

TEST REPORT

Report Number: 103615308MPK-014

Project Number: G103615308

October 30, 2018

**Testing performed on the
Vocera V5000 Smartbadge
Model: V5000**

FCC ID: QGZ V5000

IC: 4362A-V5000

to

**FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247, Issue 2**

For

Vocera Communications

Test Performed by:

Intertek

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Test Authorized by:

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Date: October 30, 2018

Reviewed by:



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Date: October 30, 2018

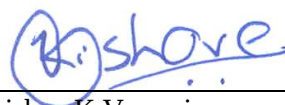
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Report No. 103615308MPK-014	
Equipment Under Test:	Vocera V5000 Smartbadge
Trade Name:	Vocera Communications
Model Number:	V5000
Part Number:	220-02100
Applicant:	Vocera Communications
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Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2
Date of Test:	September 18 – October 29, 2018

We attest to the accuracy of this report:



Anderson Soungpanya
Project Engineer



Krishna K Vemuri
Engineering Team Lead

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1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
RF Output Power	15.247(b)(3)	RSS-247, 5.4	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2	Complies
Power Density	15.247(e)	RSS-247, 5.2	Complies
Out of Band Antenna Conducted Emission	15.247(d)	RSS-247, 5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-247, 5.5	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Complies
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies

EUT receive date: September 17, 2018

EUT receive condition: The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.

Test start date: September 18, 2018

Test completion date: October 29, 2018

The test results in this report pertain only to the item tested.

2.0 General Information

2.1 Product Description

Vocera Communications supplied the following description of the EUT:

The V5000 Smartbadge is a wearable communication device powered by a removable, rechargeable Lithium Ion battery. The badge contains a 2.4" color, capacitive touch screen, with an array of microphones, a hands free speaker and an audio receiver.

For more information, see user's manual provided by the manufacturer.

This test report covers only the 2.4GHz WiFi radio.

Information about the WiFi radio is presented below:

The EUT supports a wide range of data rates in the 2.4GHz band:

IEEE 802.11b
IEEE 802.11g
IEEE 802.11n

Radio Information	
Applicant	Vocera Communications
Model Number	V5000
FCC Identifier	QGZ V5000
IC Identifier	4362A-V5000
Modulation Technique	DSSS (BPSK, QPSK, CCK), OFDM (BPSK, QPSK, 16QAM, 64QAM)
Rated RF Output	802.11b: 17.77 dBm 802.11g: 16.27 dBm 802.11n: 16.01 dBm
Frequency Range	2412 – 2462 MHz, 802.11b/g/n
Type of modulation	BPSK, QPSK, 16QAM, 64QAM
Number of Channel(s)	11 for 802.11b/g/n
Antenna(s) & Gain	Internal Antenna, Gain: +4.9 dBi
Applicant Name & Address	Vocera Communications 525 Race St, Ste 150 San Jose, CA 95126 USA

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Antenna conducted measurements were performed according to the FCC documents “Guidance for Performing Compliance Measurement on Digital Transmission Systems, Frequency Hopping Spread Spectrum System, and Hybrid System devices Operating under §15.247” (KDB 558074 D01 Meas Guidance v05), RSS-247 Issue 2, ANSI C63.10: 2013 and RSS-GEN Issue 4.

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10: 2013. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Data Sheet" of this report.

2.4 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 1 GHz	1 GHz – 2.5 GHz	> 2.5 GHz
RF Power and Power Density – antenna conducted	-	0.7 dB	-
Unwanted emissions - antenna conducted	1.1 dB	1.3 dB	1.9 dB
Bandwidth – antenna conducted	-	30 Hz	-

Measurement	Expanded Uncertainty (k=2)			
	0.15 MHz – 30MHz	30 – 200 MHz	200 MHz – 1 GHz	1 GHz – 18 GHz
Radiated emissions	-	4.7	4.6	5.1 dB
AC mains conducted emissions	2.1 dB	-	-	-

3.0 System Test Configuration

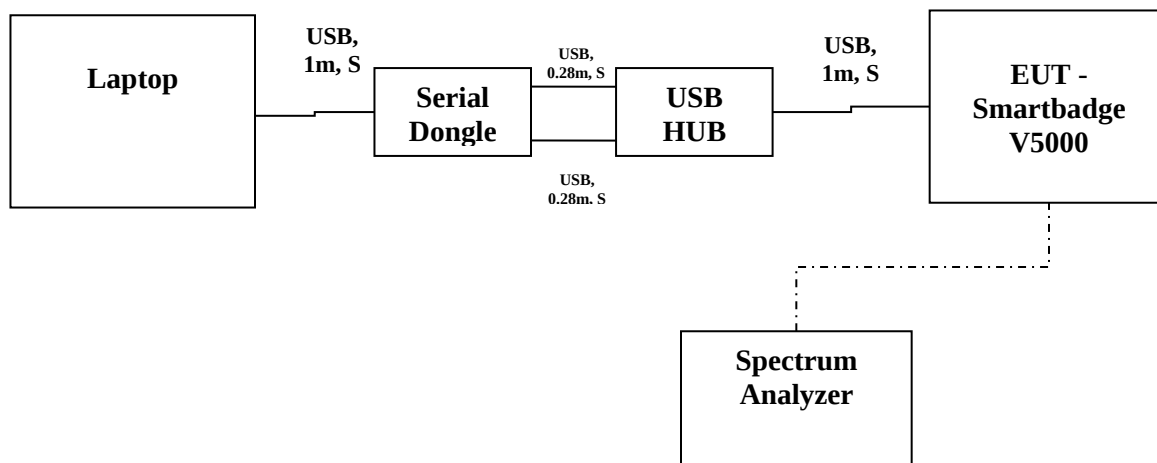
3.1 Support Equipment and description

Description	Manufacturer	Model No./ Part No.
Laptop	Lenovo	T440P
USB Hub	Tendak	CP-029-BK
Serial Dongle	Vocera	210-01516-B04

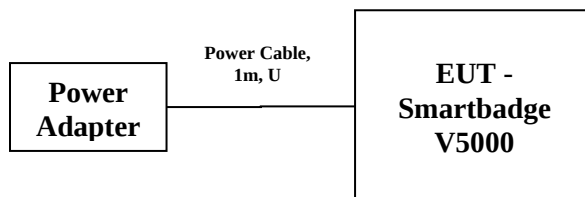
3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Smartbadge – Conducted Unit	Vocera	V5000	SA3308HF5002D6
Smartbadge – Radiated Unit	Vocera	V5000	SA3308HR50031E
Power Adapter	Asian Power Devices Inc.	WB-10E05R	S8827999000015
Earphone	Kingstate Electronics Corp.	KJFGKS172JJB-01	Not listed

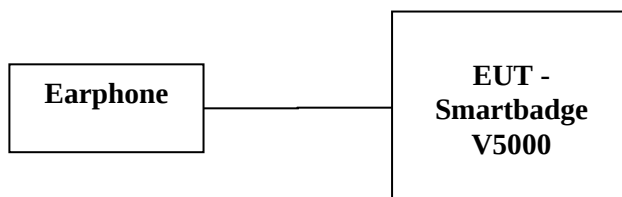
Antenna was removed and co-axial connector was installed for Conducted Measurements.



Radiated Measurements Charging Mode



Radiated Measurements Normal Mode



S = Shielded
U = Unshielded

F = With Ferrite
M = Meter

3.3 Justification

Preliminary testing was performed for all modulation/data rate modes. The worse-case data rate with highest power and widest spectrum were selected for final measurements:

CCK 1 Mbps – for 802.11b
OFDM 6 Mbps – for 802.11g
OFDM MCS0 – for 802.11n

Different orientation of the EUT were tested and only the worse-case emissions were reported.

For radiated emission measurements the EUT is placed on a non-conductive table.

The EUT was tested in 2 configurations:

- A/ Charging mode: tested with power adapter
- B/ Normal mode: tested in battery mode and earphone.

Unless otherwise stated in this report, measurements made for, Radiated Spurious were made with the worst-case power setting (mid channel power).

3.4 Mode of Operation During Test

During transmitter testing, the transmitter was setup to transmit continuously using the maximum RF power setting provided by the manufacturers via test scripts. The corresponding output power in dBm can be found in section 4.2 of this report.

The table below reflects the RF power setting needed to be compliant with radiated restricted band edge requirements of 15.205 & 15.209.

Channels	802.11b	802.11g	802.11n
1	18	13	13
2	18	16	16
6	18	18	18
9	18	16	16
10	18	15	15
11	16	13	13

3.5 Modifications Required for Compliance

No modifications were made by the manufacturer or Intertek to the EUT in order to bring the EUT into compliance.

3.6 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

4.0 Measurement Results

4.1 6-dB Bandwidth and 99% Occupied Bandwidth FCC Rule: 15.247(a)(2); RSS-247 A8.2 and RSS-GEN;

4.1.1 Requirement

The minimum 6-dB bandwidth shall be at least 500 kHz

4.1.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

For FCC 6dB Channel Bandwidth the Procedure described in the FCC Publication KDB 558074 D01 Meas Guidance v05 was used to determine the DTS occupied bandwidth. Section 11.8.1 Option 1 of ANSI 63.10 was used.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

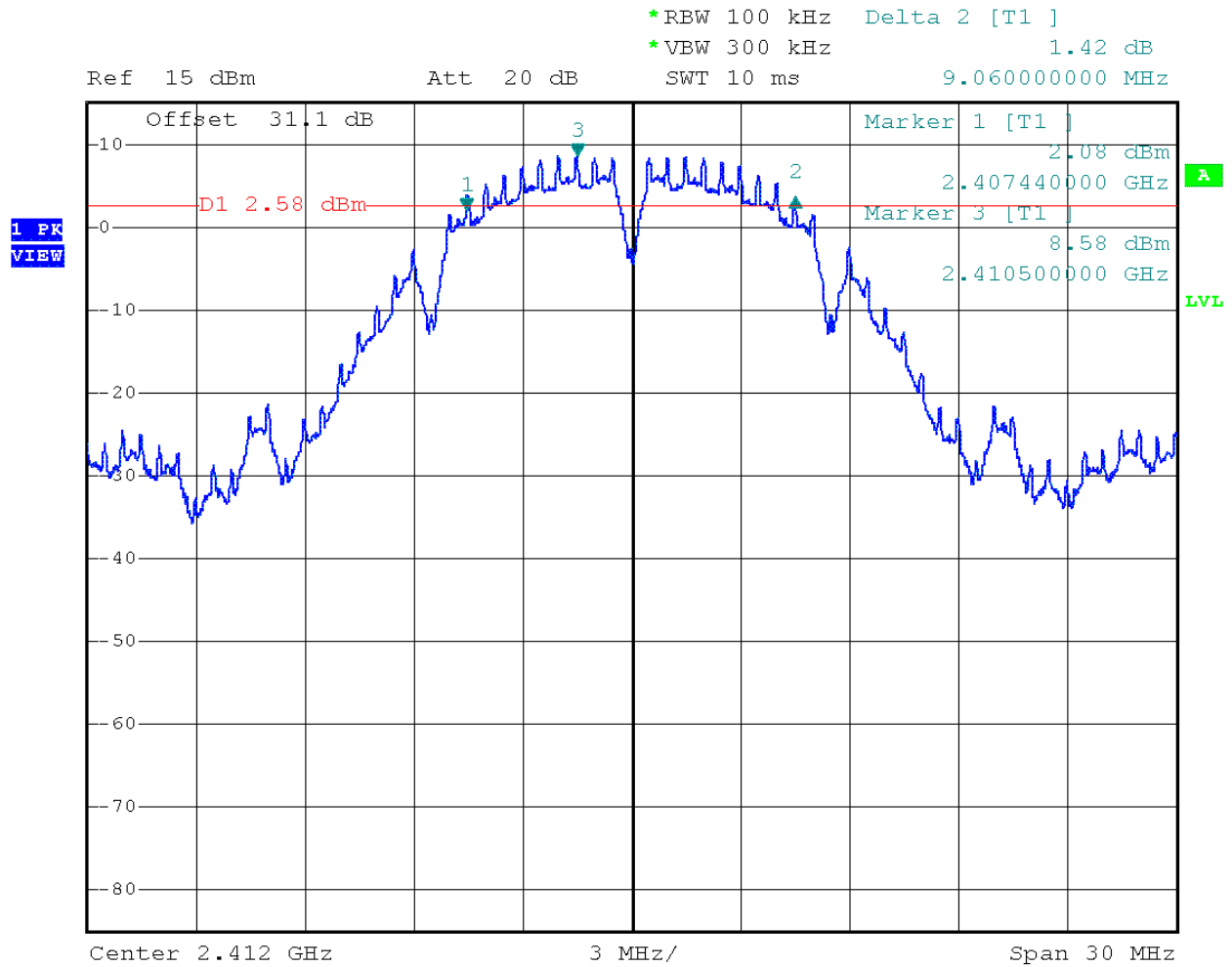
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

Tested By	Test Date
Anderson Soungpanya	September 18 & 19, 2018

4.1.3 Test Result

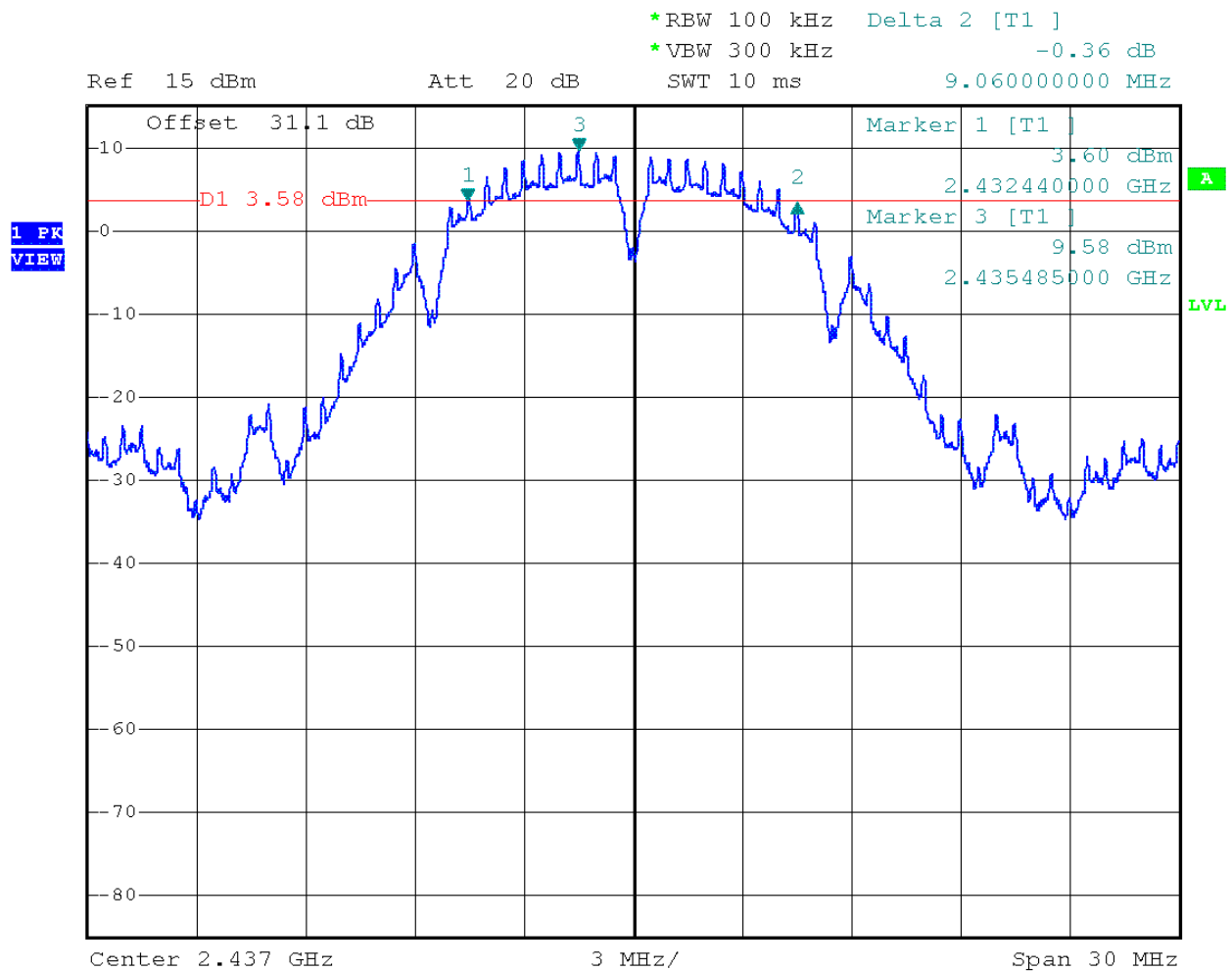
Frequency MHz	Ch.	Frequency MHz	6 dB FCC Bandwidth, MHz	Plot #	99% Bandwidth, MHz	Plot #
802.11b	1	2412	9.060	1.1	12.450	1.10
	6	2437	9.060	1.2	12.450	1.11
	11	2462	9.000	1.3	12.270	1.12
802.11g	1	2412	16.378	1.4	17.395	1.13
	6	2437	16.335	1.5	17.325	1.14
	11	2462	16.293	1.6	16.888	1.15
802.11n	1	2412	17.483	1.7	18.375	1.16
	6	2437	17.500	1.8	18.288	1.17
	11	2462	17.500	1.9	17.955	1.18

Plot 1.1 – 6dB Bandwidth (FCC)



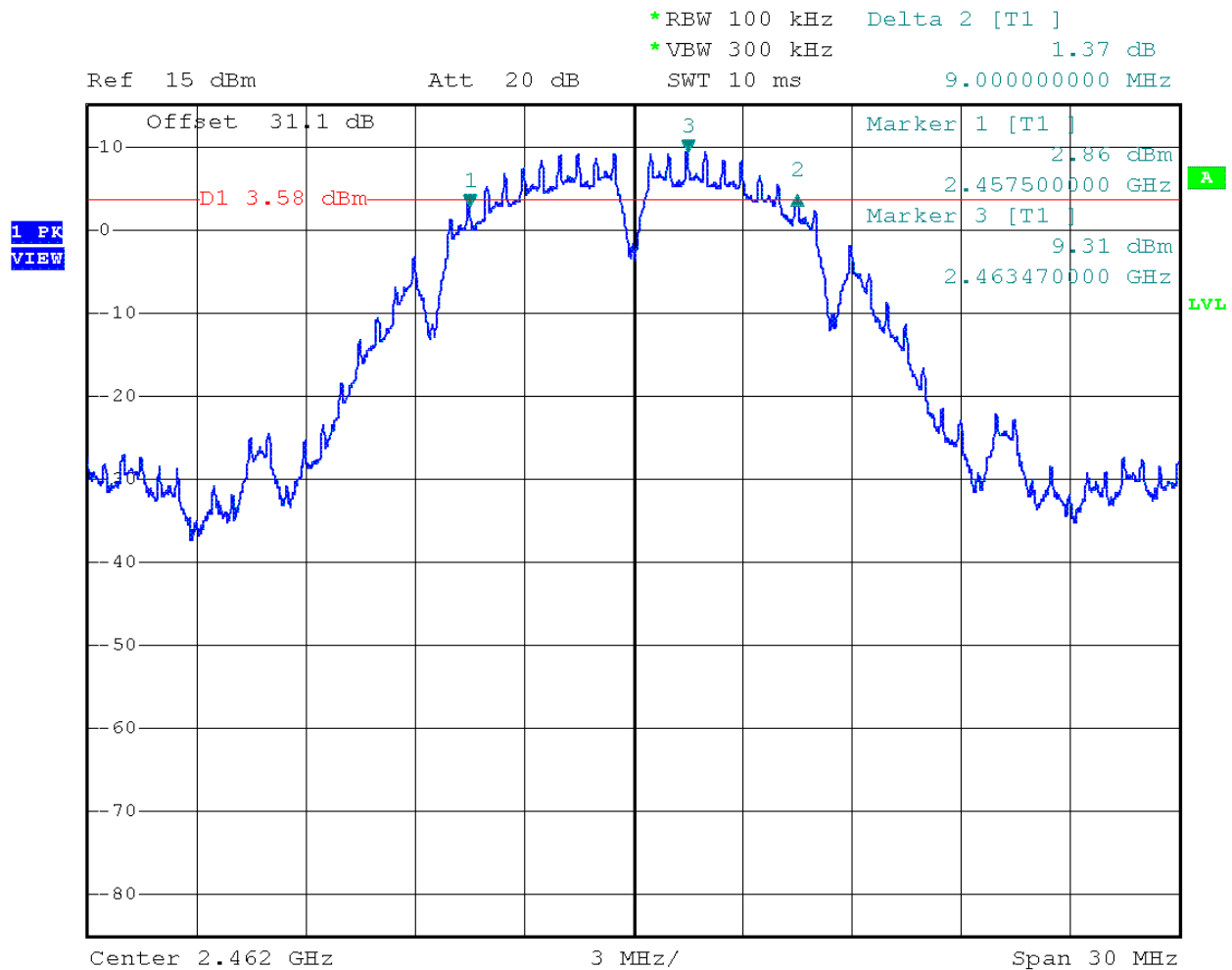
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Plot 1.2 – 6dB Bandwidth (FCC)



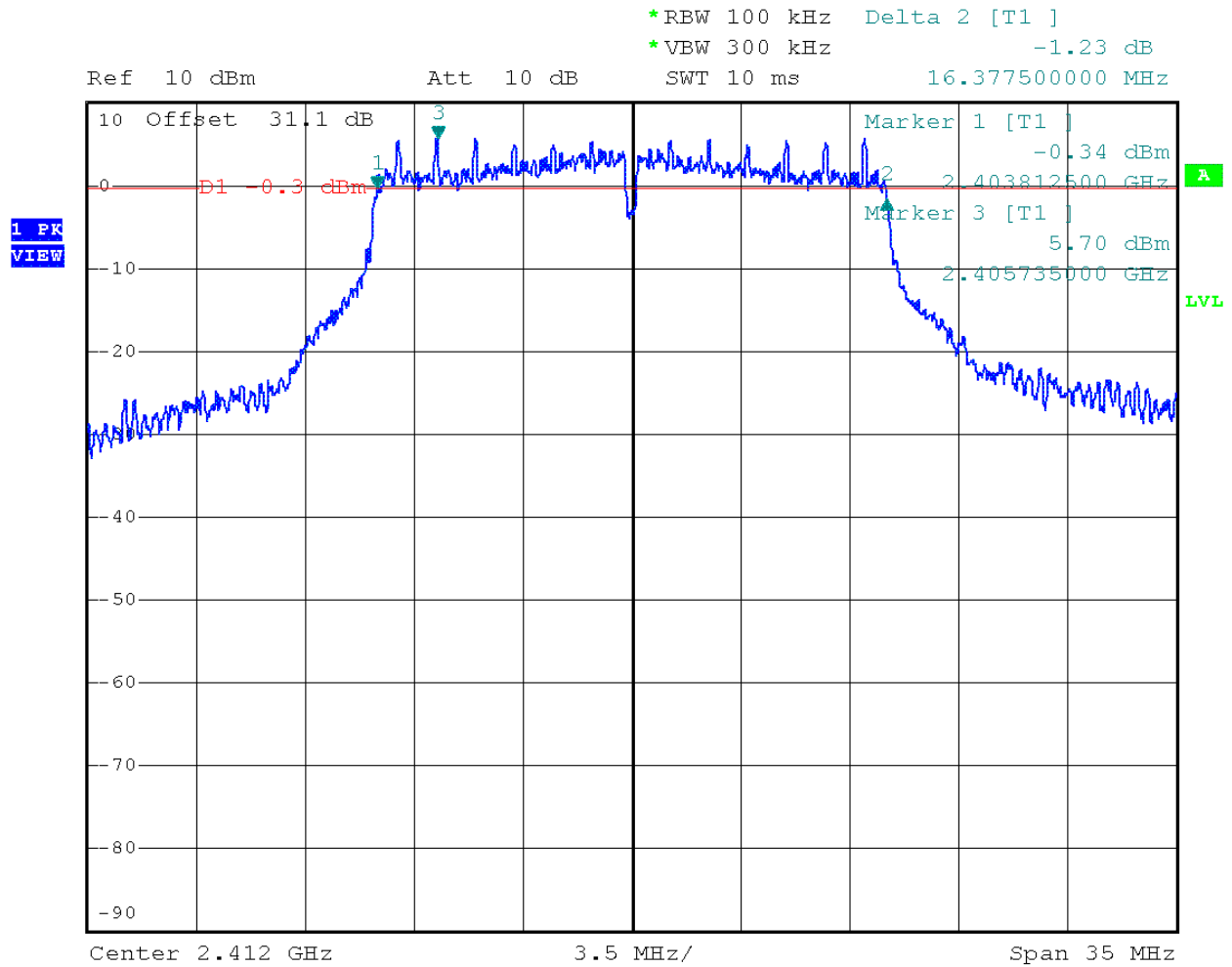
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Plot 1 3 – 6dB Bandwidth (FCC)



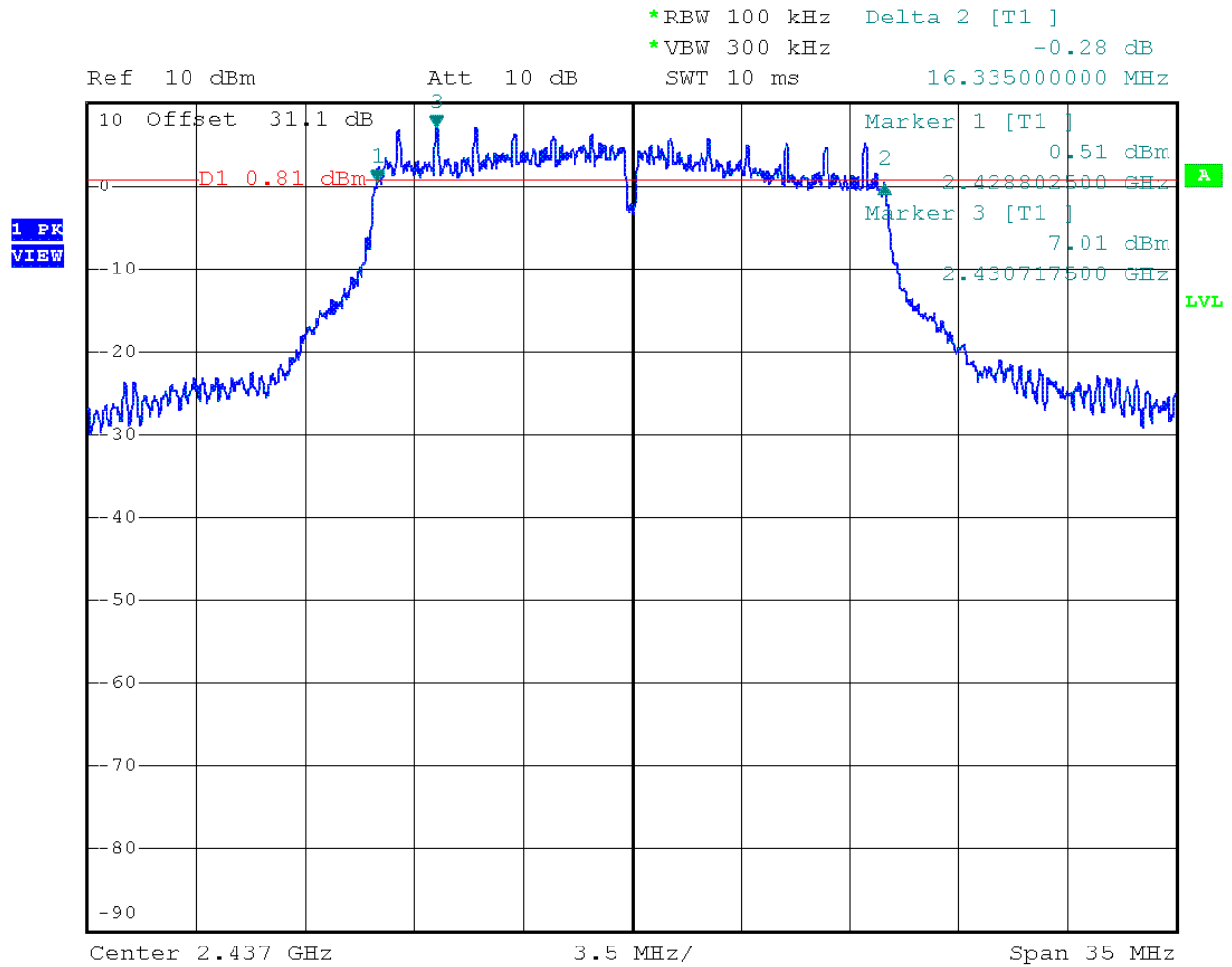
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Plot 1.4 – 6dB Bandwidth (FCC)



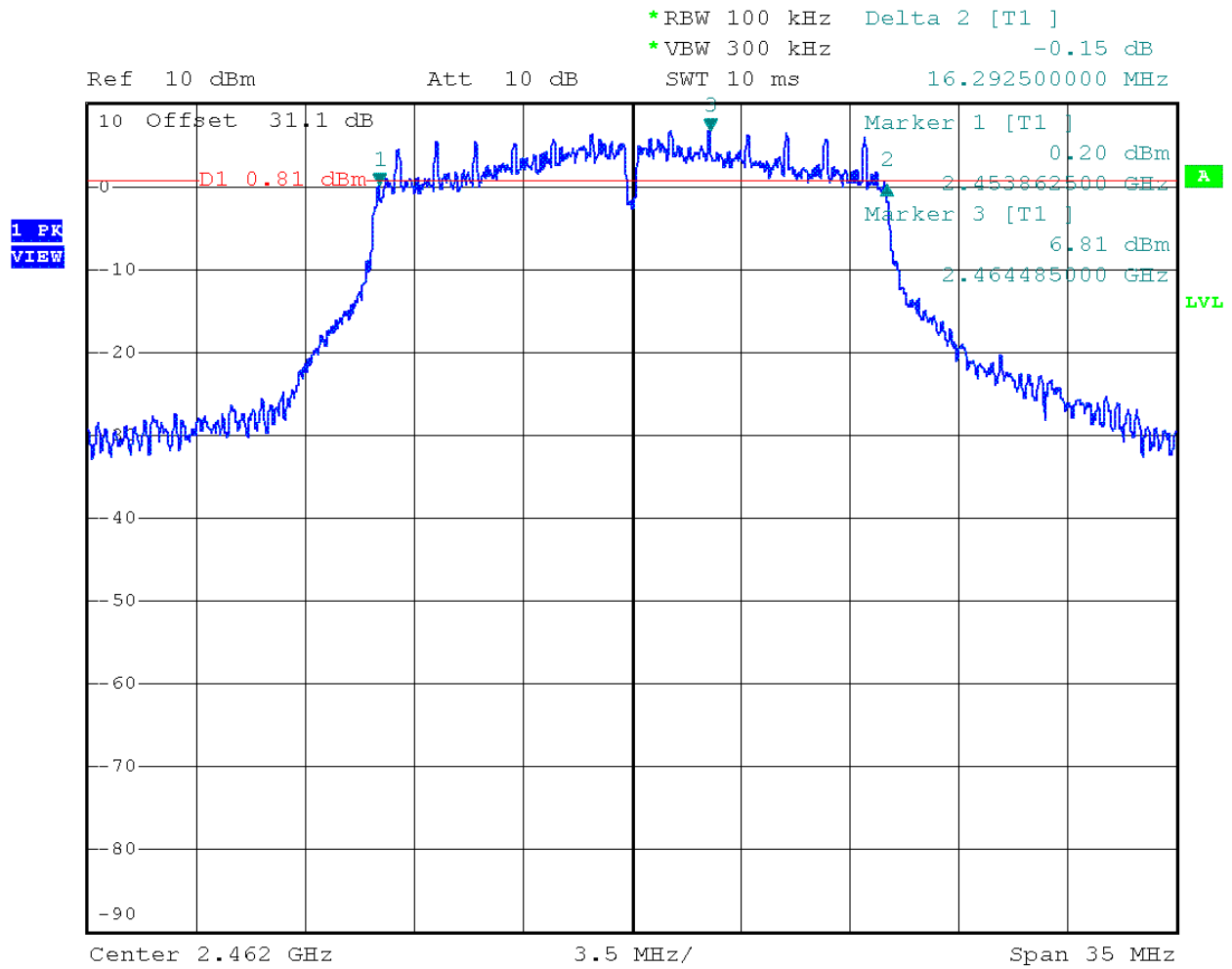
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Plot 1.5 – 6dB Bandwidth (FCC)



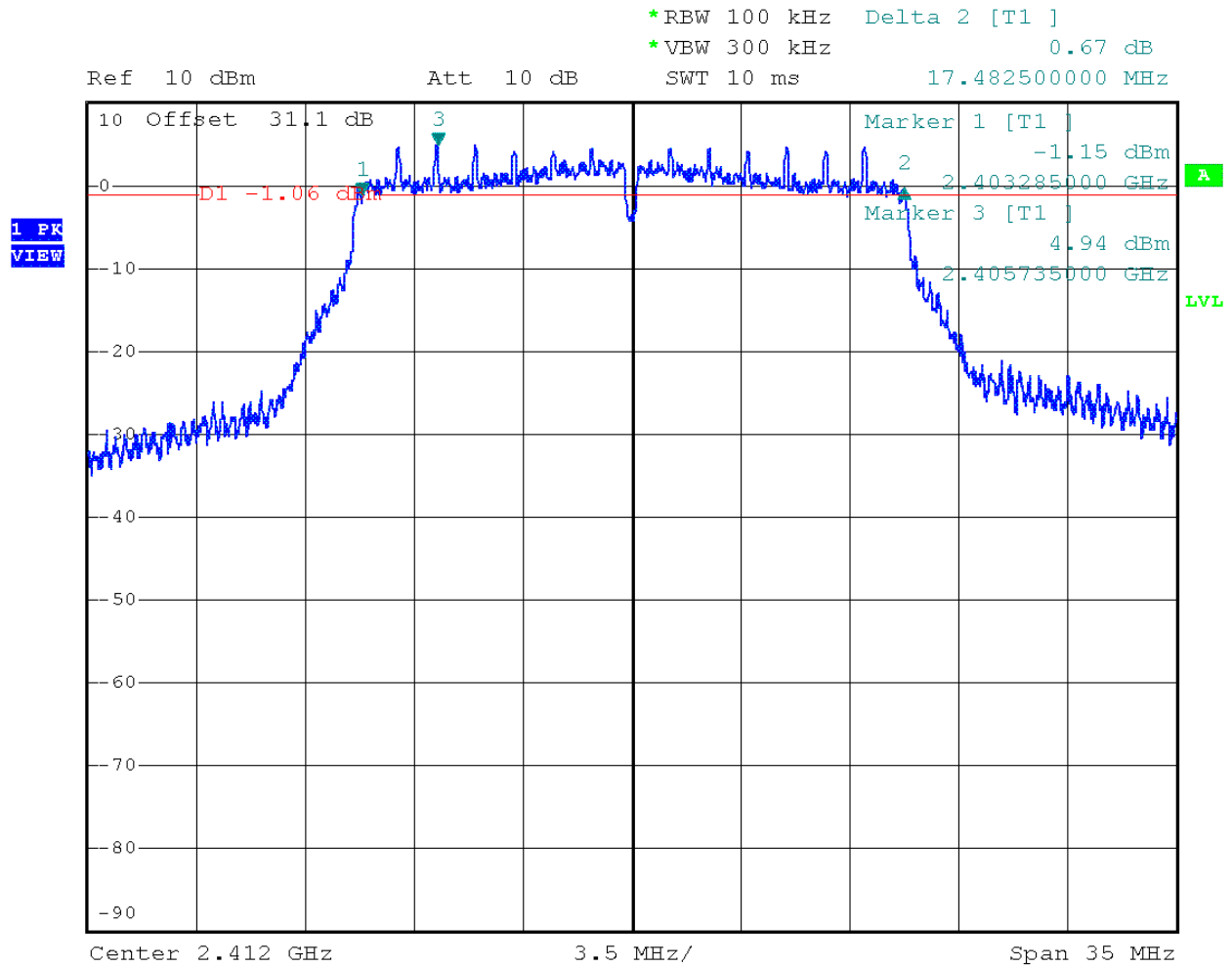
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Plot 1.6 – 6dB Bandwidth (FCC)



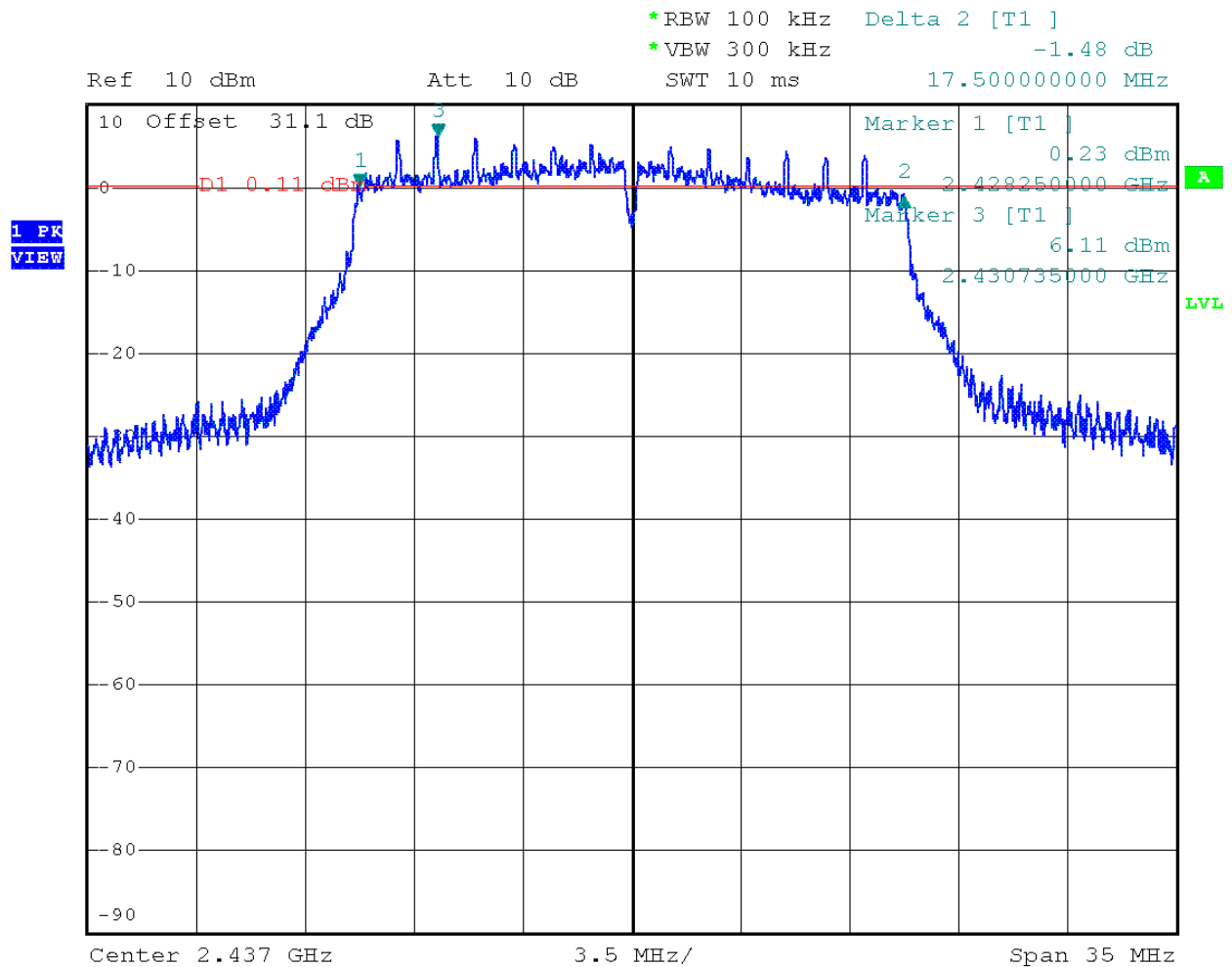
Date: 19.SEP.2018 12:11:07

Plot 1.7 – 6dB Bandwidth (FCC)



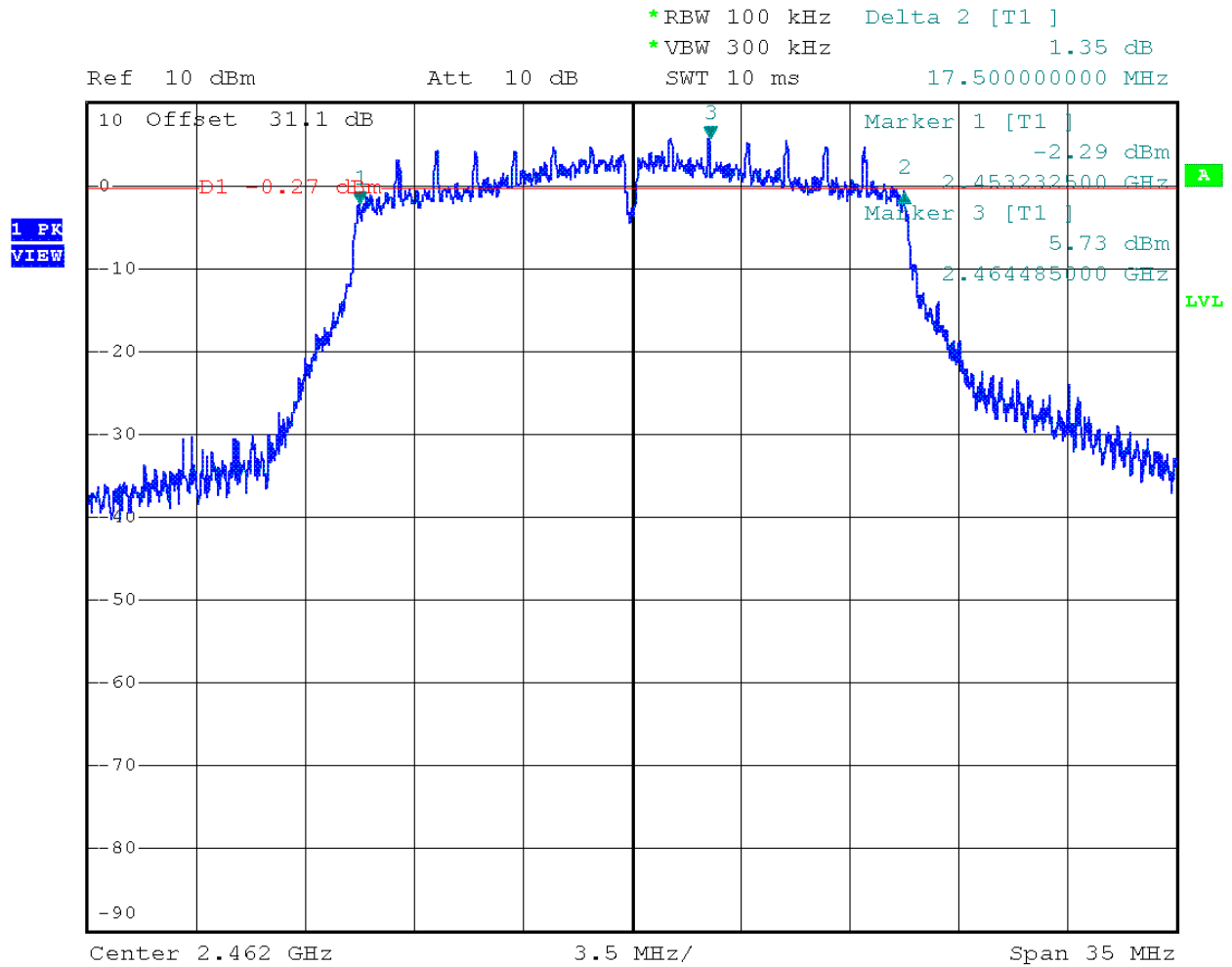
Date: 19.SEP.2018 11:51:59

Plot 1.8 – 6dB Bandwidth (FCC)



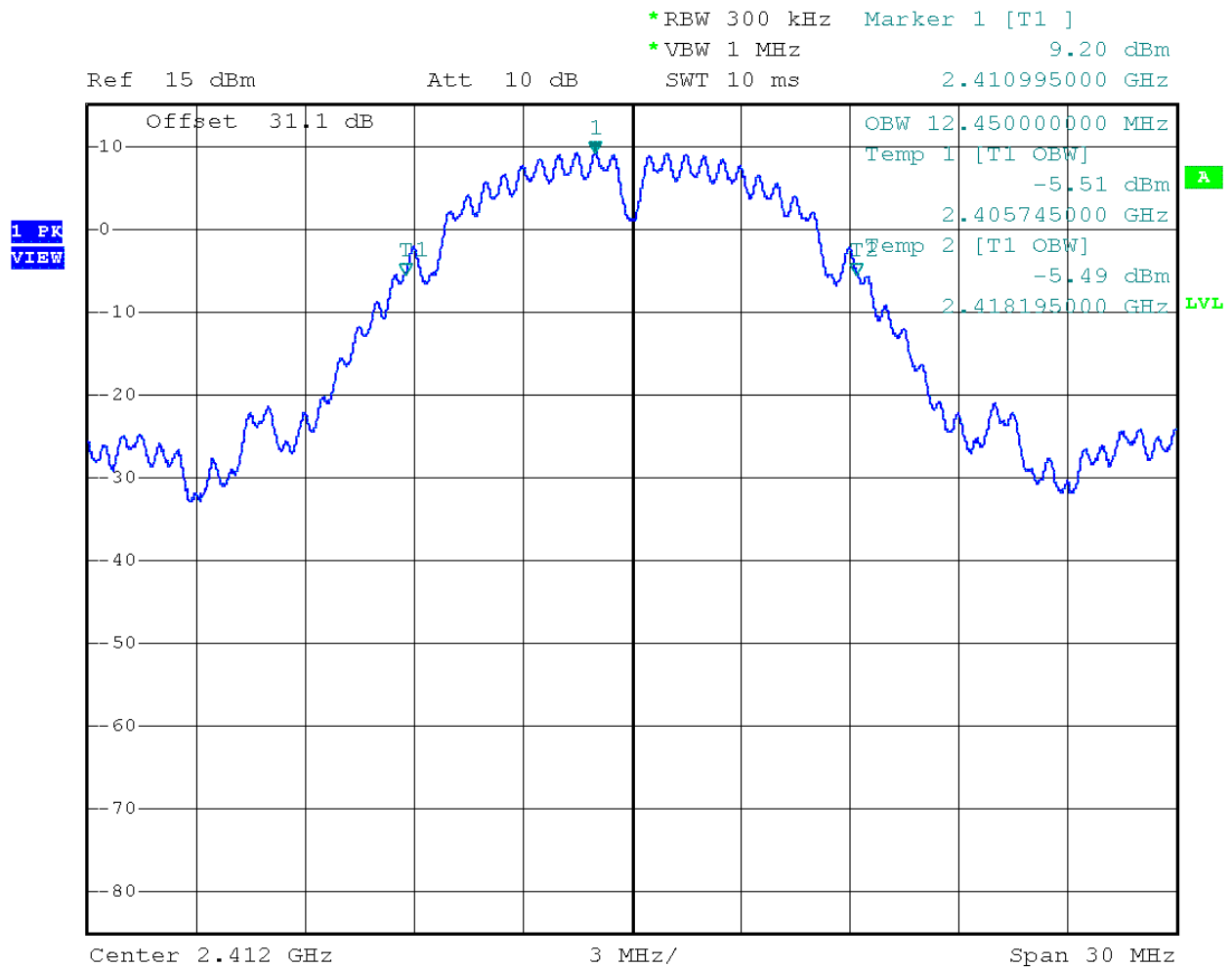
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Plot 1.9 – 6dB Bandwidth (FCC)



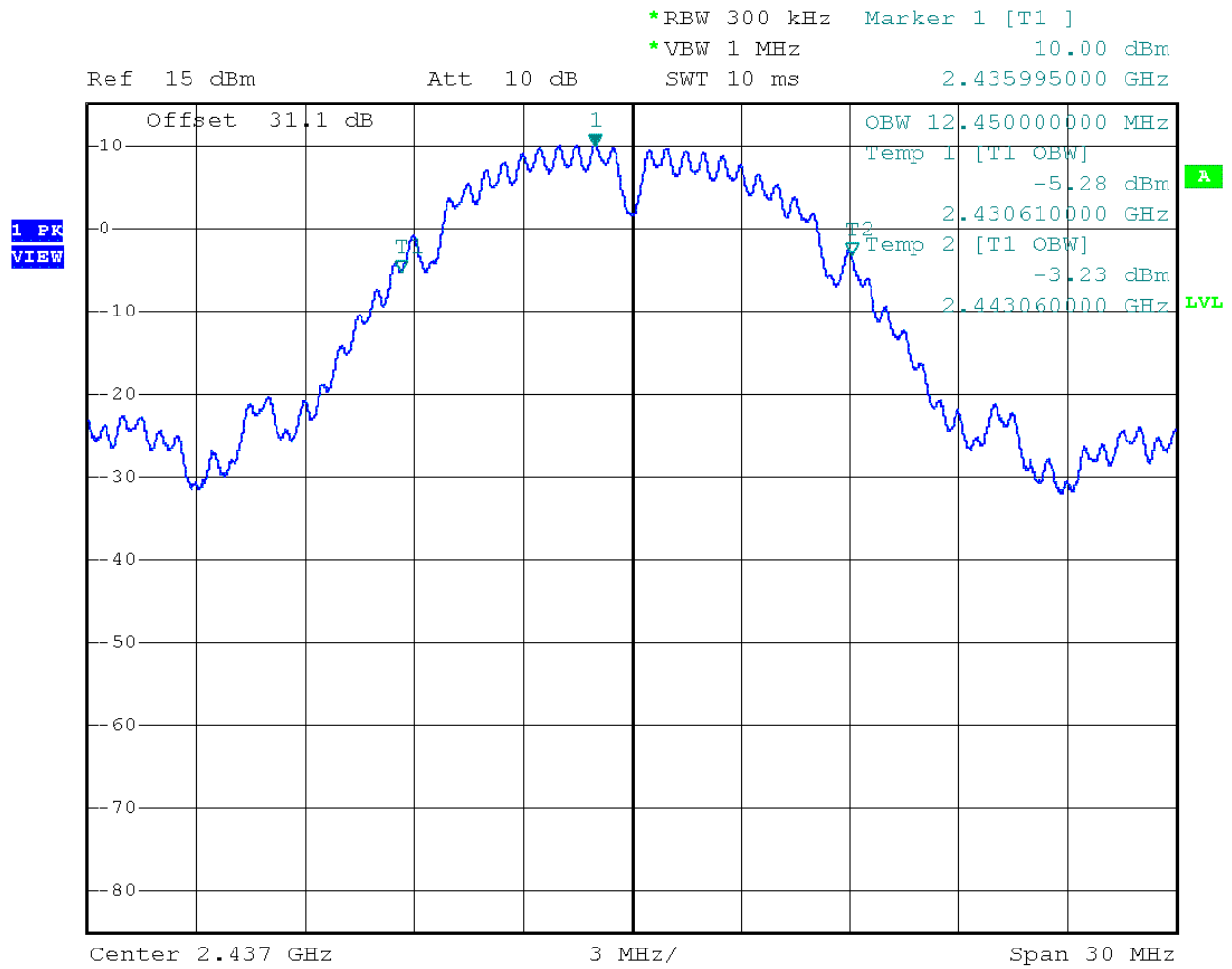
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Plot 1.10 – 99% Bandwidth



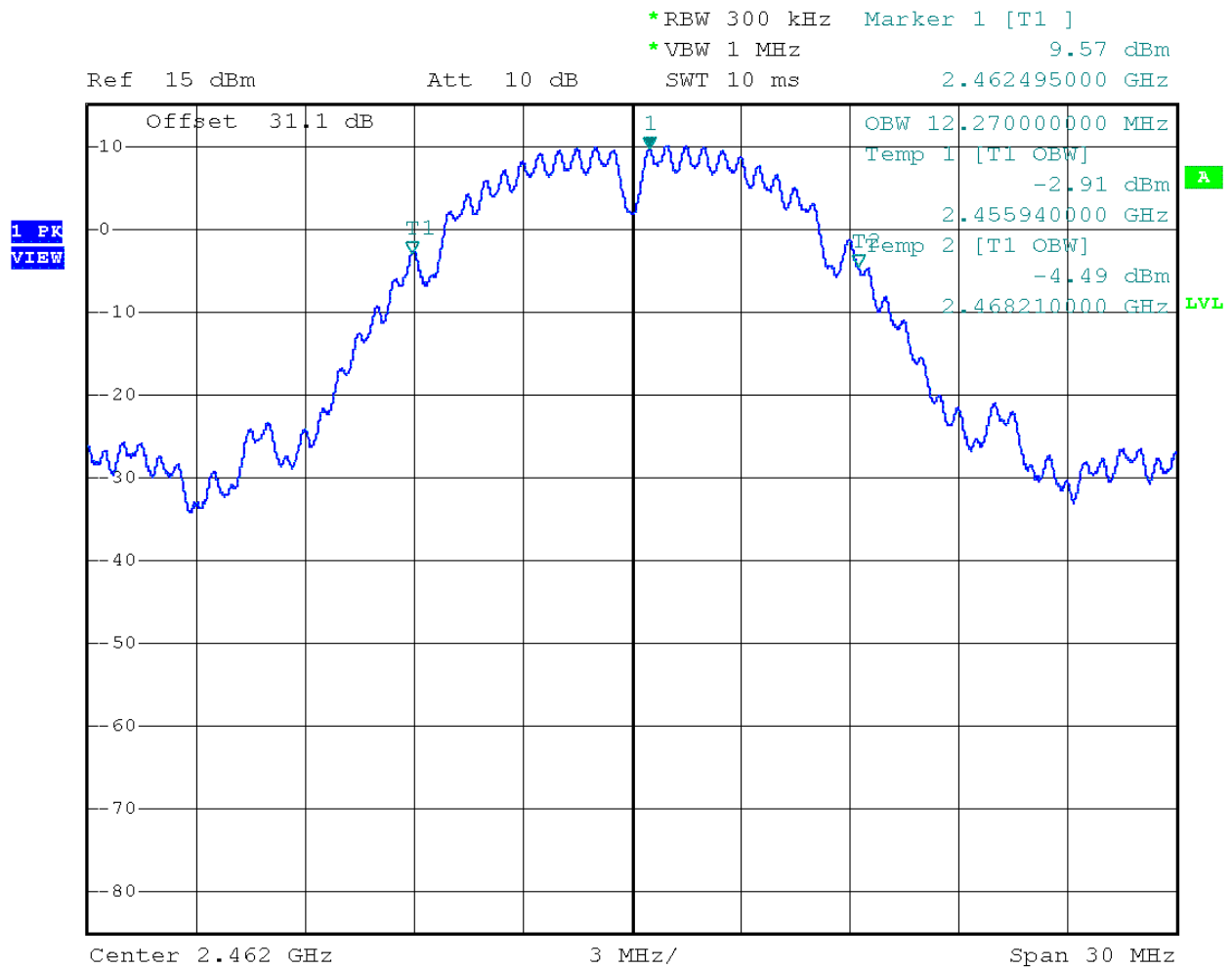
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Plot 1.11 – 99% Bandwidth



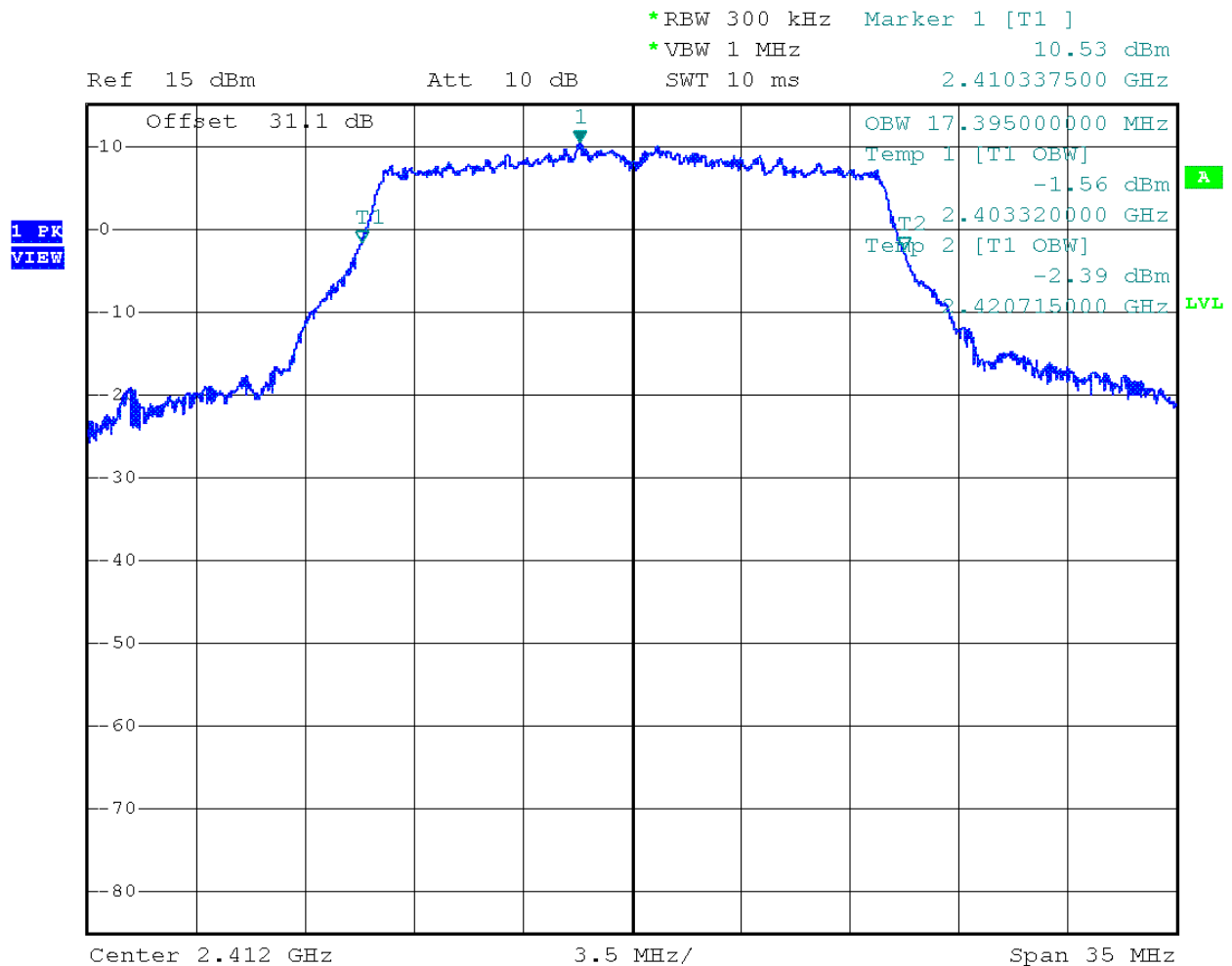
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Plot 1.12 – 99% Bandwidth



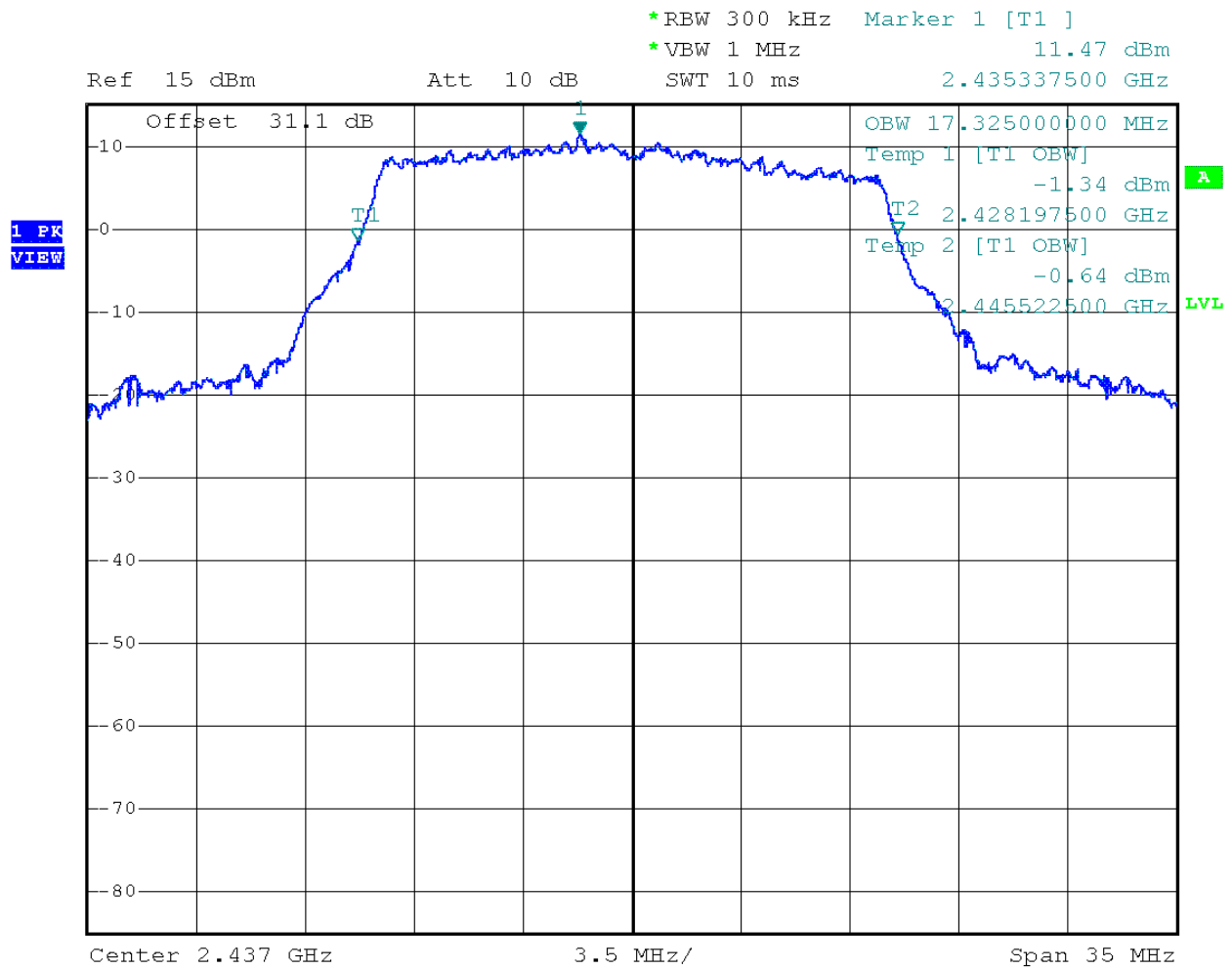
Date: 18.SEP.2018 13:43:52

Plot 1.13 – 99% Bandwidth



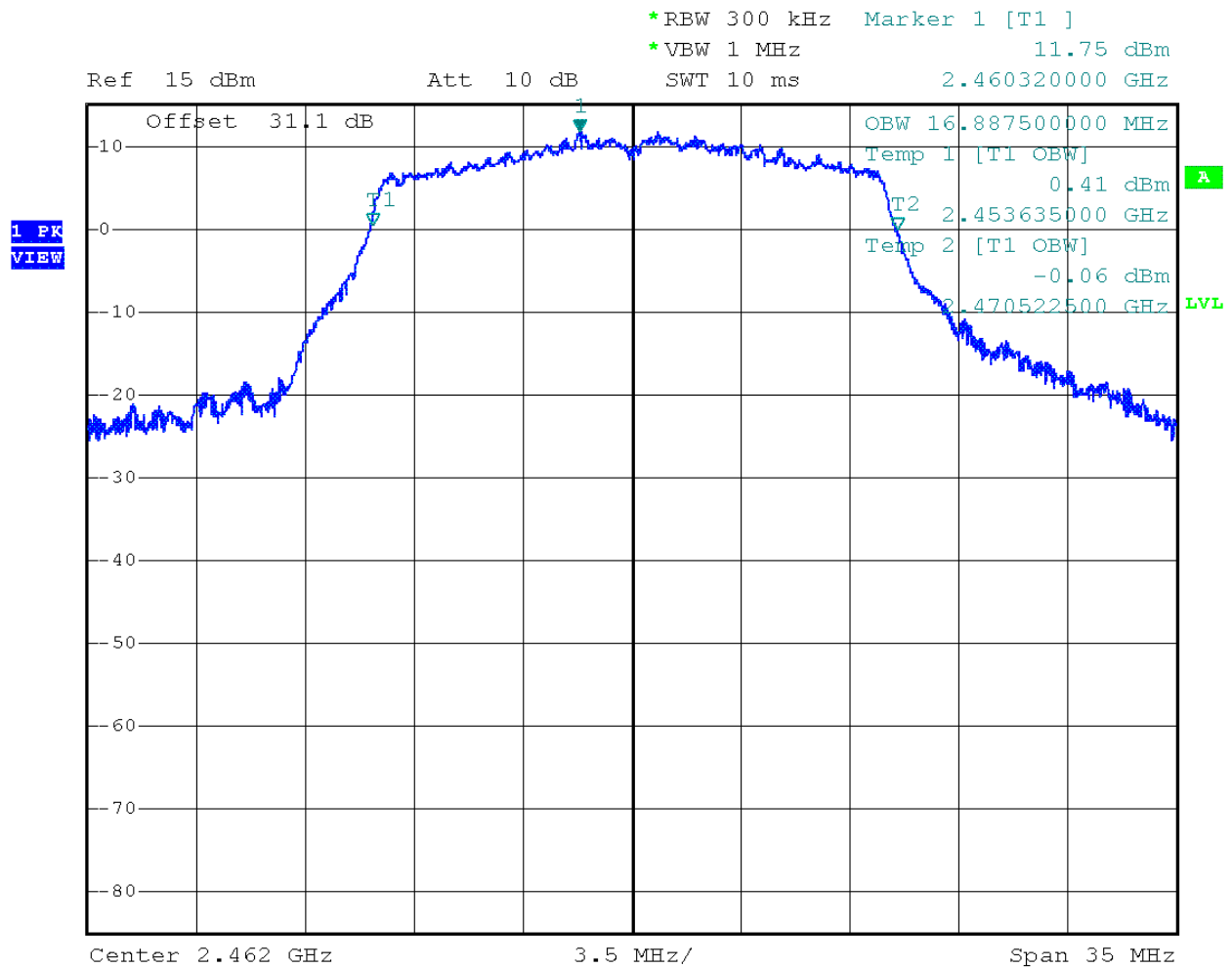
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Plot 1.14 – 99% Bandwidth



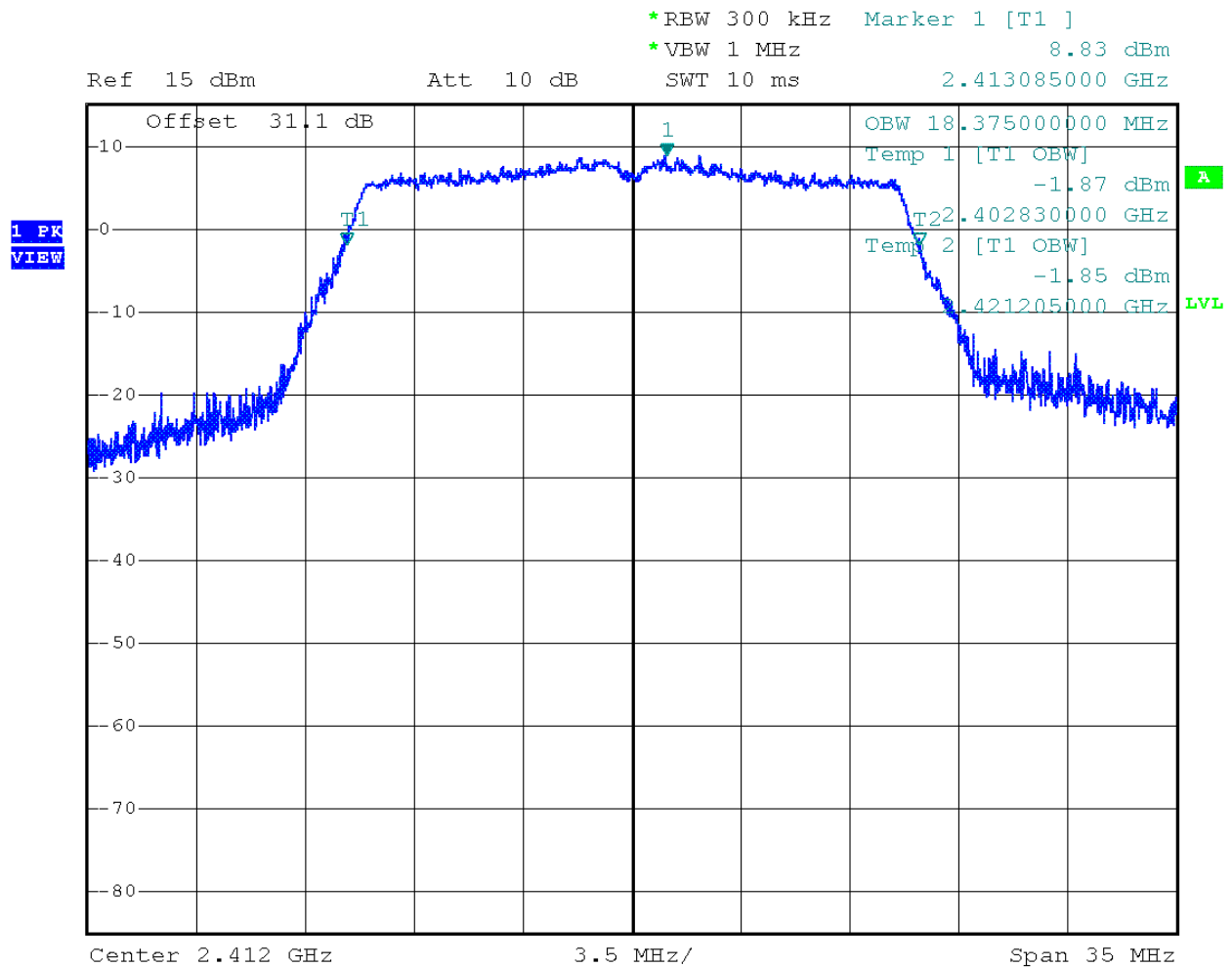
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Plot 1.15 – 99% Bandwidth



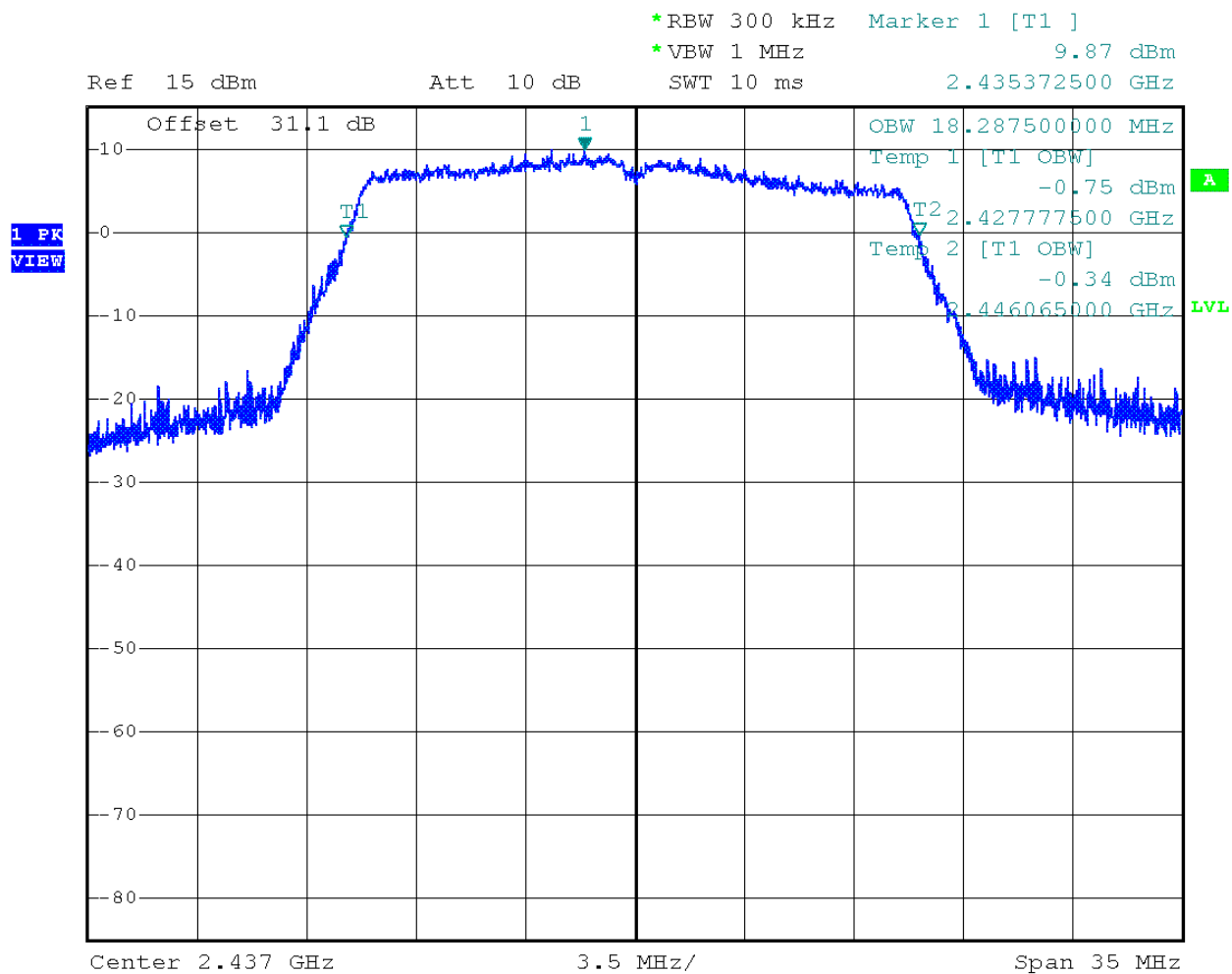
Date: 19.SEP.2018 12:27:35

Plot 1.16 – 99% Bandwidth



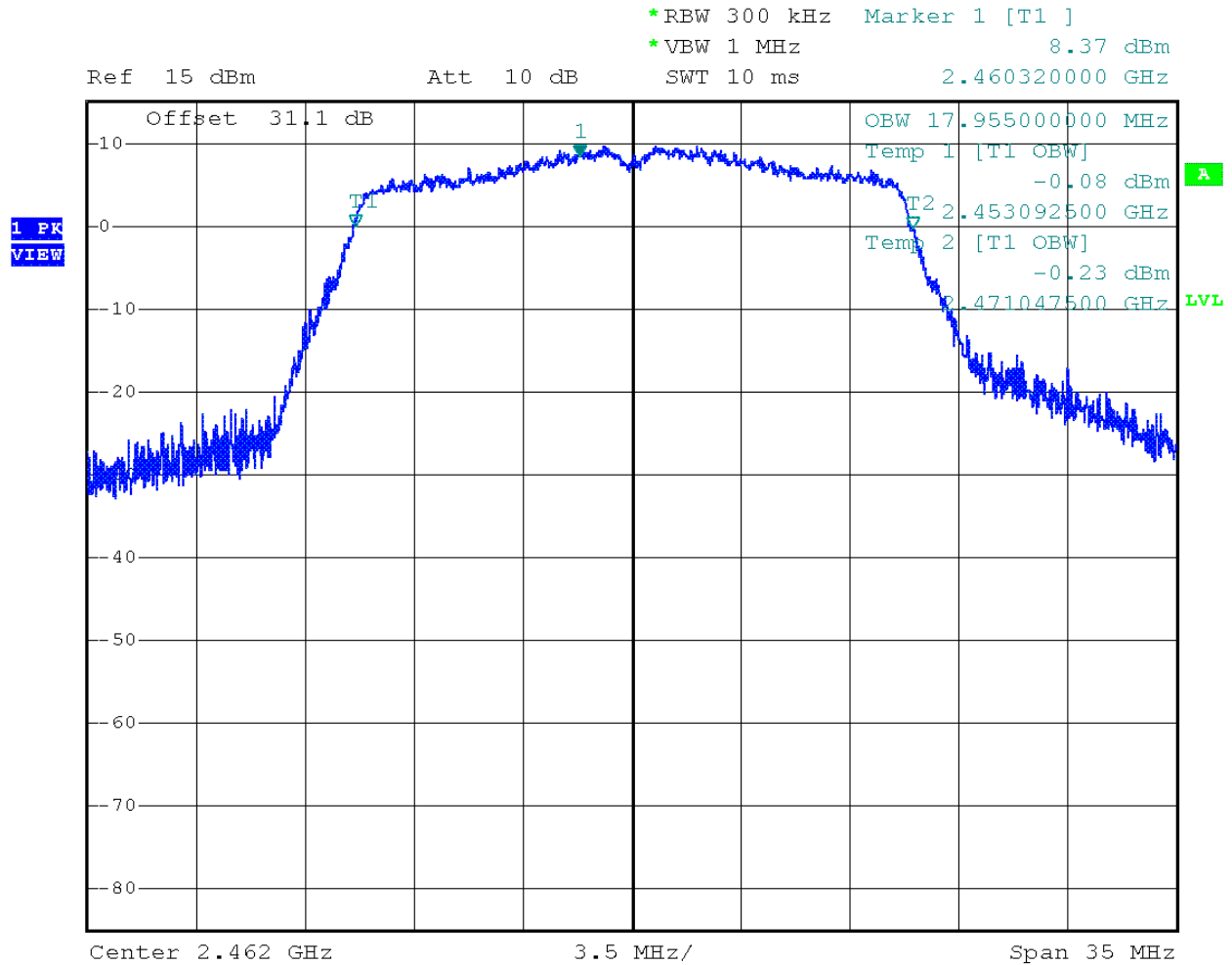
Date: 19.SEP.2018 12:31:58

Plot 1.17 – 99% Bandwidth



Date: 19.SEP.2018 12:30:28

Plot 1.18 – 99% Bandwidth



Date: 19.SEP.2018 12:29:03

4.2 Maximum Conducted Output Power at Antenna Terminals FCC Rule 15.247(b)(3)

4.2.1 Requirement

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt (+30 dBm).
For antennas with gains greater than 6 dBi, transmitter output level must be decreased appropriately, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Maximum Conducted Transmitter Output Power. The offset programmed on the analyzer is corrected to include cable loss, attenuator and duty cycle correction.

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05 was used. Specifically, section 11.9.2.2.2 Method AVGSA-1 in ANSI 63.10.

The procedure for this method is as follows:

1. Set span to at least 1.5 times the OBW.
2. Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz.
3. Set VBW $\geq [3 \cdot \text{RBW}]$.
4. Number of points in sweep $\geq [2 \cdot \text{span} / \text{RBW}]$. (This gives bin-to-bin spacing $\leq \text{RBW} / 2$, so that narrowband signals are not lost between frequency bins.
5. Sweep time = auto.
6. Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
7. If transmit duty cycle < 98%, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at the maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no OFF intervals) or at duty cycle $\geq 98\%$, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run.”
8. Trace average at least 100 traces in power averaging (rms) mode.
9. Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

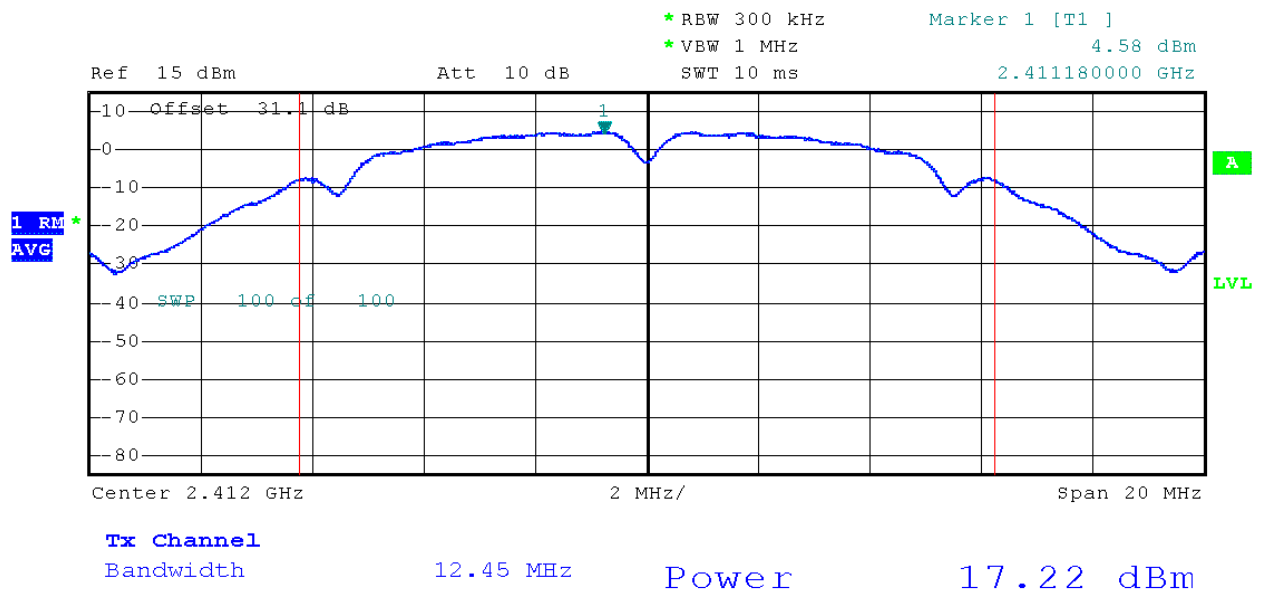
Tested By	Test Date
Anderson Soungpanya	September 18 & 19, 2018

4.2.3 Test Result

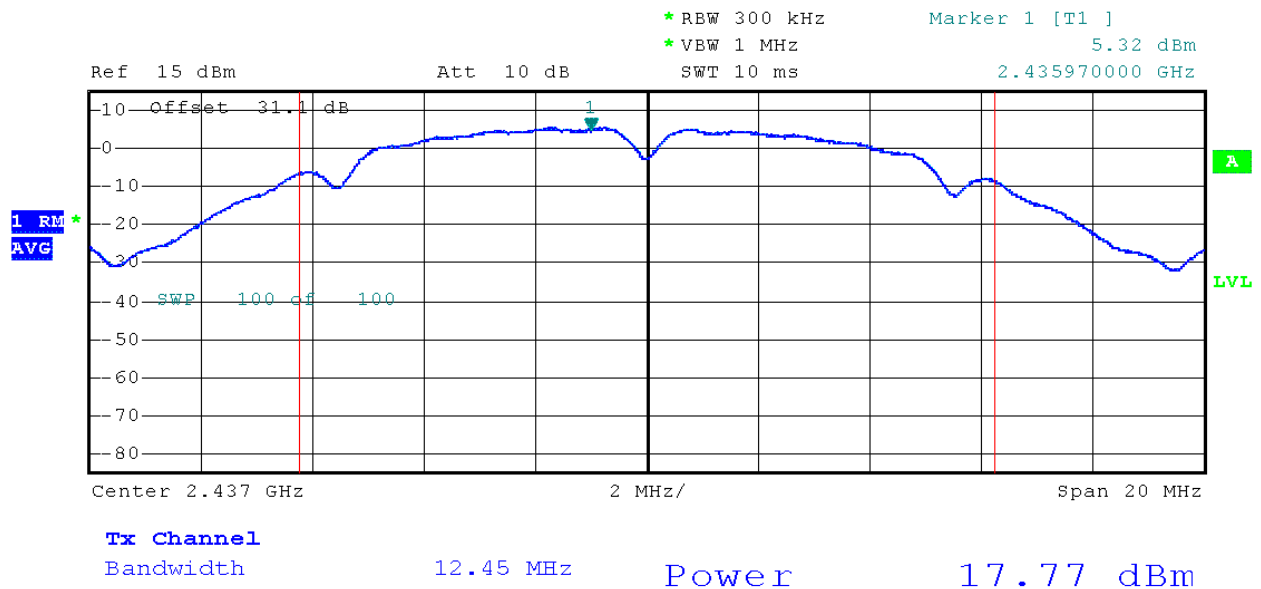
Refer to the following plots for the test result:

Standard	Data Rate	Channel	Frequency MHz	Conducted Average Power dBm	Conducted Average Power mW	Plot #
802.11b	1 Mbps	1	2412	17.22	52.723	2.1
		6	2437	17.77	59.841	2.2
		11	2462	15.85	38.459	2.3
802.11g	6 Mbps	1	2412	12.87	19.364	2.4
		6	2437	16.27	42.364	2.5
		11	2462	13.41	21.928	2.6
802.11n	0 MCS	1	2412	12.57	18.072	2.7
		6	2437	16.01	39.902	2.8
		11	2462	13.33	21.528	2.9

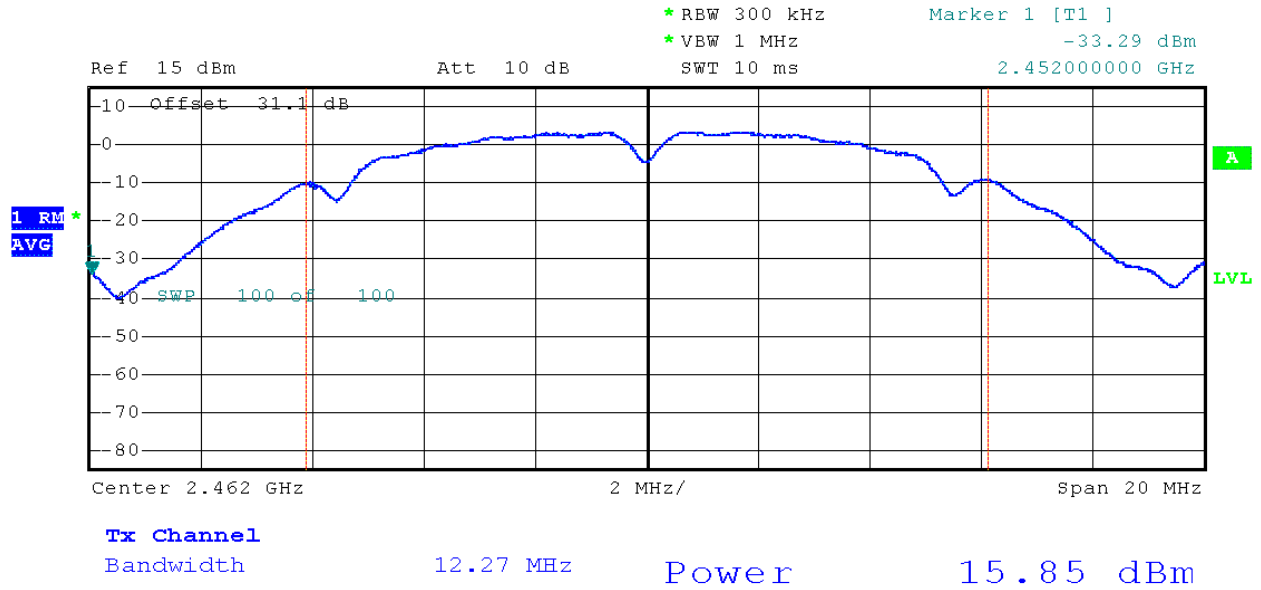
Plot 2. 1



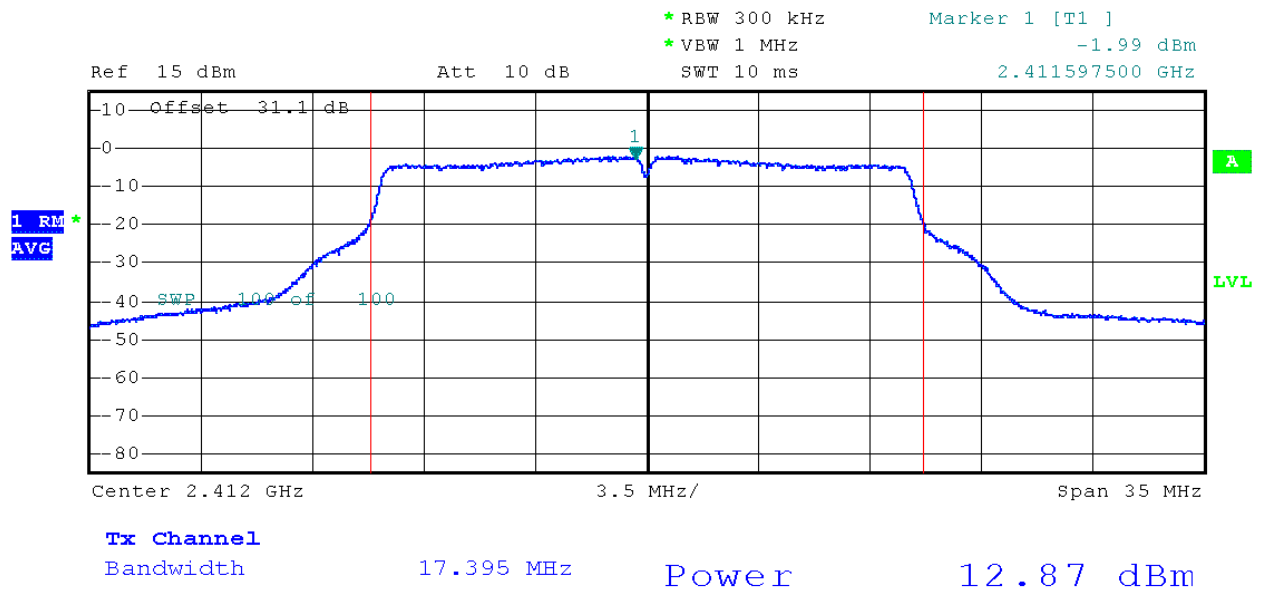
Plot 2. 2



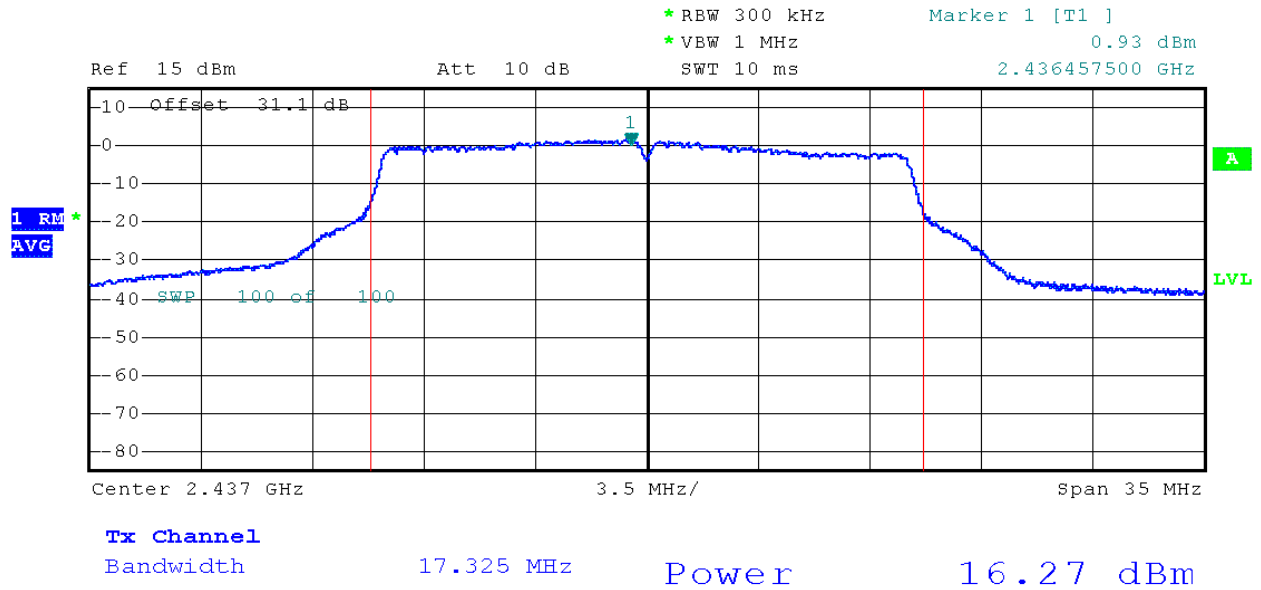
Plot 2.3



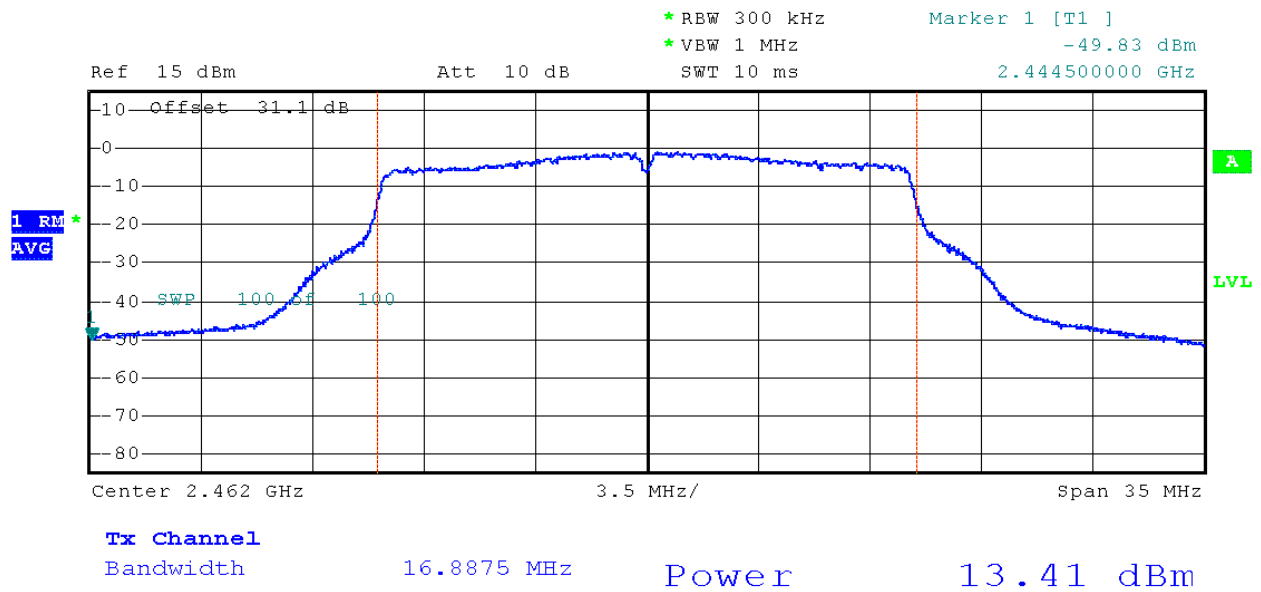
Plot 2.4



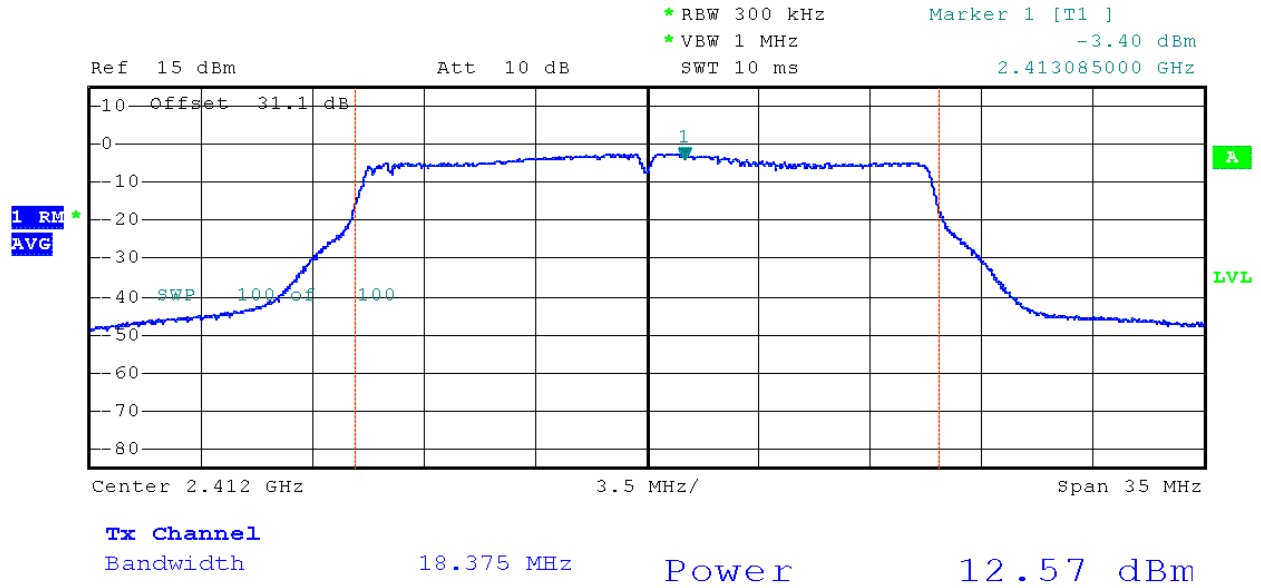
Plot 2.5



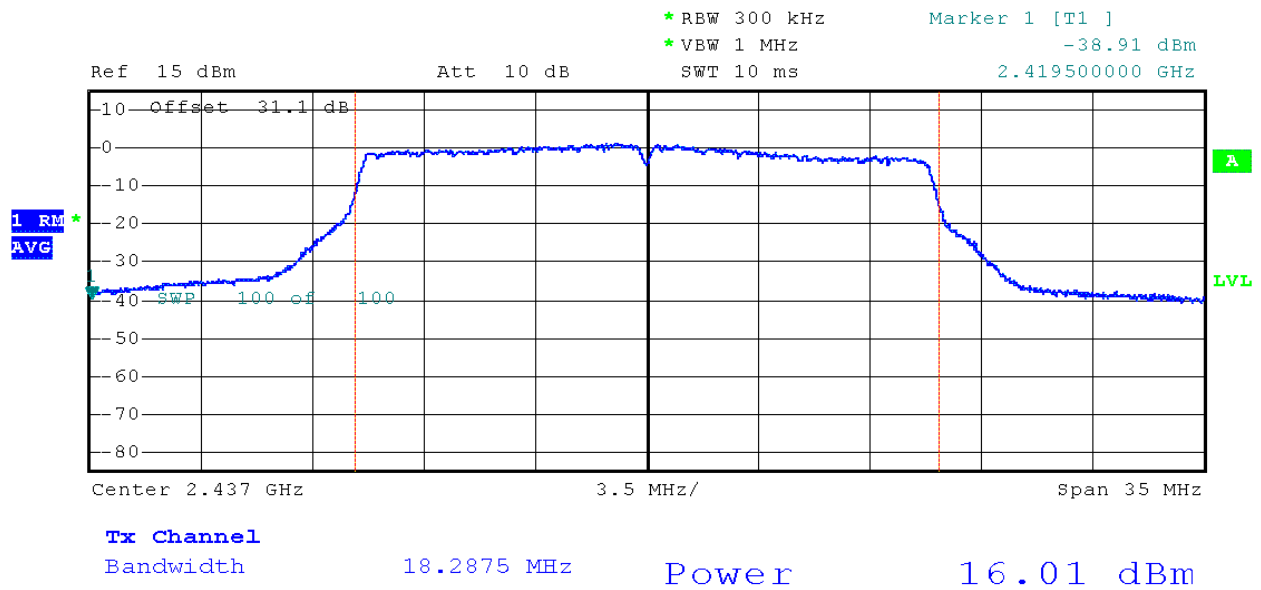
Plot 2.6



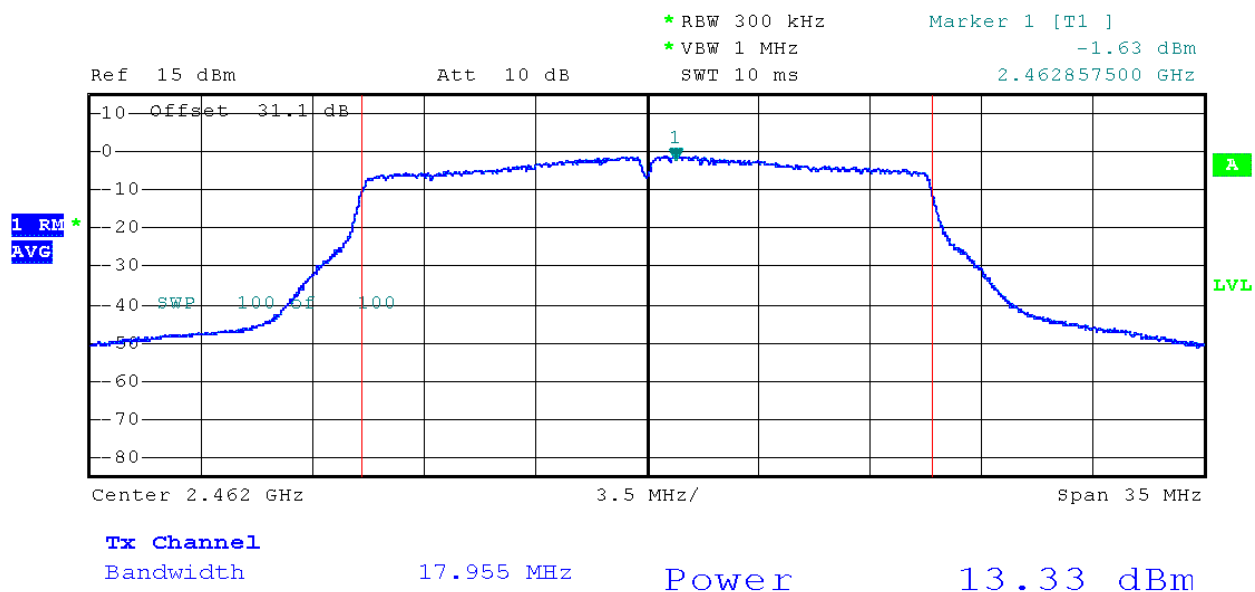
Plot 2.7



Plot 2.8



Plot 2.9



4.3 Power Spectral Density FCC 15.247 (e)

4.3.1 Requirement

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

4.3.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Transmitter Power Density (PSD). The offset programmed on the analyzer is corrected to include cable loss, attenuator.

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05, specifically section 11.10.2 Method PKPSD (peak PSD) of ANSI 63.10.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
4. Set the VBW $\geq 3 \times \text{RBW}$.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

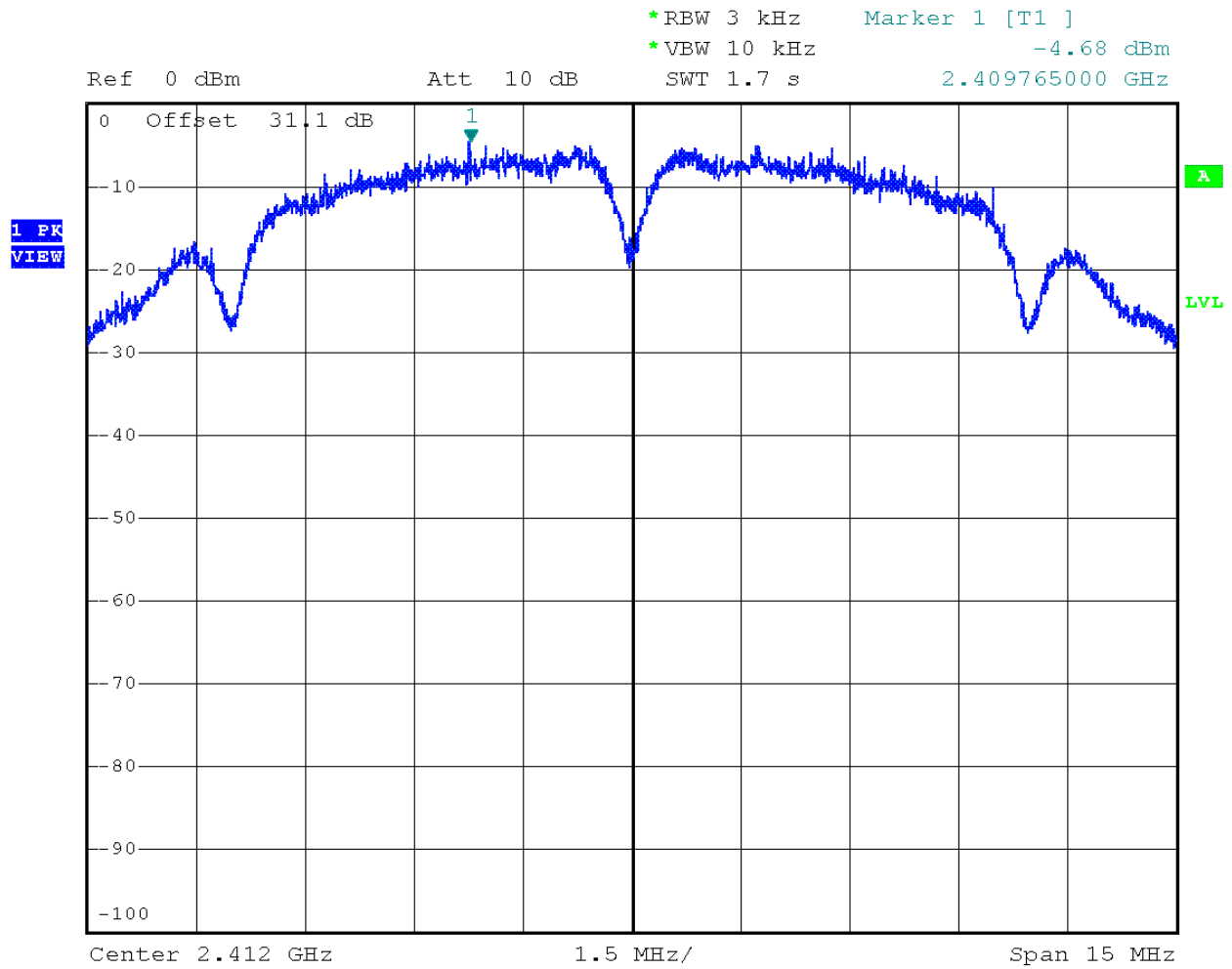
Tested By	Test Date
Anderson Soungpanya	September 18 & 19, 2018

4.3.3 Test Result

Refer to the following plots for the test result:

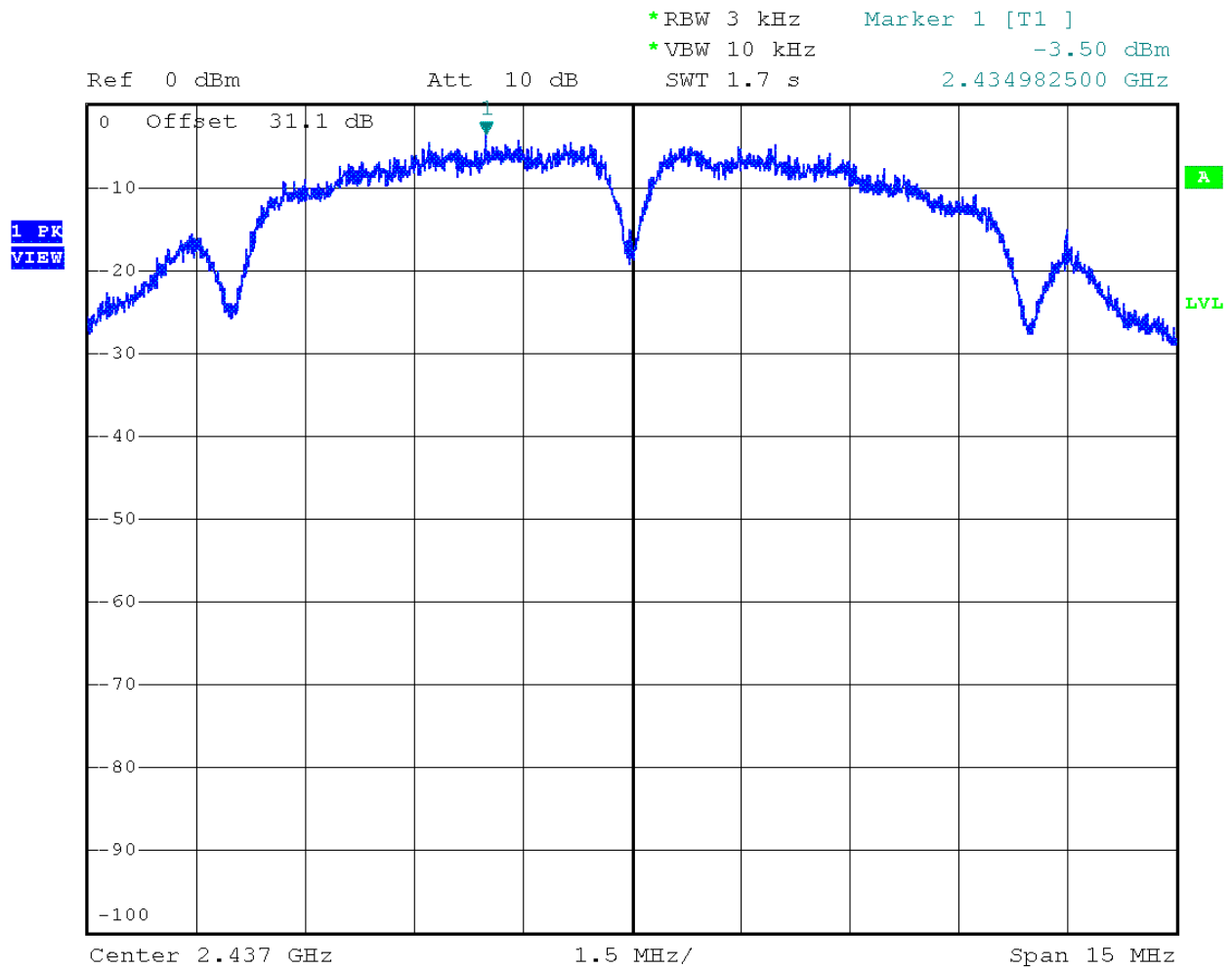
Standard	Channel	Frequency MHz	PSD (Peak) dBm	Margin to 8dBm Limit dB	Plot #
802.11b	1	2412	-4.68	-12.68	3.1
	6	2437	-3.50	-11.50	3.2
	11	2462	-4.50	-12.50	3.3
802.11g	1	2412	-11.04	-19.04	3.4
	6	2437	-7.66	-15.66	3.5
	11	2462	-9.80	-17.80	3.6
802.11n	1	2412	-10.54	-18.54	3.7
	6	2437	-7.01	-15.01	3.8
	11	2462	-8.86	-16.86	3.9

Plot 3.1



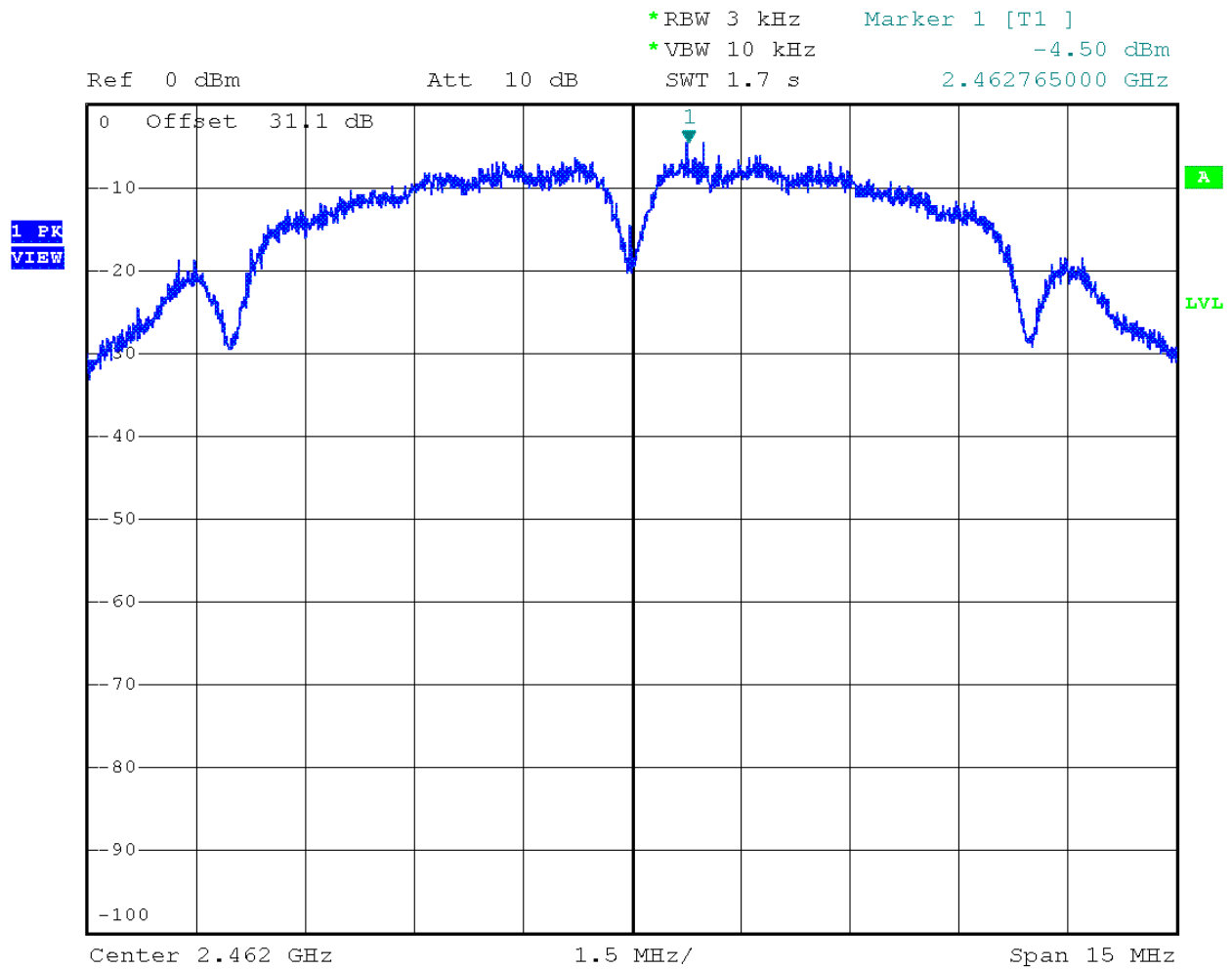
Date: 18.SEP.2018 14:25:59

Plot 3.2



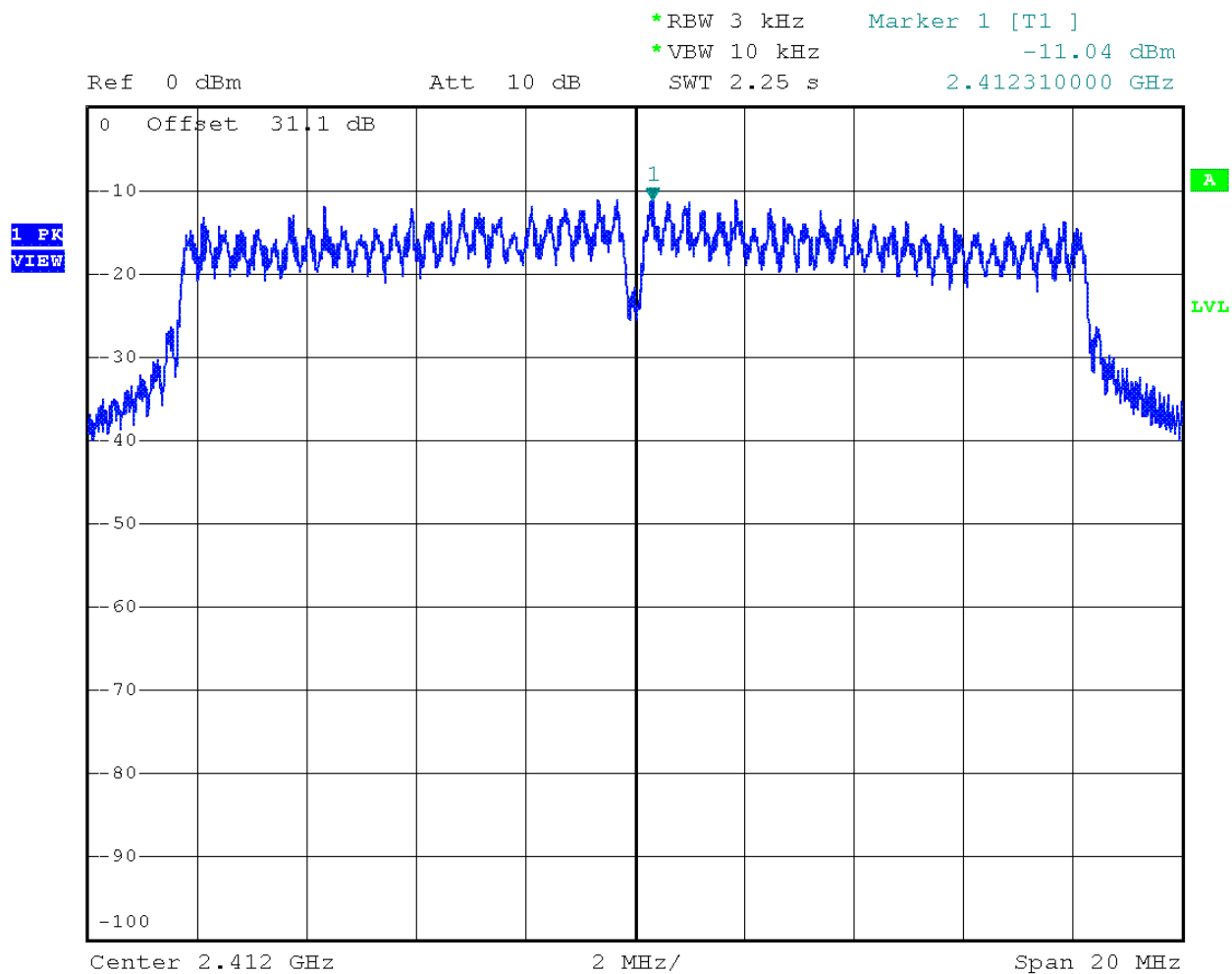
Date: 18.SEP.2018 14:21:14

Plot 3.3



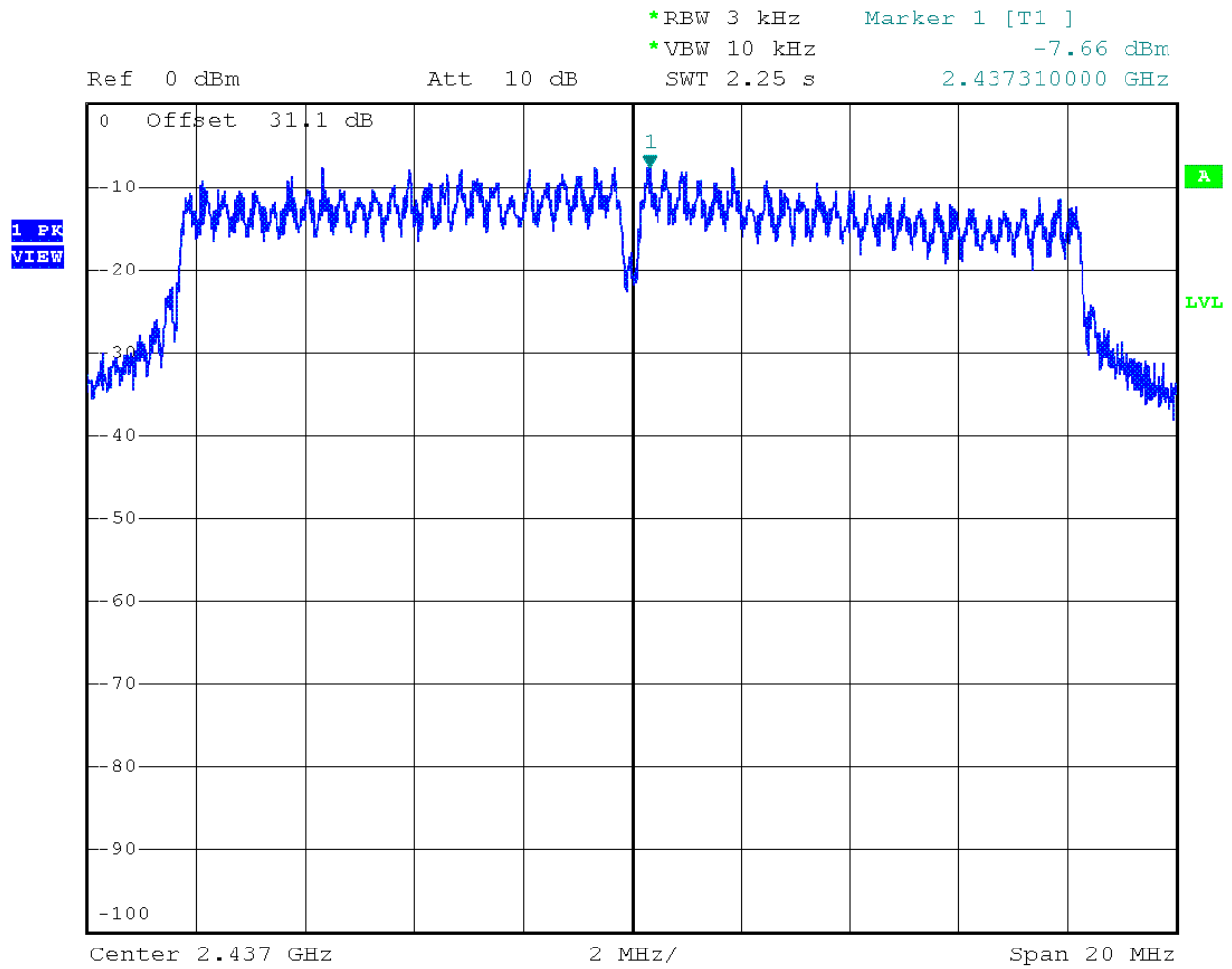
Date: 18.SEP.2018 14:16:24

Plot 3.4



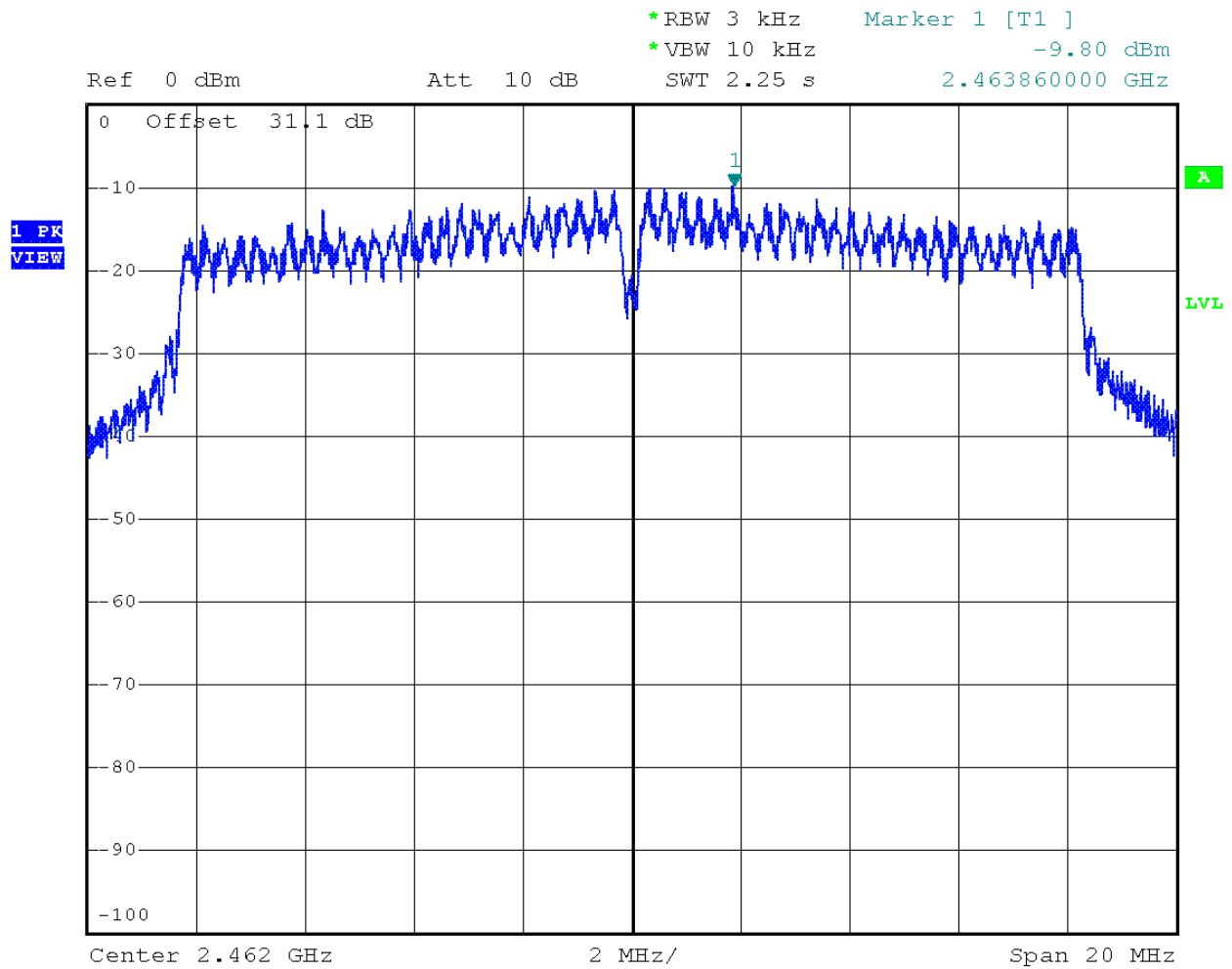
Date: 20.SEP.2018 14:22:23

Plot 3.5



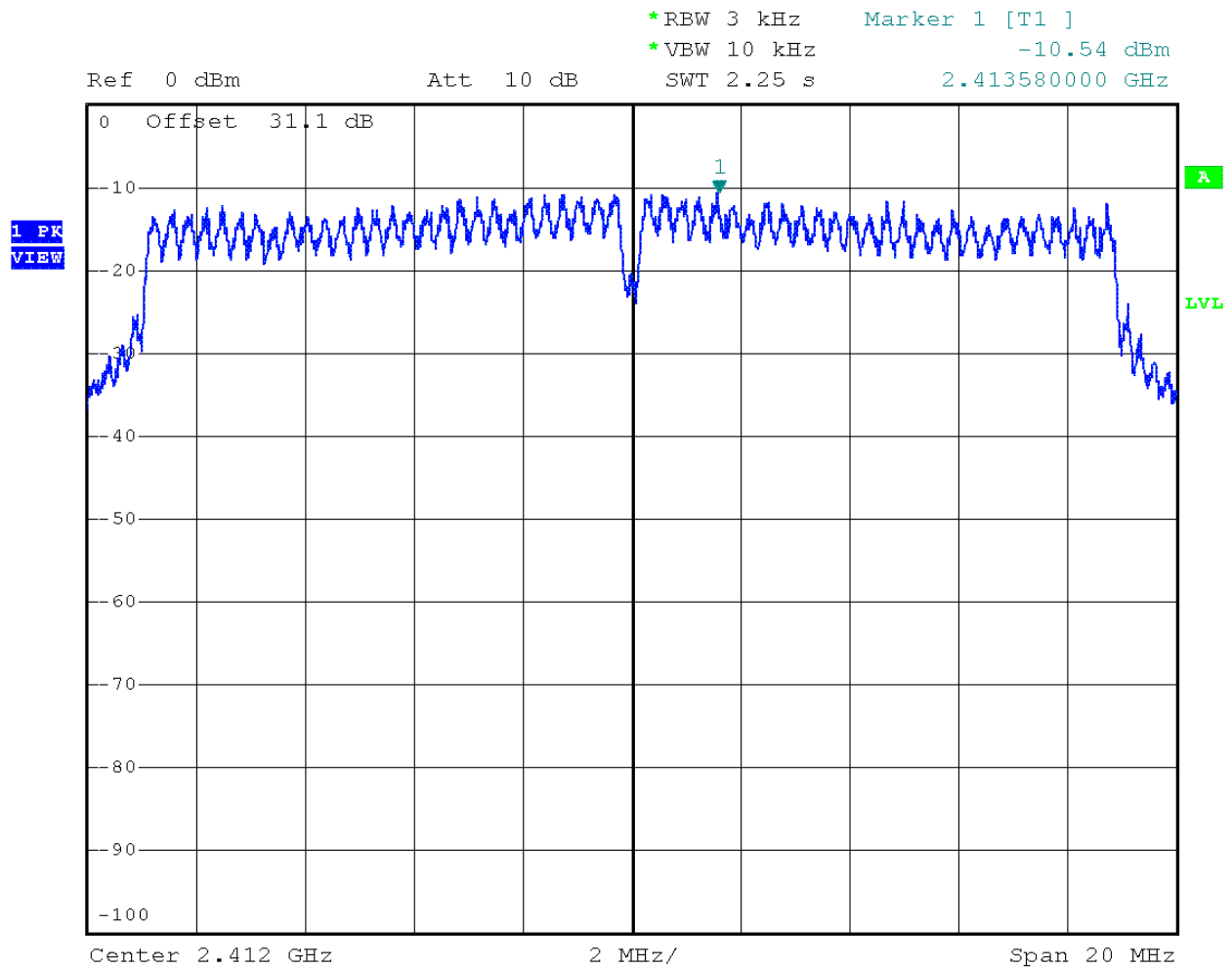
Date: 20.SEP.2018 14:01:16

Plot 3.6



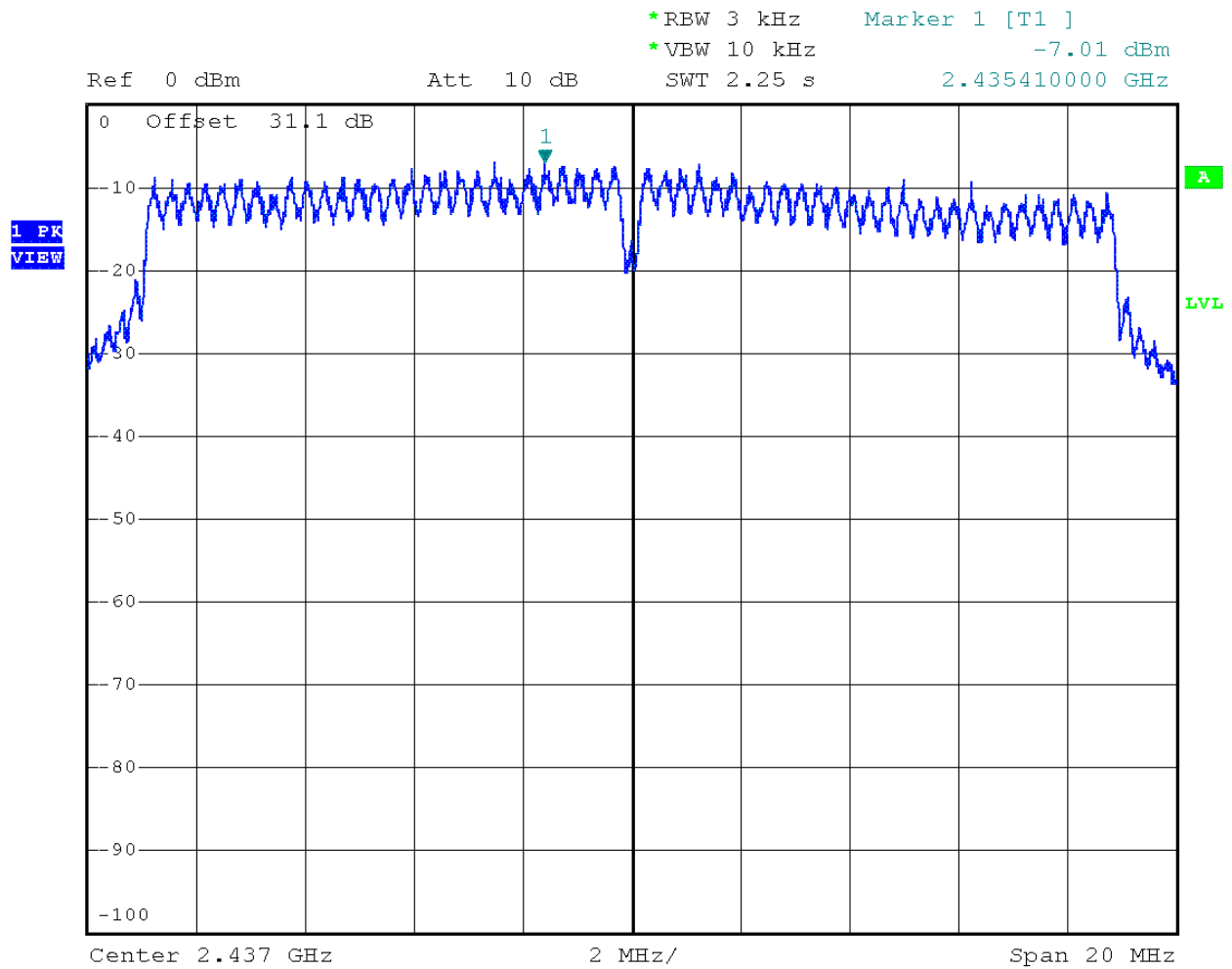
Date: 20.SEP.2018 13:57:59

Plot 3.7



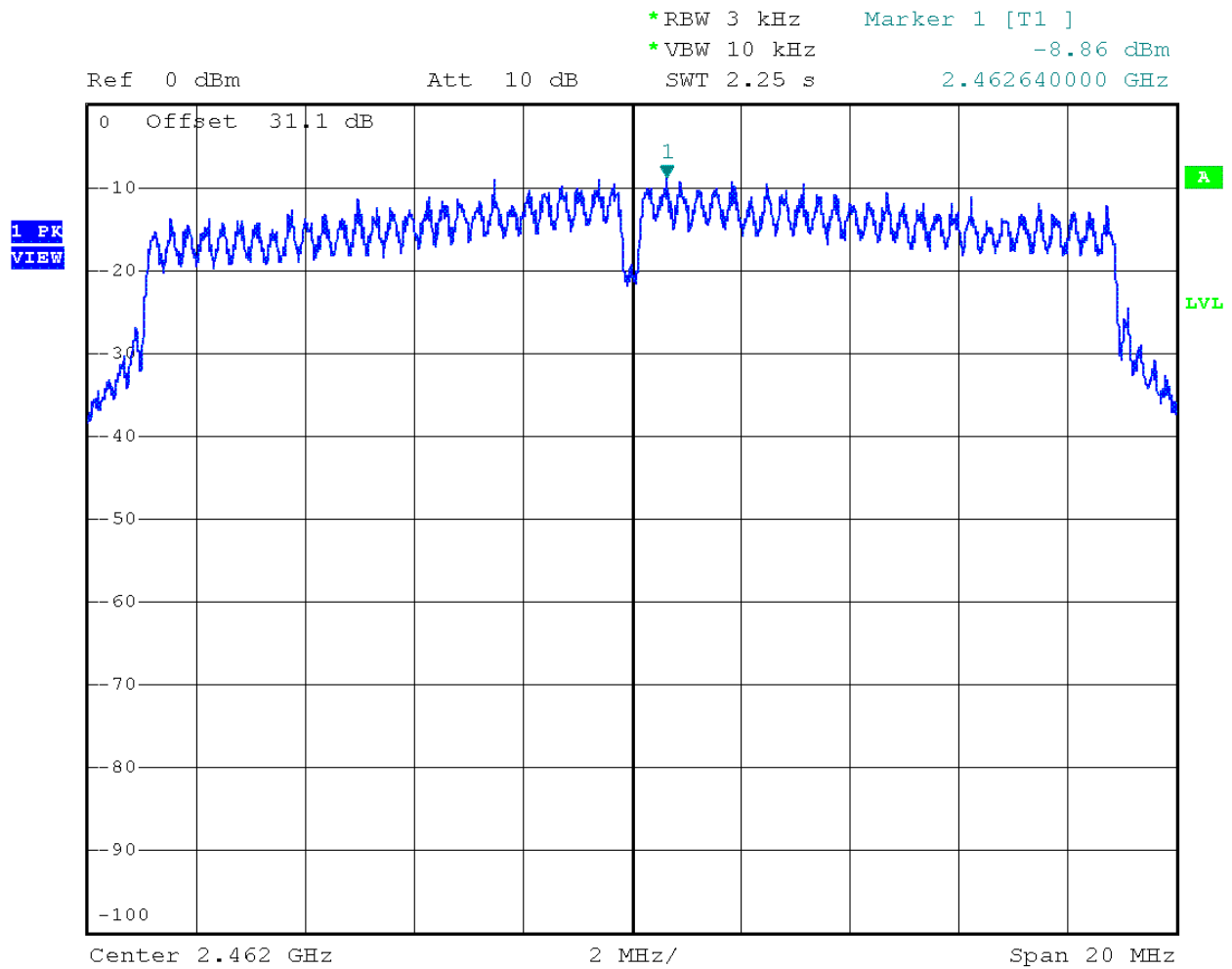
Date: 19.SEP.2018 13:16:46

Plot 3. 8



Date: 19.SEP.2018 13:05:15

Plot 3.9



Date: 19.SEP.2018 12:55:07

4.4 Out-of-Band Conducted Emissions FCC 15.247(d)

4.4.1 Requirement

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

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)

4.4.2 Procedure

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05, specifically section 11.11 DTS Emissions in non-restricted frequency bands of ANSI 63.10.

A spectrum analyzer was connected to the antenna port of the transmitter.

1. Set the RBW = 100 kHz.
2. Set the VBW $\geq 3 \times$ RBW.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

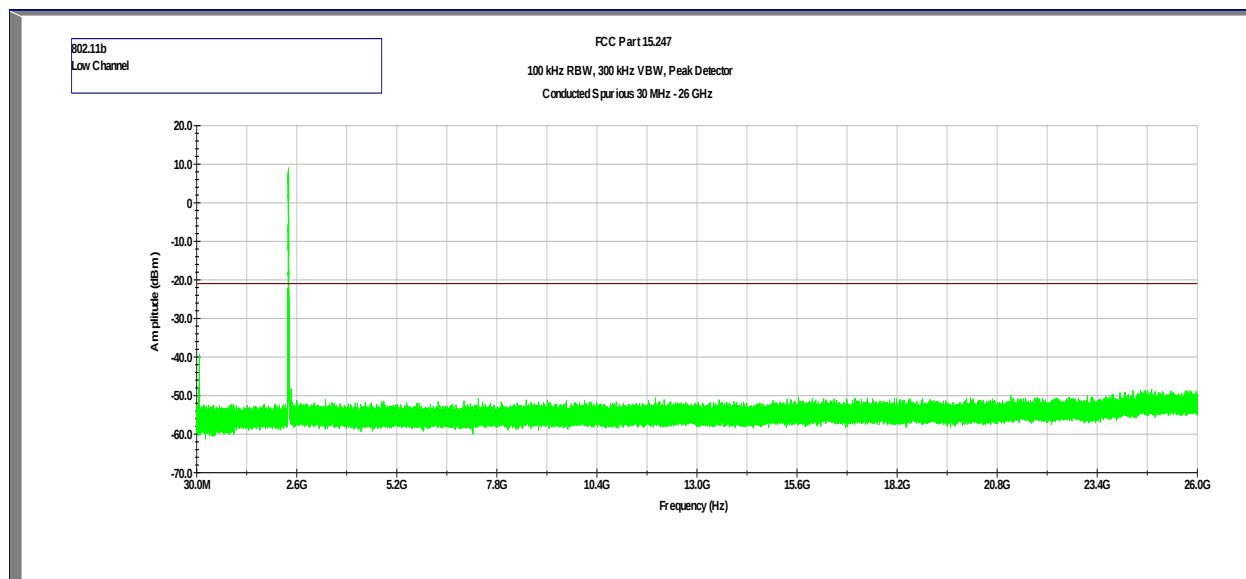
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

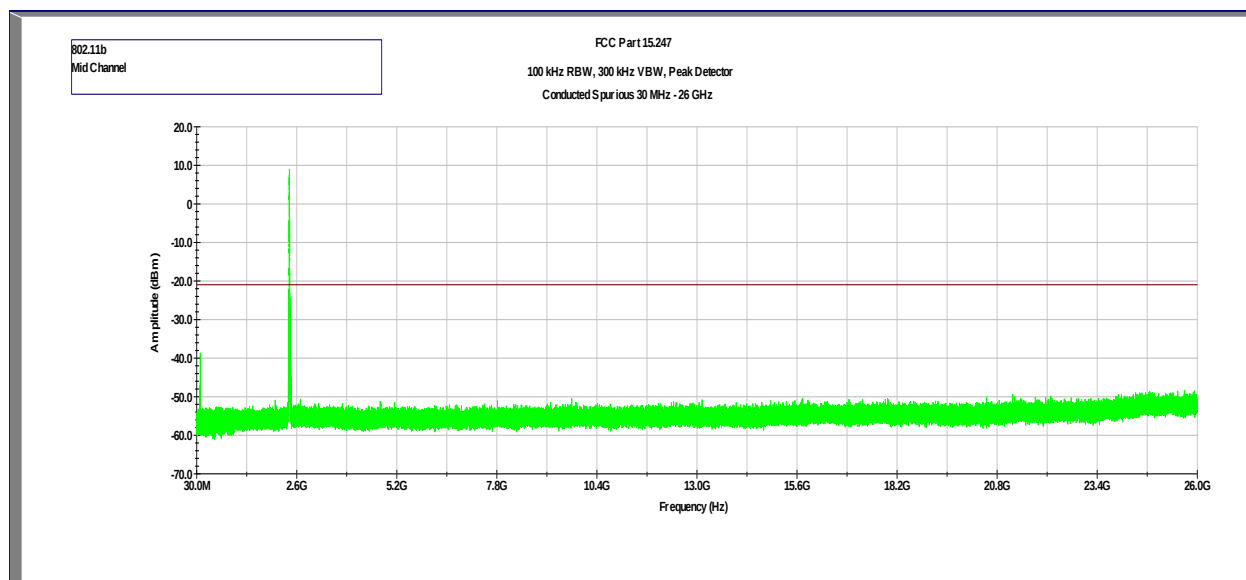
Refer to the following plots 4.1 – 4.9 for unwanted conducted emissions. The plot shows -30dB attenuation limit line.

Tested By	Test Date
Anderson Soungpanya	September 18 & 19, 2018

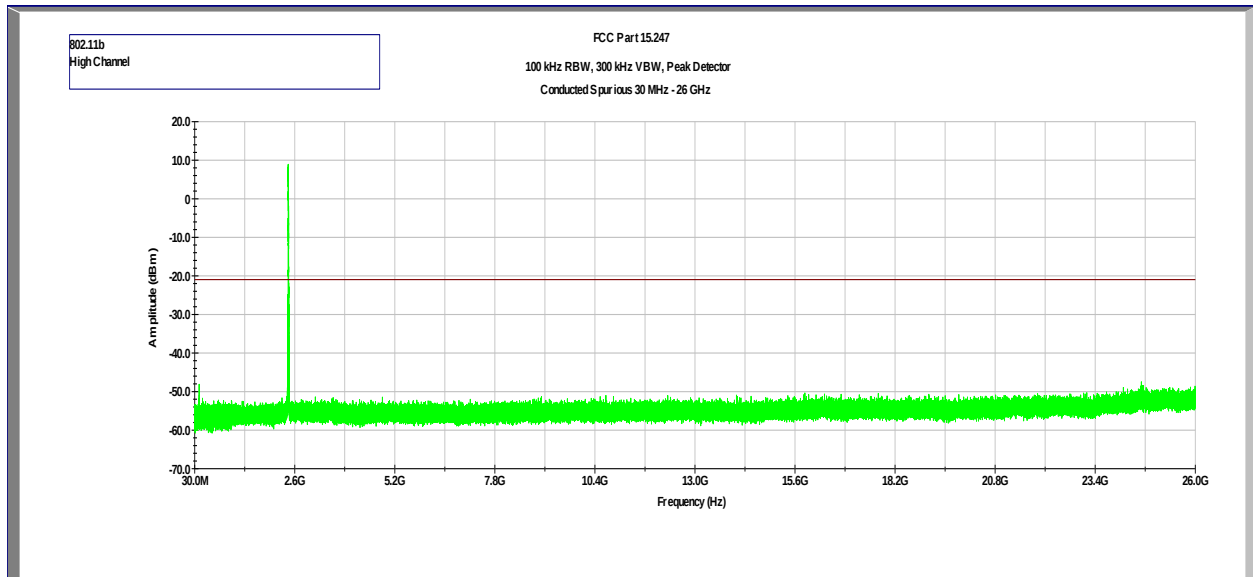
Plot 4.1
Tx @ 2412MHz 802.11b



Plot 4.2
Tx @ 2437MHz 802.11b



Plot 4.3
Tx @ 2462MHz 802.11b



Plot 4.4
Tx @ 2412MHz 802.11g

