Testing Tomorrow's Technology

CFR 47 FCC Part 2, Subpart J, and FCC Part 90, Subpart I
Certification for Private Land Mobile Radio Services,
Part 90.219 Use of signal boosters
and
ANSI/TIA-603-E (March 2016), Equipment Measurement and Performance Standards, KDB 935210 D02 Signal Boosters Certification v04r01
And
Innovation, Science and Economic Development Canada, RSS-131, Spectrum Management and Telecommunications Radio Standards Specification, Zone Enhancers,
Clause 6 Equipment Standard specifications for zone enhancers working with equipment certified under RSS-119

For the

Safe-Com Wireless
Models: SAFE-1000, SAFE-1015, SAFE-1020 and SAFE-1030

FCC ID: 2AKSM-SAFE2
IC: 22303-SAFE2

UST Project No: 18-0181
September 10, 2018

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www.ustech-lab.com

Testing Tomorrow's Technology

I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US Tech (Agent Responsible For Test):

By: 

Name: Alan Ghasiani

Title: Consulting Engineer/President

Date: September 10, 2018

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MEASUREMENT/TECHNICAL REPORT

This report concerns (check one): Original grant__X___
Class II change_____

Reevaluation _____

Equipment type: **Part 90.219 Distributed Antenna System (DAS)**

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No_____ N/A

If yes, defer until:_____
date

__N/A__ agrees to notify the Commission by__N/A

of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech
3505 Francis Circle
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1 General Information

1.1 Product Description

The Equipment under Test (EUT) is the Safe-Com Wireless model Safe-1015 which is part of a fiber Distributed Antenna System. The EUT consists of 2 physically separated units, a Head End unit and a Remote unit, that can uplink or downlink signals over fiber optic cables. Each unit accepts multiple modulated RF signals. The EUT is equipped with multiple cards; each one set to operate across a specific frequency band. The cards are designed to be hot-swap cards which enable the user to easily replace the cards as needed, depending on the band of operation required.

The EUT is designed to operate in the following uplink bands:

*138-174MHz VHF band
*380-512MHz UHF band
788-805MHz
806-824MHz
896-901MHz

The EUT is designed to operate in the following downlink bands:

*138-174MHz VHF band
*380-512MHz UHF band
763-775MHz
851-869MHz
935-941MHz

The EUT is representative of the related models SAFE-1020 and SAFE-1030. The difference is that the SAFE-1030 is a non-fiber verison. The SAFE-1015 & SAFE-1020 are both fiber versions.

The EUT is considered a Class A (non-SMR) Zone Enhancer. Its passband at one or more specific channels do not exceed 75 kHz.

(Note: Band 138-144MHz and 380-400 MHz not applicable for FCC certification)

1.2 Related Submittal(s)/Grant(s)

There are no related submittals or grants associated with this project.

2 Test and Measurements

2.1 Configuration of Tested System

Block diagrams of the tested system are shown in Figures 1 and 2. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off or set to 3x the resolution bandwidth throughout the evaluation process. Interconnecting cables were manipulated as necessary to maximize emissions.

2.2 Characterization of Tested System

The sample used for testing was received by US Tech on June 27, 2018 in good condition.

2.3 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. All radiated measurements were performed at US Tech's 3 meter EMC chamber measurement facility. Additional test such as bench testing was also performed at US Tech’s facility in Alpharetta GA. This site has been fully described and registered by the FCC under Registration Number US5301. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1. NVLAP code: 200162-0

2.4 Test Equipment

The test equipment used for this evaluation is listed in Table 2 below.

2.5 Modifications to Equipment under Test (EUT)

No modifications were made by US Tech to bring the EUT into compliance with the FCC limits for the transmitter portion of the EUT.

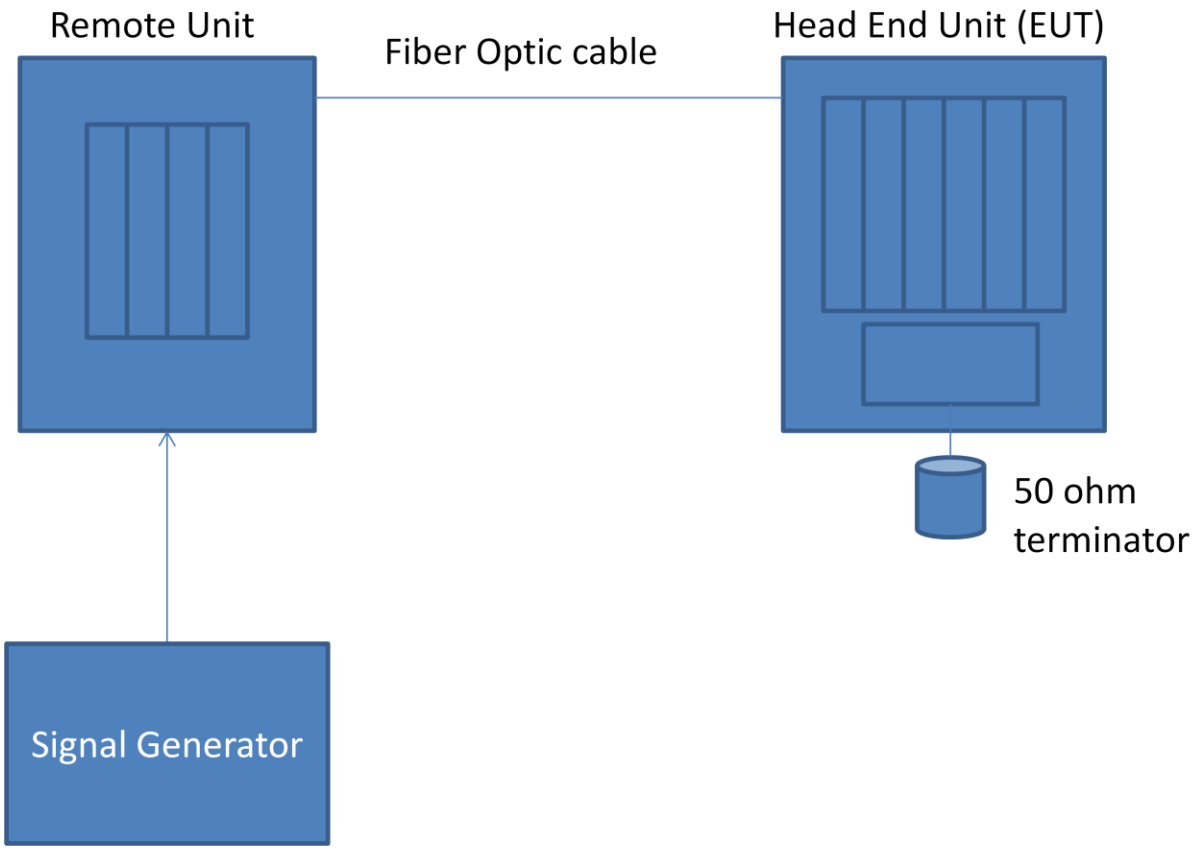

Figure 1. Block Diagram of Uplink Test Configuration

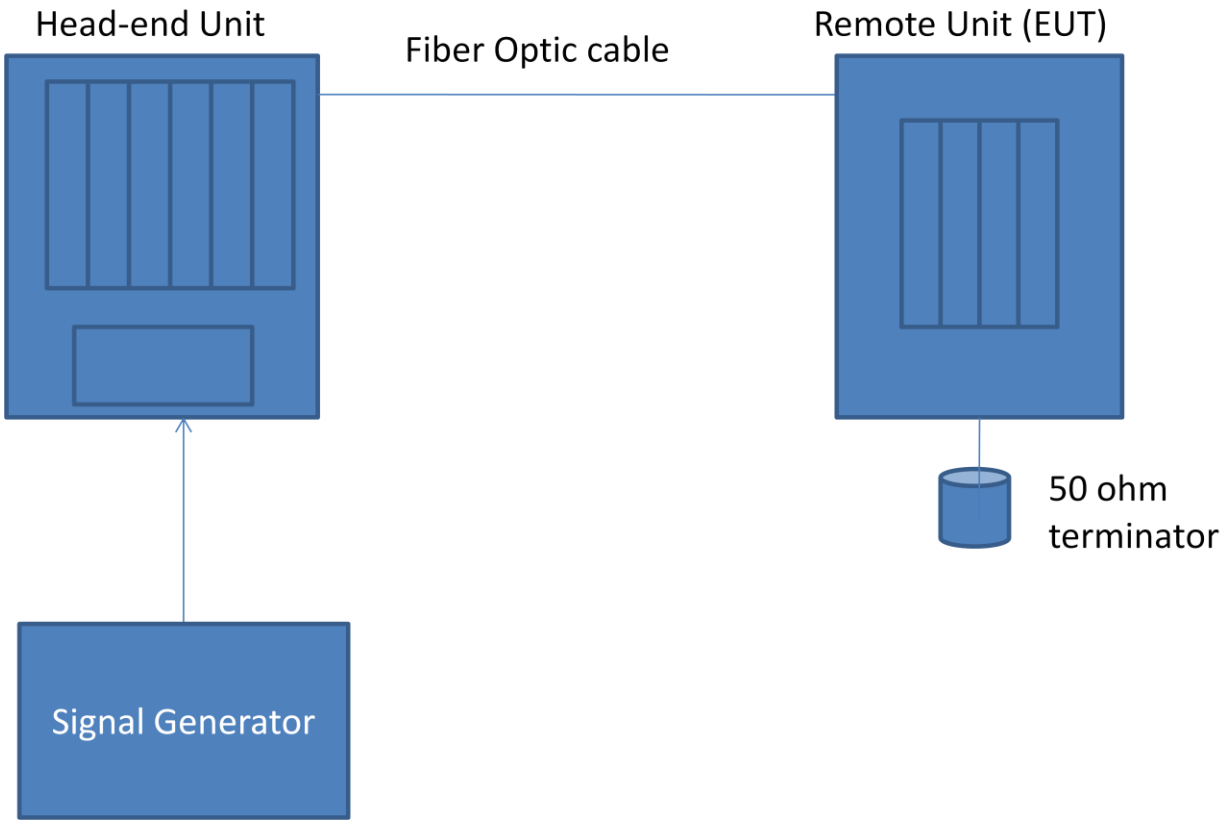

Figure 2. Block Diagram of Downlink Test Configuration

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID/ IC ID	CABLES P/D
Remote Unit with RF cards Safe-Com	SAFE-1015	Engineering Sample	FCC ID: 2AKSM-SAFE2 IC: 22303-SAFE2	0.1m U P
700 Mhz Safe-Com	SAFE-1015	Engineering Sample	--	--
800 Mhz Safe-Com	SAFE-1015	Engineering Sample	--	--
900 MHz Safe-Com	SAFE-1015	Engineering Sample	--	--
UHF Safe-Com	SAFE-1015	Engineering Sample	--	--
VHF Safe-Com	SAFE-1015	Engineering Sample	--	--
Head End Unit with RF cards Safe-Com	SAFE-1015	Engineering Sample	FCC ID: 2AKSM-SAFE2 IC: 22303-SAFE2	1m U D 0.6m U P

U= Unshielded, S= Shielded, P= Power cable, D= Data cable

Table 2. Test Instruments

EQUIPMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	8/17/2020
SPECTRUM ANALYZER	DSA815	RIGOL	DSA8A18030 0138	10/11/2018
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	10/25/2018
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	3/7/2019
RF PREAMP > 1 GHz	8449B	HEWLETT PACKARD	3008A00480	12/1/2018
LOG PERIODIC	3146	EMCO	9110-3236	9/21/2019 2 YR
BICONNICAL	3110B	EMCO	9306-1708	5/2/2019 2 YR
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 YR
SIGNAL GENERATOR	MG3671B	Anritsu	M52073/ M53573/ M17473	Verified with HP 8593E analyzer
SIGNAL GENERATOR	HP8648B	HEWLETT-PACKARD	3642U01679	Verified with HP 8593E analyzer
LISN	9247-50-TS-50-N	Solar Electronics	955824/ 955825	03/19/2019

Note: The calibration interval of the above test instruments is 12 months and all calibrations are traceable to NIST/USA.

2.6 Noise (FCC Section 90.219(e)(2) and RSS-131, 6.4)

The noise figure of a signal booster must not exceed 9 dB in either direction.

The EUT is a DAS system; this test was deemed not applicable.

2.7 Retransmitted Signals (FCC Section 90.219(e)(4) and RSS-131, 6.6)

A signal booster must be designed such that all signals, when retransmitted meet the following requirements:

1. The signals are retransmitted on the same channels as received. Minor departures from the exact provider or reference frequencies of the input signals are allowed provided that the retransmitted signals meet the requirements of 90.213.

In this case the EUT is exempt from meeting these requirements.

2. There is no change in the occupied bandwidth of the retransmitted signals.

The EUT meets this requirement; see the plots in the following section which show the input signal compared to the retransmitted signal.

3. The retransmitted signals continue to meet the unwanted emissions limits of Part 90.210 applicable to the corresponding received signal.

The EUT meets this requirement; see the emissions mask test data presented in the next section.

2.8 Intermodulation (FCC Section 90.219(d)(6i) and RSS-131, 6.3)

FCC requires good engineering practice to be used in regard to the radiation of intermodulation products and noise, such that interference to licensed communications systems is avoided. In the event of harmful interference caused by any given deployment, the FCC may require additional attenuation or filtering of the emissions and/or noise from signal boosters or signal booster systems, as necessary, to eliminate the interference.

The EUT only takes fiber optic as its input; therefore testing for intermodulation cannot be applied here.

2.9 Frequency Stability (FCC 2.1055, 90.213 and RSS-131 5.2.4)

The EUT has no input signal processing capability, the frequency stability measurements in this section are not required.

2.10 Emission Mask Definitions (FCC Section 2.1049, 90.219(e)(4iii), 90.210, RSS-131, 6.5, RSS-119, 5.8)

The EUT is equipped with a low pass filter; therefore the emissions masks for equipment utilizing a low pass filter were applied.

2.10.1 Emission Mask B (FCC Part 90.210, 2.1051, RSS-119, 5.8)

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 25 dB.

(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 35 dB.

(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.

2.10.2 Emission Mask D (FCC Part 90.210, 2.1051, RSS-119, 5.8)

Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27(f_d - 2.88$ kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

2.10.3 Emission Mask E (FCC Part 90.210, 2.1051, RSS-119, 5.8)

Emission Mask E—6.25 kHz or less channel bandwidth equipment. For transmitters designed to operate with a 6.25 kHz or less bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f_0 to 3.0 kHz removed from f_0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 3.0 kHz but no more than 4.6 kHz: At least 30 + 16.67(f_d−3 kHz) or 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

(3) On any frequency removed from the center of the authorized bandwidth by more than 4.6 kHz: At least 55 + 10 log (P) or 65 dB, whichever is the lesser attenuation.

2.10.4 Emission Mask I (FCC Part 90.210, 2.1051, RSS-119, 5.8)

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

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 6.8 kHz, but no more than 9.0 kHz: At least 25 dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 9.0 kHz, but no more than 15 kHz: At least 35 dB;

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 15 kHz: At least 43 + 10 log (P) dB, or 70 dB, whichever is the lesser attenuation.

2.11 RF Power Output (FCC Section 2.1046, 90.219(e)(1), RSS-131, 6.2) - Uplink

The output power capability of a signal booster must be designed for deployments providing a radiated power not exceeding 5 Watts ERP for each retransmitted channel.

The EUT was connected to a spectrum analyzer through a 20 dB power attenuator. All cables and attenuator losses were input into the spectrum analyzer as either a reference level offset or an external preamp gain correction to ensure that accurate readings were obtained.

A CW signal was utilized and transmitted through the EUT. The RF input signal was set at least 0.2 dB below the AGC threshold. The spectrum analyzer was set to the following settings: RBW= 100 kHz, Video= 3x RBW, Span of 1 MHz.

The output power levels are recorded below:

Band	Tuned Frequency	Measured Output power (dBm)	FCC max Output Power limit (5 Watt)	Margin (dB) From the output limit
VHF	*138.00 MHz	28.77	37 dBm	8.23
	*144.00 MHz	29.14	37 dBm	7.86
	150.00 MHz	29.12	37 dBm	7.88
	162.00 MHz	25.69	37 dBm	11.31
	174.00 MHz	23.91	37 dBm	13.09
UHF	*381.00 MHz	28.80	37 dBm	8.20
	401.00 MHz	29.41	37 dBm	7.59
	407.00 MHz	29.31	37 dBm	7.69
	421.00 MHz	29.56	37 dBm	7.44
	450.00 MHz	25.43	37 dBm	11.57
	480.00 MHz	27.12	37 dBm	9.88
	512.00 MHz	24.19	37 dBm	12.81
700	788.00 MHz	29.84	37 dBm	7.16
	798.00 MHz	30.26	37 dBm	6.74
	799.00 MHz	32.02	37 dBm	4.98
	805.00 MHz	30.90	37 dBm	6.10
800	806.00 MHz	31.42	37 dBm	5.58
	815.00 MHz	30.22	37 dBm	6.78
	824.00 MHz	31.71	37 dBm	5.29
	851.00 MHz	29.90	37 dBm	7.1
	860.00 MHz	29.77	37 dBm	7.23
	869.00 MHz	29.68	37 dBm	7.32
900	896.00 MHz	25.91	37 dBm	11.09
	901.00 MHz	27.78	37 dBm	9.22

(*) Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification

2.12 Output Power Plots

Following are the Uplink Output Power Plots.

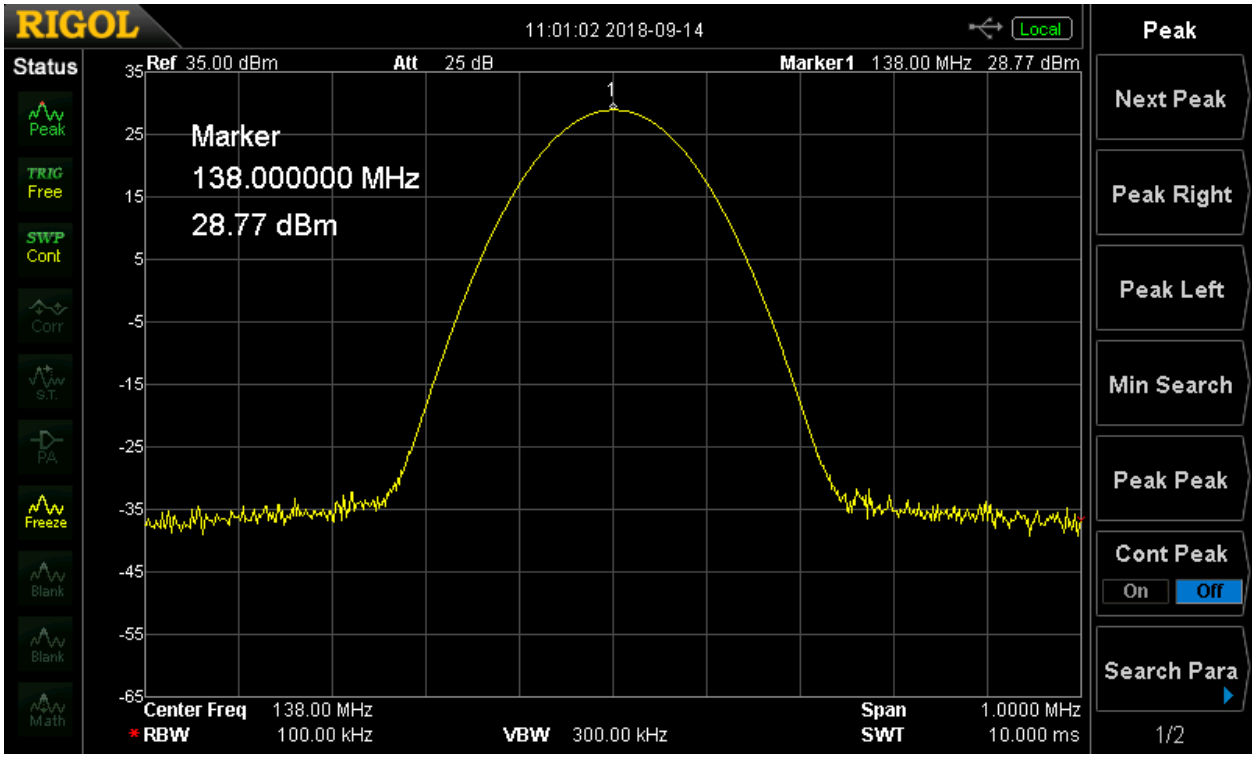

Figure 3. 138 MHz Output Power Plot

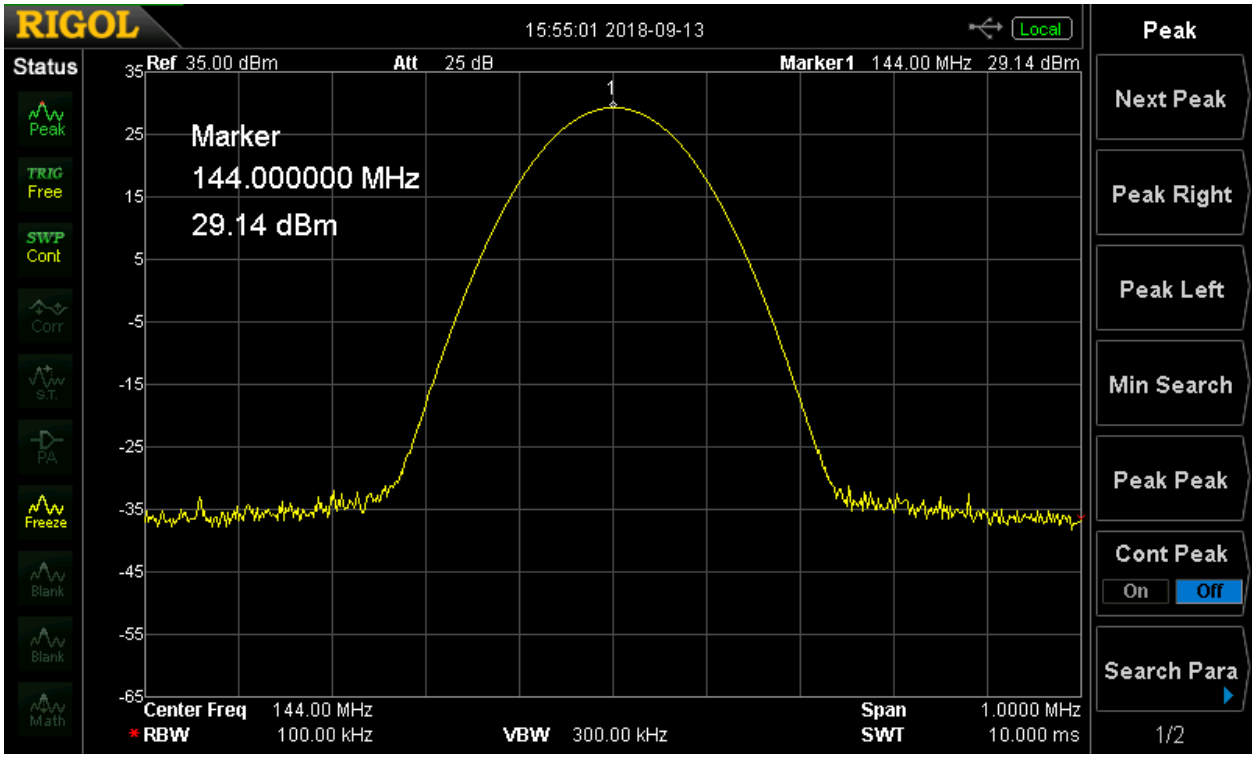

Figure 4. 144 MHz Output Power Plot

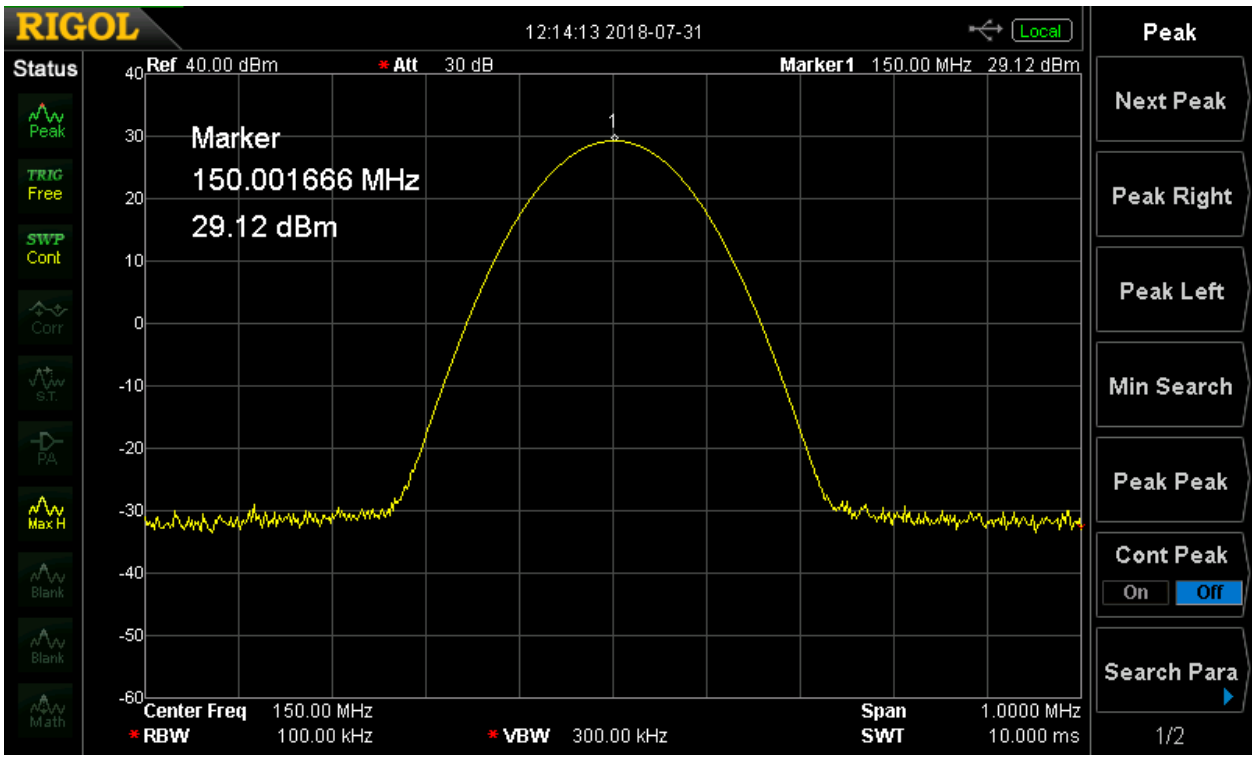

Figure 5. 150 MHz Output Power Plot

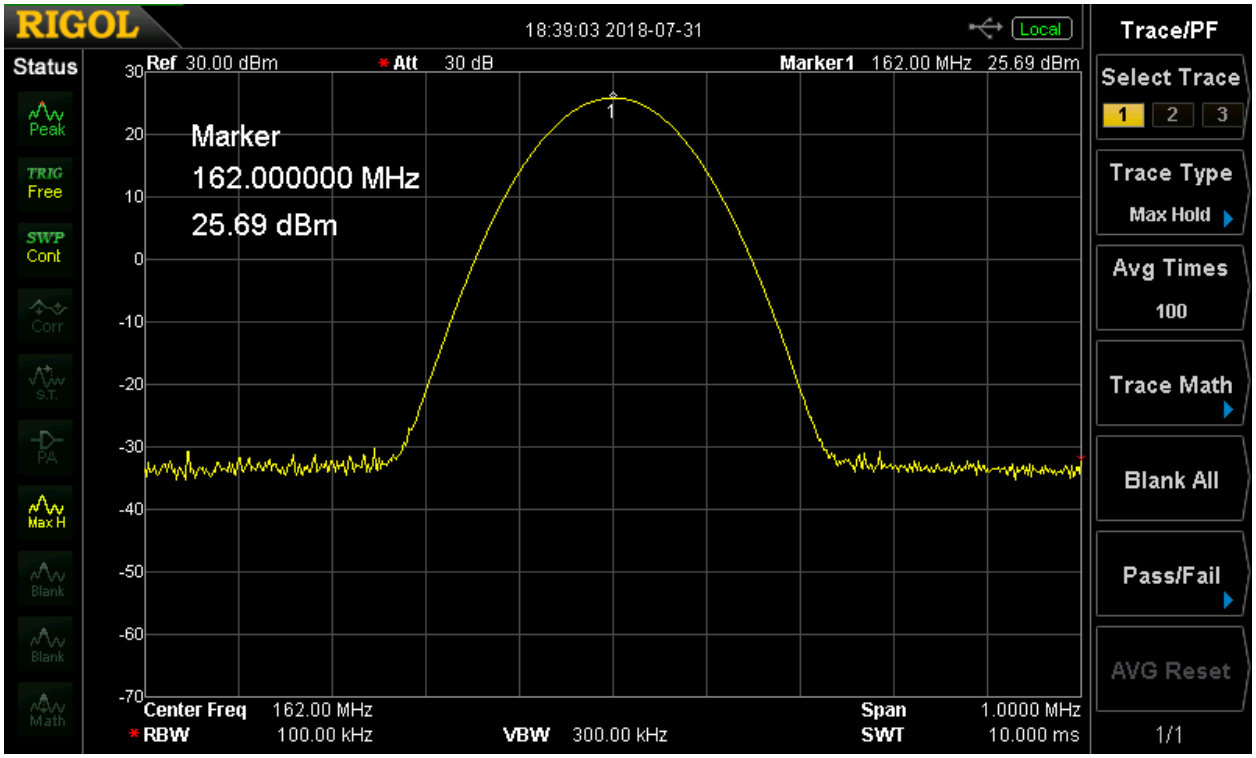

Figure 6. 162 MHz Output Power Plot

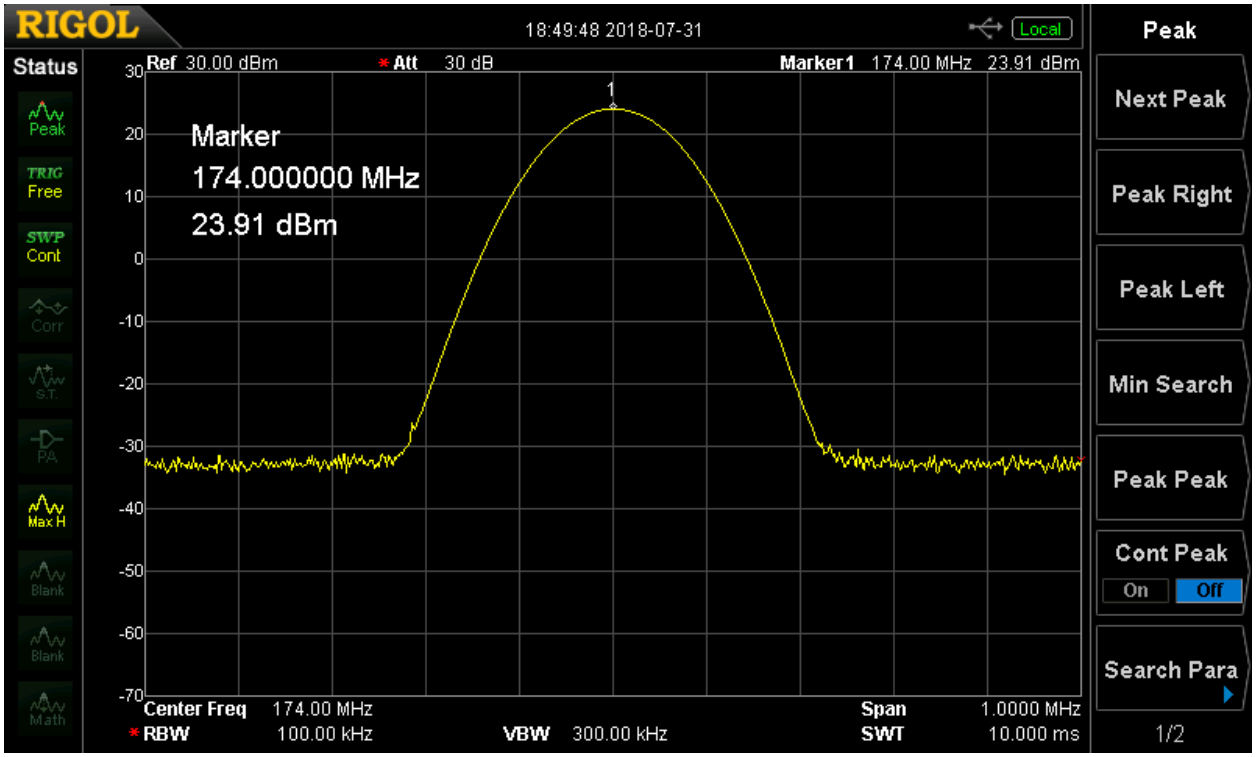

Figure 7. 174 MHz Output Power Plot

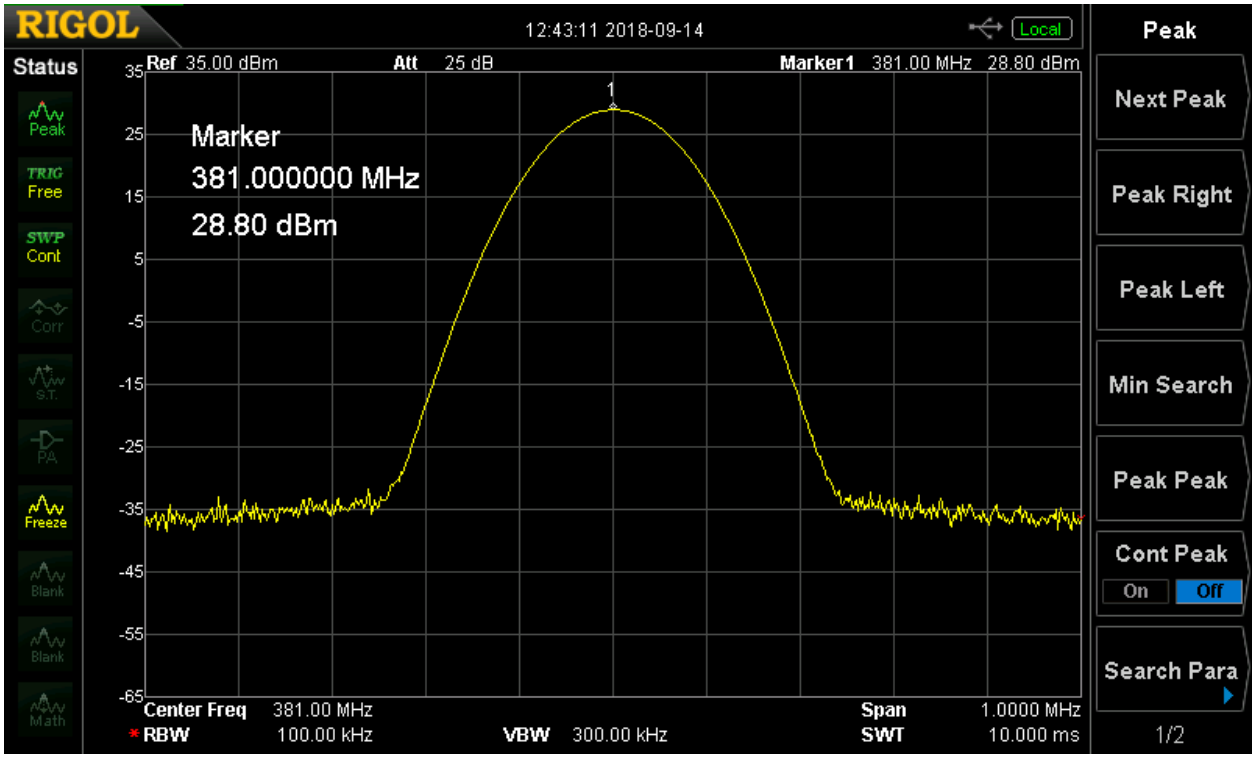

Figure 8. 381 MHz Output Power Plot

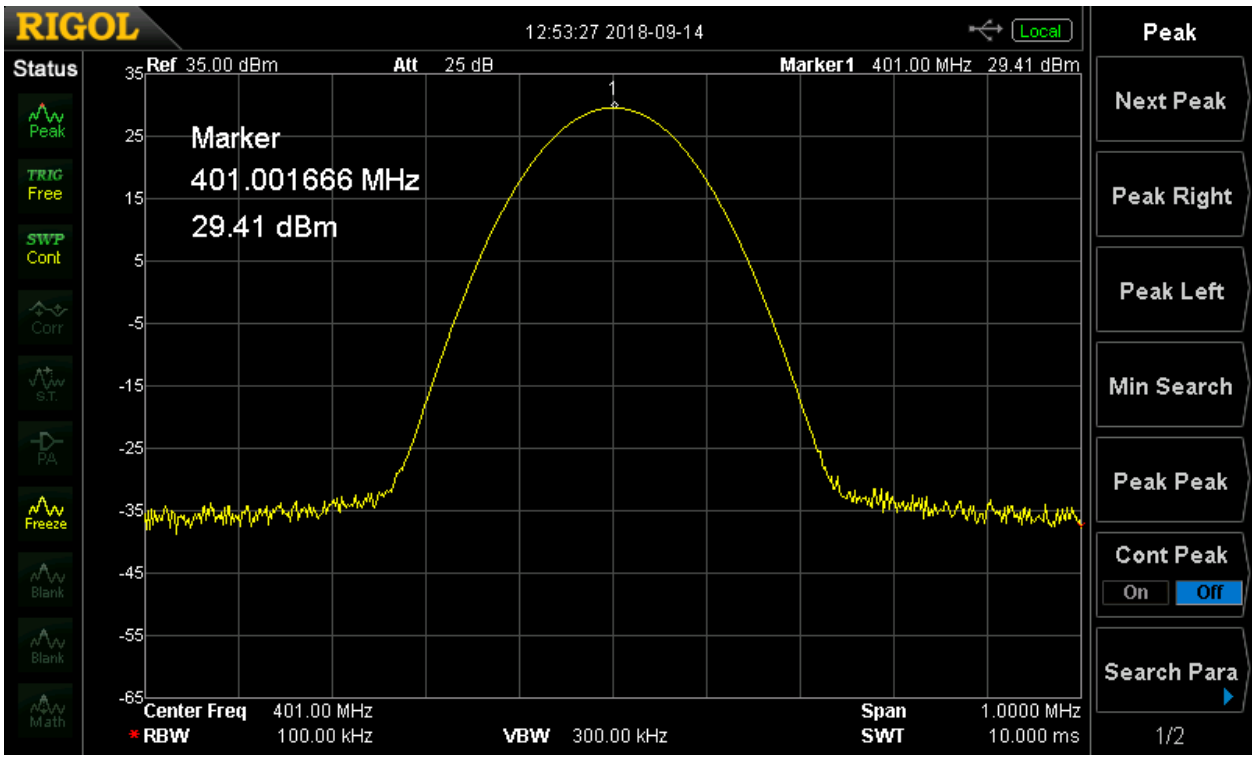

Figure 9. 401 MHz Output Power Plot

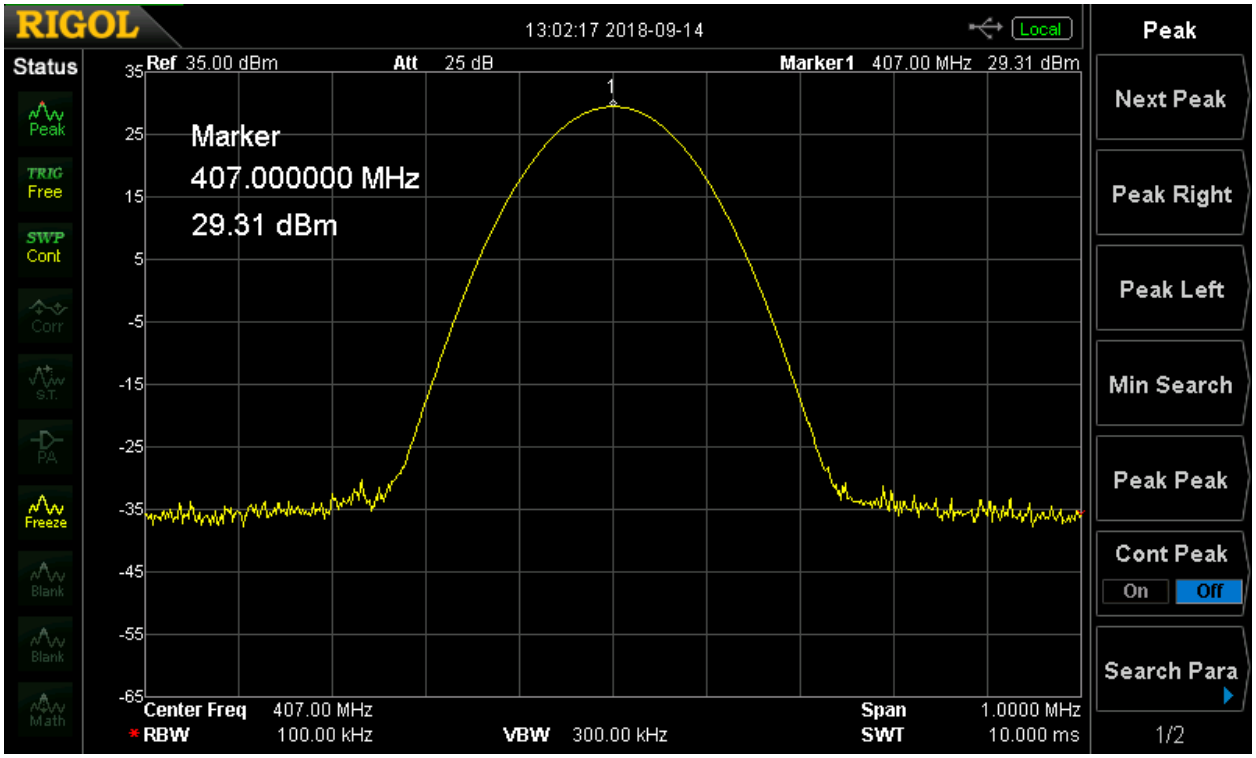

Figure 10. 407 MHz Output Power Plot

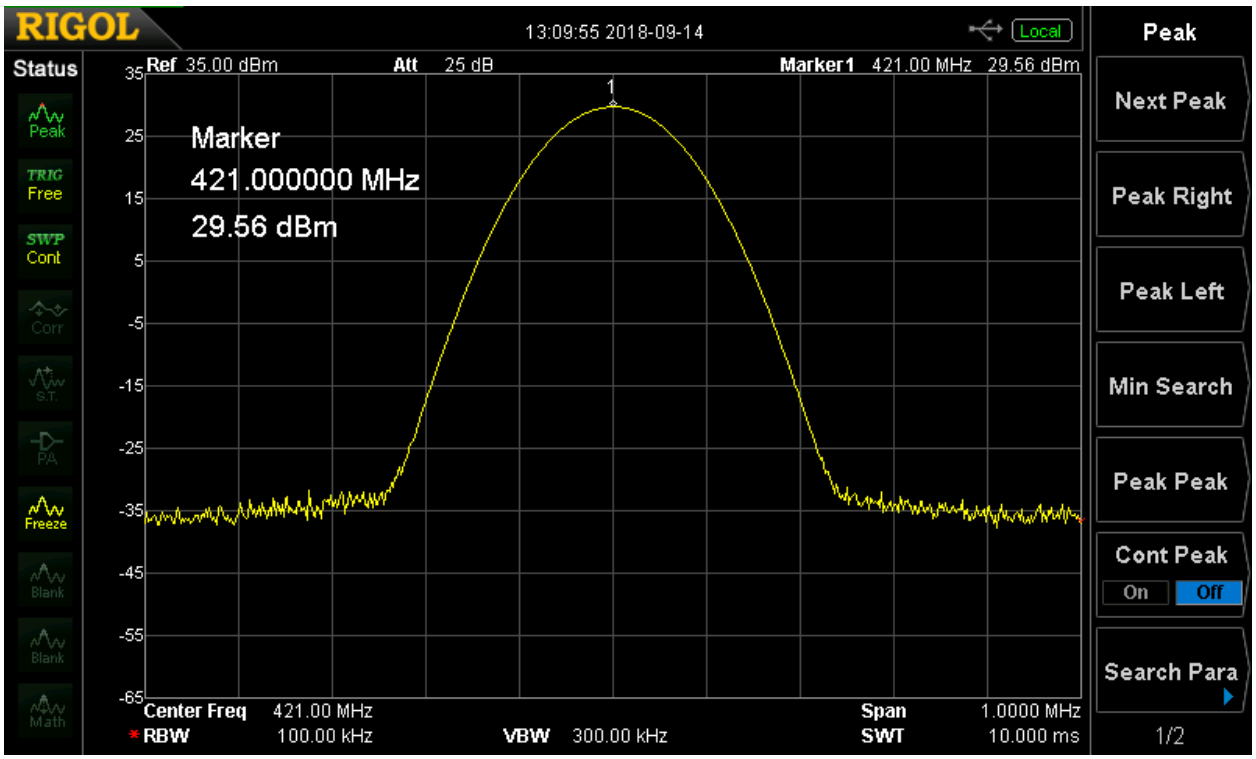

Figure 11. 421 MHz Output Power Plot

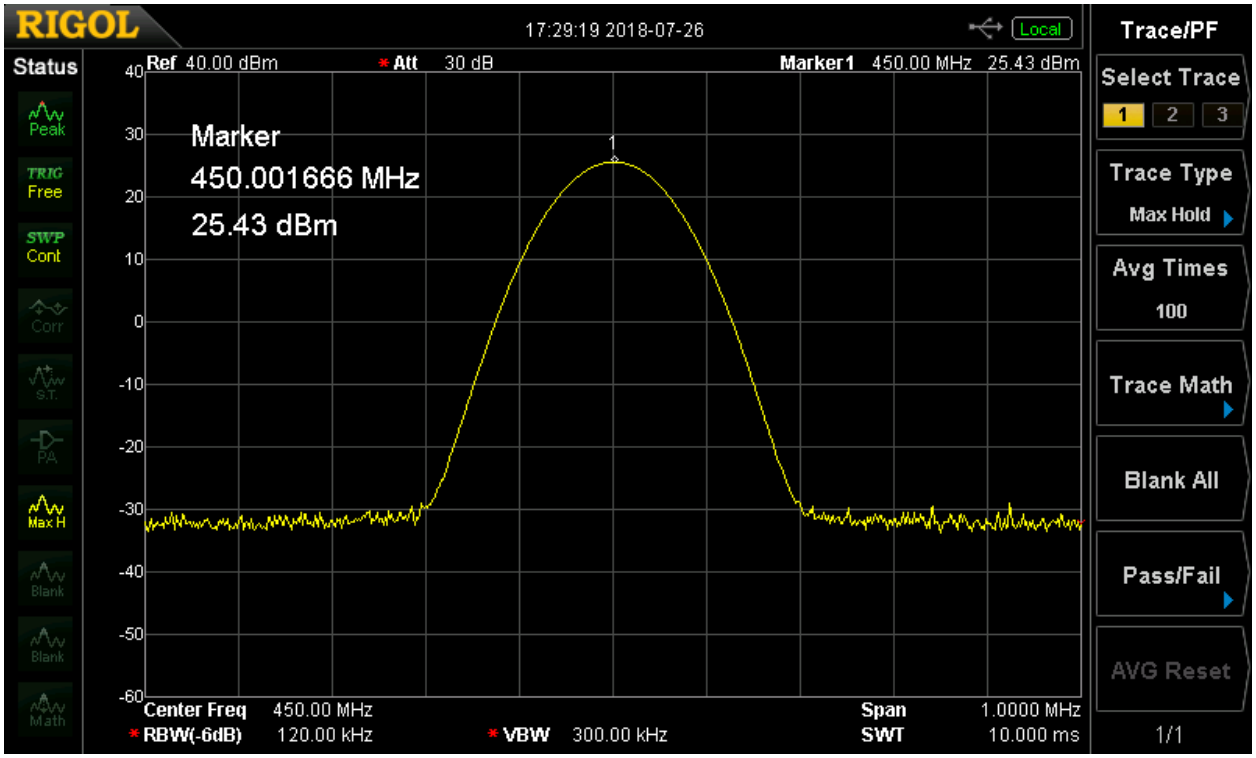

Figure 12. 450 MHz Output Power Plot

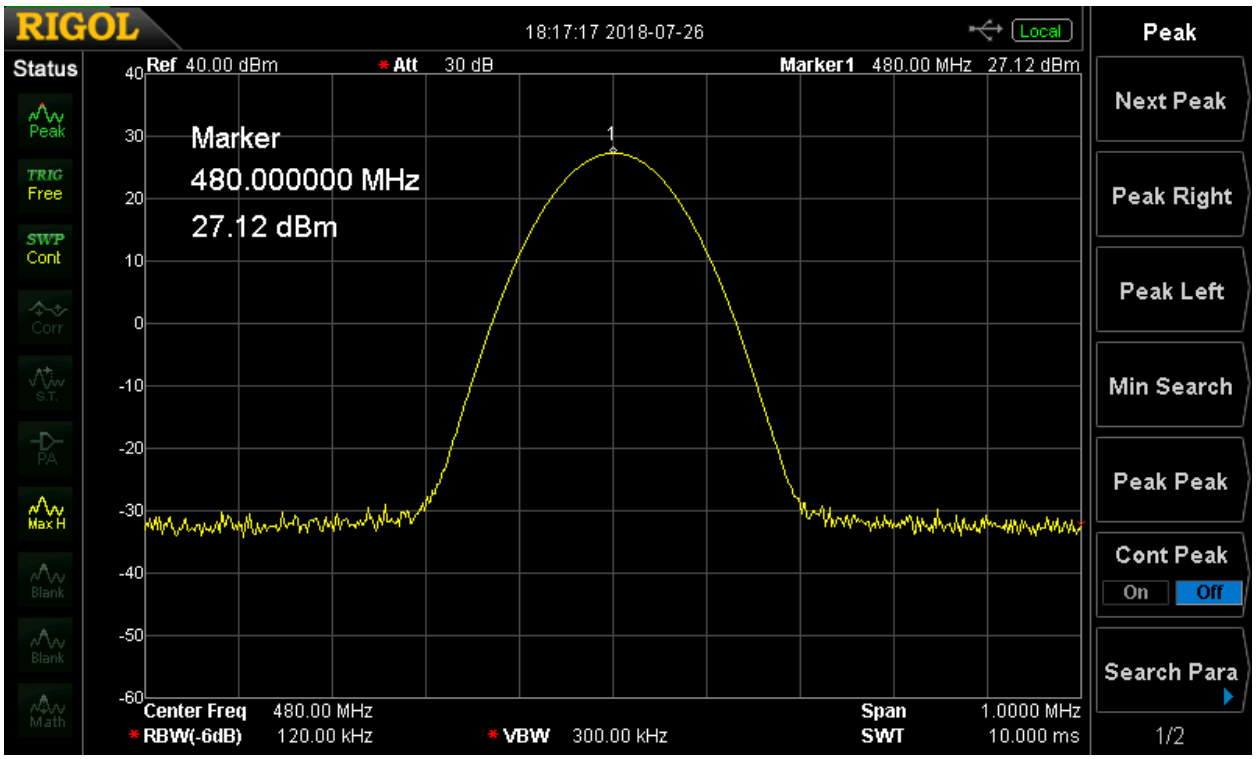

Figure 13. 480 MHz Output Power Plot

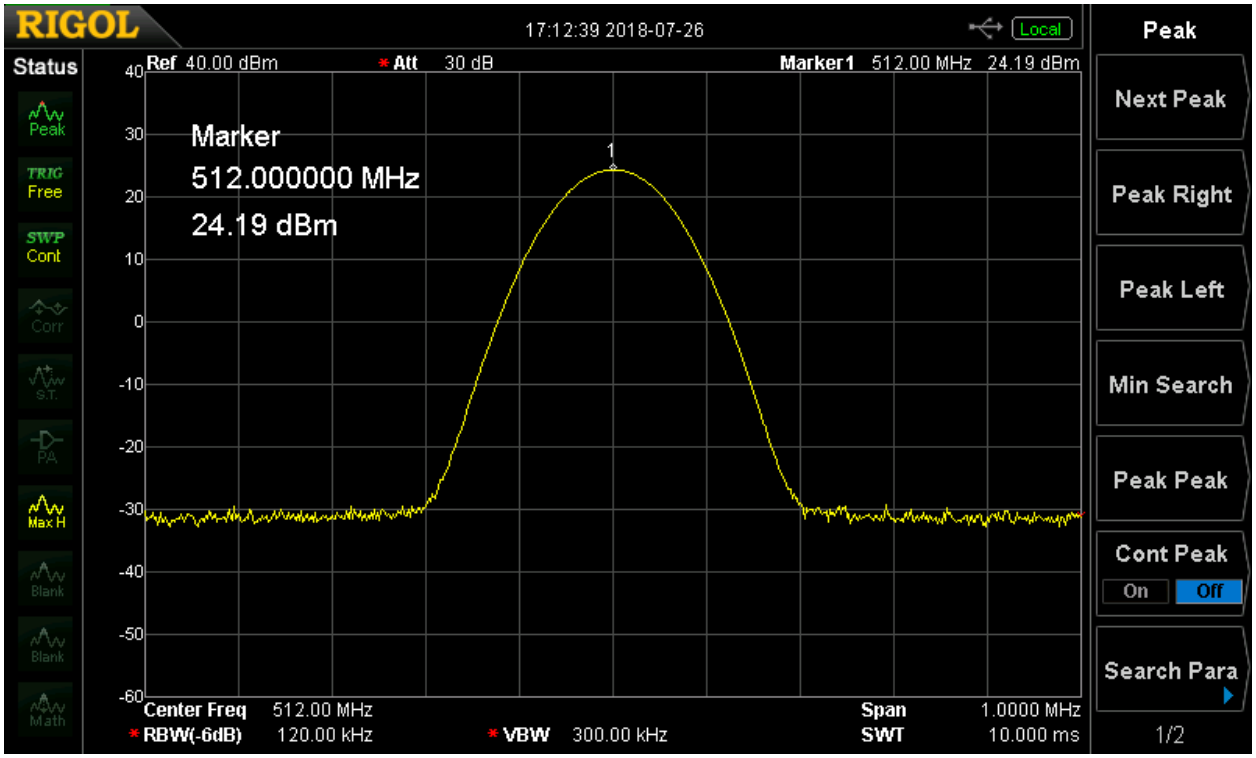

Figure 14. 512 MHz Output Power Plot

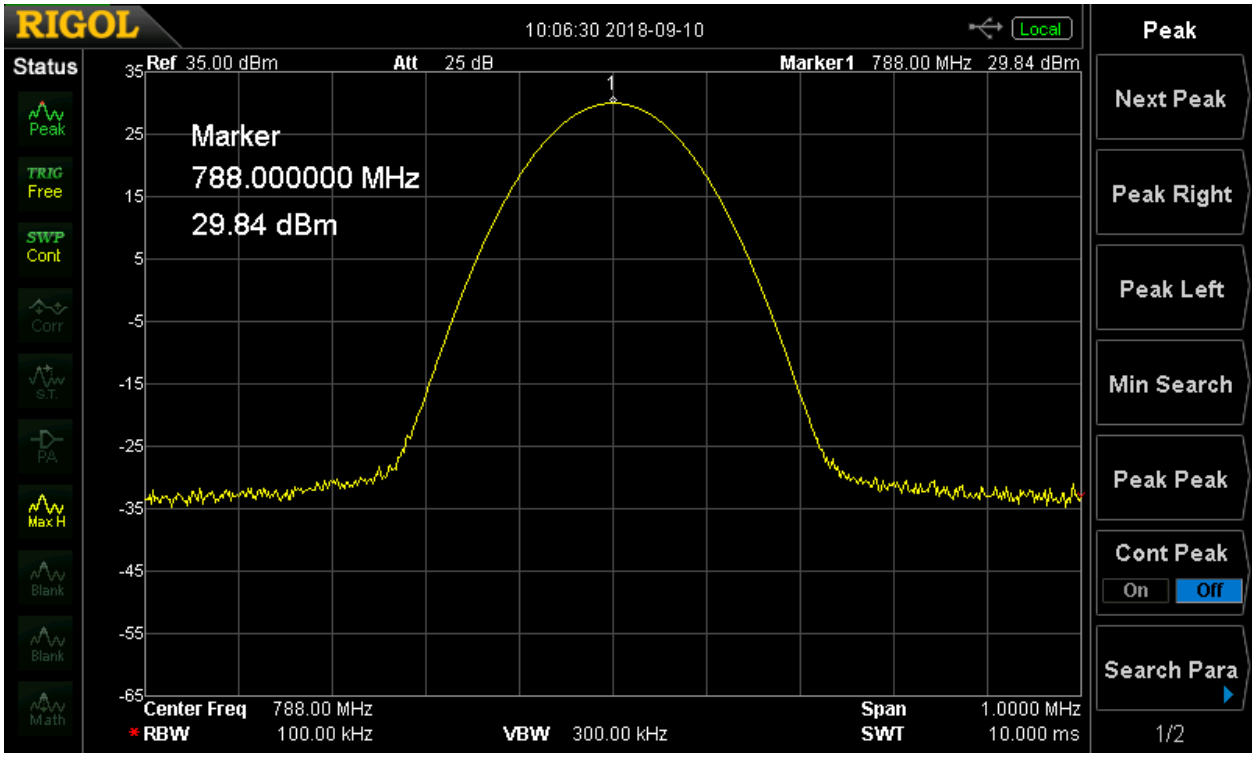

Figure 15. 788 MHz Output Power Plot

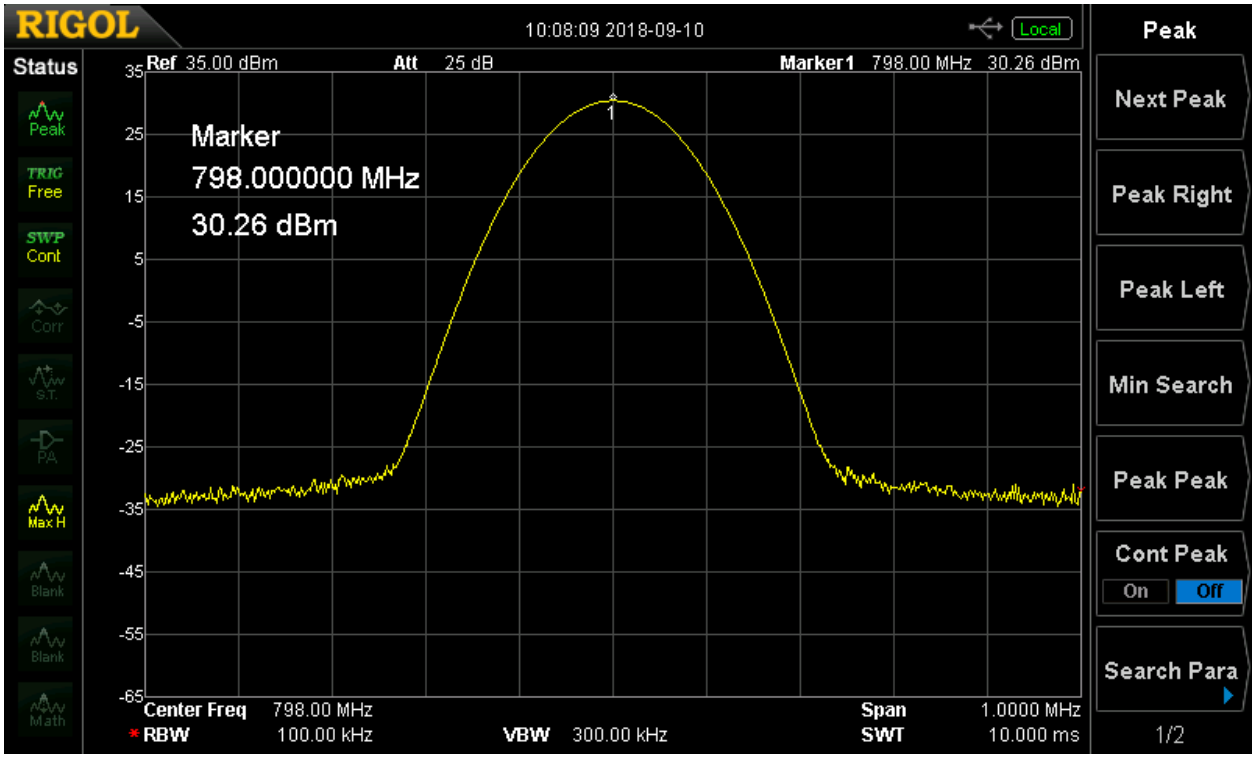

Figure 16. 798 MHz Output Power Plot

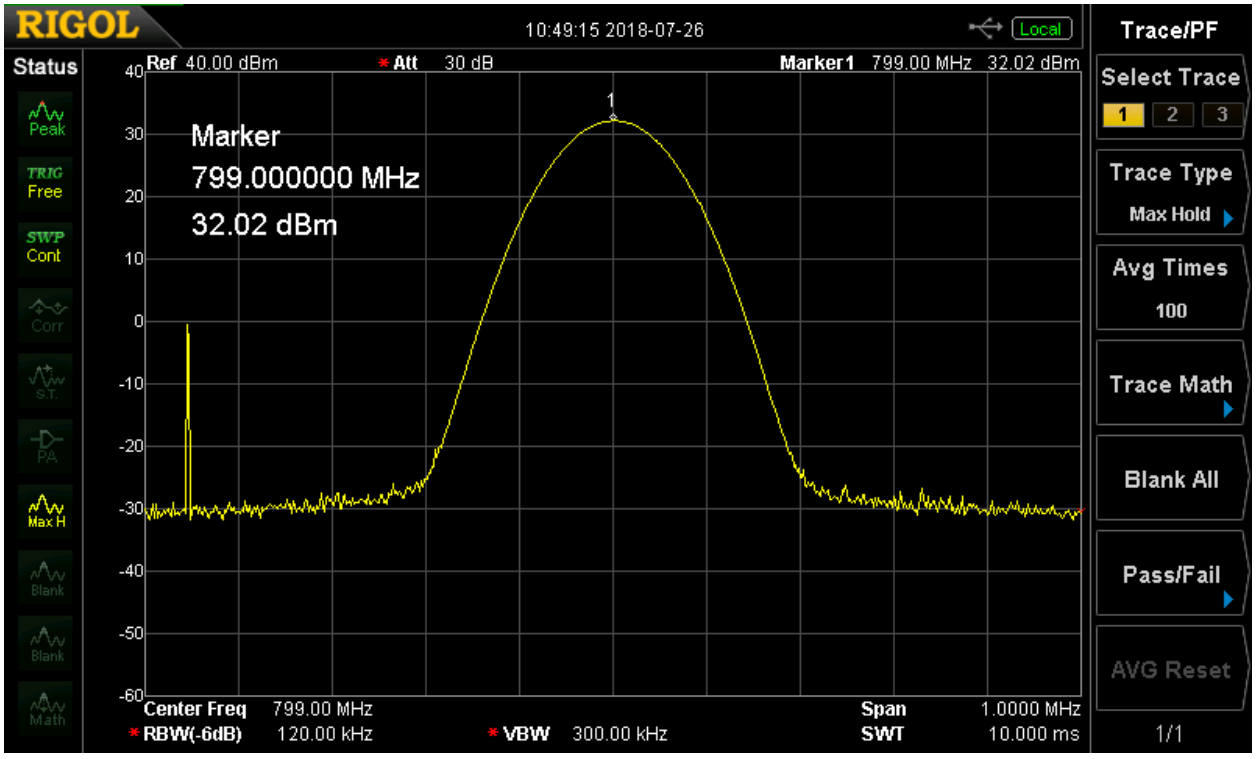

Figure 17. 799 MHz Output Power Plot

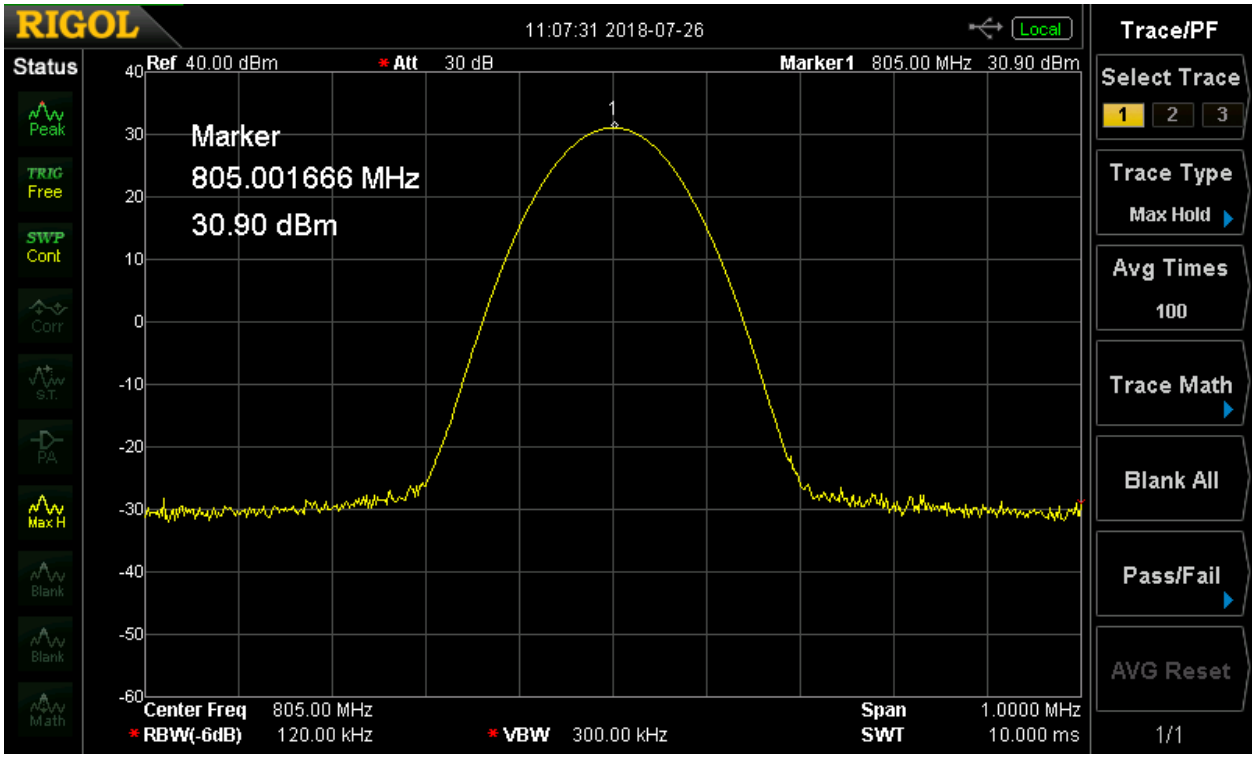

Figure 18. 805 MHz Output Power Plot

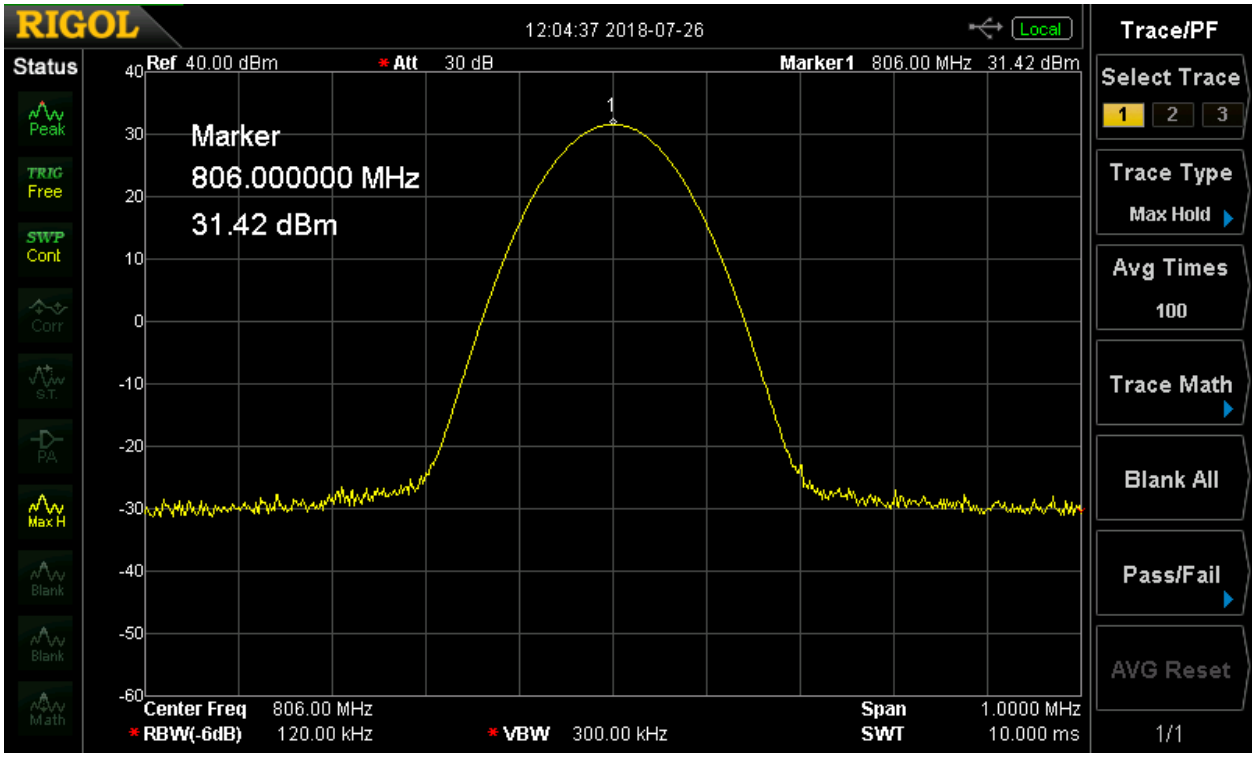

Figure 19. 806 MHz Output Power Plot

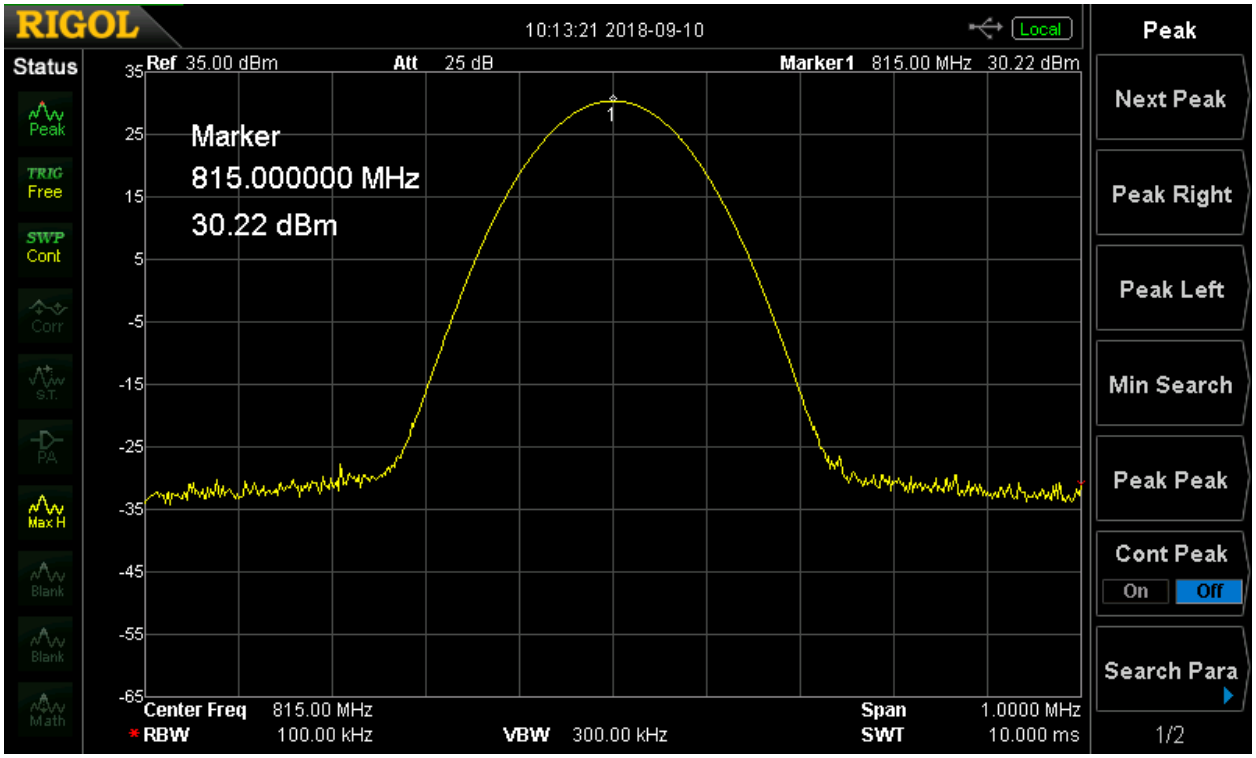

Figure 20. 815 MHz Output Power Plot

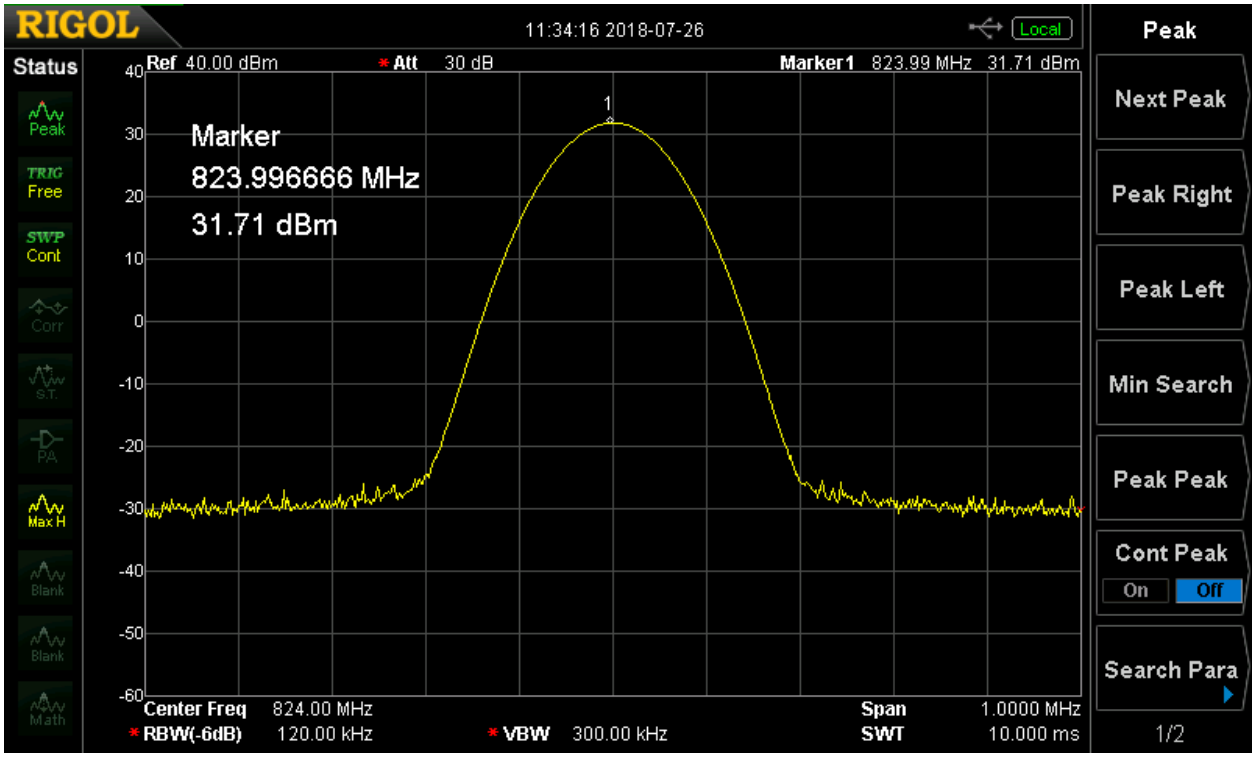

Figure 21. 824 MHz Output Power Plot

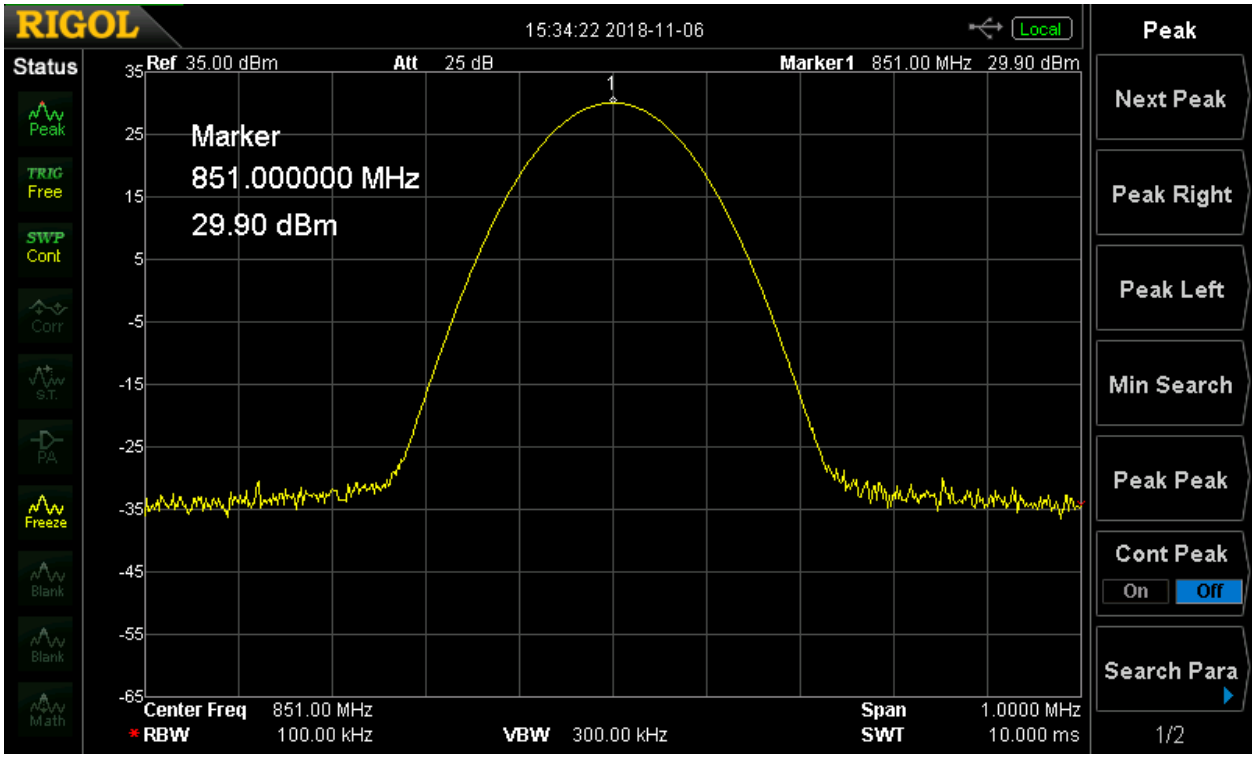

Figure 22. 851 MHz Output Power Plot

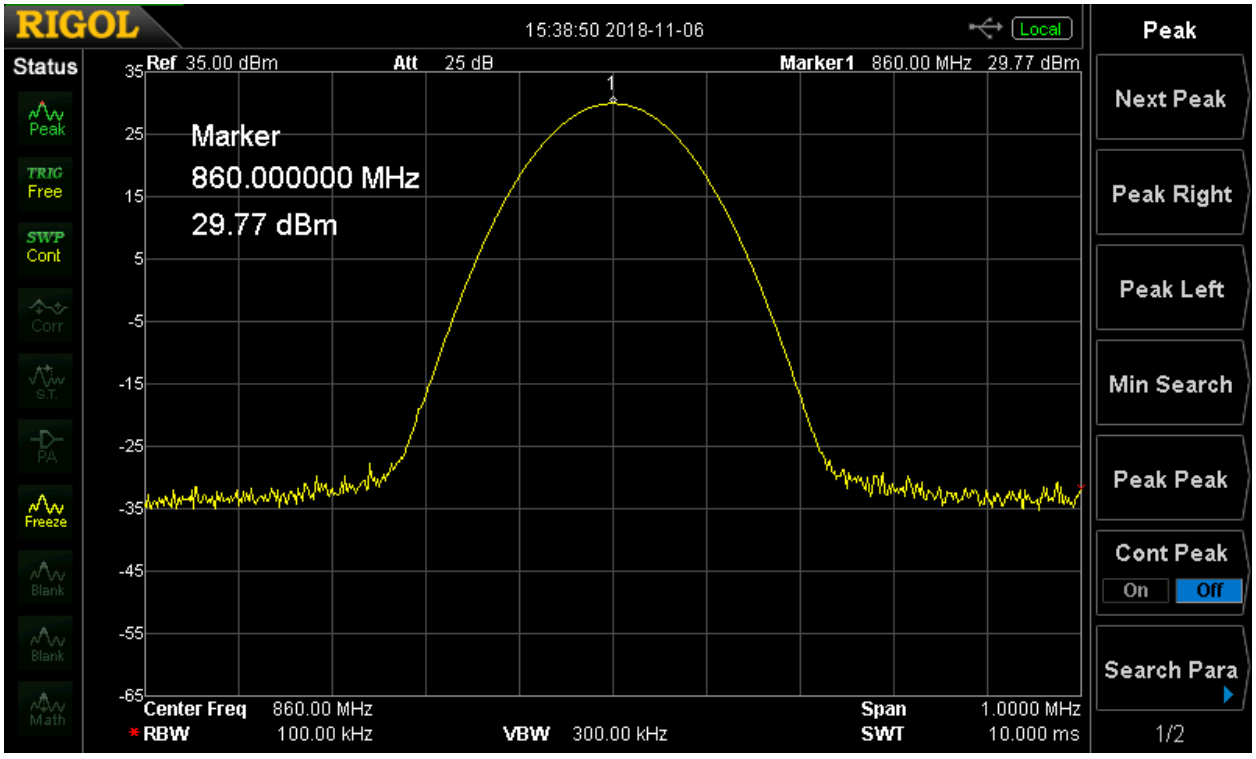

Figure 23. 860 MHz Output Power Plot

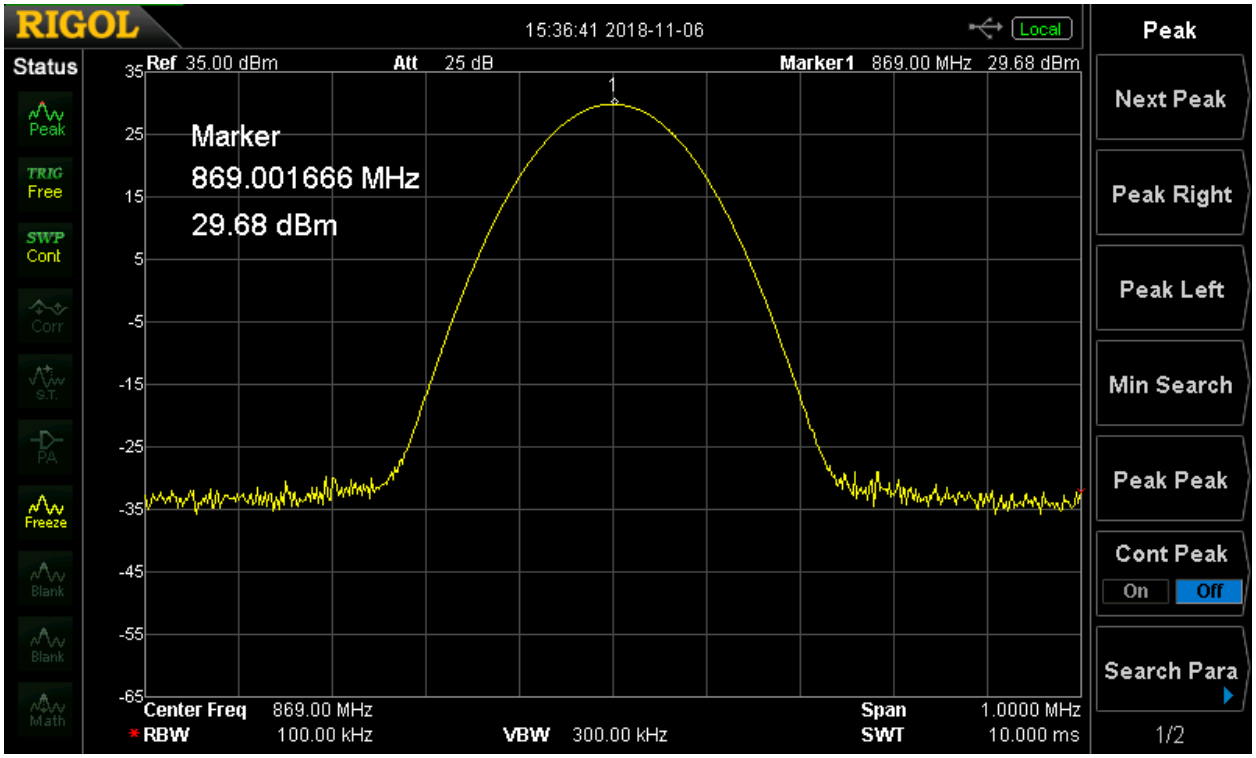

Figure 24. 869 MHz Output Power Plot

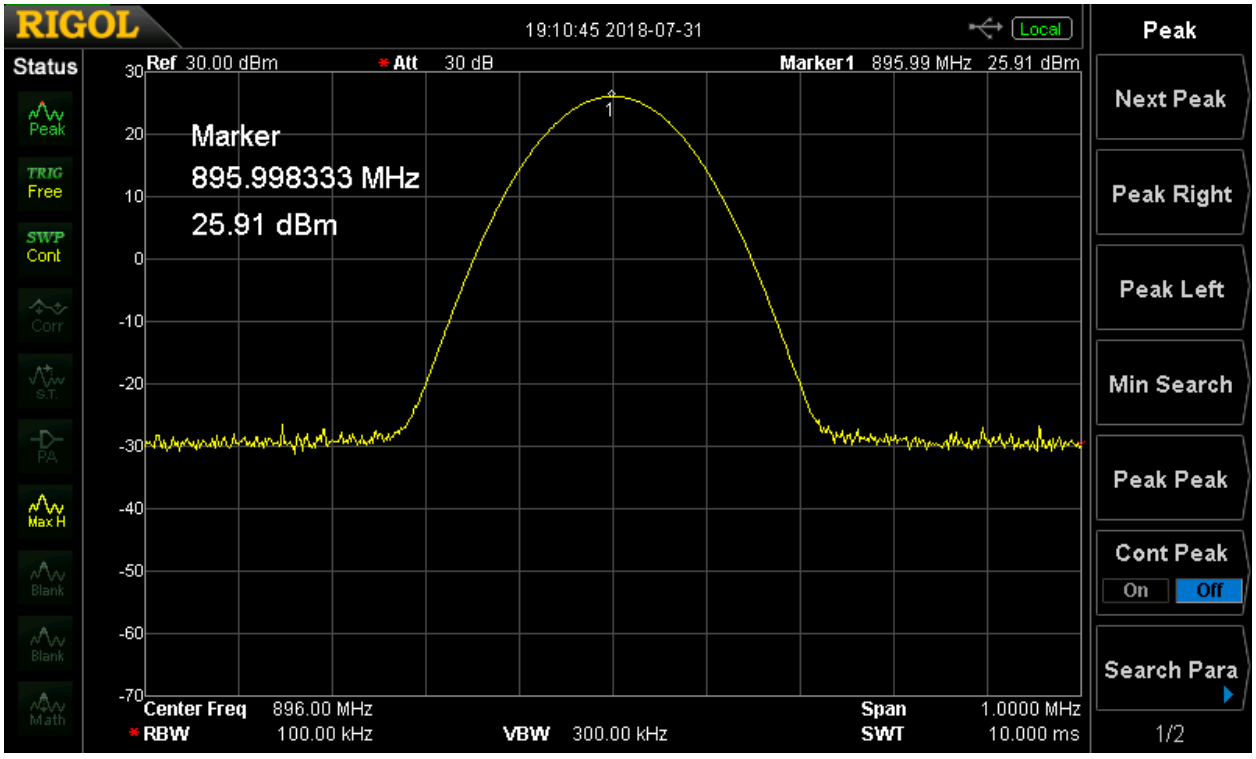

Figure 25. 896 MHz Output Power Plot

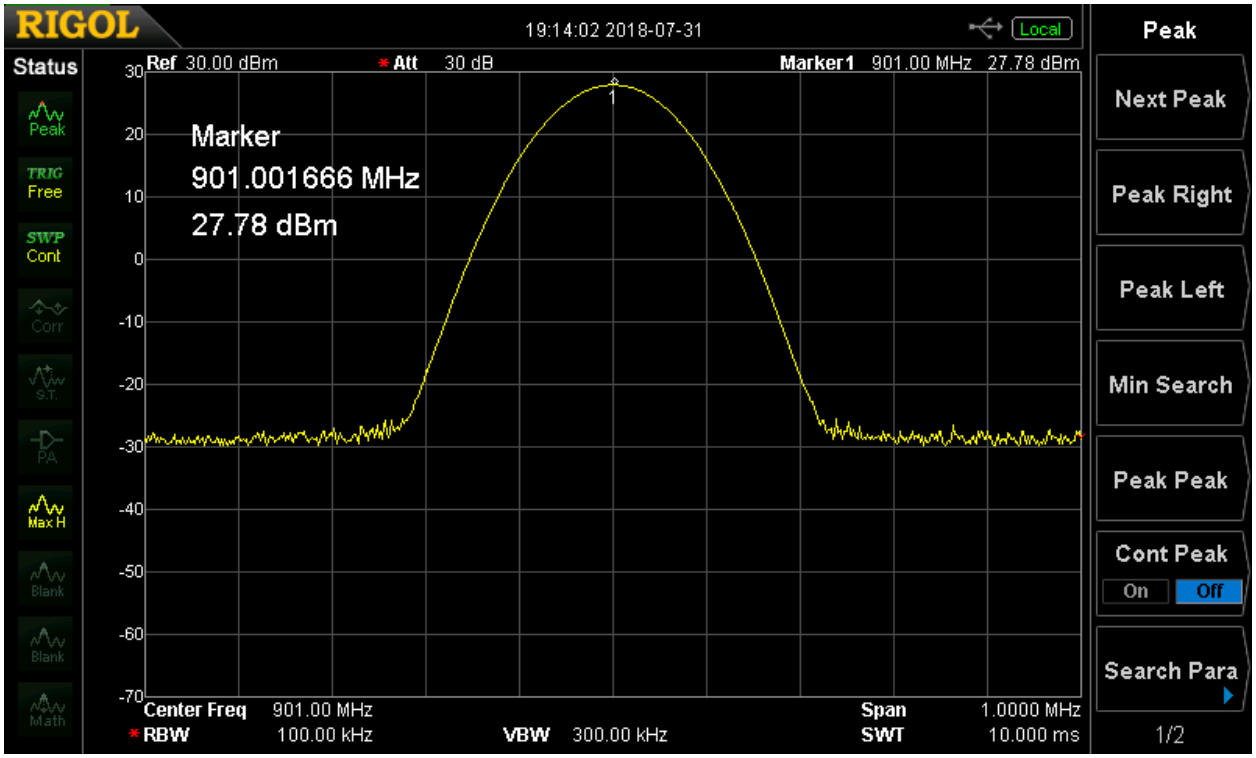

Figure 26. 901 MHz Output Power Plot

2.13 Emission Mask and Retransmitted Signal Measurements - Uplink

The EUT was connected to a spectrum analyzer through a 20 dB attenuator. All cable and attenuator losses were input into the spectrum analyzer as a combination of reference level offset and/or external correction factor offset to ensure accurate readings were obtained. Measurements were collect to verify that the EUT meets the required emissions mask parameters as cited in section 2.10 of this test report. A reference level plot is provided to show that the retransmitted signal meets the parameters as cited in section 2.10 of this test report.

The Emissions Mask were measured with the RF input set to at least 0.2 dB below the AGC level and then at +3.0 dB above the AGC level per KDB 935210 D03 V04.

2.13.1 VHF Channels

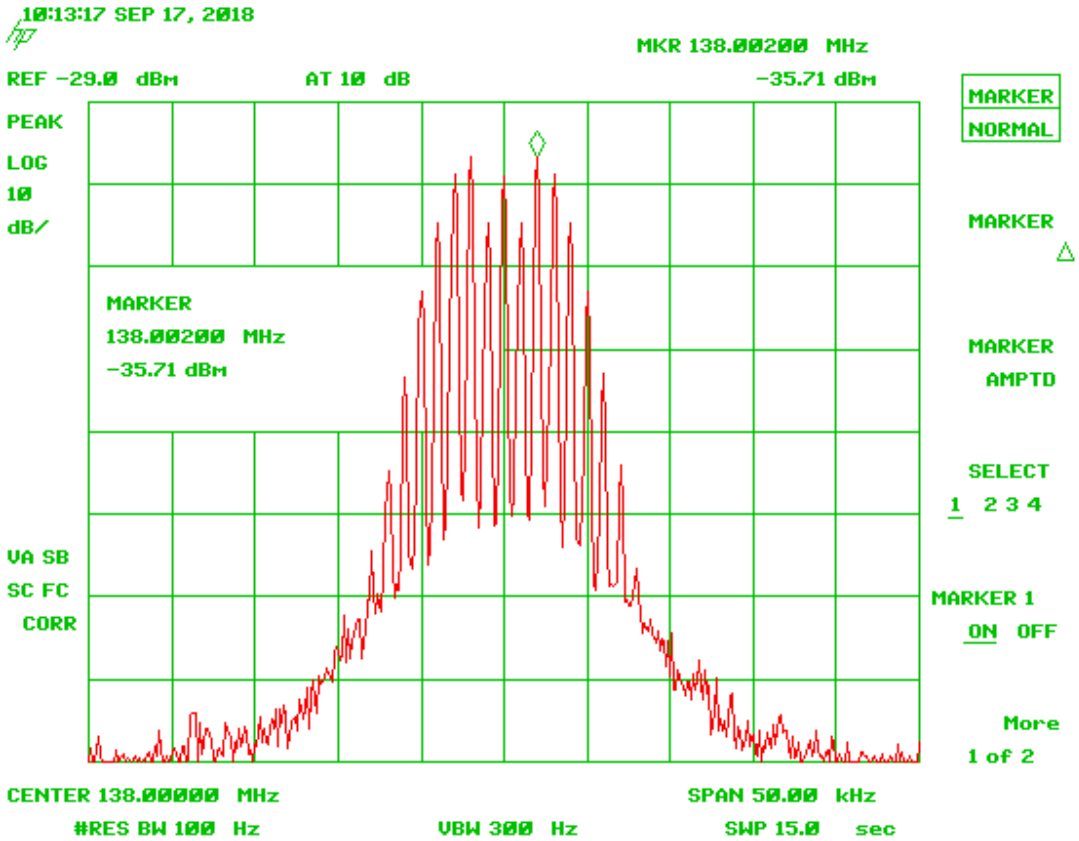

Figure 27. Input 138 MHz @ 12.5 kHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

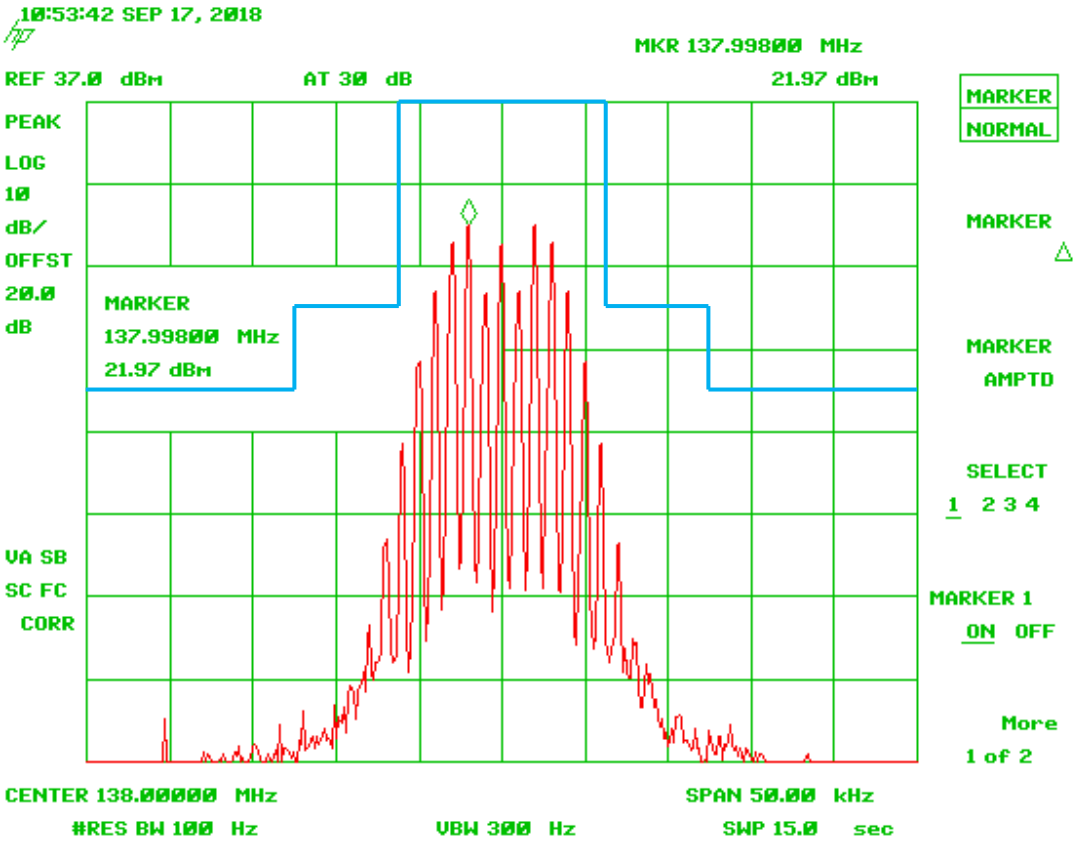

Figure 28. 138 MHz @ 12.5 kHz, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

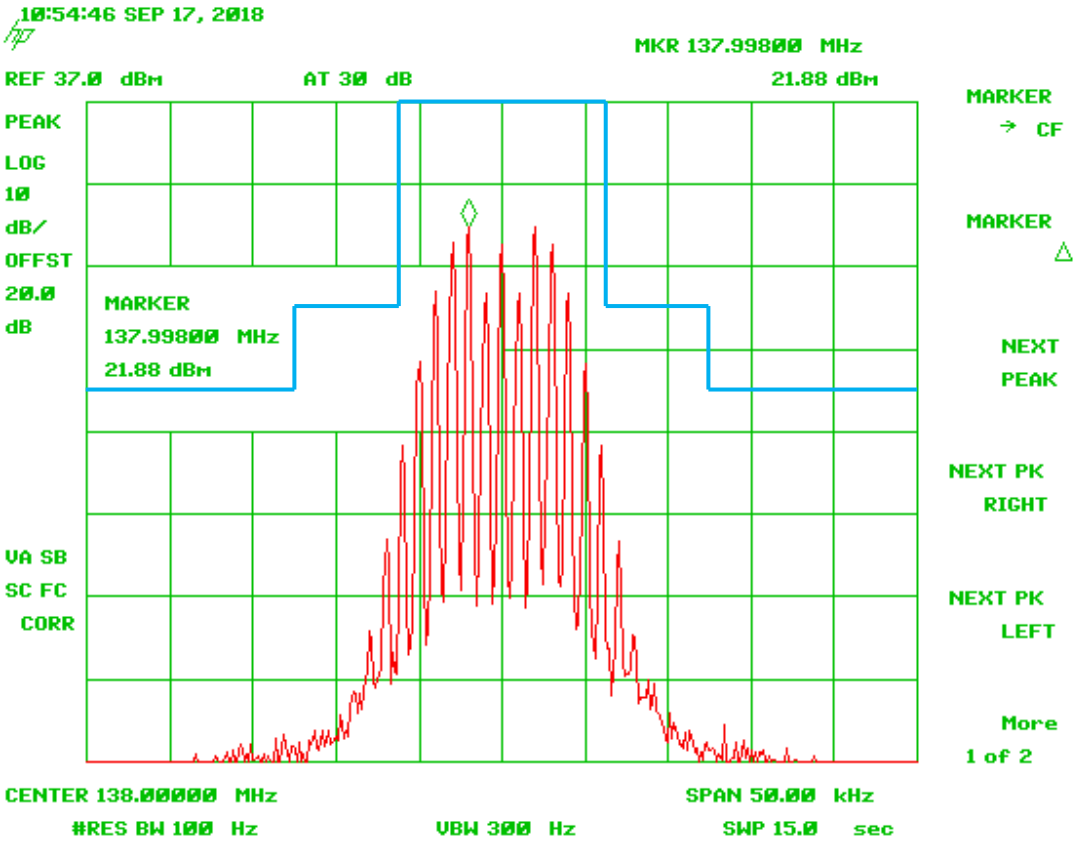

Figure 29. 138 MHz @ 12.5 kHz + 3.0 dB, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

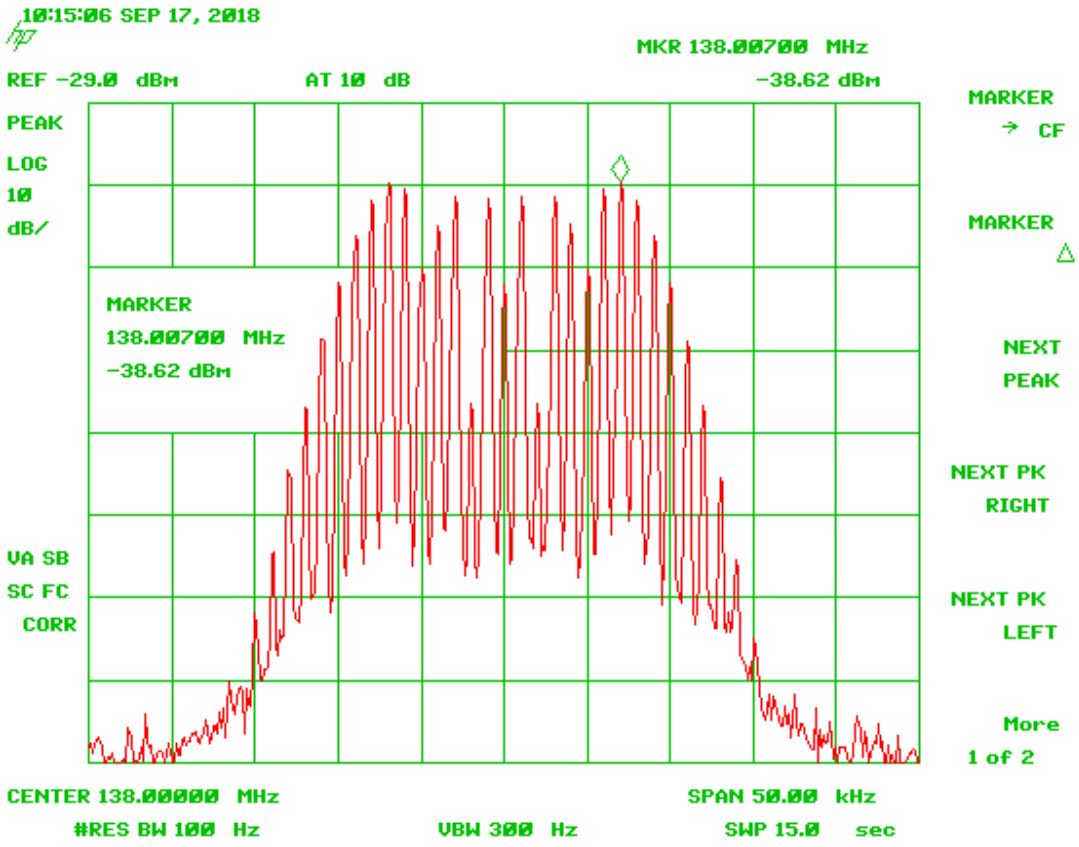

Figure 30. Input 138 MHz @ 25 kHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

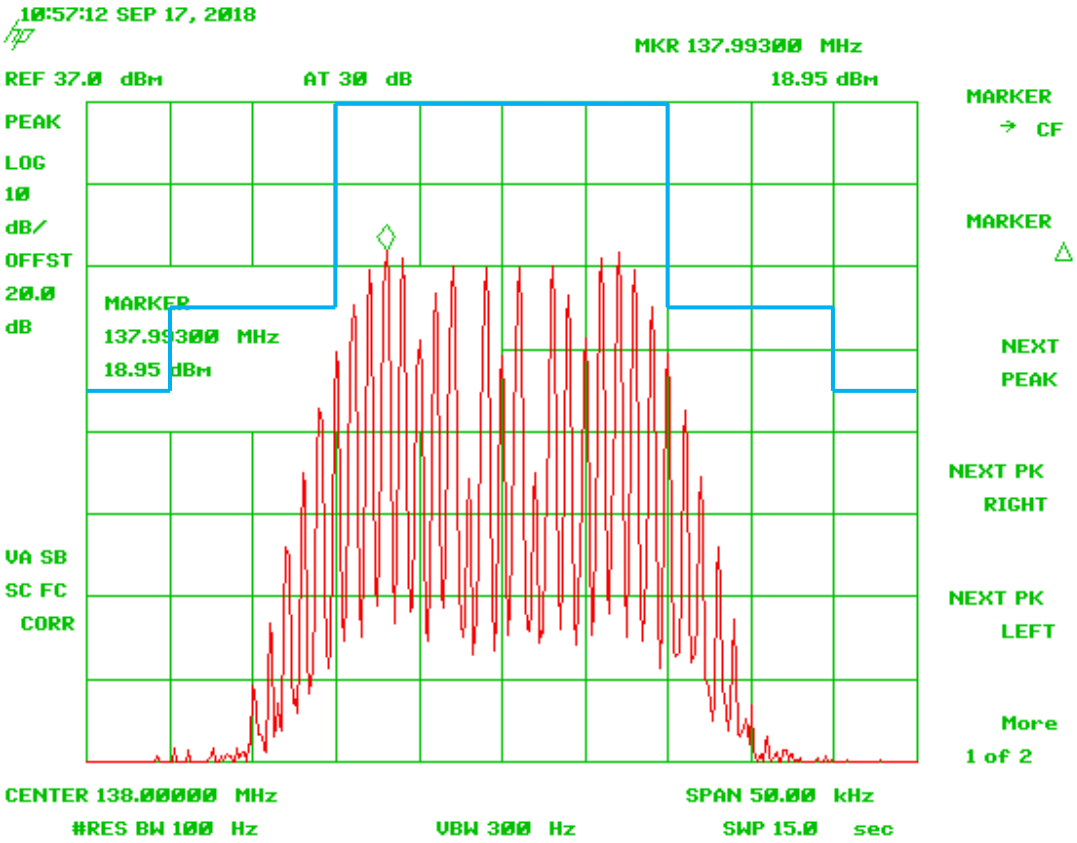

Figure 31. 138 MHz @ 25 kHz, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

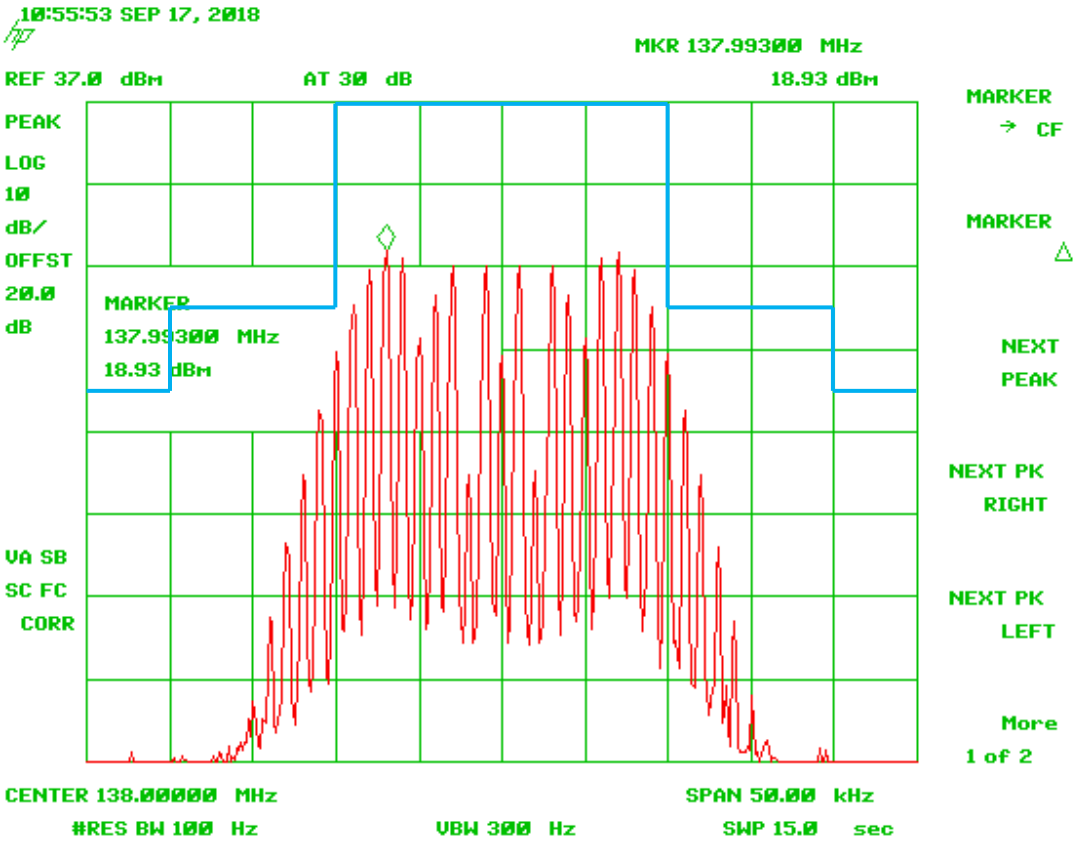

Figure 32. 138 MHz @ 25 kHz + 3.0 dB, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

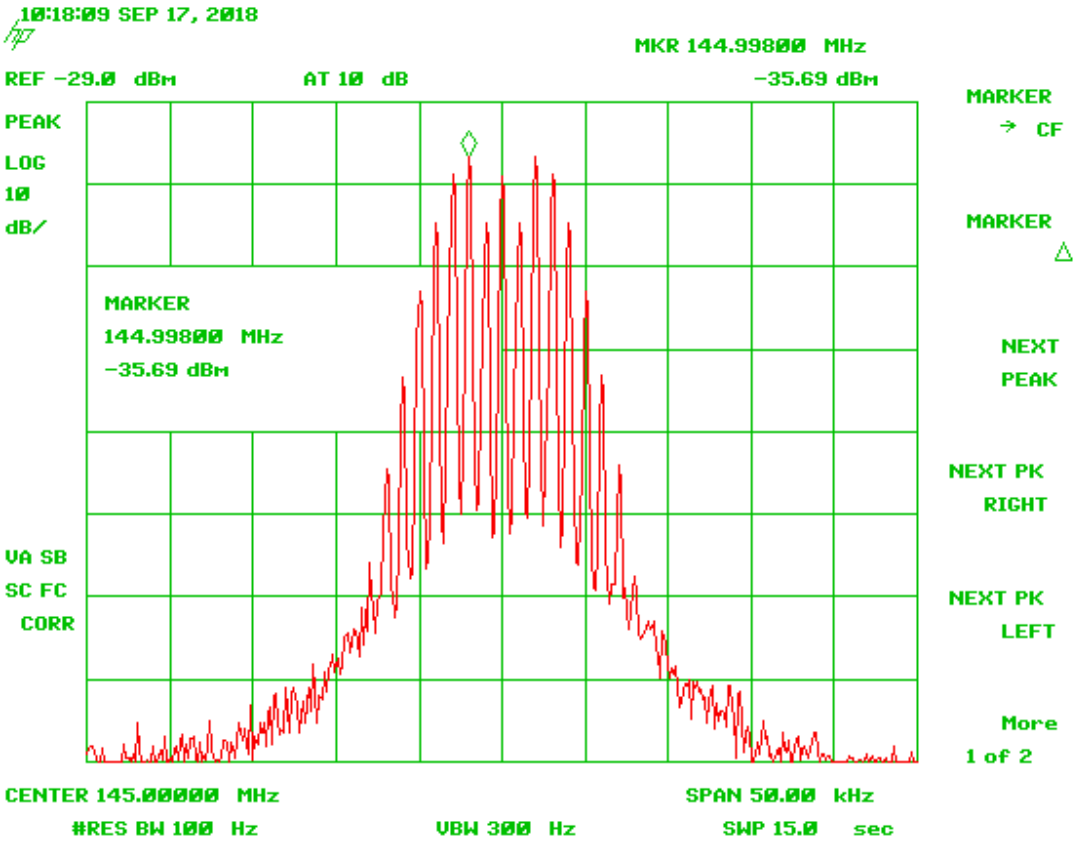

Figure 33. Input 145 MHz @ 12.5 kHz

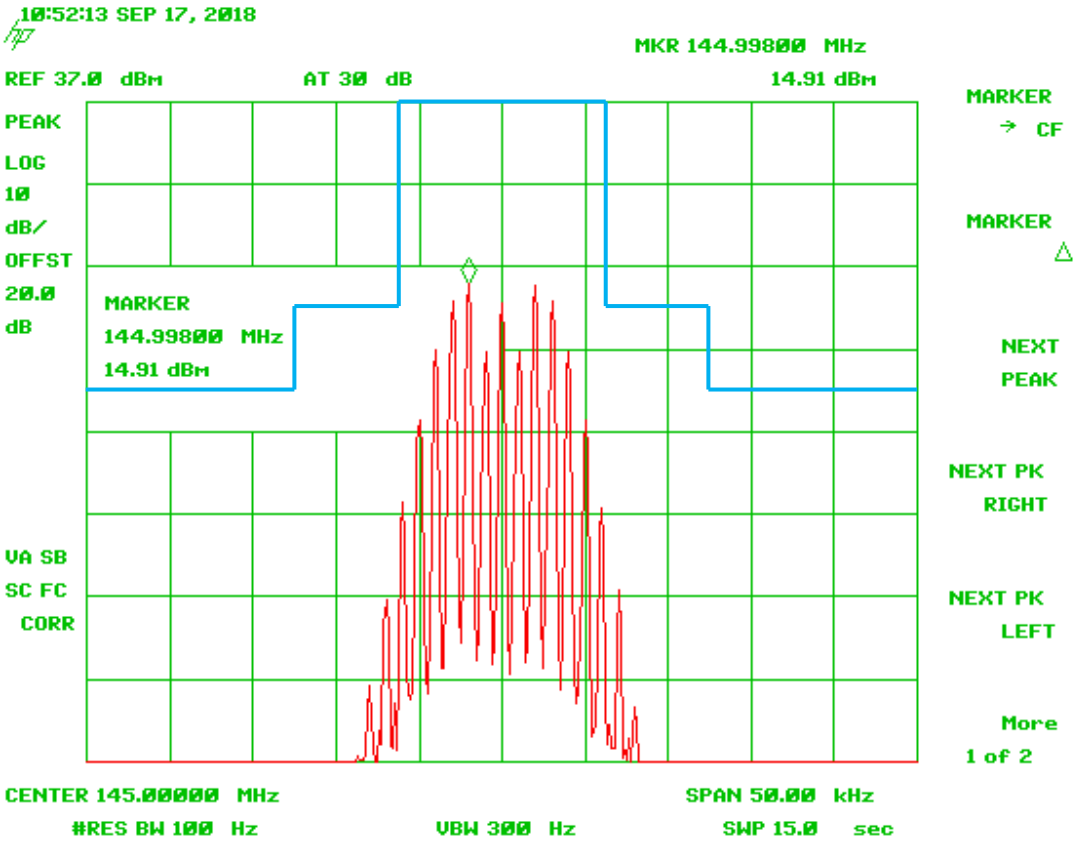

Figure 34. 145 MHz @ 12.5 kHz, Mask B

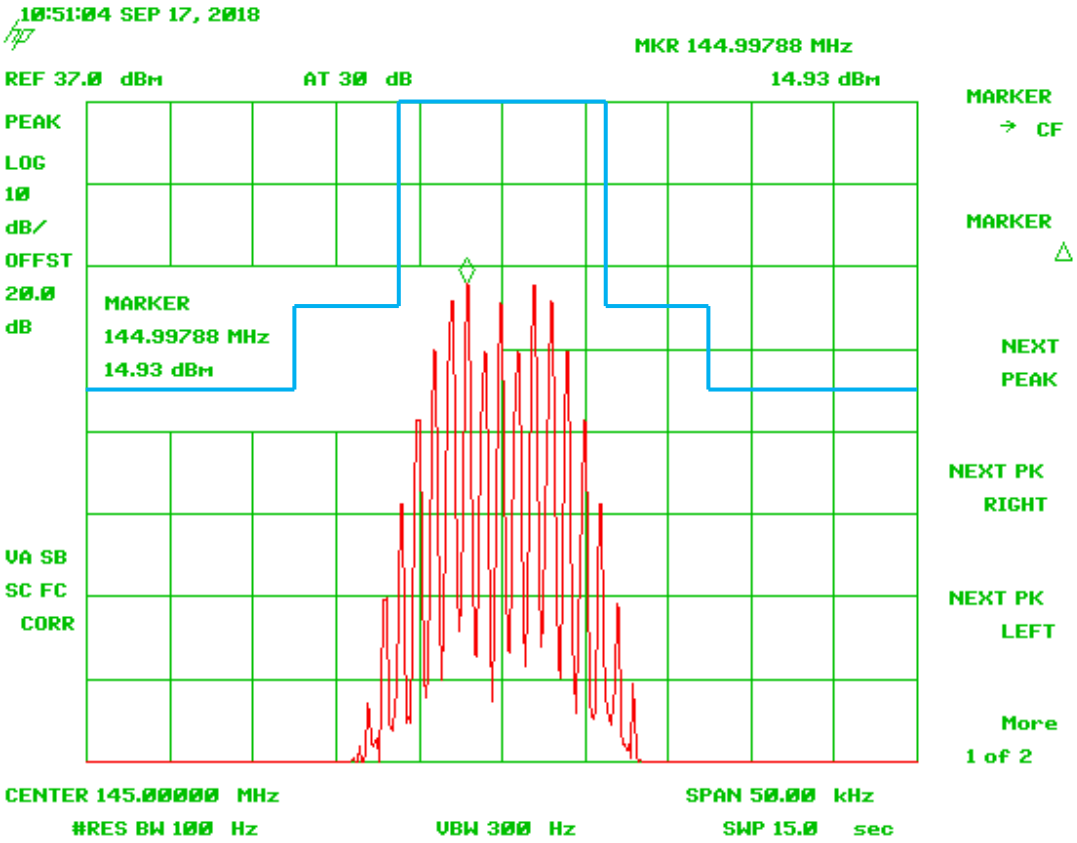

Figure 35. 145 MHz @ 12.5 kHz + 3.0 dB, Mask B

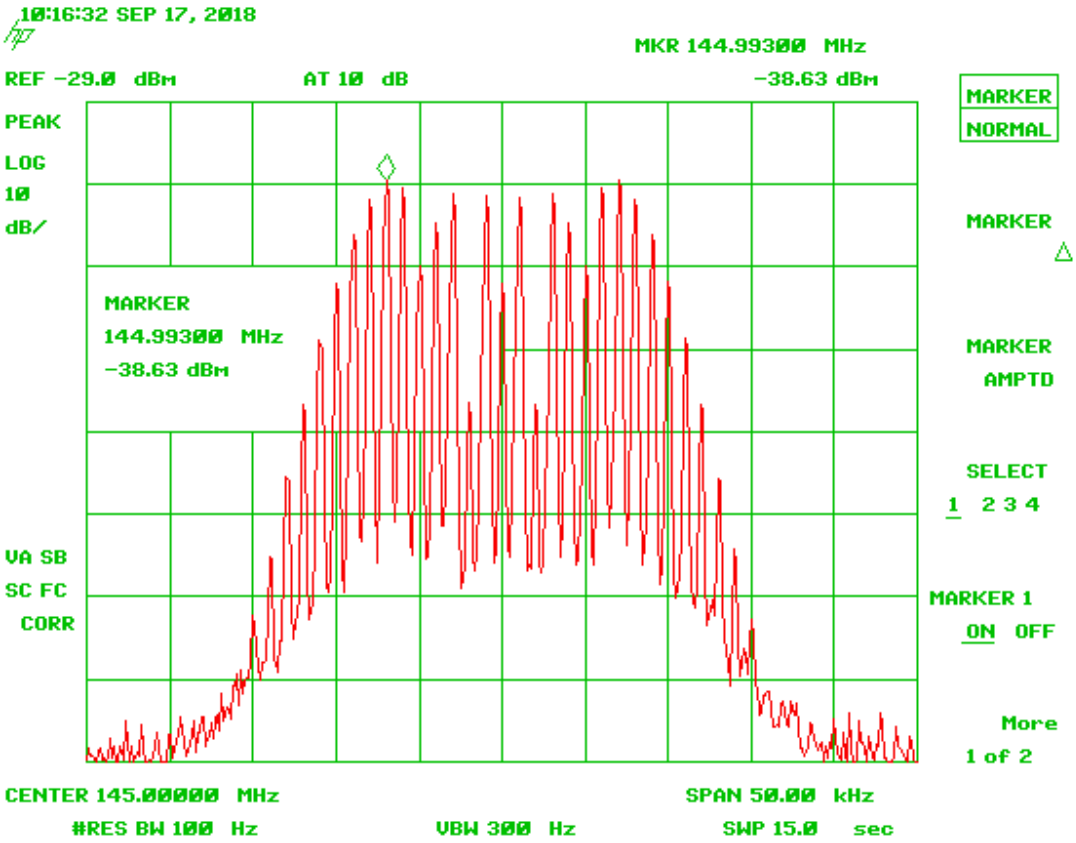

Figure 36. Input 145 MHz @ 25 kHz

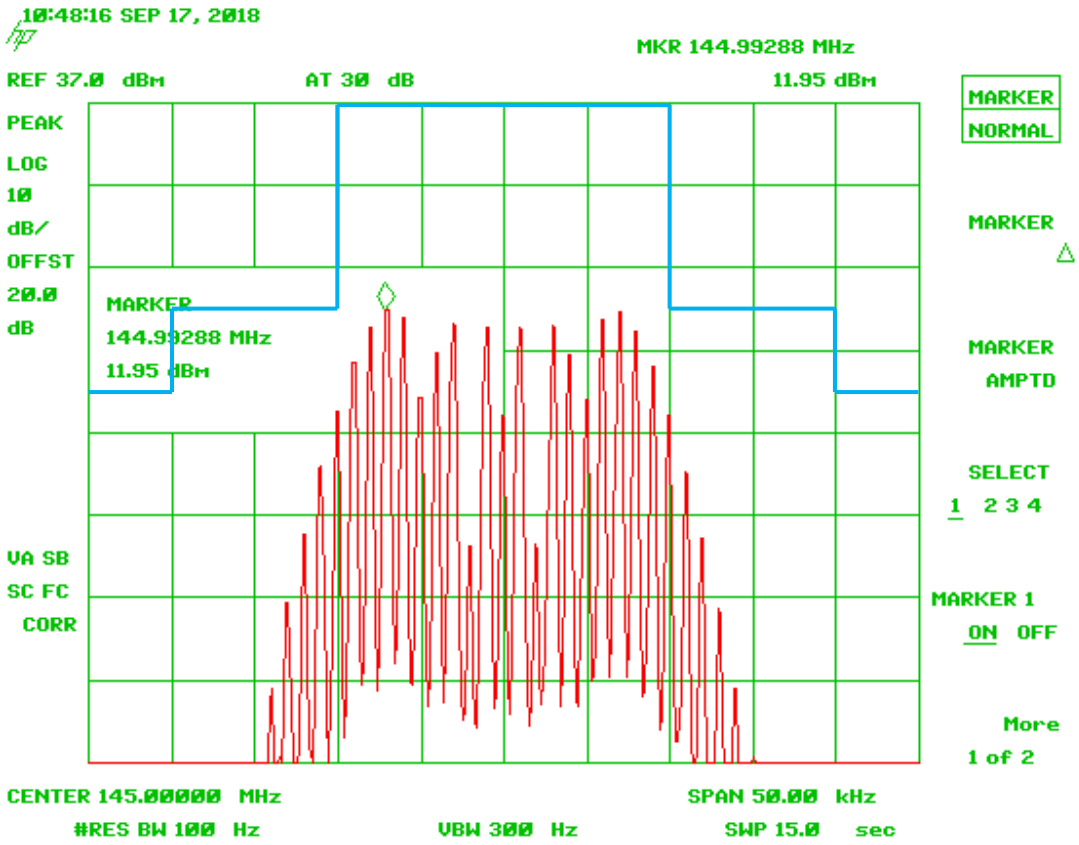

Figure 37. 145 MHz @ 25 kHz, Mask B

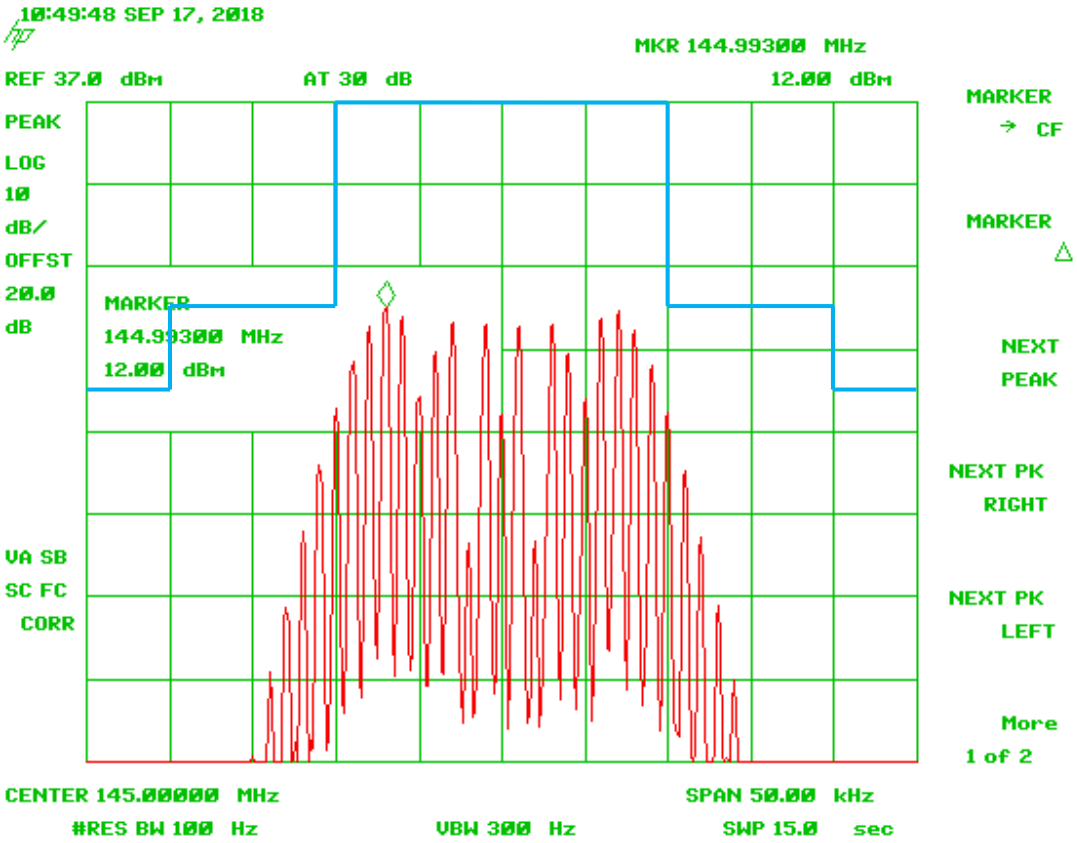

Figure 38. 145 MHz @ 25 kHz + 3.0 dB, Mask B

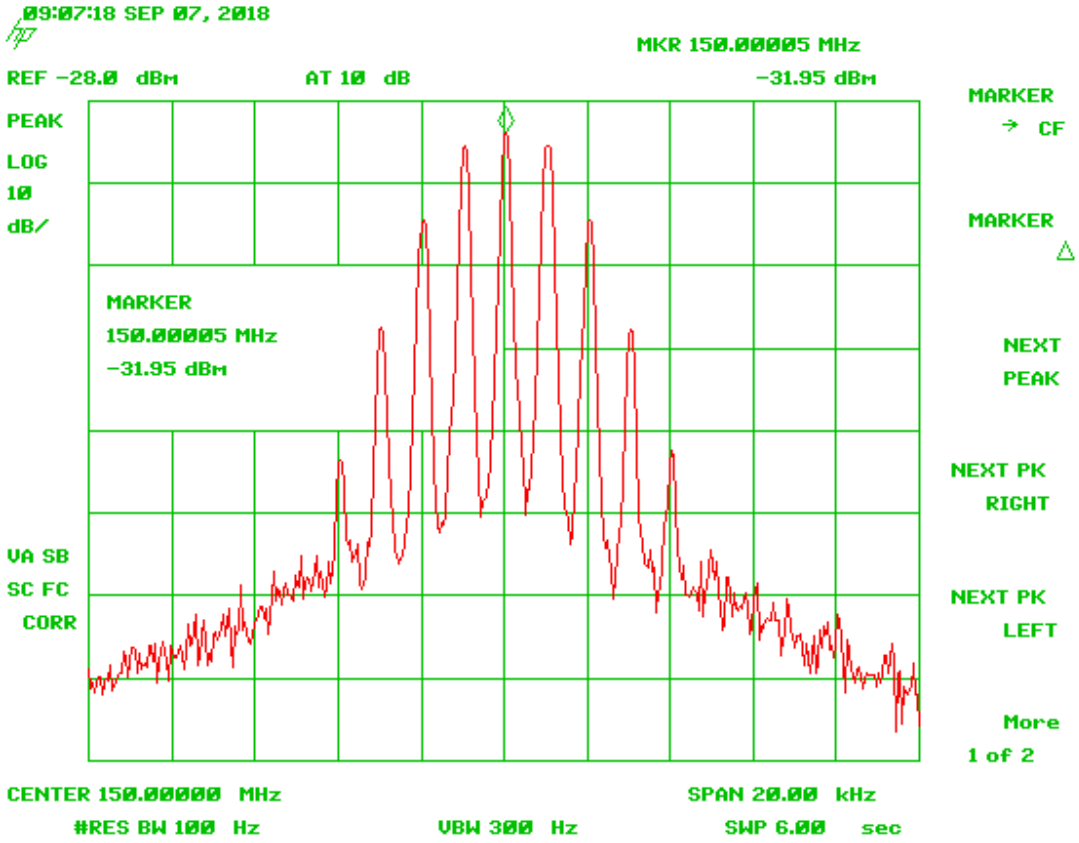

Figure 39. Input 150 MHz @ 6.25 kHz

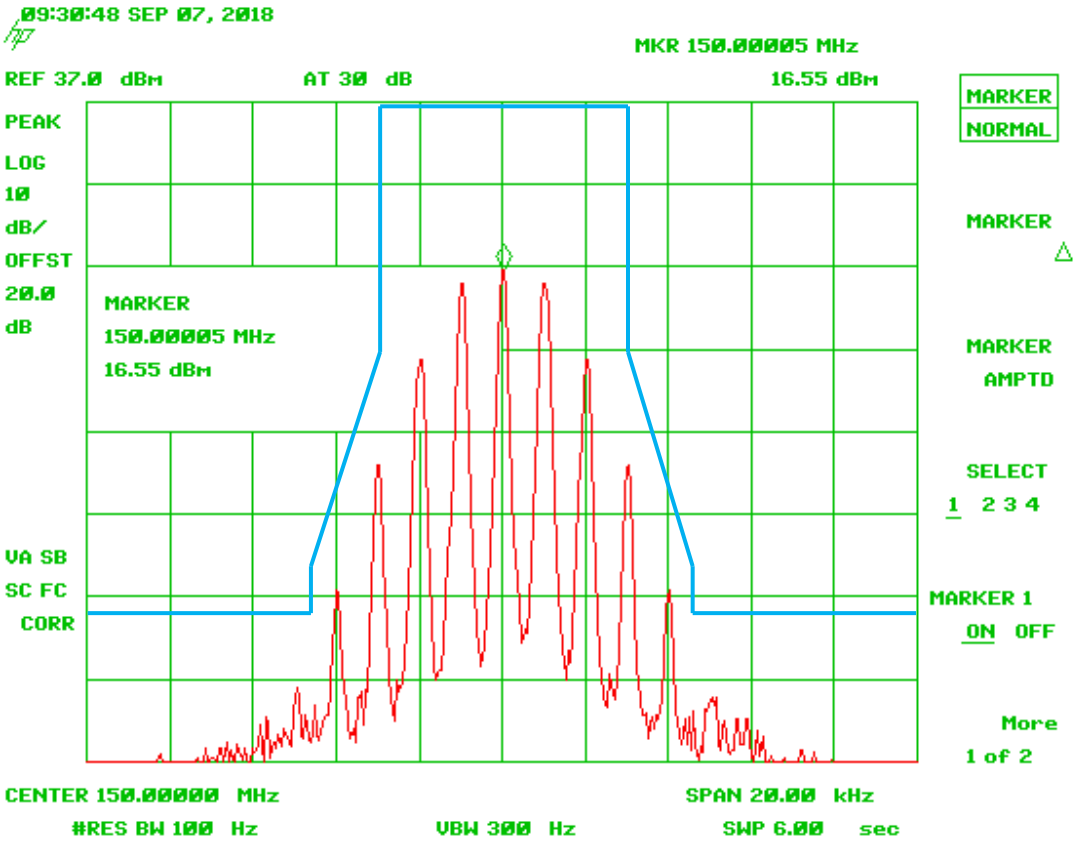

Figure 40. 150 MHz @ 6.25 kHz, Mask E

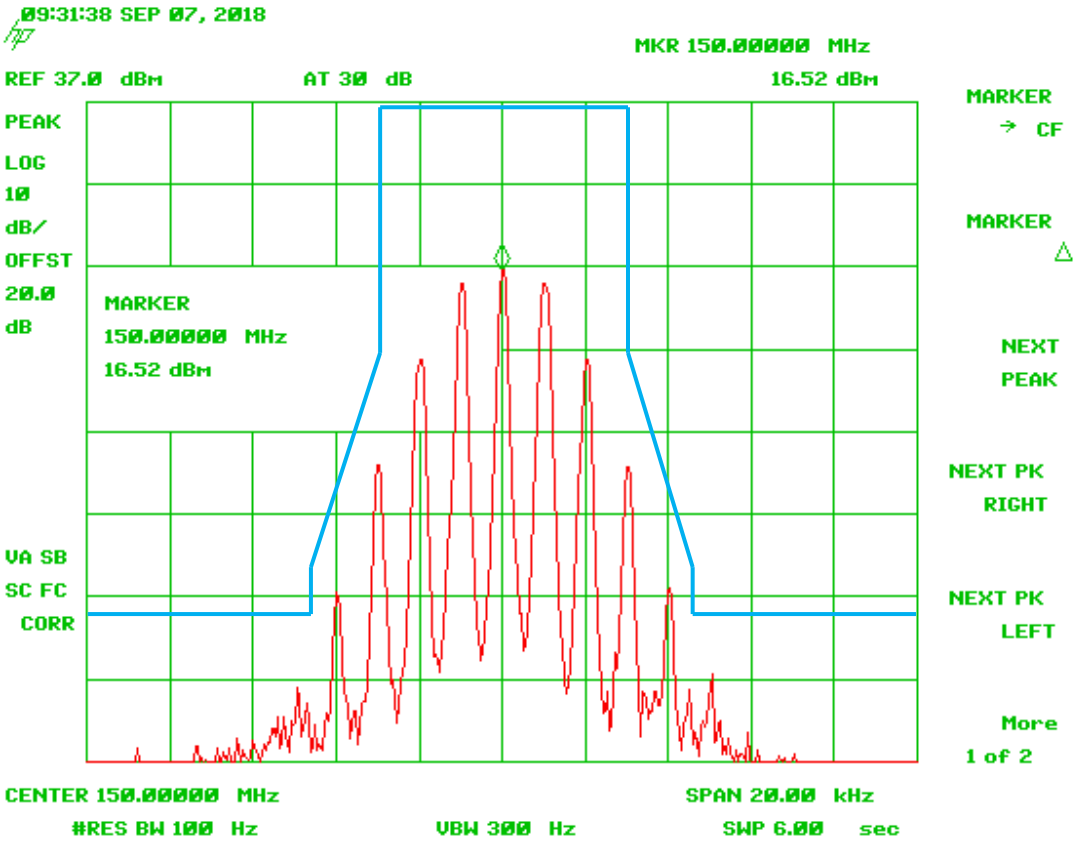

Figure 41. 150 MHz@ 6.25 kHz + 3.0 dB, Mask E

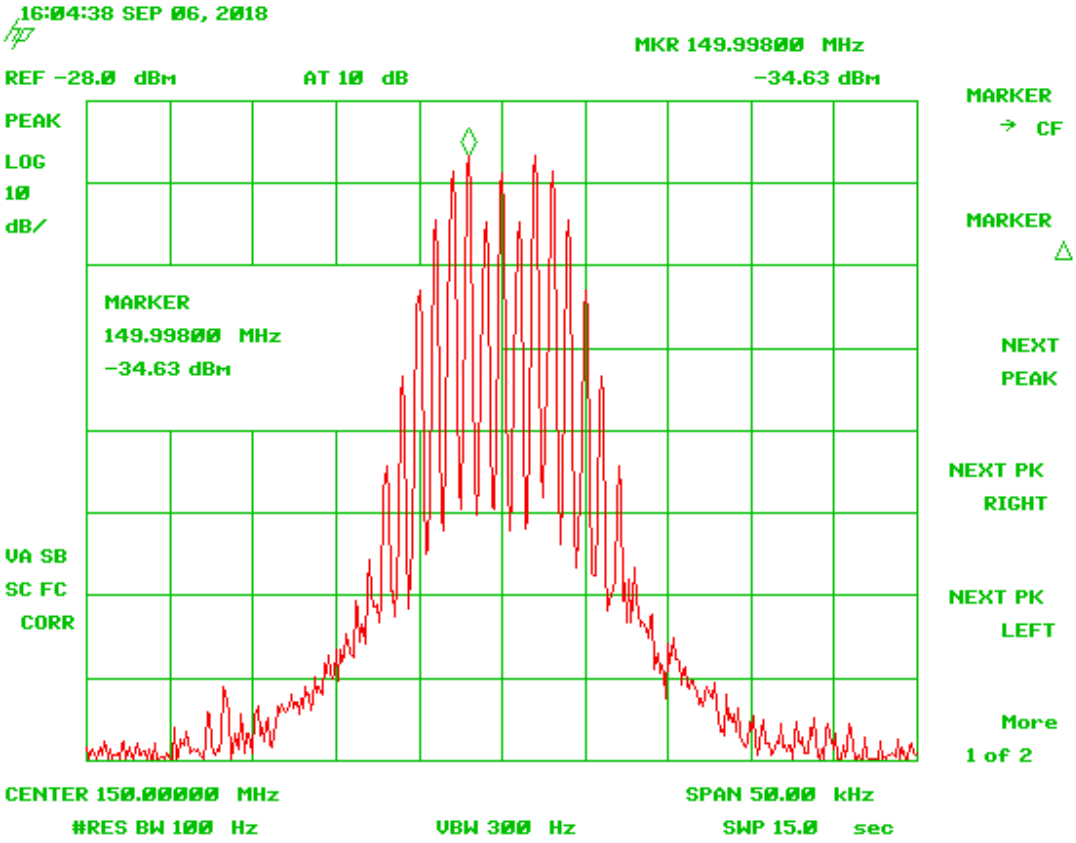

Figure 42. Input 150 MHz @ 12.5 kHz

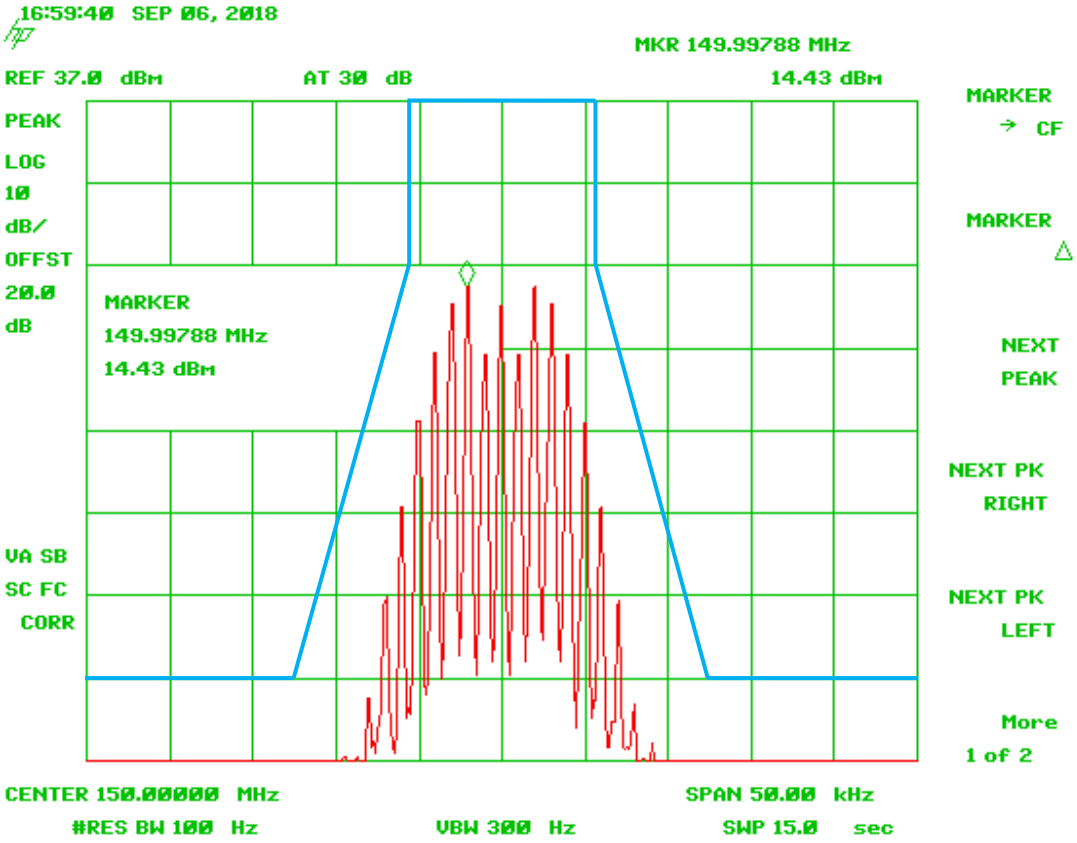

Figure 43. 150 MHz @ 12.5 kHz, Mask D

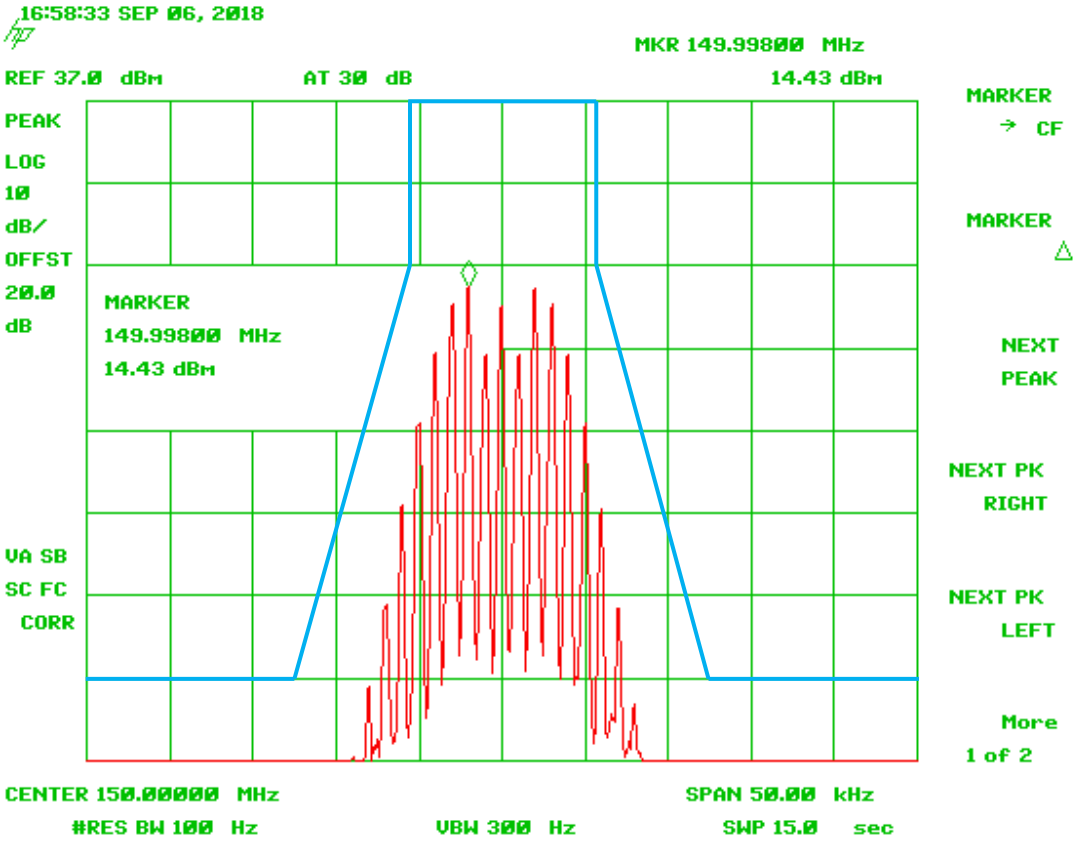

Figure 44. 150 MHz @ 12.5 kHz + 3.0 dB, Mask D

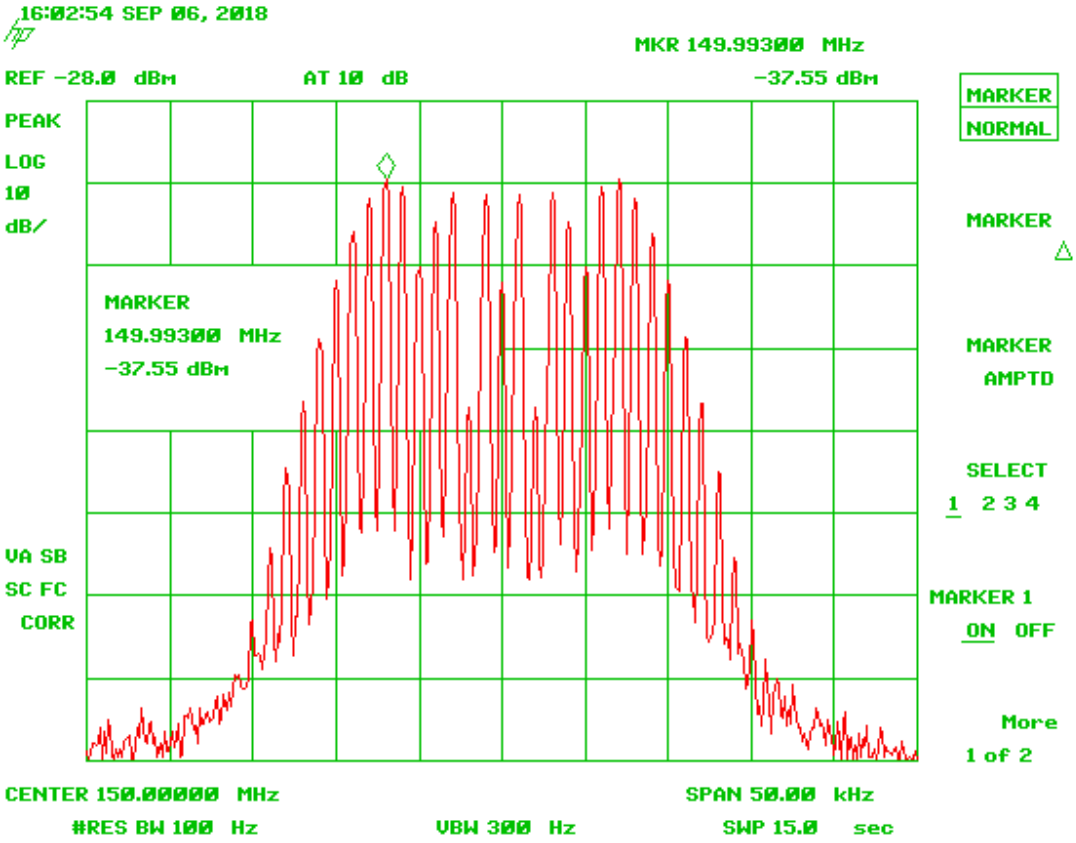

Figure 45. Input 150 MHz @ 25 kHz

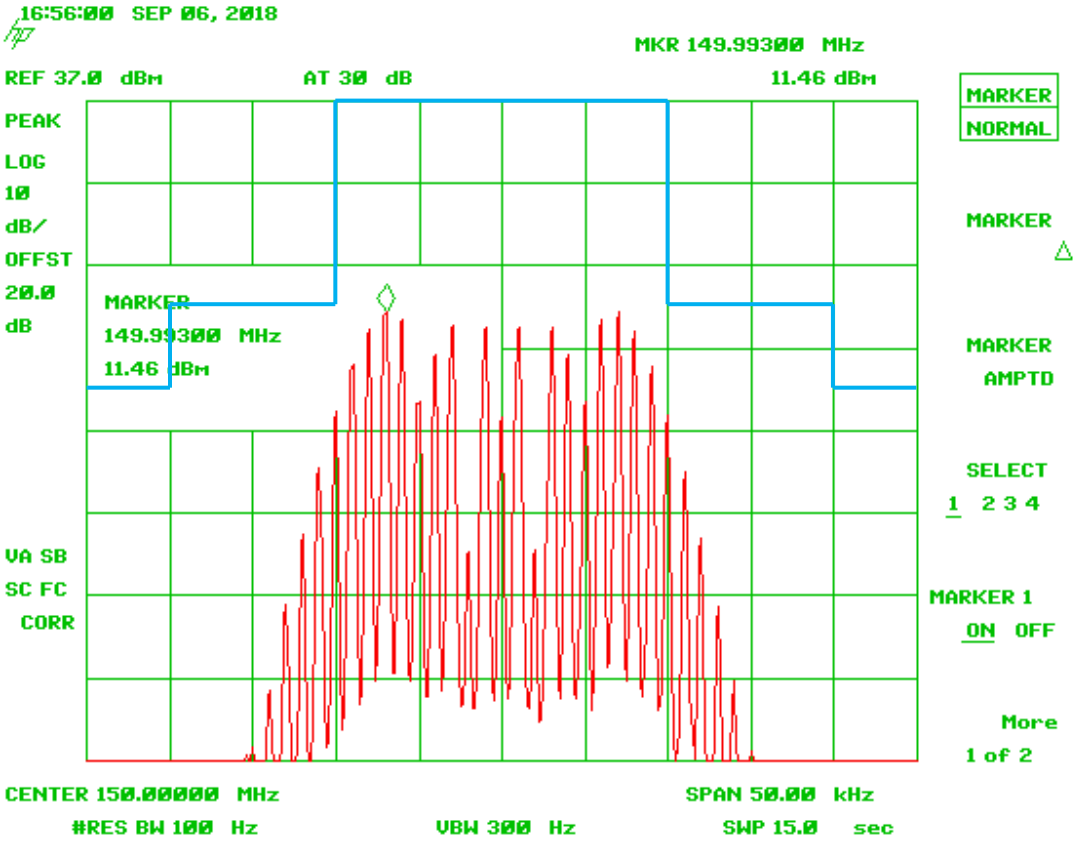

Figure 46. 150 MHz @ 25 kHz, Mask B

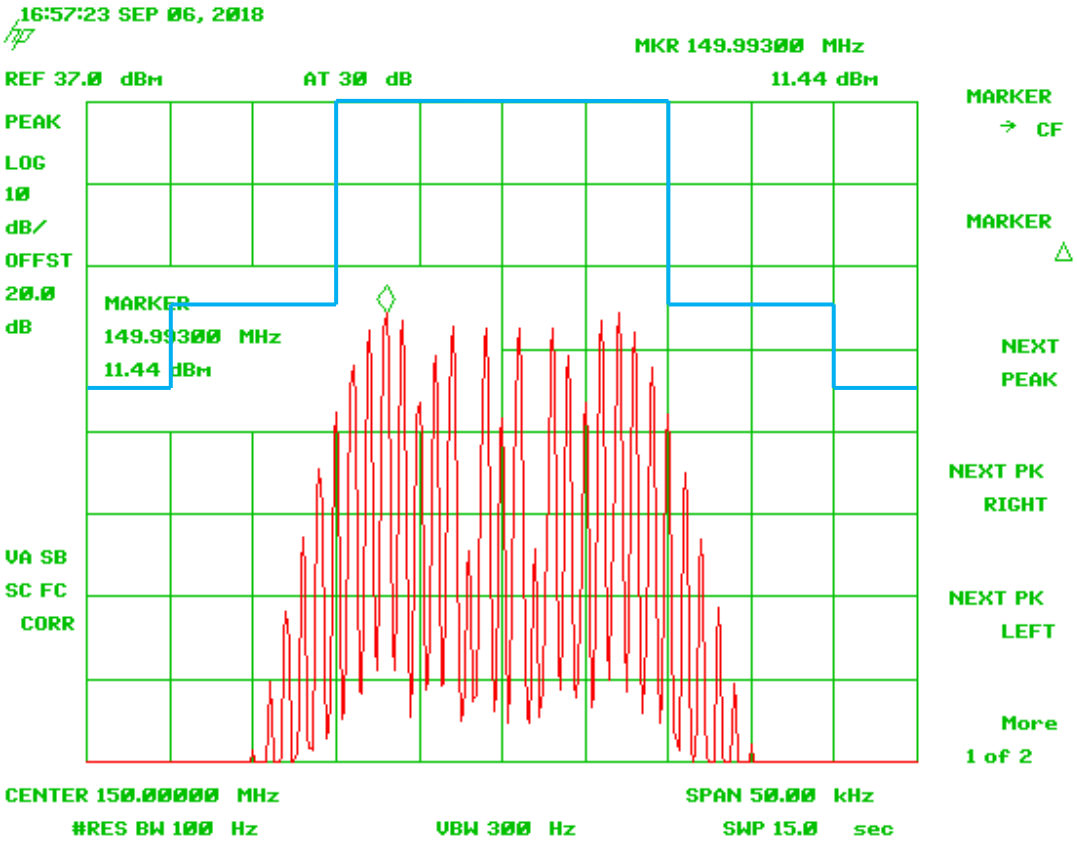

Figure 47. 150 MHz @ 25 kHz + 3.0 dB, Mask B

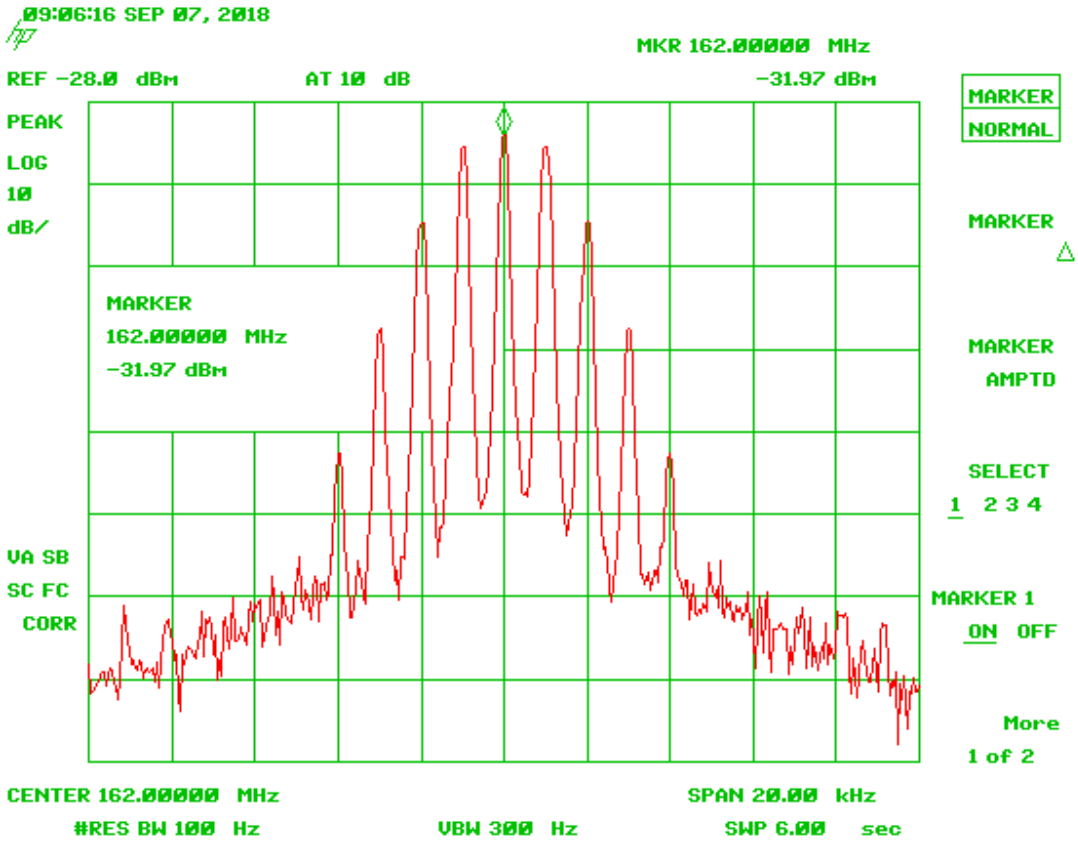

Figure 48. Input 162 MHz @ 6.25 kHz

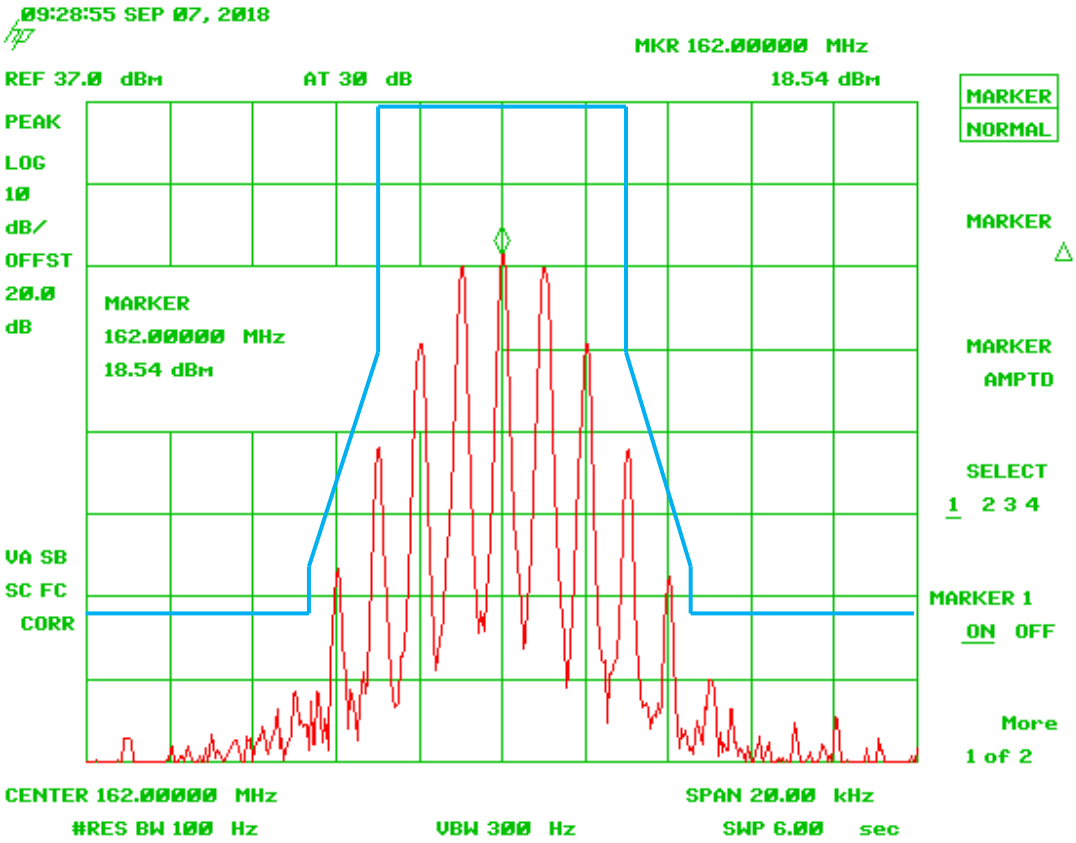

Figure 49. 162 MHz @ 6.25 kHz, Mask E

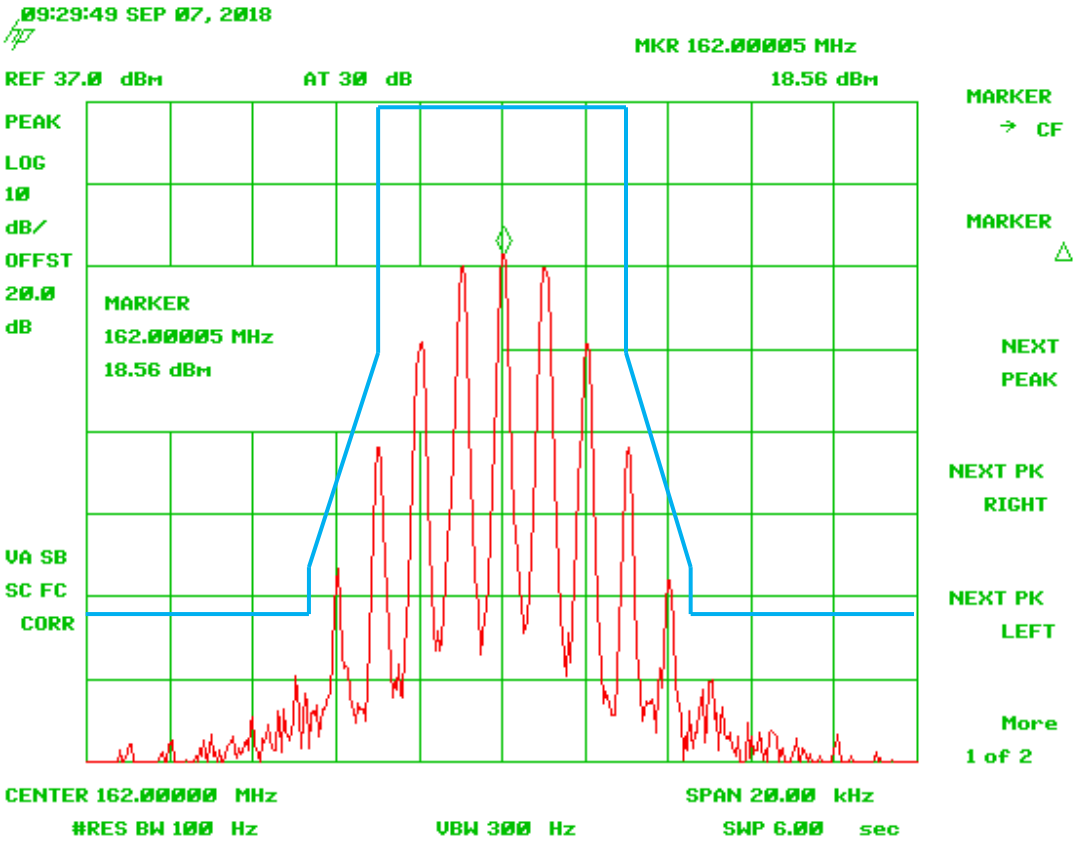

Figure 50. 162 MHz @ 6.25 kHz + 3.0 dB, Mask E

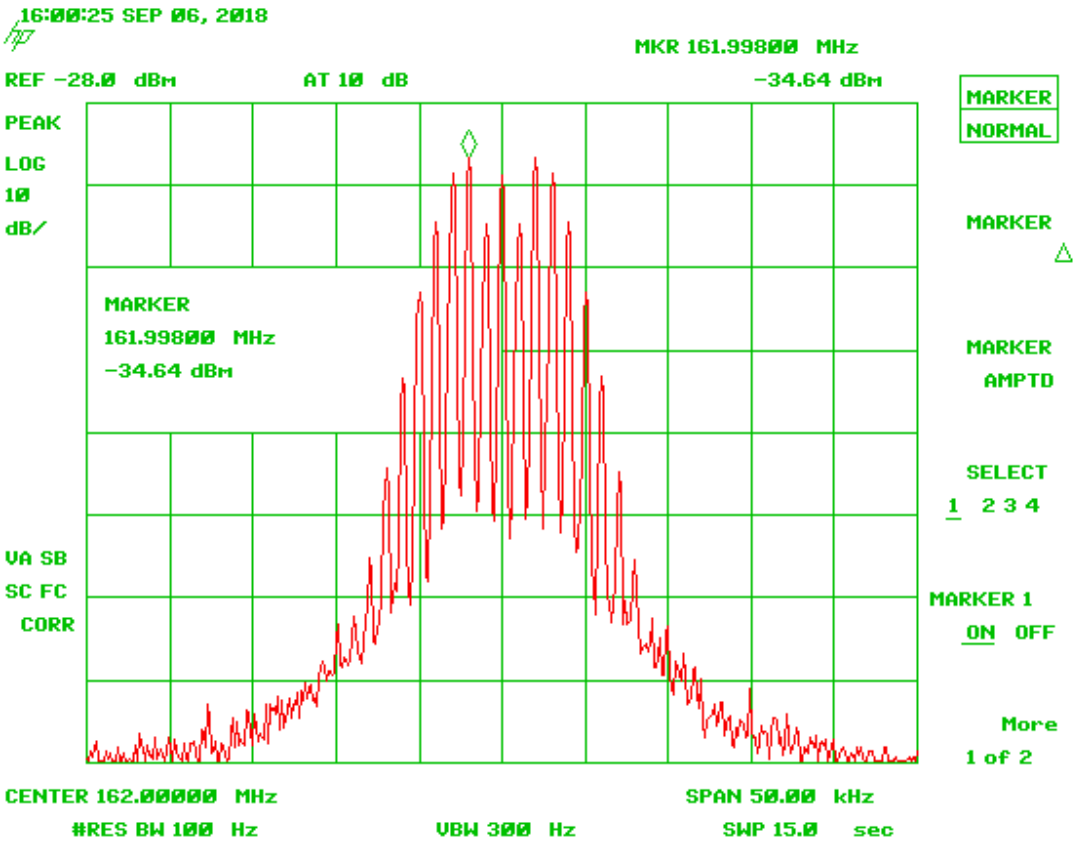

Figure 51. Input 162 MHz @ 12.5 kHz

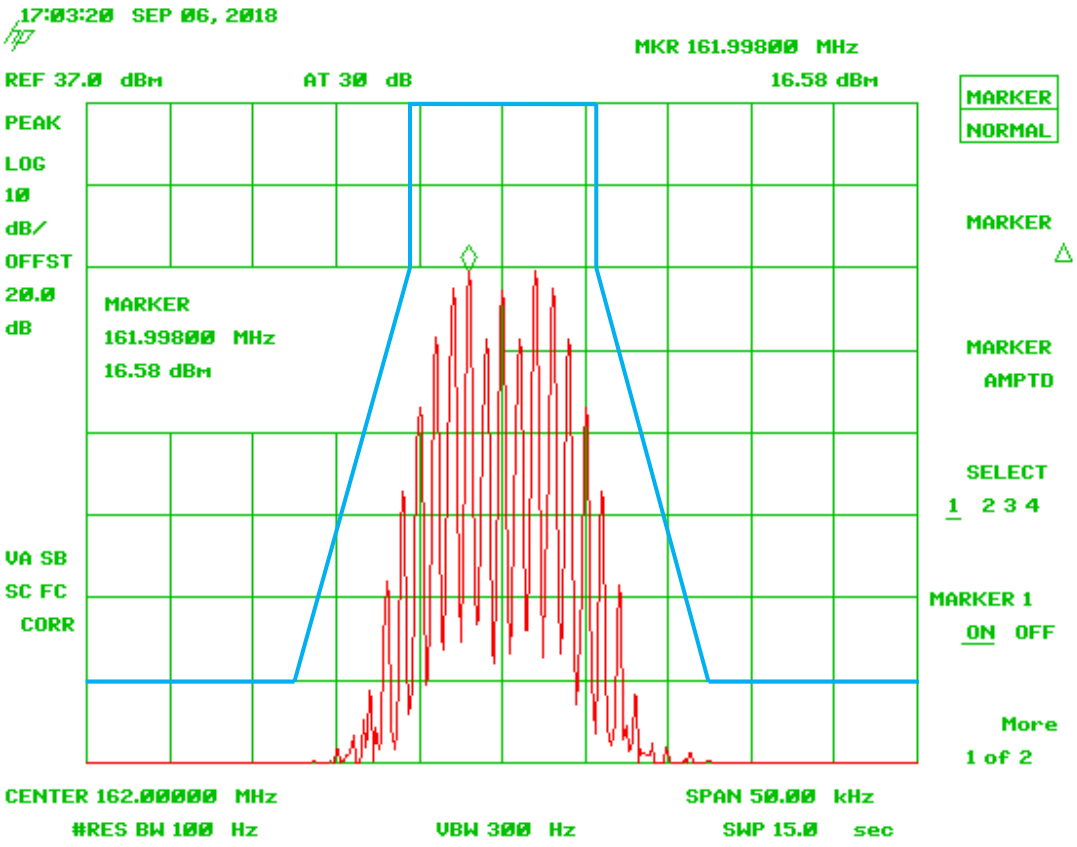

Figure 52. 162 MHz @ 12.5 kHz, Mask D

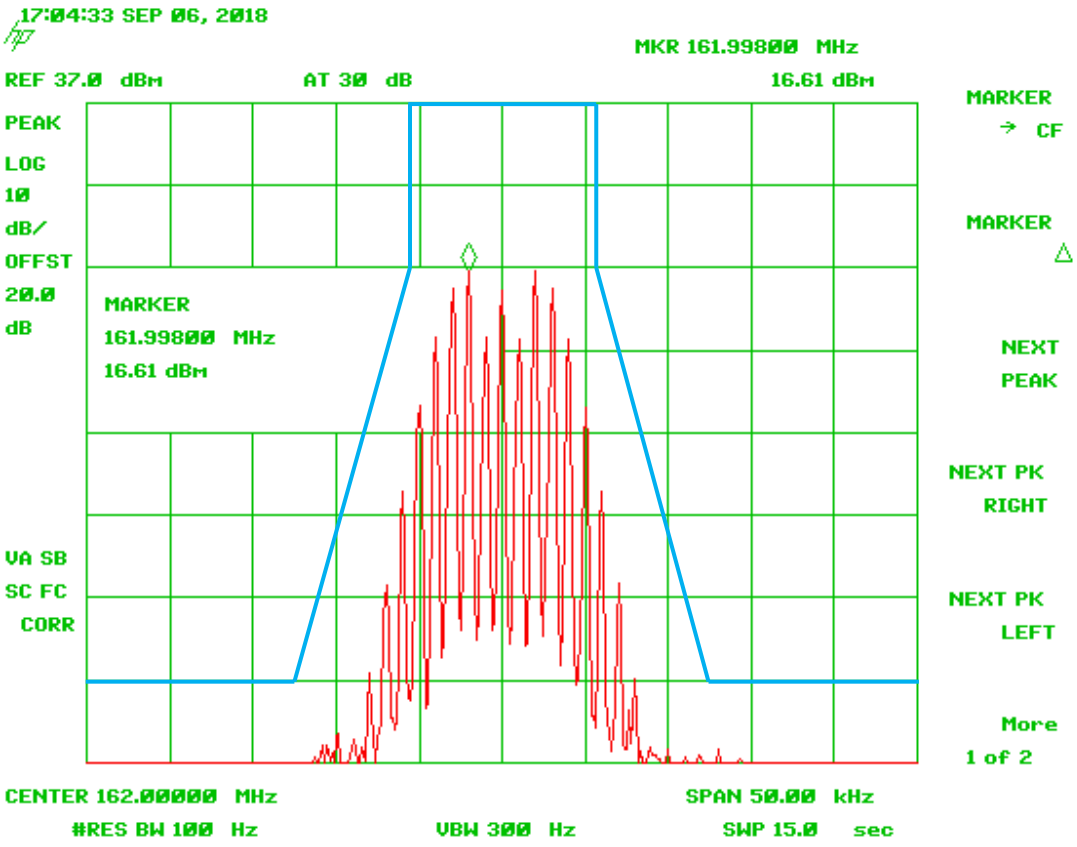

Figure 53. 162 MHz @ 12.5 kHz + 3.0 dB, Mask D

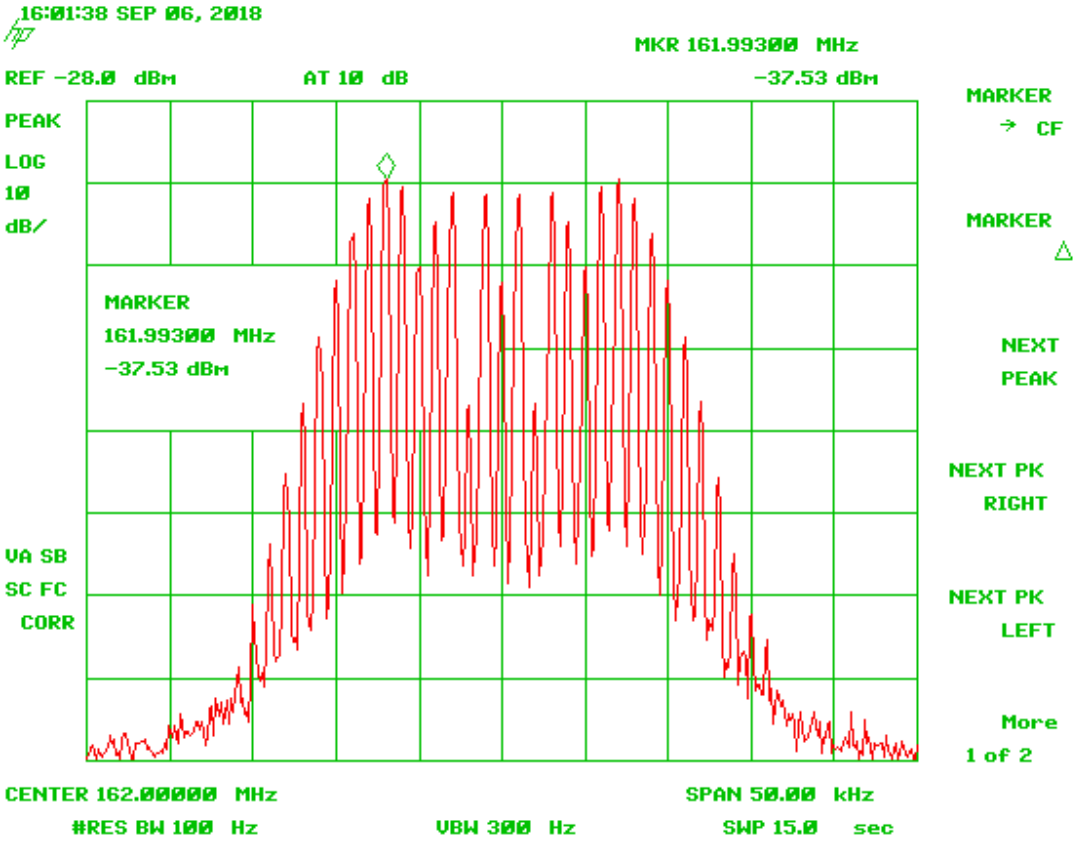

Figure 54. Input 162 MHz @ 25 kHz

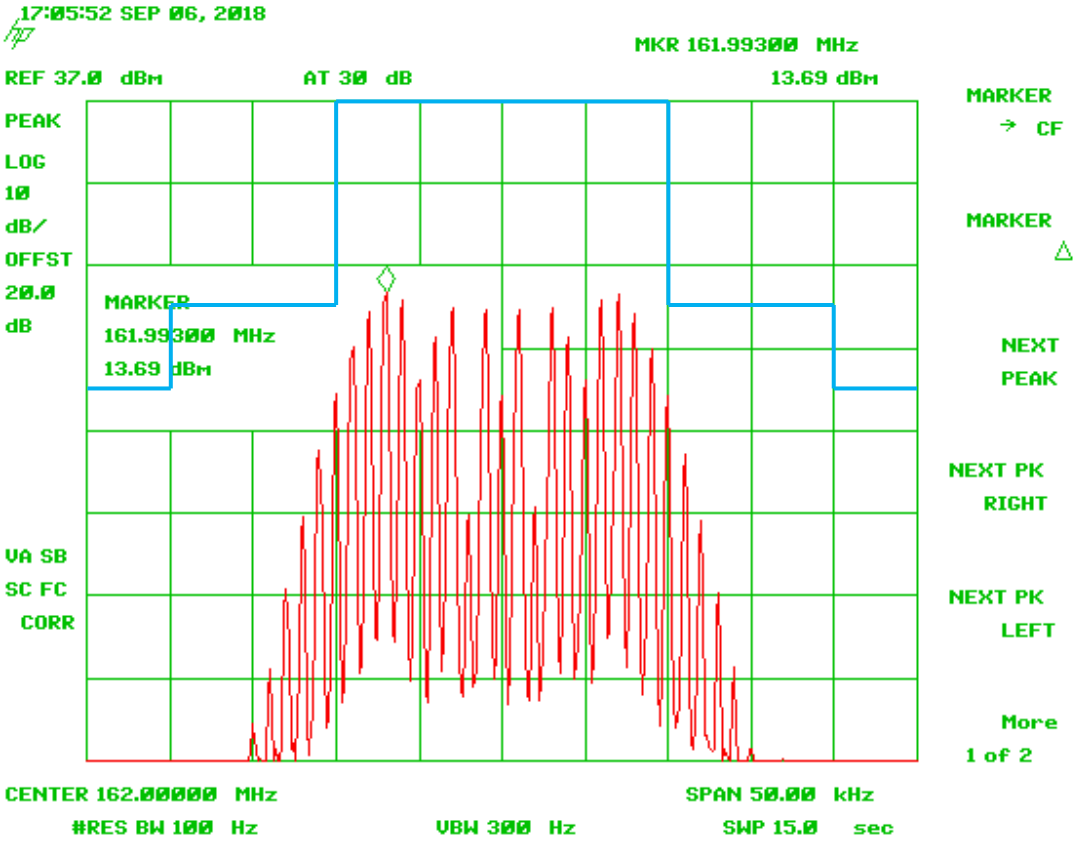

Figure 55. 162 MHz @ 25 kHz, Mask B

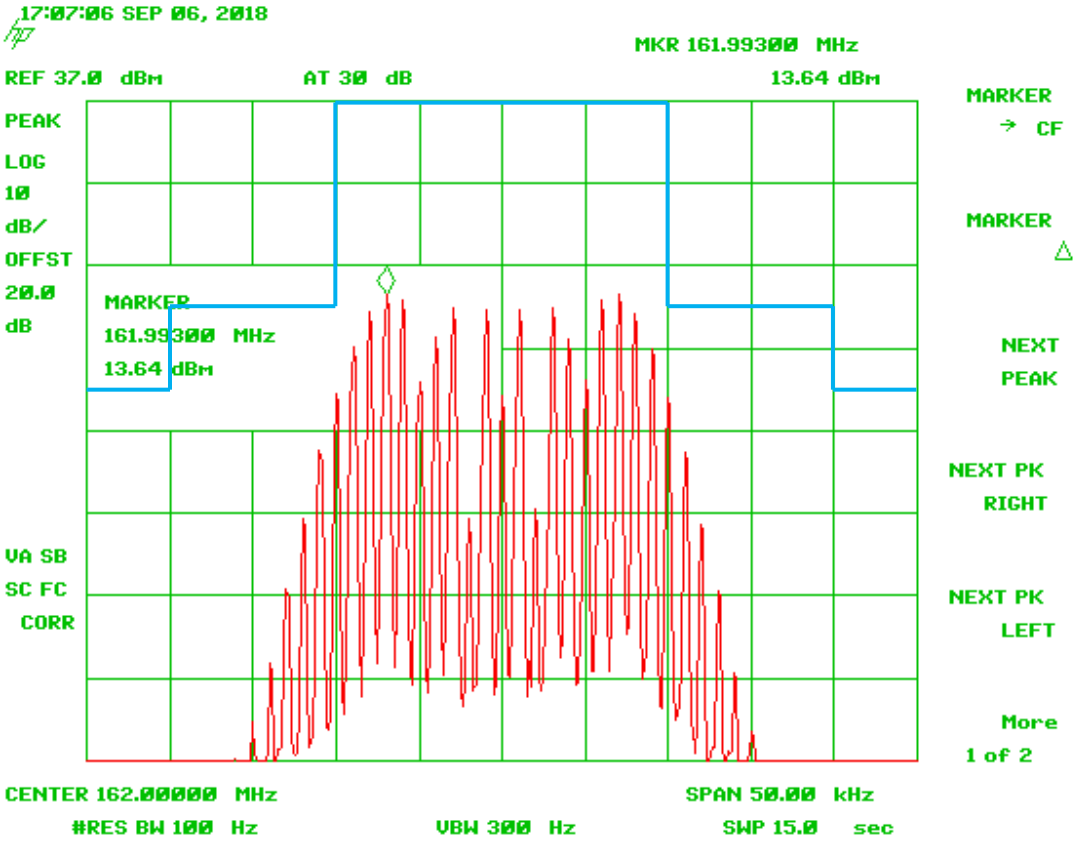

Figure 56. 162 MHz @ 25 kHz + 3.0 dB, Mask B

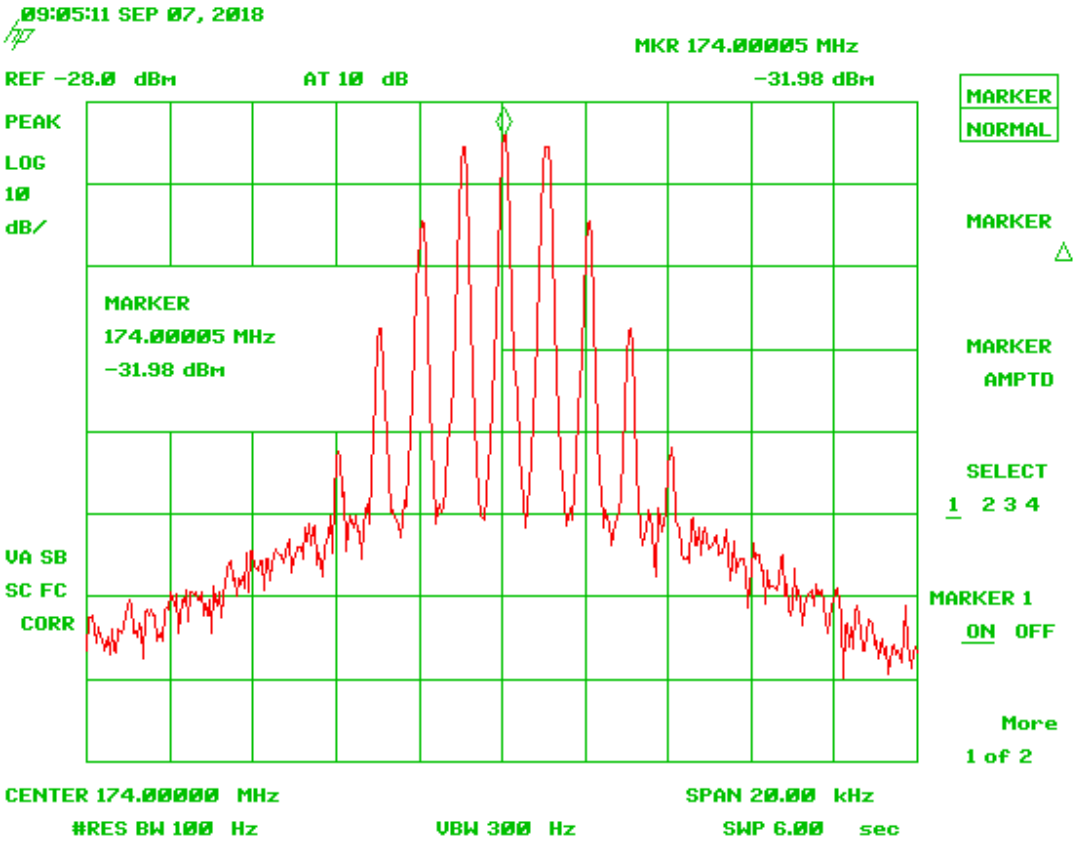

Figure 57. Input 174 MHz @ 6.25 kHz

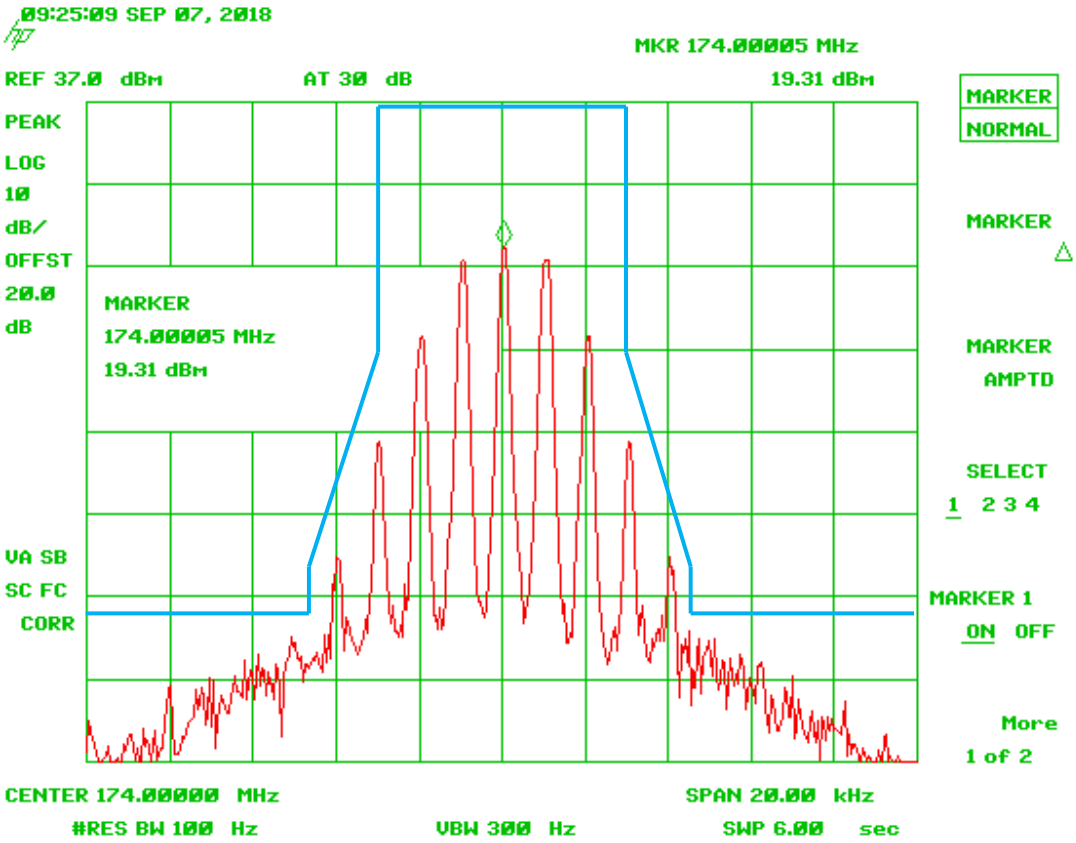

Figure 58. 174 MHz @ 6.25 kHz, Mask E

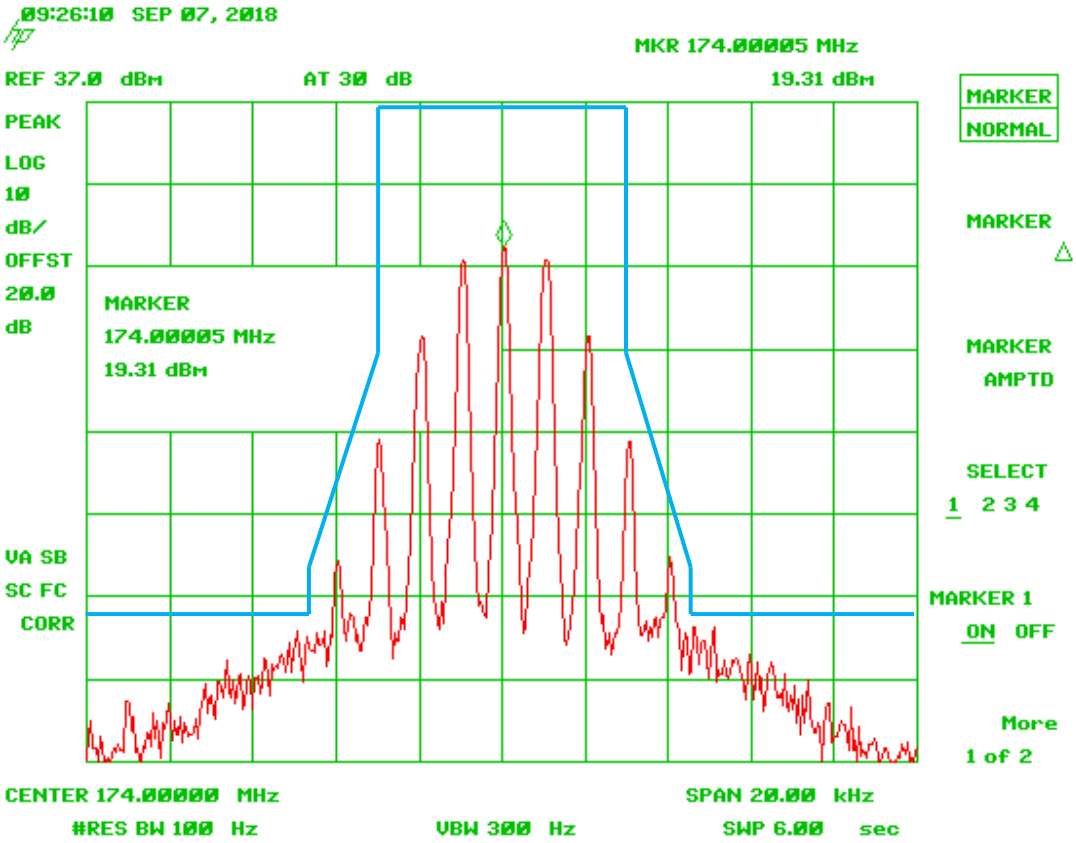

Figure 59. 174 MHz @ 6.25 kHz + 3.0 dB, Mask E

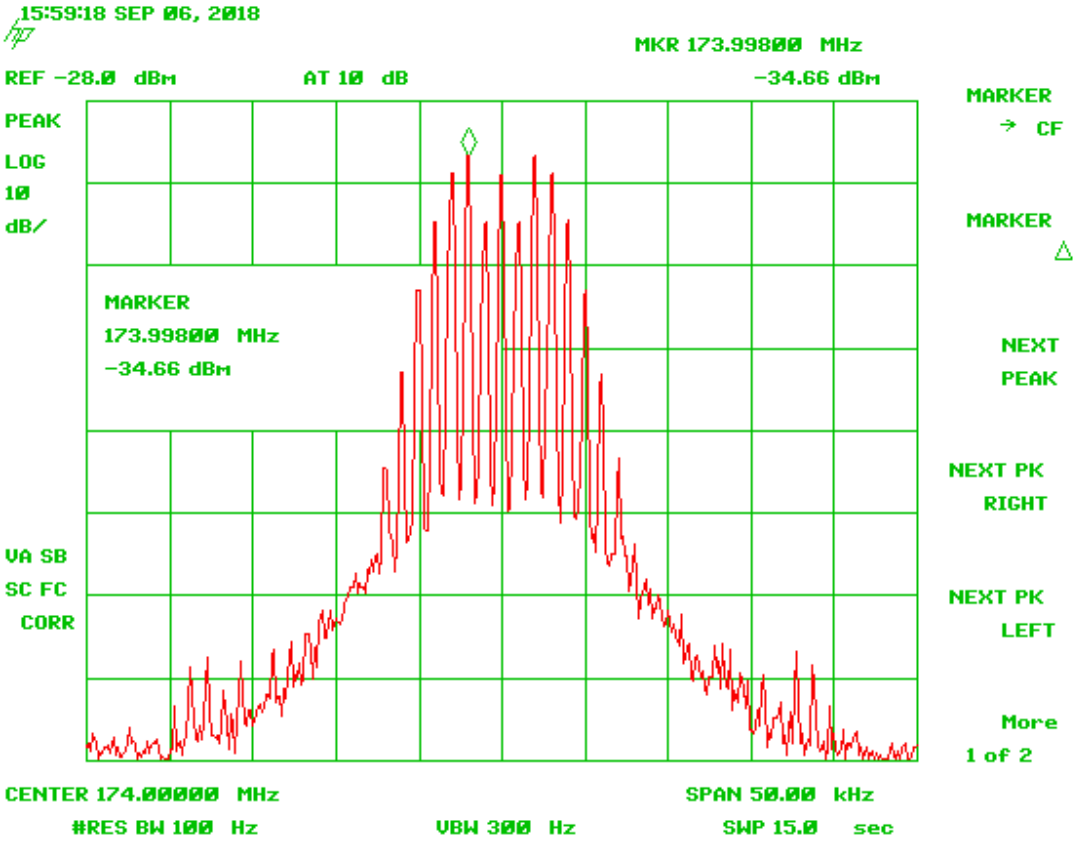

Figure 60. Input 174 MHz @ 12.5 kHz

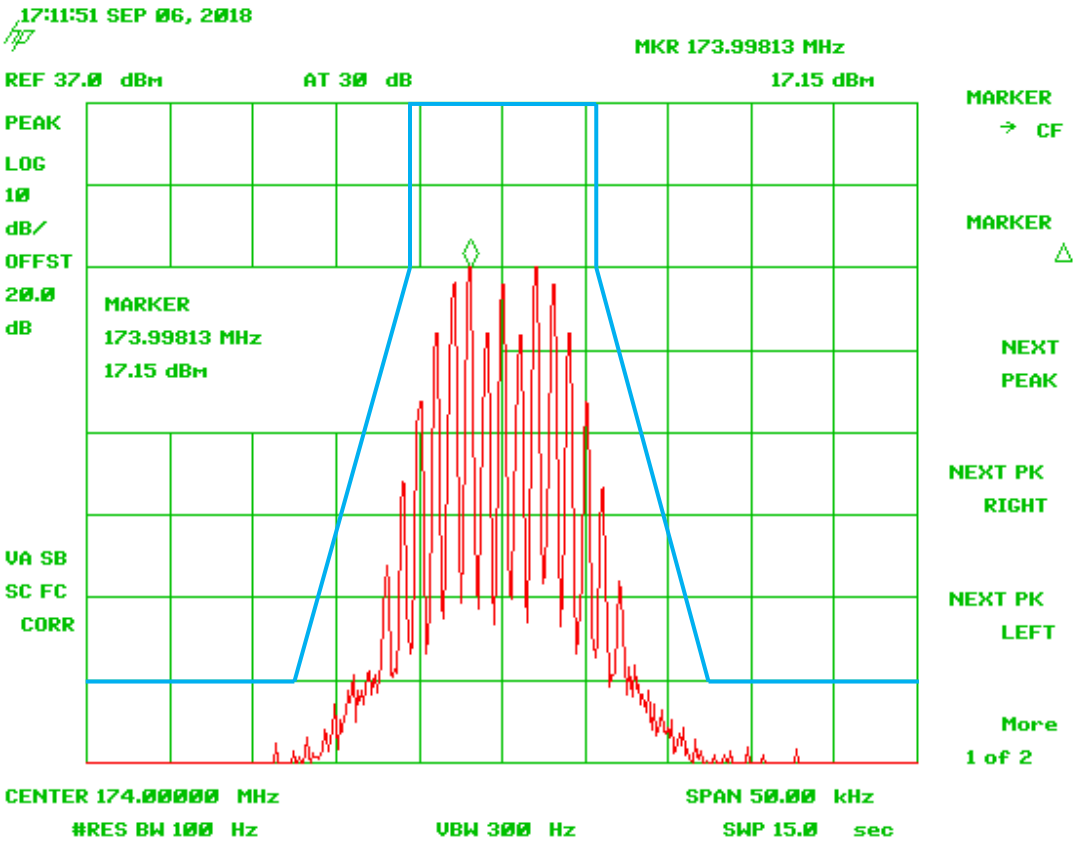

Figure 61. 174 MHz @ 12.5 kHz, Mask D

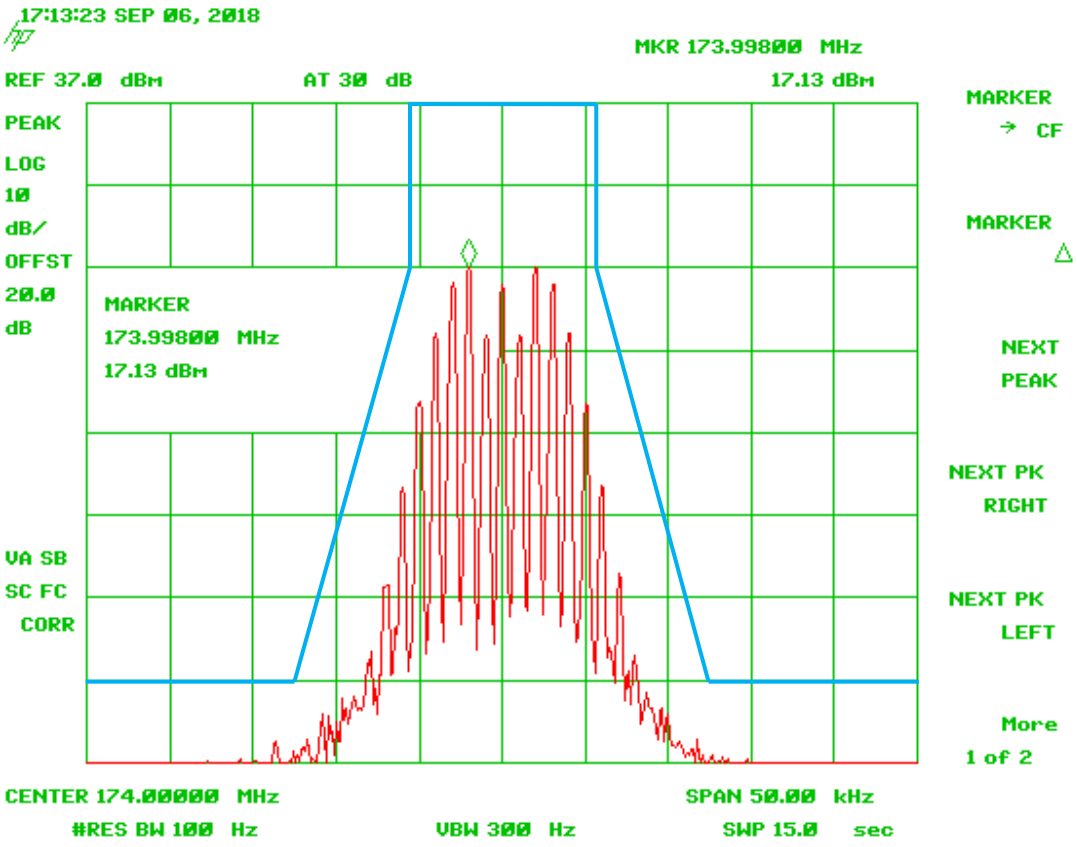

Figure 62. 174 MHz @ 12.5 kHz + 3.0 dB, Mask D

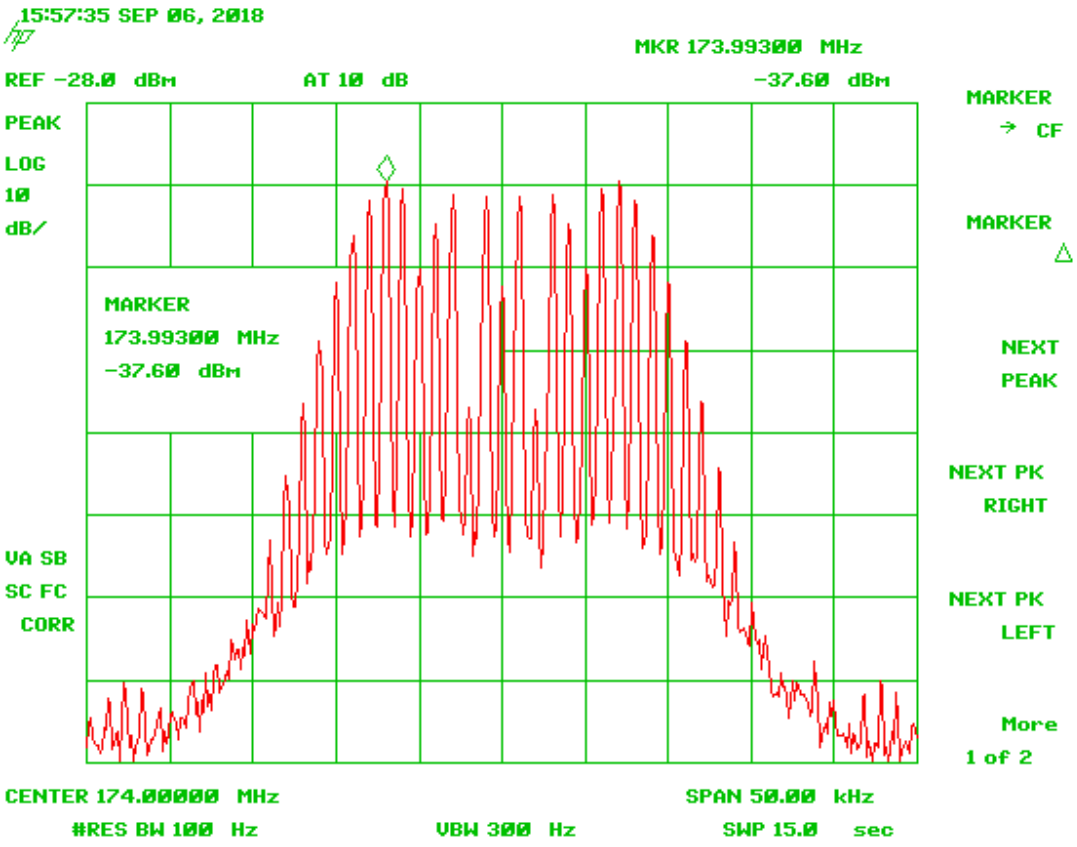

Figure 63. Input 174 MHz @ 25 kHz

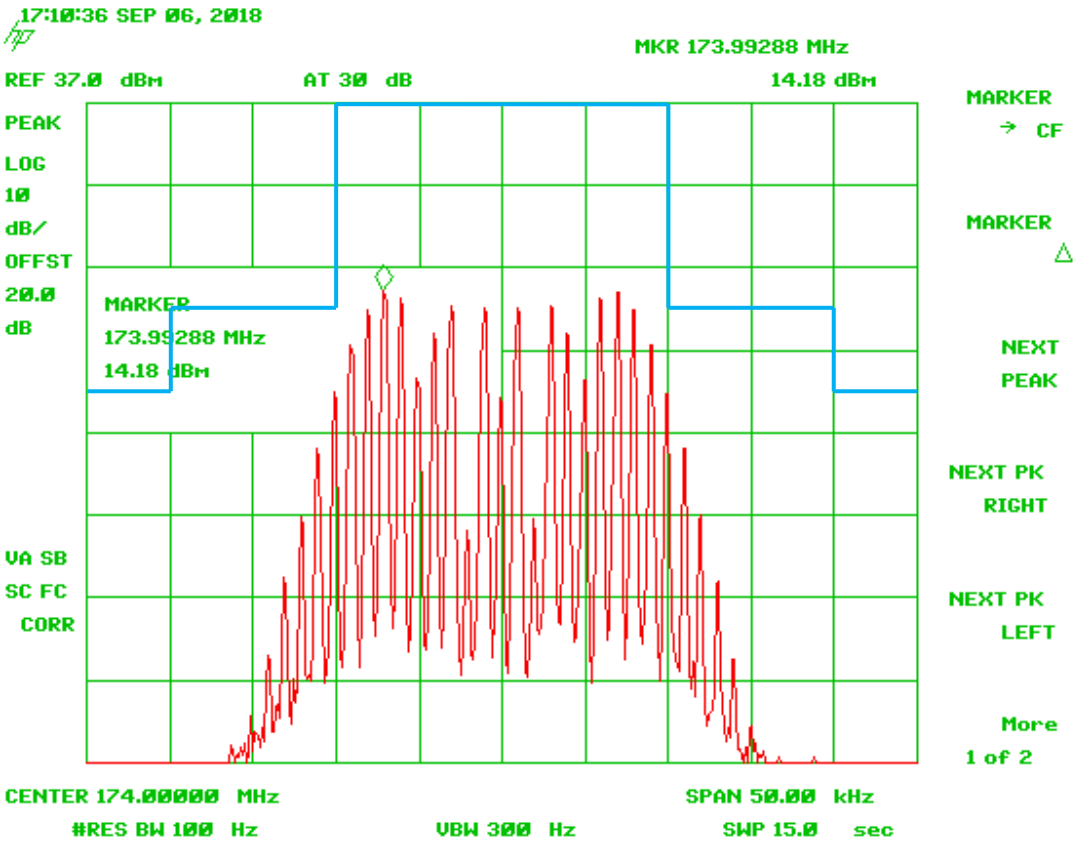

Figure 64. 174 MHz @ 25 kHz, Mask B

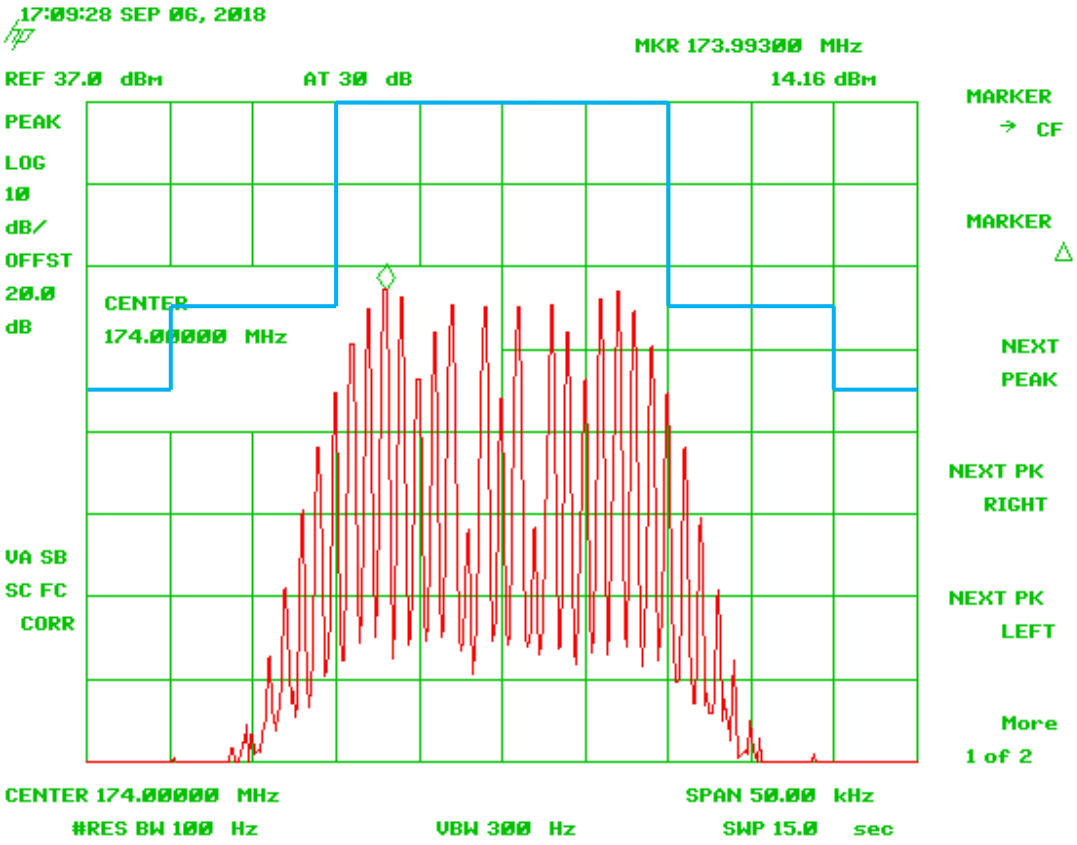

Figure 65. 174 MHz @ 25 kHz + 3.0 dB, Mask B

2.13.2 UHF Channels

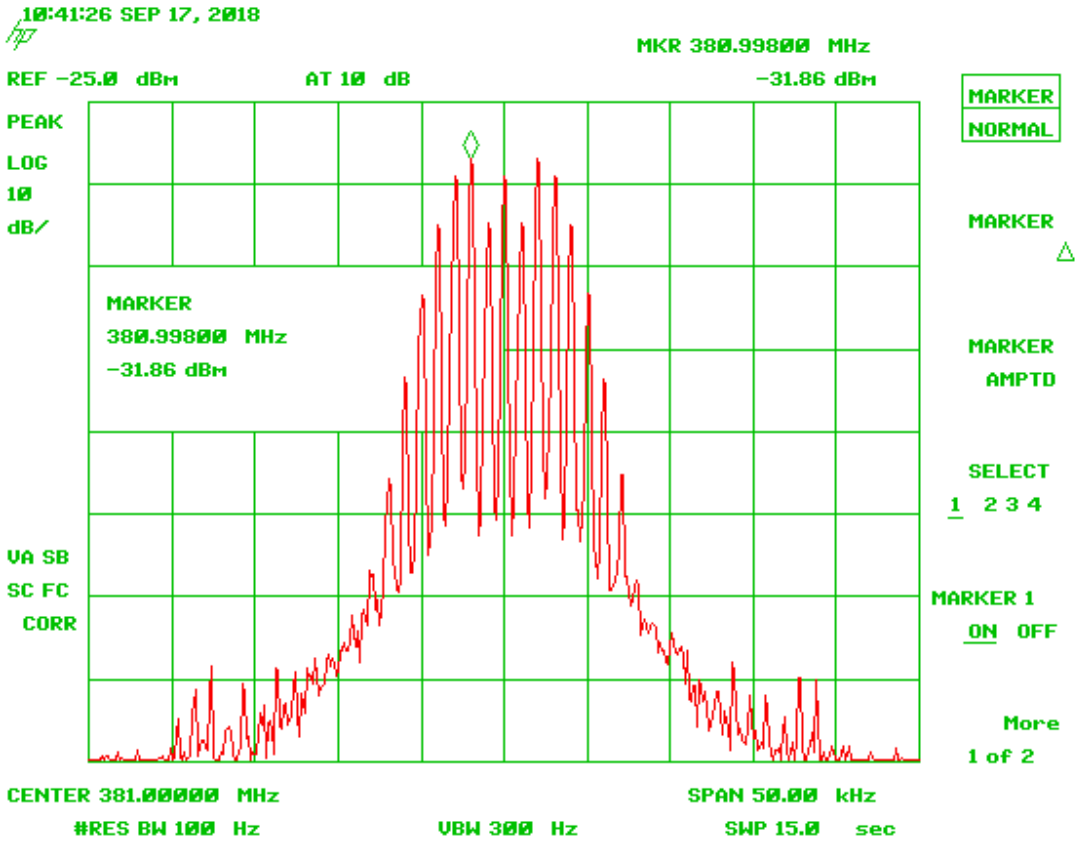

Figure 66. Input 381 MHz @ 12.5 kHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

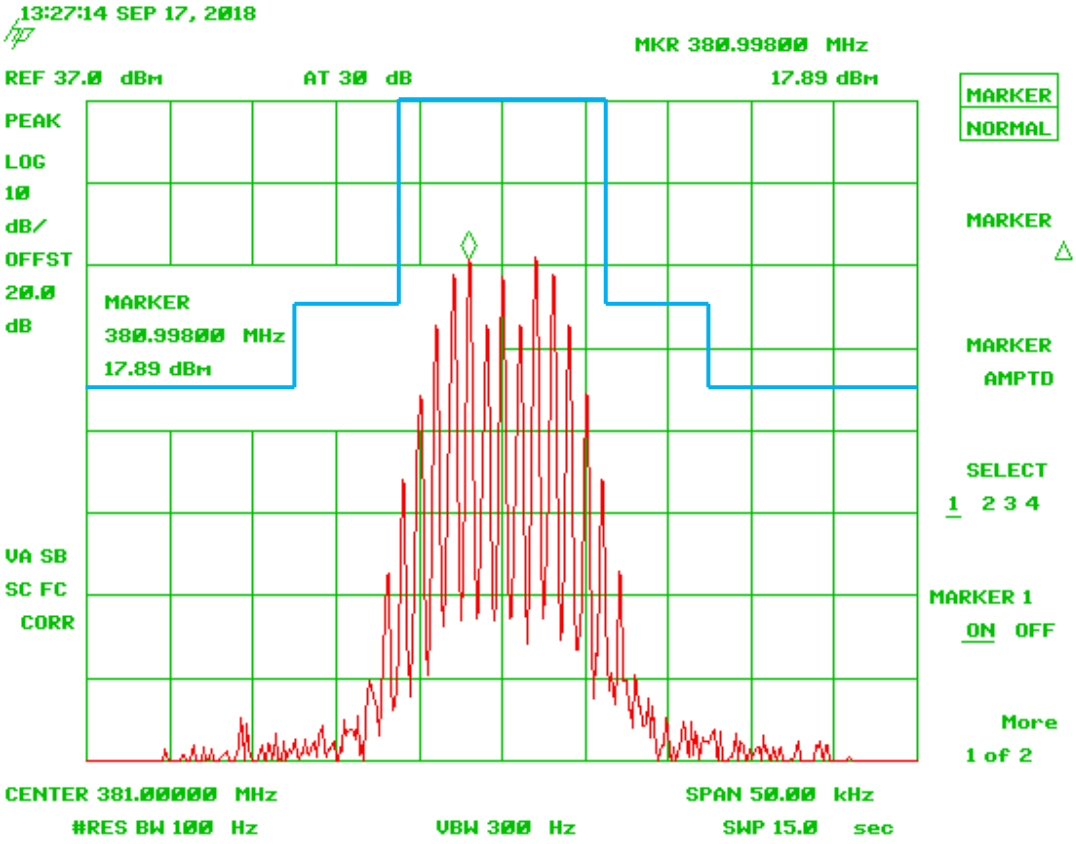

Figure 67. 381 MHz @ 12.5 kHz, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

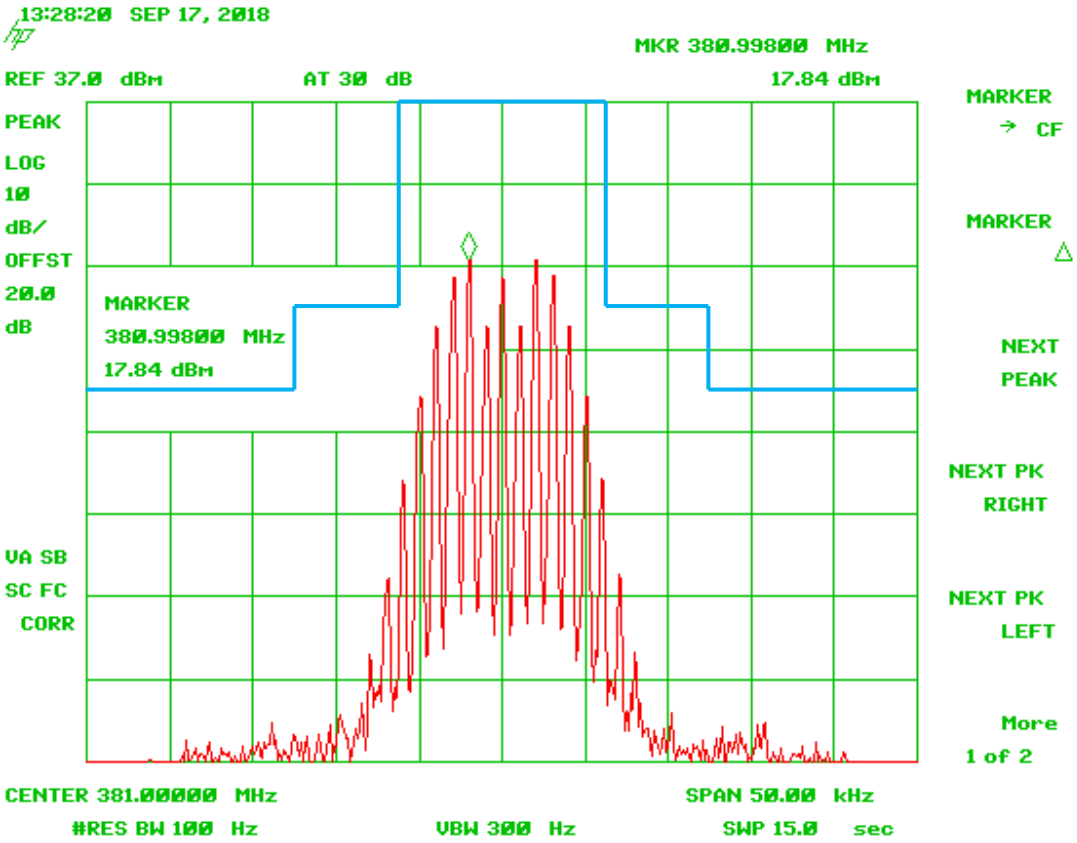

Figure 68. 381 MHz @ 12.5 kHz + 3.0 dB, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

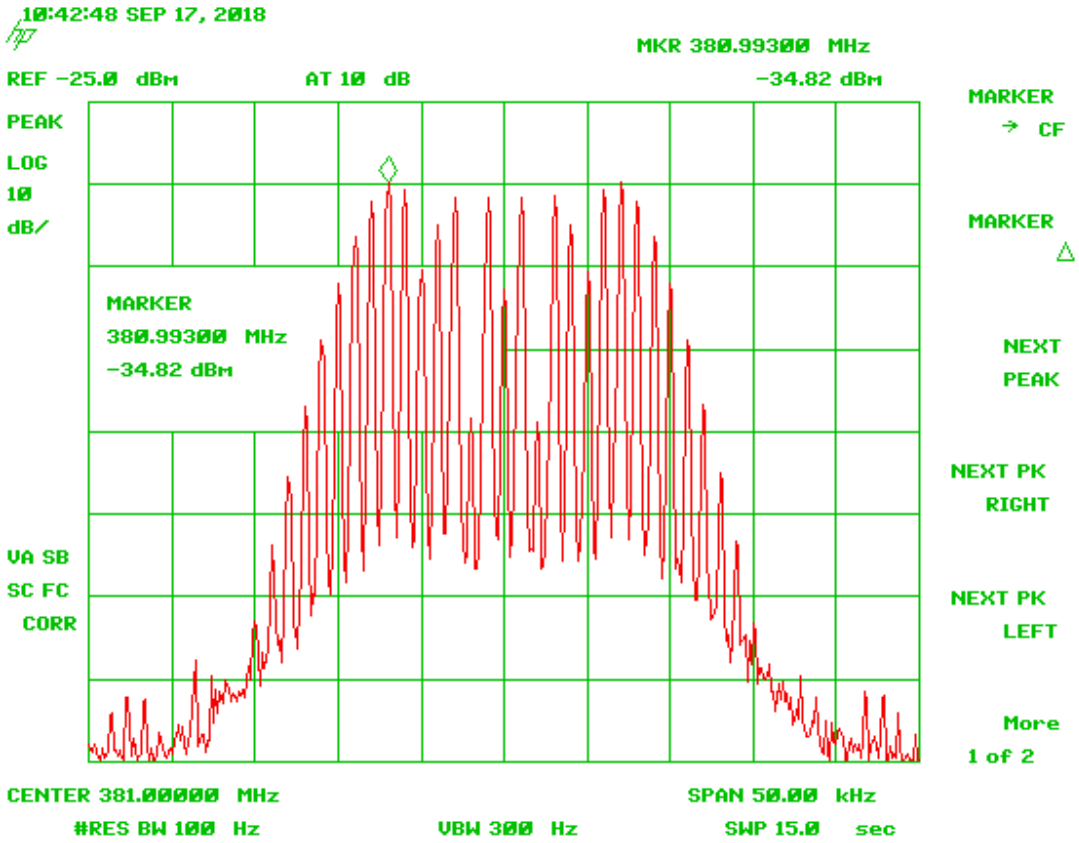

Figure 69. Input 381 MHz @ 25 kHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

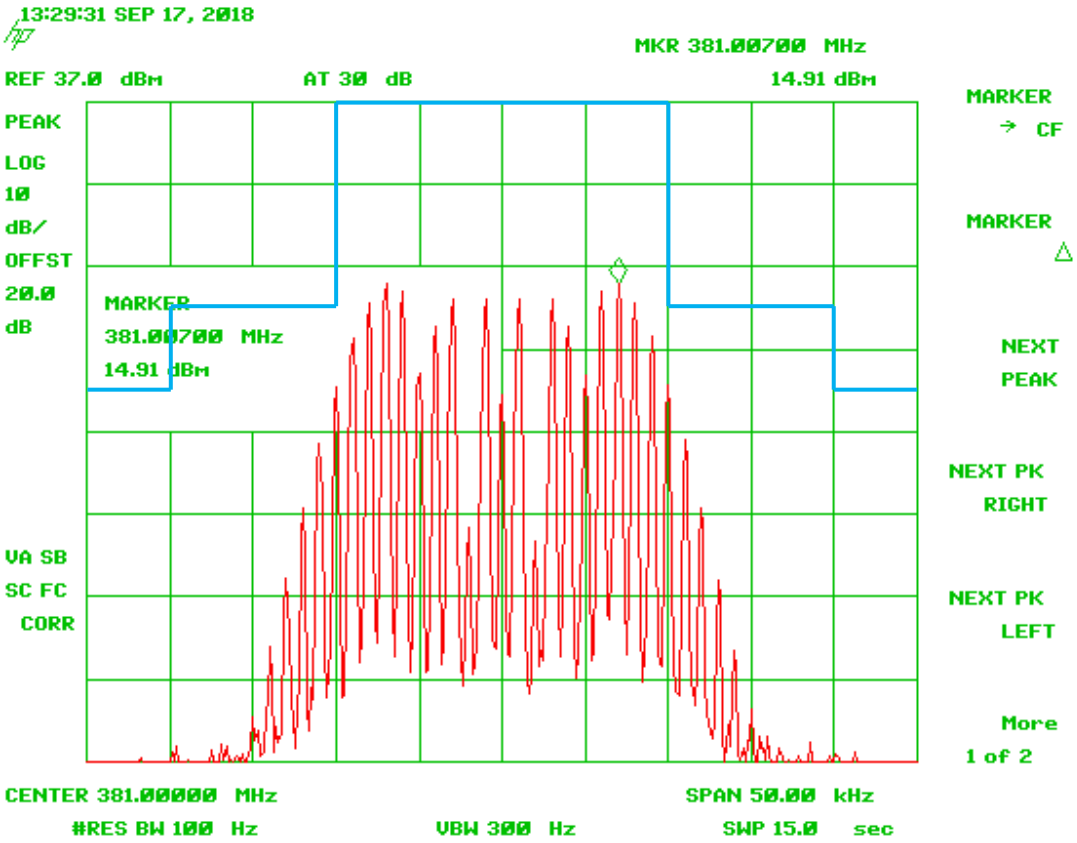

Figure 70. 381 MHz @ 25 kHz, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

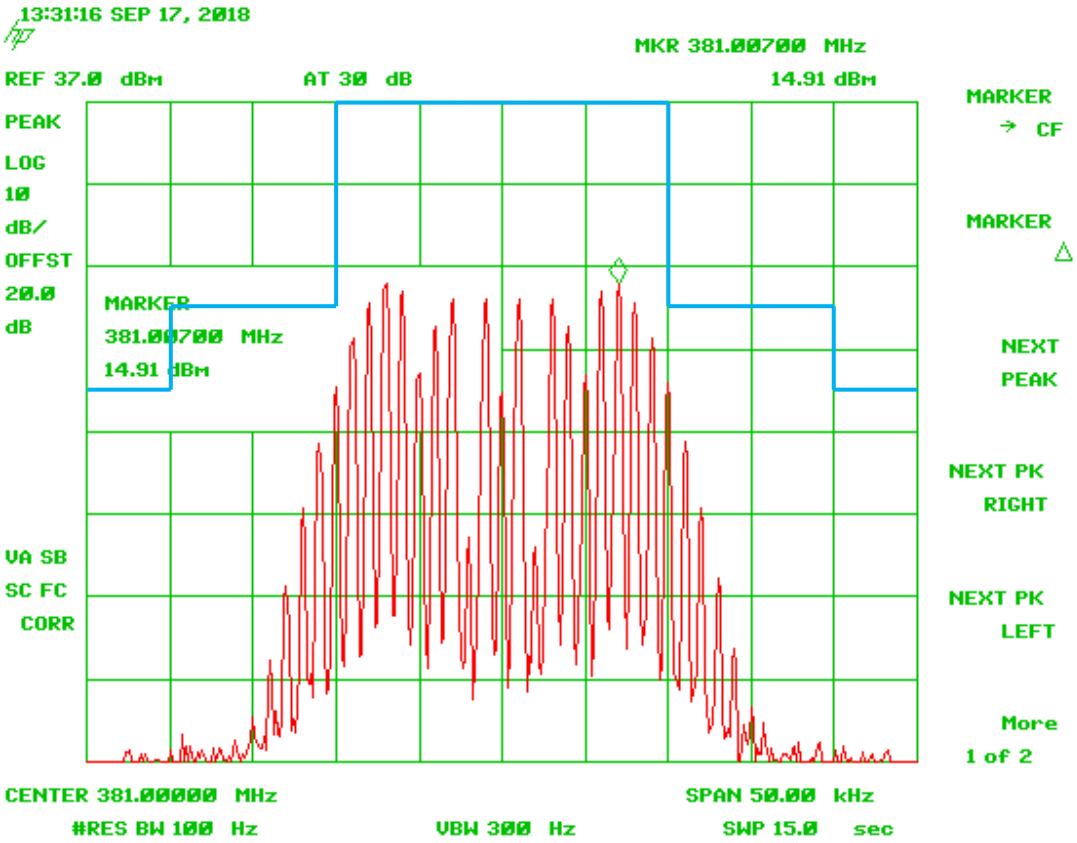

Figure 71. 381 MHz @ 25 kHz + 3.0 dB, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

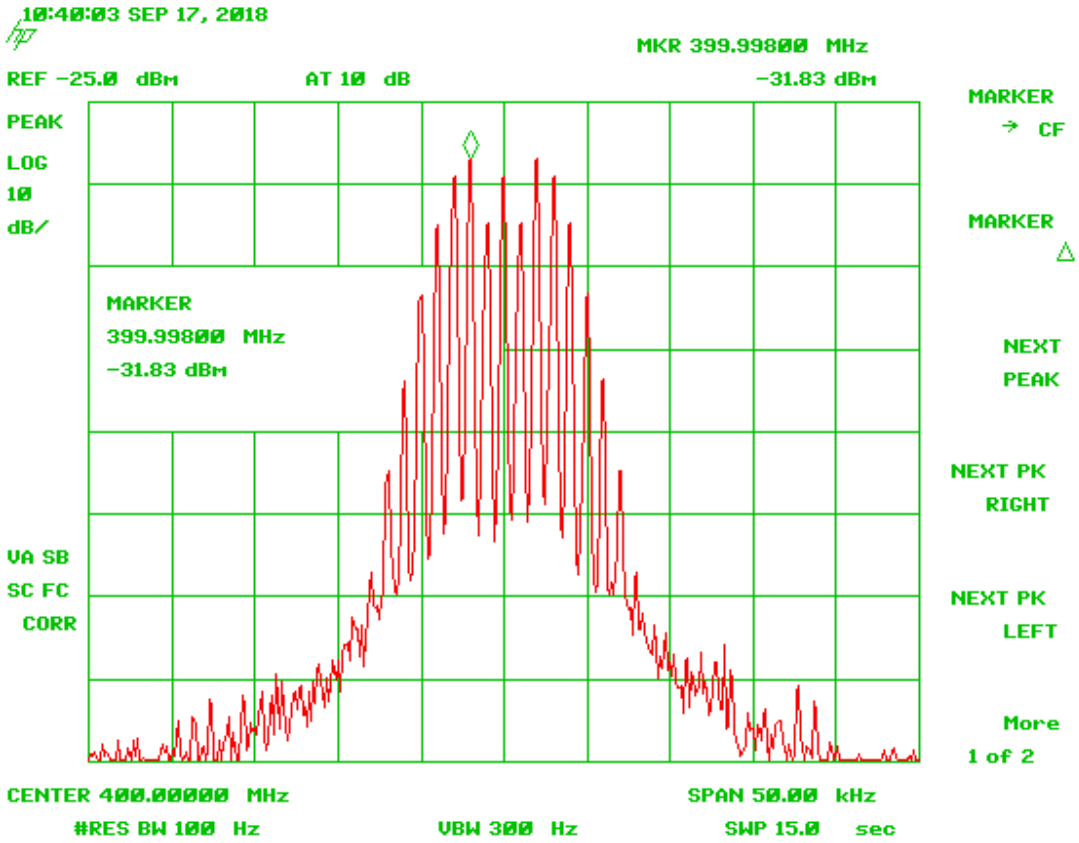

Figure 72. Input 400 MHz @ 12.5 kHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

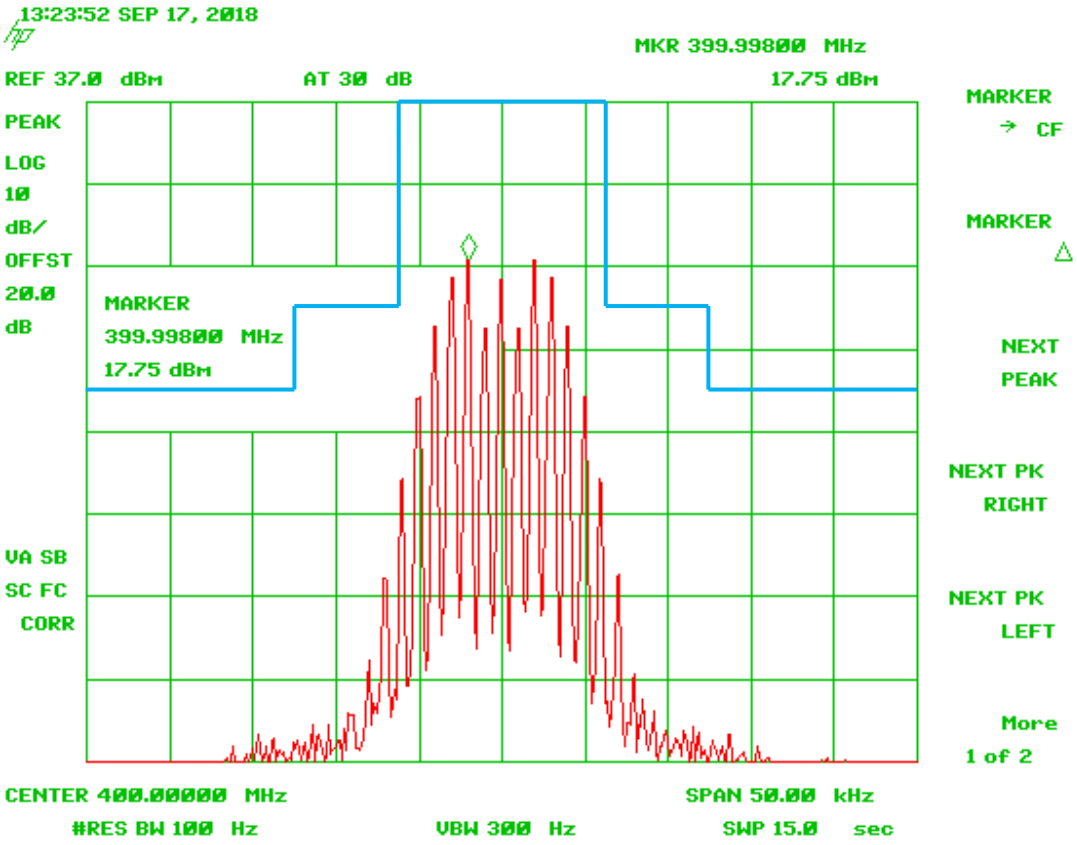

Figure 73. 400 MHz @ 12.5 kHz, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

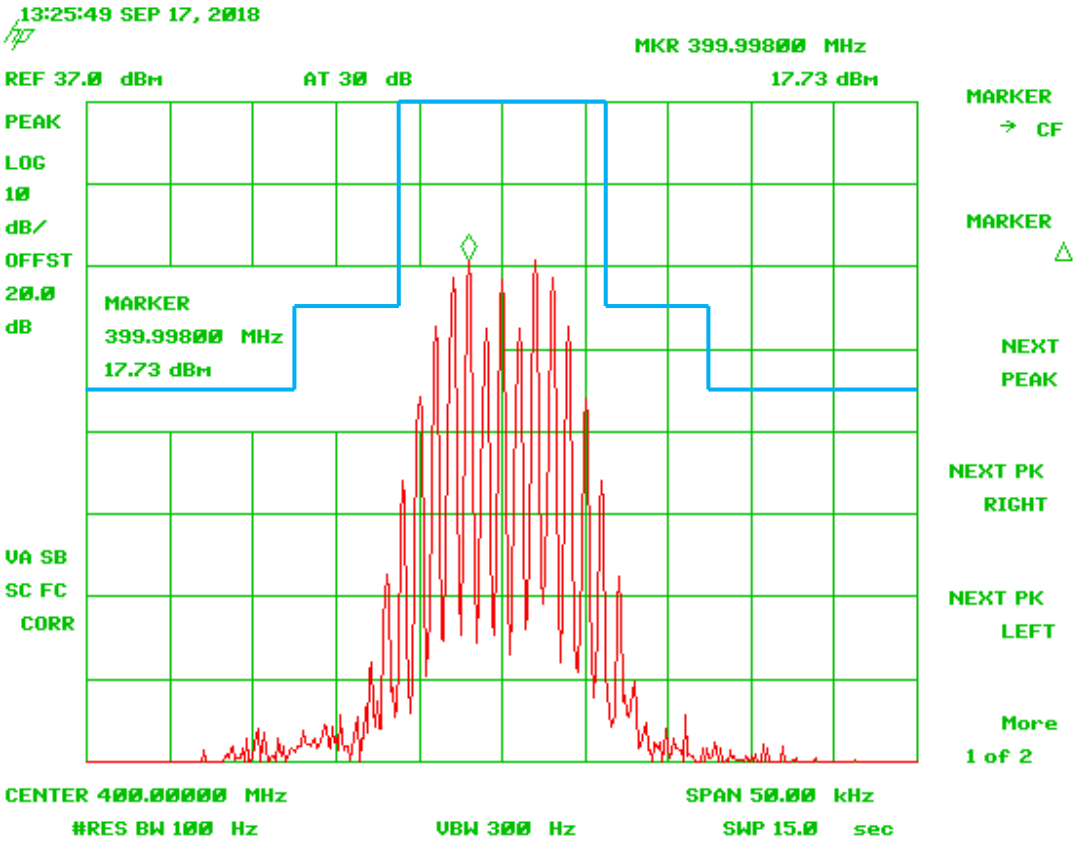

Figure 74. 400 MHz @ 12.5 kHz + 3.0 dB, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

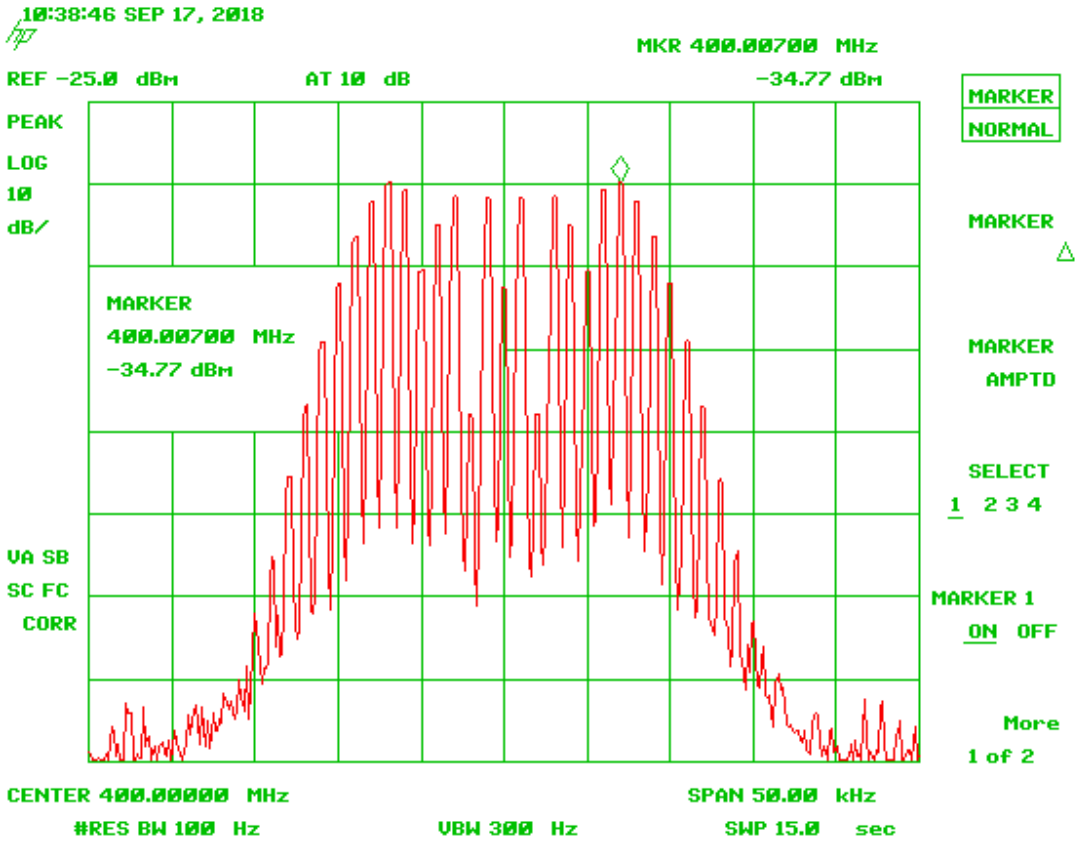

Figure 75. Input 400 MHz @ 25 kHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

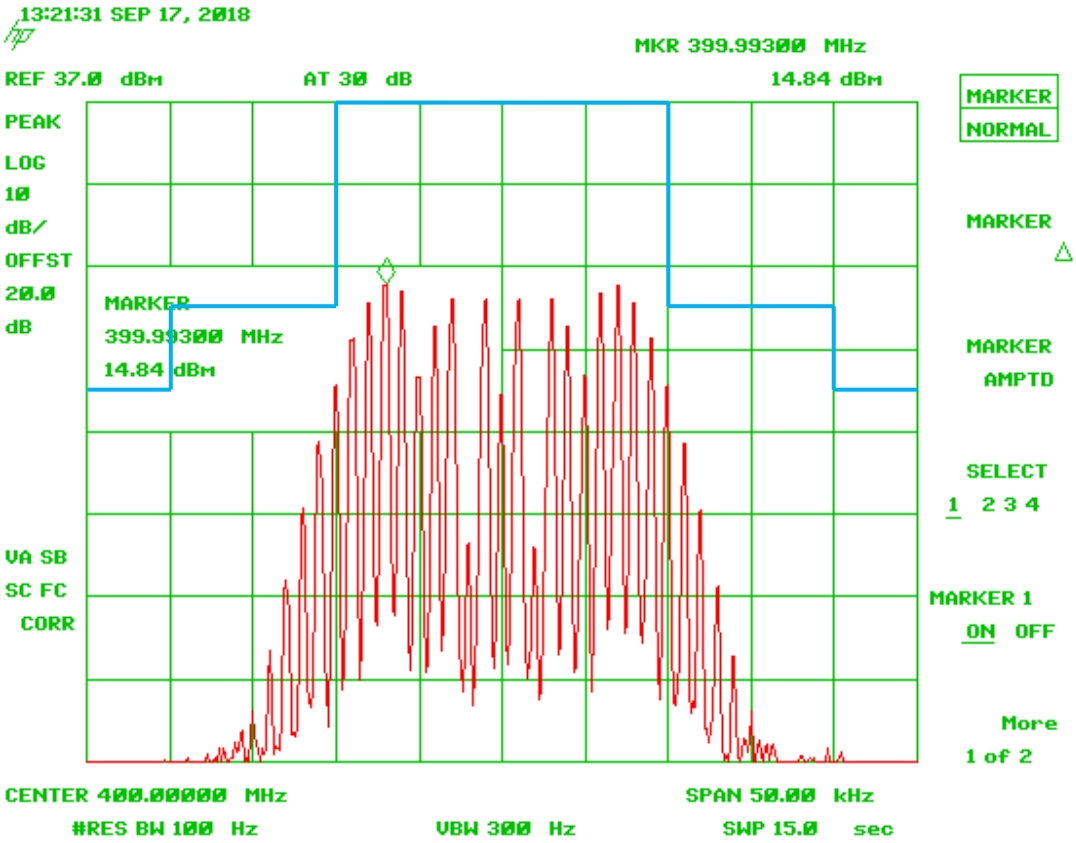

Figure 76. 400 MHz @ 25 kHz, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

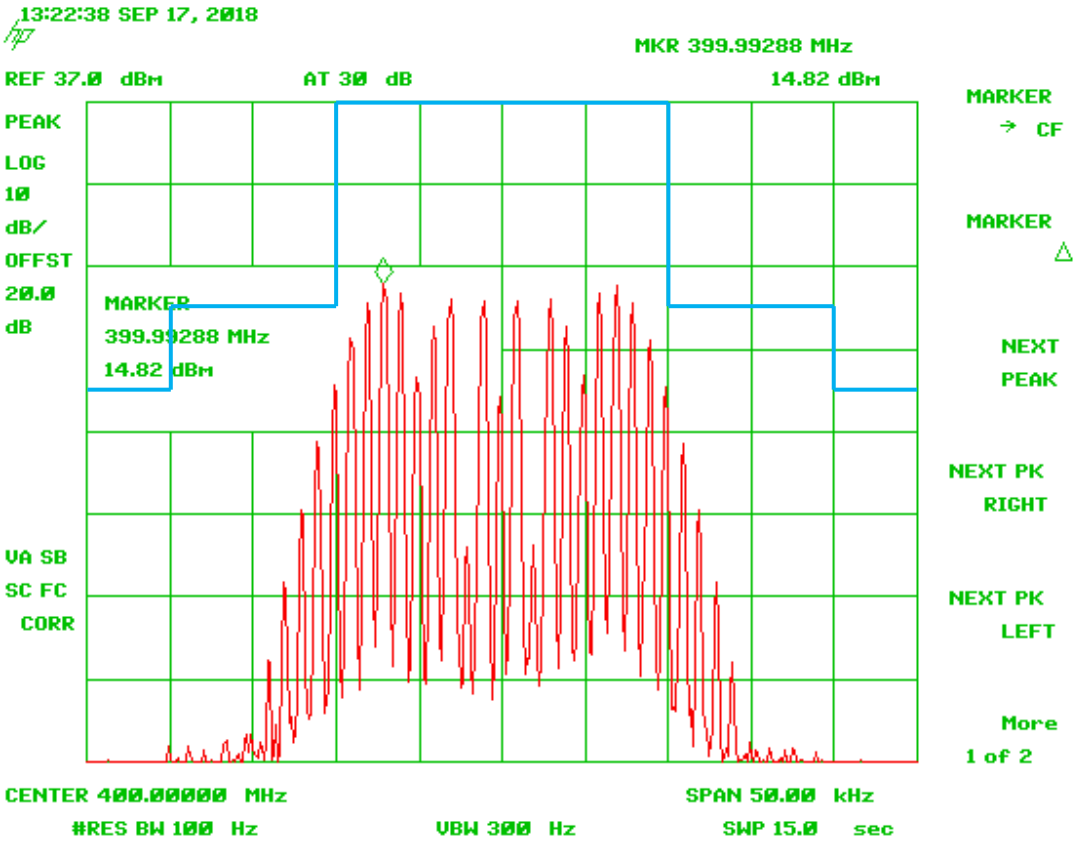

Figure 77. 400 MHz @ 25 kHz + 3.0 dB, Mask B

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

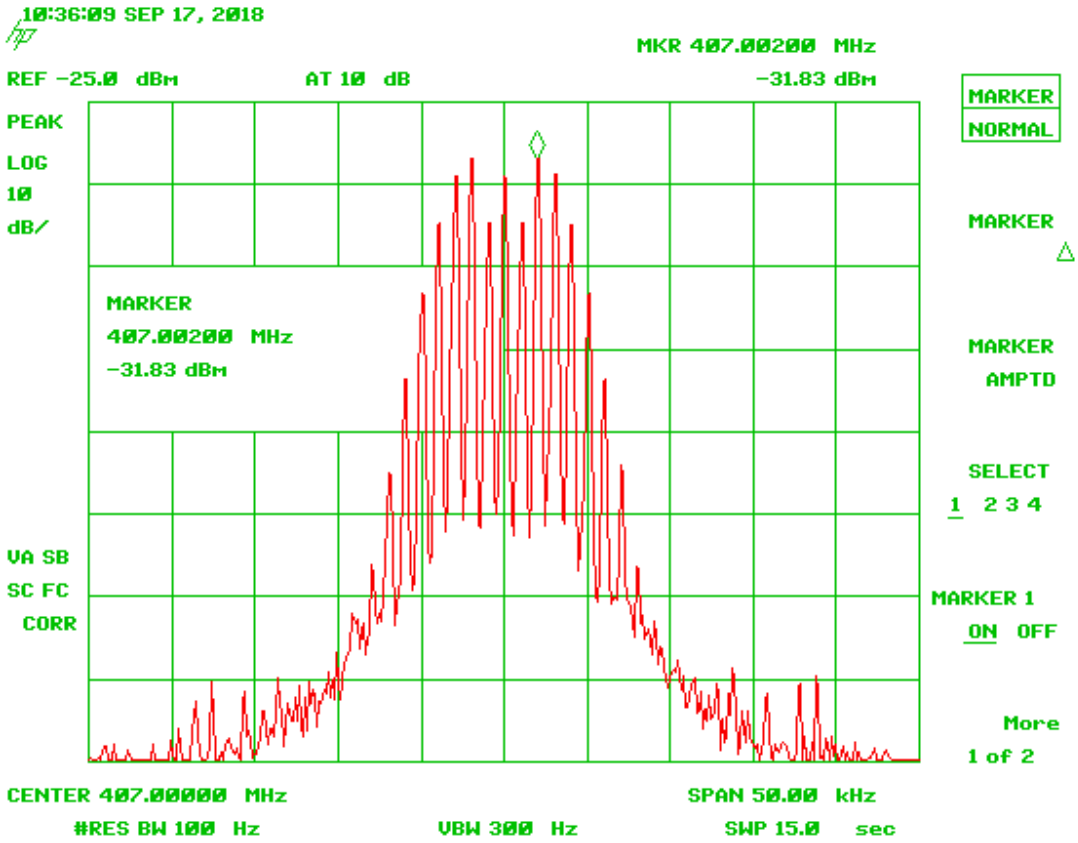

Figure 78. Input 407 MHz @ 12.5 kHz

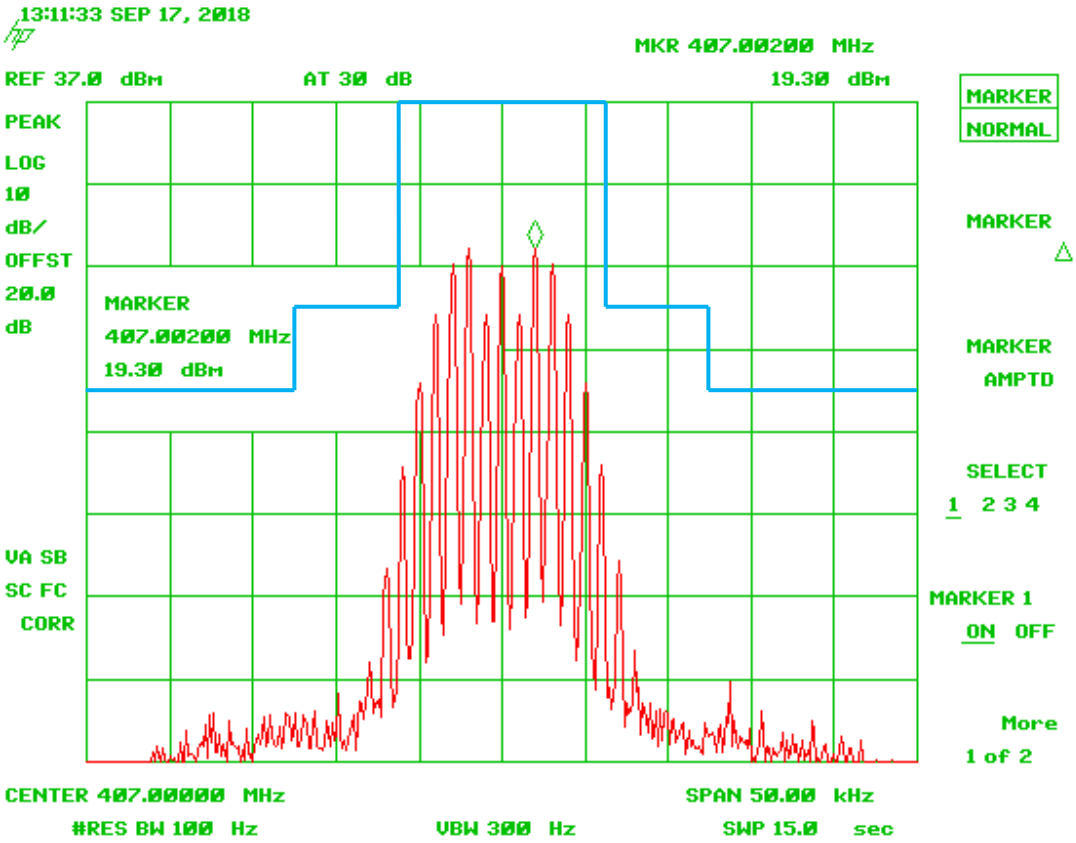

Figure 79. 407 MHz @ 12.5 kHz, Mask B

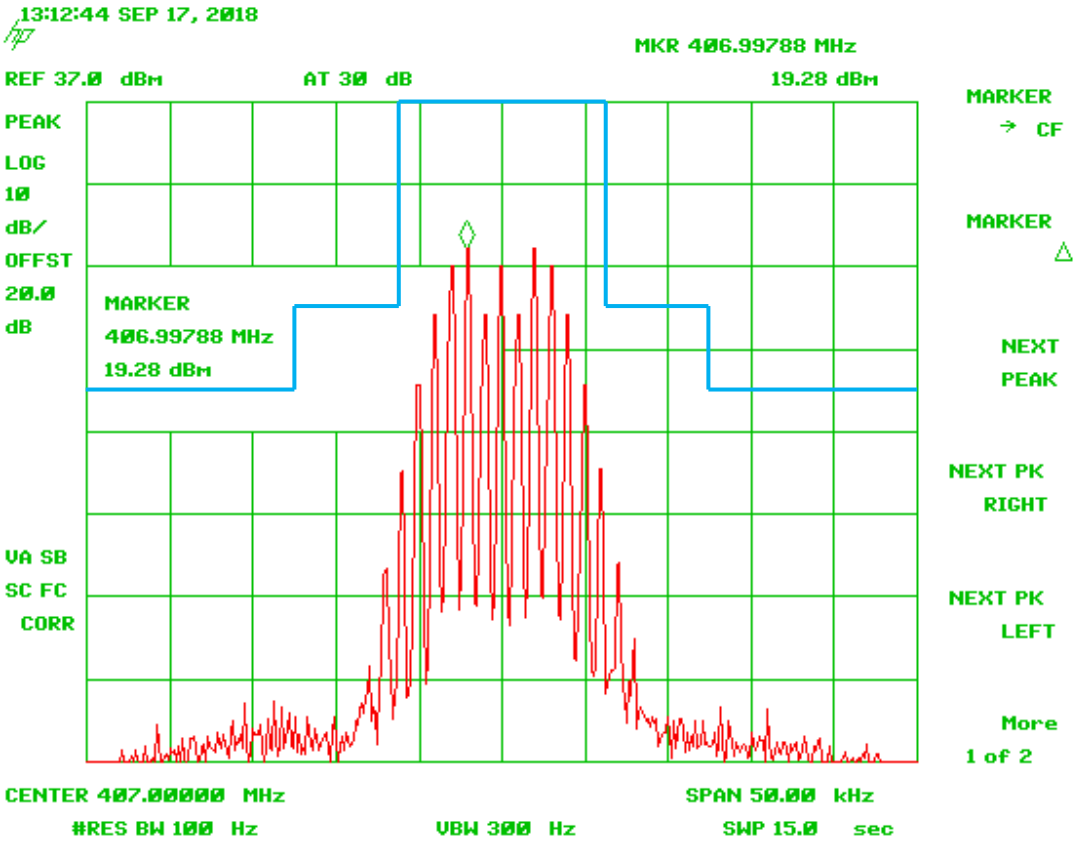

Figure 80. 407 MHz @ 12.5 kHz + 3.0 dB, Mask B

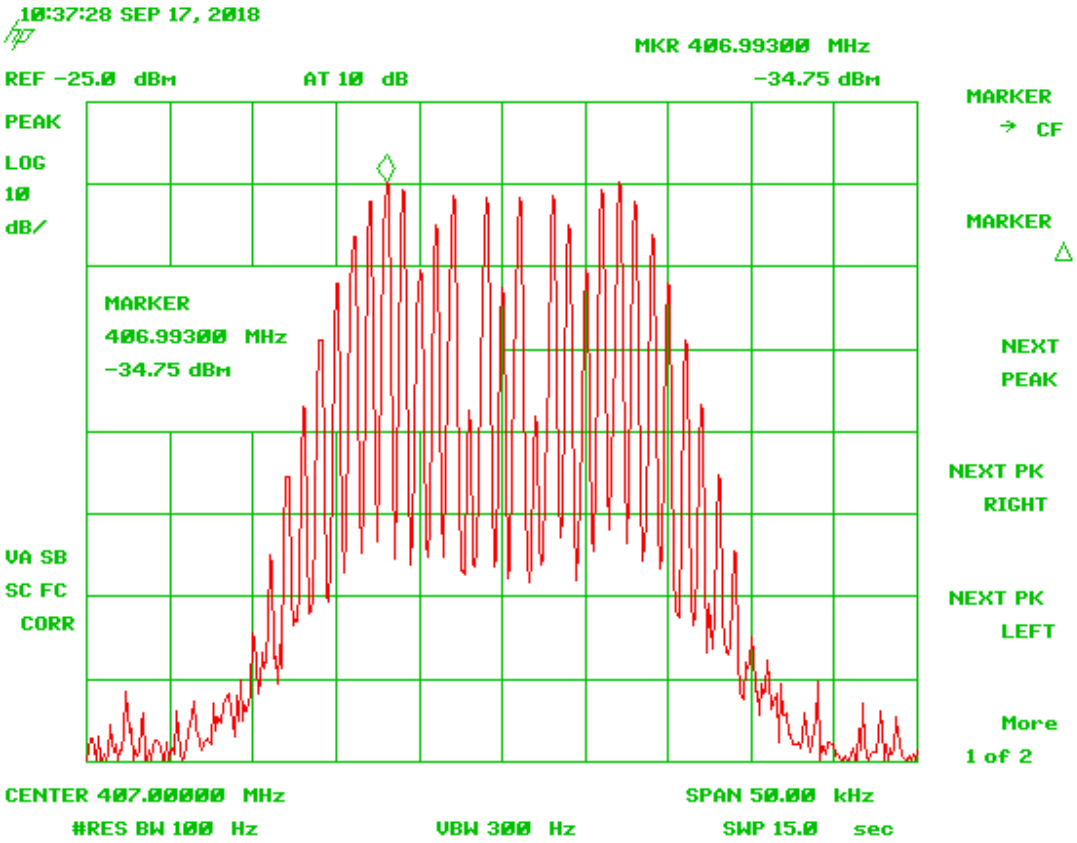

Figure 81. Input 407 MHz @ 25 kHz

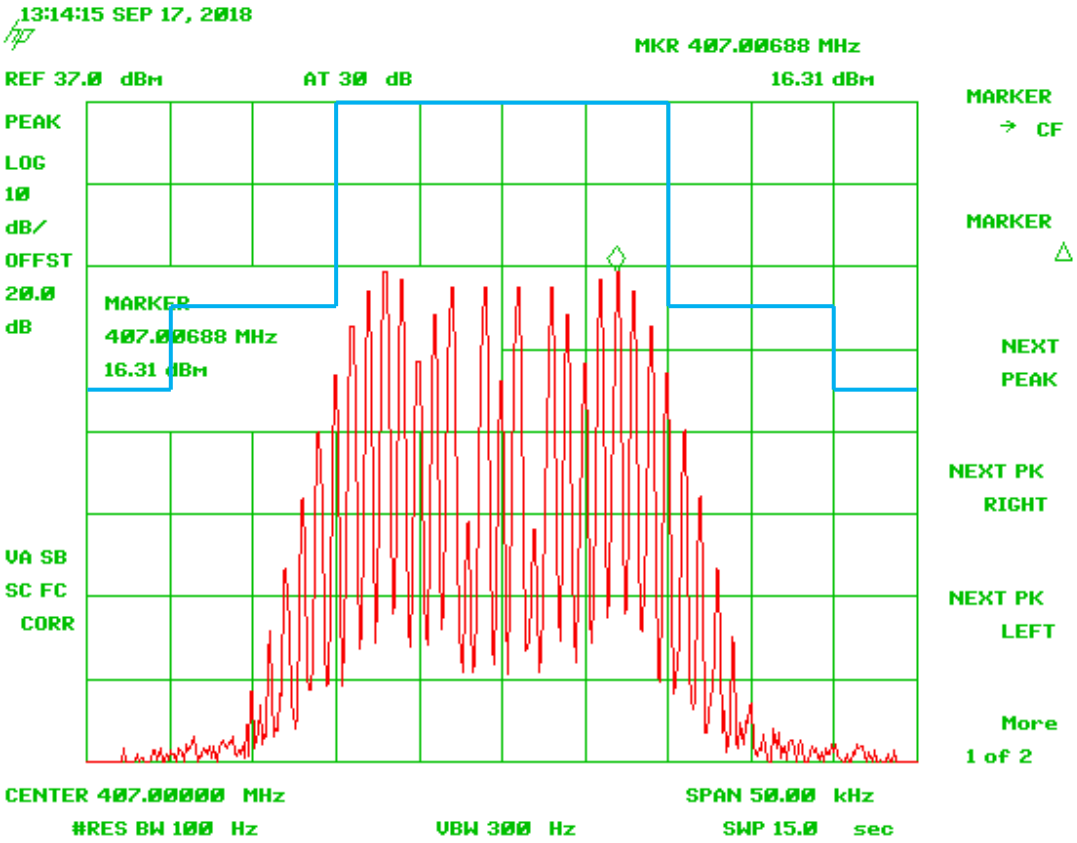

Figure 82. 407 MHz @ 25 kHz, Mask B

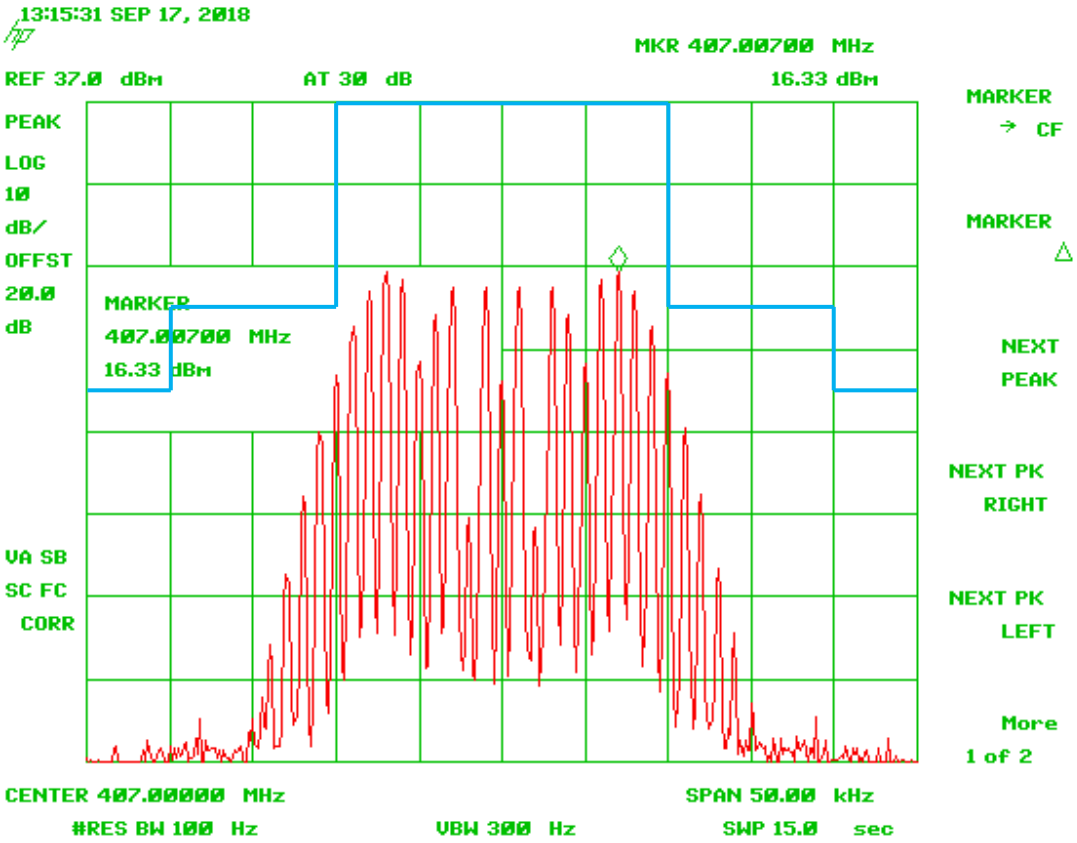

Figure 83. 407 MHz @ 25 kHz + 3.0 dB, Mask B

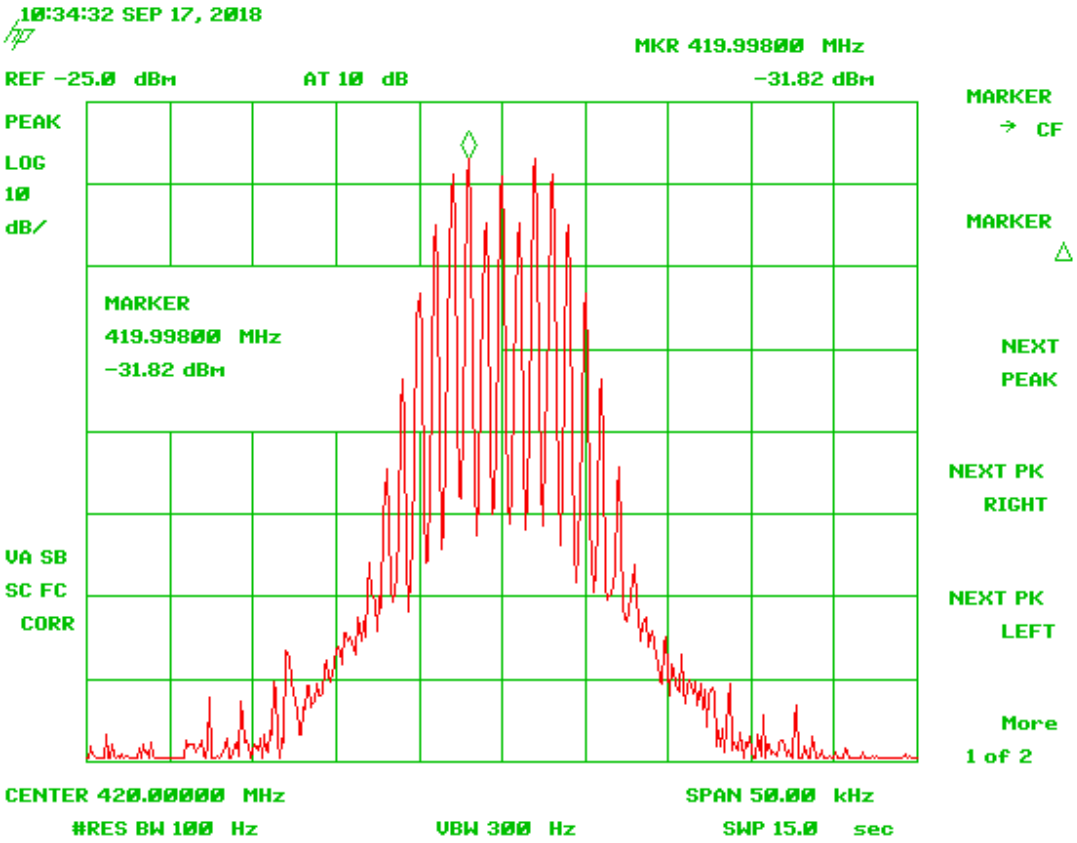

Figure 84. Input 420 MHz @ 12.5 kHz

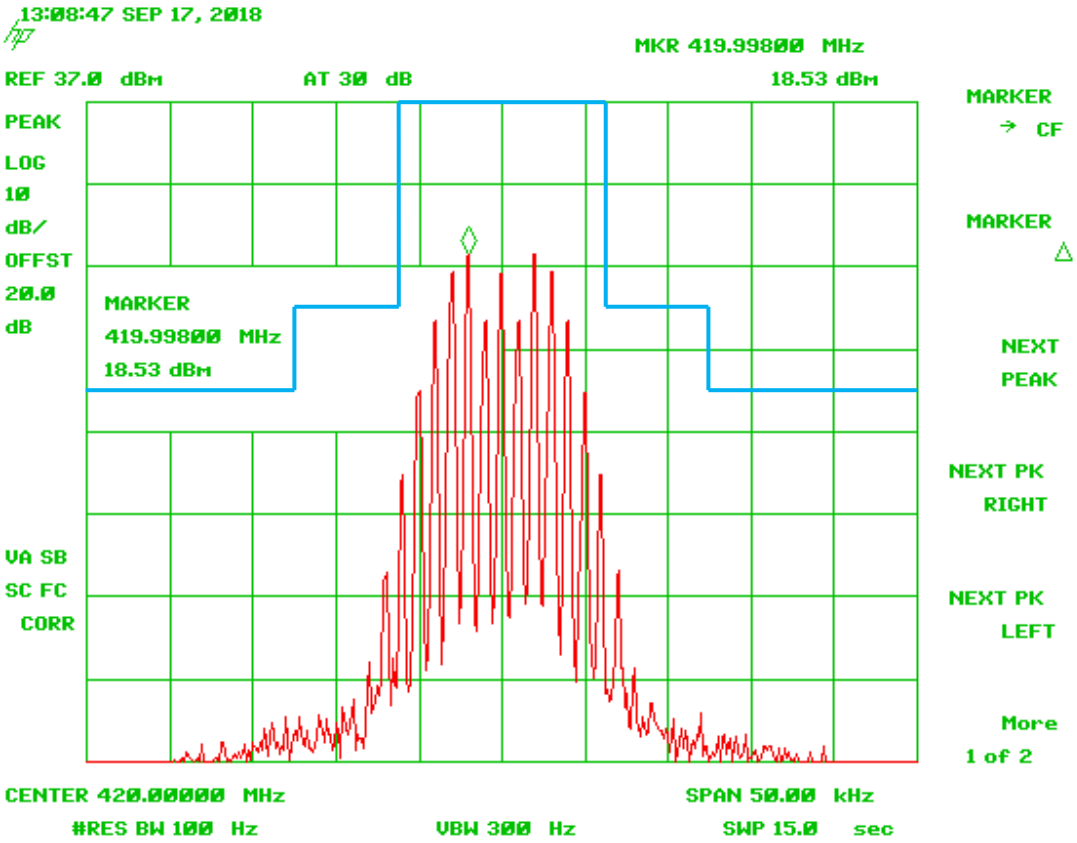

Figure 85. 420 MHz @ 12.5 kHz, Mask B

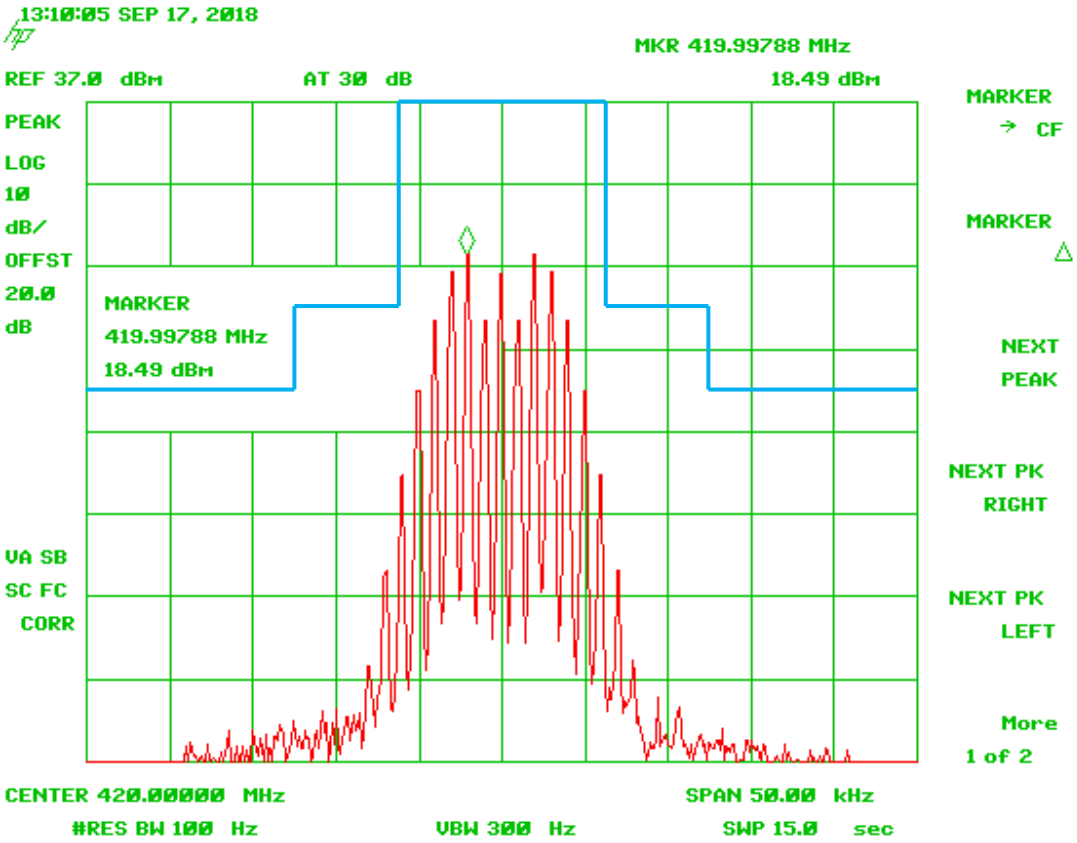

Figure 86. 420 MHz @ 12.5 kHz + 3.0 dB, Mask B

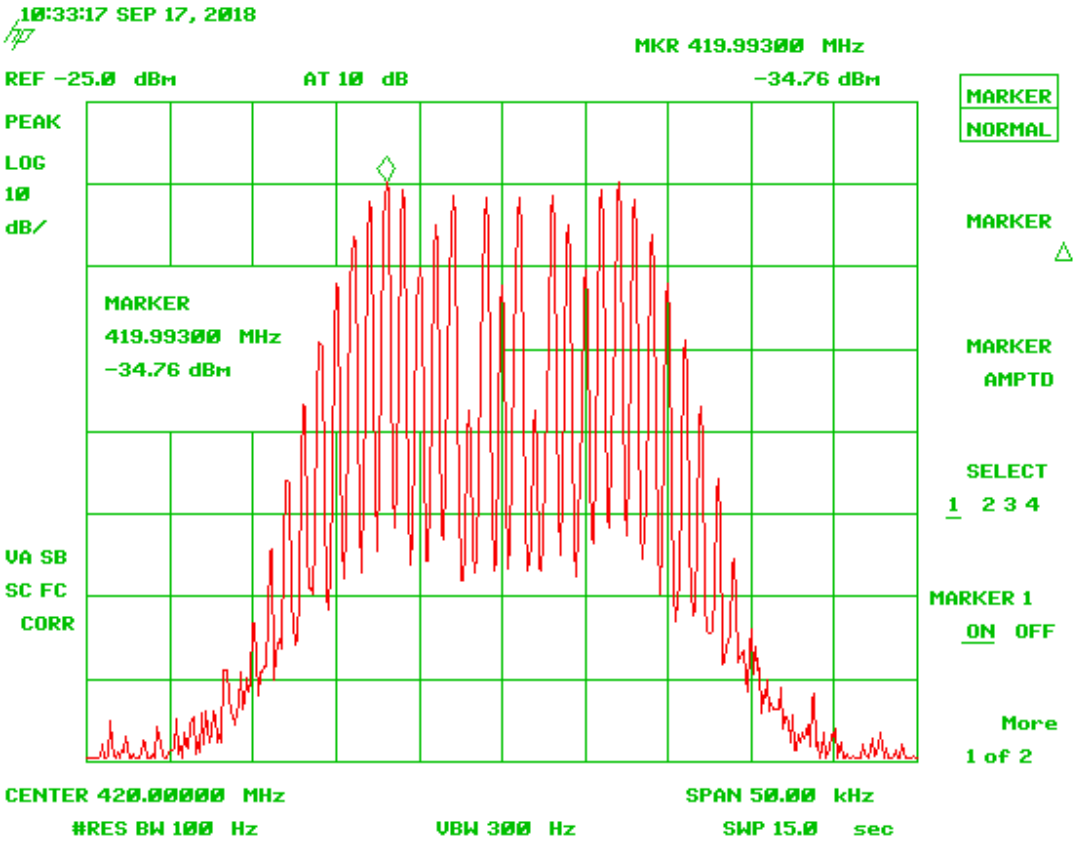

Figure 87. Input 420 MHz @ 25 kHz

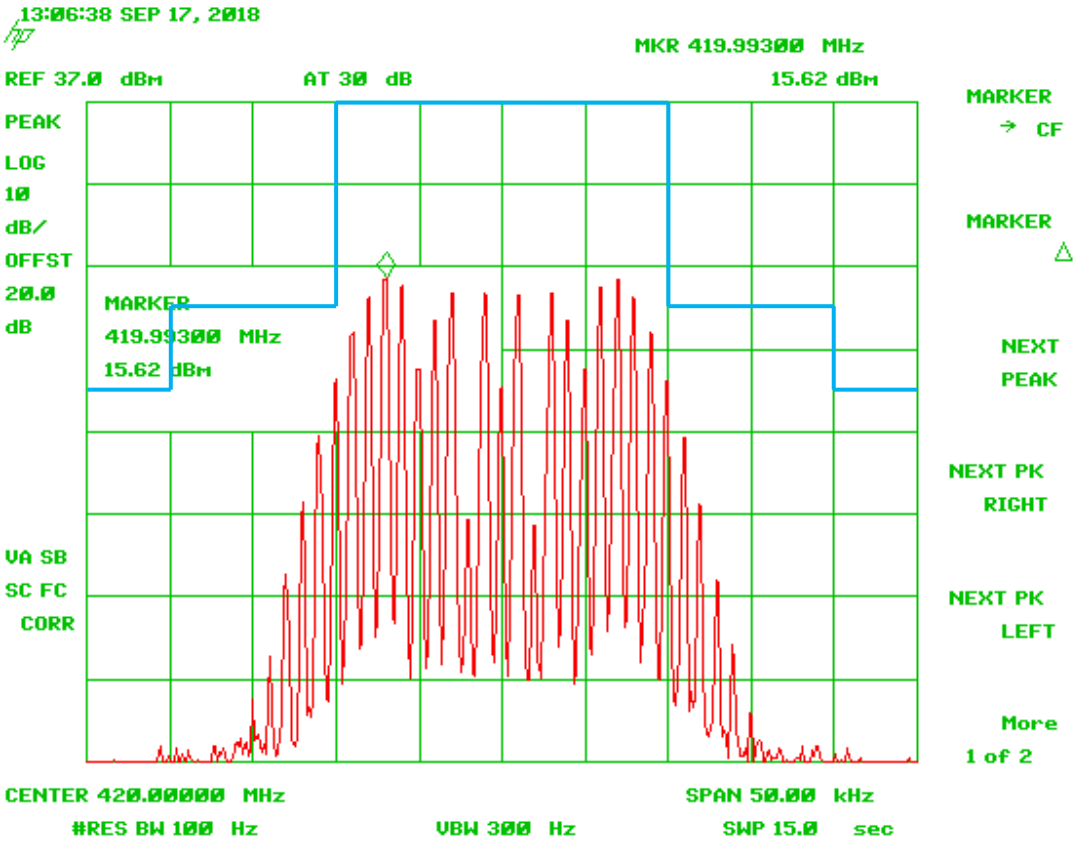

Figure 88. 420 MHz @ 25 kHz, Mask B

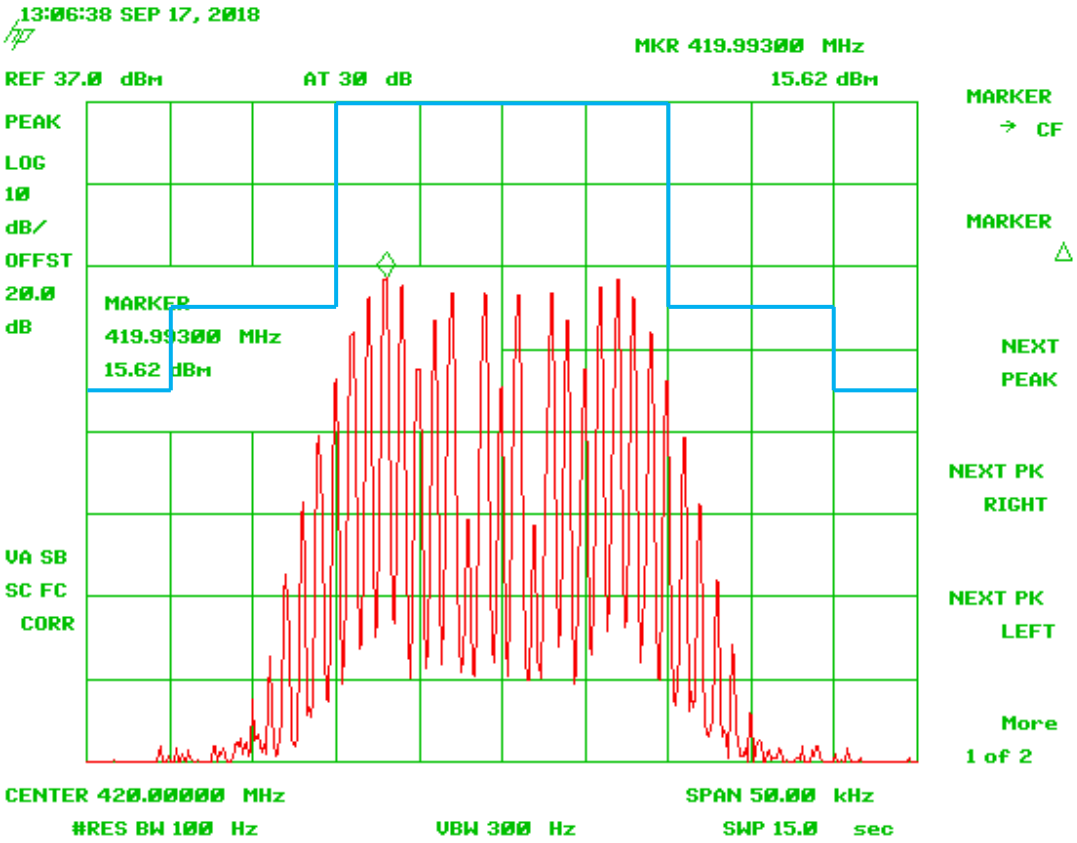

Figure 89. 420 MHz @ 25 kHz + 3.0 dB, Mask B

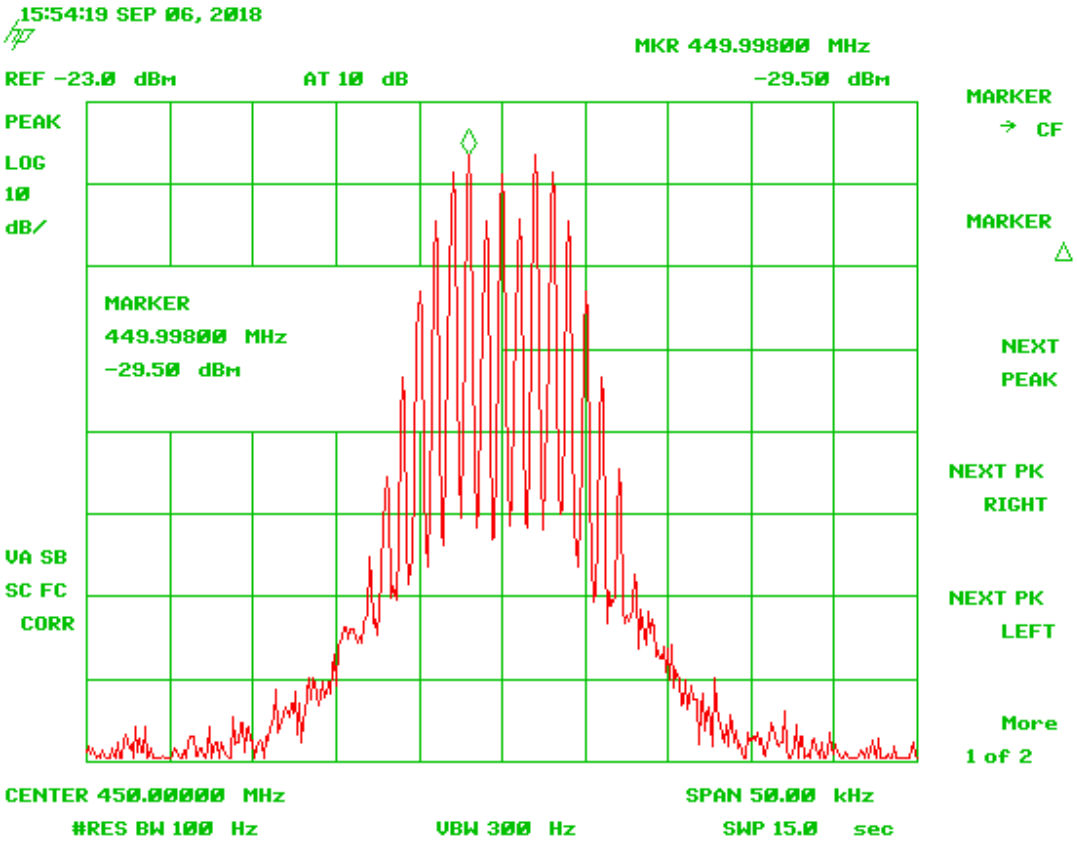

Figure 90. Input 450 MHz @ 12.5 kHz

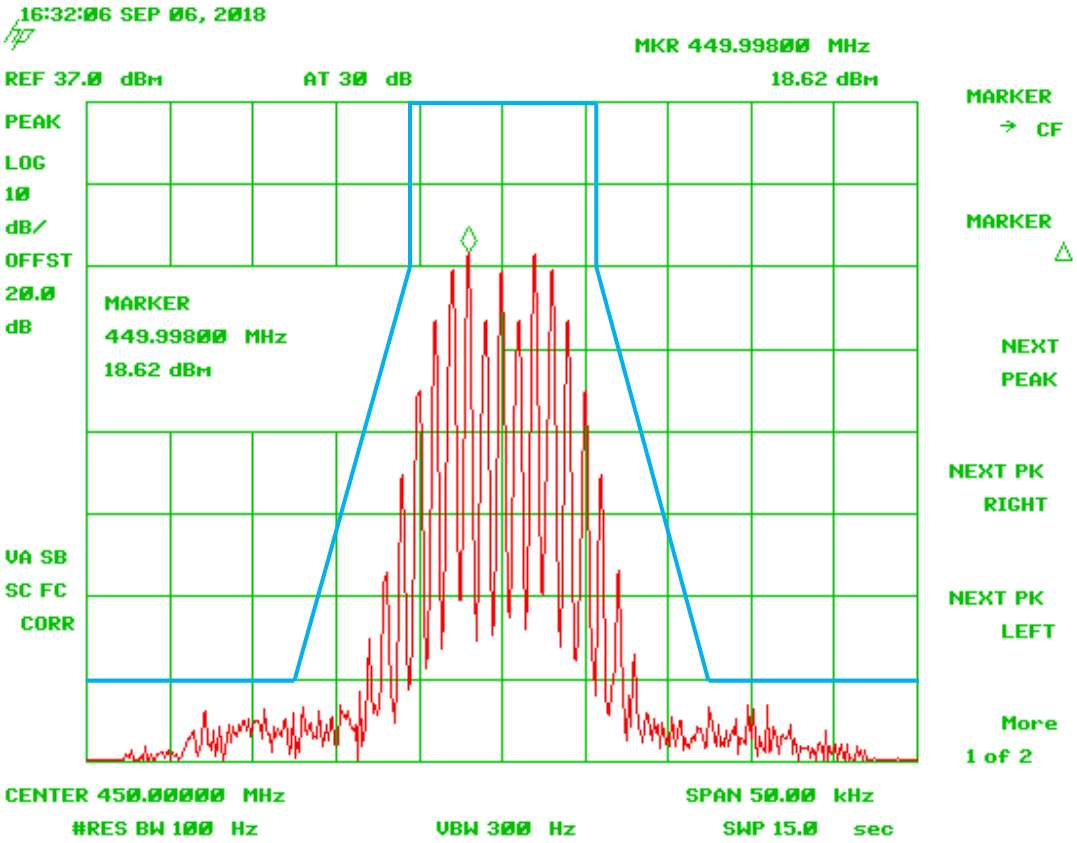

Figure 91. 450 MHz @ 12.5 kHz, Mask D

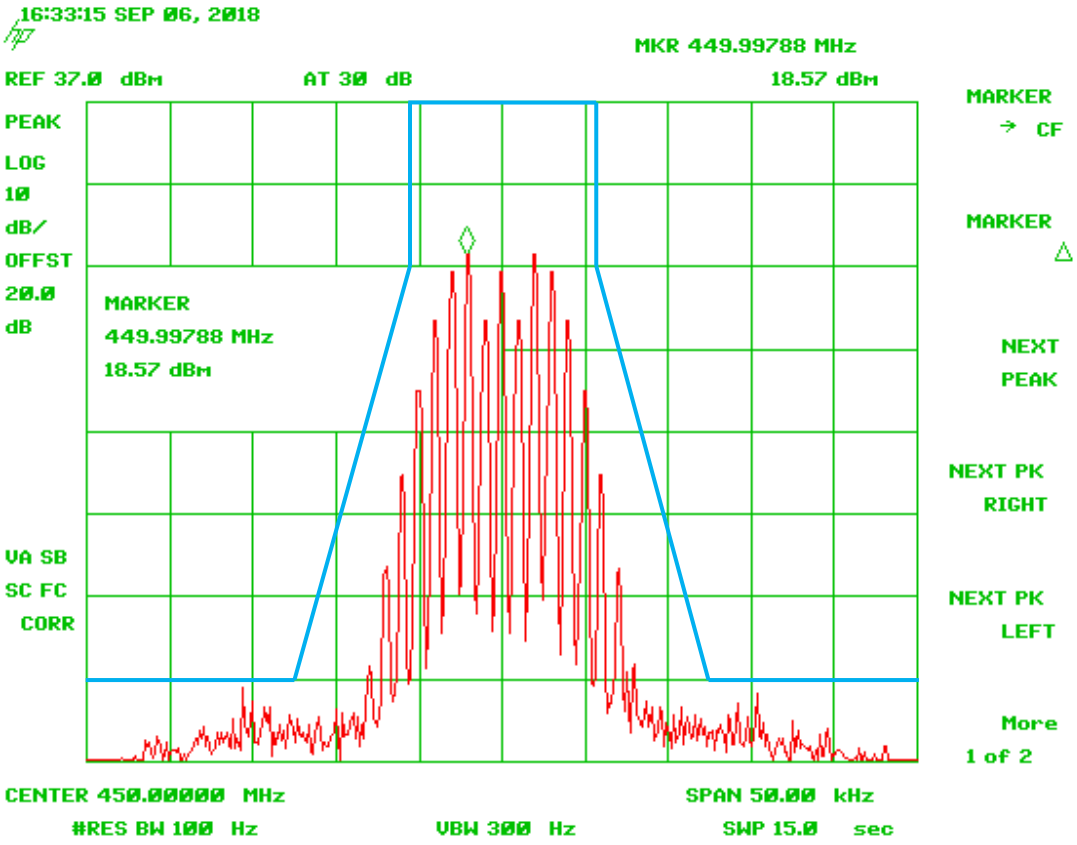

Figure 92. 450 MHz @ 12.5 kHz + 3.0 dB, Mask D

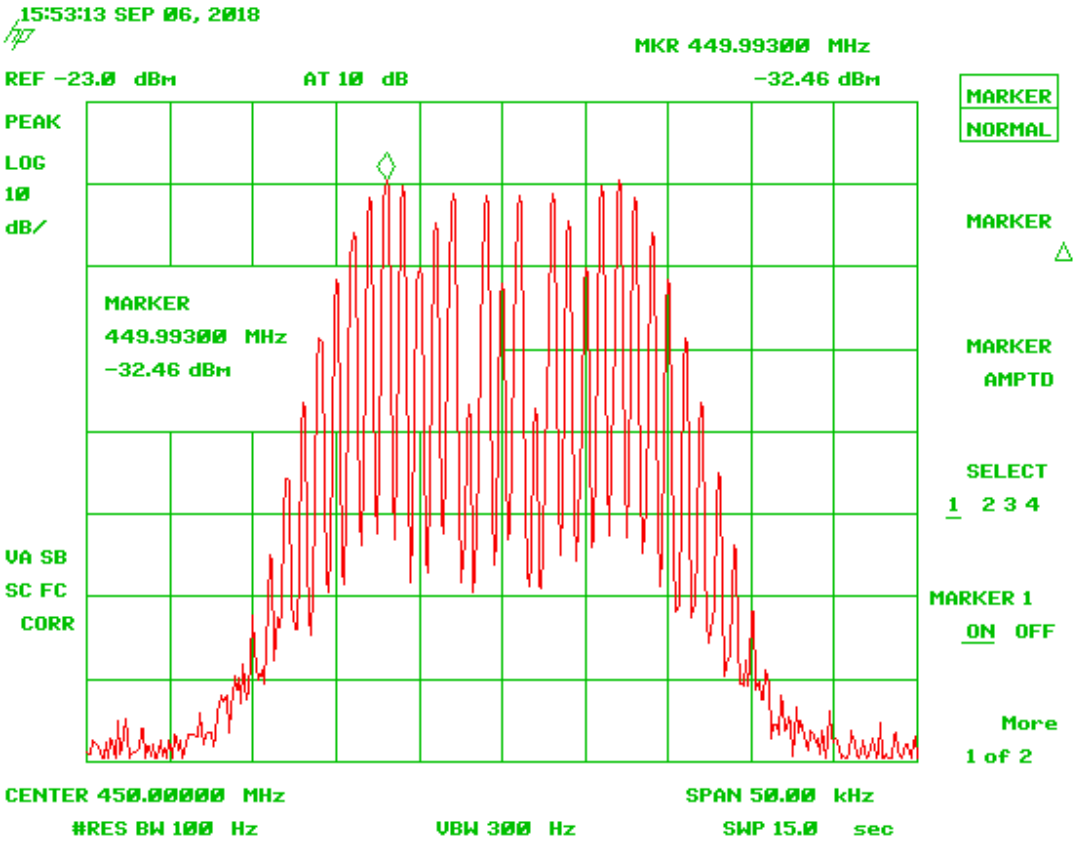

Figure 93. Input 450 MHz @ 25 kHz

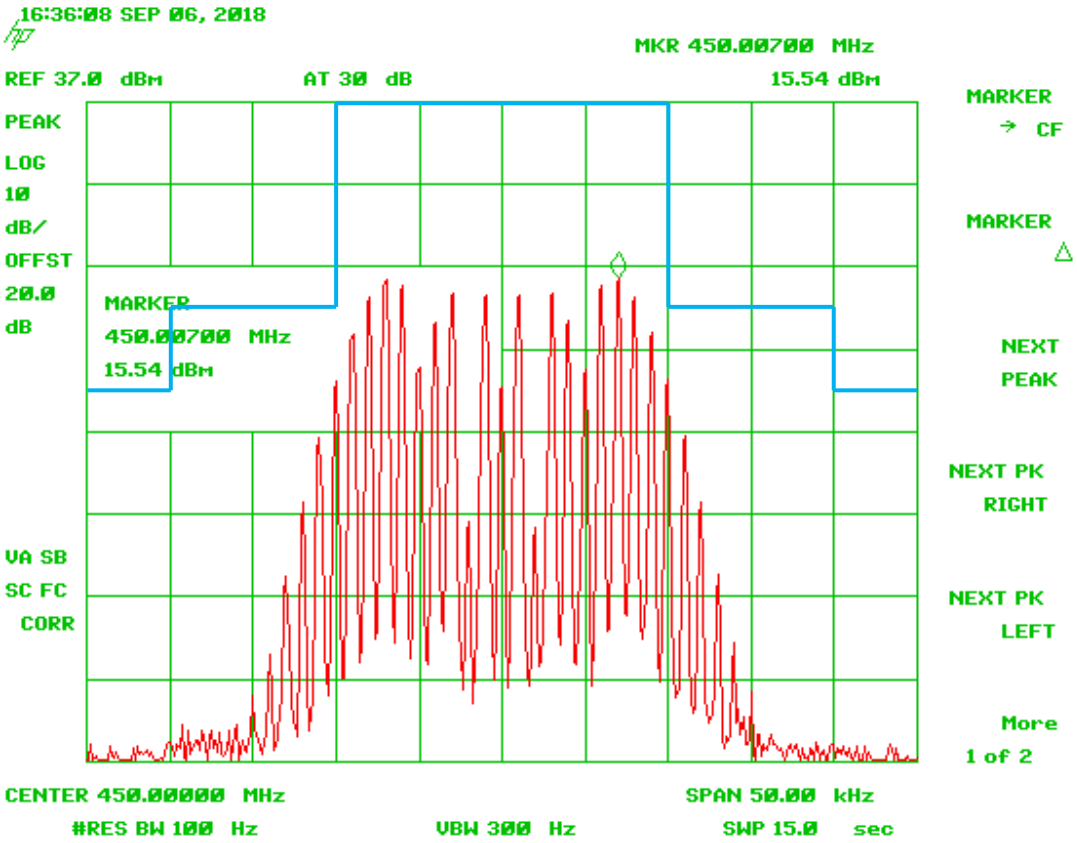

Figure 94. 450 MHz @ 25 kHz, Mask B

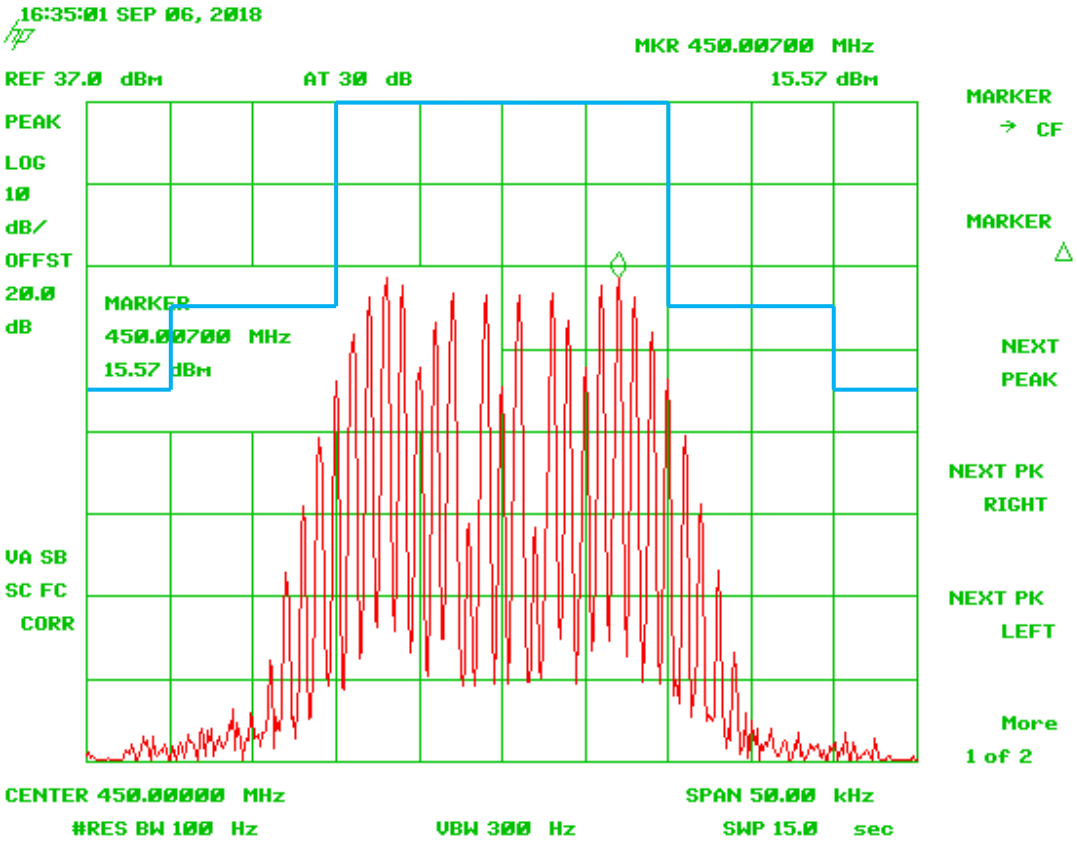

Figure 95. 450 MHz @ 25 kHz + 3.0 dB, Mask B

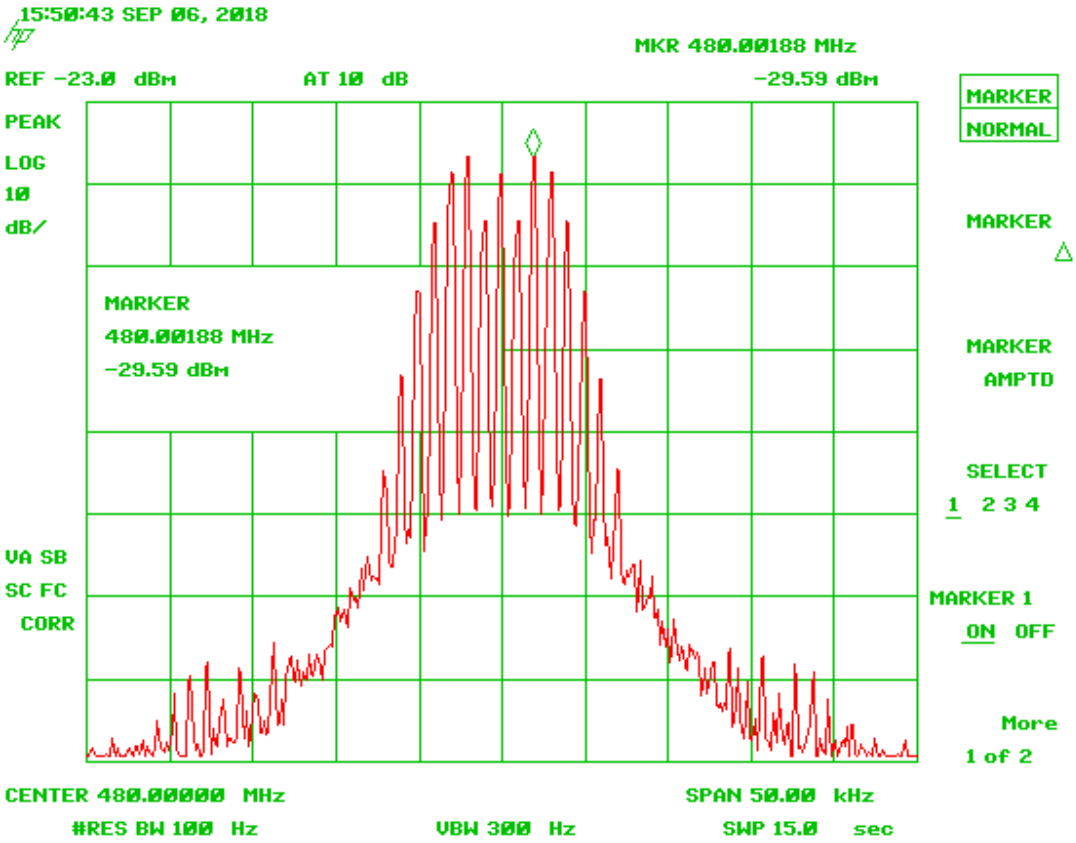

Figure 96. Input 480 MHz @ 12.5 kHz

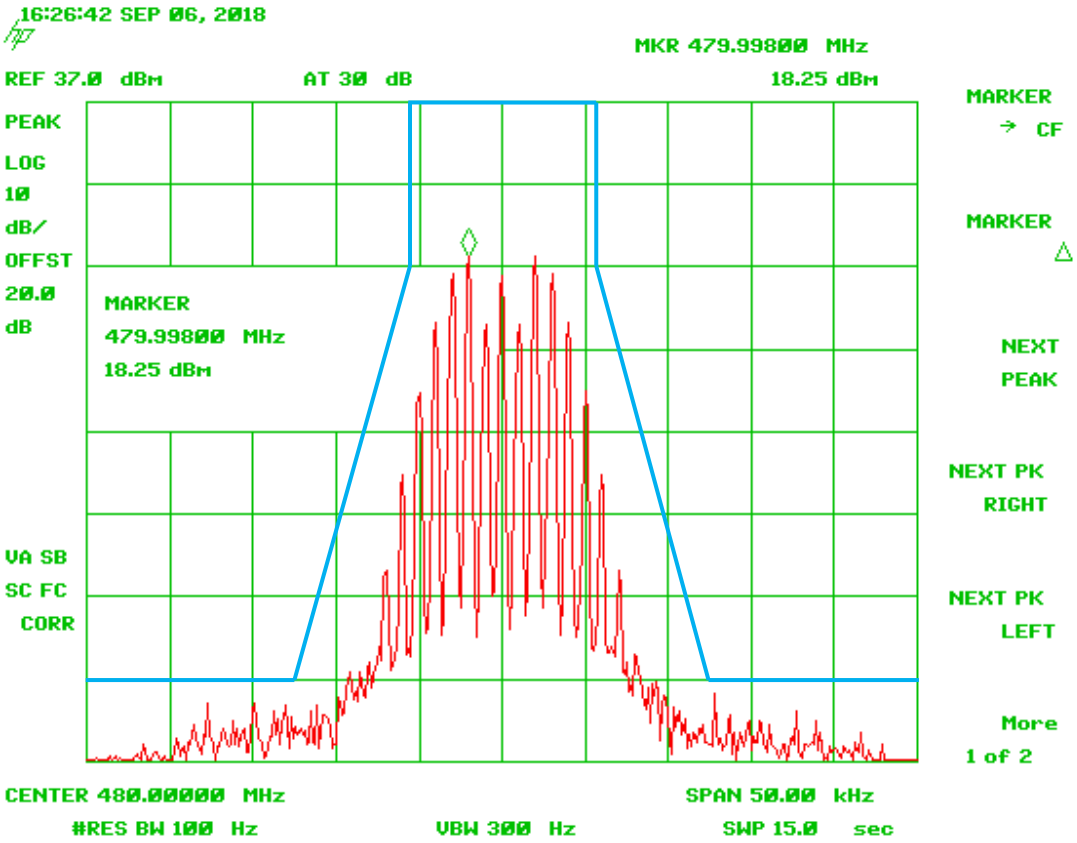

Figure 97. 480 MHz @ 12.5 kHz, Mask D

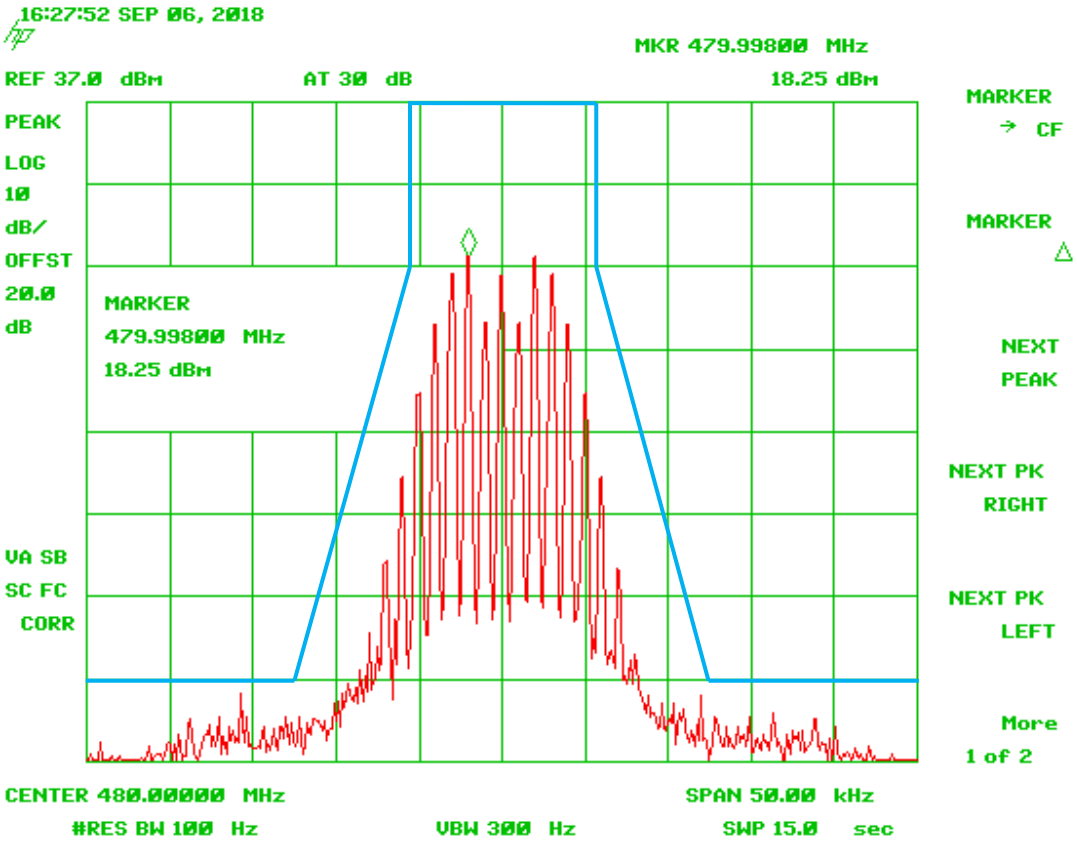

Figure 98. 480 MHz @ 12.5 kHz + 3.0 dB, Mask D

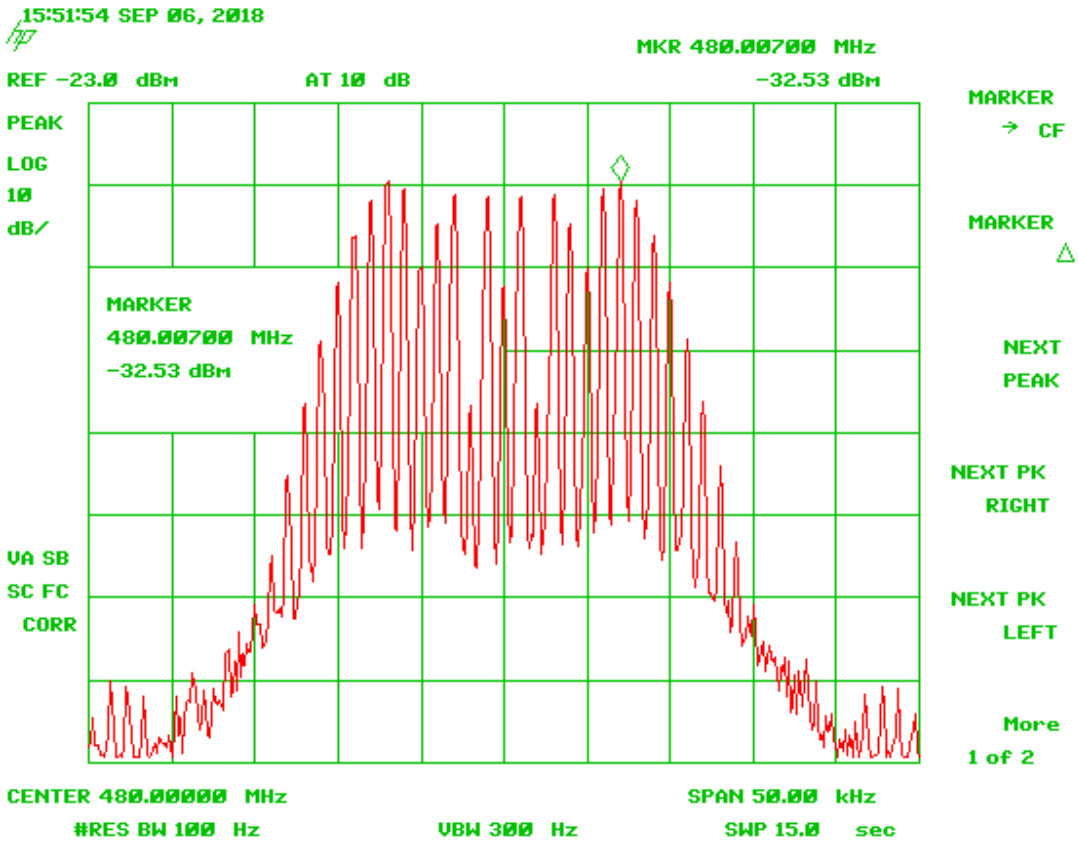

Figure 99. Input 480 MHz @ 25 kHz

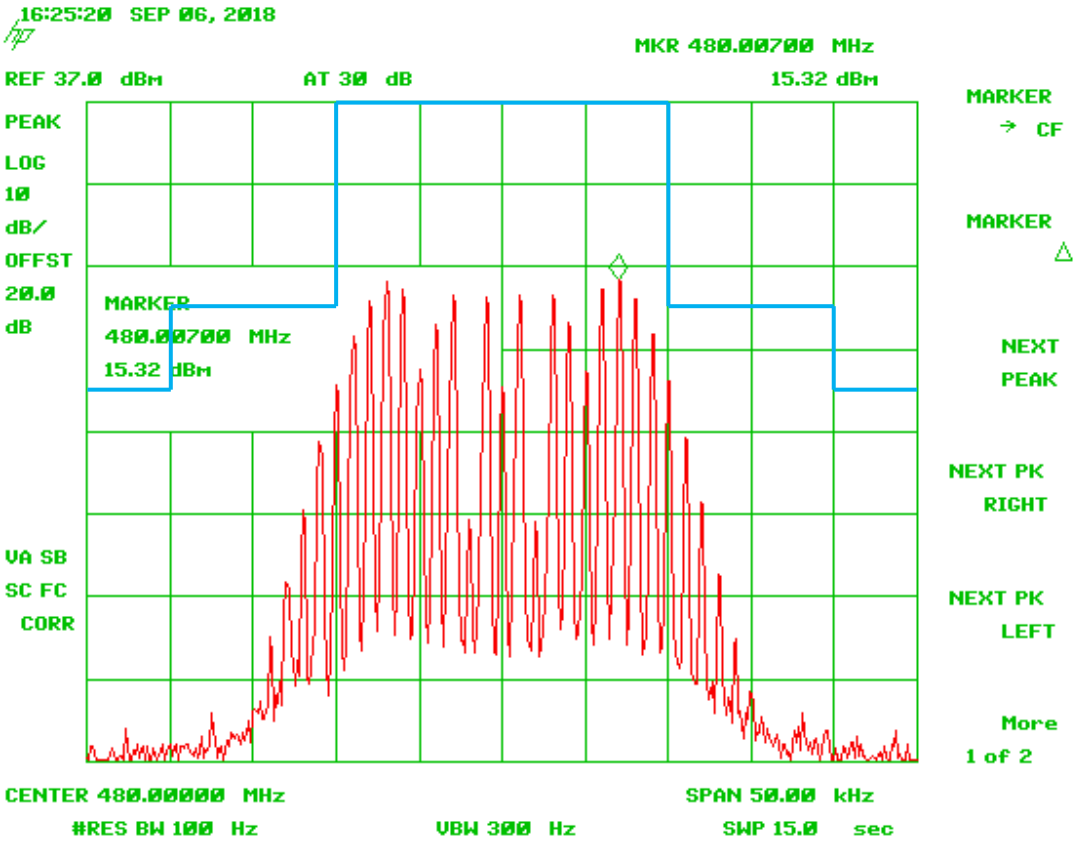

Figure 100. 480 MHz @ 25 kHz, Mask B

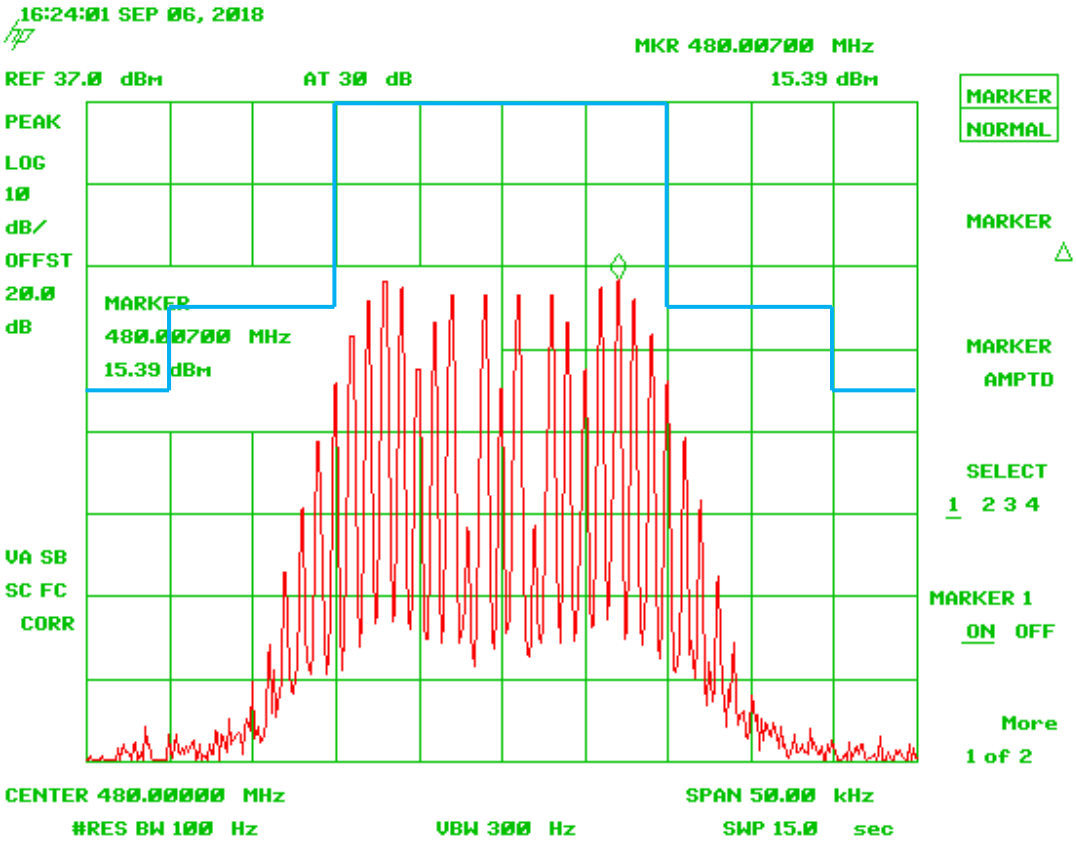

Figure 101. 480 MHz @ 25 kHz + 3.0 dB, Mask B

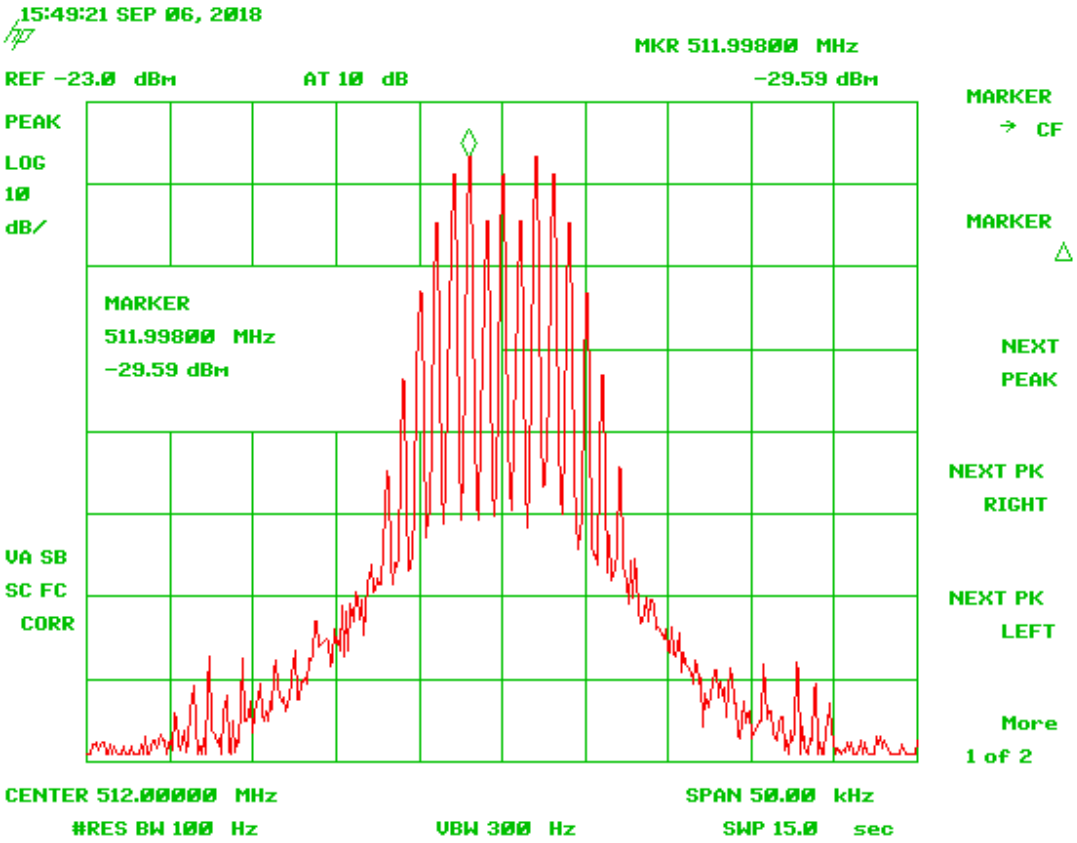

Figure 102. Input 512 MHz @ 12.5 kHz

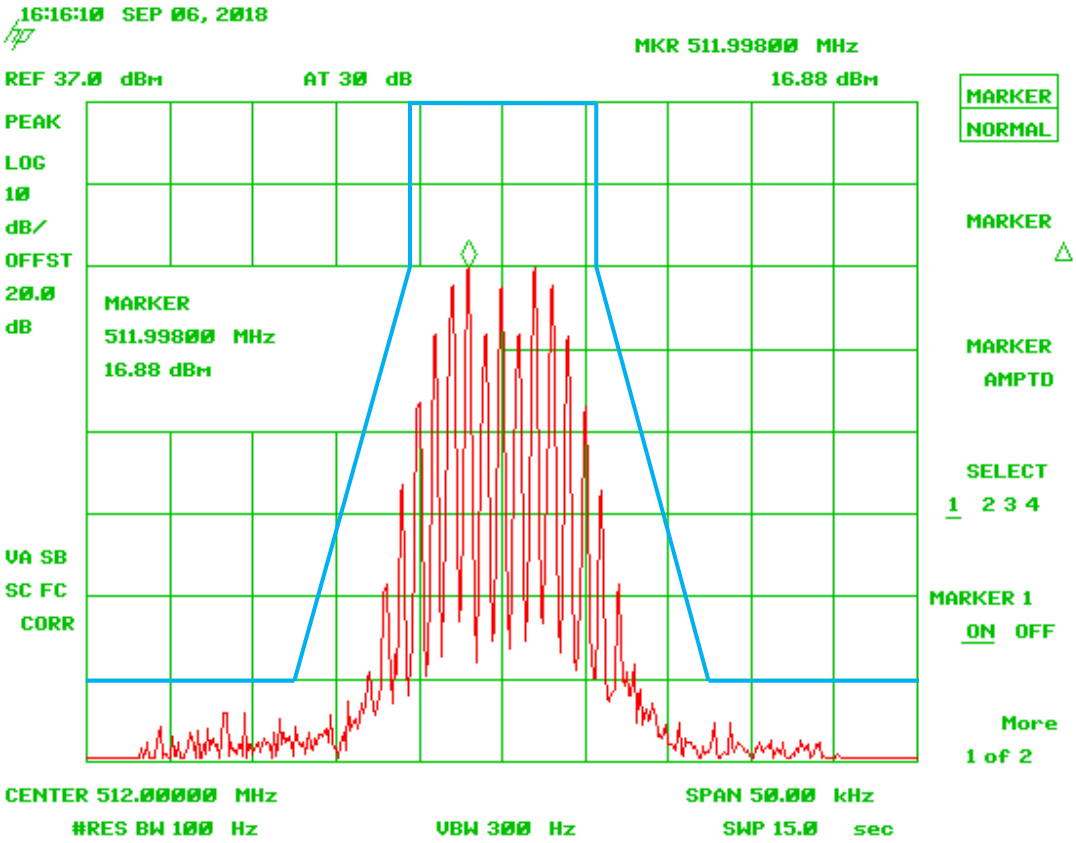

Figure 103. 512 MHz @ 12.5 kHz, Mask D

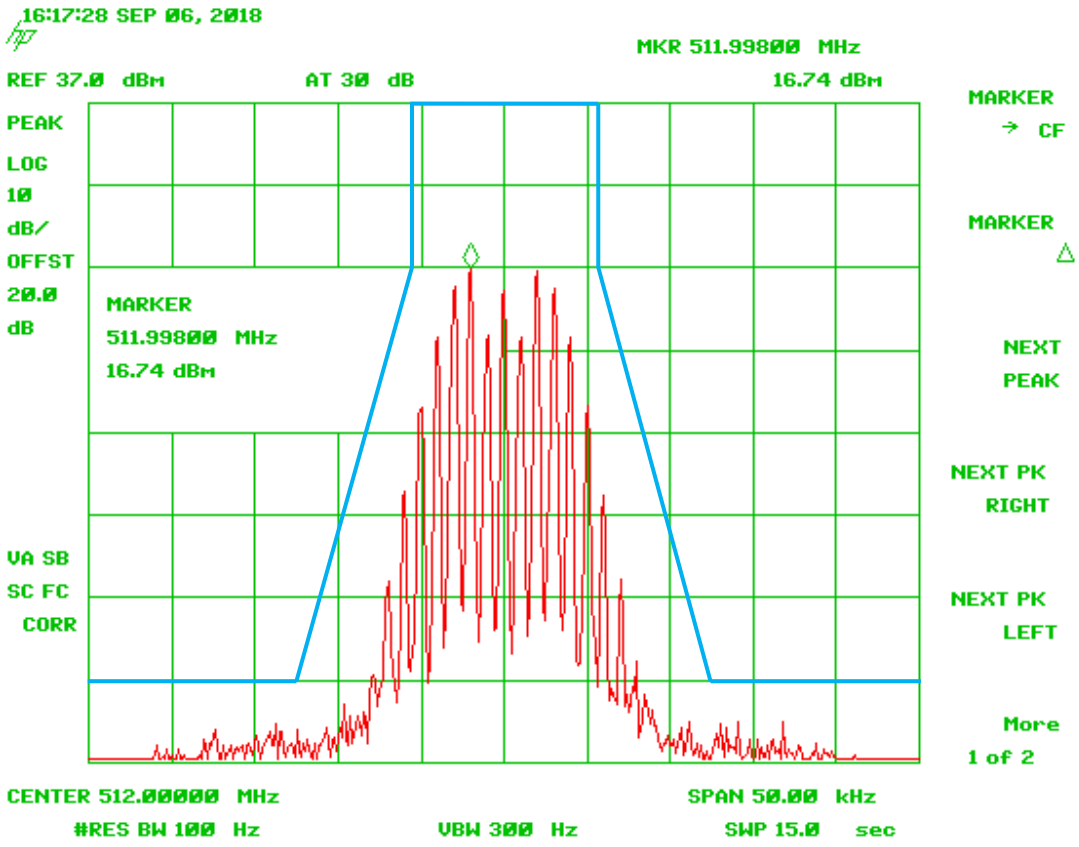

Figure 104. 512 MHz @ 12.5 kHz + 3.0 dB, Mask D

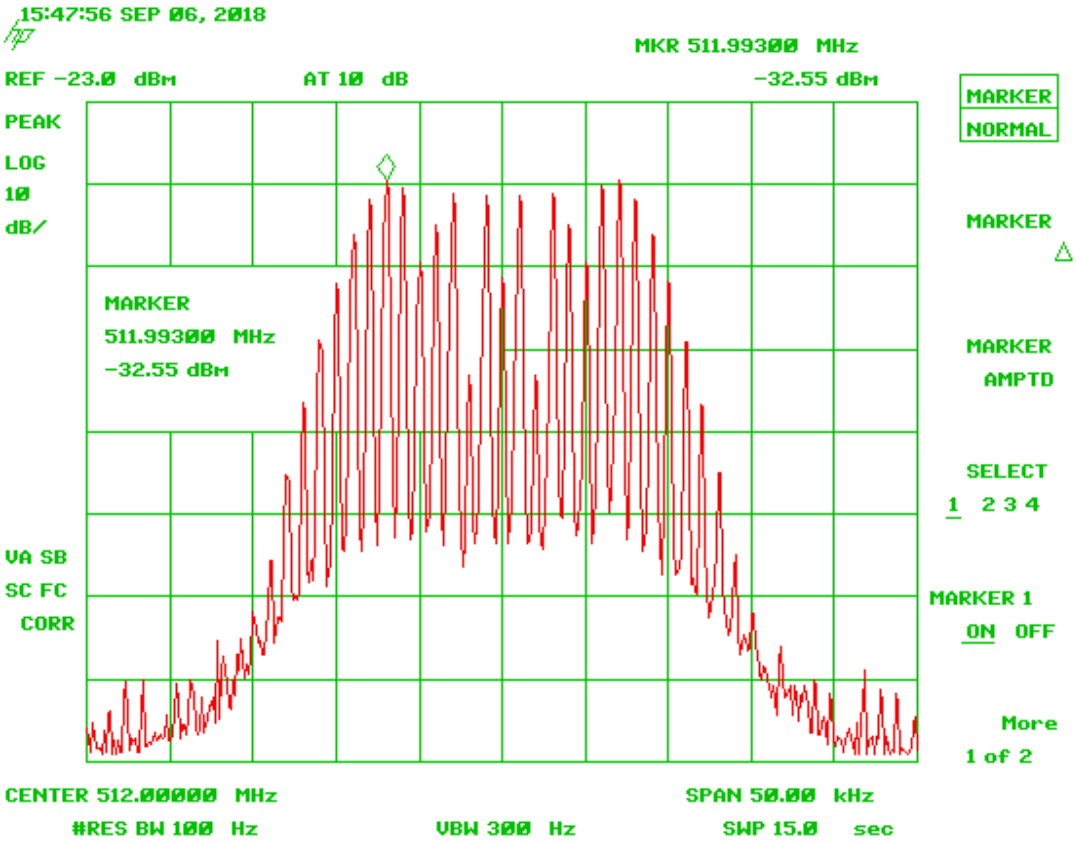

Figure 105. Input 512 MHz @ 25 kHz

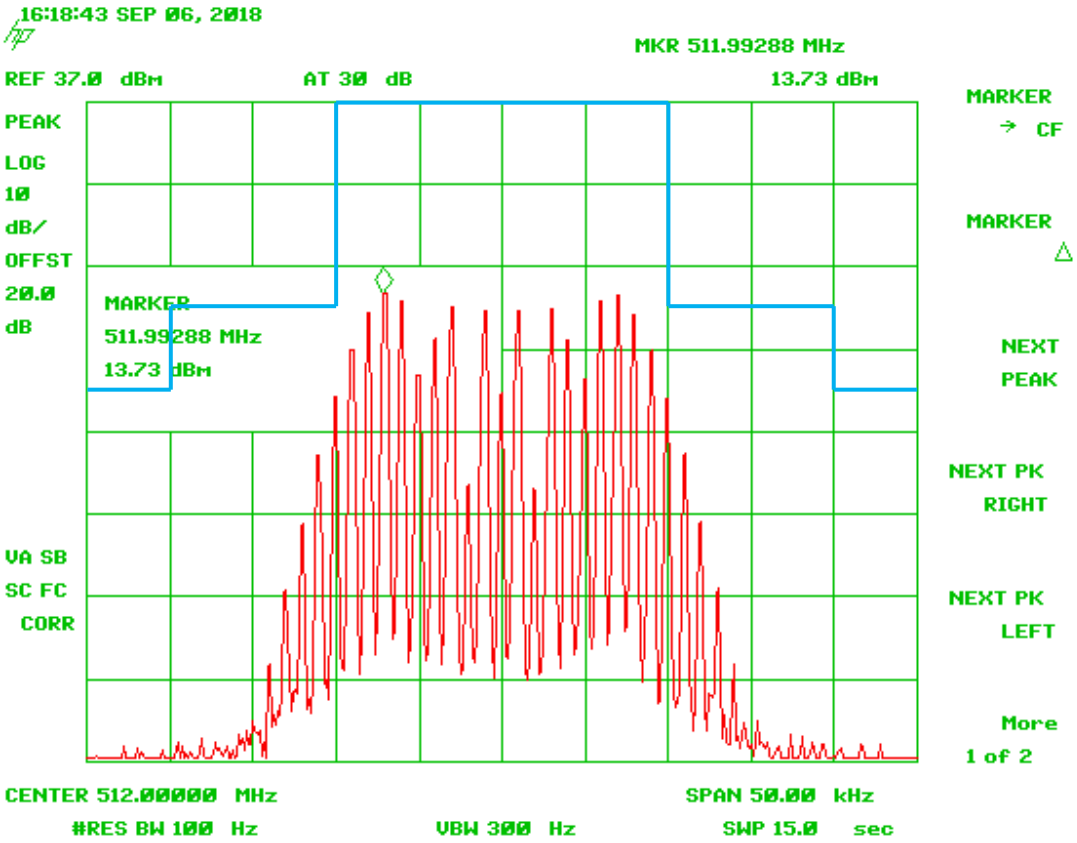

Figure 106. 512 MHz @ 25 kHz, Mask B

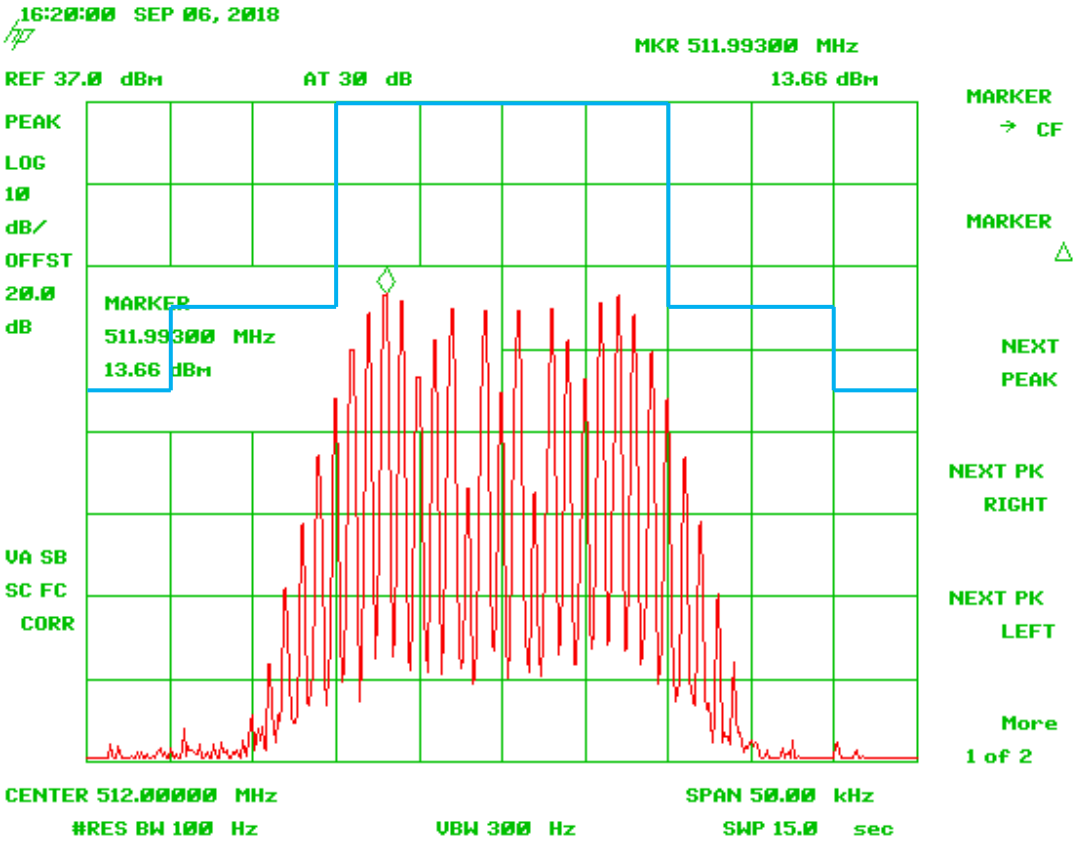

Figure 107. 512 MHz @ 25 kHz + 3.0, Mask B

2.13.3 700 MHz Channels

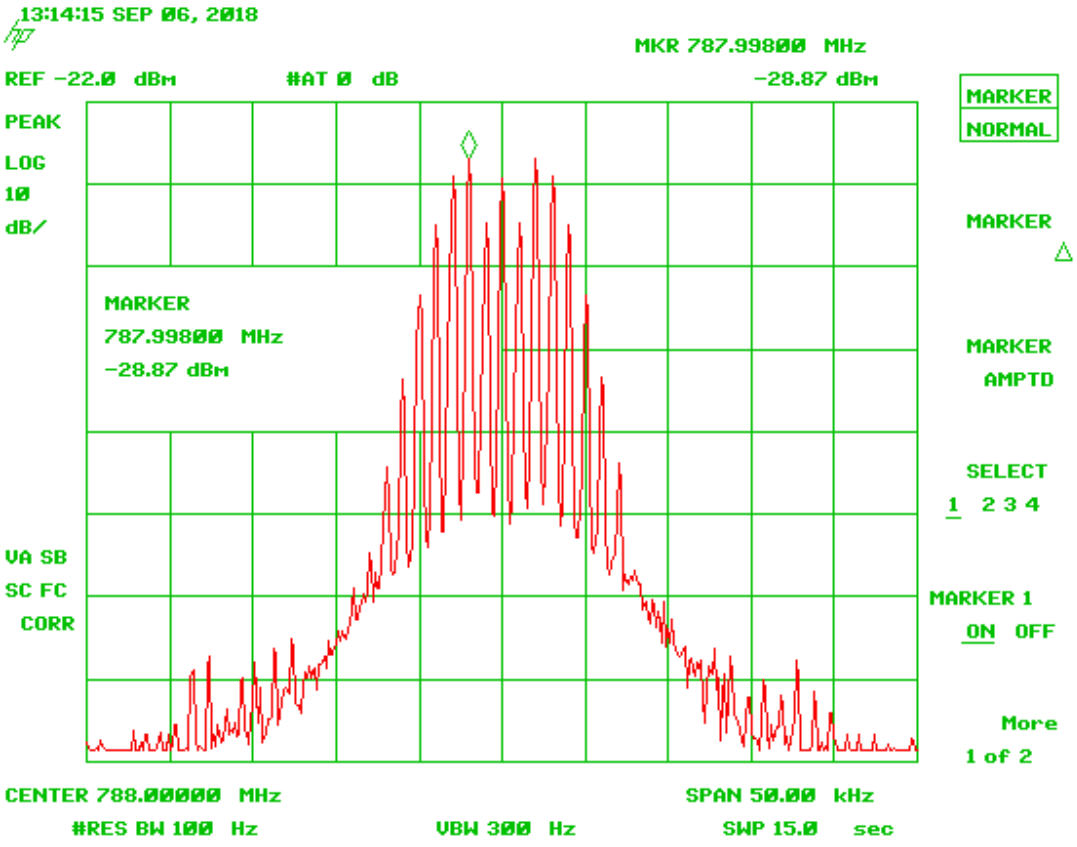

Figure 108. Input 788 MHz @ 12.5 kHz

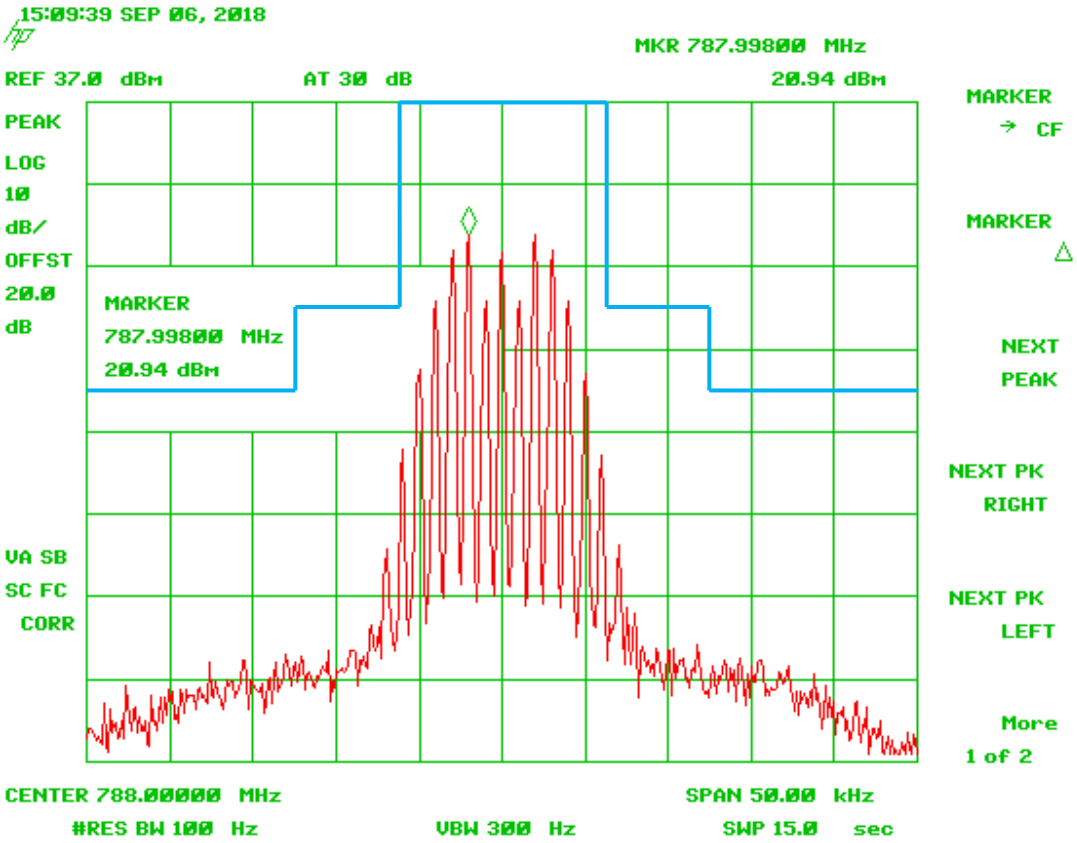

Figure 109. 788 MHz @ 12.5 kHz, Mask B

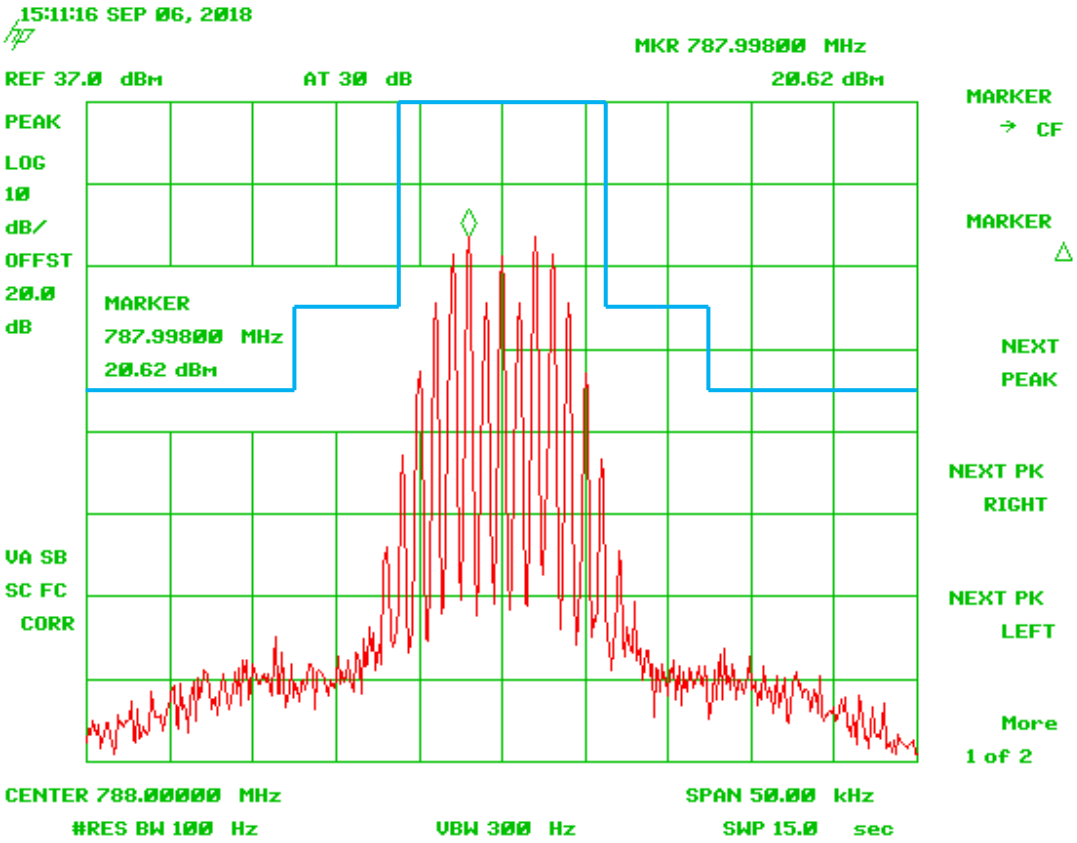

Figure 110. 788 MHz @ 12.5 kHz + 3.0 dB, Mask B

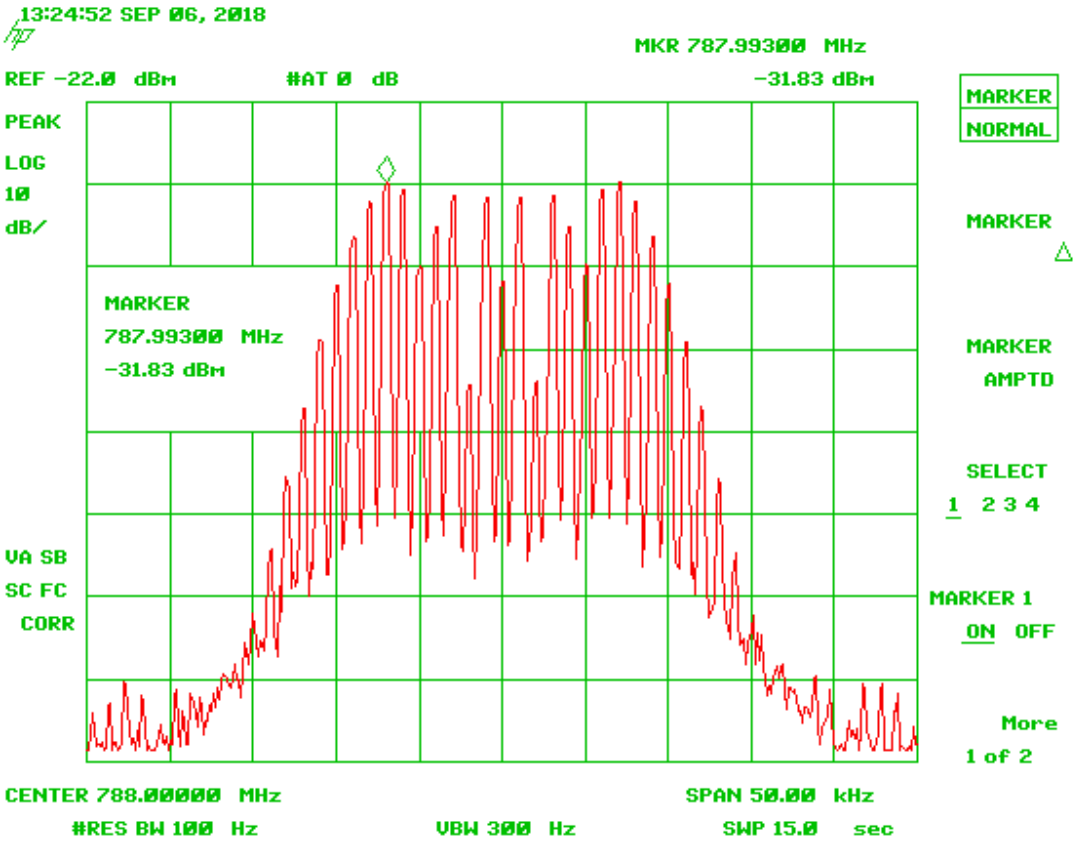

Figure 111. Input 788 MHz @ 25 kHz

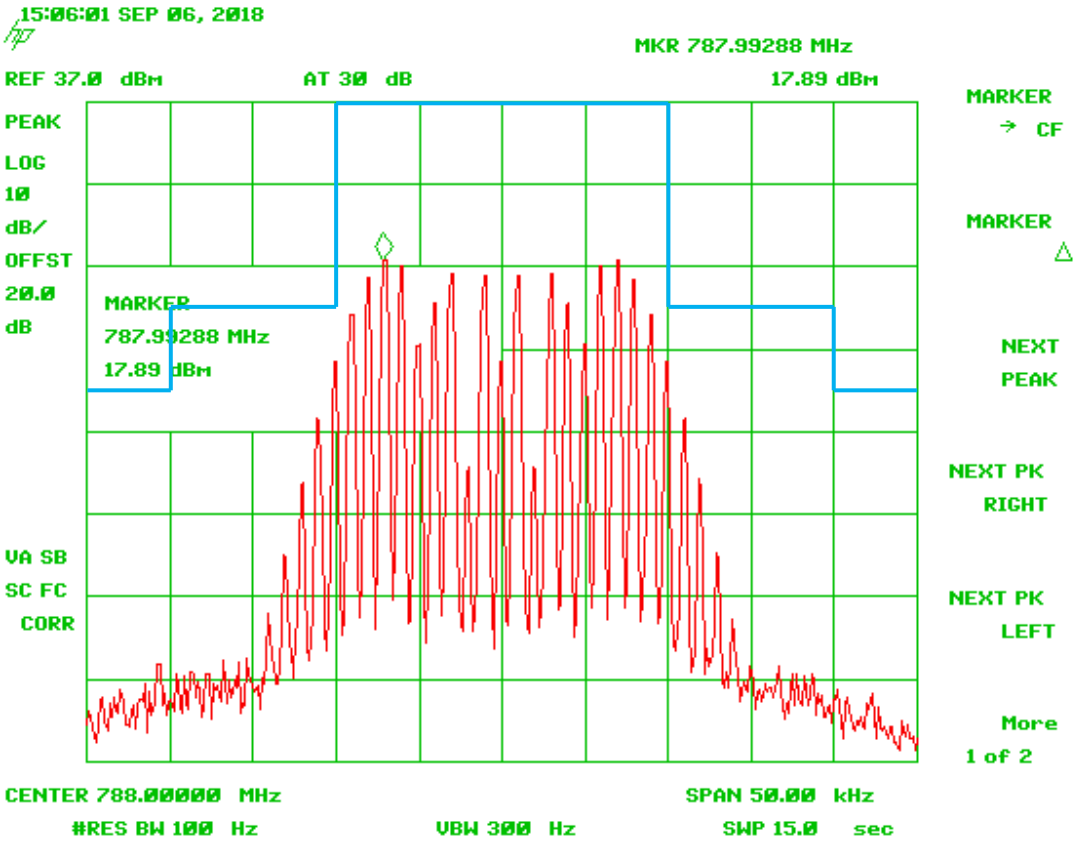

Figure 112. 788 MHz @ 25 kHz, Mask B

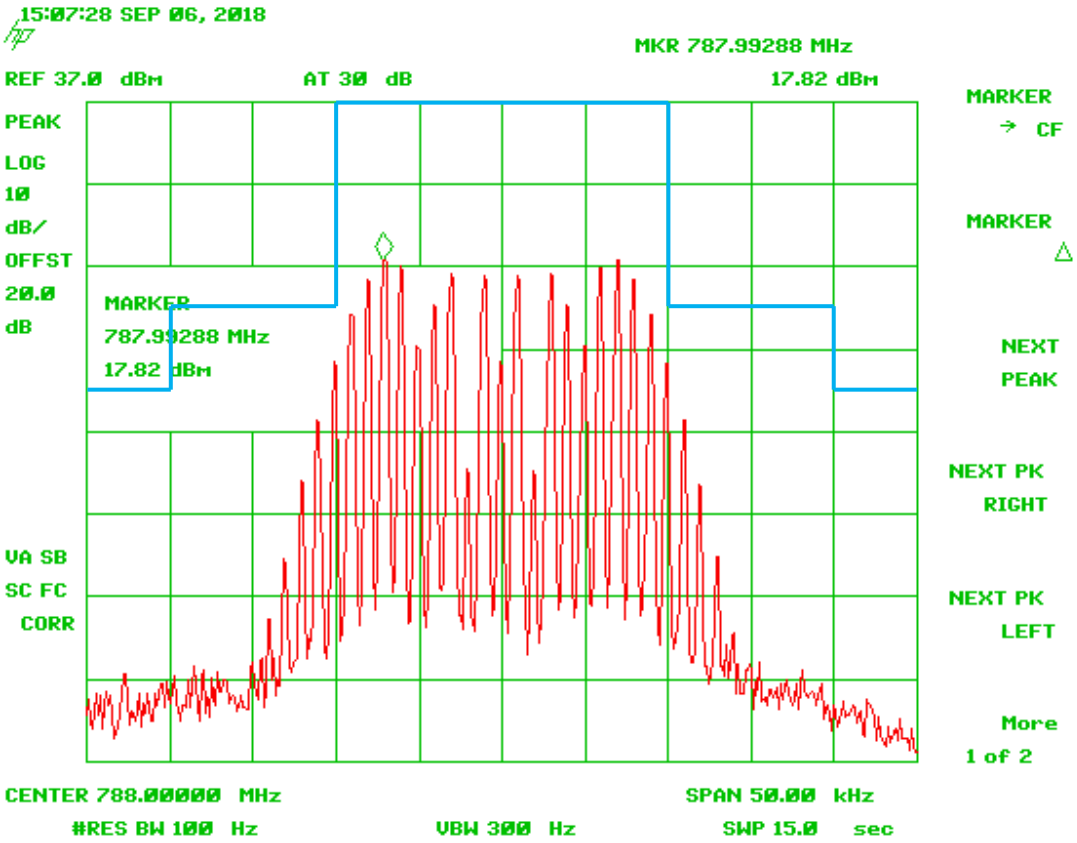

Figure 113. 788 MHz @ 25 kHz + 3.0 dB, Mask B

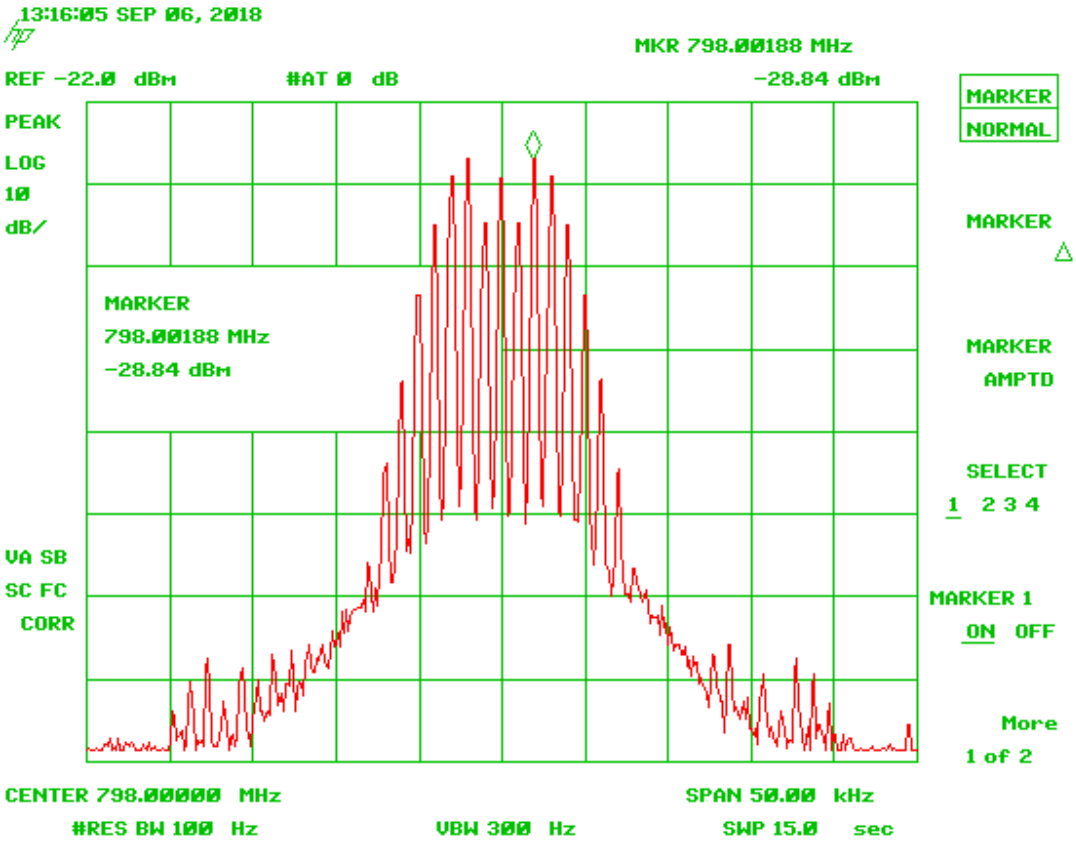

Figure 114. Input 798 MHz @ 12.5 kHz

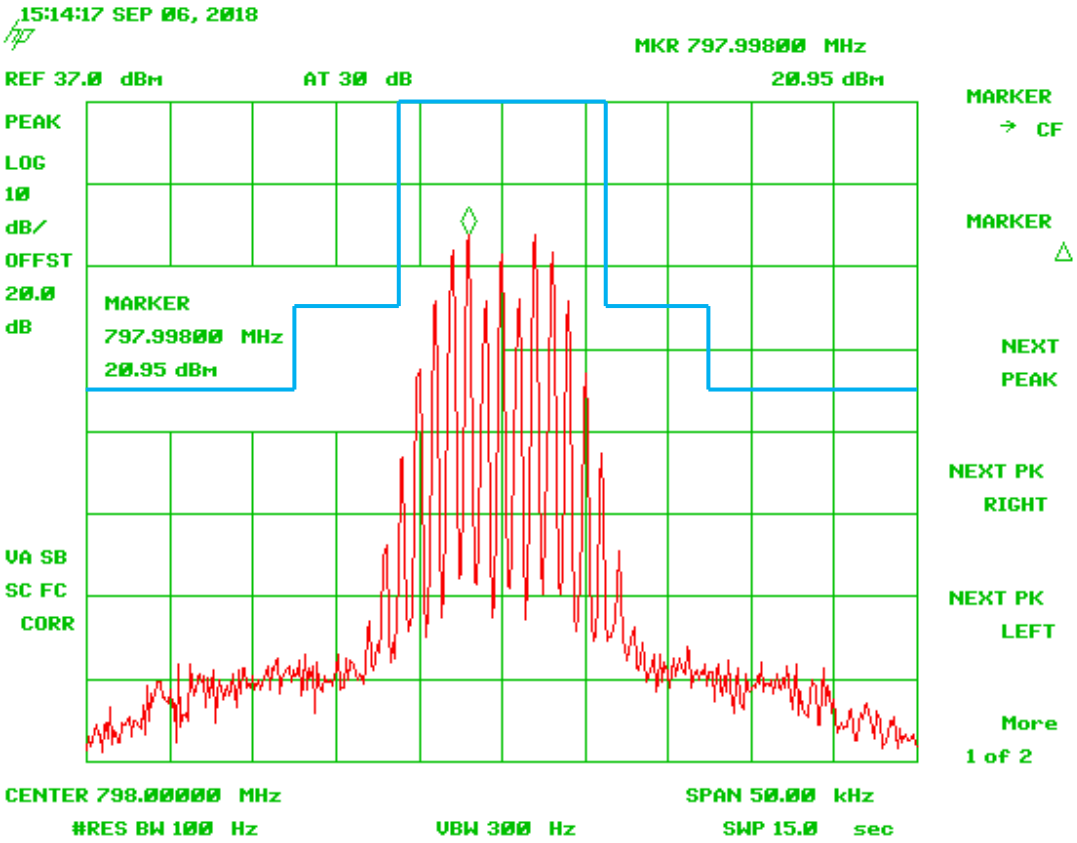

Figure 115. 798 MHz @ 12.5 kHz, Mask B

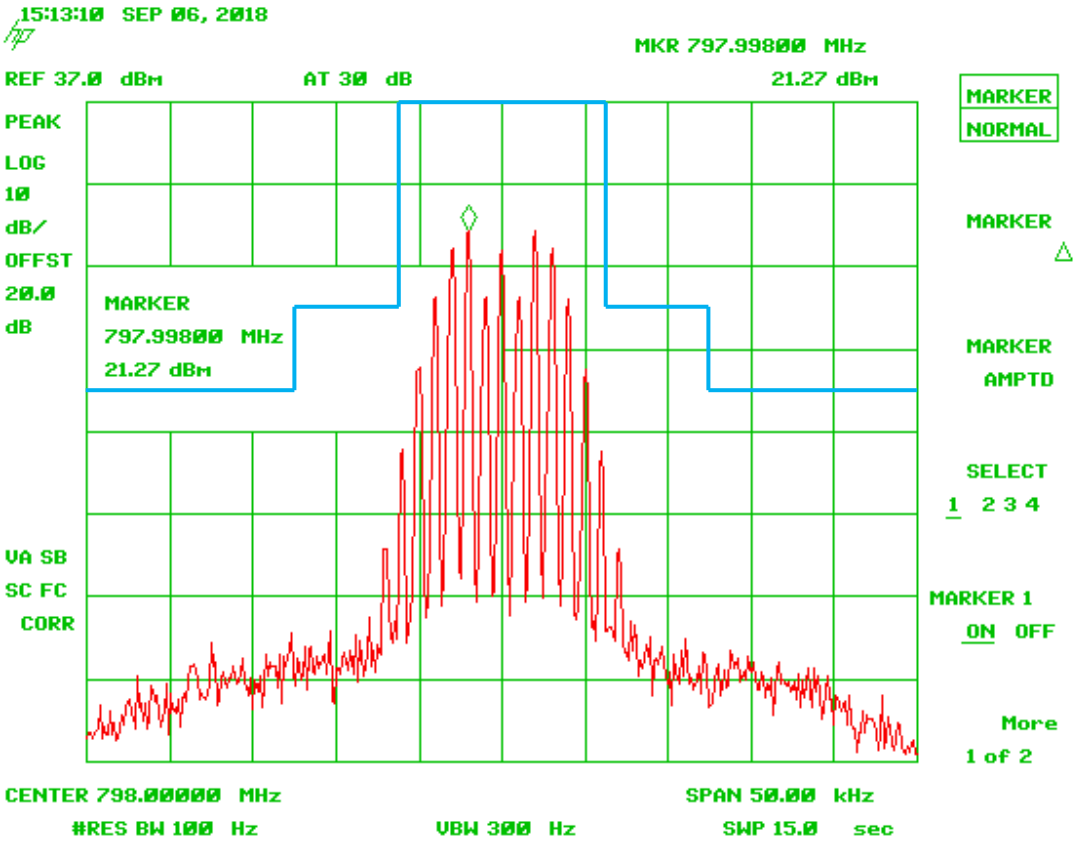

Figure 116. 798 MHz @ 12.5 kHz + 3.0 dB, Mask B

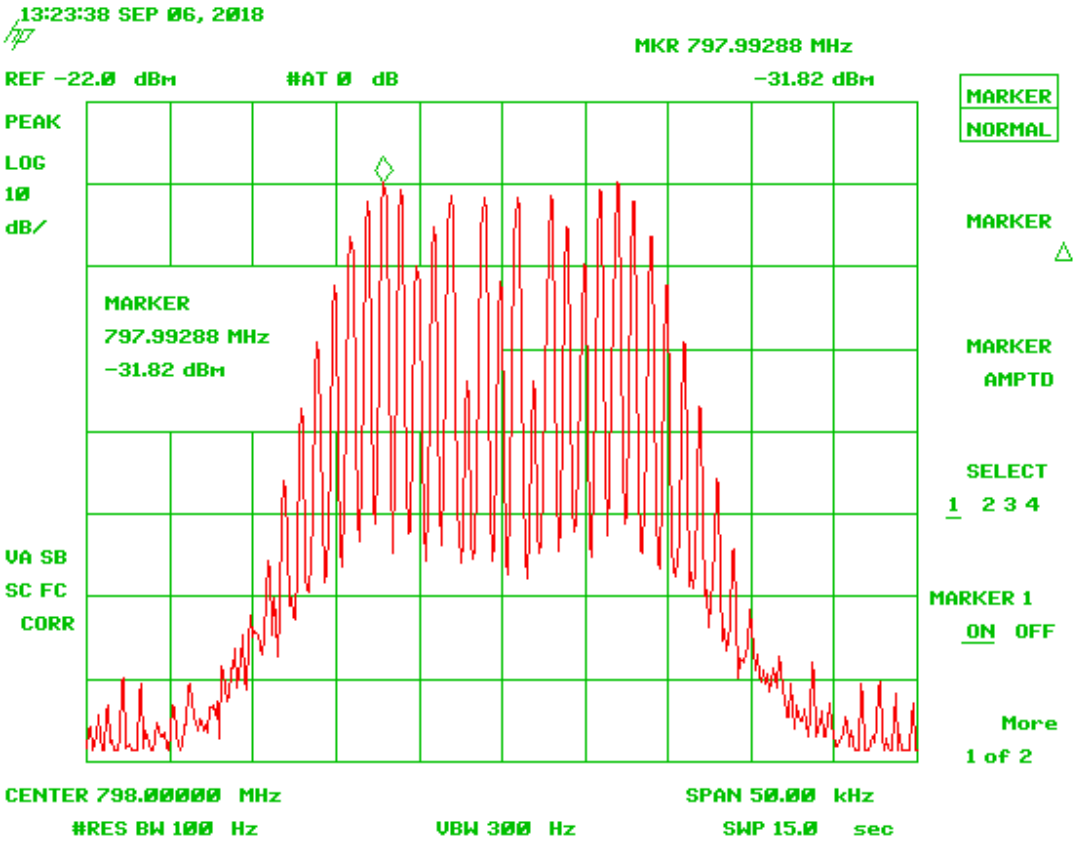

Figure 117. Input 798 MHz @ 25 kHz

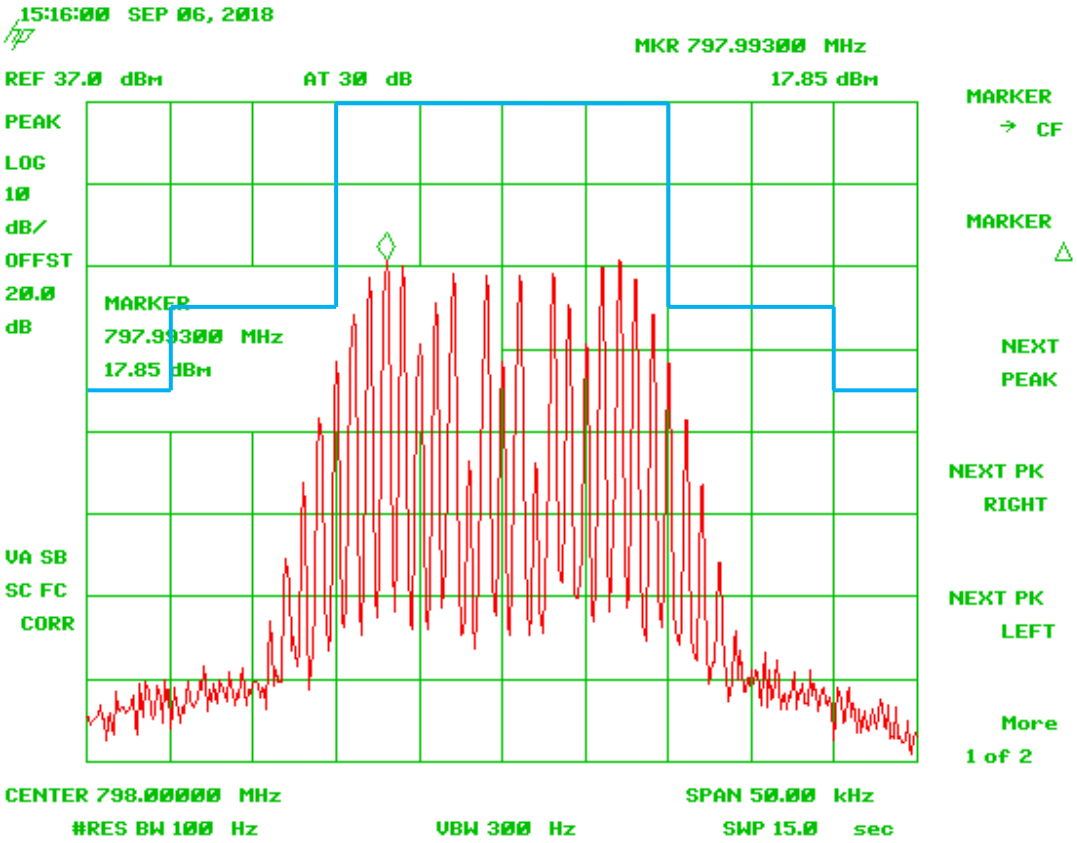

Figure 118. 798 MHz @ 25 kHz, Mask B

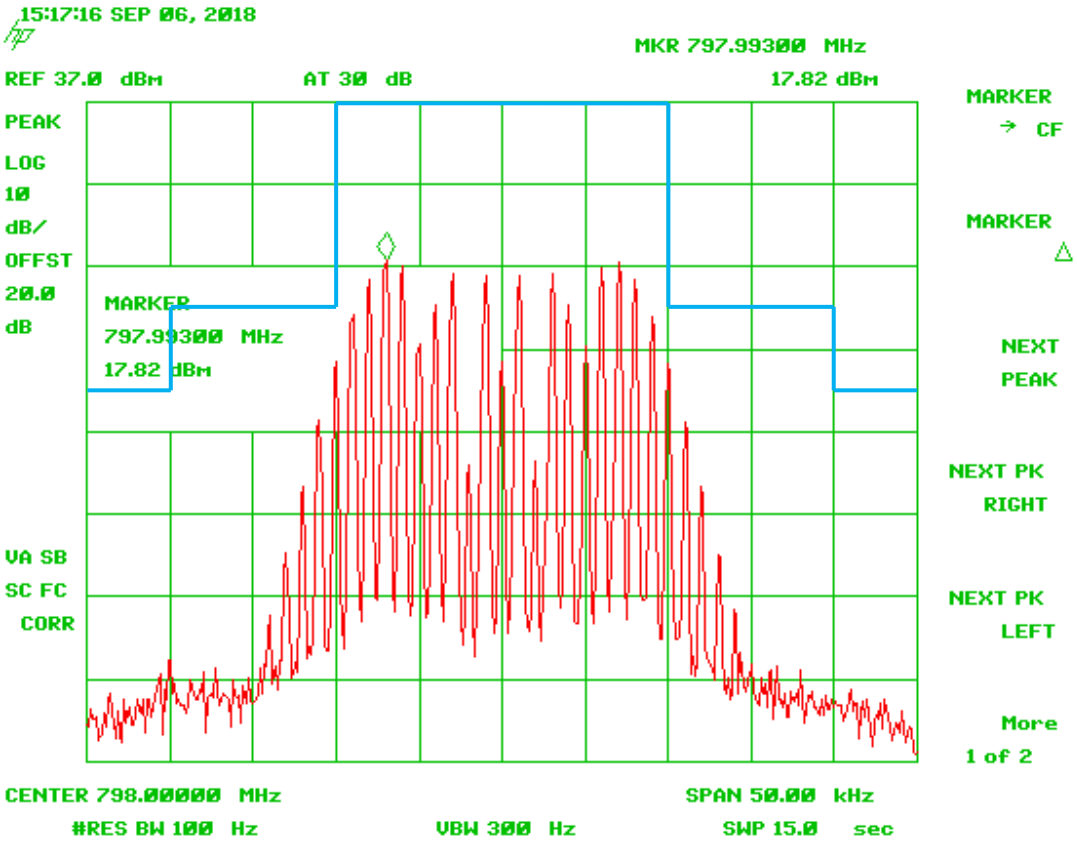

Figure 119. 798 MHz @ 25 kHz + 3.0 dB, Mask B

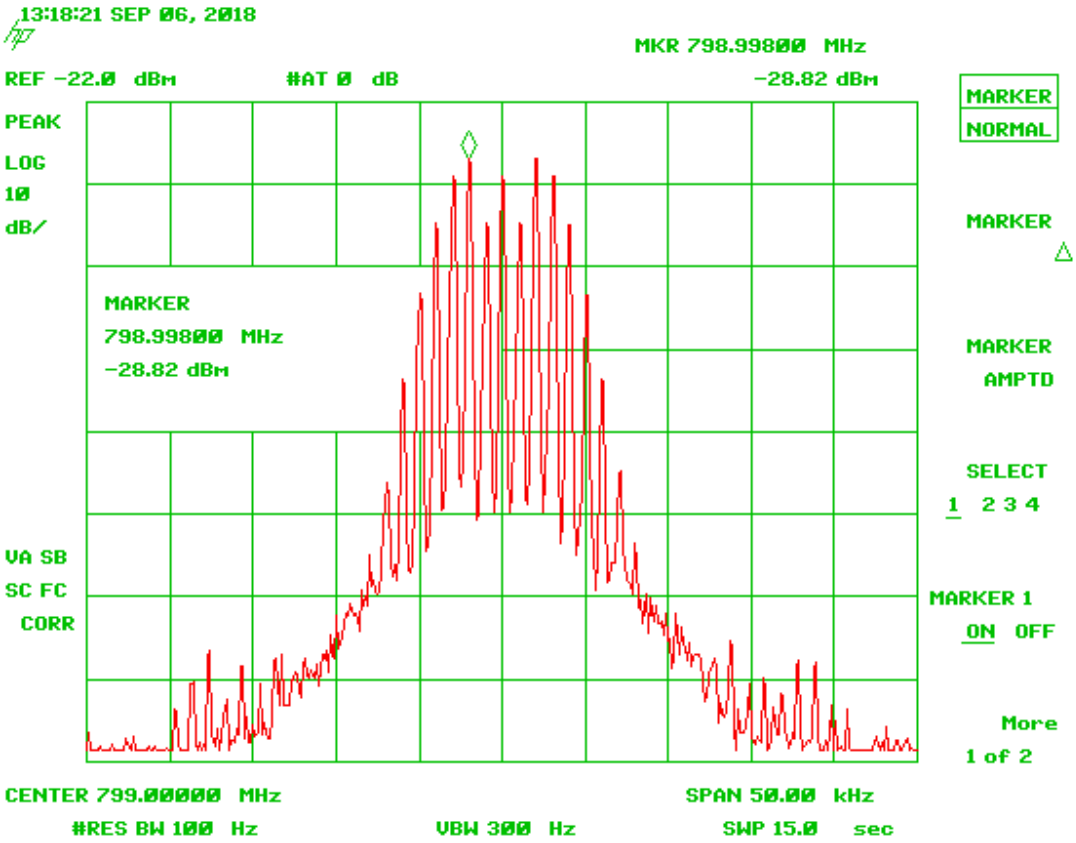

Figure 120. Input 799 MHz @ 12.5 kHz

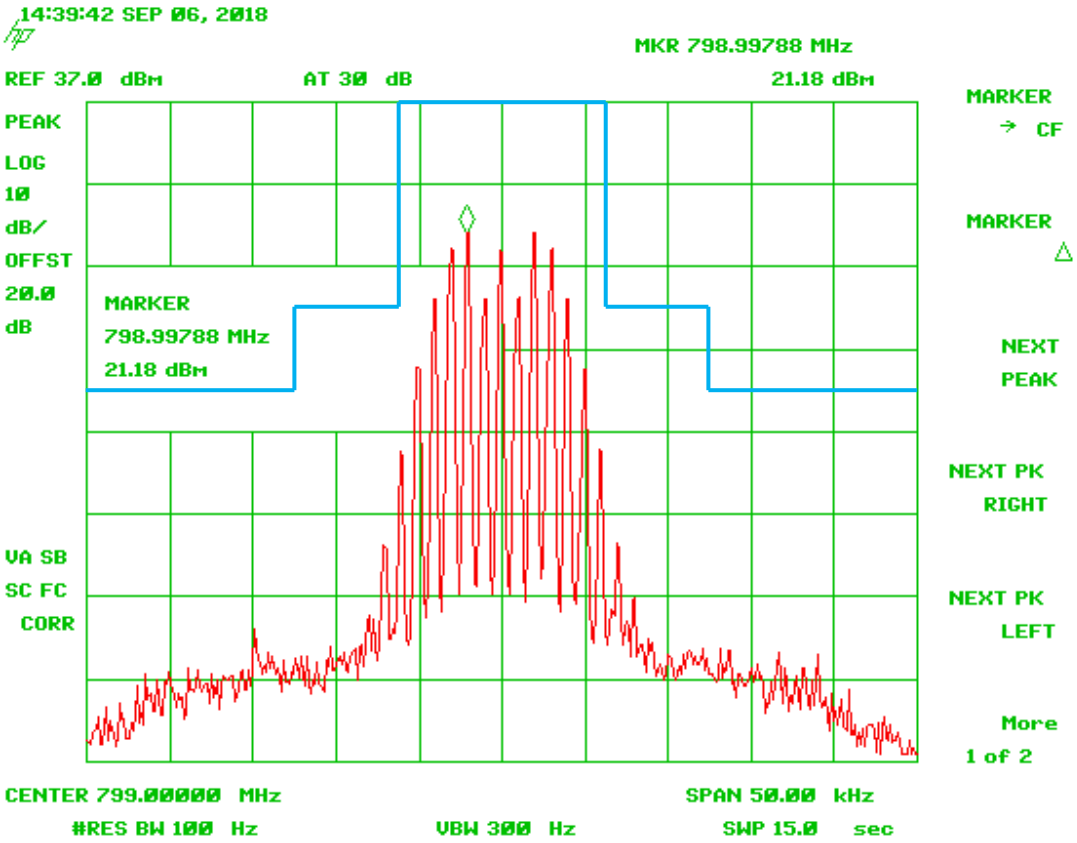

Figure 121. 799 MHz @ 12.5 MHz, Mask B

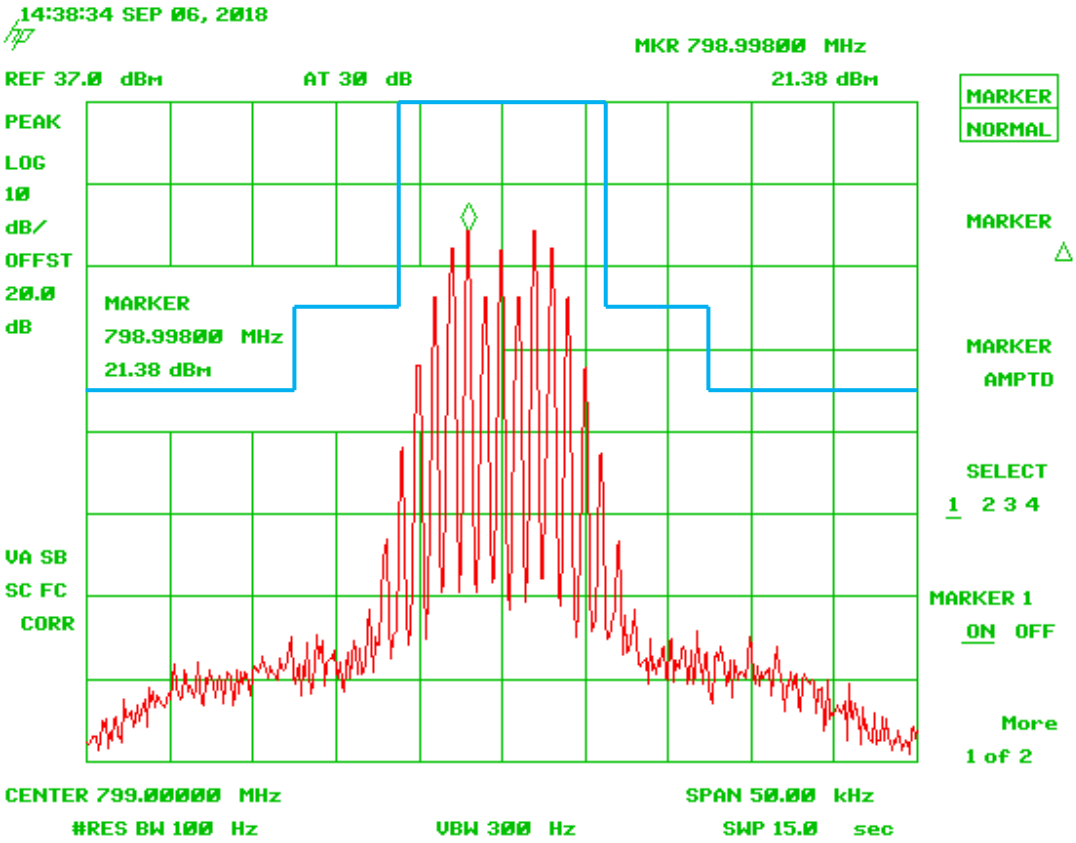

Figure 122. 799 MHz @ 12.5 kHz + 3.0 dB, Mask B

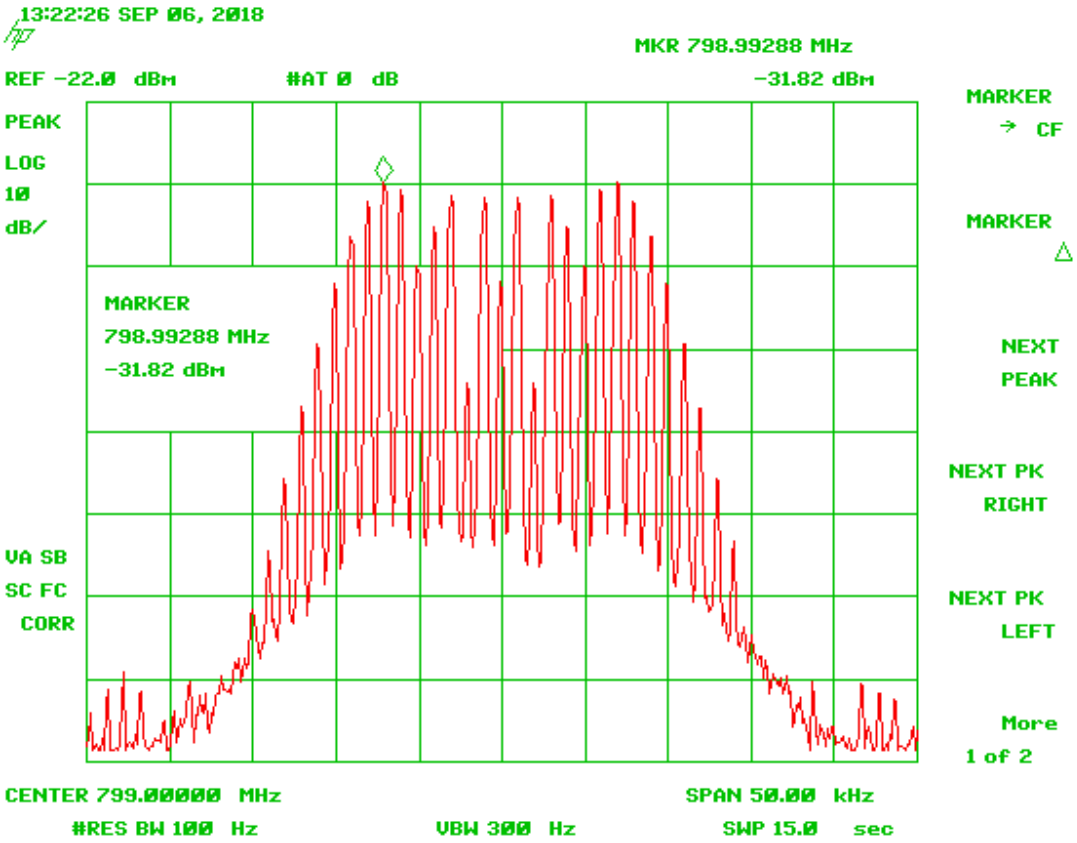

Figure 123. Input 799 MHz @ 25 kHz

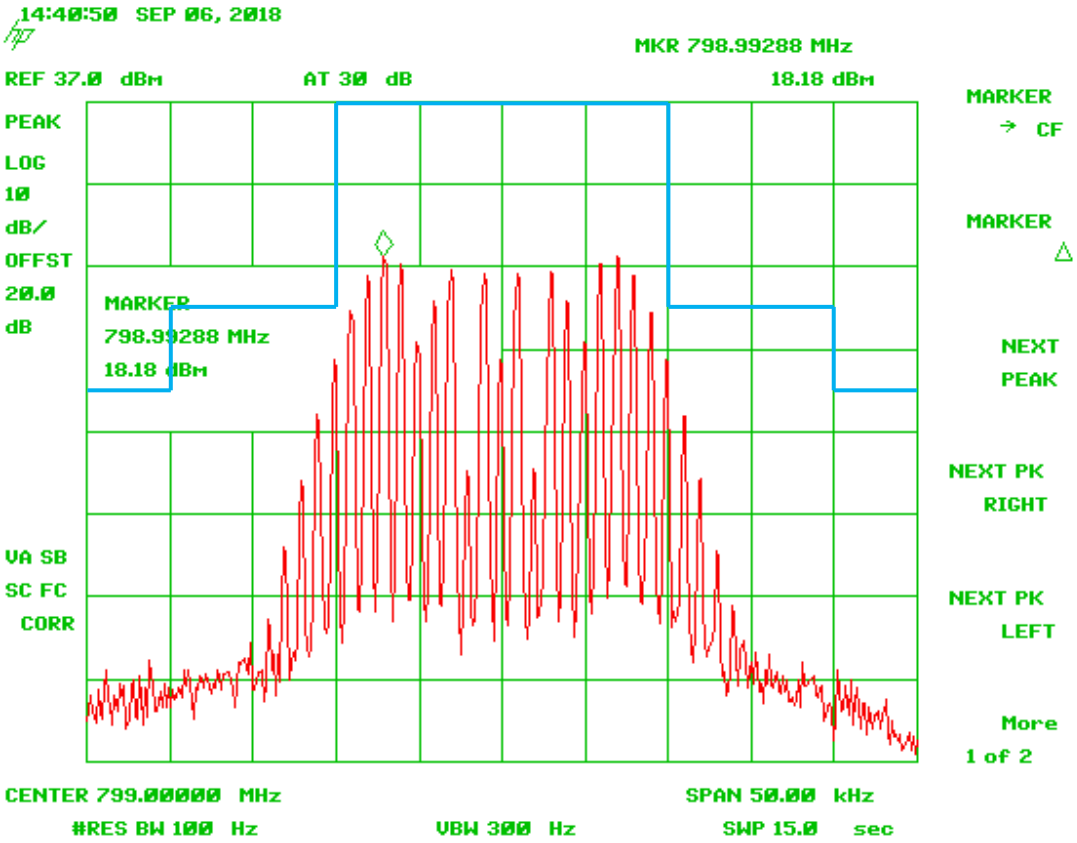

Figure 124. 799 MHz @ 25 kHz, Mask B

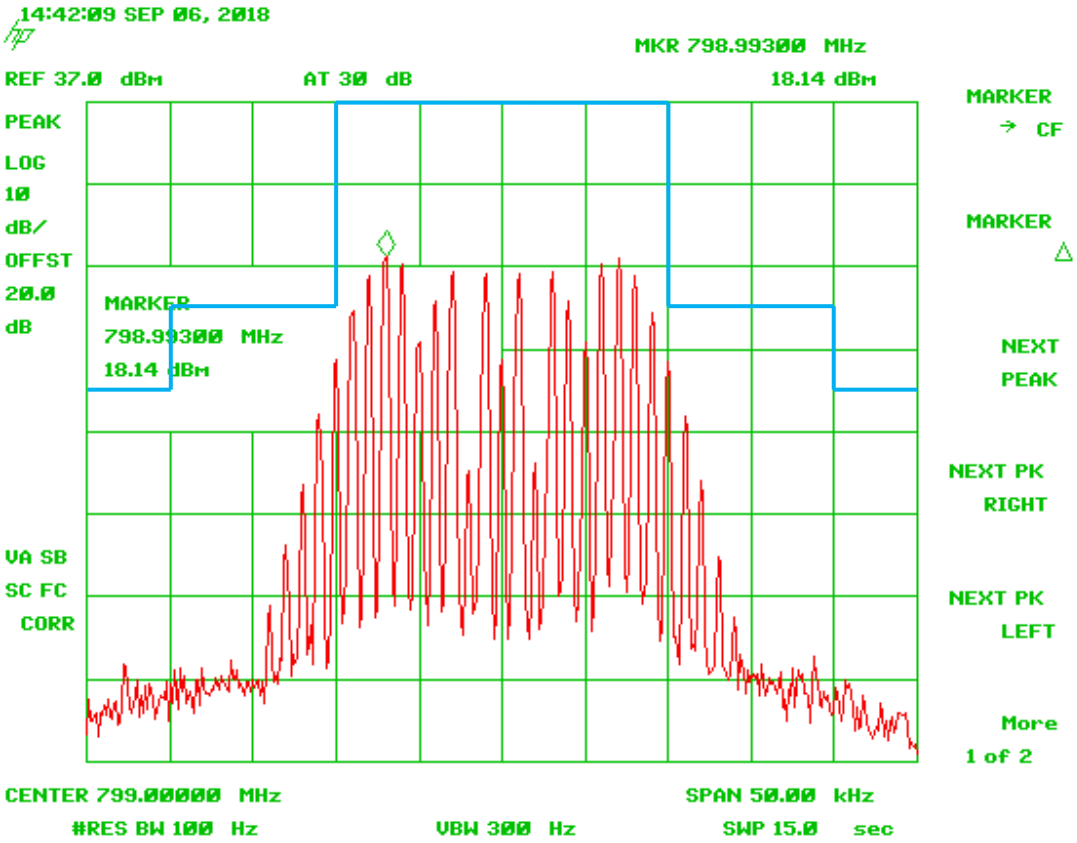

Figure 125. 799 MHz @ 25 kHz + 3.0 dB, Mask B

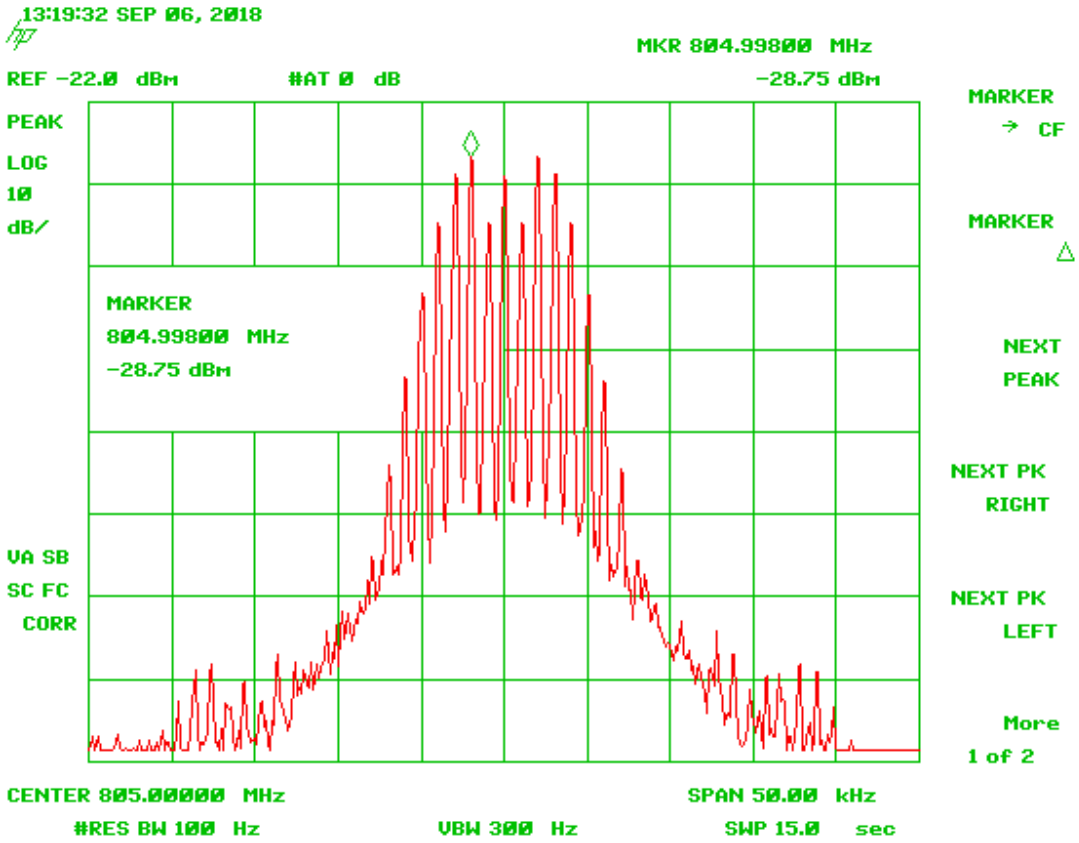

Figure 126. Input 805 MHz @ 12.5 kHz

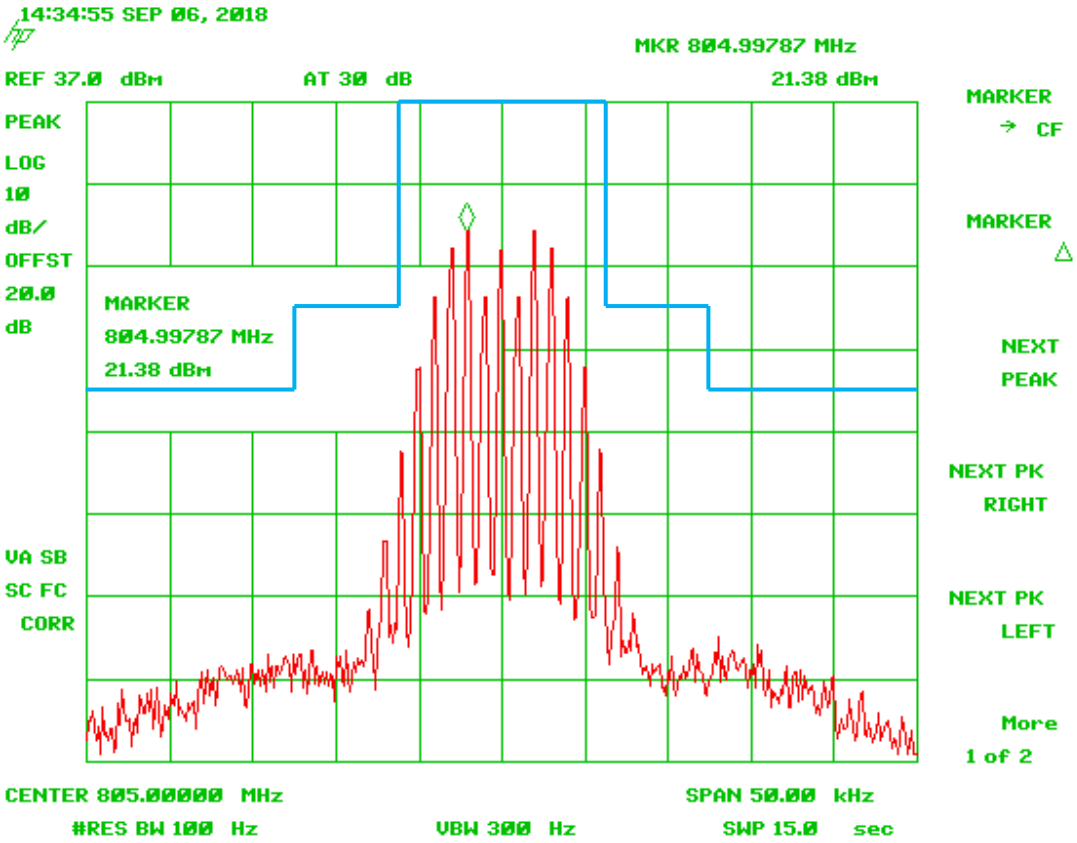

Figure 127. 805 MHz @ 12.5 kHz, Mask B

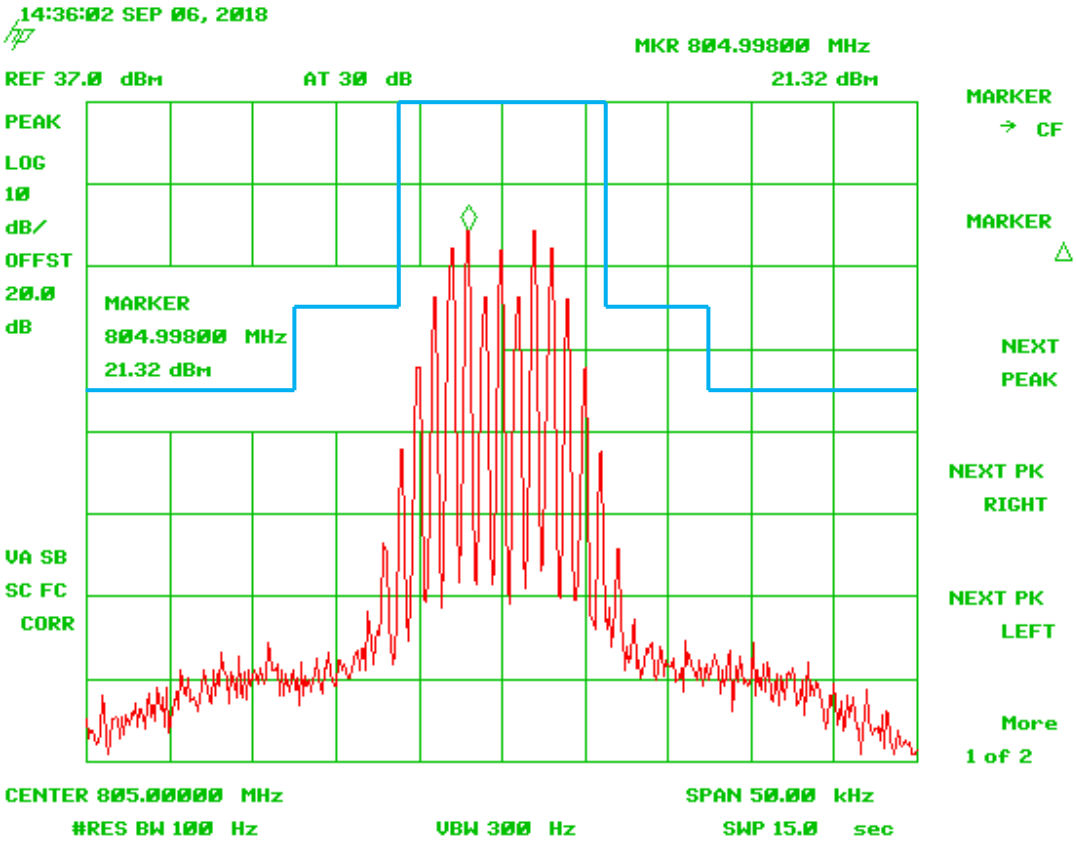

Figure 128. 805 MHz @ 12.5 kHz + 3.0 dB, Mask B

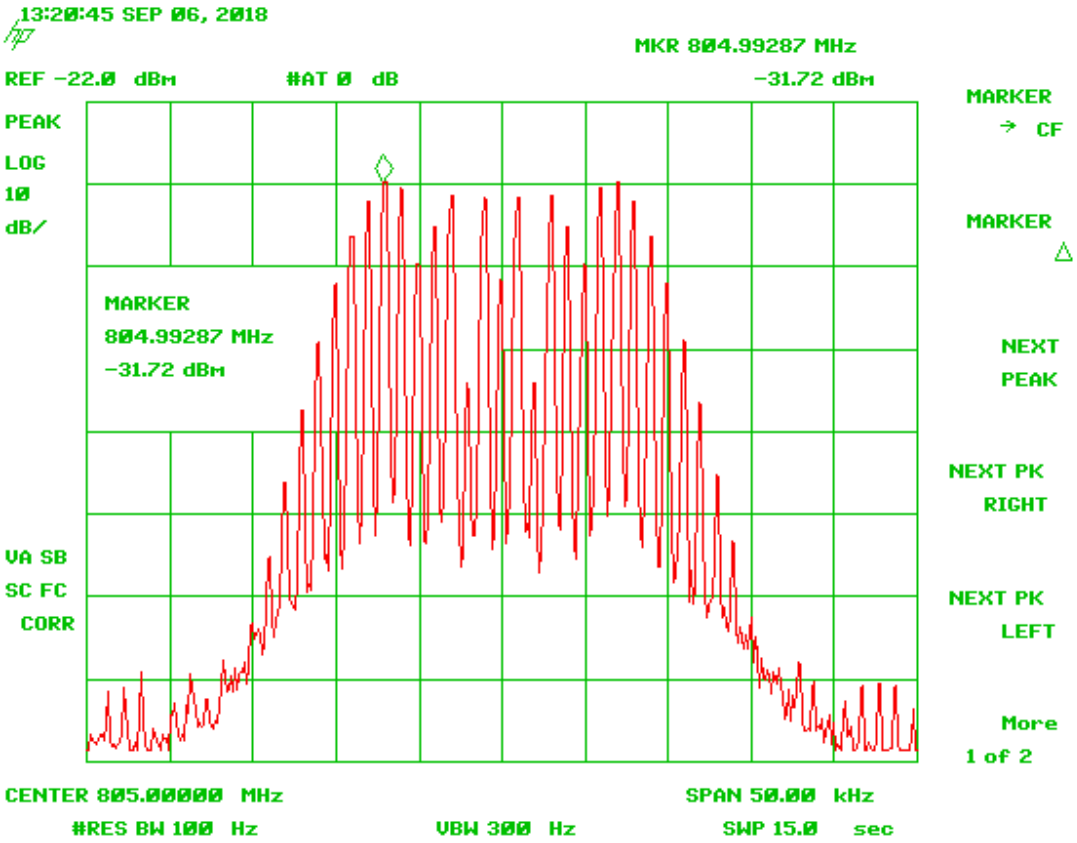

Figure 129. Input 805 MHz @ 25 kHz

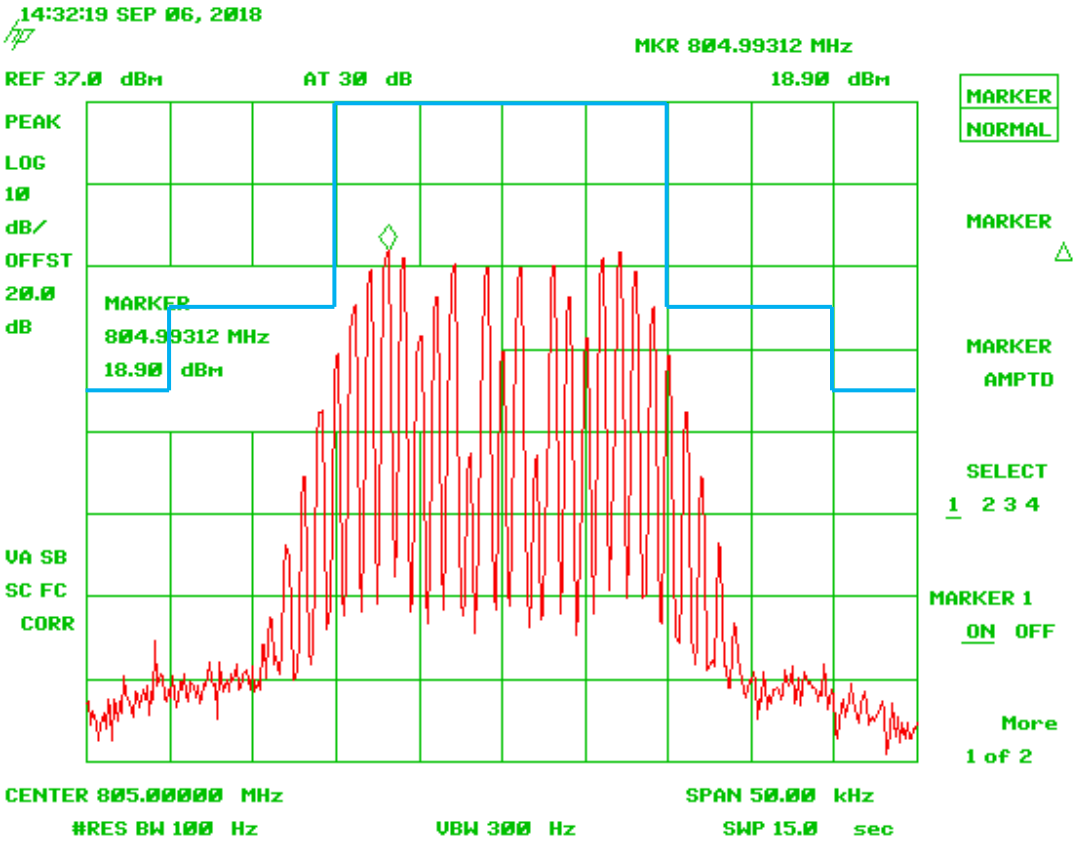

Figure 130. 805 MHz @ 25 kHz, Mask B

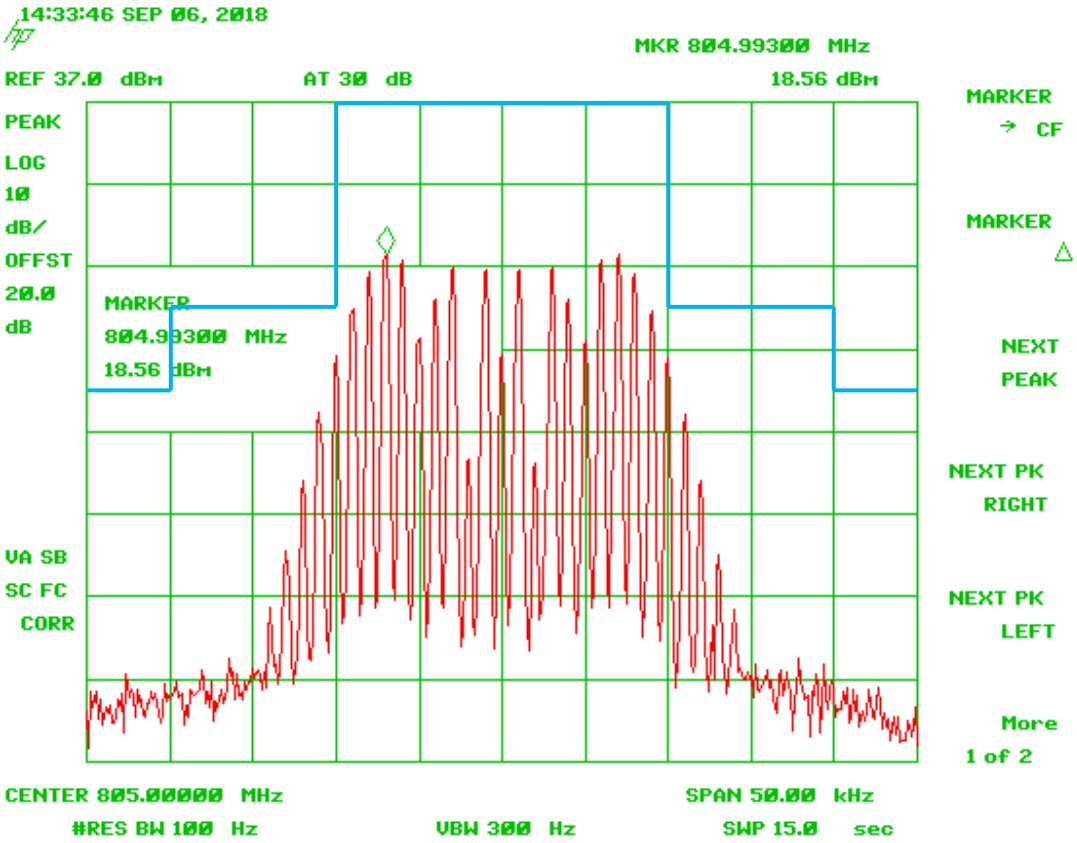

Figure 131. 805 MHz @ 25 kHz + 3.0 dB, Mask B

2.13.4 800 MHz Channel

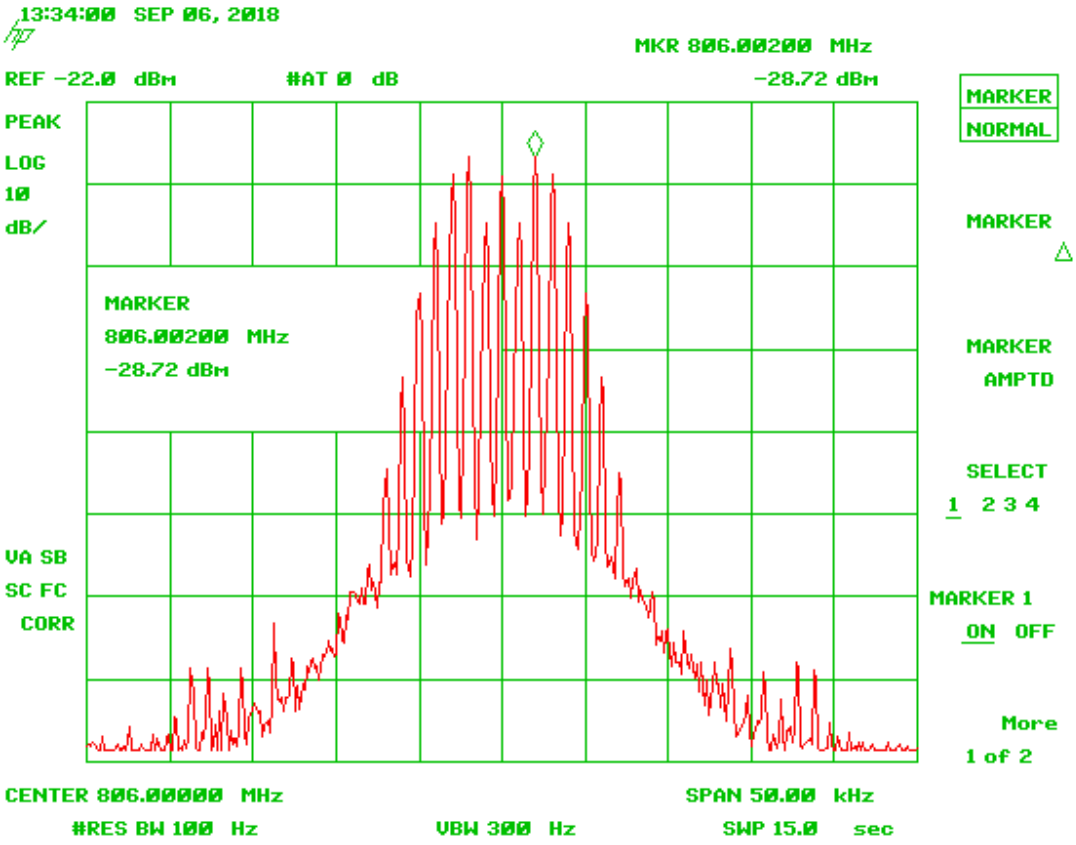

Figure 132. Input 806 MHz @ 12.5 kHz

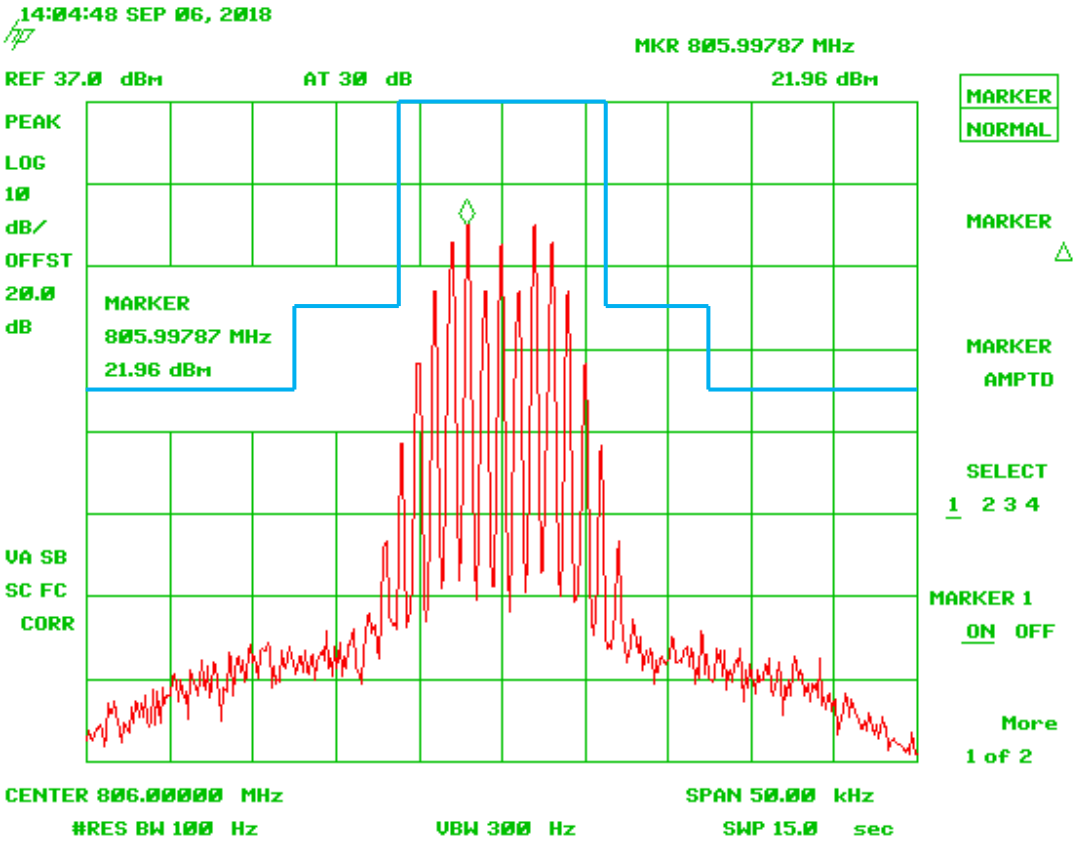

Figure 133. 806 MHz @ 12.5 kHz, Mask B

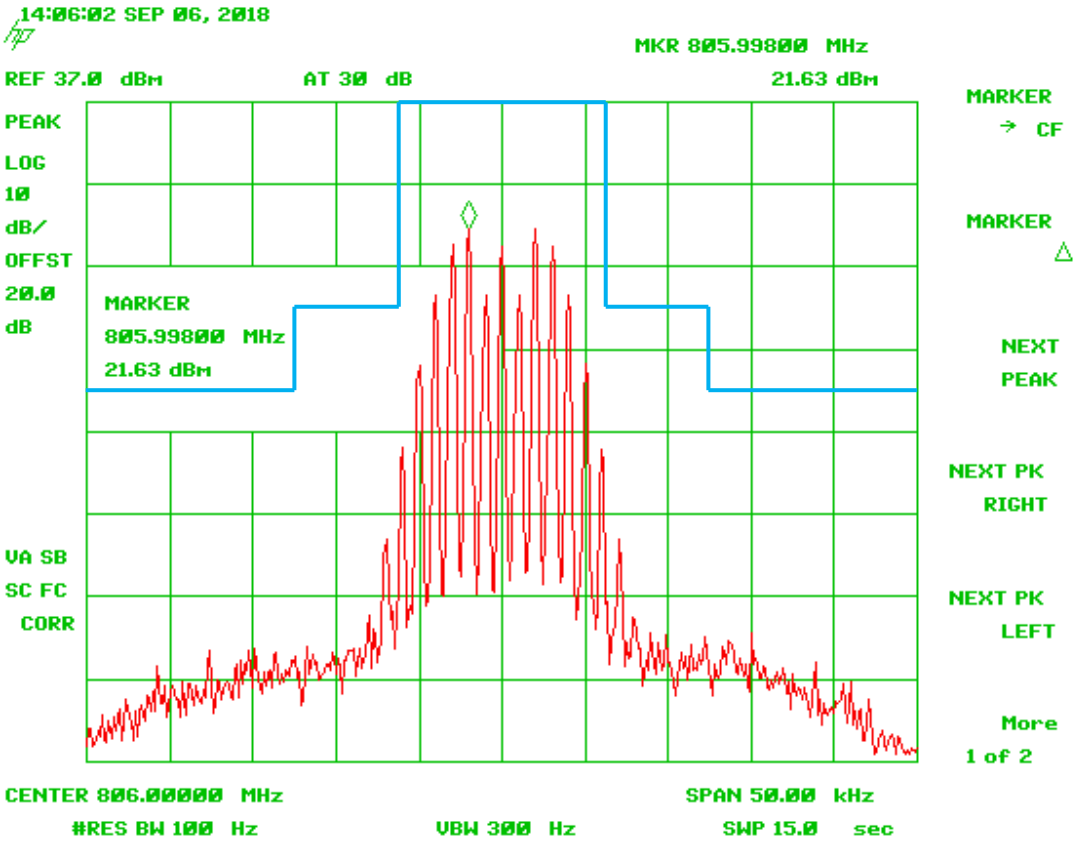

Figure 134. 806 MHz @ 12.5 kHz + 3.0 dB, Mask B

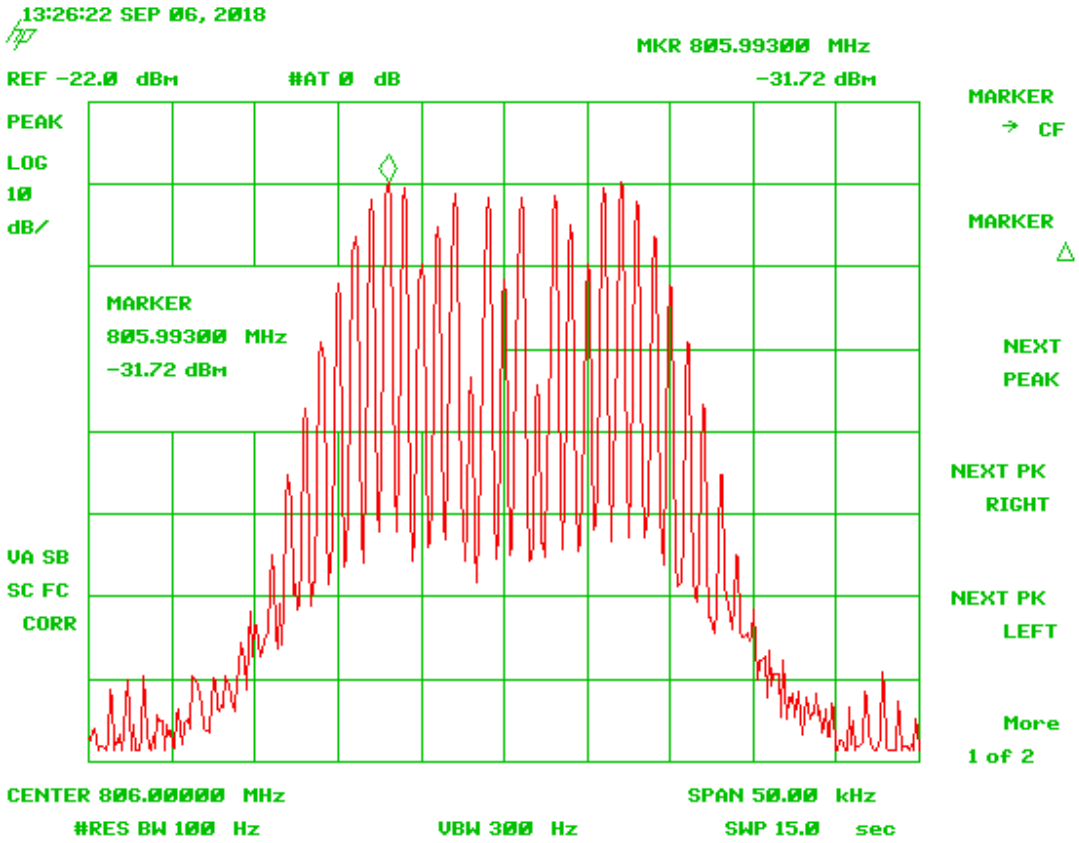

Figure 135. Input 806 MHz @ 25 kHz

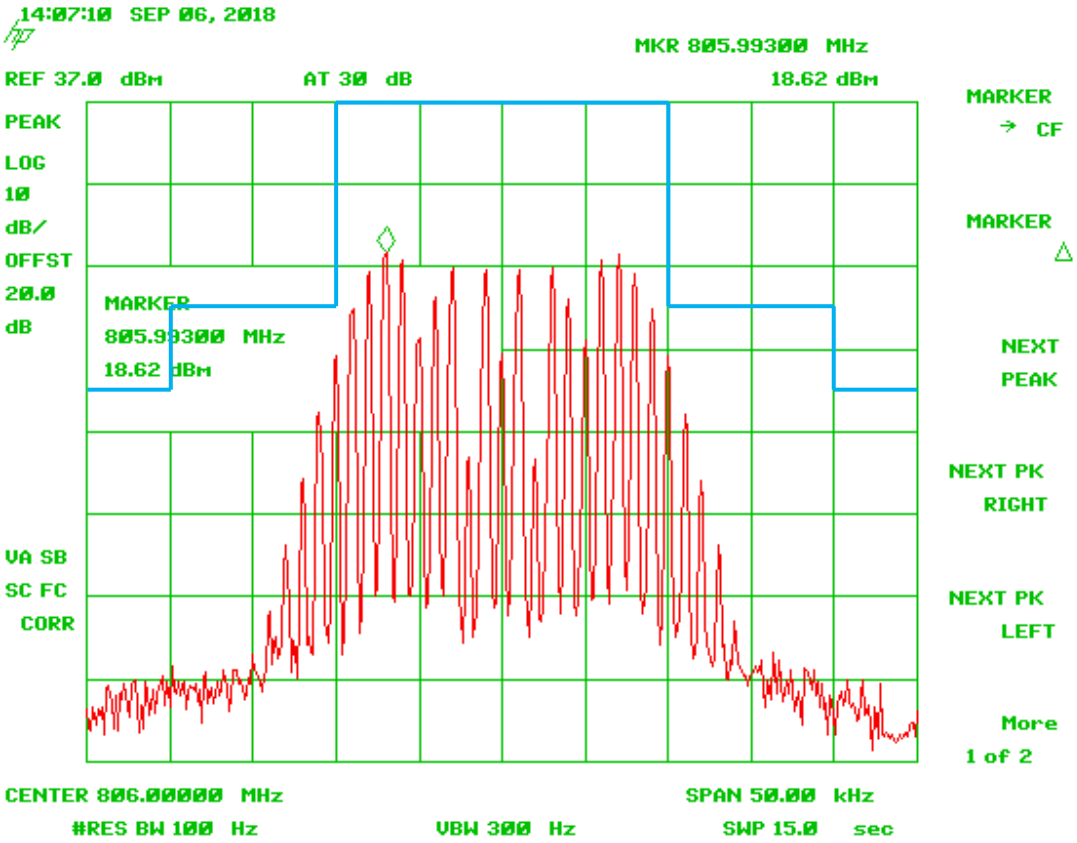

Figure 136. 806 MHz @ 25 kHz, Mask B

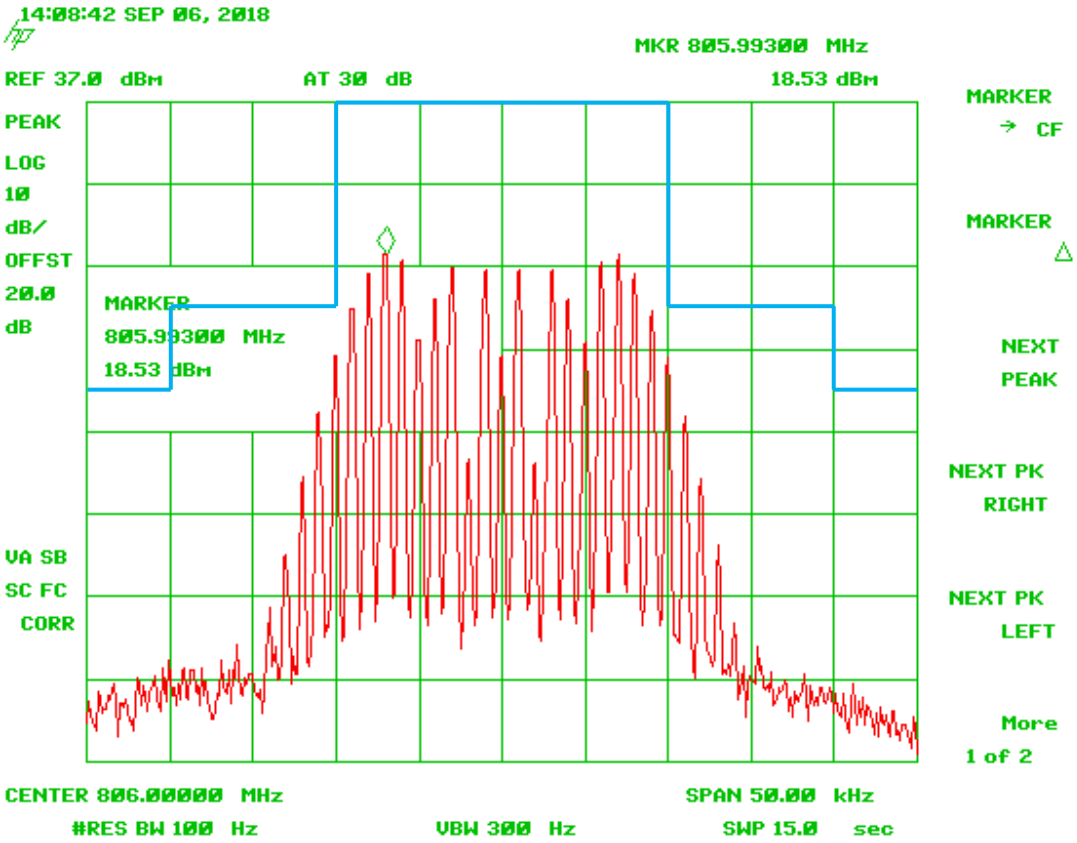

Figure 137. 806 MHz @ 25 kHz + 3.0 dB, Mask B

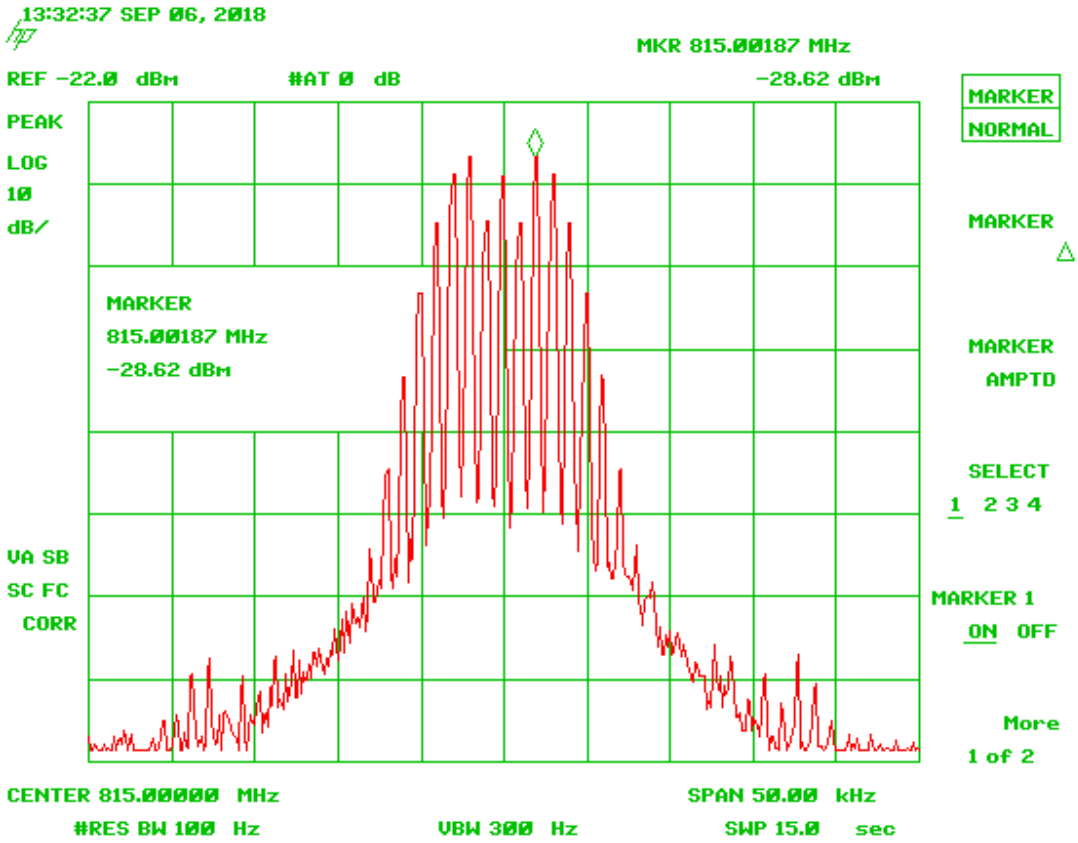

Figure 138. Input 815 MHz @ 12.5 kHz

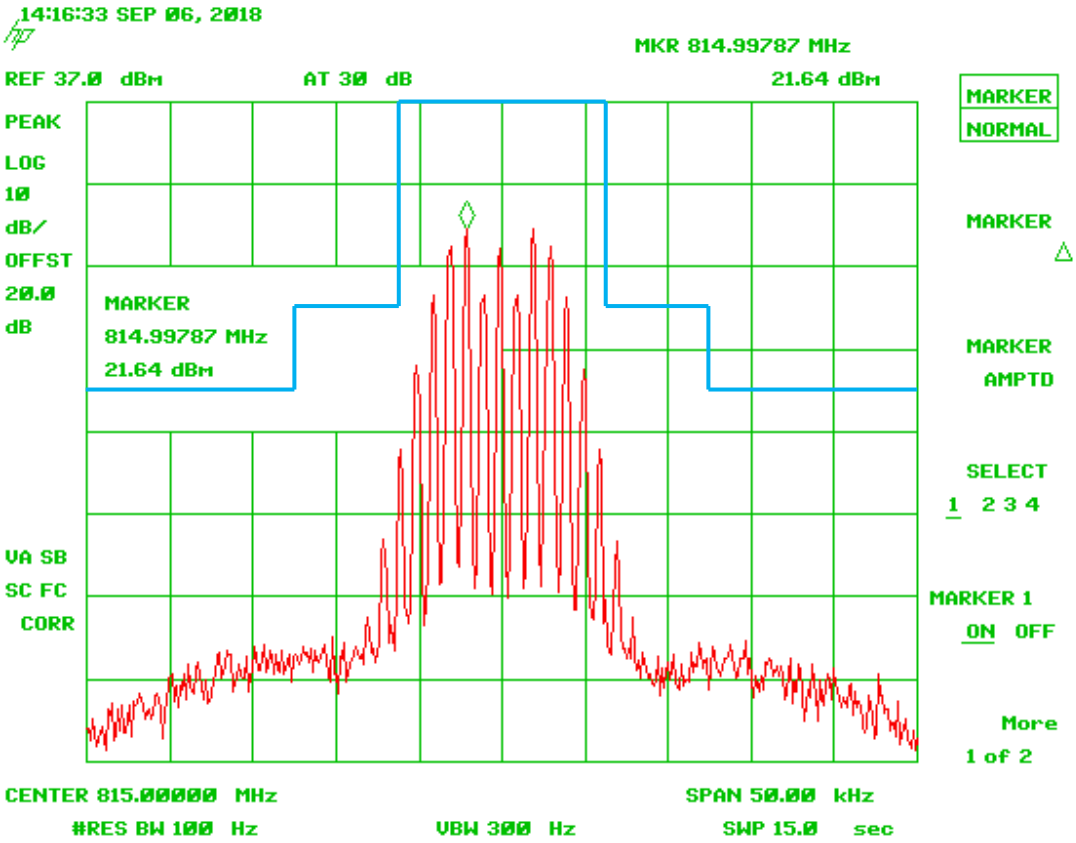

Figure 139. 815 MHz @ 12.5 kHz, Mask B

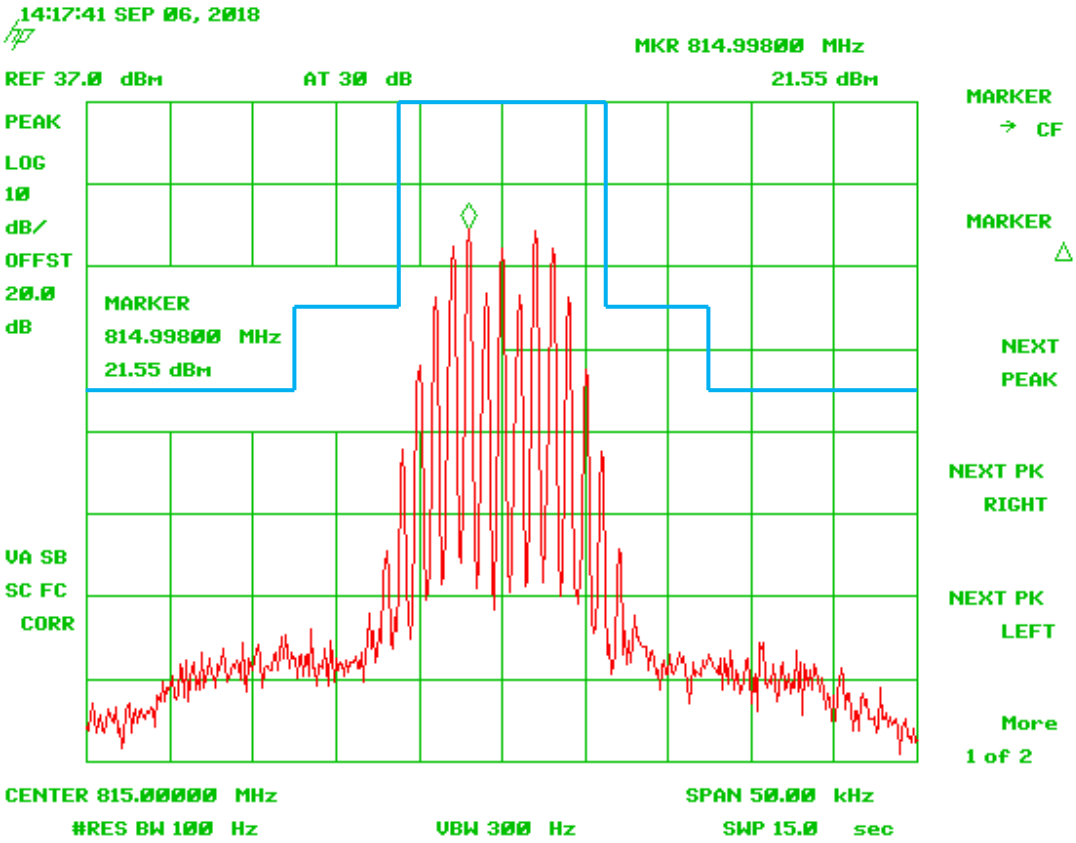

Figure 140. 815 MHz @ 12.5 kHz + 3.0 dB, Mask B

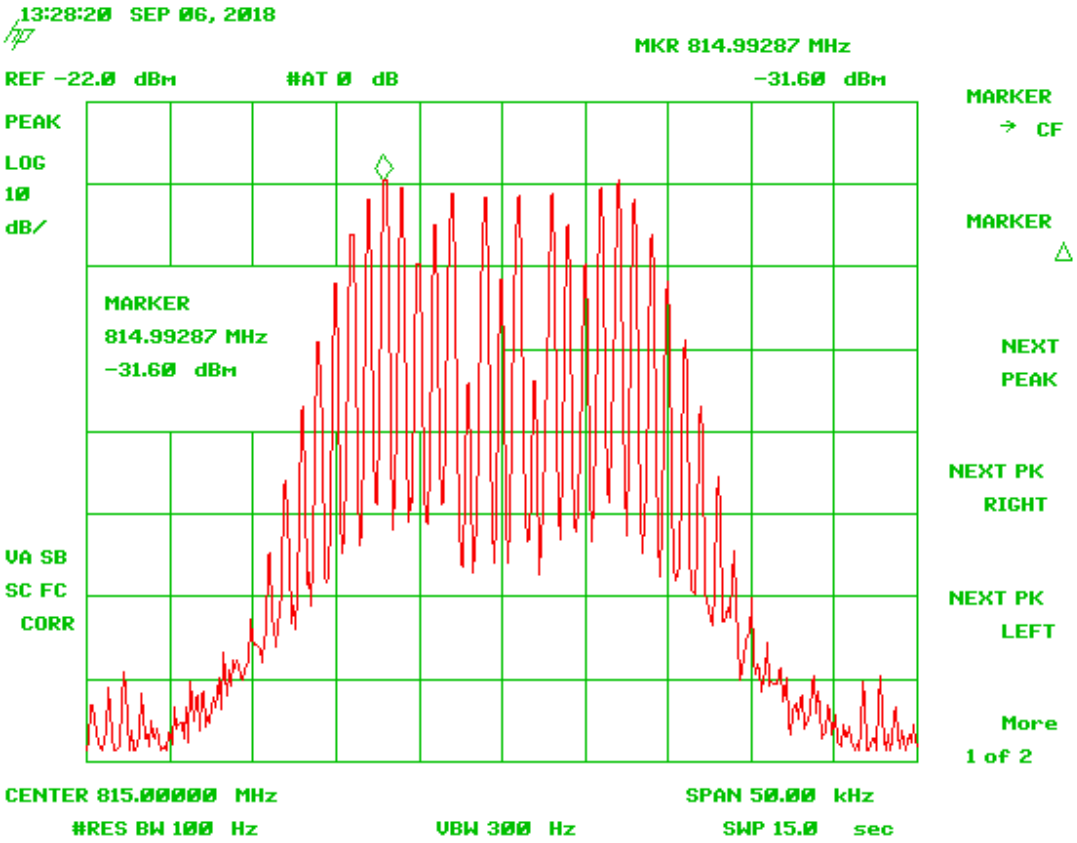

Figure 141. Input 815 MHz @ 25 kHz

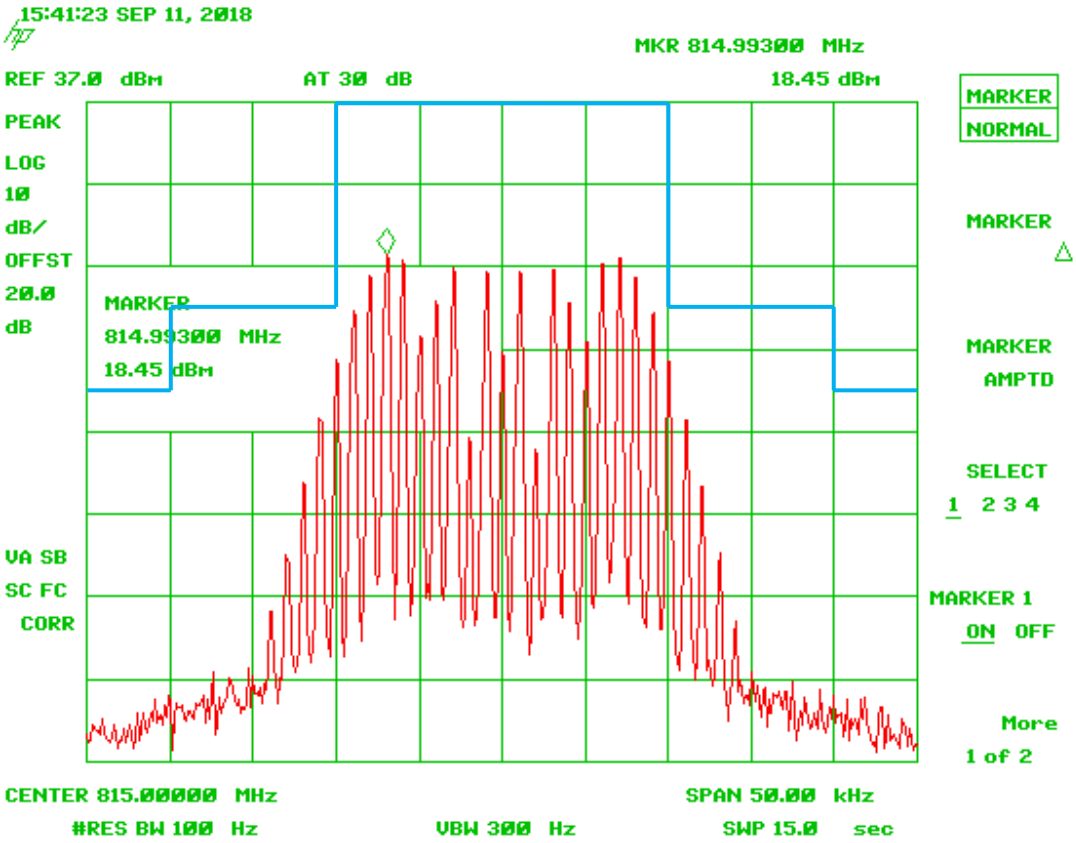

Figure 142. 815 MHz @ 25 kHz, Mask B

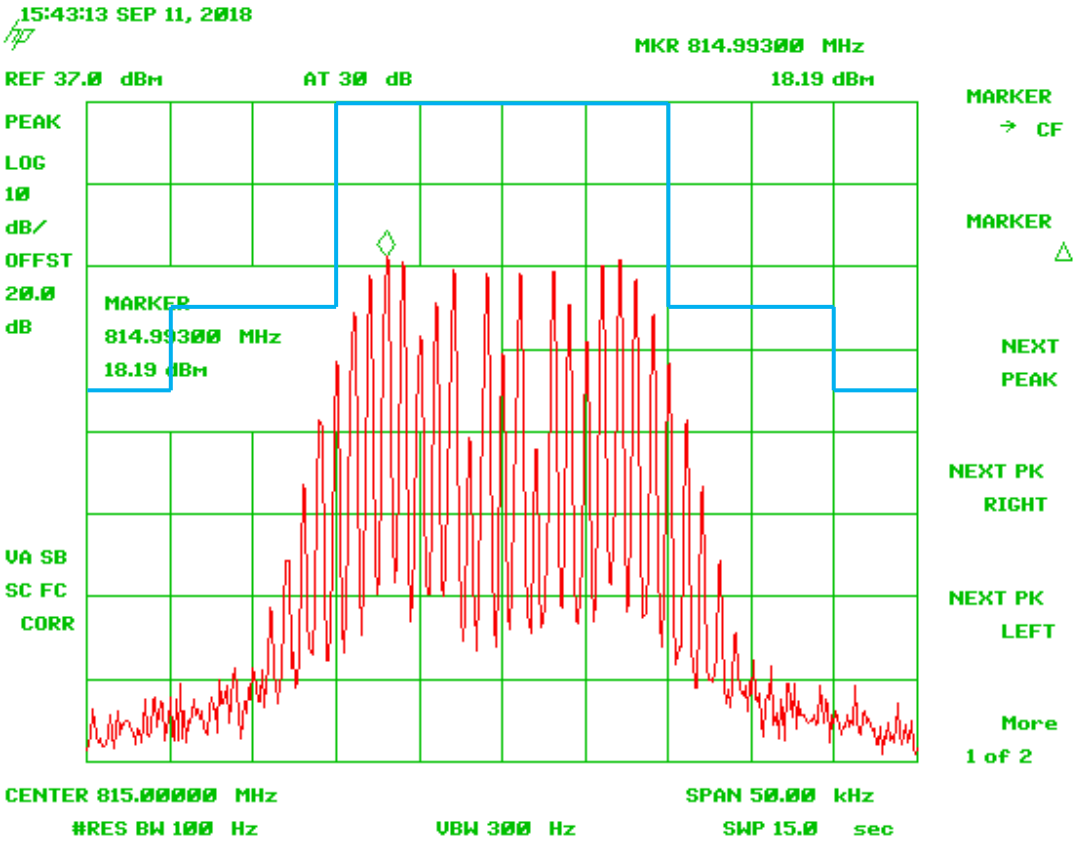

Figure 143. 815 MHz @ 25 kHz +3.0 dB, Mask B

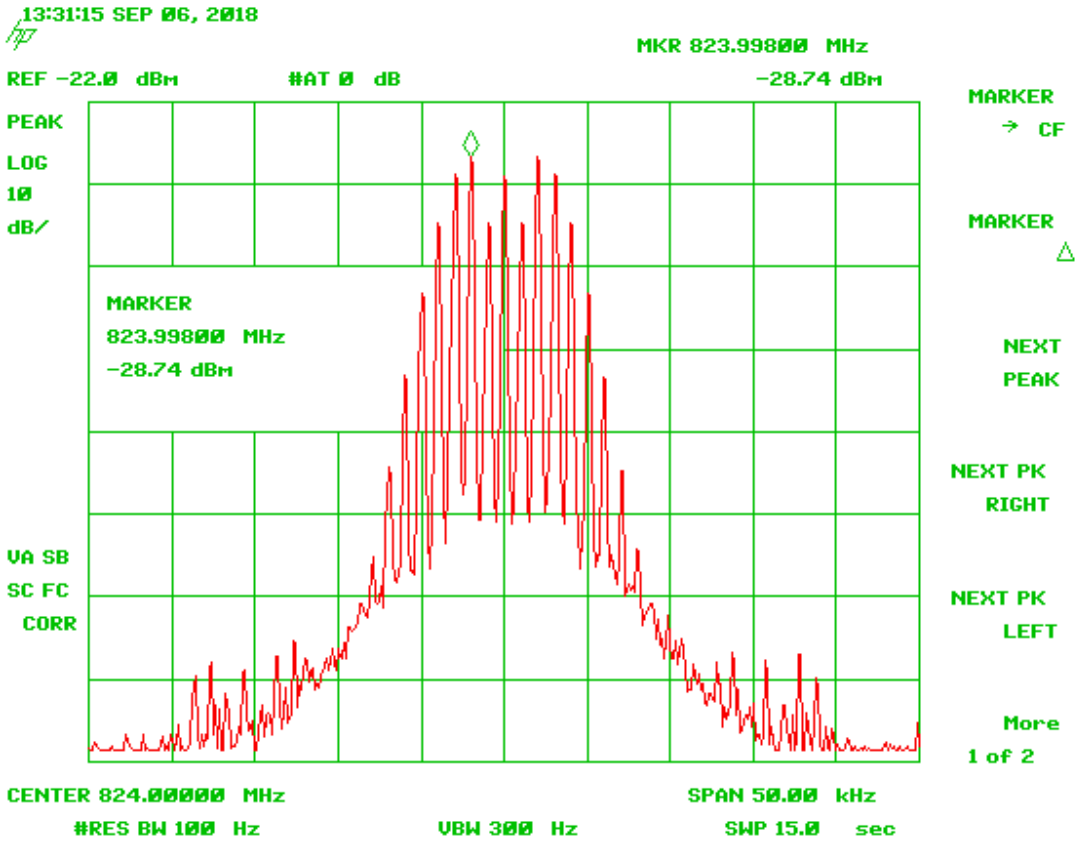

Figure 144. Input 824 MHz @ 12.5 kHz

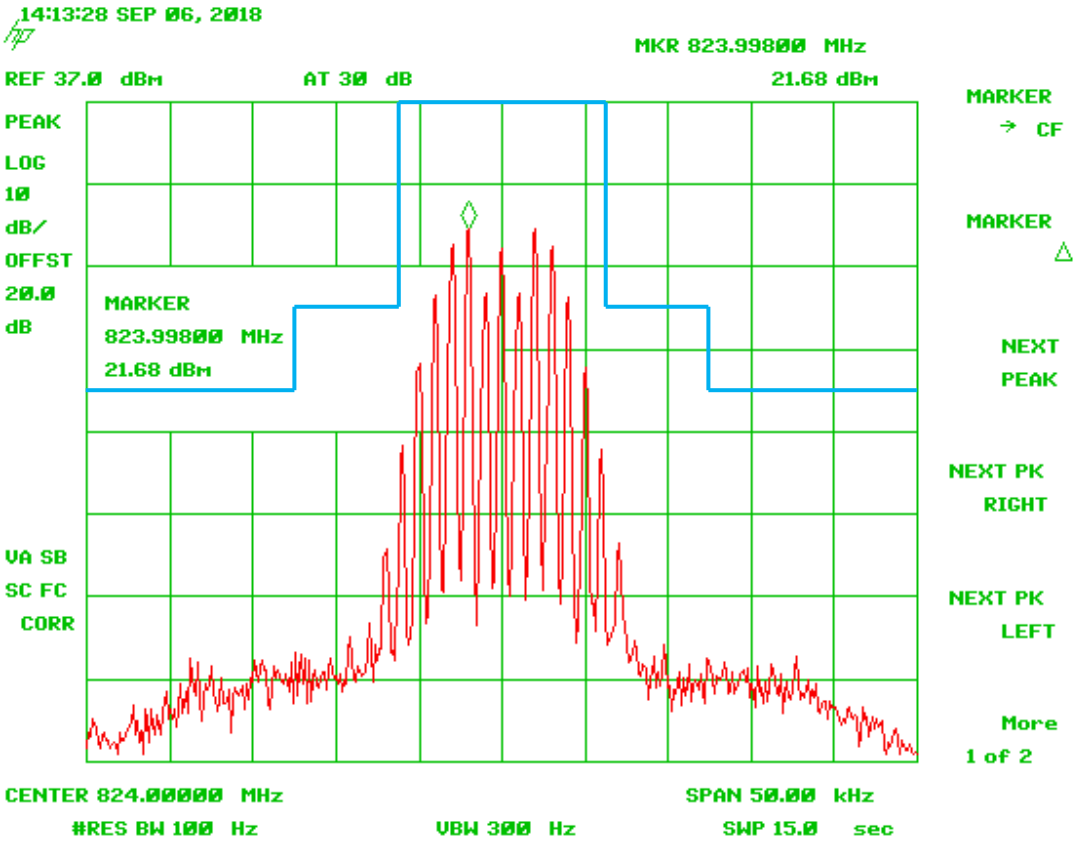

Figure 145. 824 MHz @ 12.5 kHz, Mask B

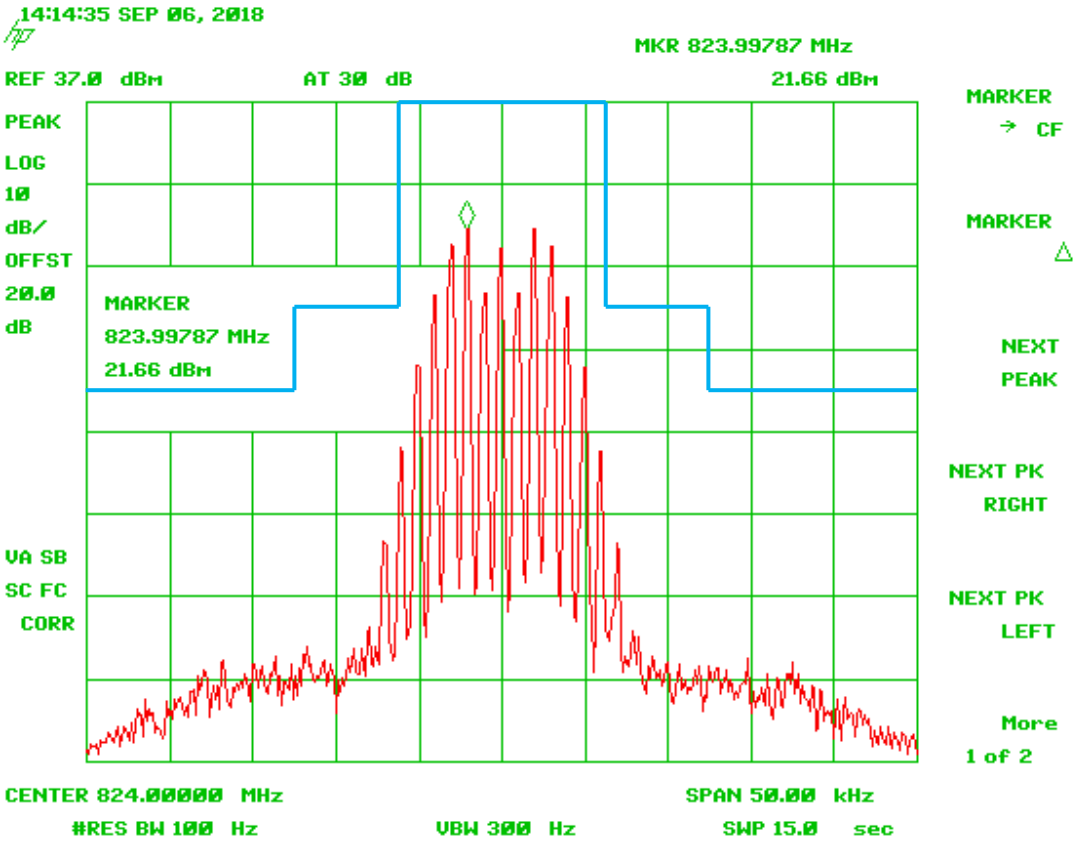

Figure 146. 824 MHz @ 12.5 kHz + 3.0 dB, Mask B

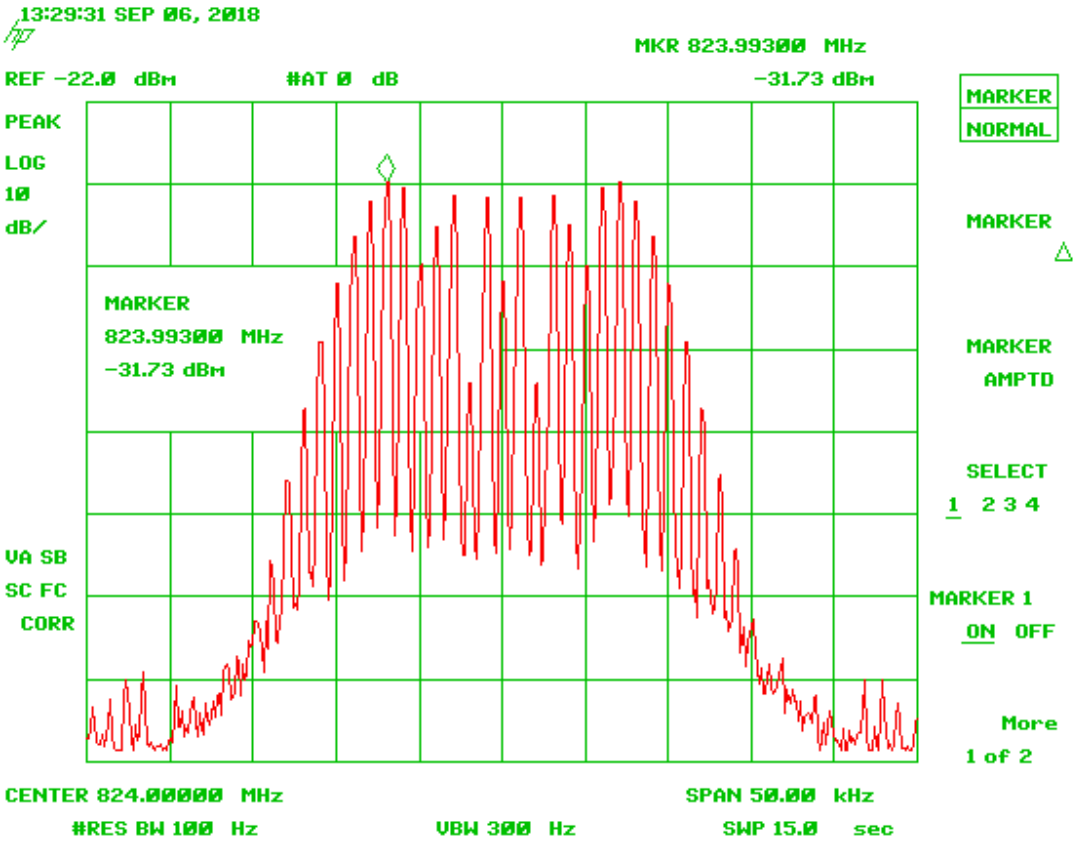

Figure 147. Input 824 MHz @ 25 kHz

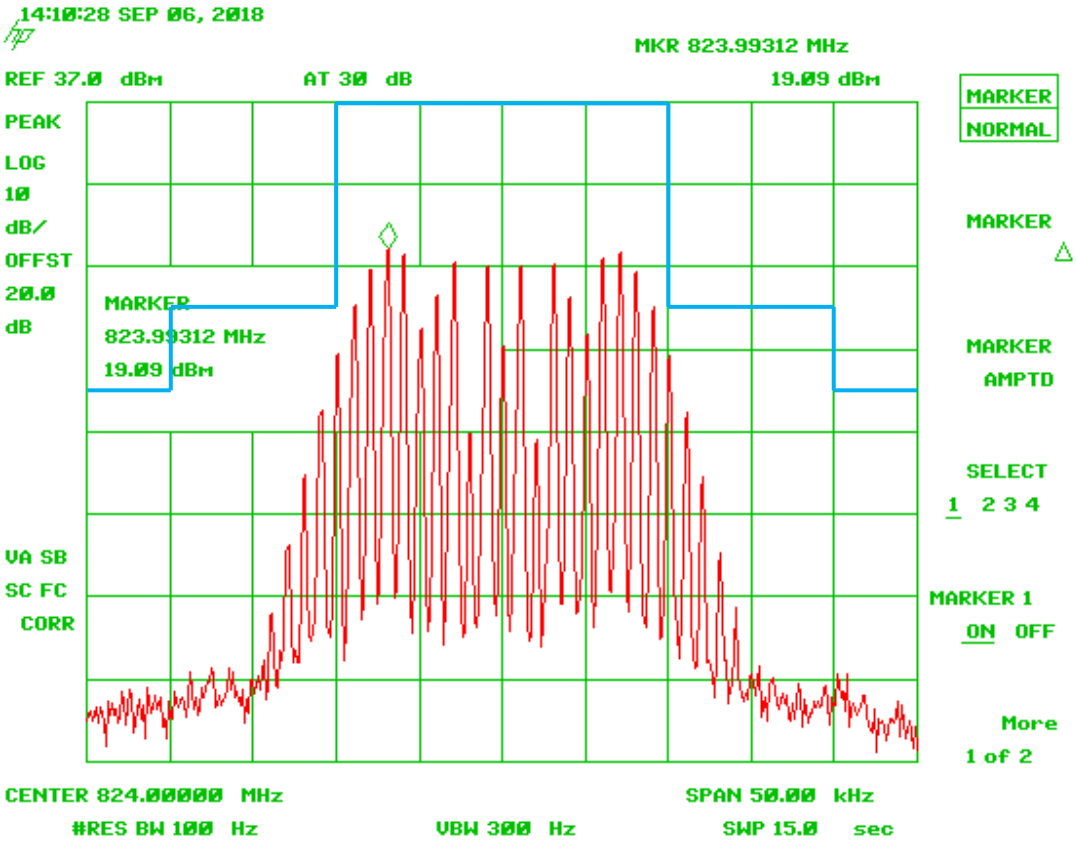

Figure 148. 824 MHz @ 25 kHz, Mask B

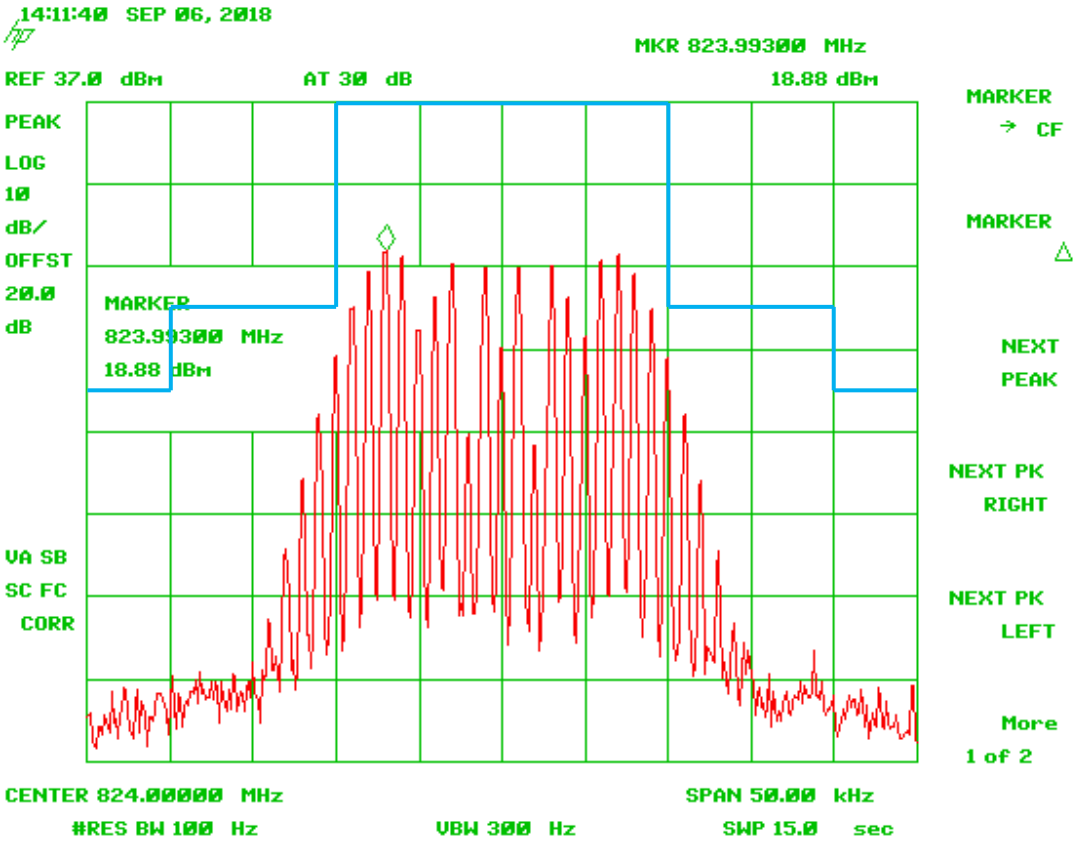

Figure 149. 824 MHz @ 25 kHz + 3.0 dB, Mask B

2.13.5 900 MHz Channel

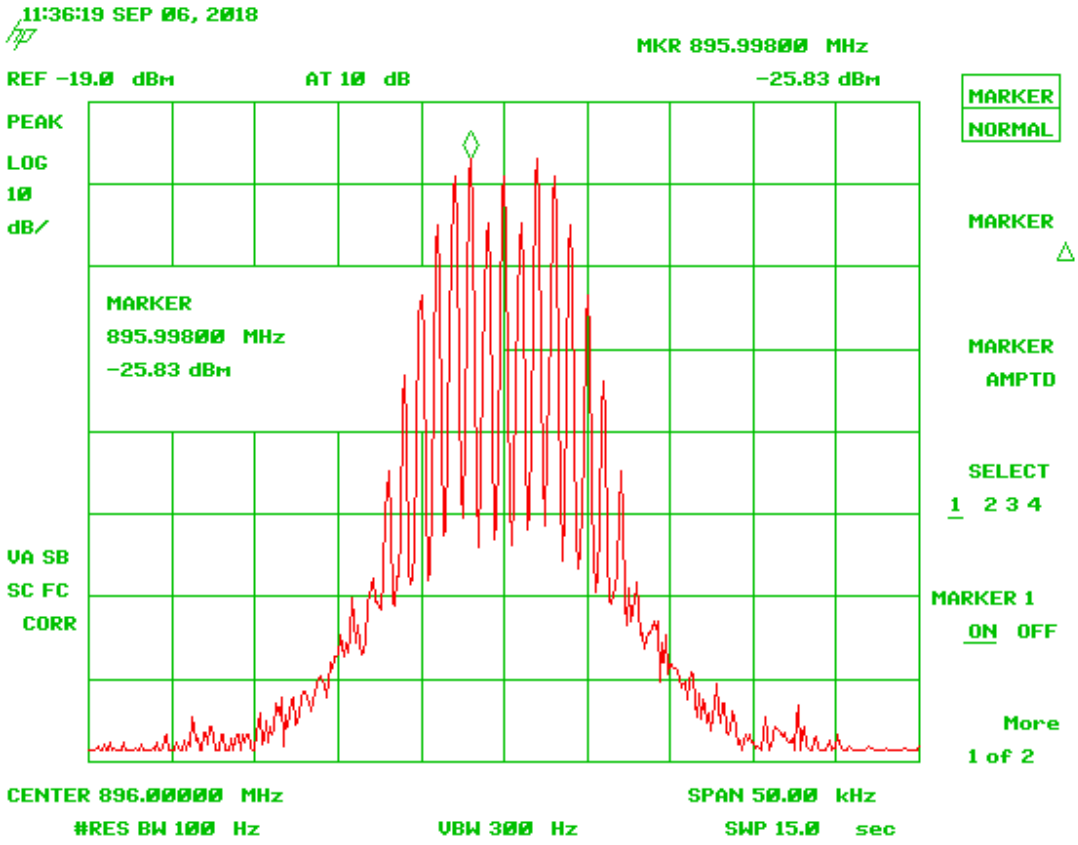

Figure 150. Input 896 MHz @ 12.5 kHz

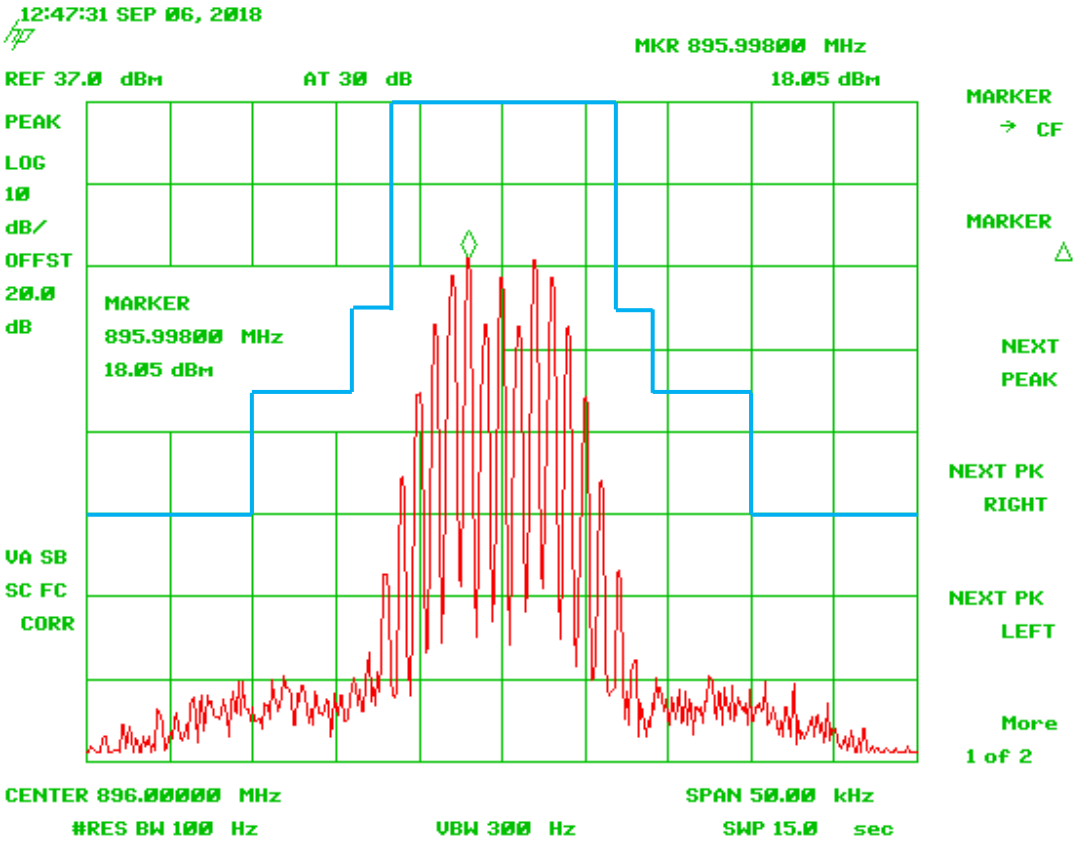

Figure 151. 896 MHz @ 12.5 kHz, Mask I

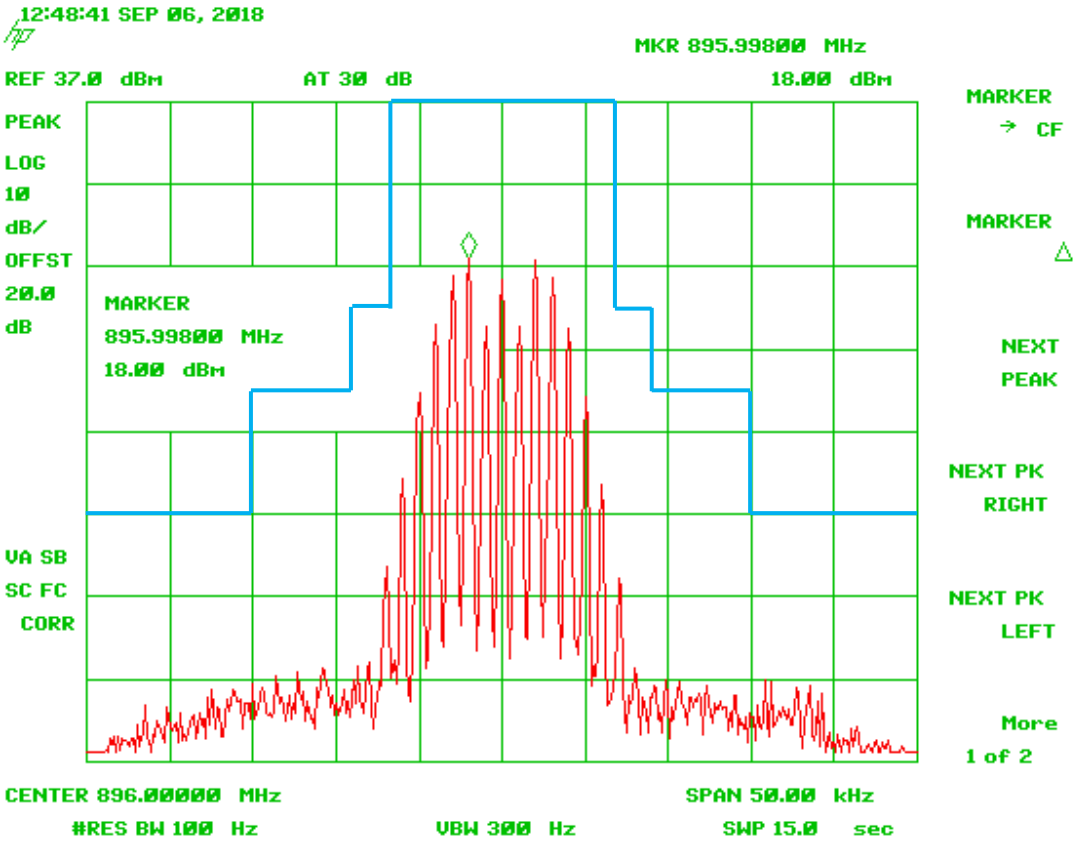

Figure 152. 896 MHz @ 12.5 + 3.0 dB, Mask I

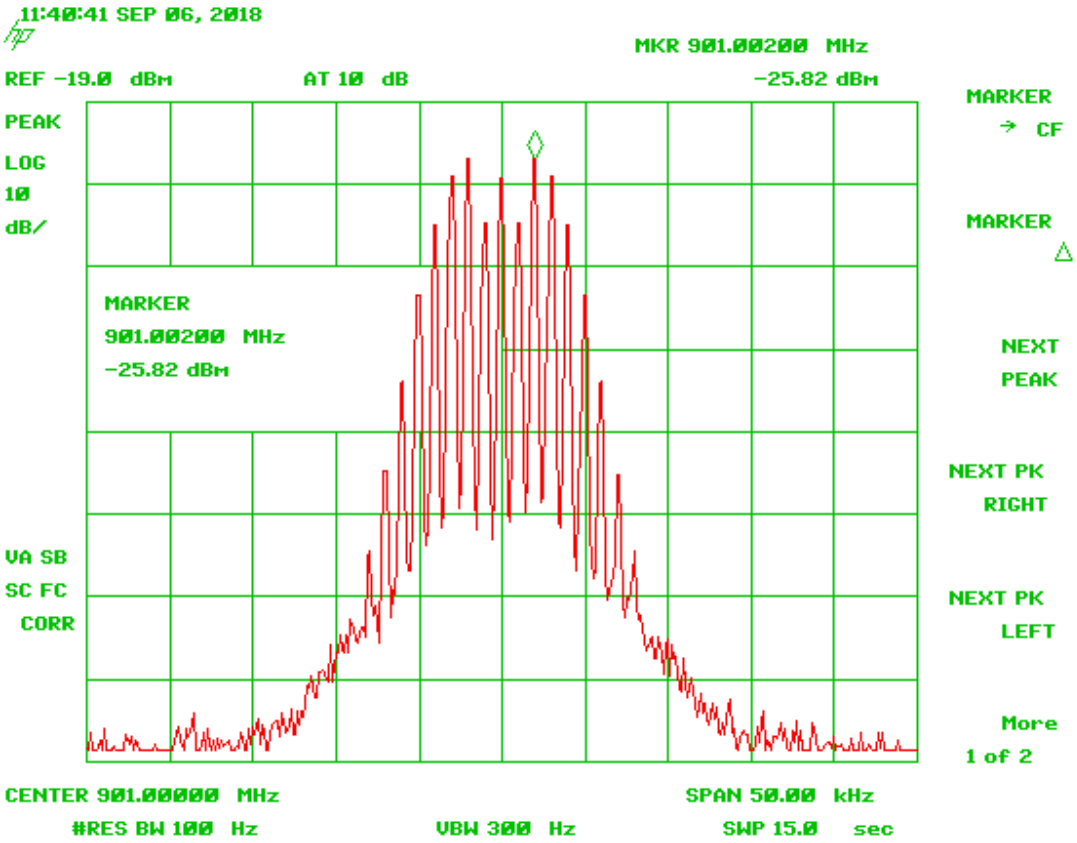

Figure 153. Input 901 MHz @ 12.5 kHz

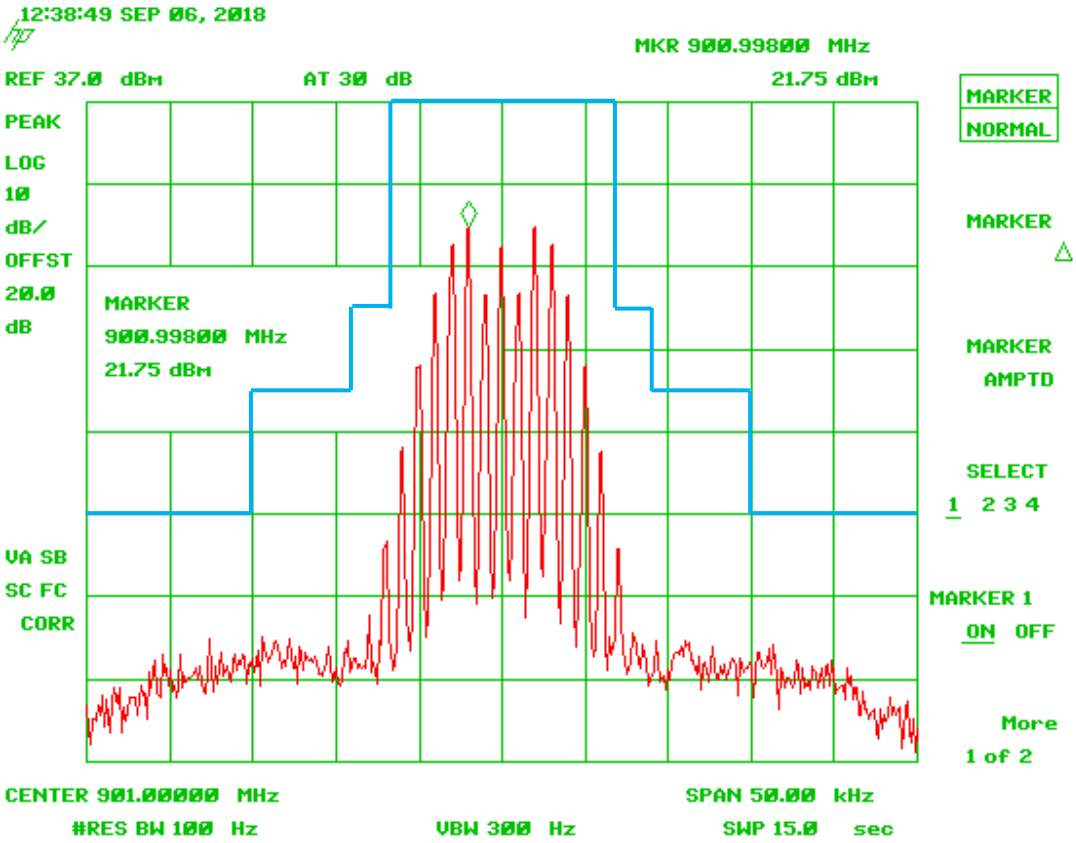

Figure 154. 901 MHz @ 12.5 kHz, Mask I

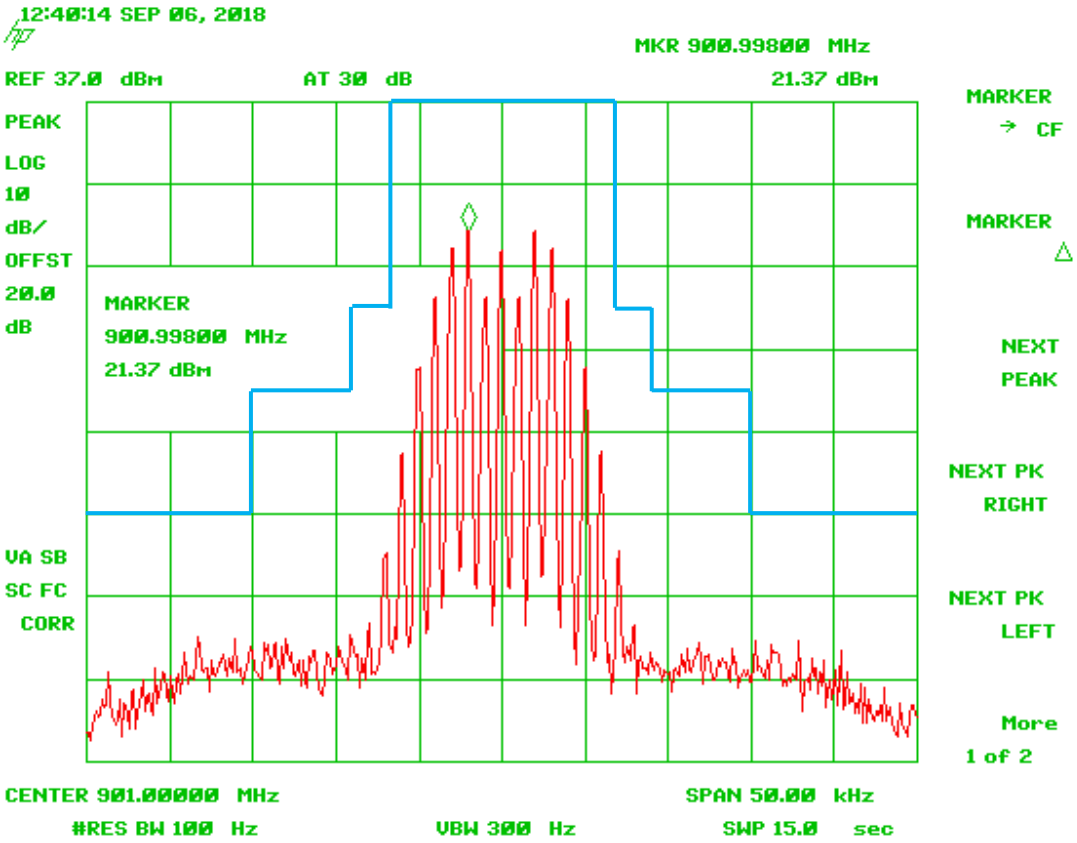

Figure 155. 901 MHz @ 12.5 kHz + 3.0 dB, Mask I

2.14 Spurious Emissions (FCC Section 90.219(d)(e)(3) and RSS-131, 6.5) - Uplink

Spurious Emissions from a signal booster must not exceed -13 dBm within any 100 kHz measurement bandwidth.

2.14.1 Radiated Spurious Emissions Measurement

The EUT was tested in a semi-anechoic chamber. The EUT was set on a turntable with the EUT positioned 3m from the receiving antenna. A spectrum analyzer was used to measure the emissions and verify that the levels met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the receiving antenna in both the vertical then horizontal position. The receive antenna was elevated from 1 m to 4 m to ensure that the maximum emission was captured. A signal generator was used to provide a signal to exercise the channel cards within the EUT. The EUT output was terminated with a 50 ohm non-radiating load.

The RBW was set to 100 KHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz. The VBW was 3 times the RBW.

FCC limit = -13 dBm (Assuming EIPR)
Radiated emission limit = -13 dBm - 20 log(3m) +104.8 = 82.25 dBuV/m

The following plots show the worst-case results, which were measured with the antennas in both horizontal and vertical position.

2.14.1.1 VHF Radiated Spurious Emissions Plots

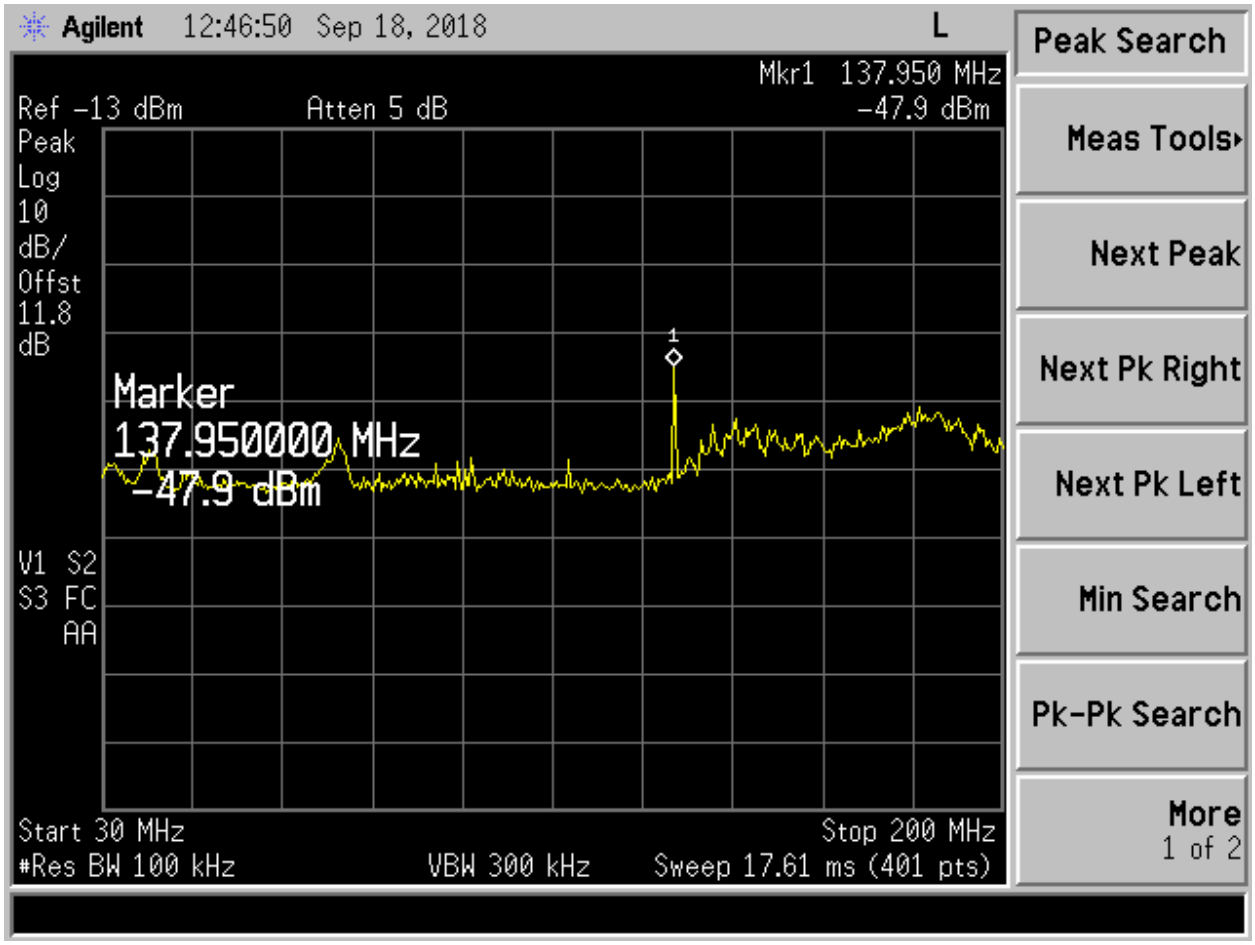

Figure 156. 138 MHz Horizontal, 30 – 200 MHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

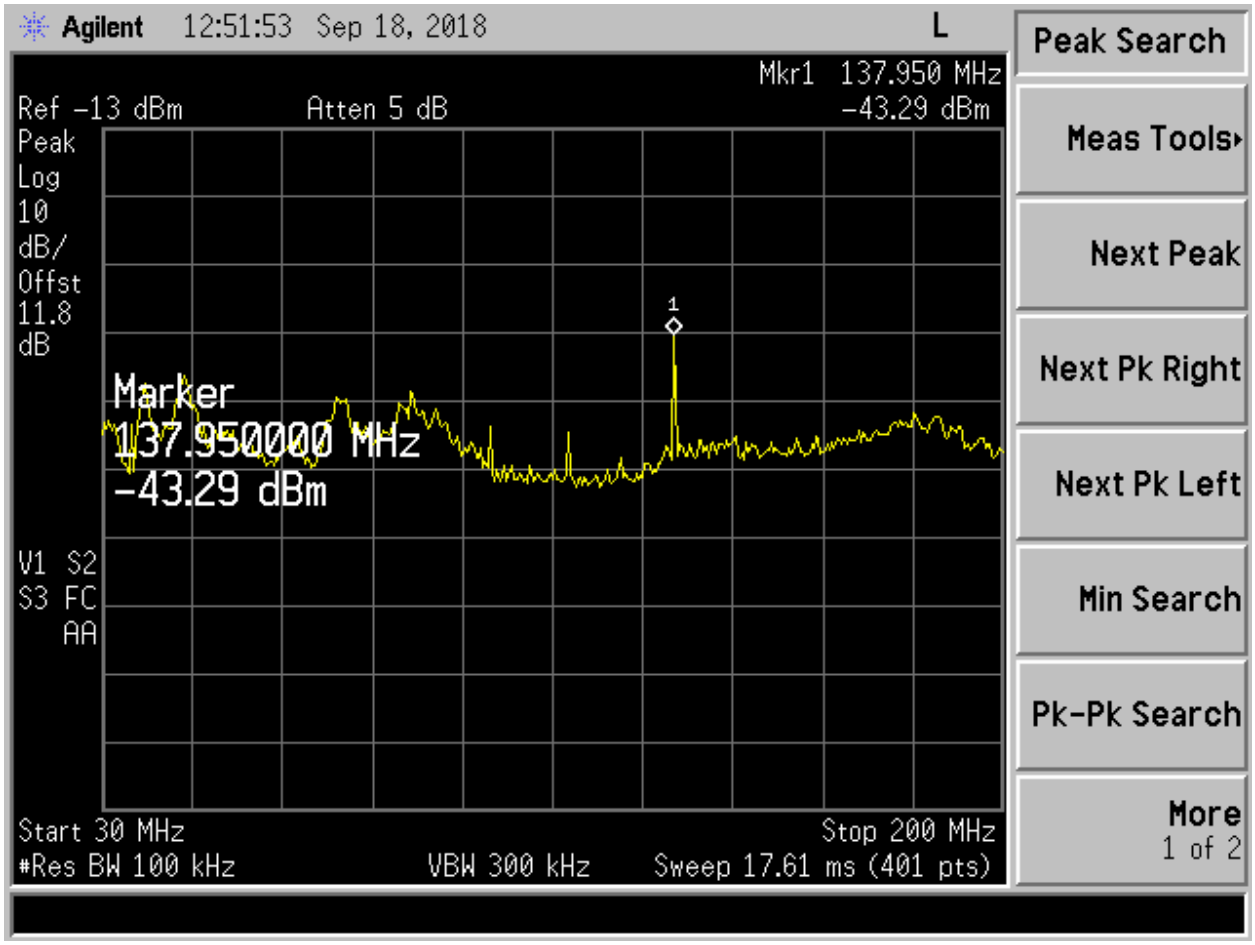

Figure 157. 138 MHz Vertical, 30 – 200 MHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

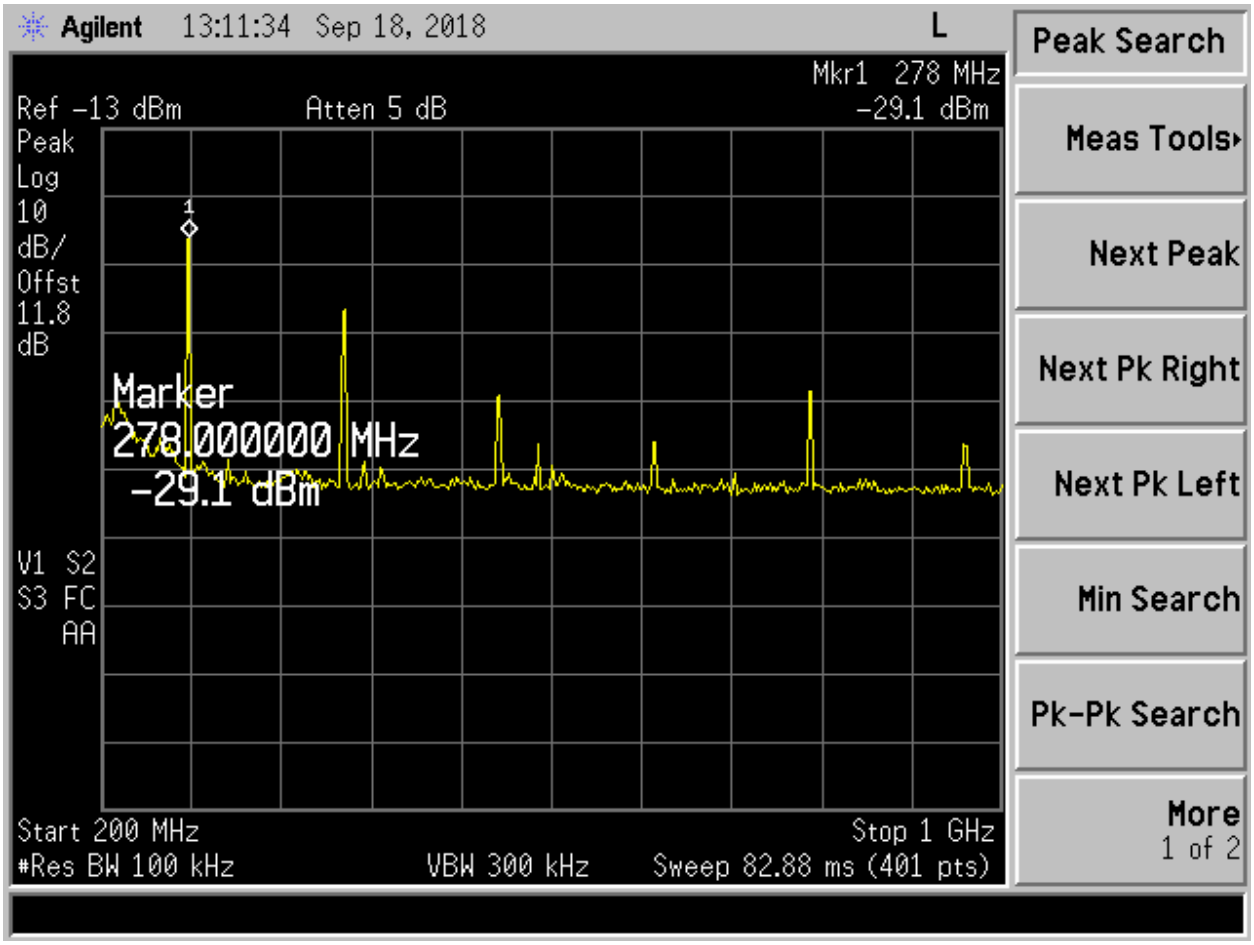

Figure 158. 138 MHz Horizontal, 200 MHz - 1 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

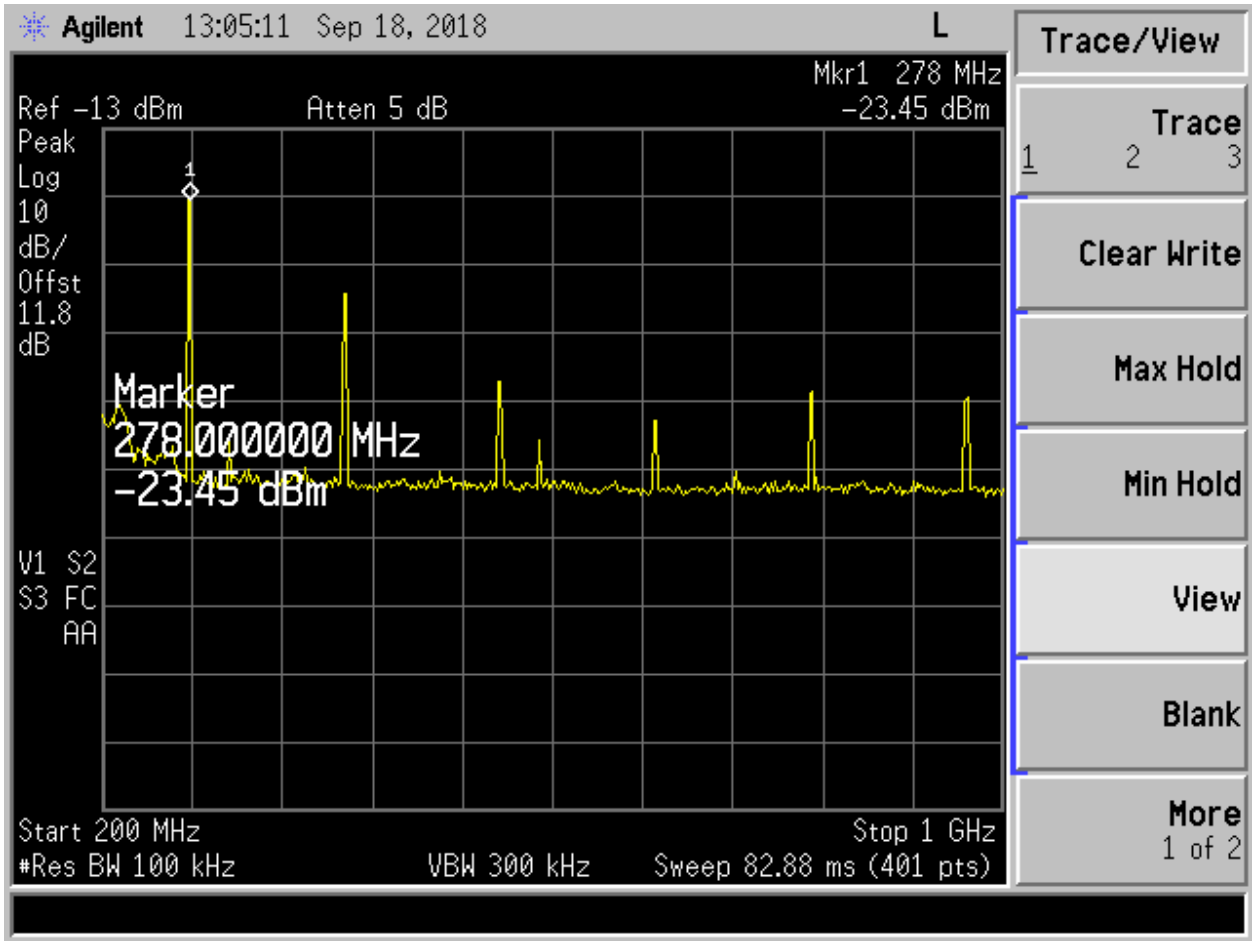

Figure 159. 138 MHz Vertical, 200 MHz - 1 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

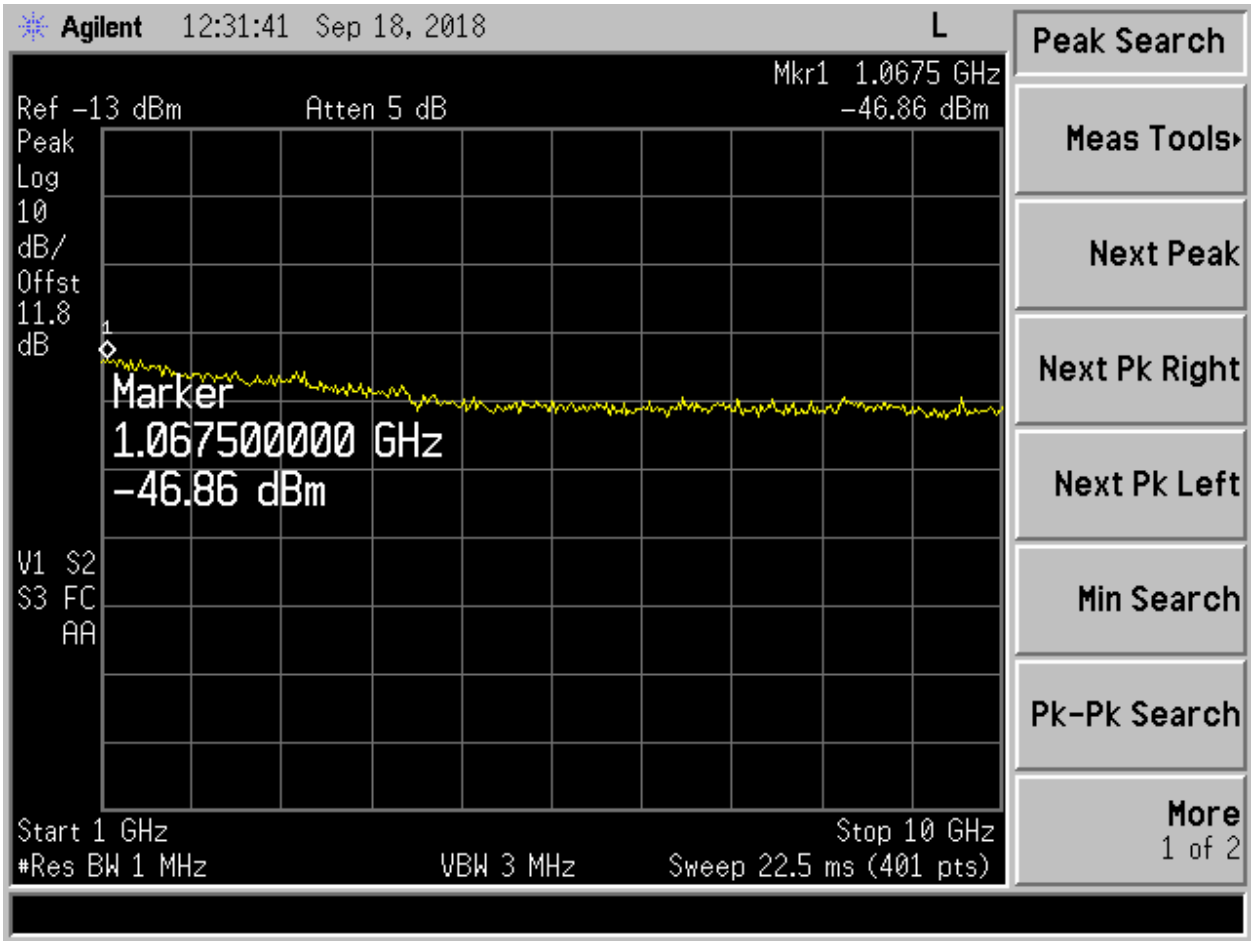

Figure 160. 138 MHz Horizontal, 1 – 10 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

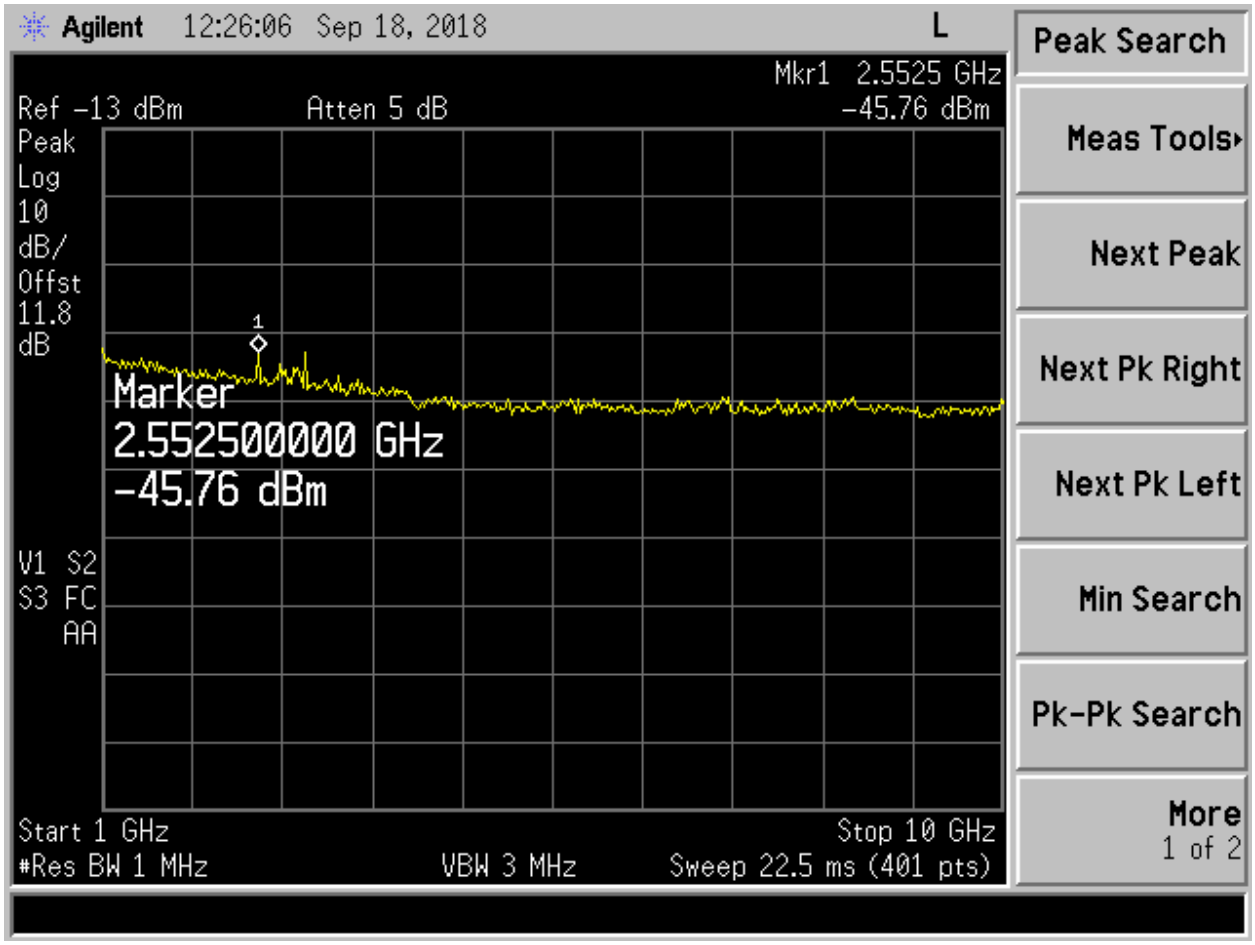

Figure 161. 138 MHz Vertical, 1 – 10 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

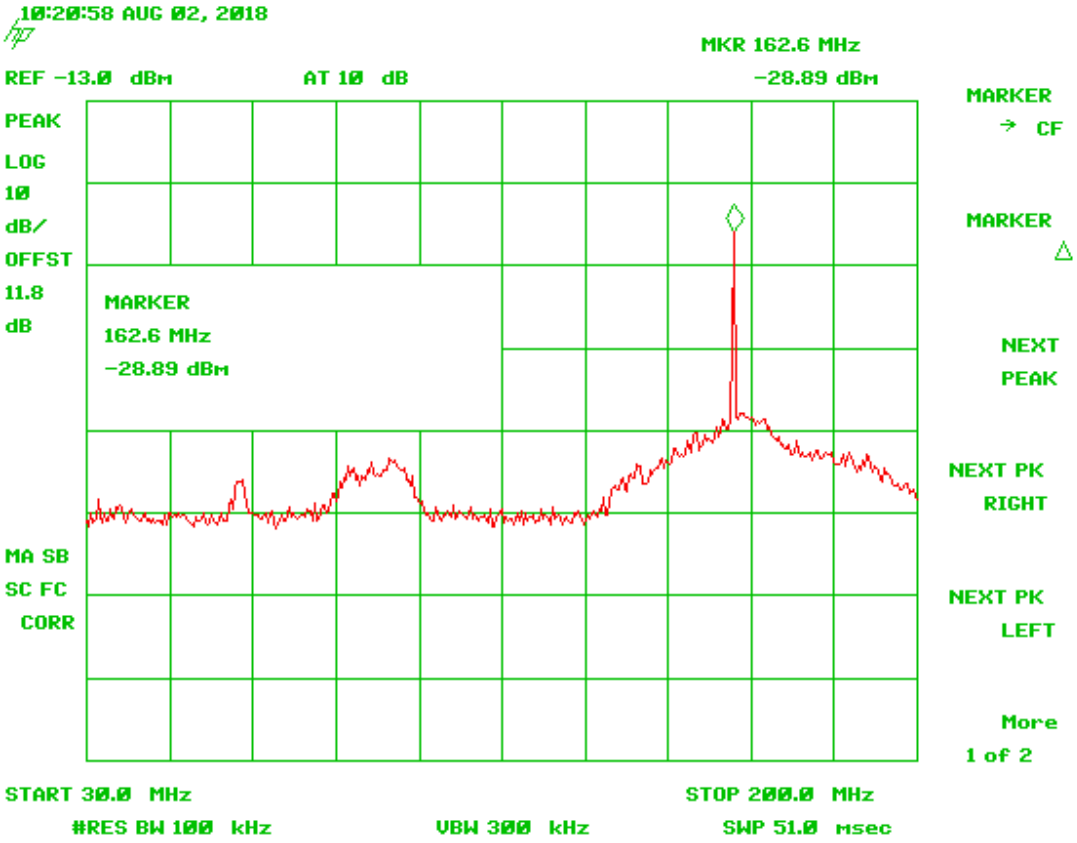

Figure 162. 162 MHz Horizontal, 30 – 200 MHz

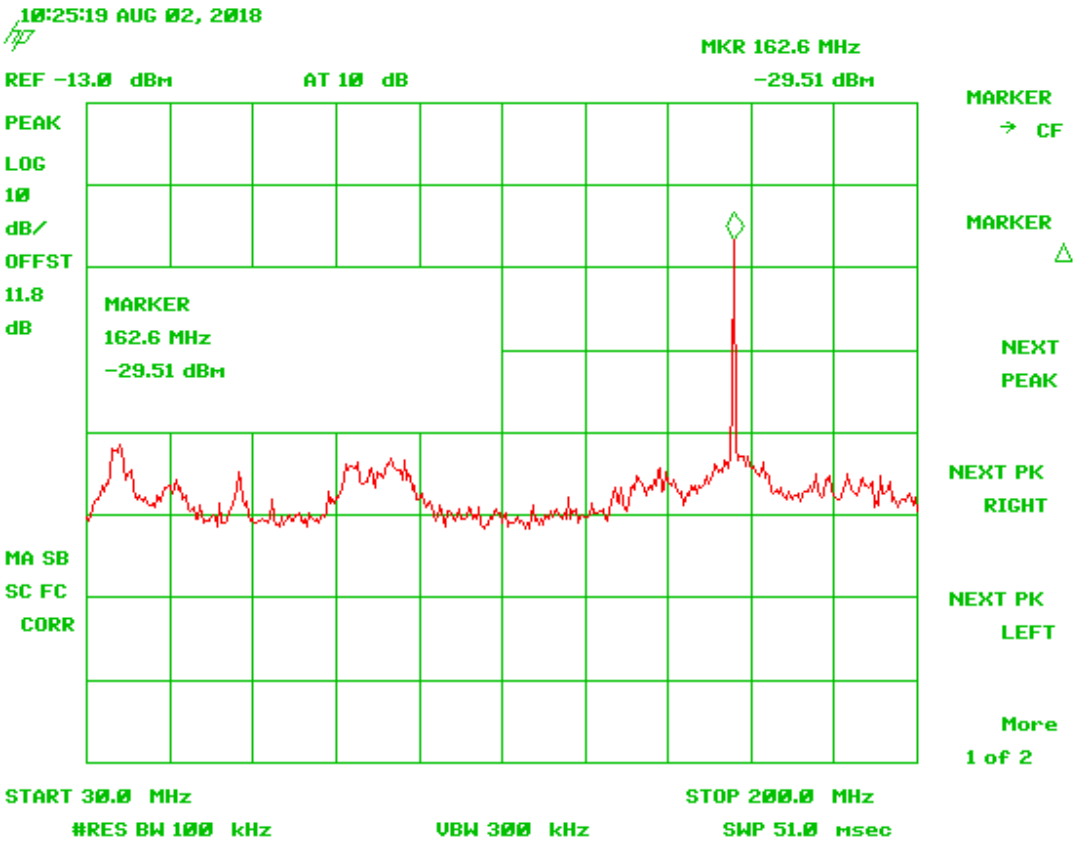

Figure 163. 162 MHz Vertical, 30 - 200 MHz

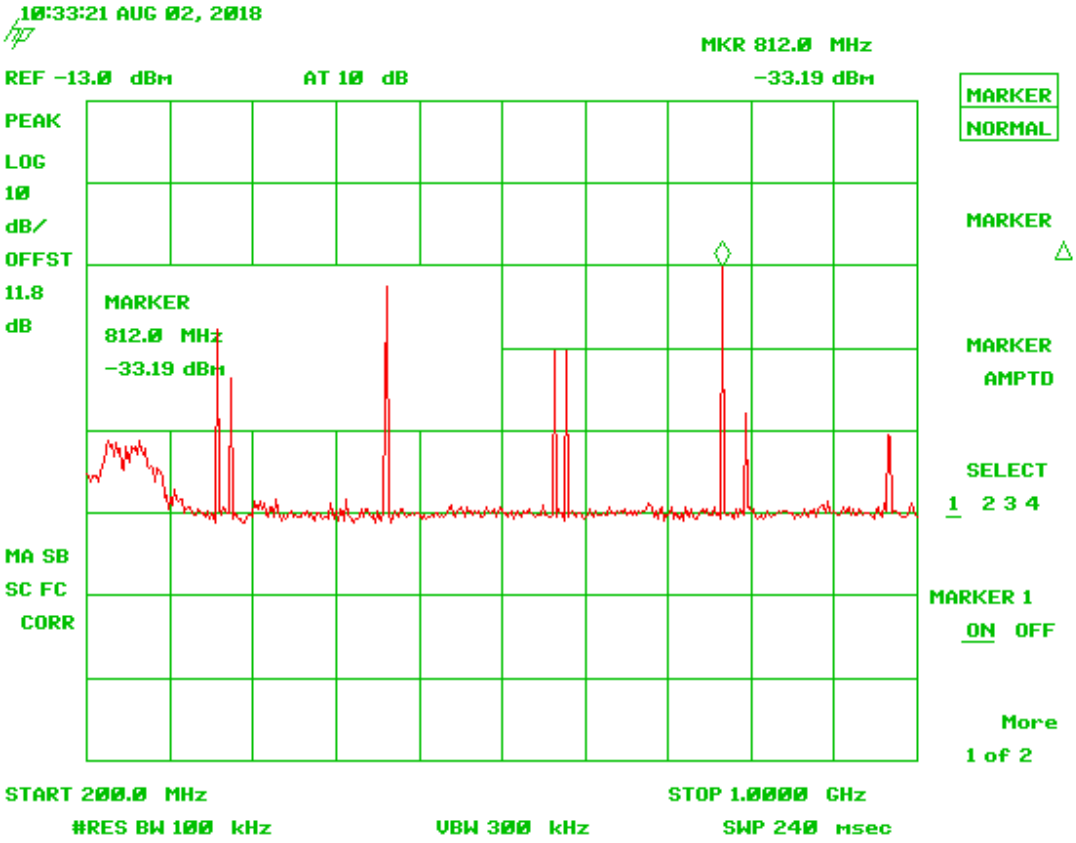

Figure 164. 162 MHz Horizontal, 200 MHz - 1 GHz

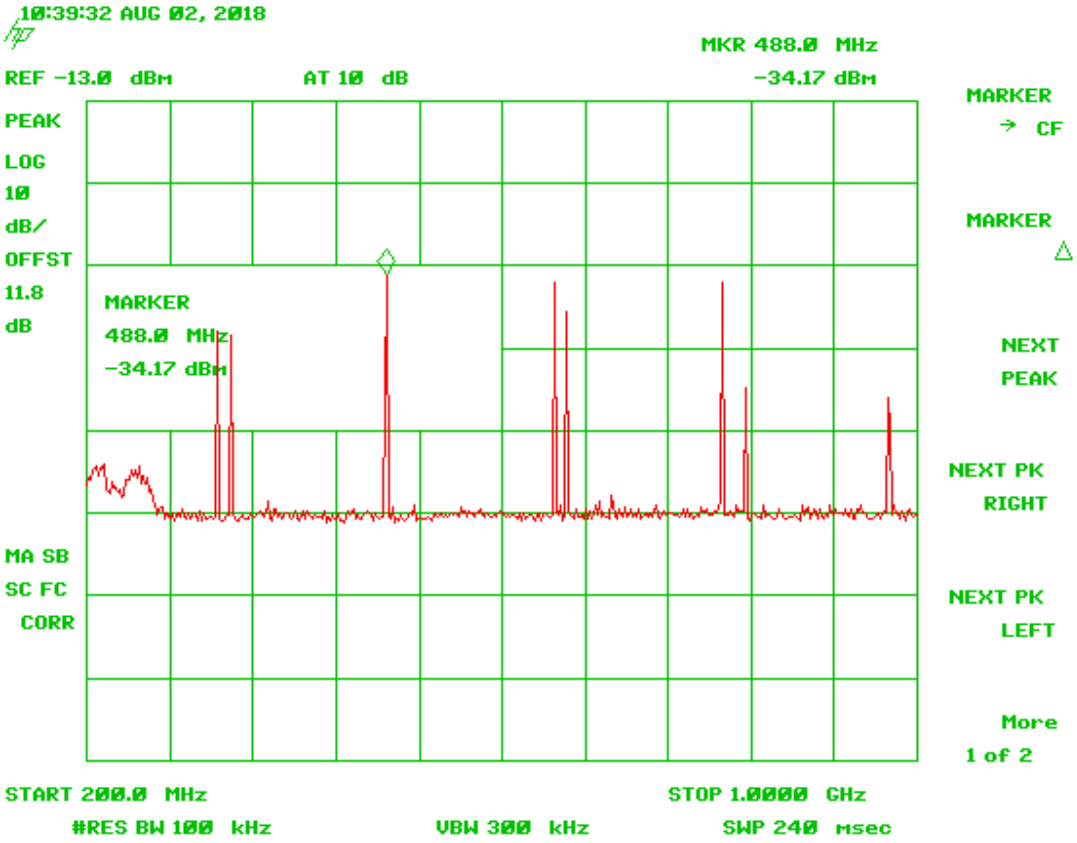

Figure 165. 162 MHz Vertical, 200 MHz – 1 GHz

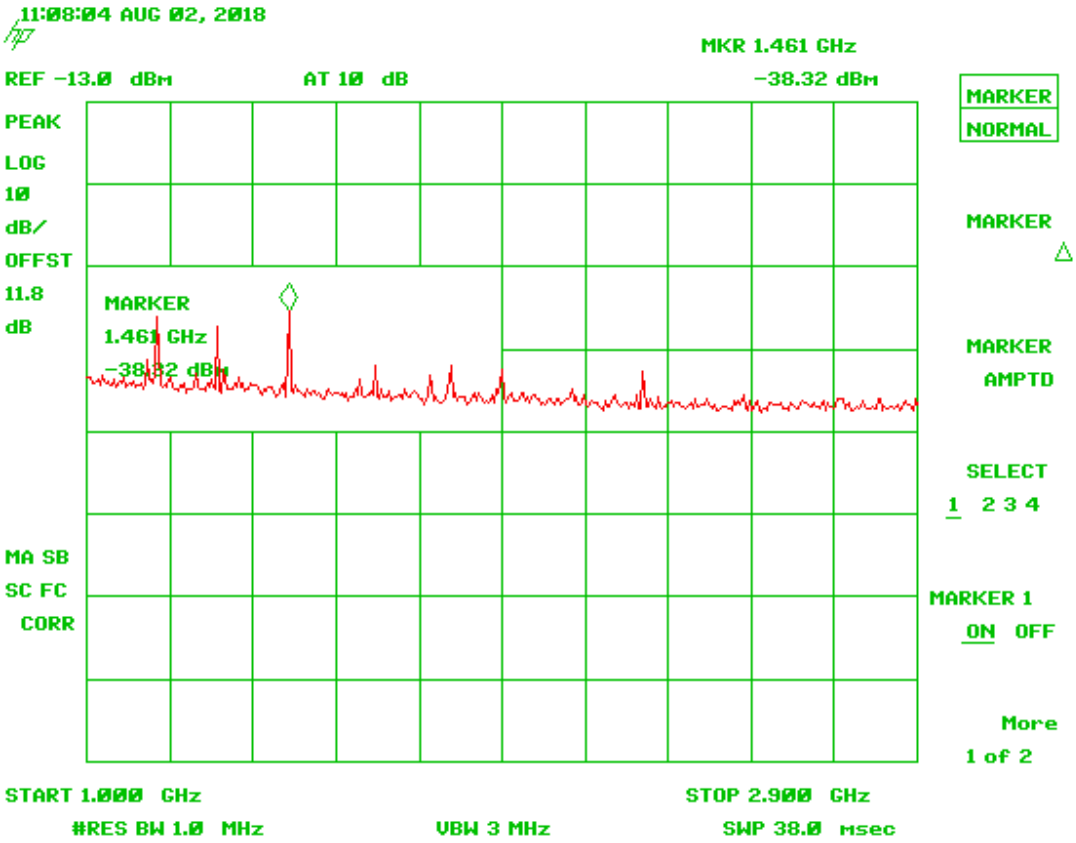

Figure 166. 162 MHz Horizontal, 1 – 2.9 GHz

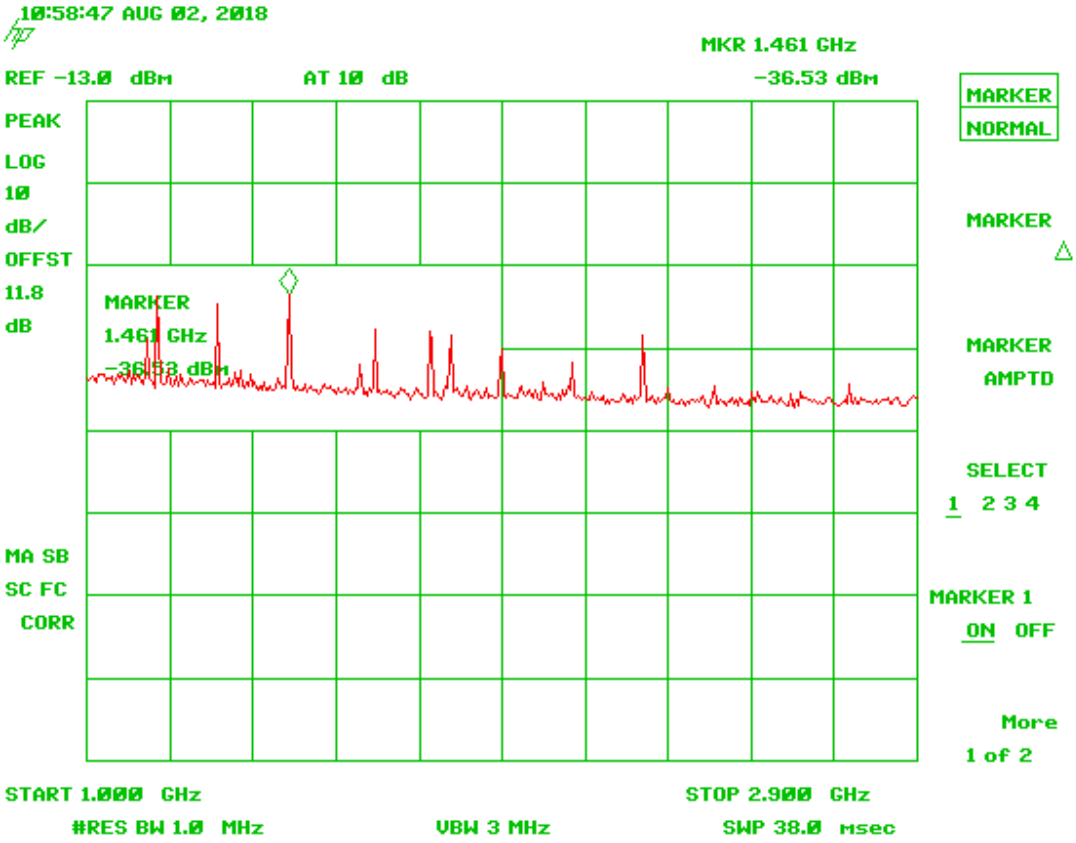

Figure 167. 162 MHz Vertical, 1 - 2.9 GHz

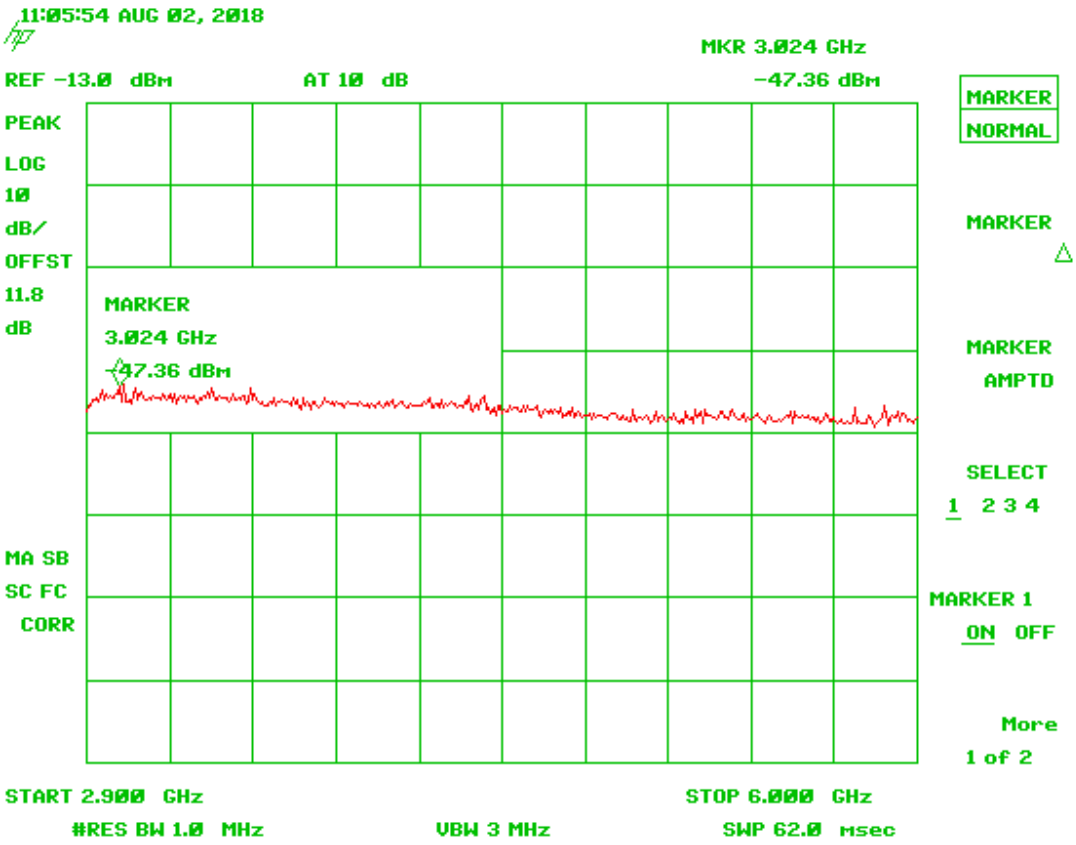

Figure 168. 162 MHz Horizontal, 2.9 – 6 GHz

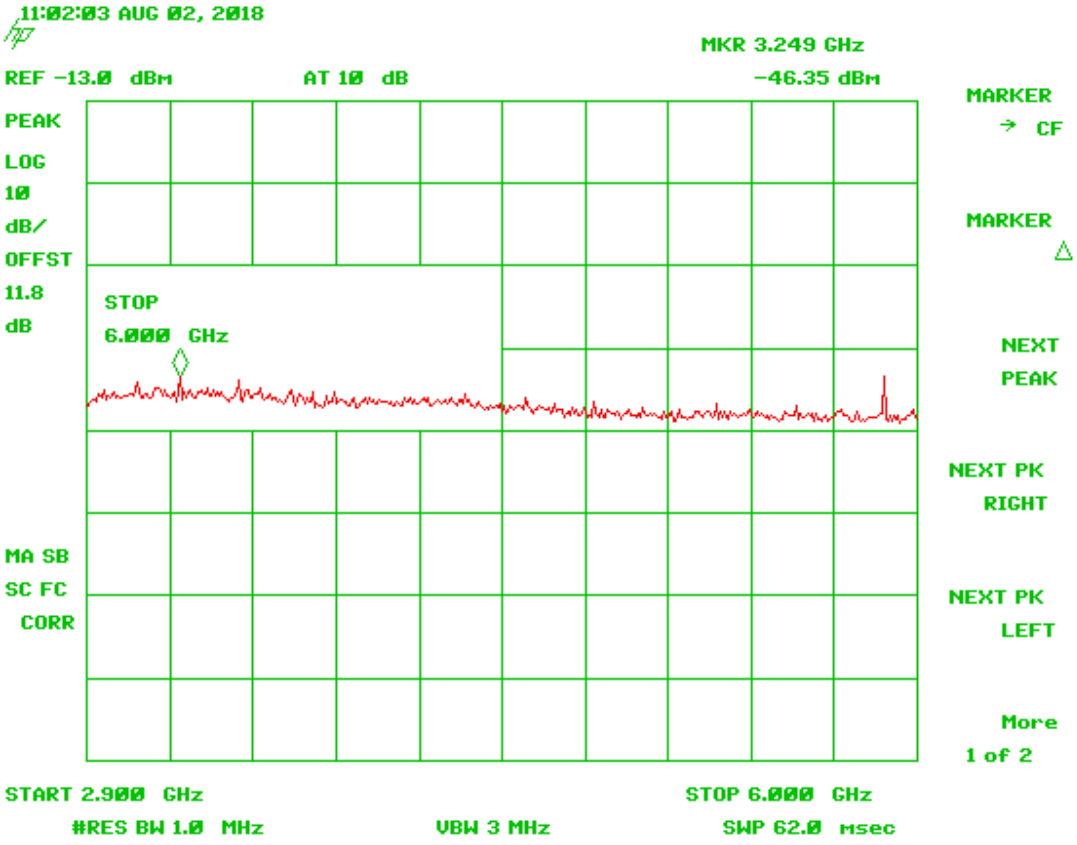

Figure 169. 162 MHz Vertical, 2.9 - 6 GHz

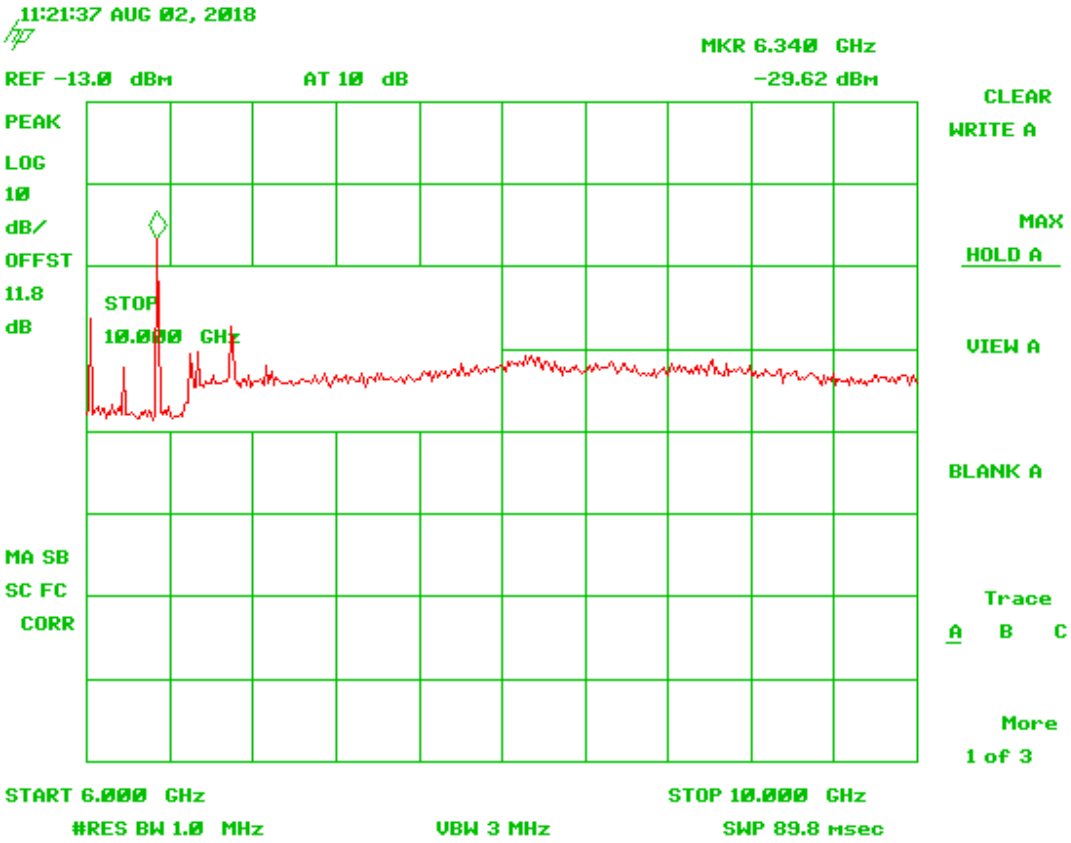

Figure 170. 162 MHz Horizontal, 6 - 10 GHz

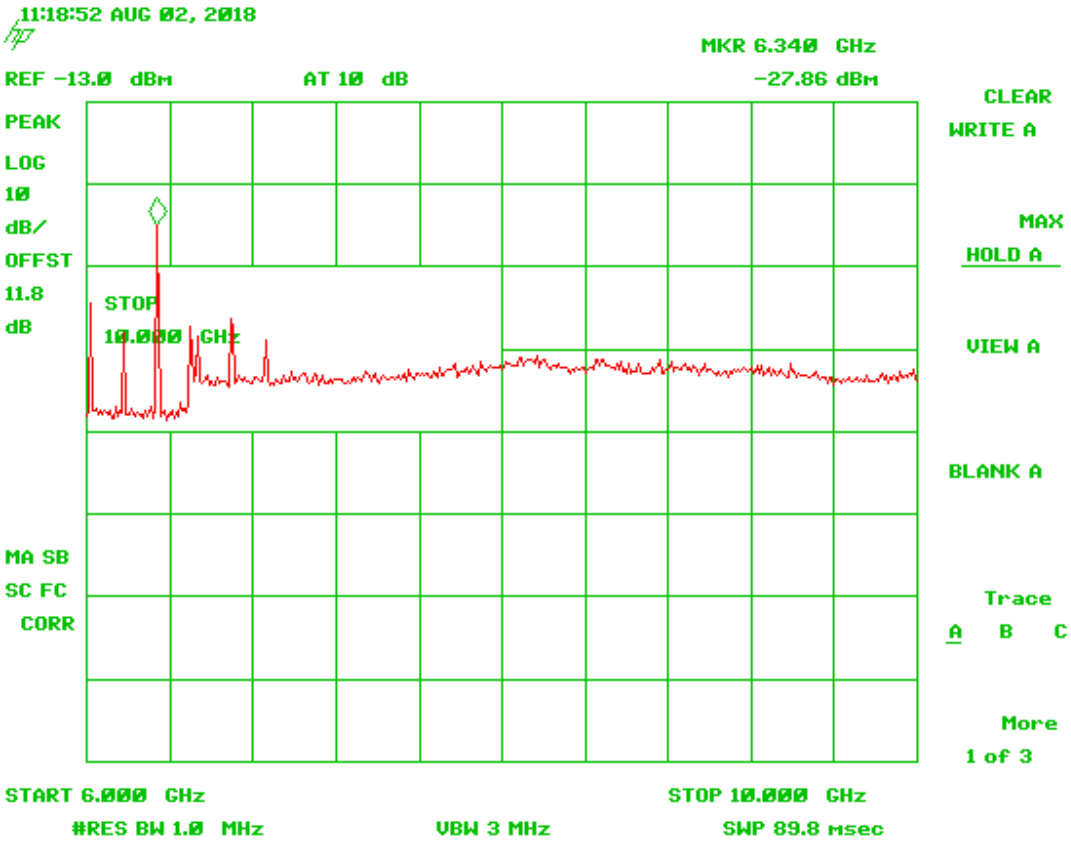

Figure 171. 162 MHz Vertical, 6 – 10 GHz

2.14.1.2 UHF Radiated Spurious Emissions Plots

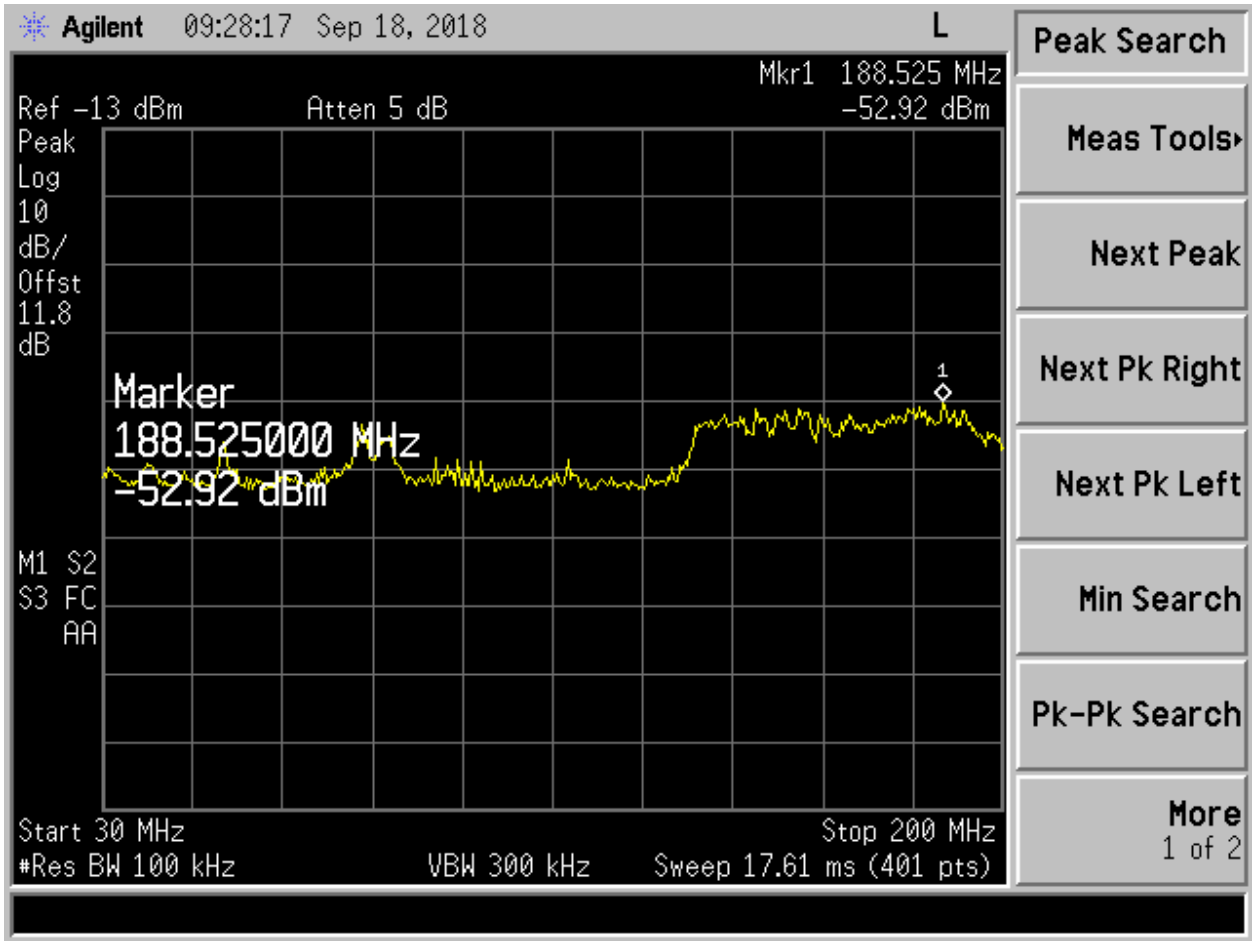

Figure 172. 380 MHz Horizontal, 30 – 200 MHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

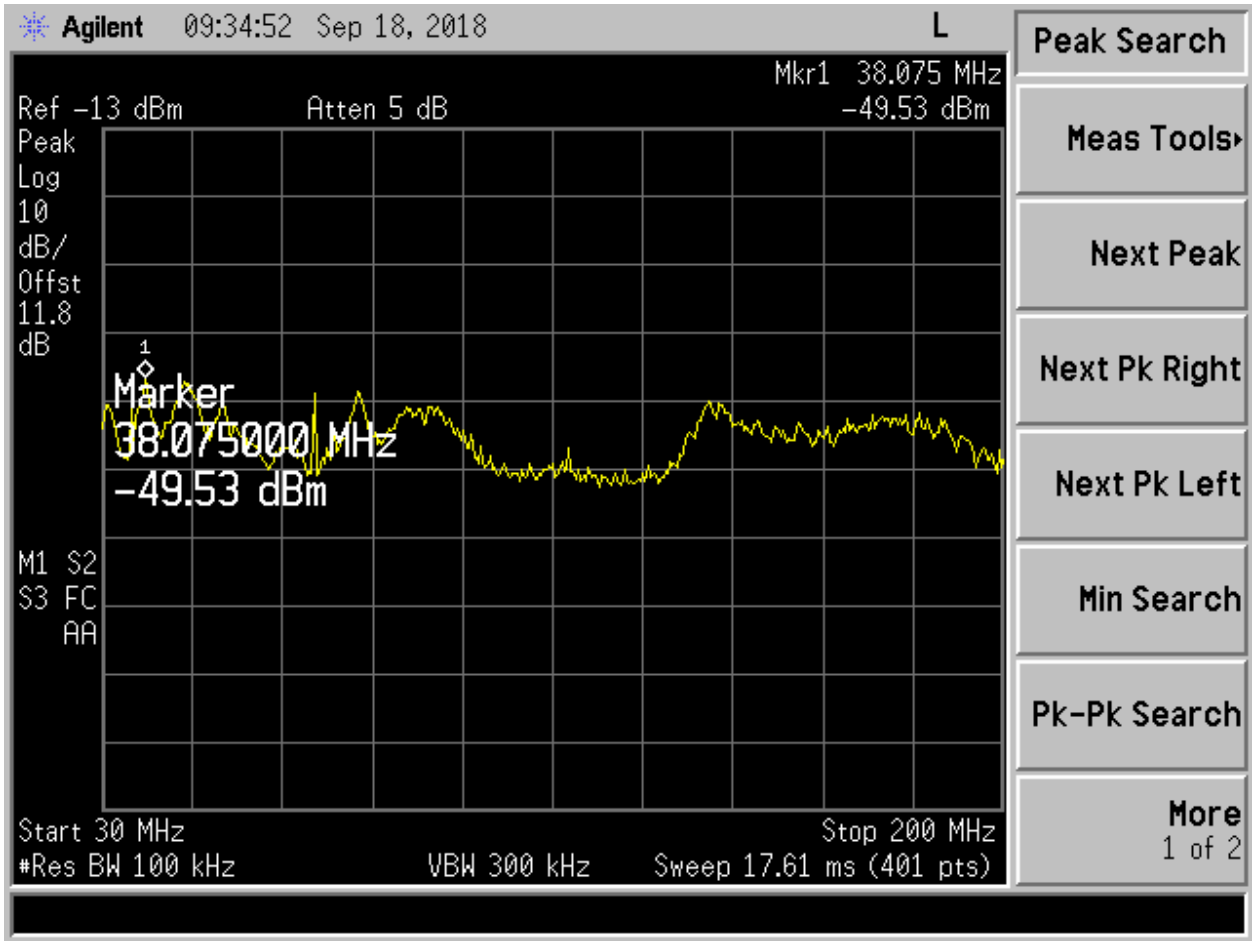

Figure 173. 380 MHz Vertical, 30 – 200 MHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

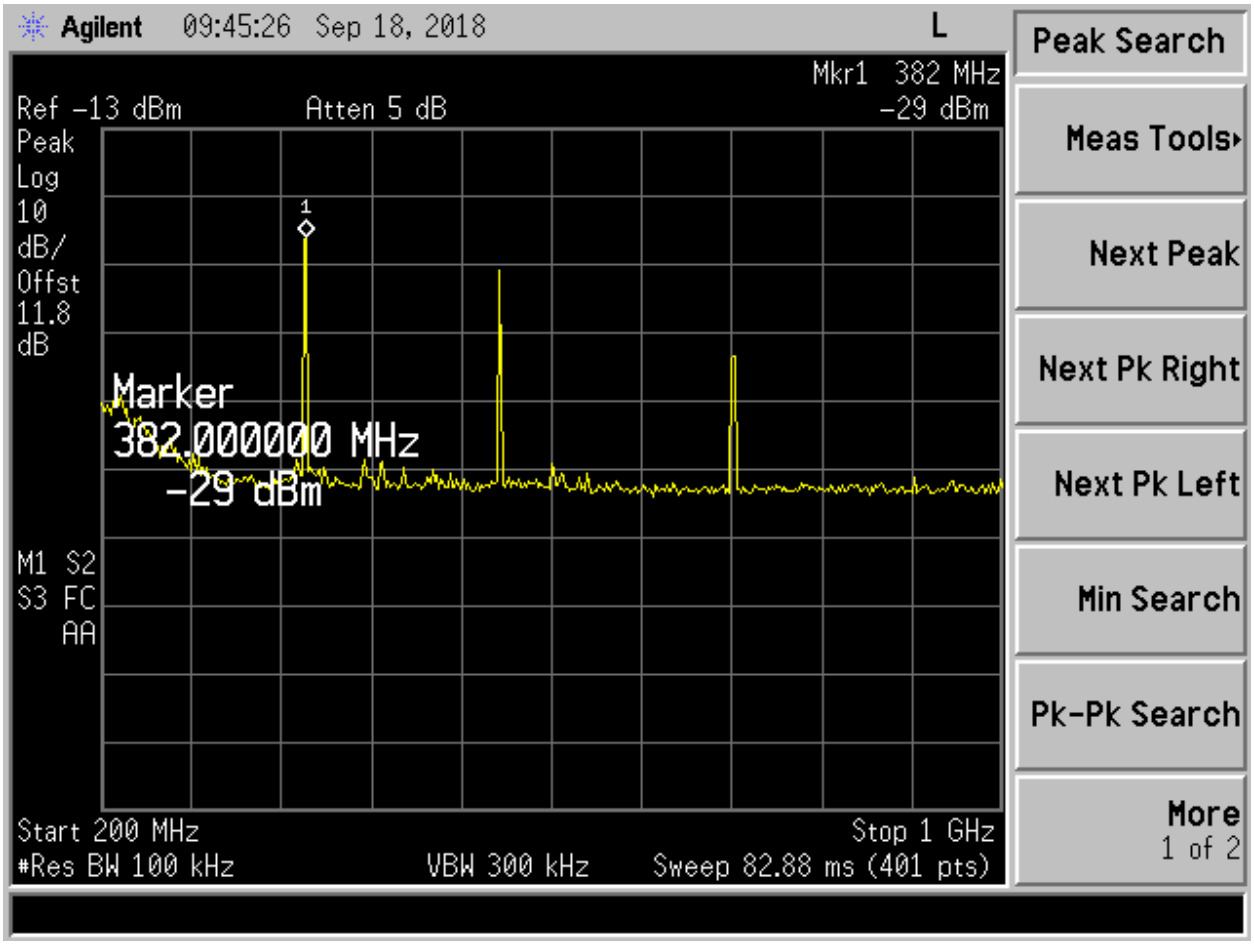

Figure 174. 380 MHz Horizontal, 200 MHz – 1 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

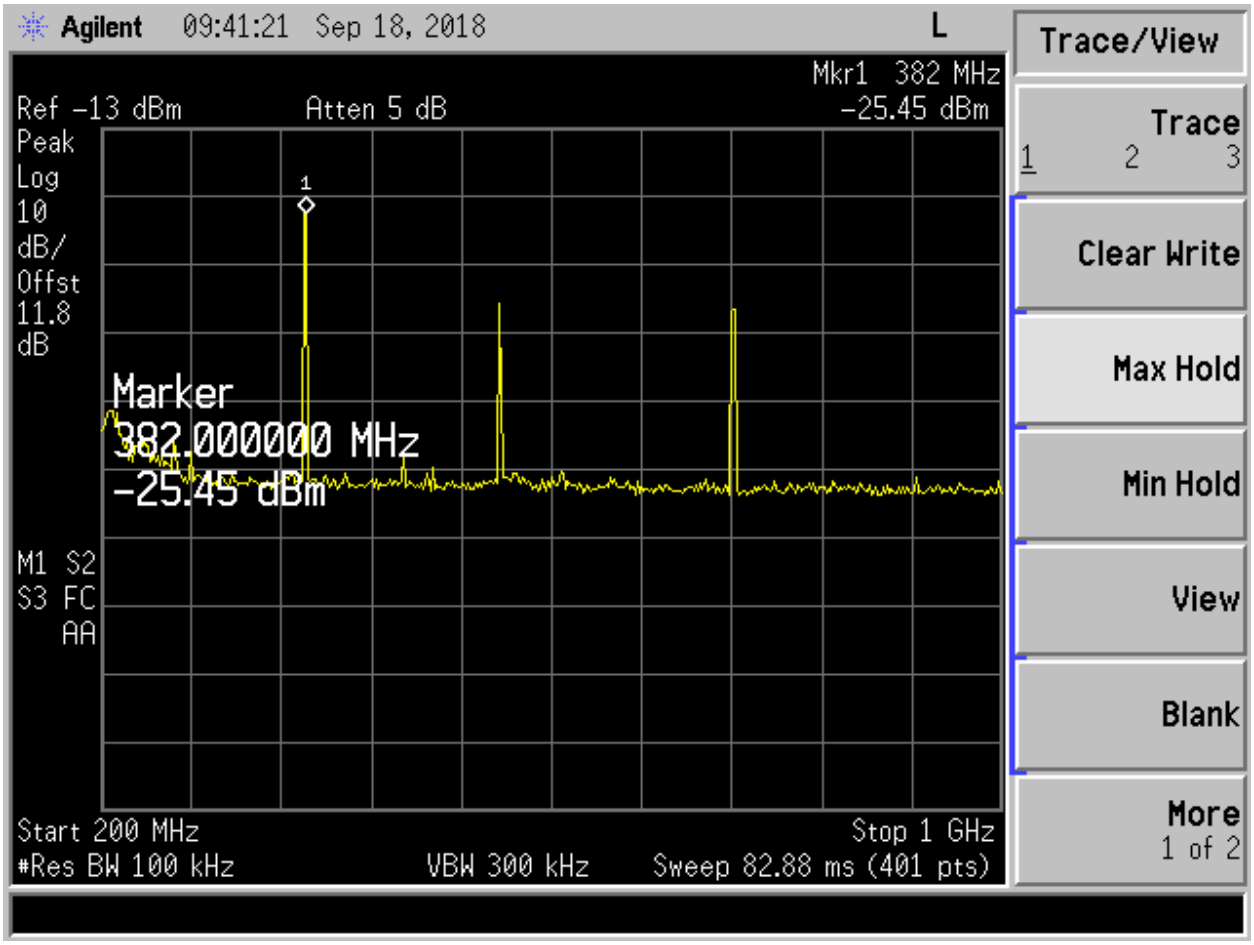

Figure 175. 380 MHz Vertical, 200 MHz – 1 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

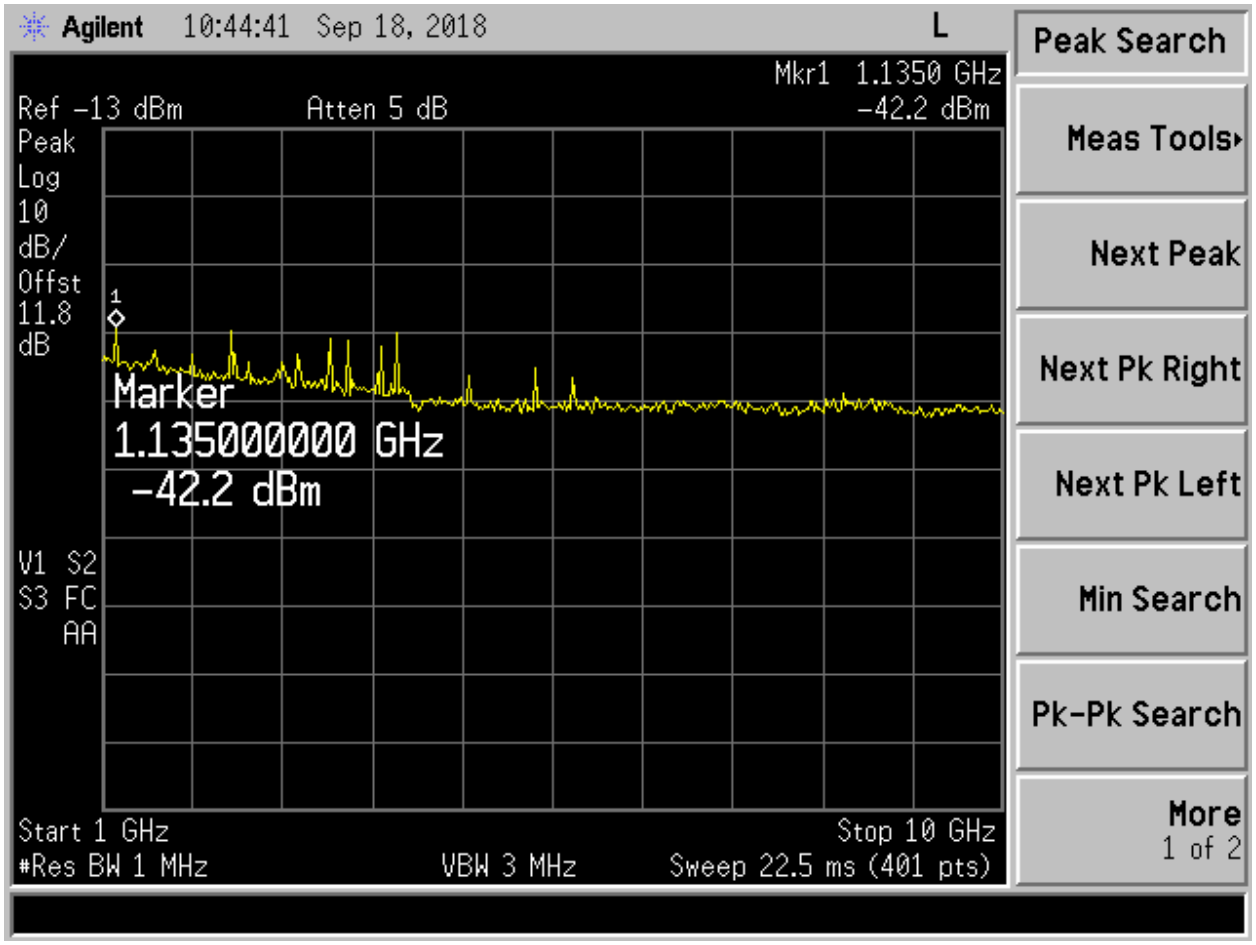

Figure 176. 380 MHz Horizontal, 1 - 10 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

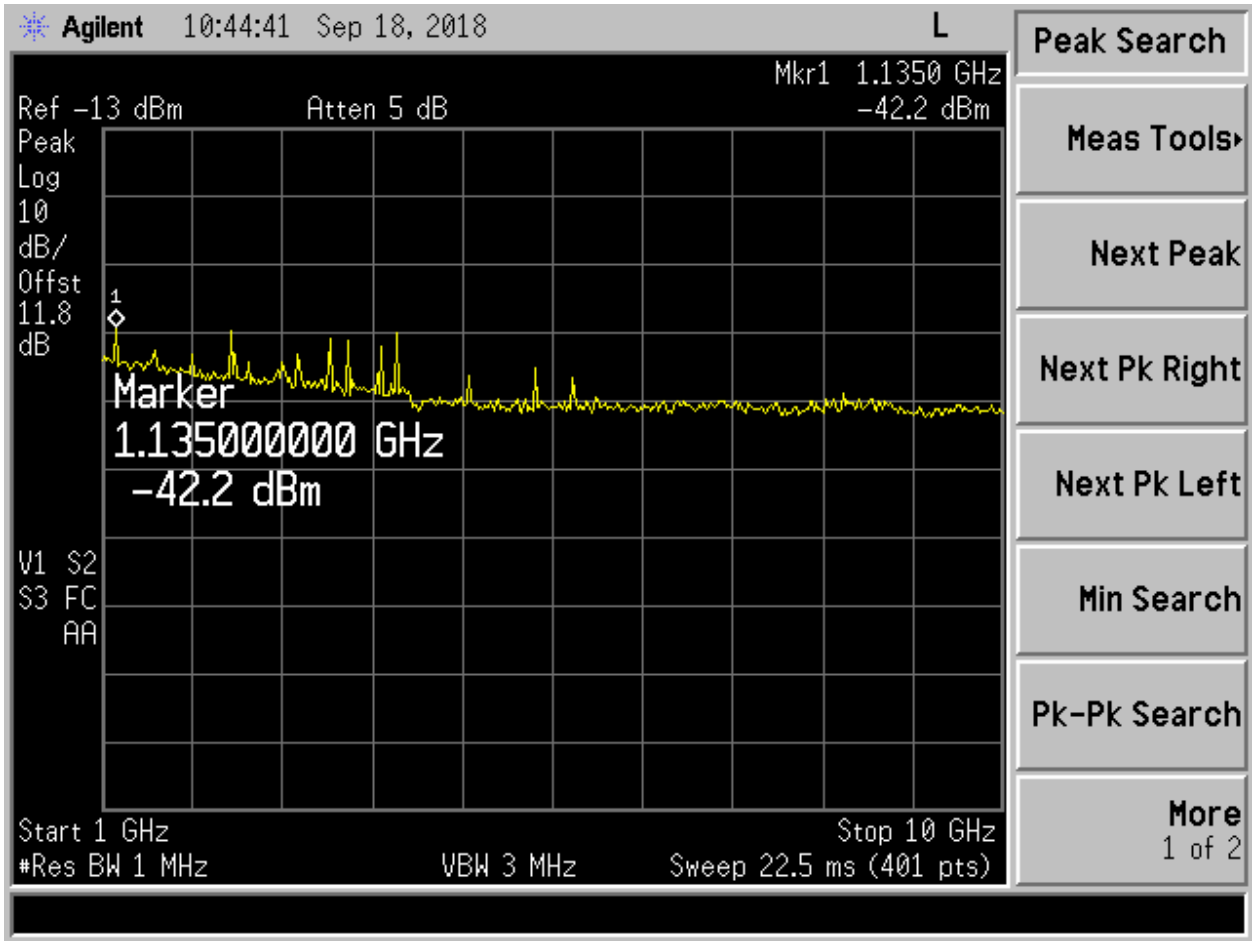

Figure 177. 380 MHz Vertical, 1 - 10 GHz

(Note: Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

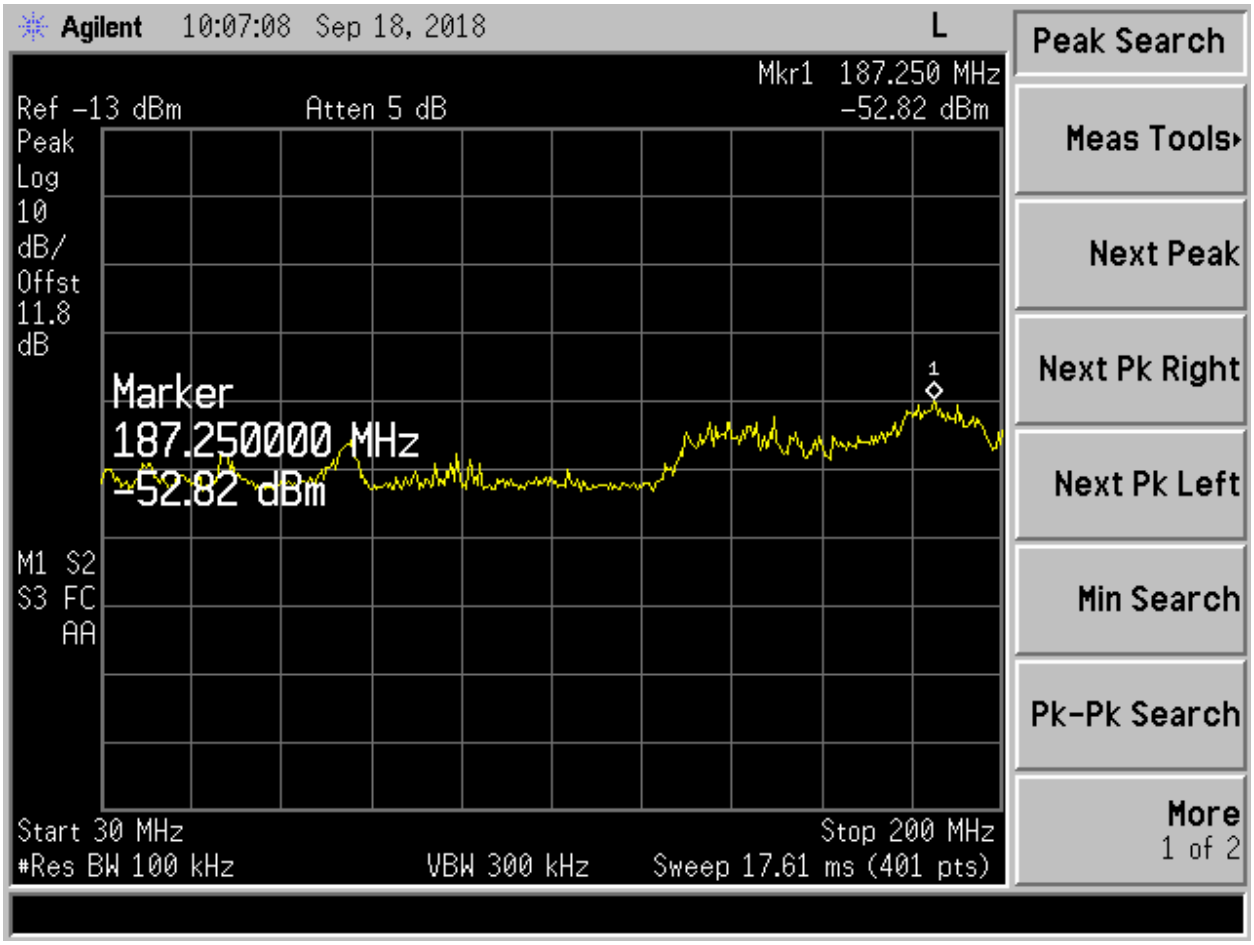

Figure 178. 407 MHz Horizontal, 30 – 200 MHz

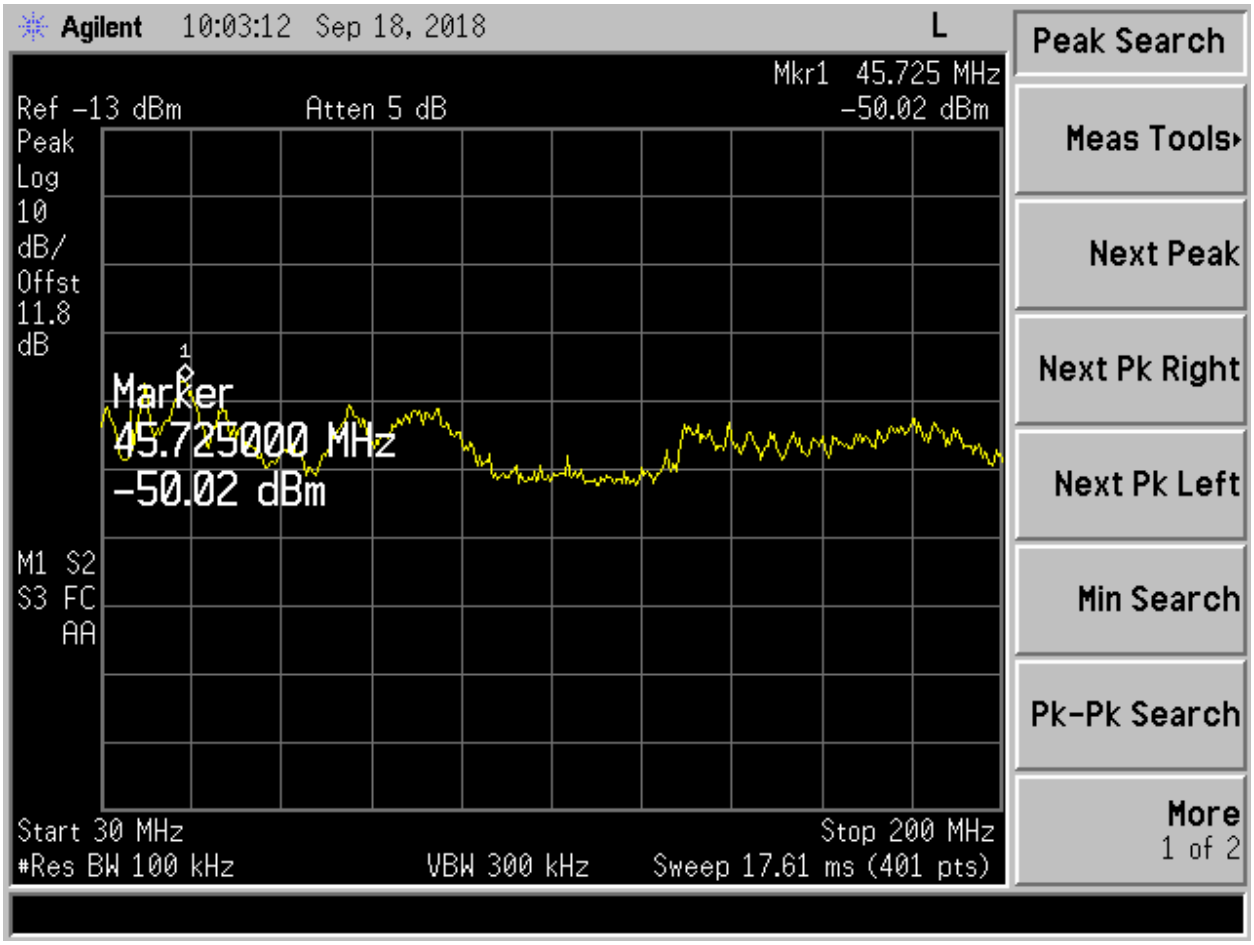

Figure 179. 407 MHz Vertical, 30 – 200 MHz

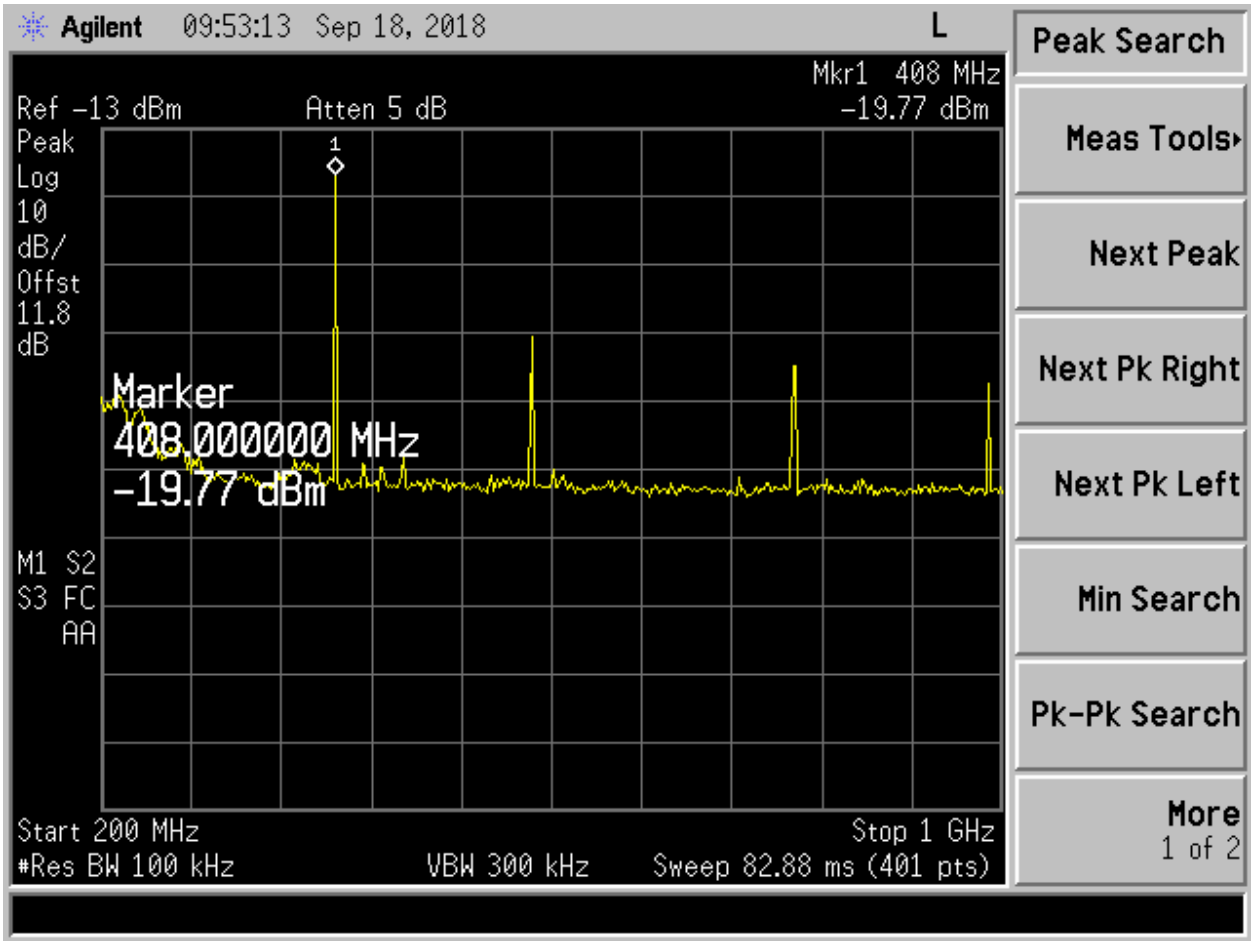

Figure 180. 407 MHz Horizontal, 200 MHz – 1 GHz

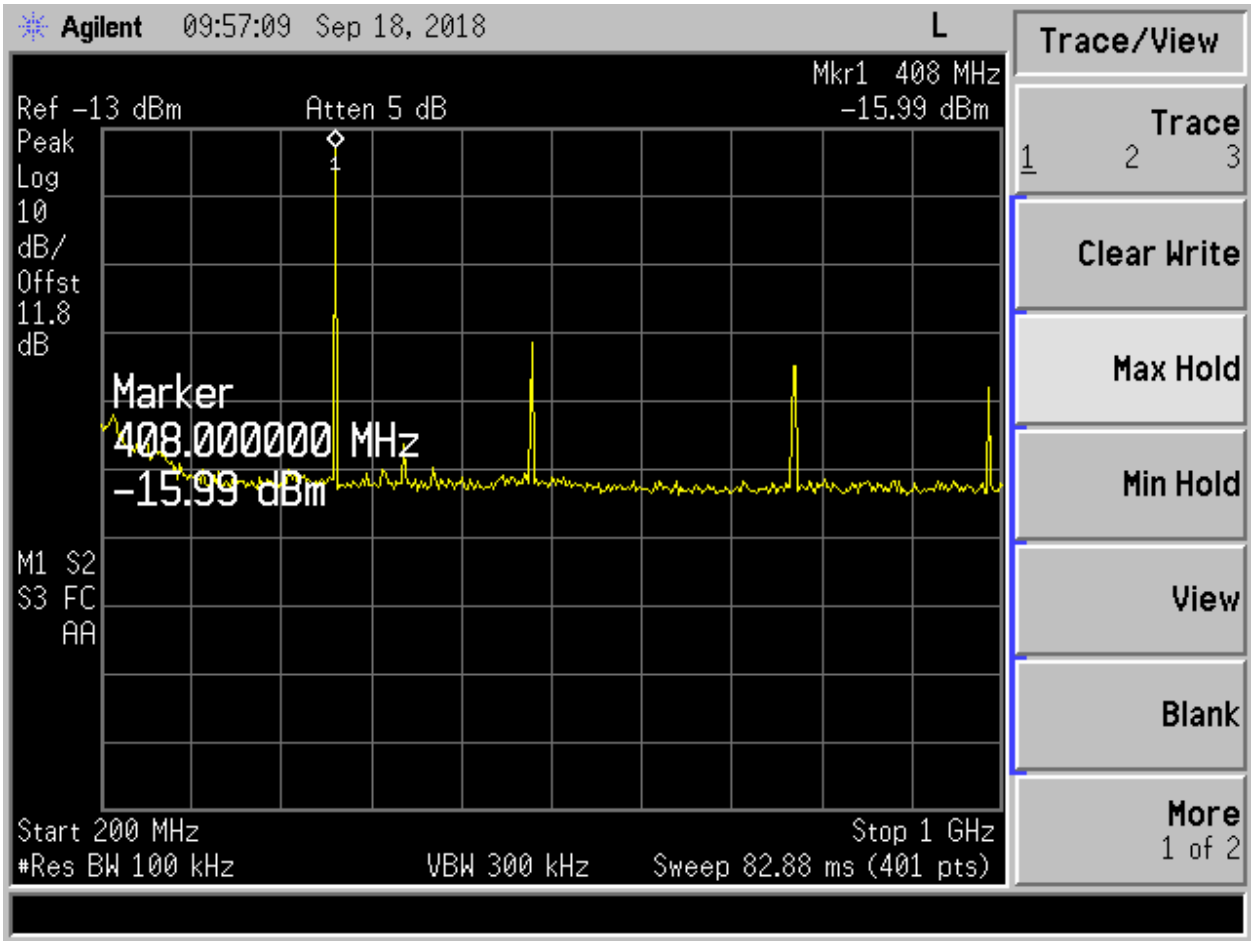

Figure 181. 407 MHz Vertical, 200 MHz – 1 GHz

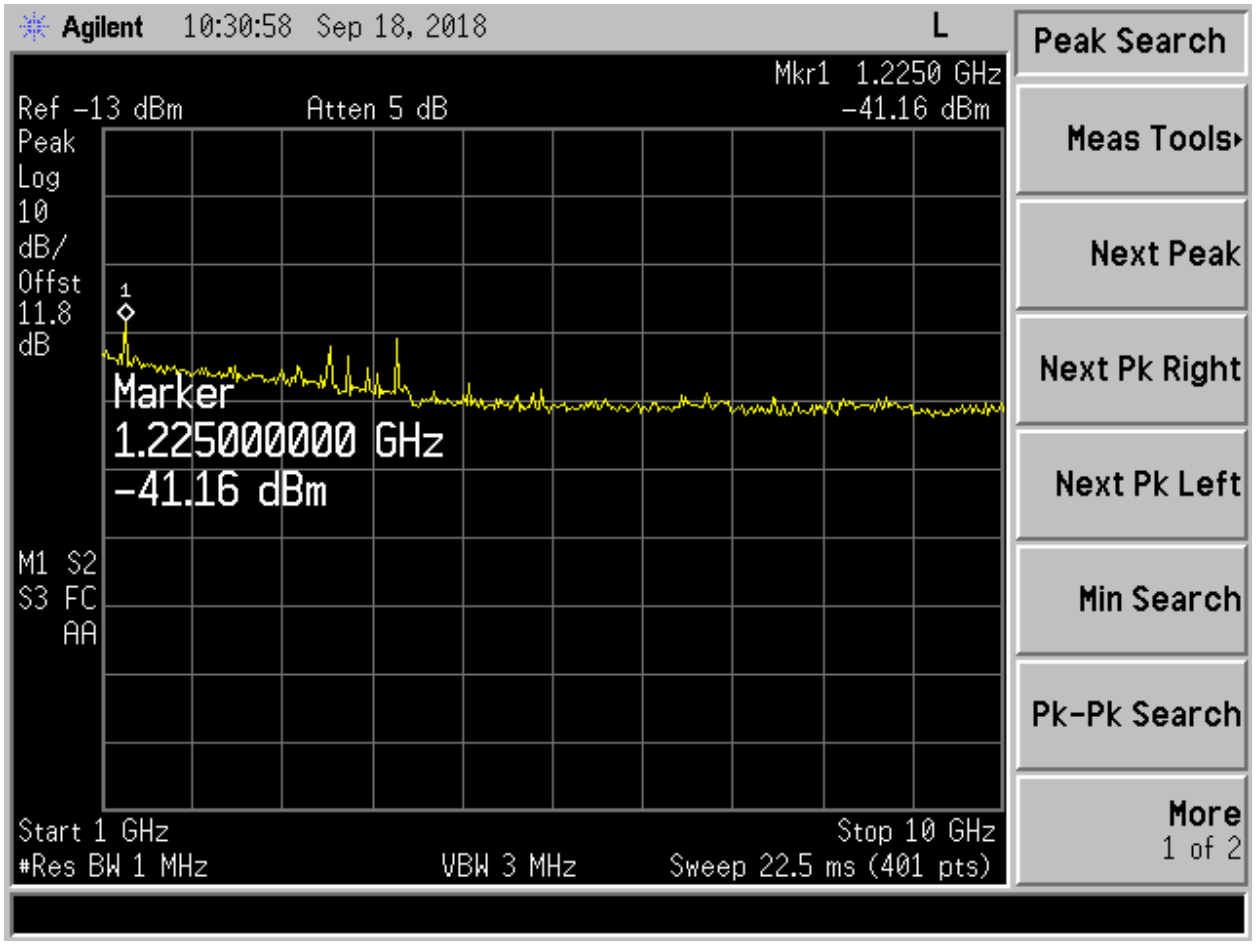

Figure 182. 407 MHz Horizontal, 1 - 10 GHz

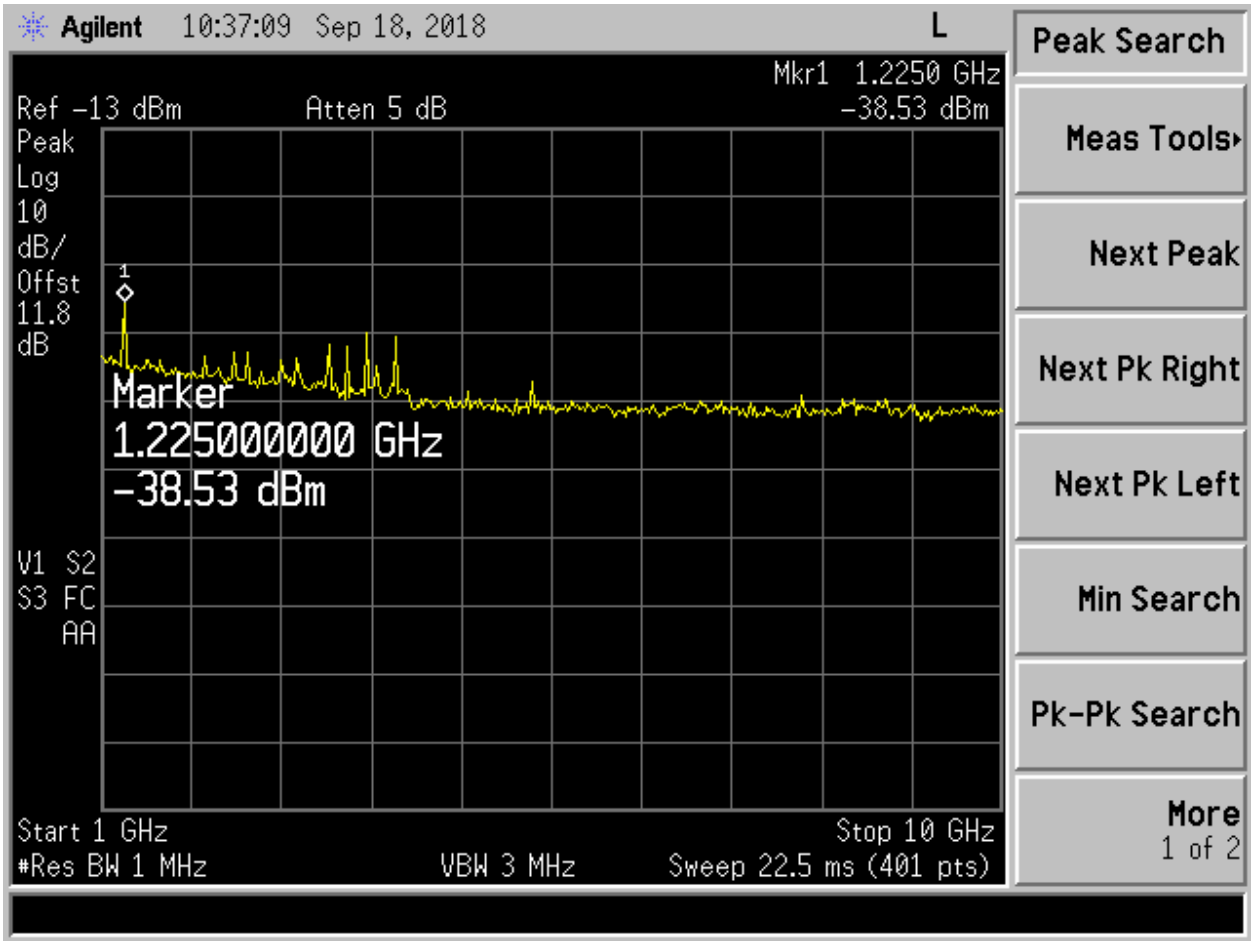

Figure 183. 407 MHz Vertical, 1 - 10 GHz

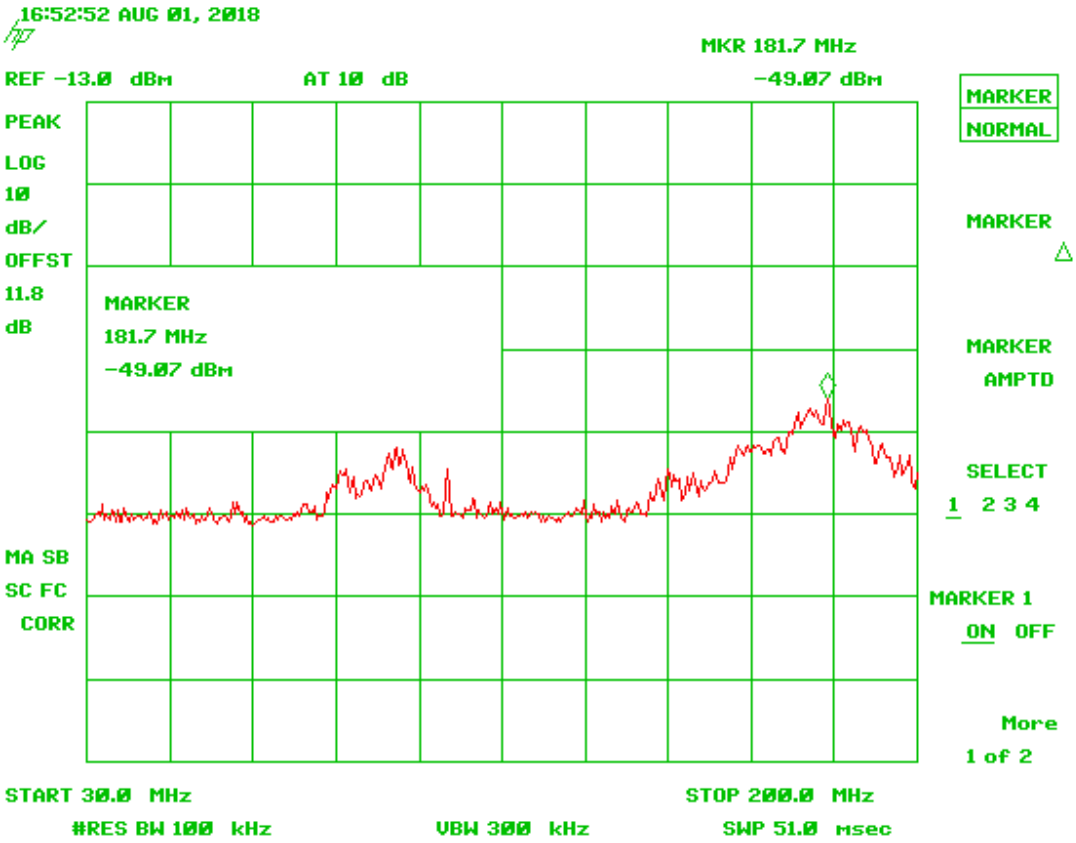

Figure 184. 481 MHz Horizontal, 30 - 200 MHz

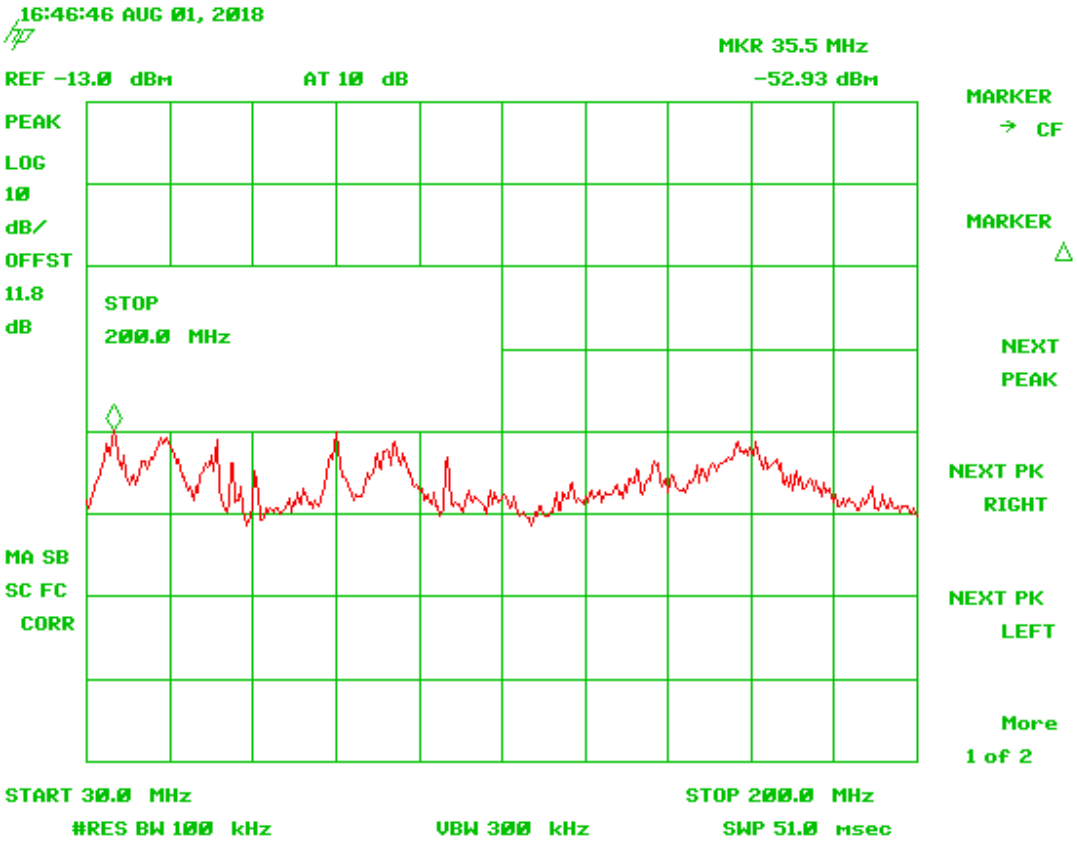

Figure 185. 481 MHz Vertical, 30 - 200 MHz

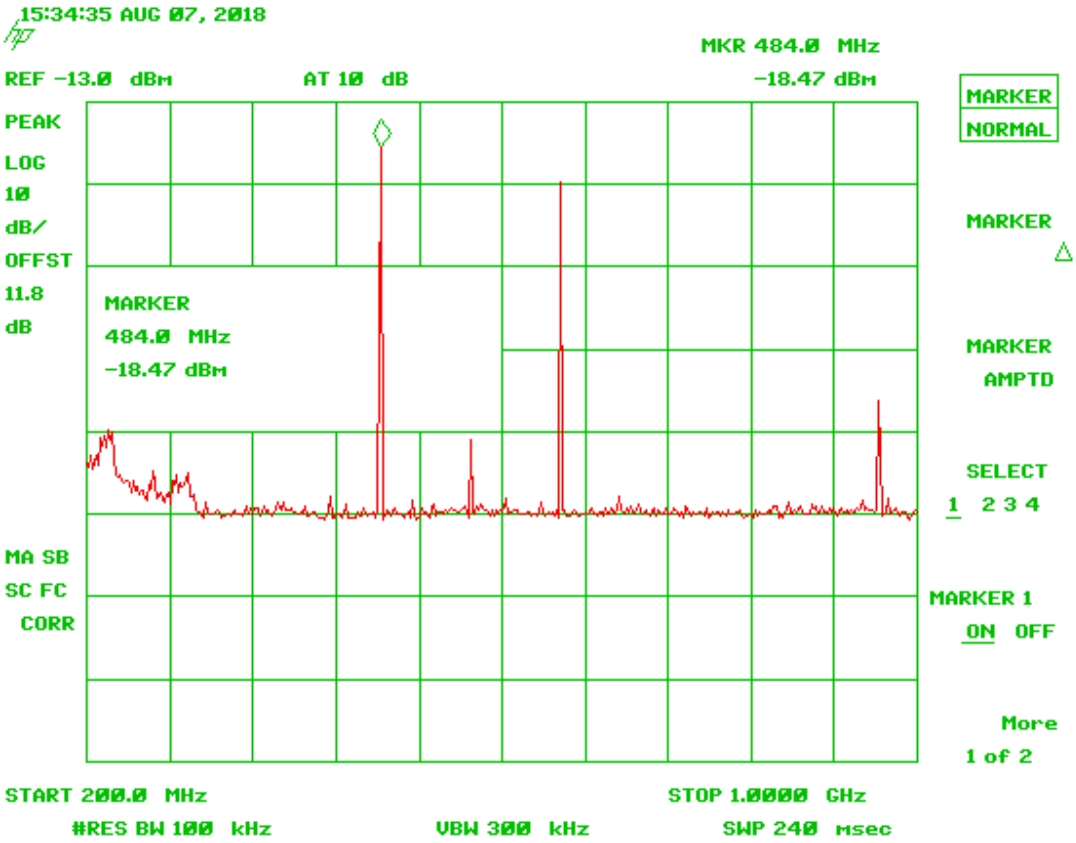

Figure 186. 481 MHz Horizontal, 200 MHz - 1 GHz

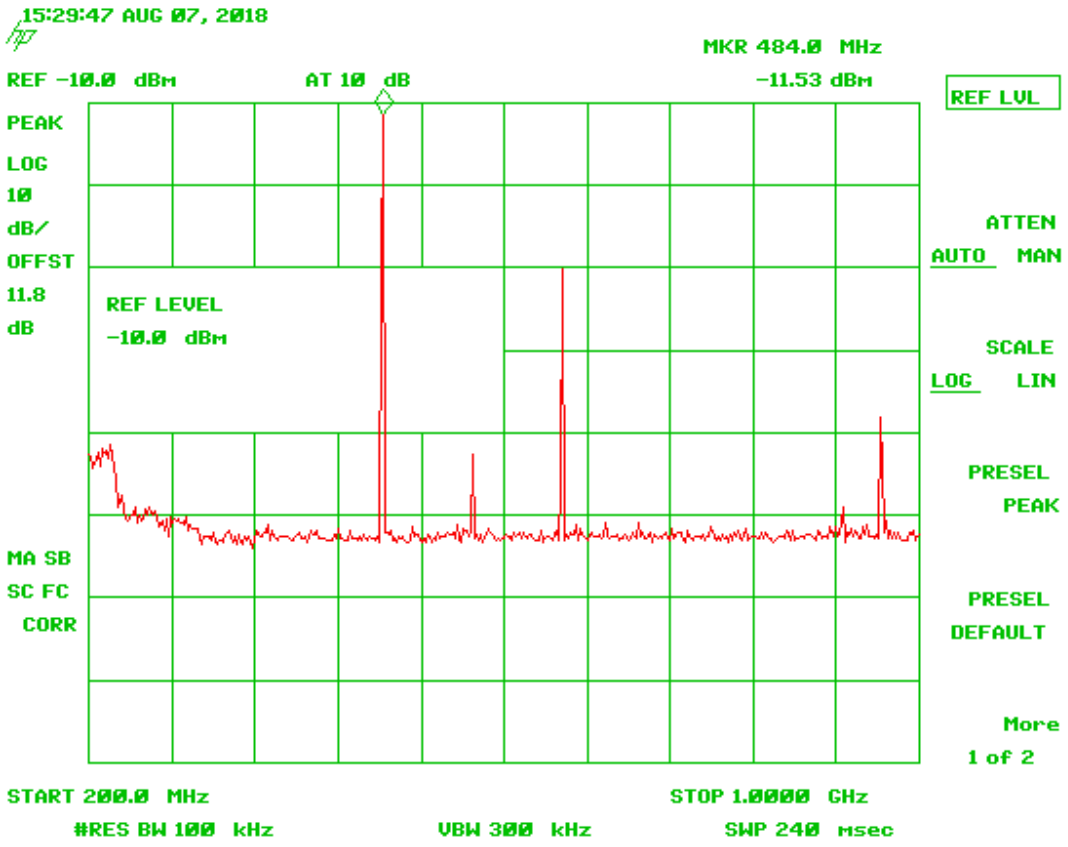

Figure 187. 481 MHz Vertical, 200 MHz - 1 GHz

Note: All spurious emissions other than fundamental and harmonics are below the -13 dBm limit level.

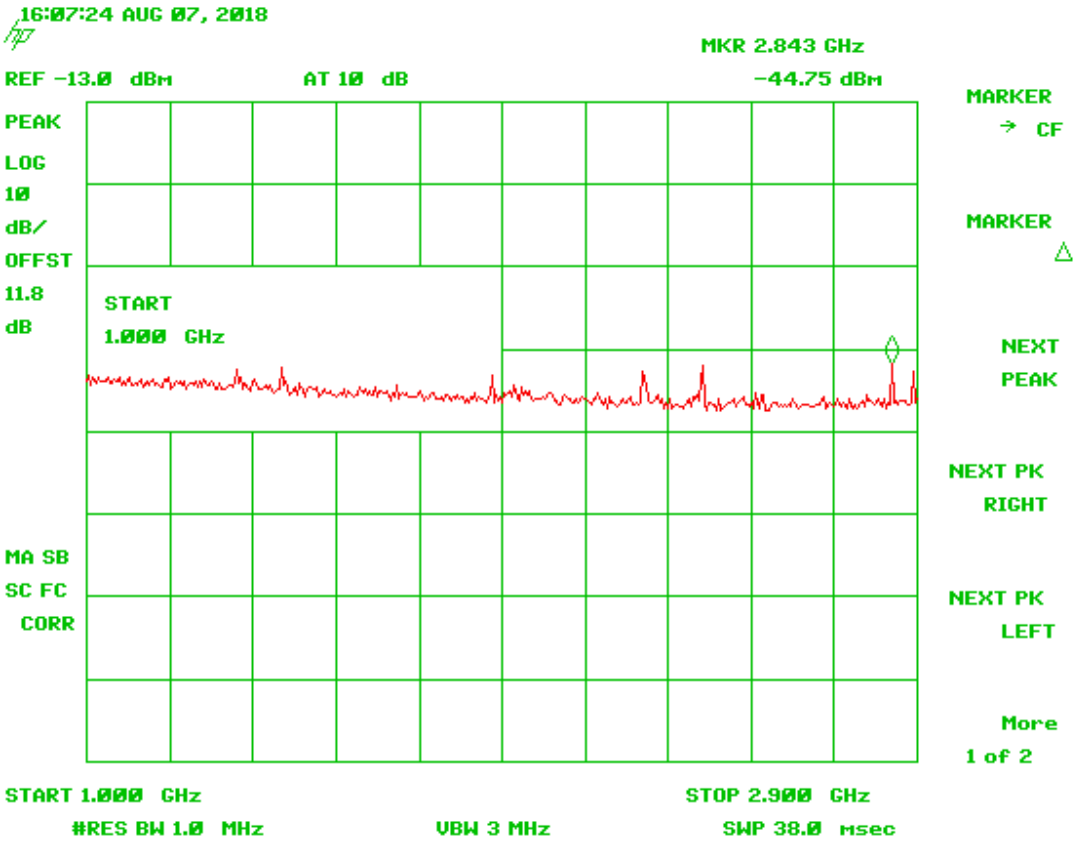

Figure 188. 481 MHz Horizontal, 1 – 2.9 GHz

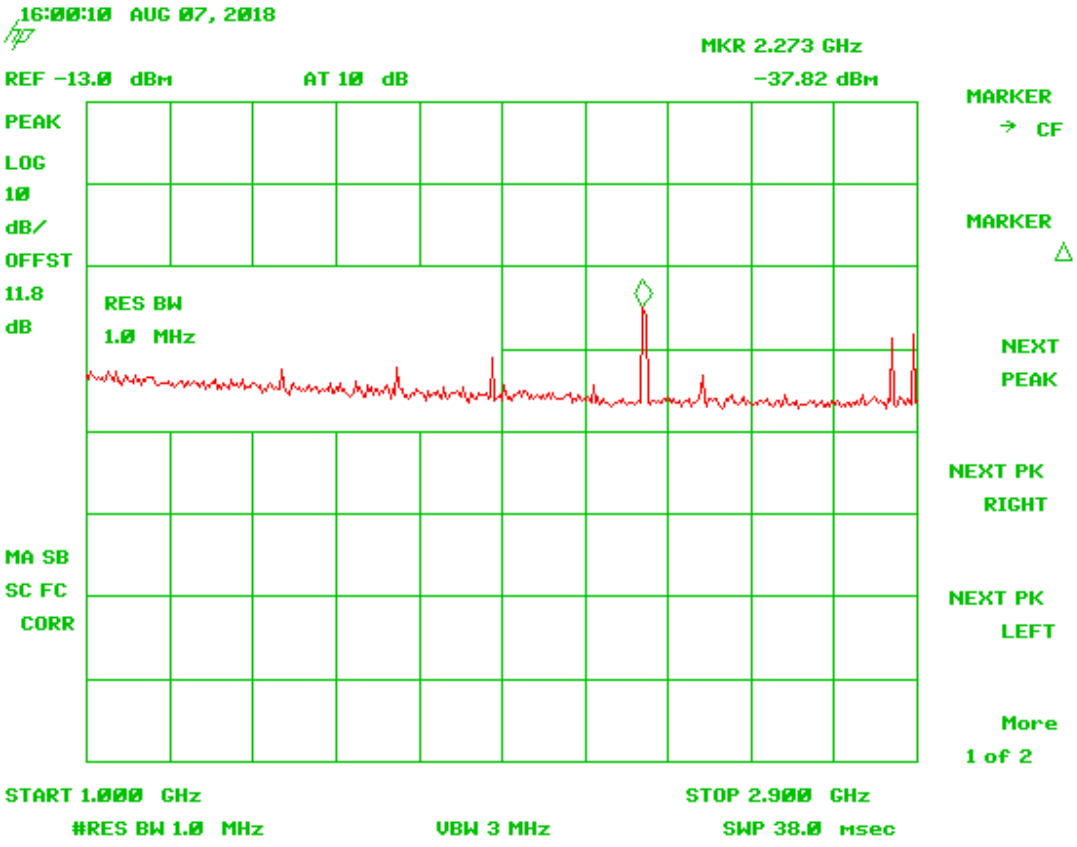

Figure 189. 481 MHz Vertical, 1 – 2.9 GHz

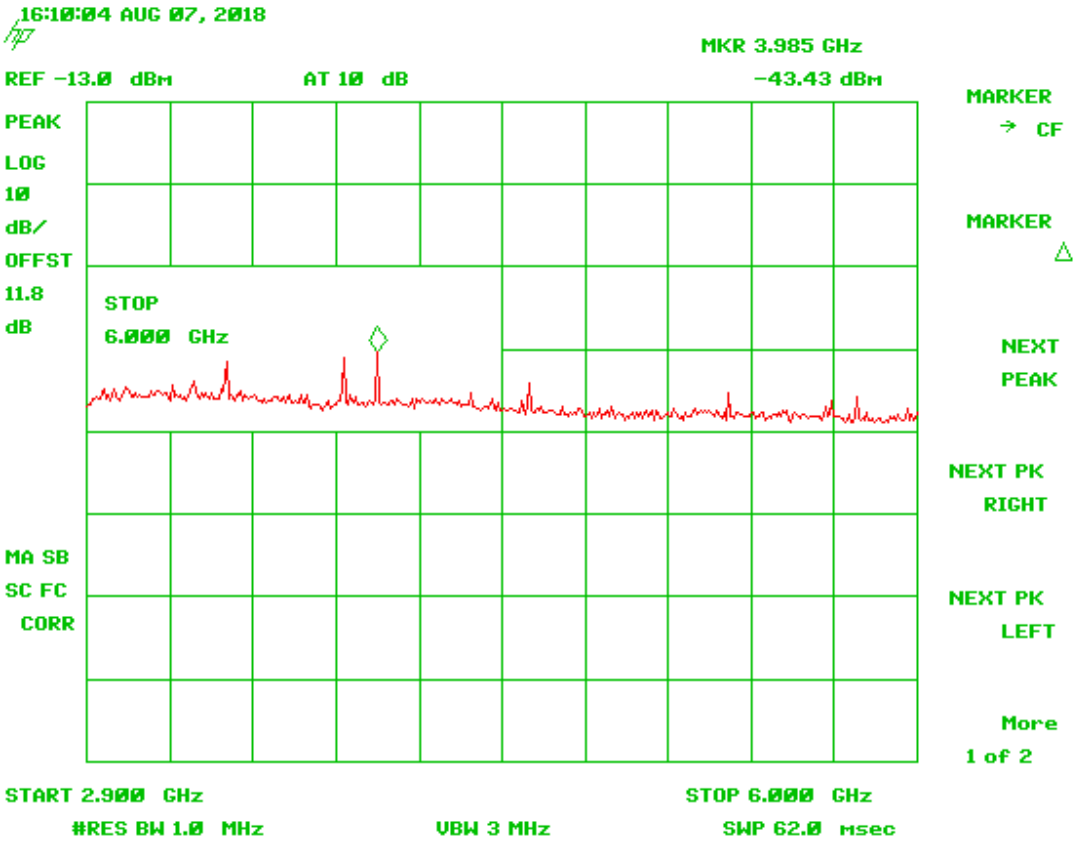

Figure 190. 481 MHz Horizontal, 2.9 - 6 GHz

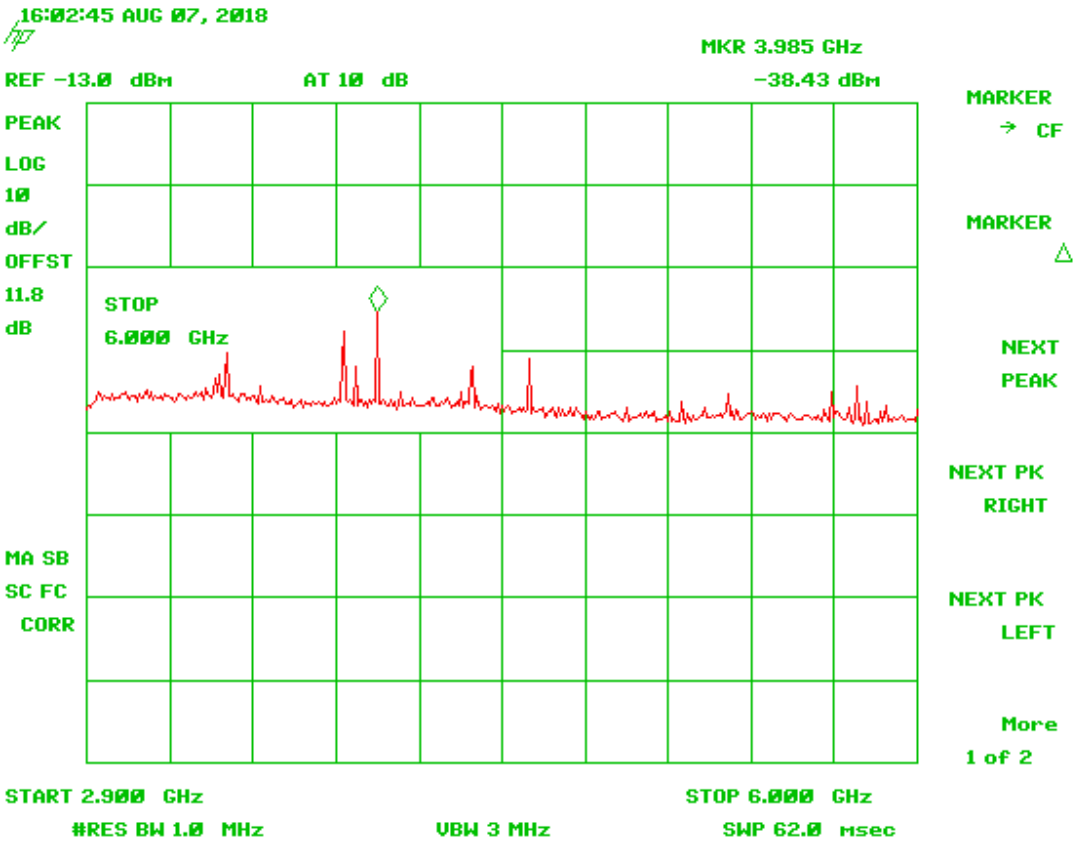

Figure 191. 481 MHz Vertical, 2.9 – 6 GHz

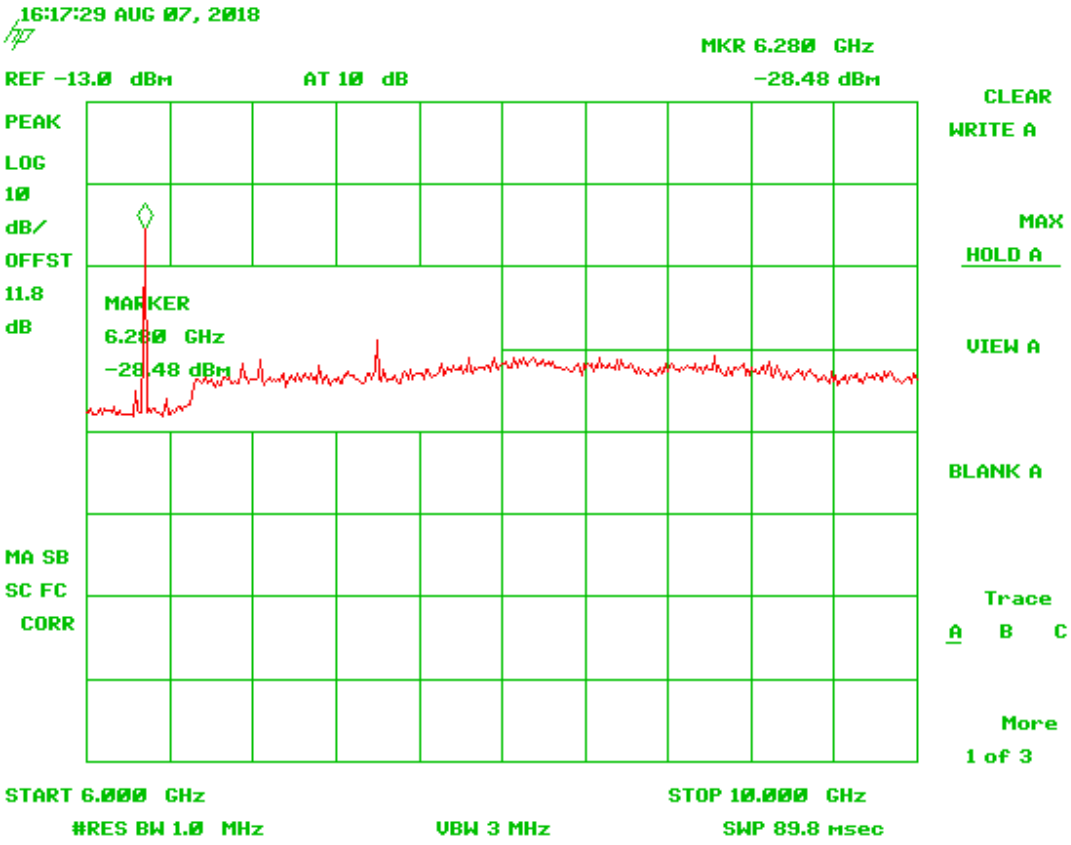

Figure 192. 481 MHz Horizontal, 6 - 10 GHz

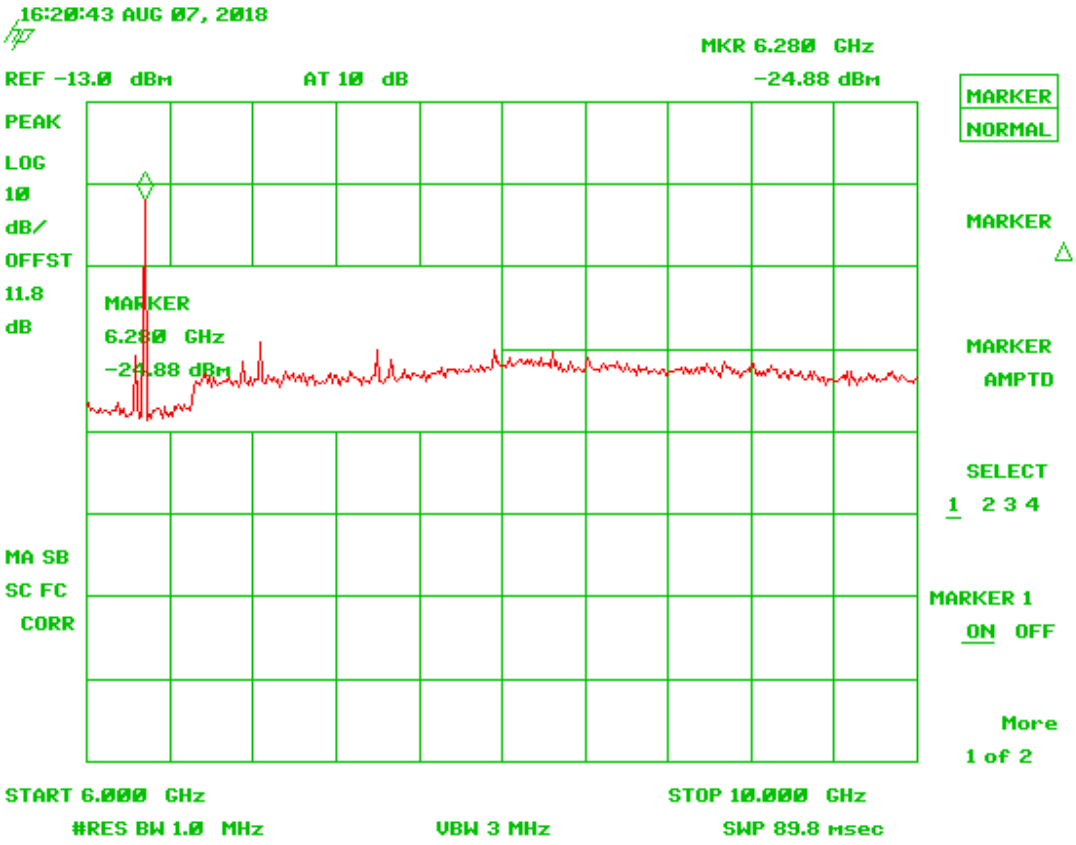

Figure 193. 481 MHz Vertical, 6 - 10 GHz

2.14.1.3 700 MHz Radiated Spurious Emissions Plots

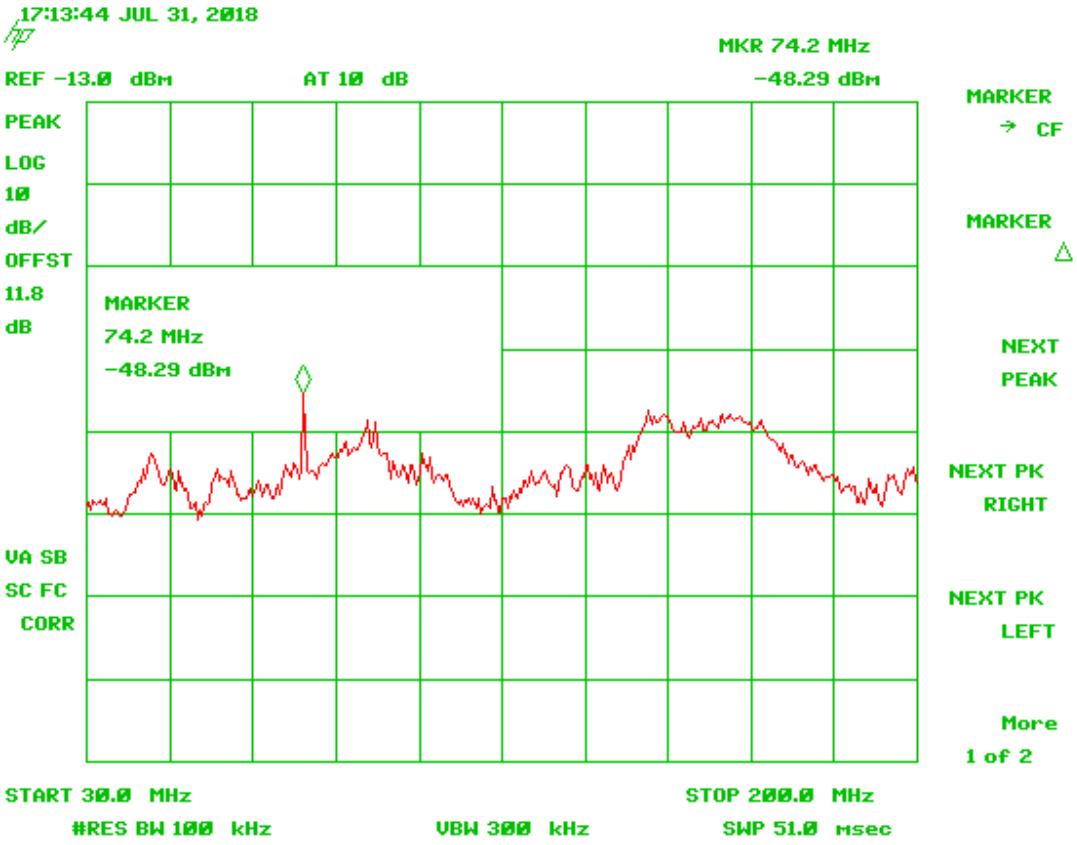

Figure 194. 805 MHz Horizontal, 30 – 200 MHz

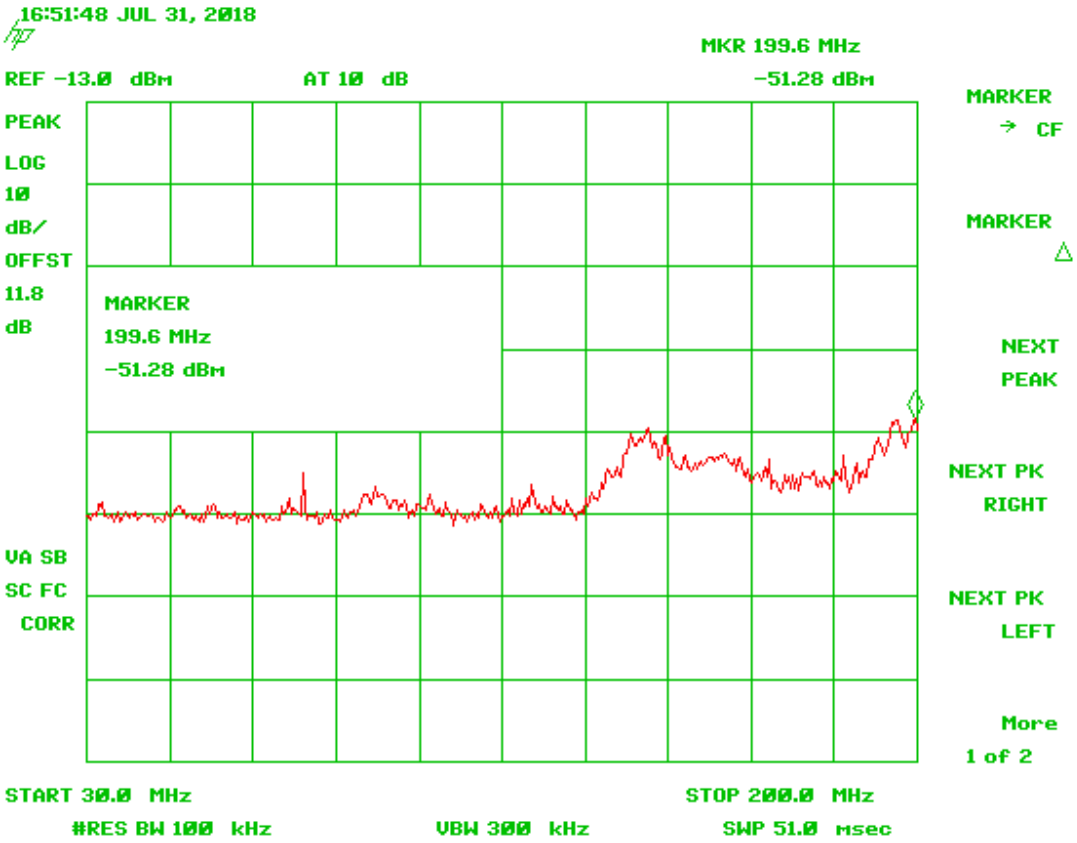

Figure 195. 805 MHz Vertical, 30 - 200 MHz

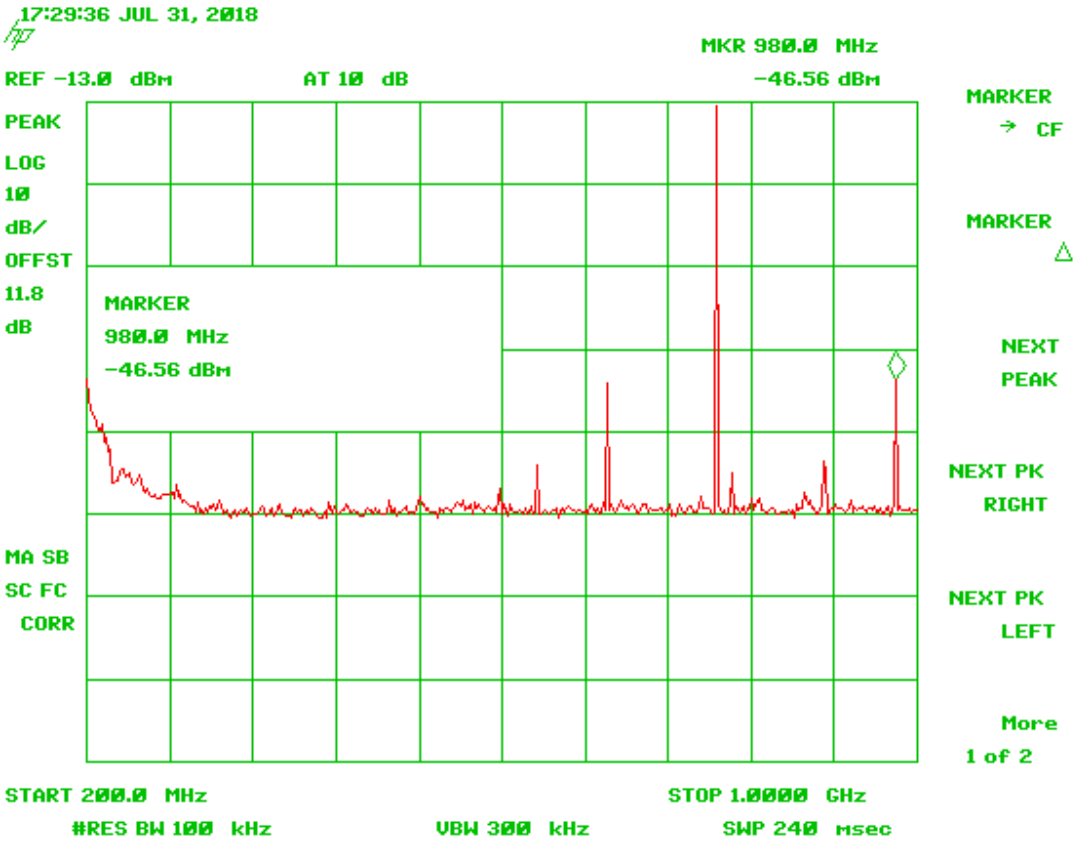

Figure 196. 805 MHz Horizontal, 200 MHz - 1 GHz

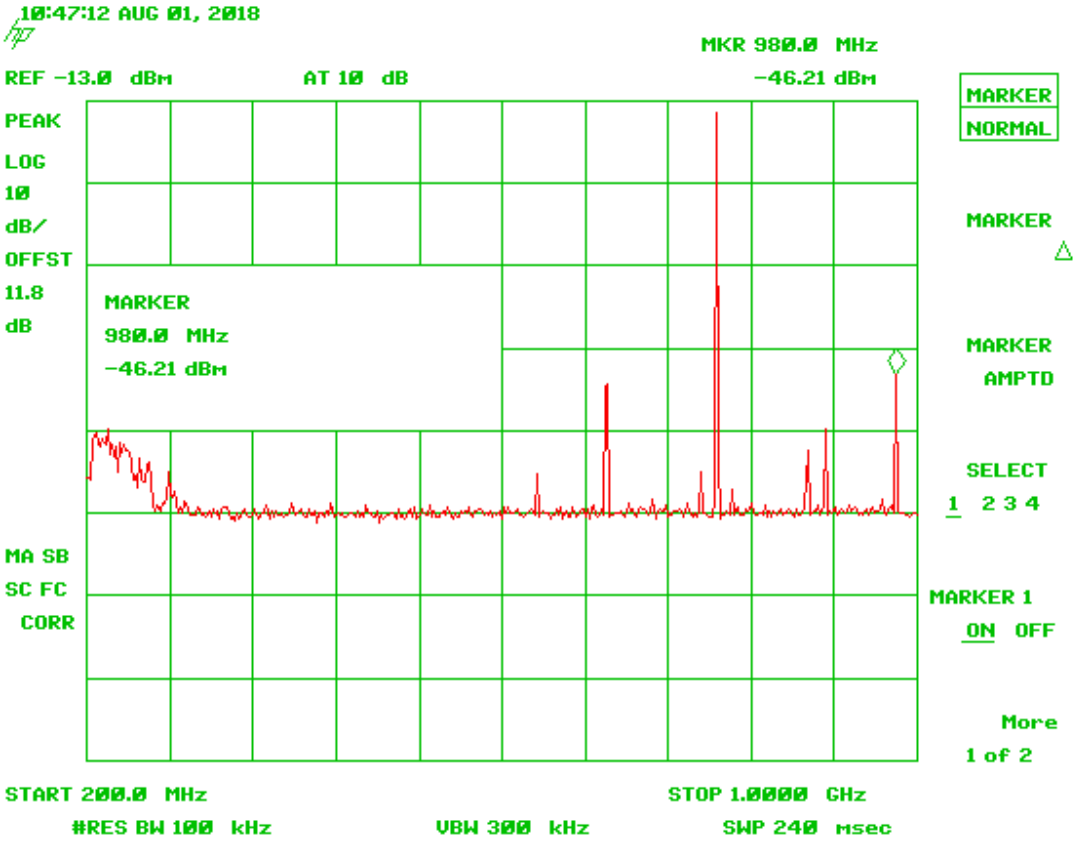

Figure 197. 805 MHz Vertical, 200 MHz - 1 GHz

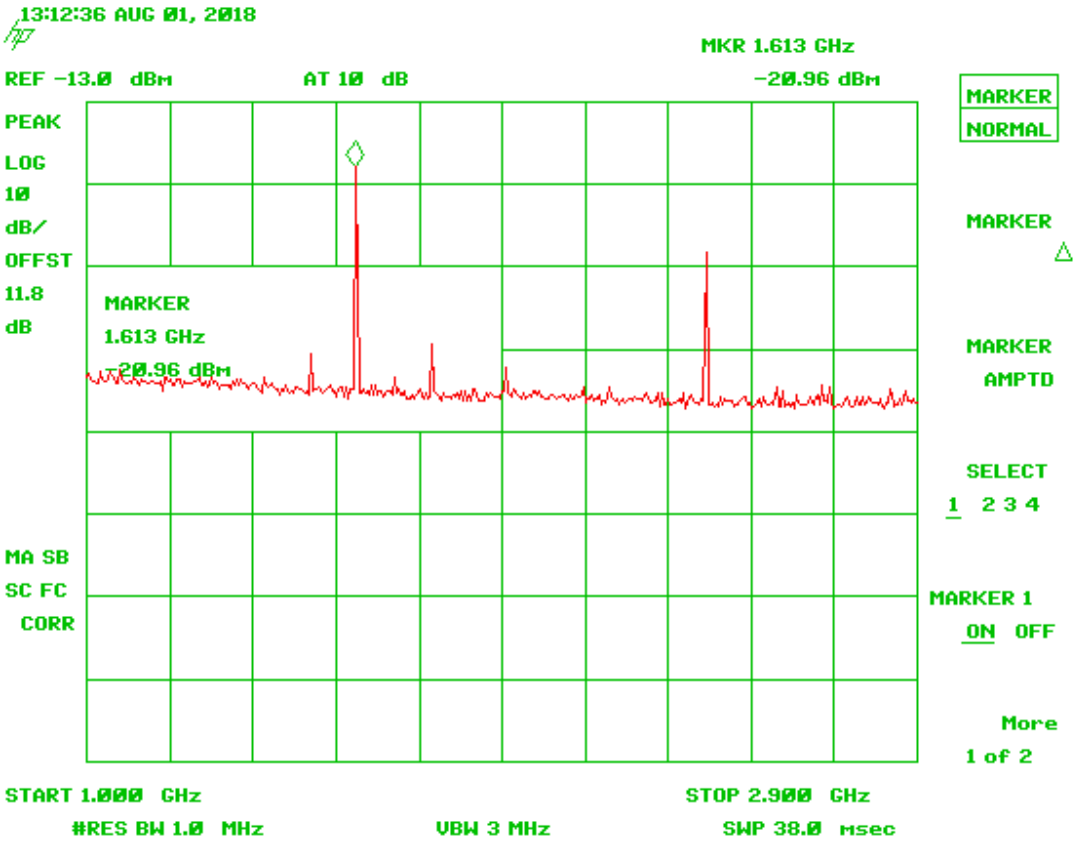

Figure 198. 805 MHz Horizontal, 1 – 2.9 GHz

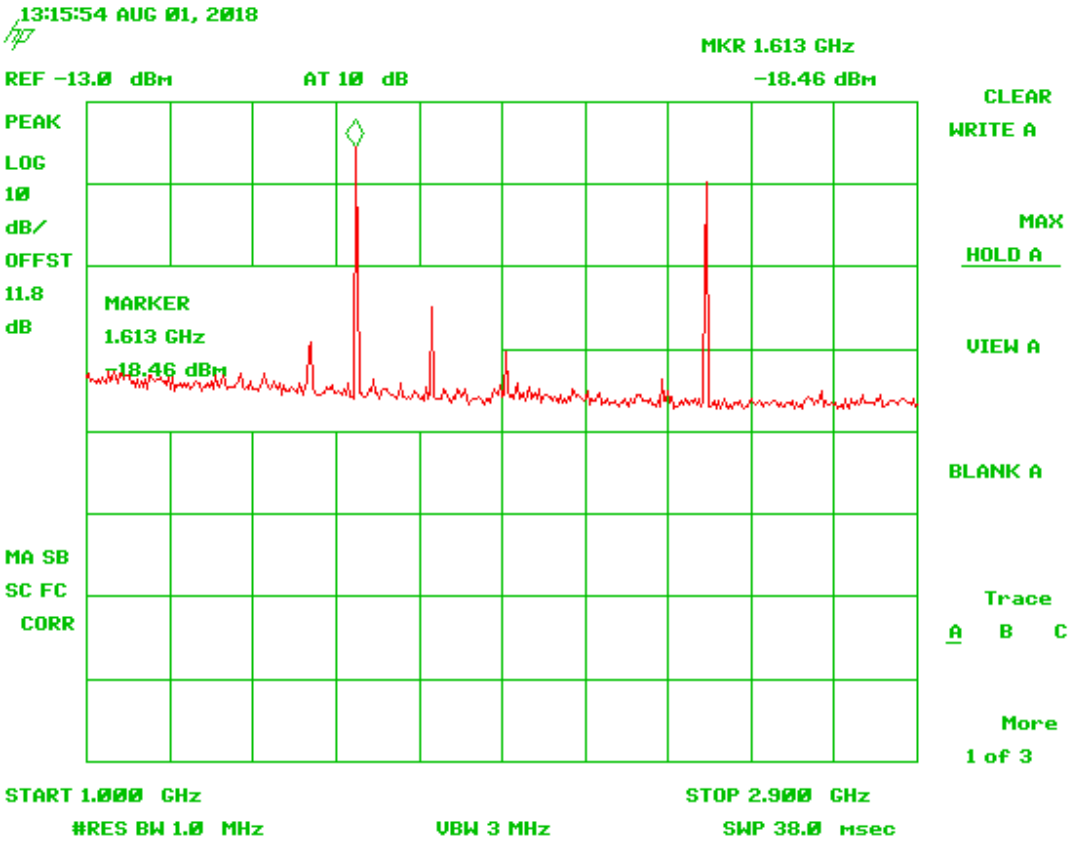

Figure 199. 805 MHz Vertical, 1 – 2.9 GHz

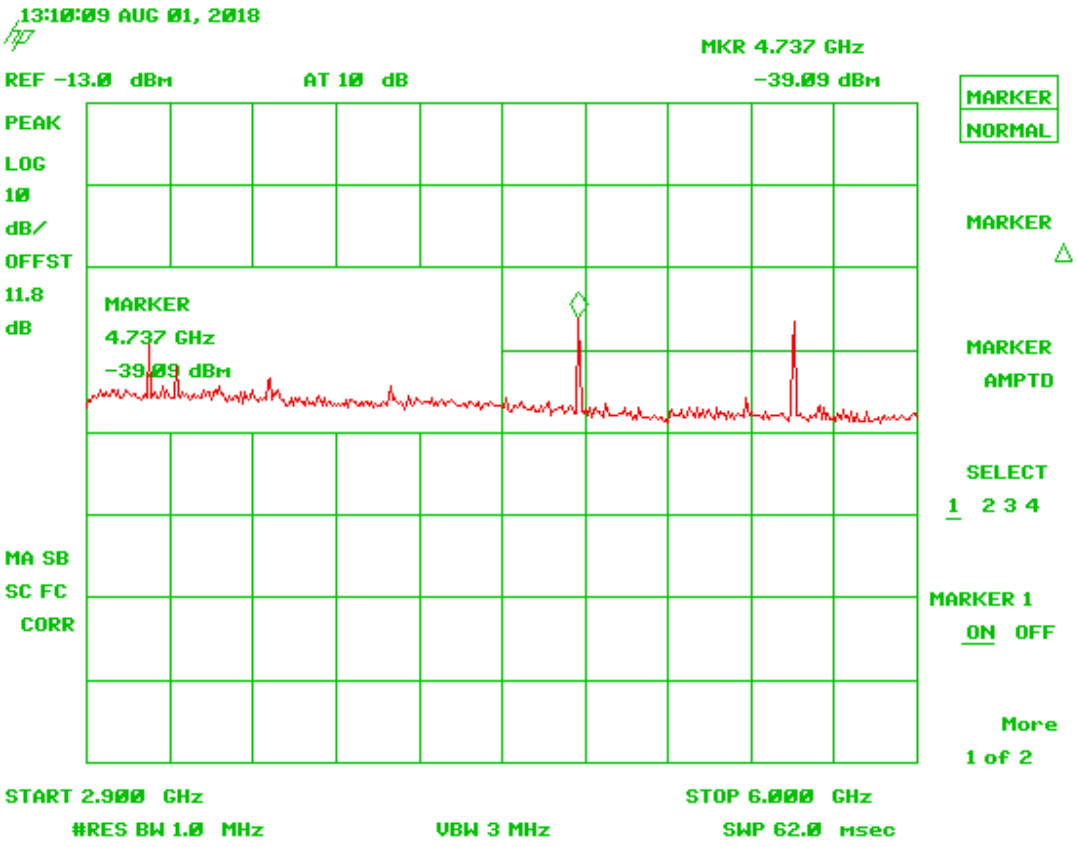

Figure 200. 805 MHz Horizontal, 2.9 - 6 GHz

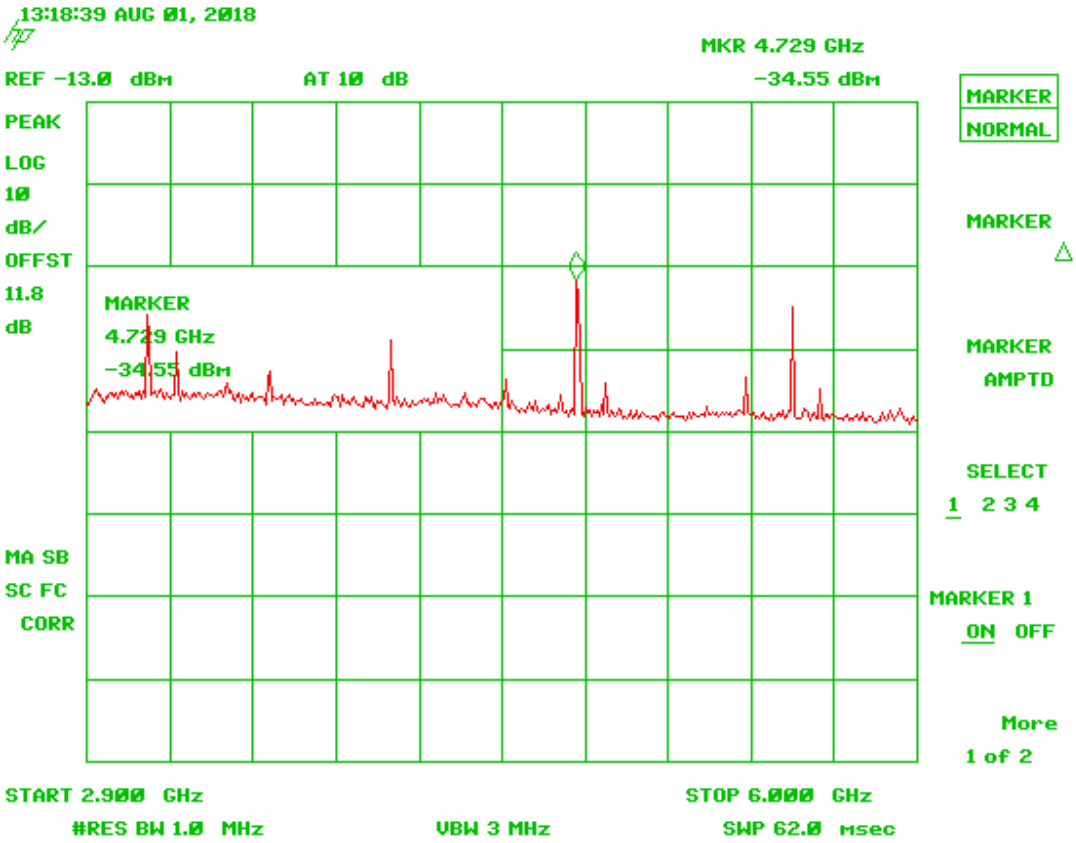

Figure 201. 805 MHz Vertical, 2.9 – 6 GHz

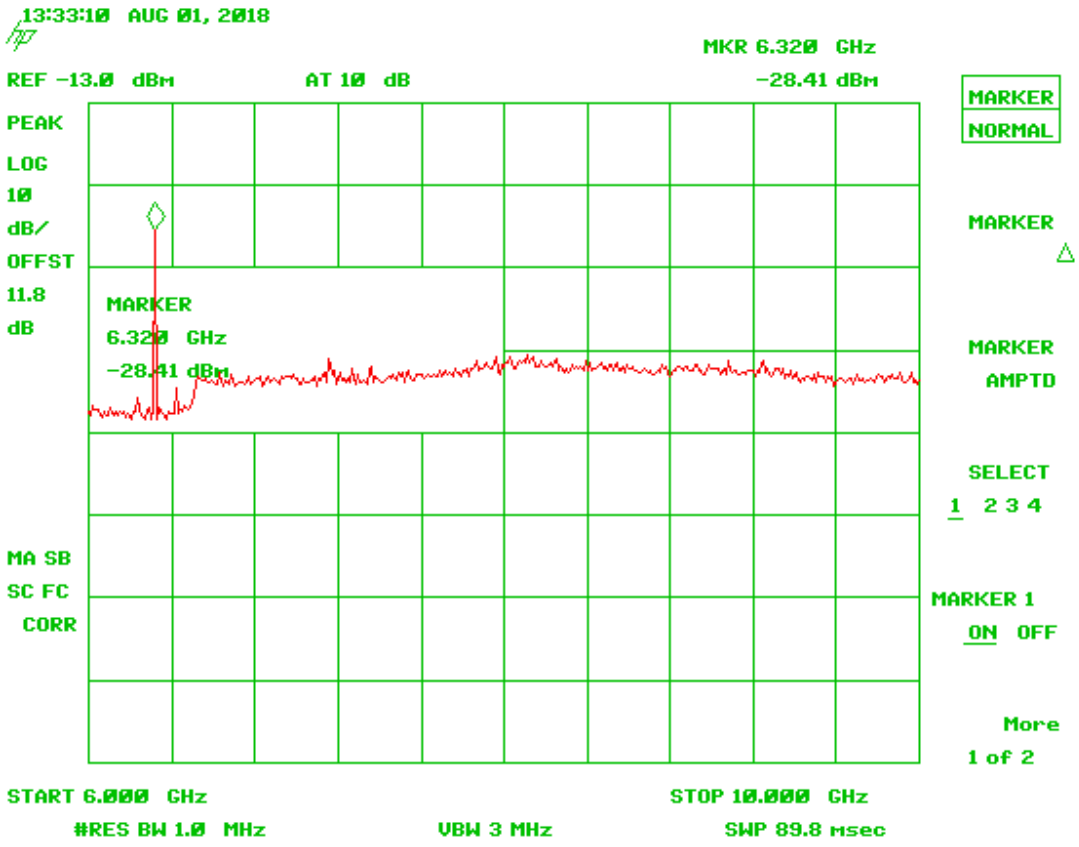

Figure 202. 805 MHz Horizontal, 6 – 10 GHz

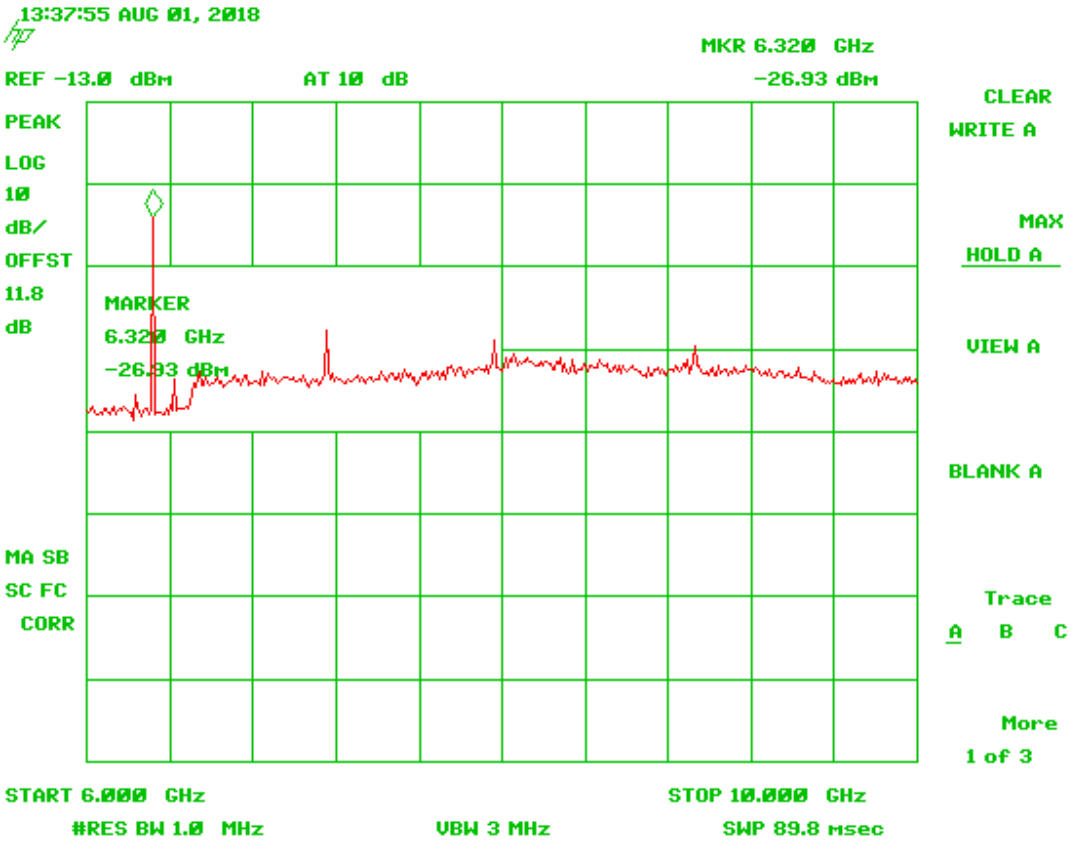

Figure 203. 805 MHz Vertical, 6 – 10 GHz

2.14.1.4 800 MHz Radiated Spurious Emissions Plots

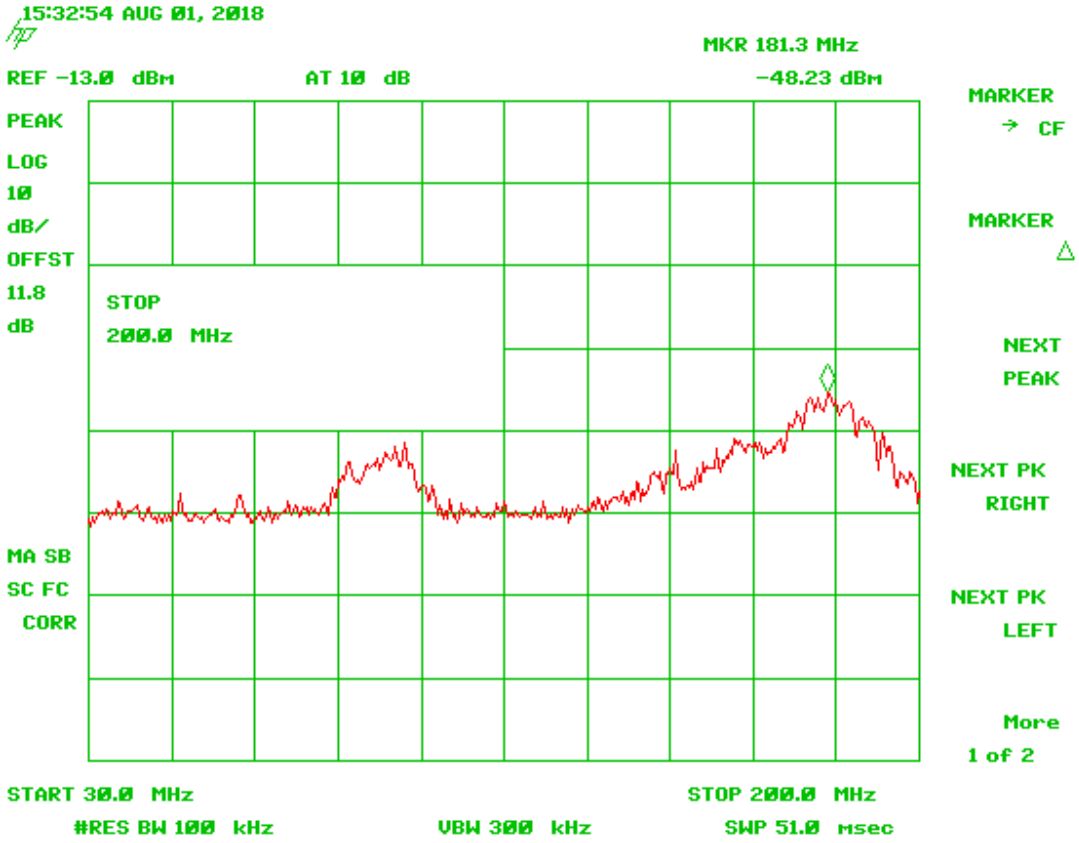

Figure 204. 824 MHz Horizontal, 30 – 200 MHz

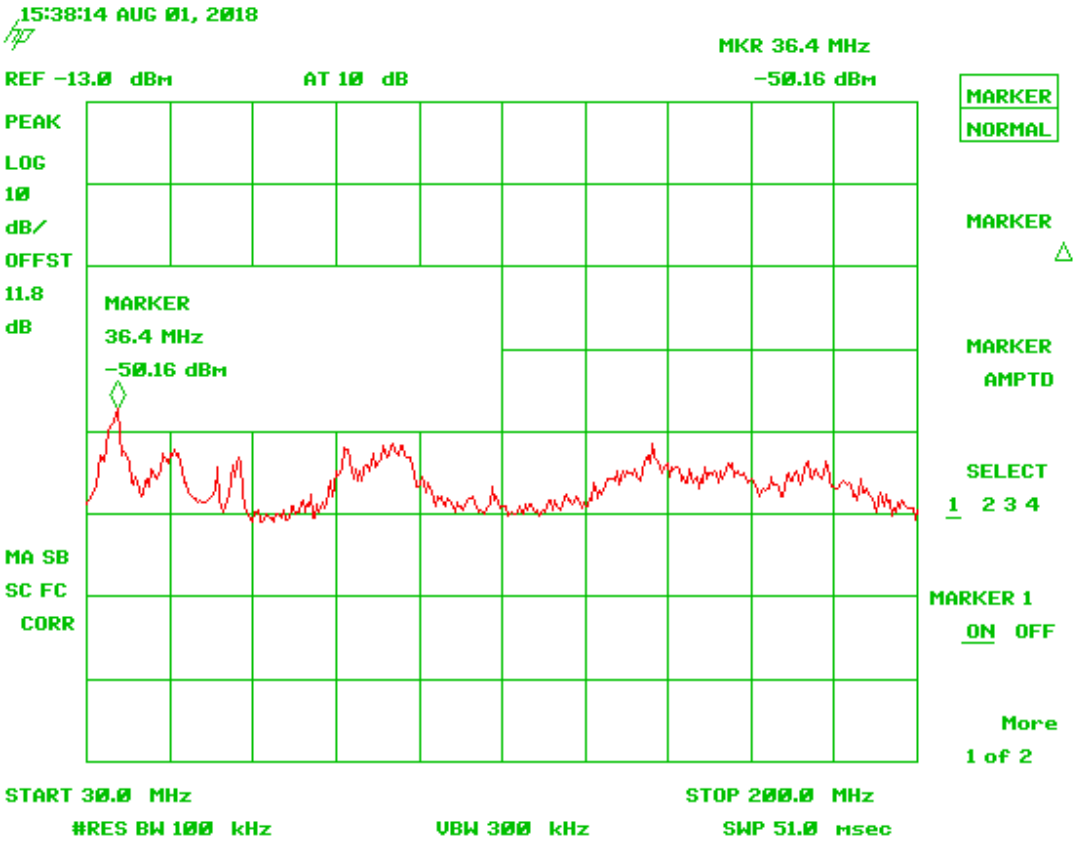

Figure 205. 824 MHz Vertical, 30 - 200 MHz

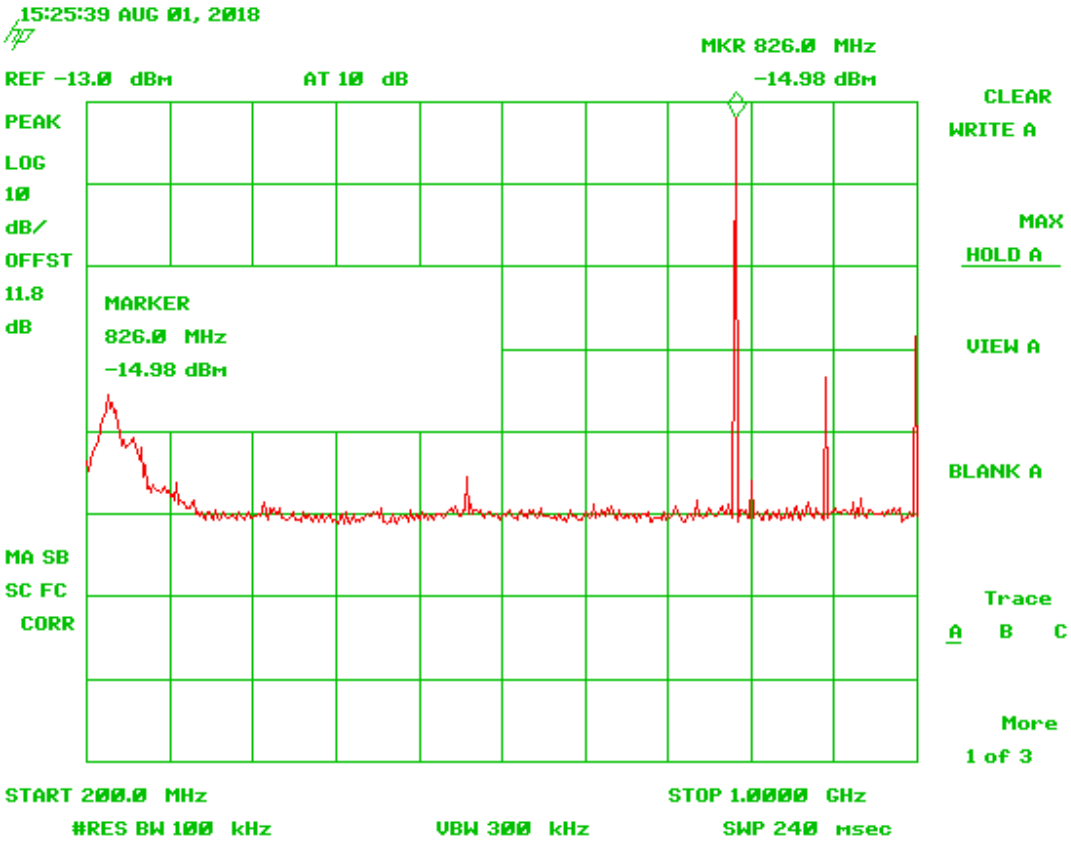

Figure 206. 824 MHz Horizontal 200 MHz - 1 GHz

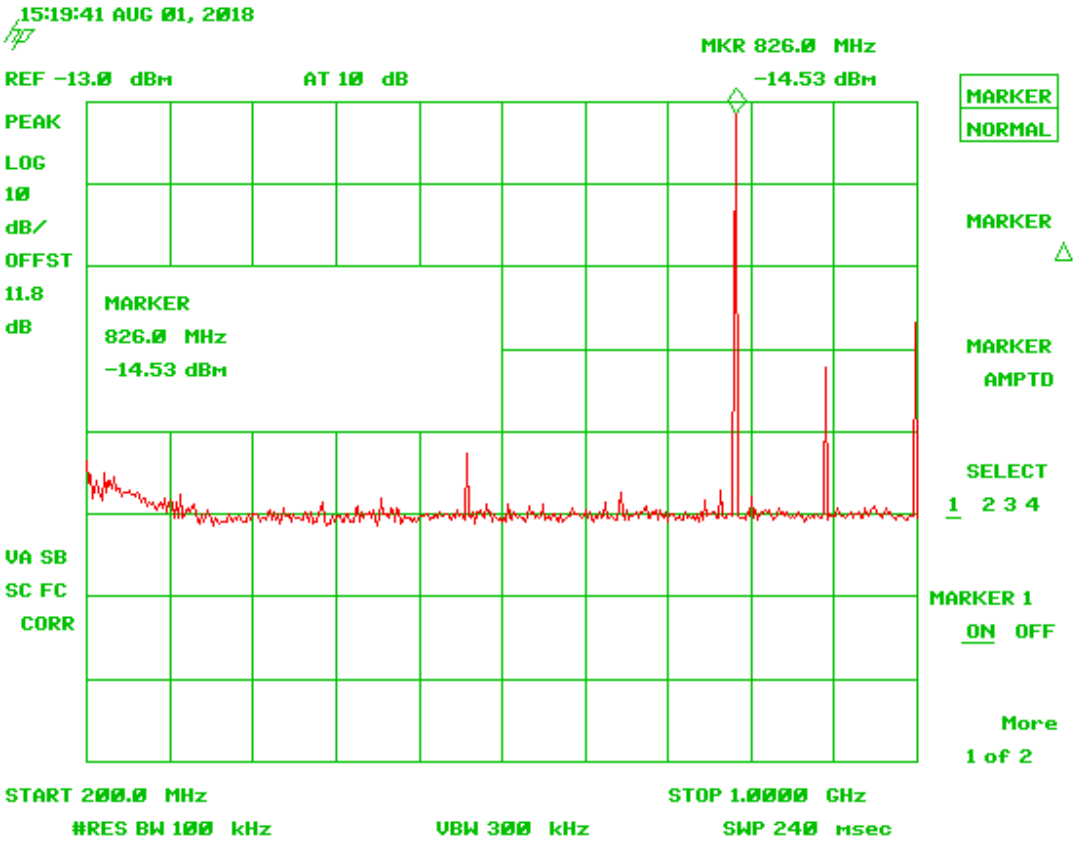

Figure 207. 824 MHz Vertical, 200 MHz – 1 GHz

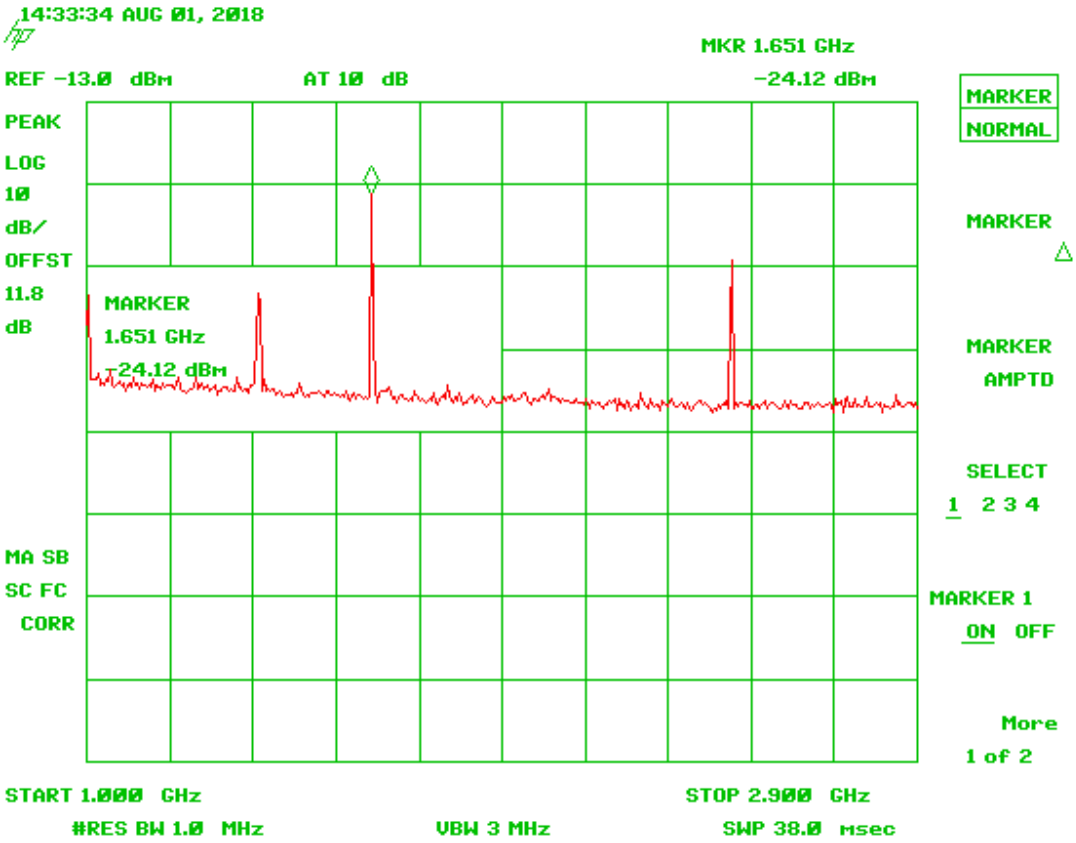

Figure 208. 824 MHz Horizontal, 1 – 2.9 GHz

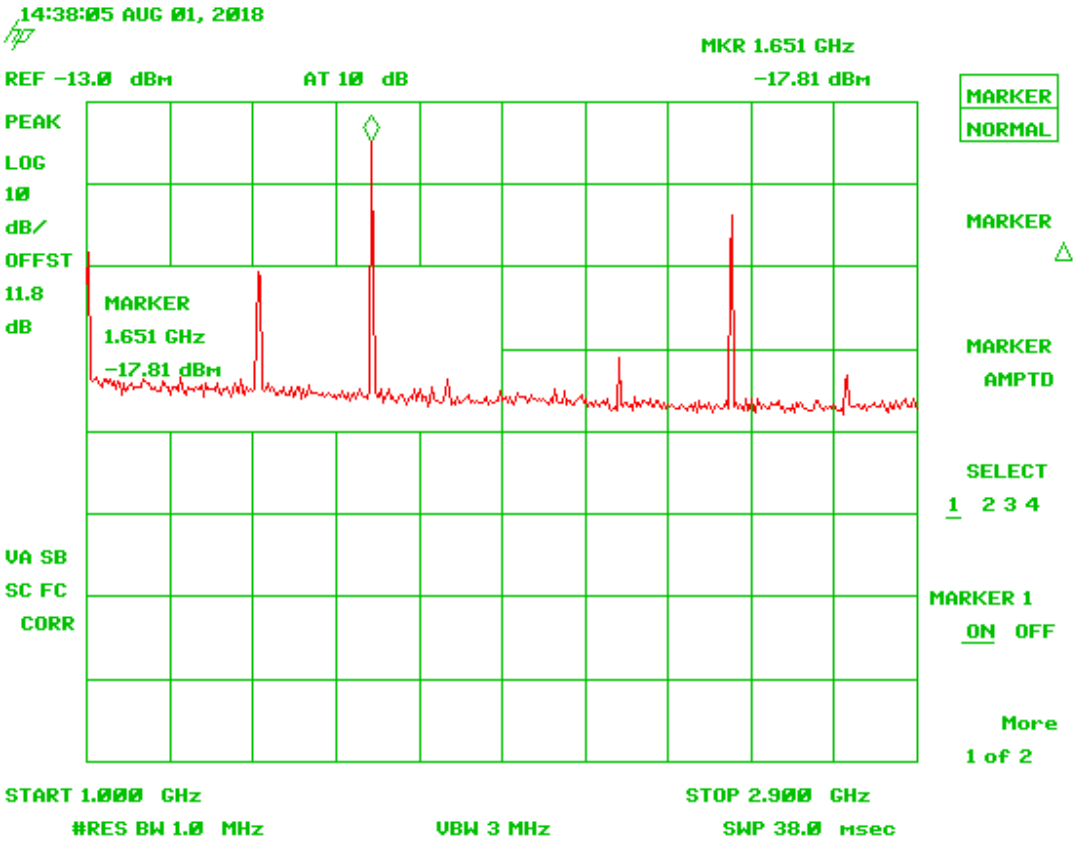

Figure 209. 824 MHz Vertical, 1 – 2.9 GHz

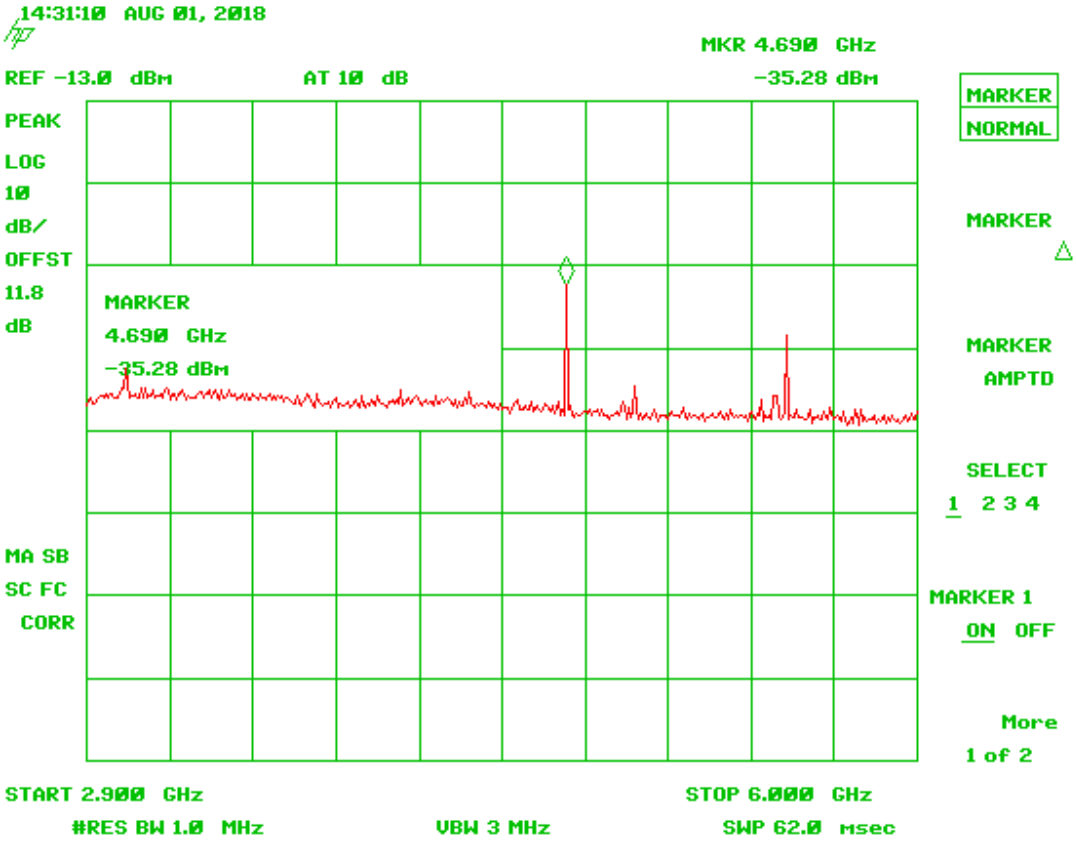

Figure 210. 824 MHz Horizontal 2.9 - 6 GHz

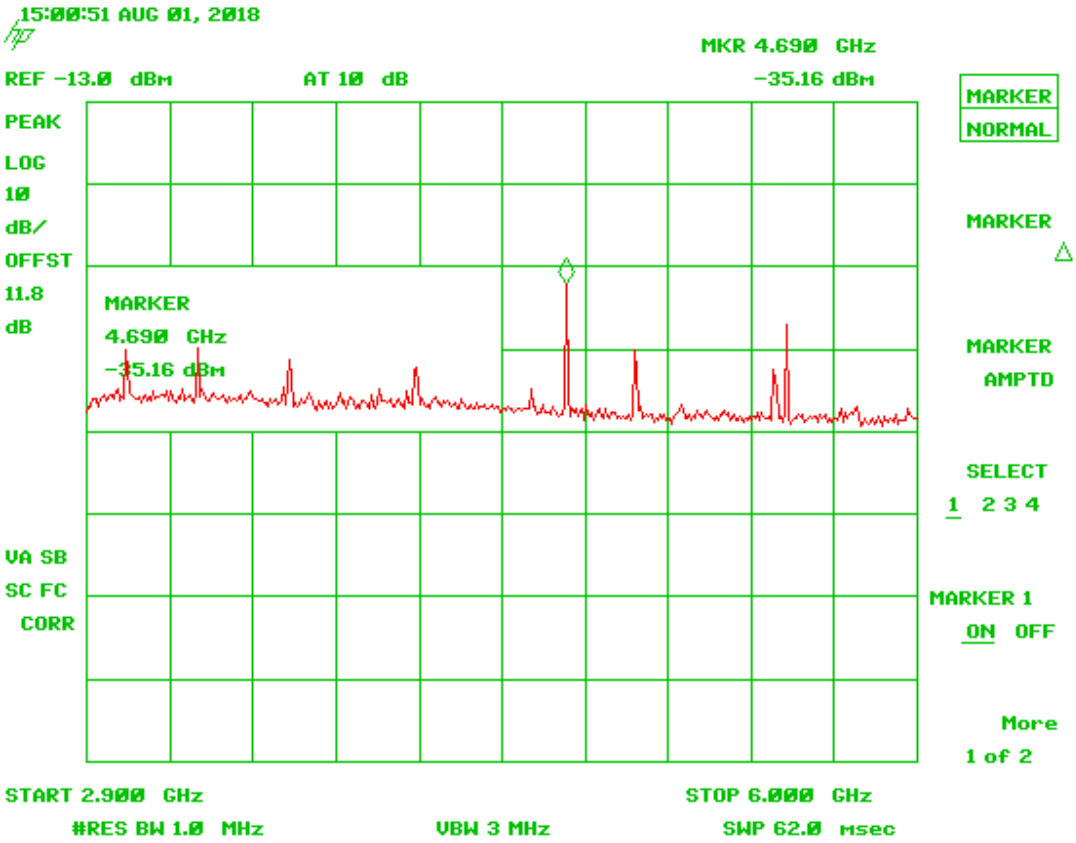

Figure 211. 824 MHz Vertical 2.9 - 6 GHz

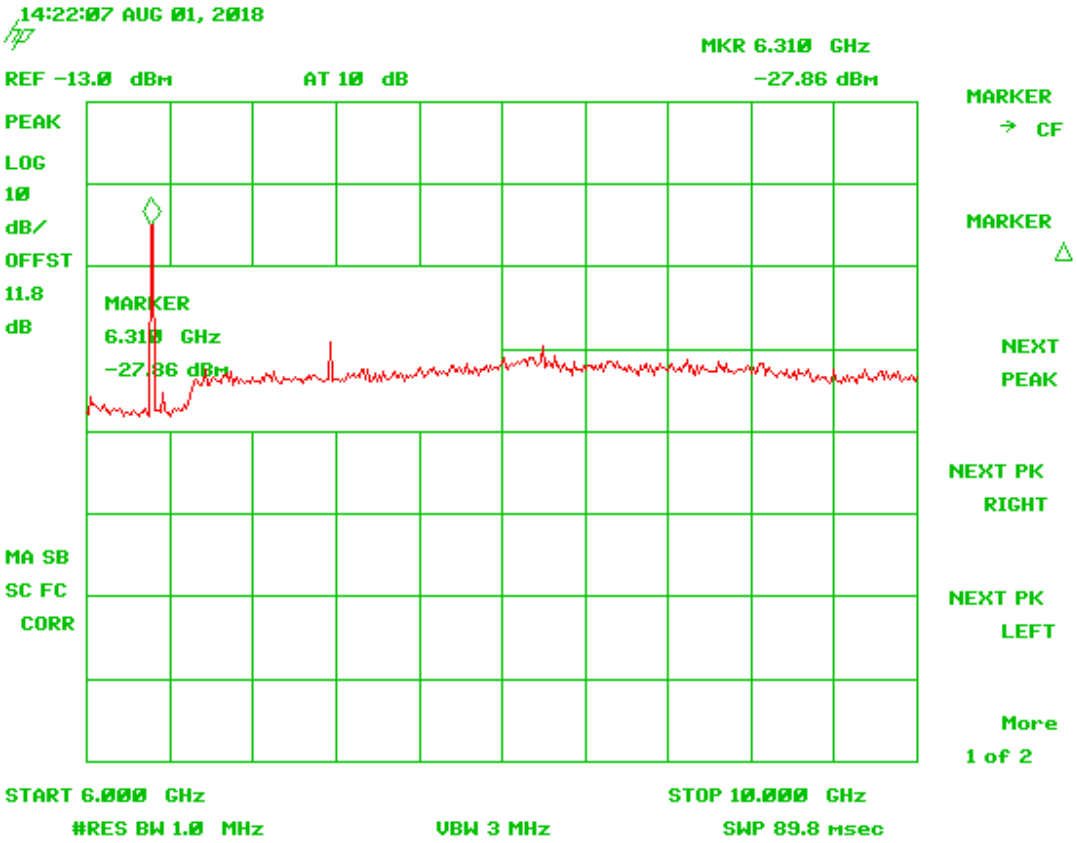

Figure 212. 824 MHz Horizontal, 6 – 10 GHz

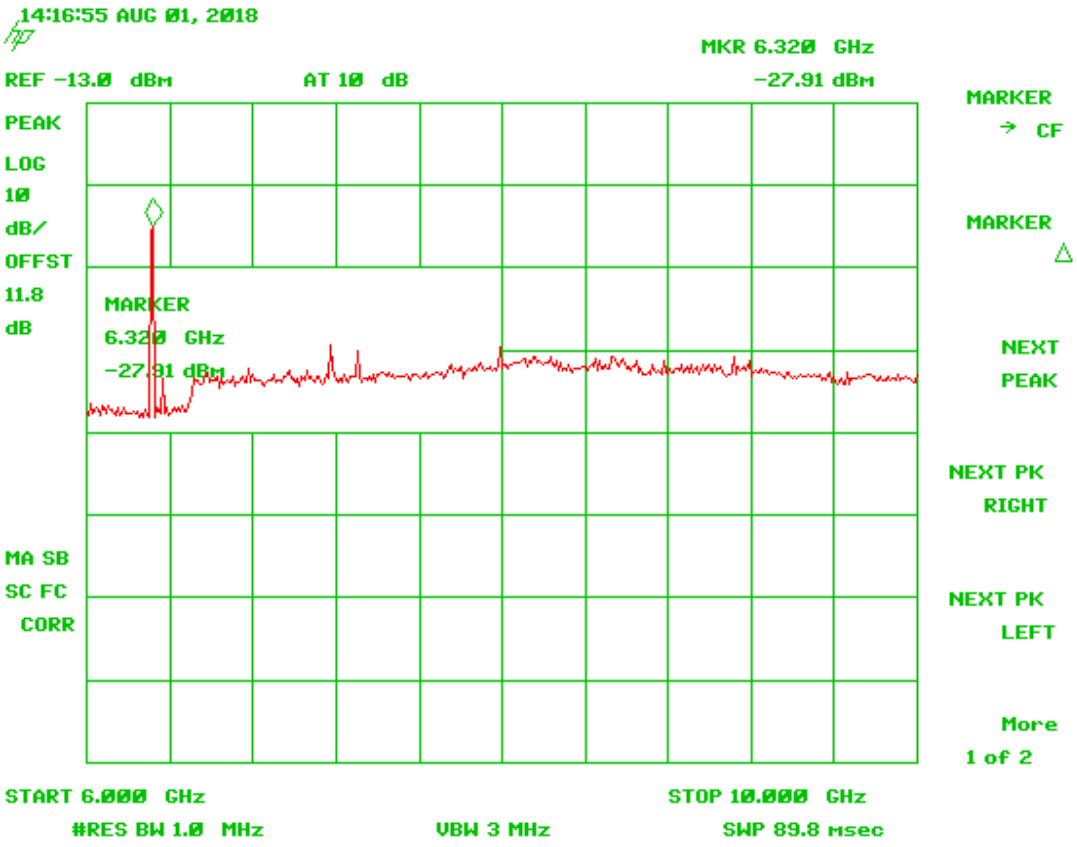

Figure 213. 824 MHz Vertical, 6 – 10 GHz

2.14.1.5 900 MHz Radiated Spurious Emissions Plots

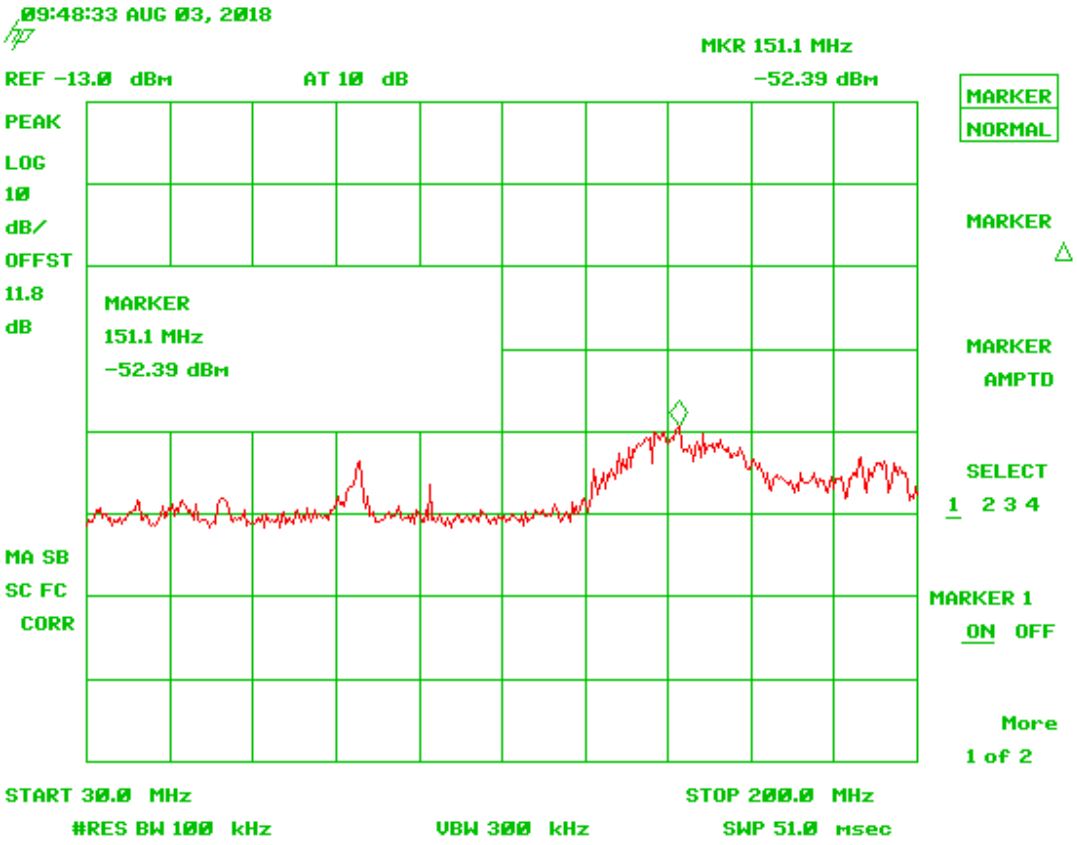

Figure 214. 901 MHz Horizontal, 30 - 200 MHz

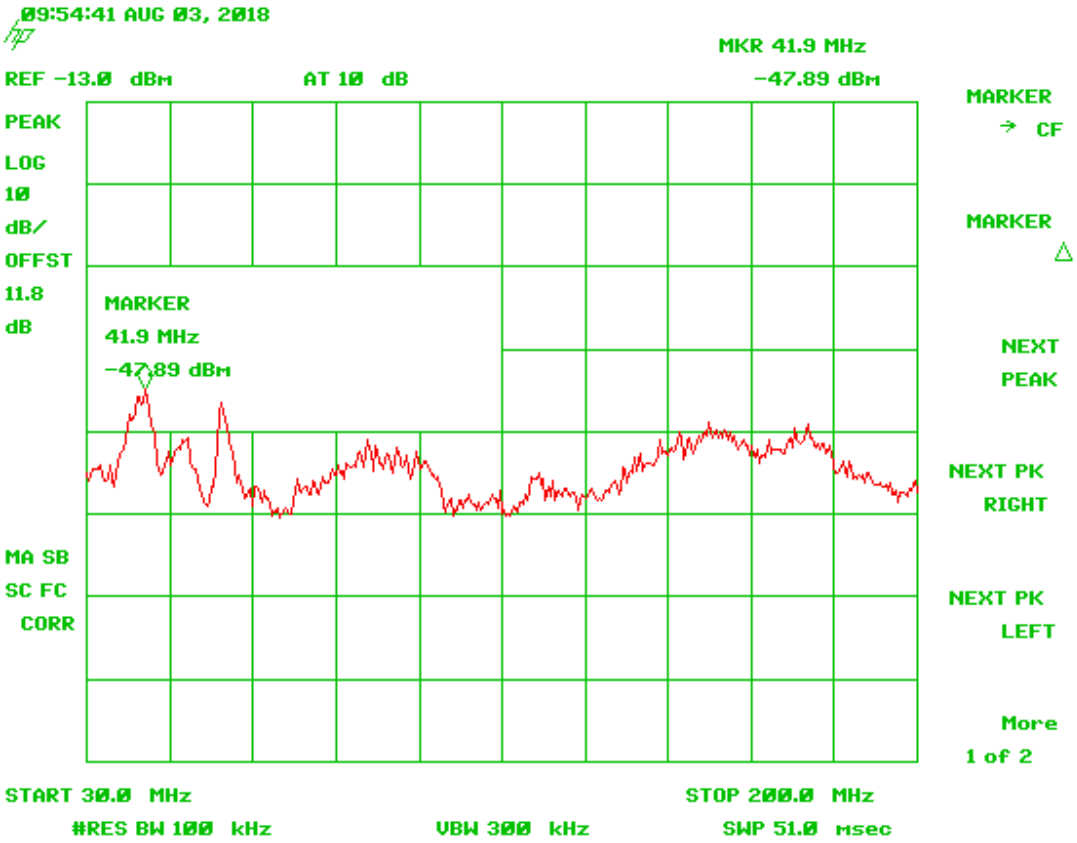

Figure 215. 901 MHz Vertical, 30 - 200 MHz

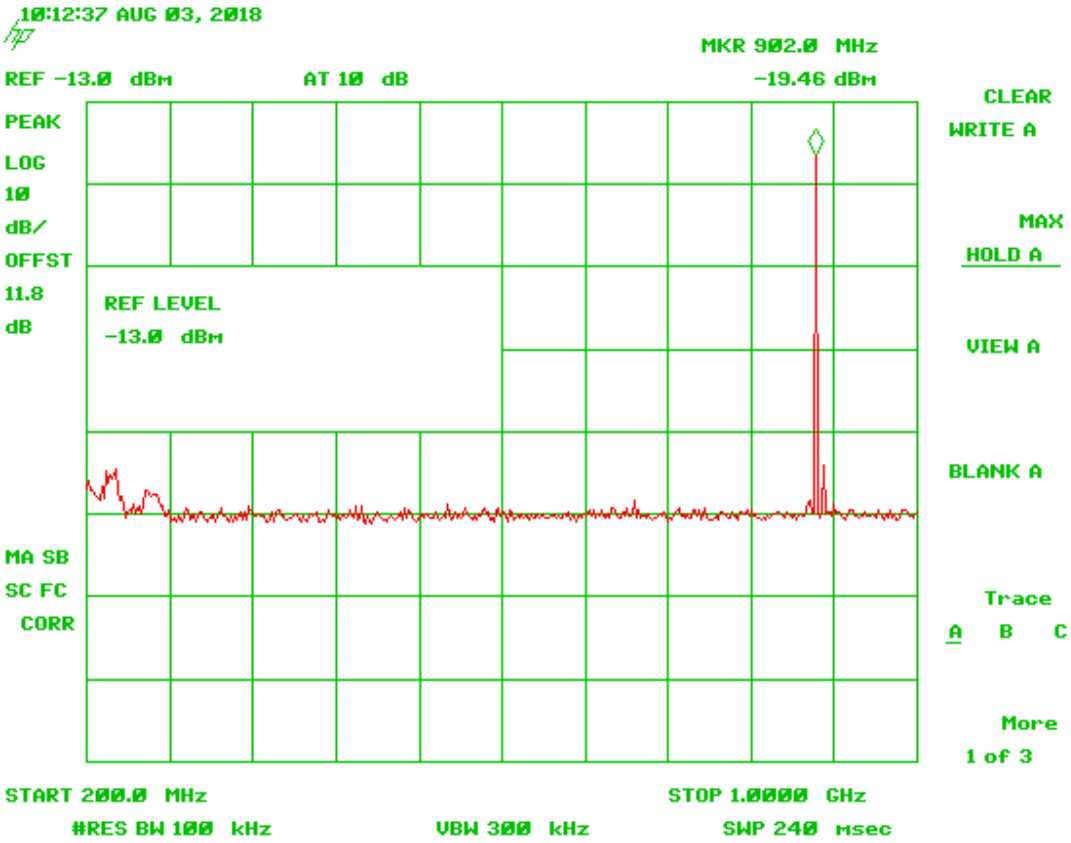

Figure 216. 901 MHz Horizontal, 200 MHz - 1 GHz

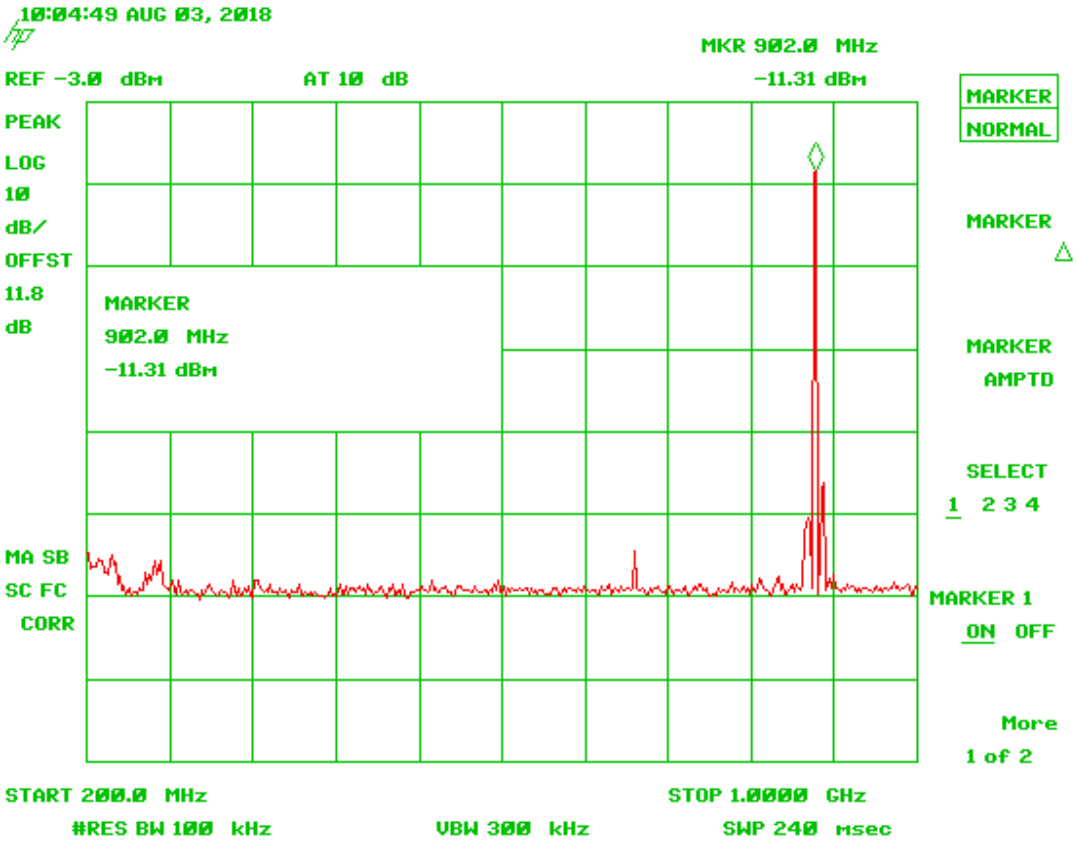

Figure 217. 901 MHz Vertical, 200 MHz - 1 GHz

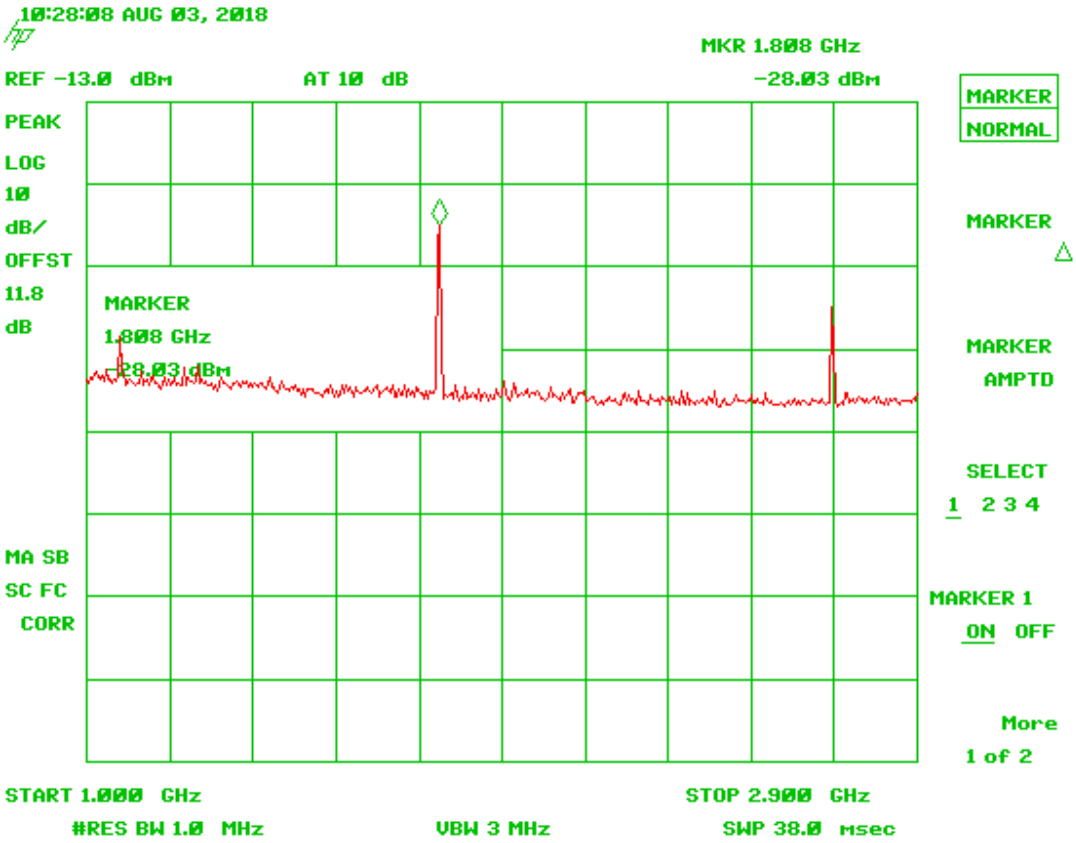

Figure 218. 901 MHz Horizontal, 1 – 2.9 GHZ

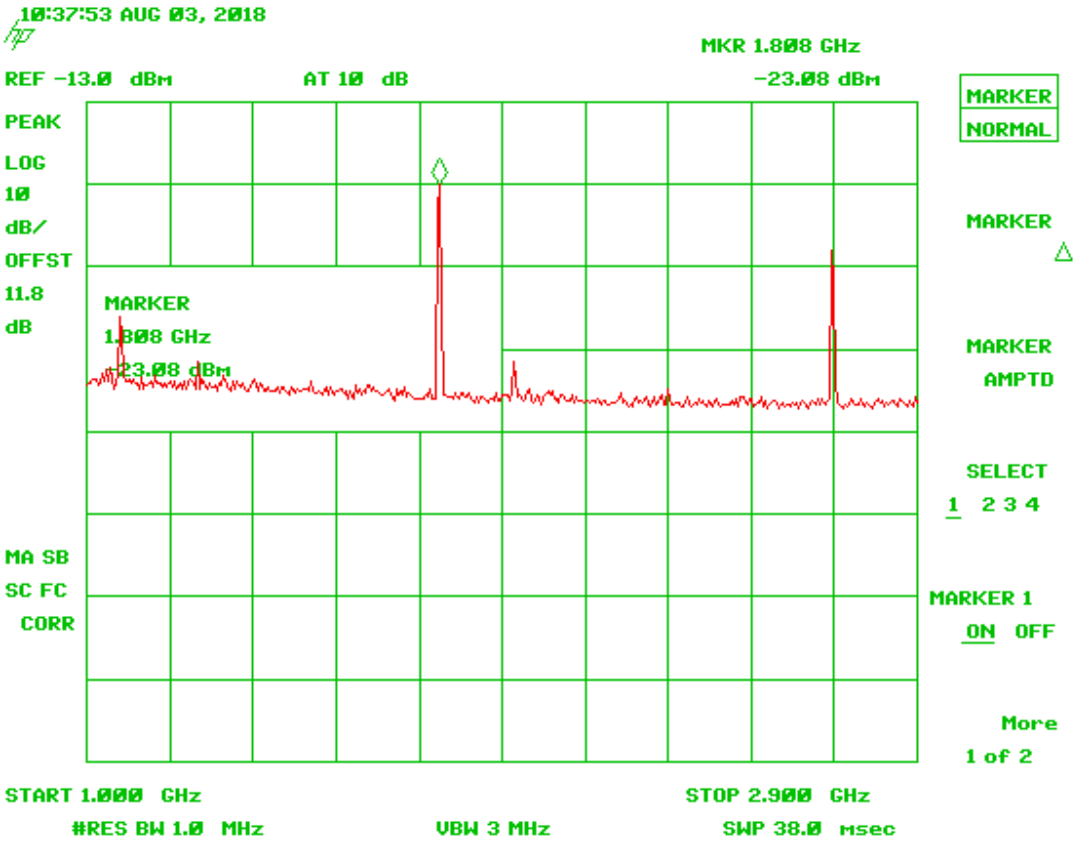

Figure 219. 901 MHz Vertical, 1 – 2.9 GHZ

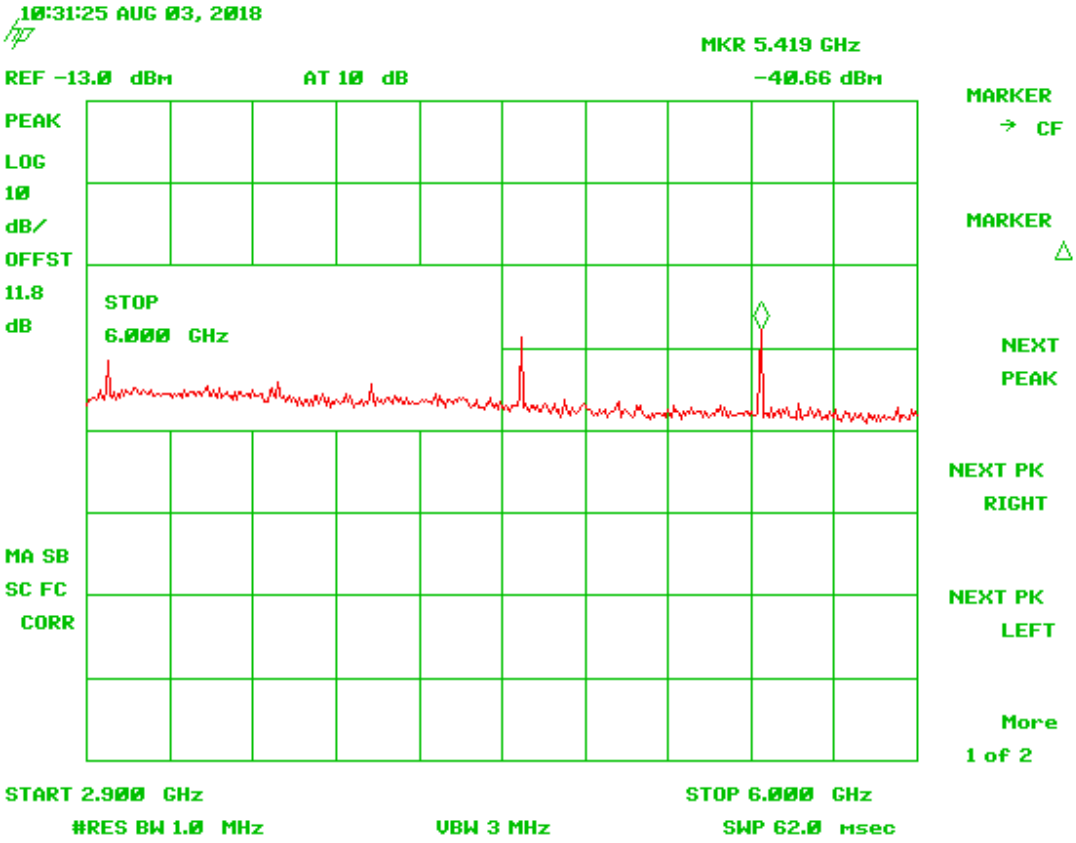

Figure 220. 901 MHz Horizontal, 2.9 - 6 GHz

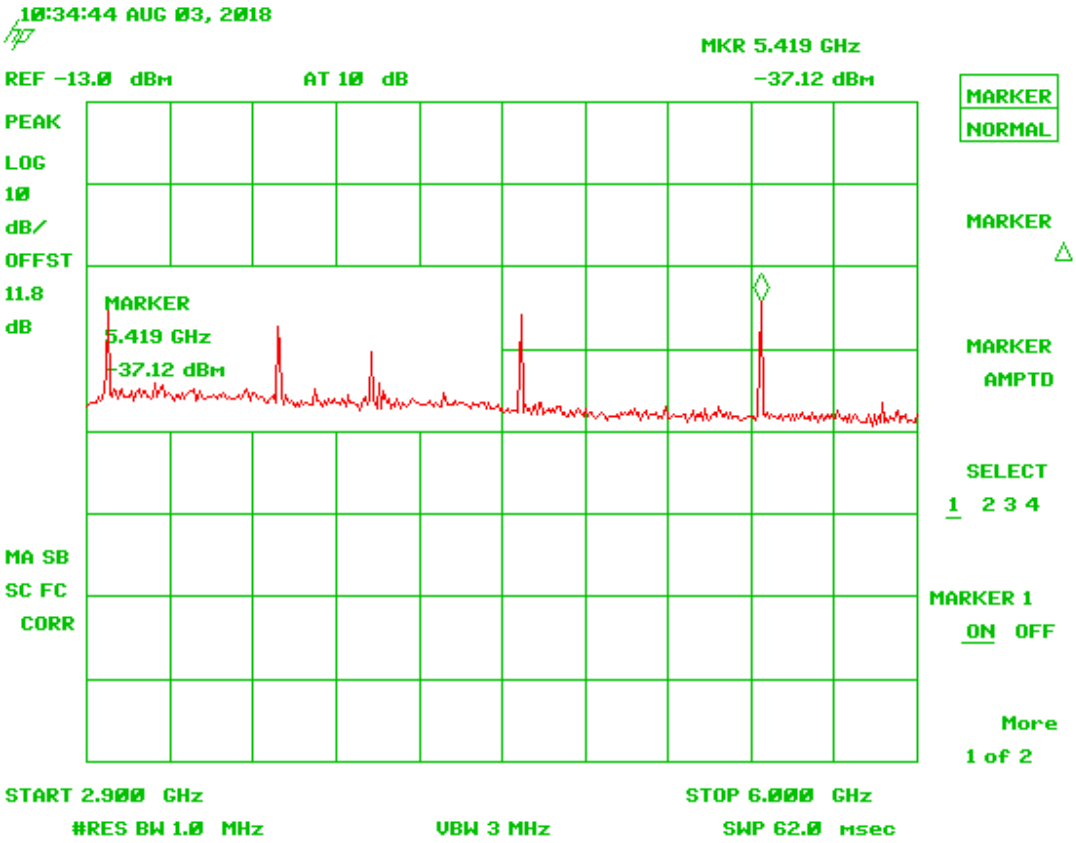

Figure 221. 901 MHz Vertical, 2.9 - 6 GHz

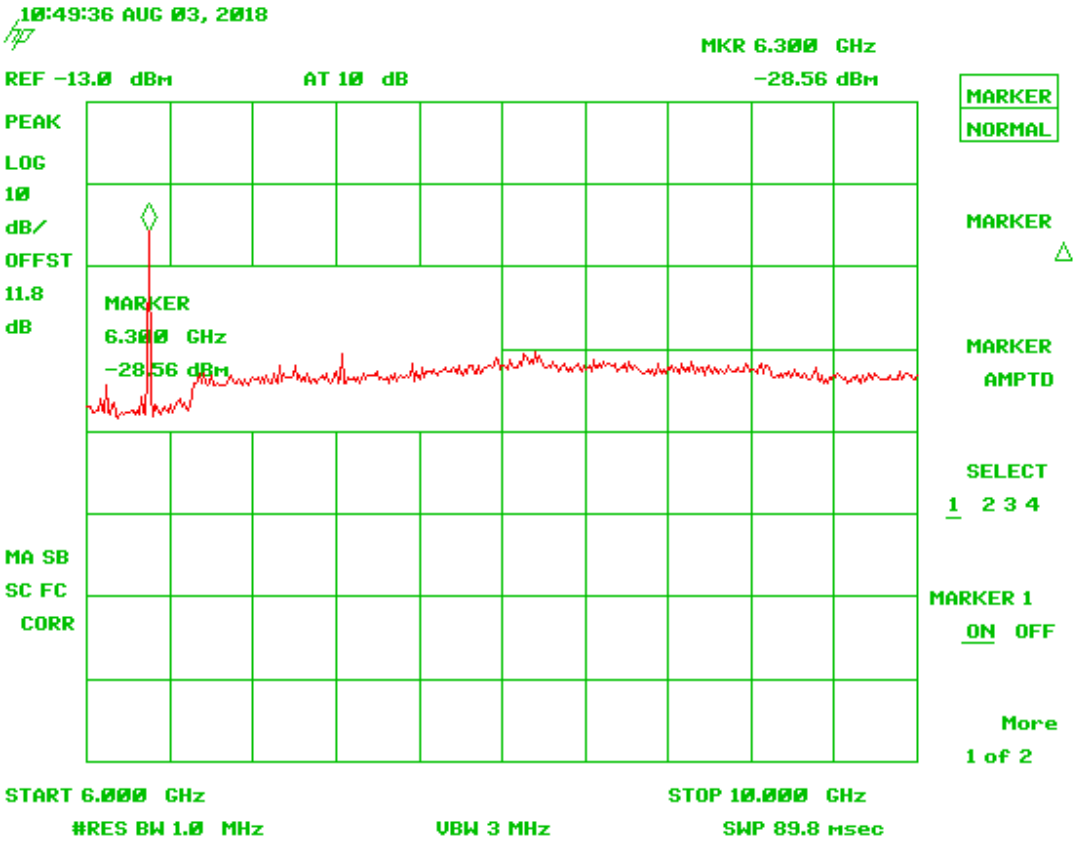

Figure 222. 901 MHz Horizontal, 6 – 10 GHz

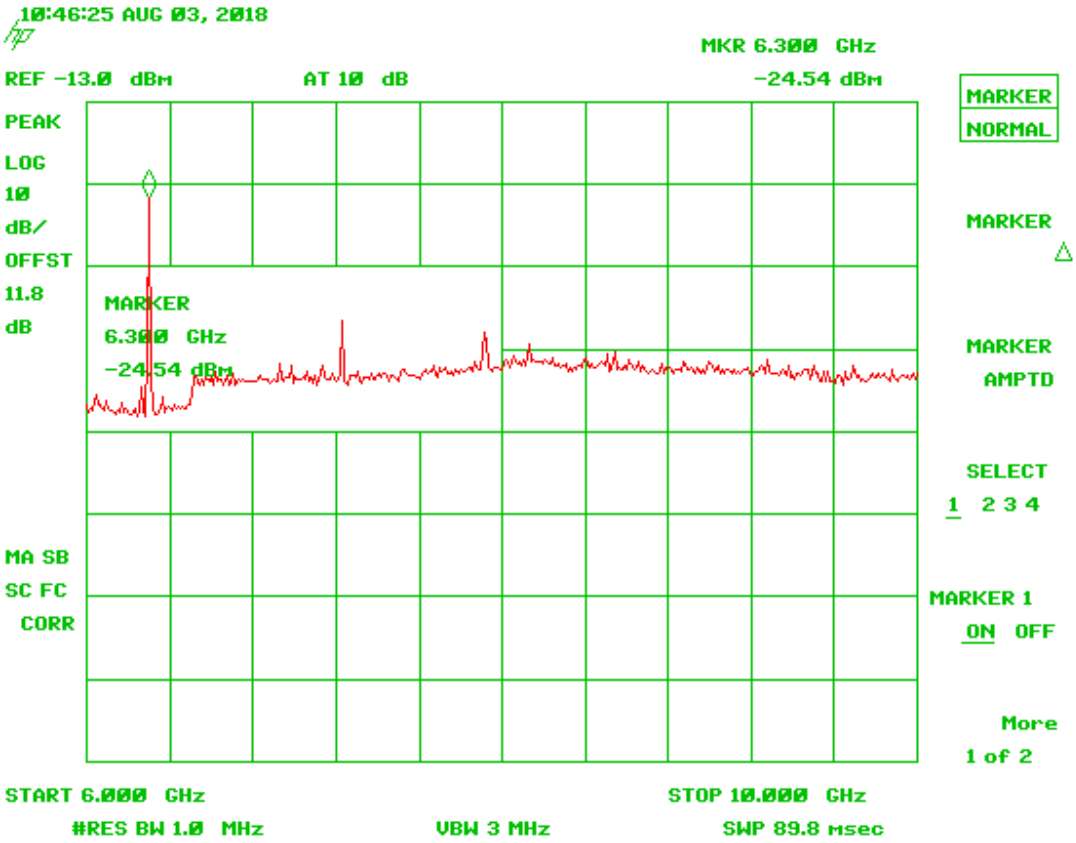

Figure 223. 901 MHz Vertical, 6 – 10 GHz

2.14.2 Conducted Spurious Emissions Measurement (90.219(e)(4), RSS-131, 6.5)

The EUT was connected to a spectrum analyzer through a 20 dB attenuator. All cable and attenuator losses were input into the spectrum analyzer as a combination of reference level offset and correction factors as needed to ensure the accuracy of the readings obtained.

A CW signal was used to set the center frequency of the transmitter. The RF input signal level was set to at least 0.2 dB below the ACG threshold.

The RBW was set to 100 KHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz. The VBW was 3 times the RBW.

Limit = -13 dBm

Emissions were investigated from 30 MHz to the 10^{th} harmonic of the applicable frequency band of concern.

The following plots show the worst-case measurements.

2.14.2.1 VHF Conducted Spurious Emissions

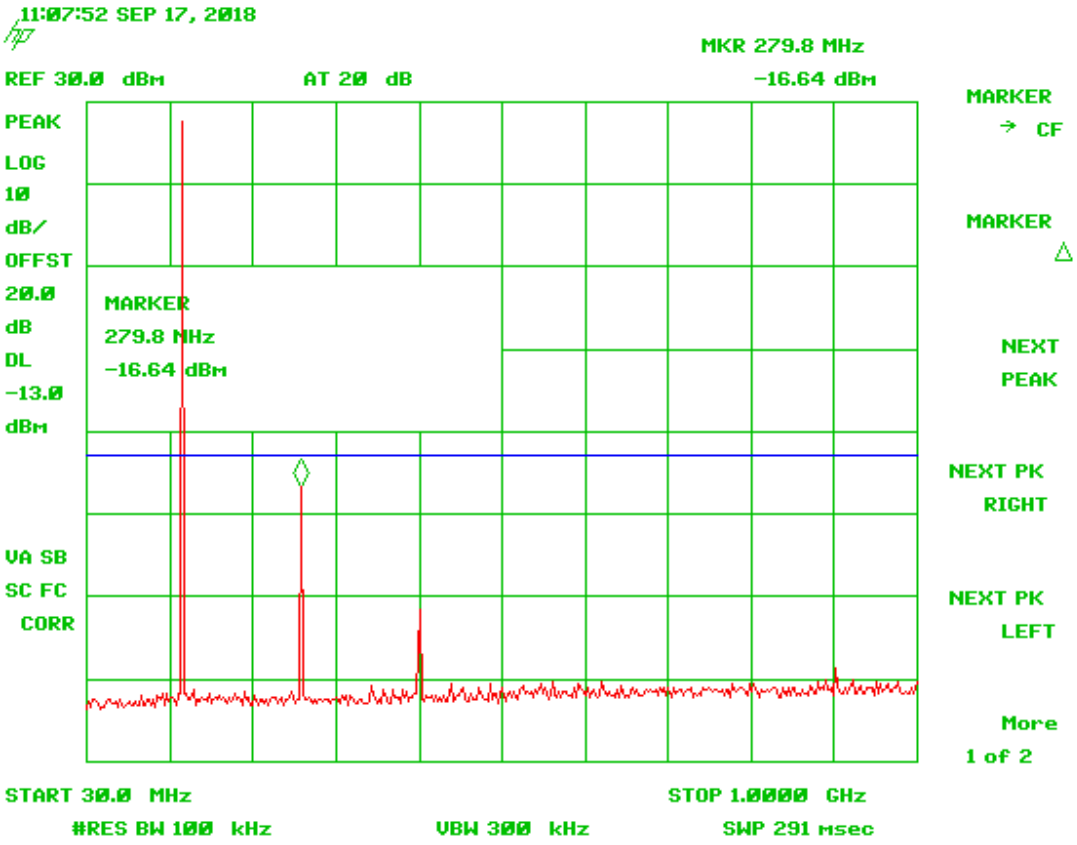

Figure 224. 138 MHz below 1 GHz

Note: All spurious emissions other than the fundamental are below -13 dBm.
(Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

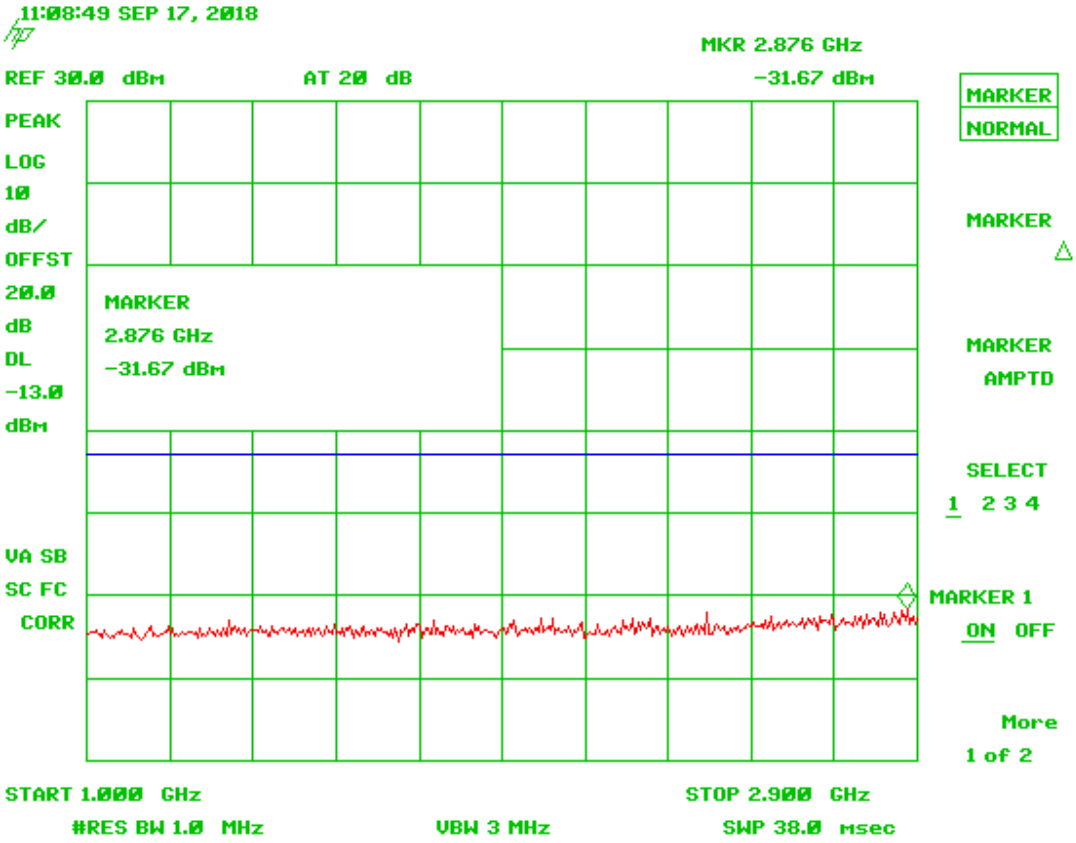

Figure 225. 138 MHz above 1 GHz

(Test data for band 138-144 MHz and 380-400 MHz not applicable for FCC certification)

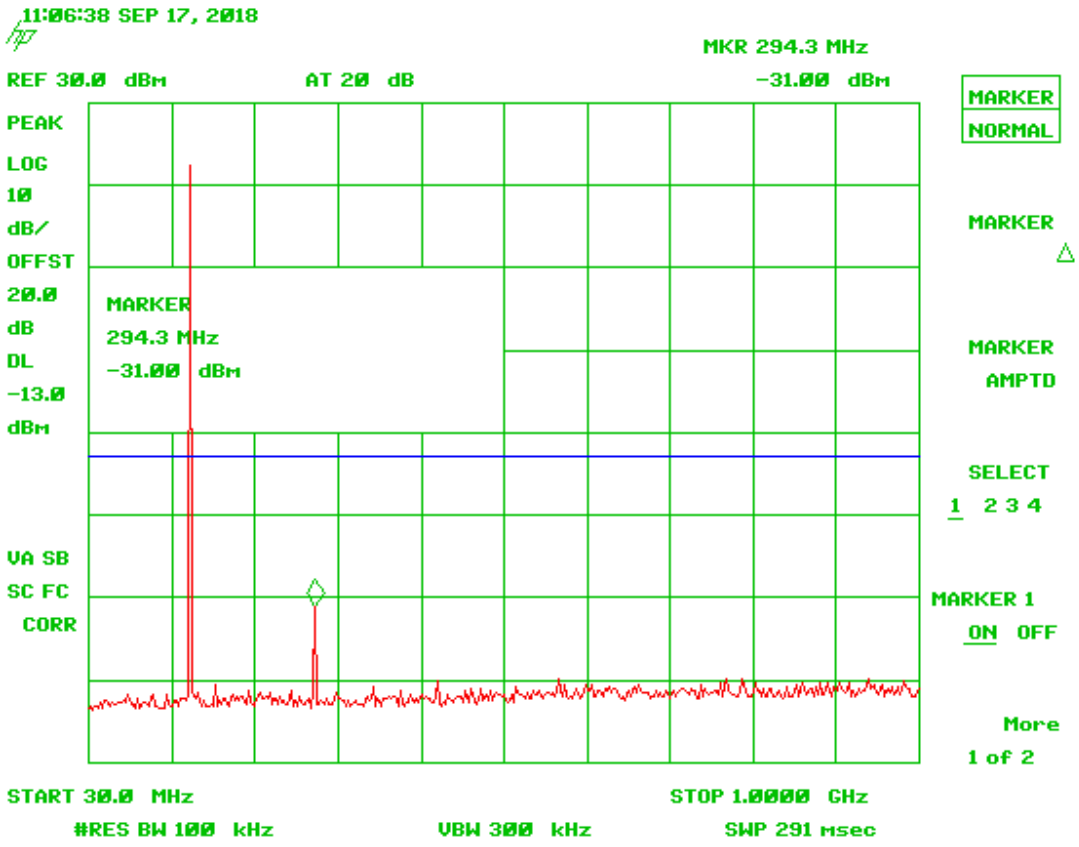

Figure 226. 145 MHz below 1 GHz

Note: All spurious emissions other than the fundamental are below -13 dBm.

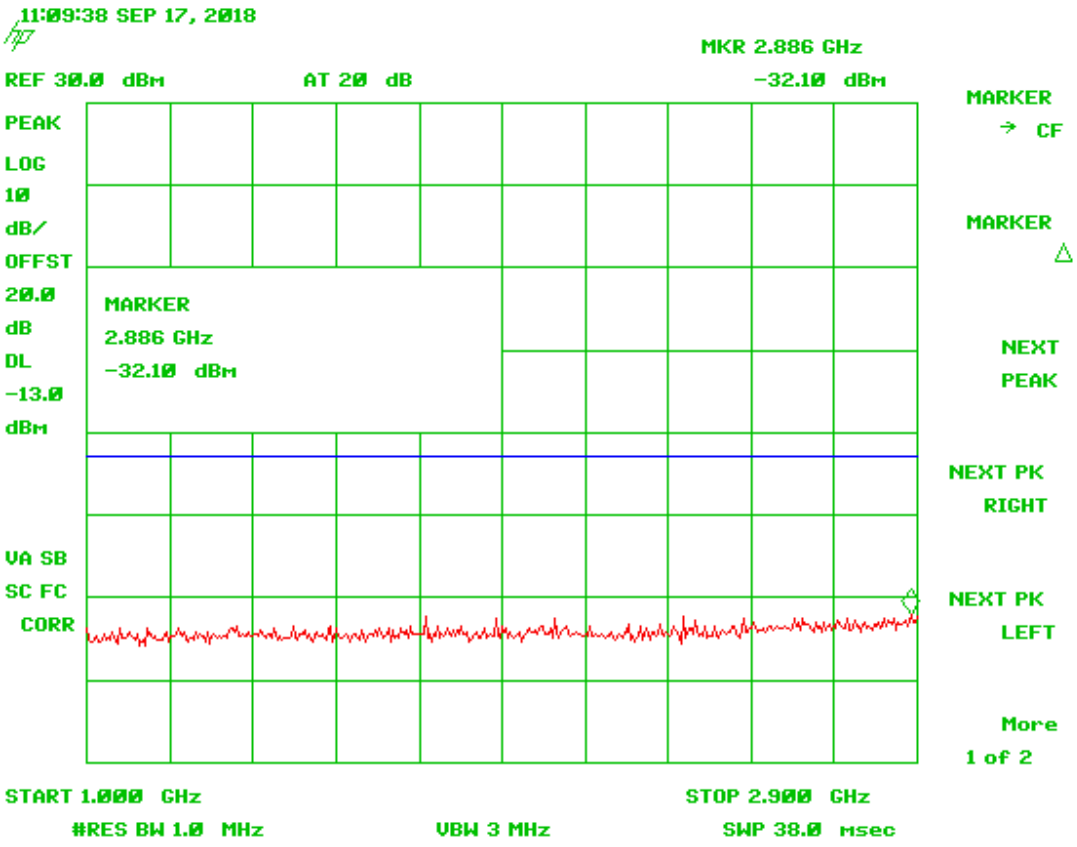

Figure 227. 145 MHz above 1 GHz

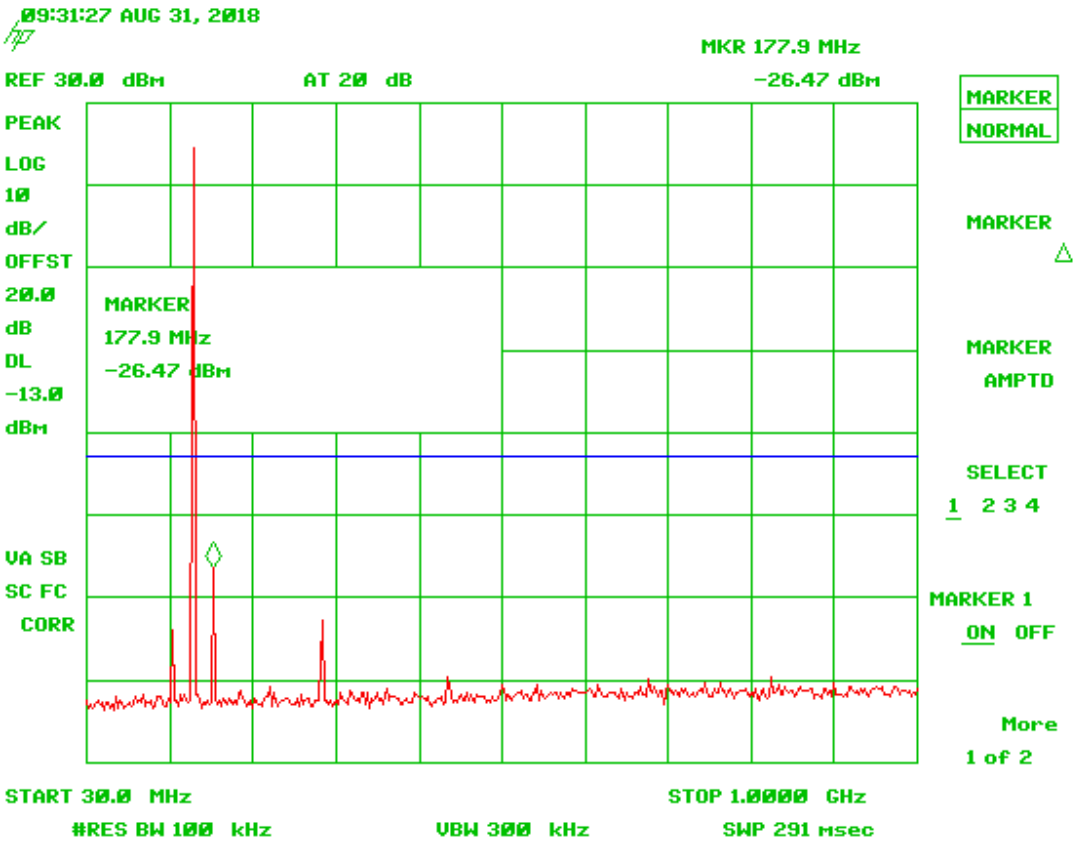

Figure 228. 150 MHz below 1 GHz

Note: All spurious emissions other than the fundamental are below -13 dBm.

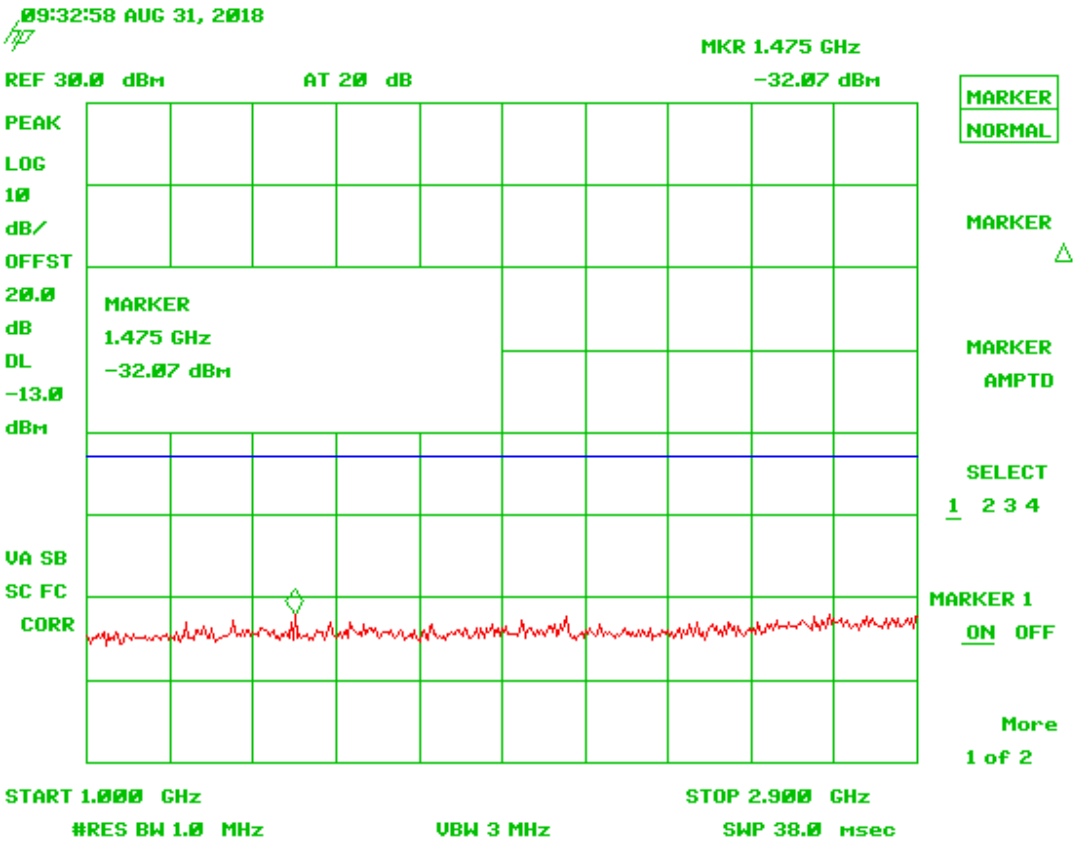

Figure 229. 150 MHz, above 1 GHz

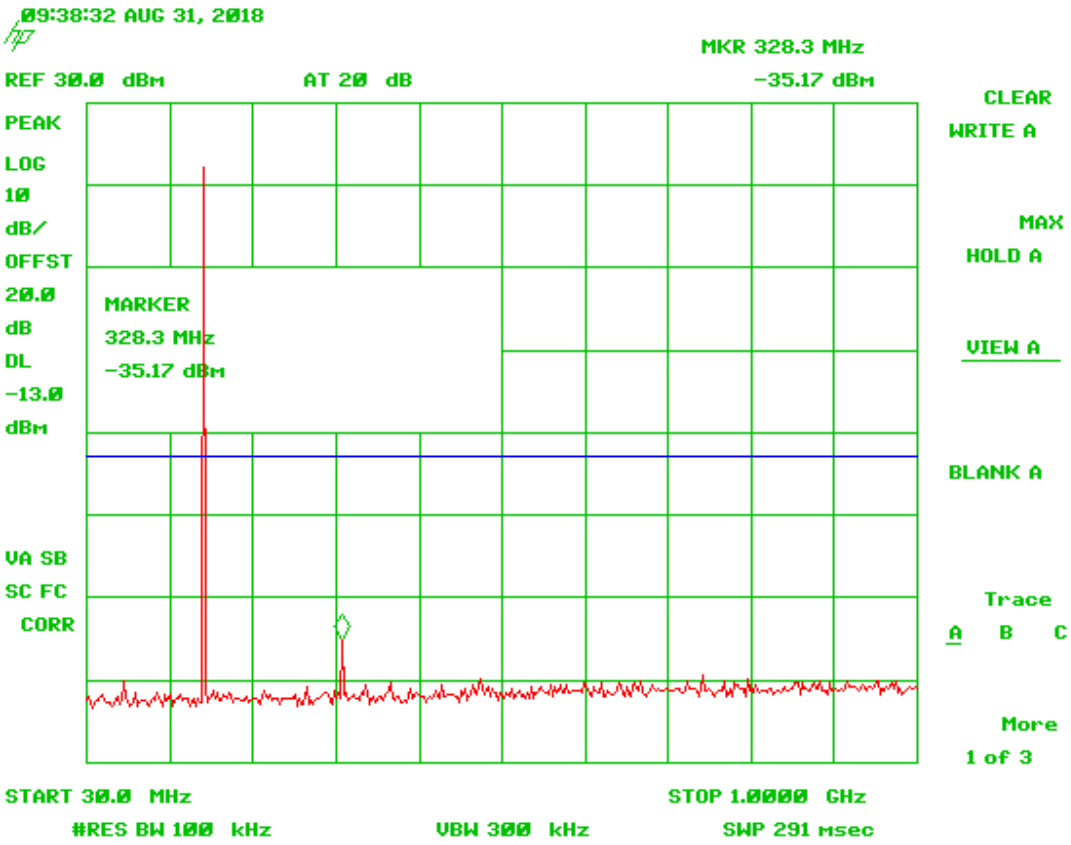

Figure 230. 162 MHz below 1 GHz

Note: All spurious emissions other than the fundamental are below -13 dBm.

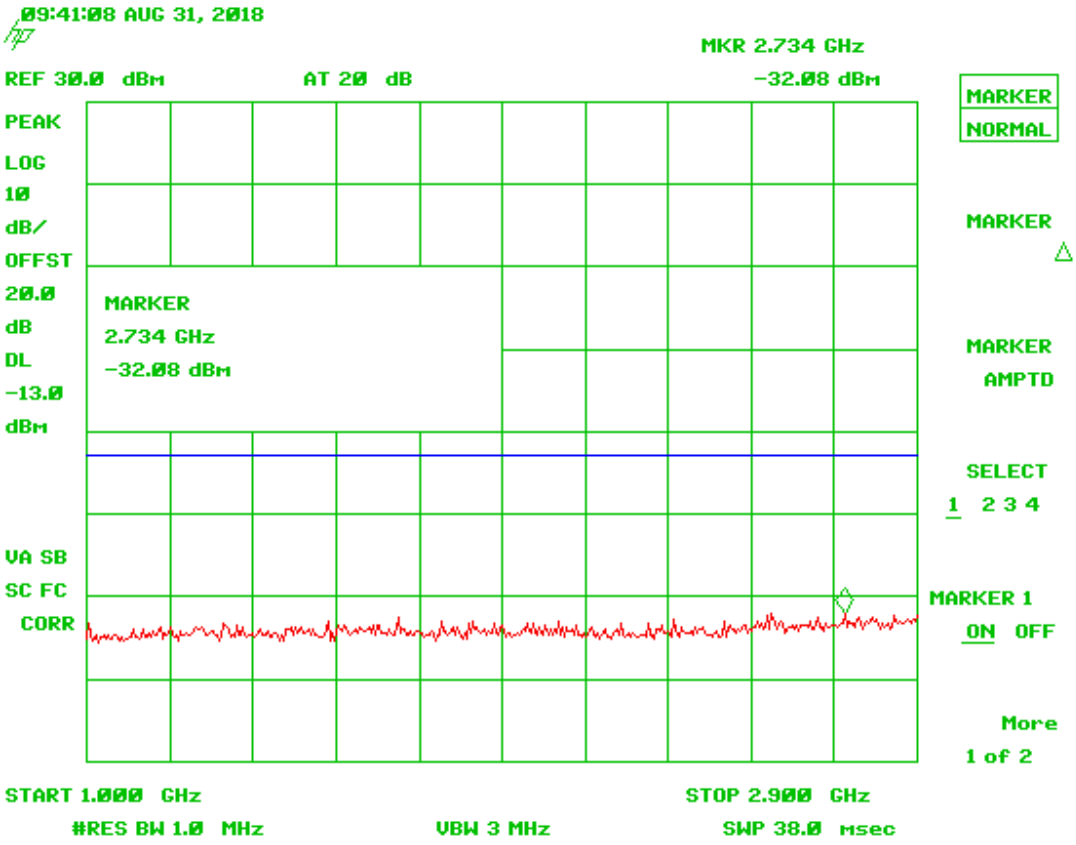

Figure 231. 162 MHz, above 1 GHz

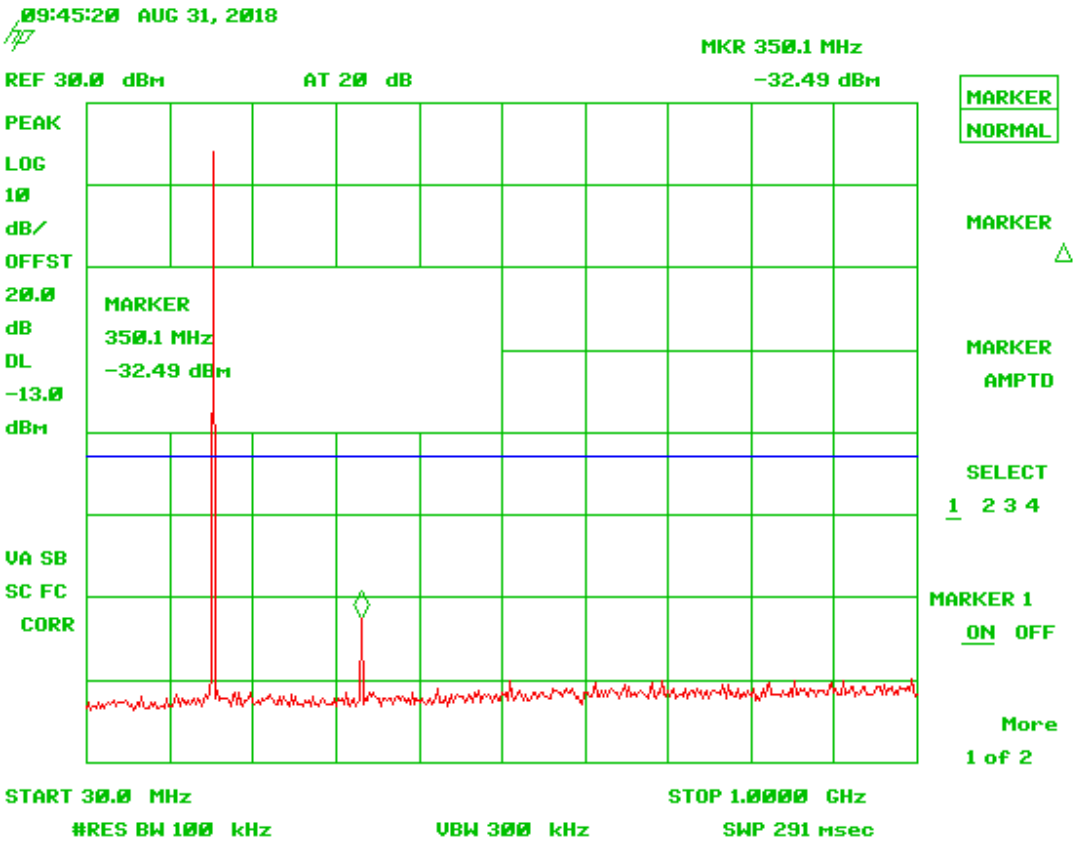

Figure 232. 174 MHz below 1 GHz

Note: All spurious emissions other than the fundamental are below -13 dBm.