	185	07/11/2011	07/10/2013
Pre-Amplifier	Agilent	8447D	2944A07676	01/04/2013	01/03/2014
Pre-Amplifier	EMC Instruments Corp.	EMC0126530	980038	01/04/2013	01/03/2014
Filter 2400-2483.5 MHz	EWT	EWT-14-0166	M2	02/28/2013	02/28/2014
Attenuator	Mini-Circuit	BW-S10W2+	004	02/28/2013	02/27/2014
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	01/04/2013	01/03/2014
3m Site NSA	SGS	966 chamber	N/A	07/15/2012	07/14/2013

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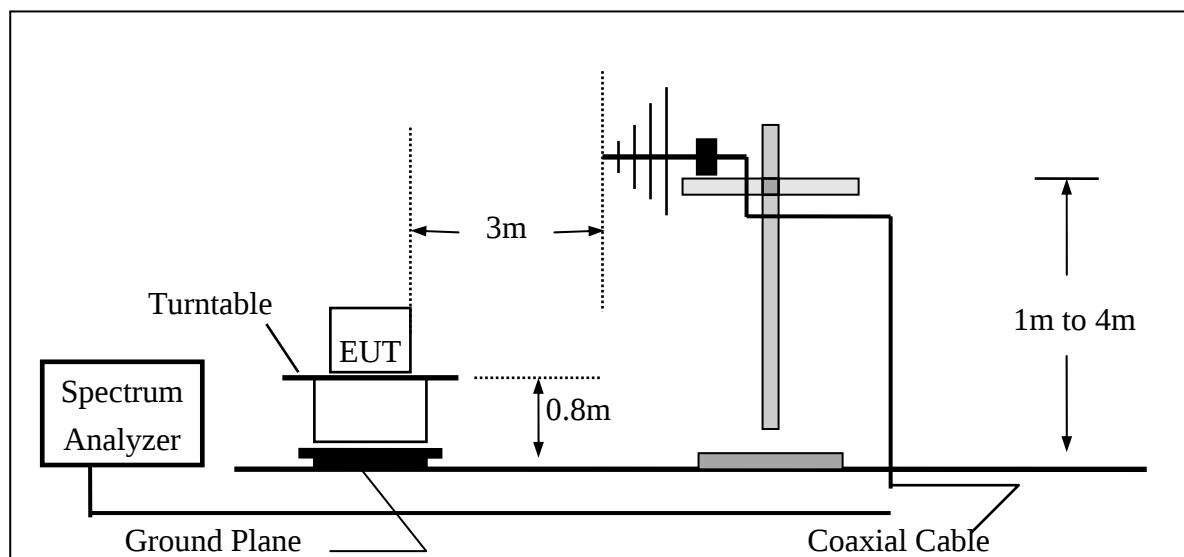
8.3. Test SET-UP:

8.3.1. Conducted Emission at antenna port:

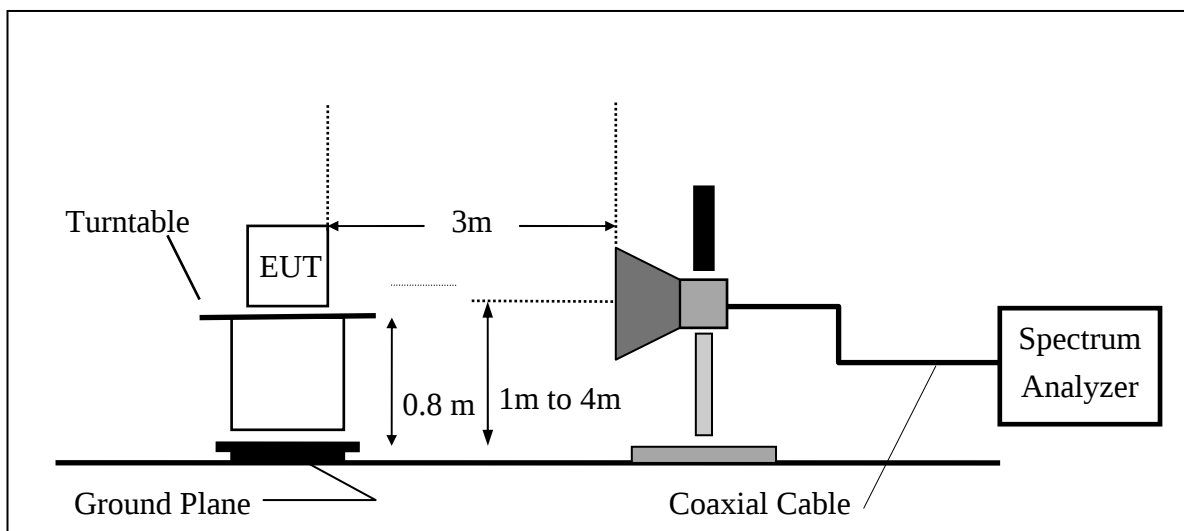
Refer to section 7.3 for details.

8.3.2. Radiated emission:

(A) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(B) Radiated Emission Test Set-Up Frequency Over 1 GHz



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8.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW, VBW=100KHz, Span=25MHz, Sweep = auto
5. Mark Peak, 2.390GHz and 2.4835GHz and record the max. level.
6. Repeat above procedures until all frequency measured were complete.

8.5. 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	

8.6. Measurement Result:

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

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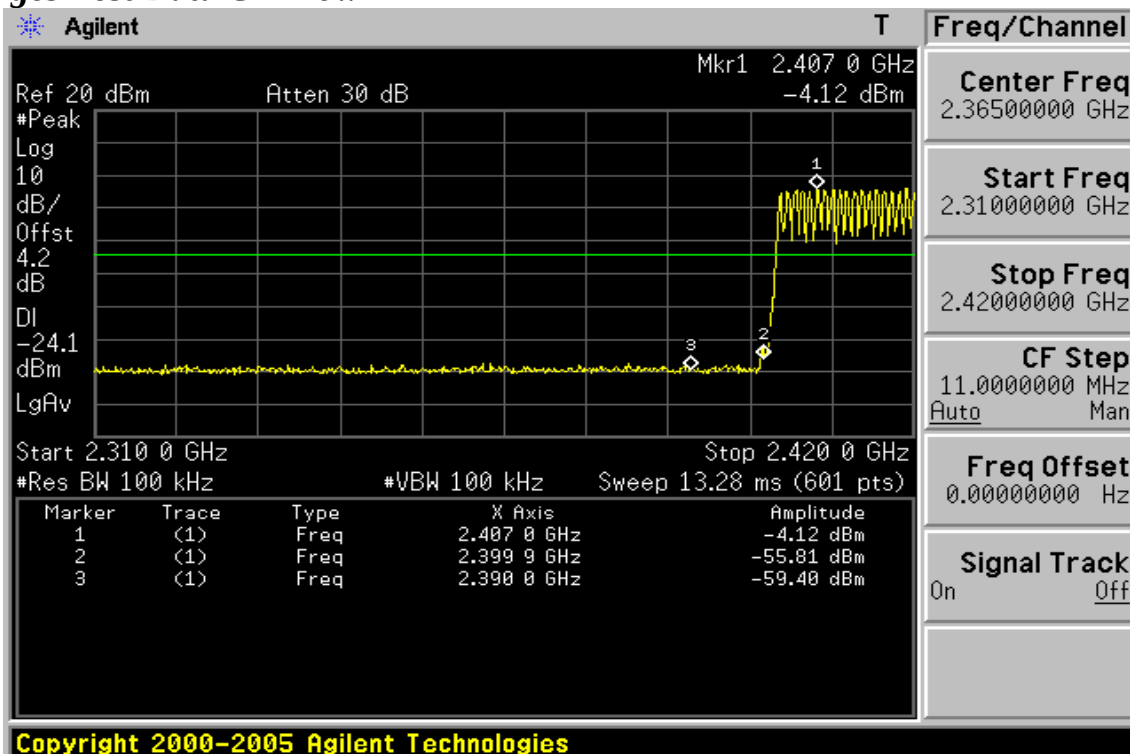
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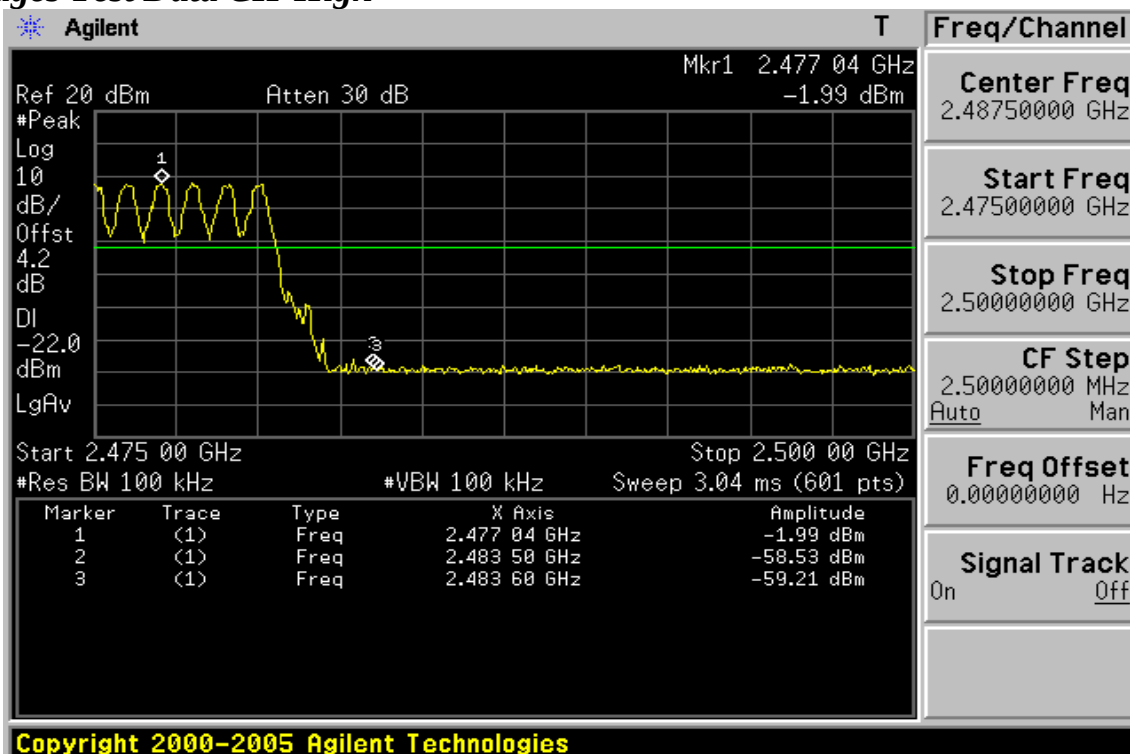
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BR Mode

Band Edges Test Data CH-Low



Band Edges Test Data CH-High



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Radiated Emission: (BR mode)

Operation Band	:BR	Test Date	:2013-04-22
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23deg_C/60RH
Operation Mode	:Bandedge LOW	Engineer	:Nick
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:VERTICAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	E	Average	36.87	2.12	38.99	54.00	-15.01
2390.00	E	Peak	42.96	2.12	45.08	74.00	-28.92

Operation Band	:BR	Test Date	:2013-04-22
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23deg_C/60RH
Operation Mode	:Bandedge LOW	Engineer	:Nick
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:HORIZONTAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	E	Average	36.83	2.74	39.57	54.00	-14.43
2390.00	E	Peak	44.06	2.74	46.80	74.00	-27.20

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

The trace on RE(radiation emission) plot is as colored blue, and the detection manner we’ve employed is peak detector.

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Operation Band	:BR	Test Date	:2013-04-22
Fundamental Frequency	:2480 MHz	Temp./Humi.	:23deg_C/60RH
Operation Mode	:Bandedge HIGH	Engineer	:Nick
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:VERTICAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	E	Average	36.75	2.53	39.28	54.00	-14.72
2483.50	E	Peak	42.78	2.53	45.31	74.00	-28.69

Operation Band	:BR	Test Date	:2013-04-22
Fundamental Frequency	:2480 MHz	Temp./Humi.	:23deg_C/60RH
Operation Mode	:Bandedge HIGH	Engineer	:Nick
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:HORIZONTAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	E	Average	36.71	3.56	40.27	54.00	-13.73
2483.50	E	Peak	43.08	3.56	46.64	74.00	-27.36

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

The trace on RE(radiation emission) plot is as colored blue, and the detection manner we’ve employed is peak detector.

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9. SPURIOUS EMISSION TEST

9.1. Standard Applicable:

According to §15.247(c), all other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a). 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.

9.2. Measurement Equipment Used:

9.2.1. Conducted Emission at antenna port:

Refer to section 7.2 for details.

9.2.2. Radiated emission:

Refer to section 8.2.2 for details.

9.3. Test SET-UP:

9.3.1. Conducted Emission at antenna port:

Refer to section 7.3 for details.

9.3.2. Radiated emission:

Refer to section 8.3.2 for details.

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9.4. Measurement Procedure:**Radiated Emission:**

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
4. 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.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Repeat above procedures until all frequency measured were complete.

Conducted Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. Set RBW = 100K & VBW = 300K on Spectrum.
3. Sweep the frequency to determine spurious emission as seen on spectrum from span of 30 to 3G, 3G to 8G, 8G to 13G, 13G to 18G and 18G to 26.5GHz
4. Via Software, combine 5 spans of frequency range into one plot

9.5. 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	

9.6. Measurement Result:

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

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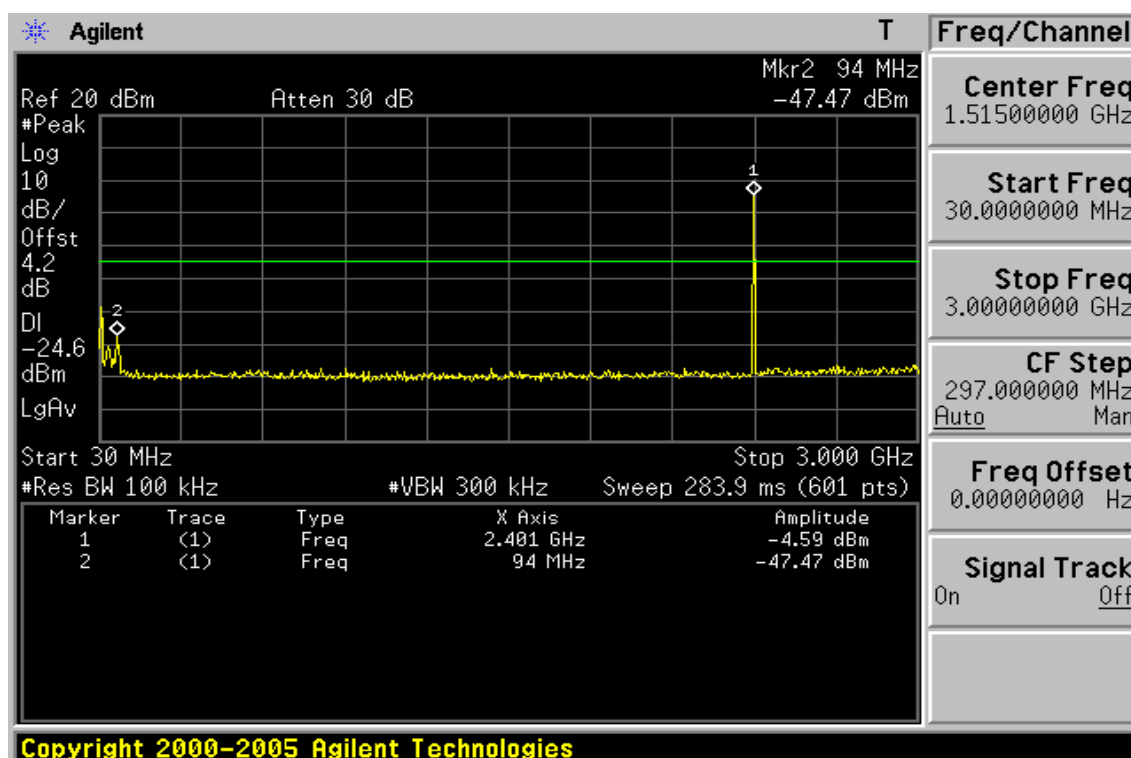
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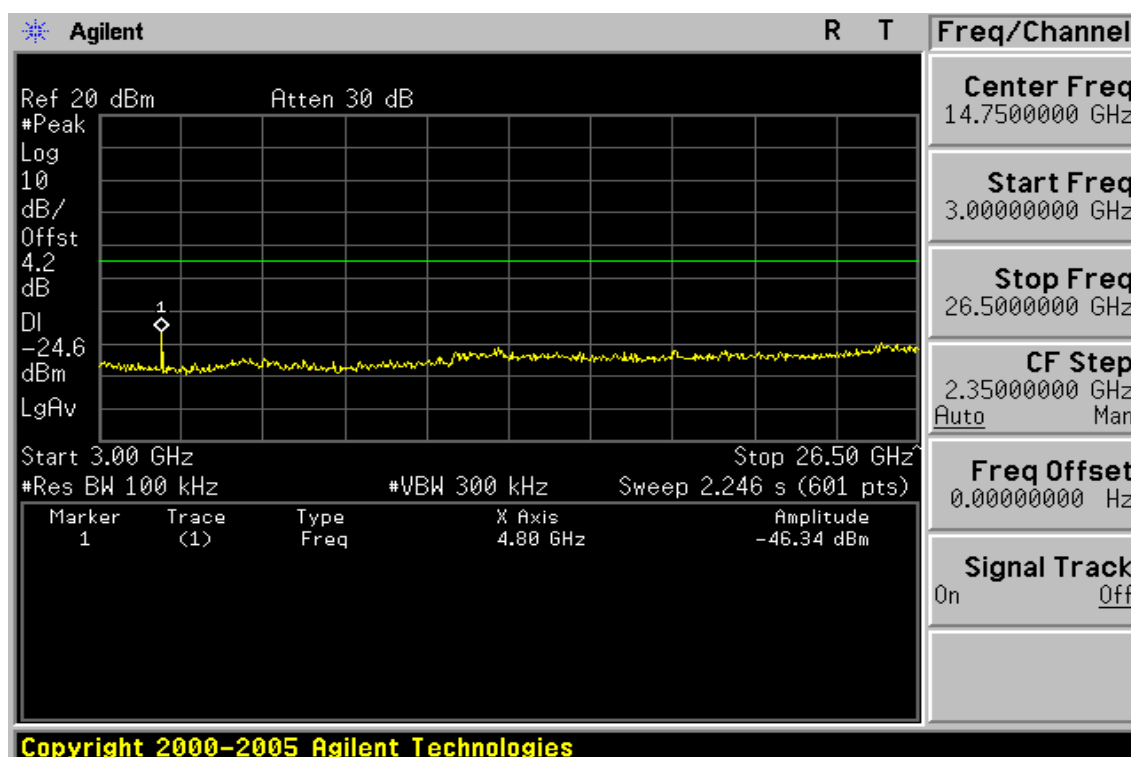
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Conducted Spurious Emission Measurement Result (BR mode)

Ch Low 30MHz – 3GHz



Ch Low 3GHz – 26.5GHz



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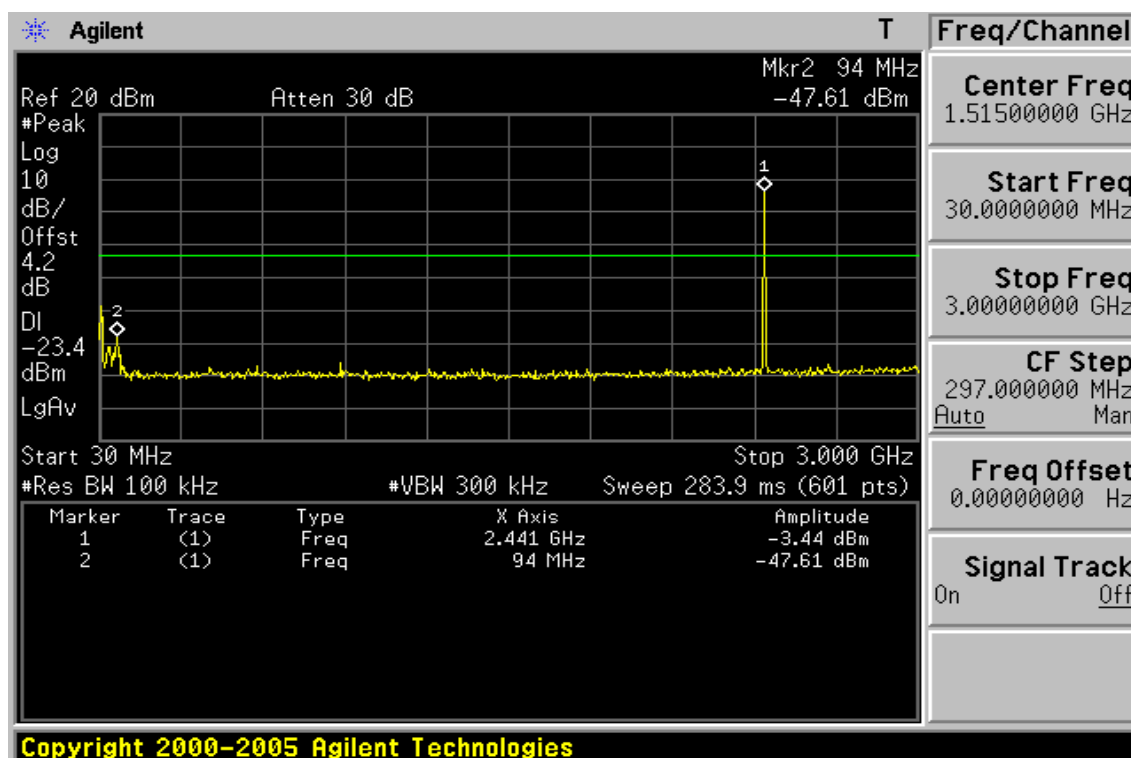
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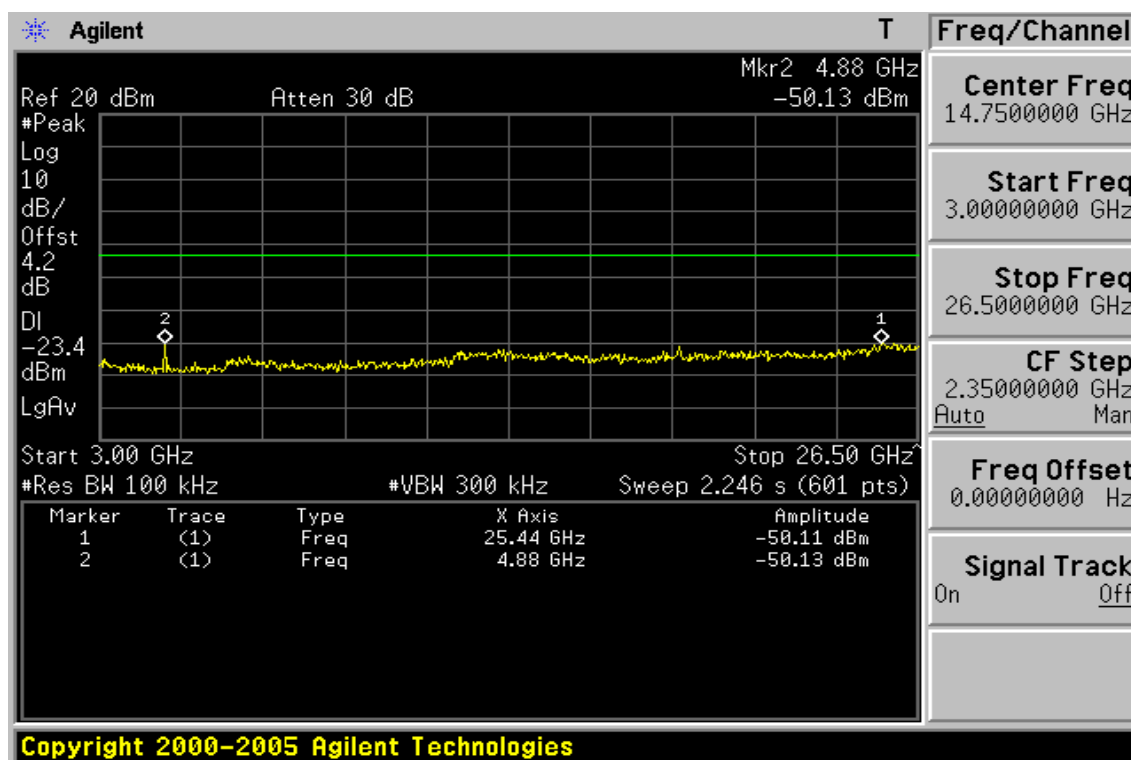
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Ch Mid 30MHz – 3GHz



Ch Mid 3GHz – 26.5GHz



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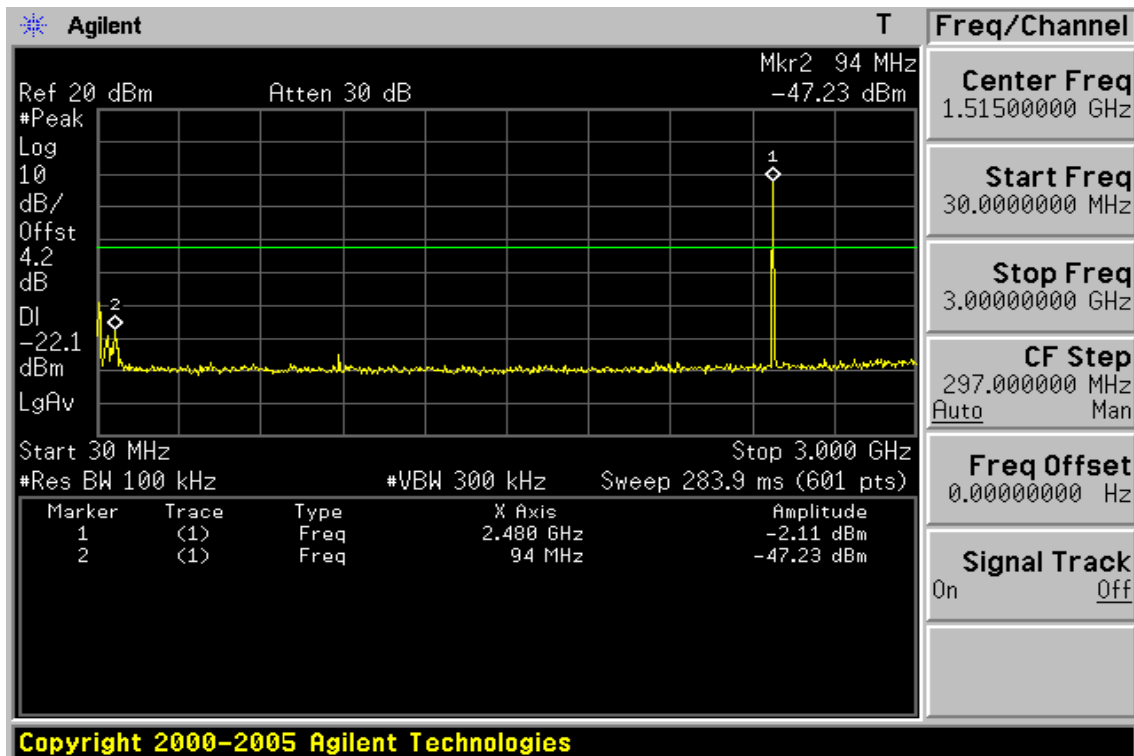
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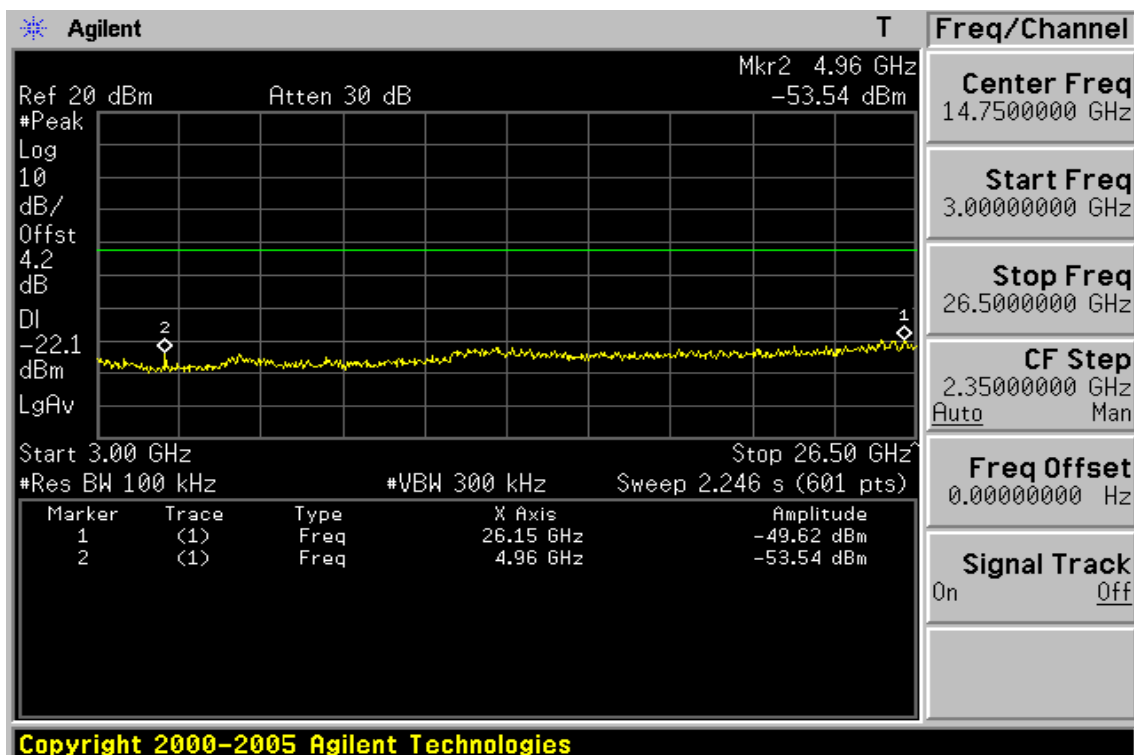
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Ch High 30MHz – 3GHz



Ch High 3GHz – 26.5GHz



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Radiated Spurious Emission Measurement Result (BR mode)

Operation Band	:BR	Test Date	:2013-04-22
Fundamental Frequency	:2402 MHz	Temp./Humi.	:23deg_C/60RH
Operation Mode	:TX LOW	Engineer	:Nick
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:VERTICAL

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
71.71	S	Peak	40.76	-16.69	24.07	40.00	-15.93
141.55	S	Peak	45.16	-12.98	32.18	43.50	-11.32
299.66	S	Peak	35.97	-12.58	23.39	46.00	-22.61
499.48	S	Peak	40.90	-9.60	31.30	46.00	-14.70
798.24	S	Peak	32.96	-4.22	28.74	46.00	-17.26
960.23	S	Peak	31.00	-2.06	28.94	54.00	-25.06
4804.00	H	Average	36.72	6.99	43.71	54.00	-10.29
4804.00	H	Peak	38.86	6.99	45.85	74.00	-28.15
7206.00	H	---					
9608.00	H	---					
12010.00	H	---					
14412.00	H	---					
16814.00	H	---					
19216.00	H	---					
21618.00	H	---					
24020.00	H	---					

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Operation Band :BR Test Date :2013-04-22
 Fundamental Frequency :2402 MHz Temp./Humi. :23deg_C/60RH
 Operation Mode :TX LOW Engineer :Nick
 EUT Pol. :E2 Plan Measurement Antenna Pol. :HORIZONTAL

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
71.71	S	Peak	42.01	-16.69	25.32	40.00	-14.68
143.49	S	Peak	38.80	-12.82	25.98	43.50	-17.52
191.99	S	Peak	43.93	-15.76	28.17	43.50	-15.33
300.63	S	Peak	44.31	-12.55	31.76	46.00	-14.24
499.48	S	Peak	37.24	-9.60	27.64	46.00	-18.36
798.24	S	Peak	34.26	-4.22	30.04	46.00	-15.96
4804.00	H	Average	34.52	7.03	41.55	54.00	-12.45
4804.00	H	Peak	37.51	7.03	44.54	74.00	-29.46
7206.00	H	---					
9608.00	H	---					
12010.00	H	---					
14412.00	H	---					
16814.00	H	---					
19216.00	H	---					
21618.00	H	---					
24020.00	H	---					

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Operation Band :BR Test Date :2013-04-22
 Fundamental Frequency :2441 MHz Temp./Humi. :23deg_C/60RH
 Operation Mode :TX MID Engineer :Nick
 EUT Pol. :E2 Plan Measurement Antenna Pol. :VERTICAL

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
		Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
71.71	S	Peak	40.43	-16.69	23.74	40.00	-16.26
141.55	S	Peak	44.40	-12.98	31.42	43.50	-12.08
427.70	S	Peak	35.38	-10.47	24.91	46.00	-21.09
495.60	S	Peak	40.31	-9.63	30.68	46.00	-15.32
672.14	S	Peak	32.83	-6.16	26.67	46.00	-19.33
960.23	S	Peak	31.54	-2.06	29.48	54.00	-24.52
4882.00	H	Average	36.23	7.16	43.39	54.00	-10.61
4882.00	H	Peak	38.92	7.16	46.08	74.00	-27.92
7323.00	H	---					
9764.00	H	---					
12205.00	H	---					
14646.00	H	---					
17087.00	H	---					
19528.00	H	---					
21969.00	H	---					
24410.00	H	---					

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Operation Band :BR Test Date :2013-04-22
 Fundamental Frequency :2441 MHz Temp./Humi. :23deg_C/60RH
 Operation Mode :TX MID Engineer :Nick
 EUT Pol. :E2 Plan Measurement Antenna Pol. :HORIZONTAL

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
71.71	S	Peak	42.26	-16.69	25.57	40.00	-14.43
191.99	S	Peak	45.02	-15.76	29.26	43.50	-14.24
299.66	S	Peak	45.70	-12.58	33.12	46.00	-12.88
499.48	S	Peak	37.08	-9.60	27.48	46.00	-18.52
672.14	S	Peak	32.14	-6.16	25.98	46.00	-20.02
800.18	S	Peak	33.99	-4.19	29.80	46.00	-16.20
4882.00	H	Average	35.63	7.10	42.73	54.00	-11.27
4882.00	H	Peak	37.83	7.10	44.93	74.00	-29.07
7323.00	H	---					
9764.00	H	---					
12205.00	H	---					
14646.00	H	---					
17087.00	H	---					
19528.00	H	---					
21969.00	H	---					
24410.00	H	---					

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Operation Band :BR Test Date :2013-04-22
 Fundamental Frequency :2480 MHz Temp./Humi. :23deg_C/60RH
 Operation Mode :TX HIGH Engineer :Nick
 EUT Pol. :E2 Plan Measurement Antenna Pol. :VERTICAL

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
71.71	S	Peak	39.58	-16.69	22.89	40.00	-17.11
141.55	S	Peak	44.38	-12.98	31.40	43.50	-12.10
427.70	S	Peak	34.99	-10.47	24.52	46.00	-21.48
499.48	S	Peak	39.71	-9.60	30.11	46.00	-15.89
663.41	S	Peak	34.02	-6.32	27.70	46.00	-18.30
797.27	S	Peak	31.80	-4.24	27.56	46.00	-18.44
4960.00	H	Average	34.61	7.17	41.78	54.00	-12.22
4960.00	H	Peak	36.25	7.17	43.42	74.00	-30.58
7440.00	H	---					
9920.00	H	---					
12400.00	H	---					
14880.00	H	---					
17360.00	H	---					
19840.00	H	---					
22320.00	H	---					
24800.00	H	---					

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Operation Band	:BR	Test Date	:2013-04-22
Fundamental Frequency	:2480 MHz	Temp./Humi.	:23deg_C/60RH
Operation Mode	:TX HIGH	Engineer	:Nick
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:HORIZONTAL

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/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.

“---” : denotes Noise Floor.

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
71.71	S	Peak	42.69	-16.69	26.00	40.00	-14.00
191.99	S	Peak	44.80	-15.76	29.04	43.50	-14.46
297.72	S	Peak	45.45	-12.62	32.83	46.00	-13.17
499.48	S	Peak	36.08	-9.60	26.48	46.00	-19.52
557.68	S	Peak	36.07	-8.42	27.65	46.00	-18.35
800.18	S	Peak	32.85	-4.19	28.66	46.00	-17.34
4960.00	H	Average	34.86	7.02	41.88	54.00	-12.12
4960.00	H	Peak	36.35	7.02	43.37	74.00	-30.63
7440.00	H	---					
9920.00	H	---					
12400.00	H	---					
14880.00	H	---					
17360.00	H	---					
19840.00	H	---					
22320.00	H	---					
24800.00	H	---					

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10. FREQUENCY SEPARATION

10.1. Standard Applicable:

According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 20dB bandwidth of the hopping channel, whichever is greater.

10.2. Measurement Equipment Used:

Refer to section 7.2 for details.

10.3. Test Set-up:

Refer to section 7.3 for details.

10.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = middle of hopping channel.
4. Set the spectrum analyzer as RBW,VBW=100KHz, Adjust Span to 3.0 MHz, Sweep = auto.
5. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

10.5. Measurement Result:

Channel separation (MHz)	Limit	Result
1	$\geq 25\text{KHz}$ or 2/3 times 20dB bandwidth	PASS

Note: Refer to next page for plots.

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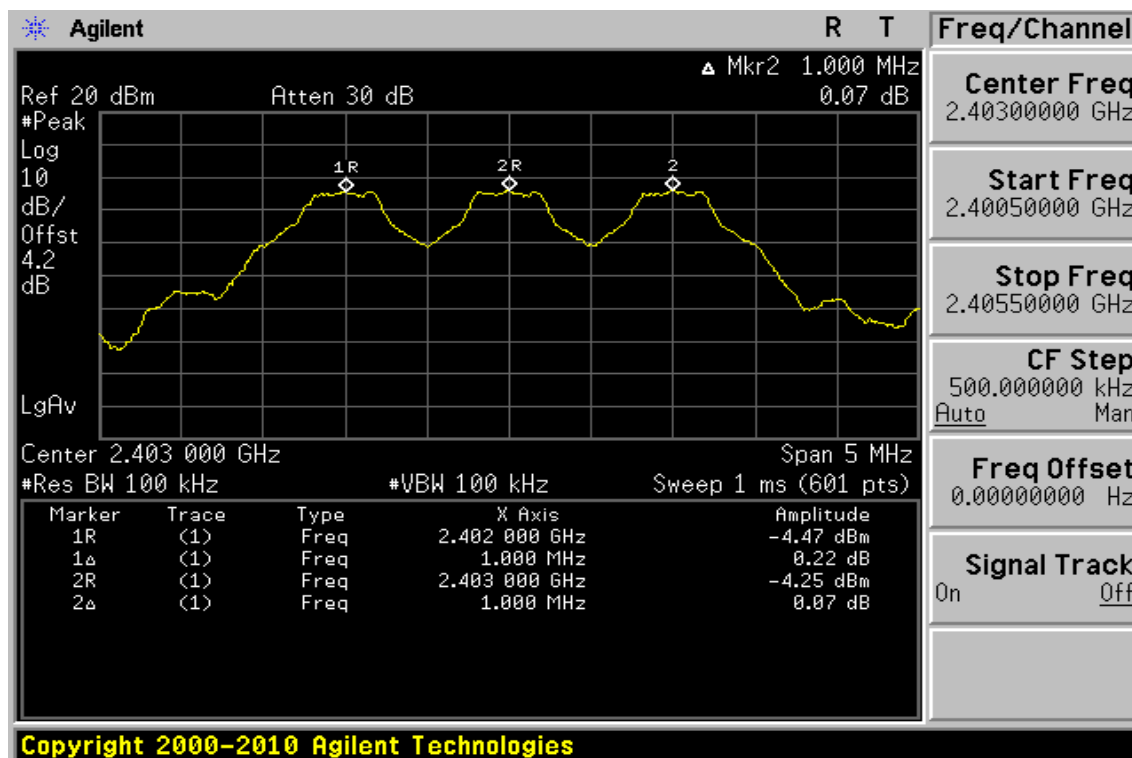
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Frequency Separation Test Data



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11. NUMBER OF HOPPING FREQUENCY

11.1. Standard Applicable:

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

11.2. Measurement Equipment Used:

Refer to section 7.2 for details.

11.3. Test Set-up:

Refer to section 7.3 for details.

11.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set spectrum analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.
4. Set the spectrum analyzer as RBW=430KHz, VBW=1.5MHz,
5. Max hold, view and count how many channel in the band.

11.5. Measurement Result:

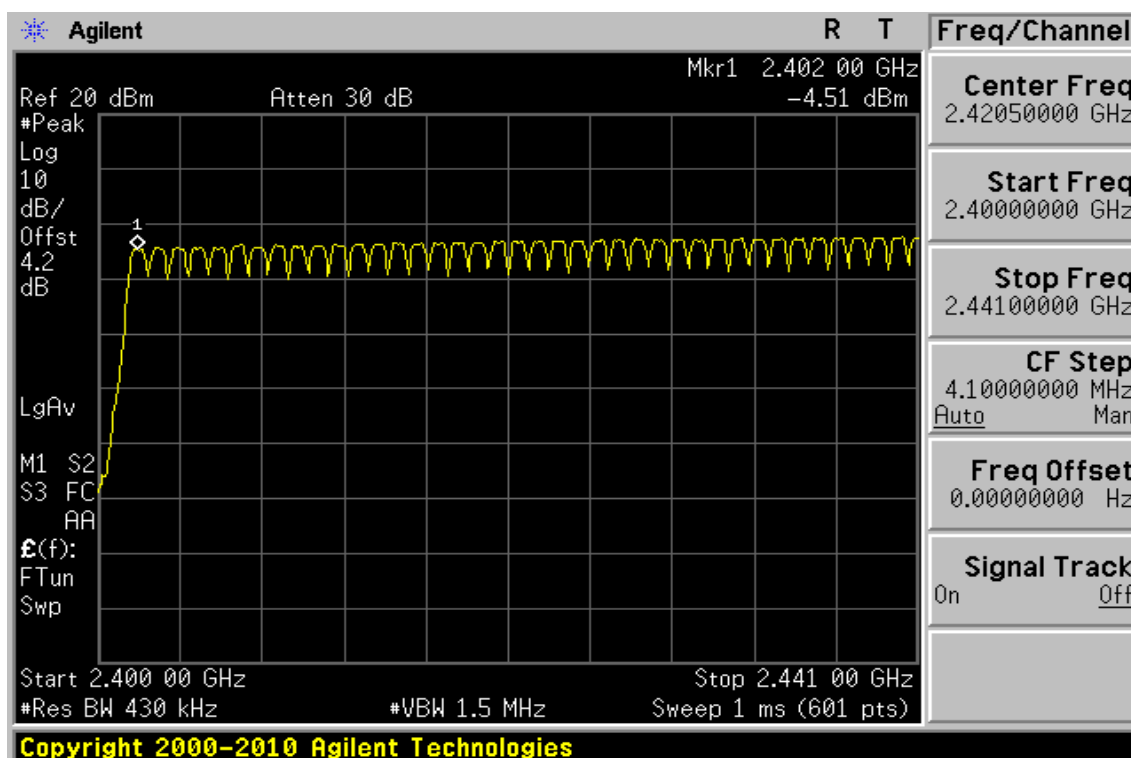
Note: Refer to next page for plots.

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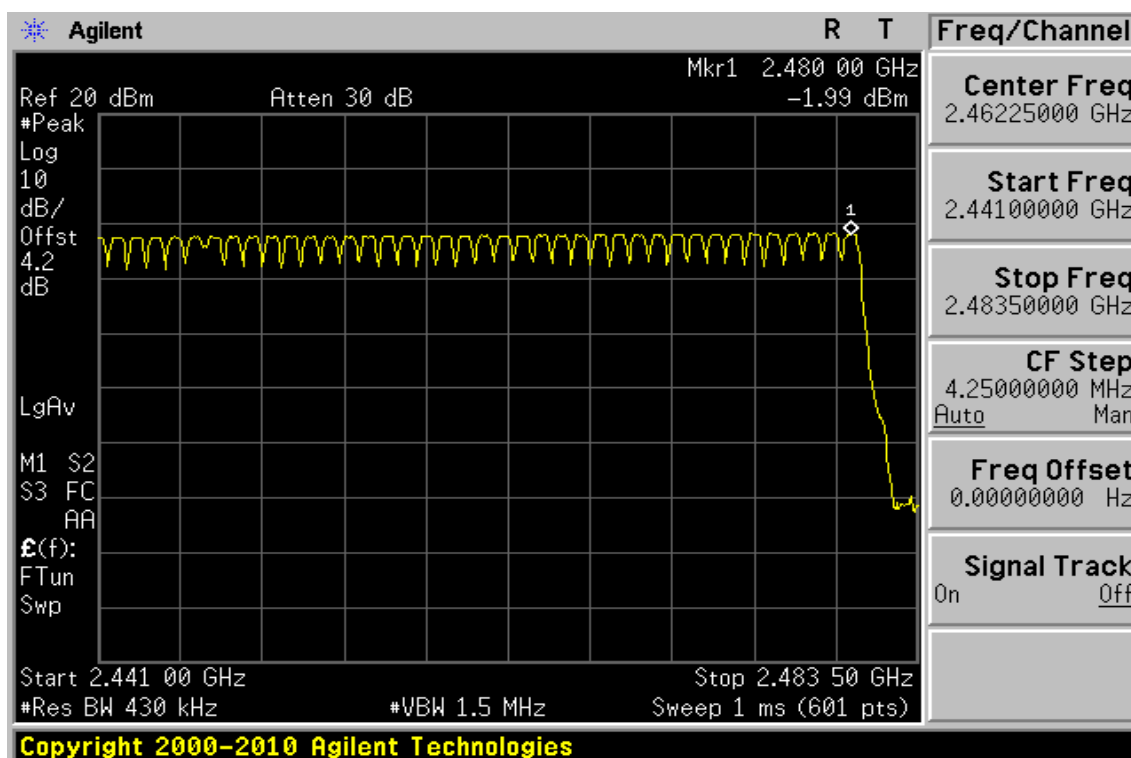
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Channel Number 2.4 GHz – 2.441GHz



2.441 GHz – 2.4835GHz



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12. TIME OF OCCUPANCY (DWELL TIME)

12.1. Standard Applicable:

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz. 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.

12.2. Measurement Equipment Used:

Refer to section 7.2 for details.

12.3. Test Set-up:

Refer to section 7.3 for details.

12.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW=1MHz, VBW=3MHz, Span = 0Hz , Adjust Sweep = 2~7ms.
5. Repeat above procedures until all frequency measured were complete.

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12.5. Measurement Result:

A period time = $0.4 \text{ (ms)} * 79 = 31.6 \text{ (s)}$

CH Low: 3DH1 time slot = $0.390 \text{ (ms)} * (1600/(2*79)) * 31.6 = 124.80 \text{ (ms)}$

3DH3 time slot = $1.650 \text{ (ms)} * (1600/(4*79)) * 31.6 = 264.00 \text{ (ms)}$

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

CH Mid: 3DH1 time slot = $0.390 \text{ (ms)} * (1600/(2*79)) * 31.6 = 124.80 \text{ (ms)}$

3DH3 time slot = $1.650 \text{ (ms)} * (1600/(4*79)) * 31.6 = 264.00 \text{ (ms)}$

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

CH High: 3DH1 time slot = $0.390 \text{ (ms)} * (1600/(2*79)) * 31.6 = 124.80 \text{ (ms)}$

3DH3 time slot = $1.650 \text{ (ms)} * (1600/(4*79)) * 31.6 = 264.00 \text{ (ms)}$

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

Note: Refer to next page for plots.

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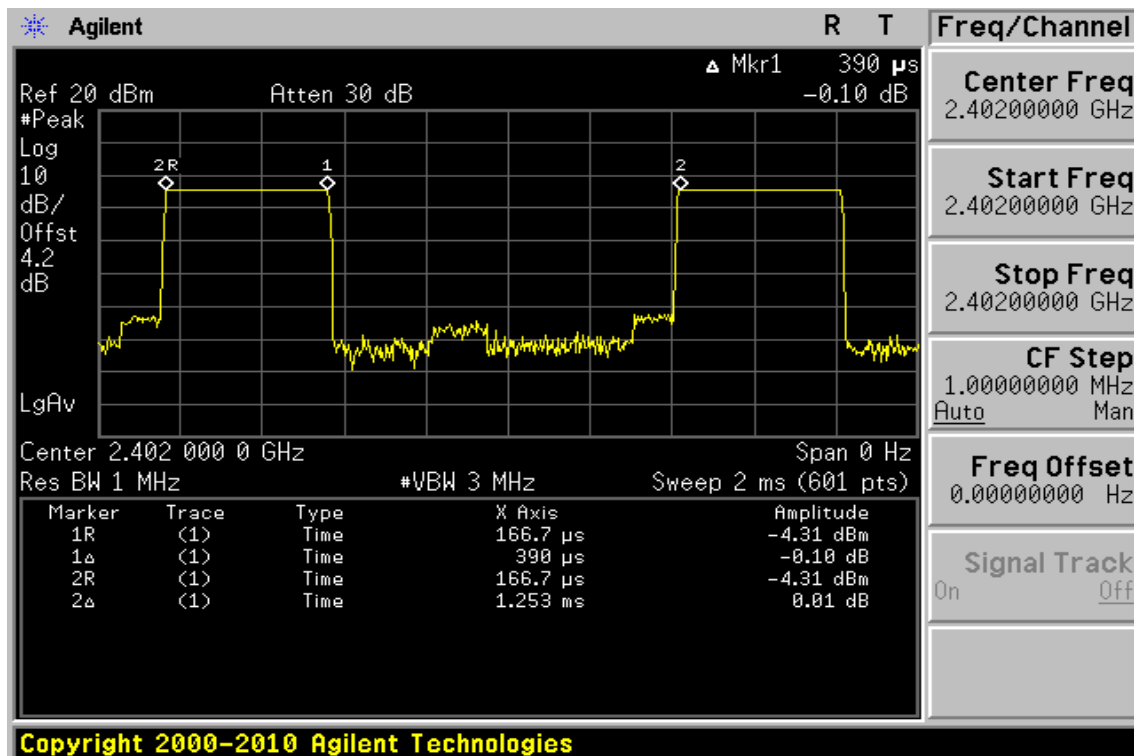
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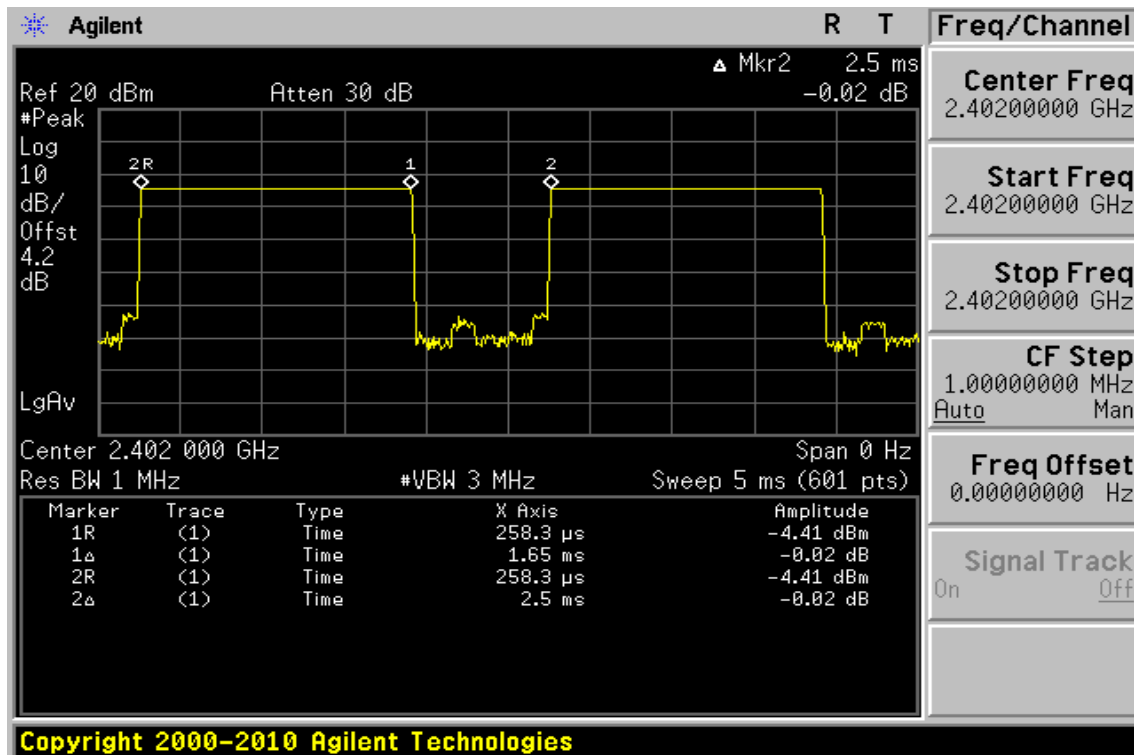
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CH-Low 3DH1



3DH3



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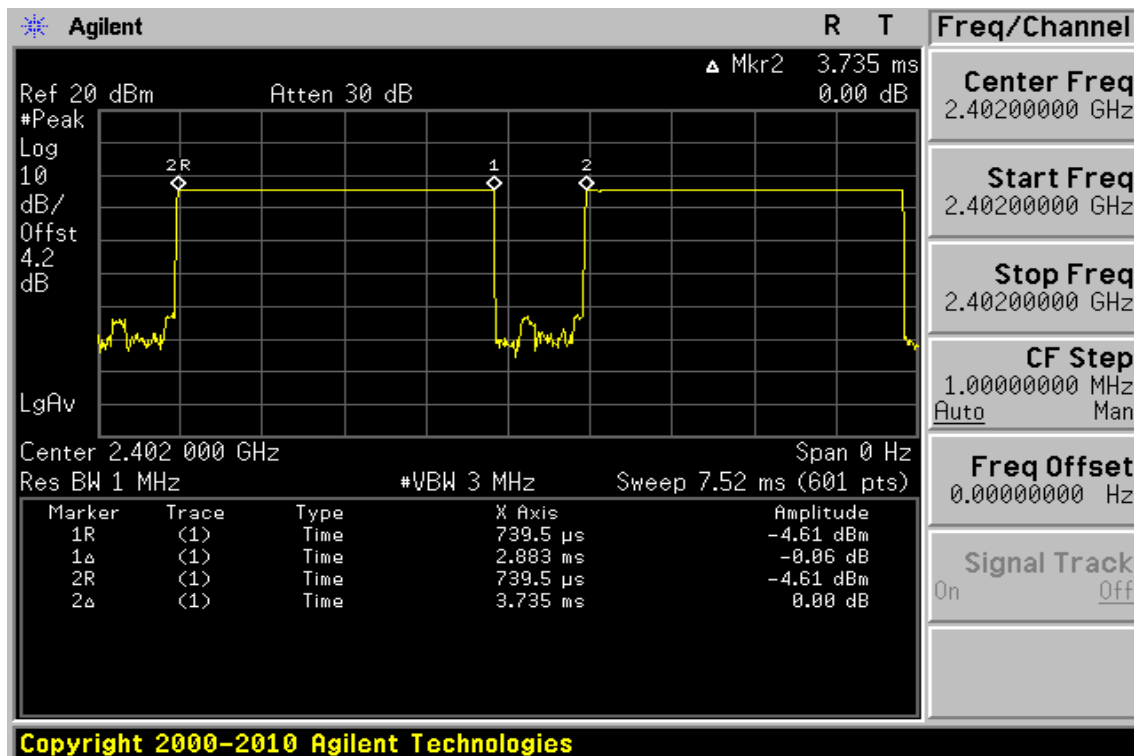
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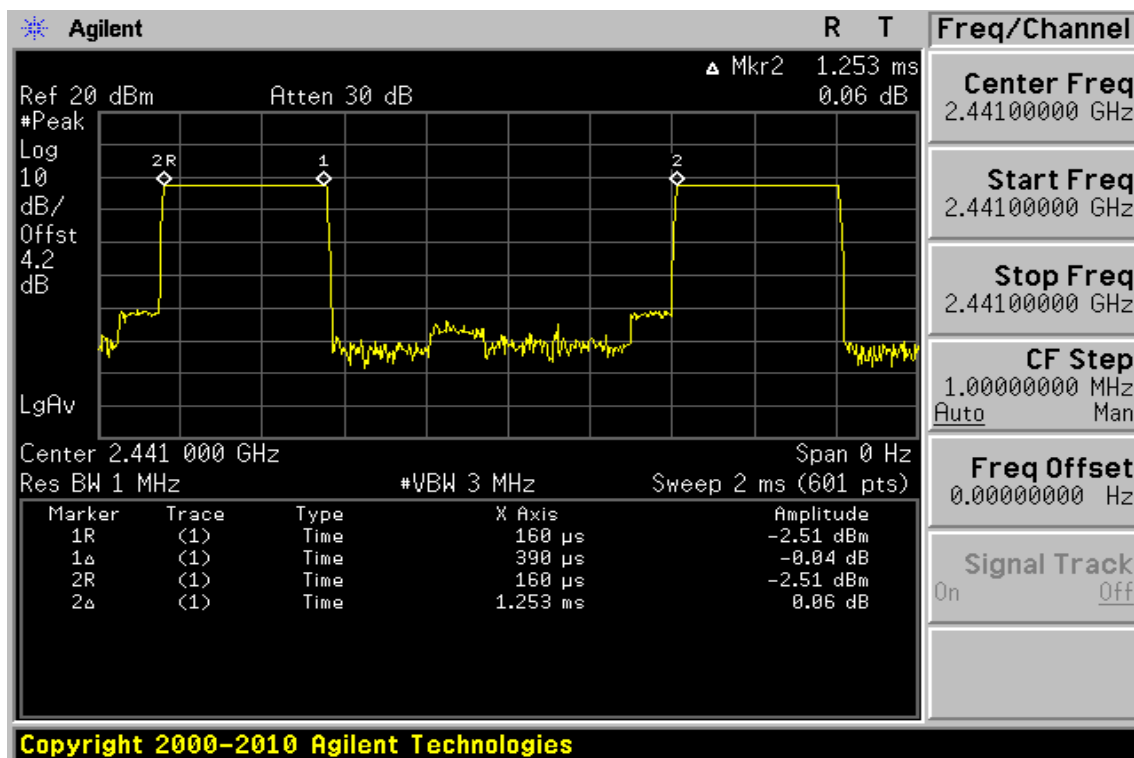
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3DH5



CH-Mid

3DH1



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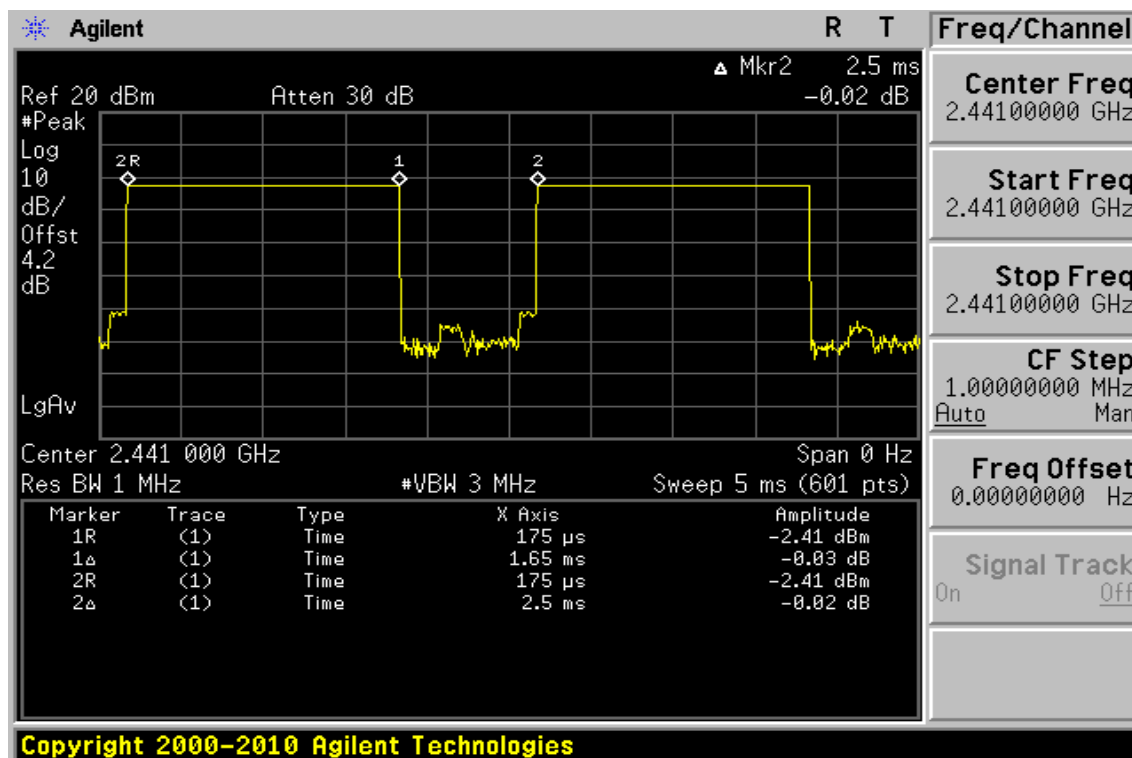
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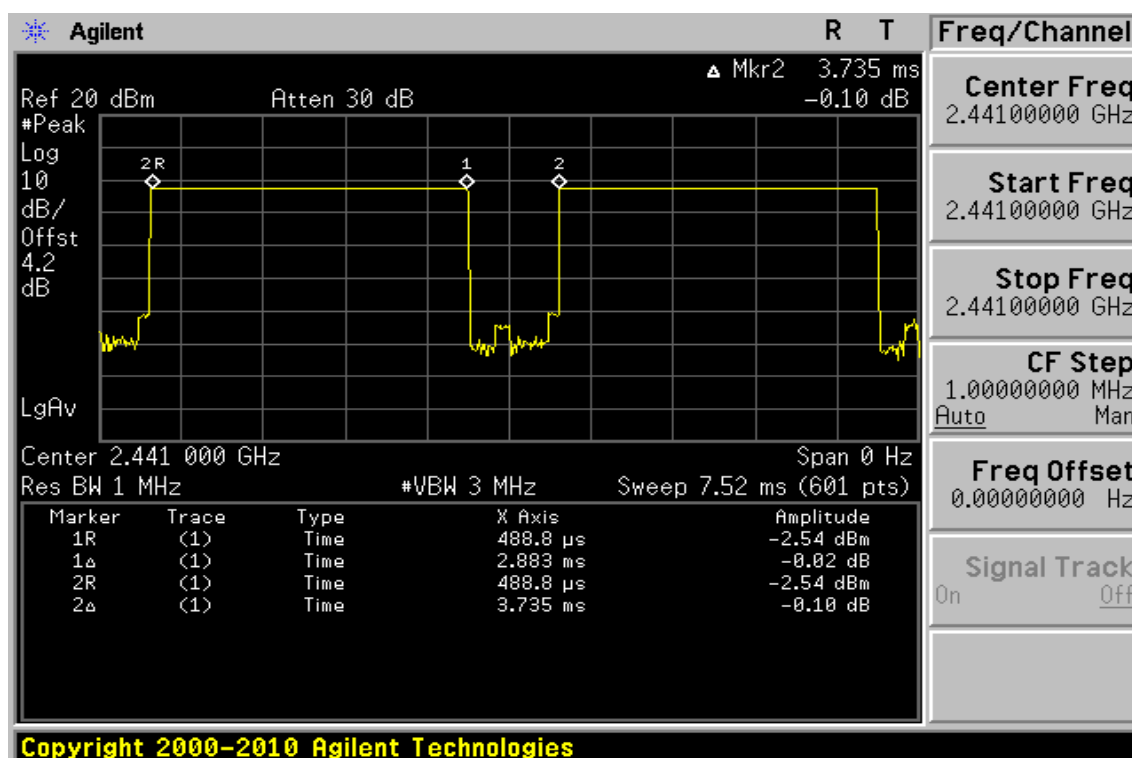
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3DH3



3DH5



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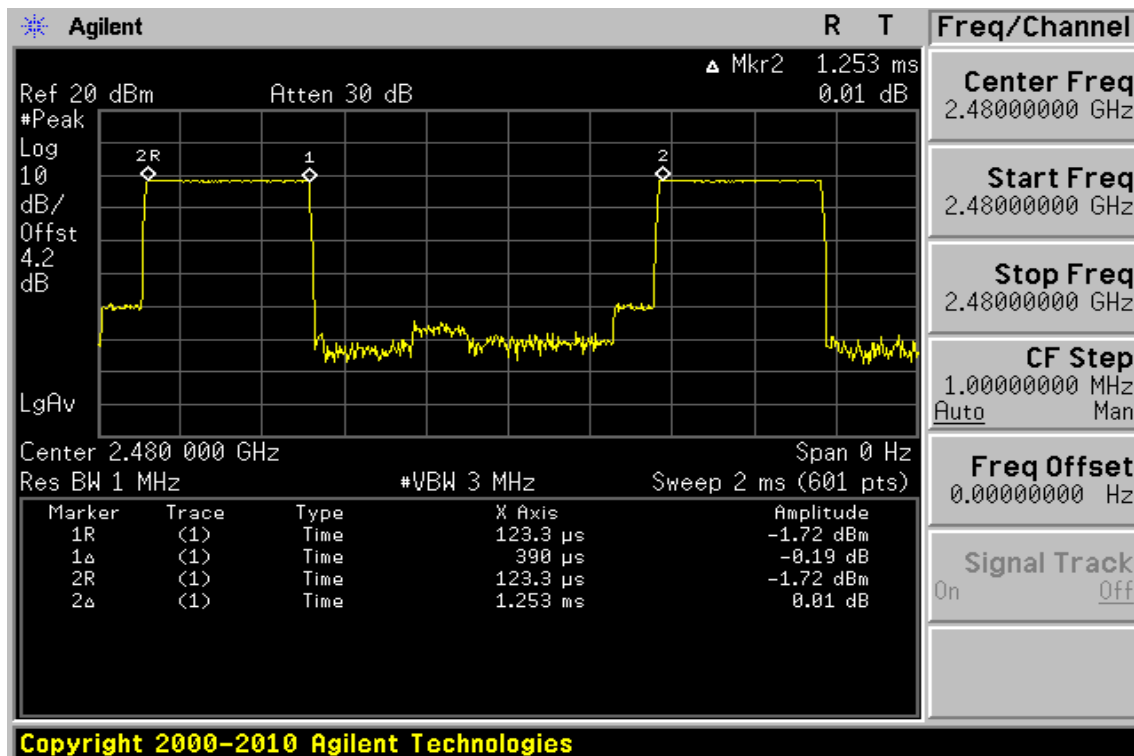
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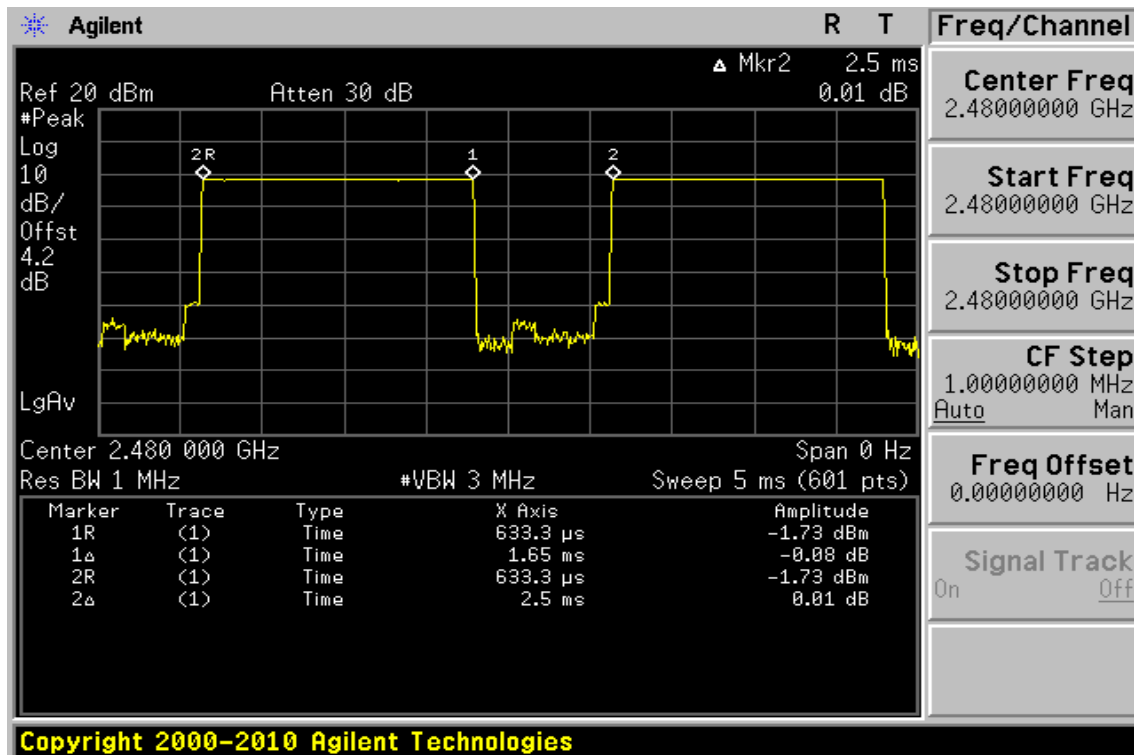
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CH-High 3DH1



3DH3



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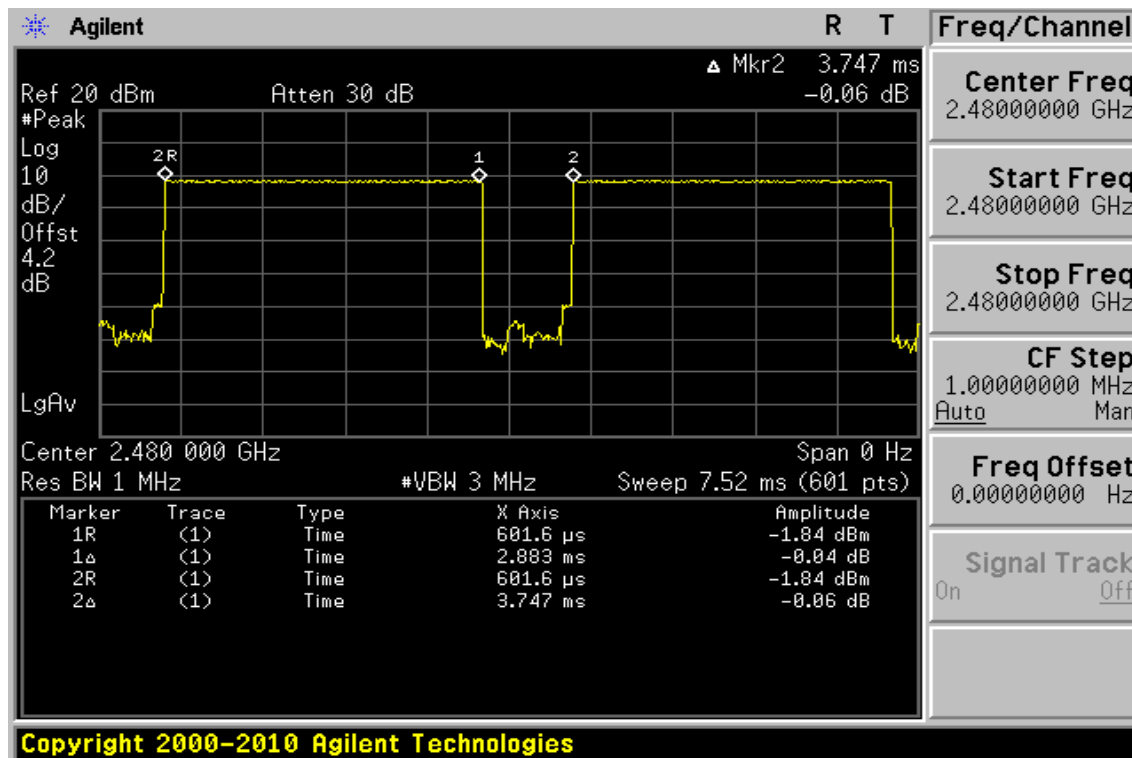
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3DH5



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13. 20DB BANDWIDTH

13.1. Standard Applicable:

According to §15.247(a)(1), for frequency hopping systems operating in the 2400MHz-2483.5 MHz no limit for 20dB bandwidth.

13.2. Measurement Equipment Used:

Refer to section 7.2 for details.

13.3. Test Set-up:

Refer to section 7.3 for details.

13.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as $RBW \geq 1\%$ of Bandwidth. $VBW \geq RBW$, Span= 3MHz, Sweep=auto
4. Mark the peak frequency and -20dB (upper and lower) frequency.
5. Repeat above procedures until all frequency measured were complete.

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13.5. Measurement Result:

20dB Bandwidth:

BR mode (GFSK):

CH	Bandwidth (MHz)
Lower	0.923
Mid	0.922
Higher	0.923

Note: Refer to next page for plots.

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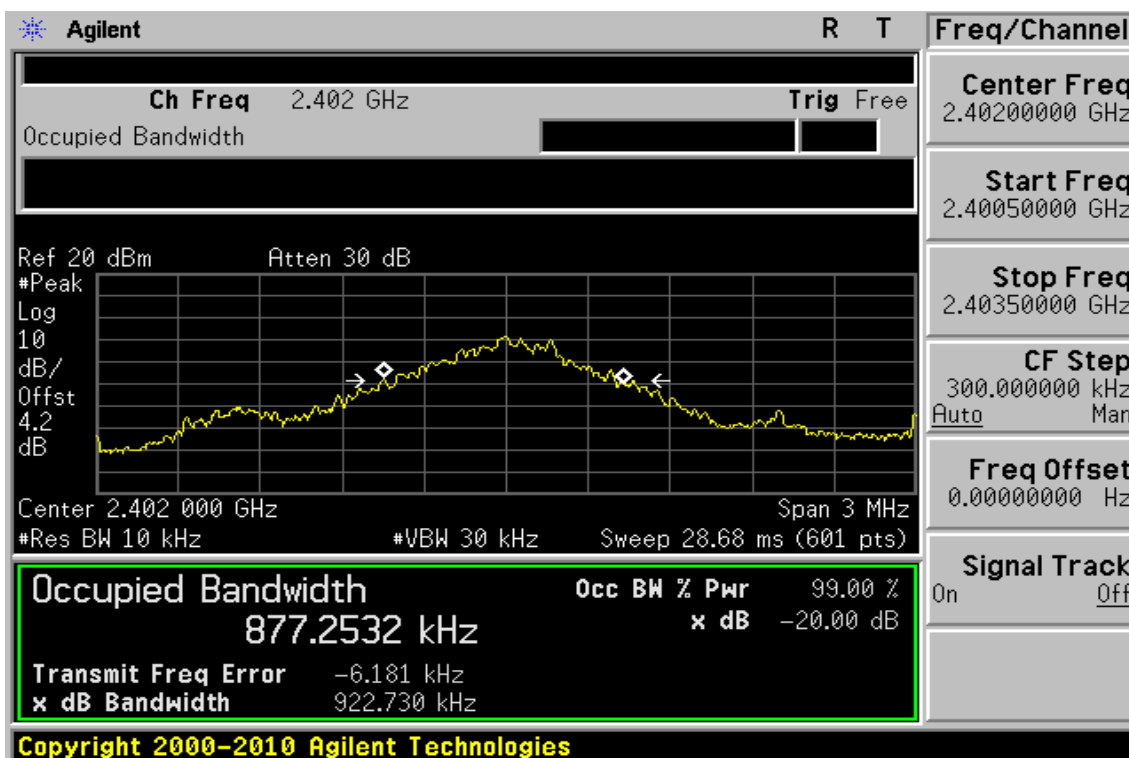
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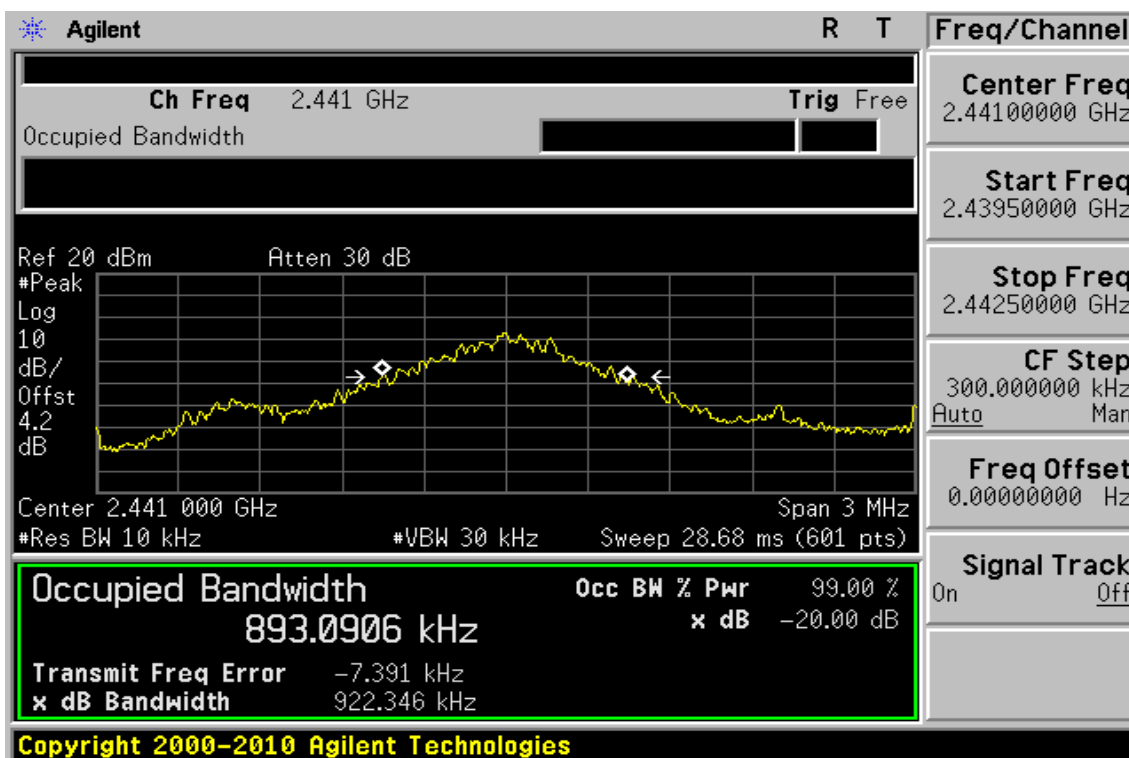
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BR Mode (GFSK)

20dB Bandwidth Test Data CH-Low



20dB Bandwidth Test Data CH-Mid



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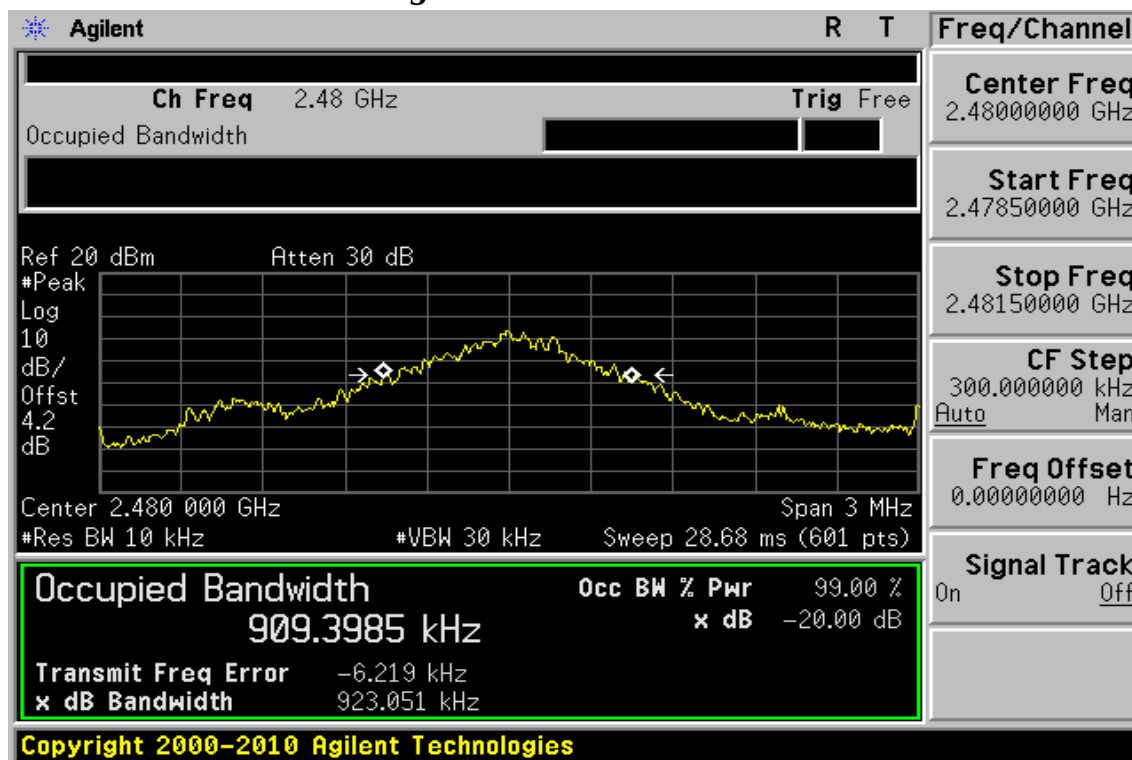
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20dB Bandwidth Test Data CH-High



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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.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

14.2. Antenna Connected Construction:

The directional gains of antenna used for transmitting is 1.9dBi, and the antenna connector is designed with permanent attachment and no consideration of replacement. Please see EUT photo for details.

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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 ²)	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 ²)	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:

BR mode (GFSK):

Frequency (MHz)	Reading Power (dBm)	Output Power (dBm)	Output Power (W)	Limit (W)
2402.00	-3.75	-3.75	0.00042	1
2441.00	-1.70	-1.70	0.00068	1
2480.00	-0.85	-0.85	0.00082	1

Offset: 4.2dB

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15.3. MPE Prediction (BR 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:	-0.85	(dBm)
Maximum peak output power at antenna input terminal:	0.82224265	(mW)
Duty cycle:	77	(%)
Maximum Pav :	0.63312684	(mW)
Antenna gain (typical):	1.9	(dBi)
Maximum antenna gain:	1.548816619	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2480	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.0001952	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.0001952 mW/cm². This is below the uncontrolled exposure limit of 1 mW/cm² at 2480MHz.

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