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FCC CFR47 PART 15 SUBPART C & IC RSS-210

TEST REPORT

For

2G Wideband MicroLite HD COFDM Transmitter

Model Number: 23WBMLT

FCC ID: I4U-23WBMLT

IC: 9479A-23WBMLT

Report Number: 0048-120822-01

Prepared for
Integrated Microwave Technologies, LLC.
101 Bilby Road, Suite 1
Hackettstown, NJ 07840
USA

Prepared by
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Date: 2/19/2013

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1. TEST RESULT CERTIFICATION

COMPANY NAME: INTEGRATED MICROWAVE TECHNOLOGIES, LLC.
101 Bilby Road, Suite 1
Hackettstown, NJ 07840, USA

EUT DESCRIPTION: 2G Wideband MicroLite HD COFDM Transmitter

MODEL: 23WBMLT

DATE TESTED: Nov. 04, 2012 to February 19, 2013

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
FCC Part 15.247 & IC RSS-210:Issue 8	NO NON-COMPLIANCE NOTED

Advanced Compliance Laboratory, Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: This document reports conditions under which testing was conducted and results of tests performed. This document may not be altered or revised in any way unless done so by Advanced Compliance Laboratory, Inc. (ACL) and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by ACL, Advanced Compliance Laboratory, Inc. will constitute fraud and shall nullify the document.

Approved & Released For ACL By:

Tested By:



Wei Li
Manager
Advanced Compliance Laboratory, Inc.



Edward Lee
EMC Engineer

2. EUT DESCRIPTION

The EUT is a low power transmitter, using digital modulation & operating in the 2400-2483.5 MHz band.

The transmitter has a maximum peak conducted output power as follows:

Frequency Range (MHz)	Rated Power Selection	Tested Average Power (dBm/W)	Tested Peak Power (dBm/W)
2404.5-2474.0	High=23dBm	23.55 /0.226	25.97/0.395

The EUT can be configured as Hi-Power Setting at +23dBm or a Low-Power setting, typical +17dBm.

The EUT can use a detachable antenna with Reversed Polarity SMA connector. The requirement for the antenna is specified by the applicant, i.e. max. output peak power at antenna shall be less than +36dBm. Qualified antenna type to be used:

Low Gain Dipole Antenna :

1. Antenna Factor, Model ANT-2.4-CW-HWR-RPS: 2.4GHz Band, RP-SMA, 5 dBi, Vertical Polarization

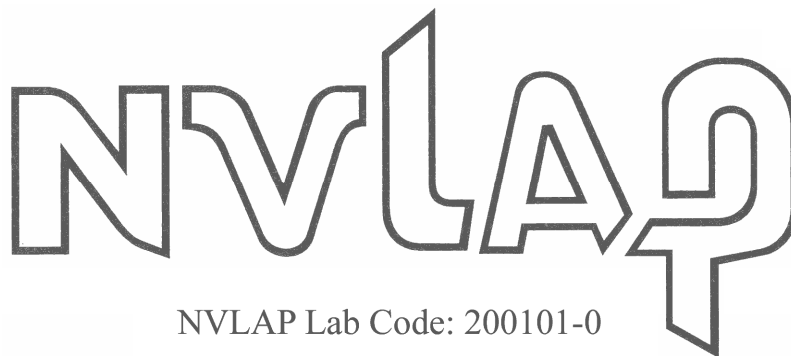
3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4/C63.10, FCC CFR 47 Part 2 & 15 and IC RSS-210. Test procedure described in FCC “KDB 558074 D01 DTS Measurement Guidance” is used in this report.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at Hillsborough, New Jersey, USA. The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.7 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

ACL is accredited by NVLAP, Laboratory Code 200101-0. The full accreditation can be viewed at <http://www.ac-lab.com>



No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government.

5. CALIBRATION AND UNCERTAINTY

5.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

5.2. MEASUREMENT UNCERTAINTY

The estimated uncertainty of the test result is given as following. The method of uncertainty calculation is provided in Advanced Compliance Lab. Doc. No. 0048-01-01.

	Prob. Dist.	Uncertainty(dB)	Uncertainty(dB)	Uncertainty(dB)
		30-1000MHz	1-6.5GHz	Conducted
Combined Std. Uncertainty u_c	norm.	± 2.36	± 2.99	± 1.83

5.3. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Manufacture	Model	Serial No.	Description	Last Cal dd/mm/ yy	Cal Due dd/mm/ yy
Agilent	E4440A	US40420700	3Hz-26.5GHz Spec. Analyzer	25/08/12	25/08/13
R & S	ESPI7	6001	9KHz-7GHz EMI Receiver	17/06/12	17/06/13
EMCO	3104C	9307-4396	20-300MHz Biconical Antenna	15/01/13	15/01/14
EMCO	3146	9008-2860	200-1000MHz Log-Periodic Antenna	15/01/13	15/01/14
EMCO	6502	2665	10KHz-30MHz Active Loop Antenna	28/05/12	28/05/13
EMCO	3115	4945	Double Ridge Guide Horn Antenna	22/01/13	22/01/14
HP	E8254A	US42110367	Signal Generator	23/03/13	23/03/14
Scientific-Atlanta	12A-18	441	Wave Guide Horn Antenna	04/08/12	04/08/13
Agilent	E4448A	MY45300108	3Hz-50GHz Spectrum Analyzer	05/09/12	05/09/13
Agilent	83650B	3844A01114	50G Swept Signal Generator	27/01/12	27/01/14
HP	5361B	3023A01322	20G Pulse/CW Microwave Counter	10/06/12	10/06/13
HP	4419A	US37292112	RF Power Meter w/ Sensor Probe	29/06/12	29/06/13
EMCO	3116	4943	Double Ridge Guide Horn Antenna	11/01/13	11/01/14
SUNSYS	EC127	96025	Temperature Test Chamber	30/06/12	30/06/13
Lorch Microwave	5NF-800/10 00-S	AC3	Notch Filter		
Lorch Microwave	5NF-1800/2 200-S	AE10	Notch Filter		
RES-NET	RFA500NFF 30	0108	30dB in-line Power Attenuator		
Narda	3022	80986	Directional Coupler		

All Test Equipment Used are Calibrated Traceable to NIST Standards.

6. SETUP OF EQUIPMENT UNDER TEST

SUPPORT EQUIPMENT

n/a

TEST SETUP

Testing Frequency/Channel/Port Selection:

- Conducted measurements were performed at EUT's antenna port.
- Using internal signal generator as testing signal source
- Professional Video Camera Battery powered (fully charged)
- Modulation: QPSK, 16QAM & 64QAM
- Signal BW: 6MHz, 7MHz and 8MHz
- Pretest data shows that modulation has no significant effect on testing results. Worst case scenario based on pretest results is applied.
- L(owest), M(iddle), H(ighest) Channels of 2.4G Band were selected based on Signal Channel Bandwidth & Power Level Settings, given as following:

Table 1: 23WBMLT at 23dBm & 17dBm Setting				
Channel BW (MHz)	Lowest Channel Fc (MHz)	Middle Cahnnel Fc (MHz)	Highest Channel Fc (MHz)	Modulation
6	2404.5	2441.75	2474.0	QPSK/16QAM/64QAM
7	2404.5	2441.75	2474.0	QPSK/16QAM/64QAM
8	2404.5	2441.75	2474.0	QPSK/16QAM/64QAM

7. APPLICABLE LIMITS AND TEST RESULTS

7.1. 6dB & 99% BANDWIDTH

LIMIT

§15.247 (a) (2) & RSS-210 A8.2(1): Min. 6dB bandwidth should be no less than 500KHz.

TEST PROCEDURE *per FCC KDB 558074D02*

Measurement Procedure for Emission Bandwidth (DTS Bandwidth)	Applicable to this EUT
7.1 DTS BW Measurement Procedure: Option 1	☐
7.2 DTS BW Measurement Procedure: Option 2	☒

RESULTS

No non-compliance noted.

Summary of Bandwidth Testing Data

(narrowest Channel BW to widest Channel BW, if applicable):

QPSK Modulation

Channel BW (MHZ)	Channel	6dB Bandwidth (KHz)	99% Bandwidth (KHz)
6	L	5700	5657.3
6	M	5687	5647.9
6	H	5746	5674.9
7	L	6625	6601.9
7	M	6639	6585.0
7	H	6674	6608.1
8	L	7544	7523.9
8	M	7536	7517.7
8	H	7546	7510.8

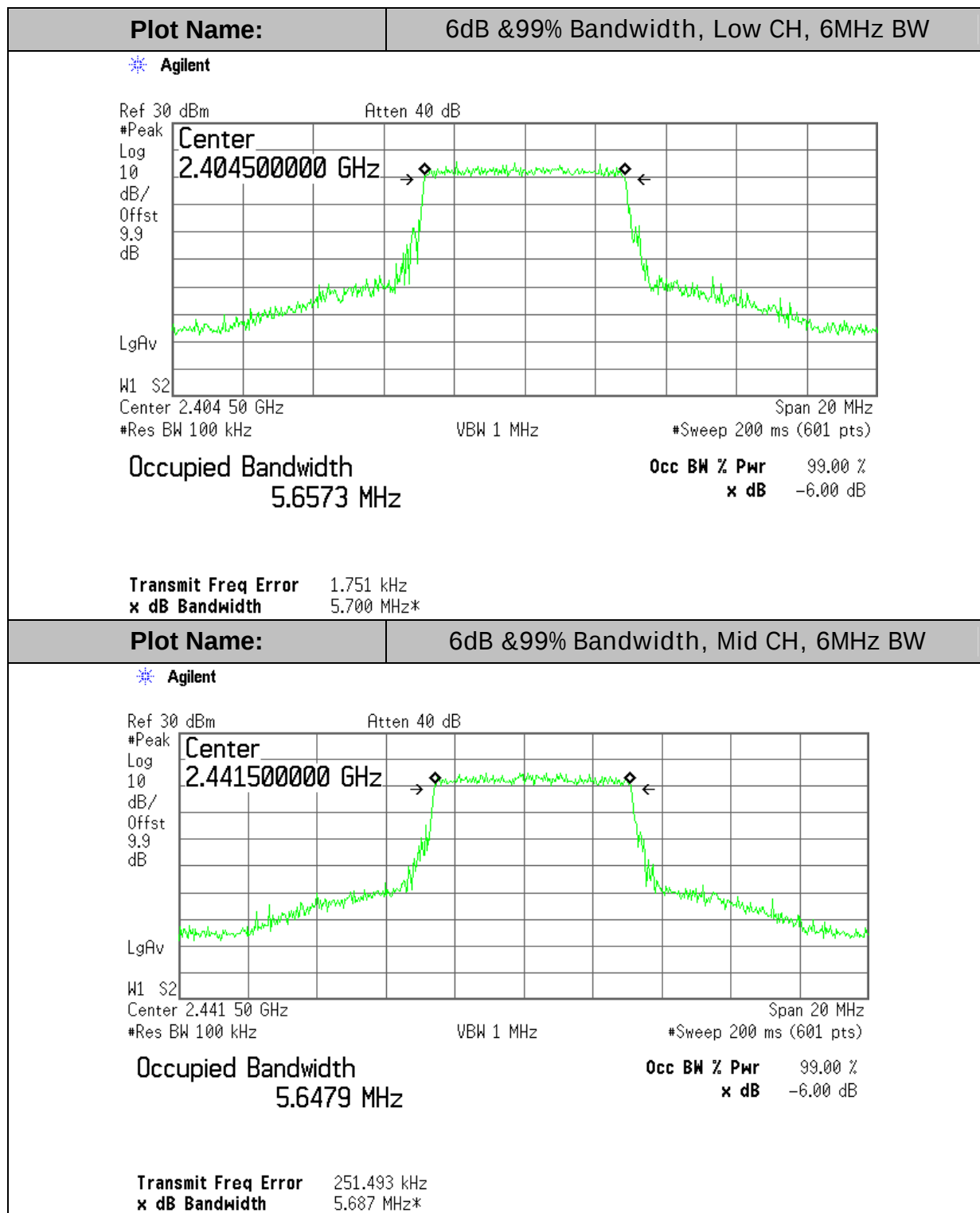
16QAM Modulation

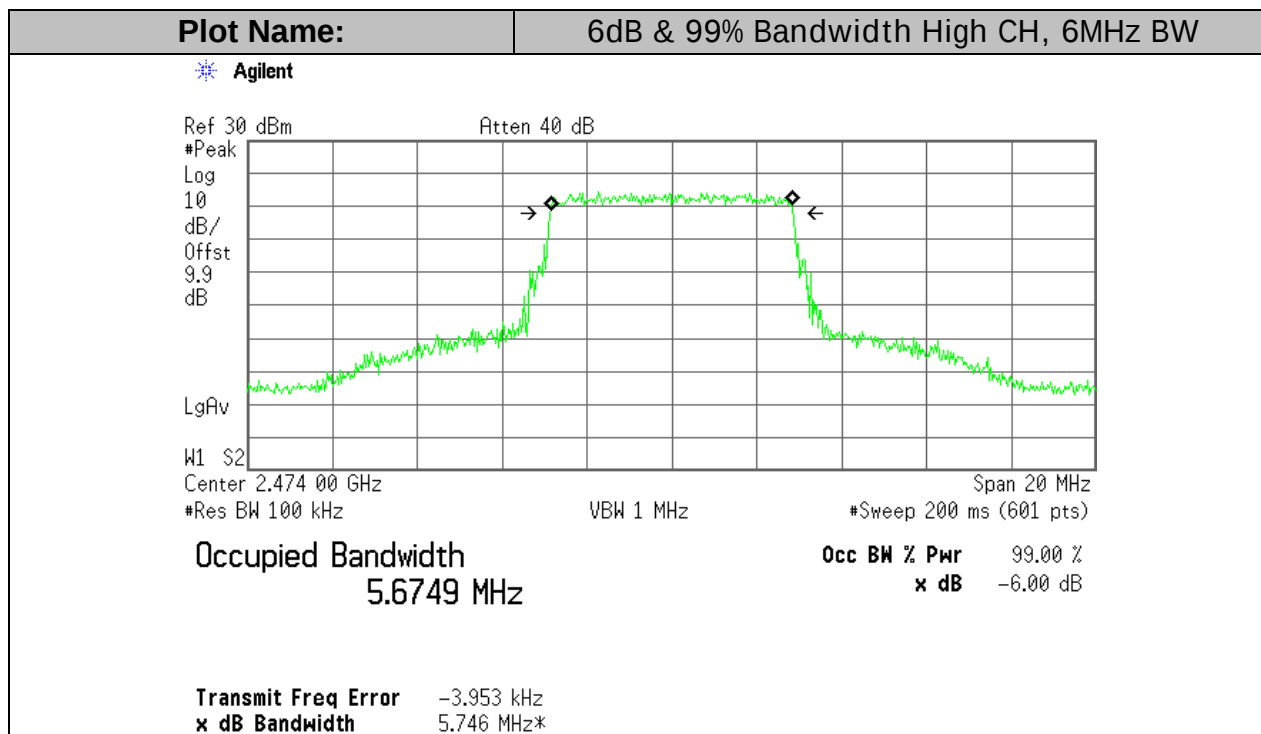
Channel BW (MHZ)	Channel	6dB Bandwidth (KHz)	99% Bandwidth (KHz)
6	L	5694	5657.2
6	M	5721	5662.7
6	H	5673	5670.2
7	L	6629	6592.9
7	M	6657	6595.0
7	H	6665	6602.2
8	L	7581	7520.0
8	M	7557	7535.2
8	H	7553	7520.2

64QAM Modulation

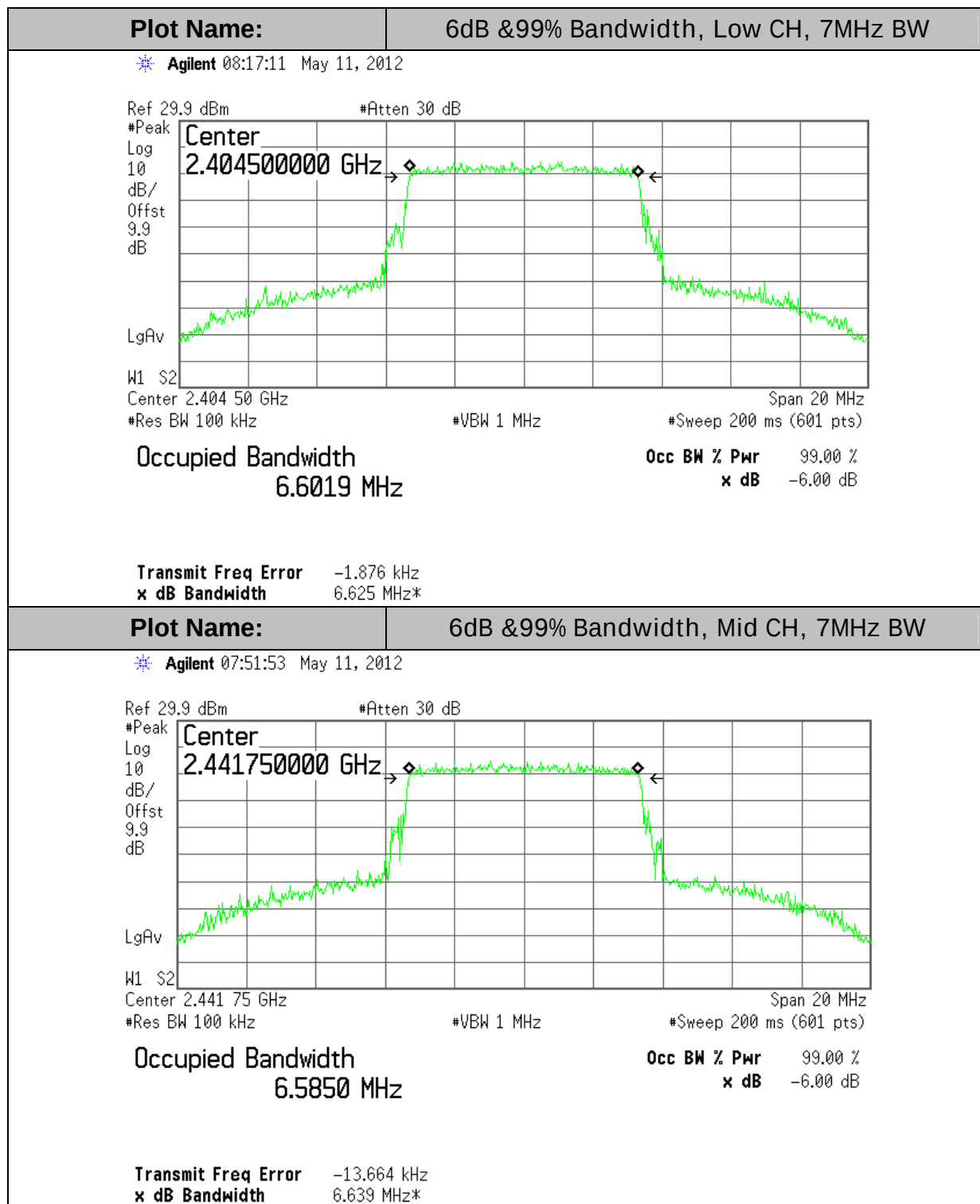
Channel BW (MHZ)	Channel	6dB Bandwidth (KHz)	99% Bandwidth (KHz)
6	L	5693	5662.1
6	M	5669	5679.1
6	H	5675	5645.6
7	L	6626	6698.4
7	M	6591	6594.5
7	H	6658	6596.1
8	L	7557	7520.3
8	M	7599	7534.7
8	H	7549	7536.0

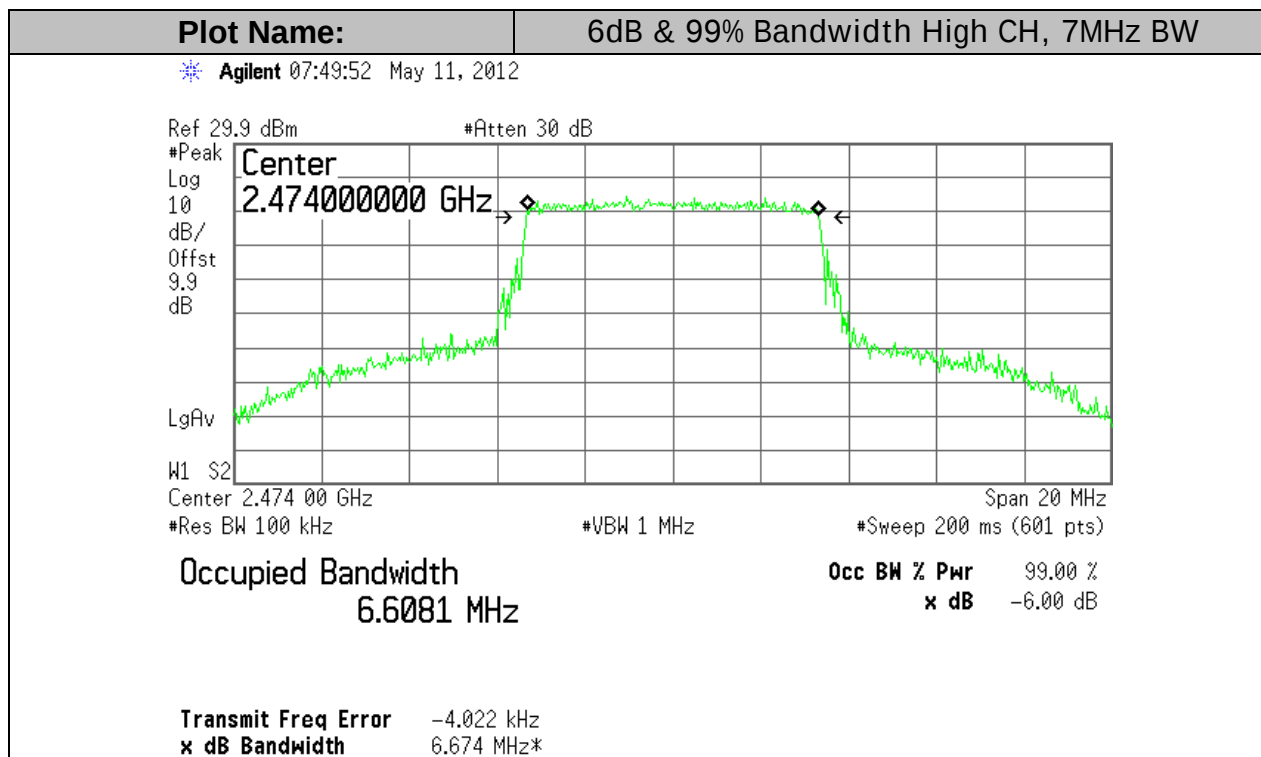
6dB & 99% BANDWIDTH for 6MHz BW Mode: QPSK Modulation



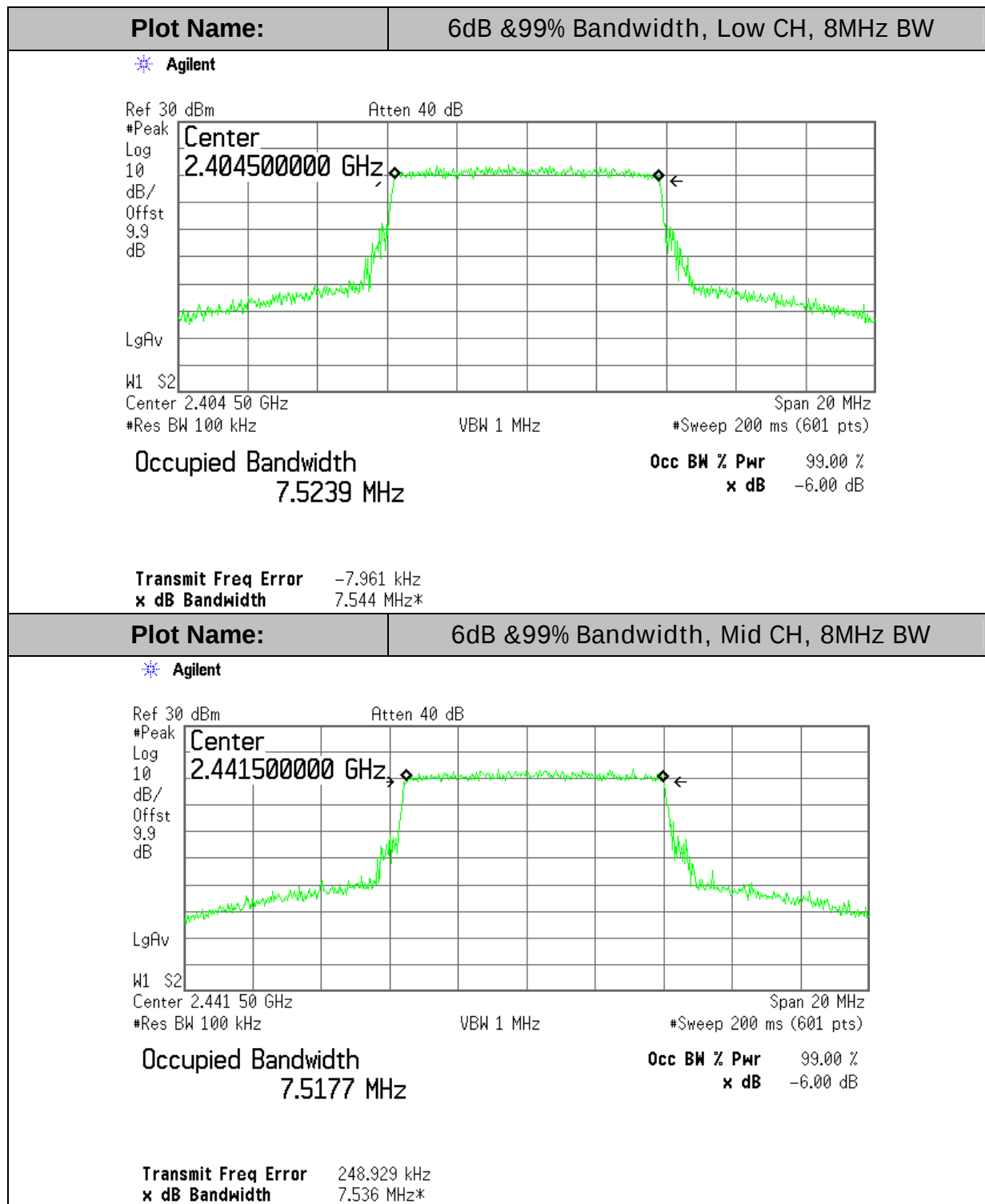


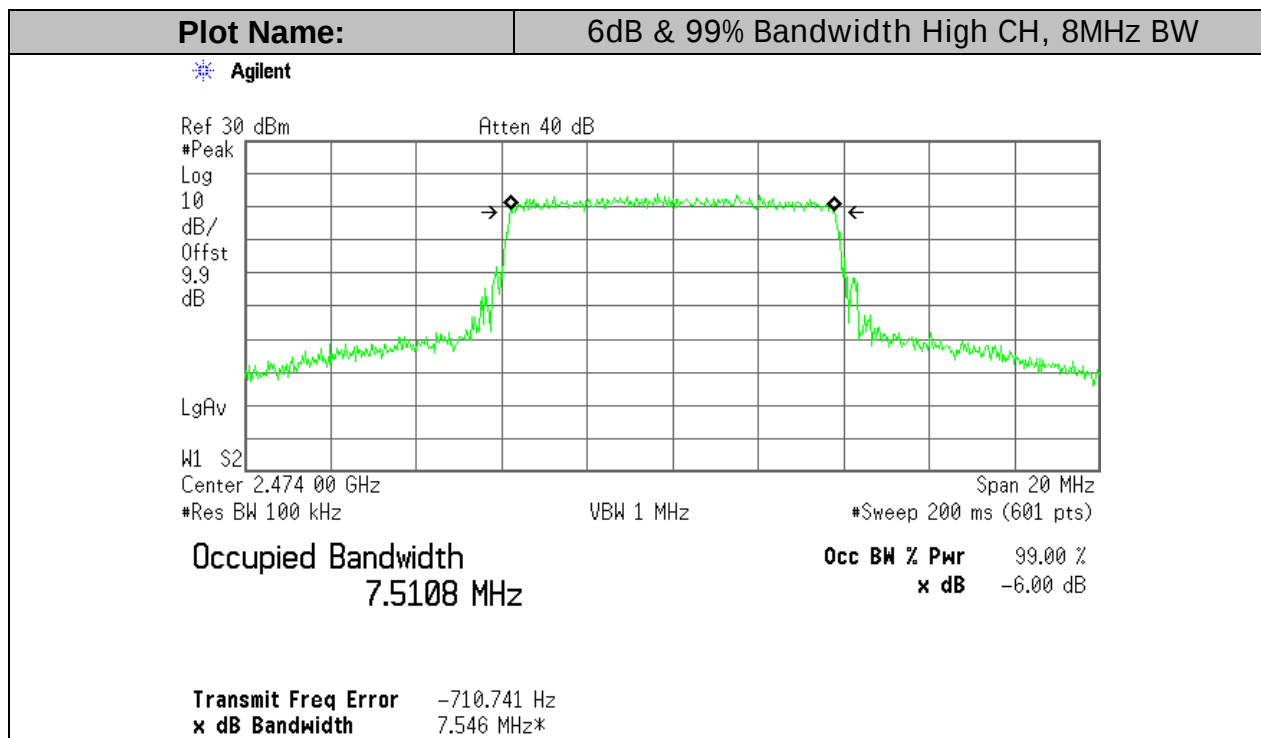
6dB & 99% BANDWIDTH for 7MHz BW Mode: QPSK Modulation



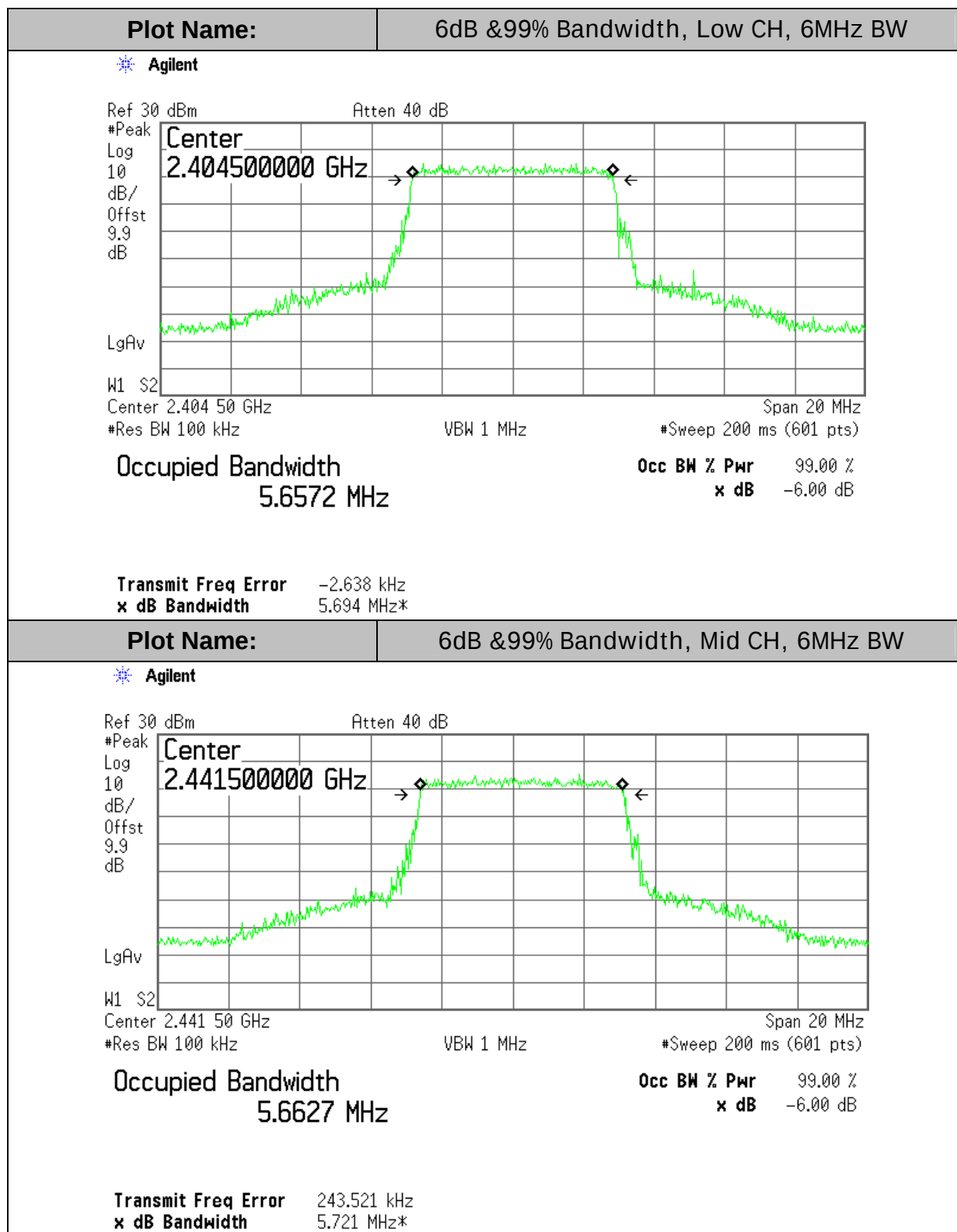


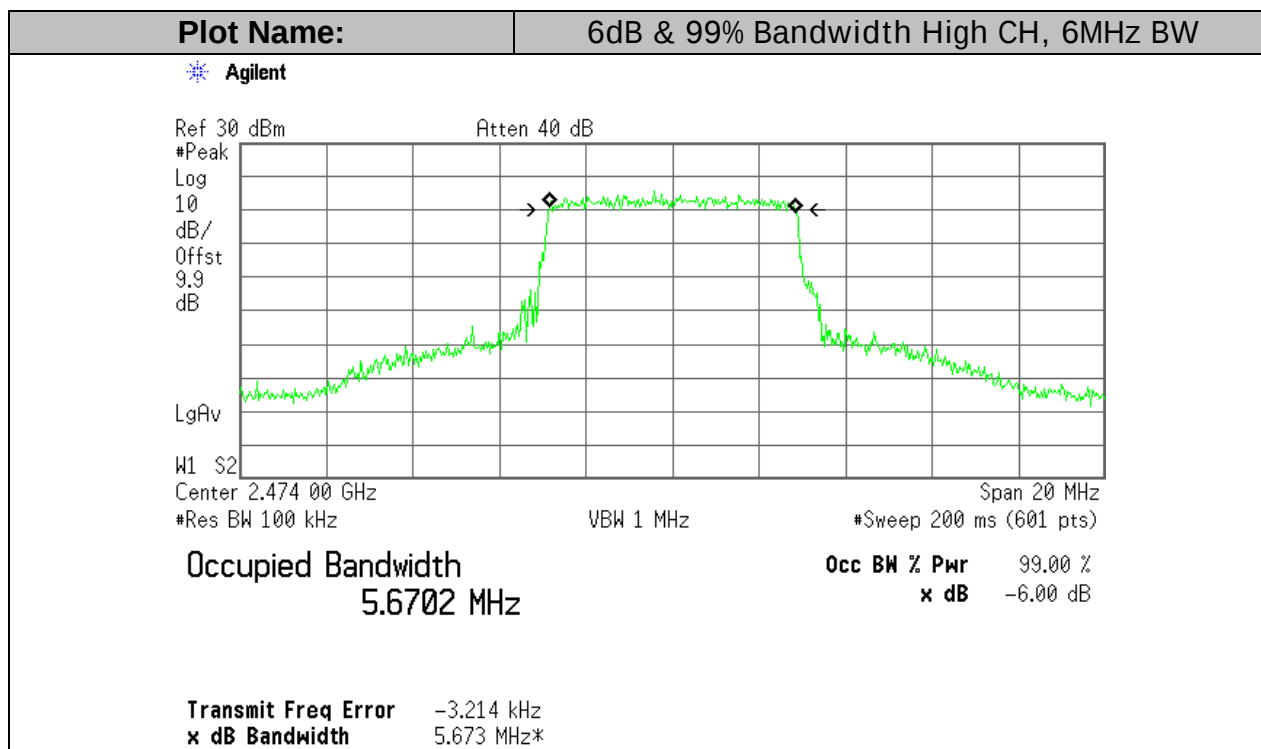
6dB & 99% BANDWIDTH for 8MHz BW Mode: QPSK Modulation



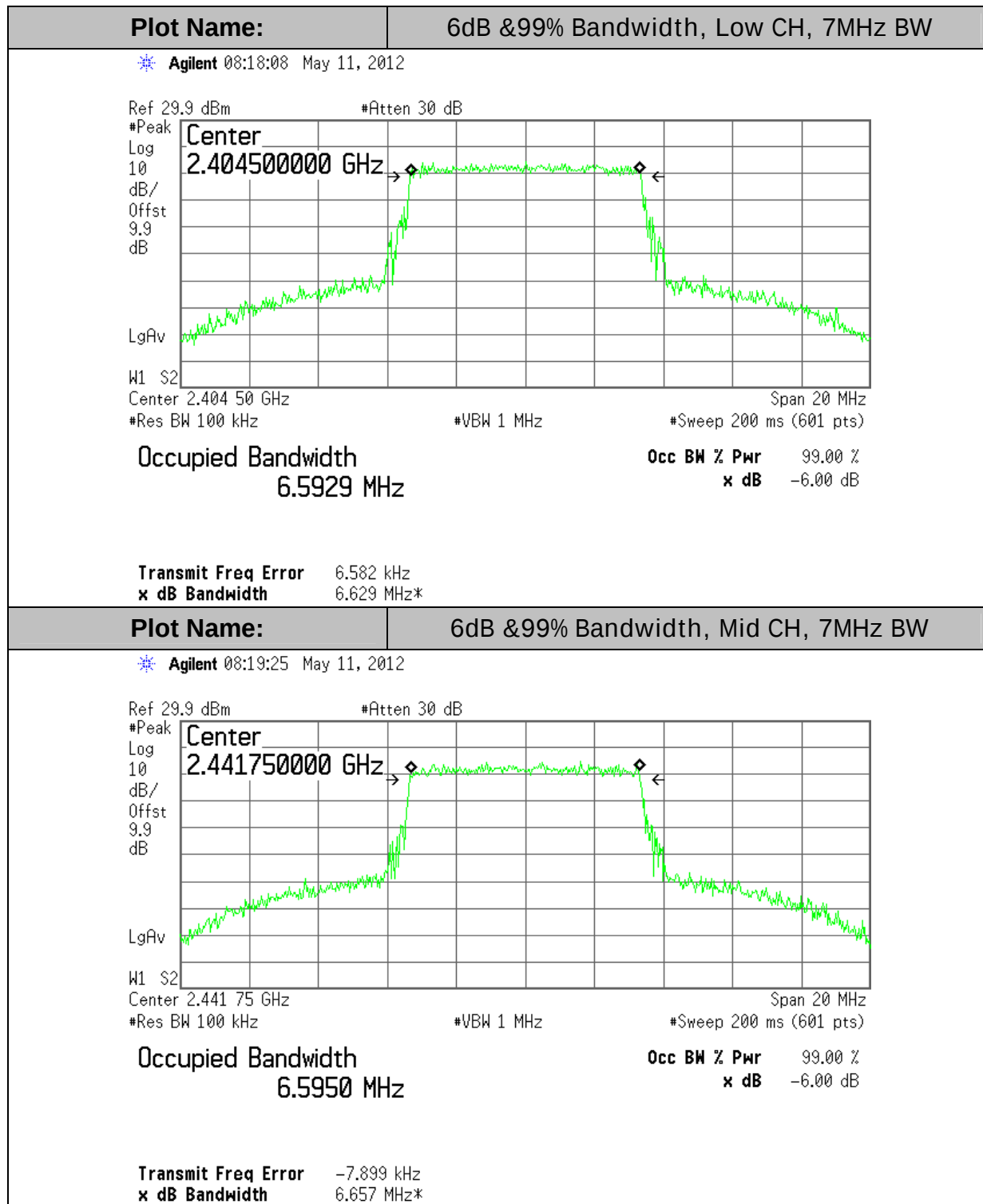


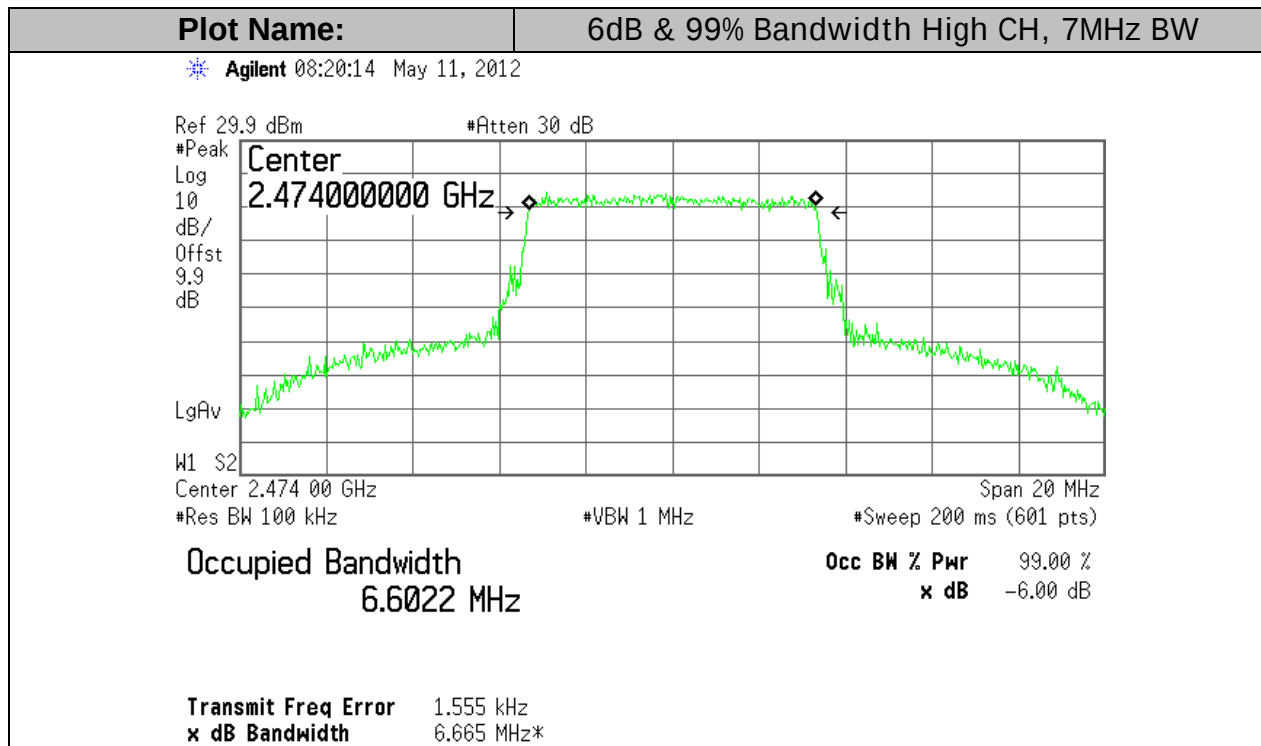
6dB & 99% BANDWIDTH for 6MHz BW Mode: 16QAM Modulation



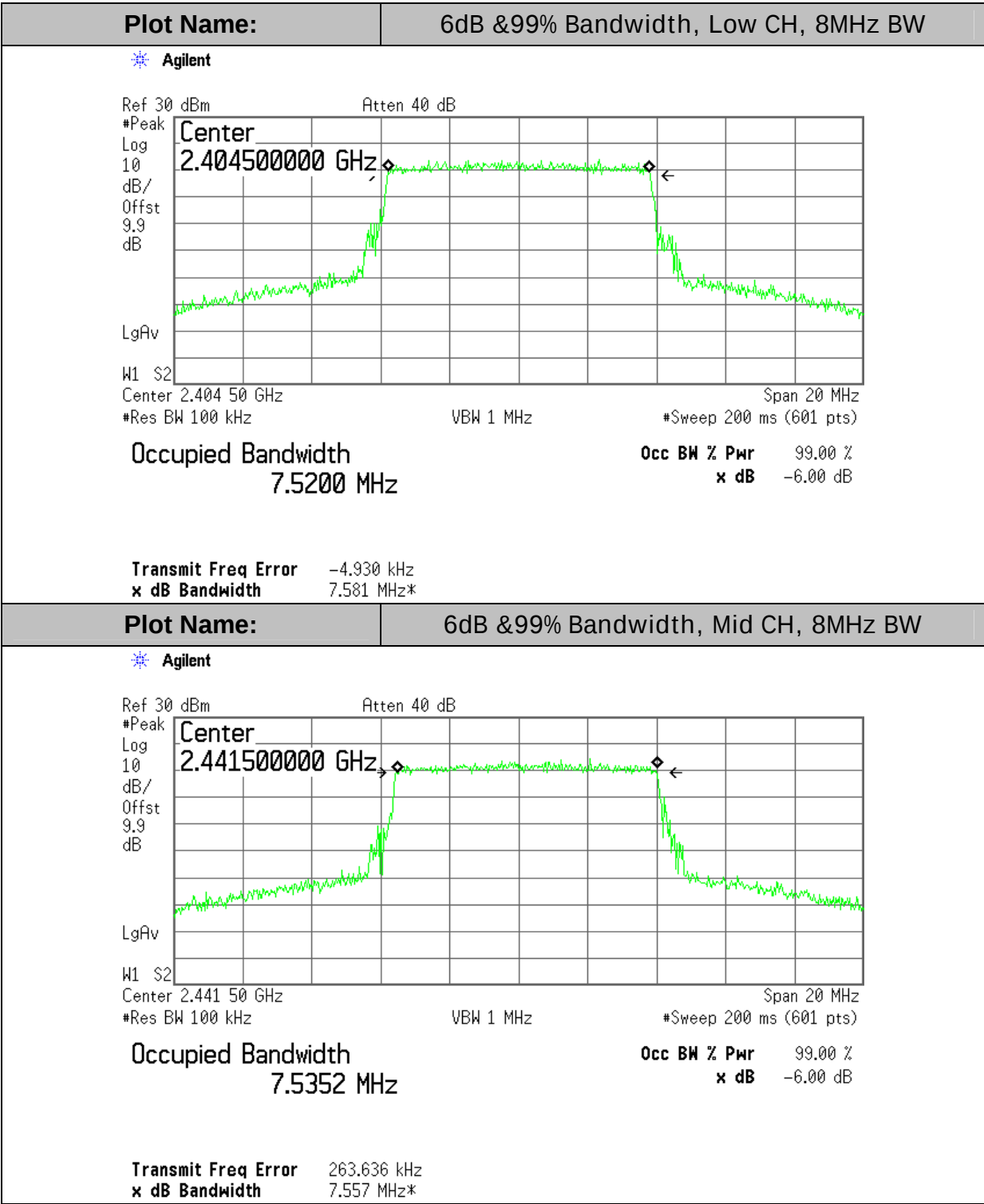


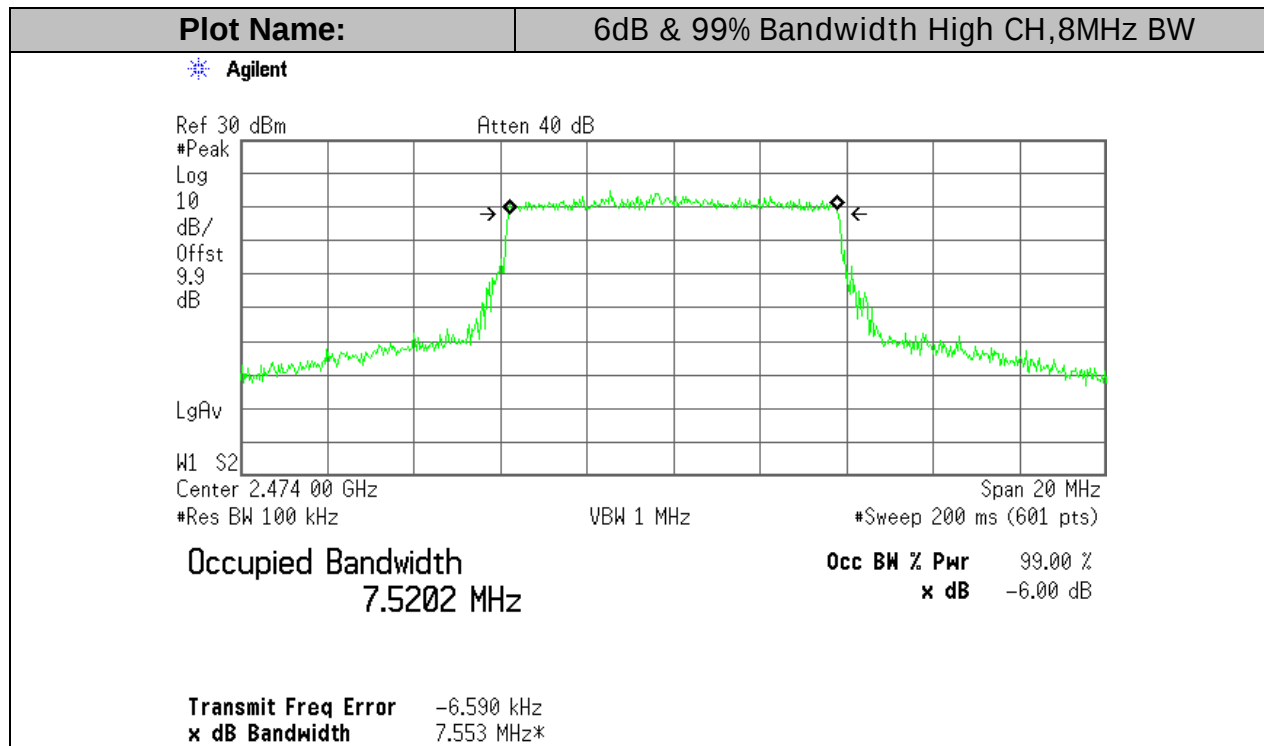
6dB & 99% BANDWIDTH for 7MHz BW Mode: 16QAM Modulation



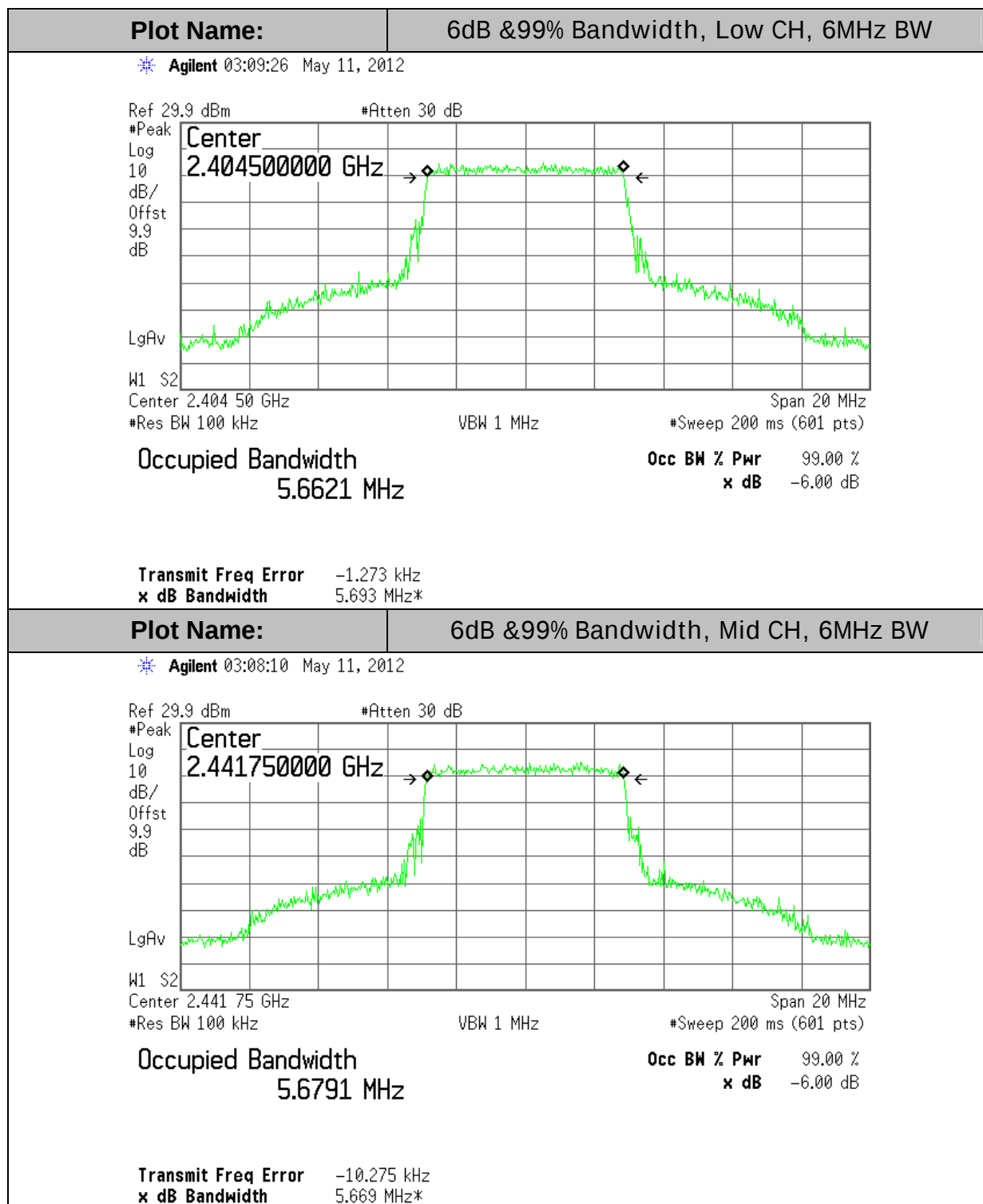


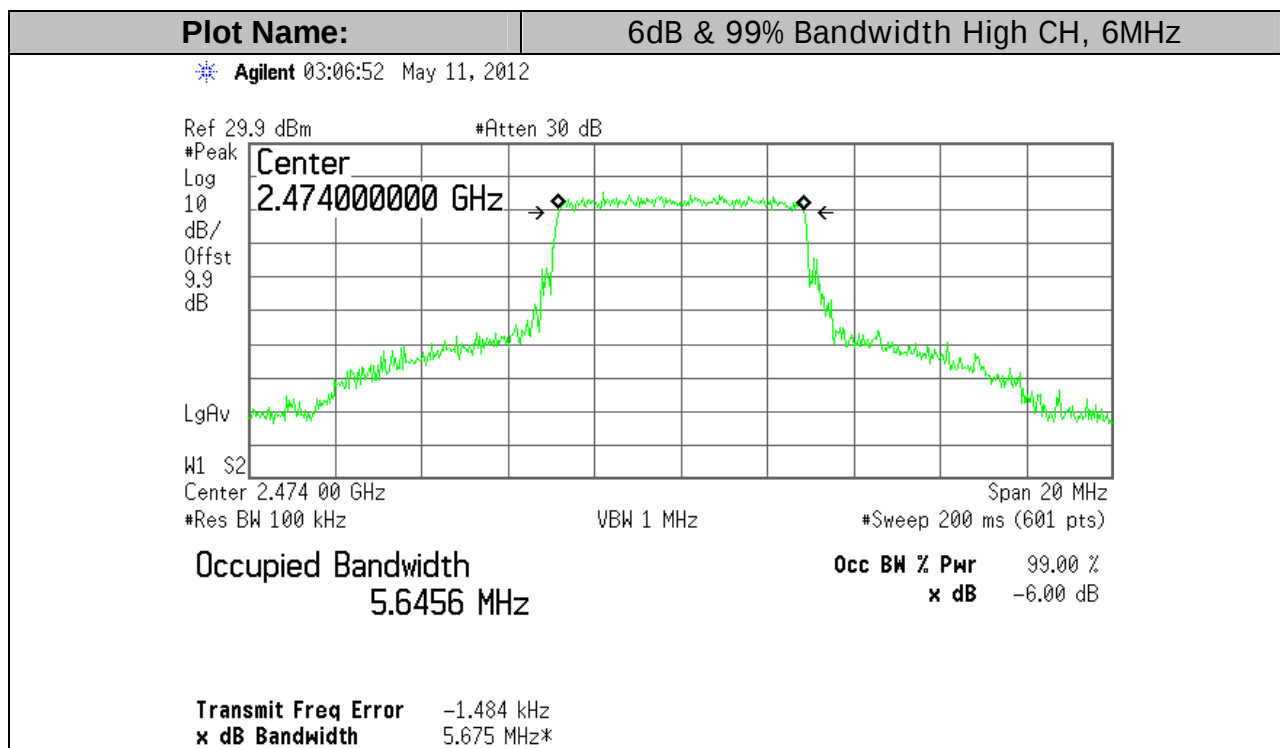
6dB & 99% BANDWIDTH for 8MHz BW Mode: 16QAM Modulation



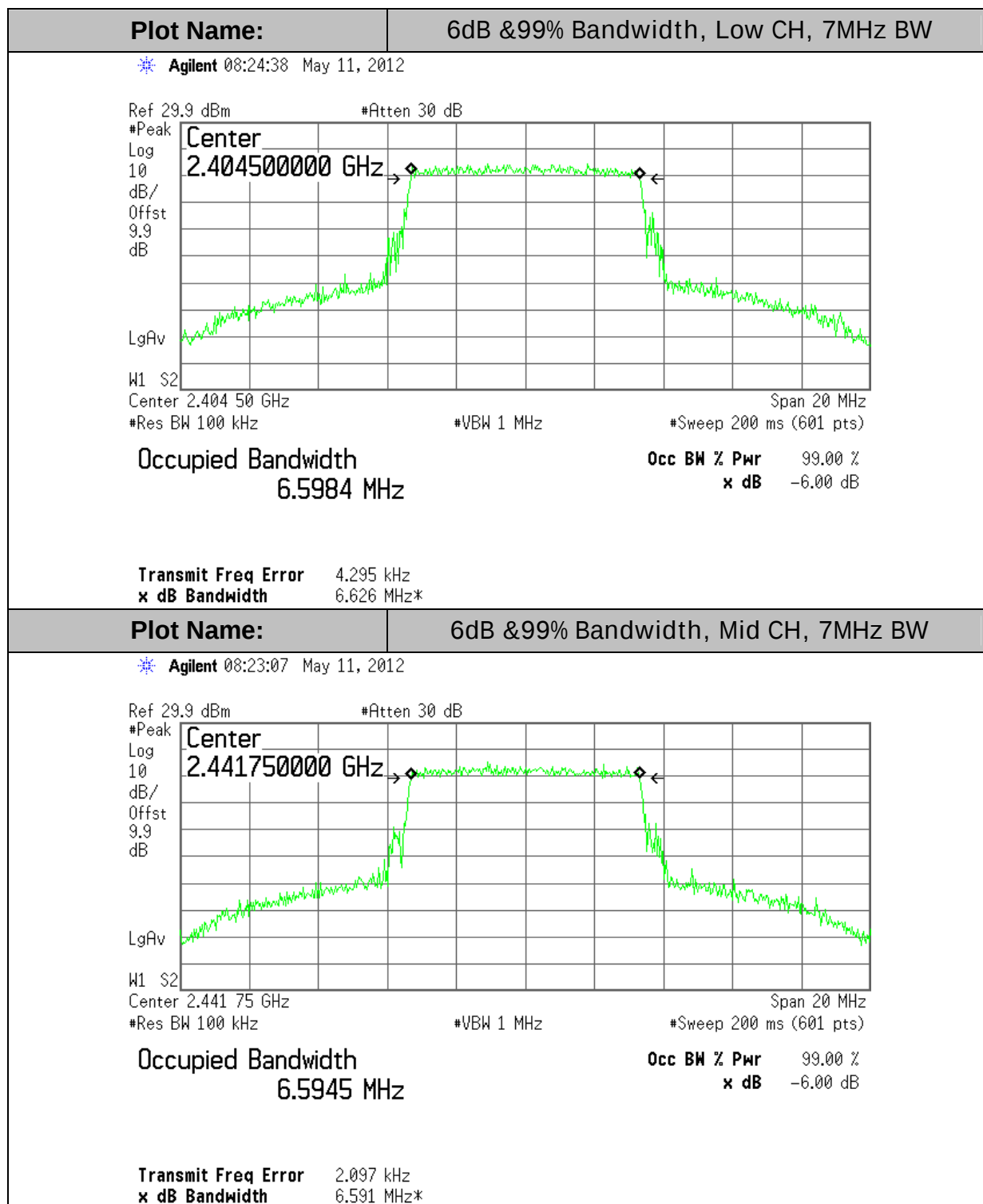


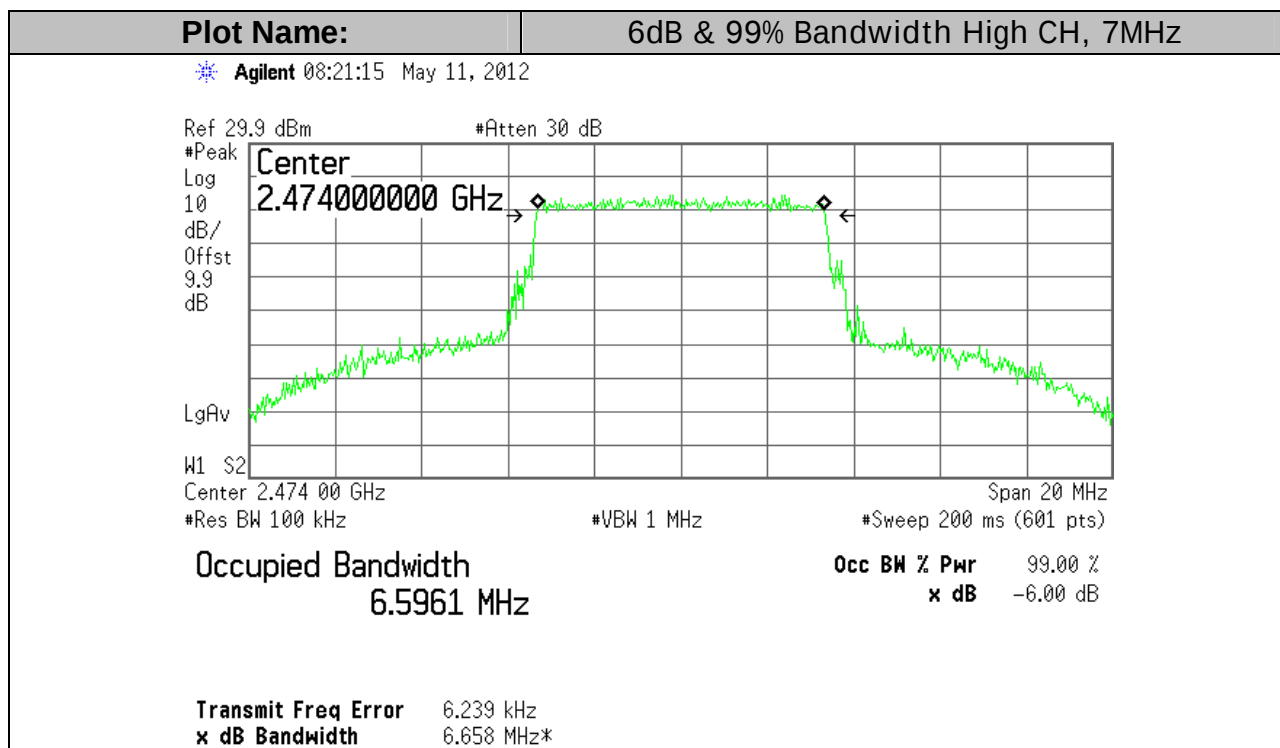
6dB & 99% BANDWIDTH for 6MHz BW Mode: 64QAM Modulation



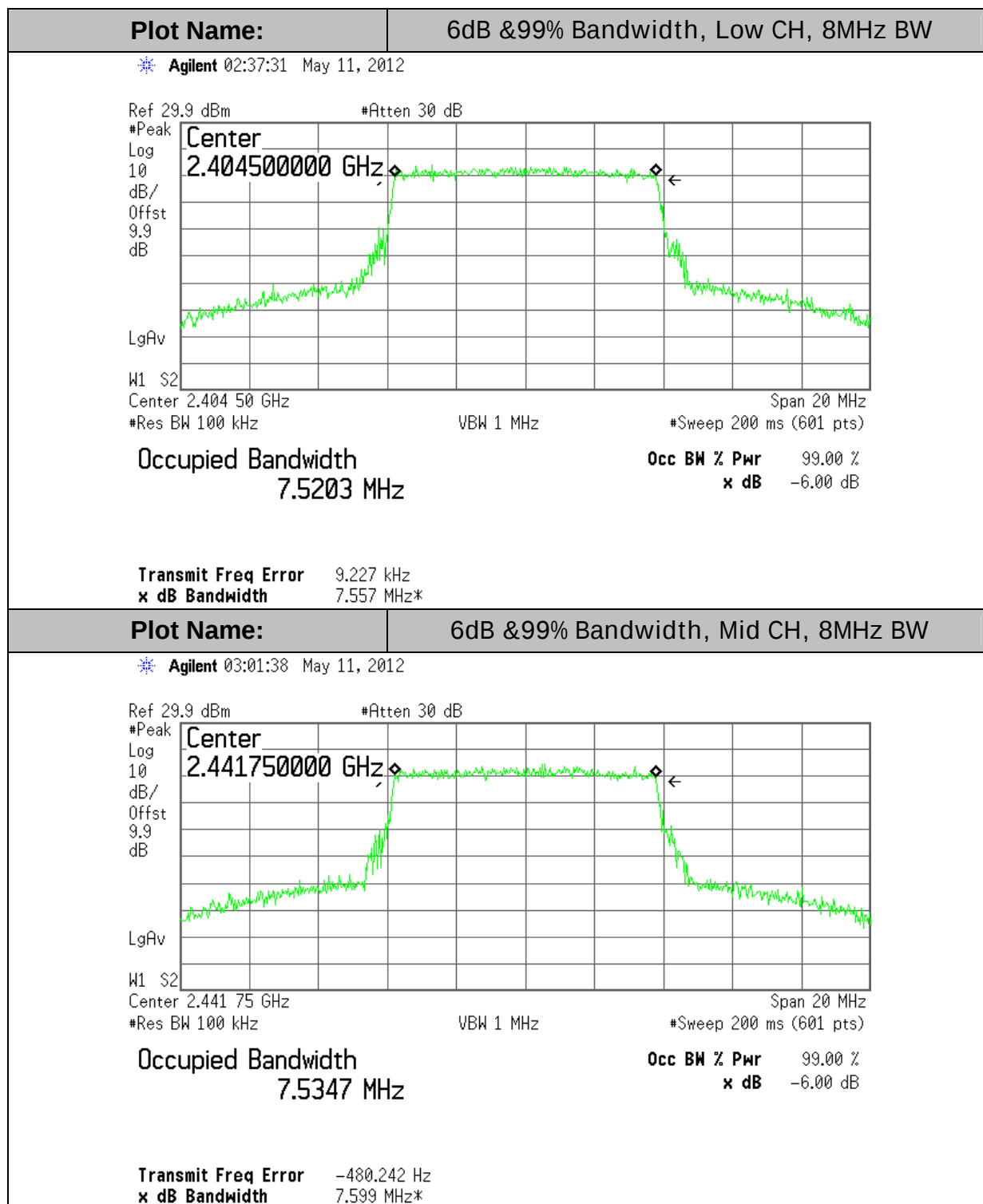


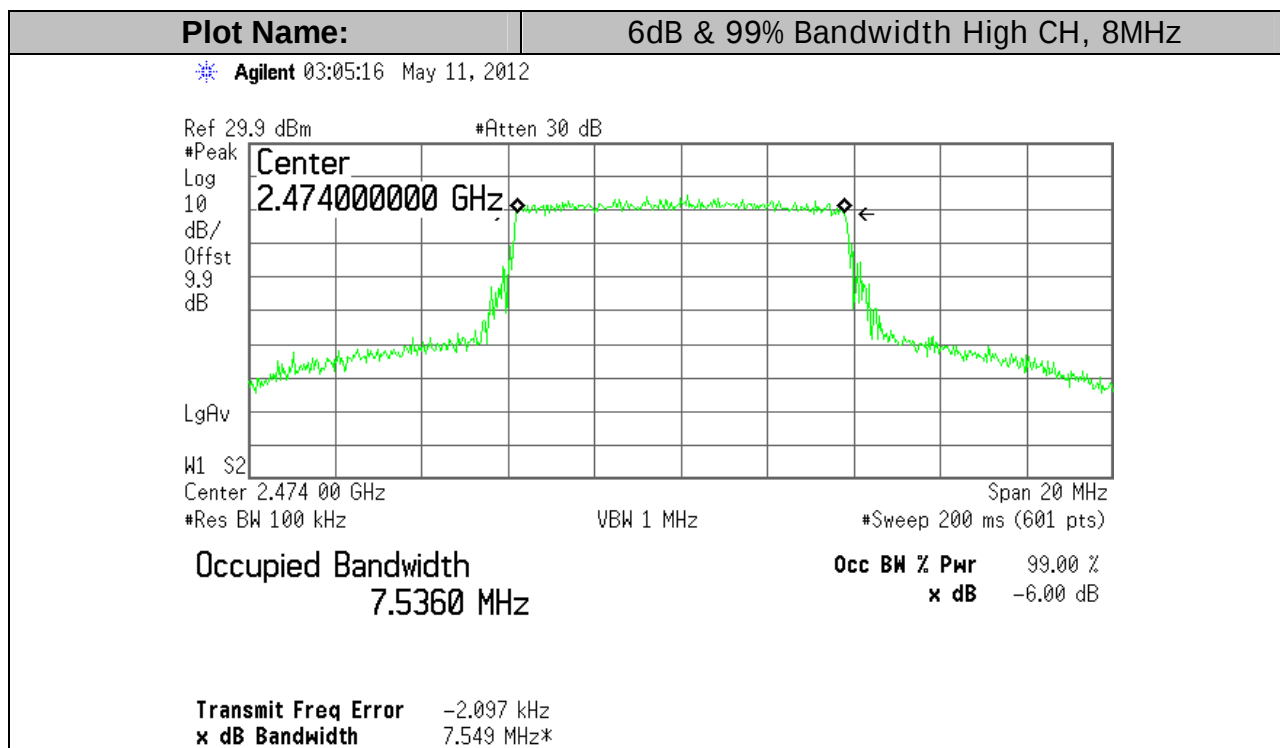
6dB & 99% BANDWIDTH for 7MHz BW Mode: 64QAM Modulation





6dB & 99% BANDWIDTH for 8MHz BW Mode: 64QAM Modulation





7.2. ~~PEAK OUTPUT POWER~~

PEAK POWER LIMIT

§15.247 (b)(3) & RSS-210 A8.4(4)

The maximum peak conducted output power of the intentional radiator shall not exceed the following:
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

b(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Therefore, the applicable output power limit shall be calculated as follows:

$P_{out} = 30 - (G_{tx} - 6)$ for antenna gain ≤ 6 dBi or

$P_{out} = 30 - \text{Floor}[(G_{tx} - 6)/3]$

G_{Tx} = the maximum transmitting antenna directional gain in dBi.

TEST PROCEDURE per FCC KDB 558074D02

Measurement Procedure for Fundamental Emission Output Power	Applicable to this EUT
8.1.1 Maximum Peak Conducted Output Power Level Measurement Procedure Option 1 (RBW $\geq$ DTS BW)	☐ preferred
8.1.2 Maximum Peak Conducted Output Power Level Measurement Procedure Option 2 (RBW < DTS BW)	☒
8.1.3 Maximum Peak Conducted Output Power Level Measurement Procedure Option 3 (Peak Power Meter Method)	☐
8.2.1 Maximum Conducted Output Power Level * Measurement Procedure Option 1 (RMS/Sample Detector with Band Power measurement)	☐
8.2.2 Maximum Conducted Output Power Level * Measurement Procedure Option 2 (RMS Power Averaging Detector with single slow sweep)	☐
8.2.3 Maximum Conducted Output Power Level * Measurement Procedure Option 2 (using a broadband RF average power meter)	☐
8.2.4 Maximum Conducted Output Power Level Measurement Procedure Alternative 1 (adding $10\log(1/DT)$, using SA or PM)	☐

* Alternative method. EUT shall be configured to transmit continuously (min. 98% duty cycle at full power). The spectrum analyzer shall be set for bin-to-bin spacing $\leq RBW/2$.

RESULTS

No non-compliance noted.

OUTPUT PEAK POWER

Summary of Peak Power Testing Data for **High Power Setting P=23dBm**.

QPSK Modulation

Channel BW (MHz)	Channel	Peak Power (dBm)	Limit (dBm)	Margin
6	L	25.64	30	-4.36
6	M	25.75	30	-4.25
6	H	25.74	30	-4.26
7	L	25.94	30	-4.06
7	M	25.47	30	-4.53
7	H	25.87	30	-4.13
8	L	25.85	30	-4.15
8	M	25.86	30	-4.14
8	H	25.77	30	-4.23

16QAM Modulation

Channel BW (MHz)	Channel	Peak Power (dBm)	Limit (dBm)	Margin
6	L	25.71	30	-4.29
6	M	25.66	30	-4.34
6	H	25.64	30	-4.36
7	L	25.70	30	-4.3
7	M	25.59	30	-4.41
7	H	25.97	30	-4.03
8	L	25.89	30	-4.11
8	M	25.68	30	-4.32
8	H	25.49	30	-4.51

64QAM Modulation

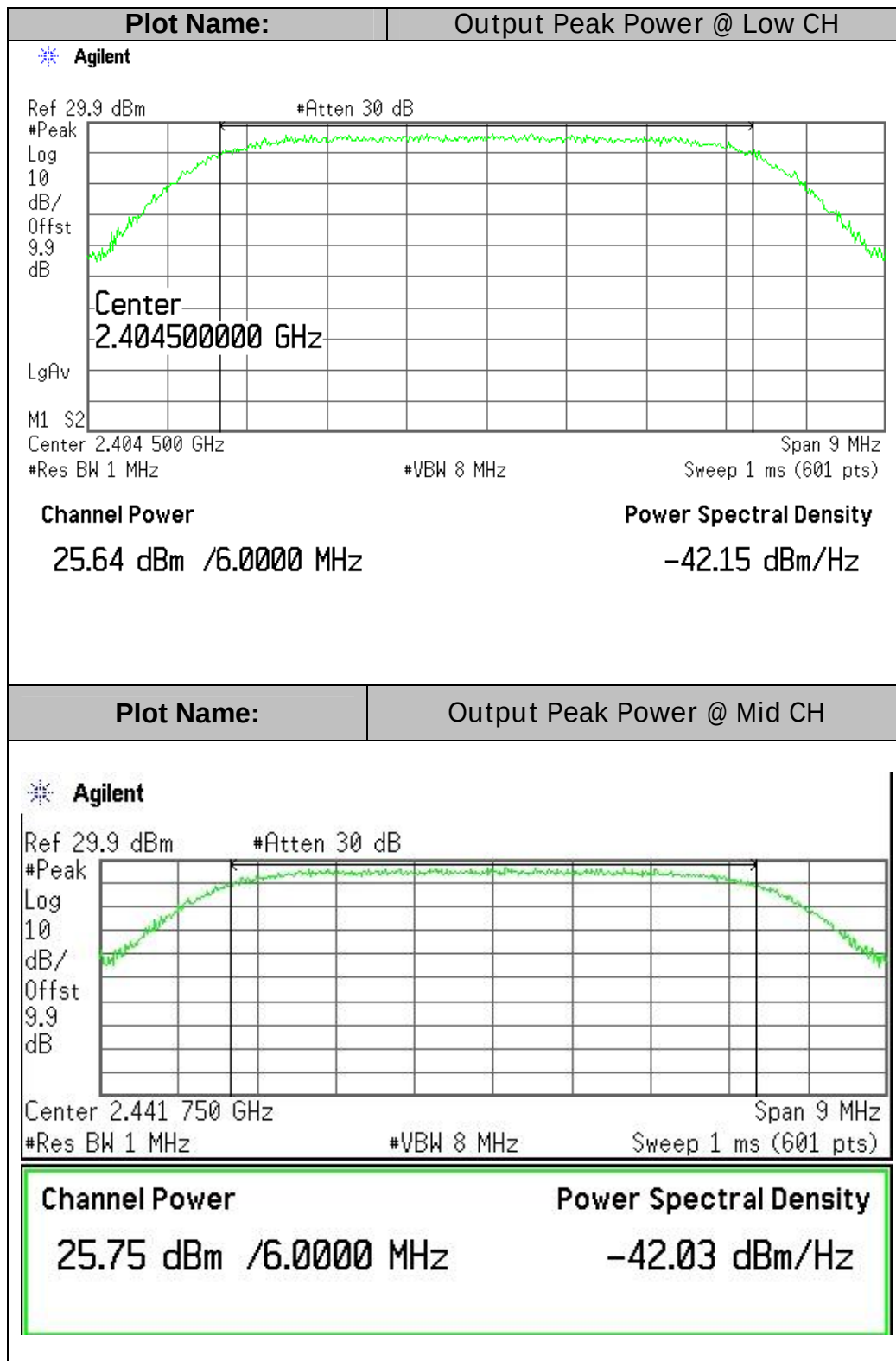
Channel BW (MHz)	Channel	Peak Power (dBm)	Limit (dBm)	Margin
6	L	25.76	30	-4.24
6	M	25.50	30	-4.5
6	H	25.78	30	-4.22
7	L	25.67	30	-4.33
7	M	25.57	30	-4.43
7	H	25.69	30	-4.31

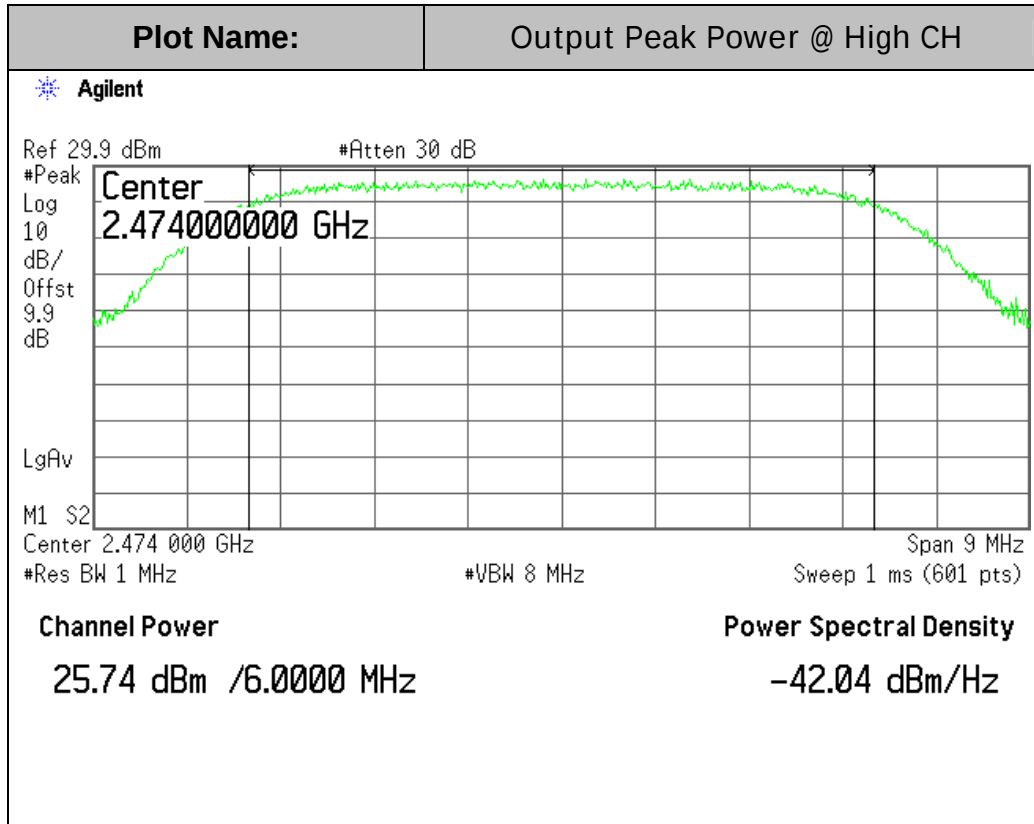
8	L	25.79	30	-4.21
8	M	25.67	30	-4.33
8	H	25.81	30	-4.19

Therefore, the max. measured peak power is +25.97dBm , which is under FCC allowed power limit.

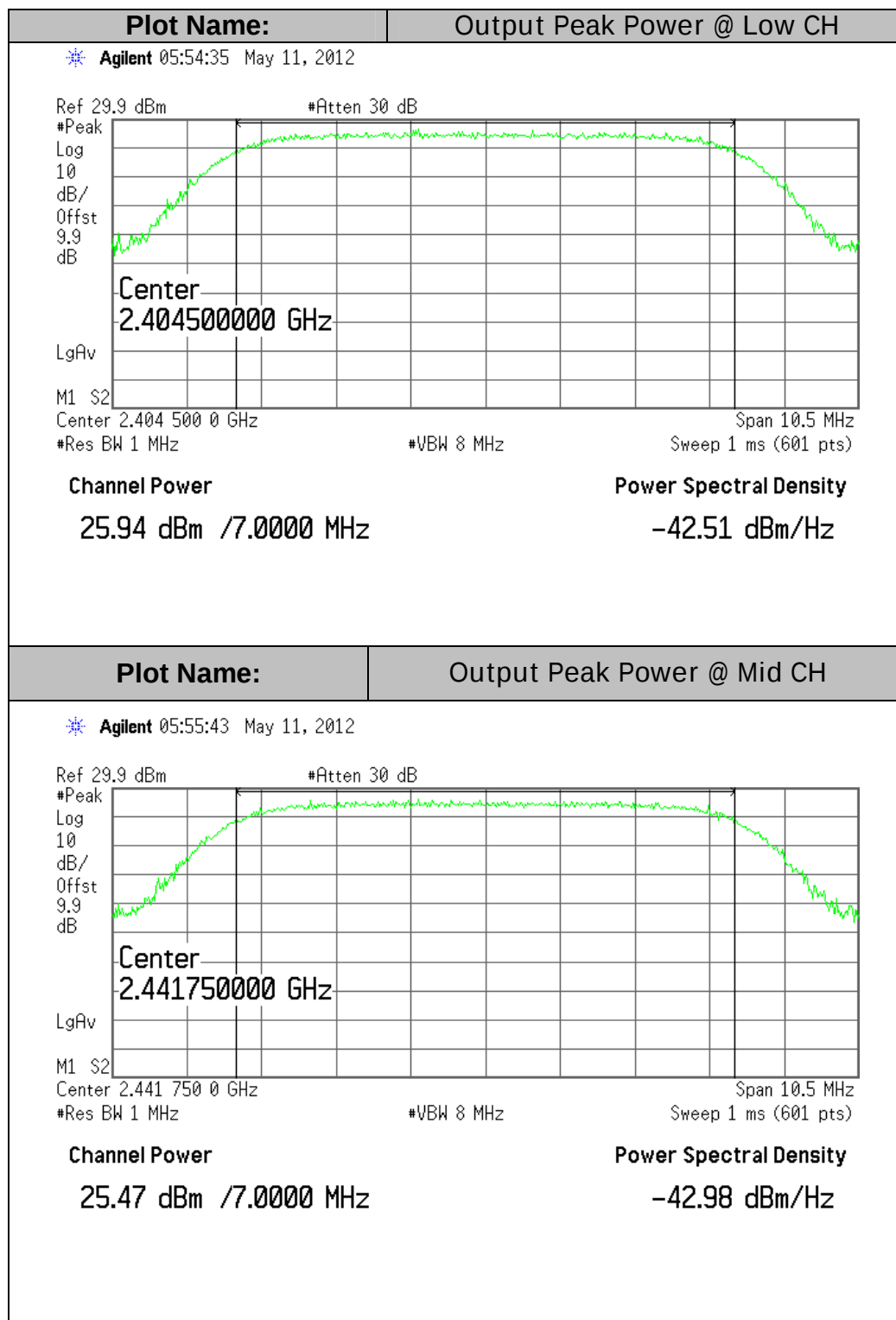
PLOTS for High Power Setting P=23dBm:

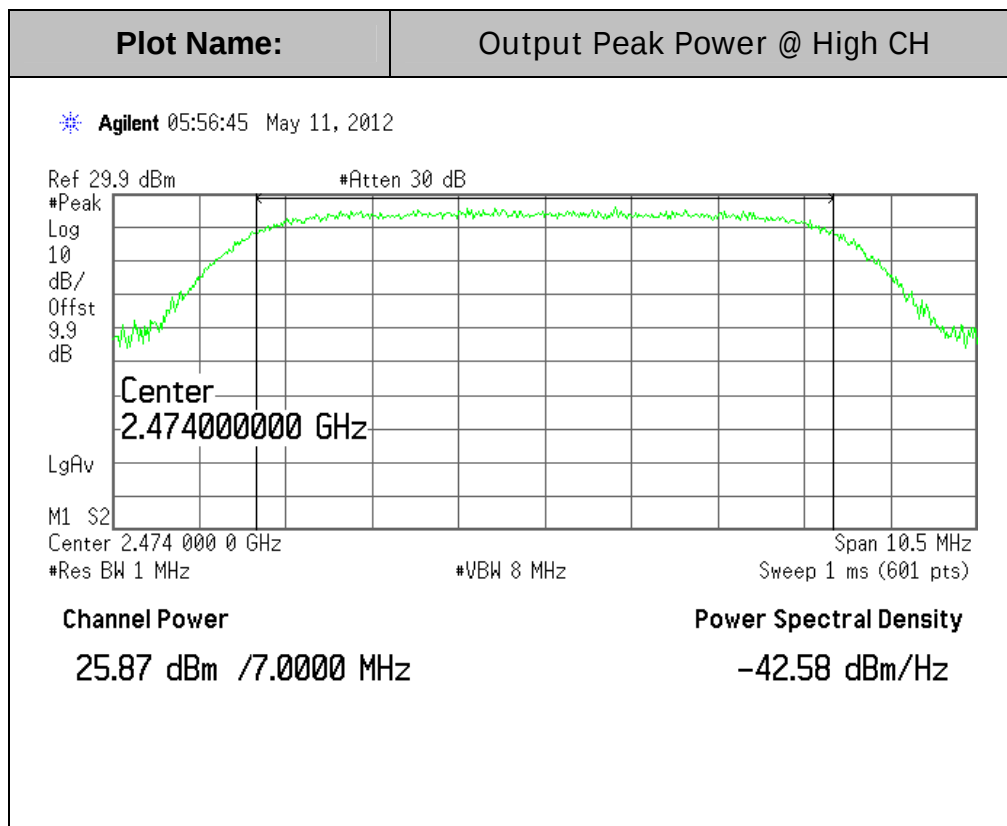
6MHz BW, QPSK Mode:



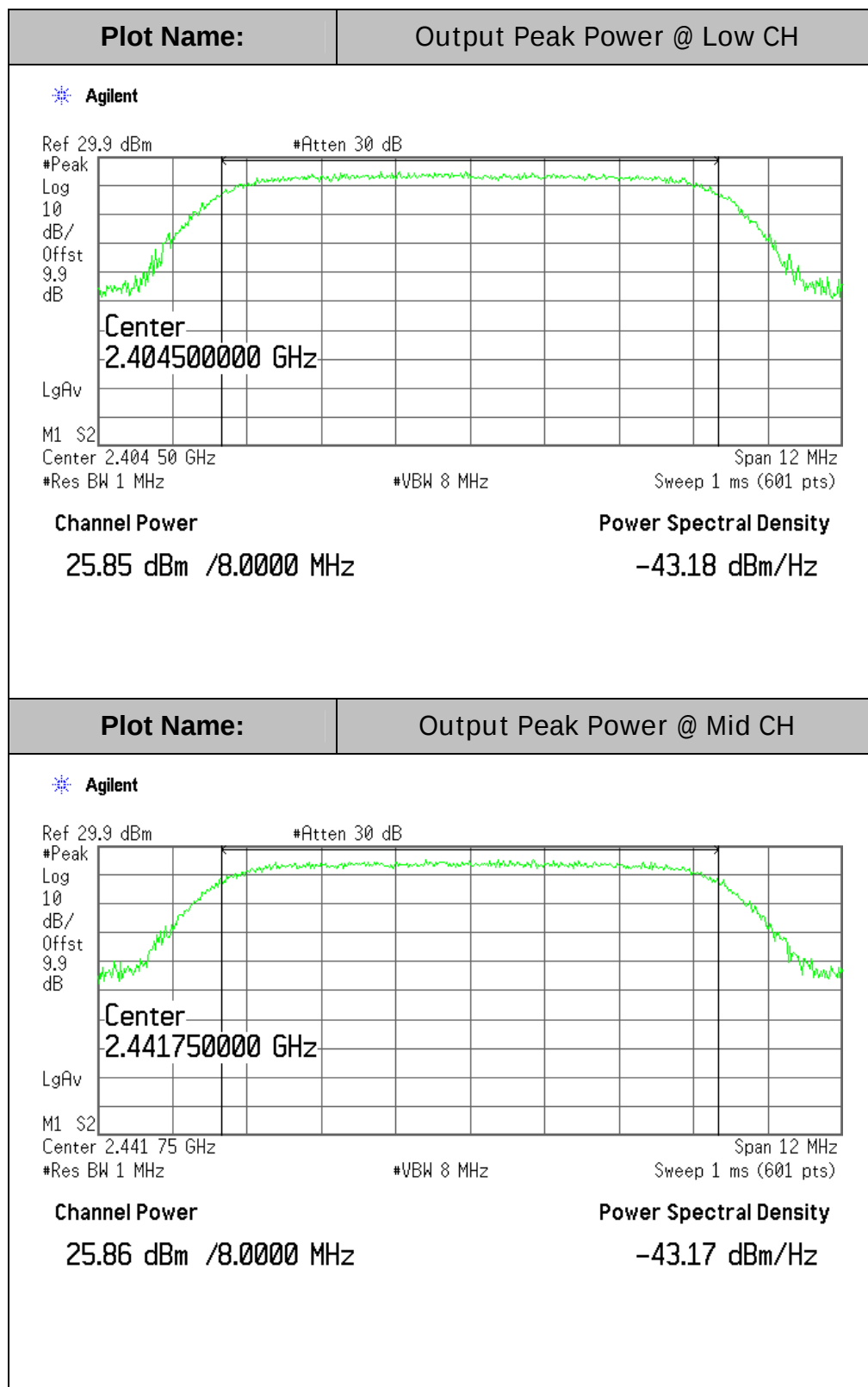


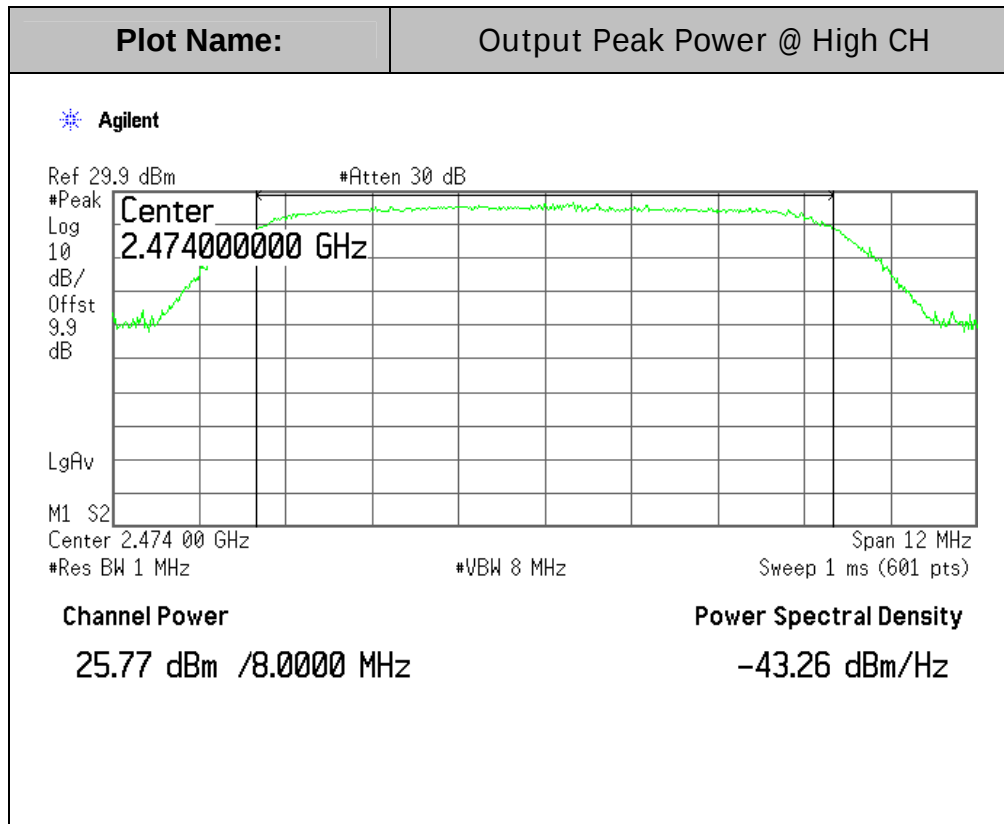
7MHz BW, QPSK Mode:



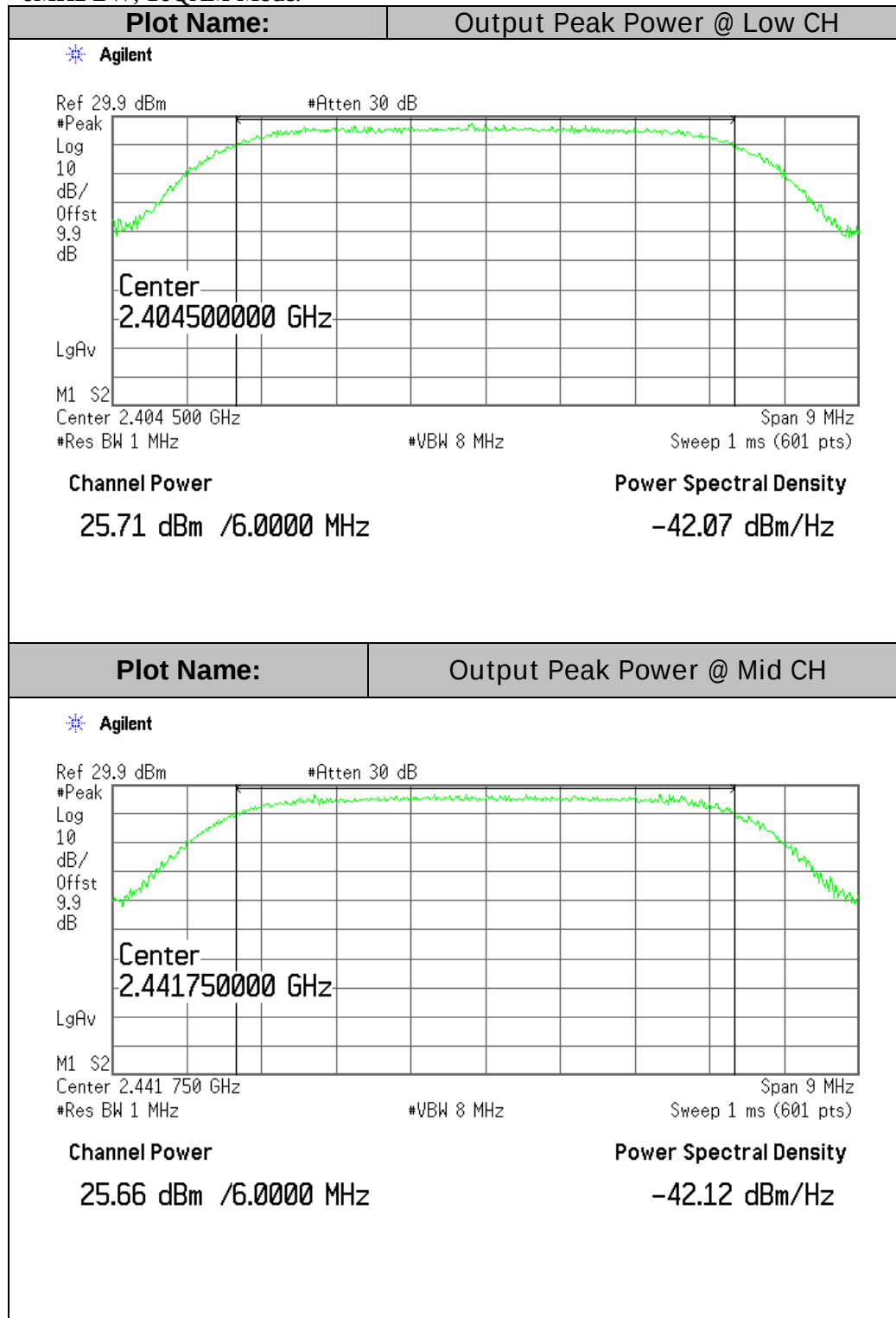


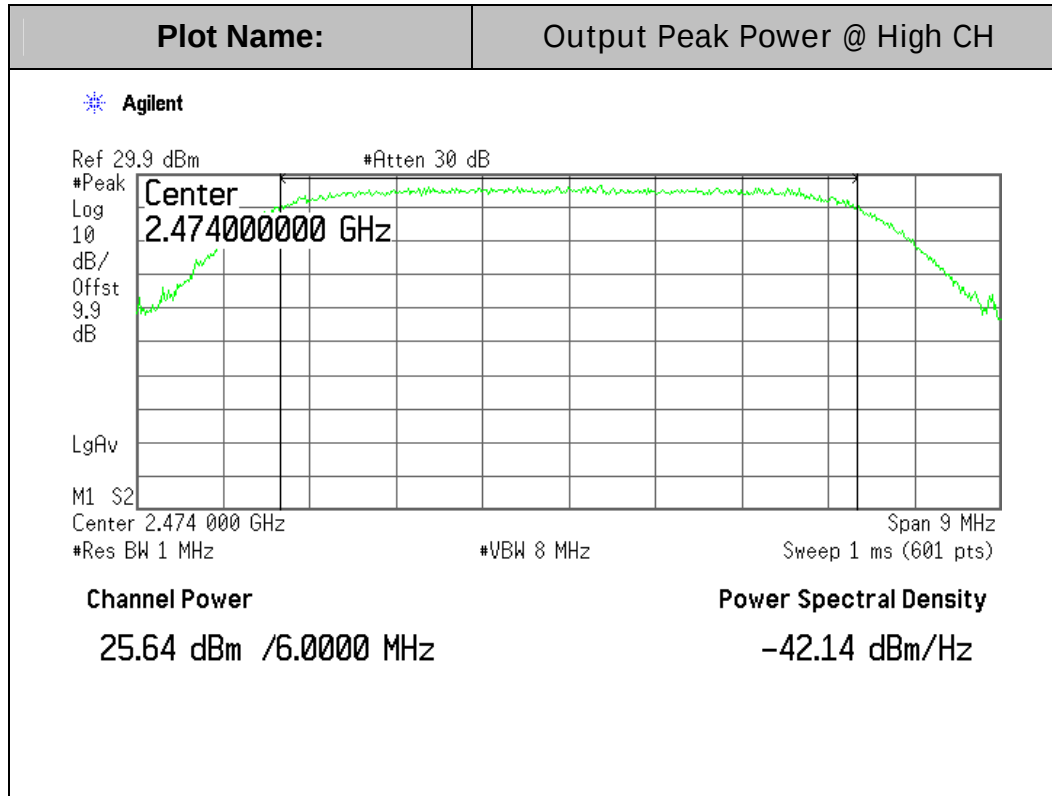
8 MHz BW, QPSK Mode:



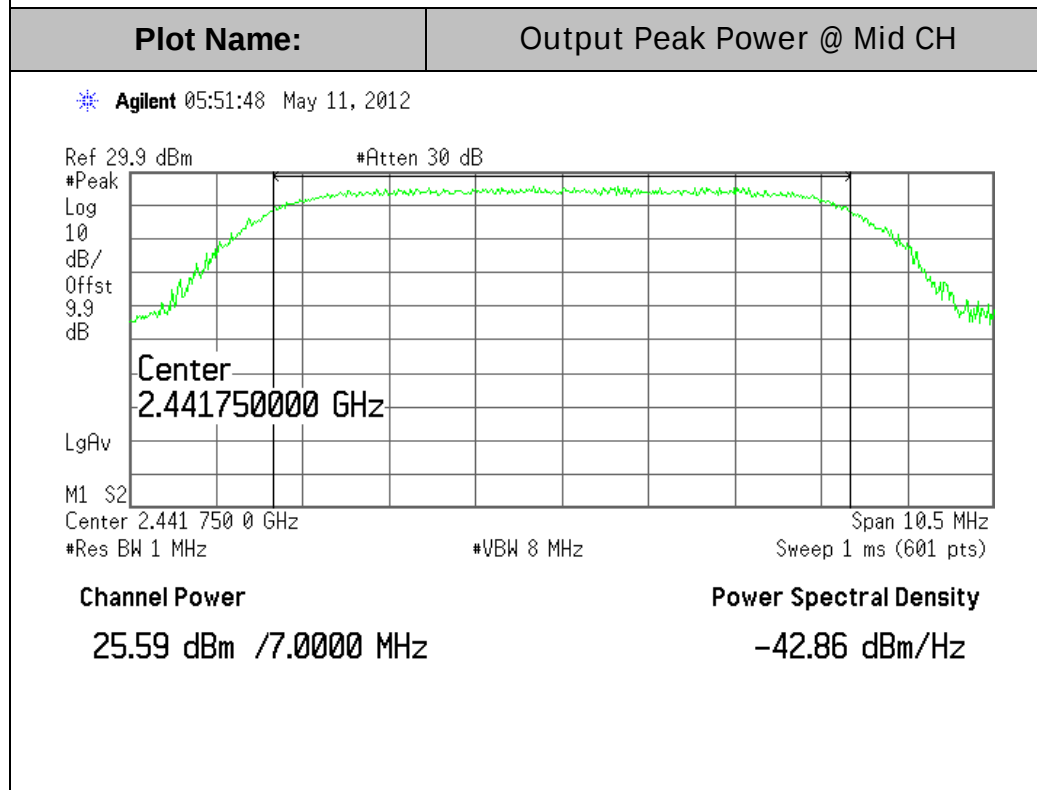
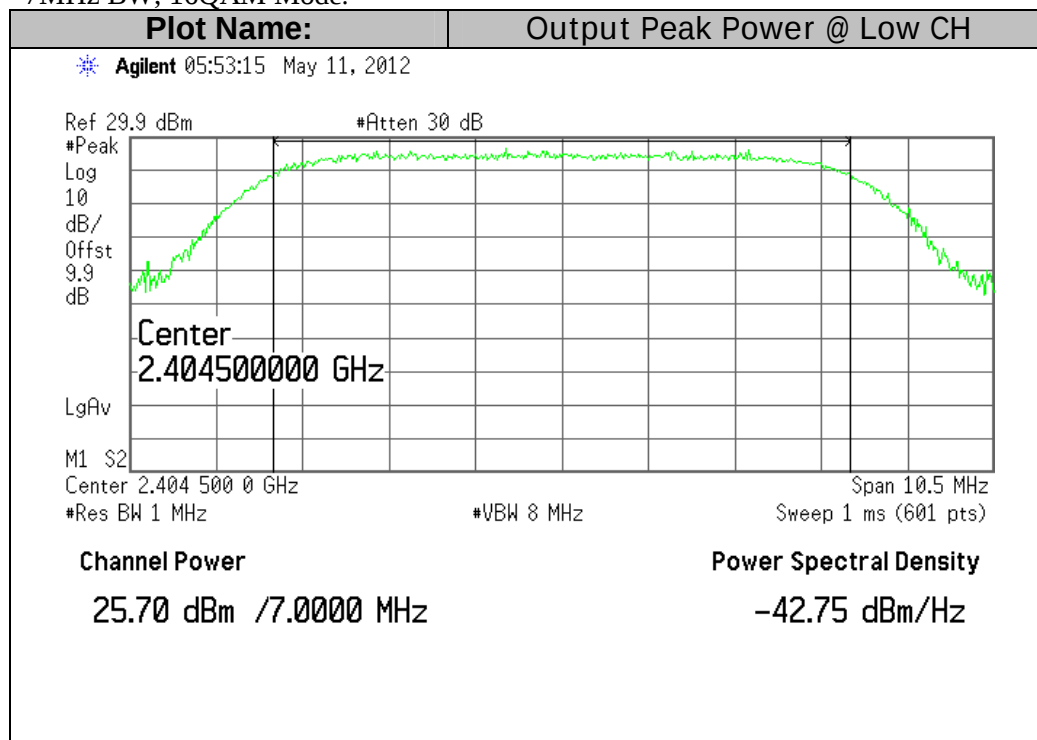


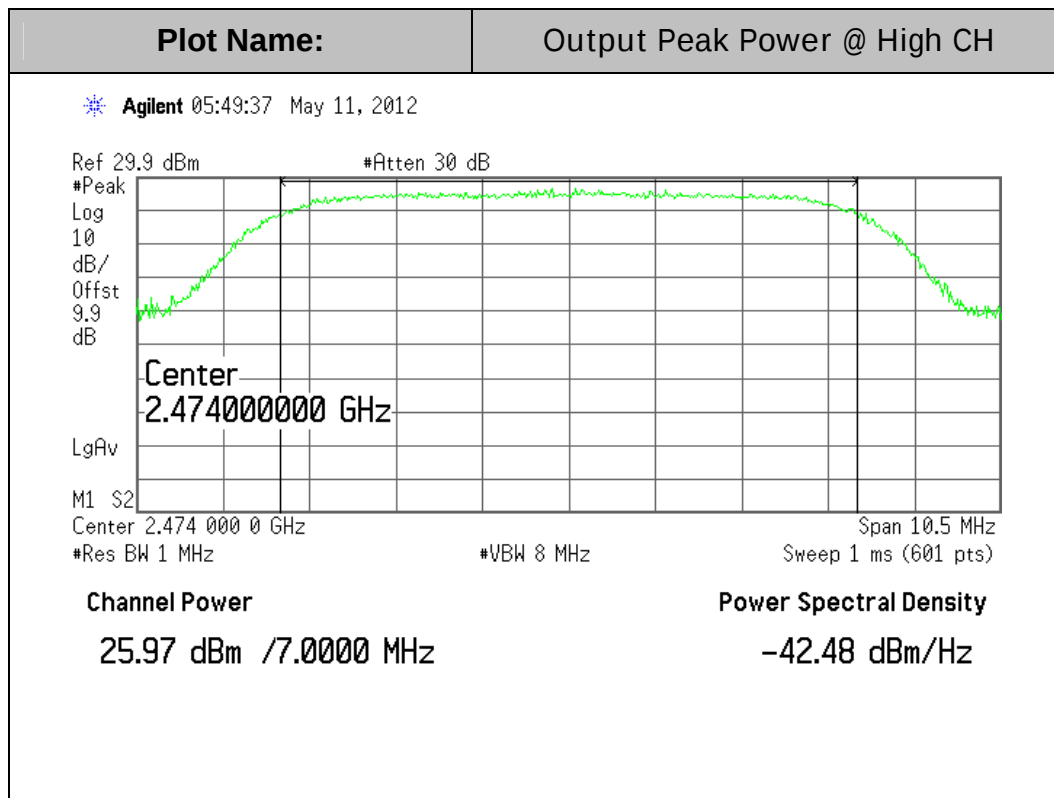
6MHz BW, 16QAM Mode:



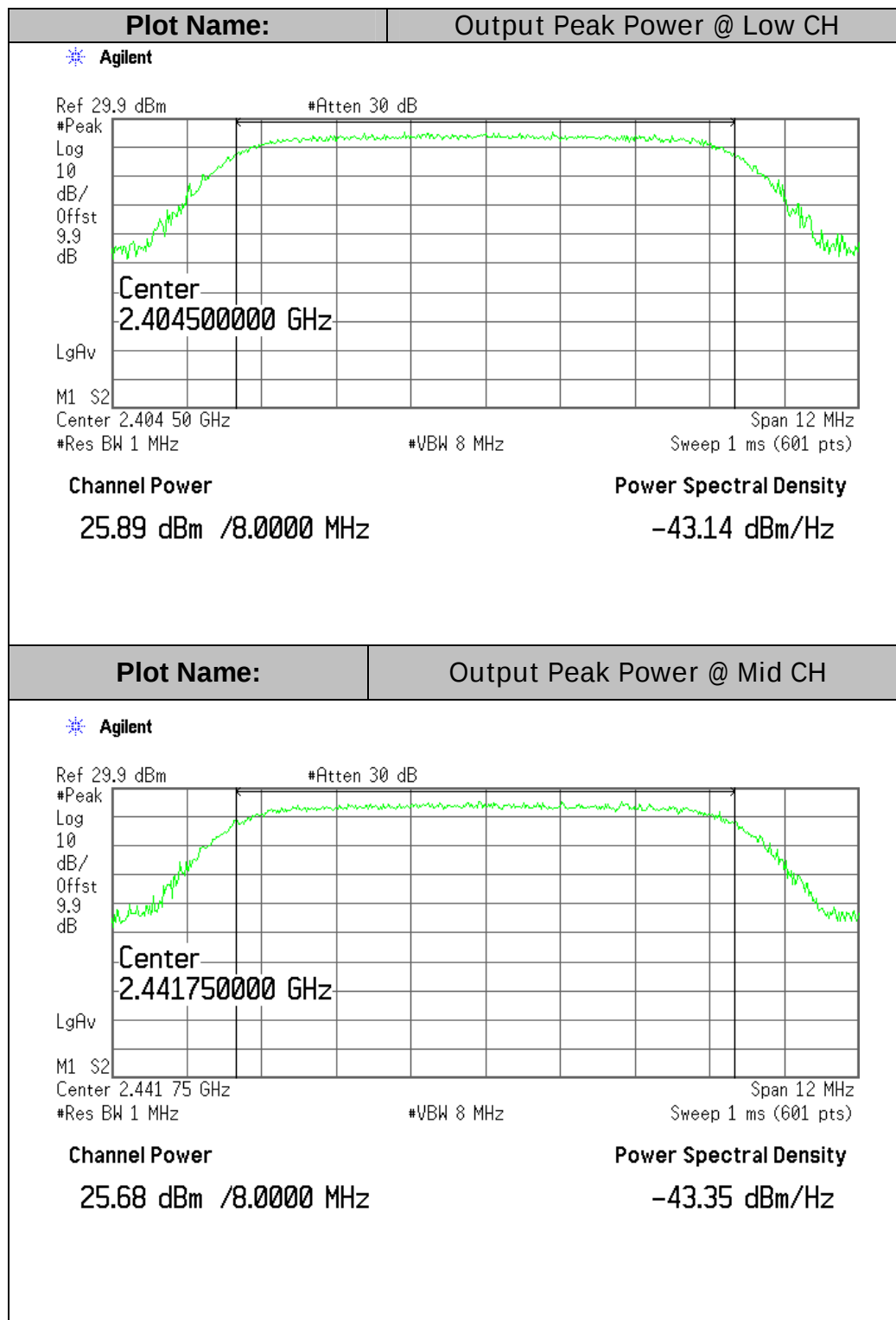


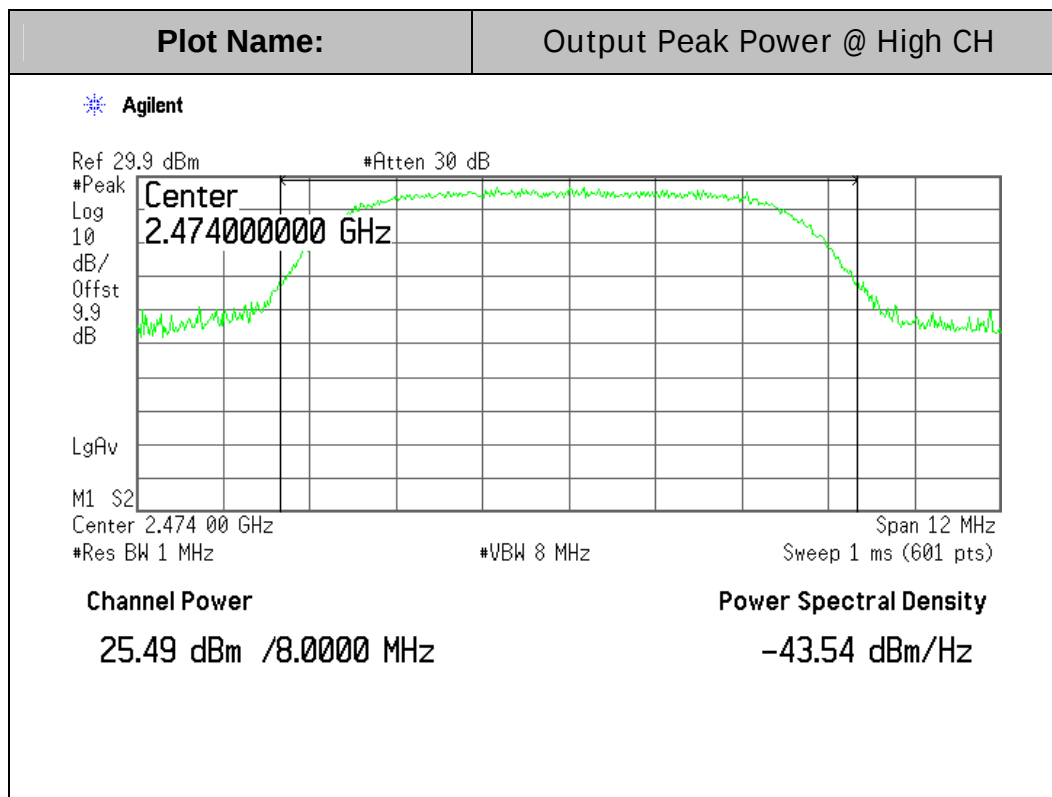
7MHz BW, 16QAM Mode:



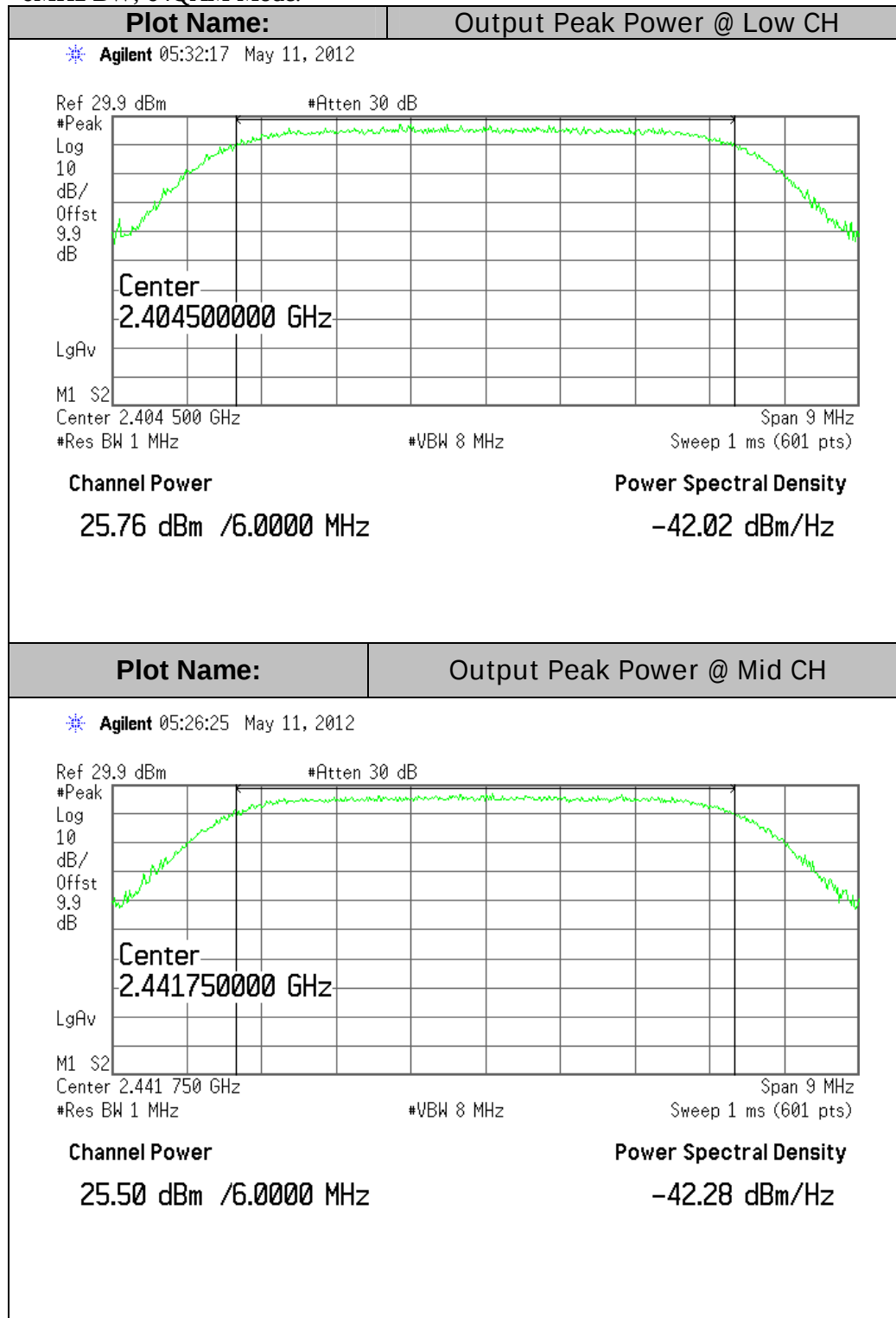


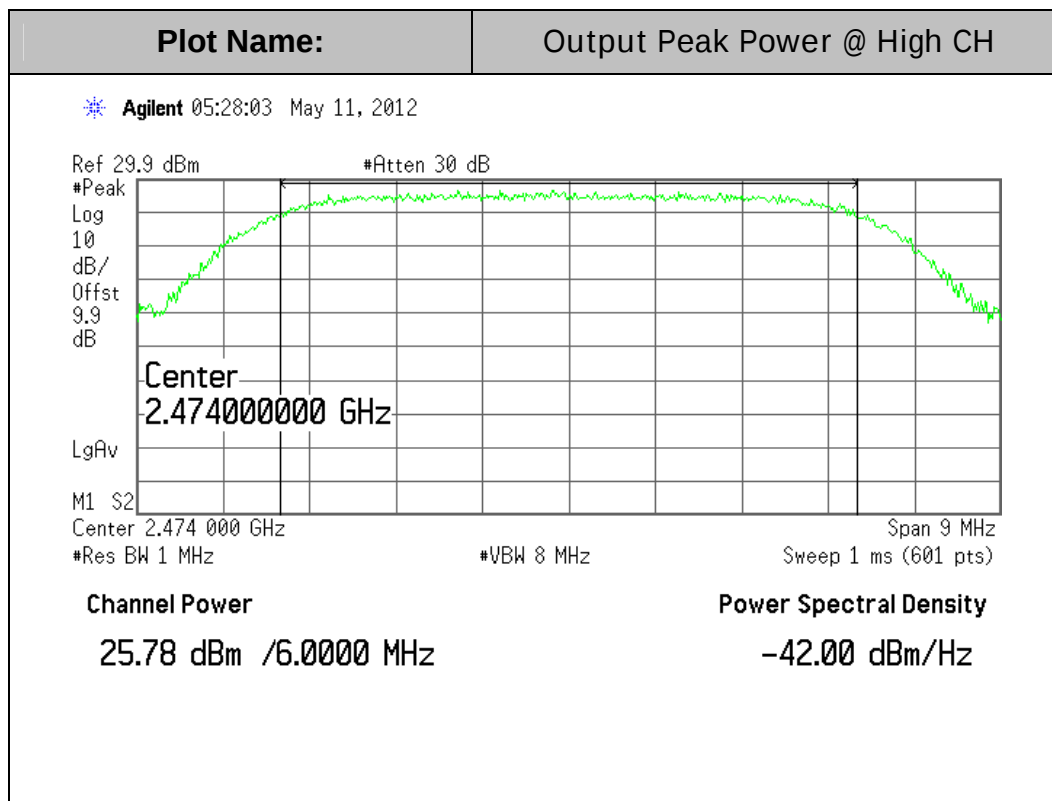
8MHz BW, 16QAM Mode:



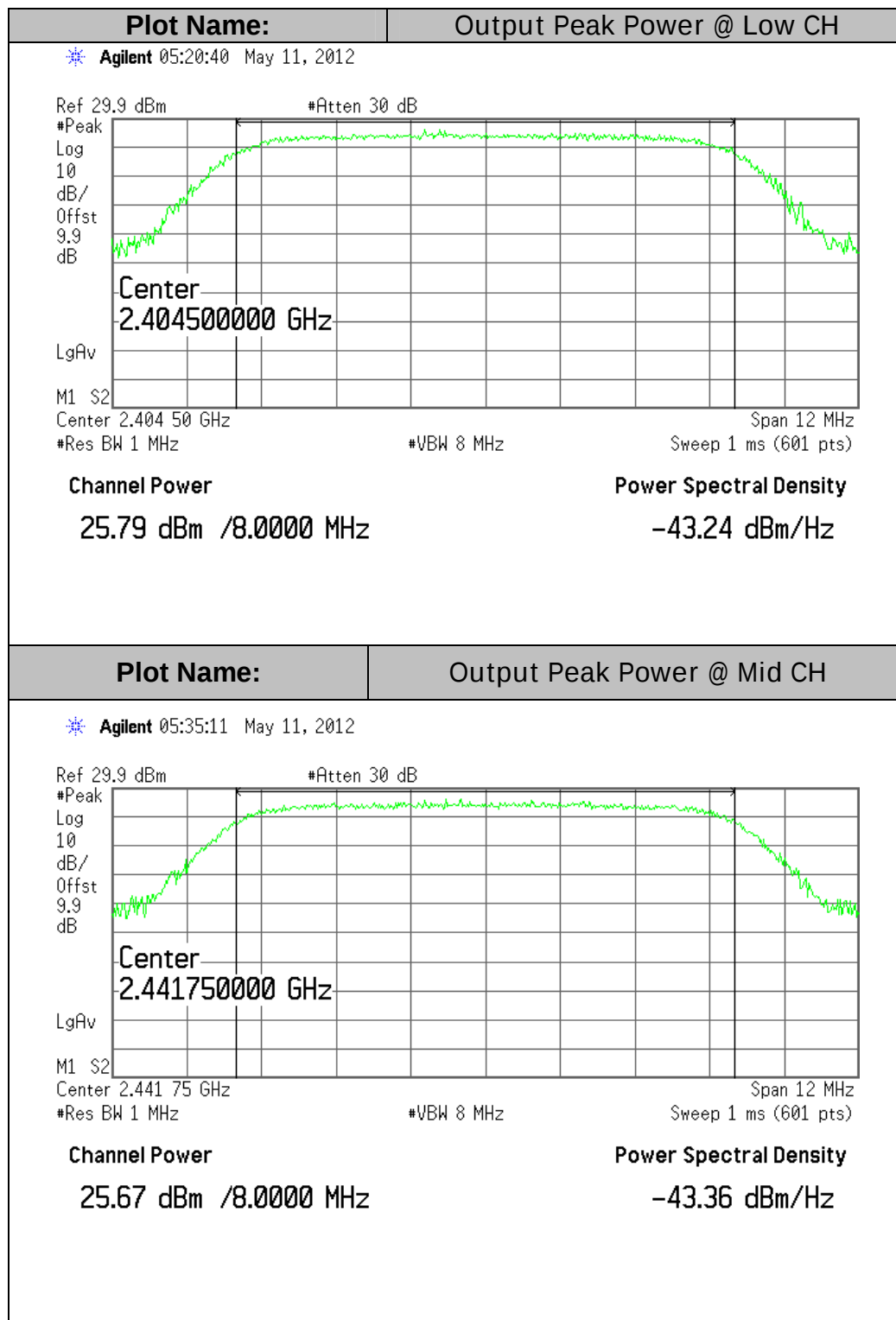


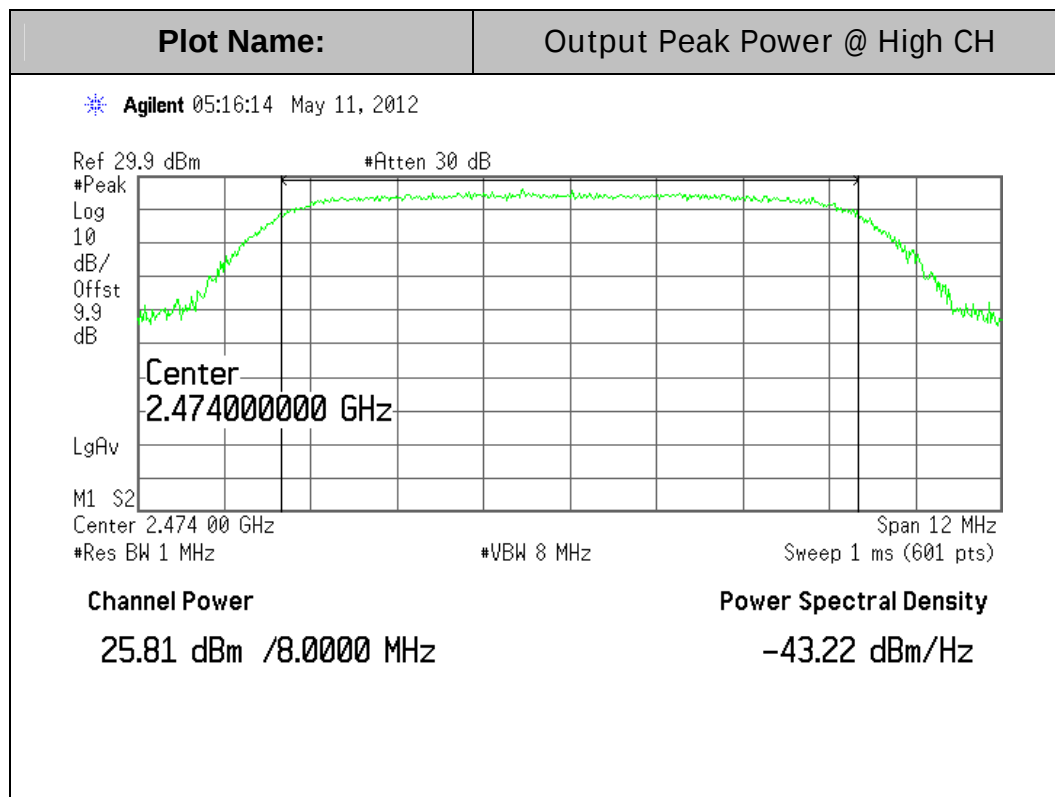
6MHz BW, 64QAM Mode:





8MHz BW, 64QAM Mode:





7.3. MAXIMUM PERMISSIBLE EXPOSURE

LIMITS & RSS-102

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) 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

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

CALCULATIONS

Given

$$E = \sqrt{(30 * P * G) / d}$$

and

$$S = E^2 / 3770$$

where

E = Field Strength in Volts/meter

P = Power in Watts

G = Numeric antenna gain

d = Distance in meters

S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$$d = \sqrt{((30 * P * G) / (3770 * S))}$$

Changing to units of Power to mW and Distance to cm, using: P

$$(mW) = P (W) / 1000 \text{ and}$$

$$d (cm) = 100 * d (m)$$

yields

$$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$$

$$d = 0.282 * \sqrt{(P * G / S)}$$

where

d = distance in cm

P = Power in mW

G = Numeric antenna gain

S = Power Density in mW/cm²

Substituting the logarithmic form of power and gain using: P

$$(mW) = 10^{(P (dBm) / 10)} \text{ and}$$

$$G (\text{numeric}) = 10^{(G (dBi) / 10)}$$

yields

$$d = 0.282 * 10^{((P + G) / 20)} / \sqrt{S} \quad \text{Equation (1)}$$

$$S = 0.0795 * 10^{((P + G) / 10)} / d^2 \quad \text{Equation (2)}$$

where

d = MPE distance in cm

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW/cm²

Equation (1) and the measured peak power is used to calculate the MPE distance.
Equation (2) and the measured peak power is used to calculate the Power density.

LIMITS

From §1.1310 Table 1 (B),
for Public S = 1.0 mW/cm²
for Professional, S = 5.0 mW/cm²

RESULTS

No non-compliance noted:

For this EUT, Max. P (peak)= 25.97 dBm, Max G= 5.0 dBi, and d=20cm

Plug all three items into equation (2), and yields,

Power Density Limit (mW/cm²)	Output Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm²)
1.0/5.0	25.97	5.0	0.315

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

7.4. AVERAGE POWER

AVERAGE POWER LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

No non-compliance noted:

OUTPUT AVERAGE POWER

Summary of Peak Power Testing Data for **High Power Setting P=23dBm**.

QPSK Modulation

Preset	Channel BW (MHz)	Channel	Average Power (dBm)
	6	L	23.52
	6	M	23.49
	6	H	23.53
	7	L	23.54
	7	M	23.52
	7	H	23.49
	8	L	23.52
	8	M	23.48
	8	H	23.50

16QAM Modulation

QPSK Modulation Preset	Channel BW (MHz)	Channel	Average Power (dBm)
	6	L	23.52
	6	M	23.53
	6	H	23.55
	7	L	23.48
	7	M	23.52
	7	H	23.51
	8	L	23.53
	8	M	23.48
	8	H	23.50

64QAM Modulation

Preset	Channel BW (MHz)	Channel	Average Power (dBm)
	6	L	23.49
	6	M	23.51
	6	H	23.53
	7	L	23.50
	7	M	23.52
	7	H	23.50
	8	L	23.49
	8	M	23.51
	8	H	23.52

7.5. PEAK POWER SPECTRAL DENSITY

LIMIT

§15.247 (e) & RSS-210 A8.2(2)

For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

TEST PROCEDURE *per FCC KDB 558074D02*

Measurement Procedure for Maximum Power Spectral Density in the Fundamental Emission*	Applicable to this EUT
9.1 Measurement Procedure Option 1 for Peak PSD	☒ preferred
9.2 Measurement Procedure Option 2 for Average PSD**	☐
9.3 Measurement Procedure Option 3 for Average PSD** (RMS Power Averaging Detector with single slow sweep)	☐
9.4 Measurement Procedure Alternative 1 for Average PSD (Adding $10\log(1/DT)$)	☐

* same method as used to determine fundamental power.

** EUT shall be configured to transmit continuously (min. 98% duty cycle at full power) or use video triggering/signal gating. The spectrum analyzer shall be set for bin-to-bin spacing $\leq RBW/2$.

RESULTS

No non-compliance noted:

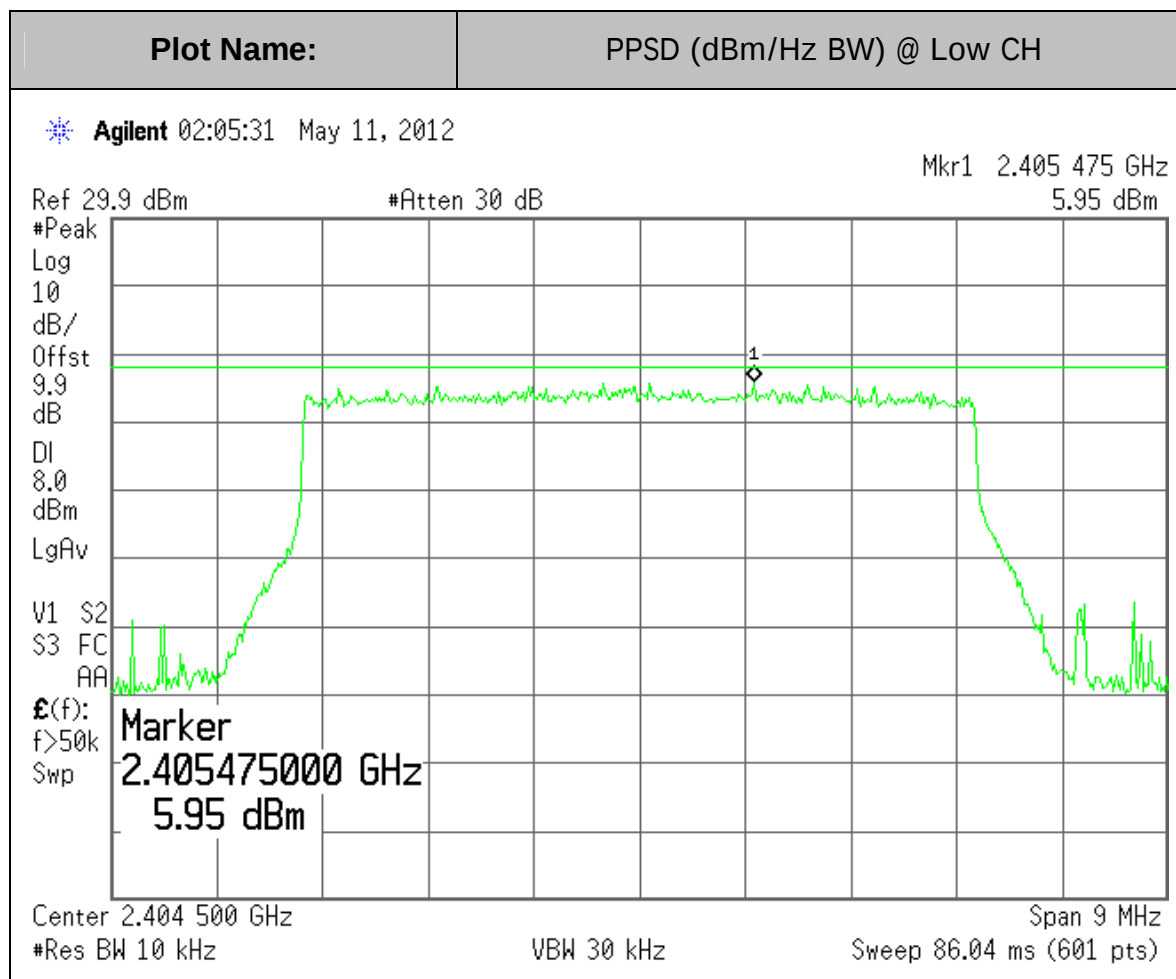
Summary of PPSD Testing Data:

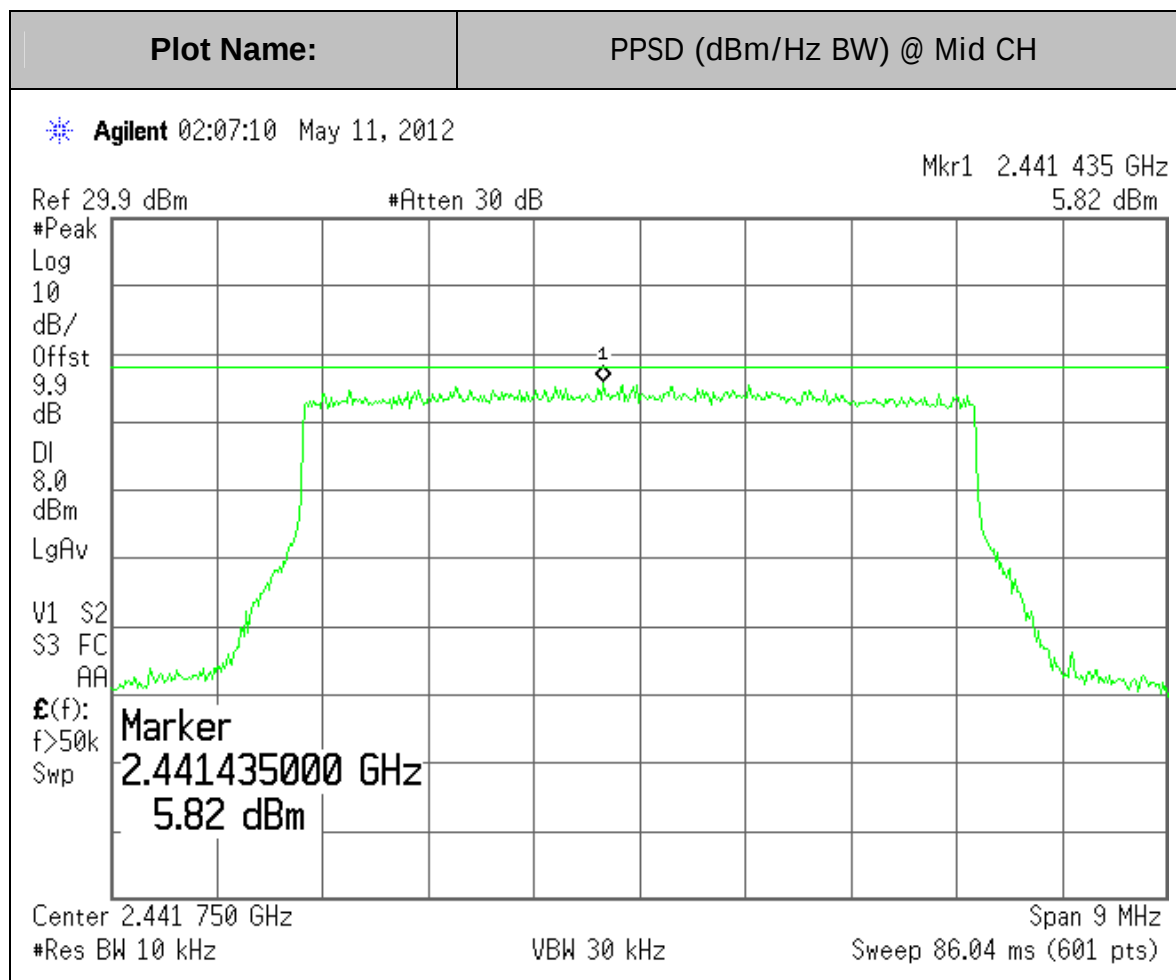
Worst case based on pretest result: 6MHz BW & QPSK Modulation with High Power P=23dBm Setting

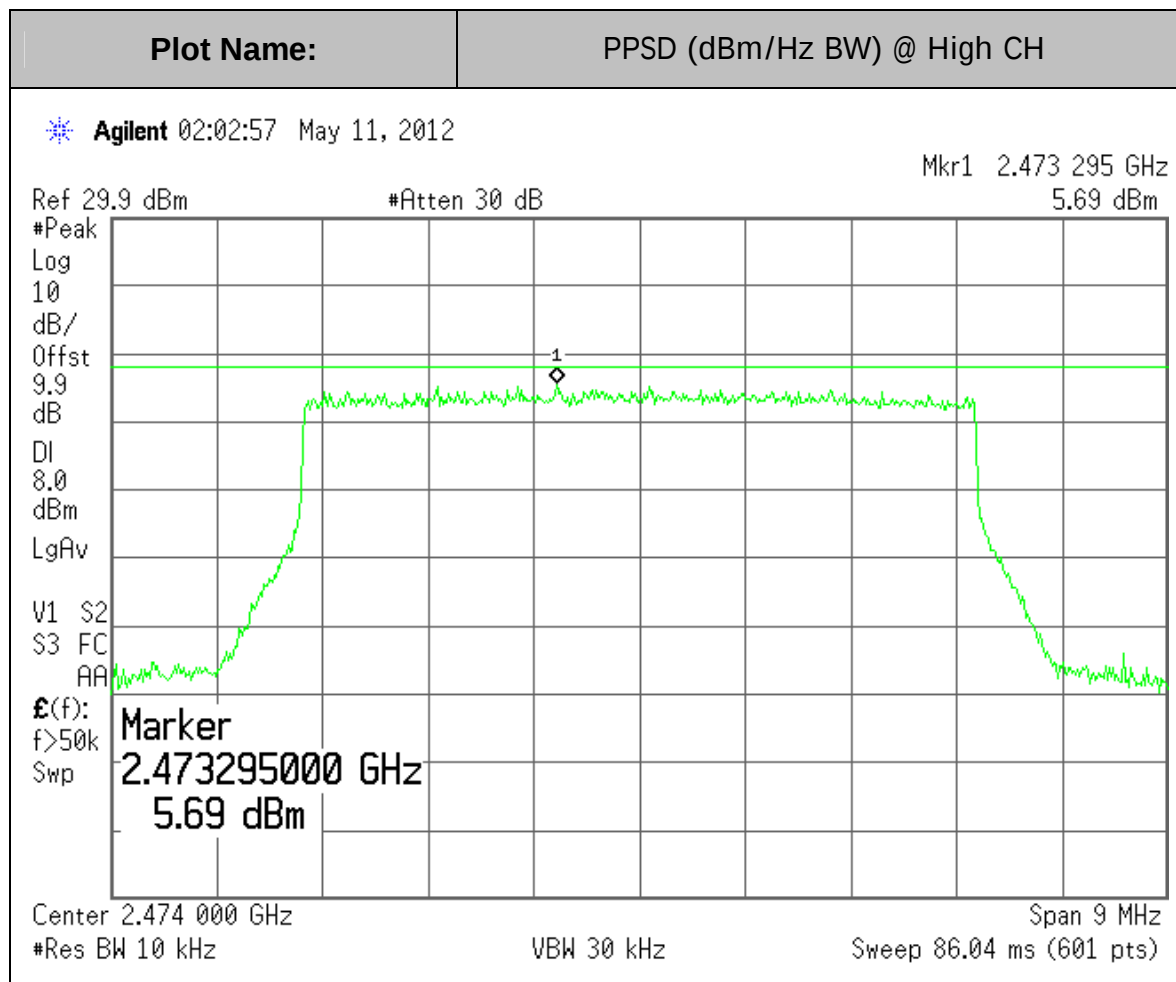
Channel	CH BW (MHz)	PPSD (dBm/10KHz BW)	Limit (dBm/3KHz BW)
Low	6	5.95	8
Middle	6	5.82	8
High	6	5.69	8

PEAK POWER SPECTRAL DENSITY

6MHz BW, QPSK Mode:







7.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

§15.247 (d) & RSS- 210 A8.5

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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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) (see §15.205(c)).

TEST PROCEDURE *per FCC KDB 558074D02*

(Report the three highest emissions relative to the limit)

Conducted Measurement Procedure for Maximum Unwanted Emissions into Non-Restricted Frequency Bands	Applicable to this EUT	
	Peak Power limit: (-20dB)	Average Power Limit: (-30dB)
10.1.1 Measurement Procedure-Reference Level (using Sec.9.1 peak PSD procedure with RBW=100KHz, VBW=300KHz)	☒	
10.1.2 Measurement Procedure-Unwanted Emissions*	☒ preferred	☐

* Different attenuation limit shall be used based on the measurement method of fundamental emission power and PSD.

Antenna-Port Conducted Measurement Procedure for Maximum Unwanted Emissions into Restricted Frequency Bands**	Applicable to this EUT
10.2.3.1 CISPR Quasi-Peak Measurement (CISPR 16)	☐
10.2.3.2 Peak Power Measurement (Sec.8.1.1 procedure with RBW=1MHz)	☐
10.2.3.3 Average Power Measurement (Sec.8.2 procedure with RBW=1MHz)	☐
10.2.4 Antenna-Port Conducted Measurement Procedure	☐
10.2.5.1 Band-Edge Marker-Delta Method (KDB913591)	☐
10.2.5.2 Band-Edge Integrated Power Measurement	☐

** To use this conducted testing method, the followings shall be taken as consideration:

1. Proper RBW and detector, per 15.35 a/b, shall be chosen in different frequency ranges;
2. **Maximum transmitter antenna gain (no less than 2dBi), G, shall be added to the measured power level to determine the EIRP;**
3. **Appropriate factor, A, shall be added to model worst case ground reflections: 6.0dB (f≤30MHz) and 4.7dB (f≤30 to 1000MHz)**
4. **Electric field strength can be obtained from the equation: E= EIRP-20log(d)+104.8+G (or 2.0) +A; Then compare to applicable limit;**
5. Unwanted emissions from EUT cabinet or casing shall be measured via radiated emission test method per C63.10 (in this case, the antenna port may be terminated properly).
6. Absolute peak power limit of -21.2dBm within the unwanted emission bandwidth shall be used for meeting 15.35(b) requirement;
7. Per 15.35(c), for pulse operation, Duty Cycle factor reduction can be applied for unwanted emissions that have the same pulse characteristics as does the fundamental emissions (such as harmonics) pulse operation

*** EUT shall be configured to transmit continuously (min. 98% duty cycle at full power). The spectrum analyzer shall be set for bin-to-bin spacing $\leq \text{RBW}/2$.

RESULTS

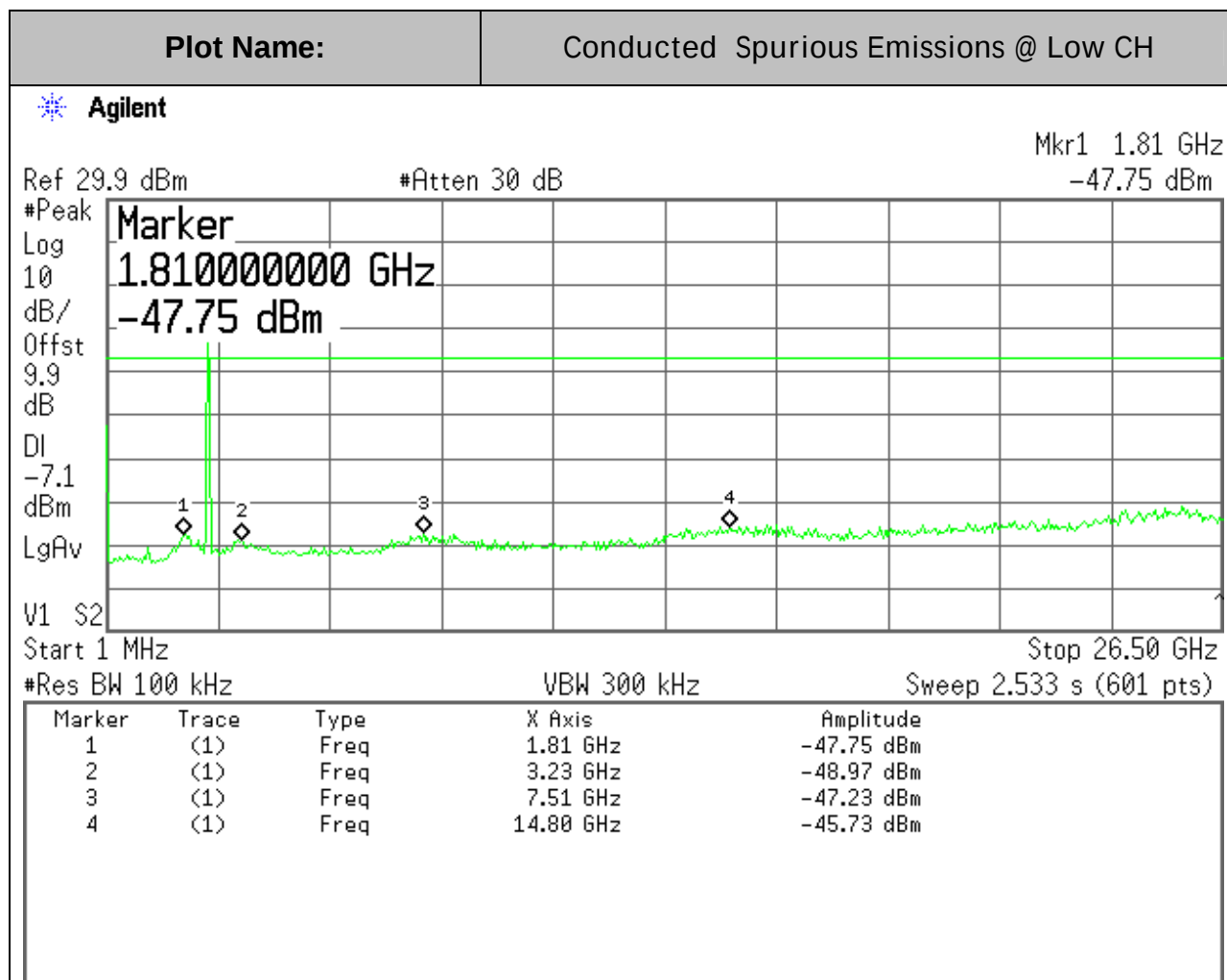
No non-compliance noted.

* Only the worse cases for 6MHz and 8MHz signal BW were recorded as final data.

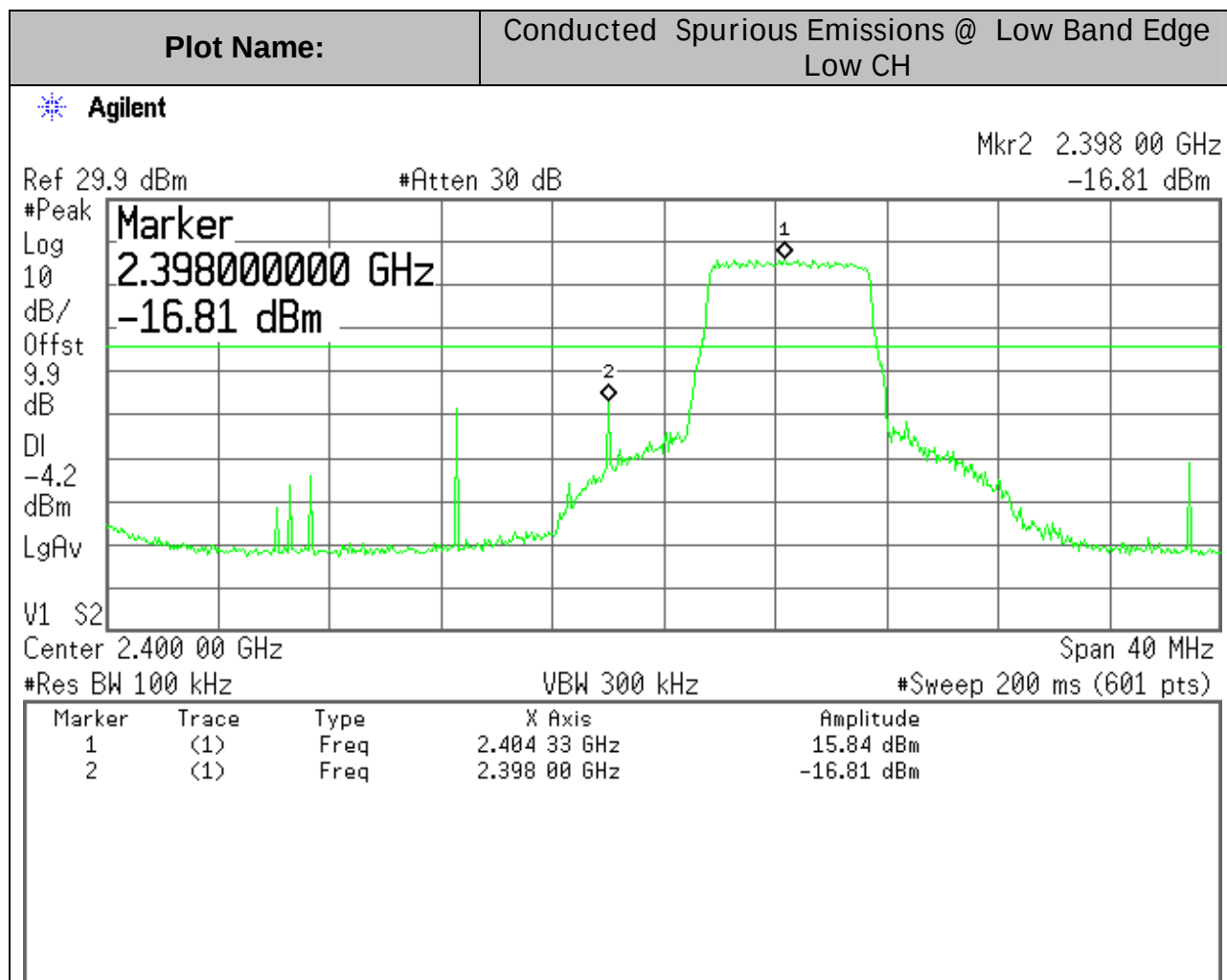
CONDUCTED PURIOUS EMISSIONS

For High Power Setting P=23dBm:

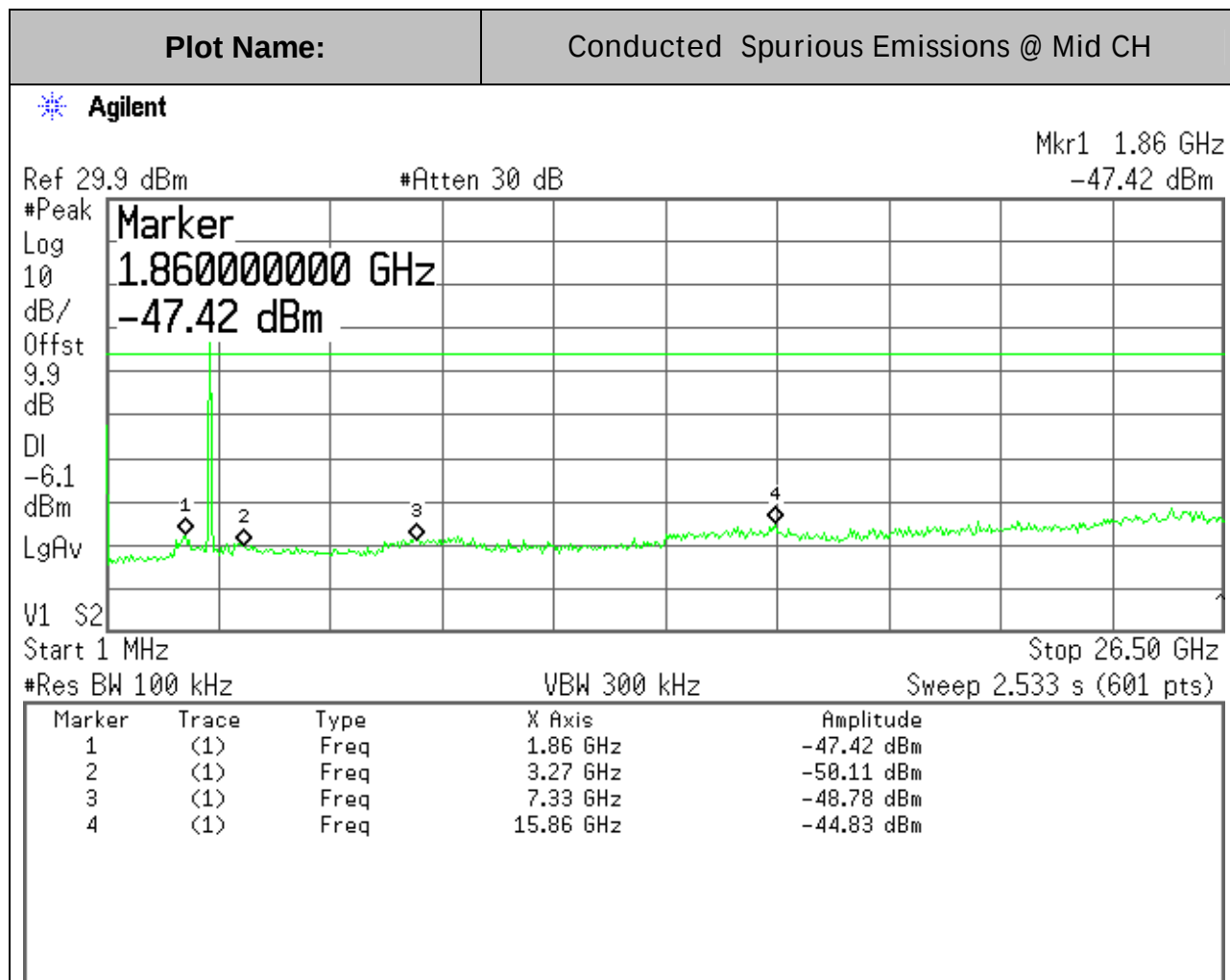
6MHz BW, QPSK Mode



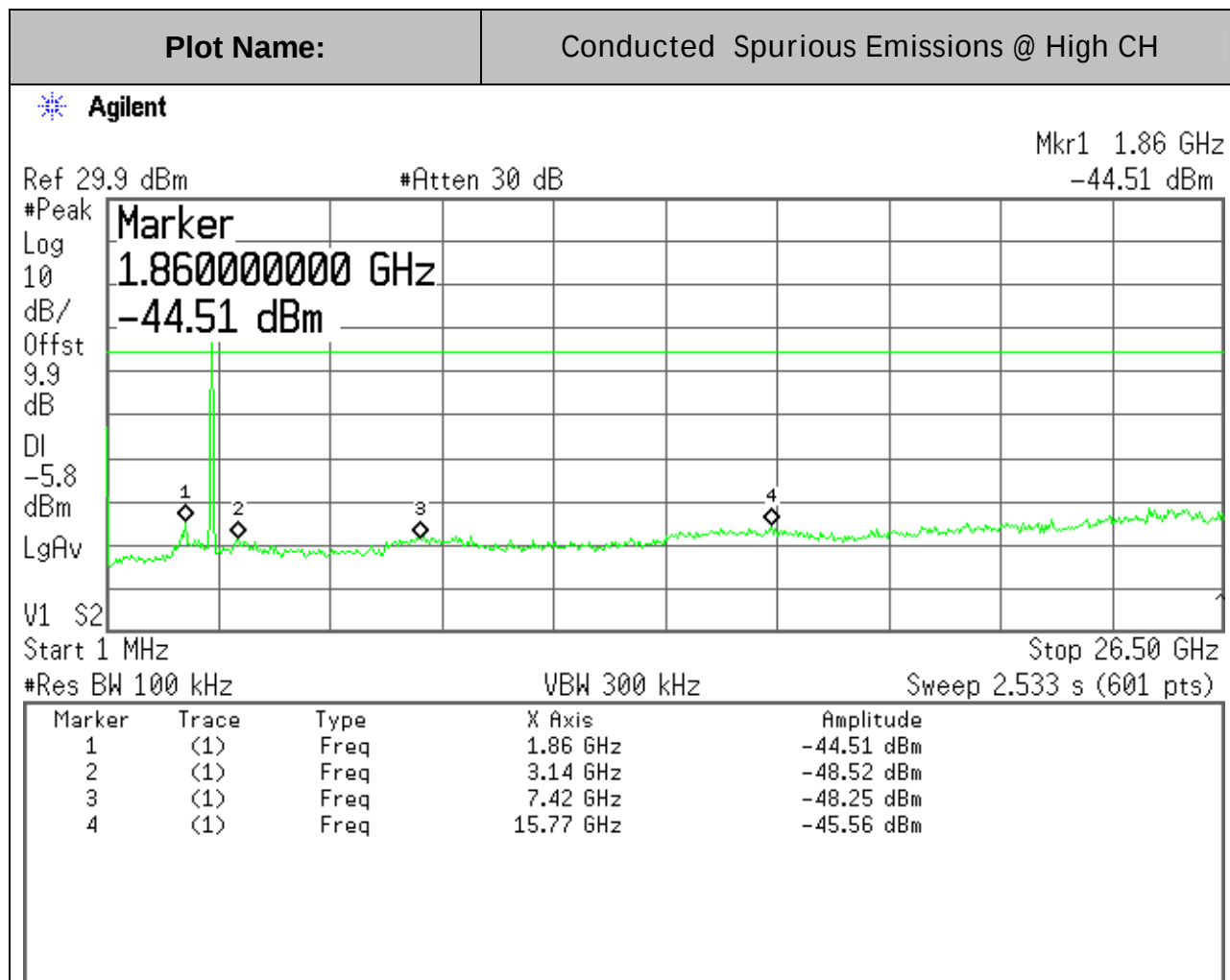
6MHz BW, QPSK Mode:



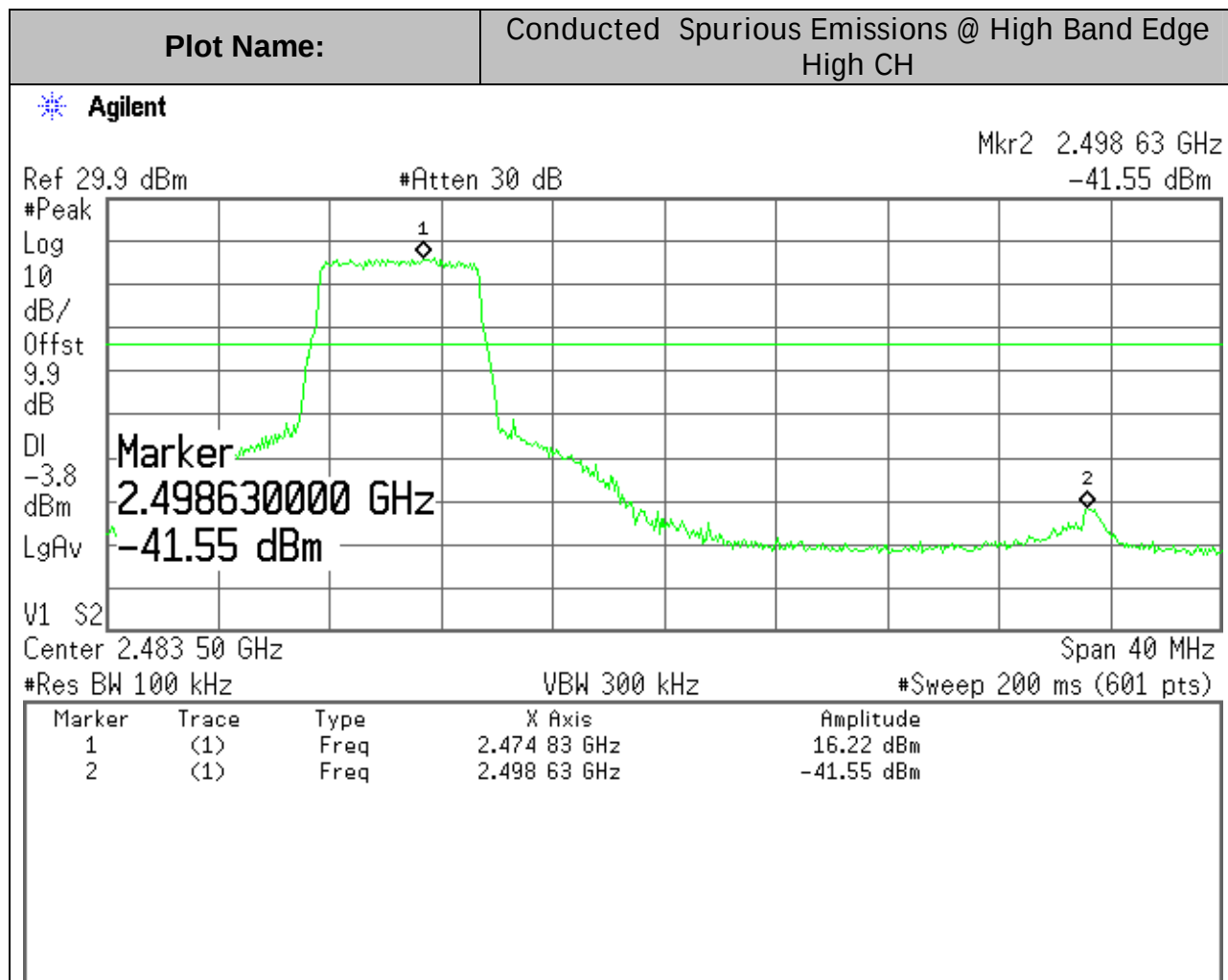
6MHz BW, QPSK Mode:



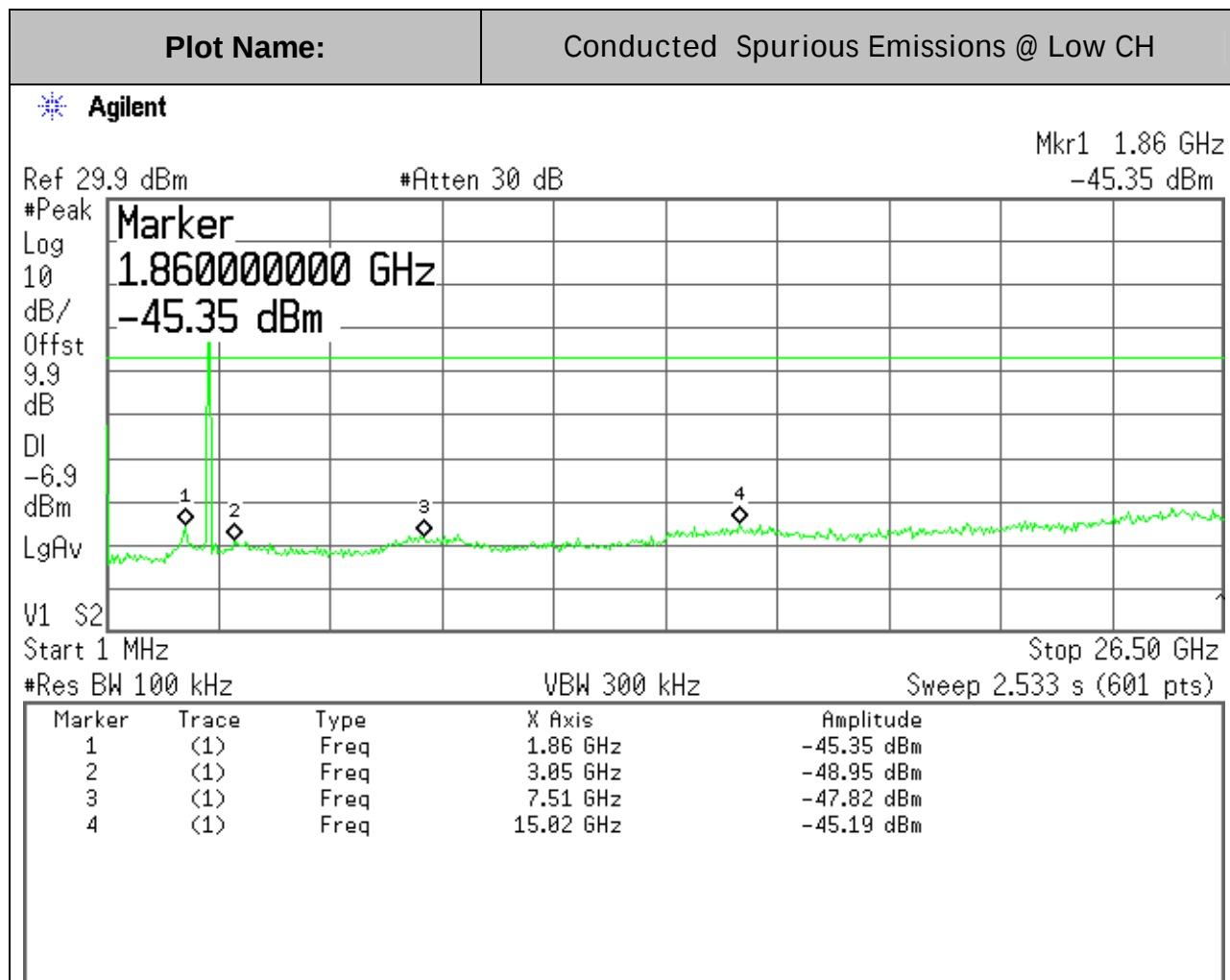
6MHz BW, QPSK Mode:



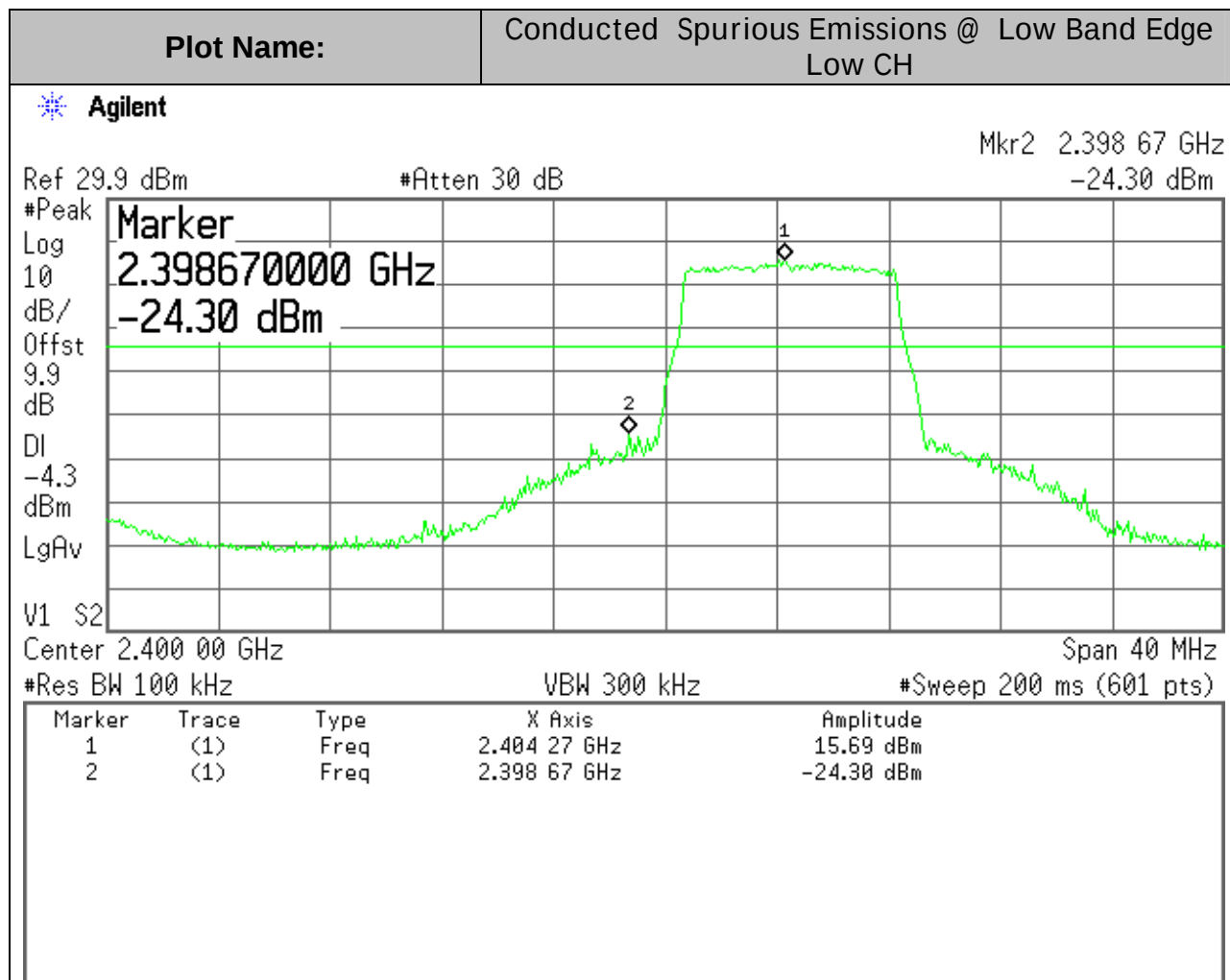
6MHz BW, QPSK Mode:



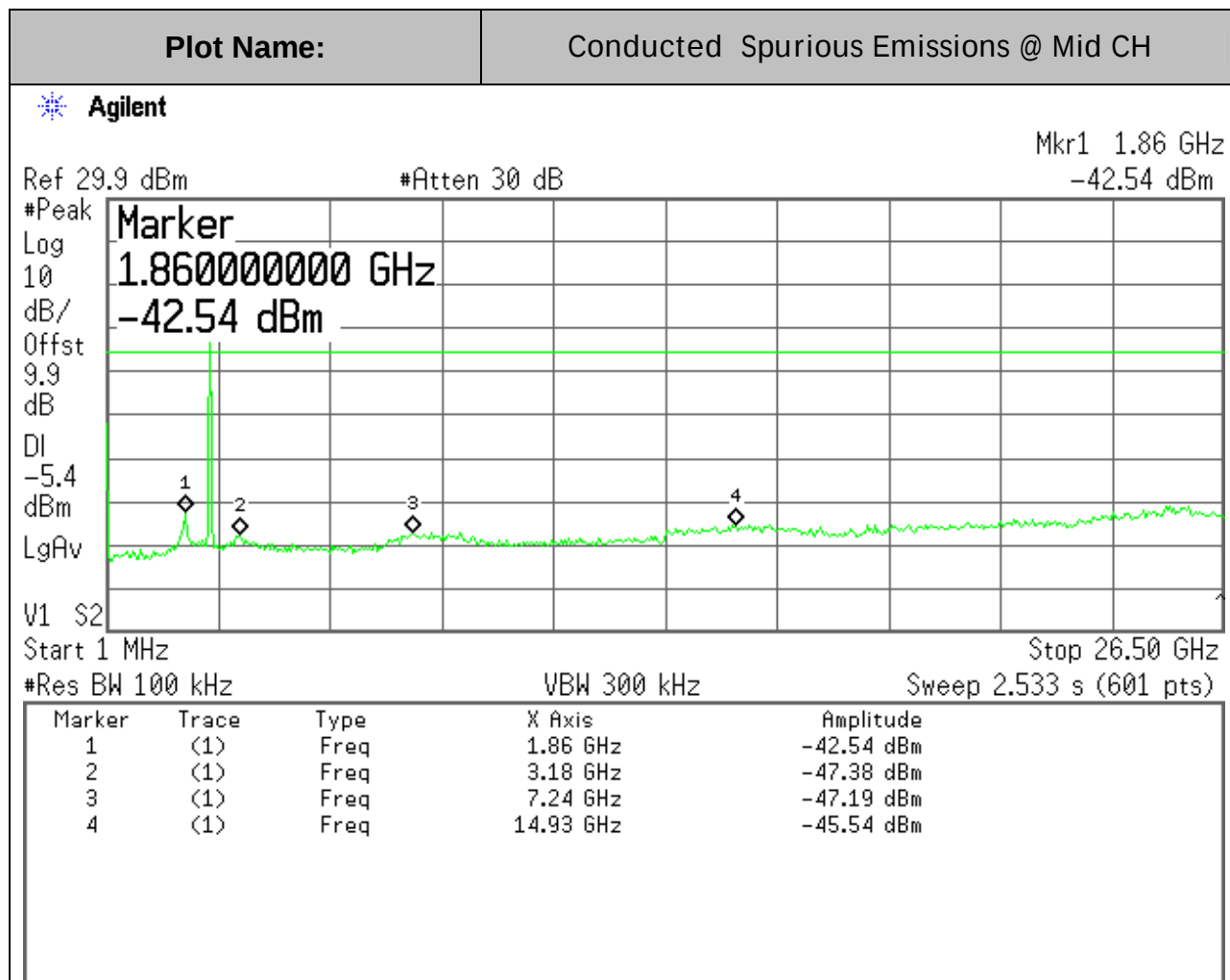
8MHz BW, QPSK Mode:



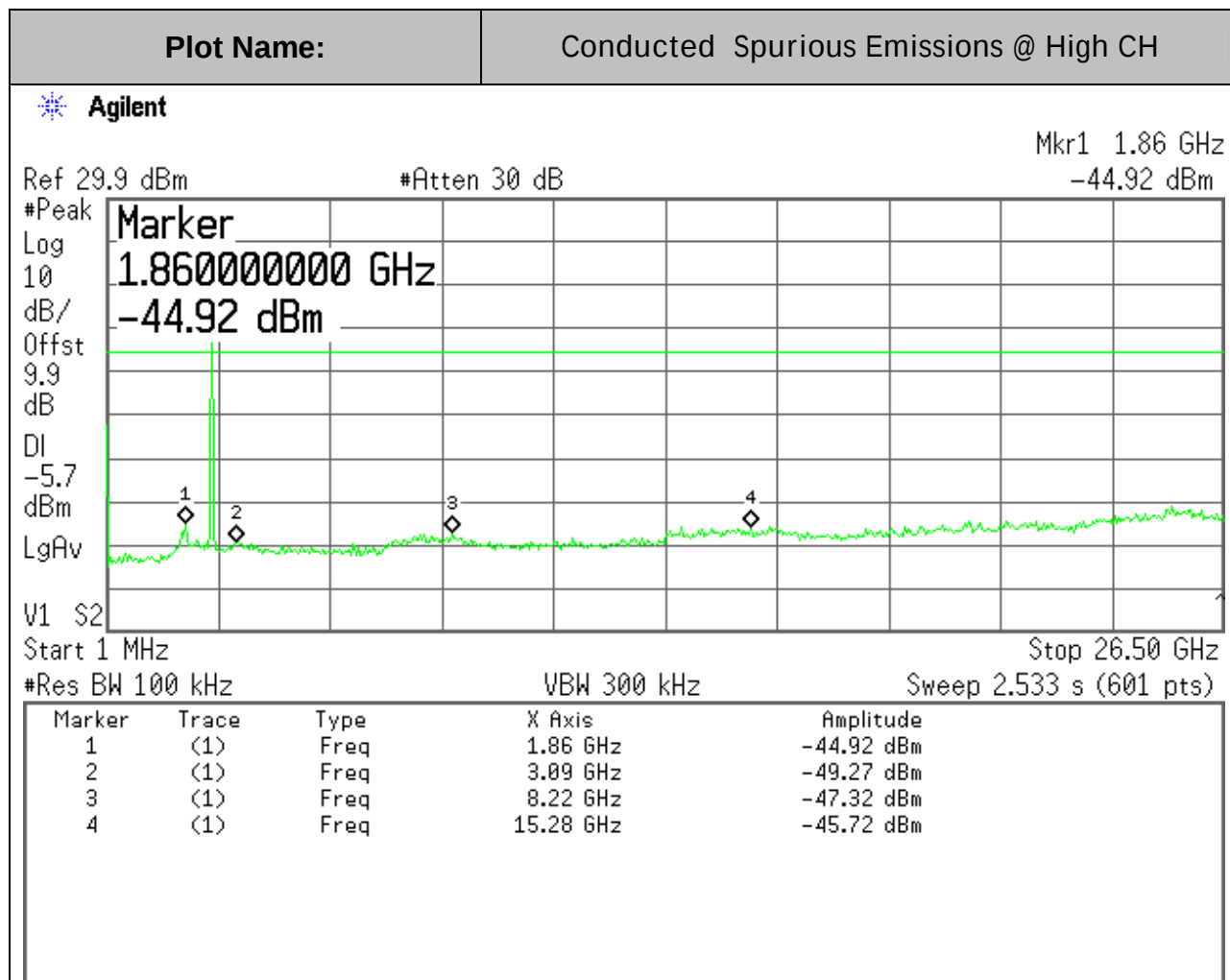
8MHz BW, QPSK Mode:



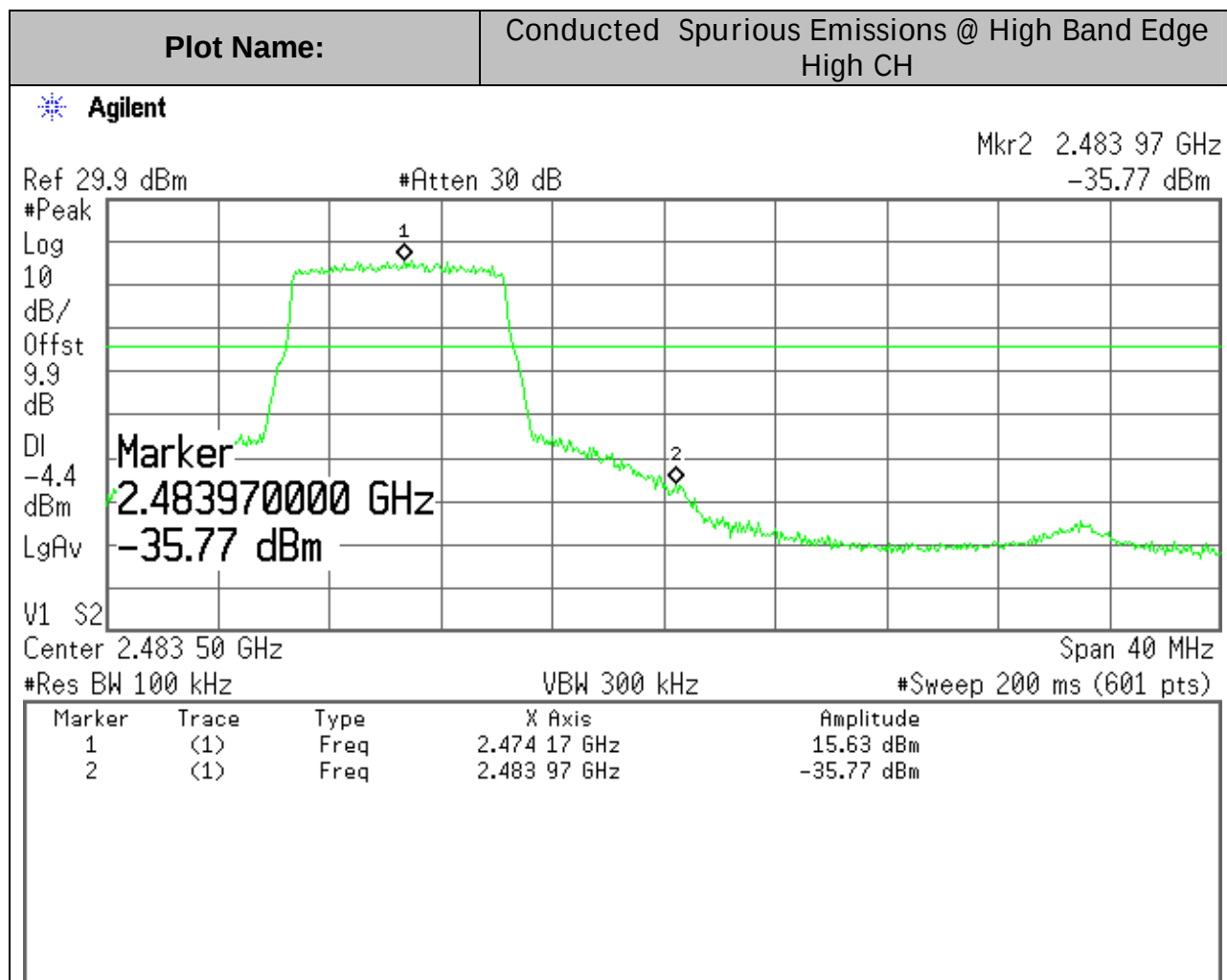
8MHz BW, QPSK Mode:



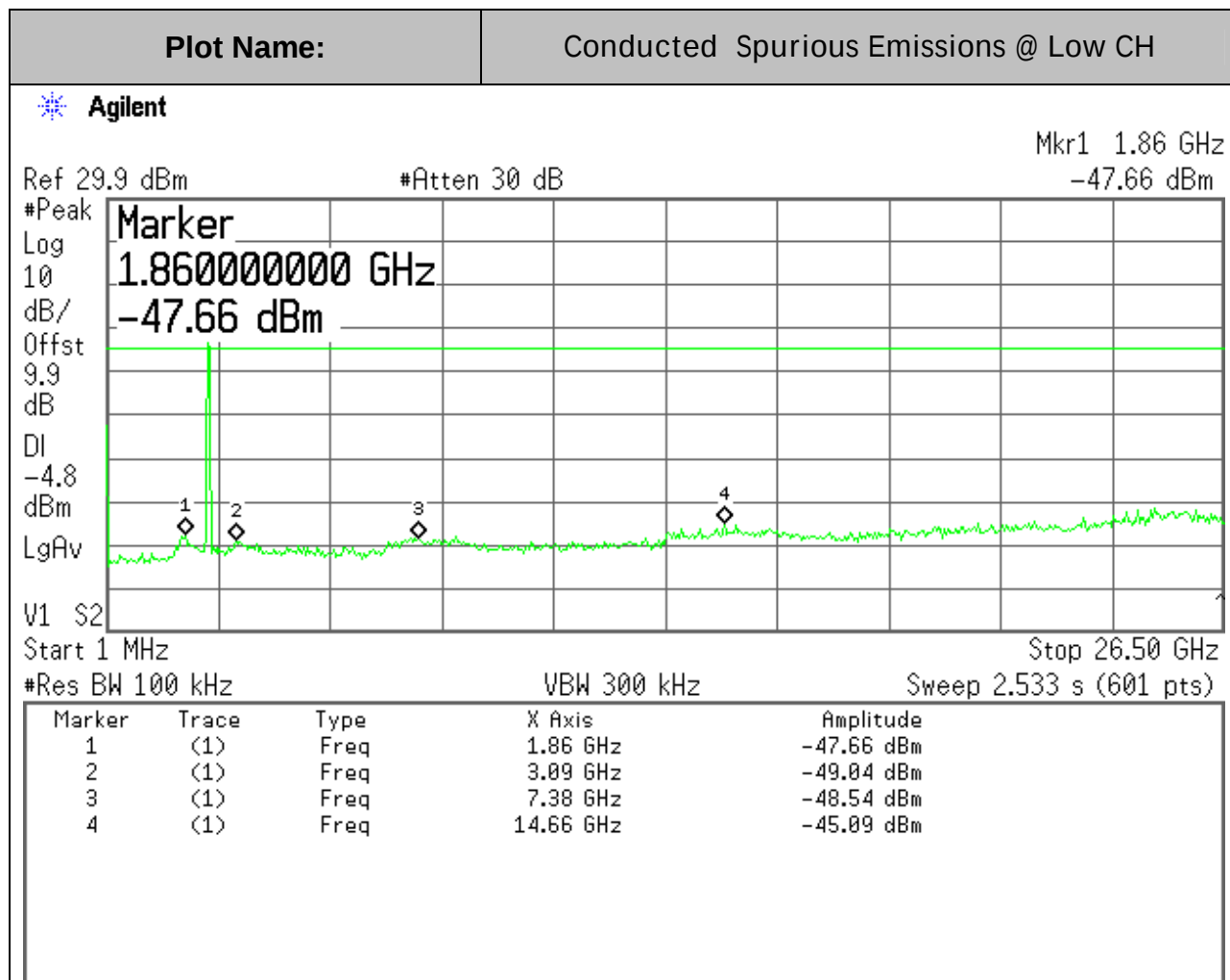
8MHz BW, QPSK Mode:



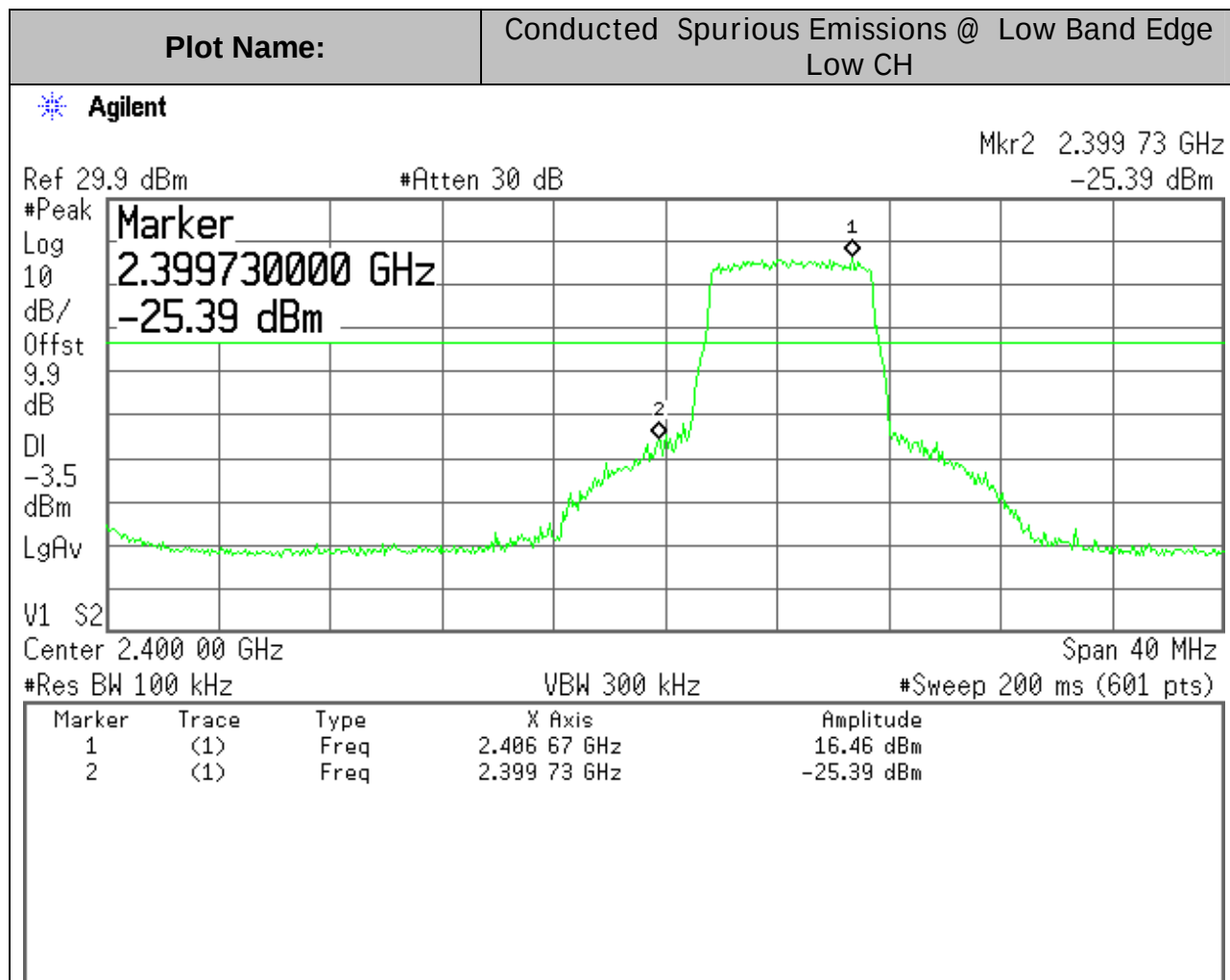
8MHz BW, QPSK Mode:



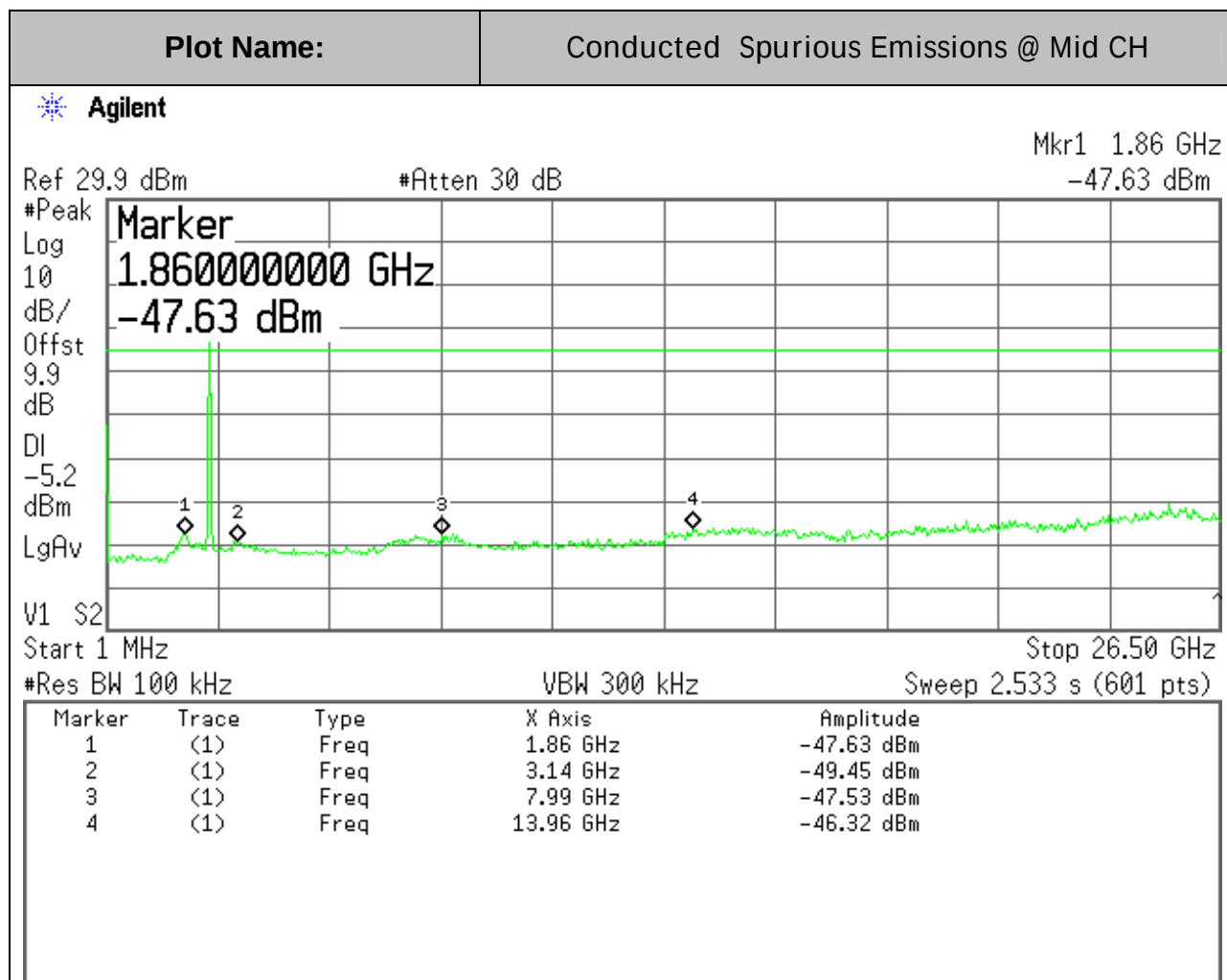
6MHz BW, 16QAM Mode:



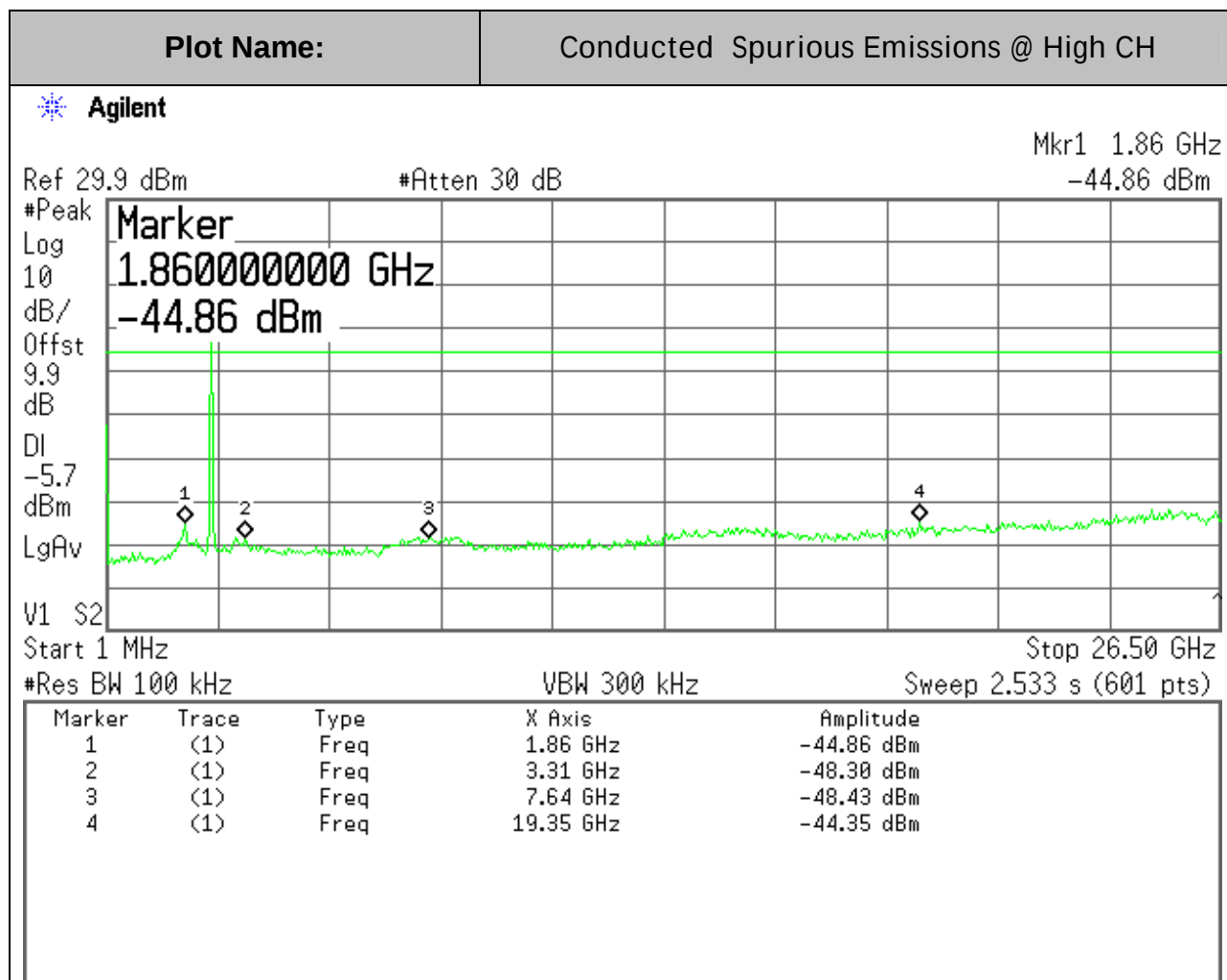
6MHz BW, 16QAM Mode:



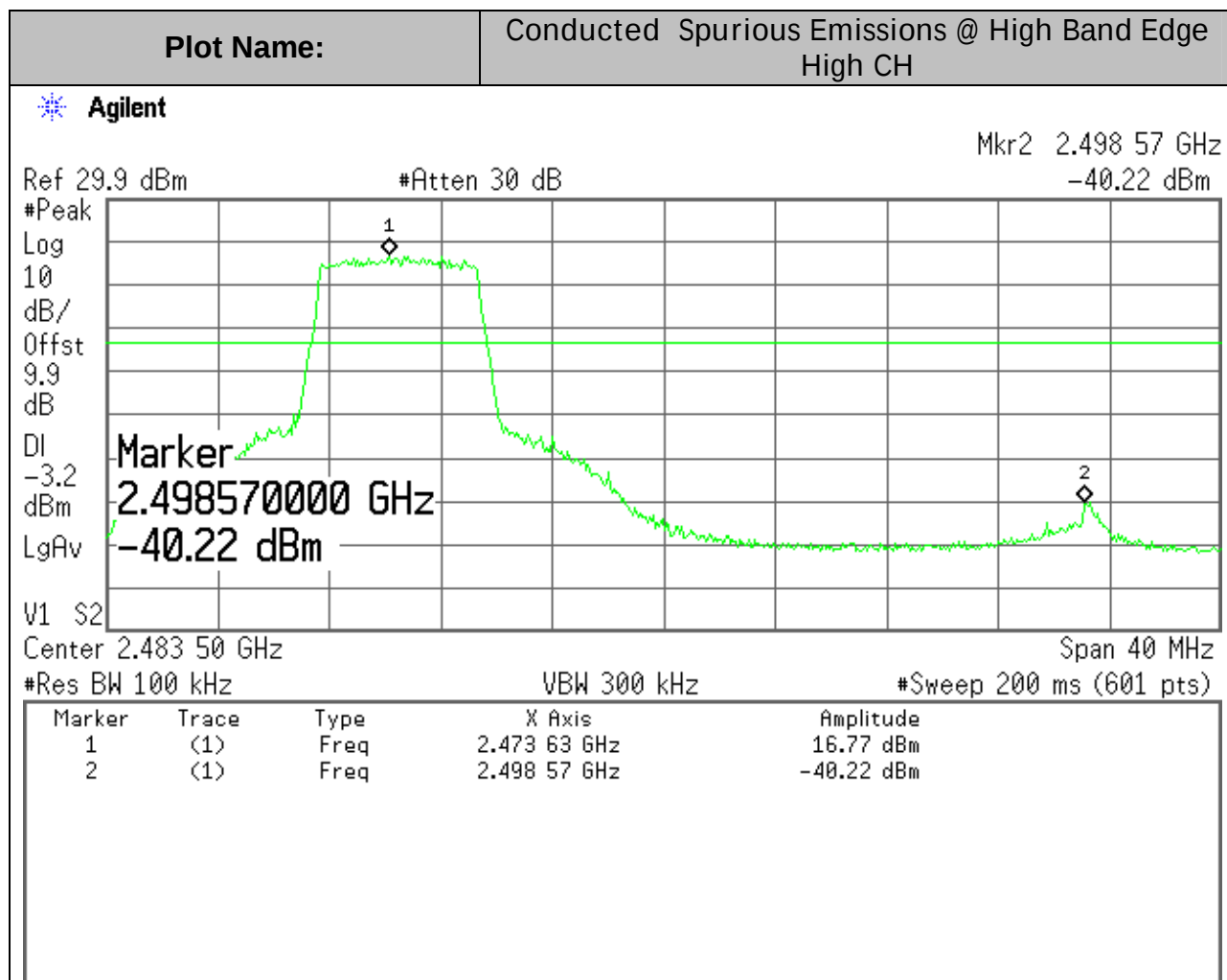
6MHz BW, 16QAM Mode:



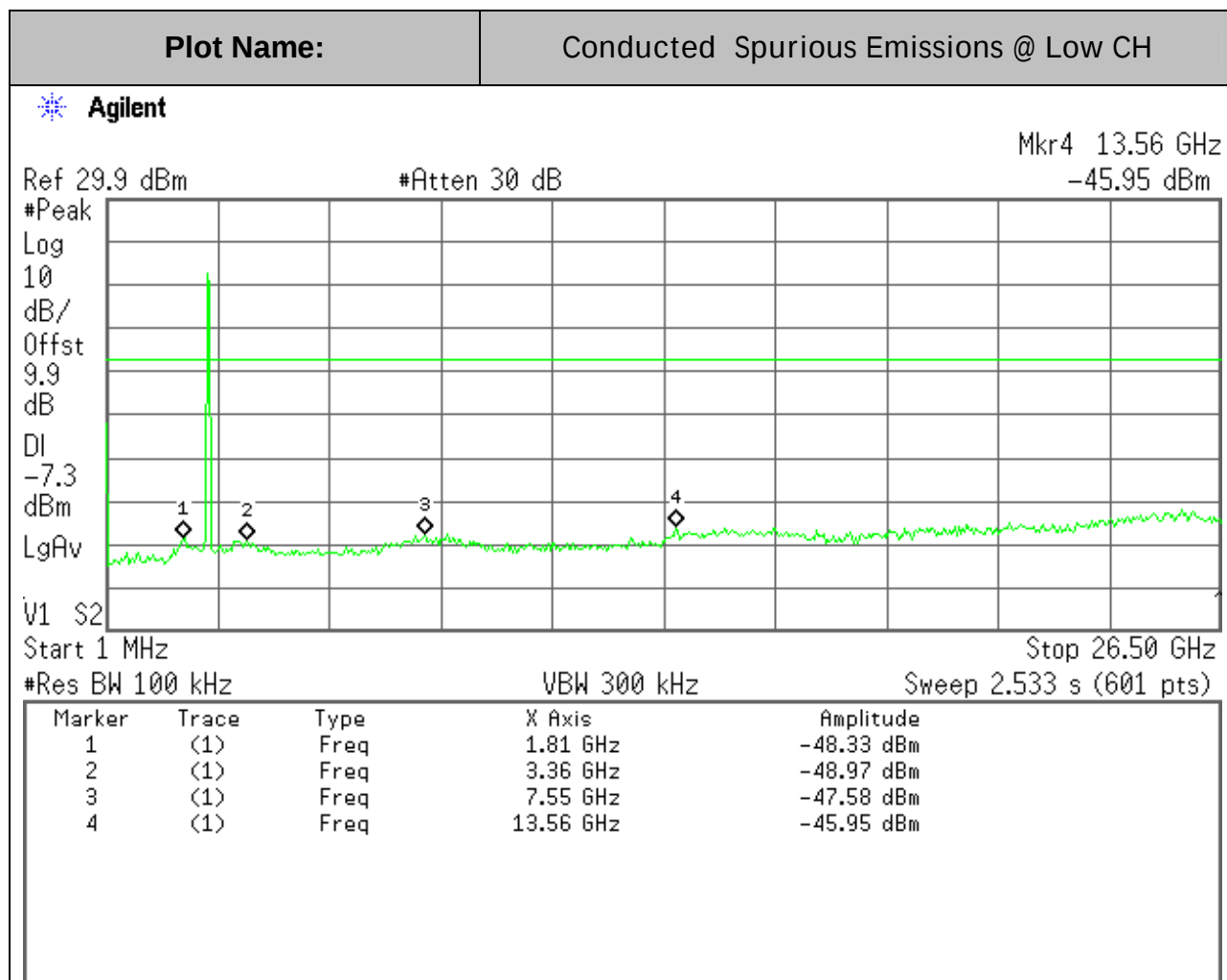
6MHz BW, 16QAM Mode:



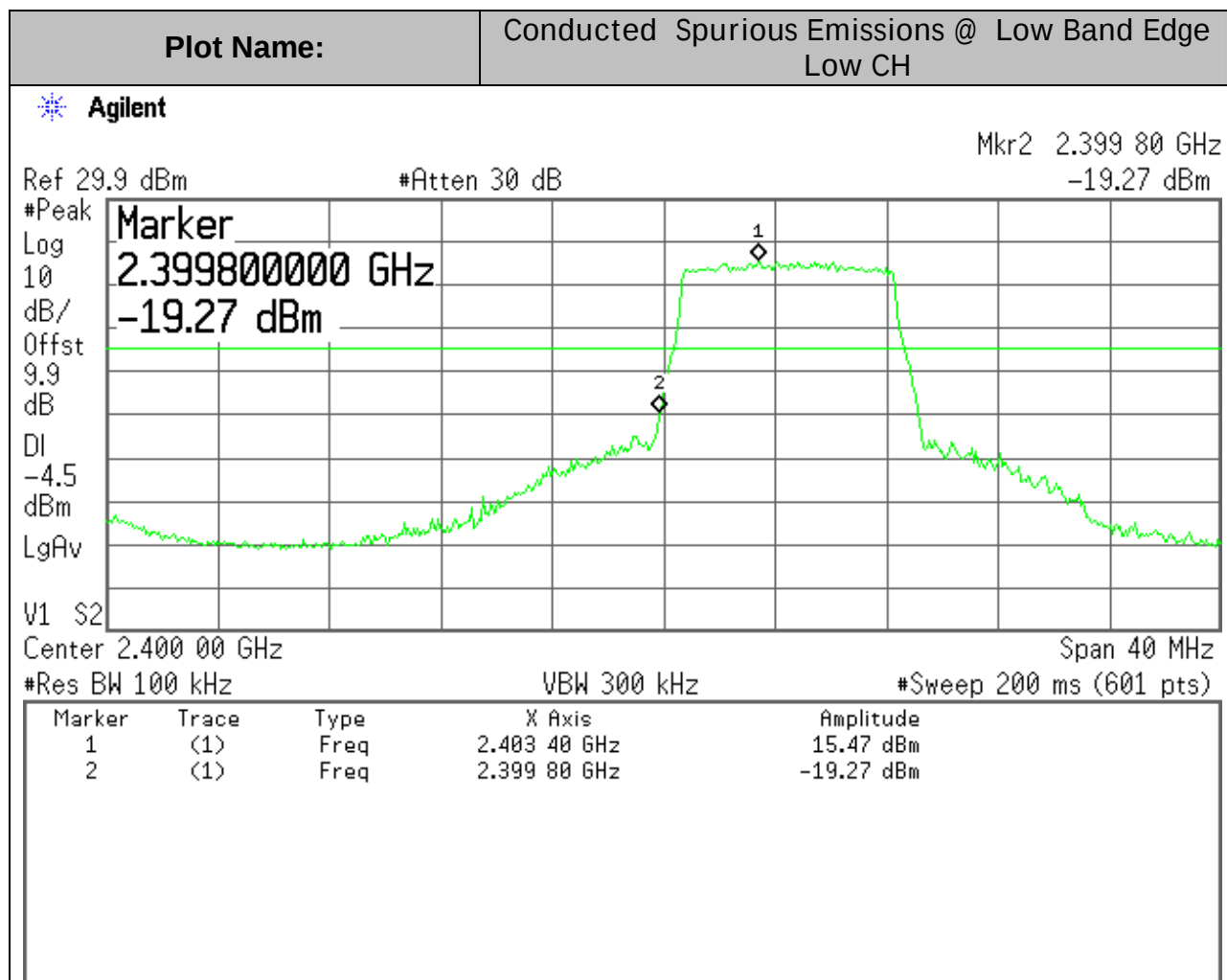
6MHz BW, 16QAM Mode:



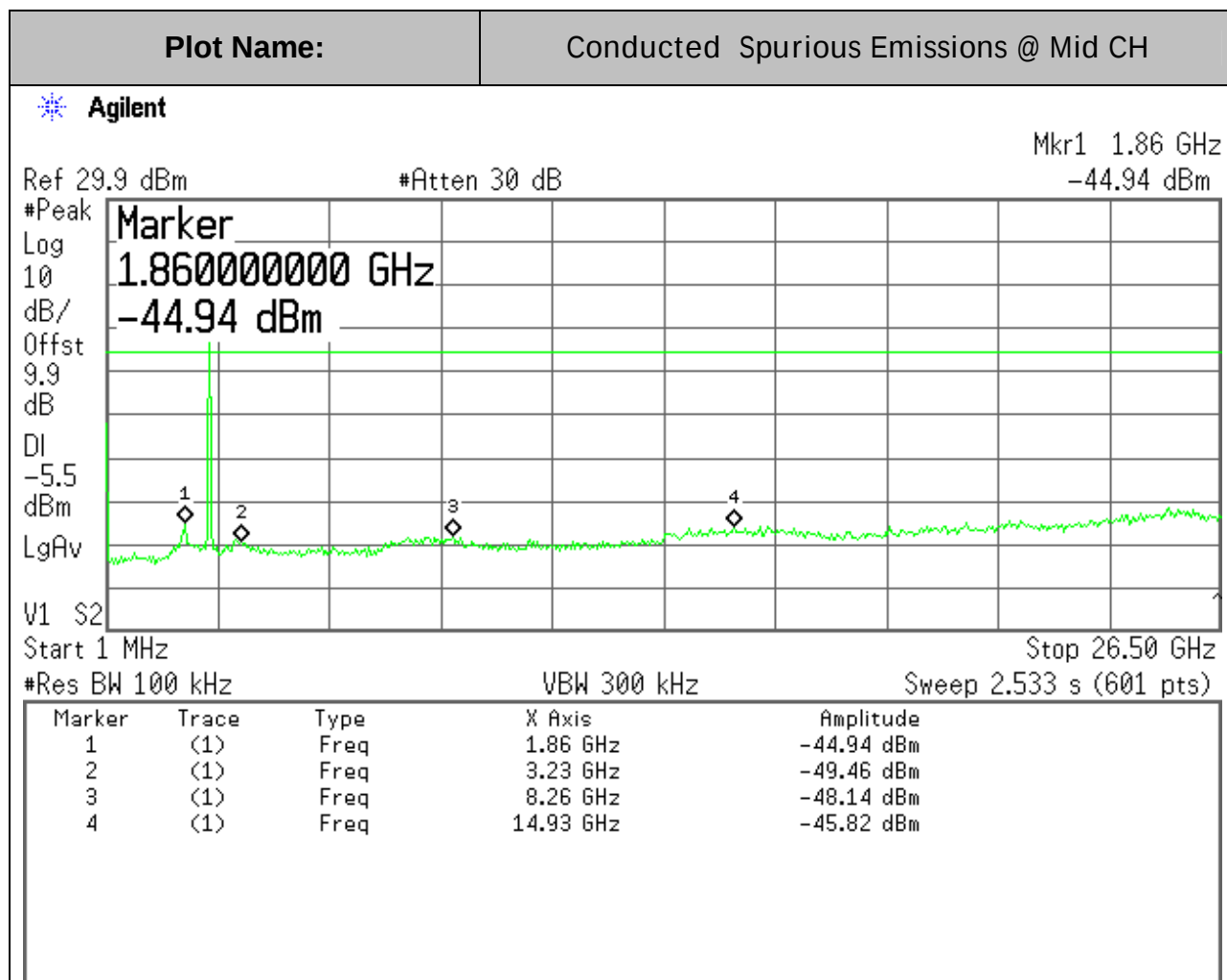
8MHz BW, 16QAM Mode:



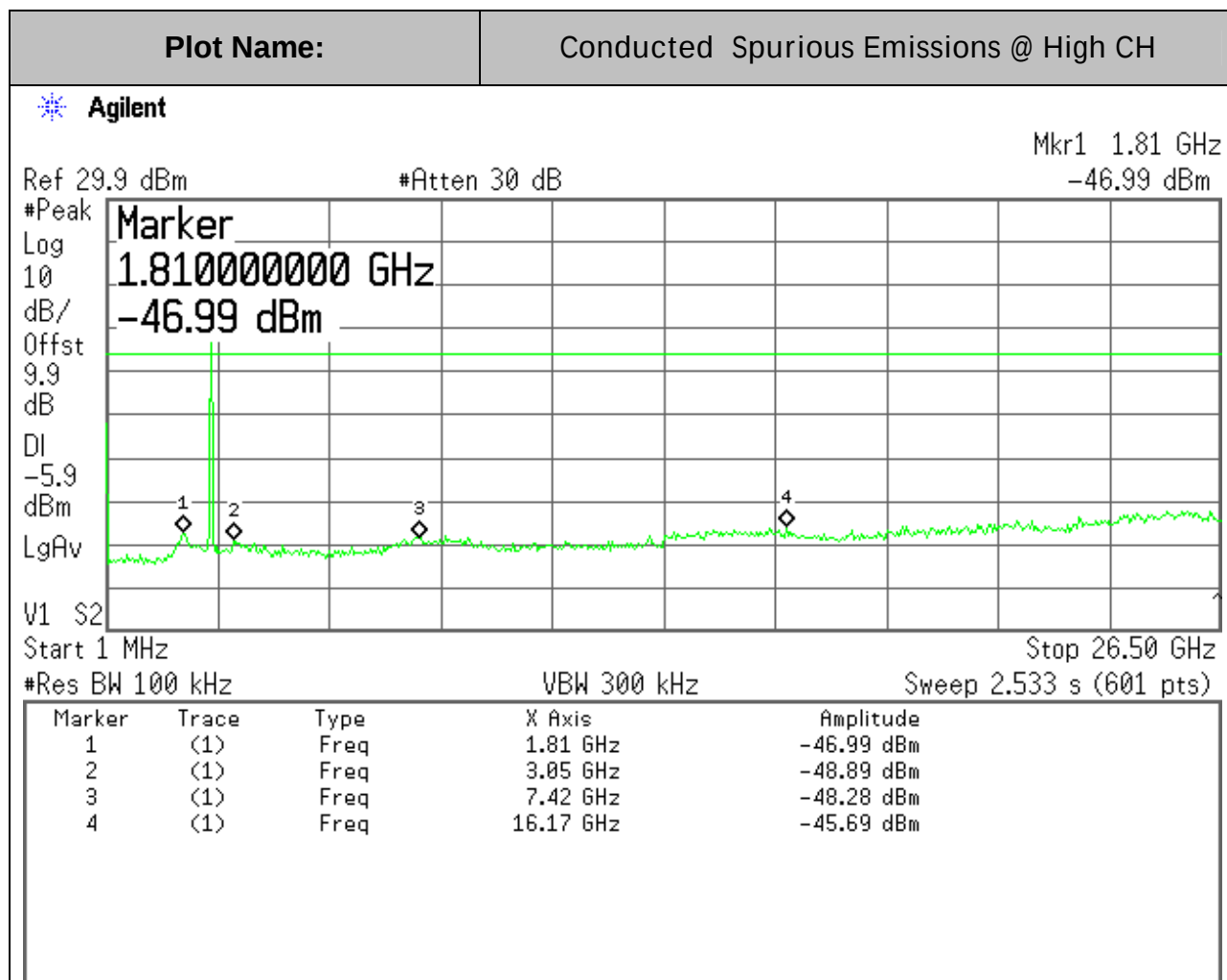
8MHz BW, 16QAM Mode:



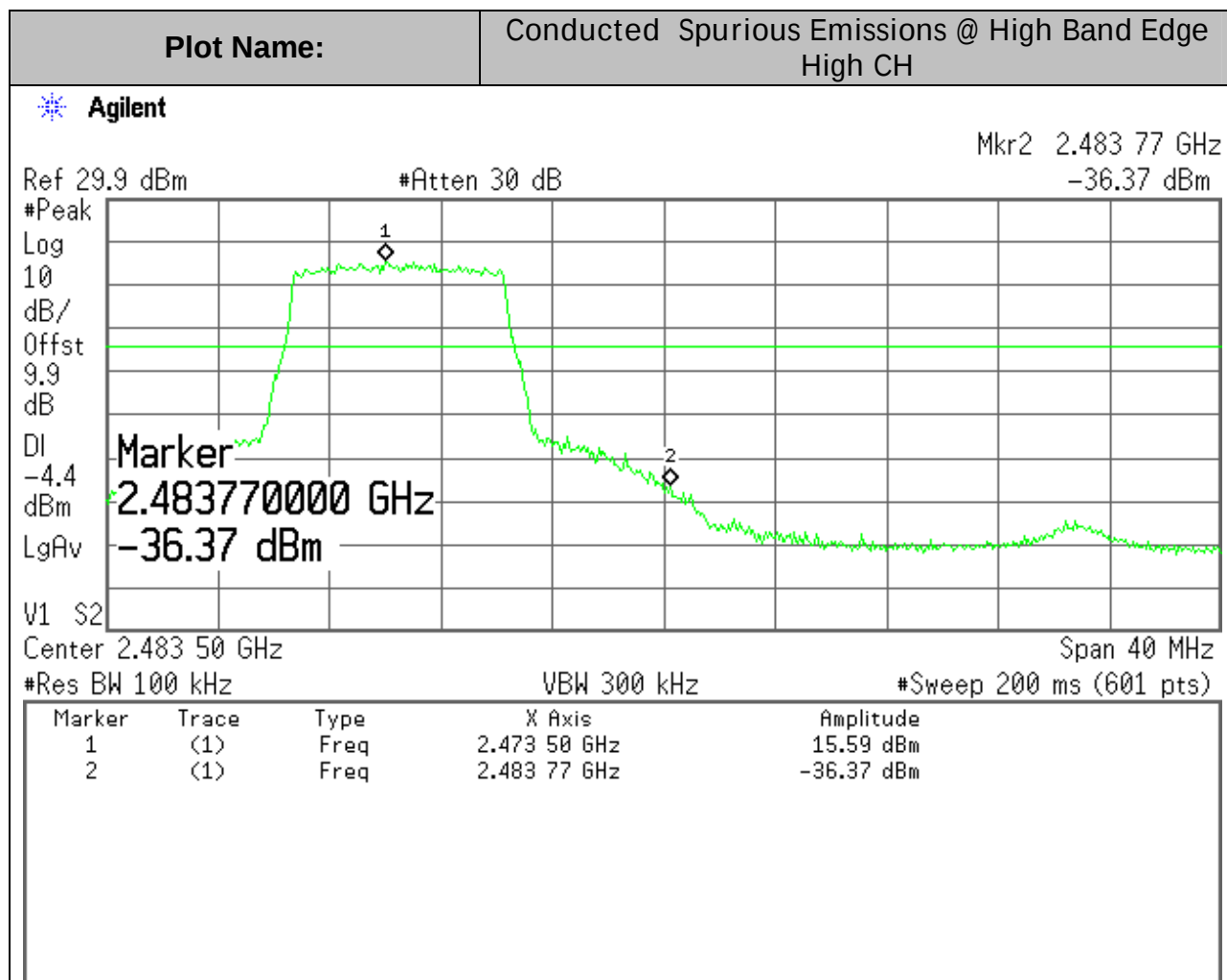
8MHz BW, 16QAM Mode:



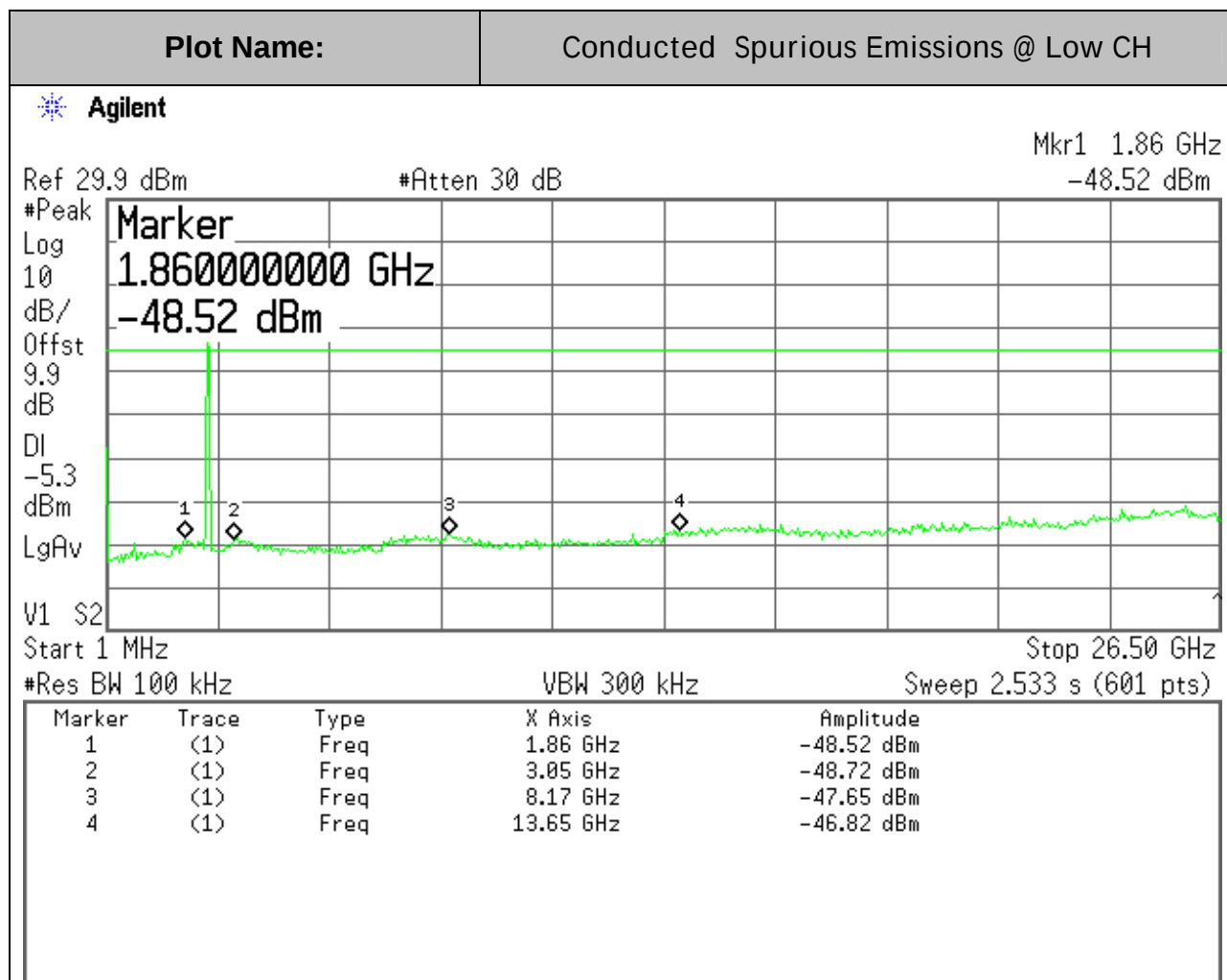
8MHz BW, 16QAM Mode:



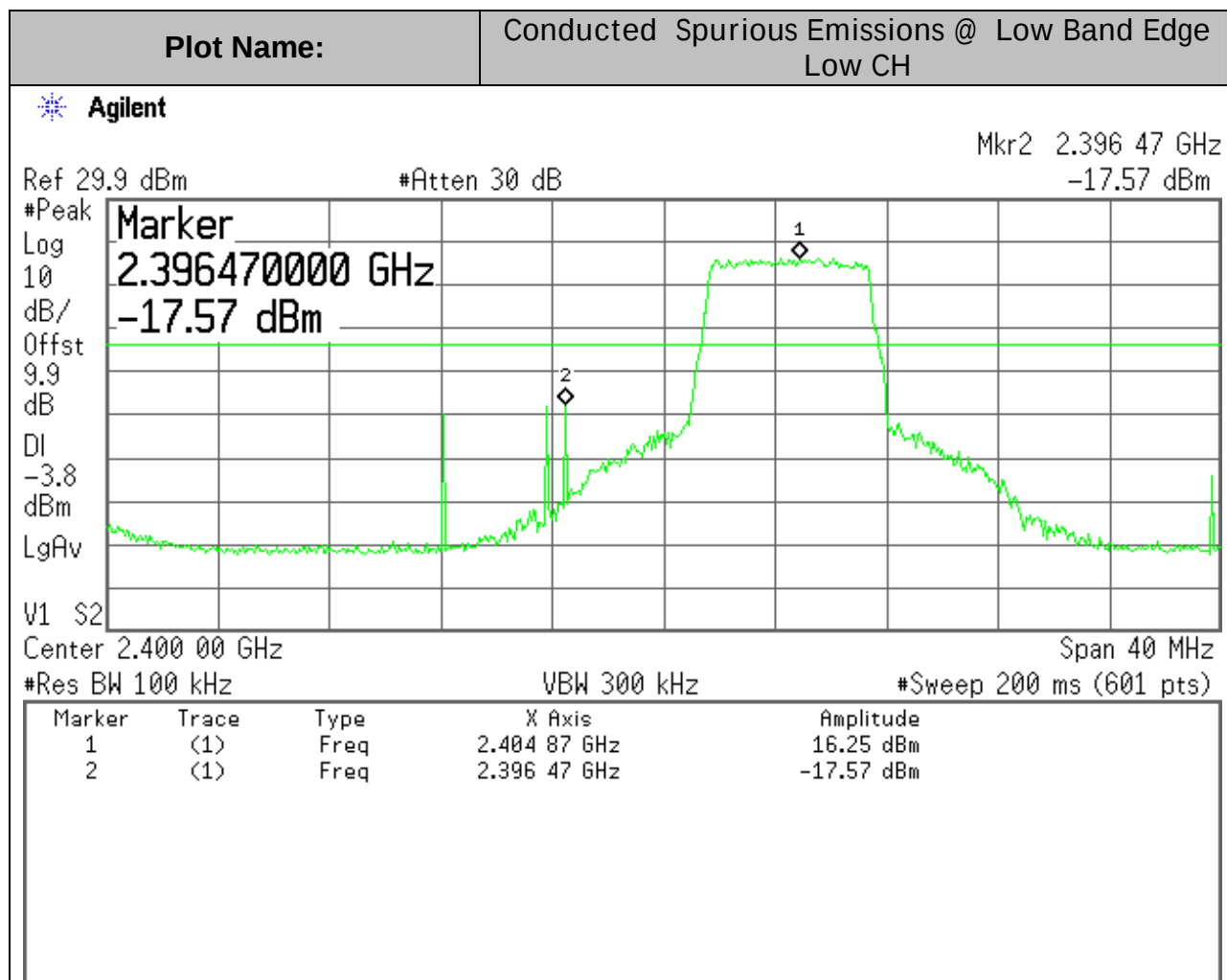
8MHz BW, 16QAM Mode:



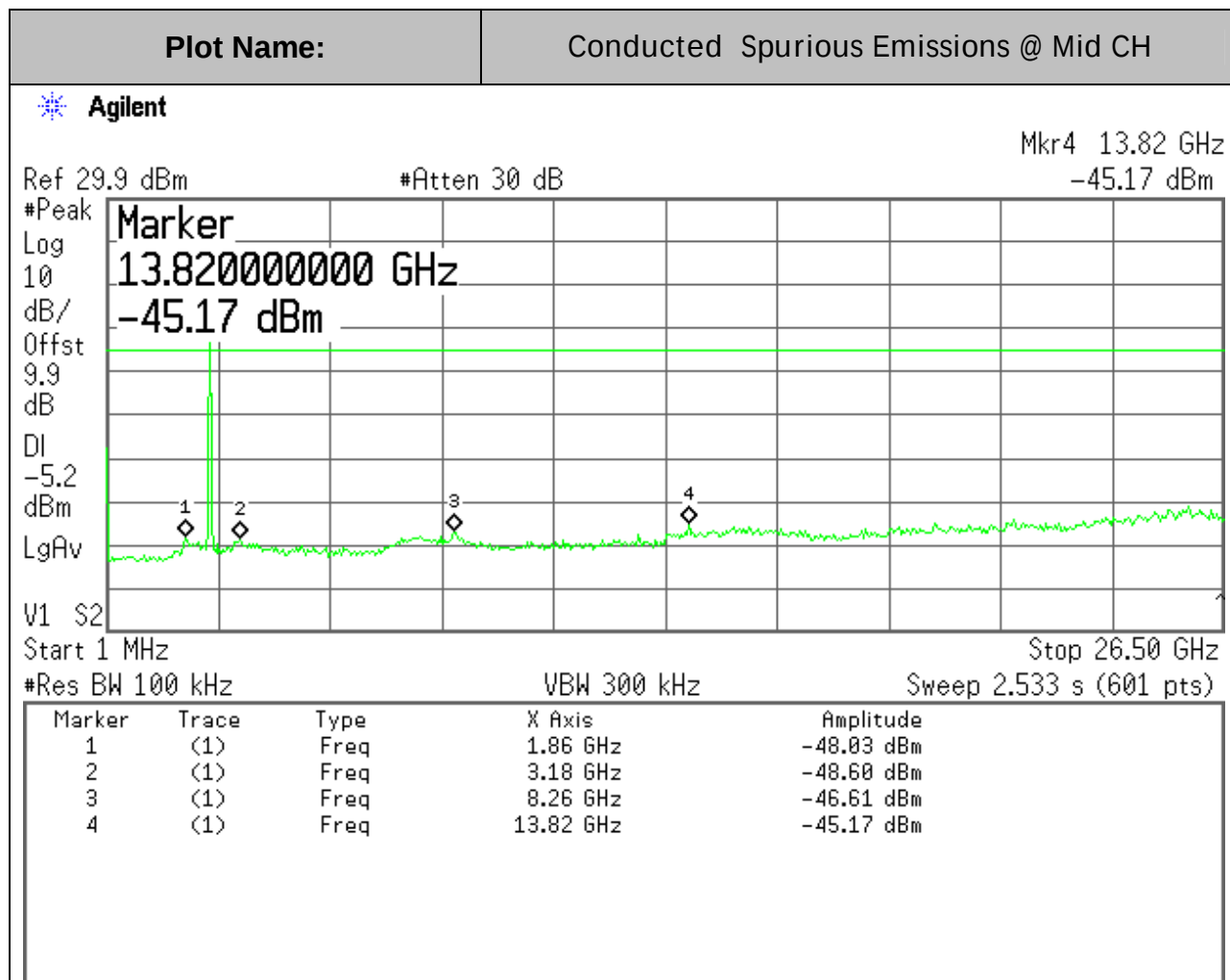
6MHz BW, 64QAM Mode:



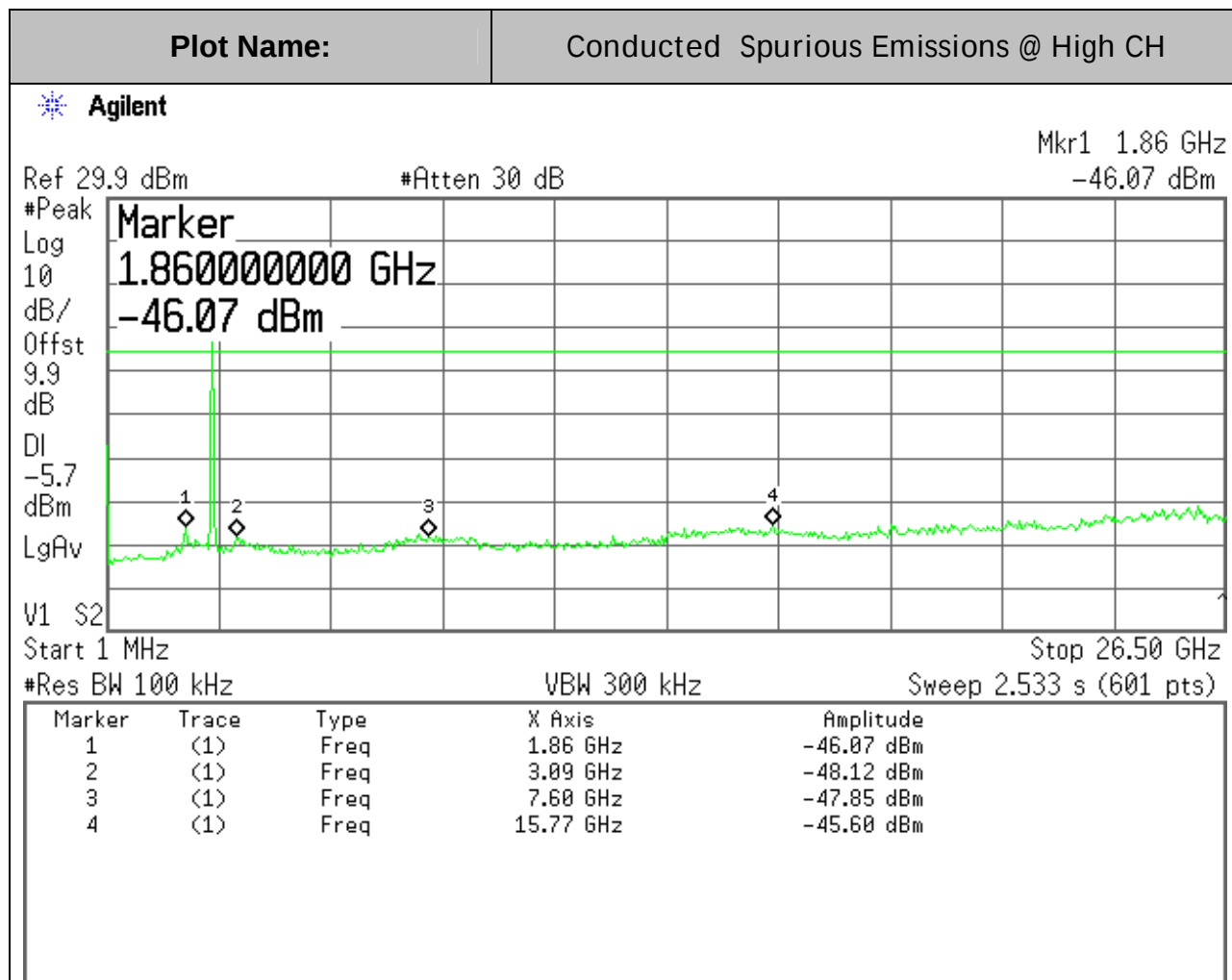
6MHz BW, 64QAM Mode:



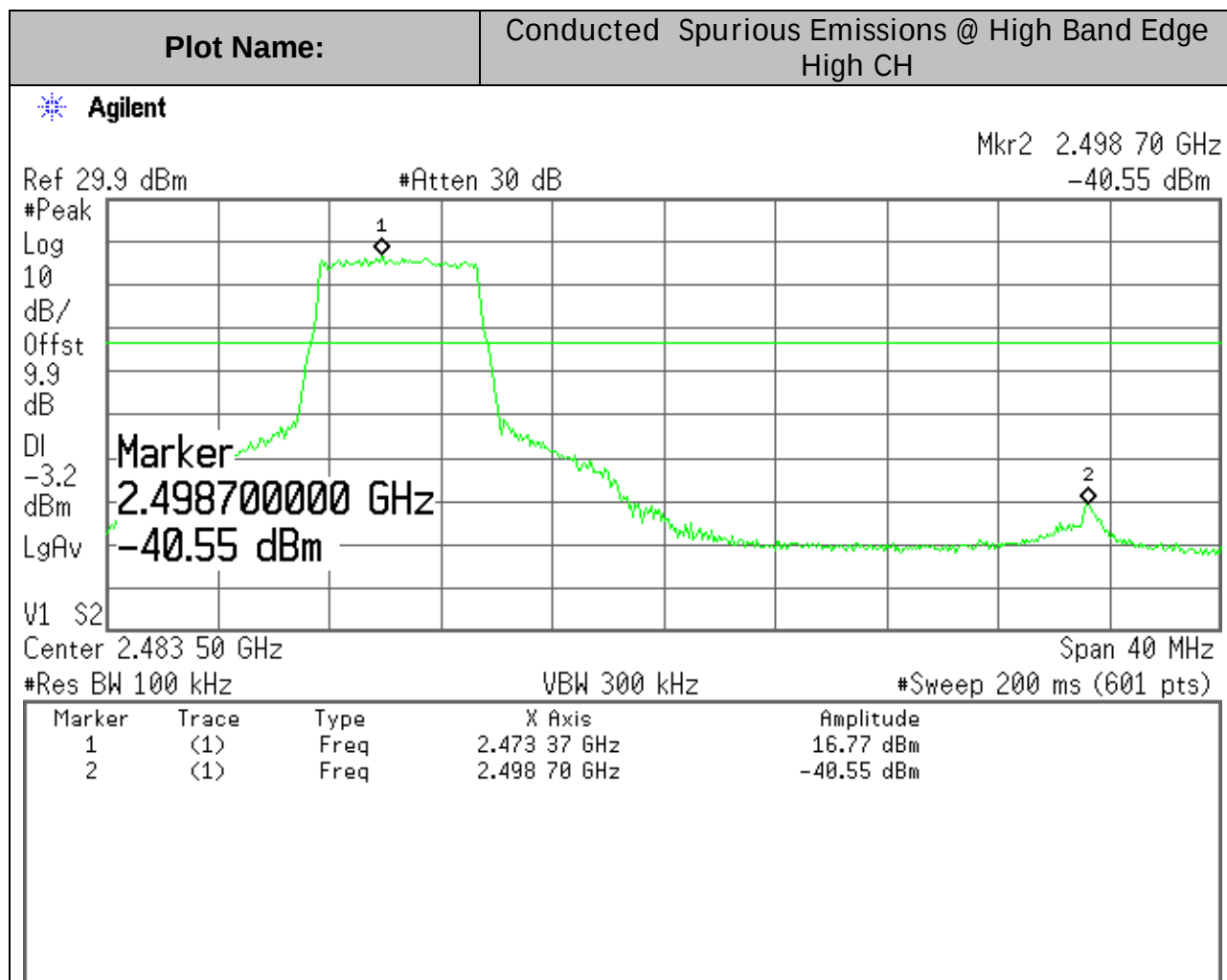
6MHz BW, 64QAM Mode:



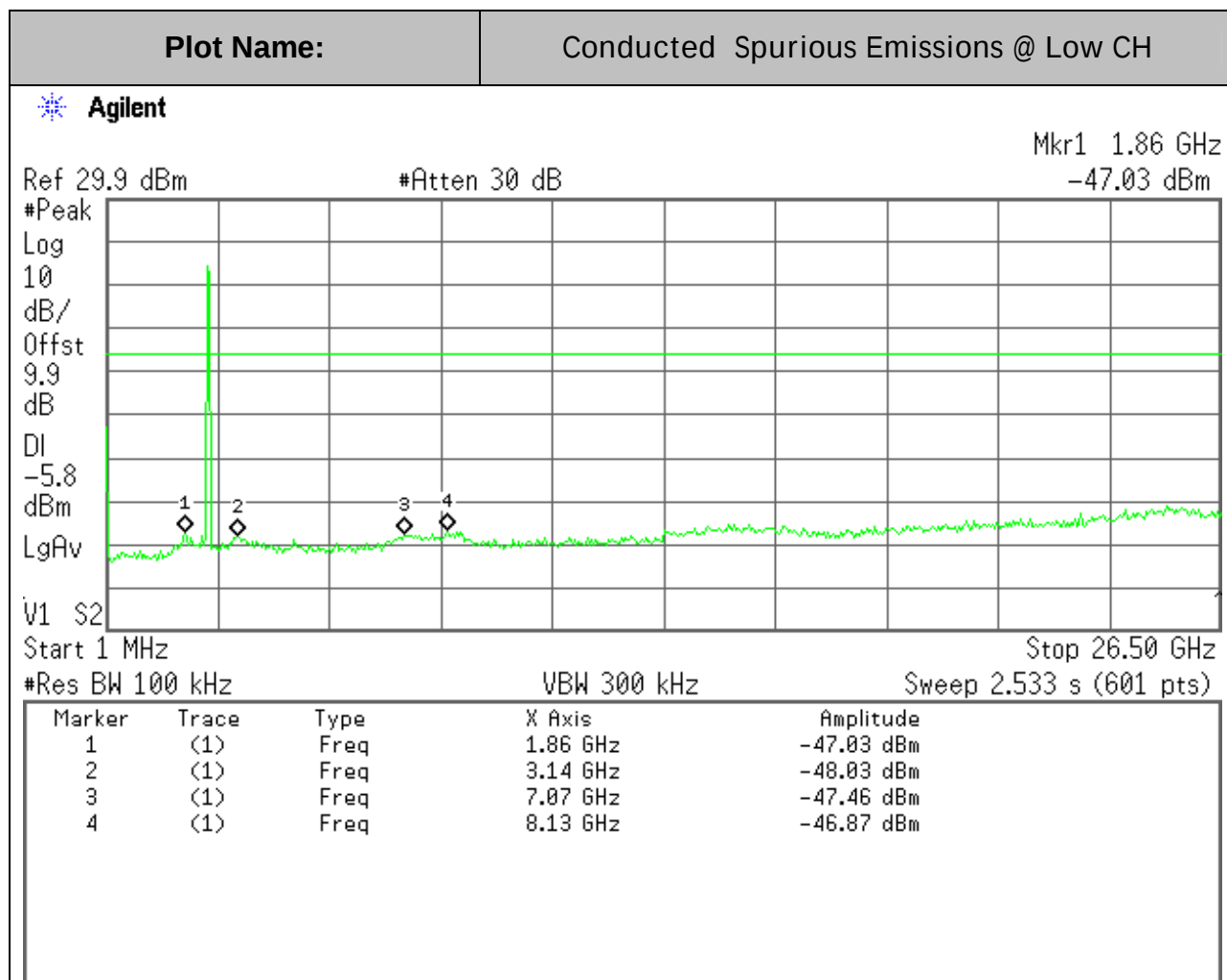
6MHz BW, 64QAM Mode:



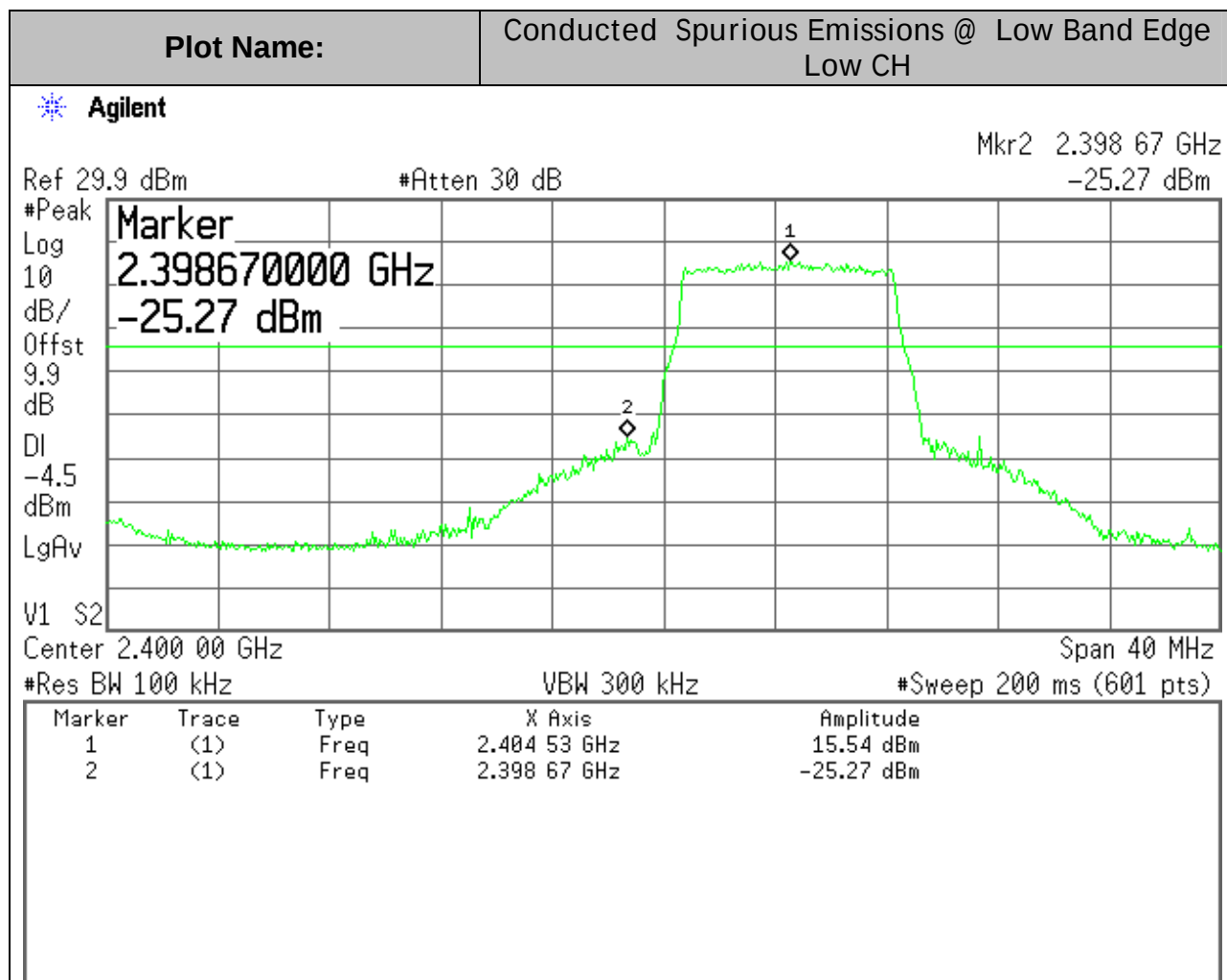
6MHz BW, 64QAM Mode:



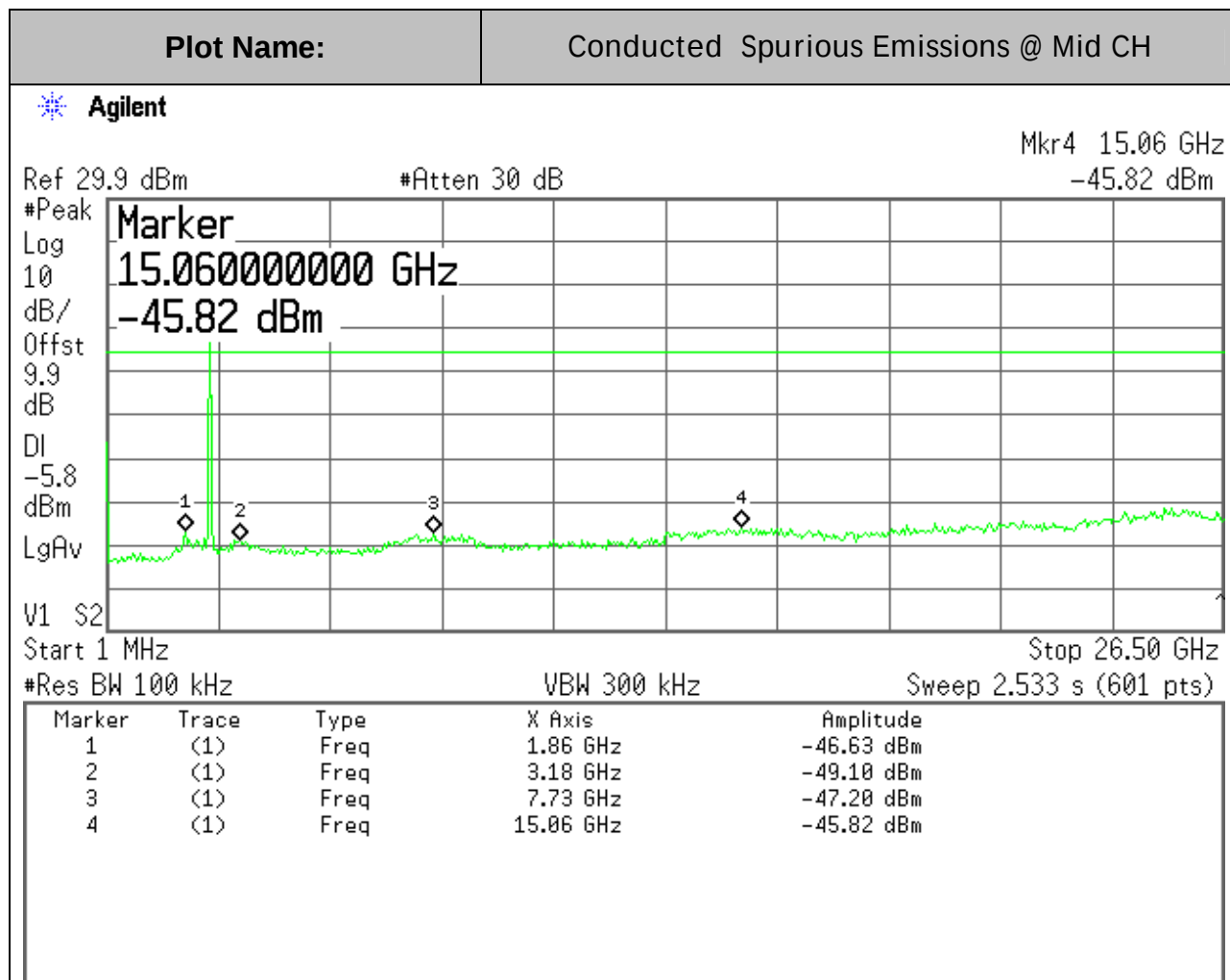
8MHz BW, 64QAM Mode:



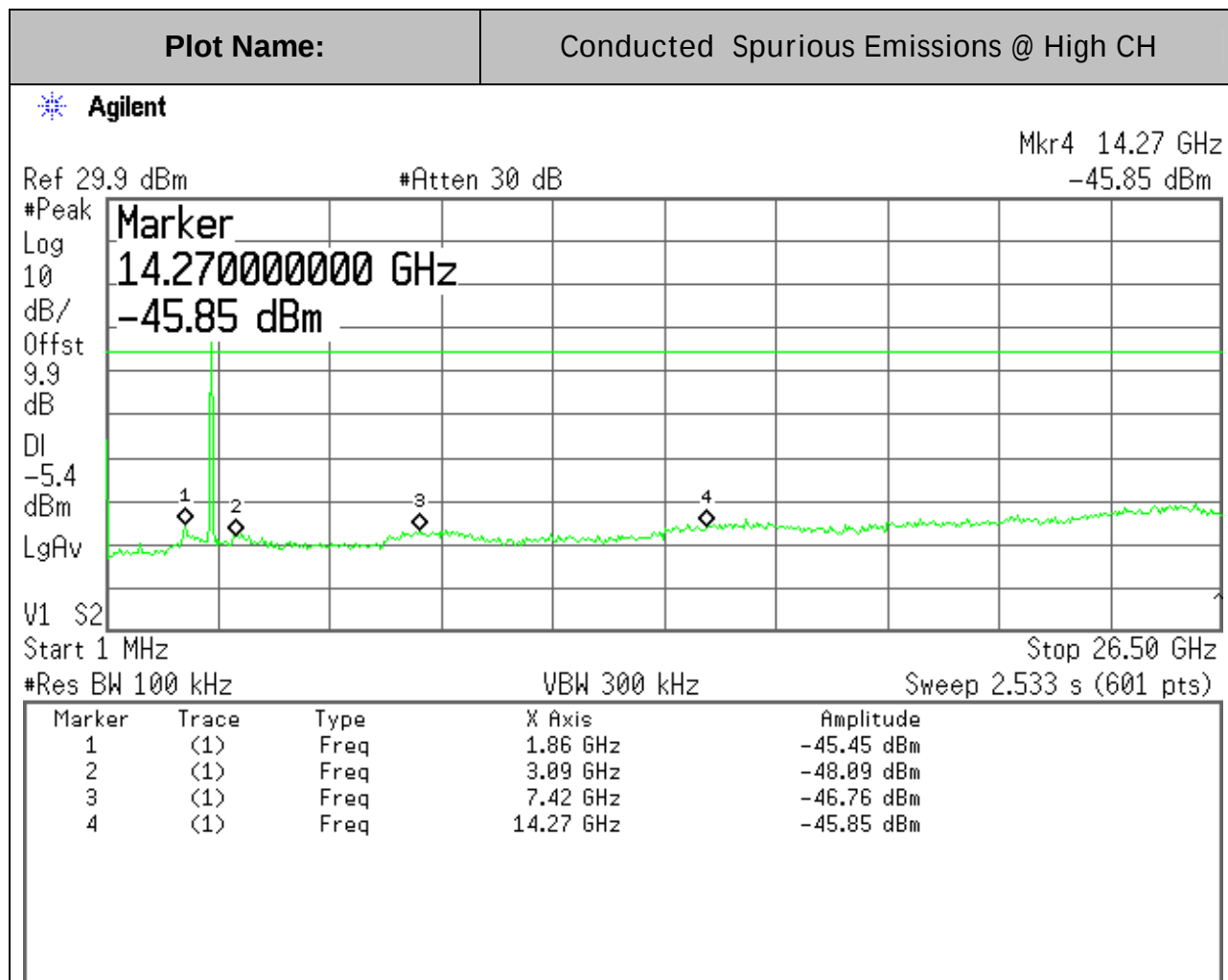
8MHz BW, 64QAM Mode:



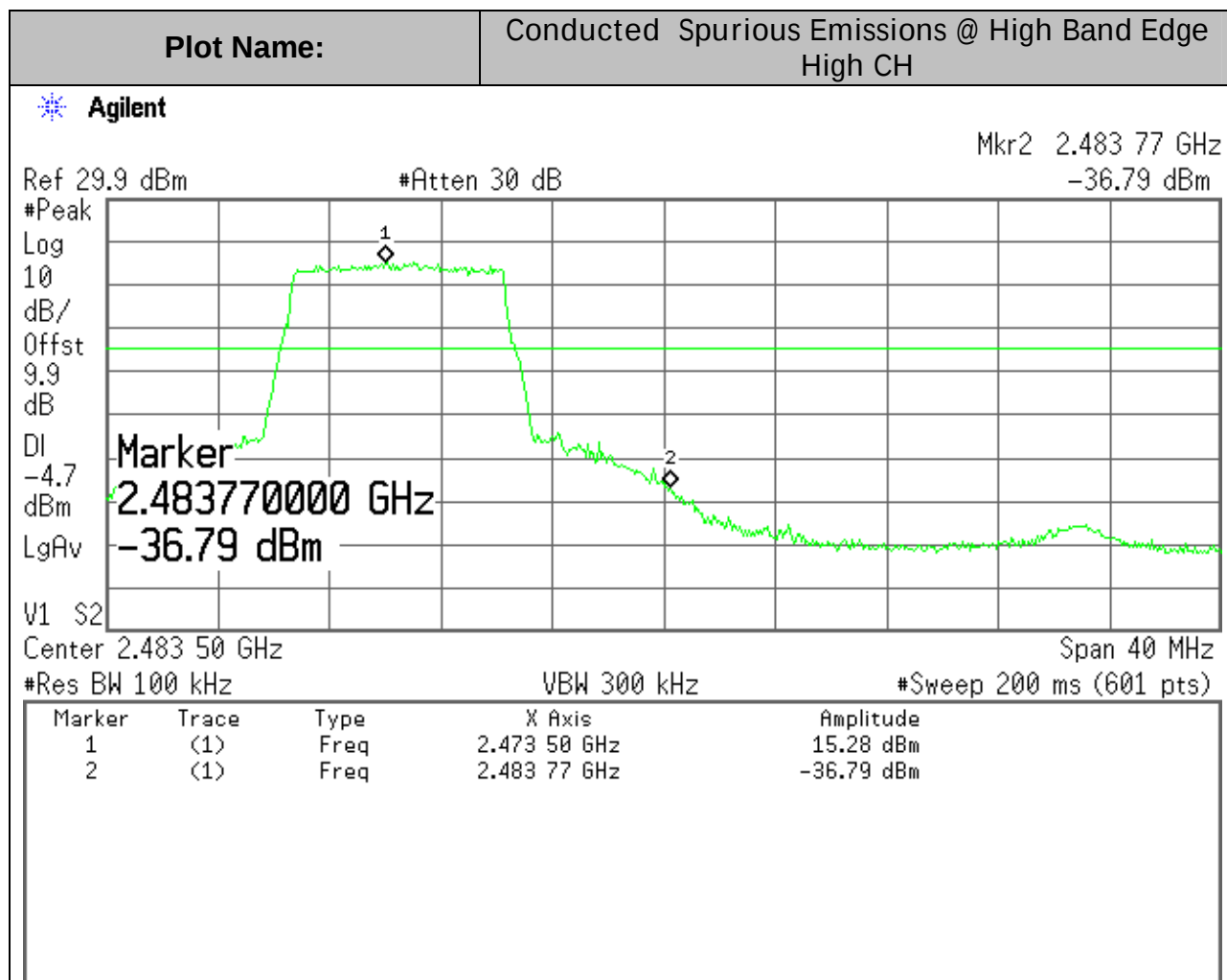
8MHz BW, 64QAM Mode:



8MHz BW, 64QAM Mode:



8MHz BW, 64QAM Mode:



7.7. RADIATED EMISSIONS

7.7.1. TRANSMITTER RADIATED SPURIOUS EMISSIONS

LIMITS

§15.205 (a) RSS-102 Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	(²)
13.36 - 13.41			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

§15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode. Established procedures in C63.10 for performing radiated measurements shall be used. For cabinet emission measurements, the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. For portable devices, the EUT was tested in three orthogonal planes.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak. For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, and then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

The radio spectrum was investigated from the lowest frequency generated within the device (without going below 9 kHz) up to the 10th harmonic of the rated transmitted emission. The emissions are investigated with the transmitter set to the lowest, middle, and highest channels.

The emissions are investigated with the transmitter set to the lowest, middle, and highest channels. The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

RESULTS

No non-compliance noted:

7.7.2. TRANSMITTER RADIATED EMISSIONS DATA (HARMONICS & SPURIOUS falling in the restricted bands listed in Sec.15.205)

A. Data for EUT with highest gain antenna (High Power Setting as the worst case)

Low Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	D Corr (dB)	Peak@3m (dBuV/m)	QP/Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
568	H	3			39.9		46.0		-6.1
594	H	3			43.2		46.0		-2.8
648	H	3			43.0		46.0		-3
704	H	3			42.8		46.0		-3.2
2634	H	3		55.3	47.0	74	54	-18.7	-7
2686	H	3		57.6	49.3	74	54	-16.4	-4.7
2710	H	3		57.6	48.7	74	54	-16.4	-5.3
4809	H	3		49.5	40.0	74	54	-24.5	-14
568	V	3			42.7		46.0		-3.3
594	V	3			43.0		46.0		-3
648	V	3			41.6		46.0		-4.4
704	V	3			42.5		46.0		-3.5
1869	V	3		54.4	45.0	74	54	-19.6	-9
2069	V	3		55.2	46.0	74	54	-18.8	-8
4809	V	3		51.4	40.2	74	54	-22.6	-13.8
7213.5	V	3		56.9	47.0	74	54	-17.1	-7

Middle Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	D Corr (dB)	Peak@3m (dBuV/m)	QP/Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
568	H	3			40.7		46.0		-5.3
594	H	3			43.6		46.0		-2.4
648	H	3			43.6		46.0		-2.4
704	H	3			42.3		46.0		-3.7
2634	H	3		56.4	48.3	74	54	-17.6	-5.7
2686	H	3		56.9	48.1	74	54	-17.1	-5.9
2710	H	3		57.6	48.7	74	54	-16.4	-5.3
4883.5	H	3		49.0	39.1	74	54	-25.0	-14.9
568	V	3			41.9		46.0		-4.1
594	V	3			43.1		46.0		-2.9
648	V	3			42.3		46.0		-3.7
704	V	3			42.7		46.0		-3.3
1869	V	3		53.6	44.8	74	54	-20.4	-9.2
2069	V	3		54.7	45.2	74	54	-19.3	-8.8
4883.5	V	3		50.9	40.3	74	54	-23.1	-13.7
7325.3	V	3		57.6	46.8	74	54	-16.4	-7.2

High Channel Harmonics/Spurious

Freq. (MHz)	Worst H/V	Dist. (m)	D Corr (dB)	Peak@3m (dBuV/m)	QP/Avg @3m (dBuV/m)	PK Lim (dBuV/m)	QP /Avg. Lim (dBuV/m)	PK Mar (dBuV/m)	QP /Avg.Mar. (dBuV/m)
568	H	3			41.2		46.0		-4.8
594	H	3			43.1		46.0		-2.9
648	H	3			42.9		46.0		-3.1
704	H	3			42.5		46.0		-3.5
2634	H	3		56.9	48.0	74	54	-17.1	-6
2686	H	3		55.2	47.7	74	54	-18.8	-6.3
2710	H	3		58.0	48.9	74	54	-16	-5.1
4948	H	3		50.0	39.8	74	54	-24.0	-14.2
568	V	3			41.3		46.0		-4.7
594	V	3			42.8		46.0		-3.2
648	V	3			42.5		46.0		-3.5
704	V	3			42.2		46.0		-3.8
1869	V	3		54.2	45.0	74	54	-19.8	-9
2069	V	3		55.9	46.4	74	54	-18.1	-7.6
4948	V	3		51.2	40.5	74	54	-22.8	-13.5
7422	V	3		57.3	46.5	74	54	-16.7	-7.5

No other harmonics or spurious emissions were detected in the rest band above system noise floor.

The worst case: EUT tested with the highest gain antenna, Dipole Antenna (5dBi). Narrowest channel BW (6MHz) and QPSK Modulation with rated High output power level (+23dBm) were selected for final testing record, based on pre-testing investigations for all modes.

B. Band Edge Data for EUT

In addition, the band-edge requirements are also verified.

Testing procedure per KDB 558074D02:

The measurement of unwanted emissions at the edge of the authorized frequency bands can be complicated by the capture of RF energy from the fundamental emission within the RBW passband. The following techniques are permitted for use in performing a measurement of the unwanted emission level at the band edges.

10.2.5.1 Marker-Delta Method

The marker-delta method, as described in KDB 913591 and in C63.10, can be used to perform measurements of the unwanted emissions level at the band-edges.

10.2.5.2 Integrated Power Measurement

A narrower resolution bandwidth can be used at the band edge to improve the measurement accuracy provided that the measurement is subsequently integrated to the relevant bandwidth specification (e.g., 100 kHz within non-restricted bands and 1 MHz within restricted frequency bands).

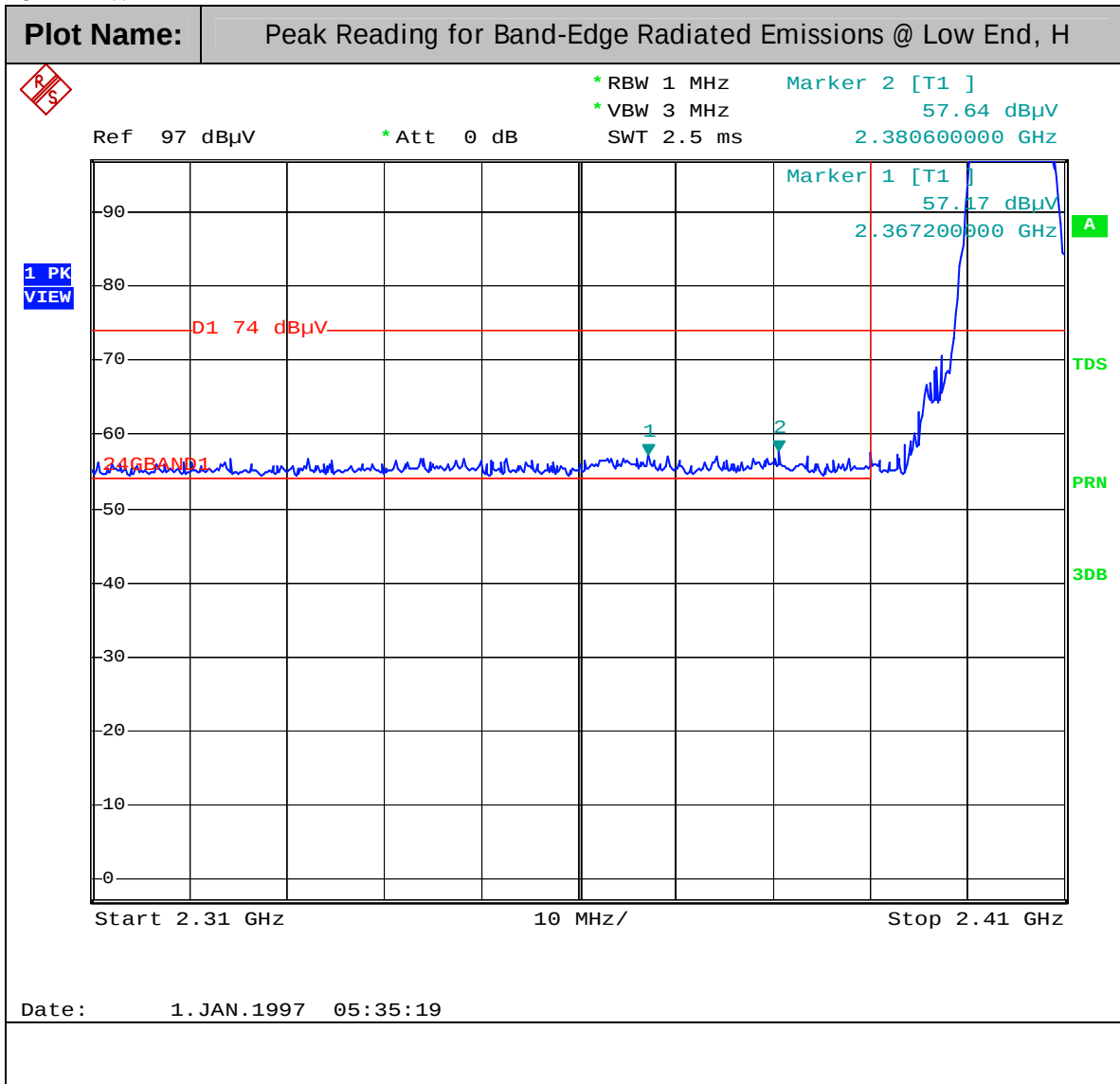
Results:

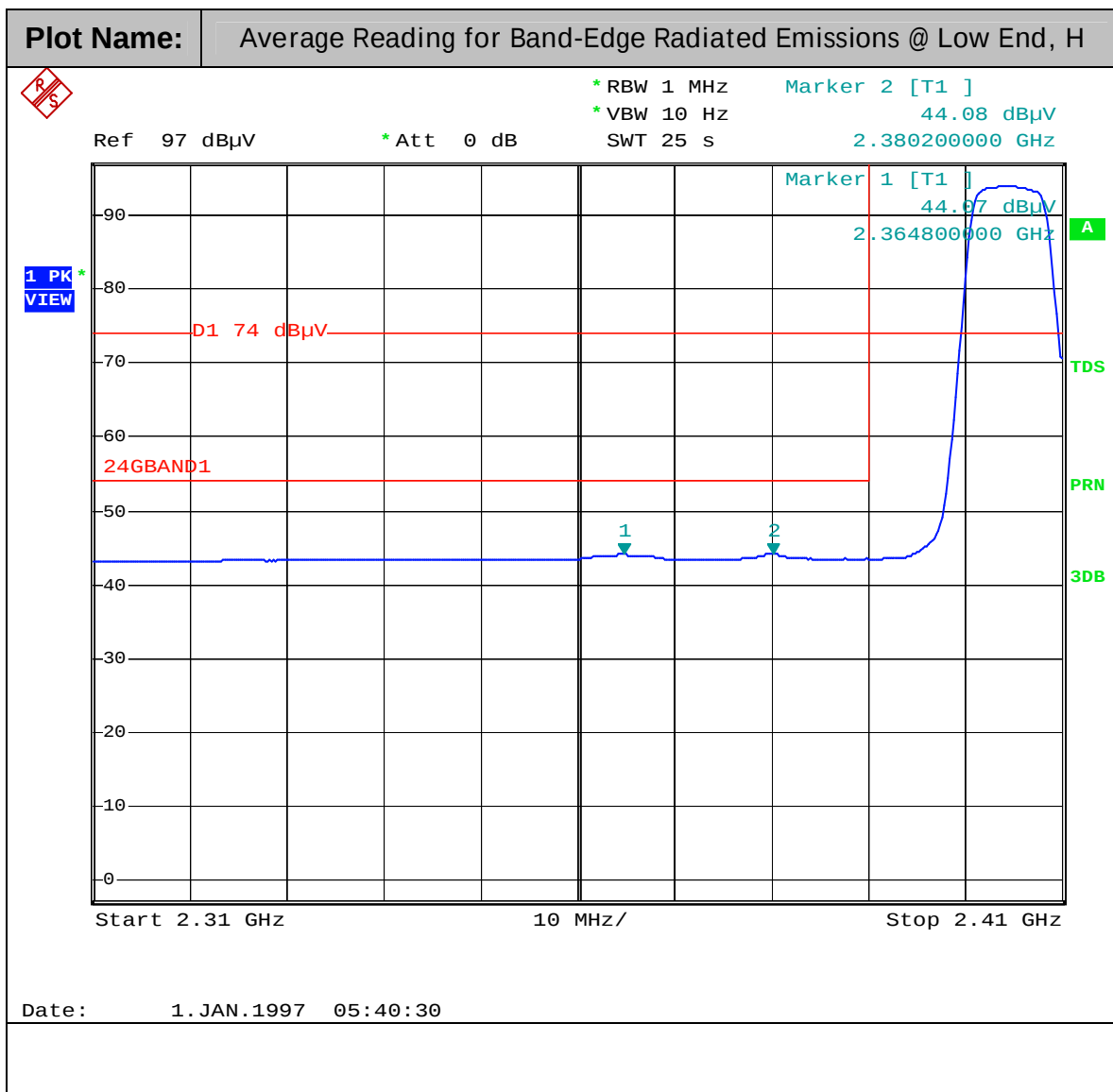
The testing results for worst case based on pretesting results are shown as following and comply with the band-edge requirements for 2400-2483.5MHz DTS per FCC Part 15.247. EUT antenna with max gain was used for this testing.

- H=Measurement antenna horizontal position
- V= Measurement antenna vertical position
- Using conventional manner for measuring the radiated emissions that are removed by more than two measurement bandwidths from band-edge, such as the emissions in the restricted band 2310-2390MHz & 2483.5-2500MHz, etc.
- Using conventional manner or if needed, using “delta” measurement technique for measuring the radiated emissions that are up to two measurement bandwidths removed from band-edge, such as the restricted band that begins at 2483.5MHz.

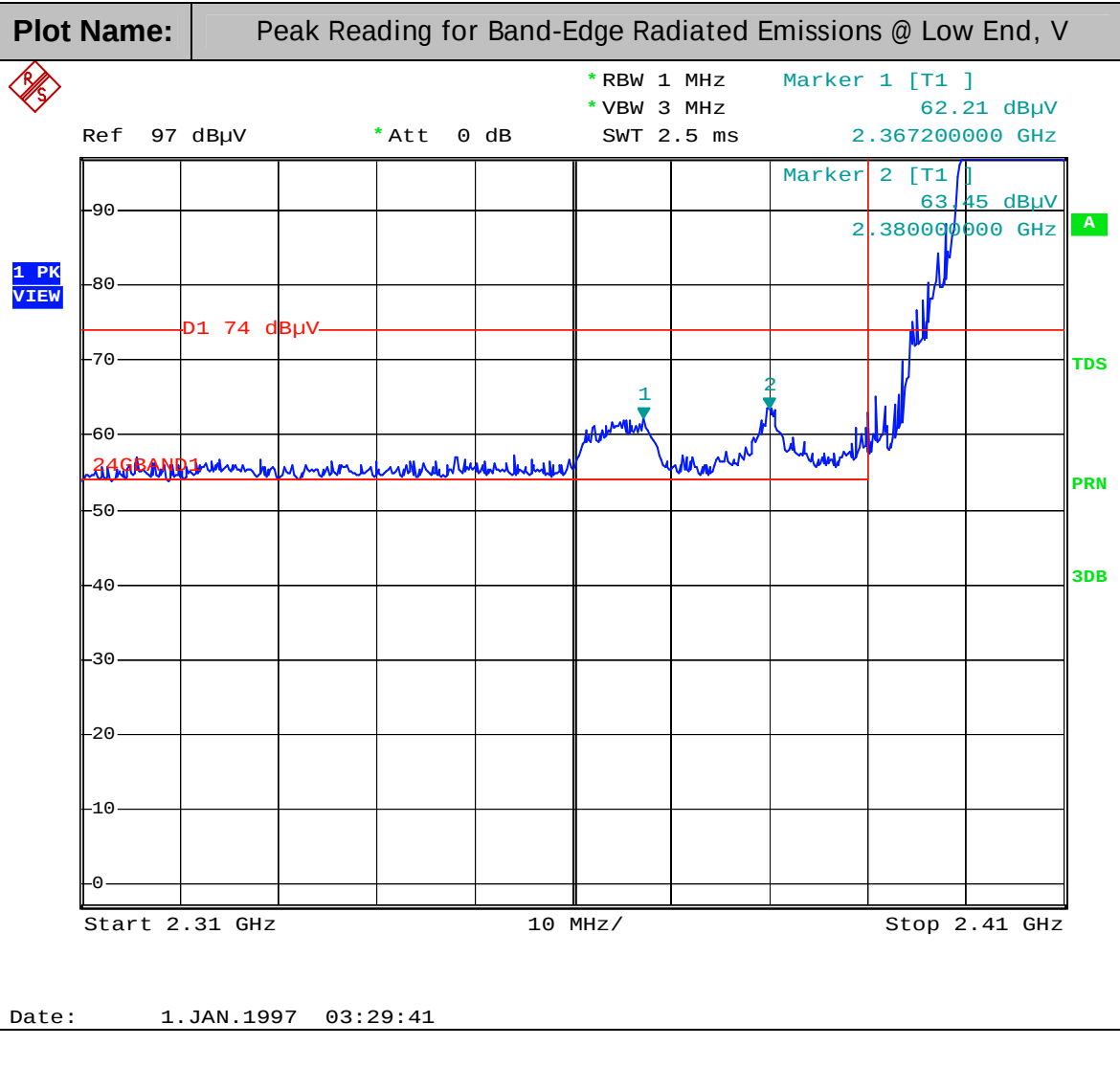
High Power Setting (P=23dBm)

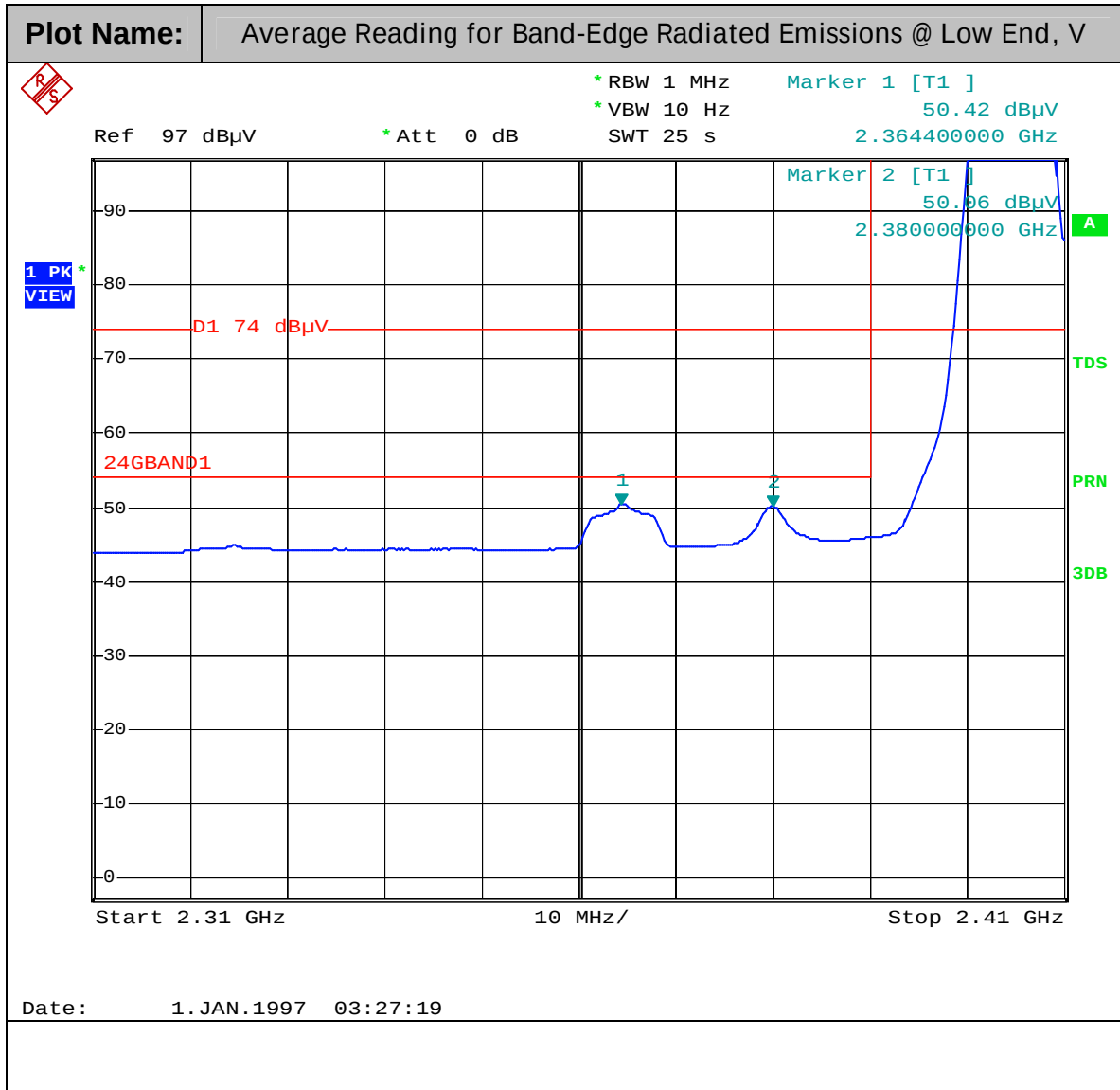
8MHz BW



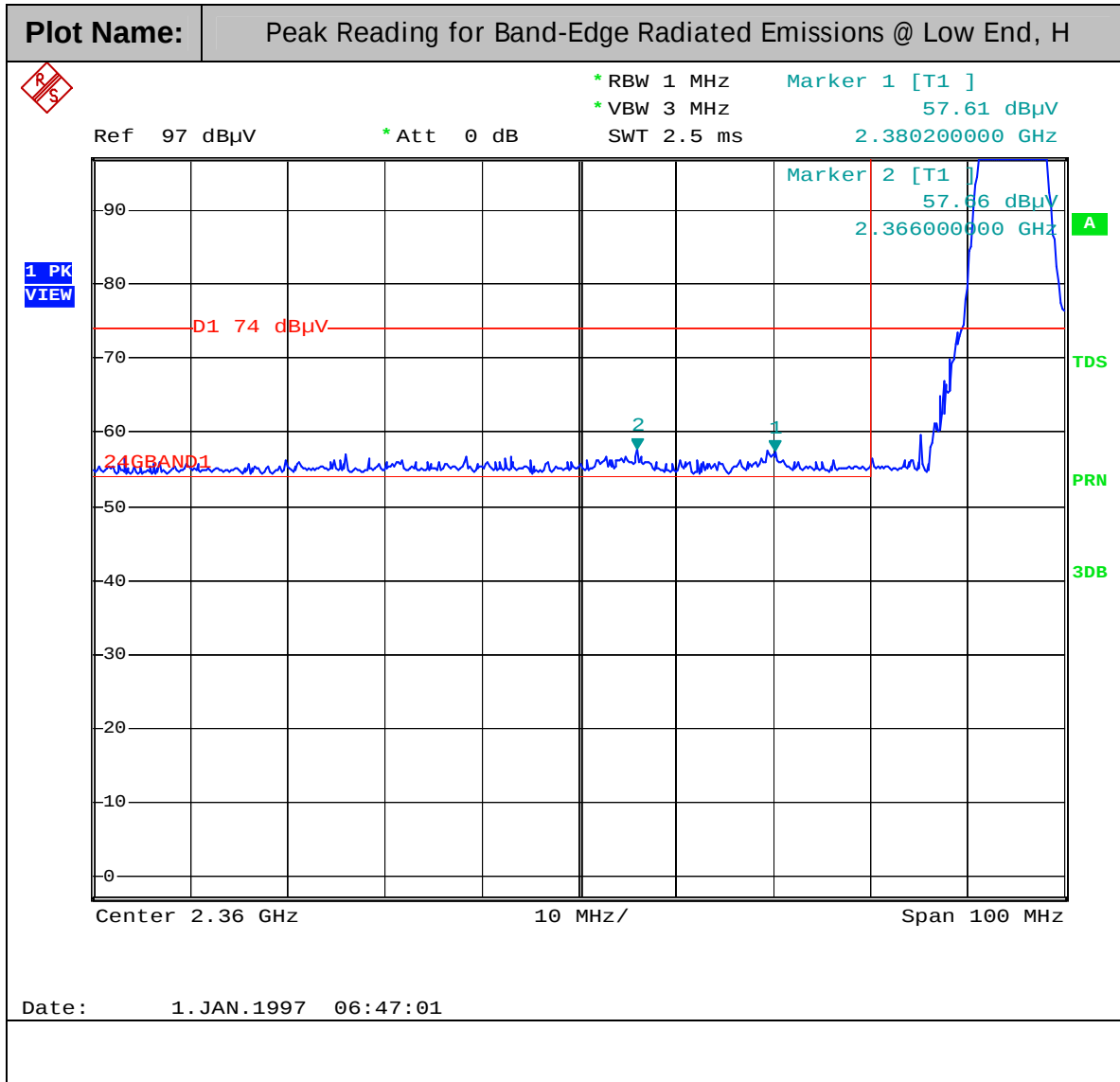


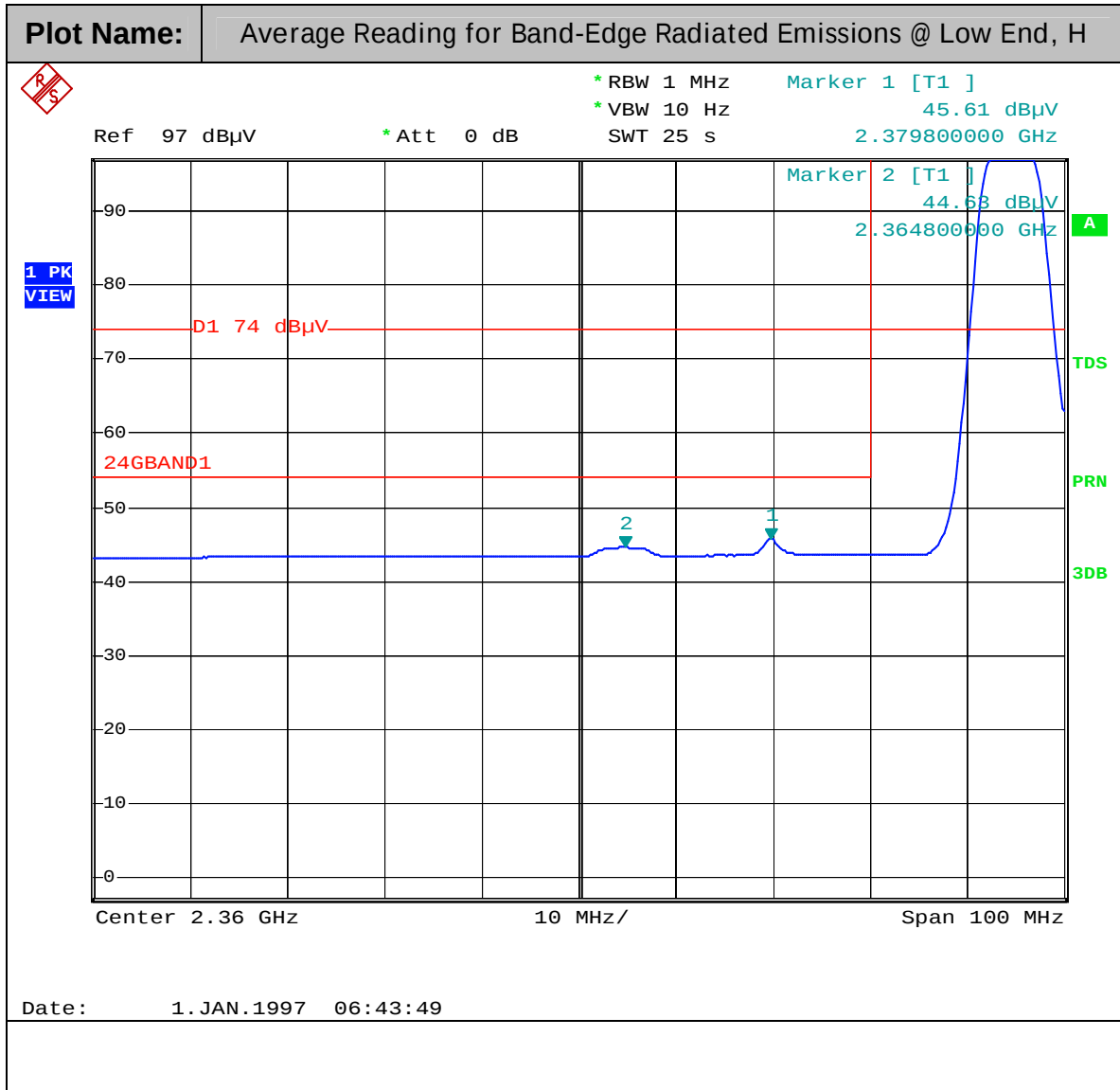
8MHz BW



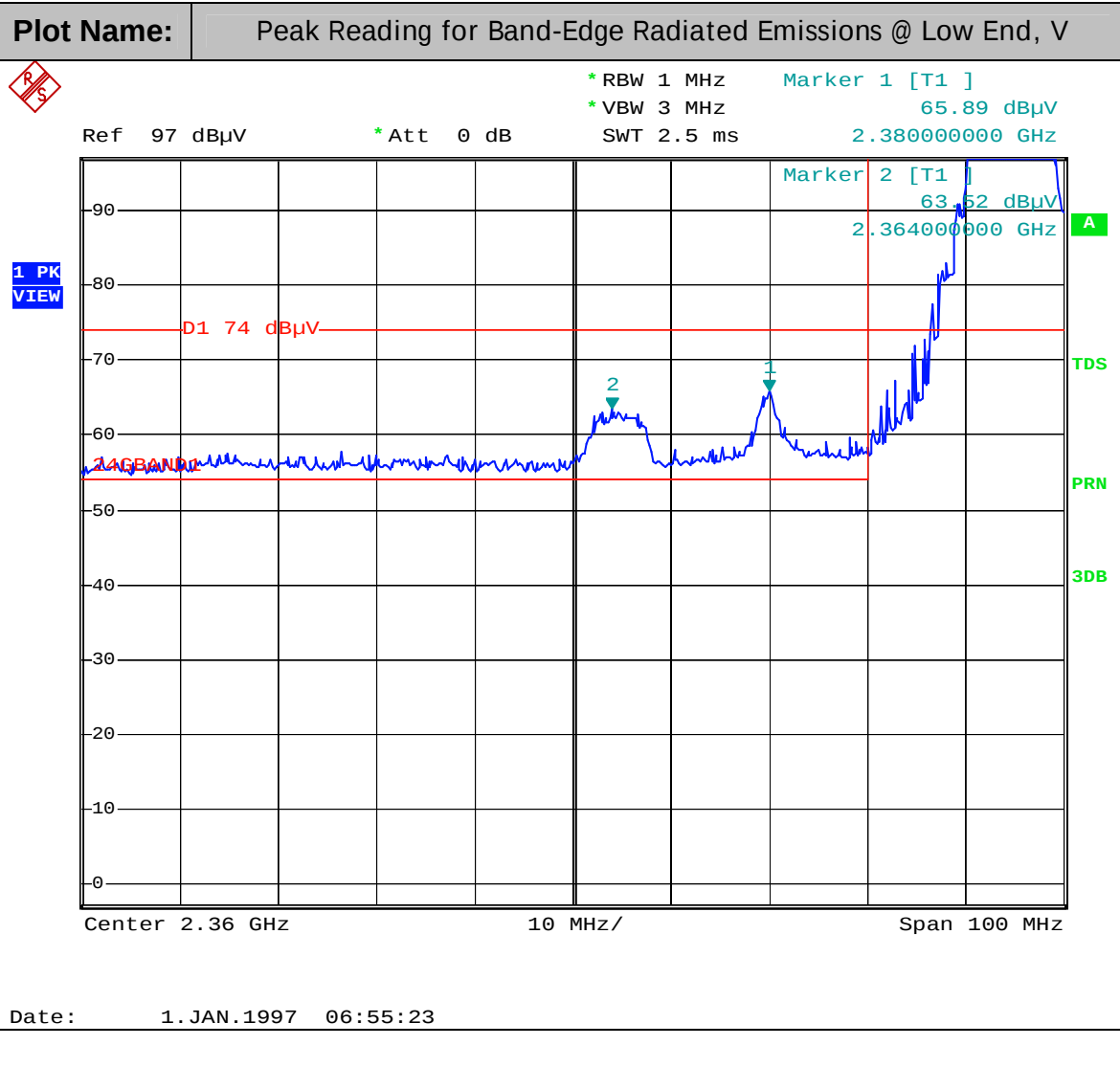


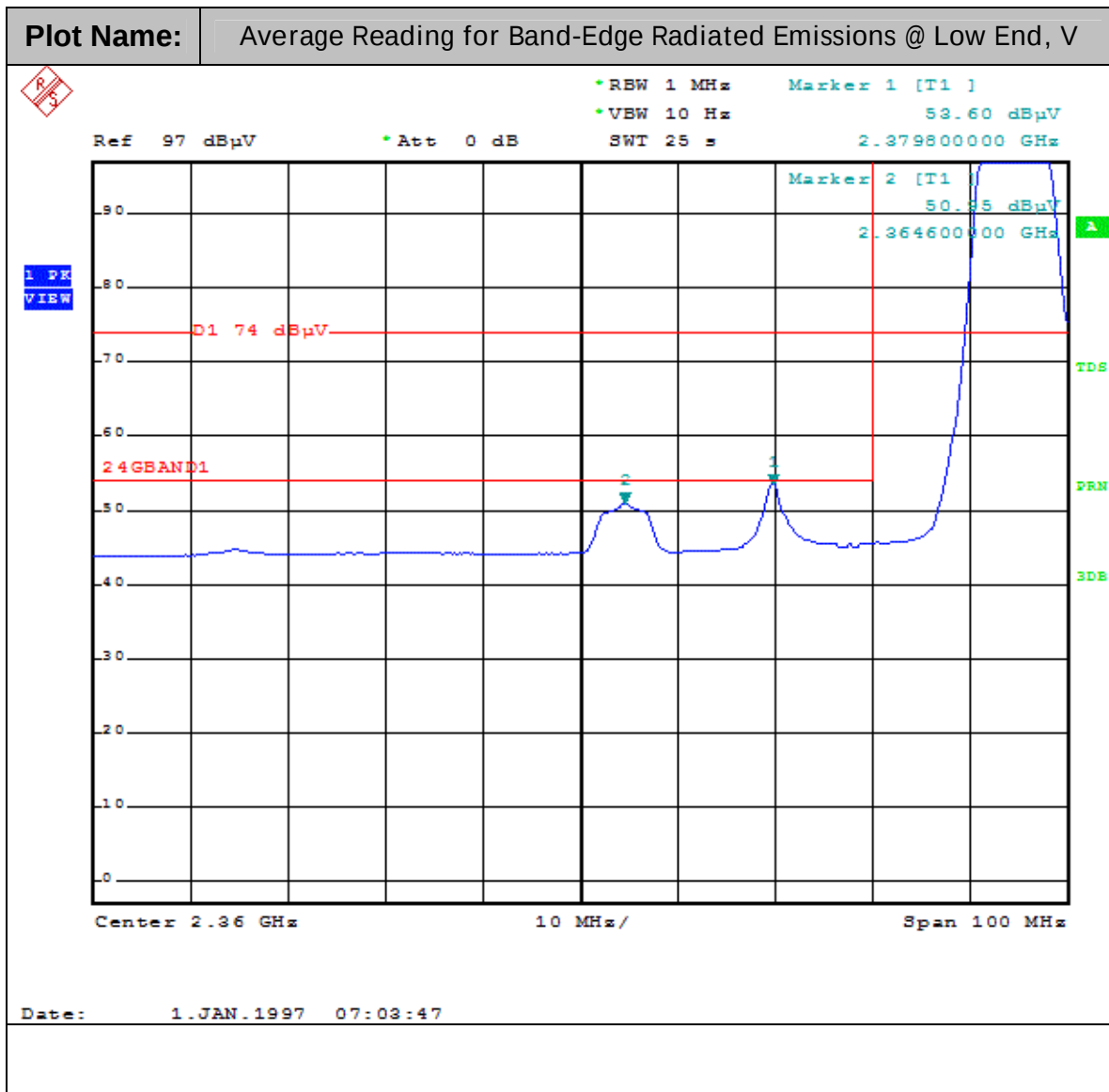
6MHz BW



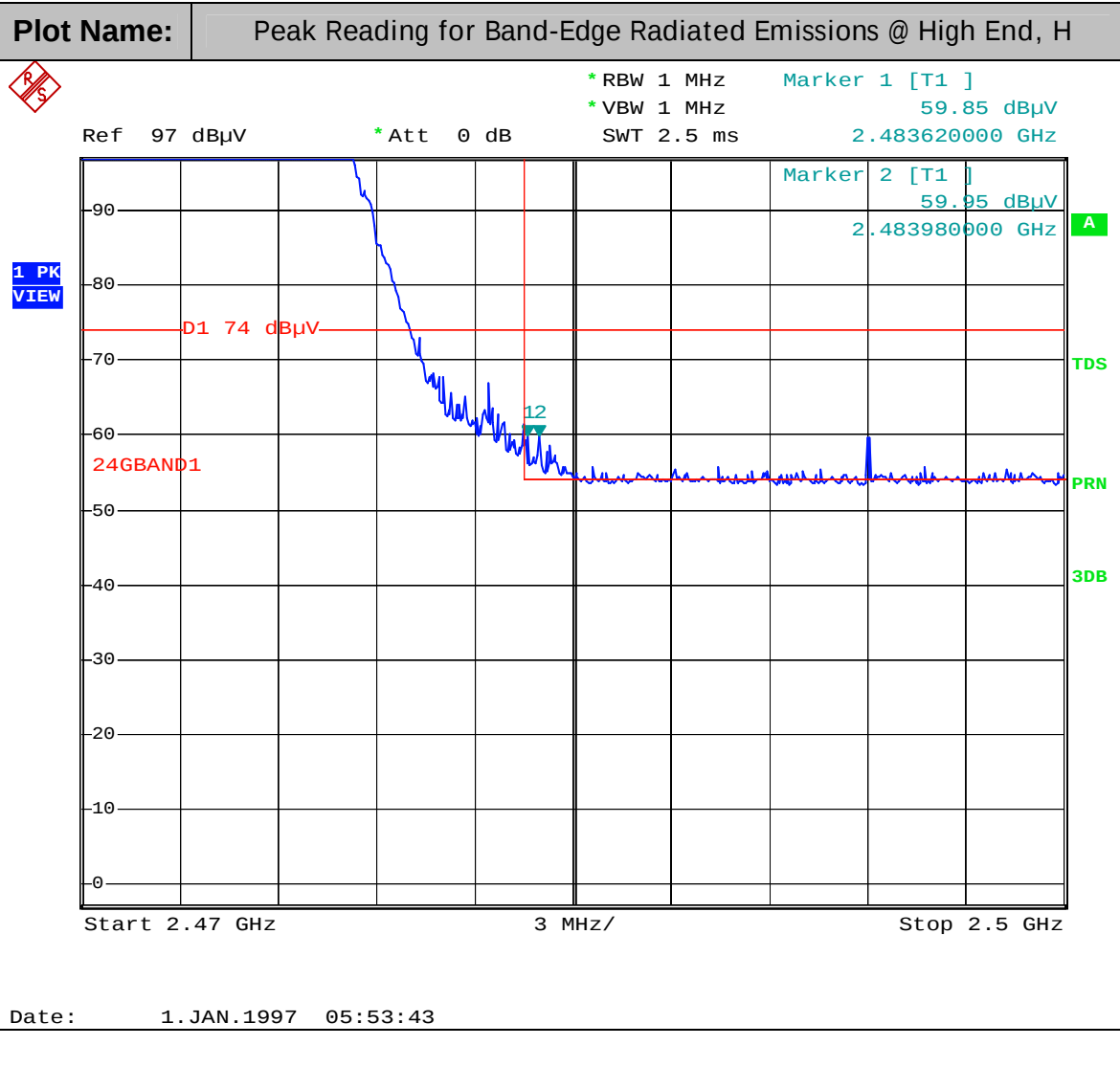


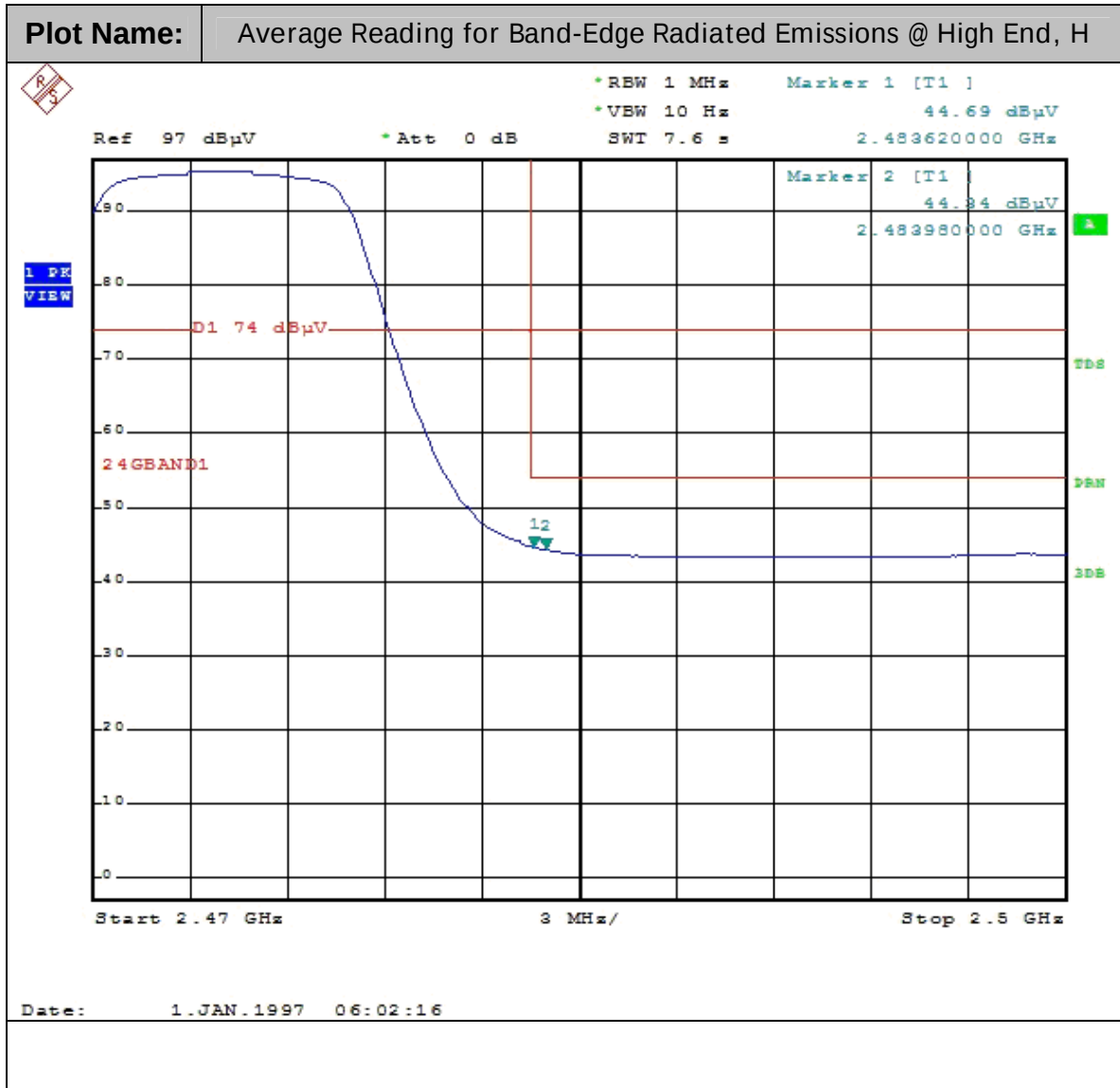
6MHz BW





8MHz BW





Plot Name: Peak Reading for Band-Edge Radiated Emissions @ High End, V

Ref 92 dBμV *Att 0 dB *RBW 1 MHz *VBW 3 MHz SWT 2.5 ms Marker 1 [T1] 122.94 dBμV 2.473240000 GHz

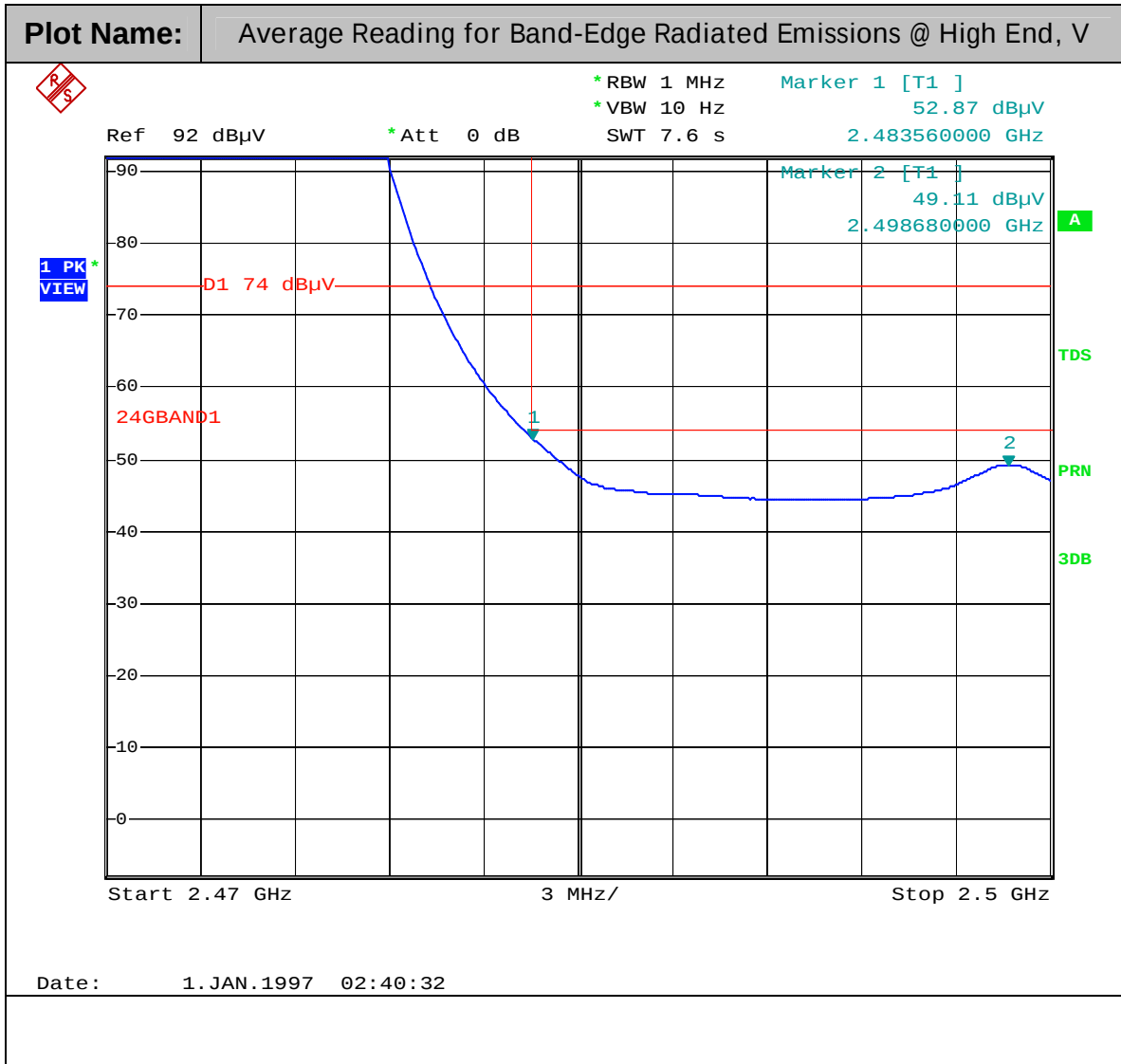
1 PK VIEW
2 PK VIEW
24GBAND1

Delta 2 [T2] -63.54 dB 10.920000000 MHz

Start 2.47 GHz 3 MHz/ Stop 2.5 GHz

Date: 1.JAN.1997 02:53:37

Using Maker-delta method, Peak Reading at high bandedge=122.94dBuV/m-63.54=59.30dBuV/m, which is under the limit, 74dBuV/m



6MHz BW

