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 (2016), Equipment Measurement and Performance Standards 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
Model: SAFE-1001

FCC ID: 2AKSM-SAFE3
IC: 22303-SAFE3

UST Project No: 19-0244
August 6, 2019

3505 Francis Circle Alpharetta, GA 30004
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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: August 6, 2019

TESTING
NVLAP LAB CODE 200162-0

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MEASUREMENT/TECHNICAL REPORT

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

Reevaluation _____

Equipment type: Part 90.219 Amplifier/Signal Booster (Class B)

Applicant /Manufacturer Name and Address:

Safe-Com Wireless
21 Longview Drive
Holmdel, NJ 07733
USA

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004

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1 General Information

1.1 Product Description

The Equipment under Test (EUT) is the Safe-Com Wireless model SAFE-1001. The EUT is a signal booster and extends the radio coverage in areas where the propagation losses prevent reliable communication. The amplifier is designed to be used with already approved DSA systems.

The EUT is designed to operate in the following bands:

For FCC Part 90.219

150.8-156.2475 MHz
157.1875-161.575 MHz
161.775-161.96 MHz
162.04-173.40 MHz
406.1-454.0 MHz
456.0-462.5375 MHz
467.74-512.0 MHz
758.0-775.0 MHz
788.0-805.0 MHz
806.0-849.0 MHz
851.0-869.0 MHz

For ISED RSS-131

150.05-174.0 MHz
406.1-430.0MHz
450.0-470.0 MHz
768.0-776.0 MHz
798.0-806.0 MHz
806.0-821.0 MHz
851.0-866.0 MHz
866.0-869.0 MHz

1.2 Related Submittal(s)/Grant(s)

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

1.3 Summary of Tests

The following tests were performed:

Part	Test Description	Verdict
90.219(e)(1), 90.205(j)	RF Output Power	Pass
90.219(e)(3)	Conducted Spurious	Pass
90.219(e)(3)	Radiated Spurious	Pass
90.219(e)(4)	Input Output	Pass
KDB 935210 D05 v01r03 4.2	AGC Threshold	Recorded
KDB 935210 D05 v01r03 4.3	Out of band rejection	Recorded
90.219(e)(2)	Noise Figure	N/A

2 Test and Measurements

2.1 Configuration of Tested System

A Block Diagram of the tested system is shown in Figure 1. 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 samples used for testing were received by US Tech on June 18, 2019 & July 15, 2019 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.

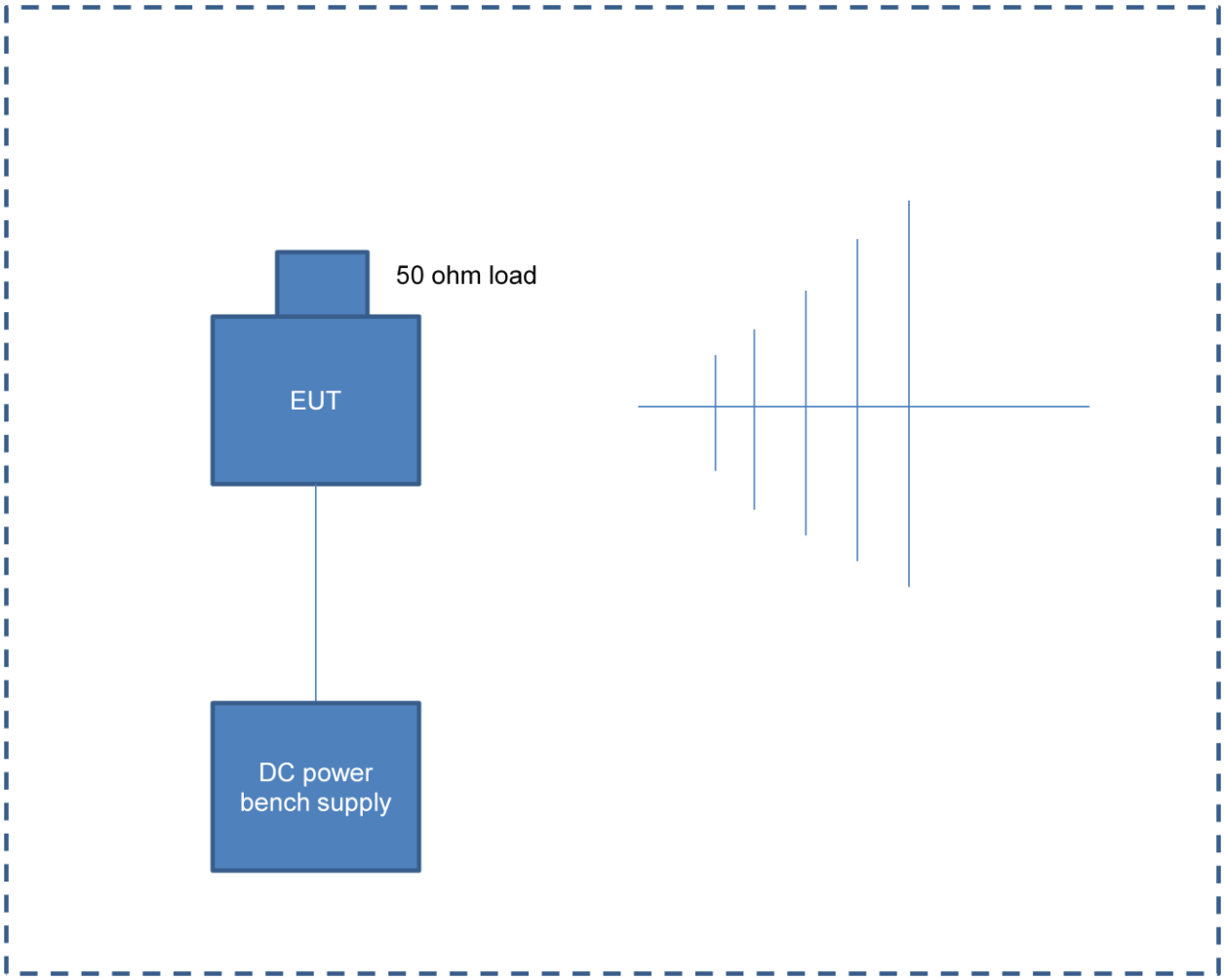

Figure 1. Block Diagram of Test Configuration

Table 1. EUT and Peripherals

EUT MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID/ IC ID	CABLES P/D
SAFE-1001 Series Power Amplifier Safe-Com	SAFE-1001	Engineering Sample	FCC ID: 2AKSM-SAFE3 IC: 22303-SAFE3	N/A
700/800 Mhz Safe-Com	SAFE-1001	Engineering Sample	--	--
UHF Safe-Com	SAFE-1001	Engineering Sample	--	--
VHF Safe-Com	SAFE-1001	Engineering Sample	--	--
Peripherals MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC ID/ IC ID**	**CABLES P/D**
DC Bench Supply Tekpower	TP3005T	218311	None	1.5 m

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	10/11/2019 2yr cal
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	10/25/2019 2yr cal
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	5/07/2020
RF PREAMP > 1 GHz	8449B	HEWLETT PACKARD	3008A00480	4/08/2020
LOG PERIODIC	3146	EMCO	9305-3600	2/01/2021 2yr cal
BICONNICAL	3110B	EMCO	9306-1708	6/27/2021 2yr cal
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2yr cal
SIGNAL GENERATOR	MG3671B	Anritsu	M52073/ M53573/ M17473	Verified with E4407B
SIGNAL GENERATOR	HP8648B	HEWLETT-PACKARD	3642U01679	Verified with E4407B
LISN	9247-50-TS-50-N	Solar Electronics	955824/ 955825	9/18/2019

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 designed for use with 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 re-transmitted on the same channels as received. Minor departures from the exact provider or reference frequencies of the input signals are allowed provided that the re-transmitted 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 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.

2.8.1 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.

2.8.2 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.

2.8.3 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.

2.8.4 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.

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

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	*150.00 MHz	36.95	37 dBm	0.05
	*162.00 MHz	36.99	37 dBm	0.01
	**174.00 MHz	36.96	37 dBm	0.04
UHF	407.00 MHz	36.96	37 dBm	0.04
	421.00 MHz	36.98	37 dBm	0.02
	***480.00 MHz	36.96	37 dBm	0.04
	**512.00 MHz	36.95	37 dBm	0.05
700/800 MHz	**758.00 MHz	36.98	37 dBm	0.02
	***763.00 MHz	37.00	37 dBm	0.00
	768.00 MHz	37.00	37 dBm	0.00
	769.00 MHz	37.00	37 dBm	0.00
	775.00 MHz	36.98	37 dBm	0.02
	**788.00 MHz	36.99	37 dBm	0.01
	798.00 MHz	36.99	37 dBm	0.01
	799.00 MHz	36.99	37 dBm	0.01
	805.00 MHz	36.99	37 dBm	0.01
	806.00 MHz	36.99	37 dBm	0.01
	815.00 MHz	37.00	37 dBm	0.00
	824.00 MHz	37.00	37 dBm	0.00
	851.00 MHz	37.00	37 dBm	0.00
	860.00 MHz	36.73	37 dBm	0.27
	869.00 MHz	36.45	37 dBm	0.55

(*) = Frequencies were selected as the representative frequency to cover channels that are less than 1 MHz apart. For example 150 MHz was used to represent 150.05 MHz (ISED) and 150.80 MHz (FCC) however only the permitted frequency will be listed for each respective market.
(**)= Frequency selected because either ISED or FCC market permits this use.
(***)= selected as representative middle channel for FCC permitted operation.

2.10 Output Power Plots

Following are the Uplink Output Power Plots.

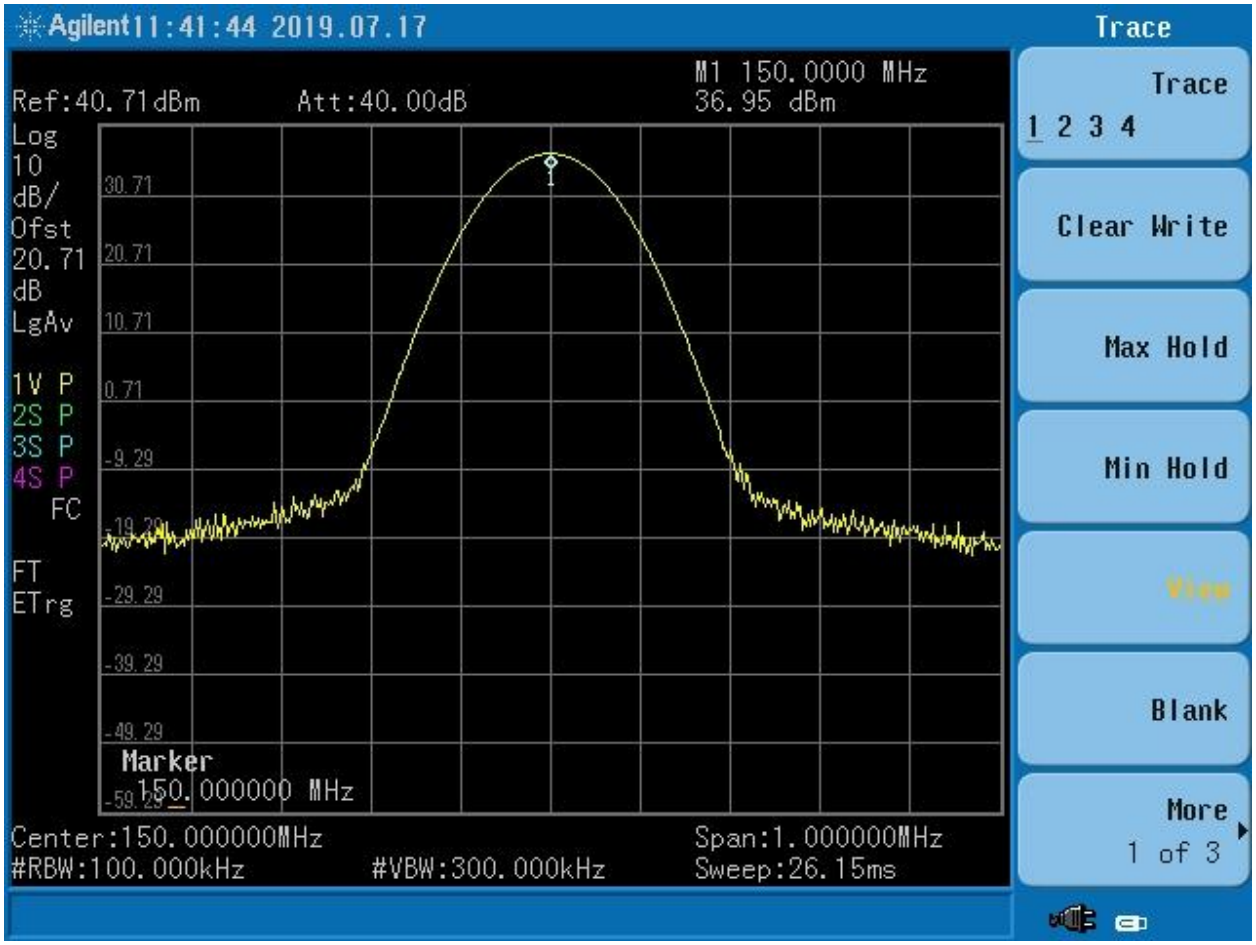

Figure 2. 150 MHz Output Power Plot

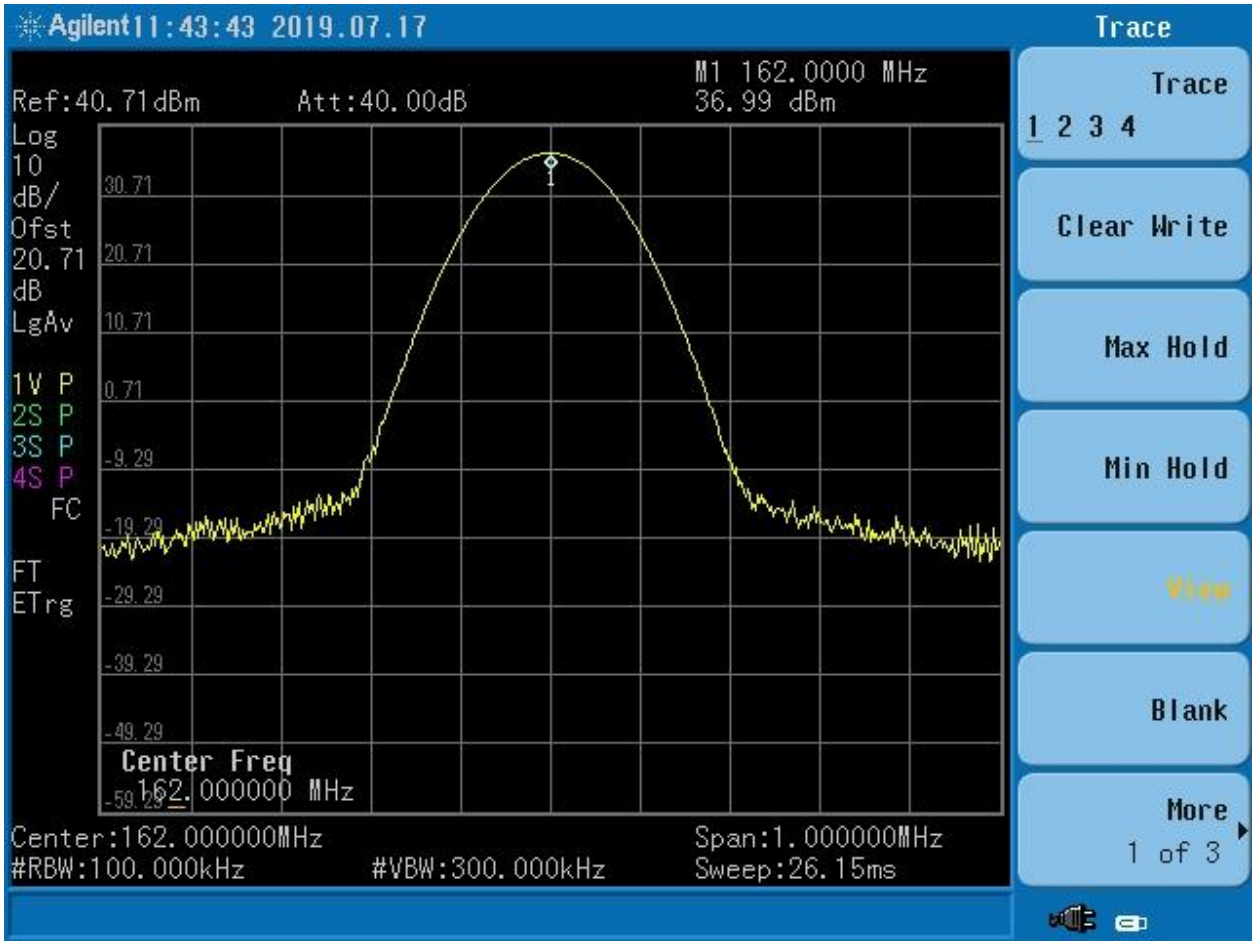

Figure 3. 162 MHz Output Power Plot

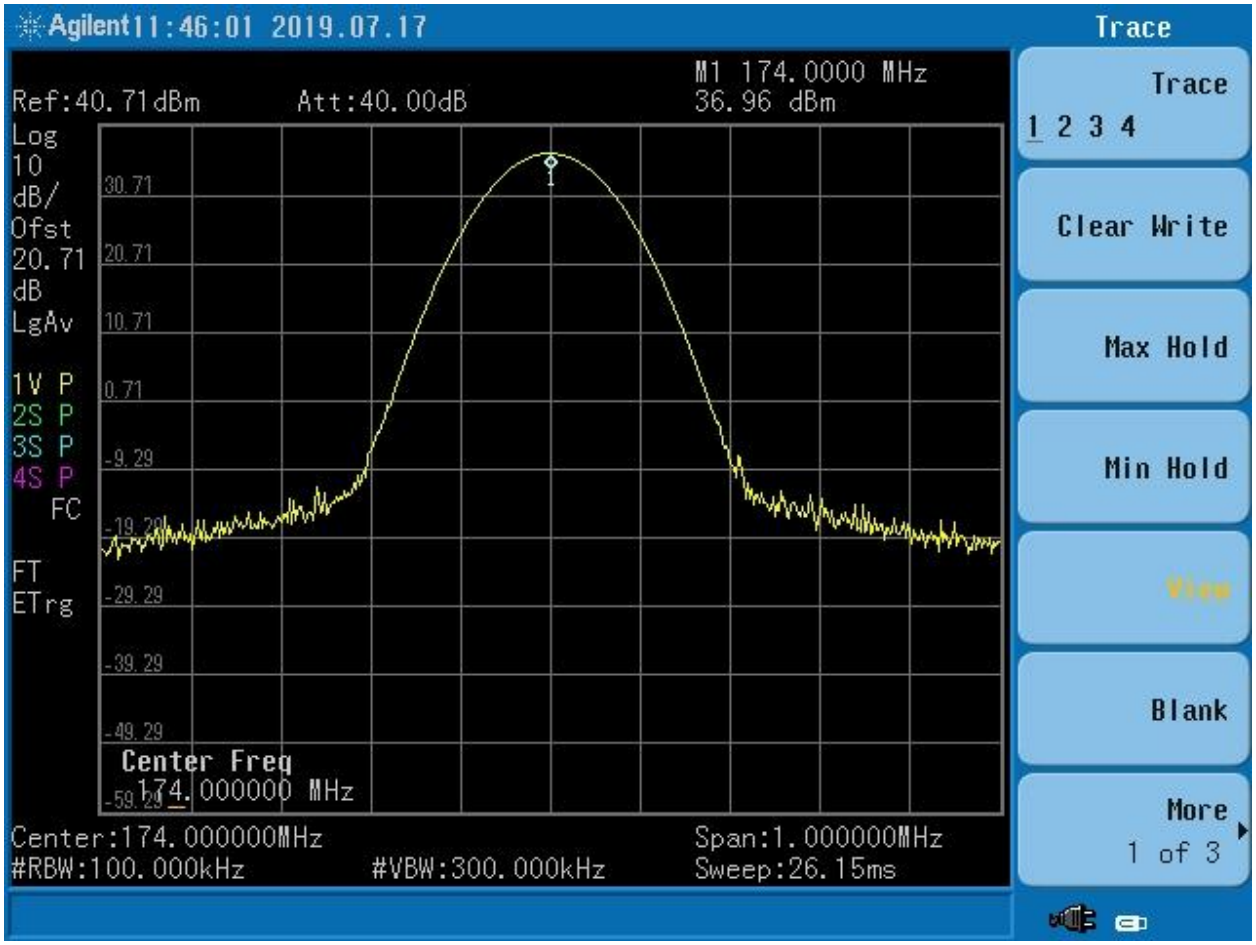

Figure 4. 174 MHz Output Power Plot

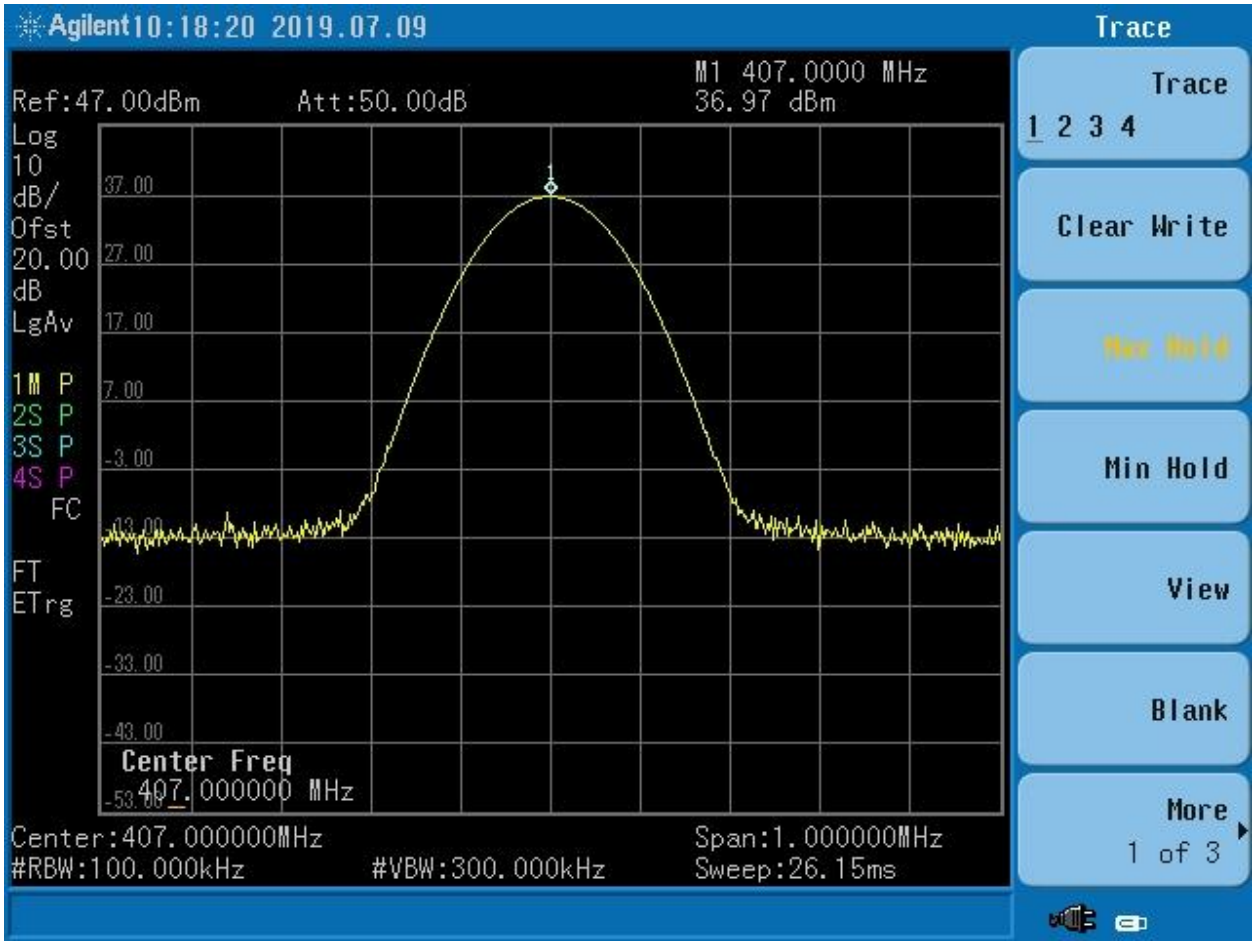

Figure 5. 407 MHz Output Power Plot

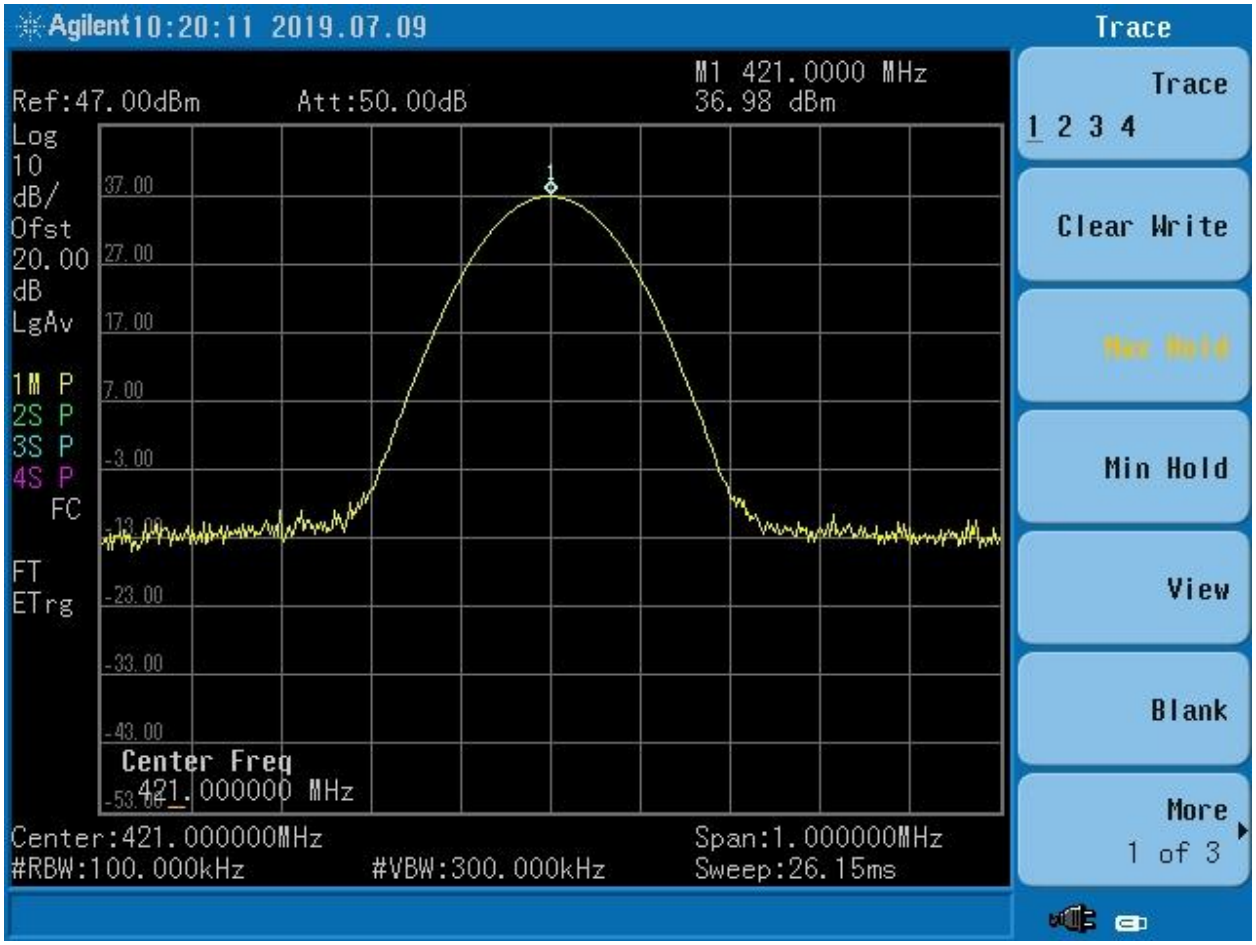

Figure 6. 421 MHz Output Power Plot

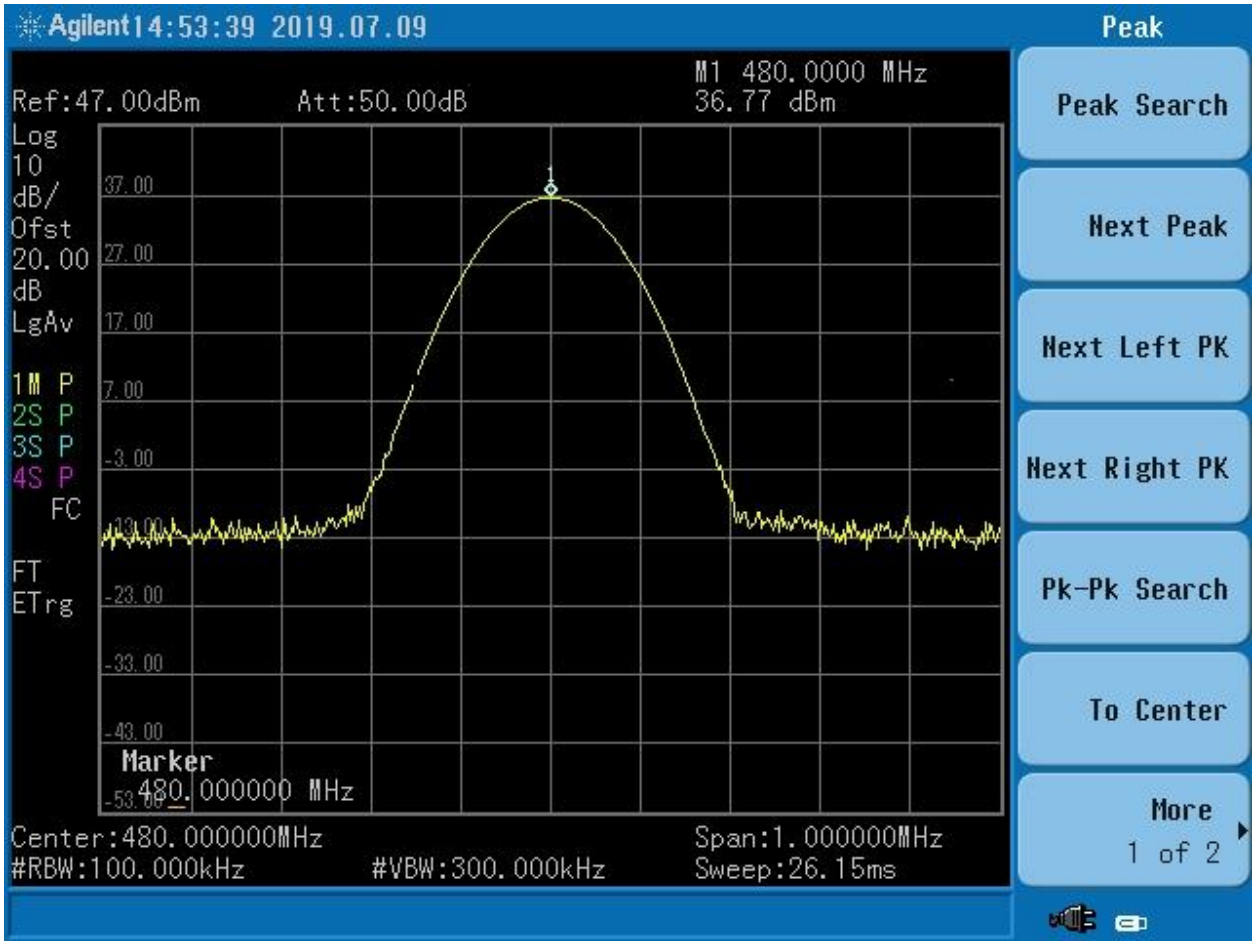

Figure 7. 480 MHz Output Power Plot

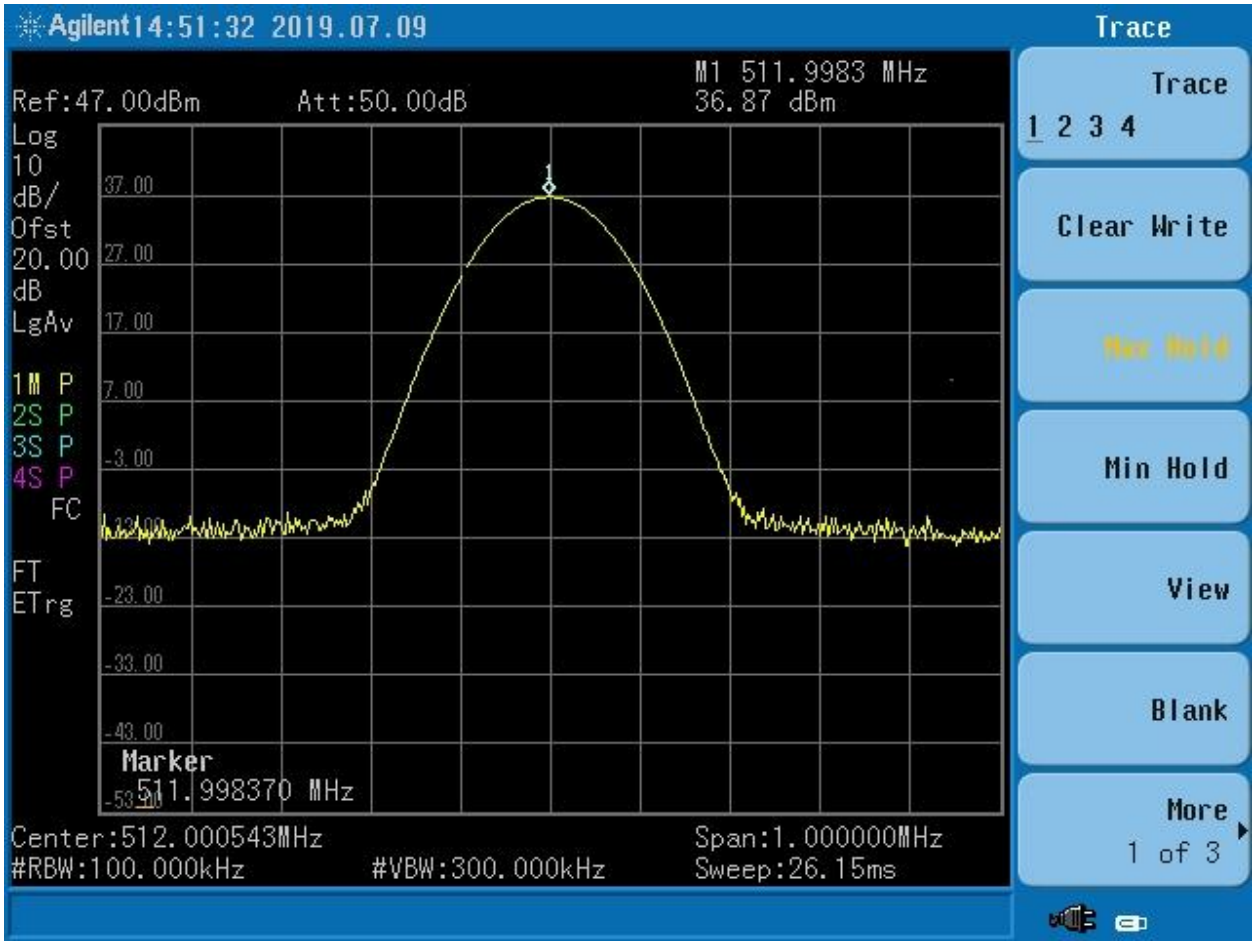

Figure 8. 512 MHz Output Power Plot

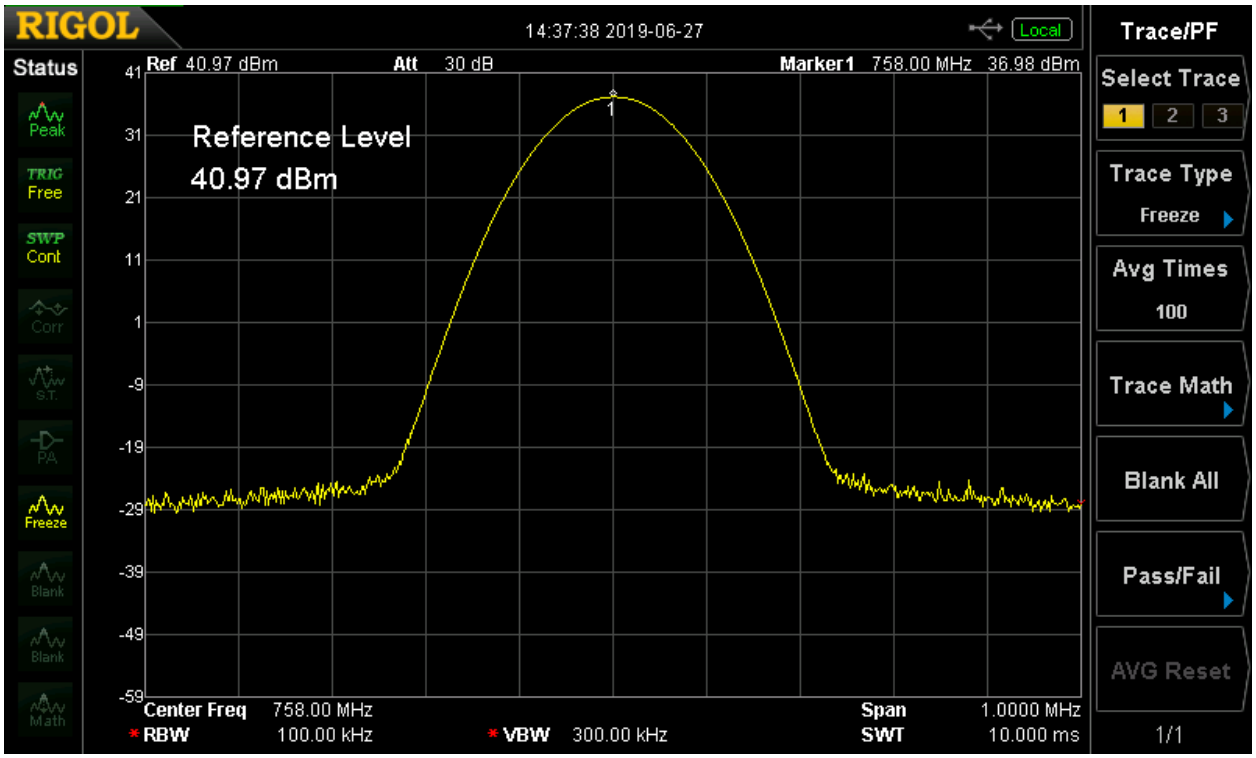

Figure 9. 758 MHz Output Power Plot

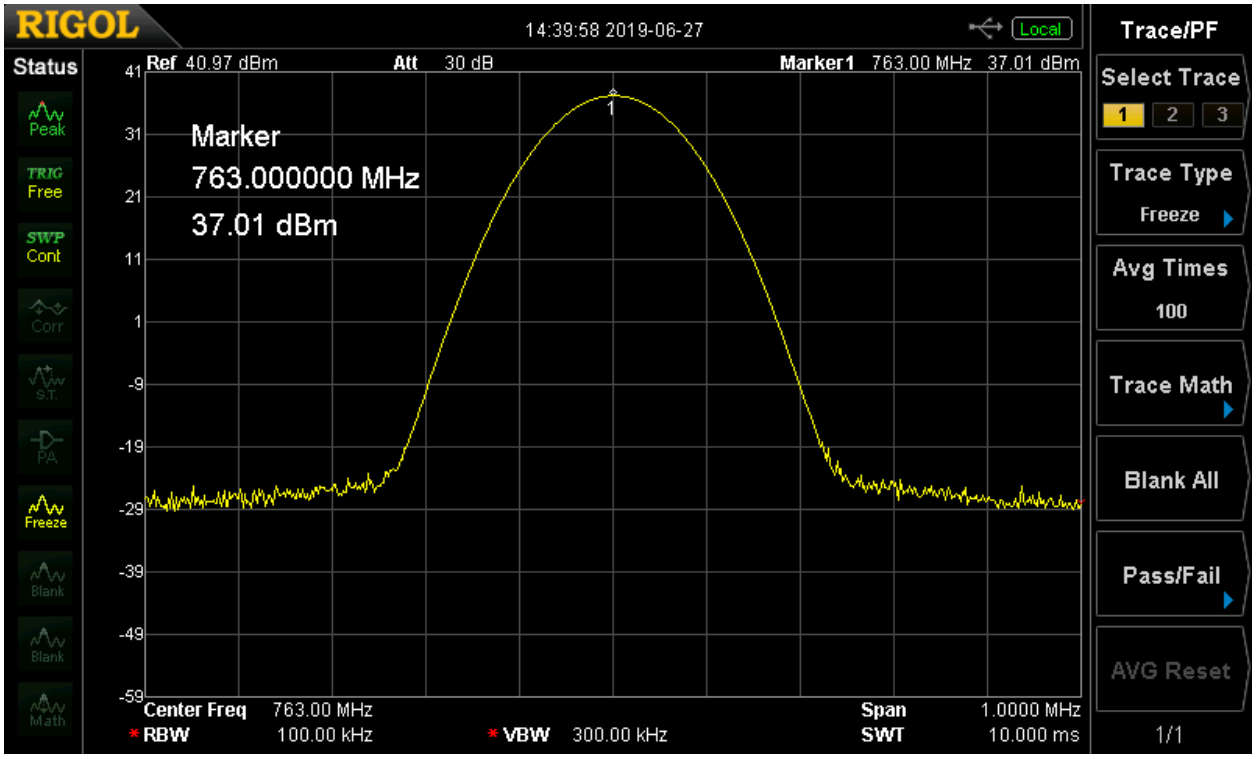

Figure 10. 763 MHz Output Power Plot

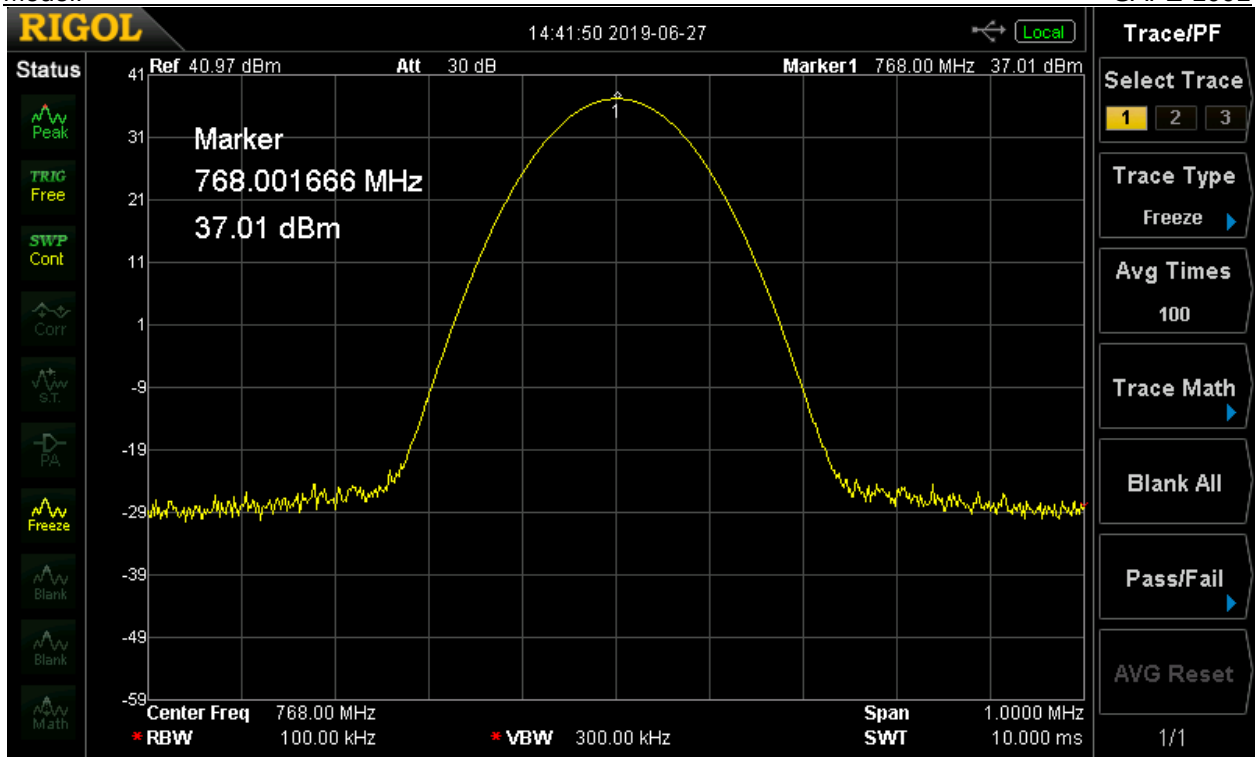

Figure 11. 768 MHz Output Power Plot

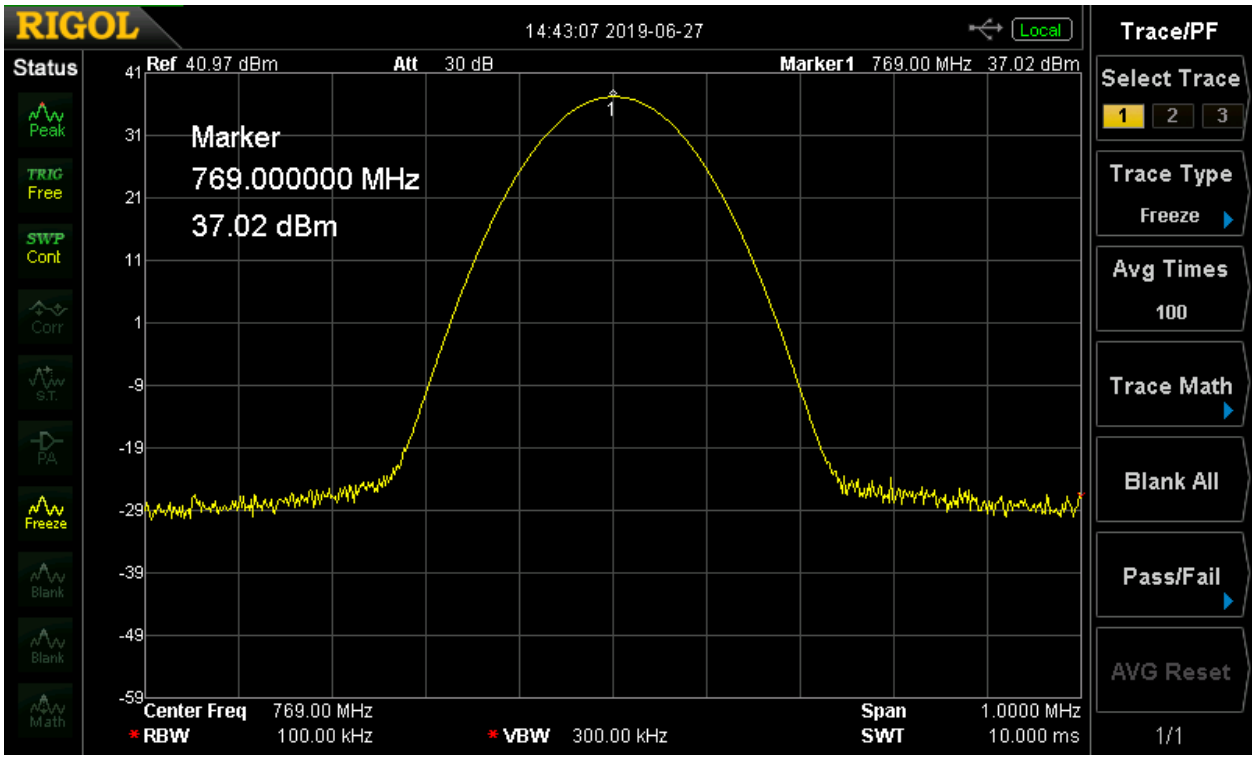

Figure 12. 769 MHz Output Power Plot

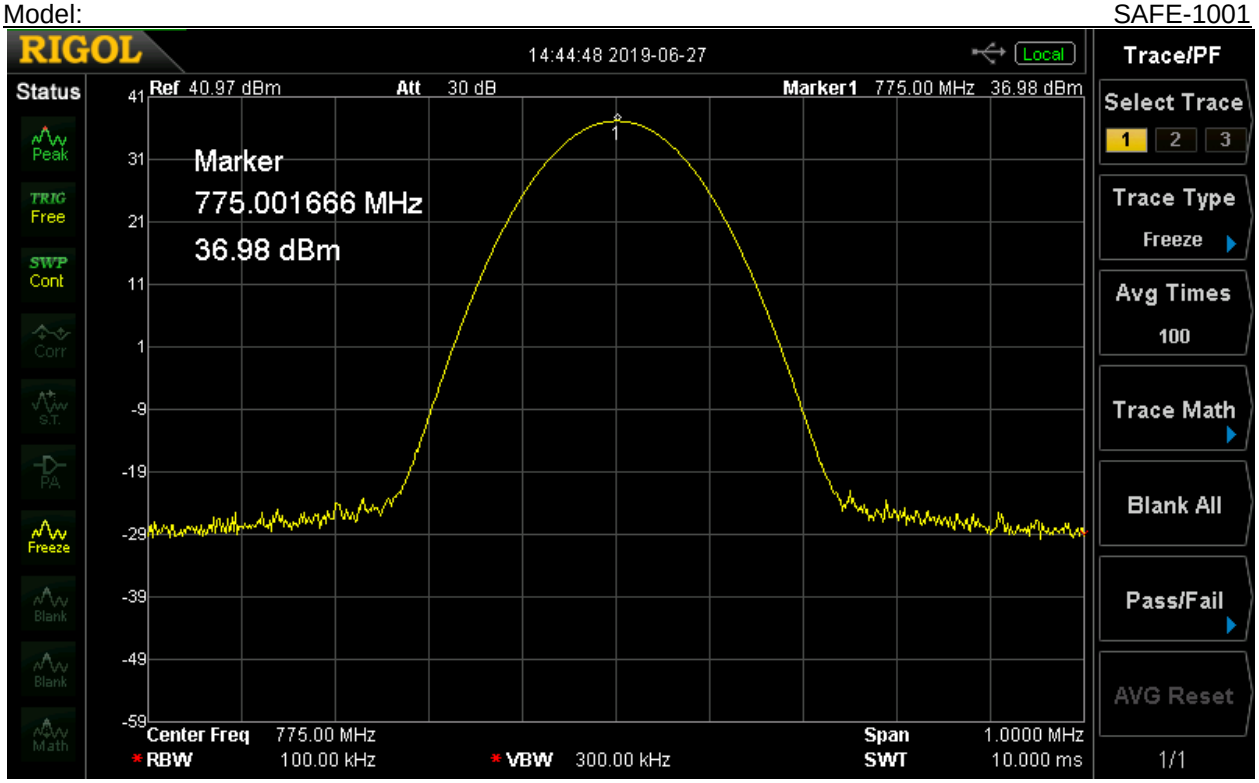

Figure 13. 775 MHz Output Power Plot

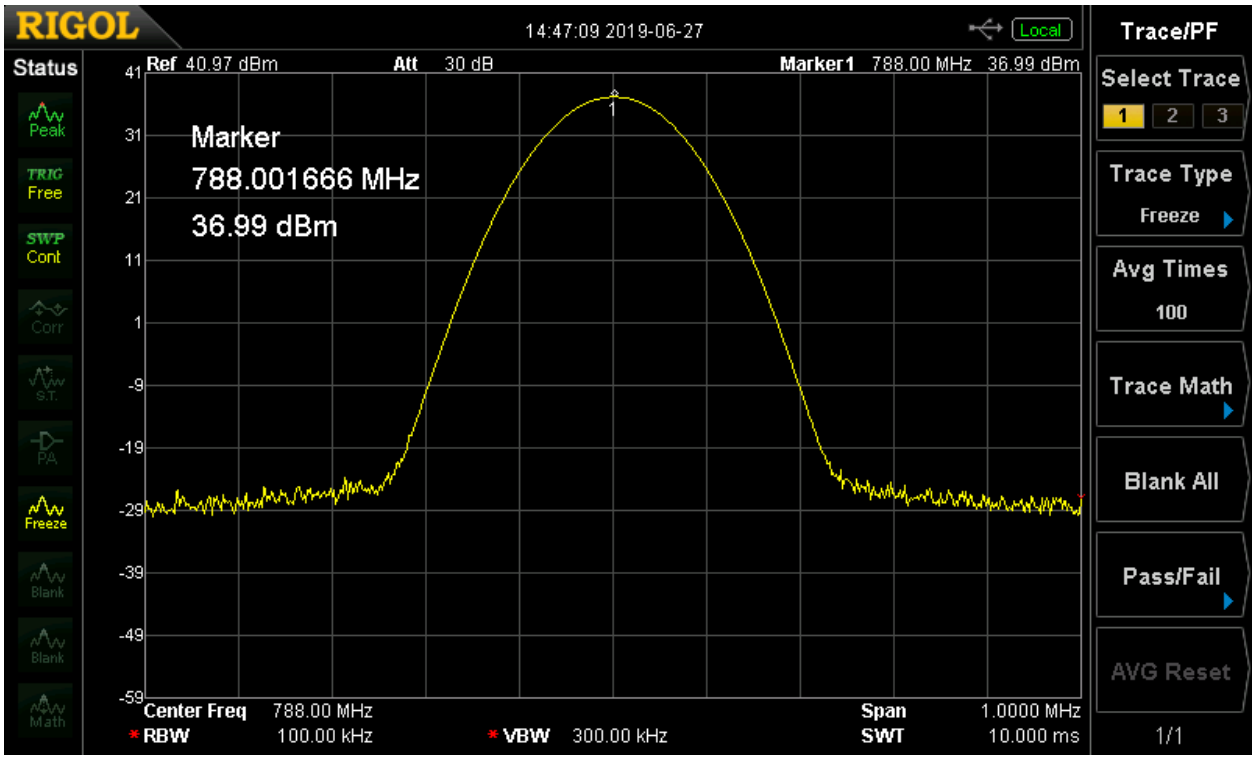

Figure 14. 788 MHz Output Power Plot

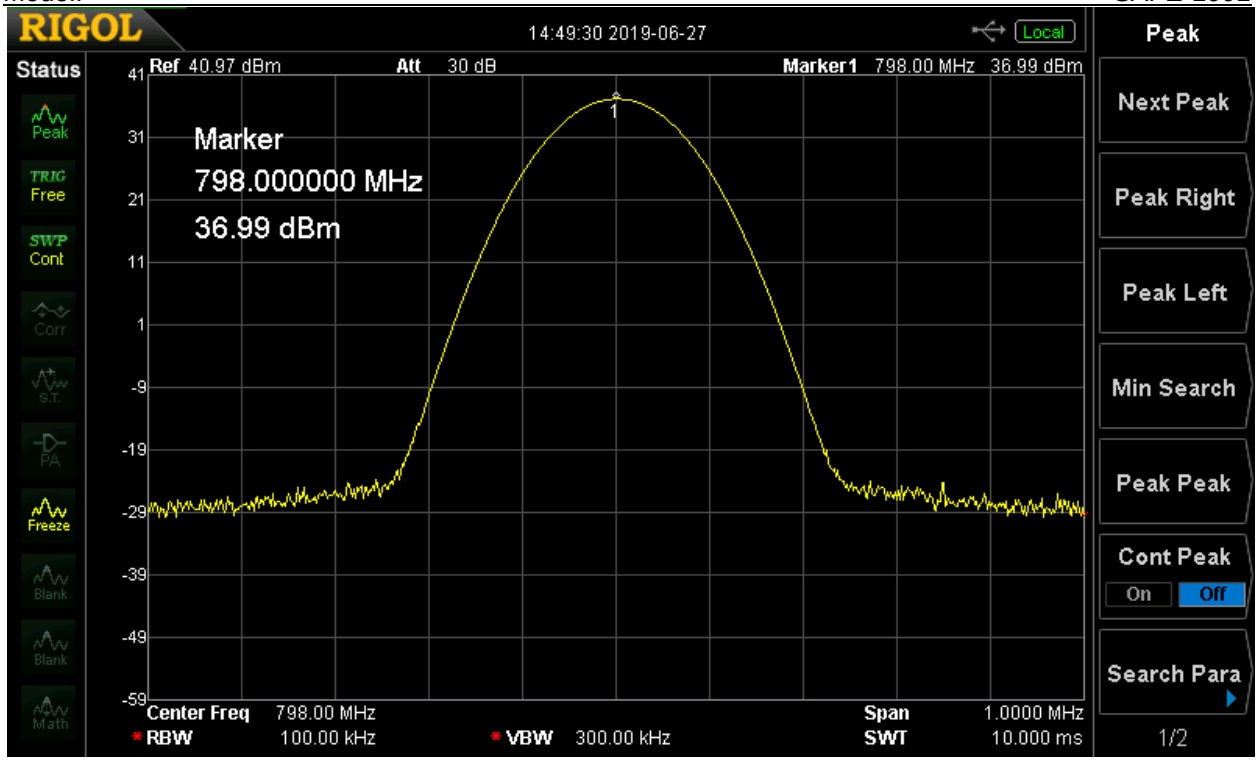

Figure 15. 798 MHz Output Power Plot

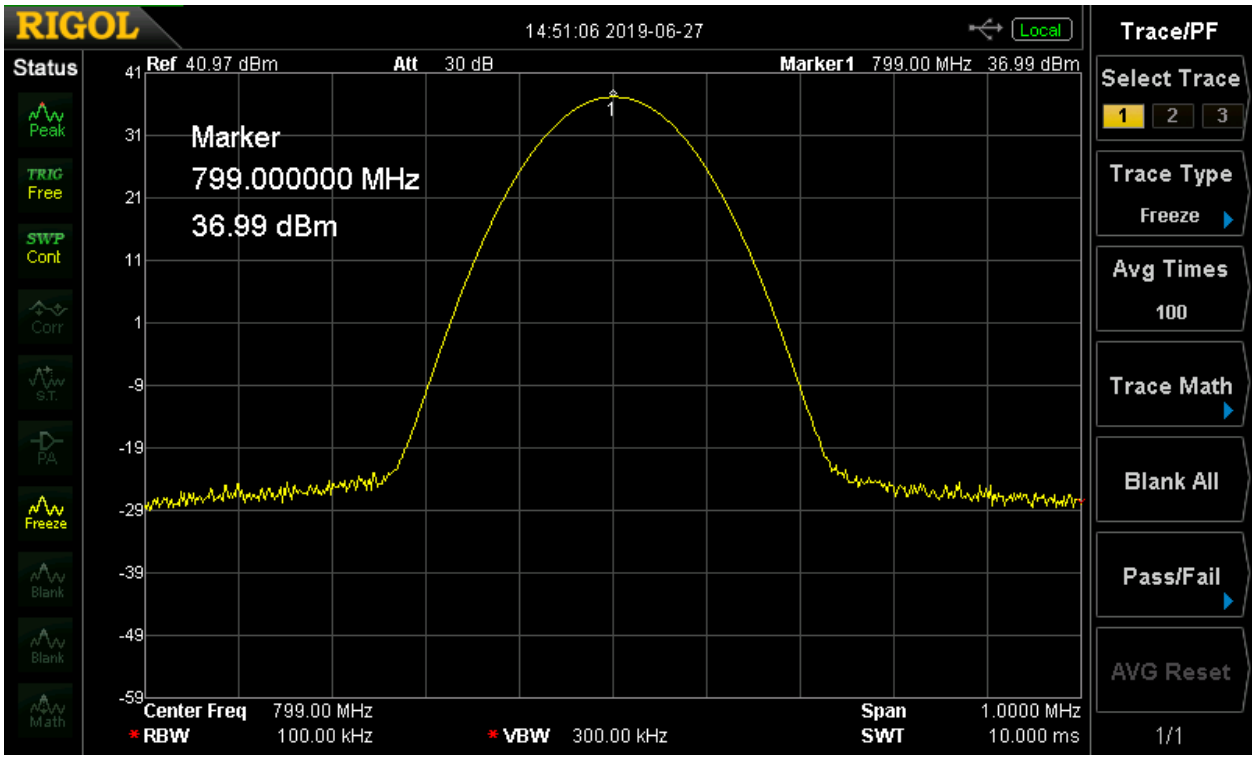

Figure 16. 799 MHz Output Power Plot

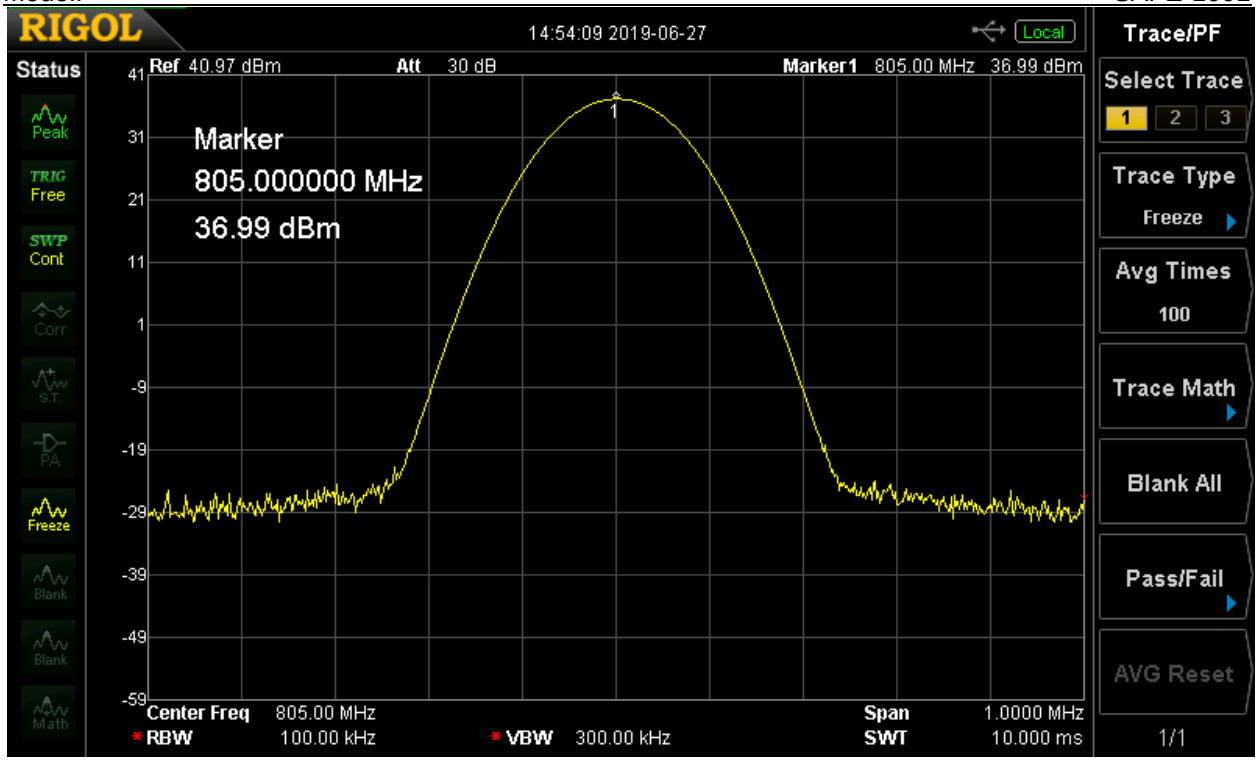

Figure 17. 805 MHz Output Power Plot

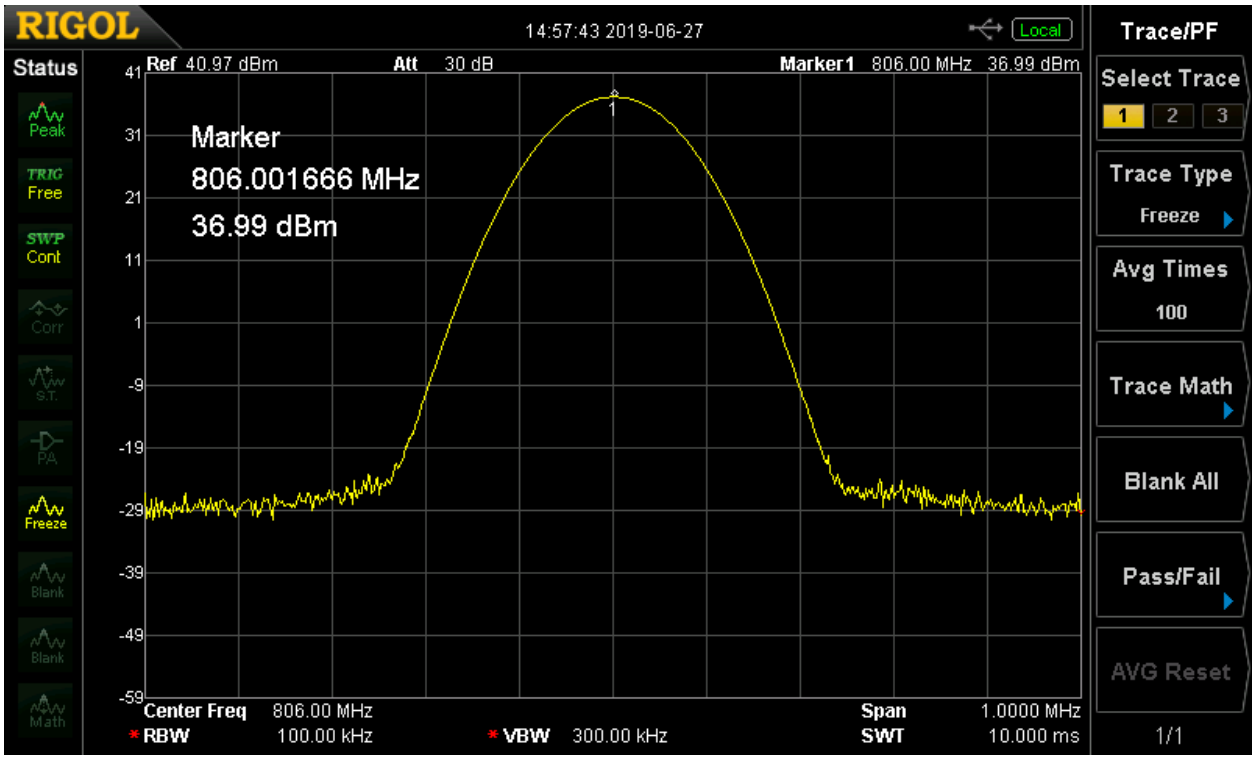

Figure 18. 806 MHz Output Power Plot

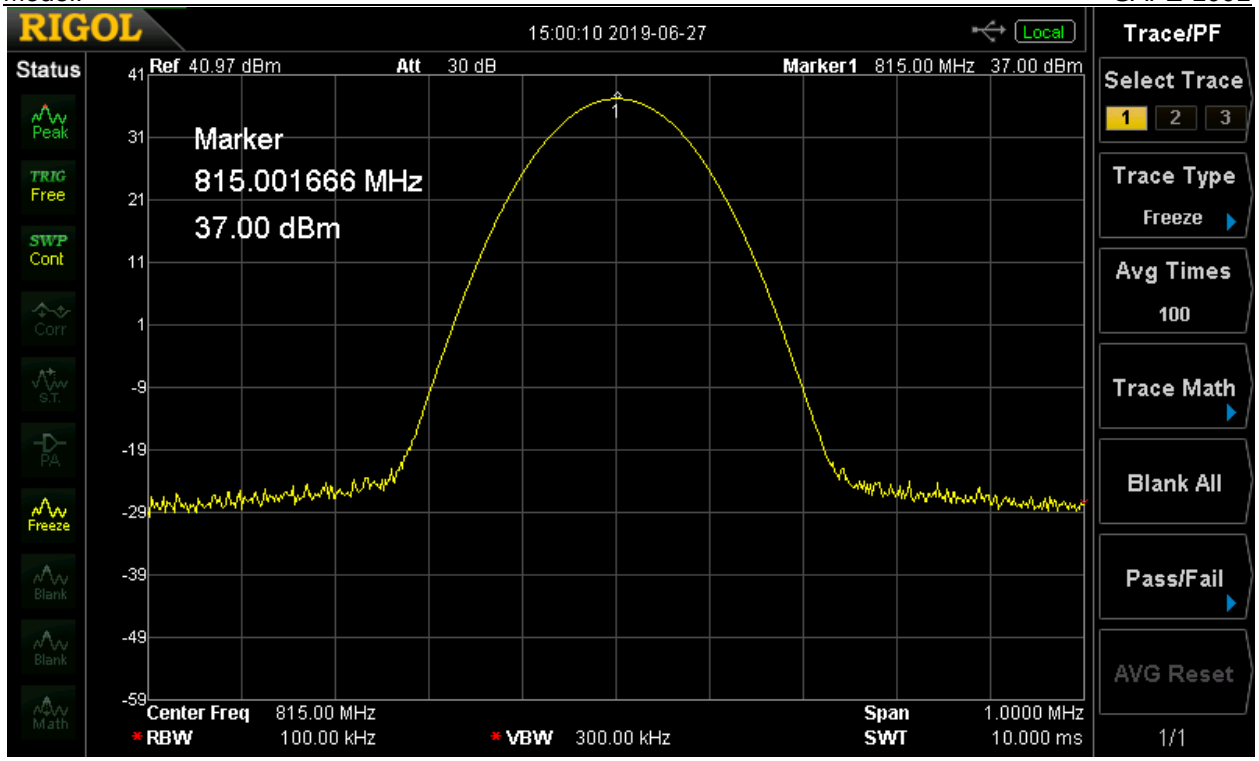

Figure 19. 815 MHz Output Power Plot

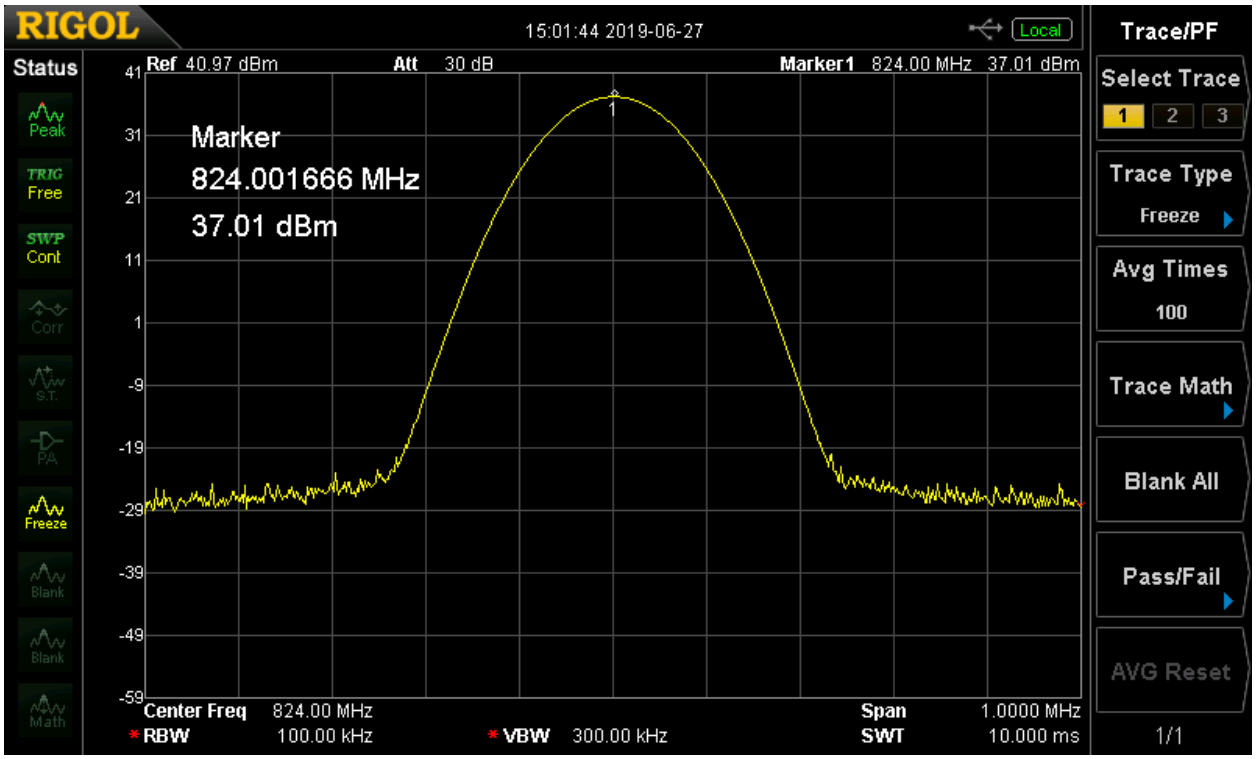

Figure 20. 824 MHz Output Power Plot

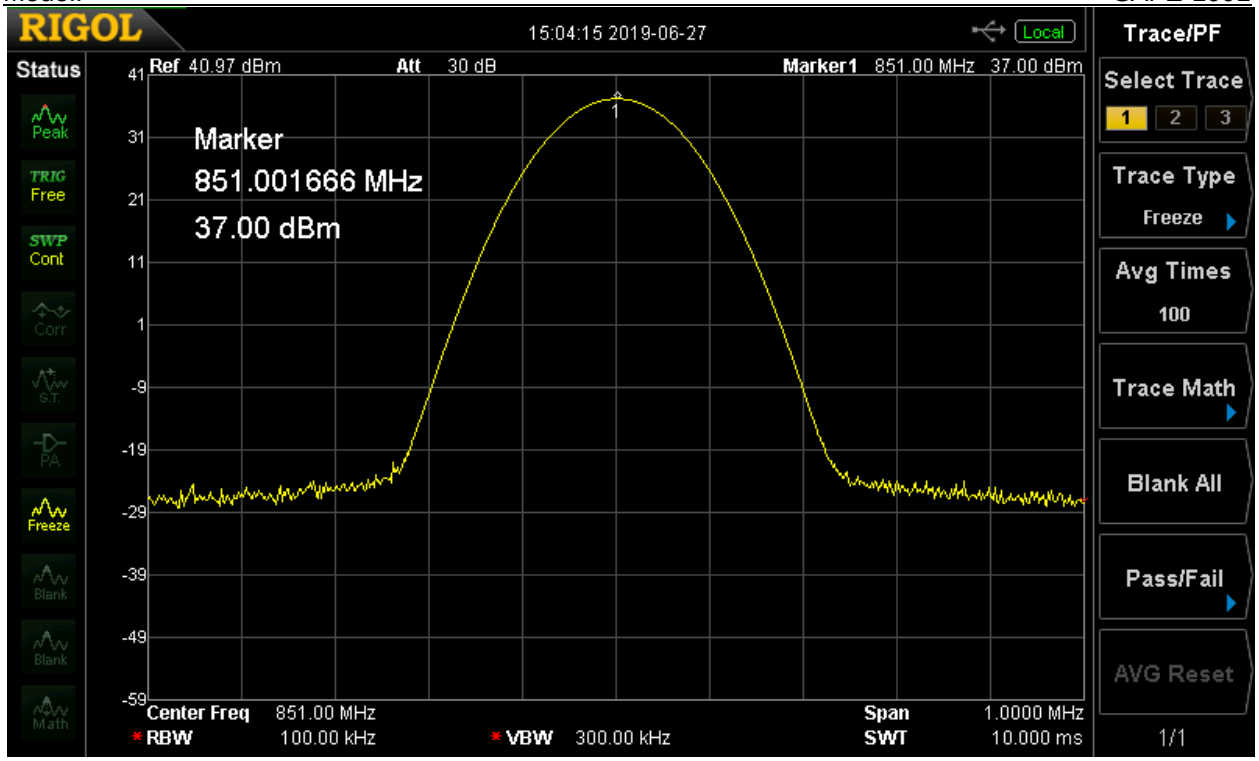

Figure 21. 851 MHz Output Power Plot

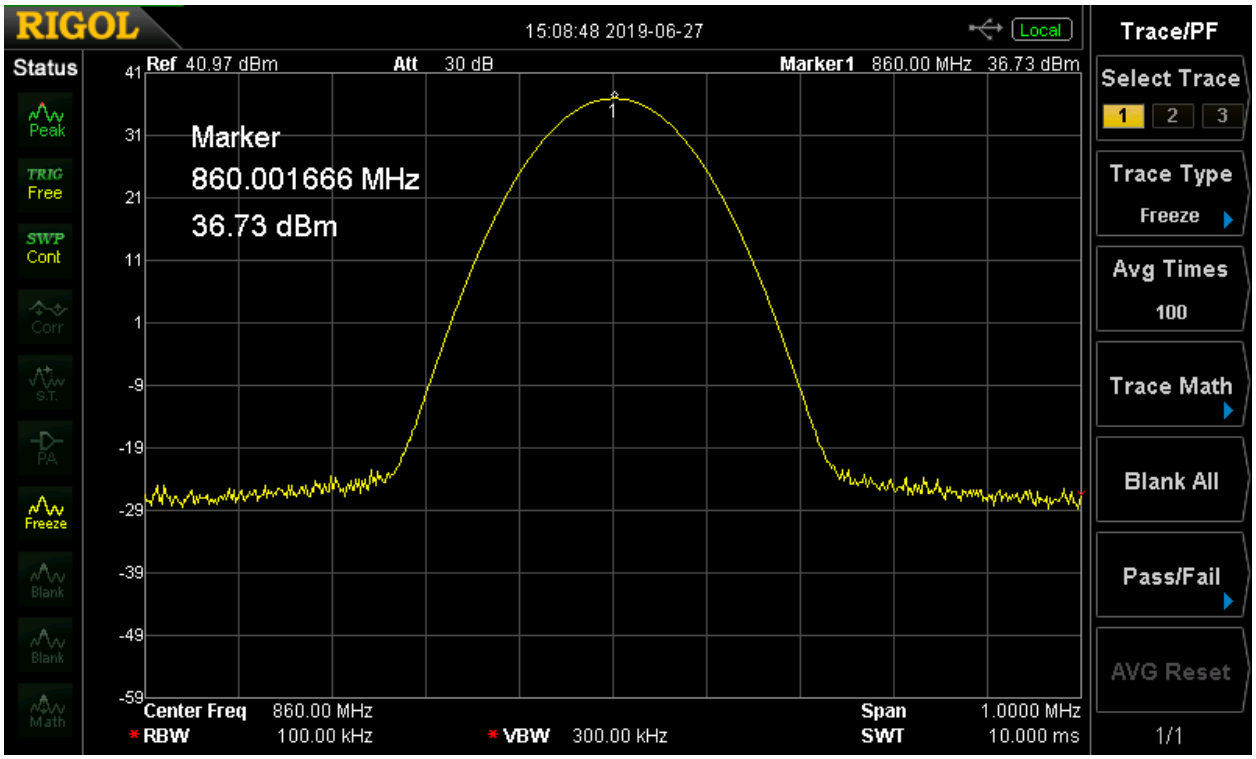

Figure 22. 860 MHz Output Power Plot

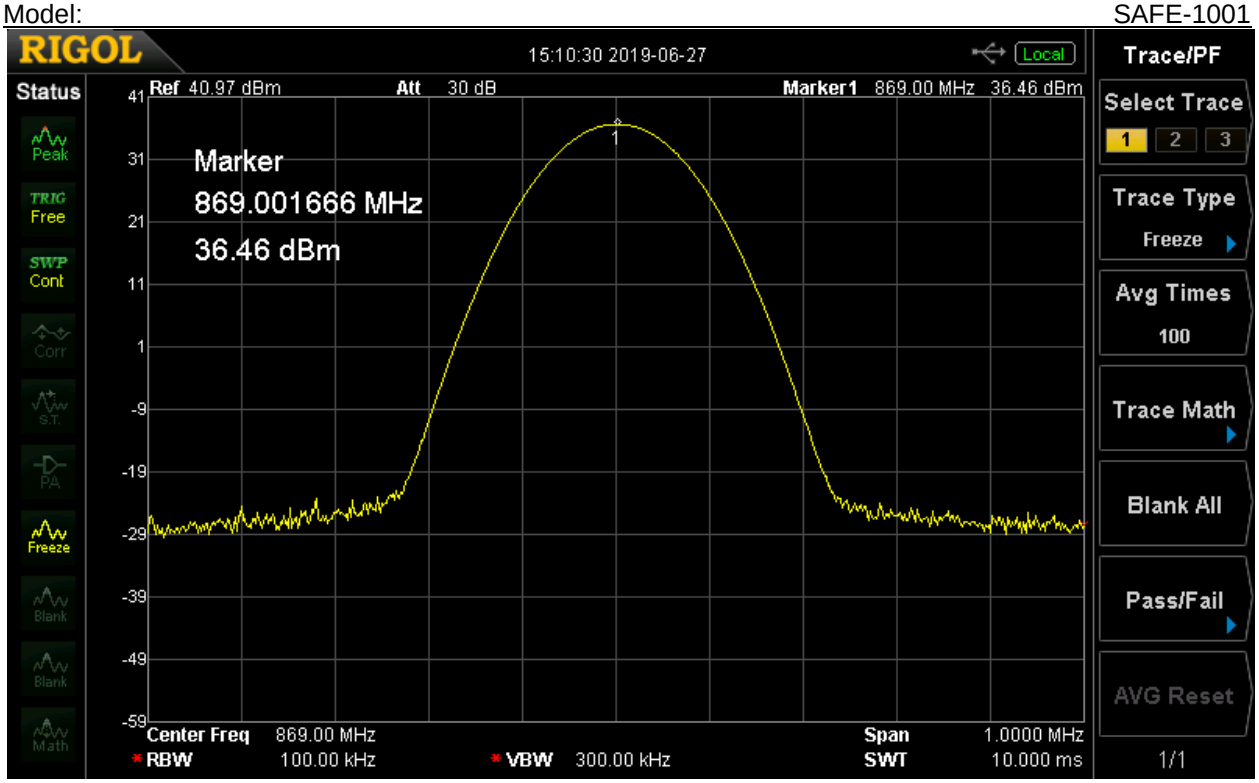

Figure 23. 869 MHz Output Power Plot

2.11 Emission Mask and Retransmitted Signal Measurements

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.

2.11.1 VHF Channels

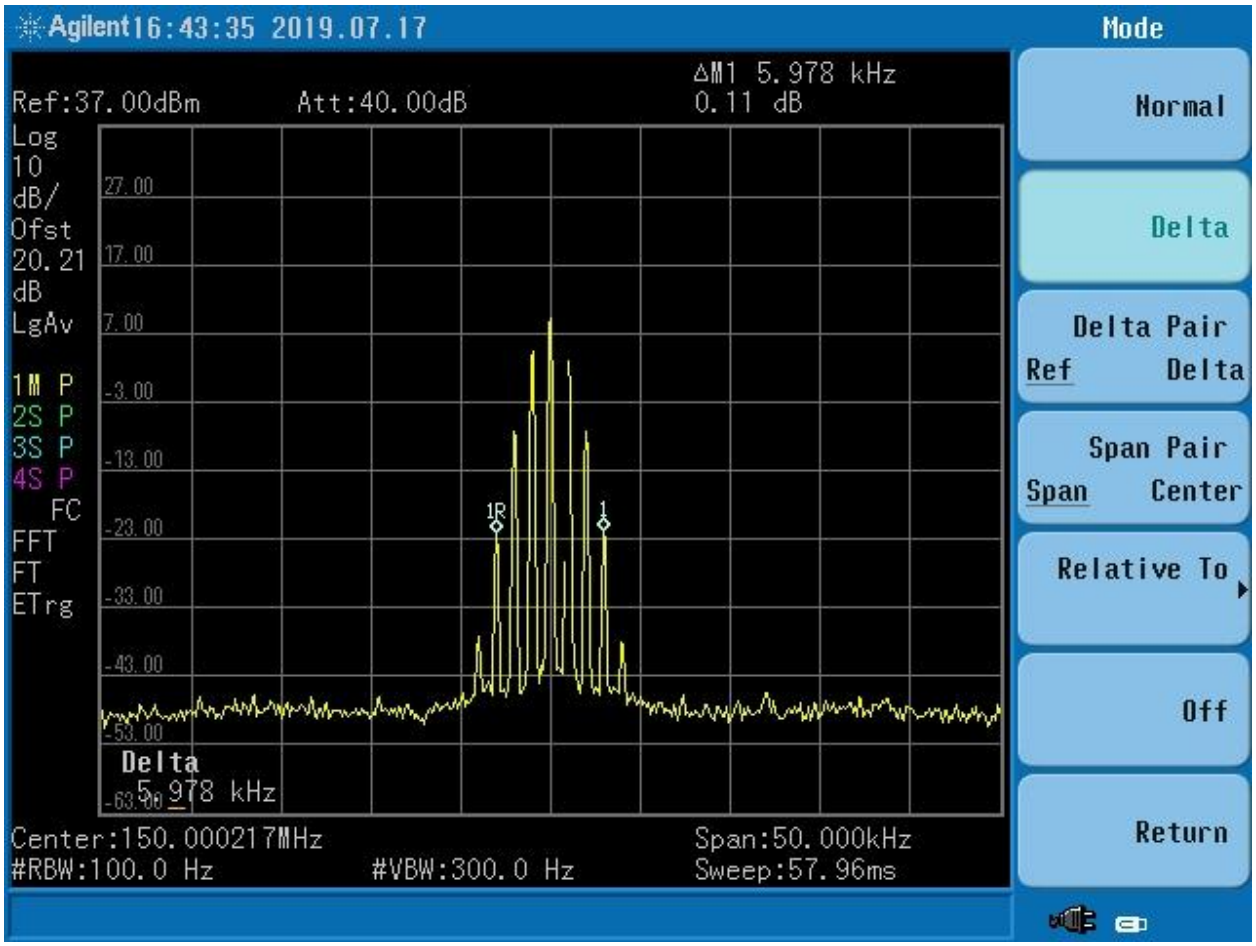

Figure 24. Input 150 MHz @ 6.25 kHz

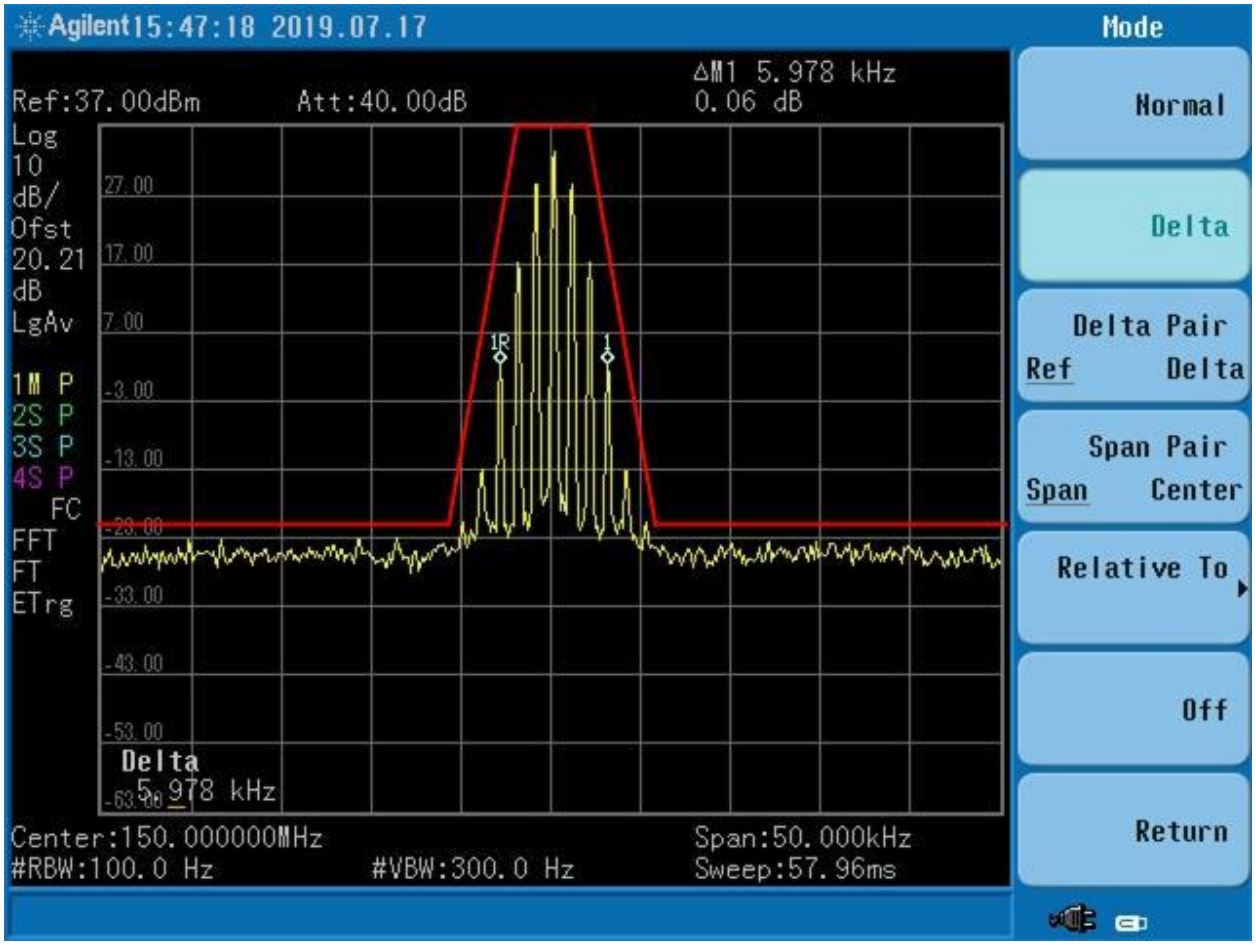

Figure 25. 150 MHz @ 6.25 kHz, Mask E

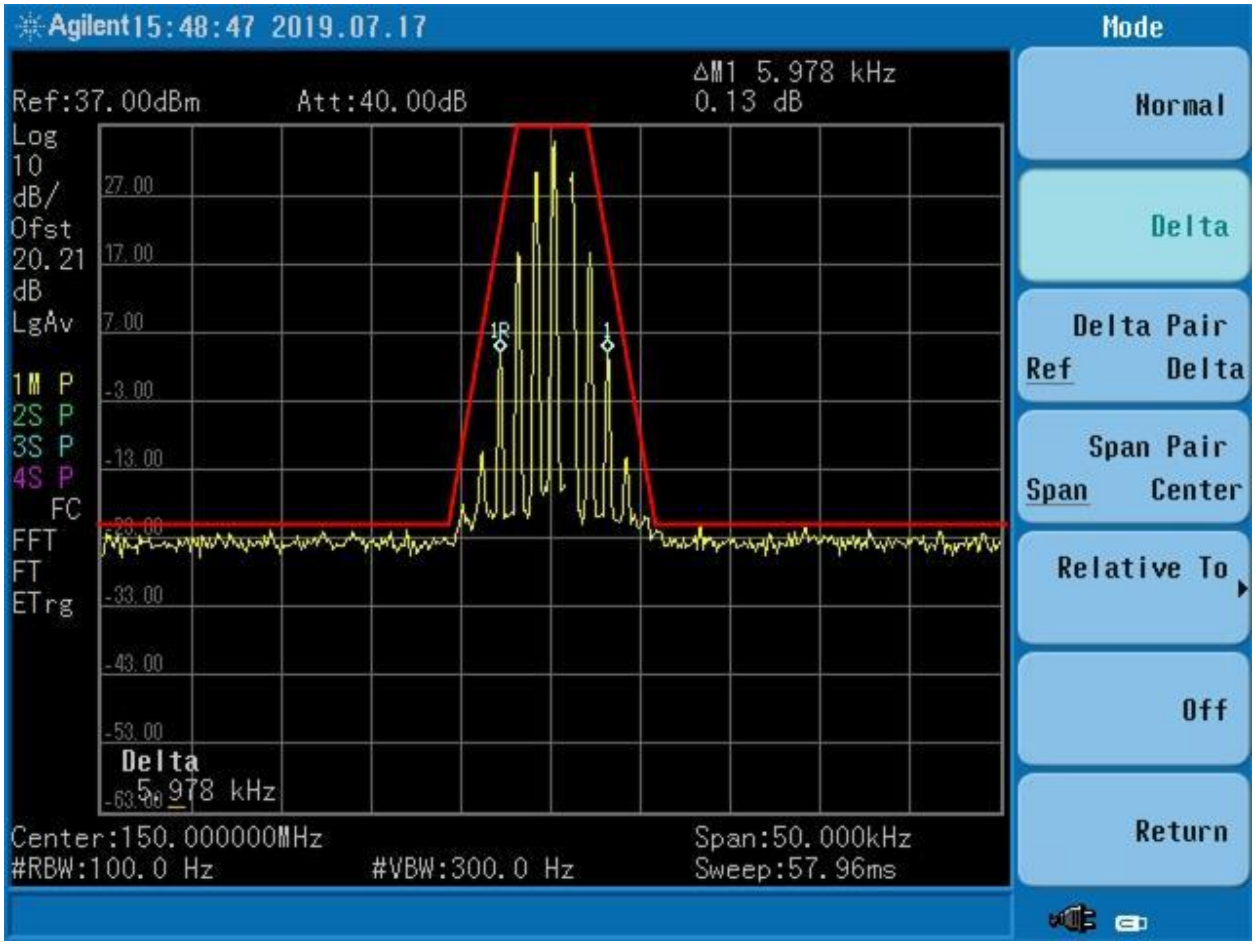

Figure 26. 150 MHz@ 6.25 kHz + 3.0 dB, Mask E

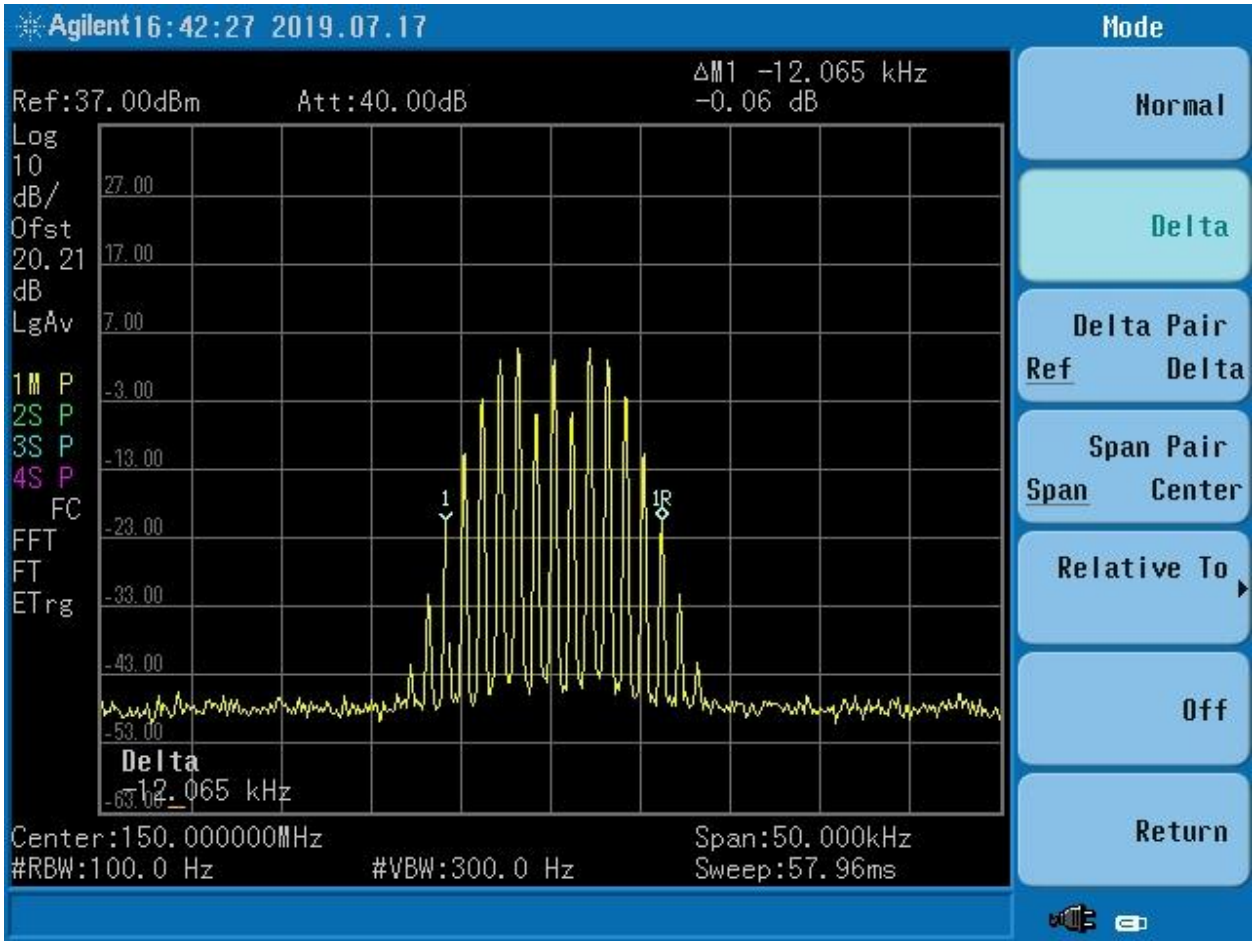

Figure 27. Input 150 MHz @ 12.5 kHz

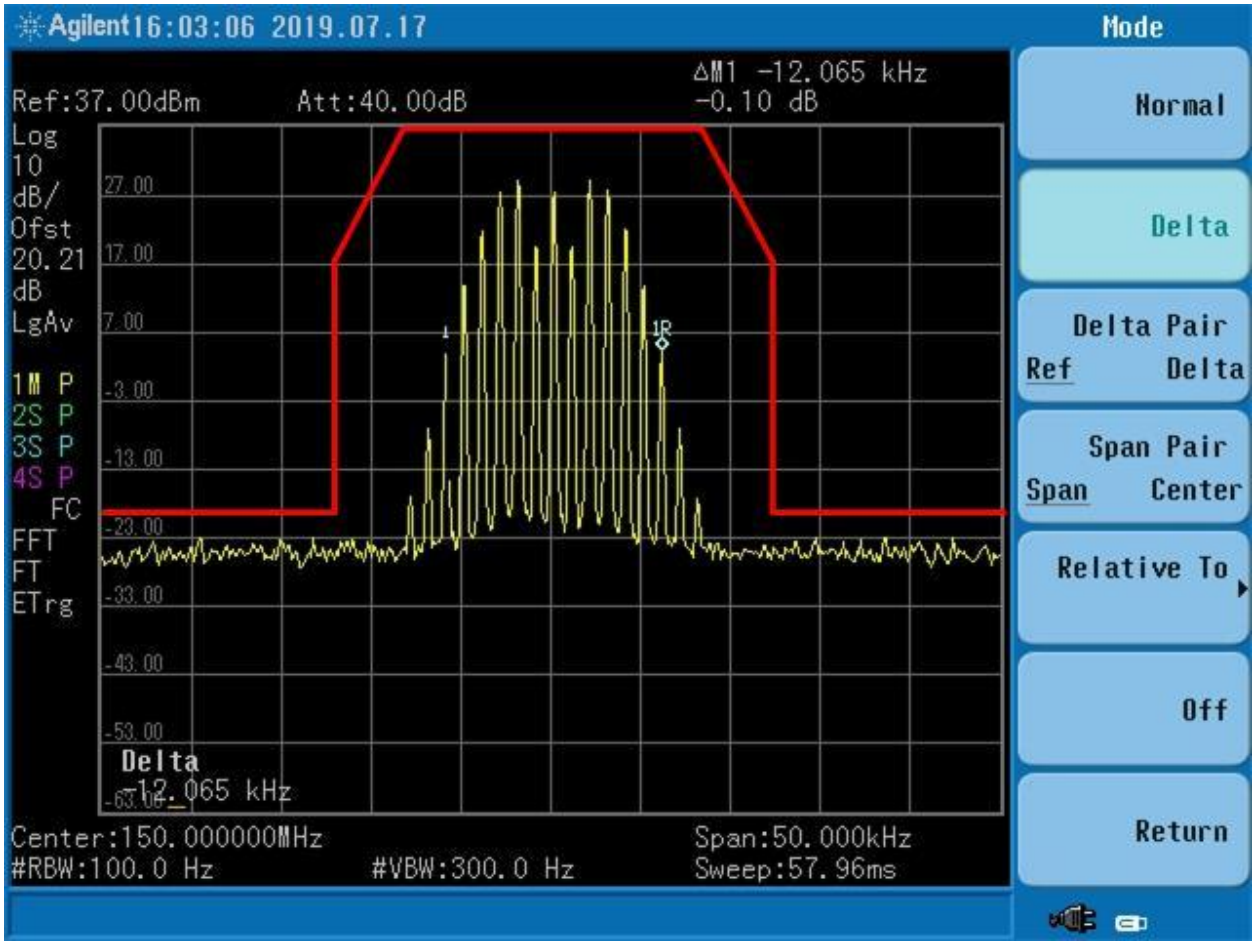

Figure 28. 150 MHz @ 12.5 kHz, Mask D

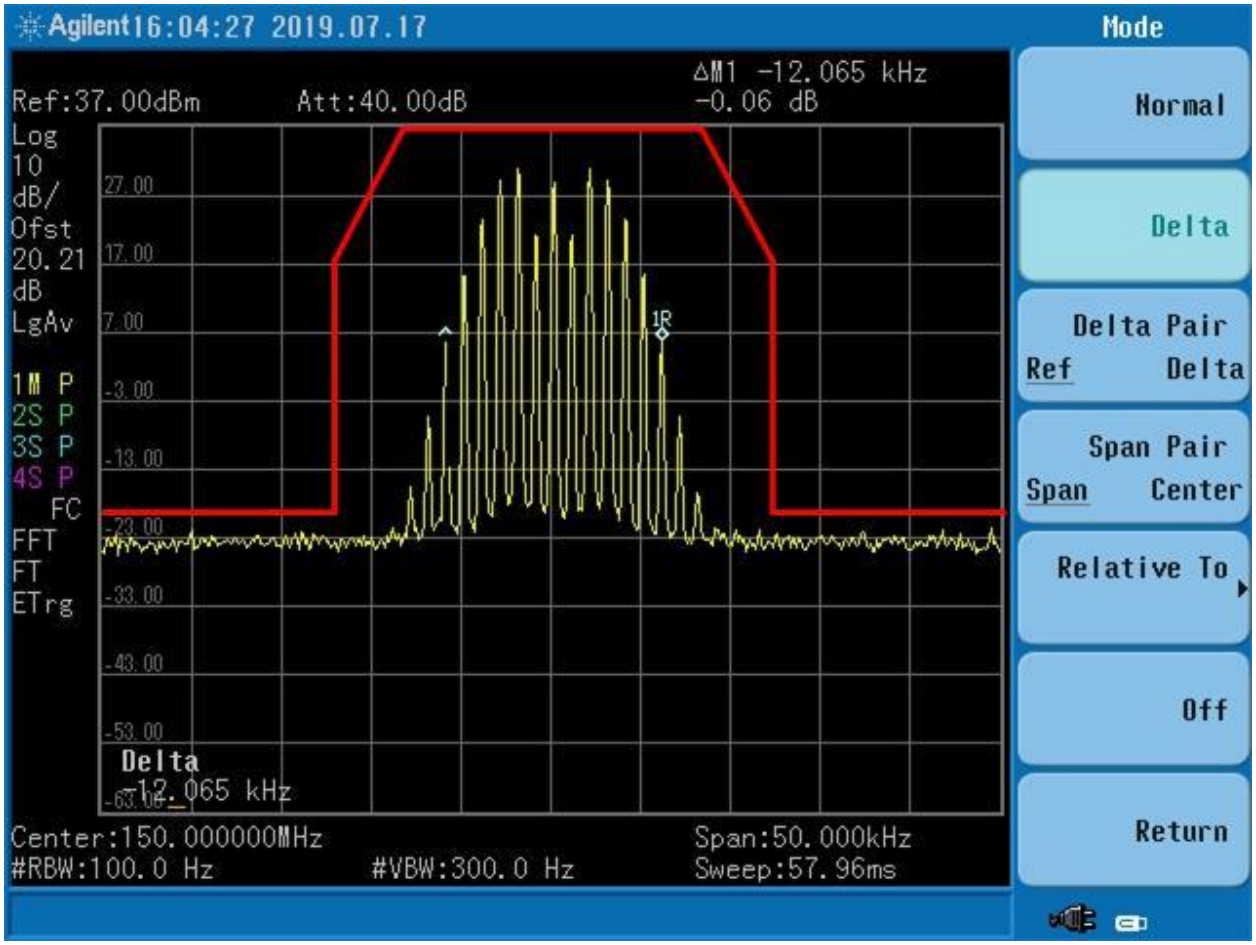

Figure 29. 150 MHz @ 12.5 kHz + 3.0 dB, Mask D

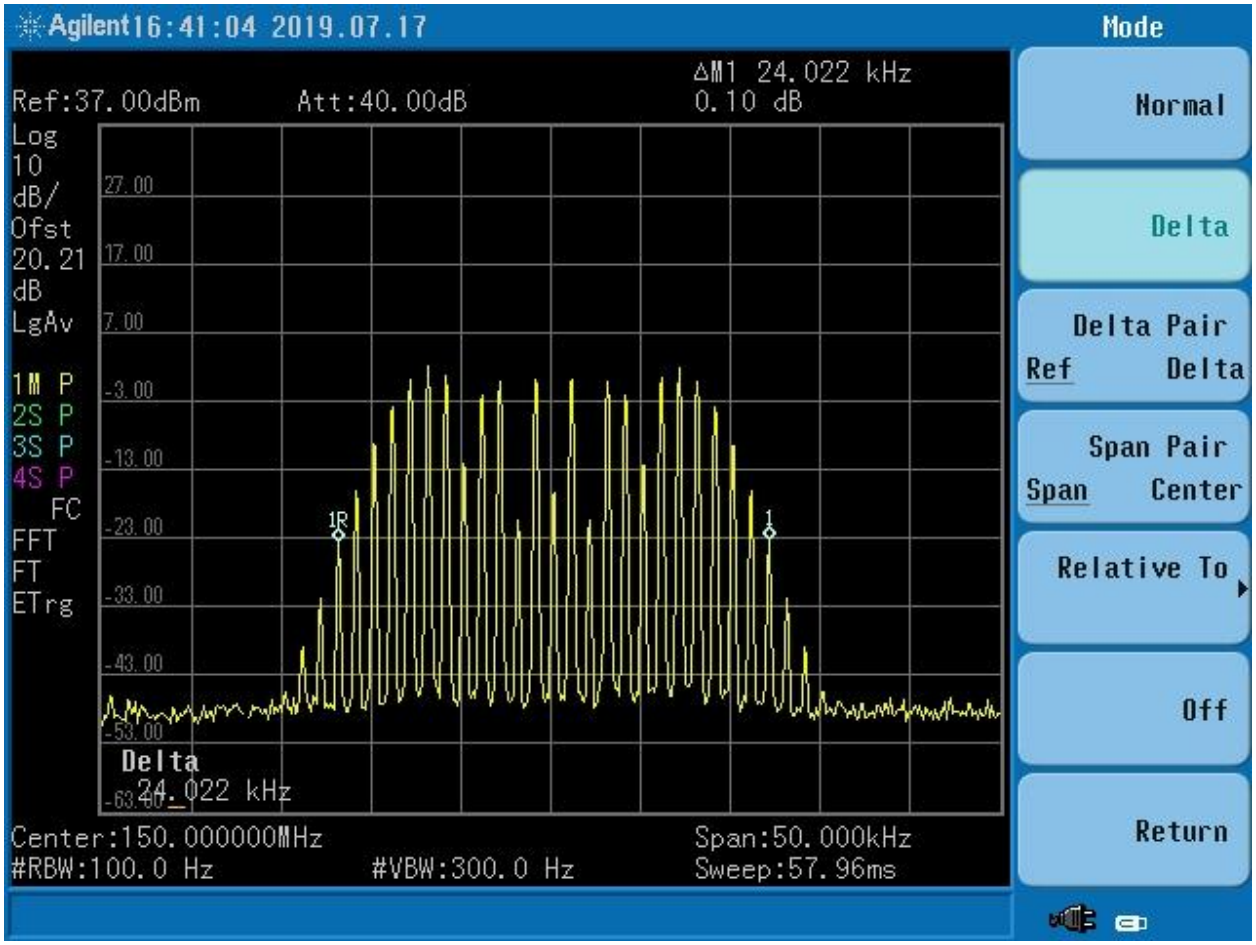

Figure 30. Input 150 MHz @ 25 kHz

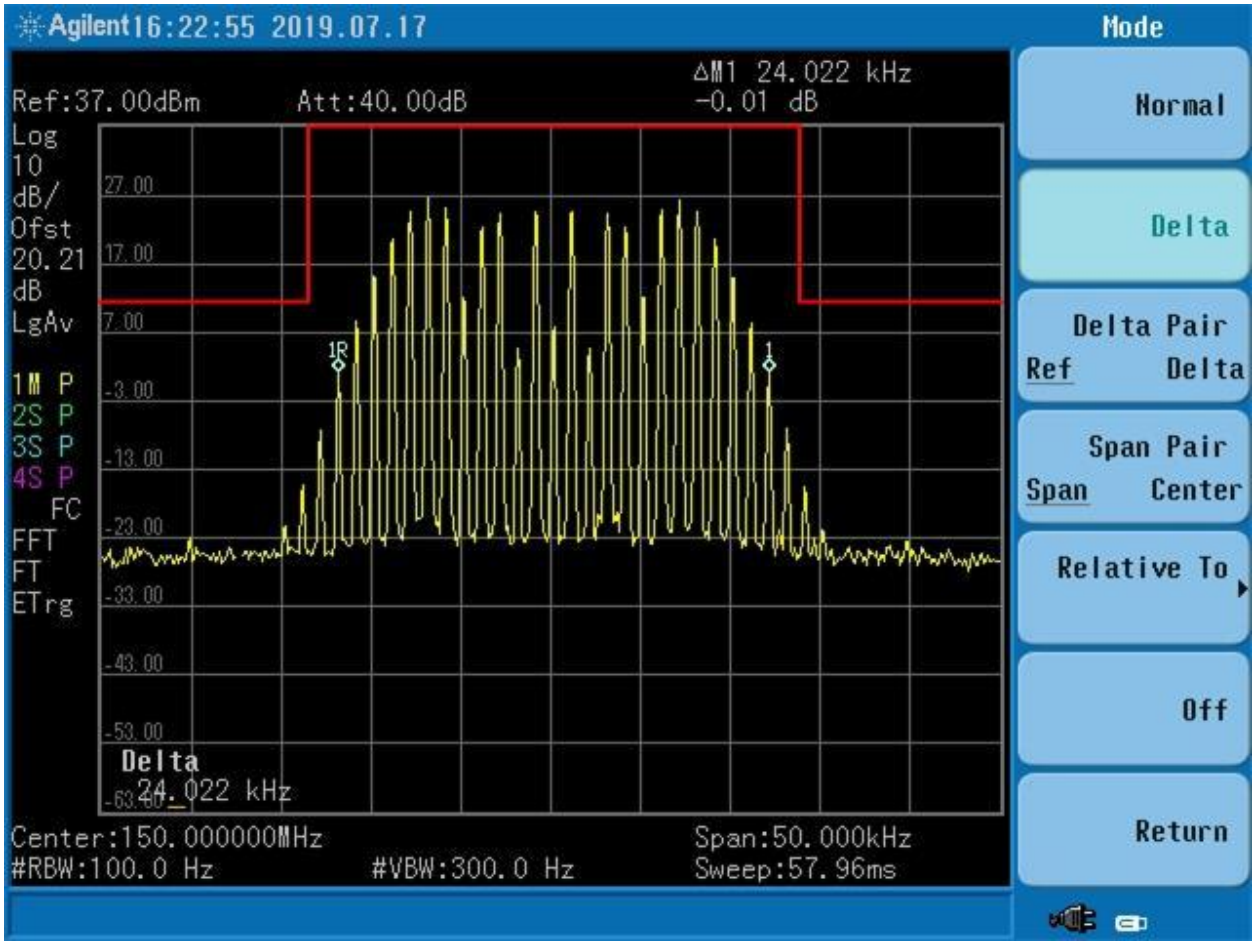

Figure 31. 150 MHz @ 25 kHz, Mask B

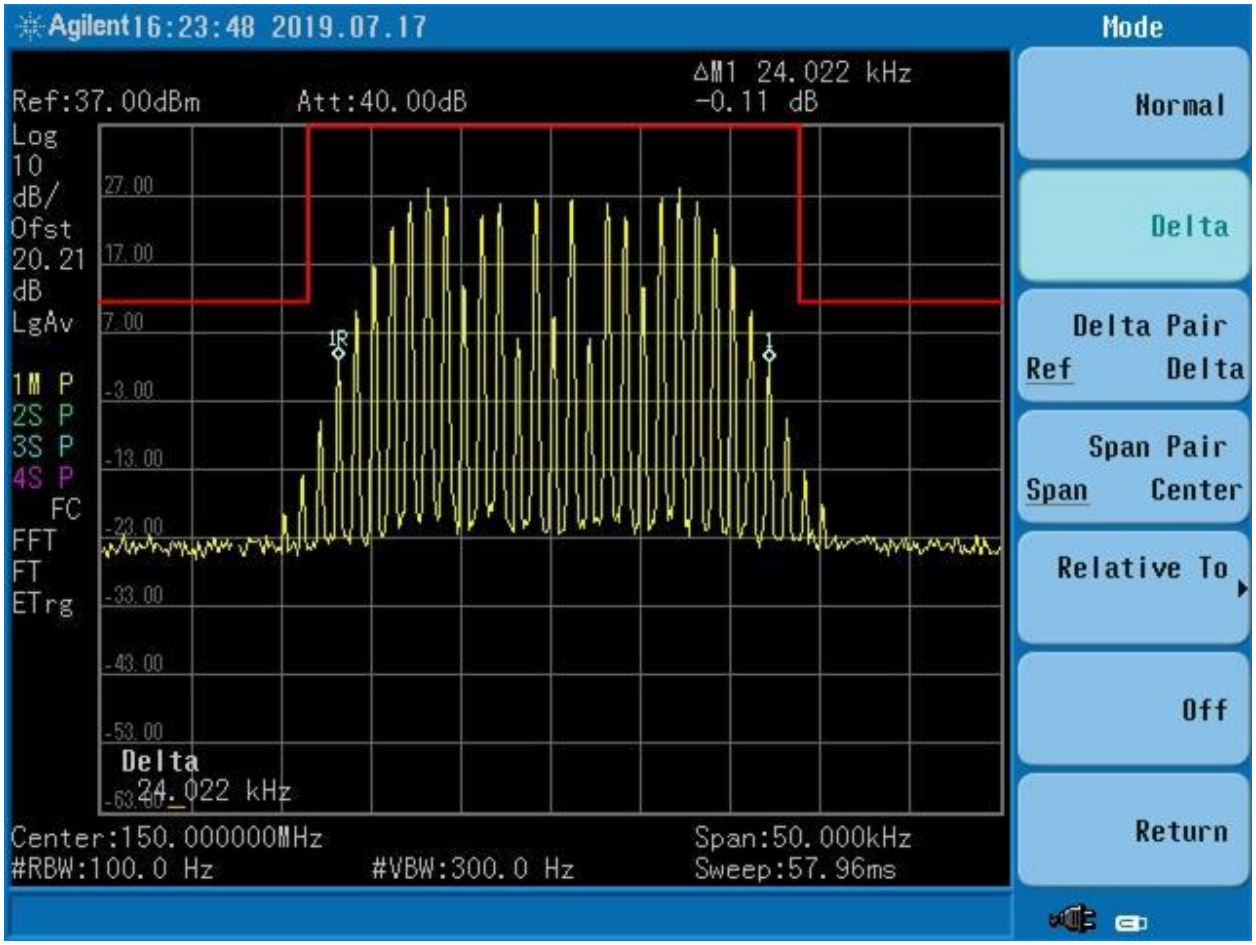

Figure 32. 150 MHz @ 25 kHz + 3.0 dB, Mask B

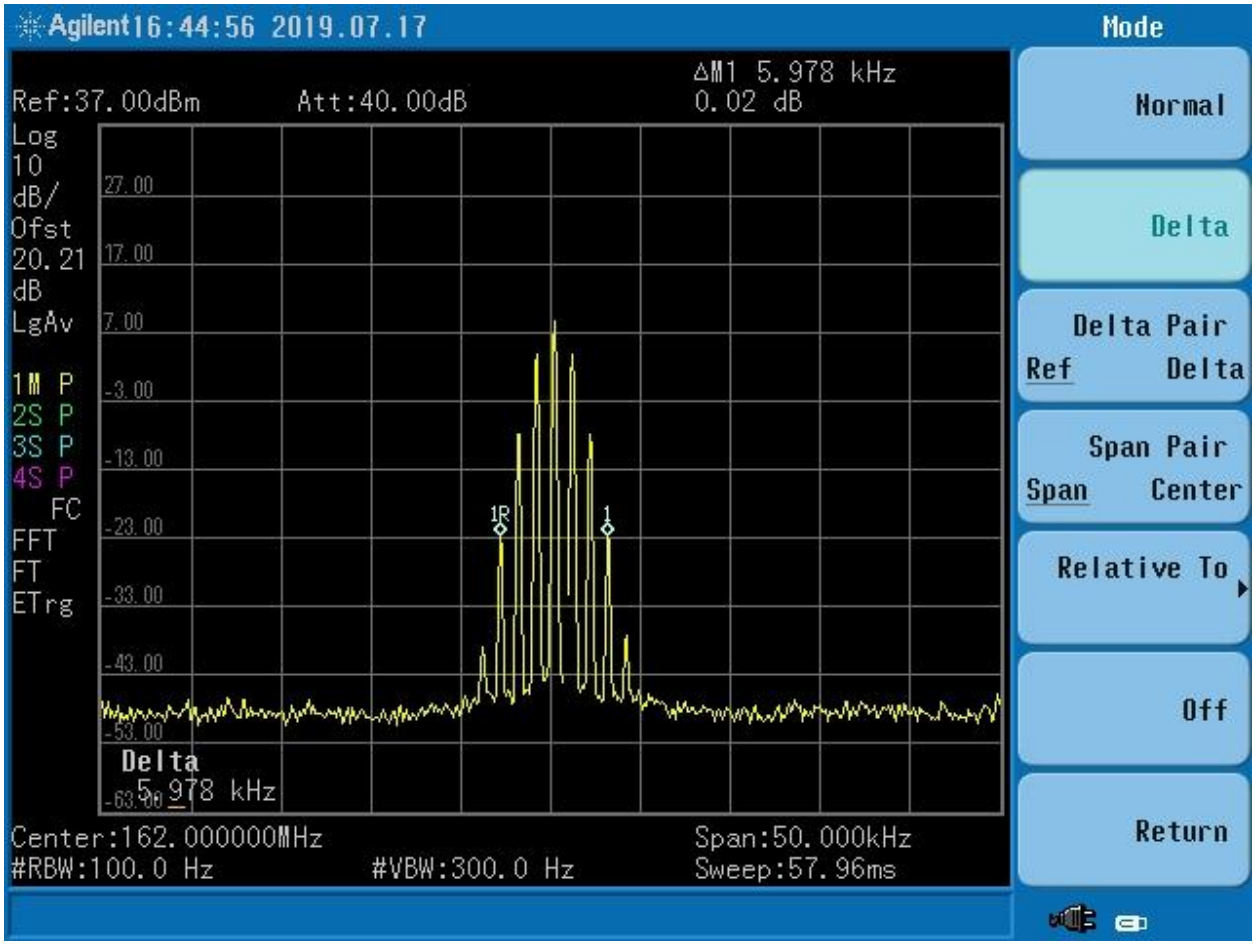

Figure 33. Input 162 MHz @ 6.25 kHz

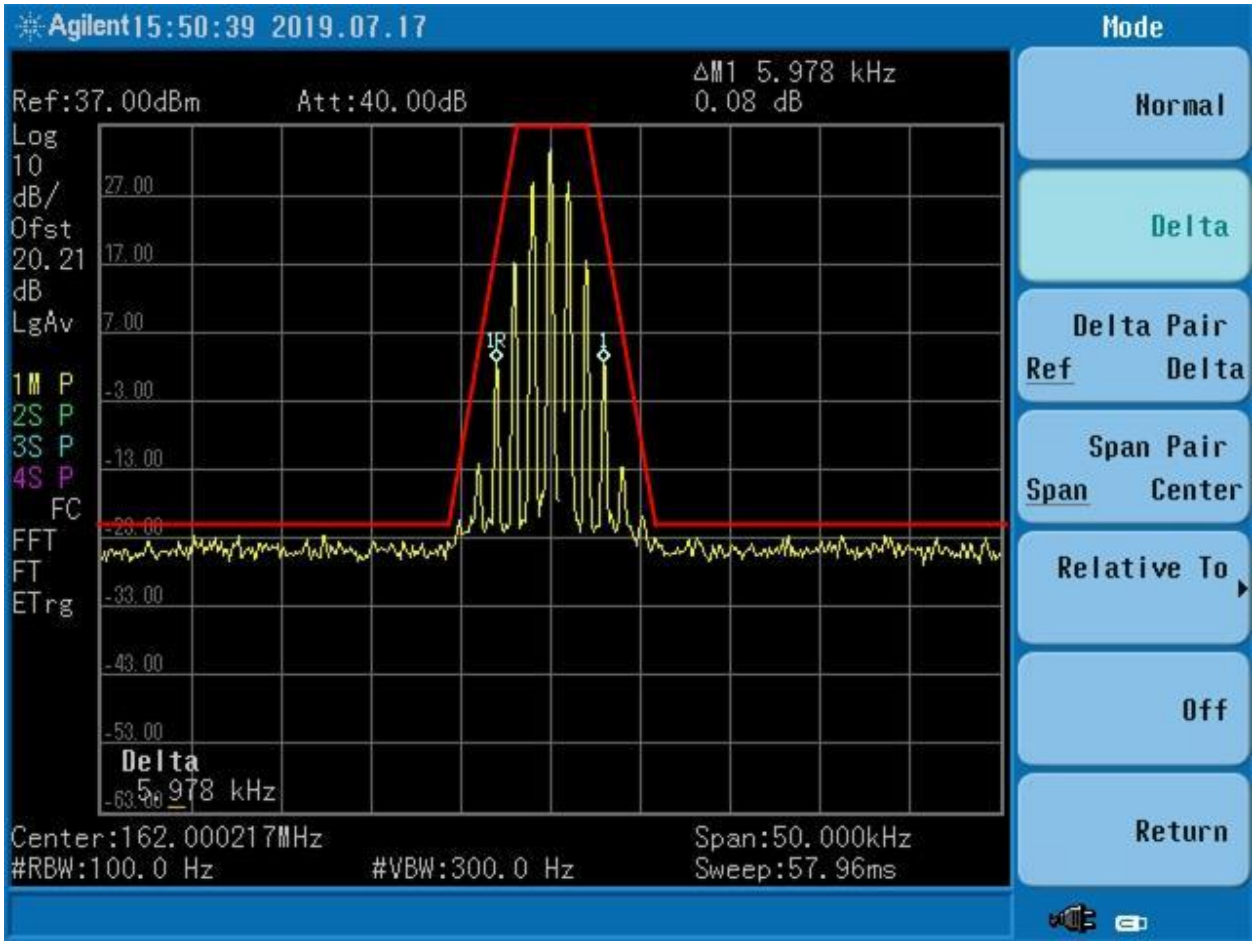

Figure 34. 162 MHz @ 6.25 kHz, Mask E

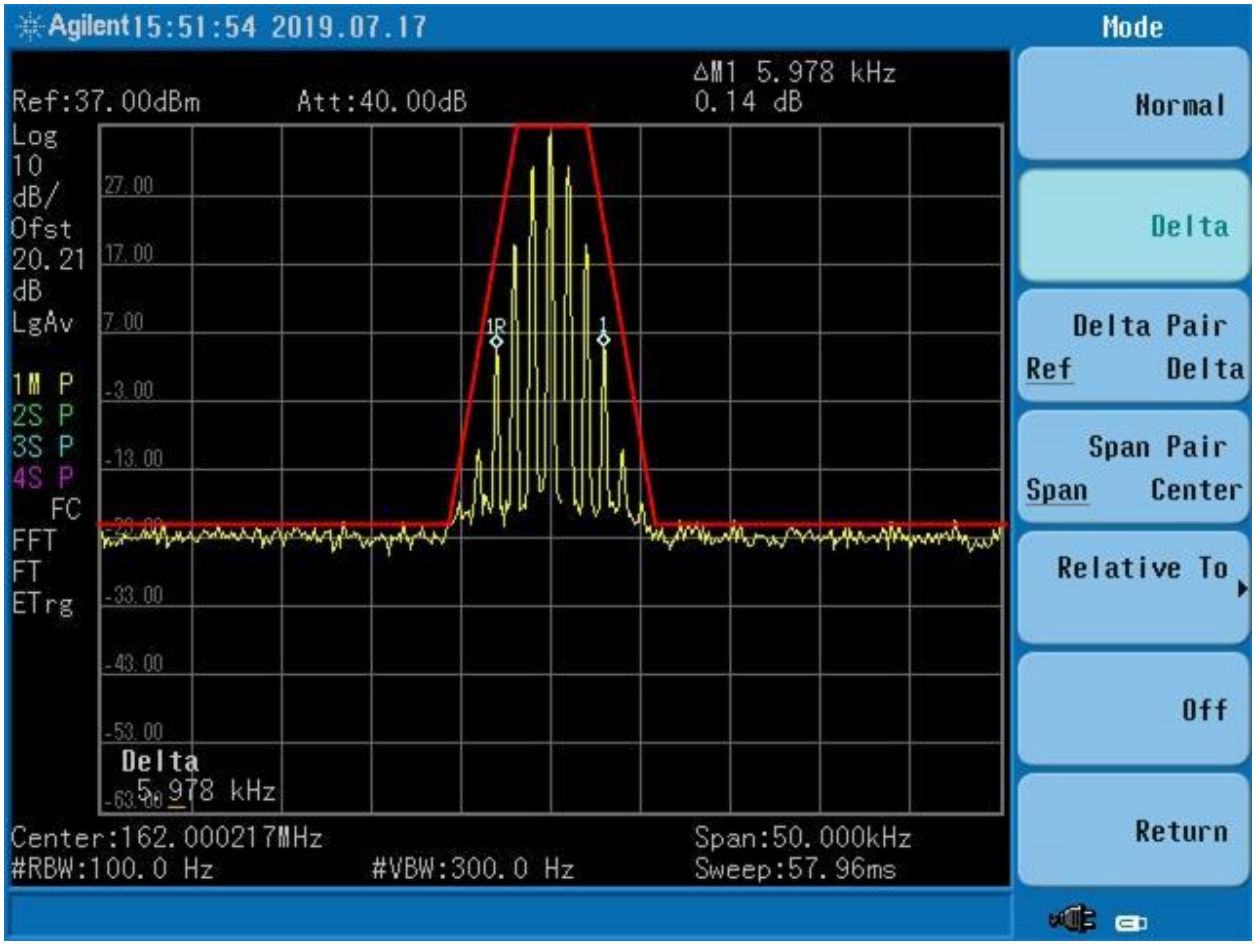

Figure 35. 162 MHz @ 6.25 kHz + 3.0 dB, Mask E

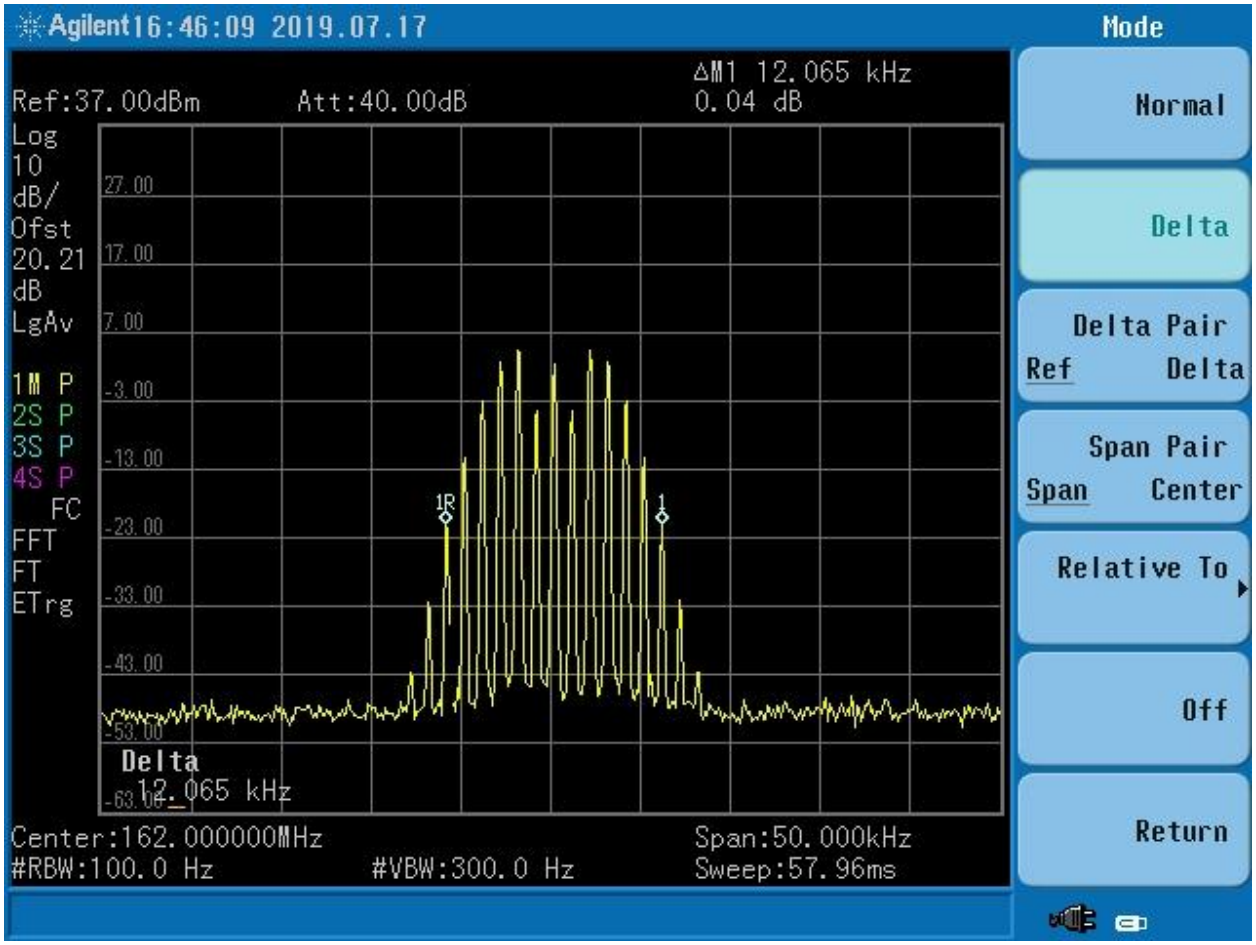

Figure 36. Input 162 MHz @ 12.5 kHz

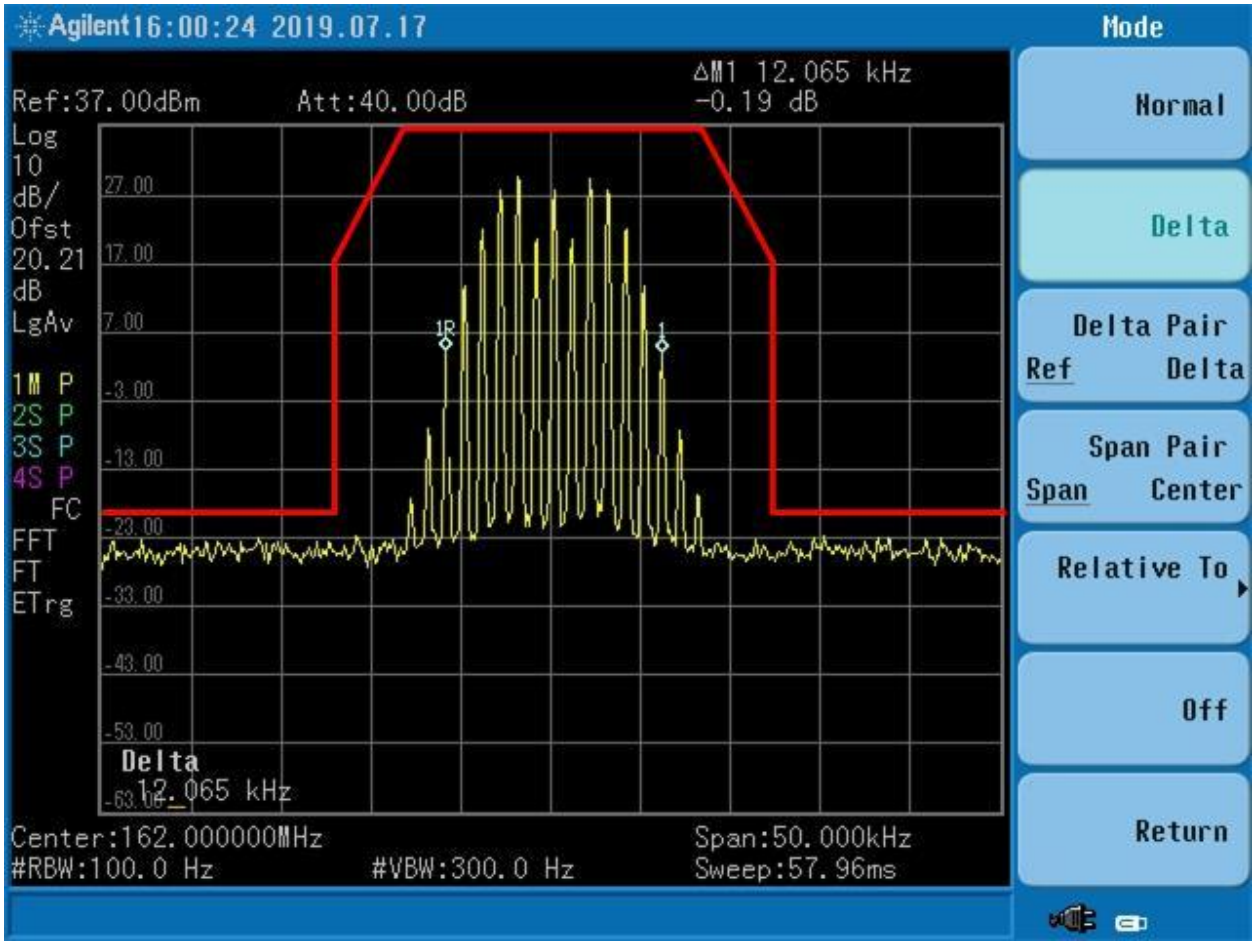

Figure 37. 162 MHz @ 12.5 kHz, Mask D

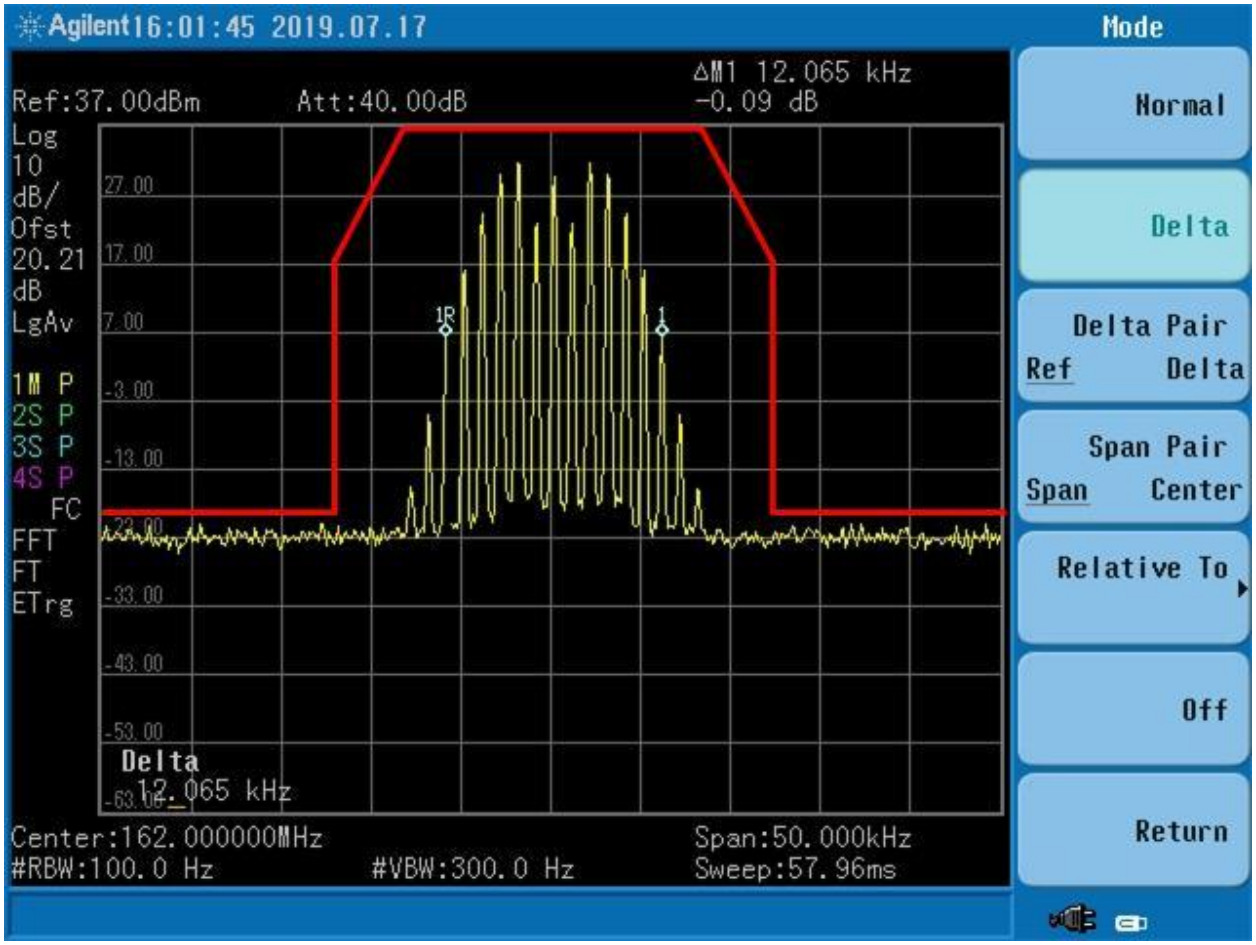

Figure 38. 162 MHz @ 12.5 kHz + 3.0 dB, Mask D

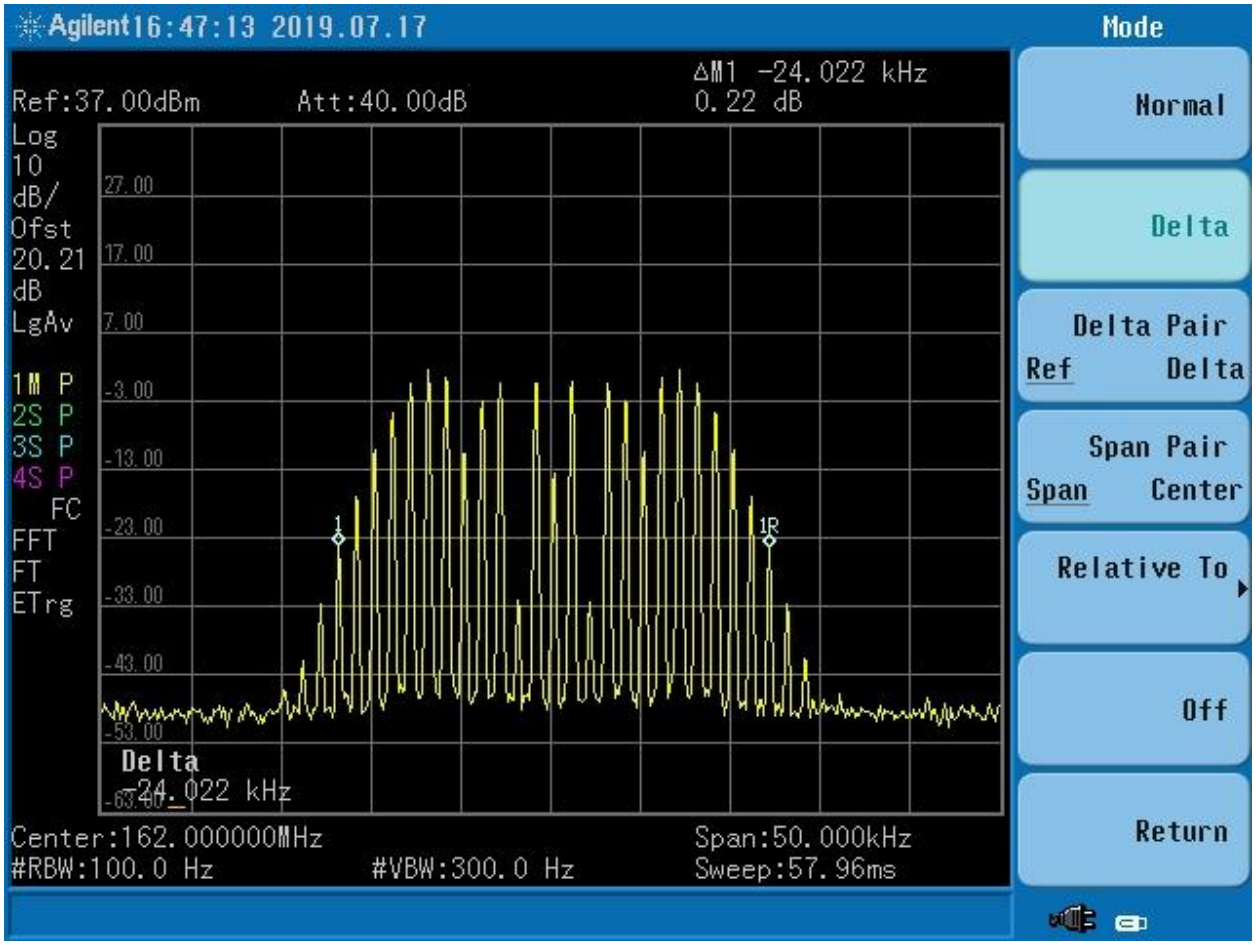

Figure 39. Input 162 MHz @ 25 kHz

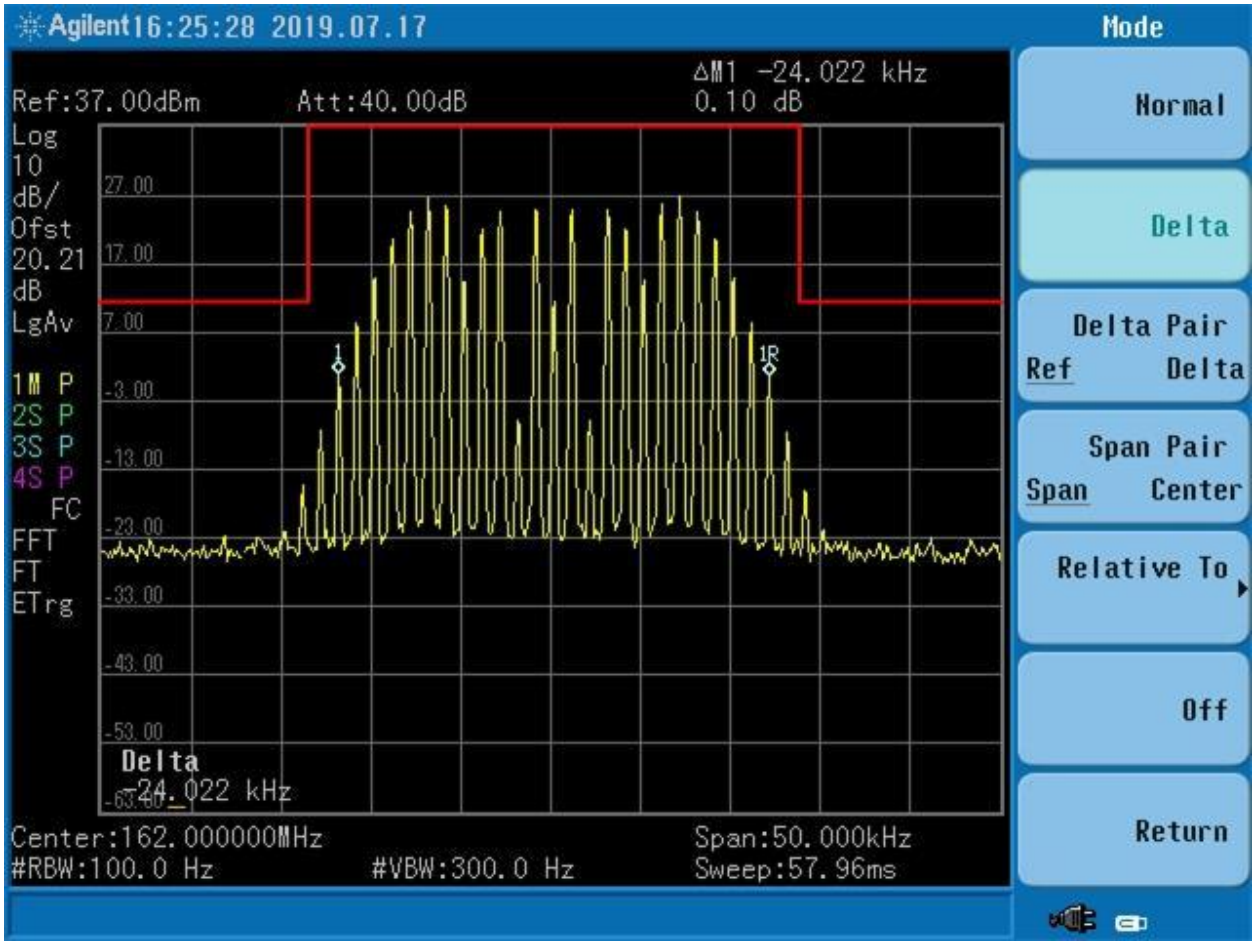

Figure 40. 162 MHz @ 25 kHz, Mask B

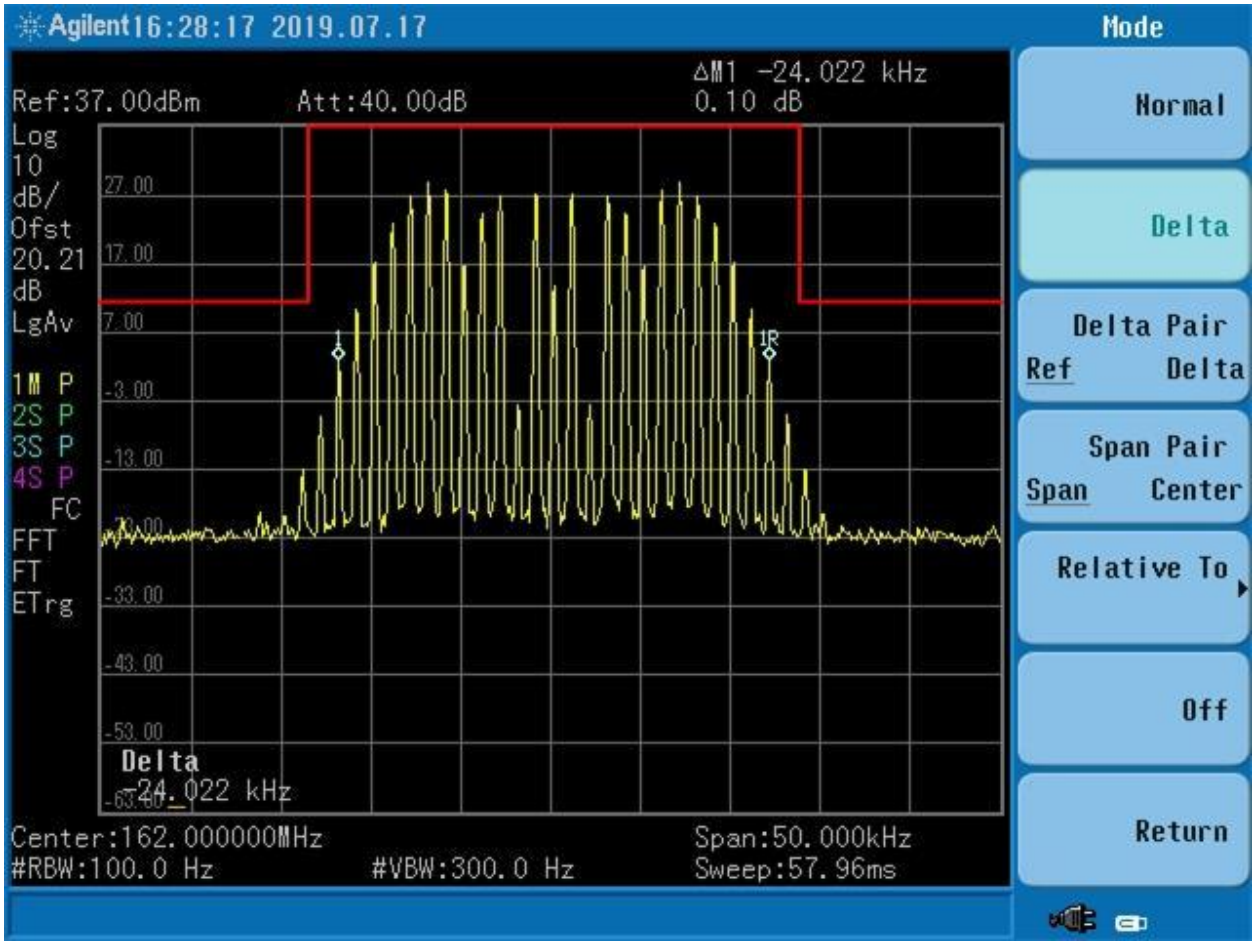

Figure 41. 162 MHz @ 25 kHz + 3.0 dB, Mask B

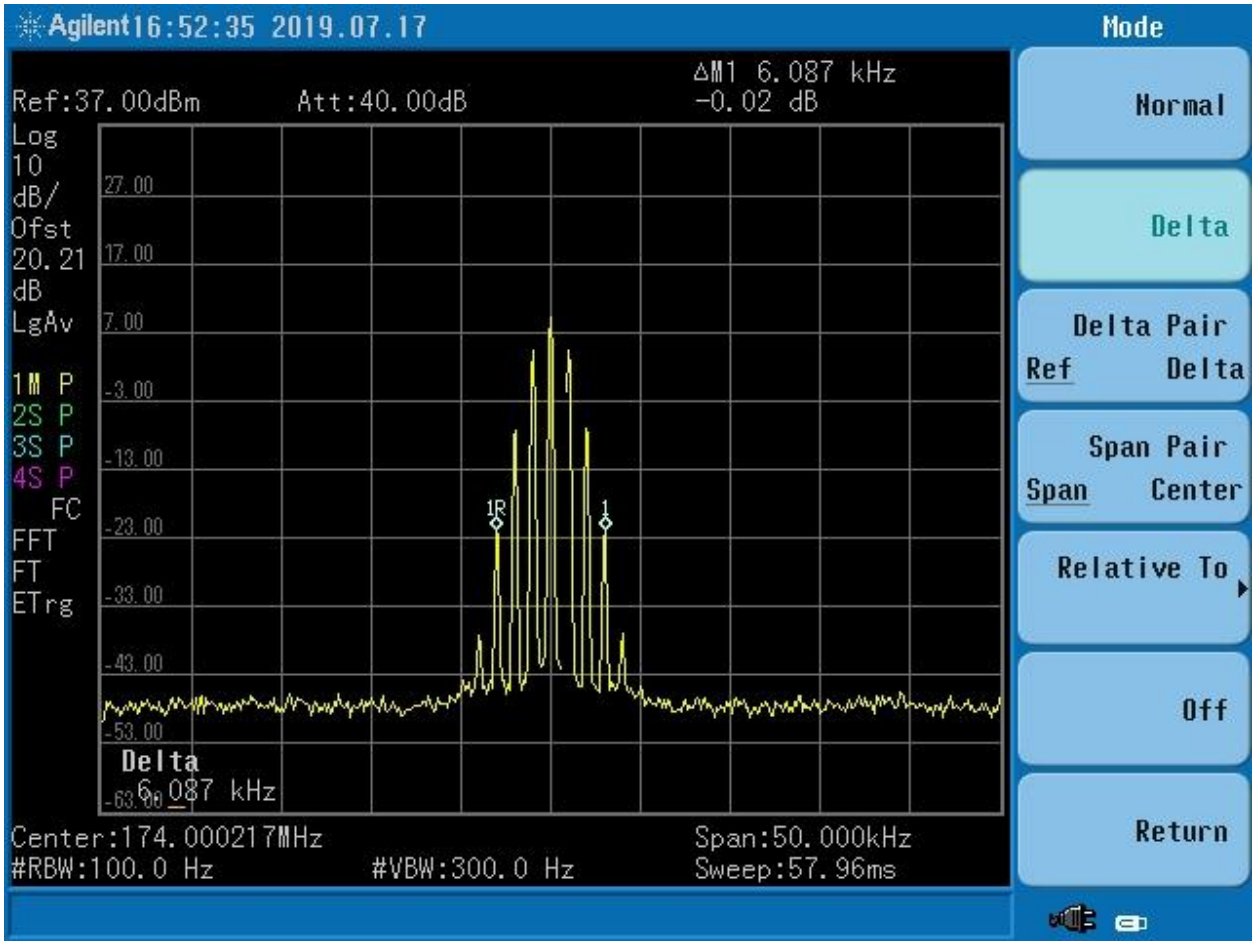

Figure 42. Input 174 MHz @ 6.25 kHz

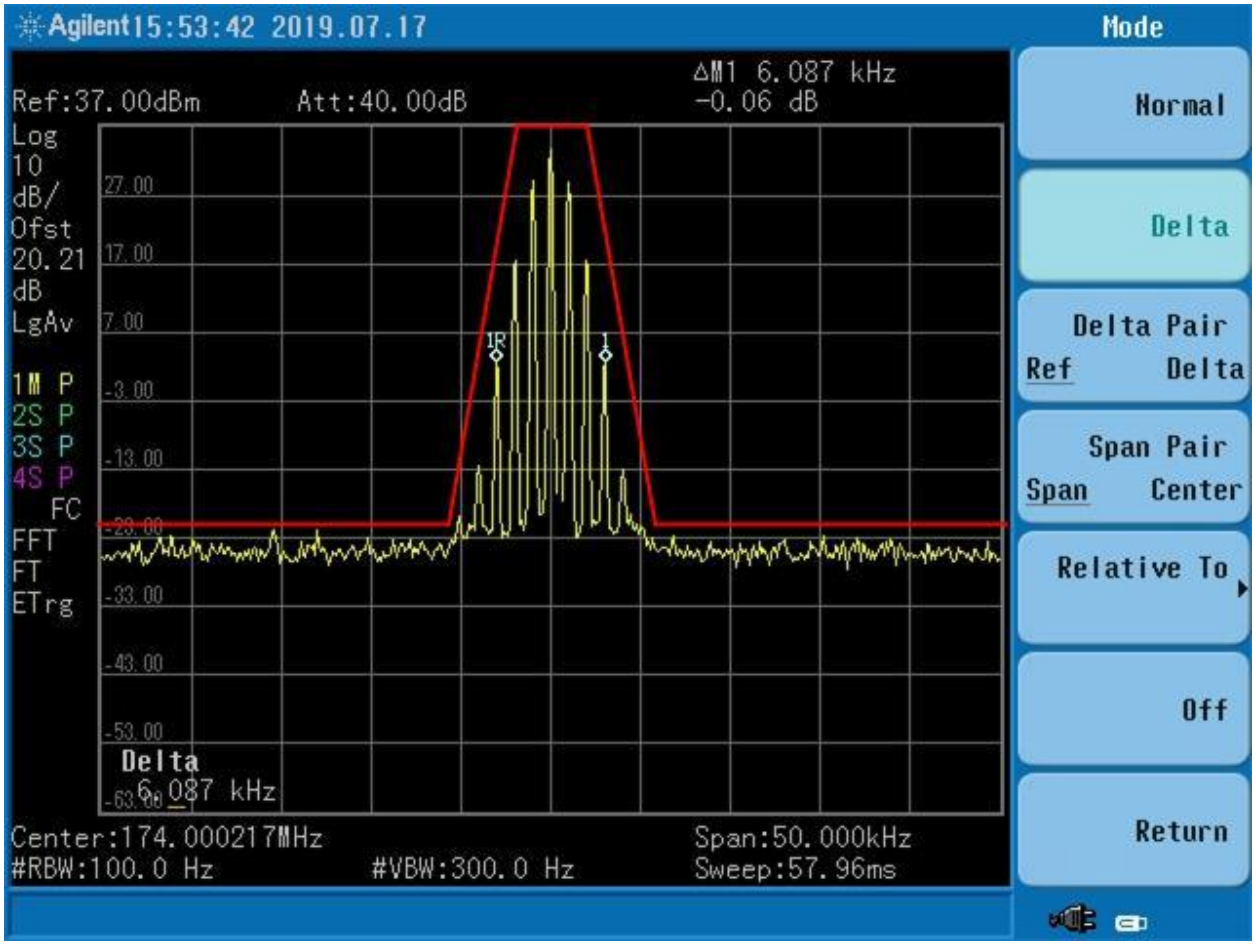

Figure 43. 174 MHz @ 6.25 kHz, Mask E

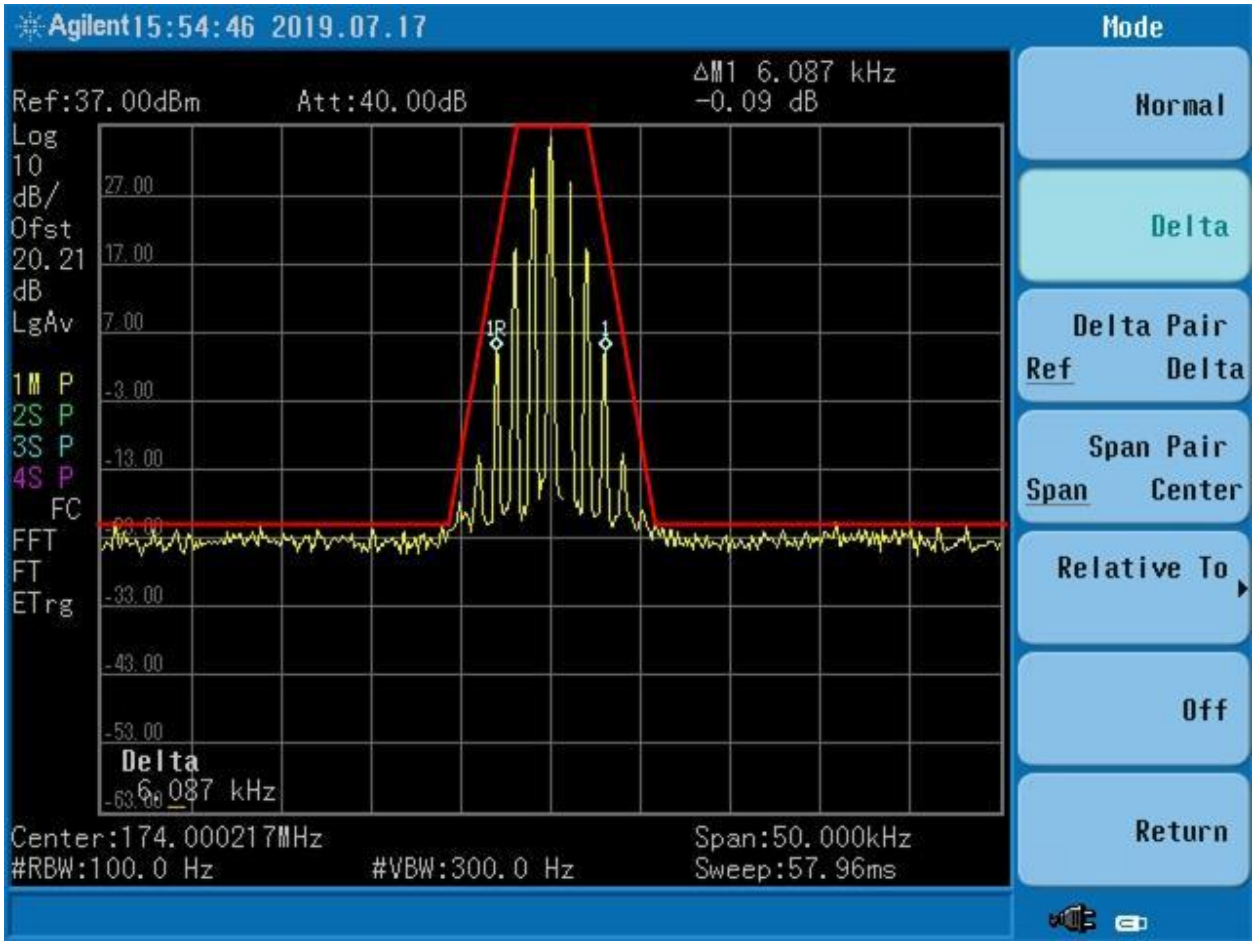

Figure 44. 174 MHz @ 6.25 kHz + 3.0 dB, Mask E

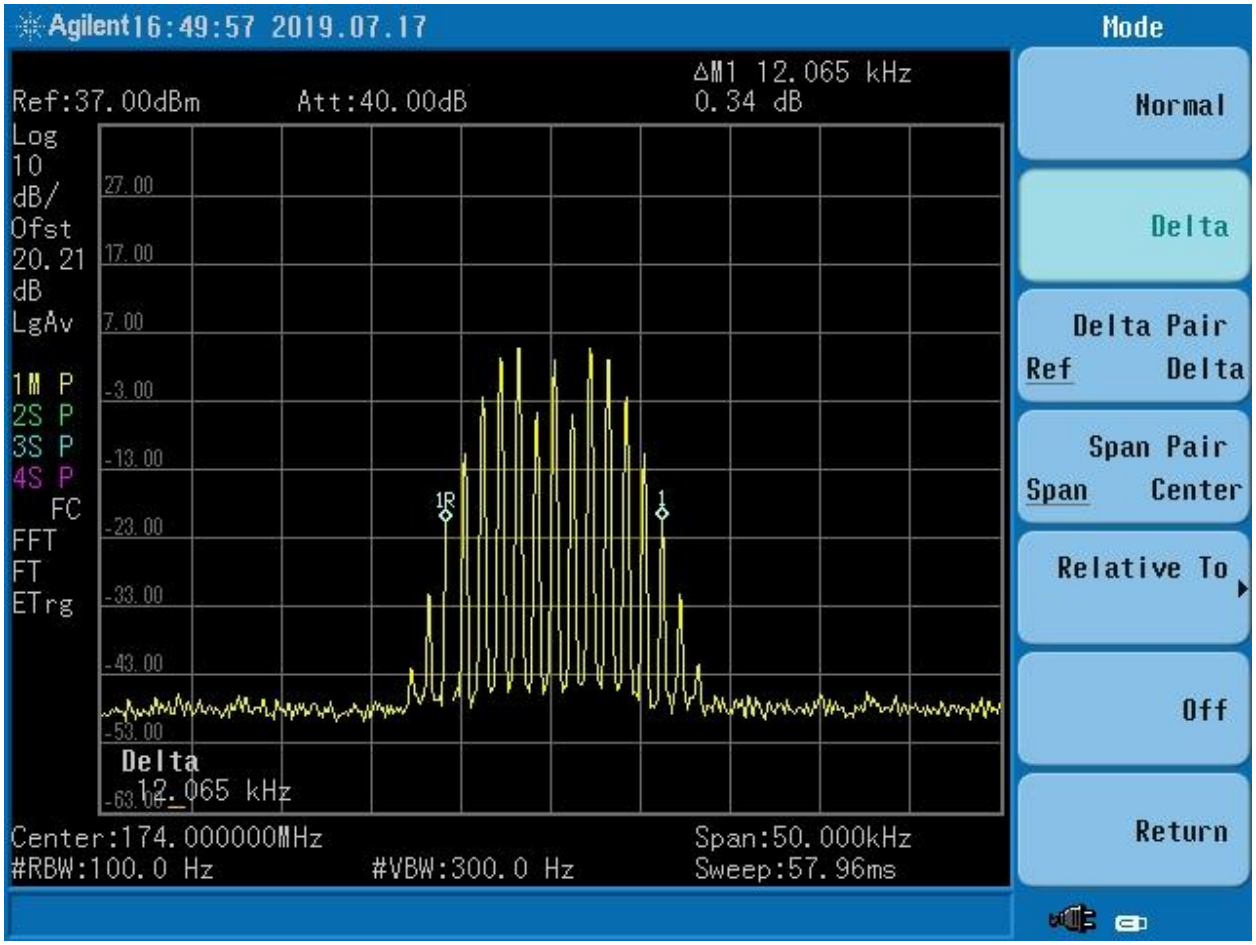

Figure 45. Input 174 MHz @ 12.5 kHz

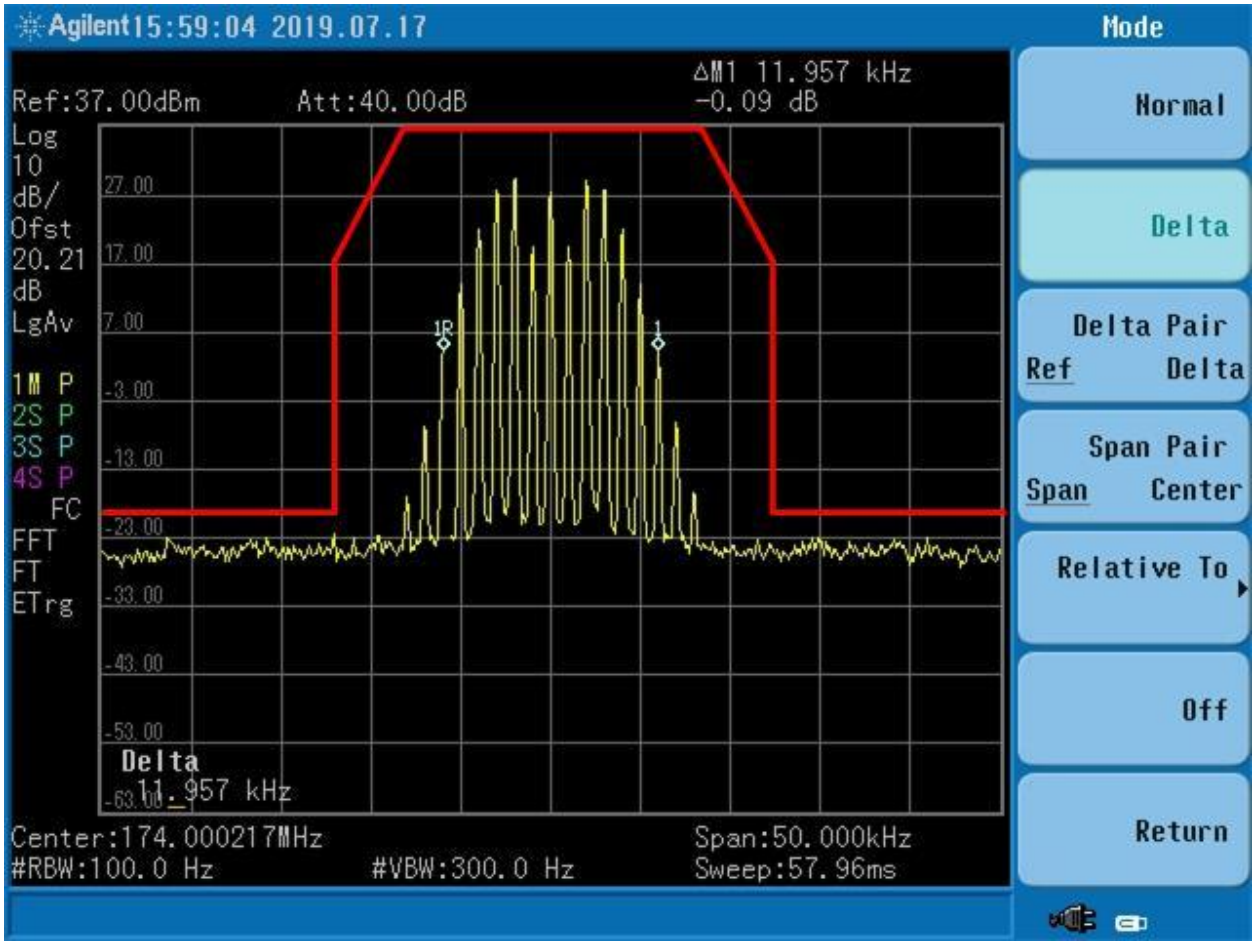

Figure 46. 174 MHz @ 12.5 kHz, Mask D

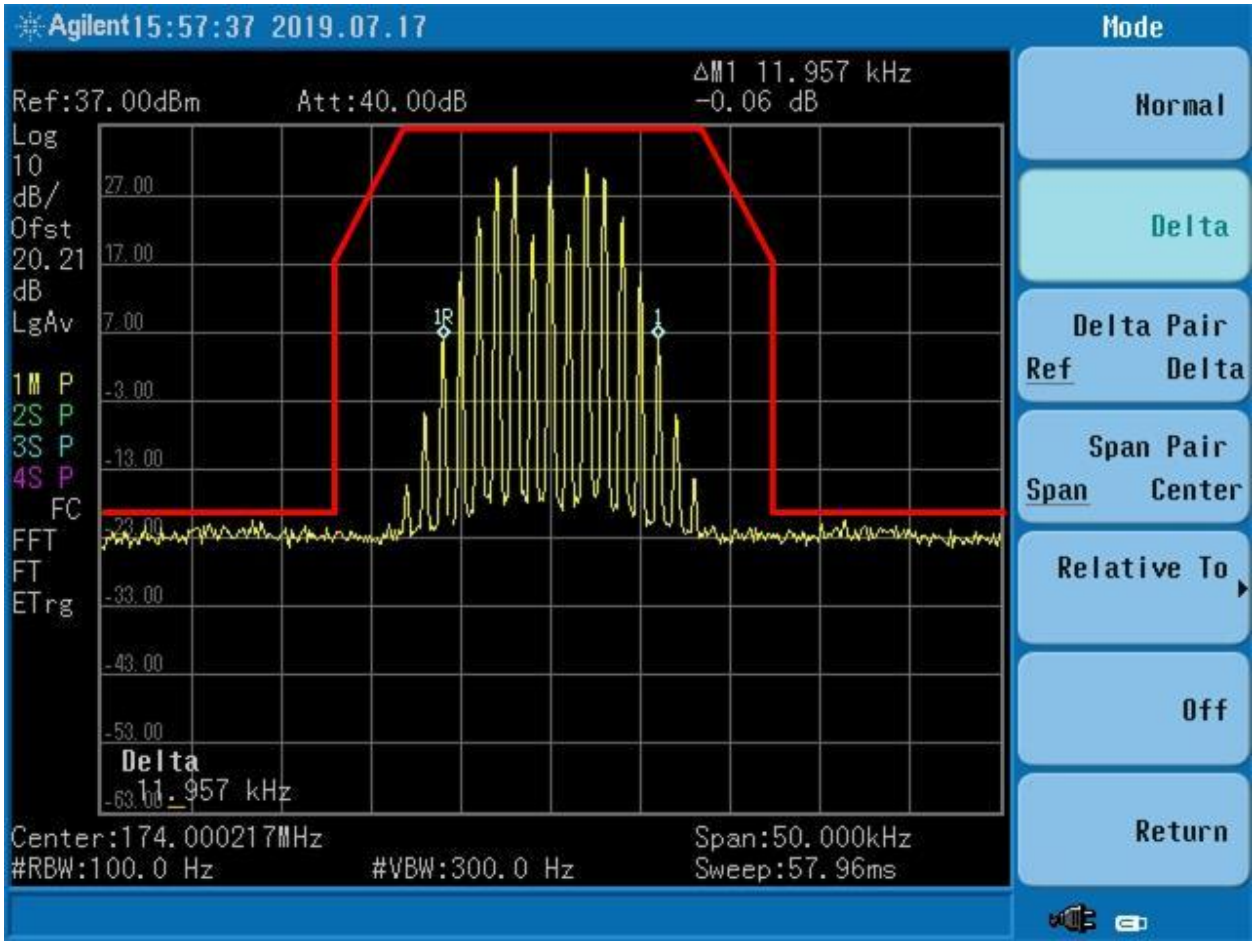

Figure 47. 174 MHz @ 12.5 kHz + 3.0 dB, Mask D

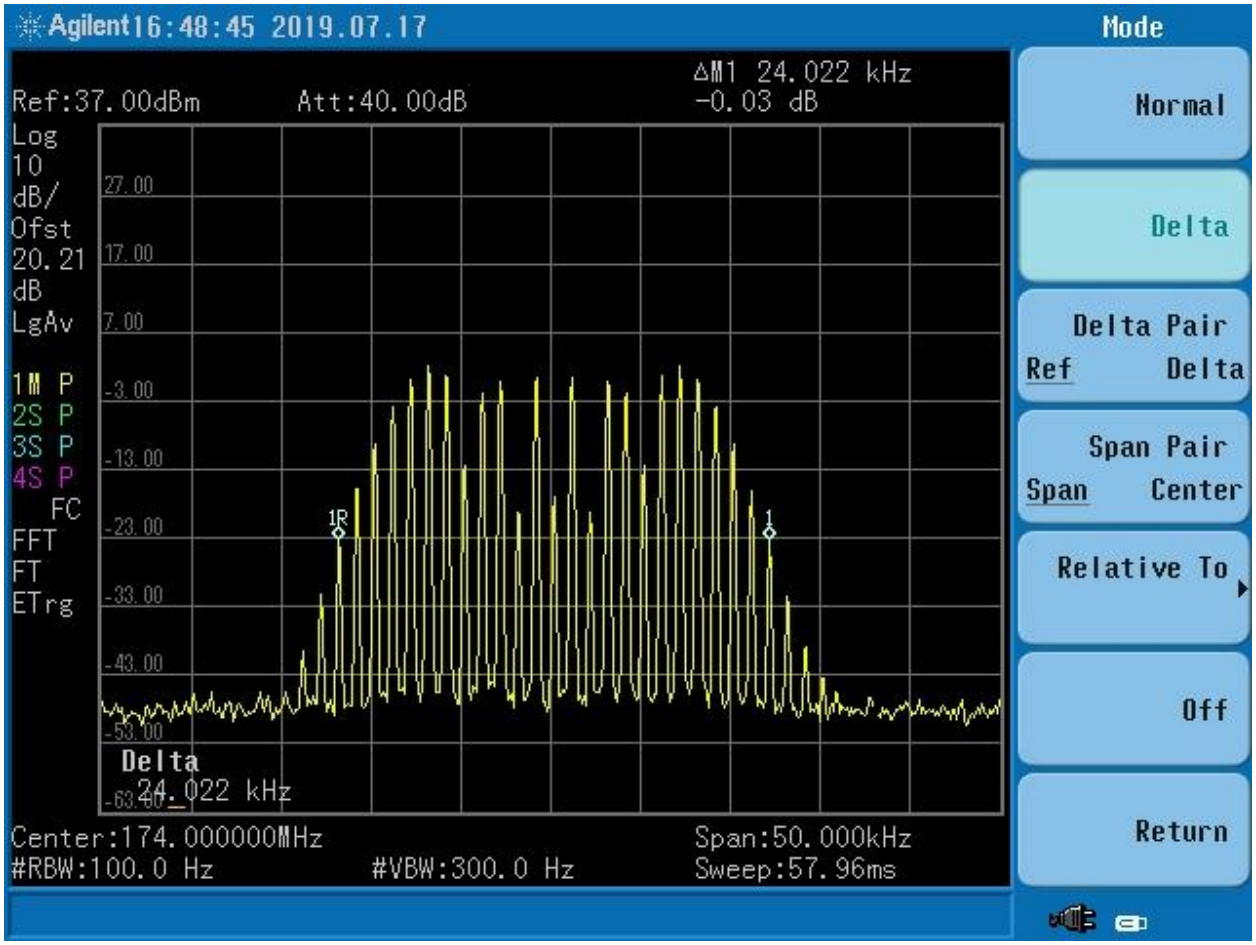

Figure 48. Input 174 MHz @ 25 kHz

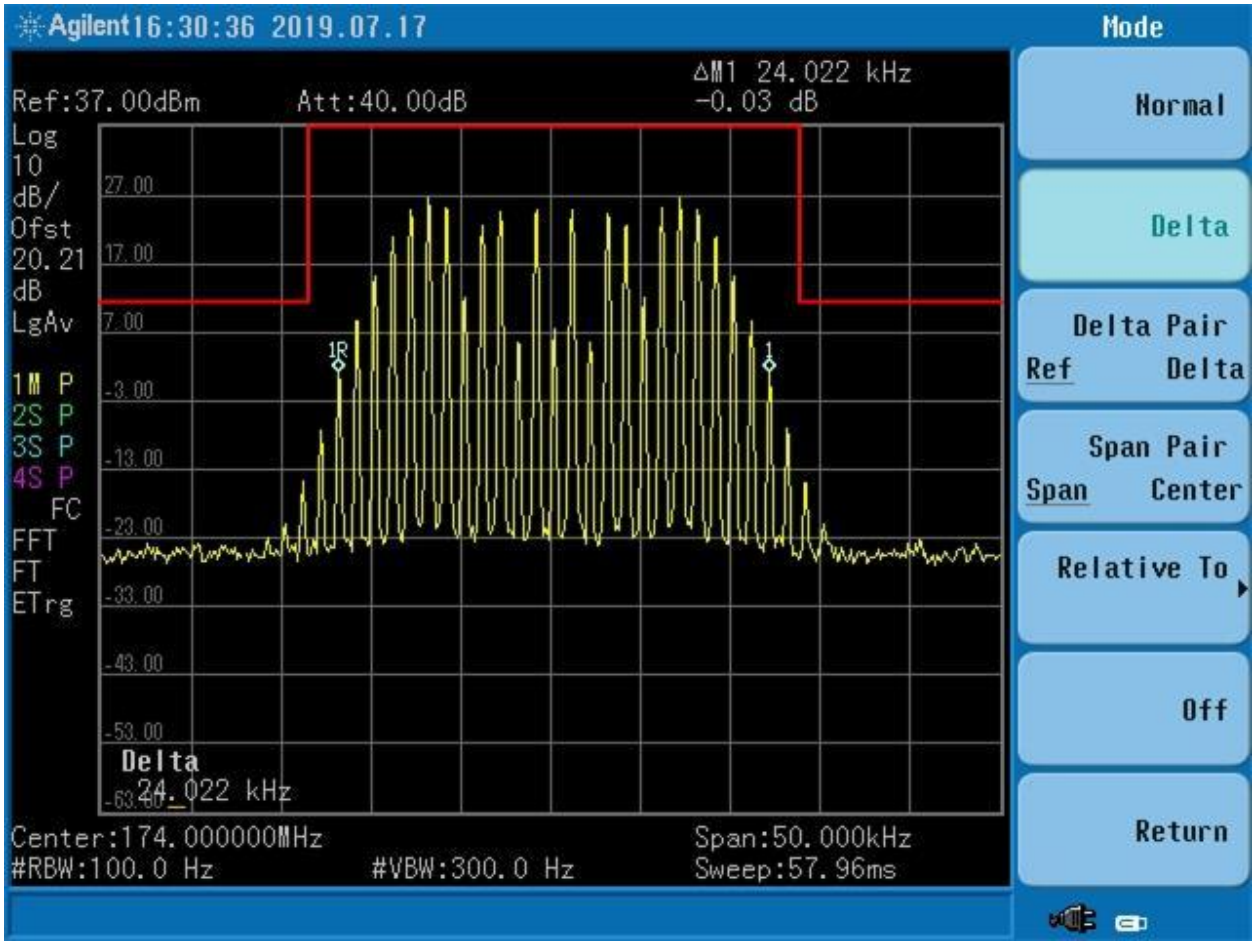

Figure 49. 174 MHz @ 25 kHz, Mask B

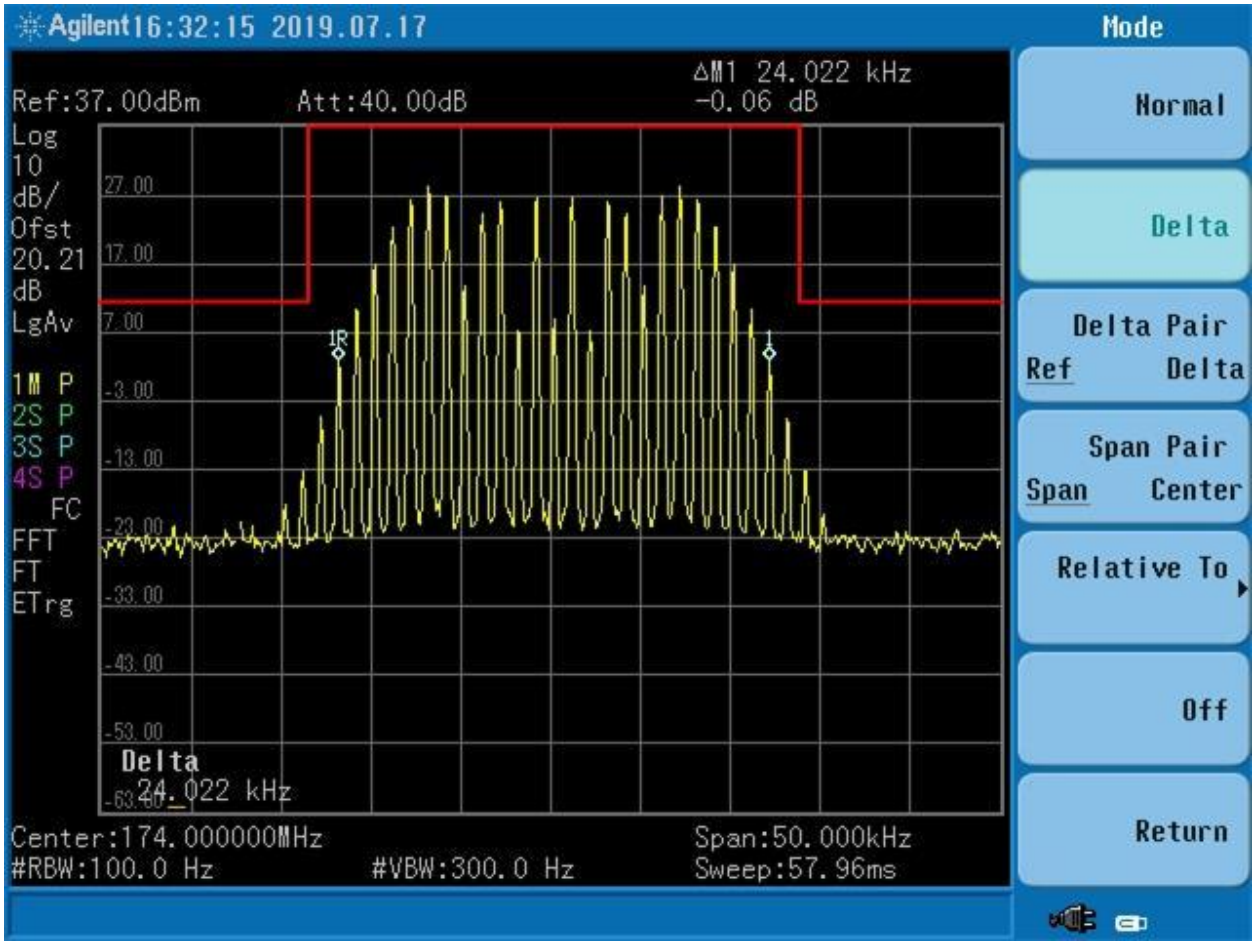

Figure 50. 174 MHz @ 25 kHz + 3.0 dB, Mask B

2.11.2 UHF Channels

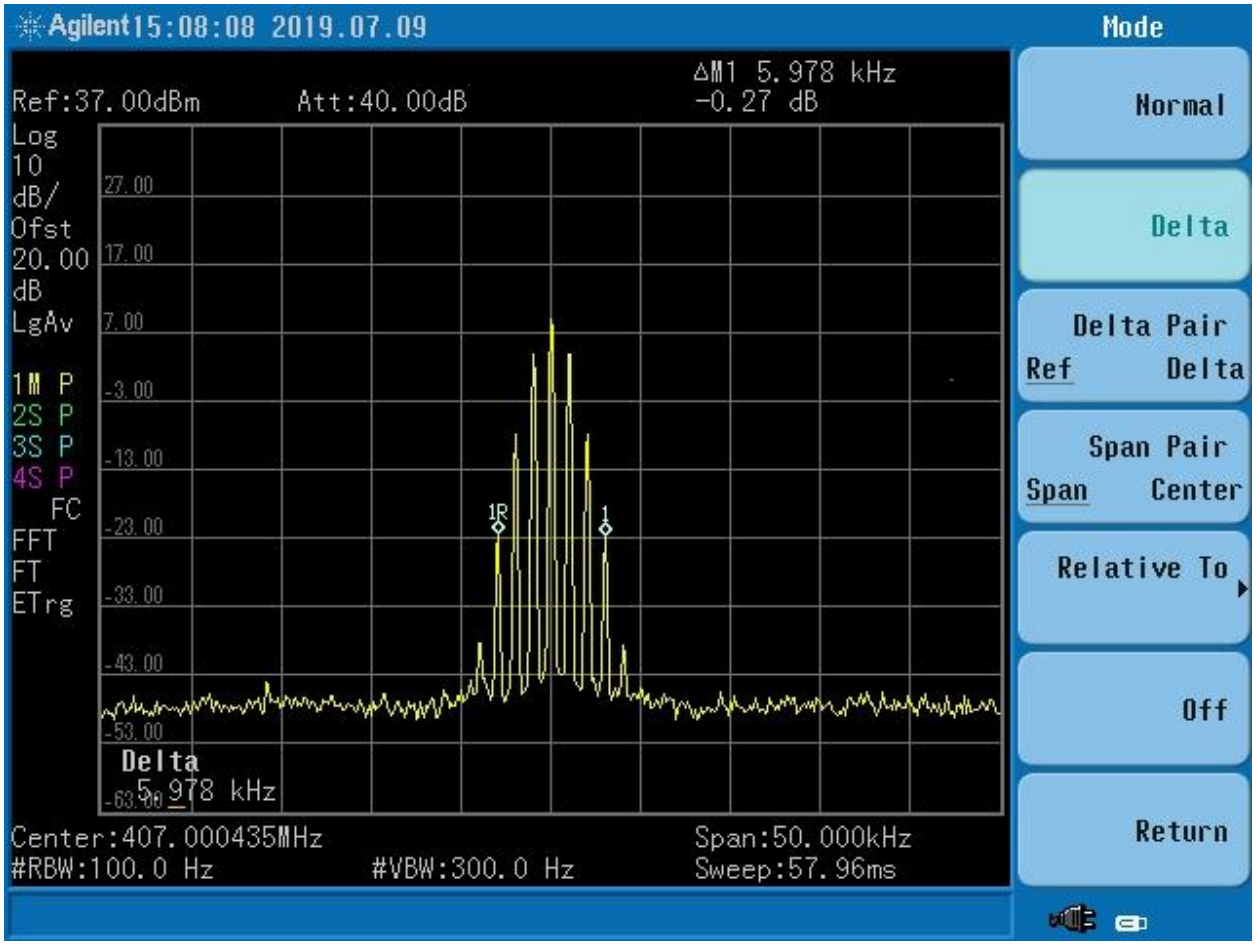

Figure 51. Input 407 MHz @ 6.25 kHz

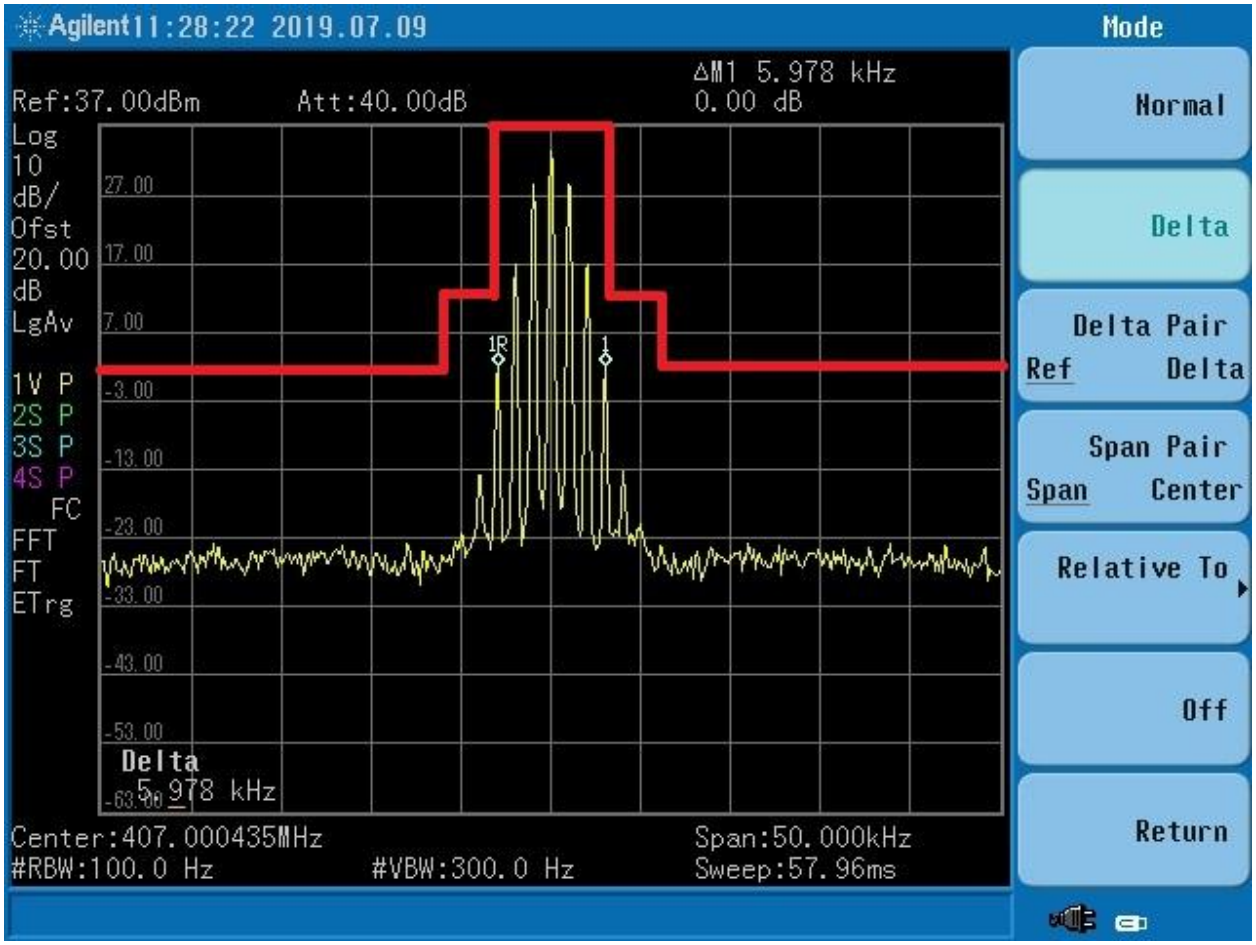

Figure 52. 407 MHz @ 6.25 kHz, Mask B

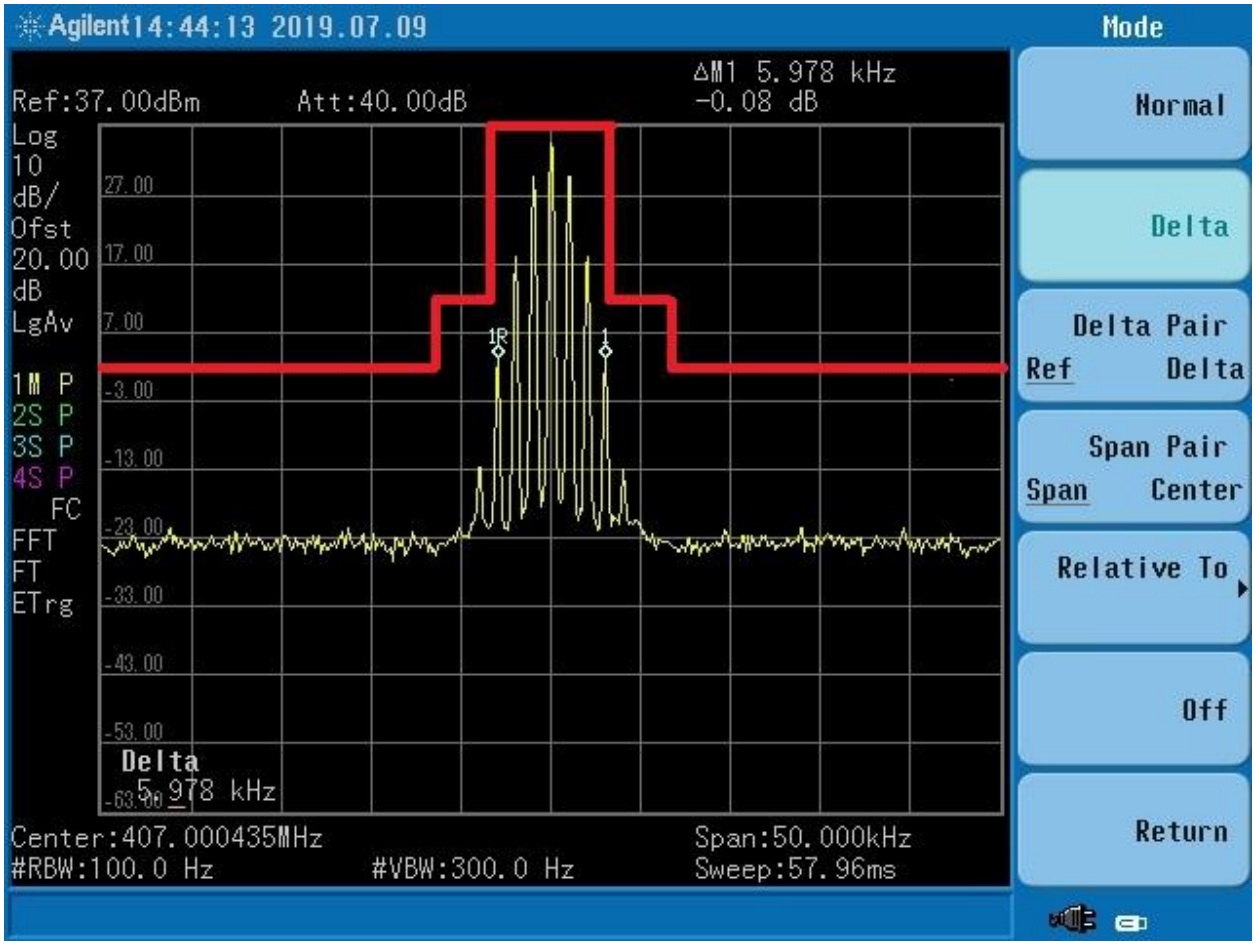

Figure 53. 407 MHz @ 6.25 kHz + 3 dB, Mask B

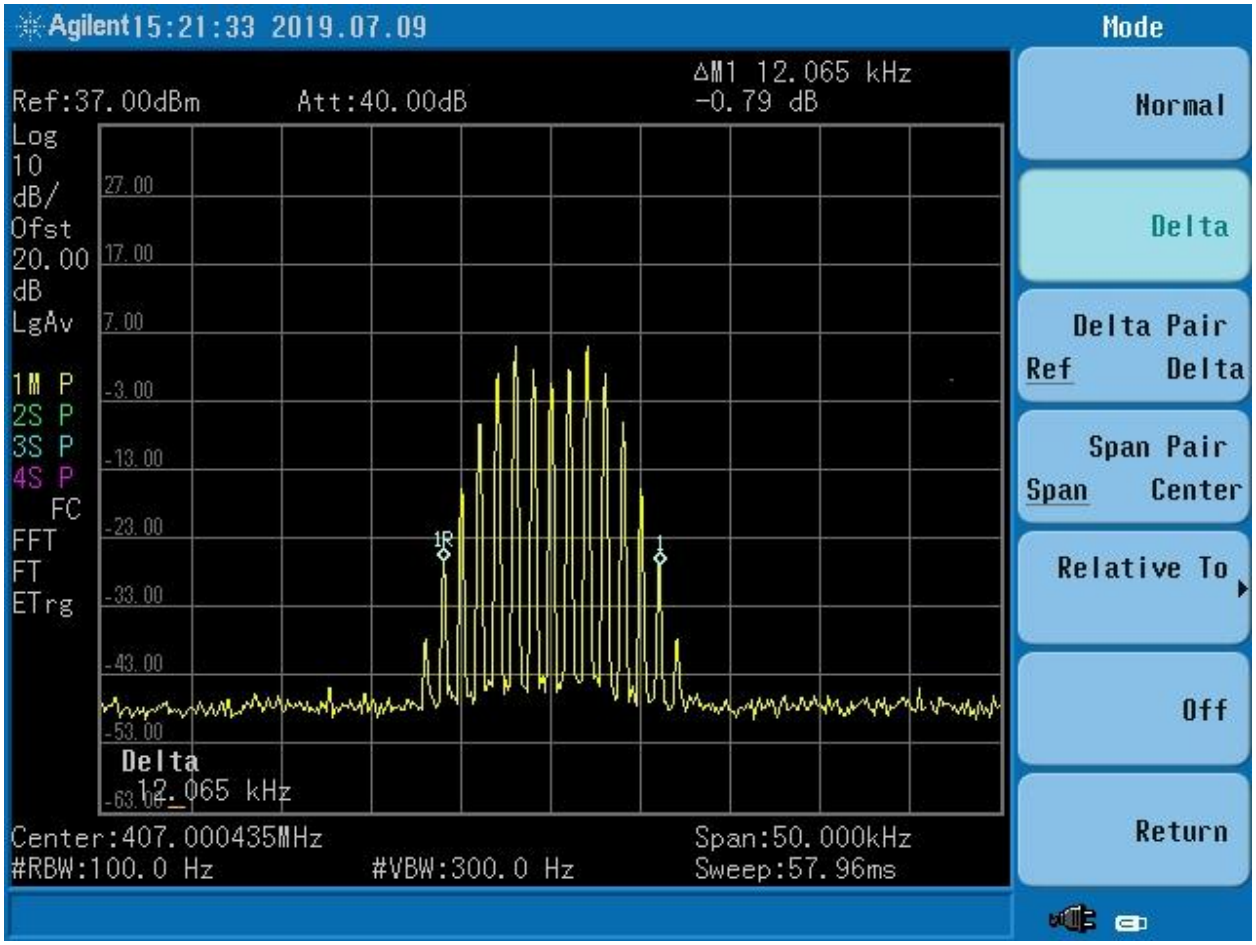

Figure 54. Input 407 MHz @ 12.5 kHz

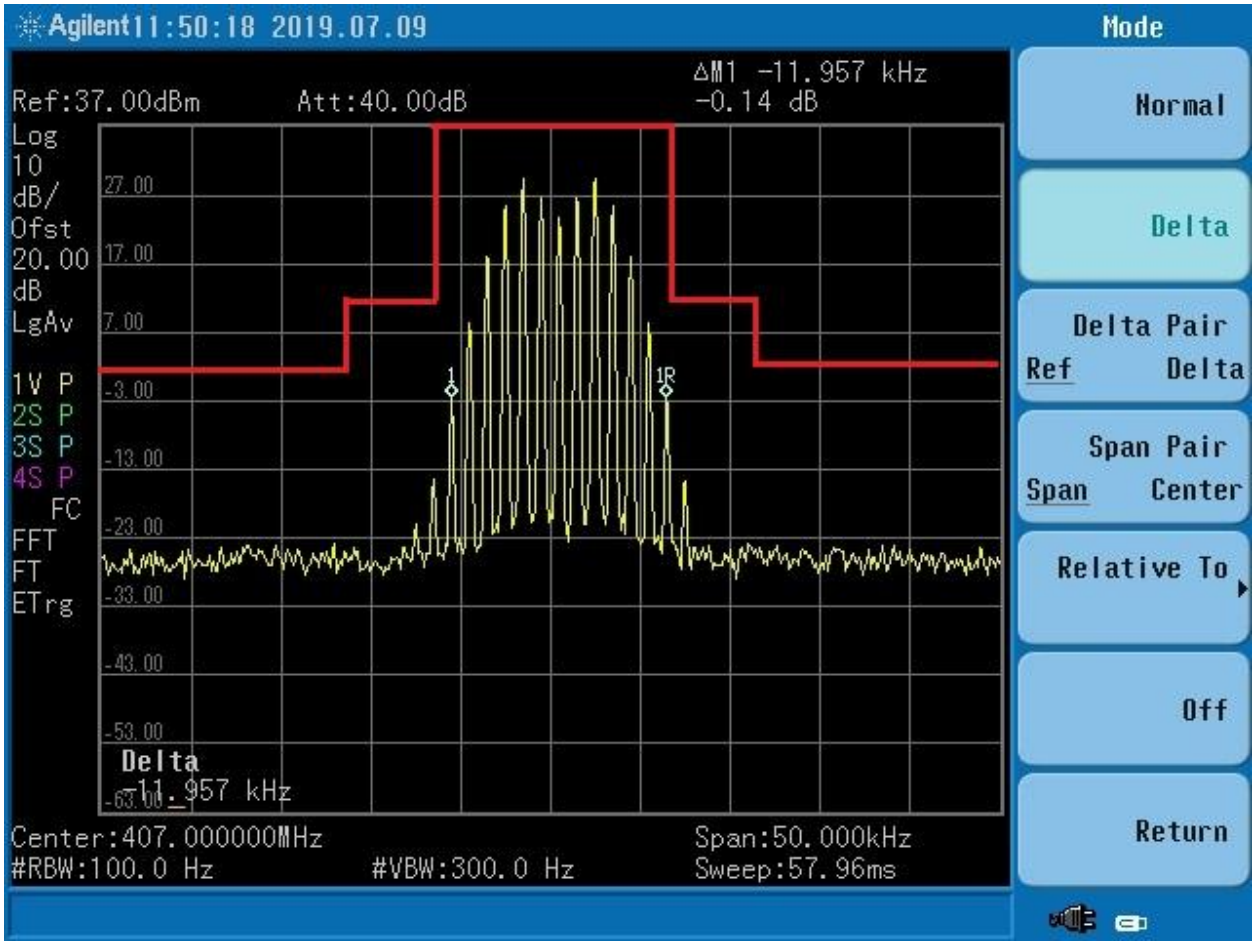

Figure 55. 407 MHz @ 12.5 kHz, Mask B

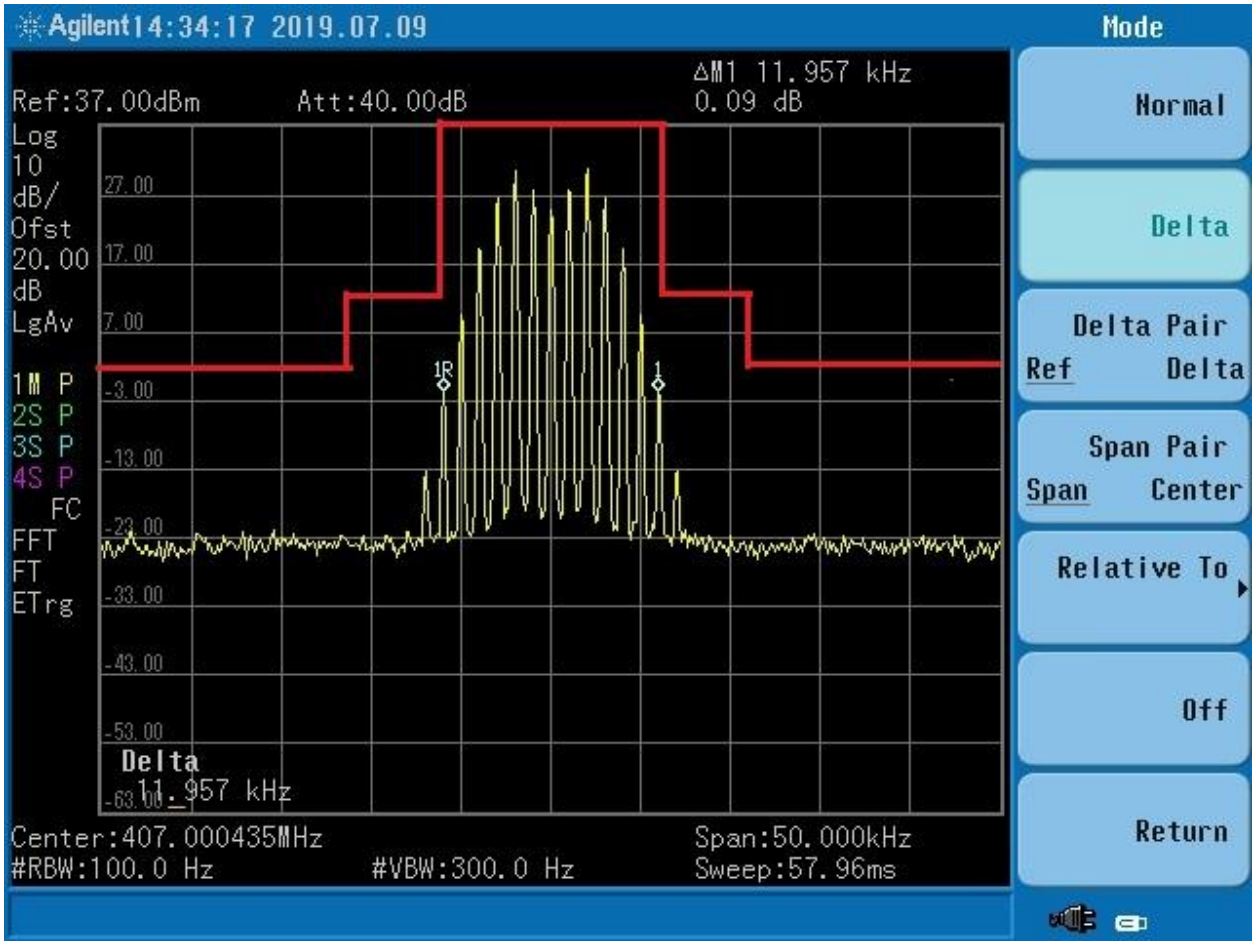

Figure 56. 407 MHz @ 12.5 kHz + 3.0 dB, Mask B

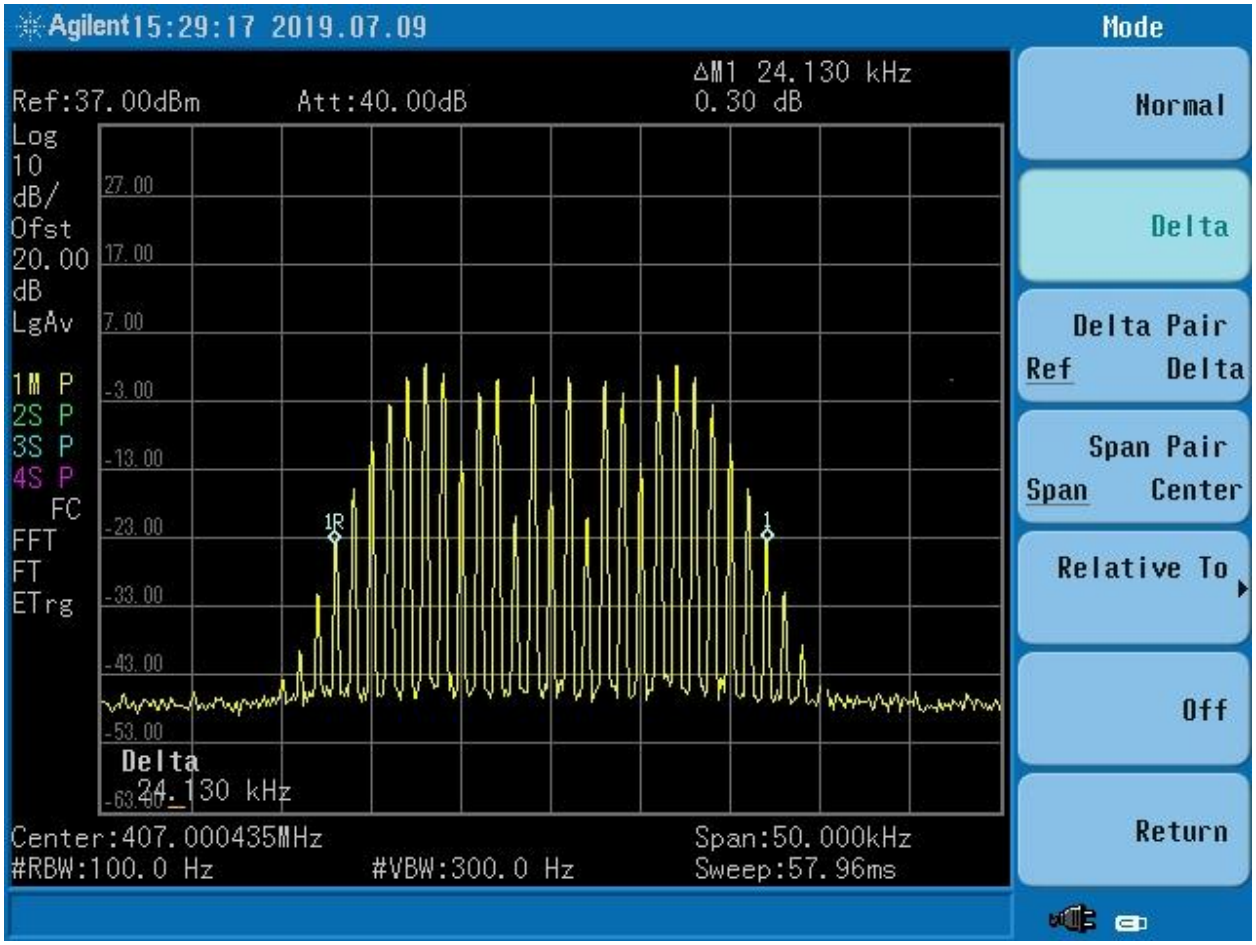

Figure 57. Input 407 MHz @ 25 kHz

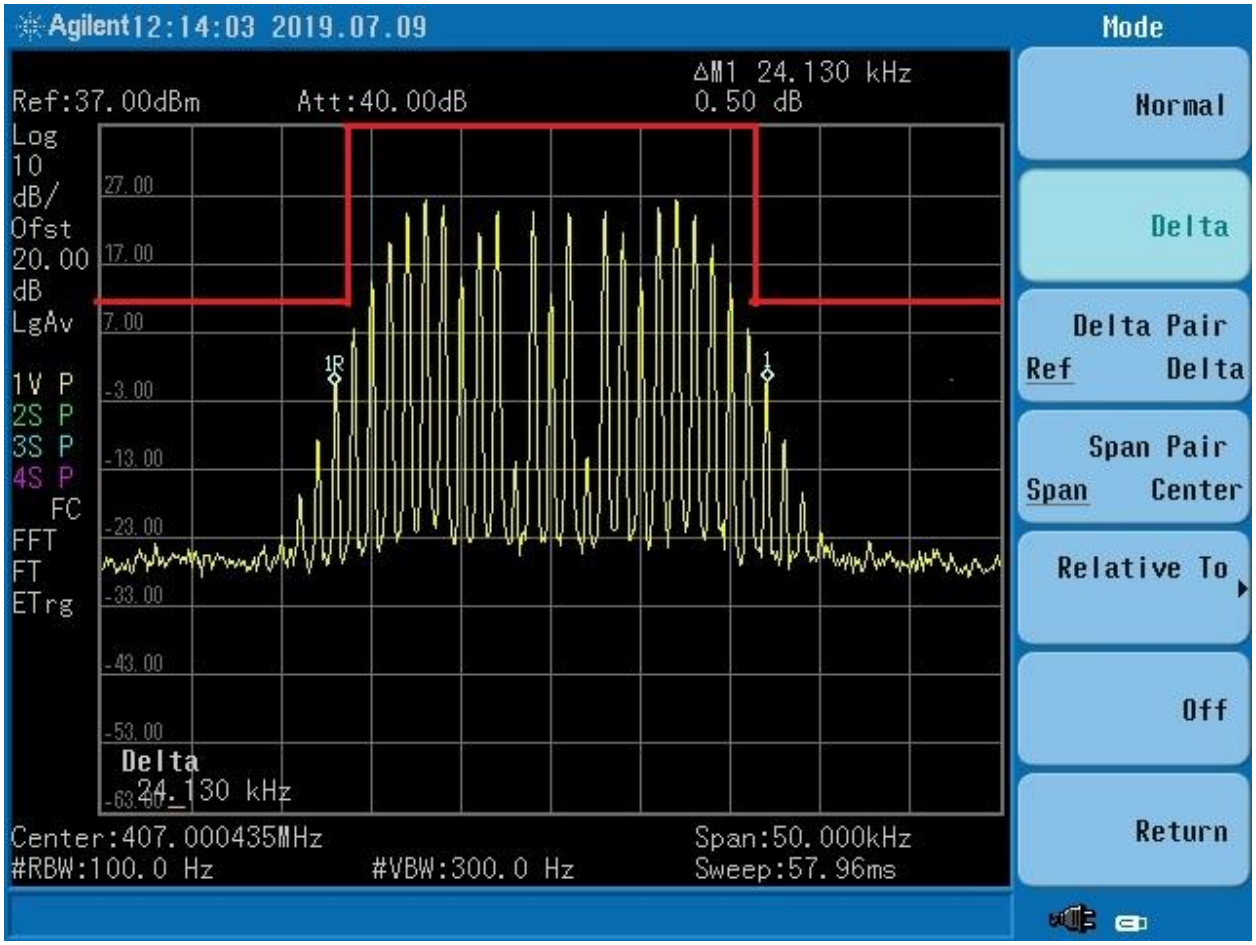

Figure 58. 407 MHz @ 25 kHz, Mask B

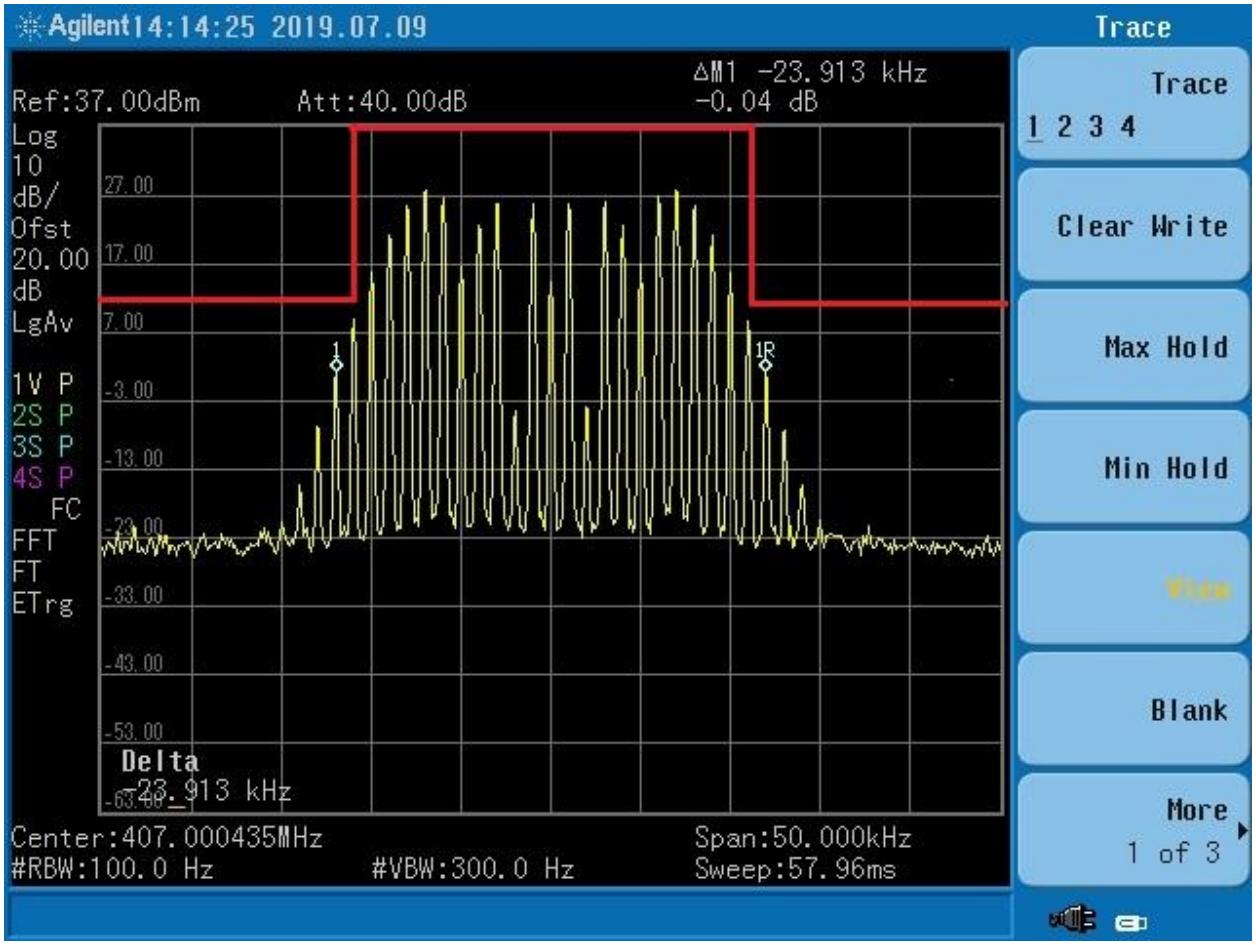

Figure 59. 407 MHz @ 25 kHz + 3.0 dB, Mask B

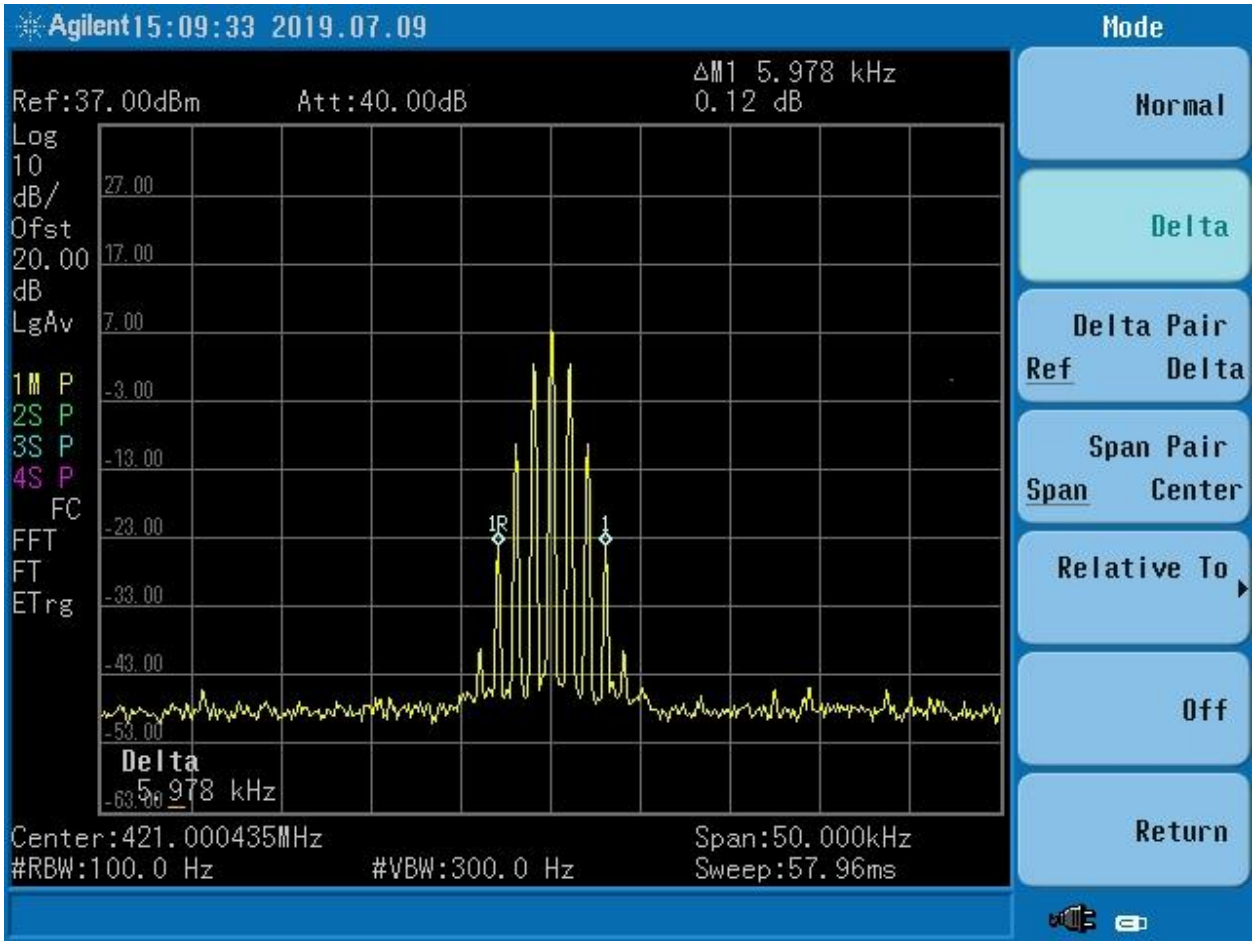

Figure 60. Input 421 MHz @ 6.25 kHz

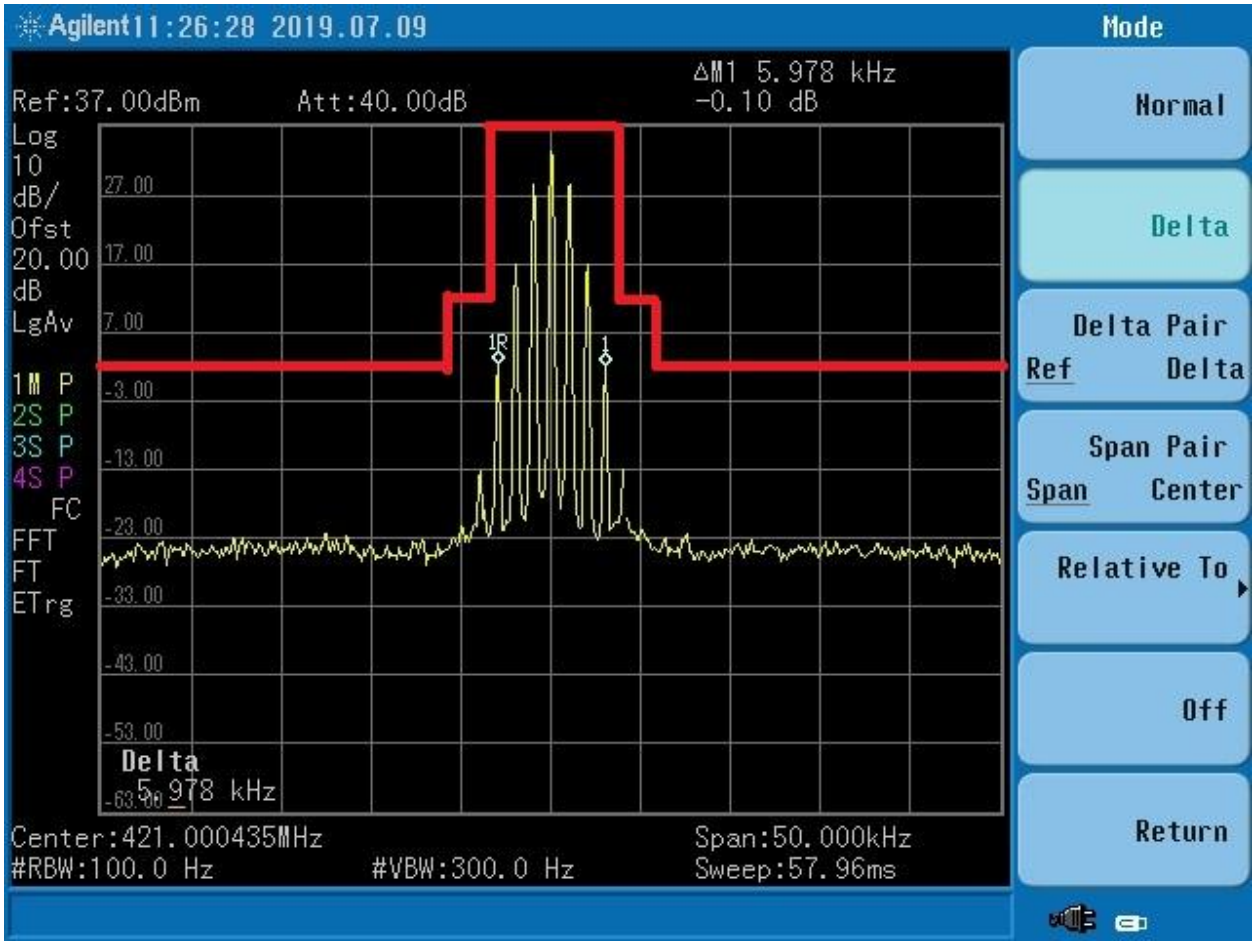

Figure 61. 421 MHz @ 6.25 kHz, Mask B

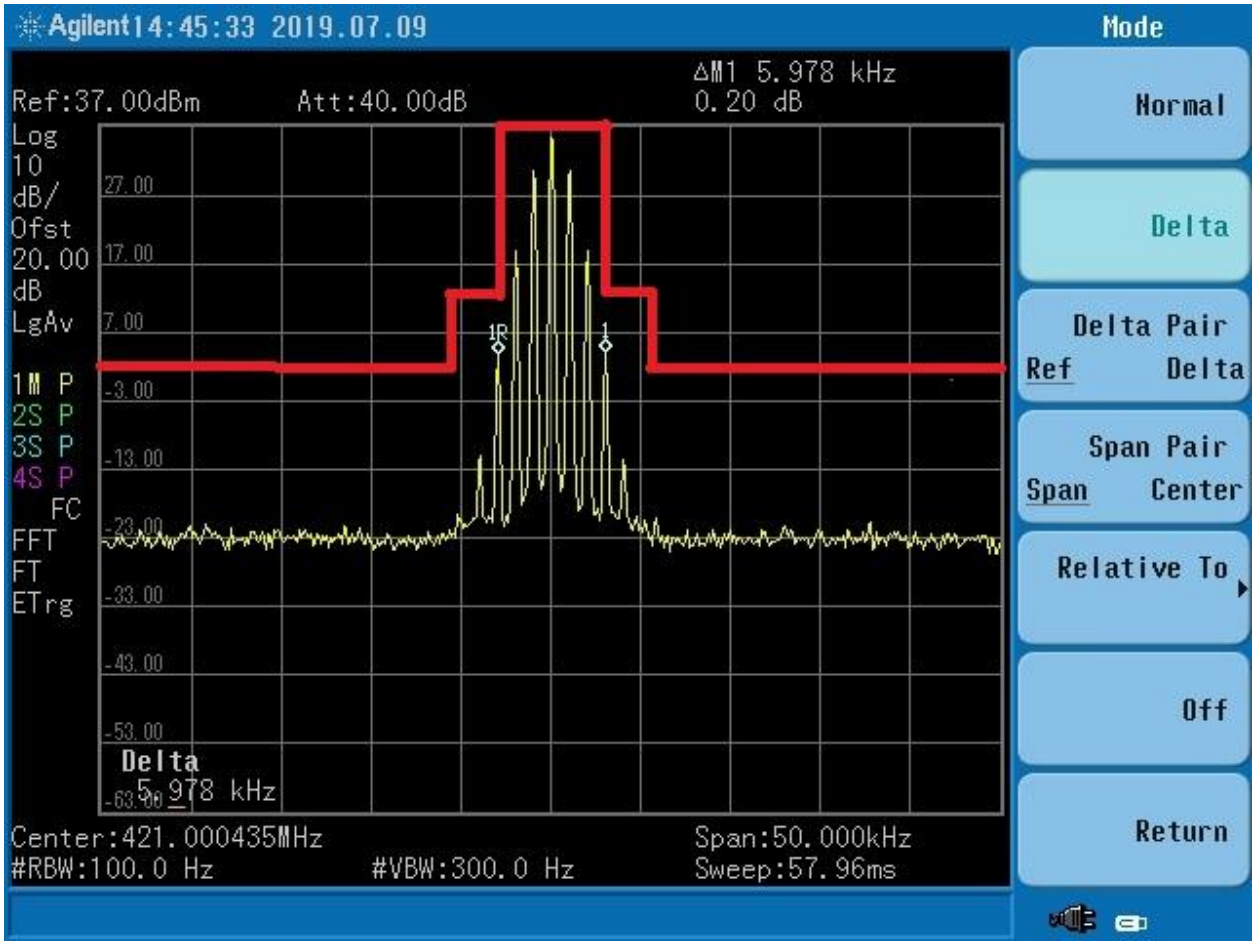

Figure 62. 421 MHz @ 6.25 kHz +3 dB, Mask B

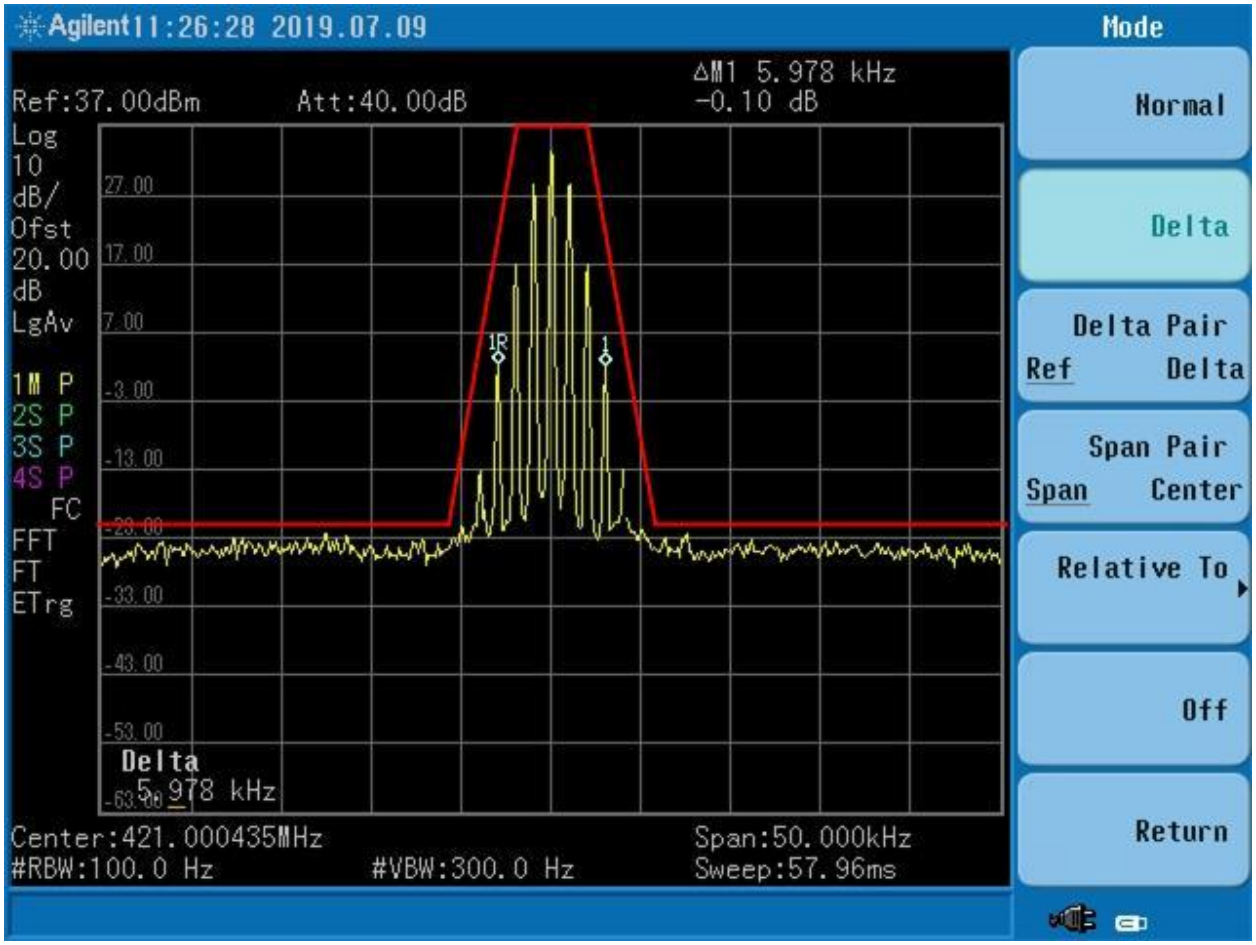

Figure 63. 421 MHz @ 6.25 kHz, Mask E

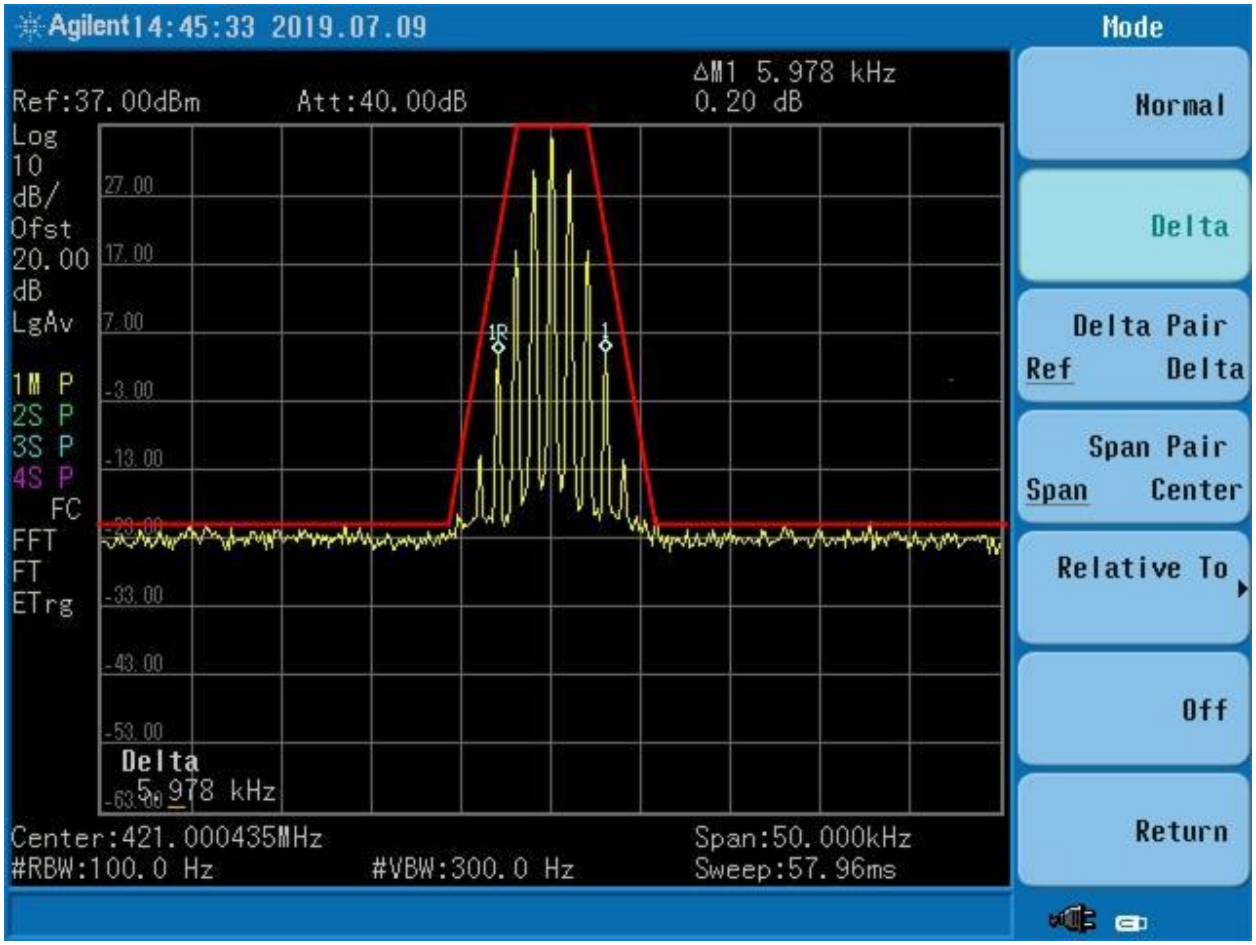

Figure 64. 421 MHz @ 6.25 kHz +3 dB, Mask E

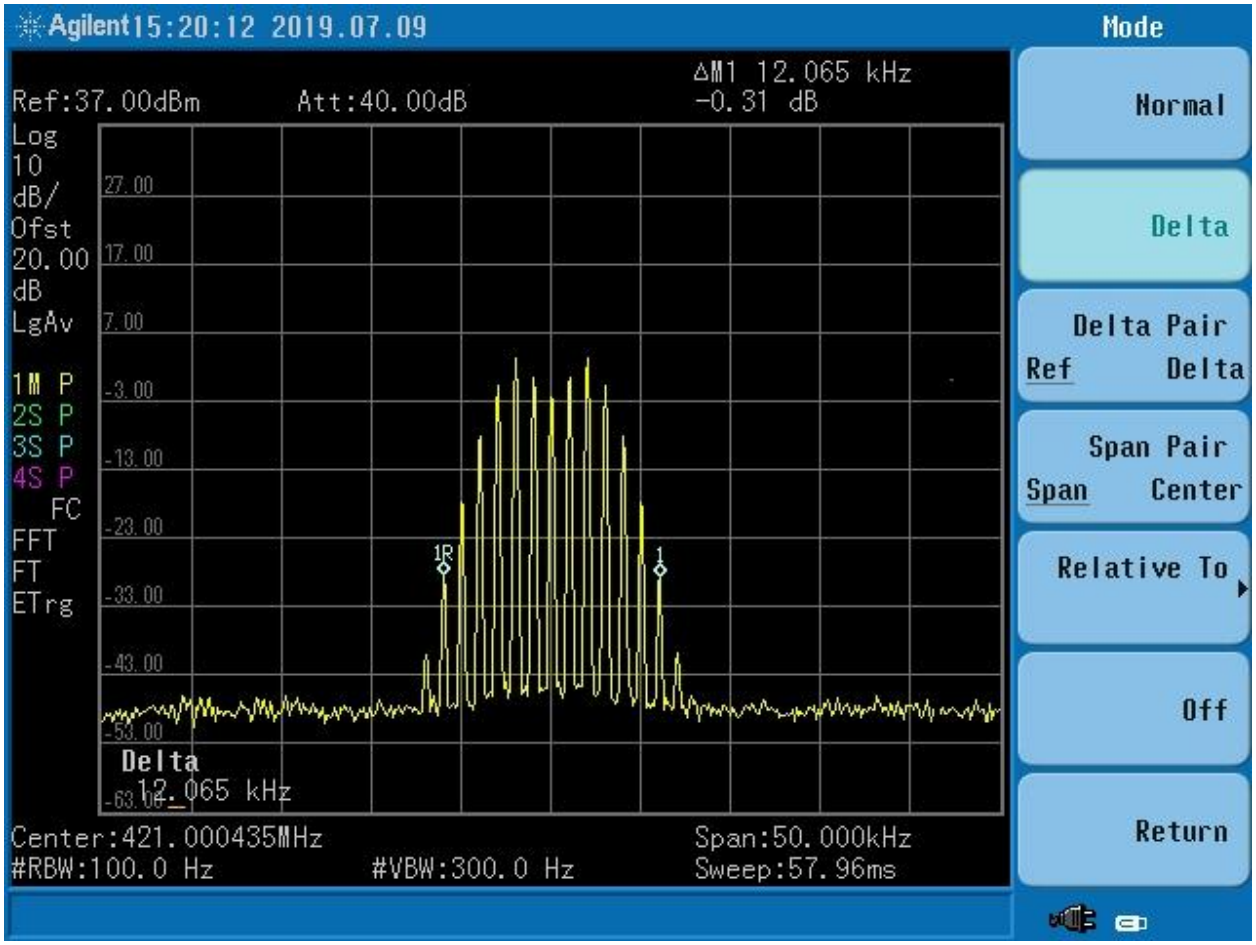

Figure 65. Input 421 MHz @ 12.5 kHz

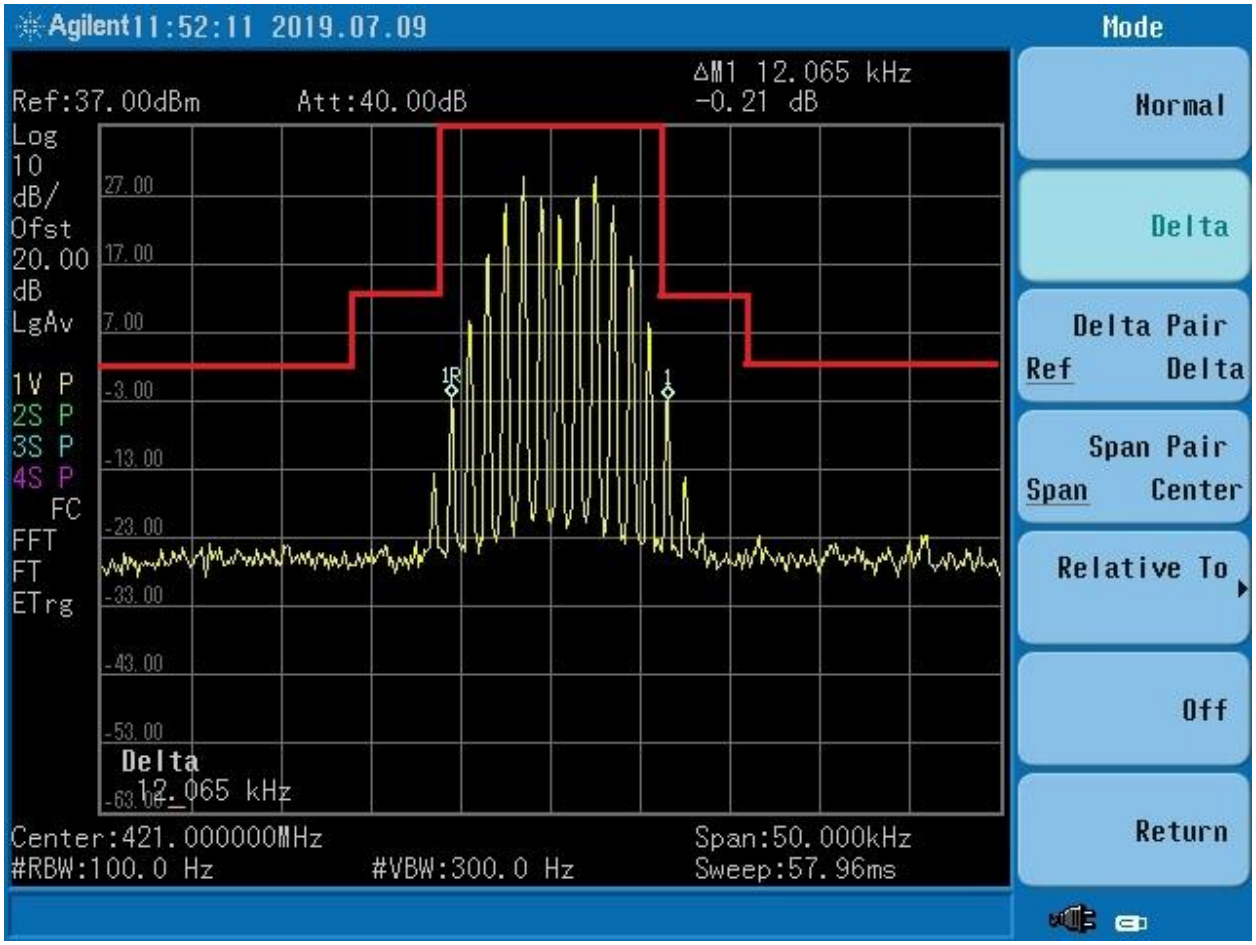

Figure 66. 421 MHz @ 12.5 kHz, Mask B

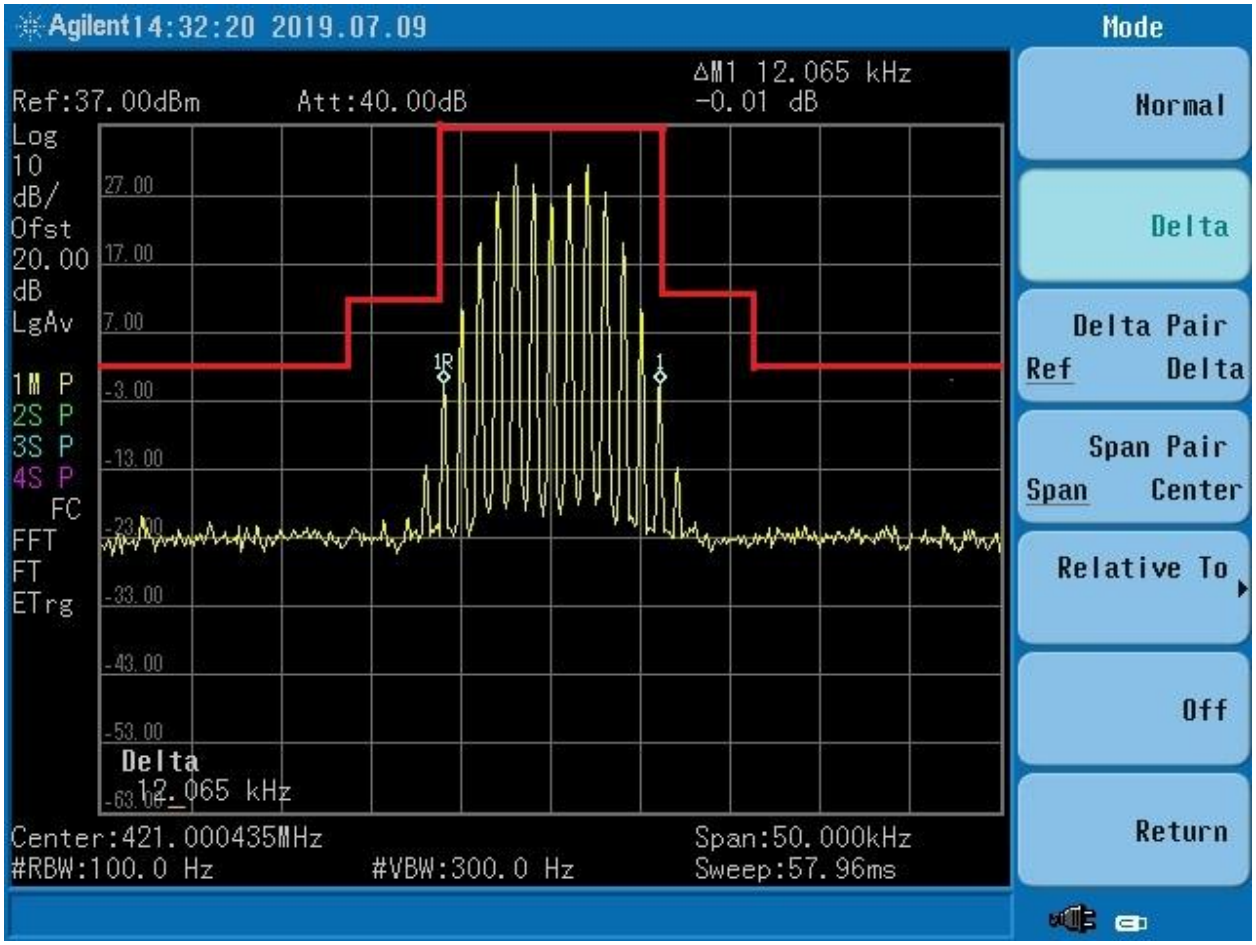

Figure 67. 421 MHz @ 12.5 kHz + 3.0 dB, Mask B

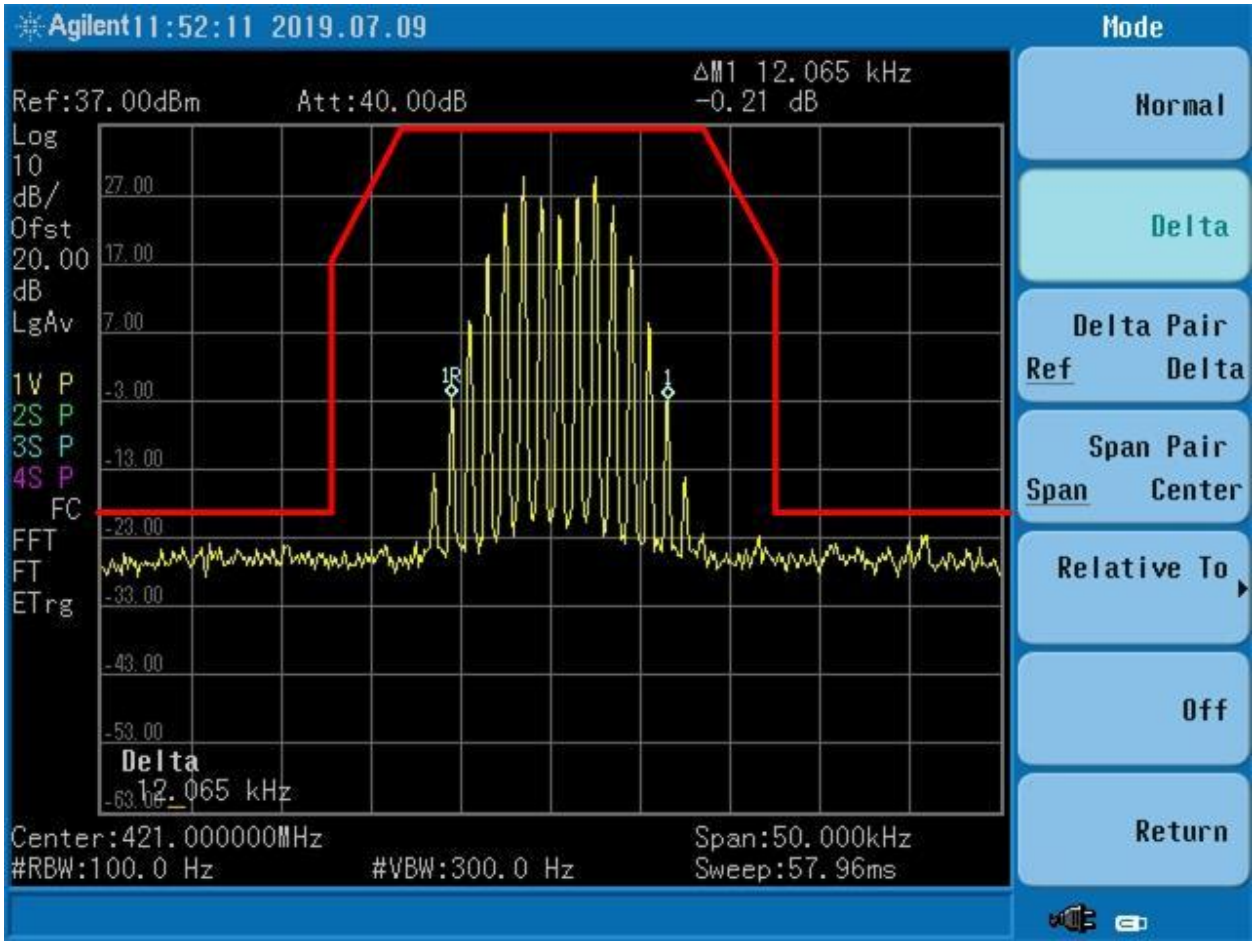

Figure 68. 421 MHz @ 12.5 kHz, Mask D

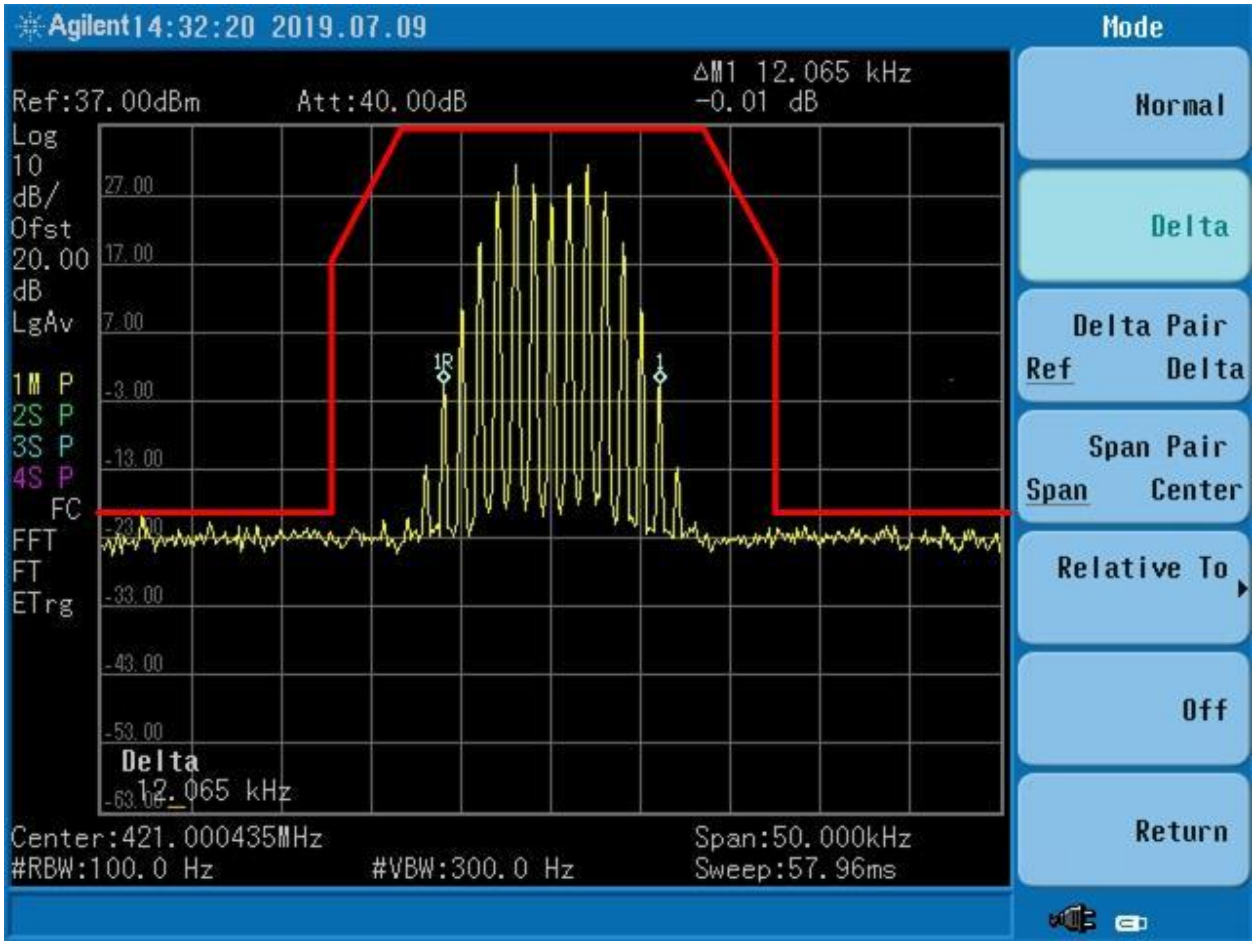

Figure 69. 421 MHz @ 12.5 kHz, +3 dB, Mask D

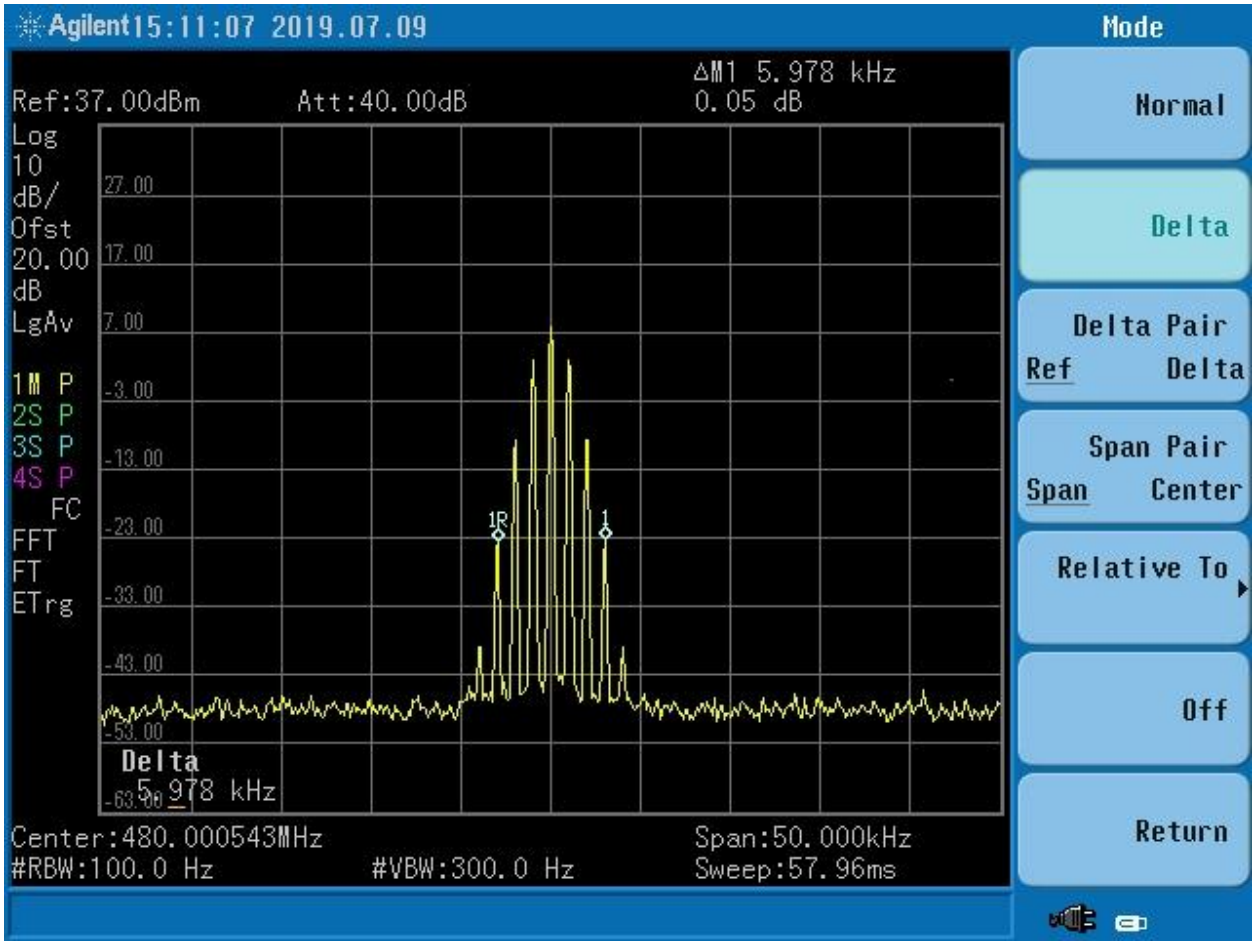

Figure 70. Input 480 MHz @ 6.25 kHz

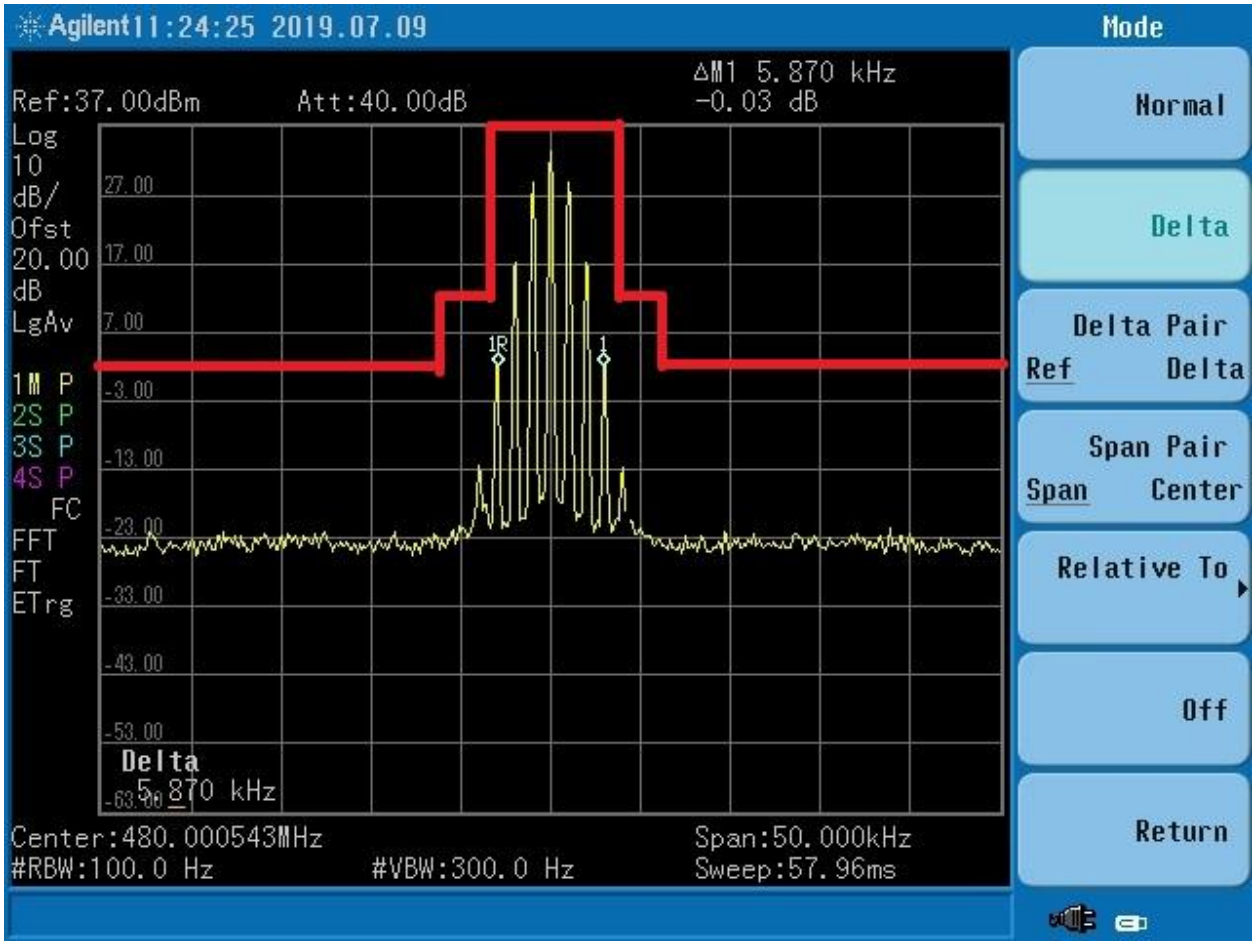

Figure 71. 480 MHz @ 6.25 kHz, Mask B

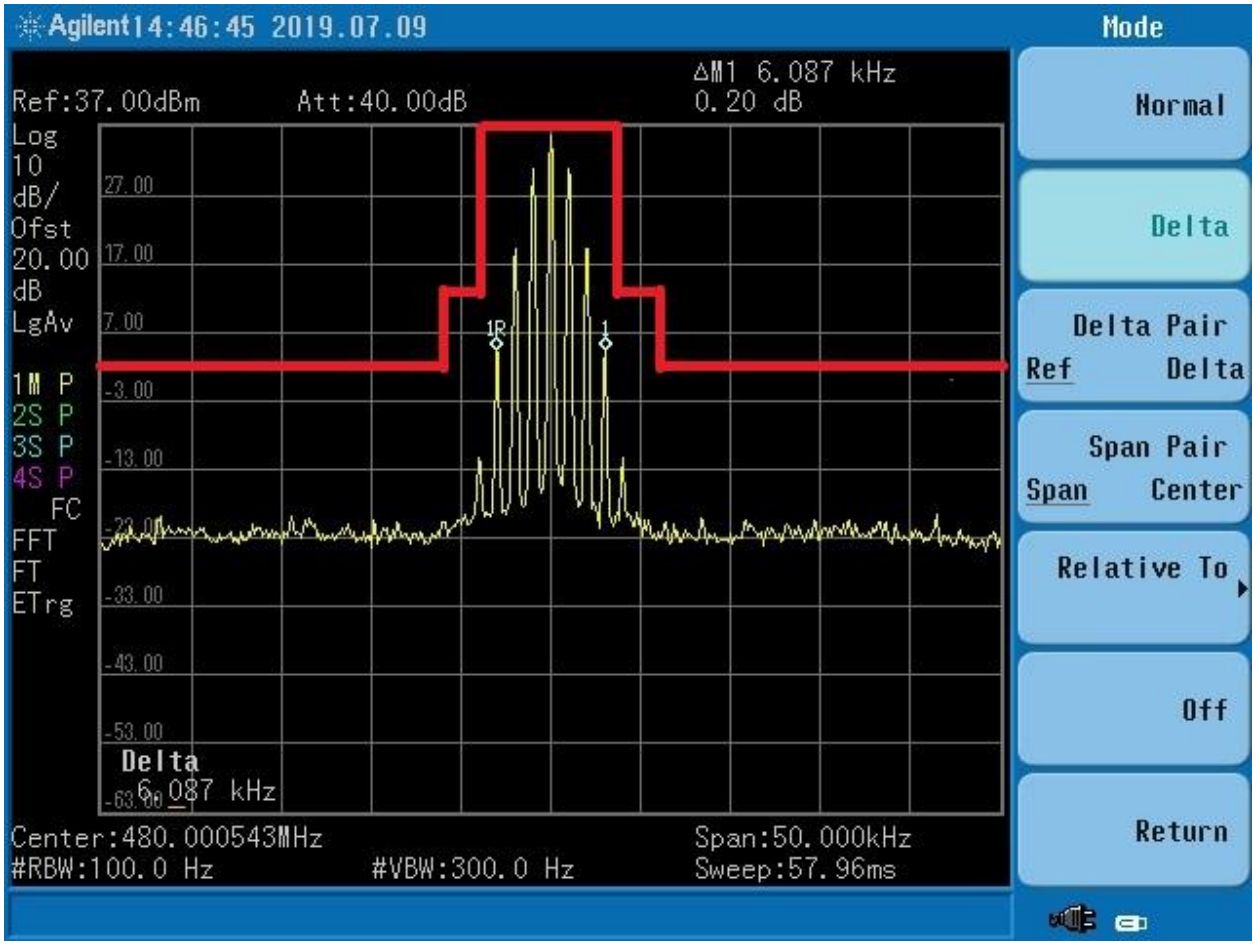

Figure 72. 480 MHz @ 6.25 kHz +3 dB, Mask B

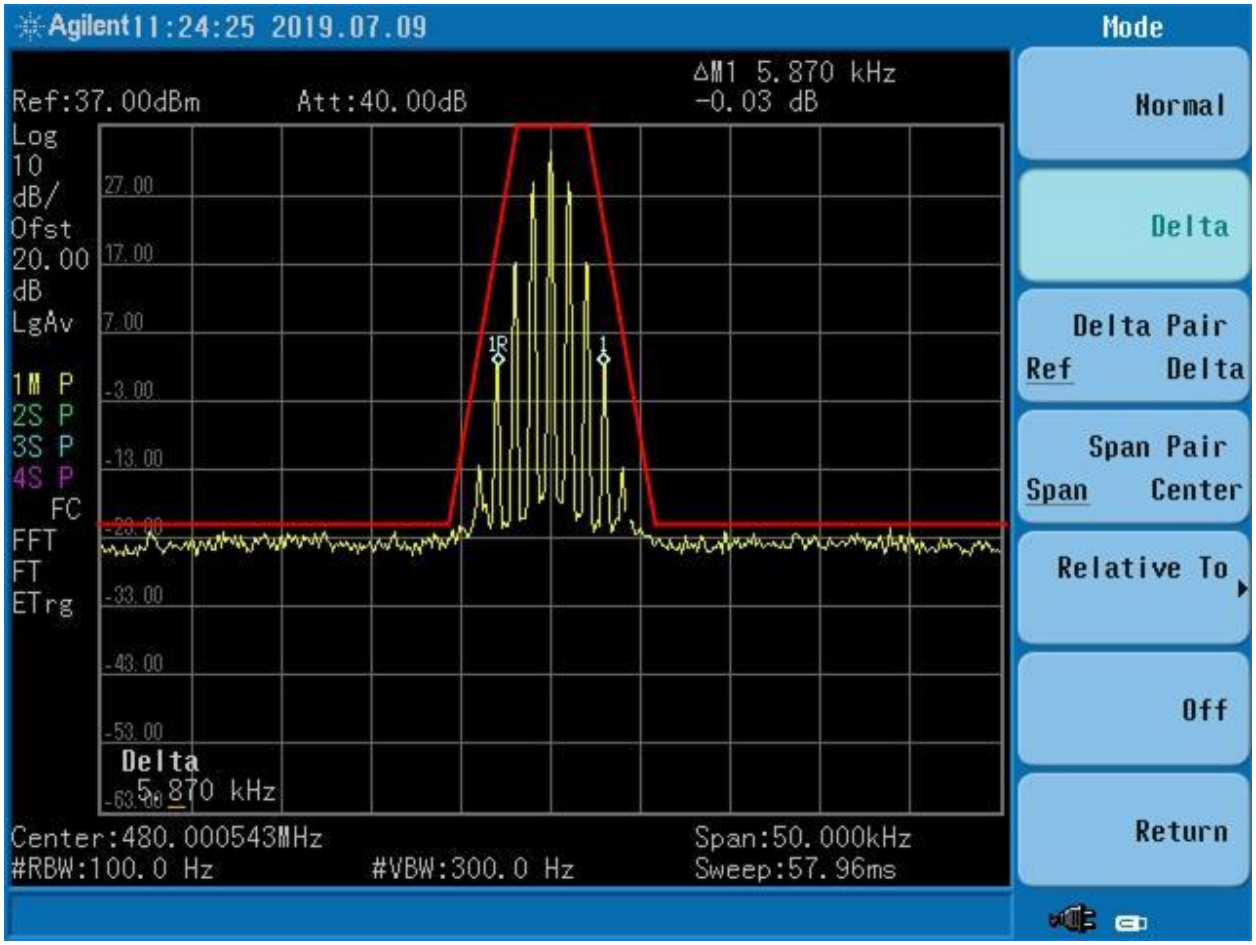

Figure 73. 480 MHz @ 6.25 kHz, Mask E

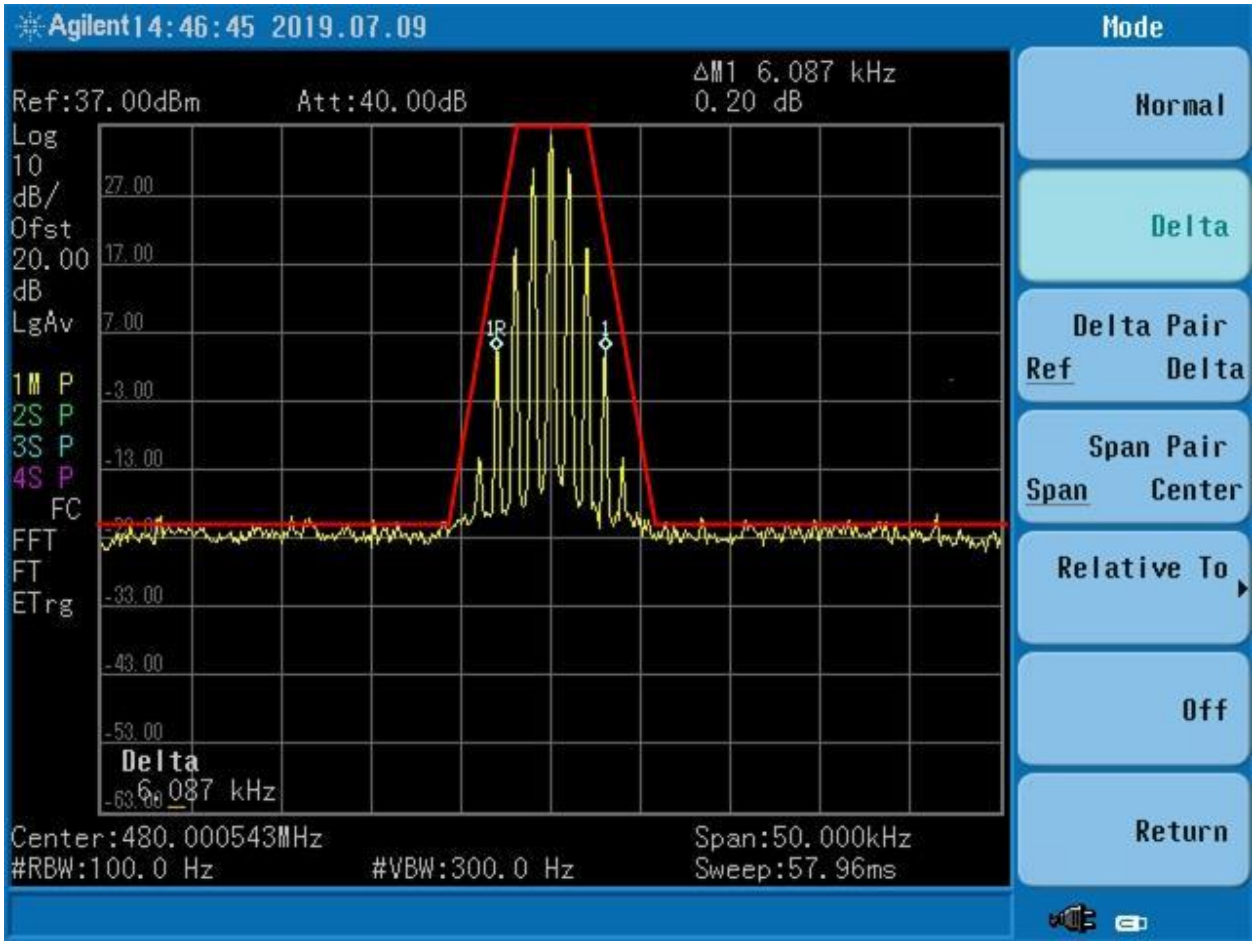

Figure 74. 480 MHz @ 6.25 kHz +3 dB, Mask E

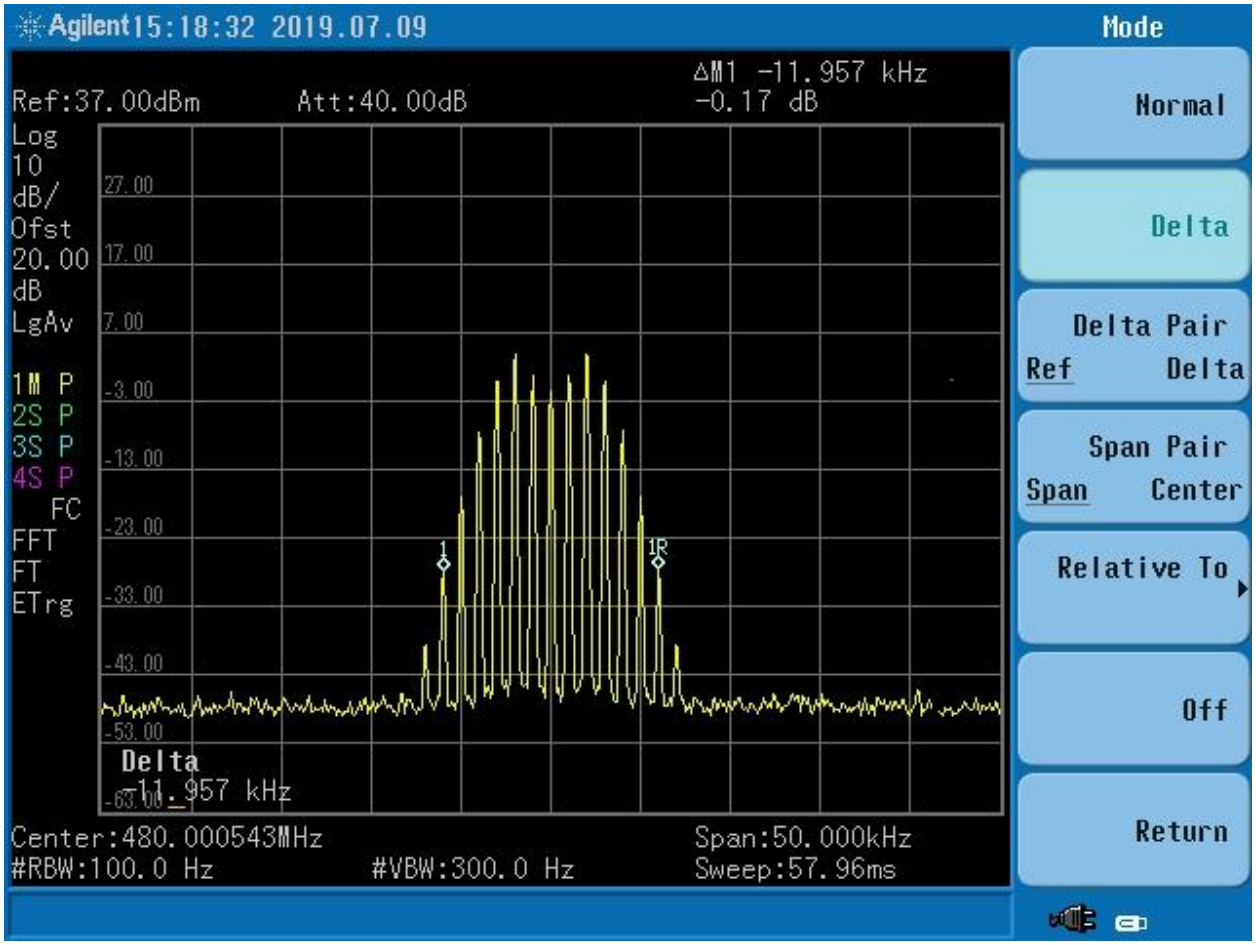

Figure 75. Input 480 MHz @ 12.5 kHz

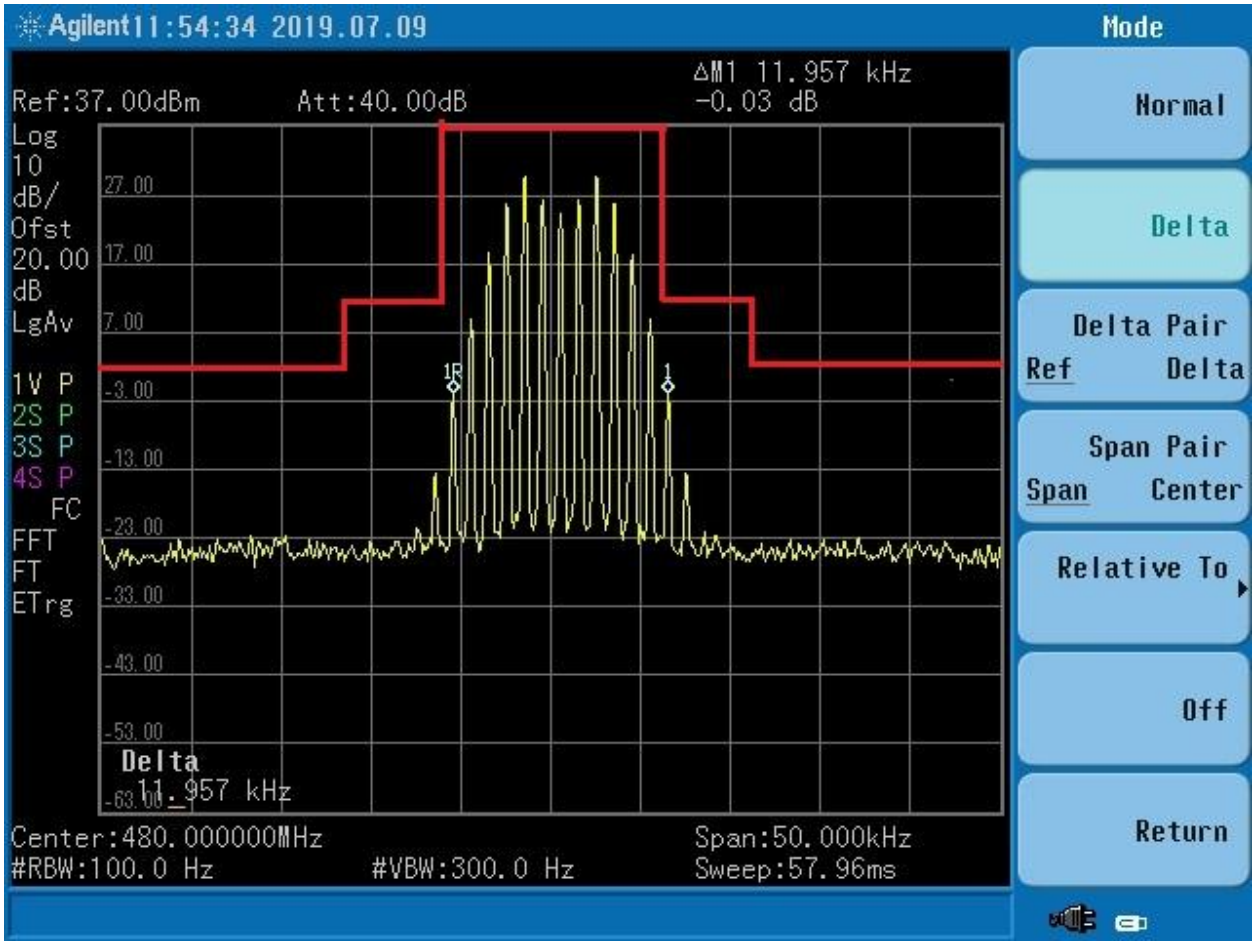

Figure 76. 480 MHz @ 12.5 kHz, Mask B

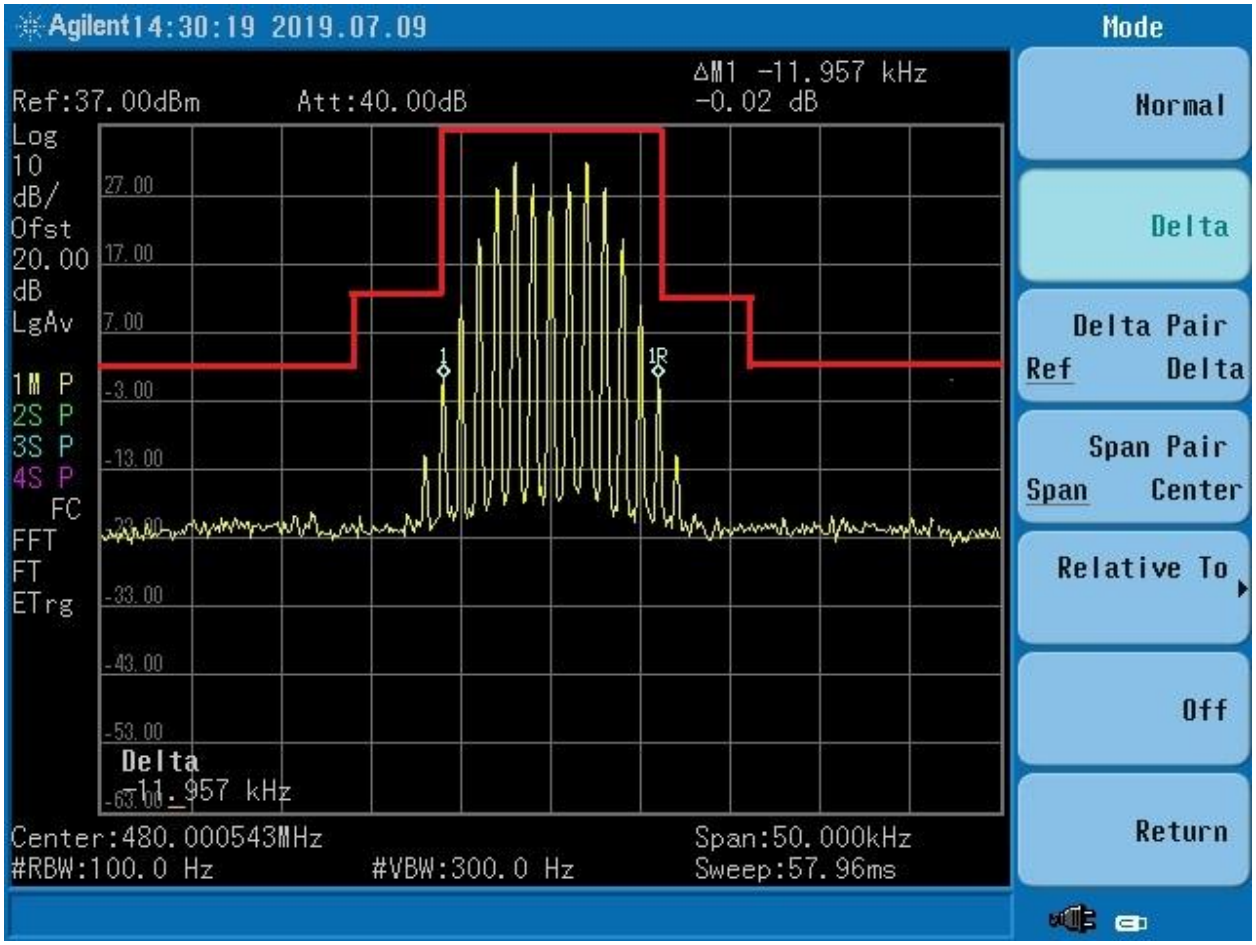

Figure 77. 480 MHz @ 12.5 kHz + 3.0 dB, Mask B

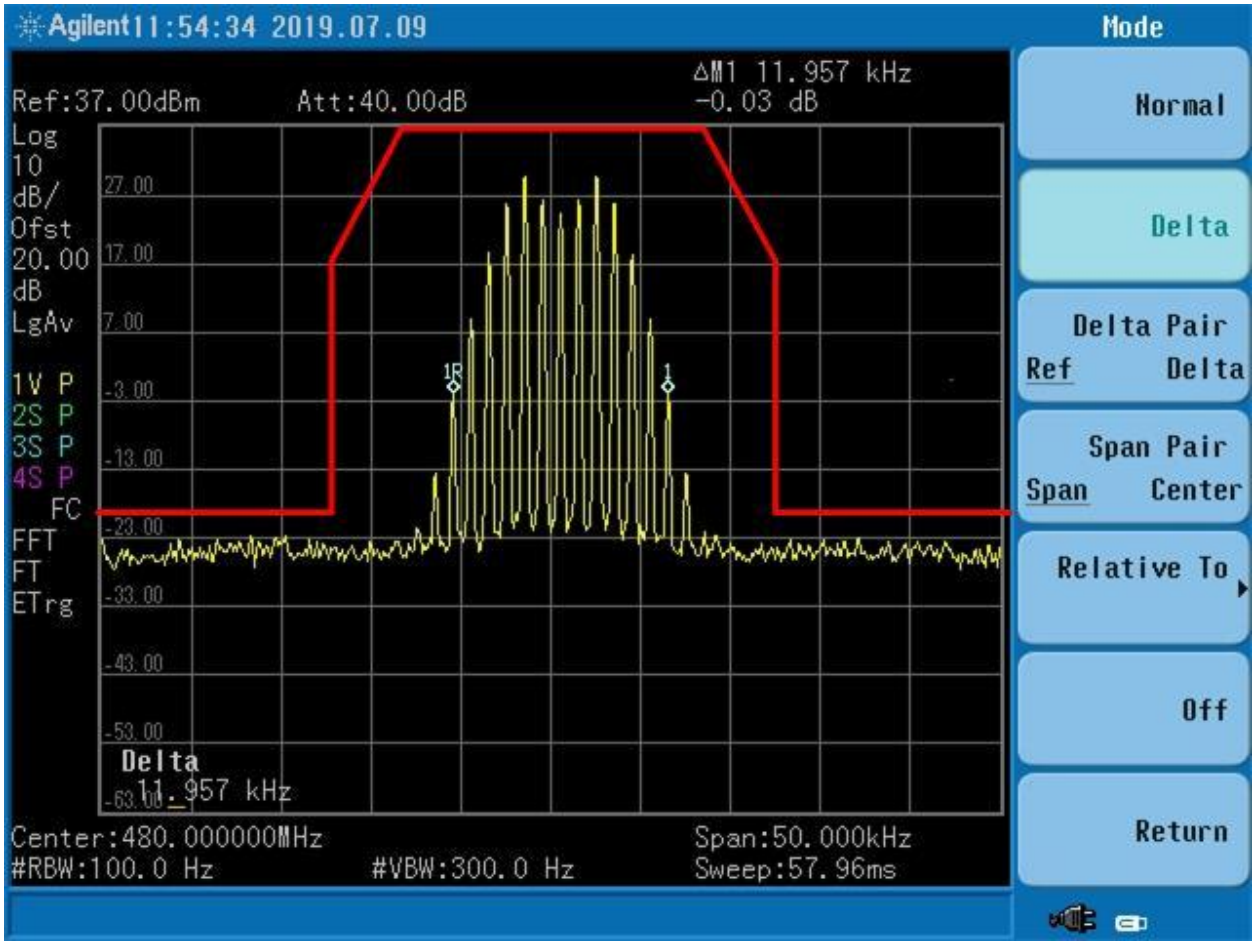

Figure 78. 480 MHz @ 12.5 kHz, Mask D

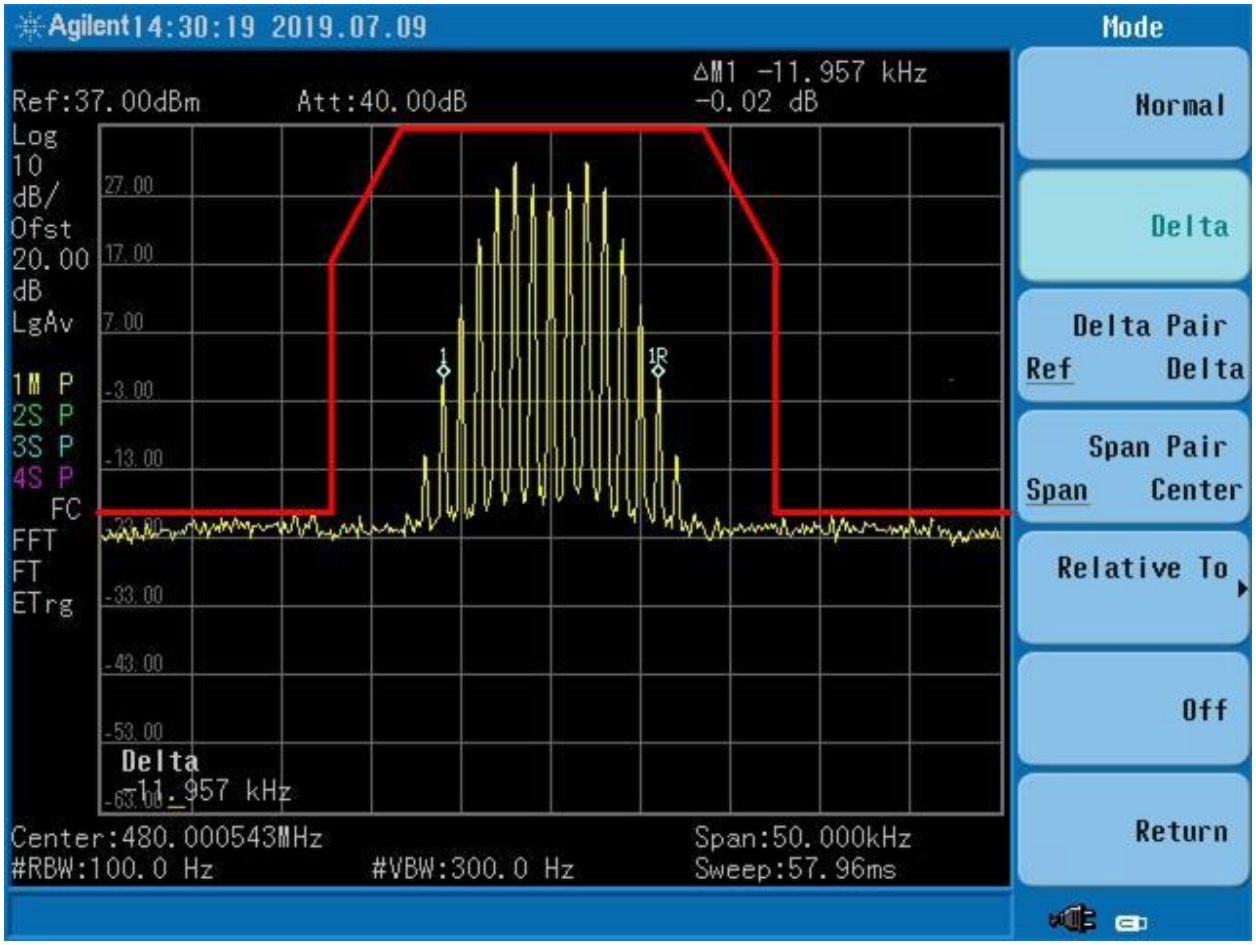

Figure 79. 480 MHz @ 12.5 kHz +3 dB, Mask D

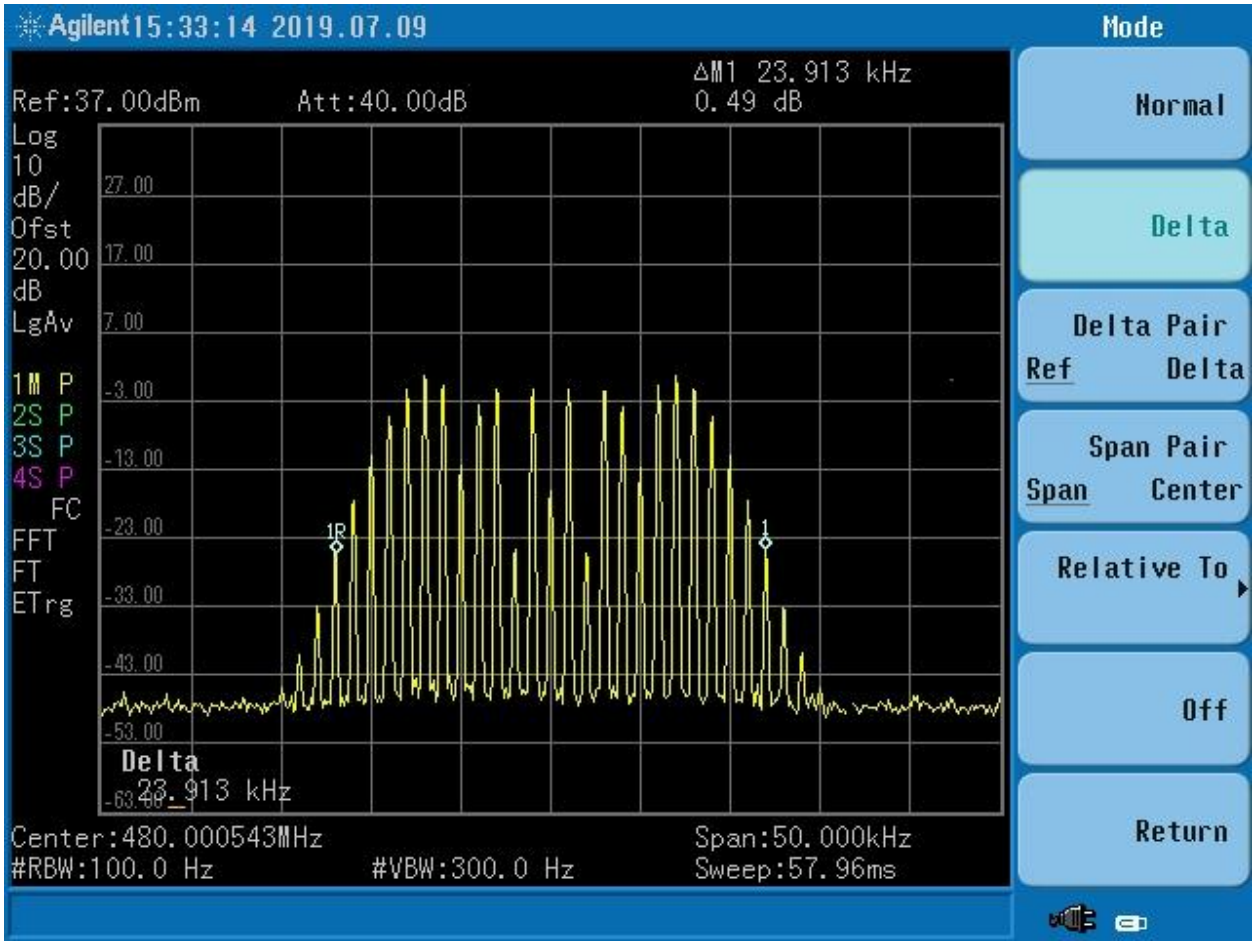

Figure 80. Input 480 MHz @ 25 kHz

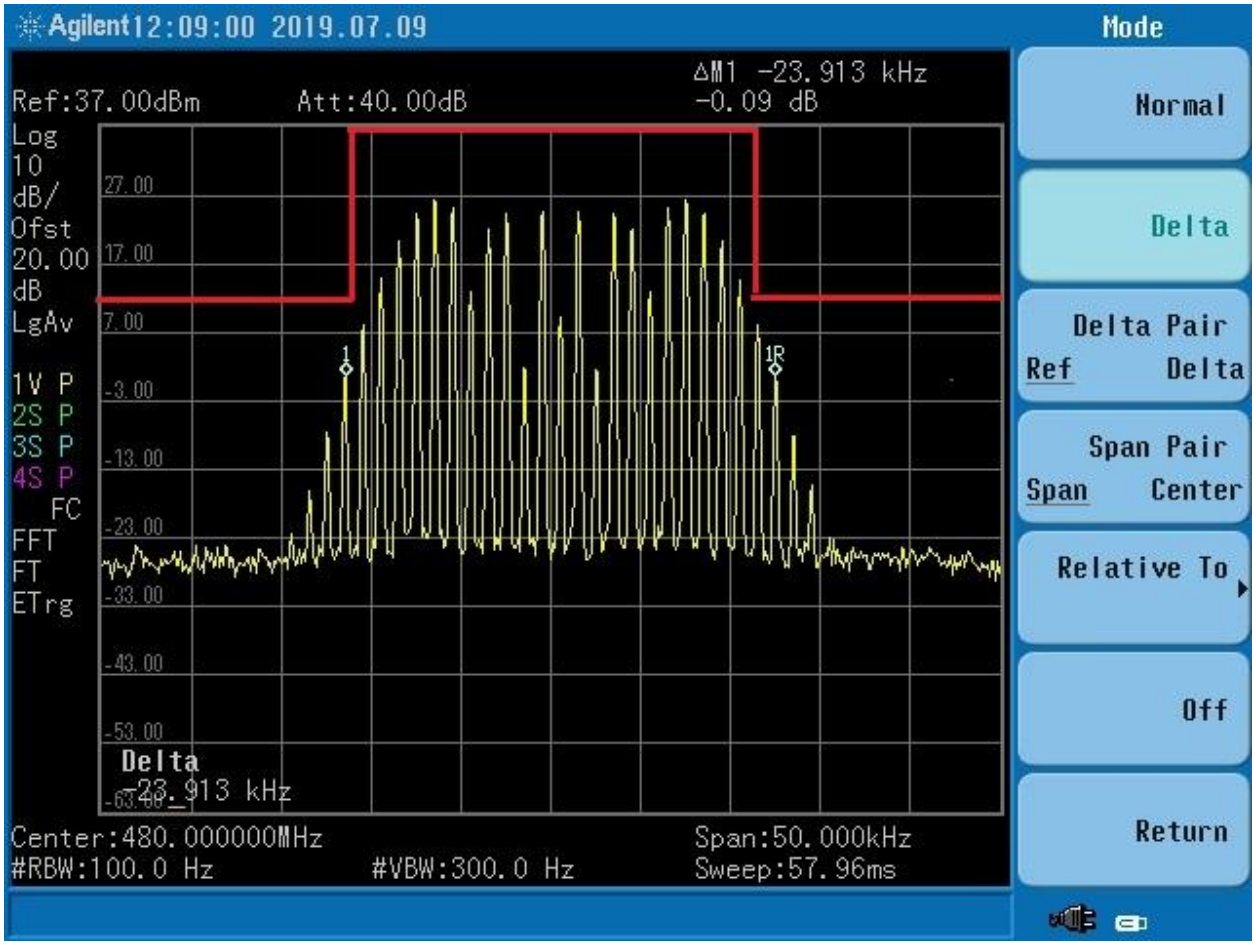

Figure 81. 480 MHz @ 25 kHz, Mask B

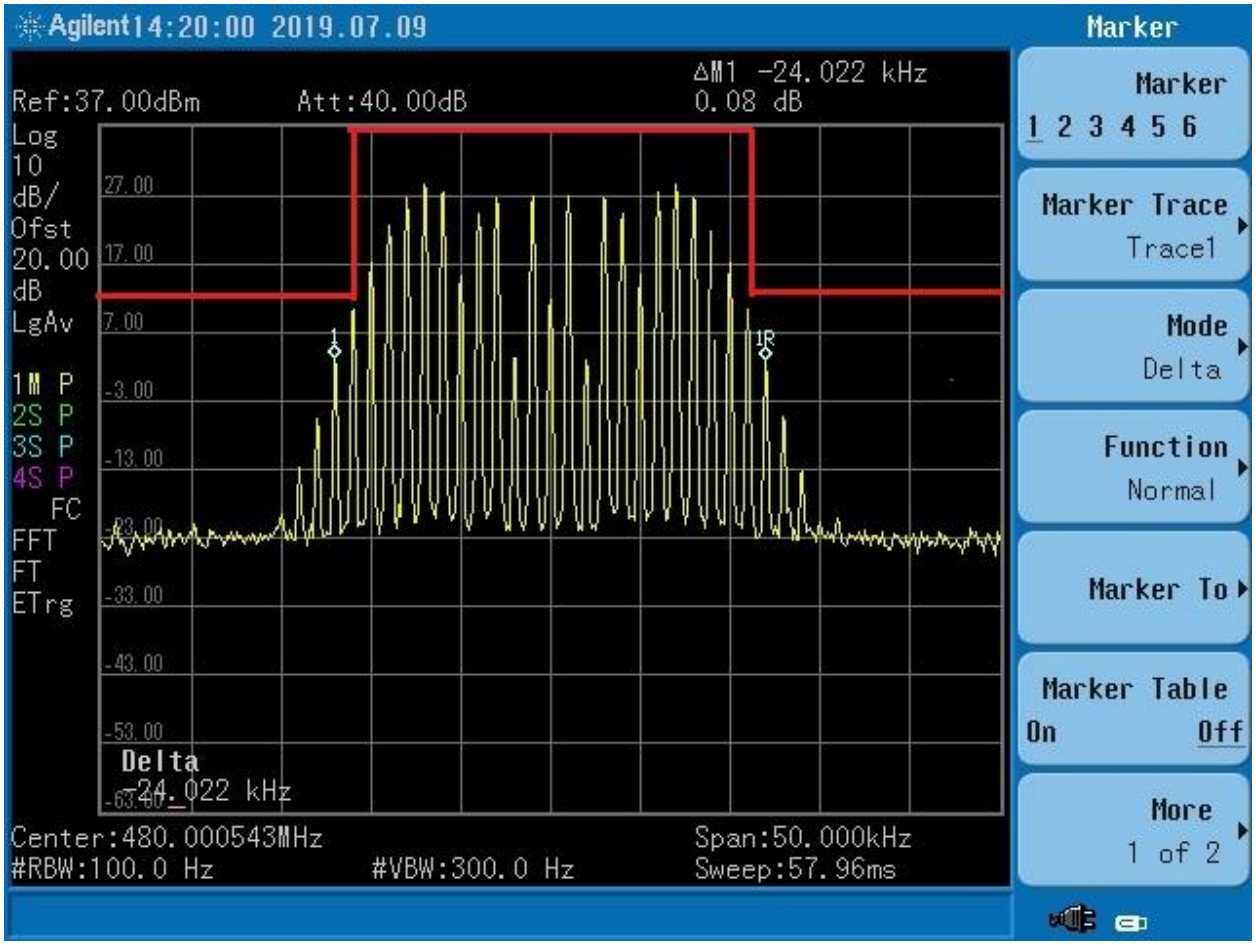

Figure 82. 480 MHz @ 25 kHz + 3.0 dB, Mask B

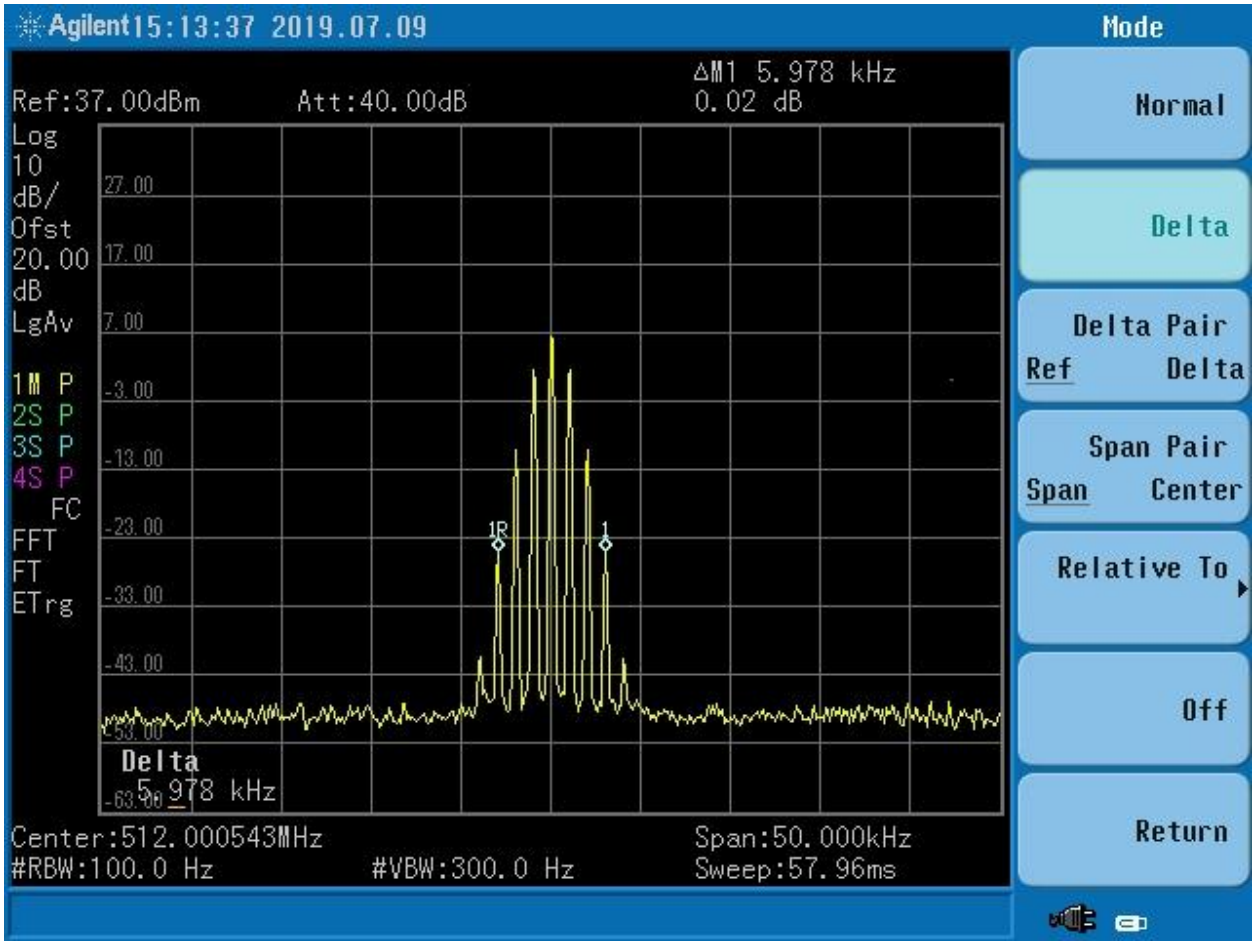

Figure 83. Input 512 MHz @ 6.25 kHz

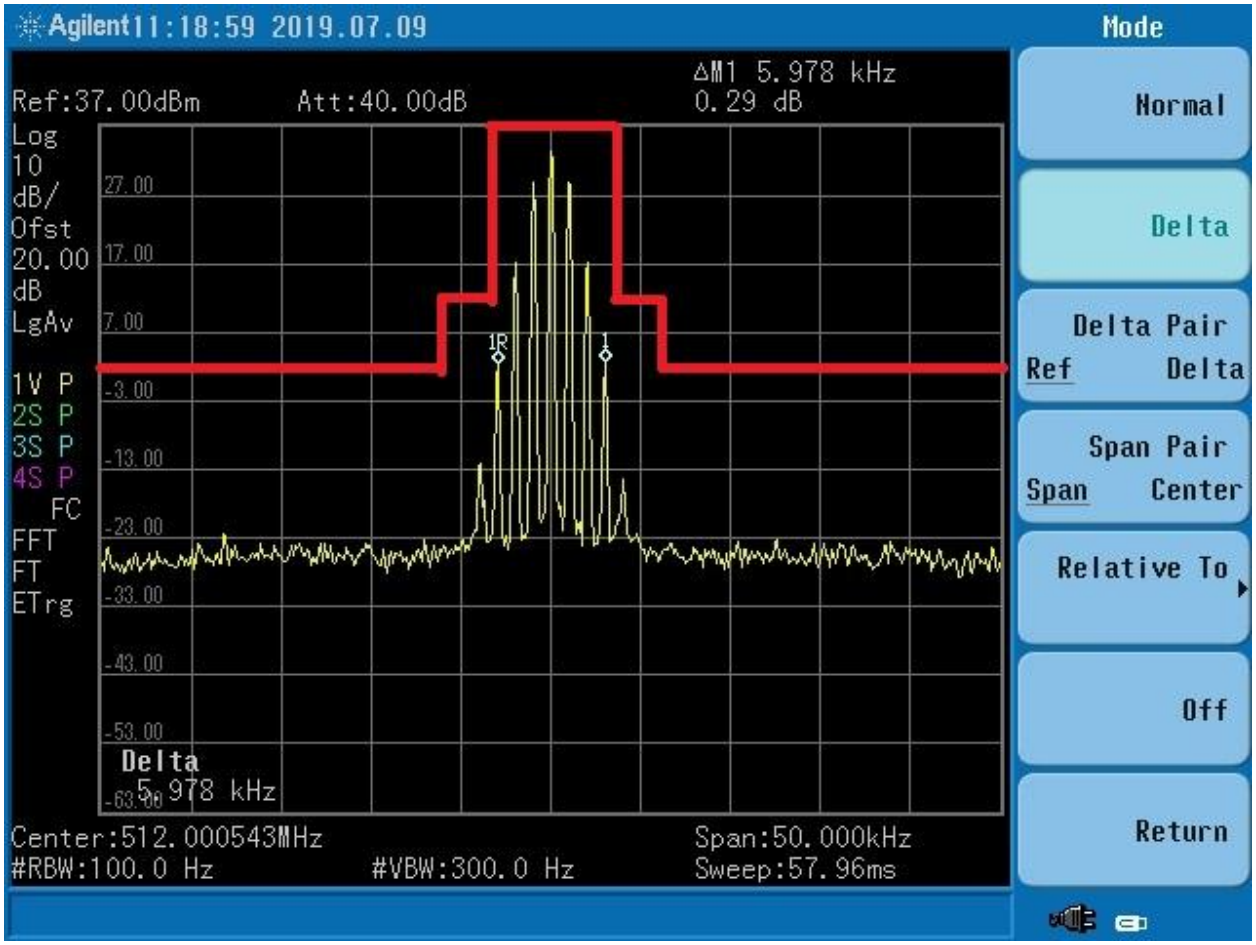

Figure 84. 512 MHz @ 6.25 kHz, Mask B

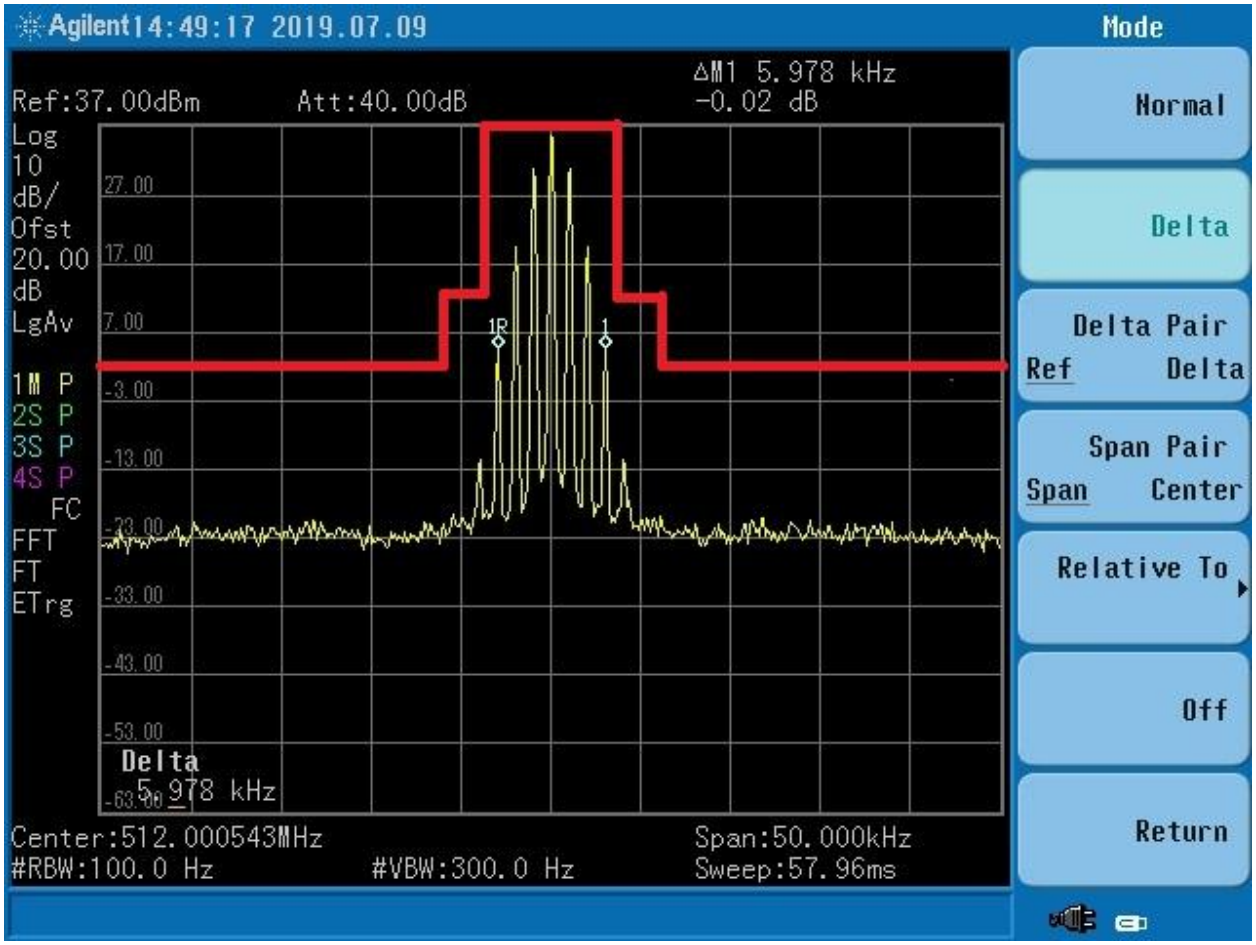

Figure 85. 512 MHz @ 6.25 kHz, +3 dB, Mask B

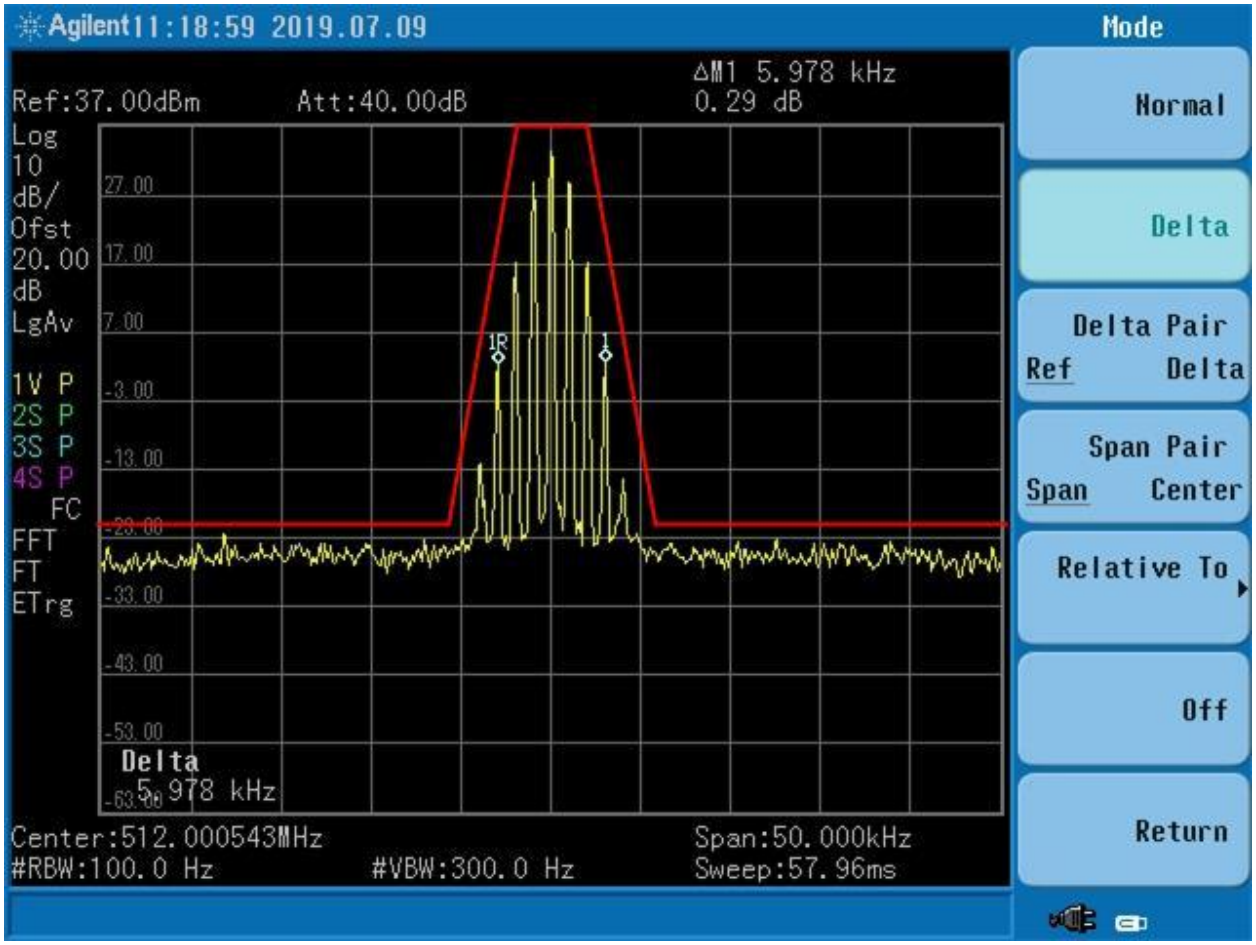

Figure 86. 512 MHz @ 6.25 kHz, Mask E