Washington Laboratories, Ltd.
www.wll.com
7560 Lindbergh Drive . Gaithersburg, MD 20879
301.216.1500 . info@wll.com

FCC CERTIFICATION TEST REPORT

FOR THE

CODAN LIMITED

2310 HF RADIO SYSTEM

SENTRY-H

FCC ID: DYY2310

WLL REPORT# 14912-01 Rev 2
February 12, 2018

Prepared for:

Codan Limited
2 Second Avenue,
Mawson Lakes SA 5095, Australia

Prepared By:
Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

Testing Certificate AT-1448

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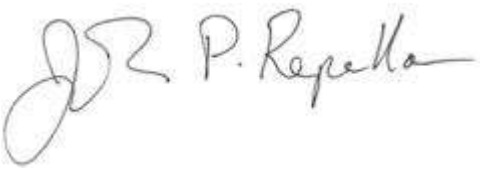

John Repella
Manager, EMC & Wireless Services

Reviewed by:

Steven D. Koster
President

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Abstract

This report has been prepared on behalf of Codan Limited to support the Codan 2310 HF Radio System (Sentry-H). The test report was constructed with guidance from Part 90 Private Land Mobile Radio Services, Subpart I- General Technical Standards section of the FCC Rules and Regulations (10/2014).

Testing was performed at Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879.

Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

Revision History	Reason	Date
Rev 0	Initial Release	May 15, 2017
Rev 1	Update the test report to include the PSK/QAM modulation information & correct typos identified by customer review.	July 18, 2017
Rev 2	Addressed comments from the reviewing engineer.	February 12, 2018

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1 Introduction

1.1 Compliance Statement

The Codan Limited Sentry-H was tested to Part 90 Private Land Mobile Radio Services Subpart I- General Technical Standard's section of the FCC Rules and Regulations (10/2014).

1.2 Test Scope Summary

The following tests were performed using the applicable parts of the FCC rules as guidance:

Tests	Reference Requirement	Test Method	Report section
RF Output Power	90.205	2.1046	Section 4.1
Emissions Type	90.207		
Occupied Bandwidth	90.209	2.1049	Section 4.2
Spurious Emissions(Conducted)	90.210	2.1051	Section 4.3
Spurious Emissions(Radiated)	90.210	2.1053	Section 4.3
Frequency Stability	90.213	2.1055	Section 4.4
Modulation Characteristics	2.1047		Section 4.5

1.3 Contract Information

Customer:	Codan Limited 2 Second Avenue Mawson Lakes SA 5095, Australia
Purchase Order Number:	Deposit Terms, Reference PO 837520
Quotation Number:	Q69899

1.4 Test Dates

Testing was performed on the following date(s):	03/15/2017 to 04/07/2017

1.5 Test and Support Personnel

Washington Laboratories, Ltd.	John P. Repella
Customer Representative	Bruce Johnson

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1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**c**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

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2 Equipment Under Test

2.1 EUT Identification

The results obtained relate only to the item(s) tested.

Table 1: Overview of Sentry RF Unit, Equipment Under Test

Model(s) Tested: *(name of the equipment as it should appear in the test report)*	2310 HF Radio System
EUT Specifications:	
Manufacturer:	Codan Limited
FCC ID:	DYY2310
IC:	None
EUT Name:	2310 HF Radio System
Model:	Codan 2310
FCC Rule Parts:	§90
Industry Canada:	None
Frequency Range:	1.6 MHz – 30 MHz
Maximum Output Power:	150 W PEP
Modulation:	2K75J3E, 3K00H3E, 2K75J2B, 2K75J2D, 2K75J2E, 2K75G1D and 3K00G1D, 3K25G1D
Necessary Bandwidth	2.75kHz, 3.0kHz, 3.5kHz
Occupied Bandwidth:	2.28kHz(USB&USBW), 2.968kHz(PSK), 3.250kHz(QAM)
Keying:	Automatic, Manual
Type of Information:	Data and Voice
Number of Channels:	1000
Measured Output Power:	145.88W @1.71MHz, 132.74W@14.4MHz, 121.06W @27.6MHz
Frequency Tolerance:	Below 25MHz 100 ppm (0.01%), 25-50MHz 20 ppm (0.002%)
Antenna Connector:	N type
Antenna Type:	Whip for mobile applications,
Interface Cables:	RF coax, PTT test, DC input
Power Source & Voltage:	Mains supply, 13.8 V DC
Receiver LO:	Carrier Frequency + 45.000 MHz

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2.2 EUT Description

The 2310 Radio System is a HF Radio system intended to operate in the 1.6-30MHz Frequency range. The equipment is declared to be both Mobile equipment (DC battery supply) and Base station equipment (with separate AC mains supply). The 2310 HF Radio System is base and mobile radio system that delivers 150 W of RF power without the added cost, weight and complexity of an external amplifier. The Sentry-H has an in-built power amplifier that provides full-duty cycle performance across the complete HF band for all supported modes. Designed for maximum efficiency and a wide range of DC input voltages, the Sentry-H is the HF radio of choice for vehicle and other battery based systems.

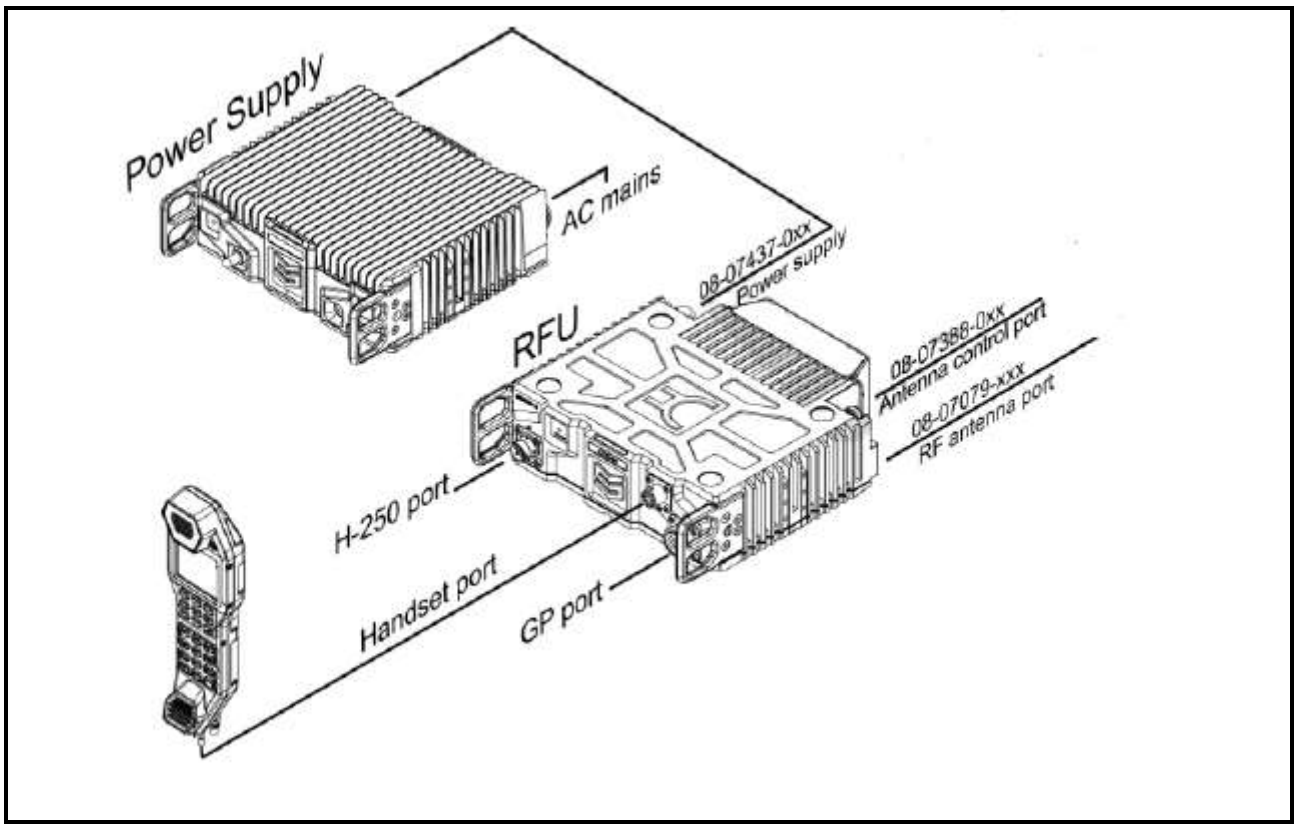

Figure 1: EUT Diagram

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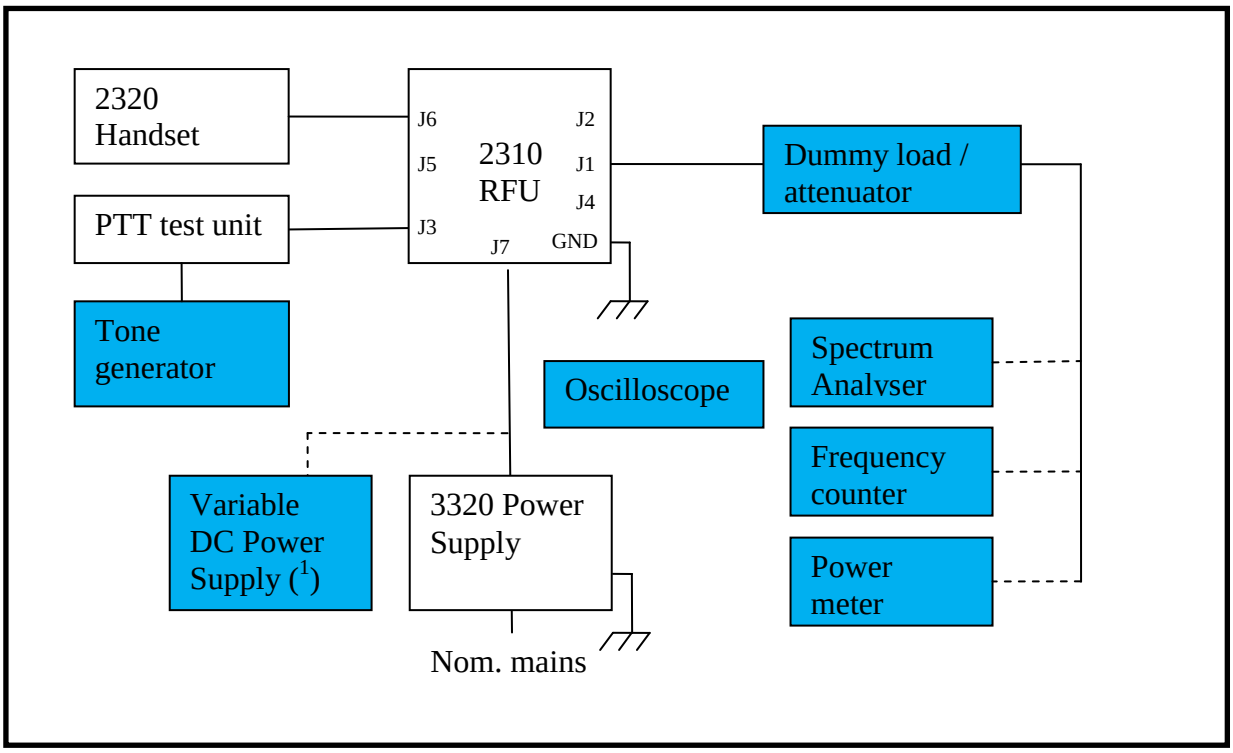

Figure 2: EUT Test Setup

2.3 Test Configuration

The Codan Limited 2310 HF Radio System (Sentry-H), Equipment Under Test (EUT), was operated from an internal AC power supply. The device is pre-configured with the transmit frequency (not user changeable). A single unit was provided and was configured to operate at one of three frequencies, 1.710MHz, 14.4MHz and 27.600MHz with selectable modulations.

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2.4 Equipment Configuration

The EUT was comprised of the following equipment. (All Modules, PCBs, etc. listed were considered as part of the EUT, as tested.)

Table 2: Equipment Configuration

Quantity	Description	Serial #	Codan Part #
1	Codan 2310 RF Unit with fan (**EUT**)	GB40794A0002	2310
1	Codan 2320 Handset (**EUT**)	H240802A0001	2320
1	Codan AC Power supply 3320	0008	3320
1	Codan DC Power cable, 3320 to 2310	N/A	08-0
1	Codan DC Power cable, open end	N/A	08-0
1	Codan Mains cable (US plug)	N/A	08-0
1	Codan PTT Test unit, 19-way GPIO	N/A	08-0
2	Earth braids	N/A	05-06374

2.5 Support Equipment

The following support equipment was used during testing:

Table 3: Support Equipment

Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
PTT Test unit	Codan	6801 control box	Not applicable

2.6 Interface Cables

Table 4: Interface Cables

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length (m)	Shielded?	Termination Box ID & Port ID
J1	RFU J1	RF connection	1	3	Y	50 Ohm dummy load
J2	RFU J2	N/C, ATU control port				
J3	RFU J3	GPIO port	1	3	N	PTT test unit
J4	RFU J4	N/C, GPS antenna port				
J5	RFU J5	N/C, H250 handset port				
J6	RFU J6	2320 handset port	1	6	Y	2320 Handset
J7	RFU J7	DC input	1		N	3320 power supply
	AC input	AC input	1	2	N	Mains
	DC output	DC output	1		N	2310 DC input
GND	RFU GND, PS GND	Braid to RF ground	2		N	RF ground
J7	RFU J7	DC Input (battery)	1	6	N	12V Battery

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2.7 EUT Modifications

There were no modifications needed to comply with the requirements.

2.8 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.9 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a, b, c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

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Where U = expanded uncertainty

k = coverage factor

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 5 below.

Table 5: Expanded Uncertainty List

Parameter	**Uncertainty**	**Actual (+/-)**	**Unit**
Radio Frequency	±1 x 10^{-7}	8.64E-08	parts
RF Power conducted (up to 160 W)	±0.75 dB	0.3	dB
Conducted RF Power variations using a test fixture	±0.75 dB	0.3	dB
Radiated RF power	±6 dB	N/A	dB
Adjacent channel power	±5 dB	0.6	dB
Transmitter transient time	±20 %	9.2	%

Scope	**Standard(s)**	**Expanded Uncertainty**
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±4.55 dB
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±2.33 dB

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3 Test Equipment

The following is a list of the test equipment used.

Test Name:	**Temperature Stability**	Test Date:	**03/21/2017**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00776	TENNY - TJR-A-WS4	1.22 FT^3 TEMPERATURE CHAMBER	5/22/2017
00771	TEKTRONIX - TDS1012C-EDU	TWO CHANNEL 100MHZ OSCILLOSCOPE	8/8/2017
00867	CALIFORNIA INSTRUMENTS - CSW5550	PROGRAMMABLE POWER SUPPLY	5/31/2017
00528	AGILENT - E4446A	3HZ - 44GHZ ANALYZER SPECTRUM	8/10/2017
00823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	12/21/2017

Test Name:	**Radiated & Bench Conducted Emissions**	Test Date:	**3/15/2017**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00528	AGILENT/E4446A	3HZ - 44GHZ ANALYZER SPECTRUM	8/10/2017
00823	AGILENT/N9010A	EXA SPECTRUM ANALYZER	12/21/2017
00833	KEITHLEY/3390	50MHz ARBITRARY WAVEFORM GENERATOR	1/4/2018
00698	KEITHLEY/3390	50MHz ARBITRARY WAVEFORM GENERATOR	1/4/2018
Rental	TELEDYNE Lecroy/HDO6104-MS	High Definition Mixed Signal O-Scope	3/1/2018

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4 Test Results

Application to part 90 of The Commission's Rules is declared by the manufacturer.

4.1 Output Power (Part 90.205)

4.1.1 Test Method (Part 2.1046 (b) (1))

For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as follows. In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

Single sideband transmitters in the J3E and H3E emission modes—by two tones at frequencies of 400 Hz and 1800 Hz, applied simultaneously, the input levels of the tones so adjusted that the two principal frequency components of the radio frequency signal produced are equal in magnitude.

Power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

4.1.2 Test Limit

Part 90.205 states an operating power not to exceed 1000W peak envelope power for devices operating below 25MHz and 300W peak envelope power for the frequency range 25-50MHz.

4.1.3 Test Results

The test results are shown in Table 6.

4.1.4 Test Summary

The conducted output complies with the requirements of 90.205.

Table 6: Conducted Output Power

LC @1.71MHz	CC @ 14.4MHz	HC @27.6MHz
51.64dBm/145.88W	51.23dBm/132.74W	50.83dBm/121.06W

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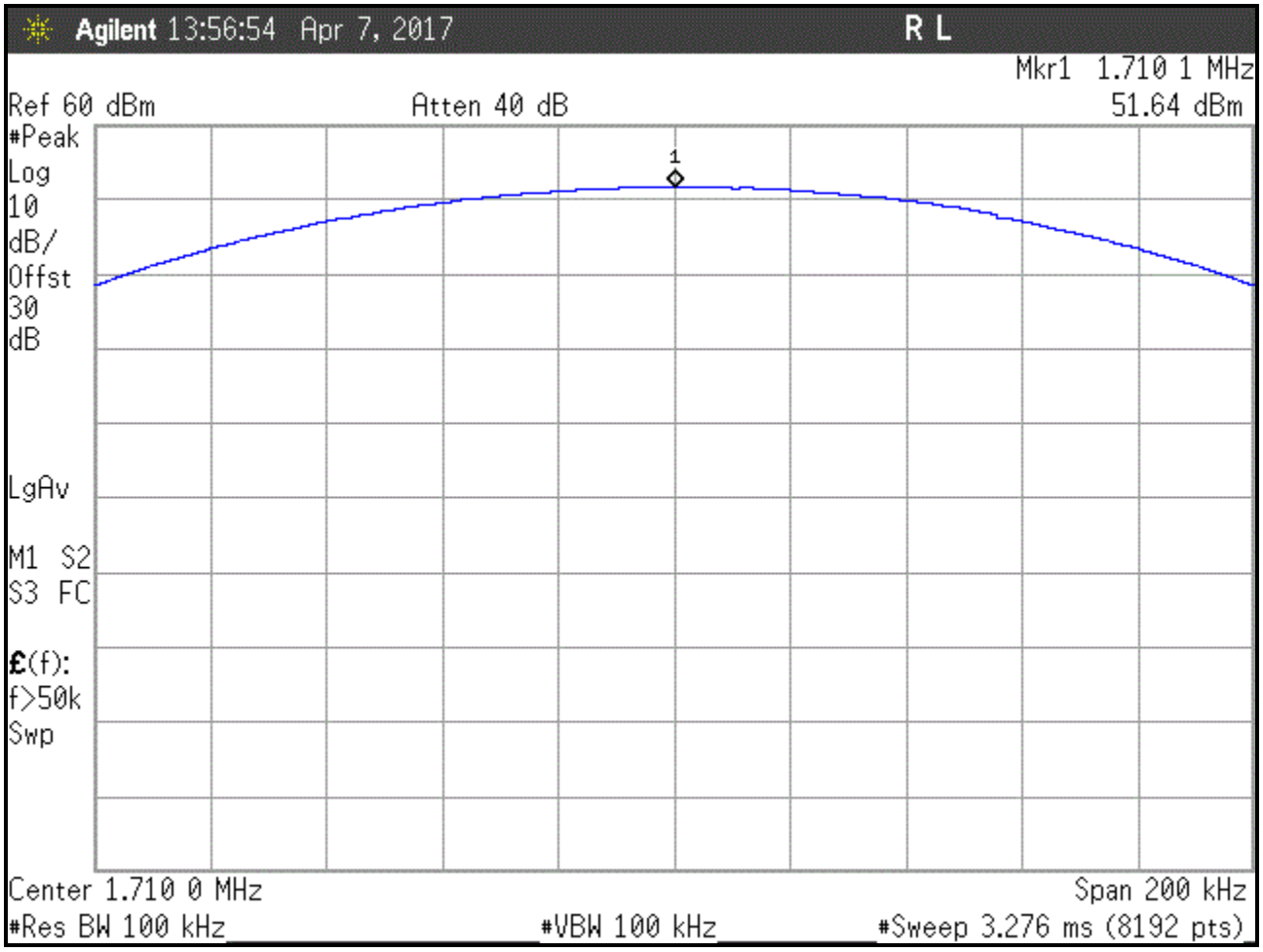

Figure 3: LC Power

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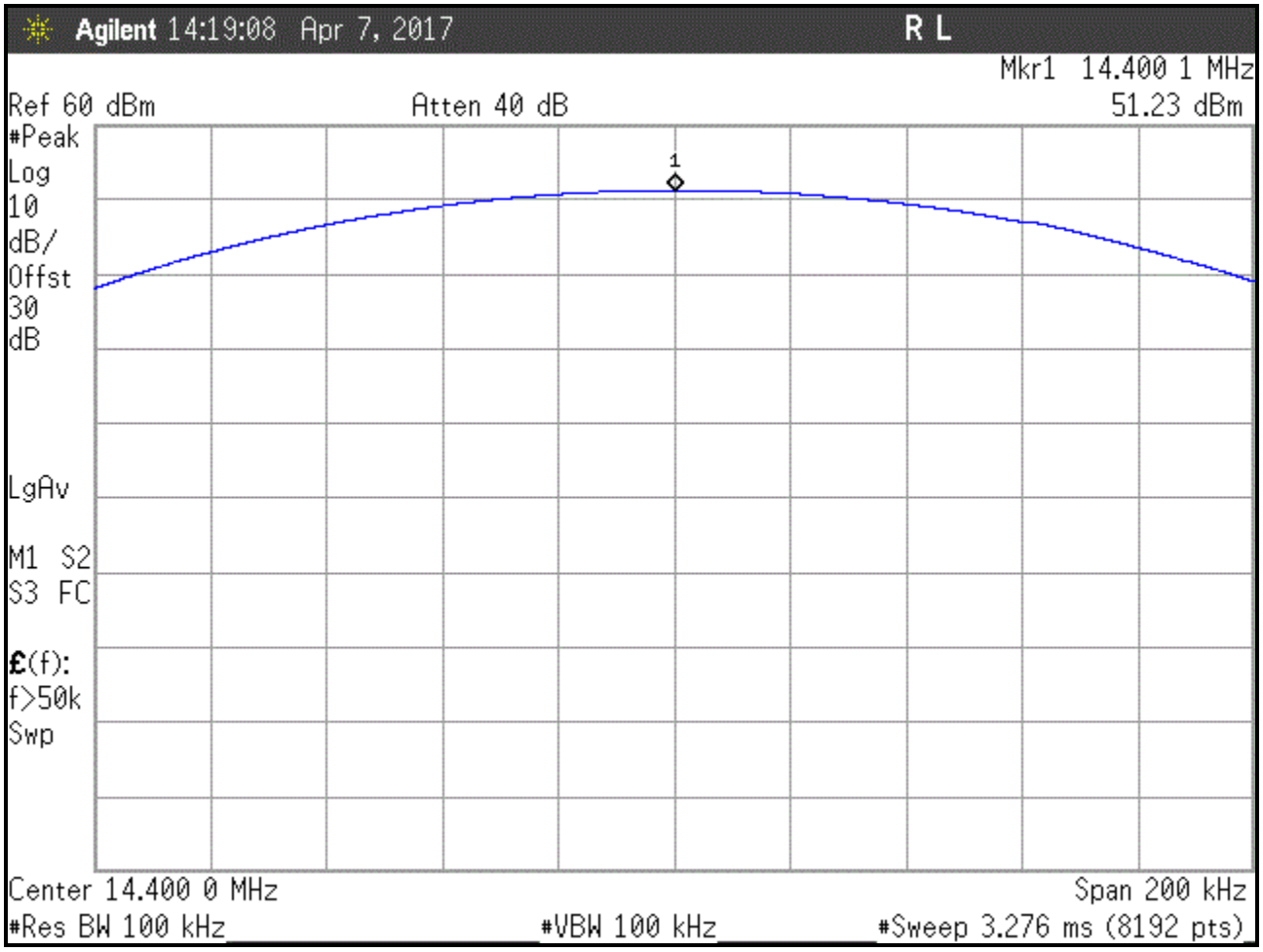

Figure 4: CC Power

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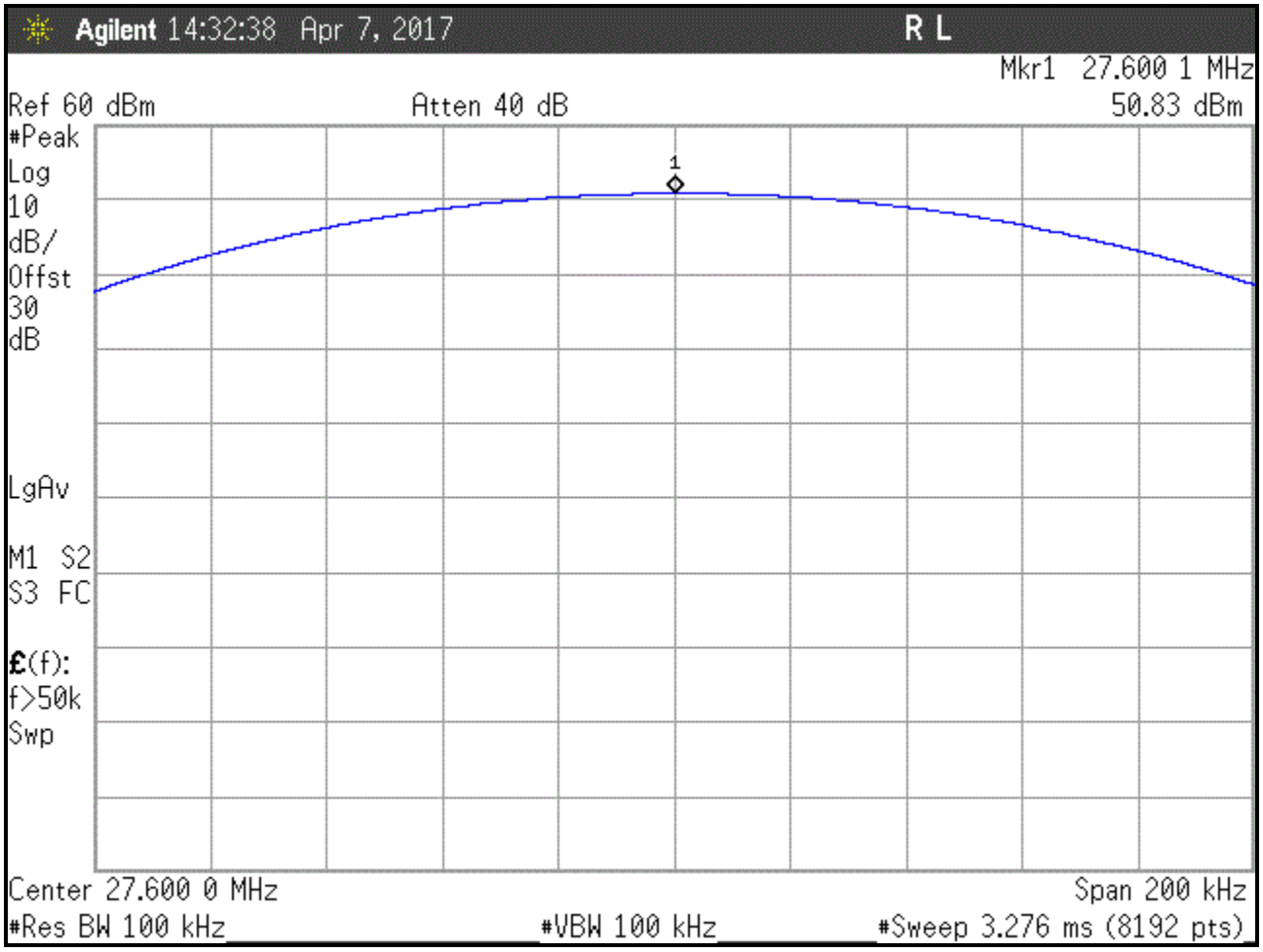

Figure 5: HC Power

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4.2 Occupied Bandwidth [Part 90.209]

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable

4.2.1 Test Method (Part 2.1049(c) (2))

Radiotelephone transmitters equipped with a device to limit modulation or peak envelope power shall be modulated as follows. For single sideband and independent sideband transmitters, the input level of the modulating signal shall be 10 dB greater than that necessary to produce rated peak envelope power. Single sideband transmitters in J3E and H3E emission modes—when modulated by two tones at frequencies of 400 Hz and 1800 Hz (for 3.0 kHz authorized bandwidth), or 500 Hz and 2100 Hz (for 3.5 kHz authorized bandwidth), or 500 Hz and 2400 Hz (for 4.0 kHz authorized bandwidth), applied simultaneously. The input levels of the tones shall be so adjusted that the two principal frequency components of the radio frequency signal produced are equal in magnitude.

The emission bandwidth test was performed as an occupied bandwidth measurement. The EUT antenna was disconnected from its internal antenna port and replaced with a calibrated cable connected to a spectrum analyzer through appropriate attenuators. A spectrum analyzer was tuned to the center of the transmit frequency. The span of the analyzer was the reduced to approximately 2 to 3 times the span of the TX signal. The resolution bandwidth of the device was lowered to approximately 1% of the estimated occupied bandwidth. The span between points on each side of the TX signal corresponding to 26dB below the peak was then recorded as the emission bandwidth. This corresponds to the 99% power bandwidth.

4.2.2 Test Limit

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission. The limit is defined @ 3.0, 3.5 or 4.0 kHz

4.2.3 Test Results

Table 7 lists the OBW for the two available modes, and Figures 6-11 show the plots of the bandwidth measurements. It should be noted that all modulations were evaluated and the table below represents the maximum observed bandwidths.

8PSK @ 75, 150, 300, 600, 1200, 2400, 4800 bps

QPSK @ 3200bps

16QAM @ 64bps

32QAM @ 8000bps

64QAM @ 9600bps

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Table 7: Occupied Bandwidth

Mode	LC BW(kHz)	CC BW(kHz)	HC BW(kHz)
USB	2.276	2.277	2.280
USBW	2.282	2.285	2.285
PSK	2.889	2.969	2.958
QAM	3.250	3.231	3.223

4.2.4 Test Summary

The plots below show a sampling of the measured emissions bandwidths for the available modes of operation.

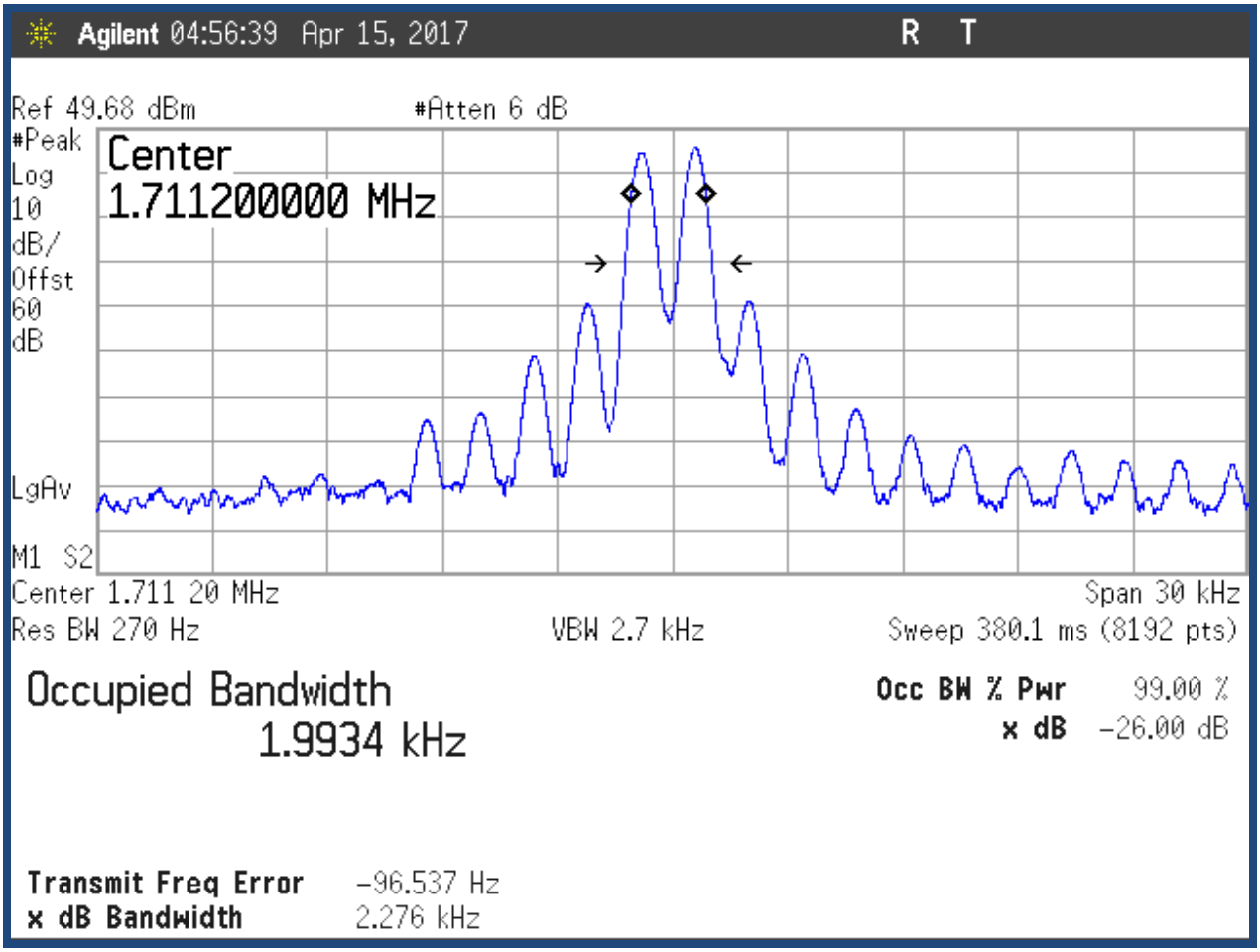

Figure 6: LC Occupied bandwidth (USB Setting)

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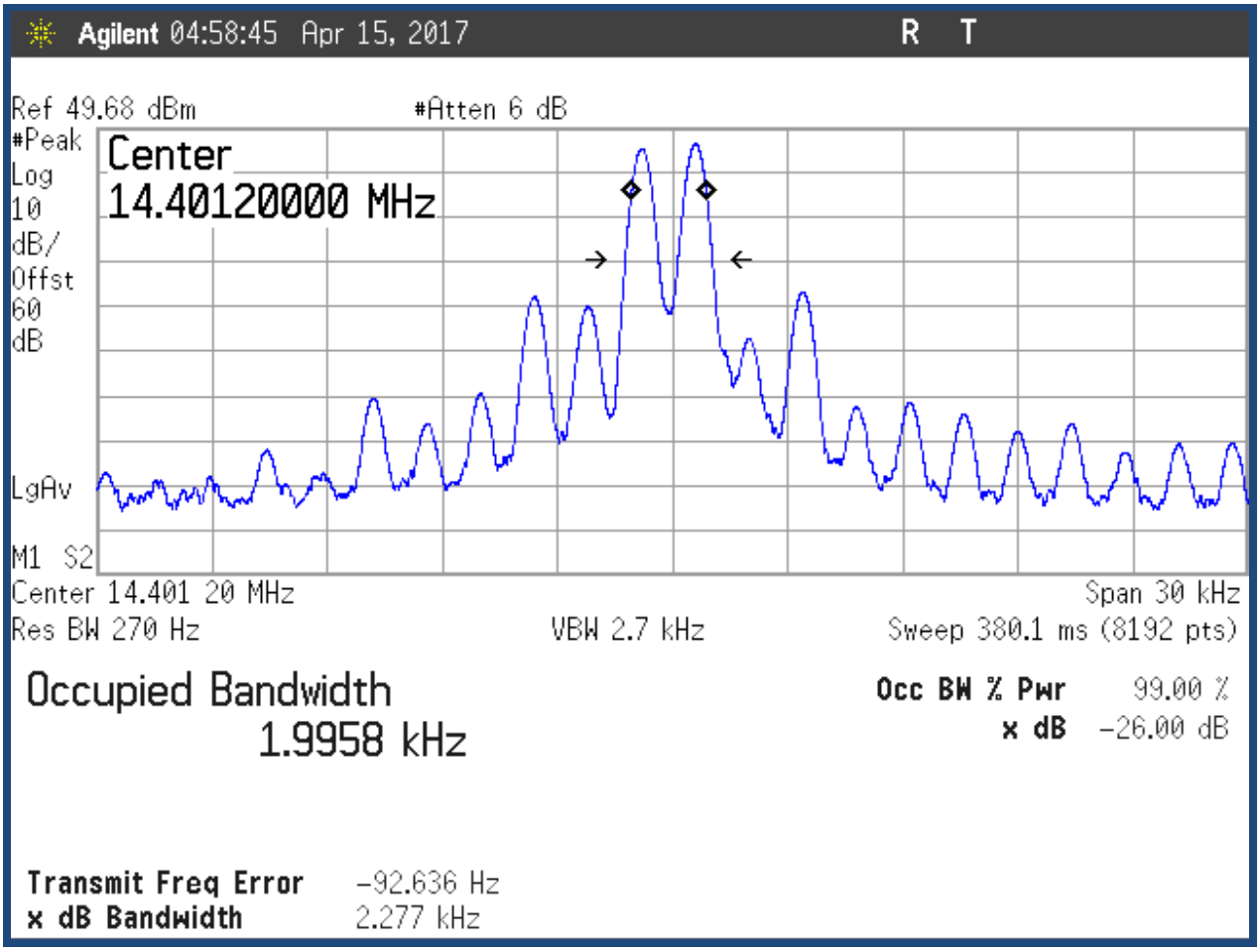

Figure 7: CC Occupied bandwidth (USB Setting)

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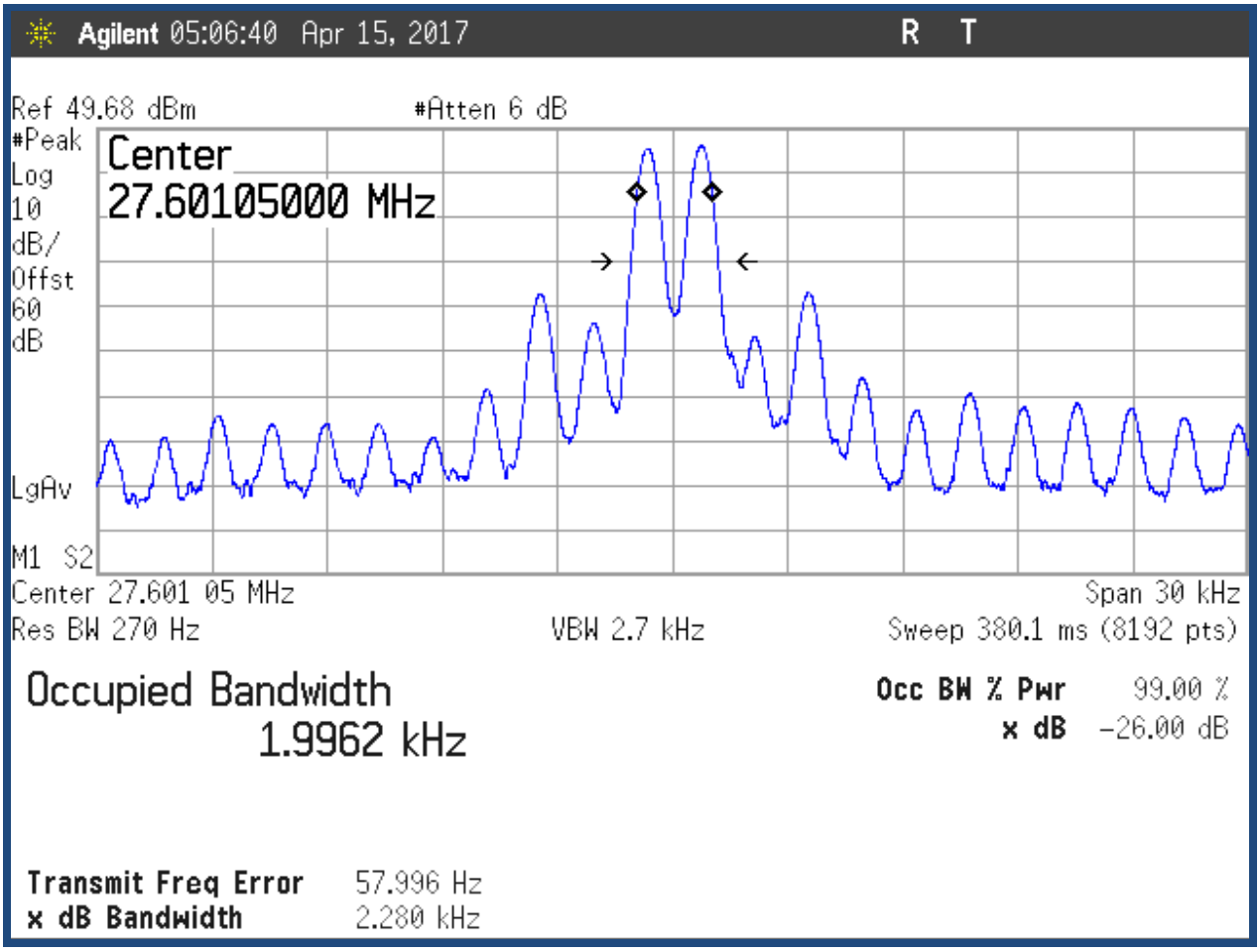

Figure 8: HC Occupied bandwidth (USB Setting)

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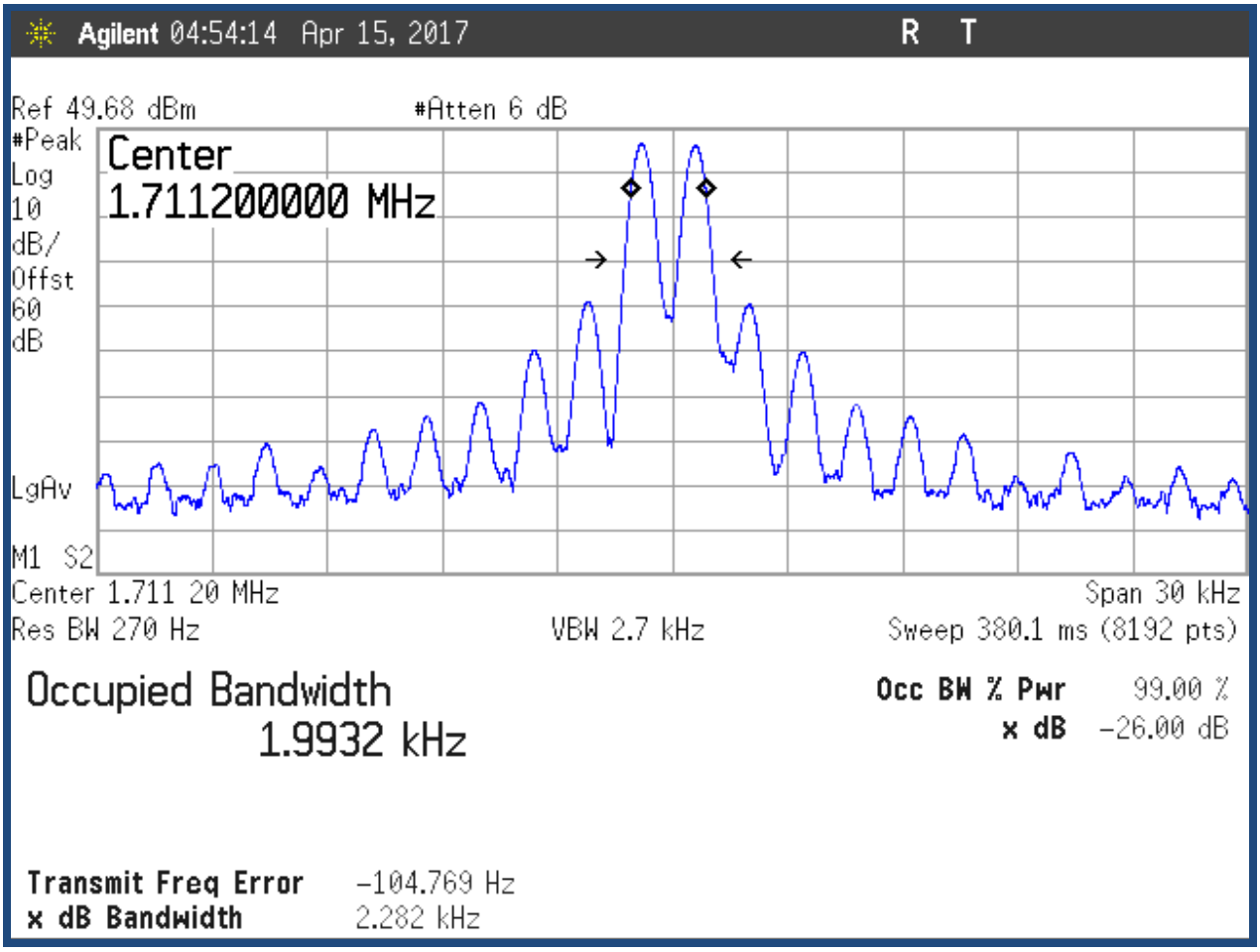

Figure 9: LC Occupied bandwidth (USBW Setting)

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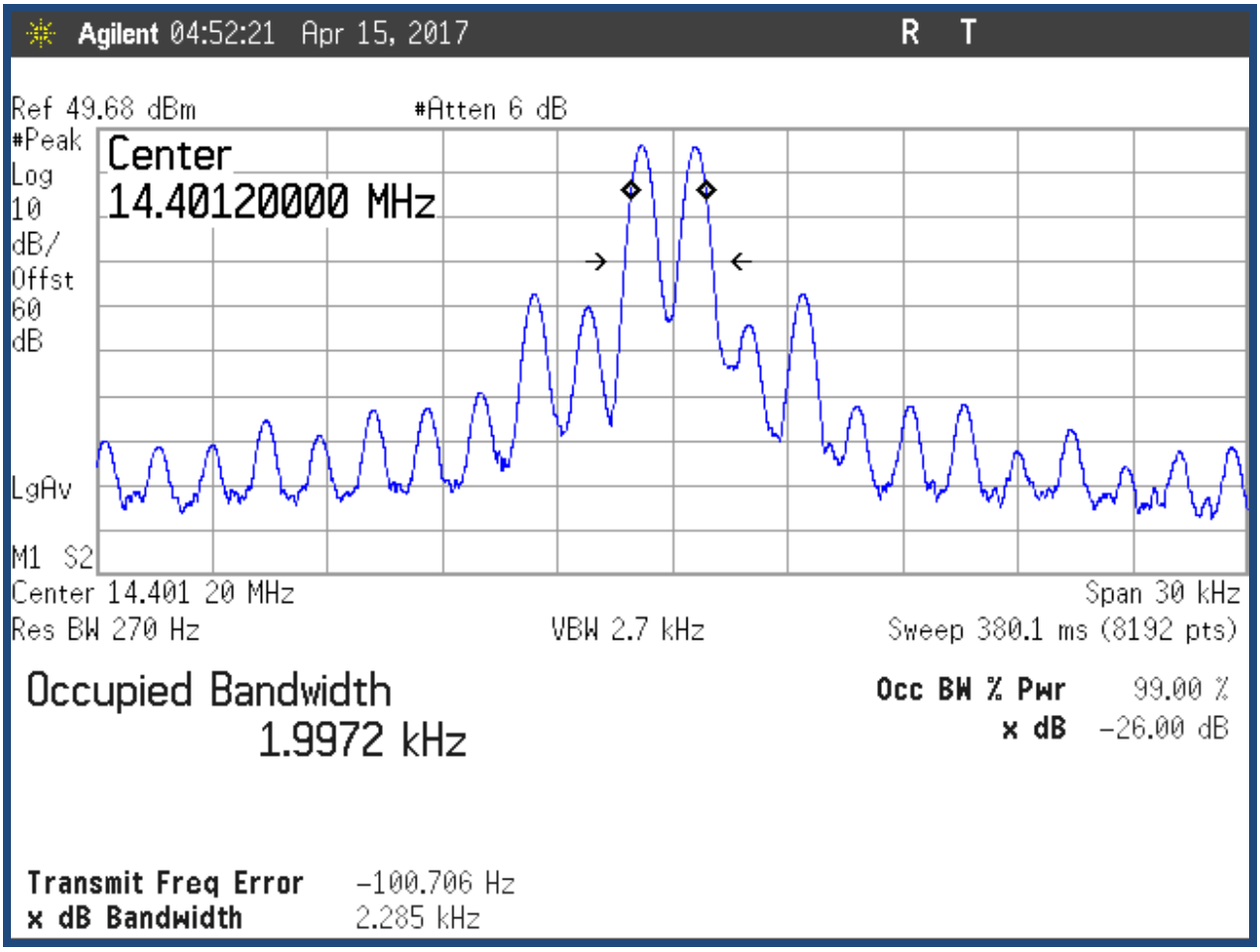

Figure 10: CC Occupied bandwidth (USBW Setting)

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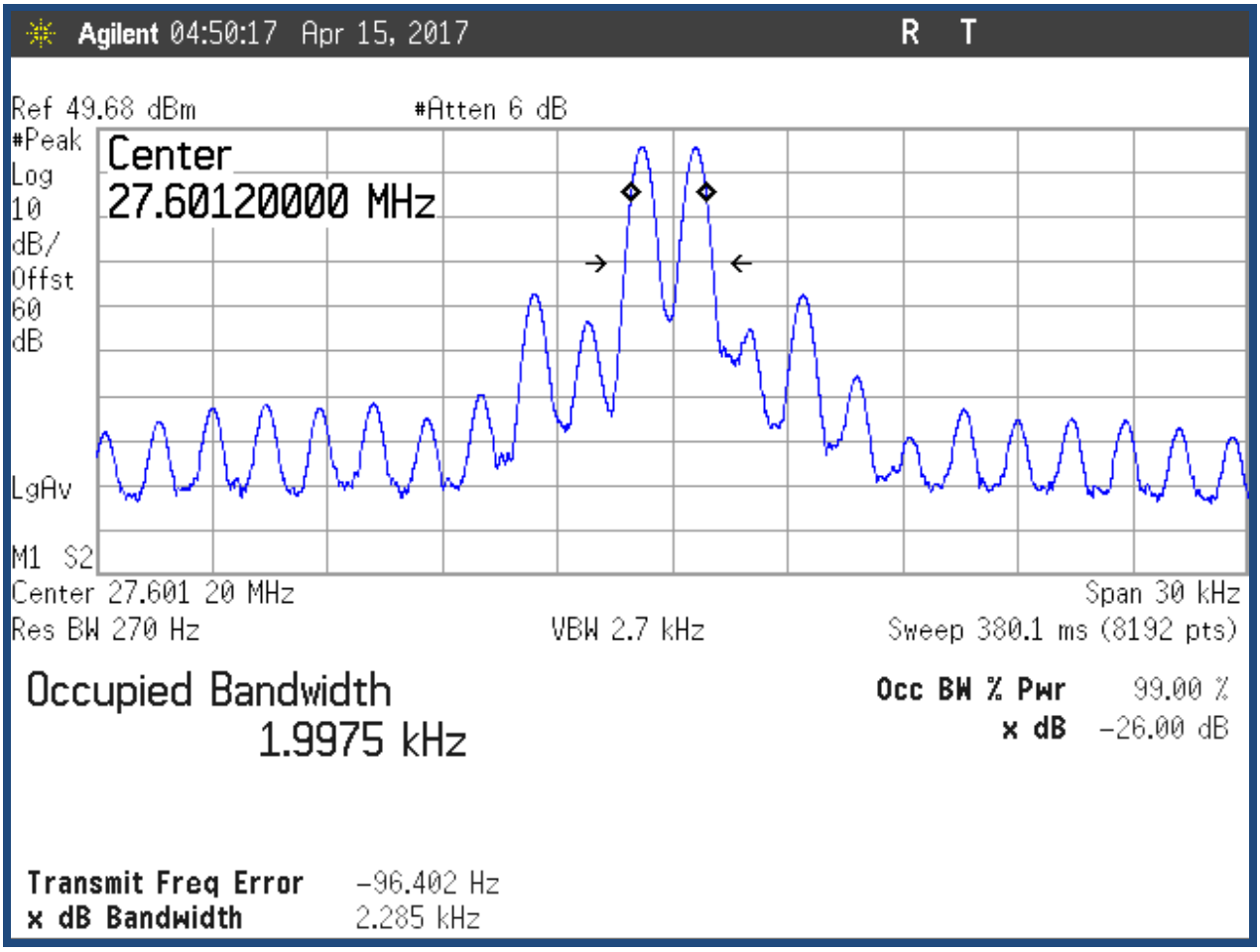

Figure 11: HC Occupied bandwidth (USBW Setting)

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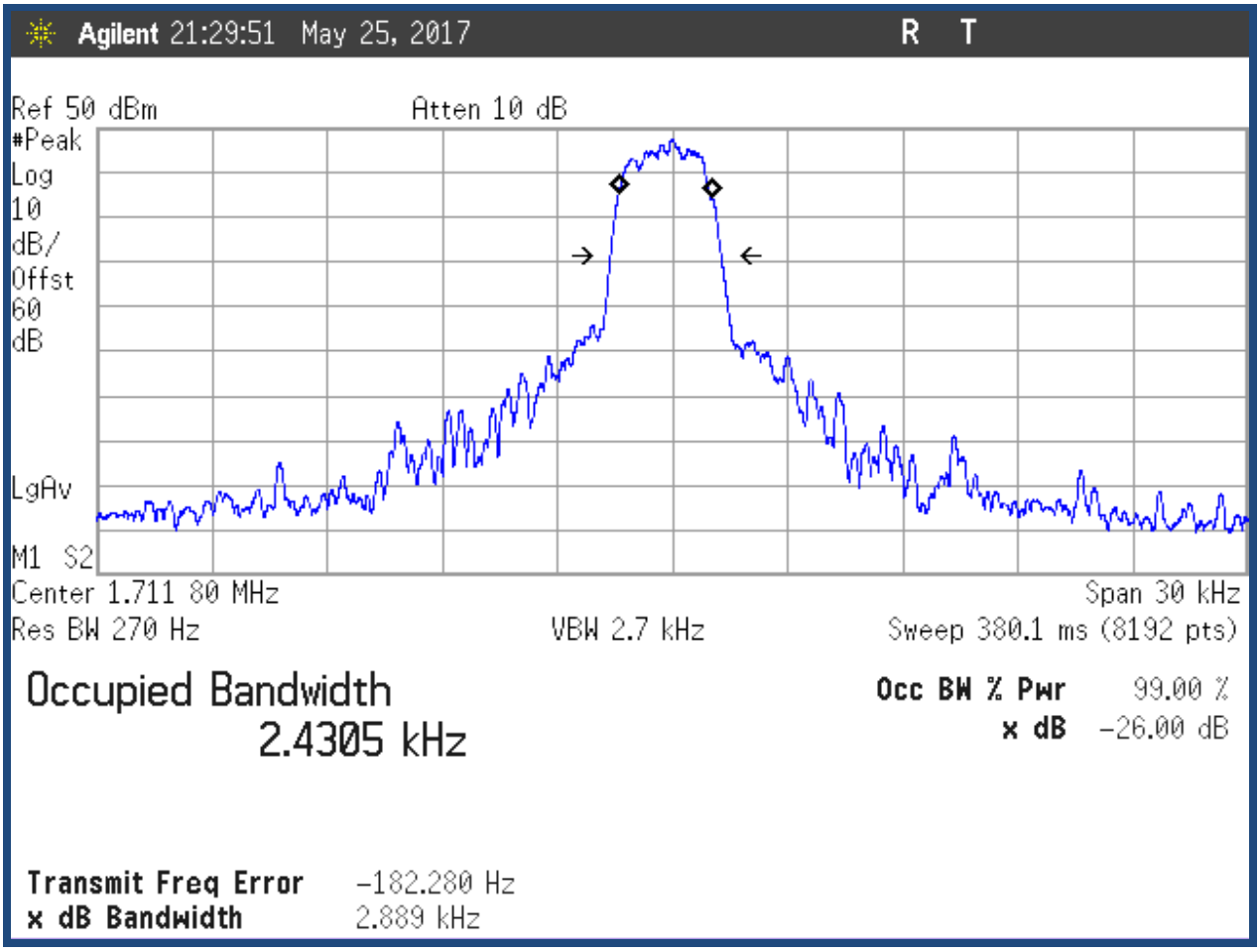

Figure 12: LC Occupied bandwidth (PSK Setting)

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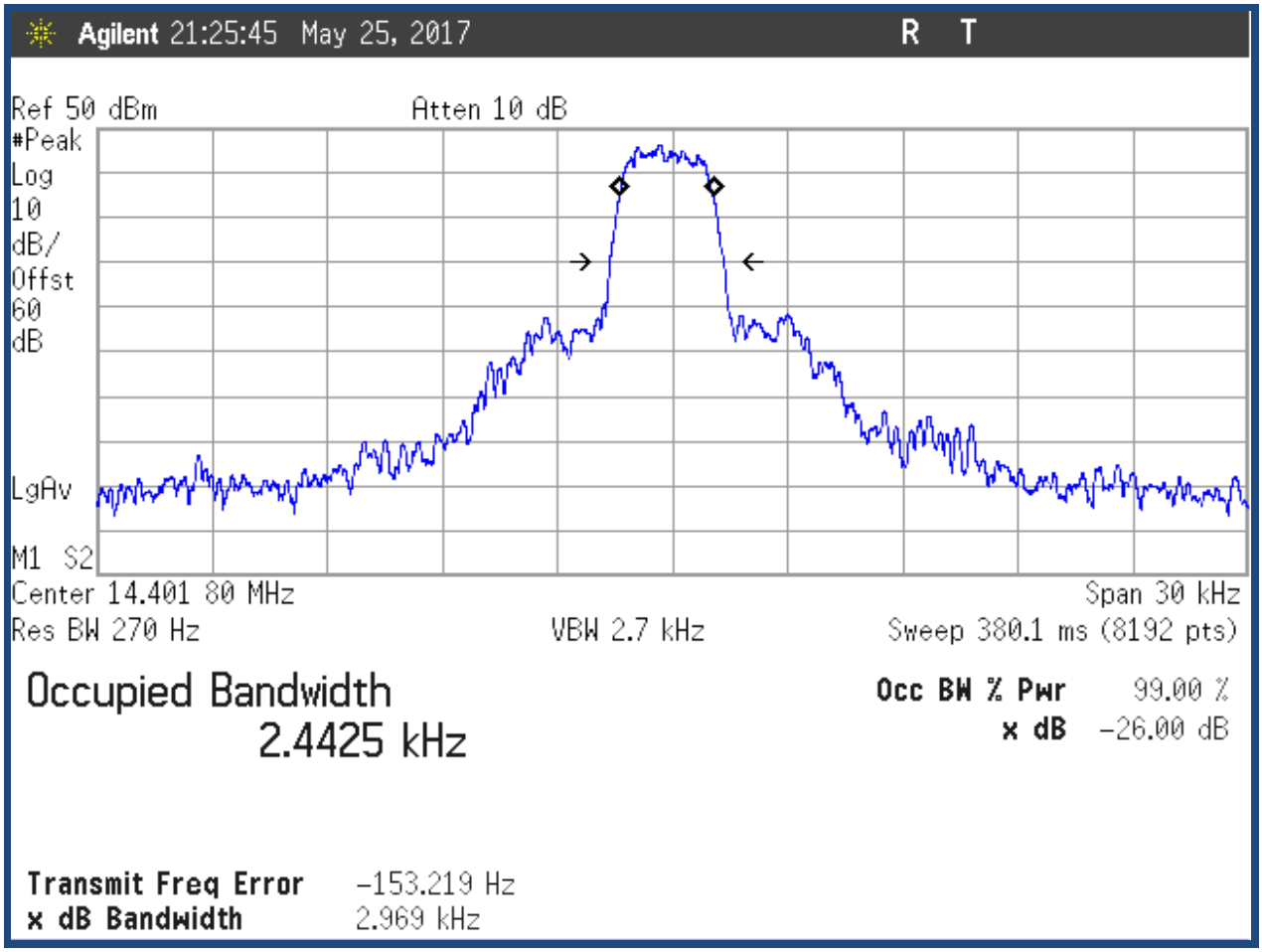

Figure 13: CC Occupied bandwidth (PSK Setting)

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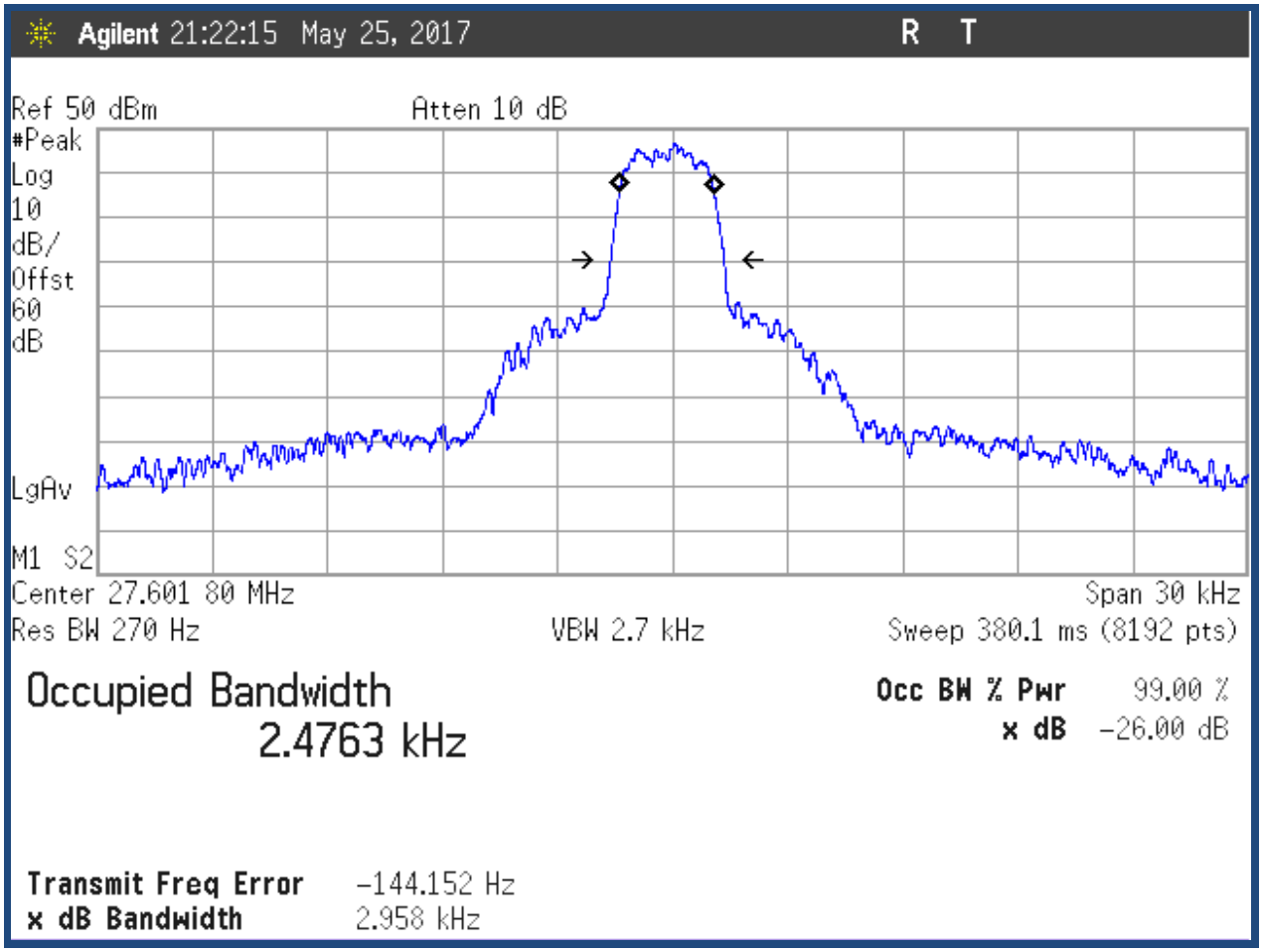

Figure 14: HC Occupied bandwidth (PSK Setting)

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4.3 Emissions Masks & Out of Band Unwanted Radiation [FCC Part 90.210 (b)(1)(2)(3)]

4.3.1 Test Method

In addition the EUT was tested out of band (>250 % of authorized bandwidth) for radiated emissions on an open air test site (OATS) using a substitution method The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The EUT was tested in 3 orthogonal positions for compliance. A resolution bandwidth of 100 kHz was used for radiated measurements. The EUT antenna was in place for these readings.

4.3.2 Test Limit

Frequency Band(MHz)	Mask(Equipment w Audio Low Filter)
Below 25MHz	A
25-50MHz	B

(a) **Emission Mask A**. For transmitters utilizing J3E emission, the carrier must be at least 40 dB below the peak envelope power and the power of emissions must be reduced below the output power (P in watts) of the transmitter as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 150 percent of the authorized bandwidth: At least 25dB.

(2) On any frequency removed from the assigned frequency by more than 150 percent, but not more than 250 percent of the authorized bandwidth: At least 35dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

(b) **Emission Mask B**. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

4.3.3 Test Results

The emissions mask tests are shown in Figures 10-12 and the conducted out of band spurious emissions are shown in Figures 13-16. The radiated emissions test results are shown in Tables 7-9. Worst case emissions are shown in all tables and plots.

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4.3.4 Test Summary

The EUT complied with the requirements of FCC Part [90.210 b (1)(2)(3)].

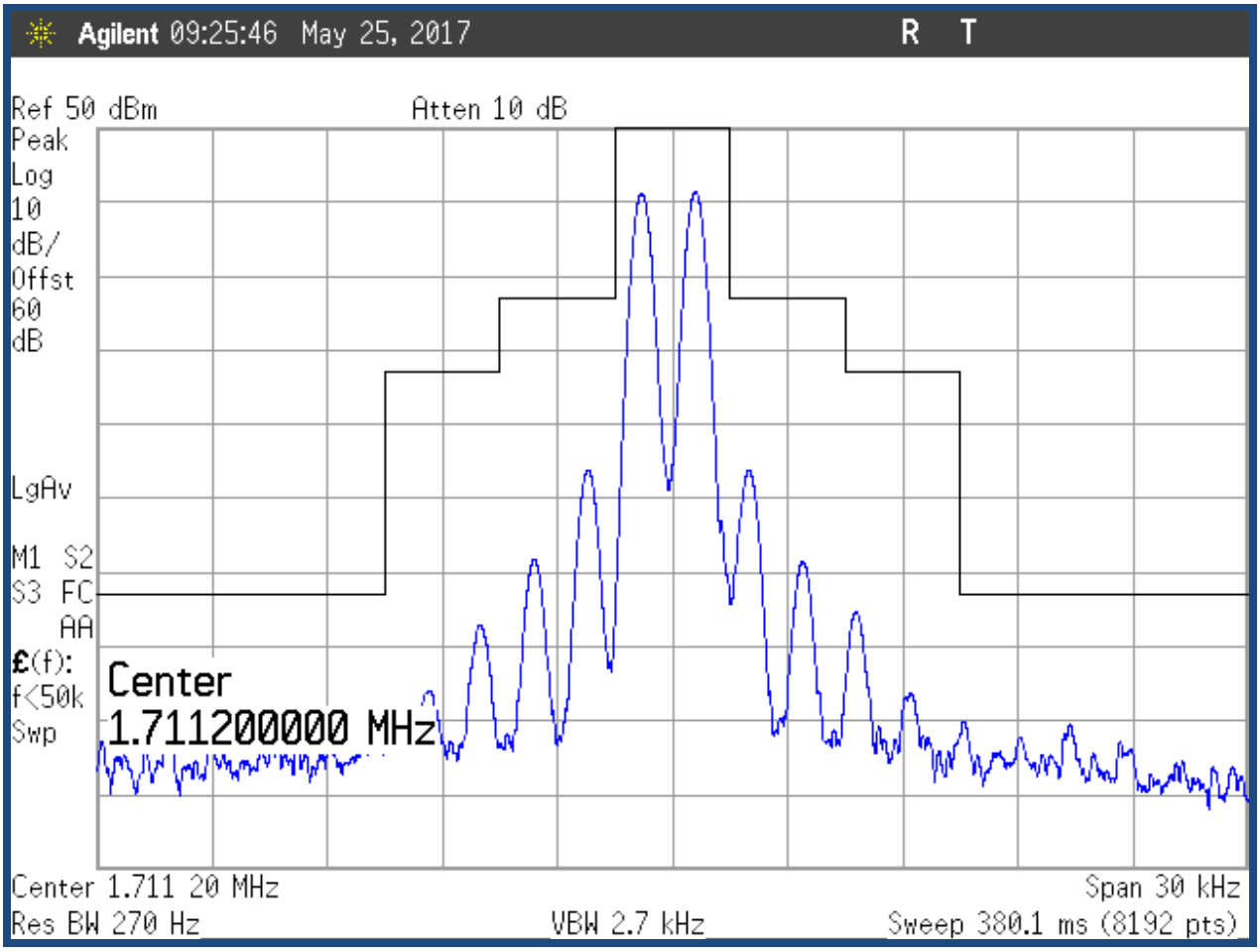

Figure 15: In-Band Emissions Mask, Low Channel USBW)

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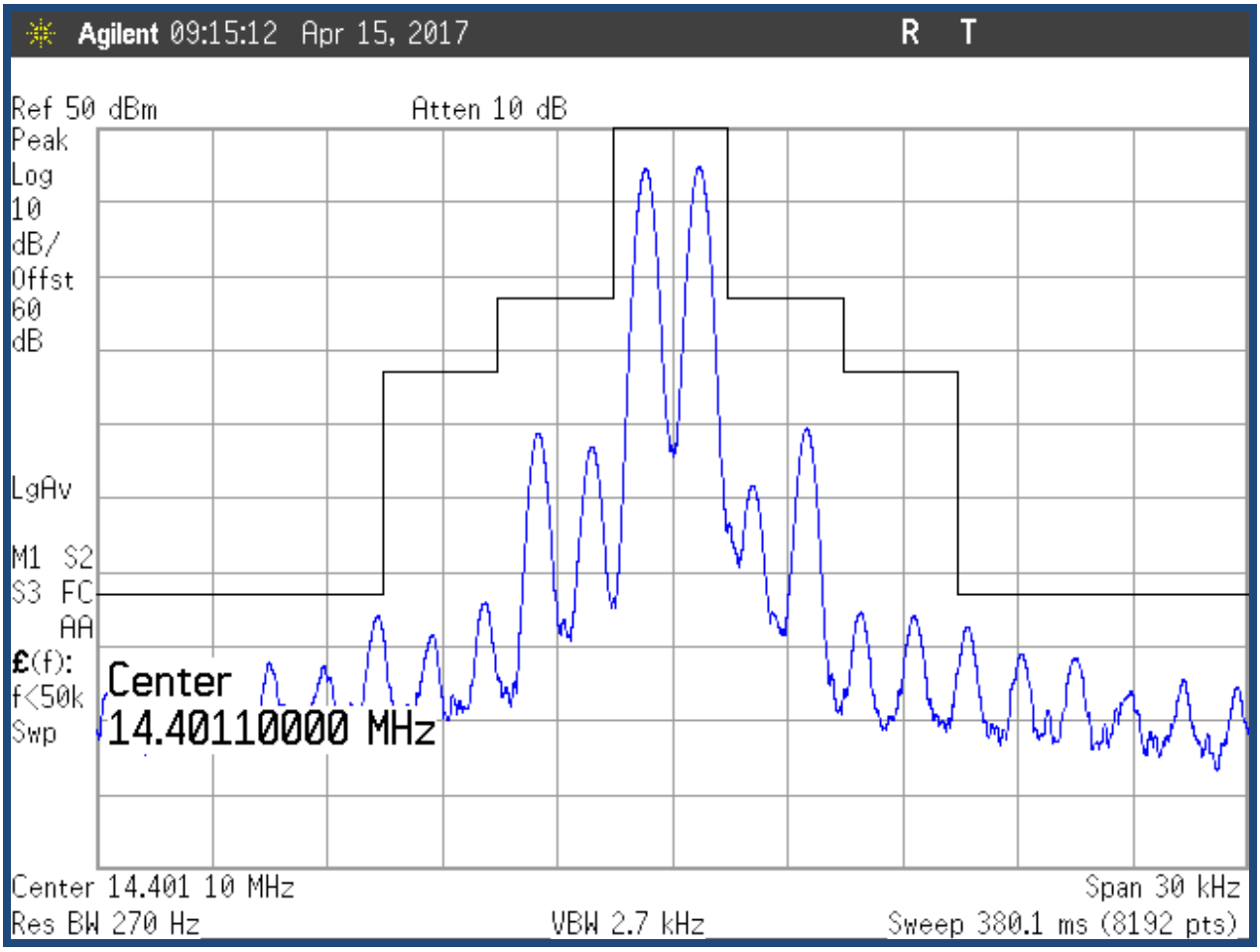

Figure 16: In-Band Emissions Mask, Center Channel(USBW)

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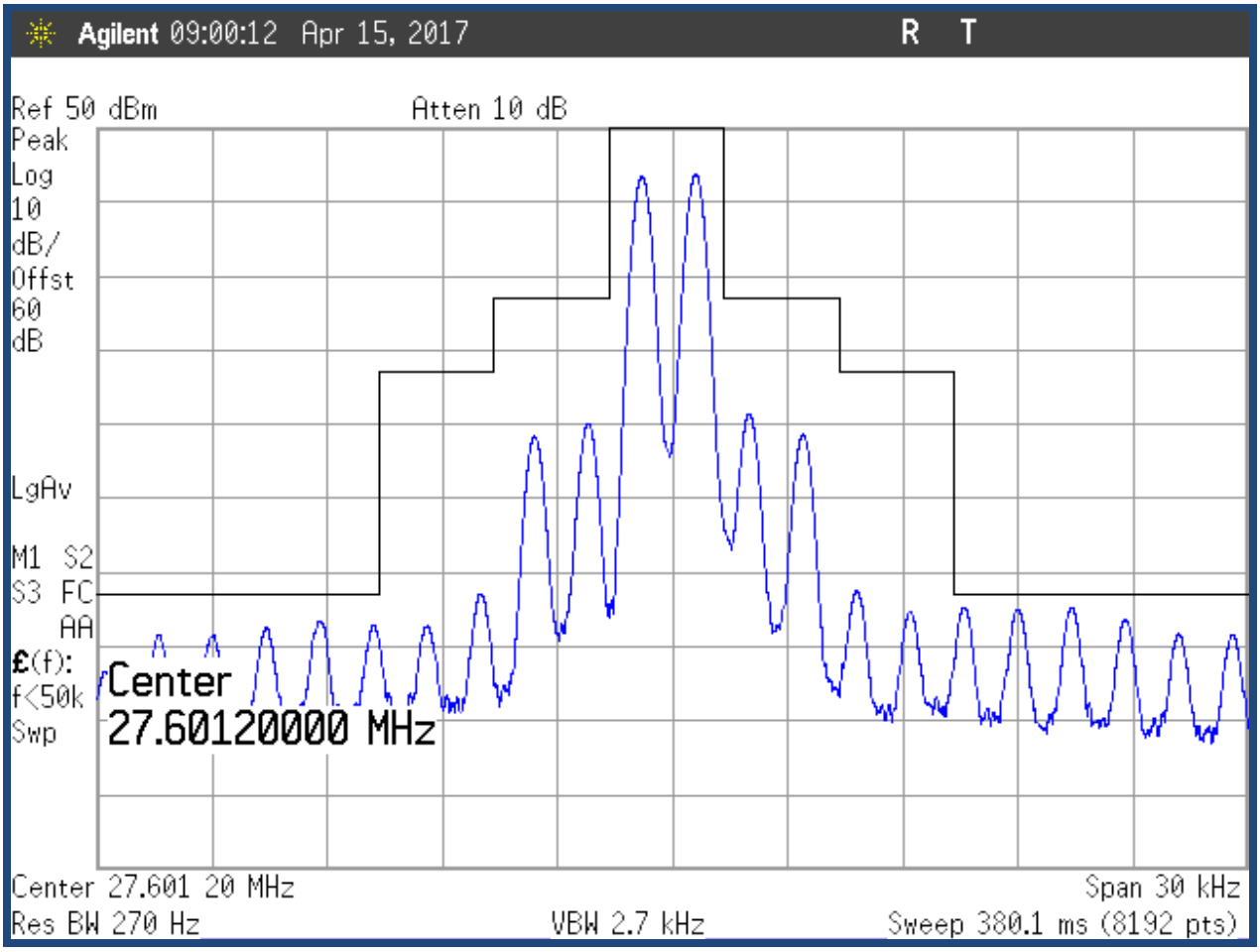

Figure 17: In-Band Emissions Mask, High Channel (USBW)

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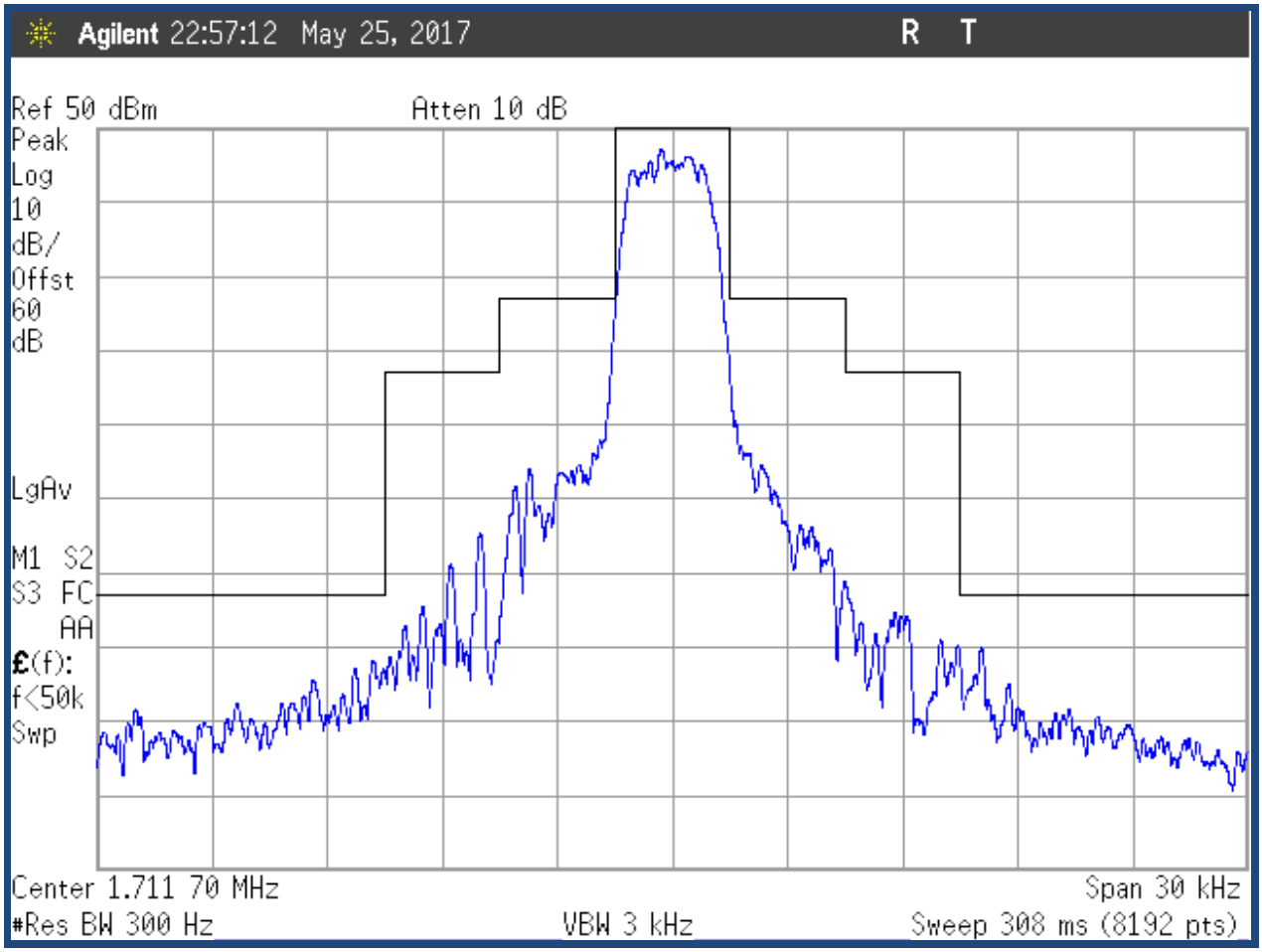

Figure 18: In-Band Emissions Mask, Low Channel (PSK)

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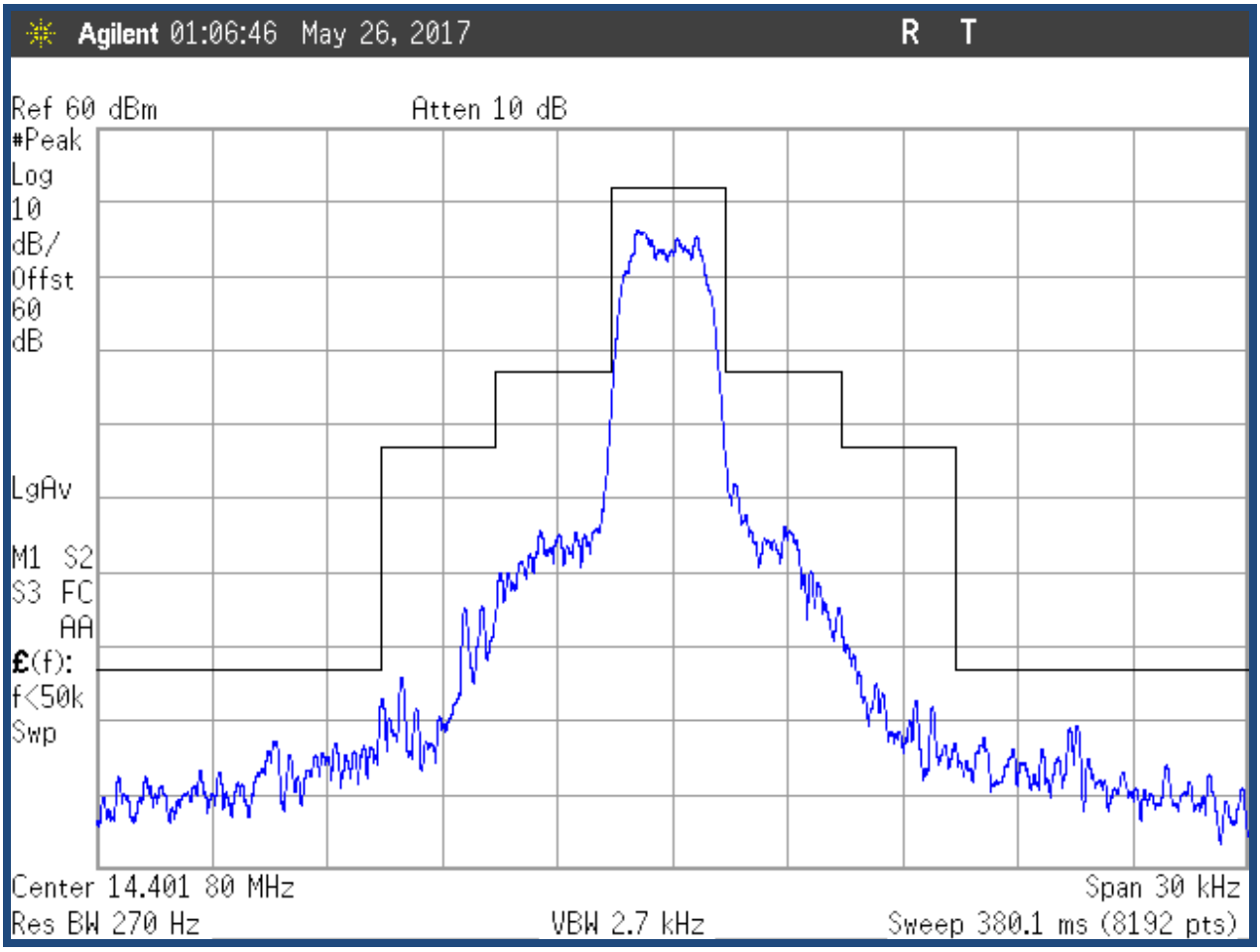

Figure 19: In-Band Emissions Mask, Center Channel (PSK)

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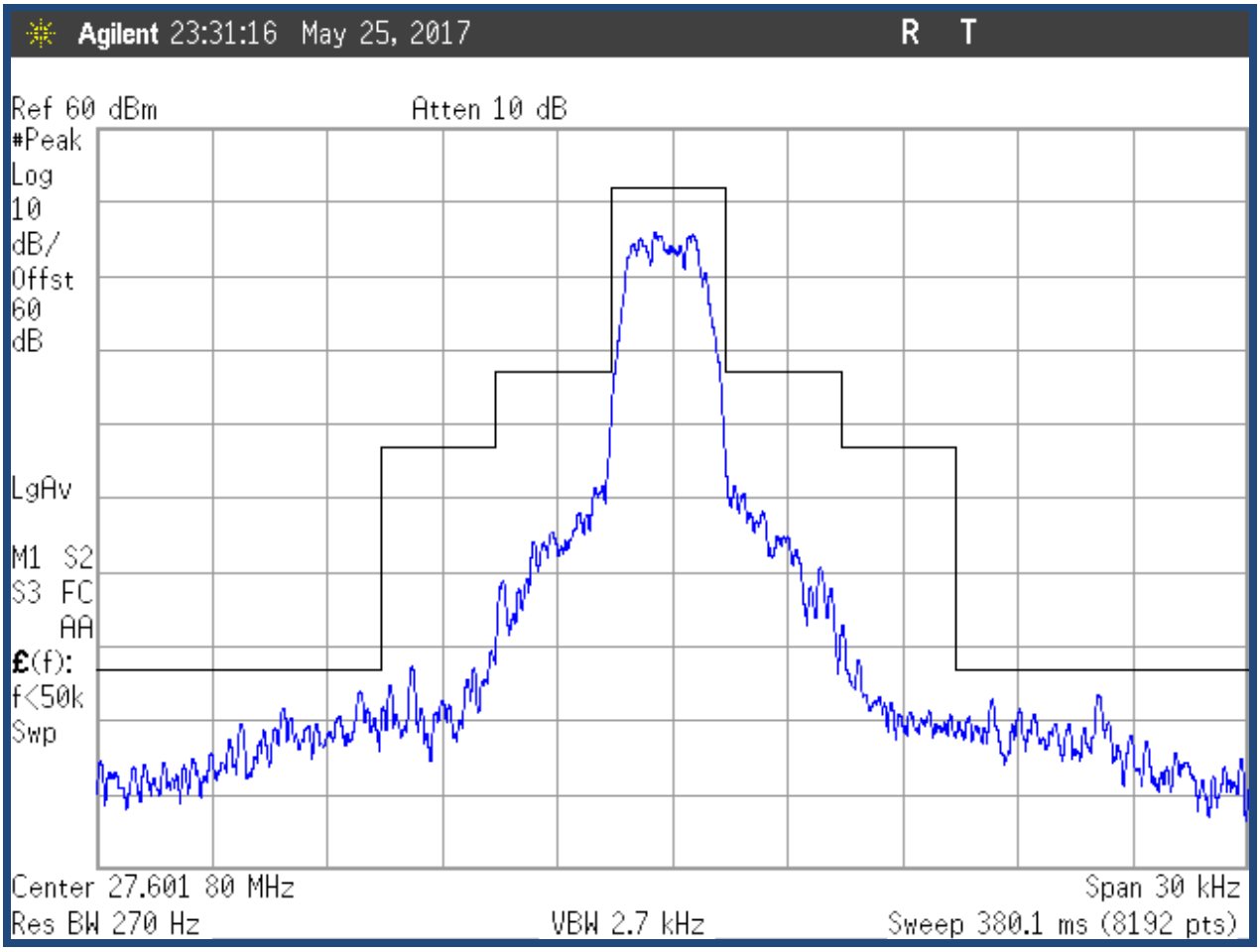

Figure 20: In-Band Emissions Mask, High Channel (PSK)

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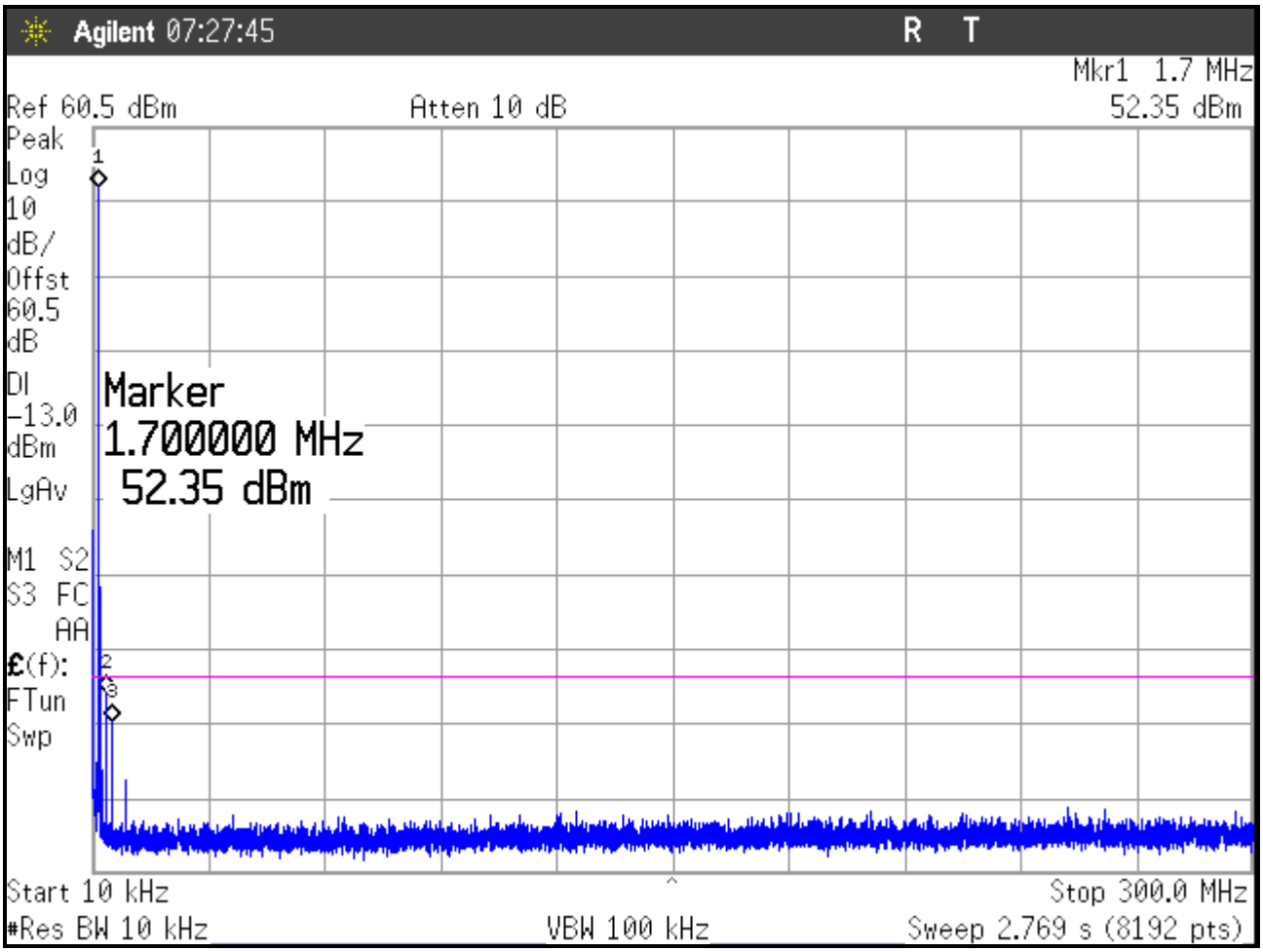

Figure 21: Spurious Emissions, Low Channel (USBW)

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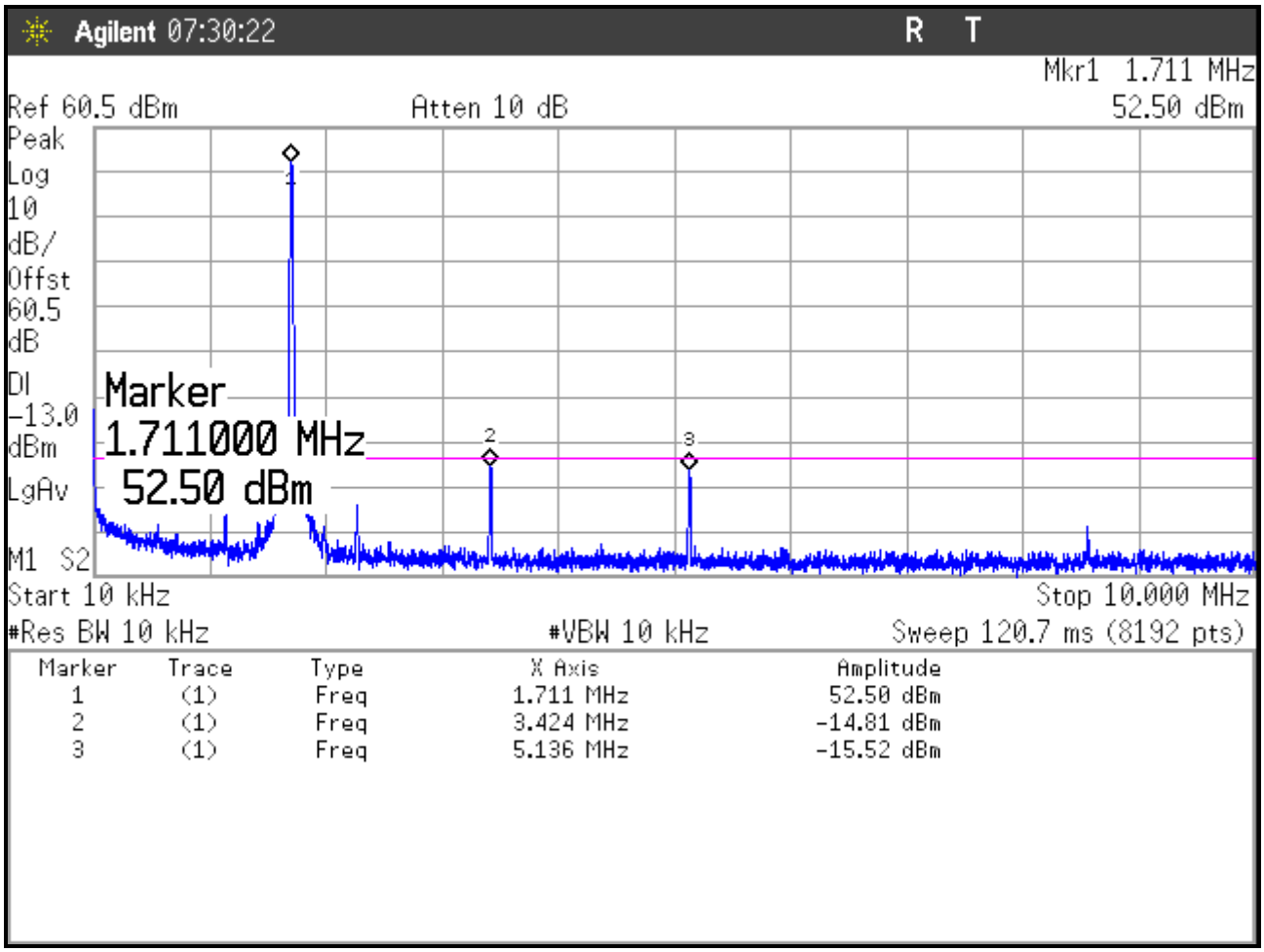

Figure 22: Spurious Emissions, Low Channel, Close-up (USBW)

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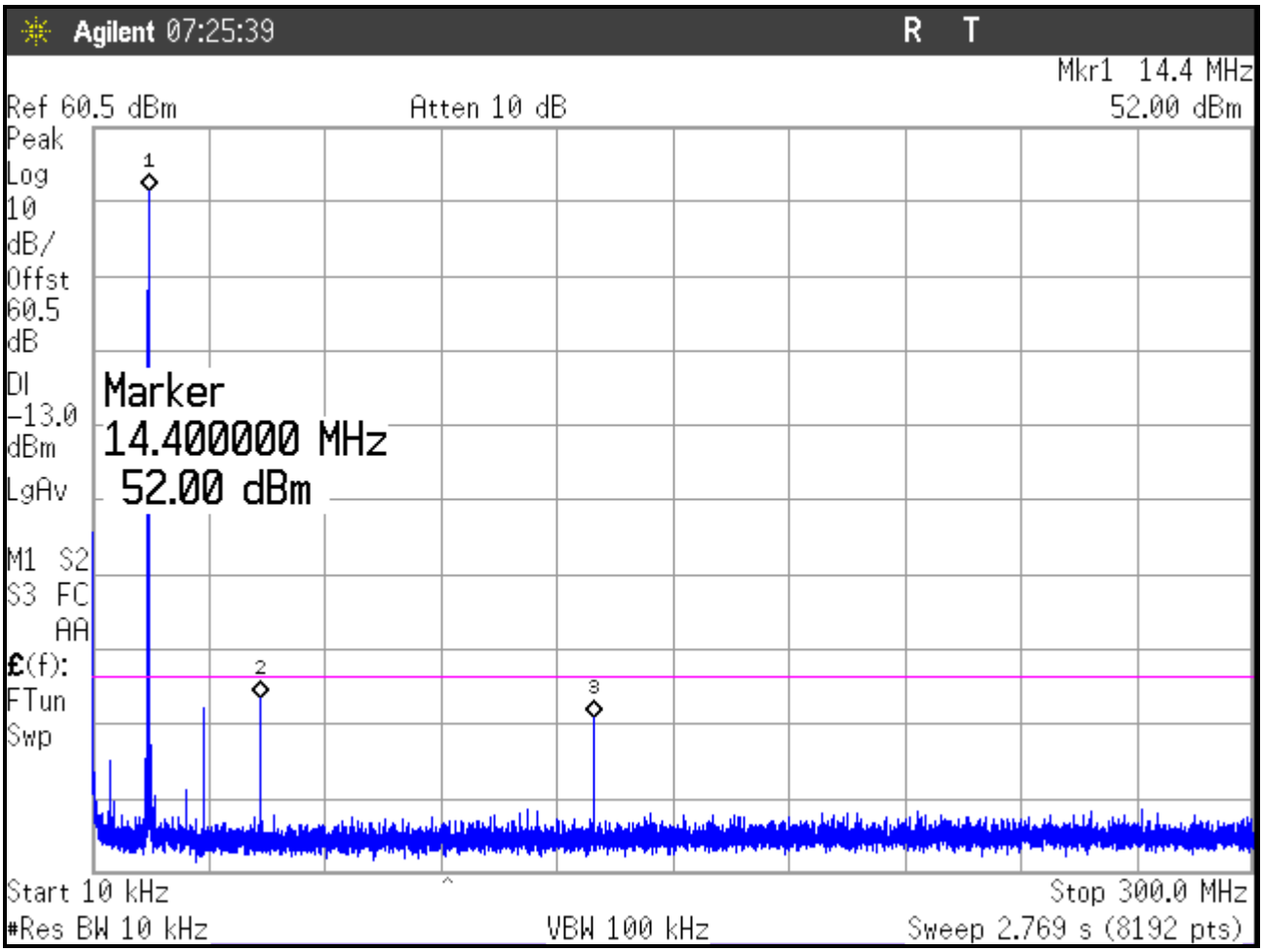

Figure 23: Spurious Emissions, Center Channel (USBW)

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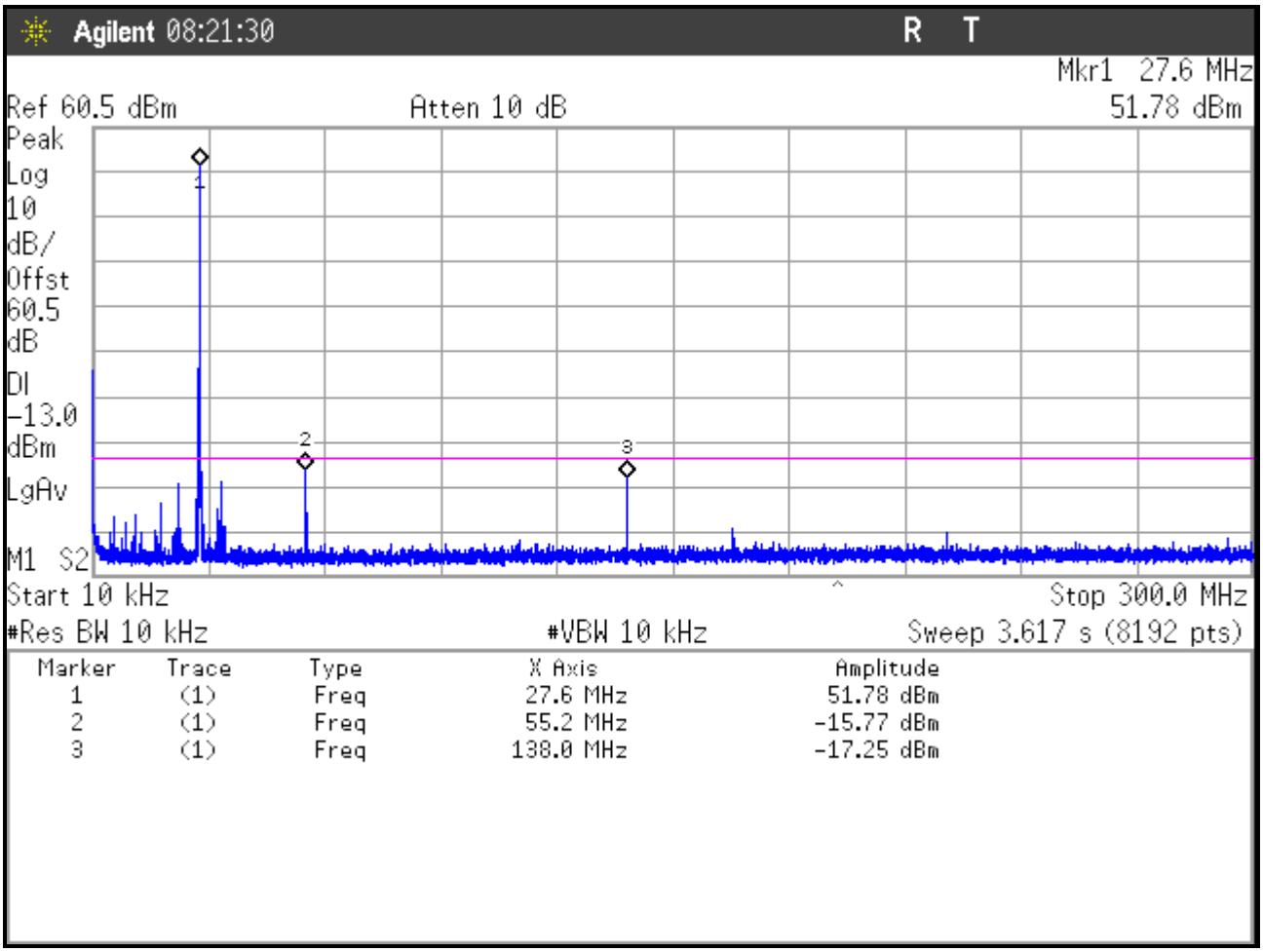

Figure 24: Spurious Emissions, High Channel (USBW)

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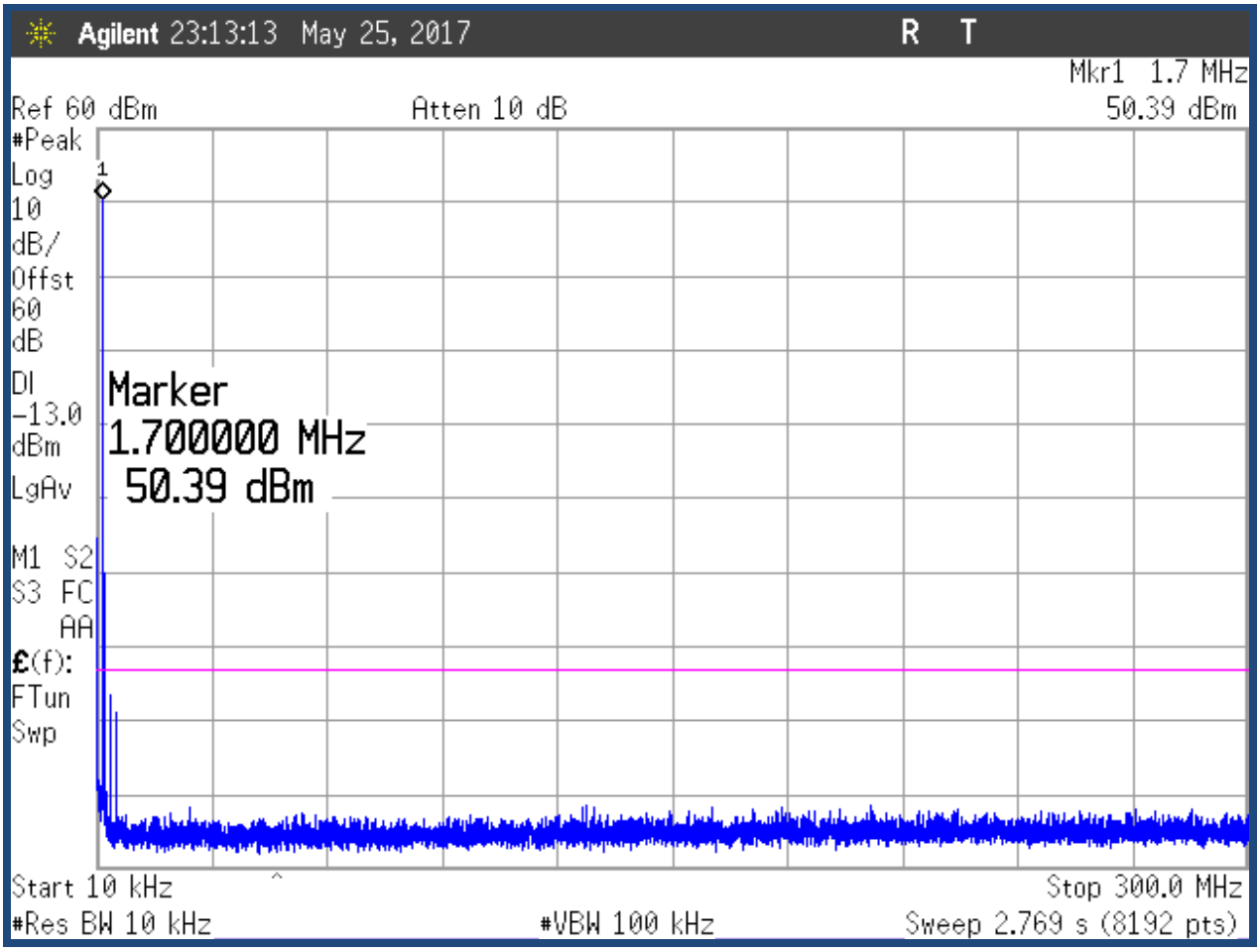

Figure 25: Spurious Emissions, Low Channel (PSK/QAM)

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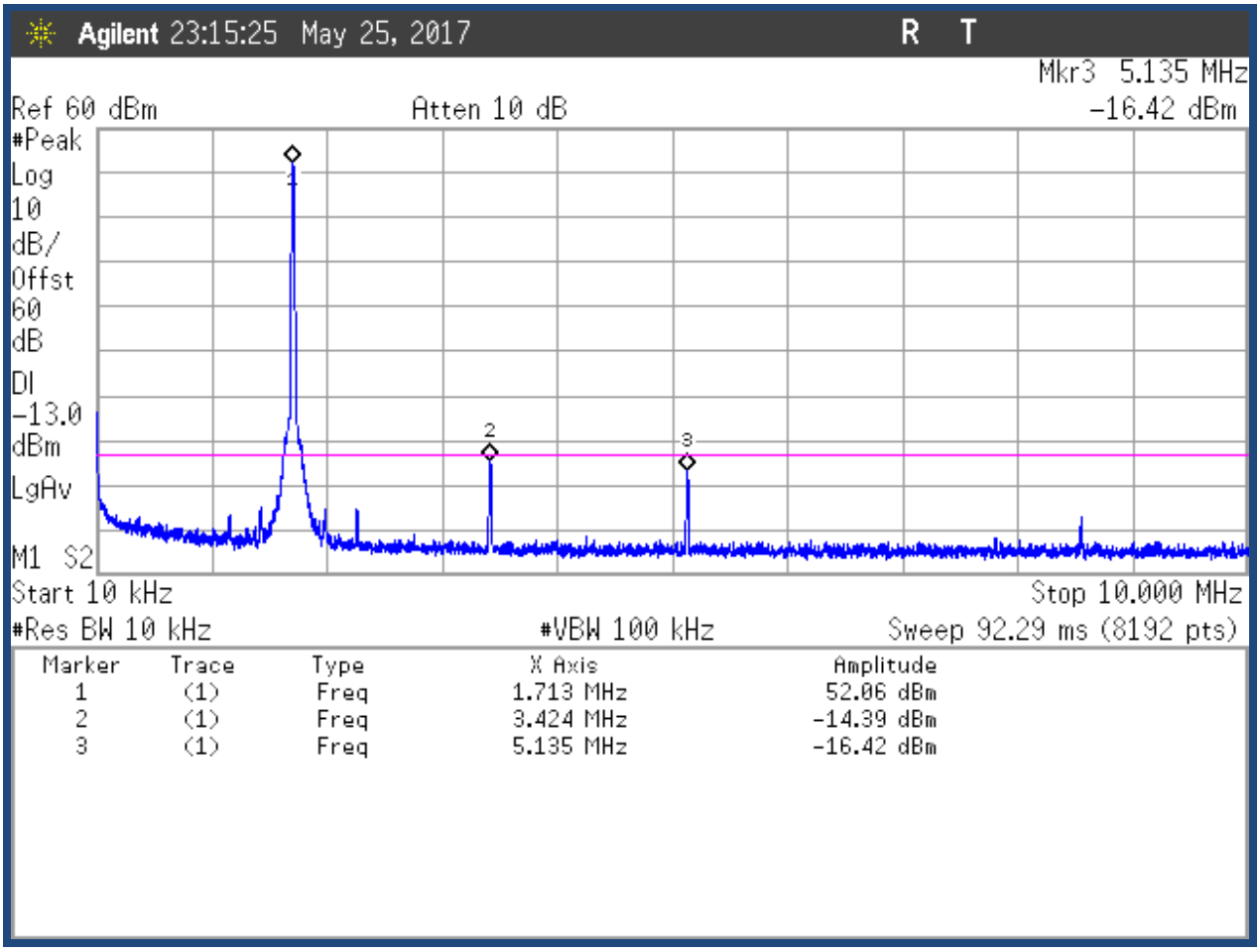

Figure 26: Spurious Emissions, Low Channel (PSK/QAM)

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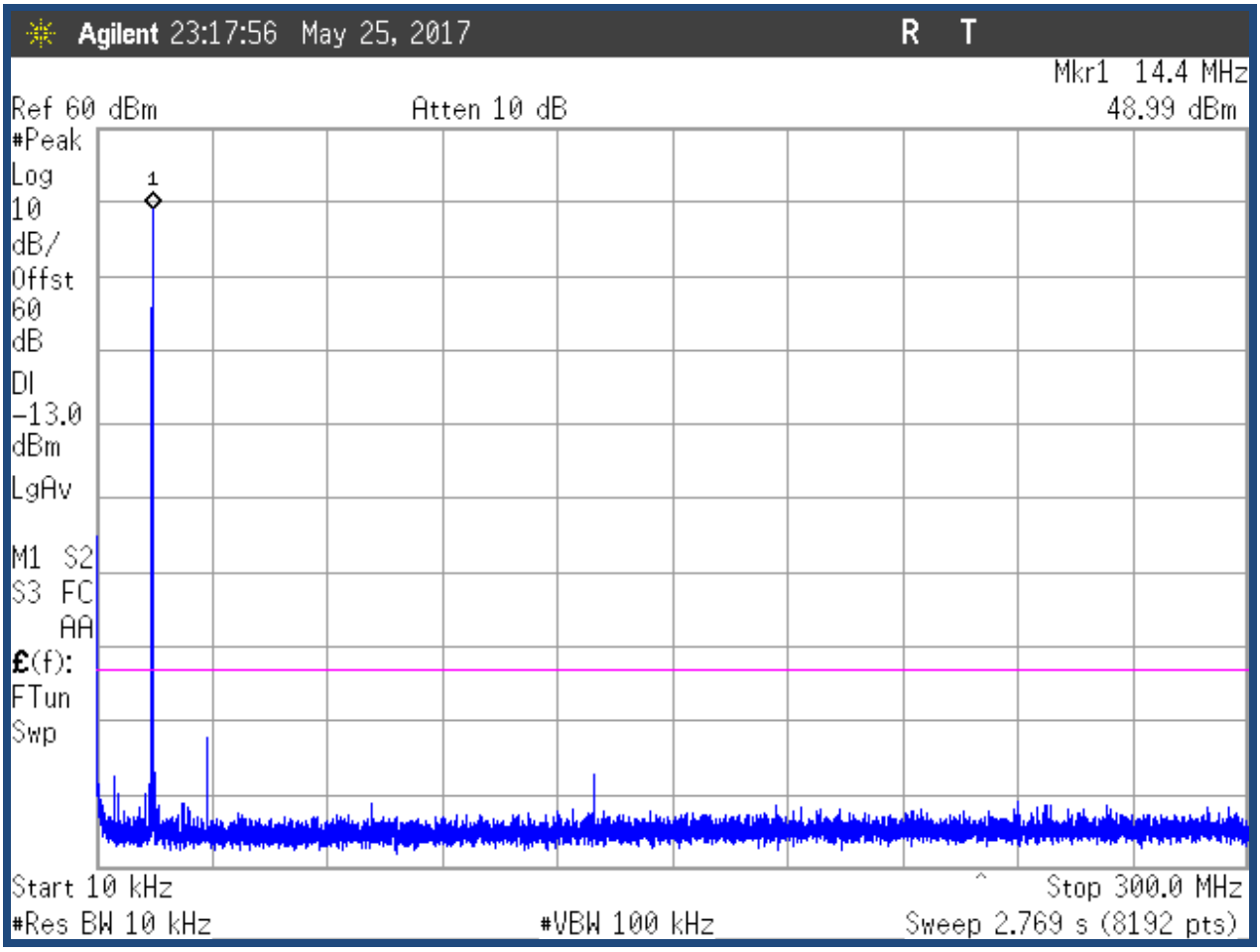

Figure 27: Spurious Emissions, Center Channel (PSK/QAM)

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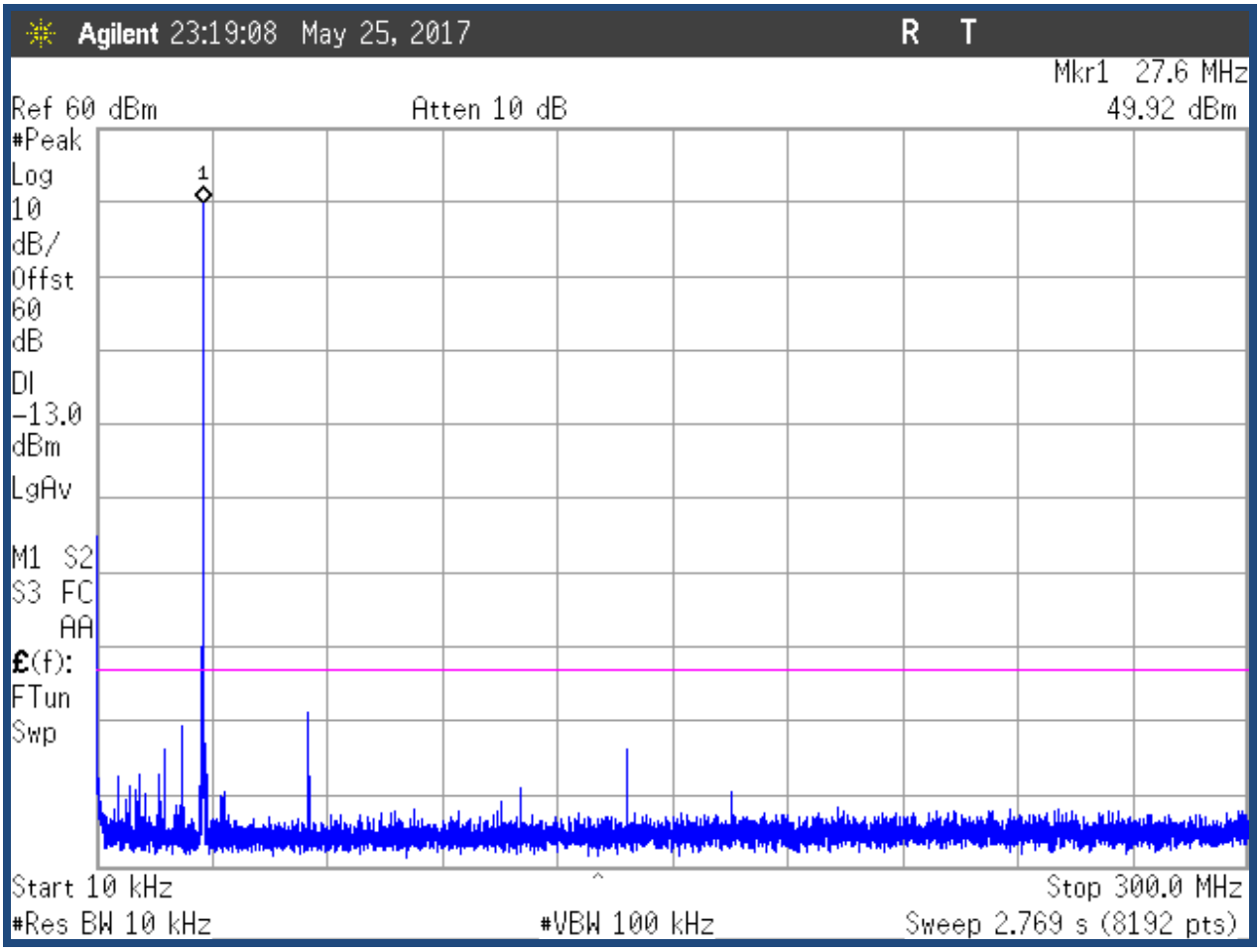

Figure 28: Spurious Emissions, High Channel (PSK/QAM)

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Table 8: Unwanted Radiated Emissions (TX @1.71MHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
119.70	V	180.00	1.00	35.50	-9.8	19.3	150.0	-17.8	
147.10	V	180.00	1.00	34.12	-11.1	14.2	150.0	-20.5	
162.45	V	180.00	1.00	38.49	-11.4	22.7	150.0	-16.4	
119.70	H	225.00	3.00	35.20	-9.8	18.6	150.0	-18.1	
147.10	H	225.00	3.00	34.00	-11.1	14.0	150.0	-20.6	
162.45	H	225.00	3.00	37.90	-11.4	21.2	150.0	-17.0	

Table 9: Unwanted Radiated Emissions (TX @14.4MHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
43.21	V	180.00	1.00	48.06	-13.0	56.7	100.0	-4.9	
57.61	V	180.00	1.00	44.70	-17.2	23.8	100.0	-12.5	
86.41	V	45.00	1.00	41.55	-16.2	18.6	100.0	-14.6	
144.01	V	45.00	1.00	47.29	-11.0	65.5	150.0	-7.2	
172.81	V	45.00	1.00	45.42	-11.8	48.1	150.0	-9.9	
230.41	V	225.00	1.00	32.33	-11.7	10.8	200.0	-25.4	
331.21	V	0.00	1.00	29.62	-8.2	11.8	200.0	-24.6	
43.21	H	225.00	4.00	43.10	-13.0	32.0	100.0	-9.9	
57.61	H	225.00	4.00	39.81	-17.2	13.5	100.0	-17.4	
86.41	H	45.00	4.00	42.25	-16.2	20.1	100.0	-13.9	
115.21	H	45.00	3.50	38.96	-10.3	27.1	150.0	-14.9	
144.01	H	45.00	3.50	46.90	-11.0	62.7	150.0	-7.6	
172.81	H	90.00	3.50	49.16	-11.8	74.1	150.0	-6.1	
230.41	H	225.00	3.50	42.23	-11.7	33.7	200.0	-15.5	
331.21	H	180.00	3.00	34.28	-8.2	20.2	200.0	-19.9	

Table 10: Unwanted Radiated Emissions (TX @26.7MHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
55.20	V	180.00	1.00	39.00	-17.2	12.3	100.0	-18.2	
110.40	V	180.00	1.00	34.90	-11.0	15.6	150.0	-19.7	
165.60	V	45.00	1.00	39.90	-11.4	26.5	150.0	-15.1	
55.20	H	270.00	3.00	36.20	-17.2	8.9	100.0	-21.0	
110.40	H	225.00	3.00	36.60	-11.0	19.0	150.0	-18.0	
165.60	H	45.00	3.00	40.80	-11.4	29.4	150.0	-14.2	

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4.4 Frequency Tolerance [FCC Part 90.213(a)]

4.4.1 Test Method

The EUT was placed in a calibrated temperature chamber. A receive antenna was placed in the temperature chamber with the device connected to a frequency counter outside the chamber. The EUT was set to transmit at 14.4 MHz and also 27.6MHz due to the variance in the requirements. A frequency reading was taken with the temperature at ambient (22C). The EUT was turned off and the temperature chamber set to -30 Celsius after 1 hour at this temperature the unit was turned on and a frequency reading was taken. The unit was turned back off and the temperature changed to -20 C. This process was repeated in 10 degree increments up to 60 Degrees Celsius allowing the unit to stabilize for 1 hour at each level before turning on the unit and recording the frequency. At each level the frequency recorded was compared to the ambient reading with the amount of deviation in Hz compared to the part 90 limit.

4.4.2 Test Limit

The requirements for Frequency Tolerance are stated in Table 11.

Table 11: Frequency Tolerance Limits

Frequency Range (MHz)	Fixed and base stations	Mobile Stations	
		Over 2W output power	2W or less output power
Below 25	[1 2] 100	100	200
25-50	20	20	50

Note 1: Fixed and base stations with over 200 watts transmitter power must have a frequency stability of 50 ppm except for equipment used in the Public Safety Pool where the frequency stability is 100 ppm.

Note 2: For single sideband operations below 25 MHz, the carrier frequency must be maintained within 50 Hz of the authorized carrier frequency.

4.4.3 Test Results

The test results are shown in Table 12 and Table 13.

4.4.4 Test Summary

The EUT complied with the requirements of Part 90.213(a).

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Table 12: Frequency Tolerance vs. Temperature

Temperature (Centigrade)	Frequency (MHz)	Difference (Hz)	Deviation (%)		Temperature (Centigrade)	Frequency (MHz)	Difference (Hz)	Deviation (%)
Ambient	14.399999	0.0	0		Ambient	27.599983	0.0	0
-30	14.399995	-4.0	0.000028		-30	27.600012	29.0	0.000105
-20	14.399995	-4.0	0.000028		-20	27.600013	30.0	0.000109
-10	14.399995	-4.0	0.000028		-10	27.600008	25.0	0.000091
0	14.399994	-5.0	0.000035		0	27.600000	17.0	0.000062
10	14.399994	-5.0	0.000035		10	27.599998	15.0	0.000054
20	14.399994	-5.0	0.000035		20	27.600002	19.0	0.000069
30	14.400001	2.0	0.000014		30	27.600002	19.0	0.000069
40	14.400002	3.0	0.000021		40	27.600002	19.0	0.000069
50	14.400004	5.0	0.000035		50	27.600004	21.0	0.000076
60	14.400005	6.0	0.000042		60	27.599998	15.0	0.000054

Table 13: Frequency Tolerance vs. Battery Voltage

Voltage (Volts)	Frequency (MHz)	Difference (Hz)	Deviation (%)	Voltage (Volts)		Voltage (Volts)	Frequency (MHz)	Difference (Hz)	Deviation (%)
At rated	14.399998	0	0.0	13.8		At rated	27.599983	0	0.0
At 85%	14.400001	-3	0.000021	11.7		At 85%	27.599984	-1	0.000004
At 115%	14.400001	-3	0.000021	15.9		At 115%	27.599984	-1	0.000004

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4.5 Modulation Characteristics

§2.1047 Measurements required: Modulation characteristics.

(a) Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted

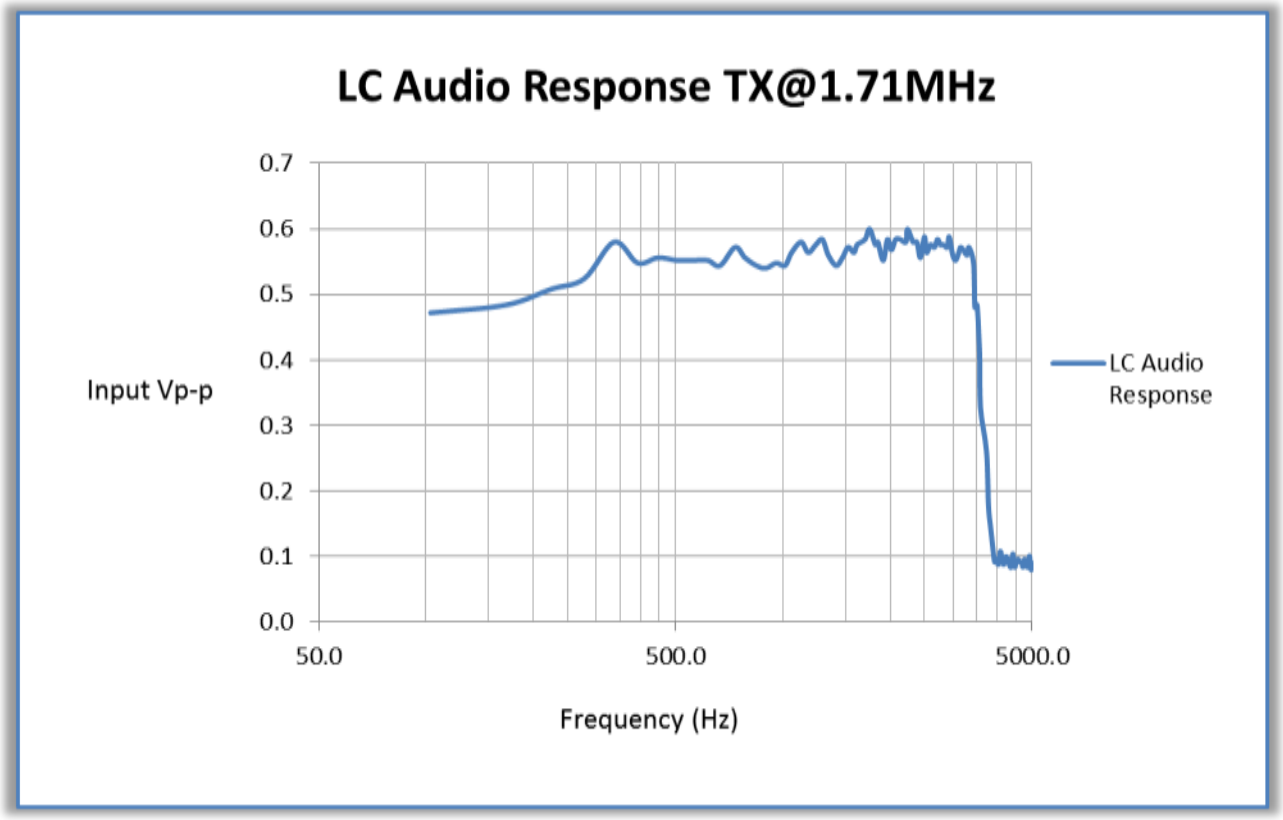

Figure 29: Audio Frequency Response, Low Channel

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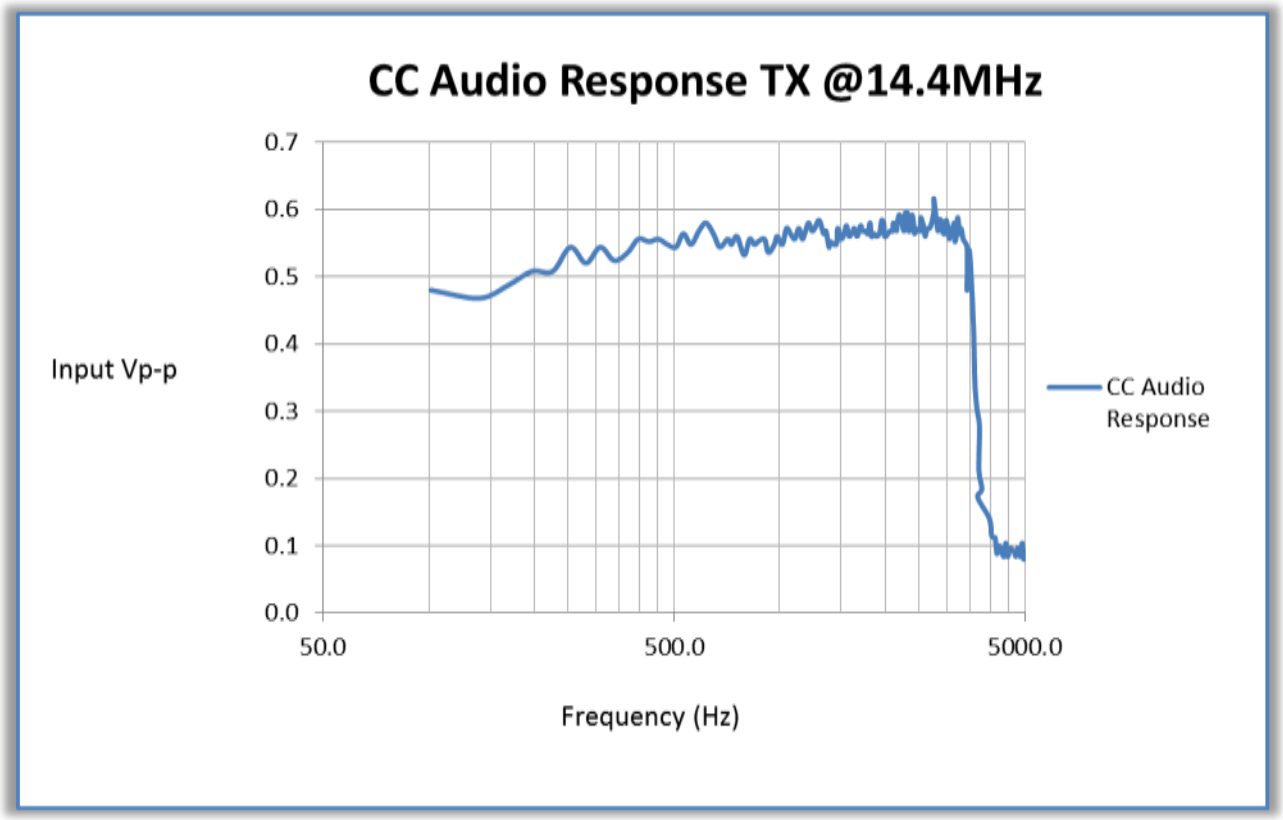

Figure 30: Audio Frequency Response, Center Channel

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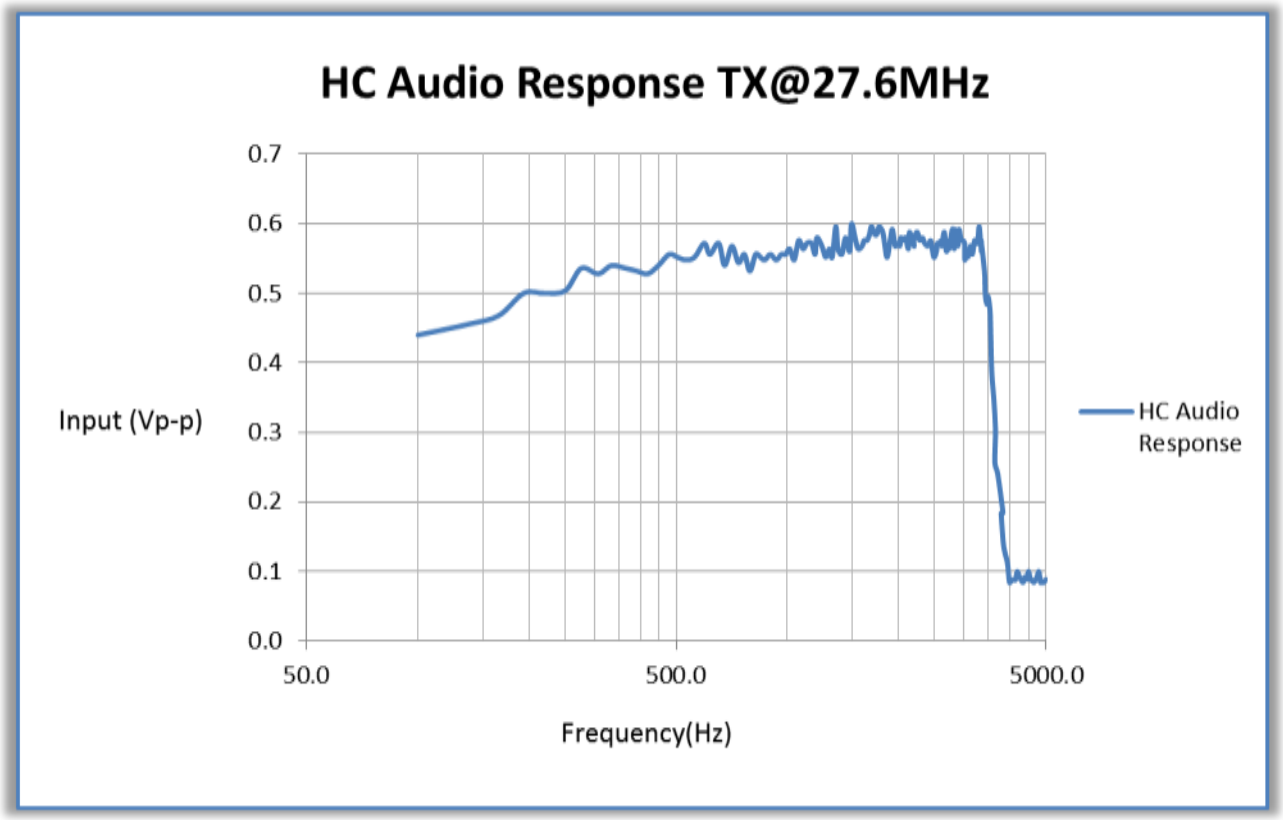

Figure 31: Audio Frequency Response, High Channel

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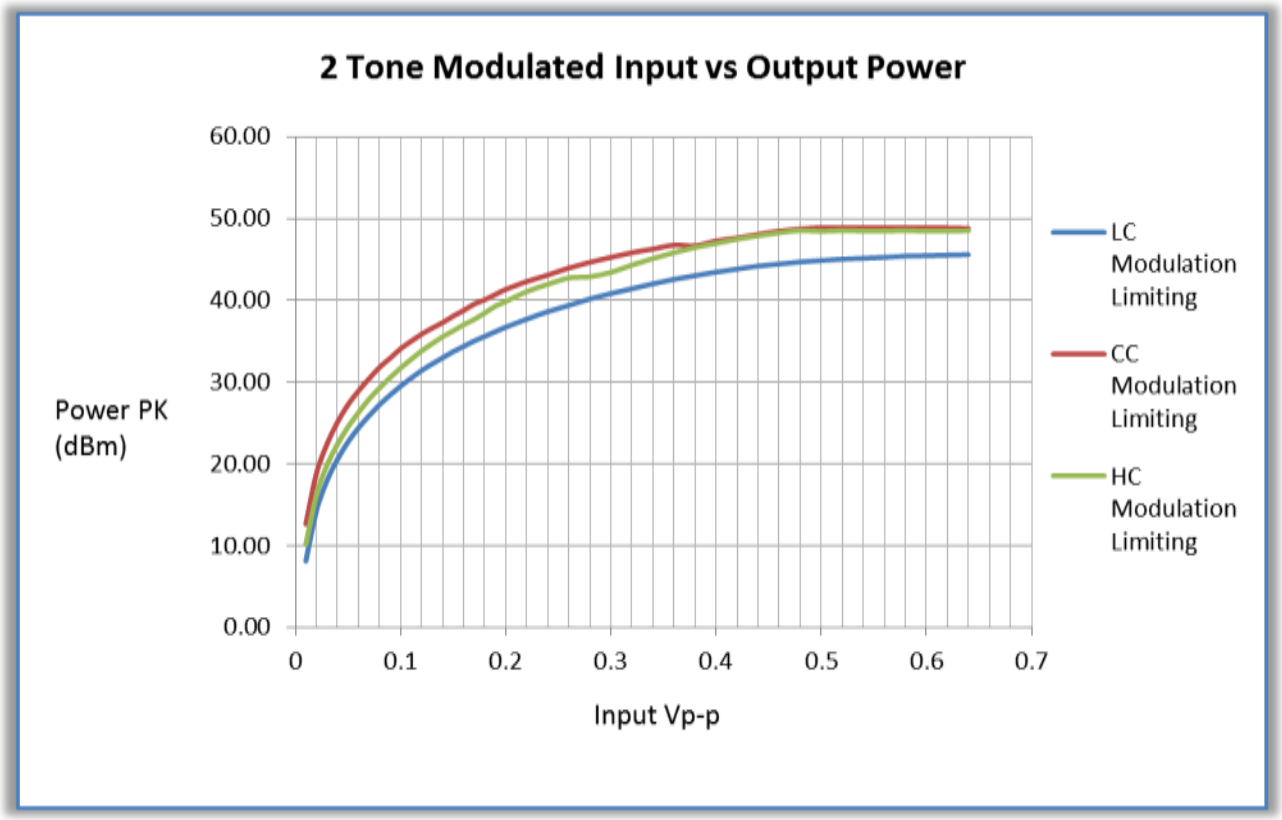

Figure 32: Modulation Limiting

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