Testing Tomorrow's Technology

CFR 47 FCC Part 2, Subpart J, and FCC Part 90, Subpart I Certification for Private Land Mobile Radio Services
and
ANSI/TIA-603-D (2010), Equipment Measurement and Performance Standards
And
Innovation, Science and Economic Development Canada, RSS-131, Spectrum Management and Telecommunications Radio Standards Specification, Zone Enhancers

For the

Safe-Com Wireless
Model: SAFE-1000

FCC ID: 2AKSM-SAFE1
IC: 22303-SAFE1

UST Project No: 17-0001
March 14, 2017

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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: March 14, 2017

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MEASUREMENT/TECHNICAL REPORT

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

Reevaluation _____

Equipment type: **Part 90 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
Alpharetta, GA 30004

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1 General Information

1.1 Product Description

The Equipment Under Test (EUT) is the Safe-Com Safe-1000 which part of a fiber Distributed Antenna System. The EUT accepts multiple modulated RF signals from a radio base station to a head-end unit which then transmits that information over fiber optic lines to the Remote Unit (EUT). 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 downlink bands:

150-174MHz VHF band
450-512MHz UHF band
763-775MHz
851-869MHz
929-941MHz

The EUT does not transmit uplink signals wirelessly. The uplink communication is via fiber connection.

The EUT is considered a Class B (non-SMR) Zone Enhancer.

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

A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious emissions measurements are shown in Figure 2. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off 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 February 2, 2017 in good condition.

2.3 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. Conducted and digital device testing was performed at US Tech's 3 meter EMC chamber measurement facility. This site has been fully described and registered by the FCC under Registration Number 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

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.

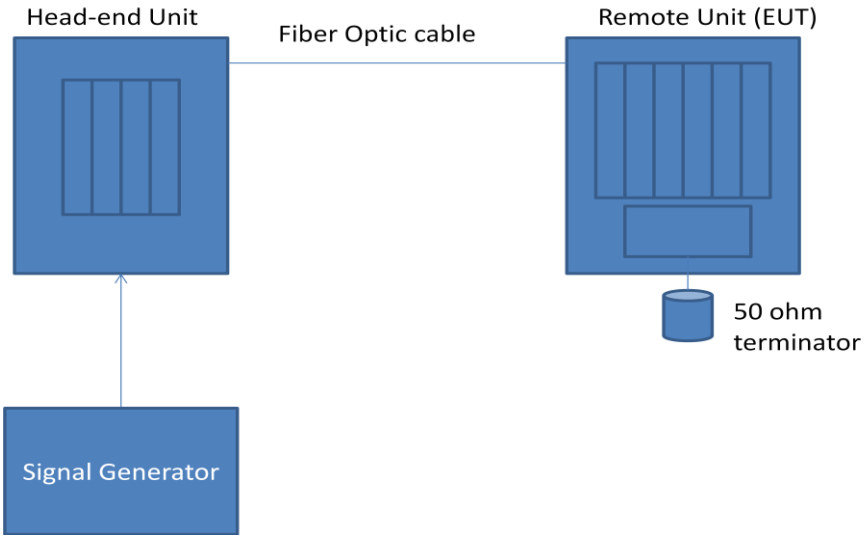

Figure 1. Block Diagram of Test Configuration

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID/ IC ID	CABLES P/D
Remote Unit with RF cards Safe-Com	SAFE-1000	Engineering Sample	FCC ID: 2AKSM-SAFE1 IC: 22303-SAFE1	3m U D 1m U P
700 Mhz Safe-Com	SAFE-1000	Engineering Sample	--	--
800 Mhz Safe-Com	SAFE-1000	Engineering Sample	--	--
900 MHz Safe-Com	SAFE-1000	Engineering Sample	--	--
UHF Safe-Com	SAFE-1000	Engineering Sample	--	--
VHF Safe-Com	SAFE-1000	Engineering Sample	--	--
Head End Unit	SAFE-1010	Engineering Sample	None	3m U D 1.5m 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	DSA815	RIGOL	DSA8A18030 0138	6/30/2017
SPECTRUM ANALYZER	E4407B	Agilent	US41442935	5/11/2017
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	8/23/2017
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	4/02/2017
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	2434A02157	9/26/2017
RF PREAMP > 1 GHz	8449B	HEWLETT PACKARD	3008A00480	4/01/2017
LOG PERIODIC	3146	EMCO	9305-3600	9/21/2018 2 YR
BICONNICAL	3110B	EMCO	9307-1431	8/25/2017 2 YR
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 YR
SIGNAL GENERATOR	MG3671B	Anritsu	M52073/ M53573/ M17473	Verified with Agilent E4407B analyzer
SIGNAL GENERATOR	HP8648B	HEWLETT-PACKARD	3642U01679	Verified with Agilent E4407B analyzer

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

2.6 RF Power Output (FCC Section 2.1051, 90.219(e)(1))

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)	Manufacturer rated max Output Power limit (< 5 Watt)	Margin (dB) From the rated output
VHF	150.00 MHz	27.66	30 dBm	2.34
	162.00 MHz	25.90	30 dBm	4.10
	174.00 MHz	24.15	30 dBm	5.85
UHF	450.00 MHz	30.90	33 dBm	2.10
	459.00 MHz	30.73	33 dBm	2.27
	490.00 MHz	29.80	33 dBm	3.20
	512.00 MHz	28.70	33 dBm	4.30
700	763.00 MHz	31.16	33 dBm	1.84
	768.50 MHz	31.45	33 dBm	1.55
	775.00 MHz	31.69	33 dBm	1.31
800	851.00 MHz	32.33	33 dBm	0.67
	860.00 MHz	32.31	33 dBm	0.69
	869.00 MHz	32.26	33 dBm	0.74
900	929.50 MHz	32.20	33 dBm	0.80
	937.00 MHz	31.80	33 dBm	1.20

2.7 Output Power Plots

Following are the Output Power Plots.

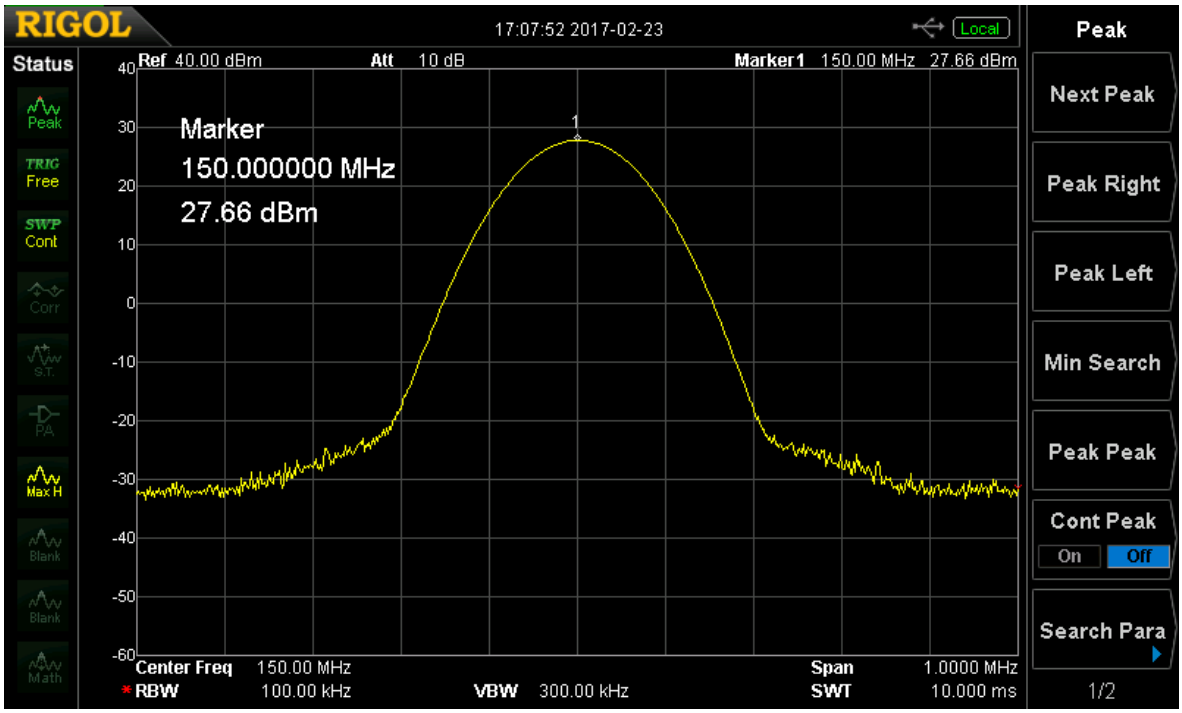

Figure 2. 150 MHz Output Power Plot

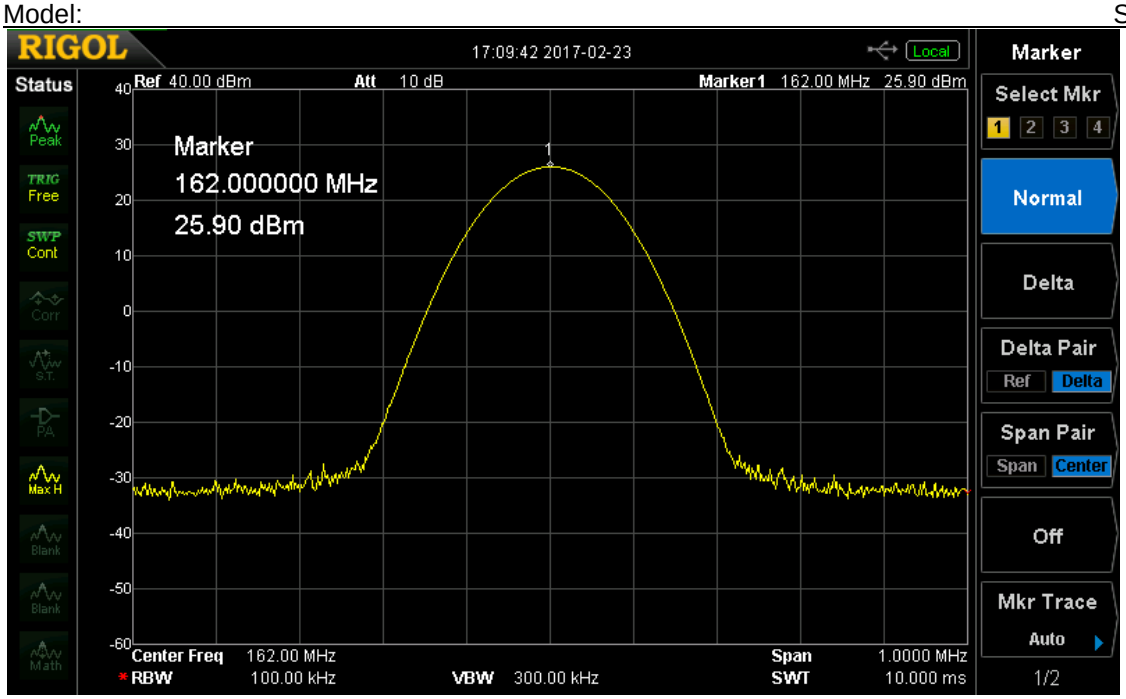

Figure 3. 162 MHz Output Power Plot

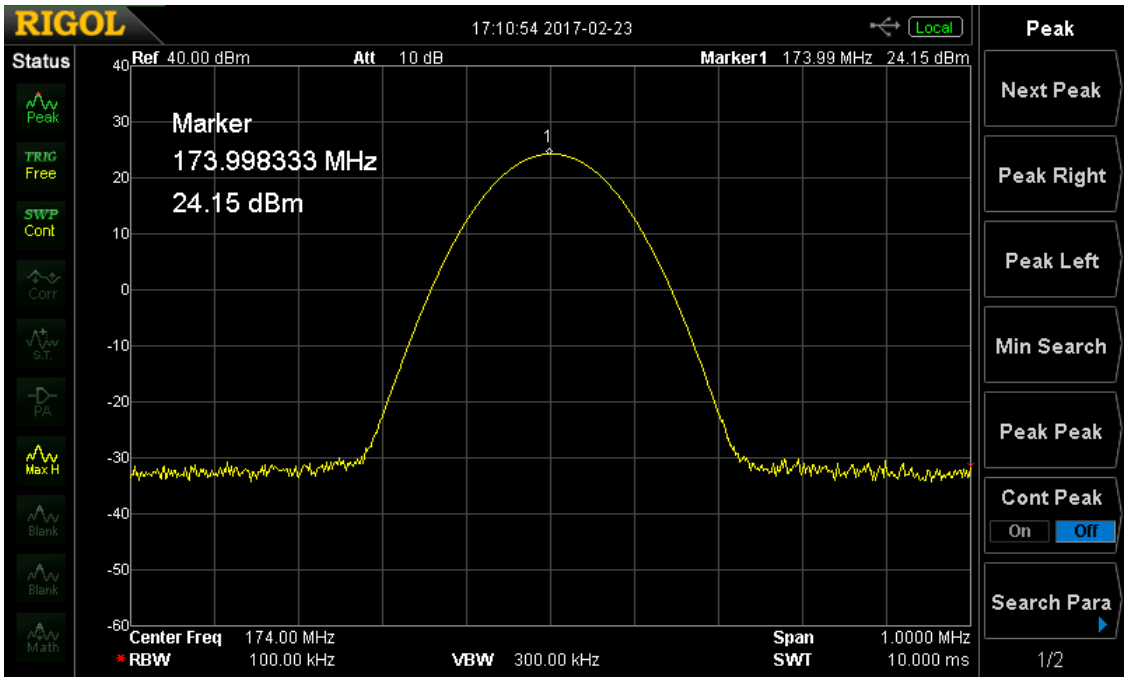

Figure 4. 174 MHz Output Power Plot

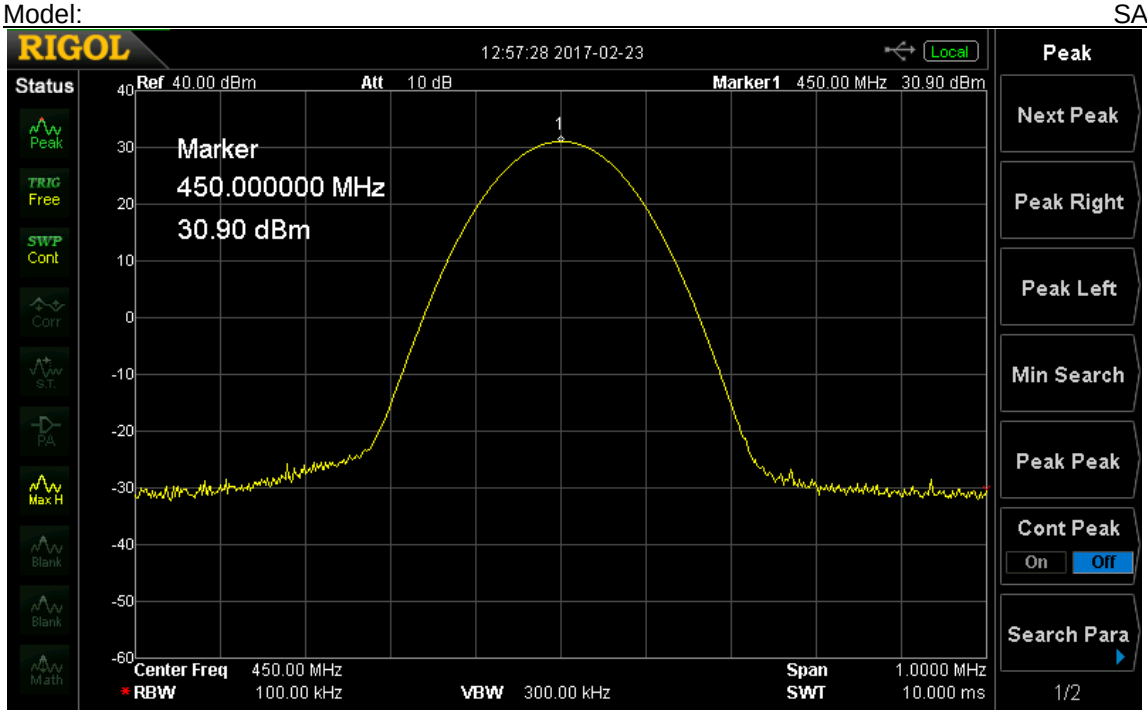

Figure 5. 450 MHz Output Power Plot

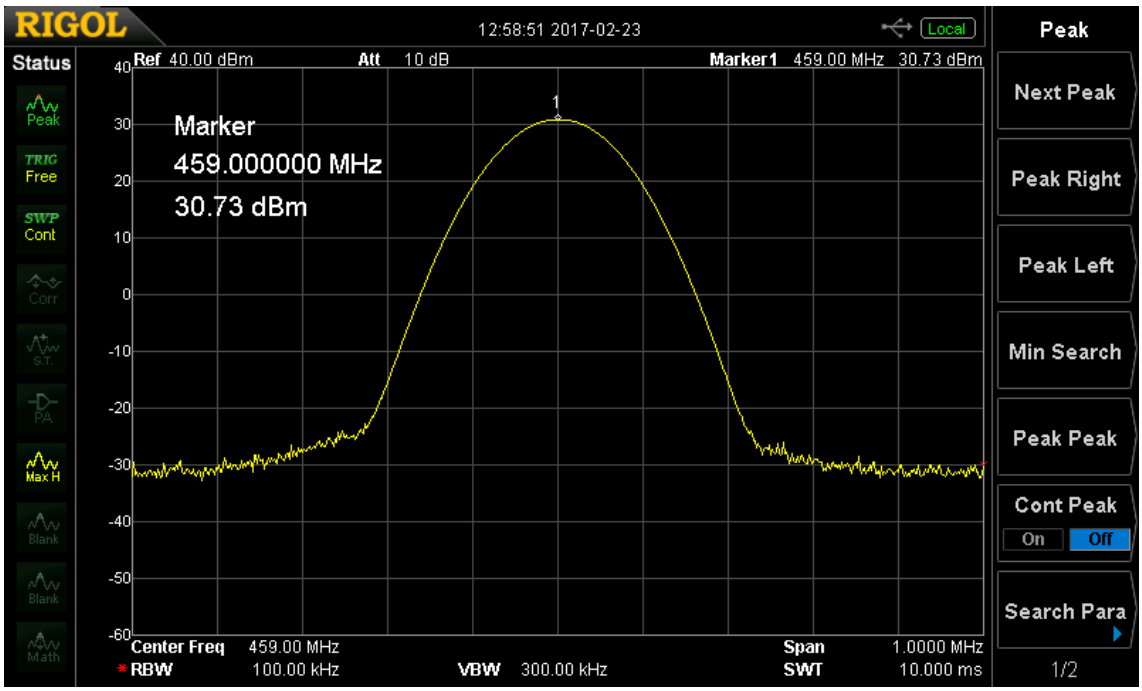

Figure 6. 459 MHz Output Power Plot

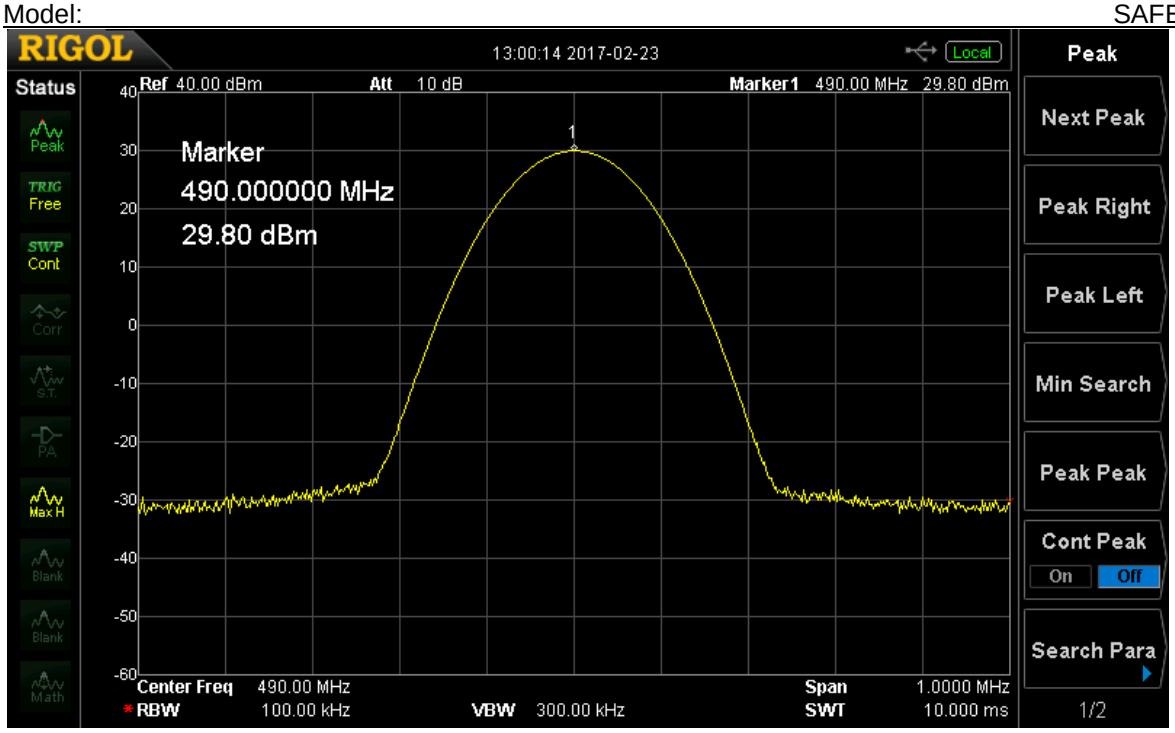

Figure 7. 490 MHz Output Power Plot

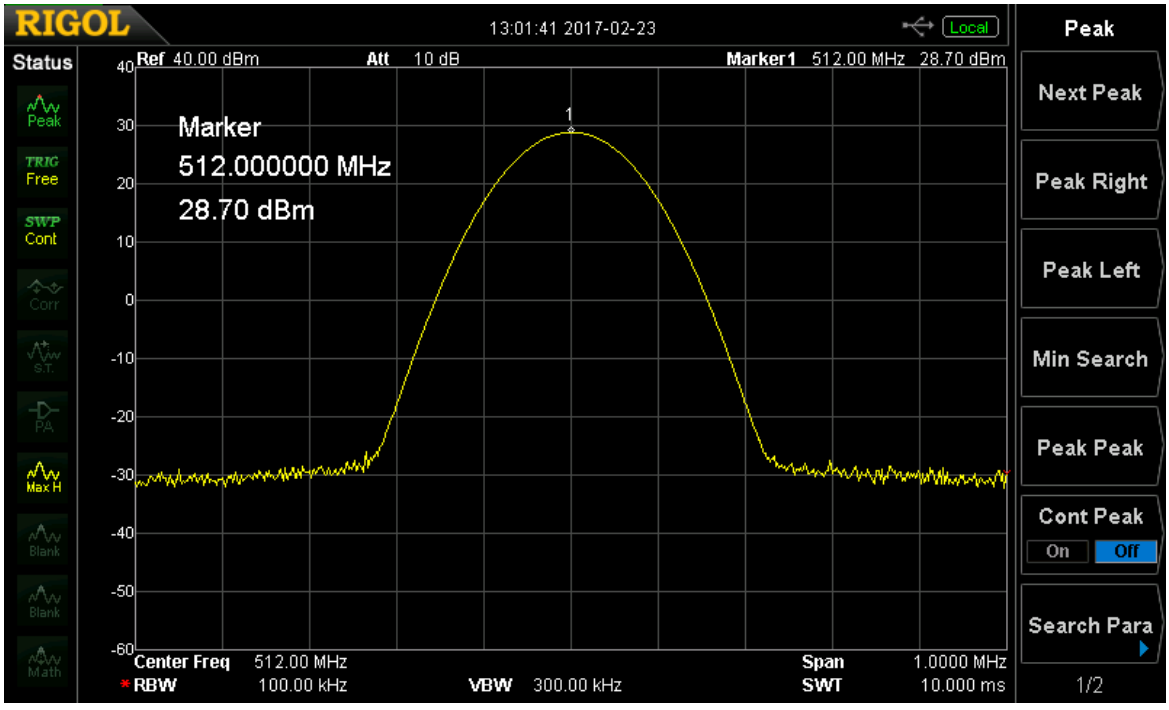

Figure 8. 512 MHz Output Power Plot

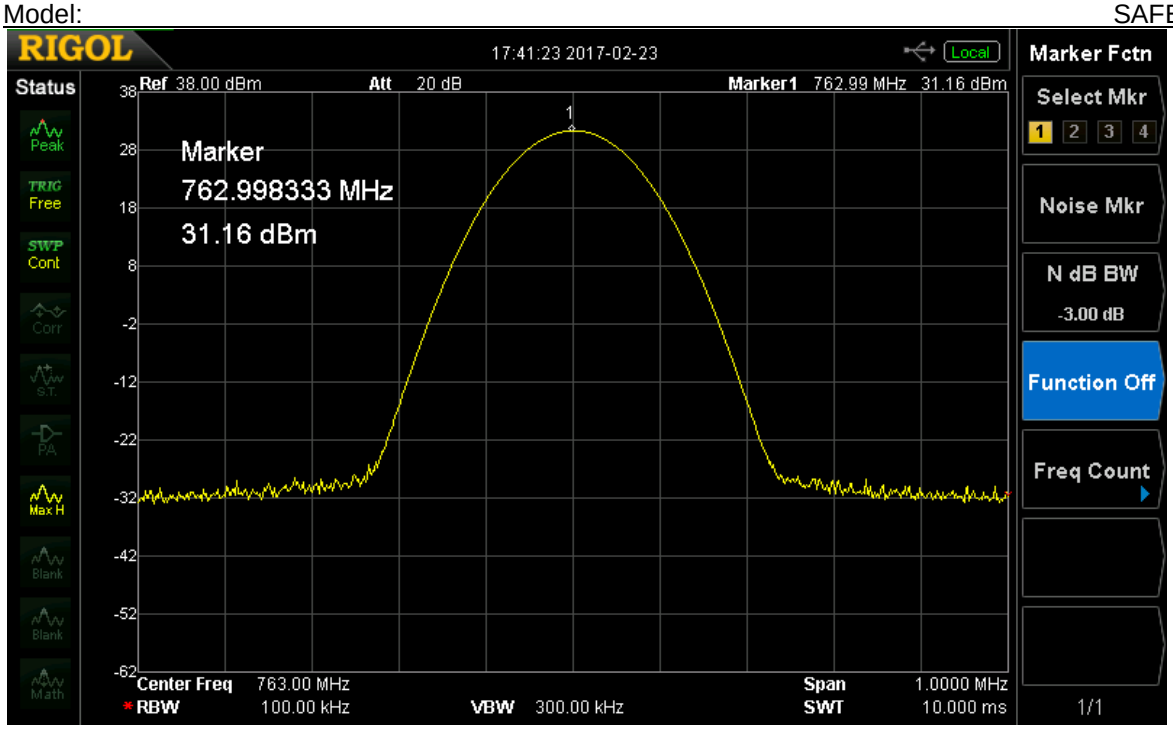

Figure 9. 763 MHz Output Power Plot

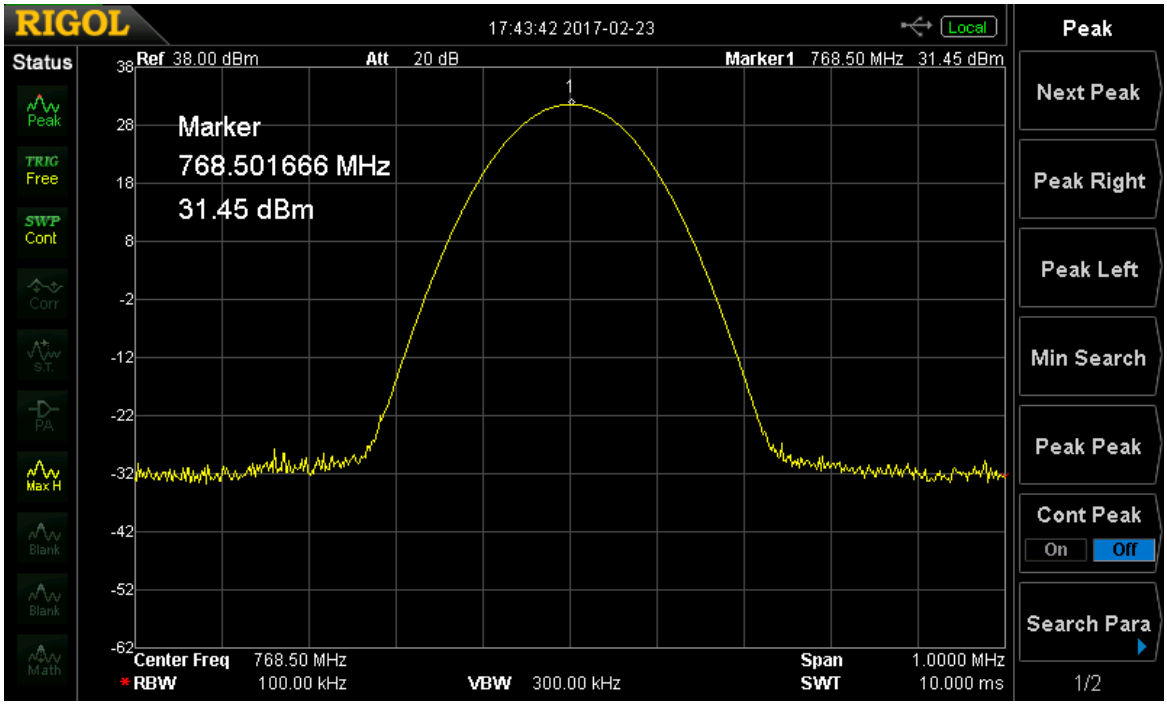

Figure 10. 768.5 MHz Output Power Plot

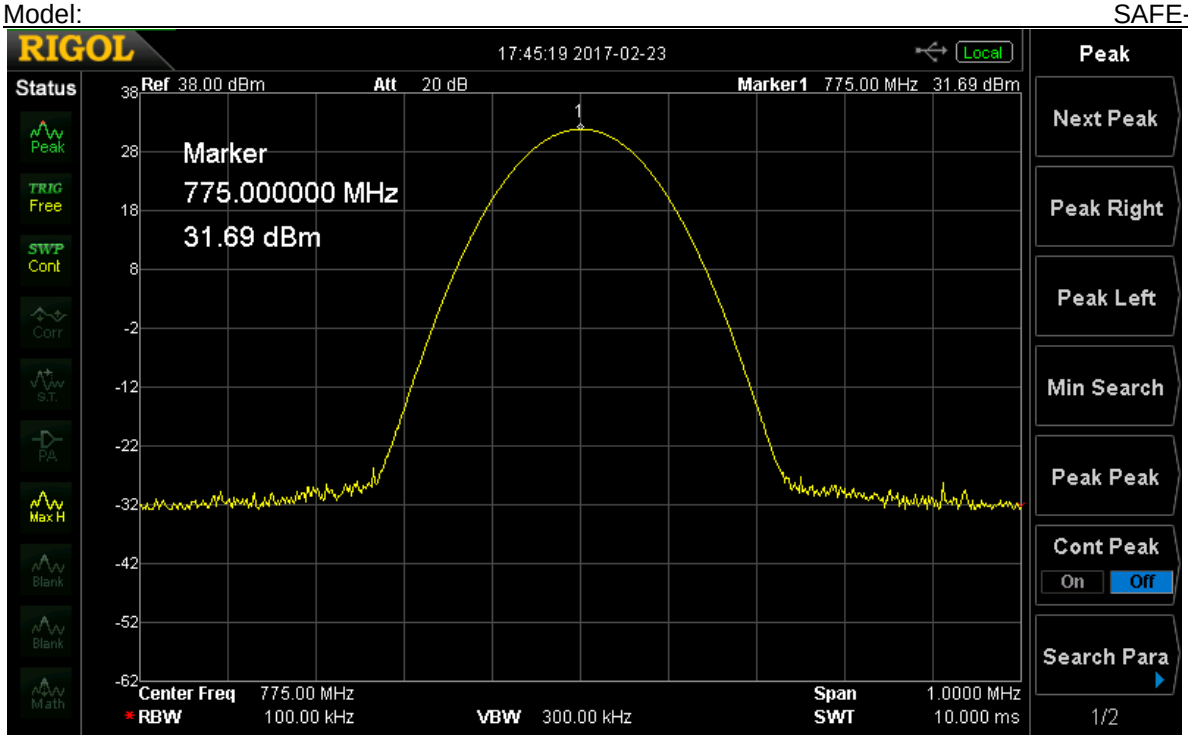

Figure 11. 775 MHz Output Power Plot

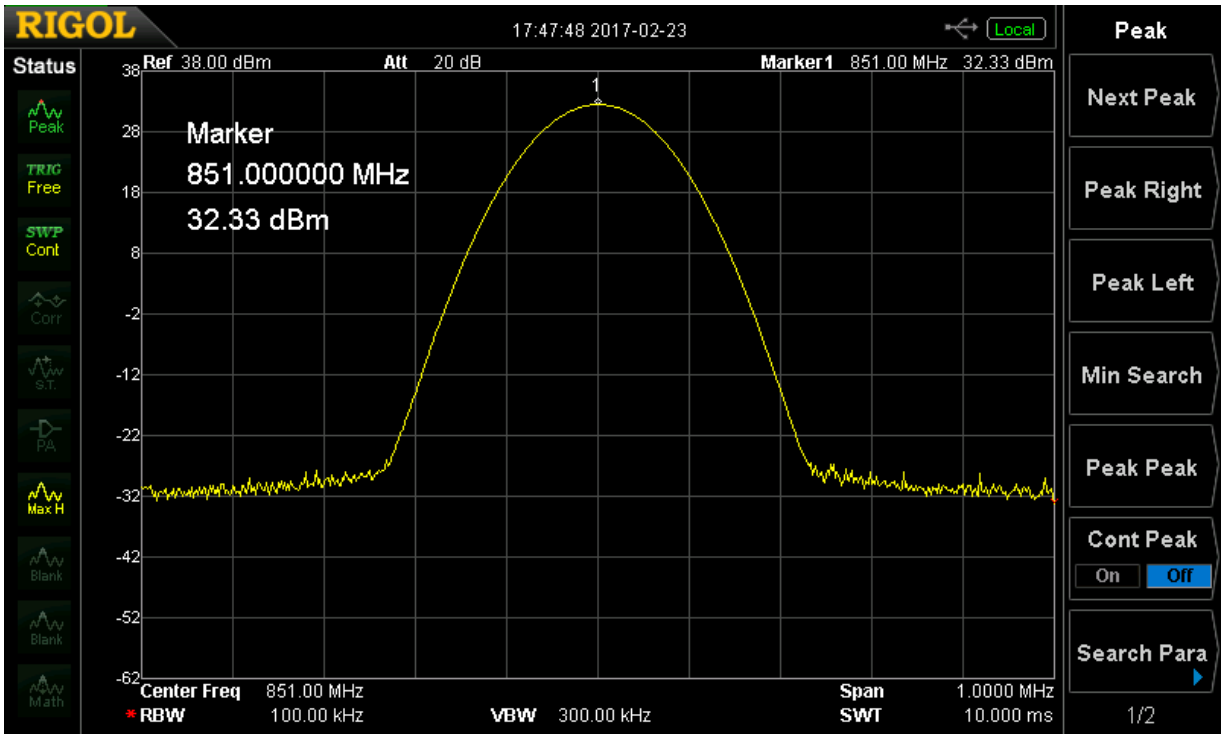

Figure 12. 851 MHz Output Power Plot

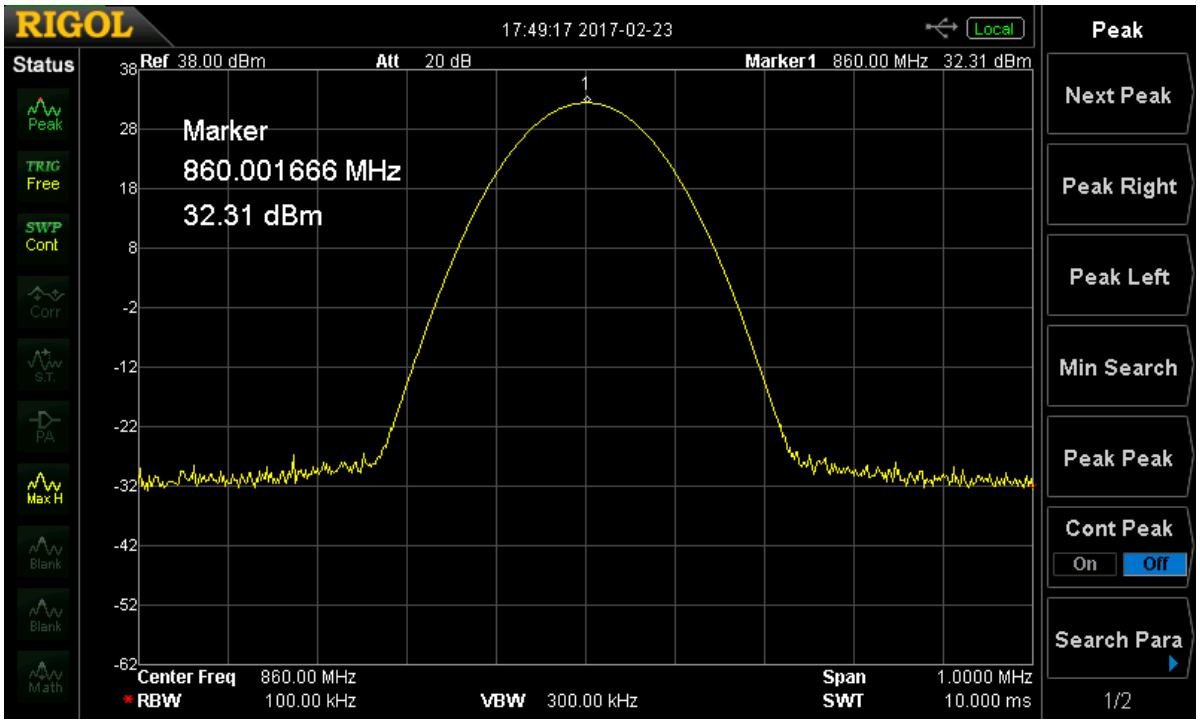

Figure 13. 860 MHz Output Power Plot

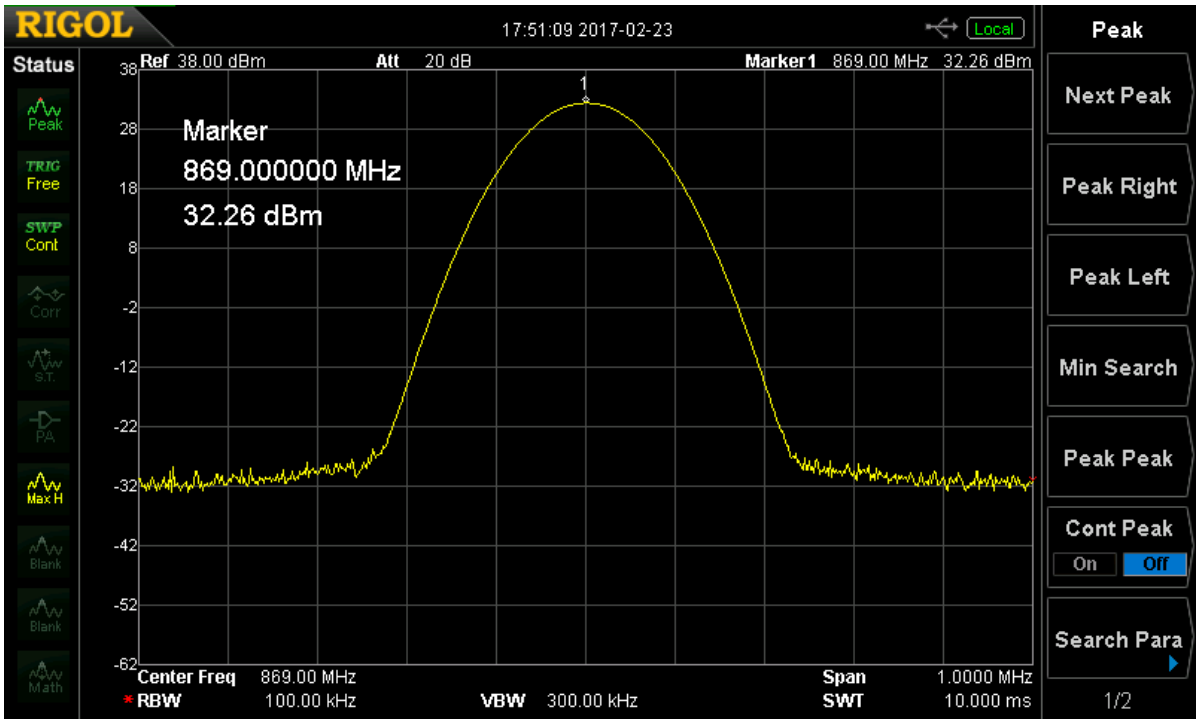

Figure 14. 869 MHz Output Power Plot

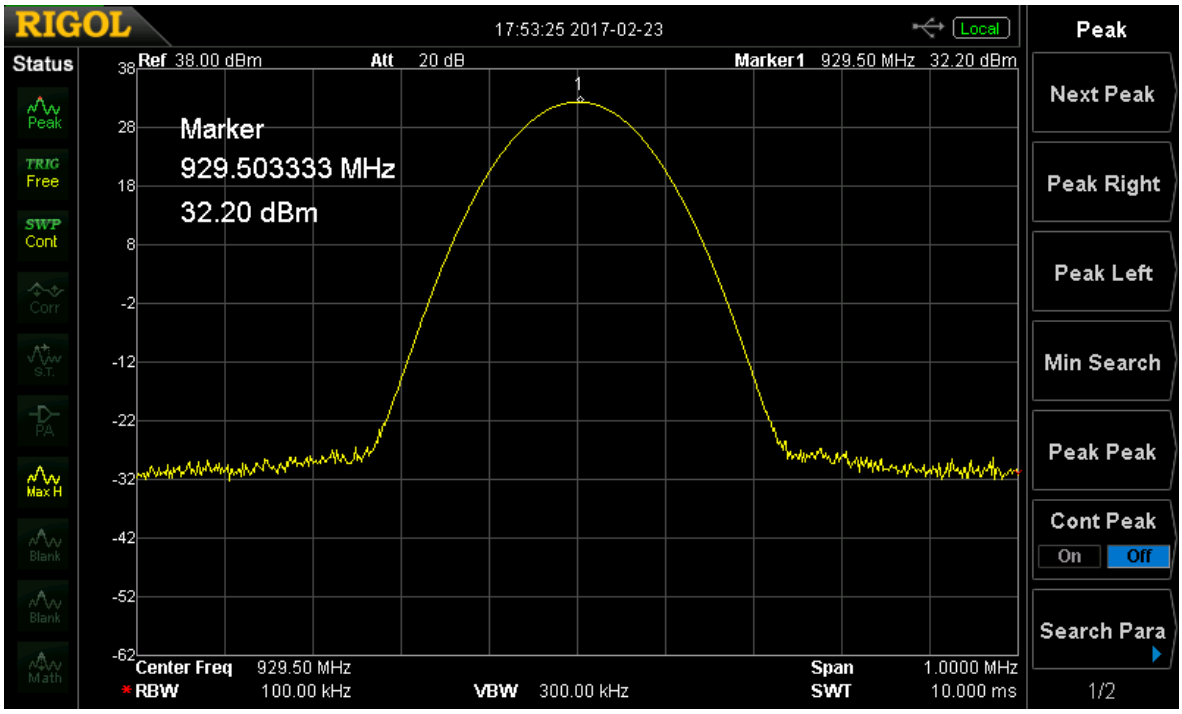

Figure 15. 929.5 MHz Output Power Plot

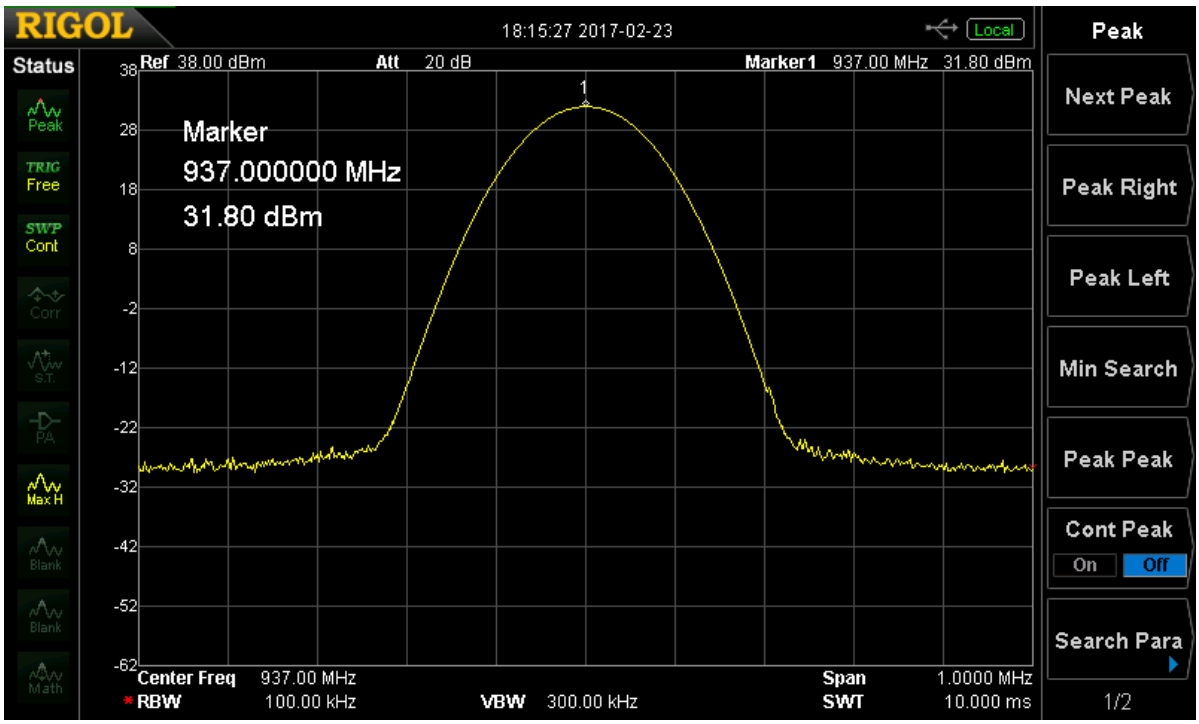

Figure 16. 937 MHz Output Power Plot

2.8 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.

2.9 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.

2.10 Emissions Mask Definitions (FCC Section 2.1049, 90.219(e)(4iii), 90.210)

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 Emissions Mask B (FCC Part 90.210, 2.1051)

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 Emissions Mask D (FCC Part 90.210, 2.1051)

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 Emissions Mask E (FCC Part 90.210, 2.1051)

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 Mask I (FCC Part 90.210, 2.1051)

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 Emissions 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 Channel

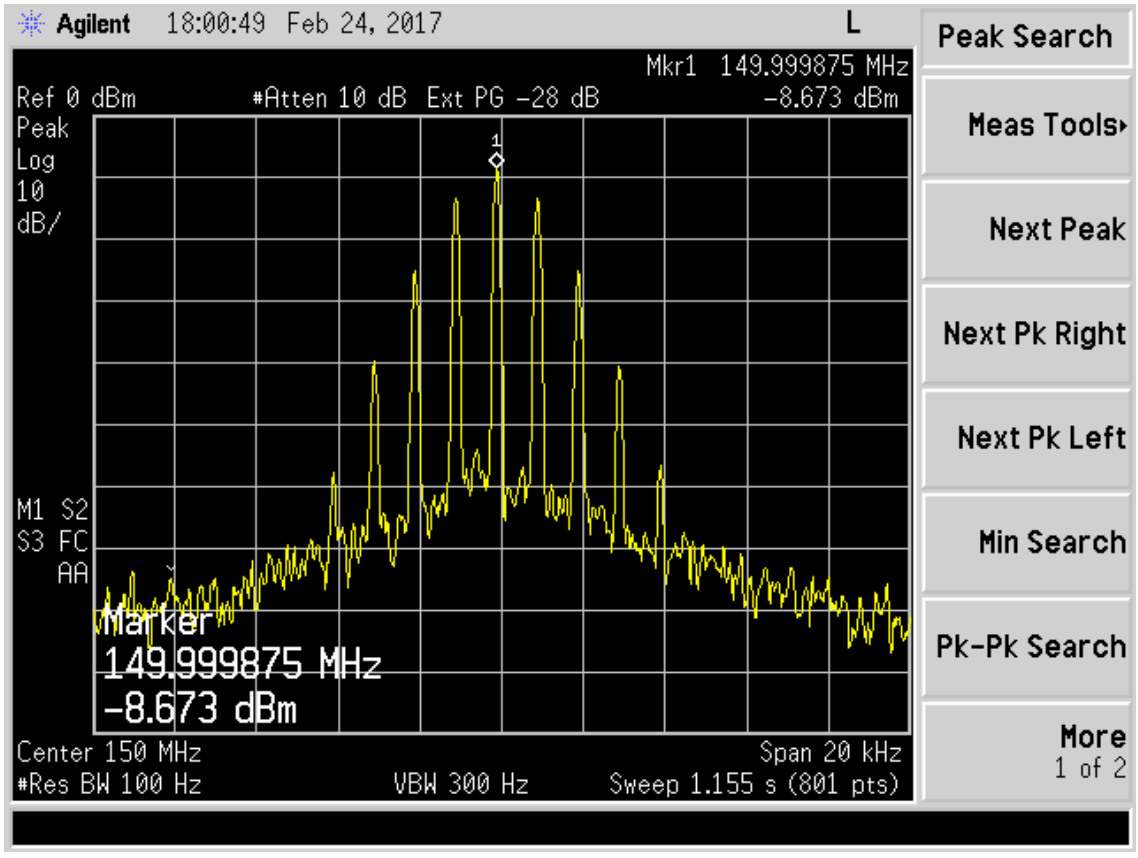

Figure 17. Input 150 MHz @ 6.25 kHz

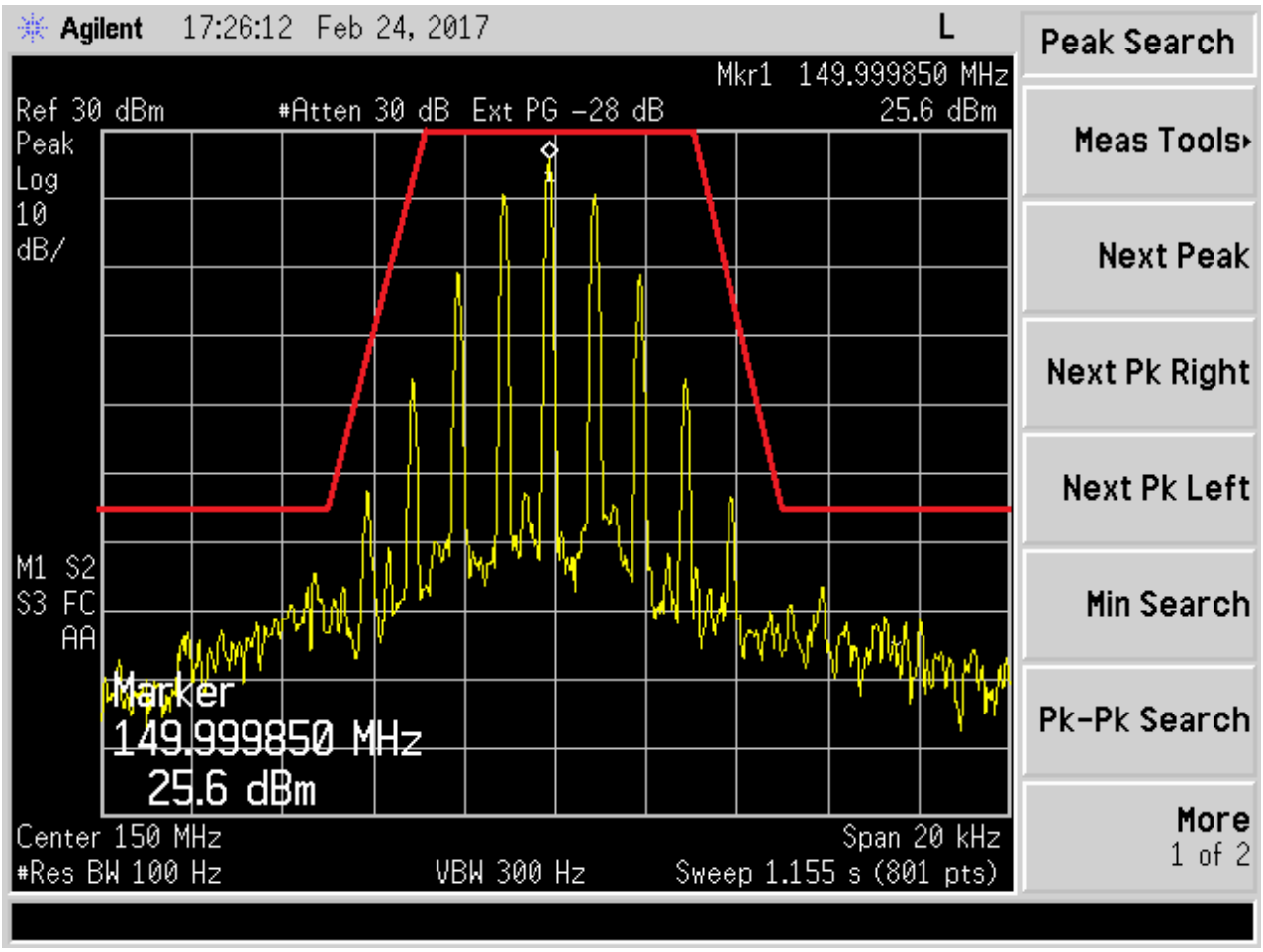

Figure 18. 150 MHz @ 6.25 kHz, Mask E

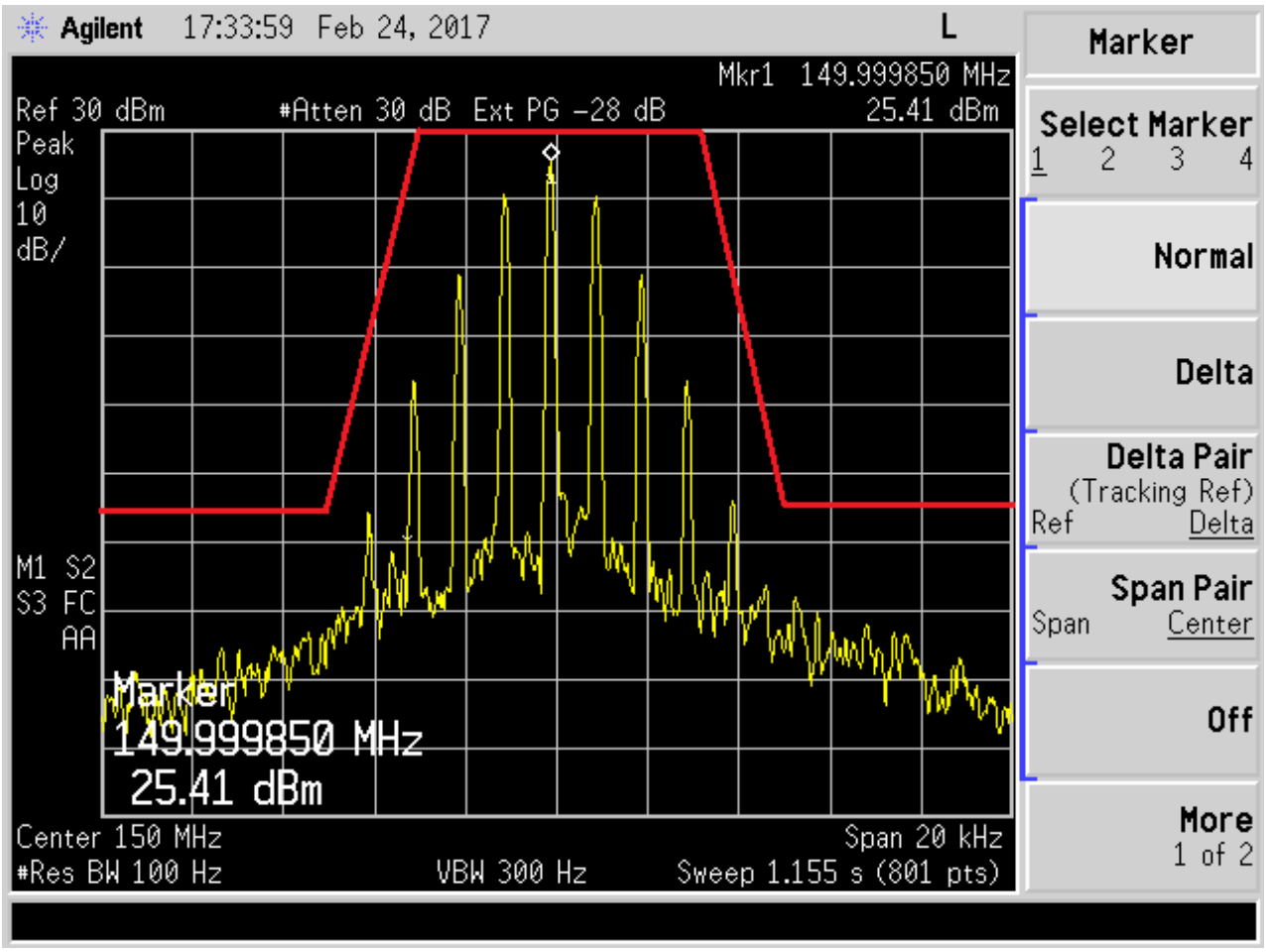

Figure 19. 150 MHz@ 6.25 kHz +3.0 dB, Mask E

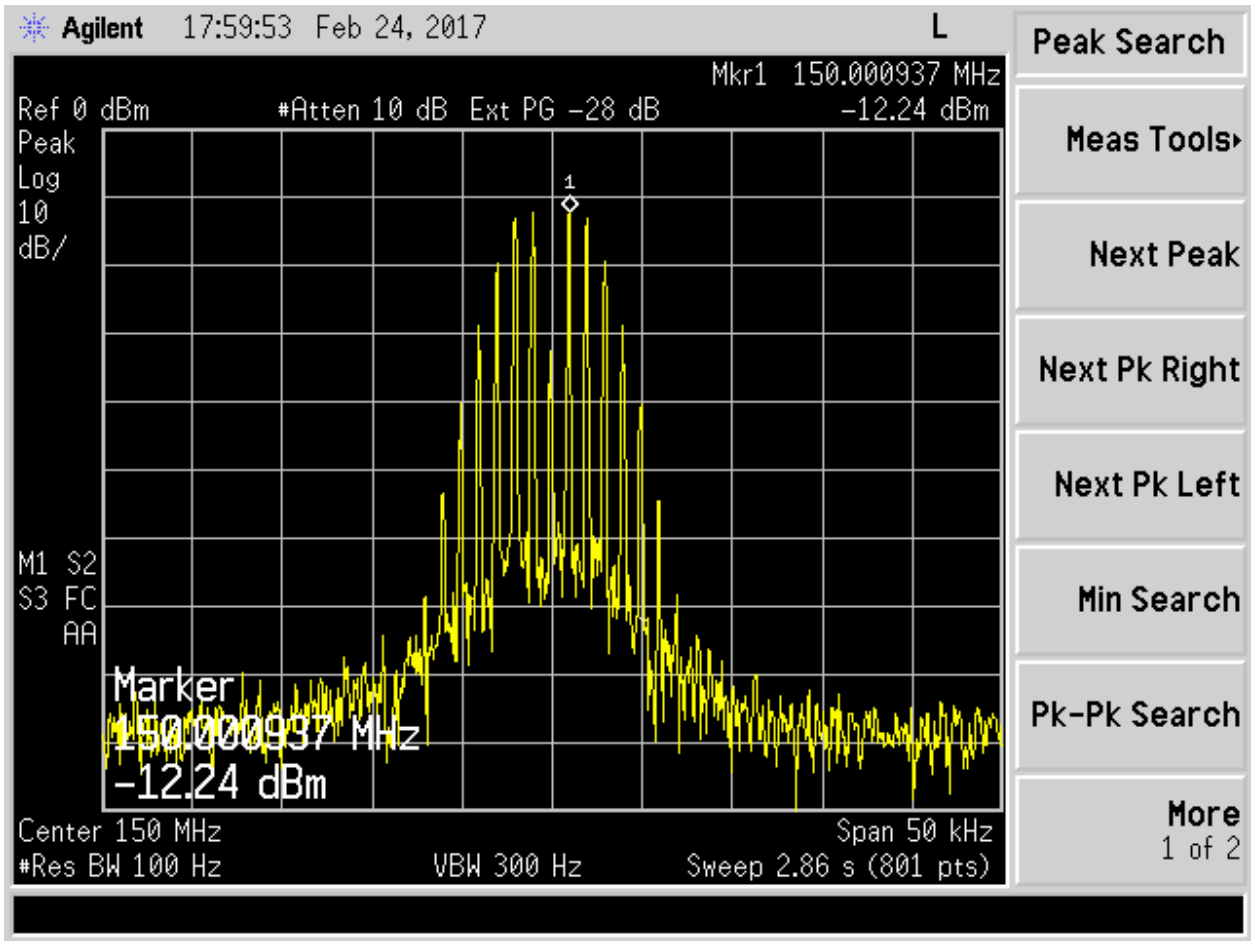

Figure 20. Input 150 MHz @ 12.5 kHz

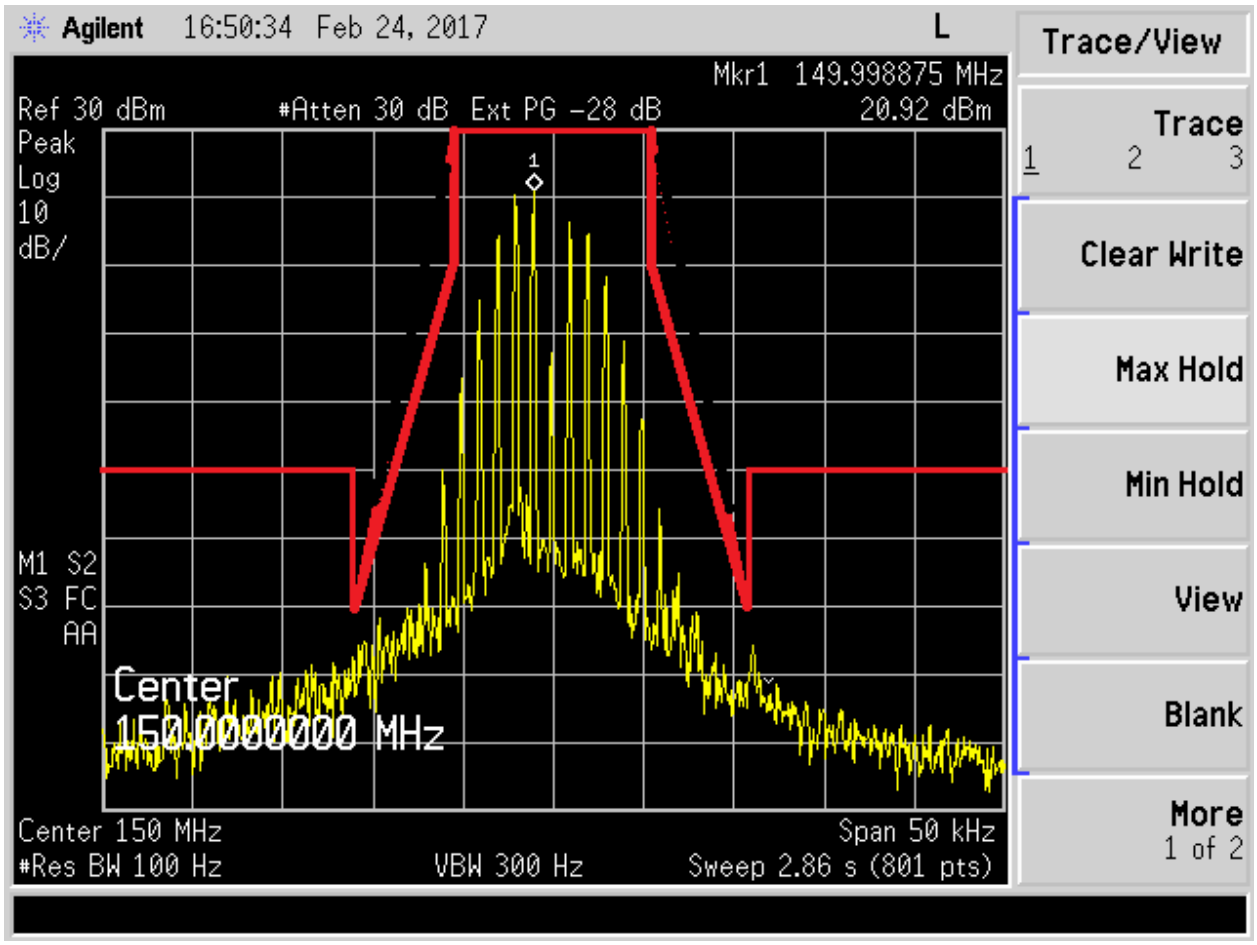

Figure 21. 150 MHz @ 12.5 kHz, Mask D

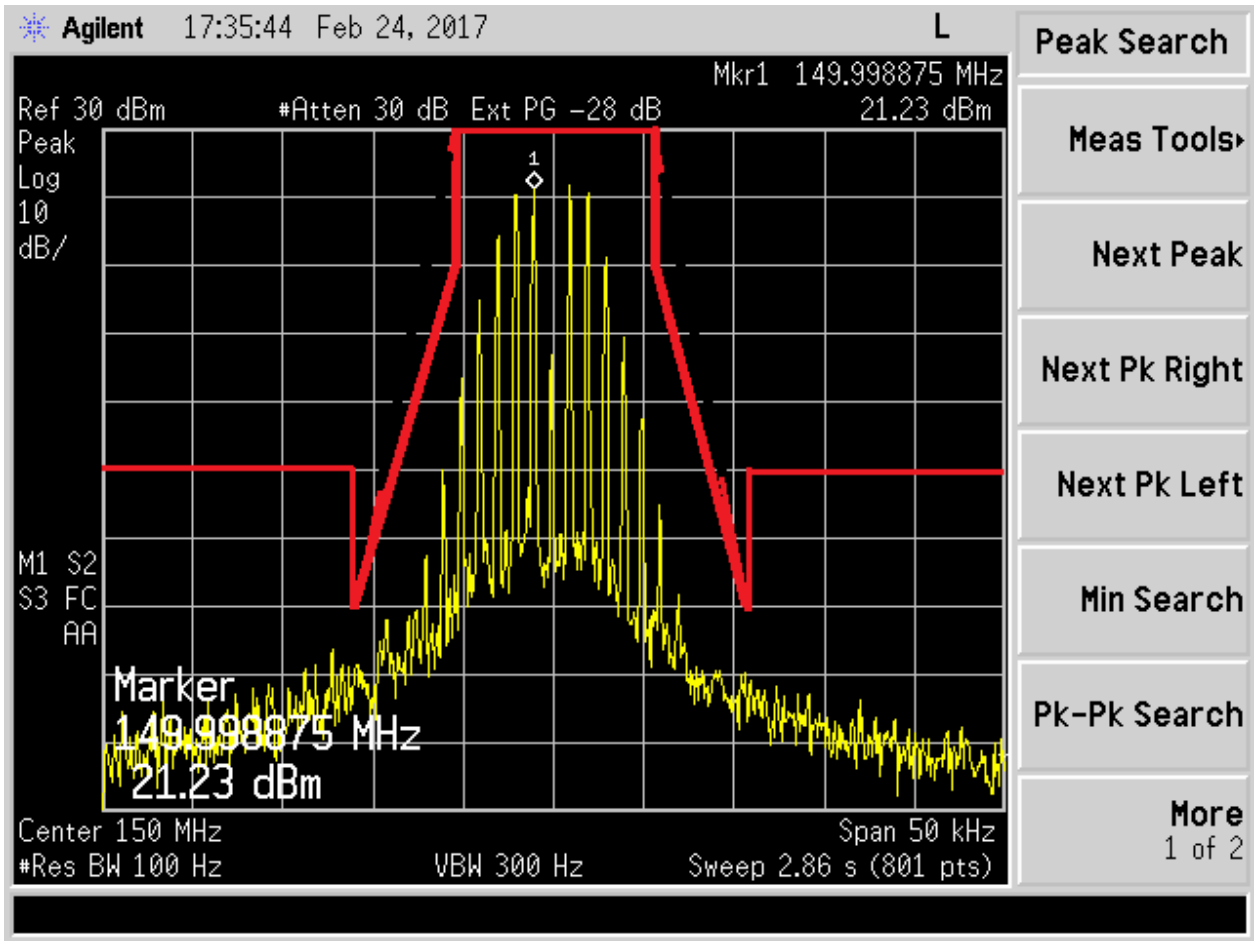

Figure 22. 150 MHz @ 12.5 kHz +3.0 dB, Mask D

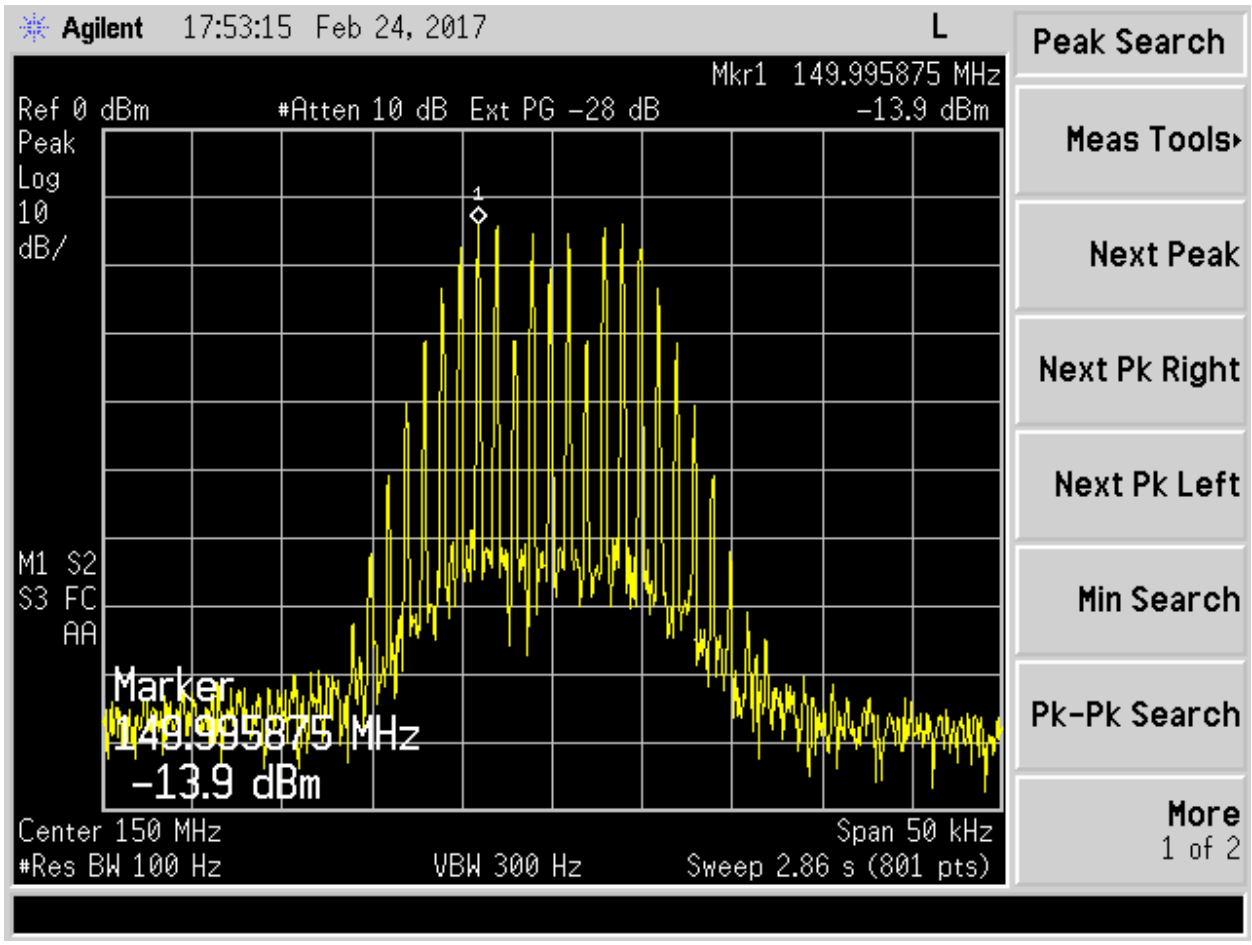

Figure 23. Input 150 MHz @ 25 kHz

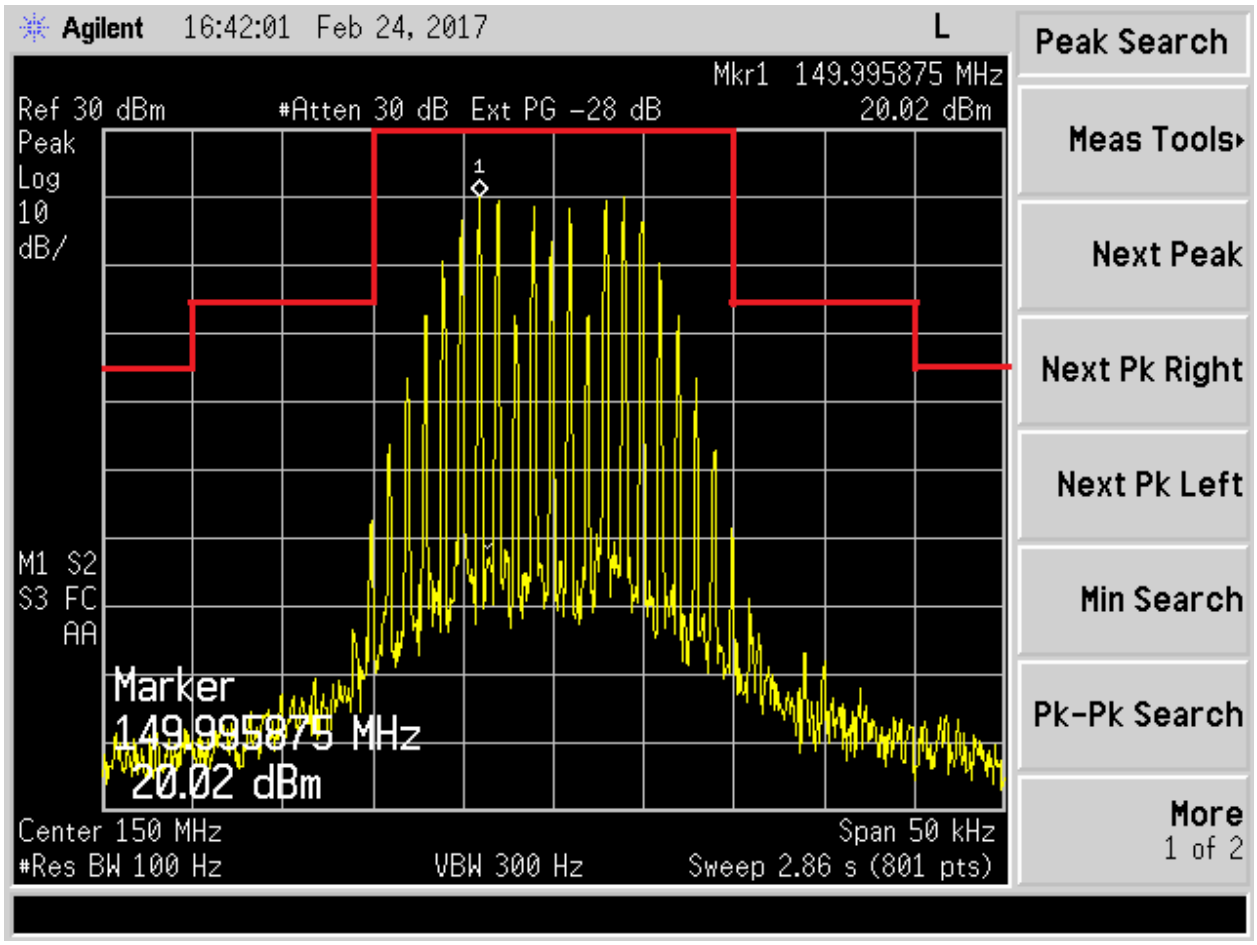

Figure 24. 150 MHz @ 25 kHz, Mask B

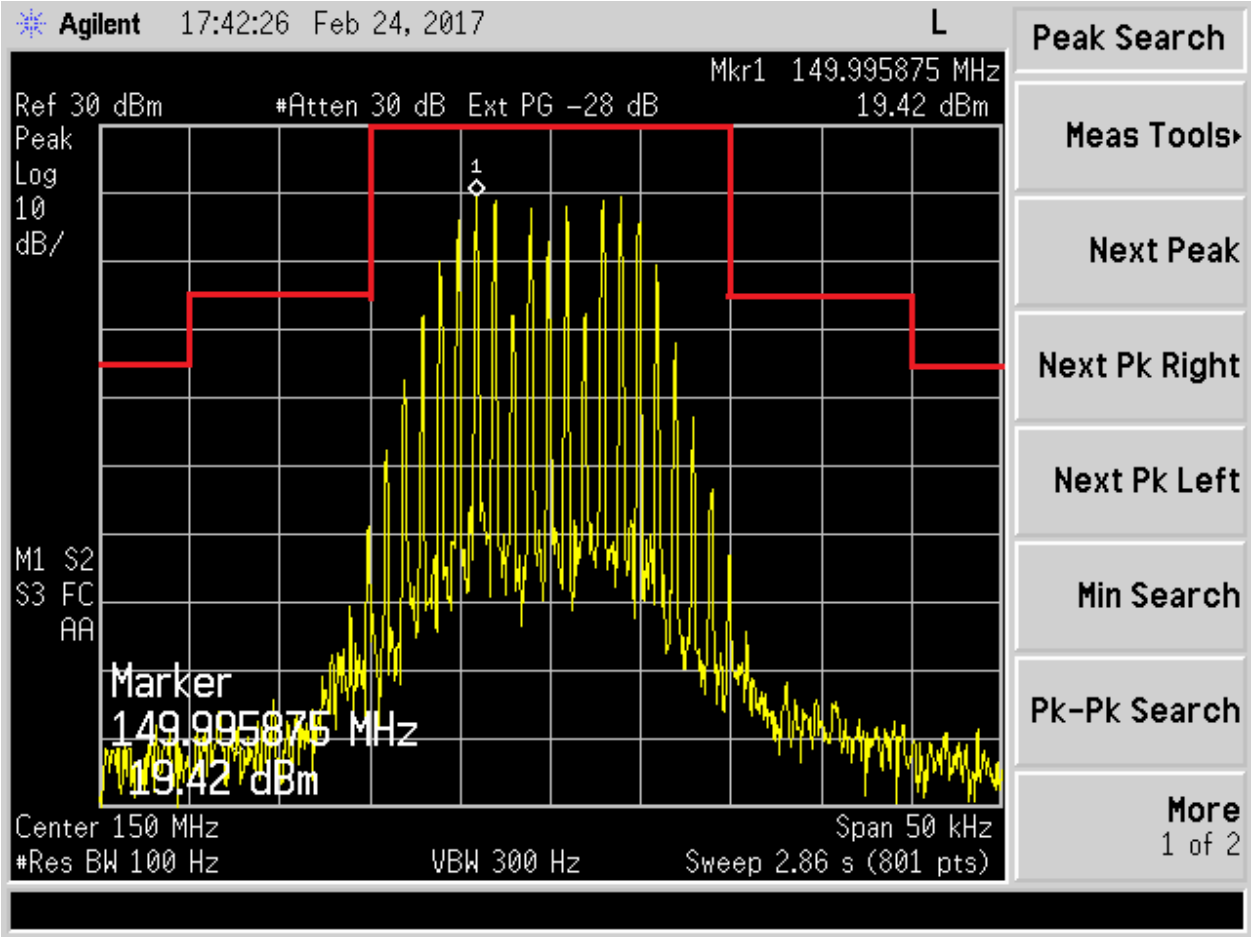

Figure 25. 150 MHz @ 25 kHz,+ 3.0 dB, Mask B

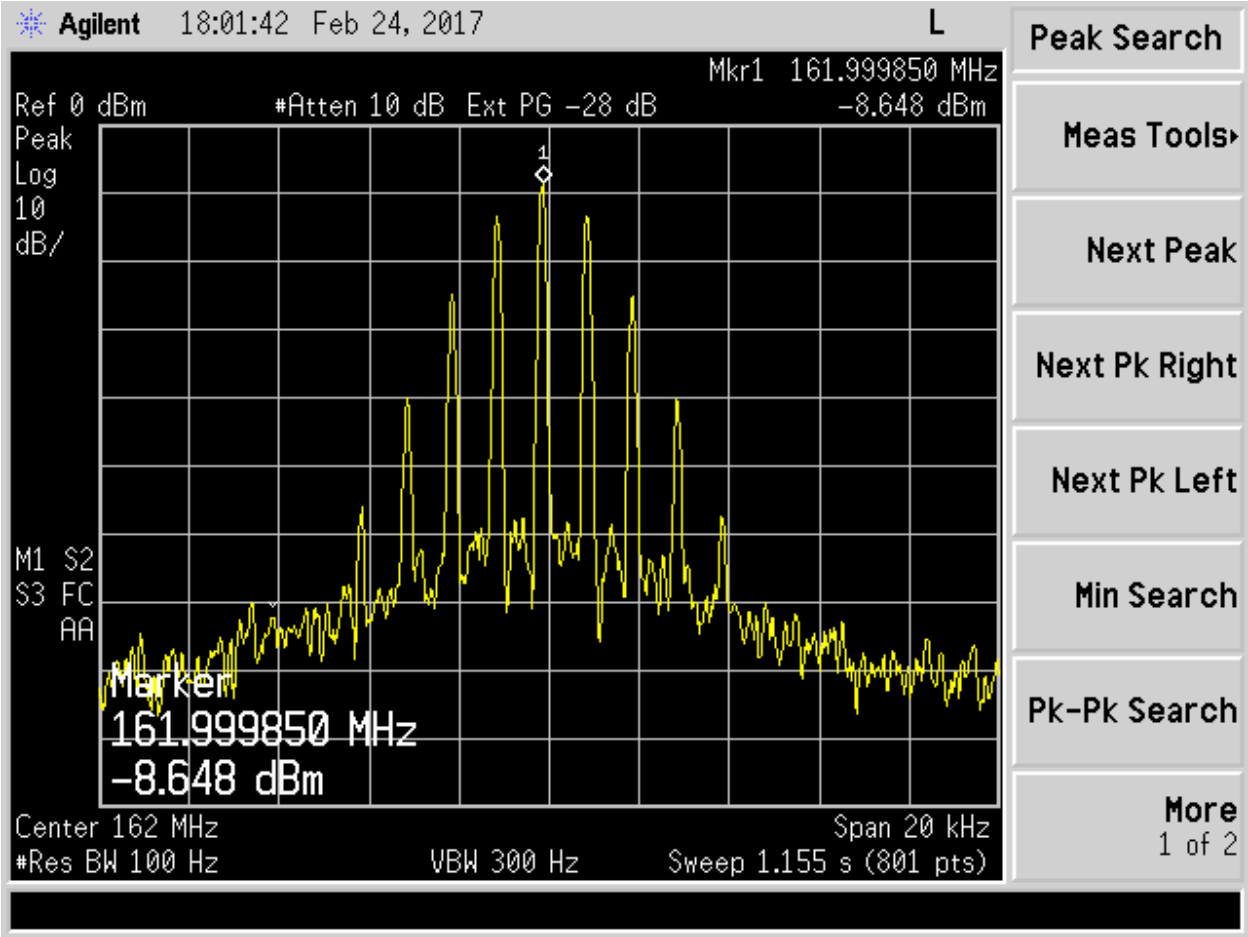

Figure 26. Input 162 MHz @ 6.25 kHz

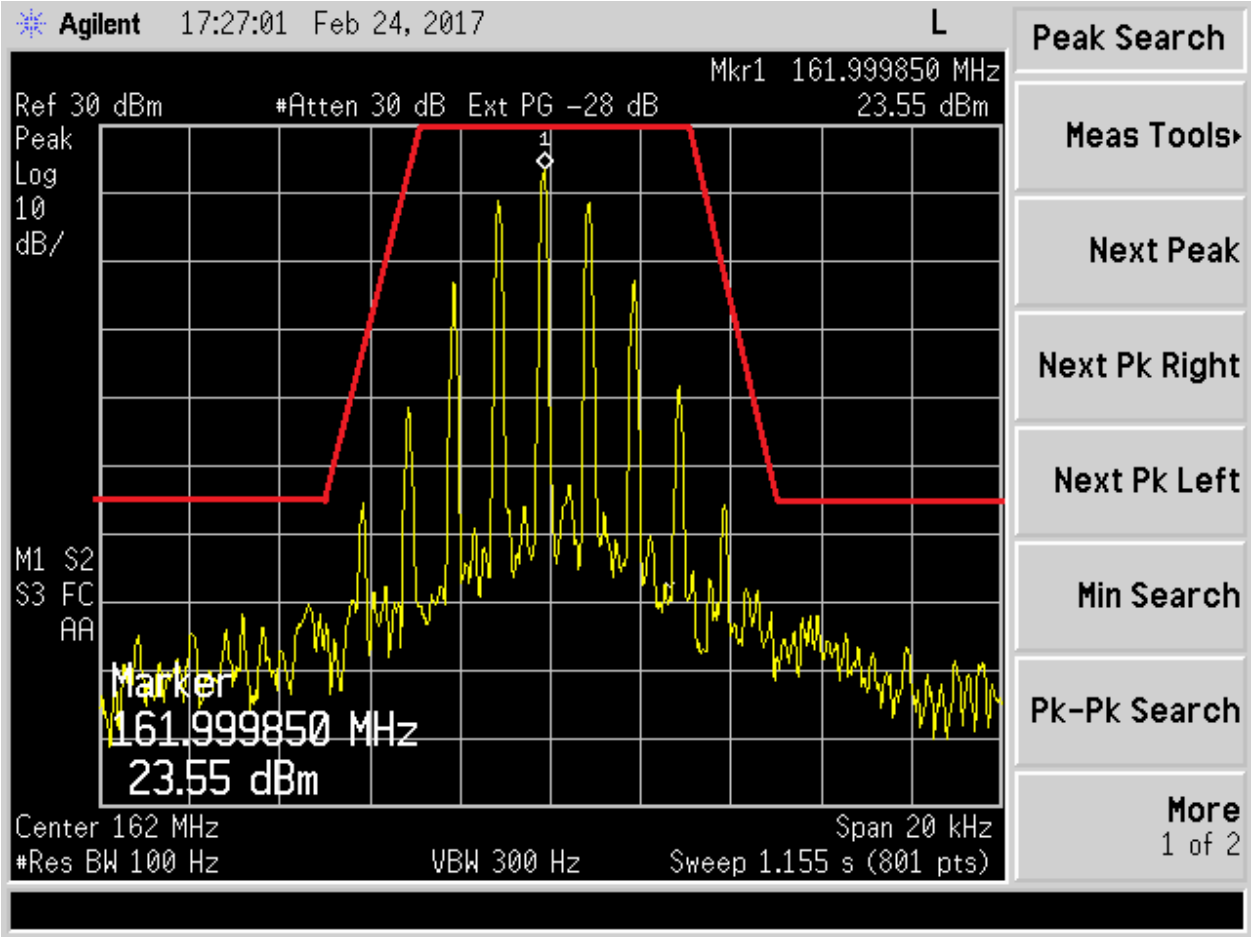

Figure 27. 162 MHz @ 6.25 kHz, Mask E

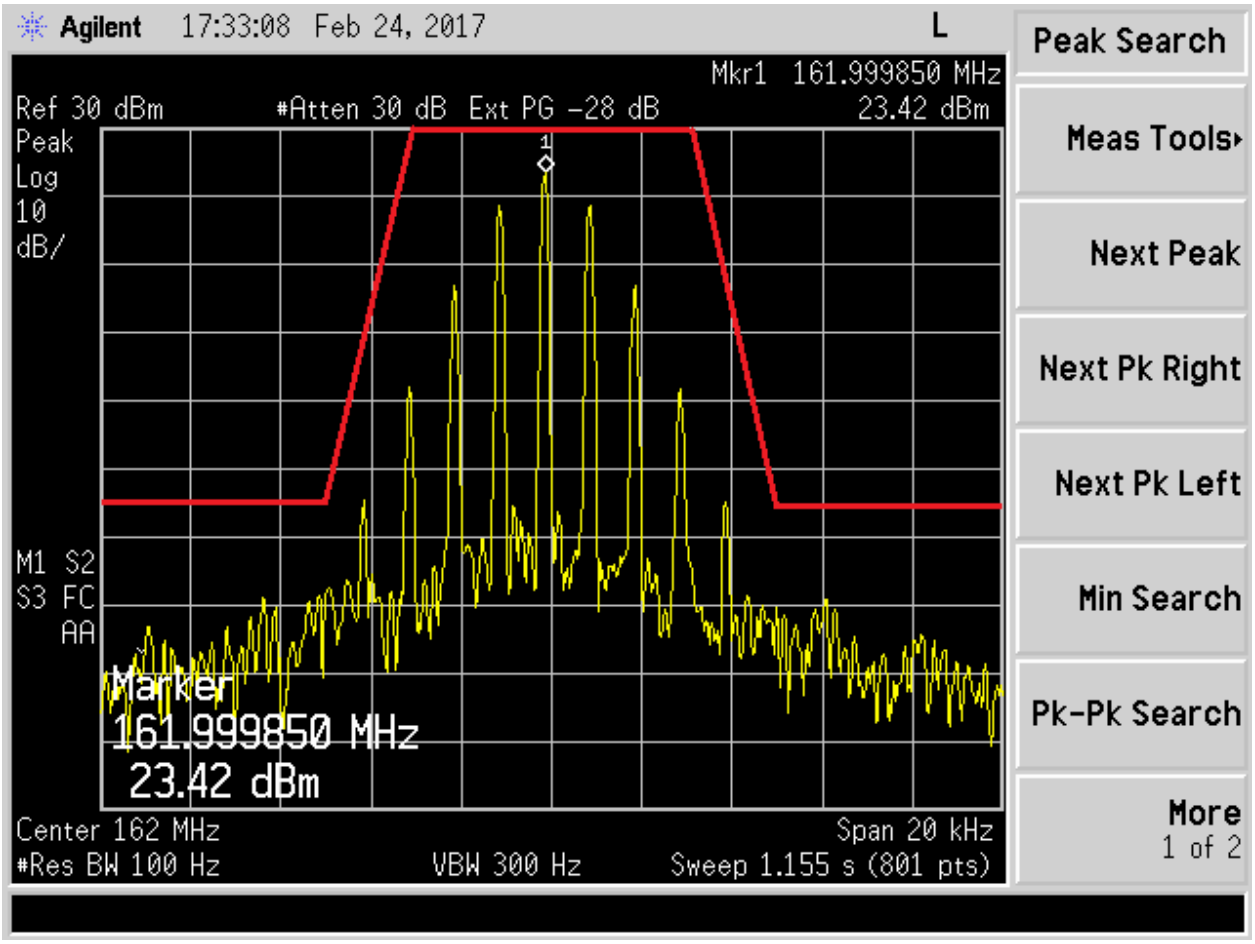

Figure 28. 162 MHz @ 6.25 kHz +3.0 dB, Mask E

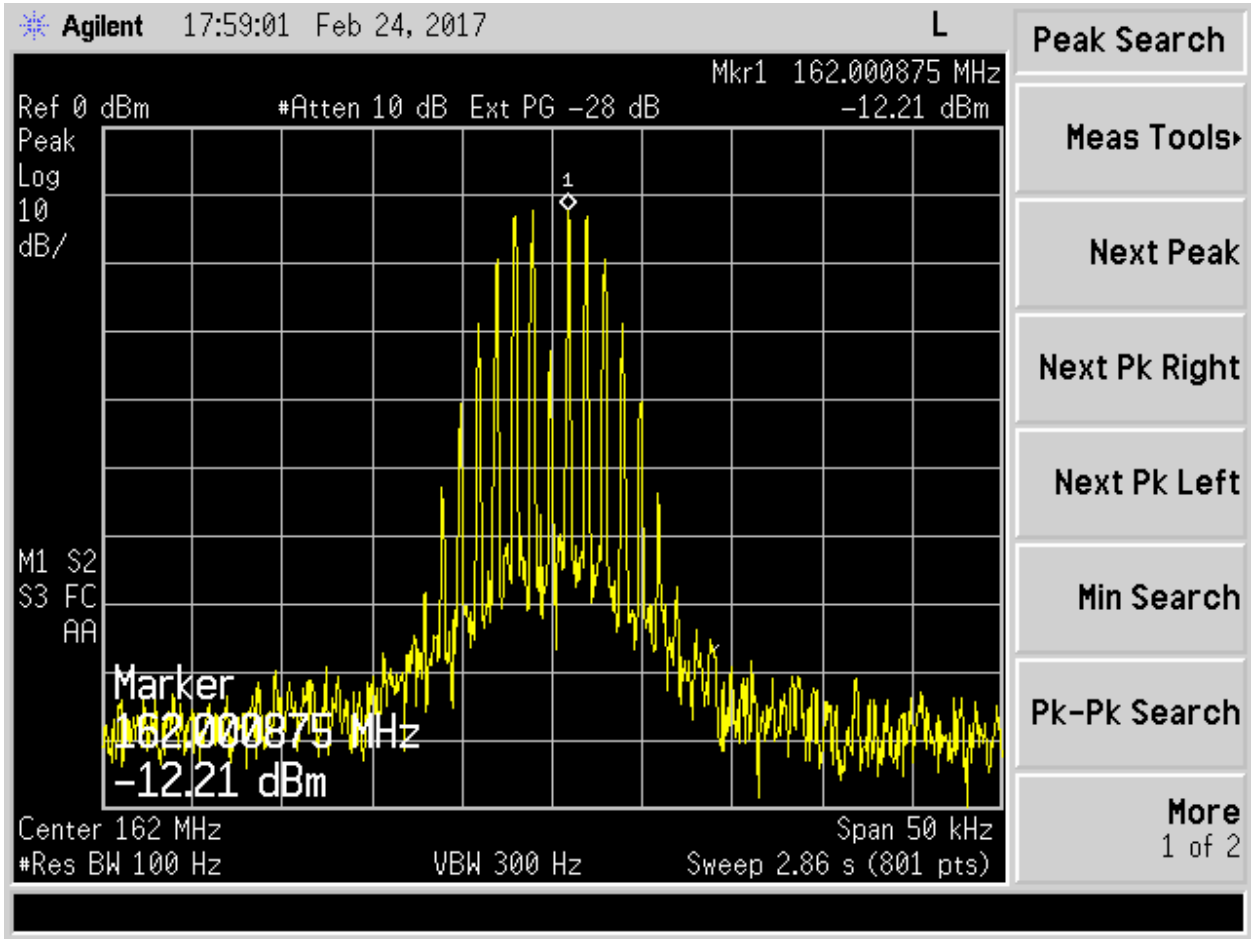

Figure 29. Input 162 MHz @ 12.5 kHz

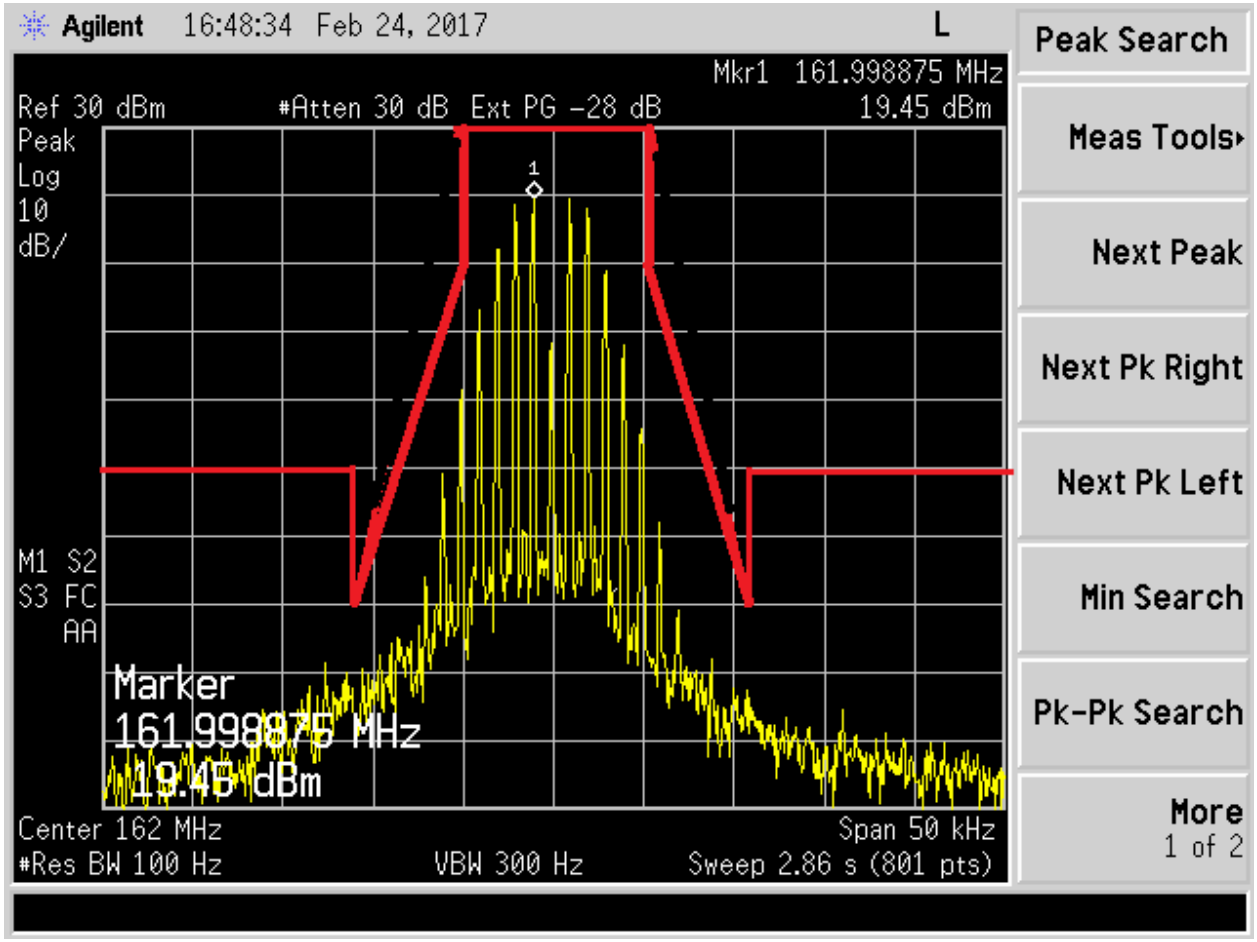

Figure 30. 162 MHz @ 12.5 kHz, Mask D

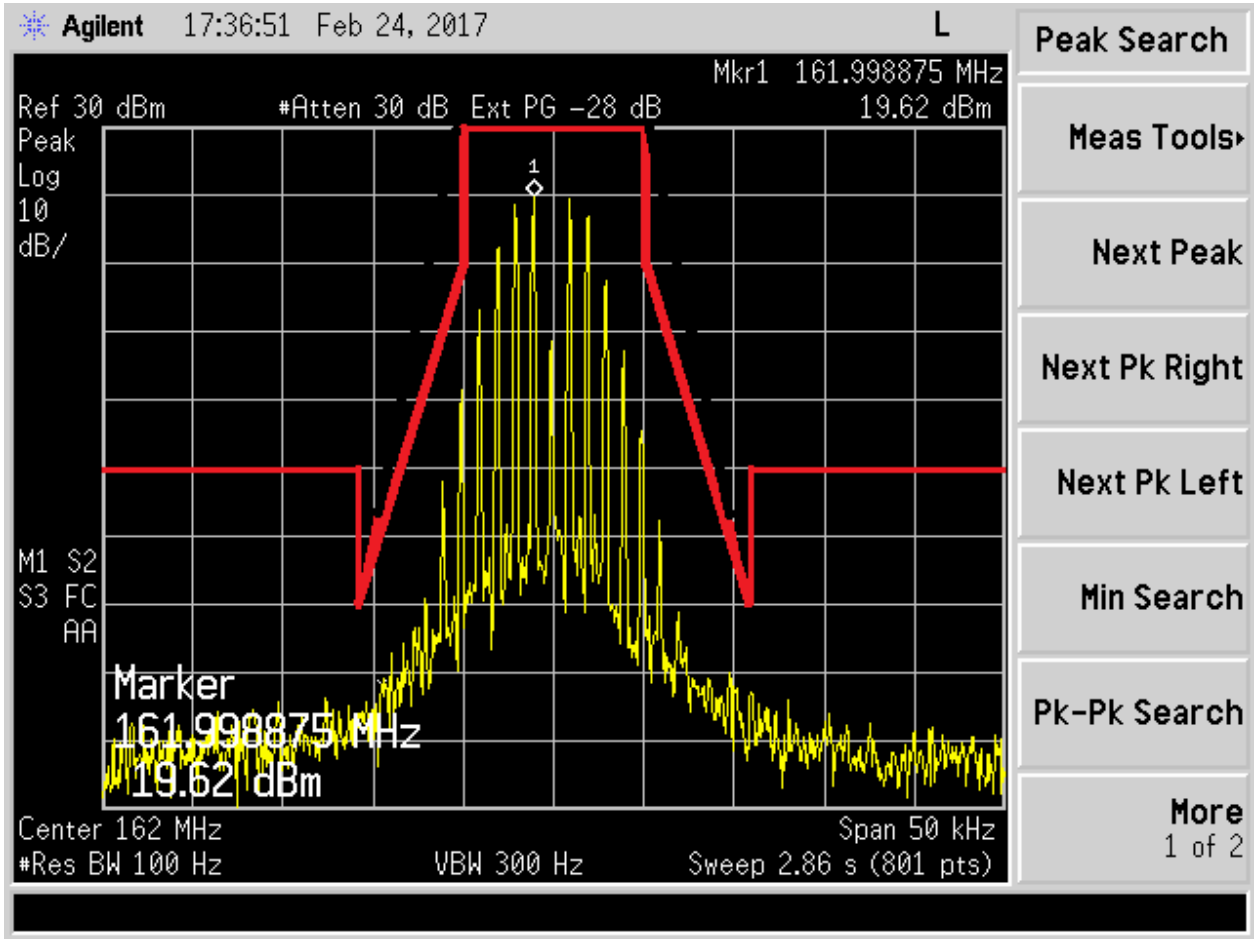

Figure 31. 162 MHz @ 12.5 kHz +3.0 dB, Mask D

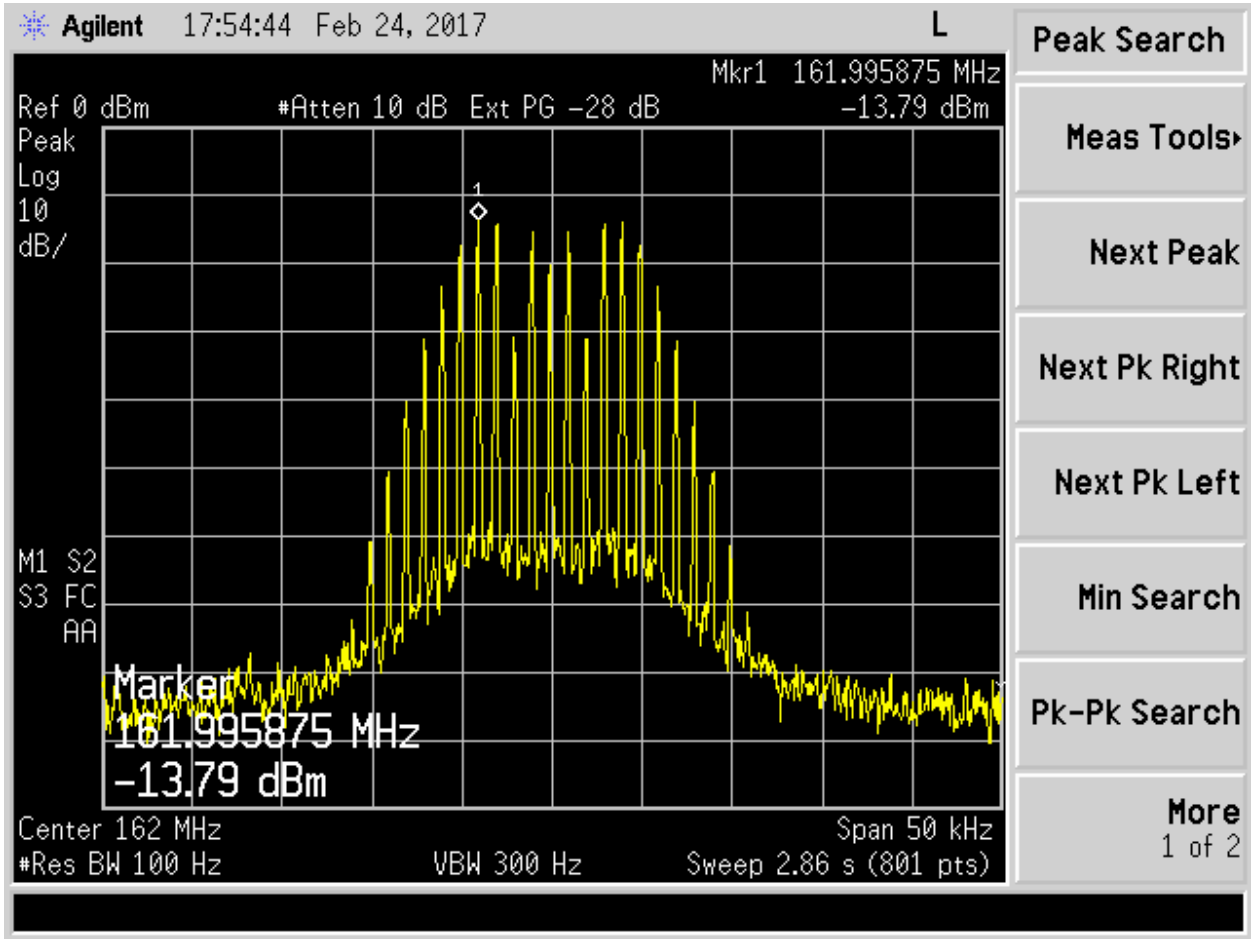

Figure 32. Input 162 MHz @ 25 kHz

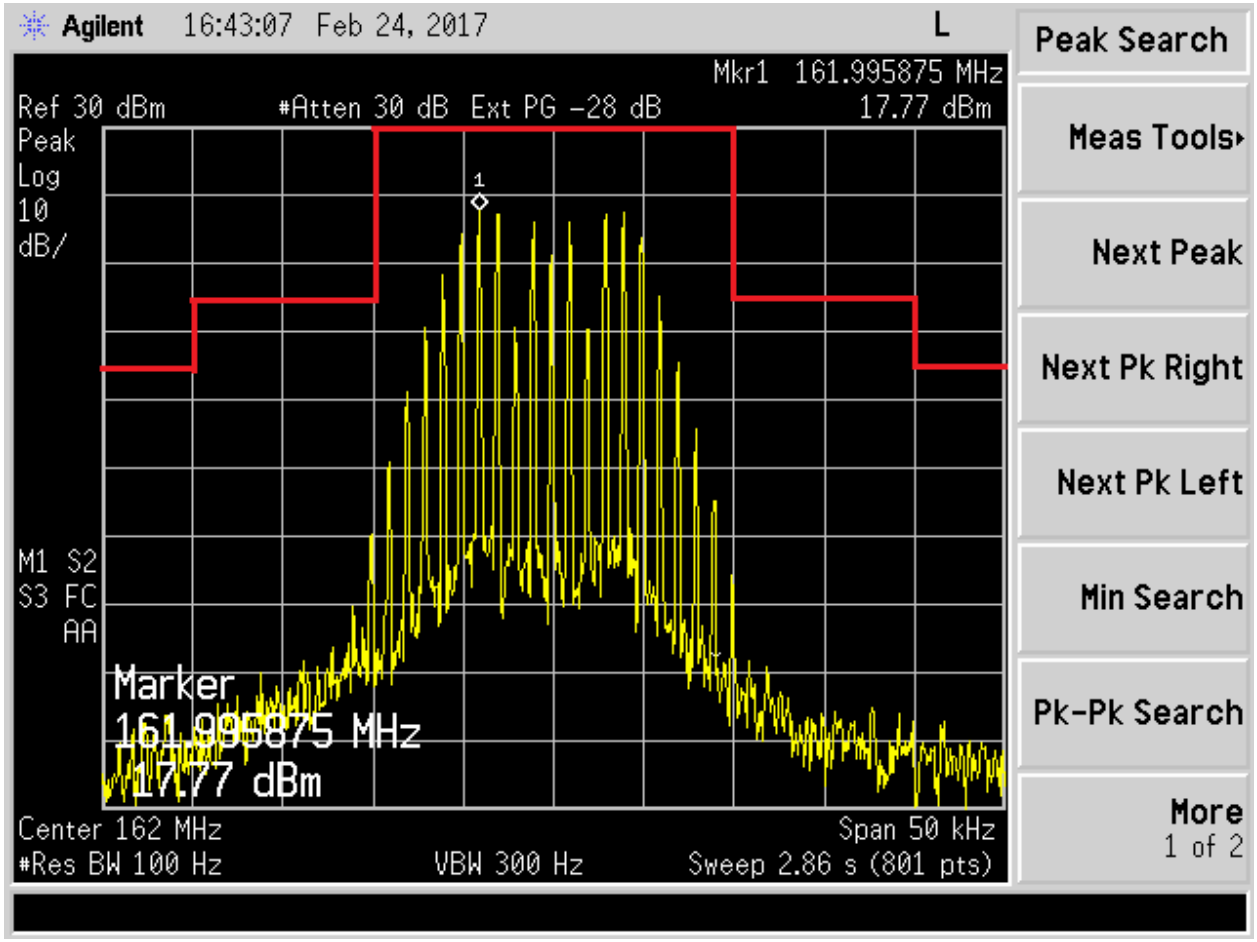

Figure 33. 162 MHz @ 25 kHz, Mask B

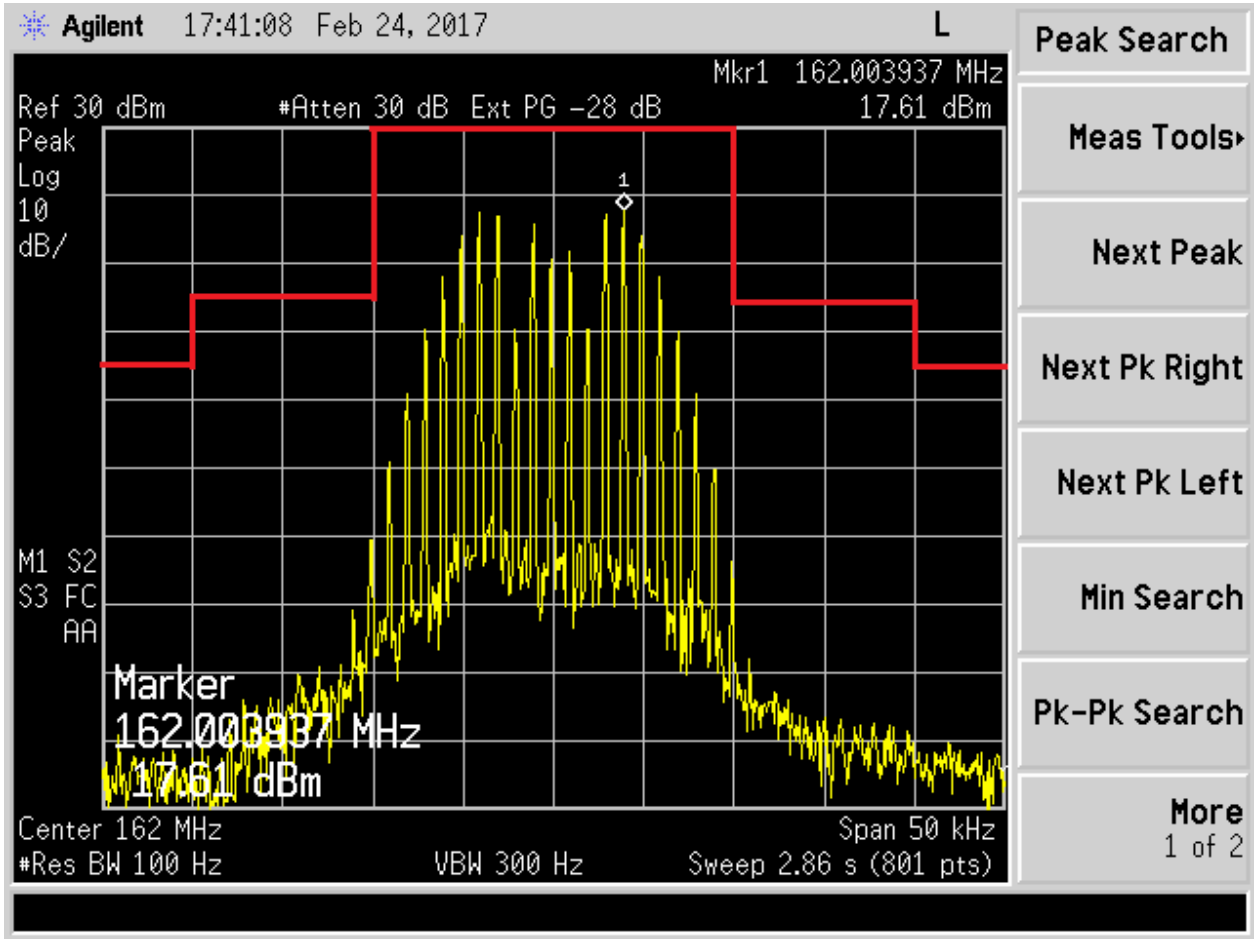

Figure 34. 162 MHz @ 25 kHz +3.0 dB, Mask B

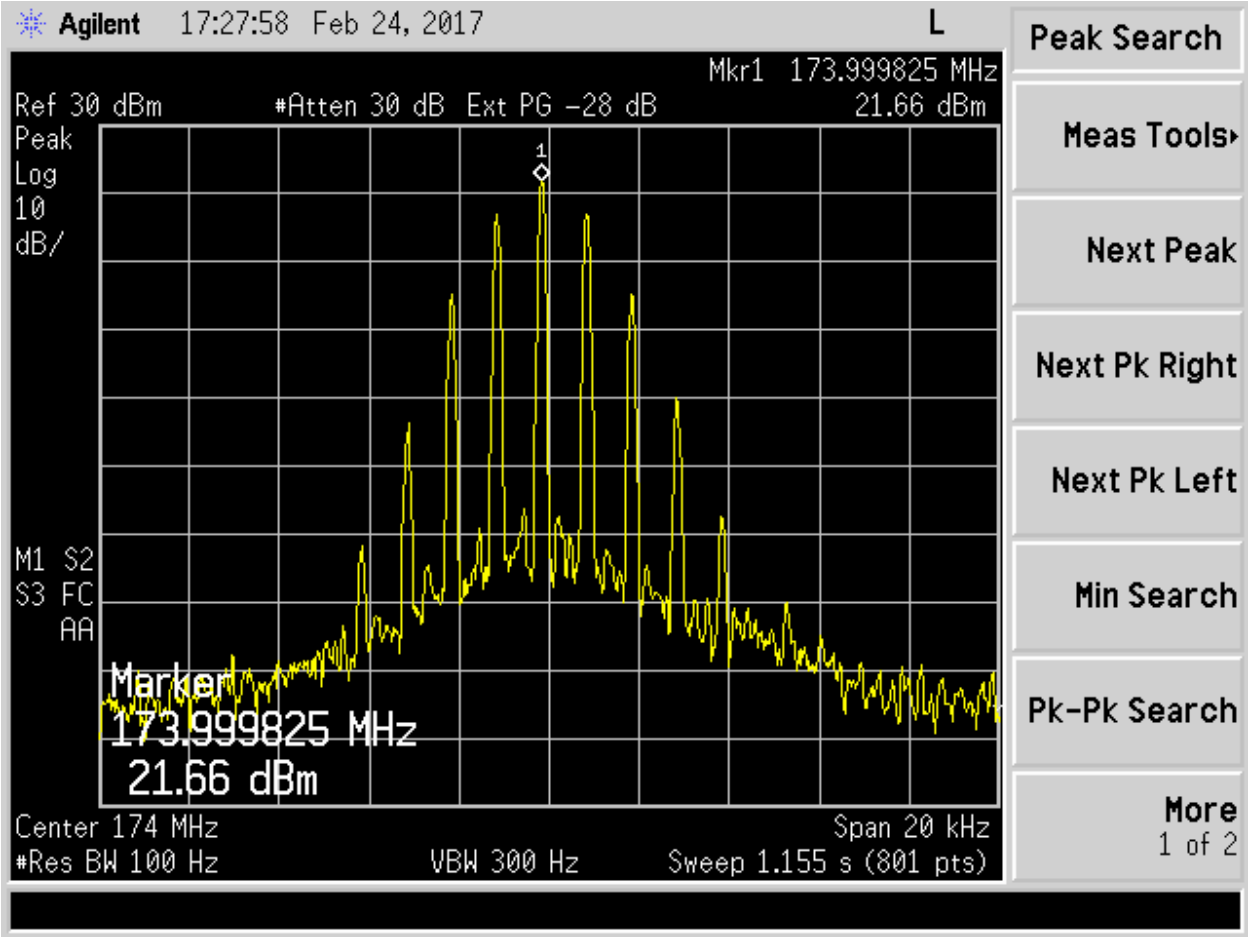

Figure 35. Input 174 MHz @ 6.25 kHz

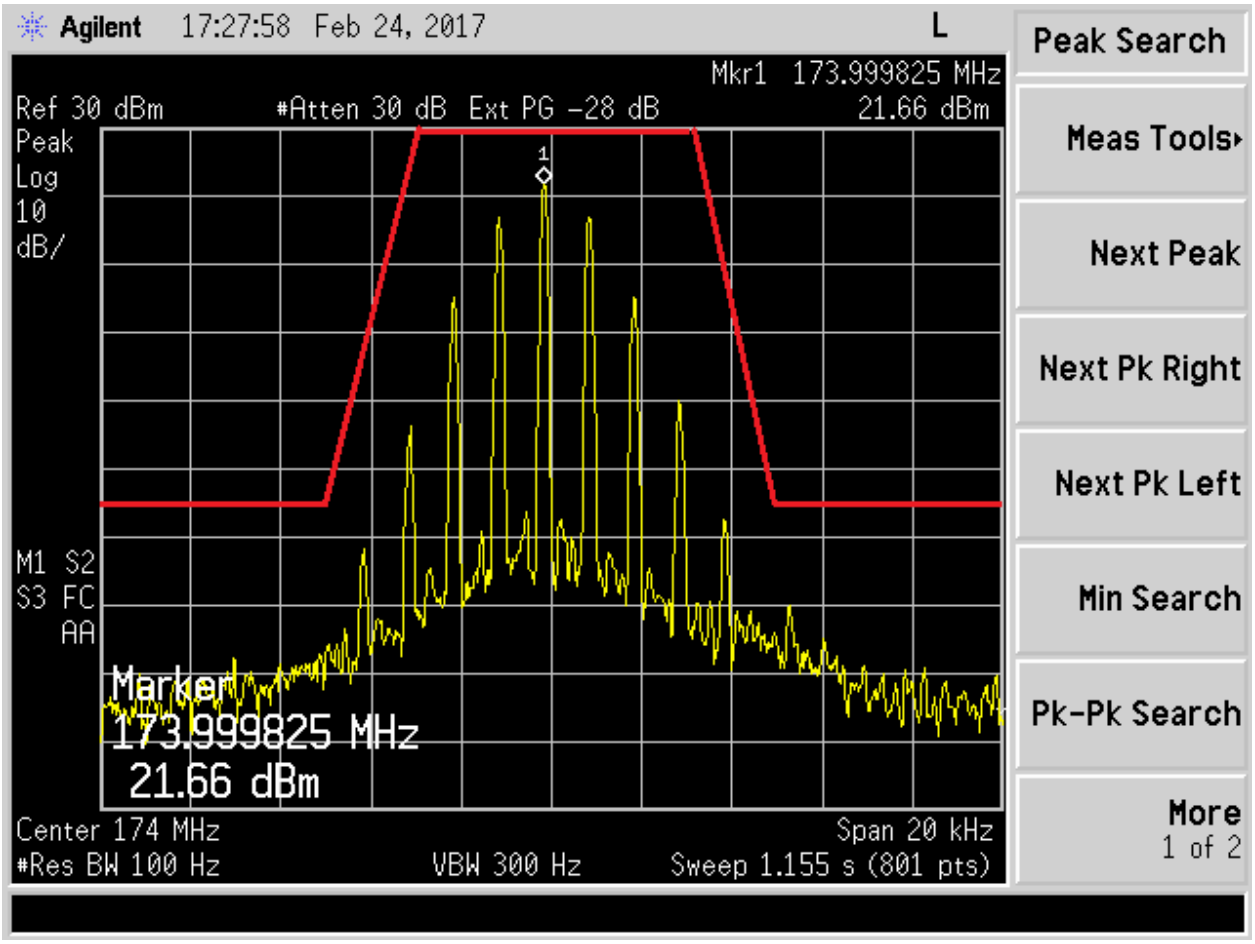

Figure 36. 174 MHz @ 6.25 kHz, Mask E

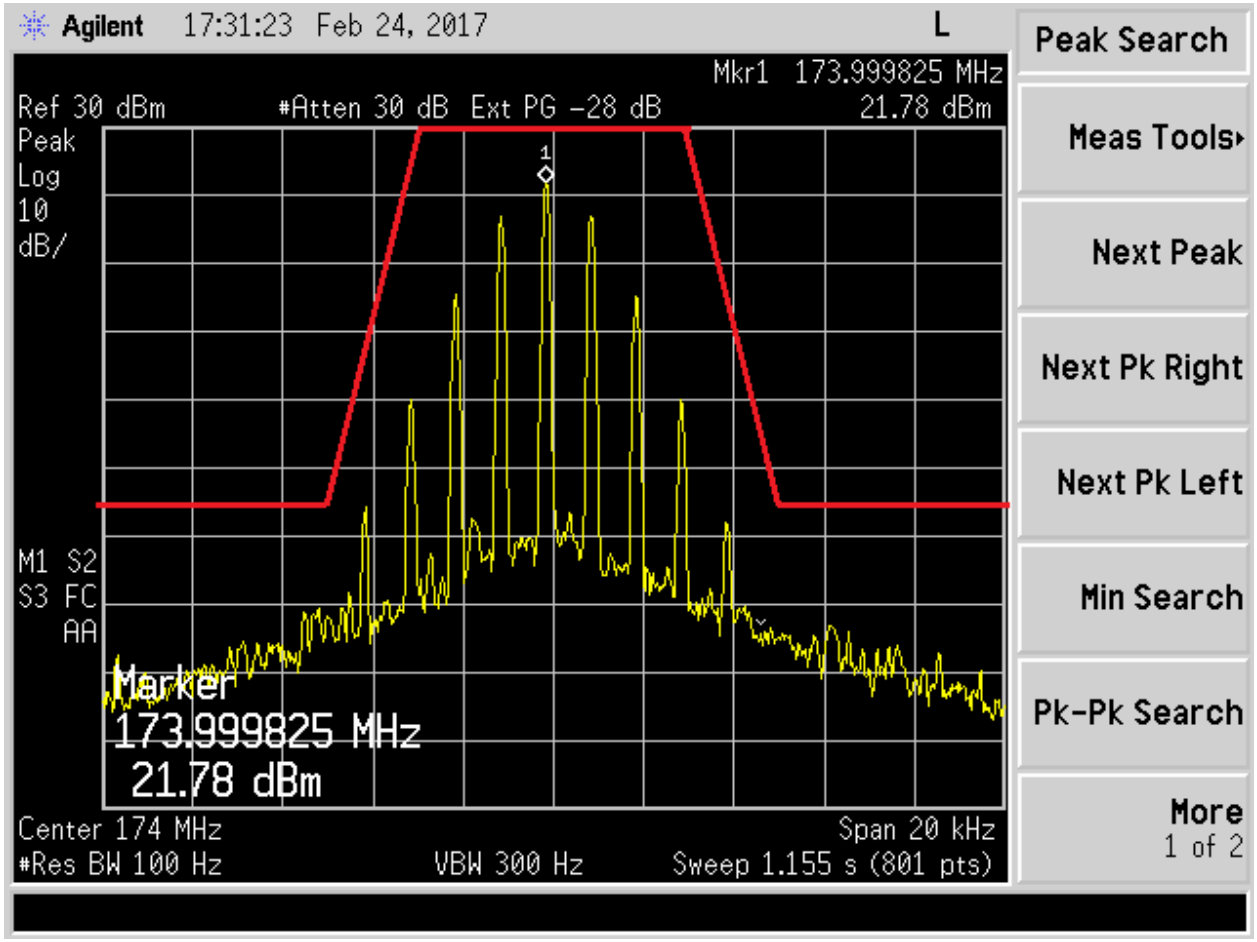

Figure 37. 174 MHz @ 6.25 kHz +3.0 dB, Mask E

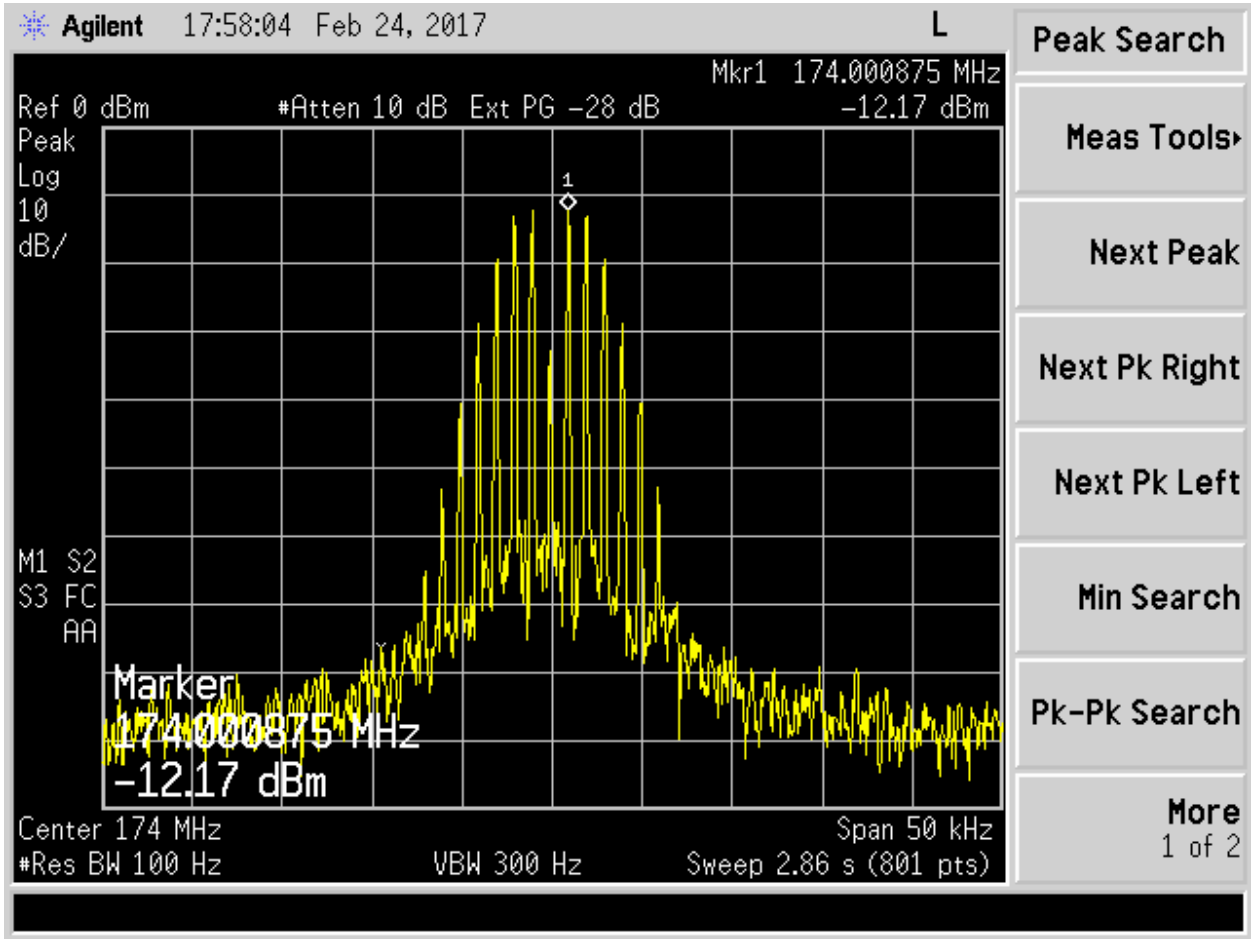

Figure 38. Input 174 MHz @ 12.5 kHz

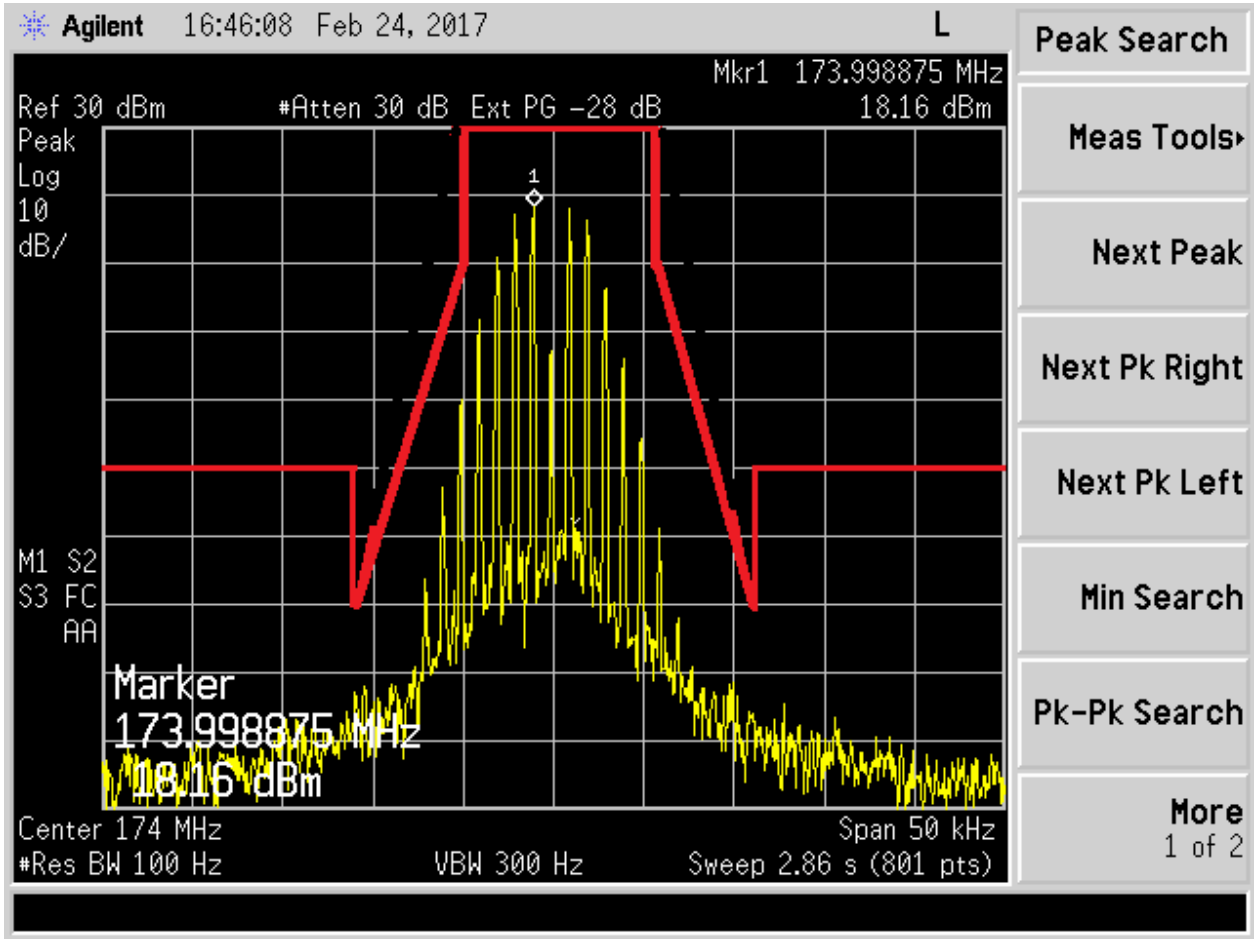

Figure 39. 174 MHz @ 12.5 kHz, Mask D

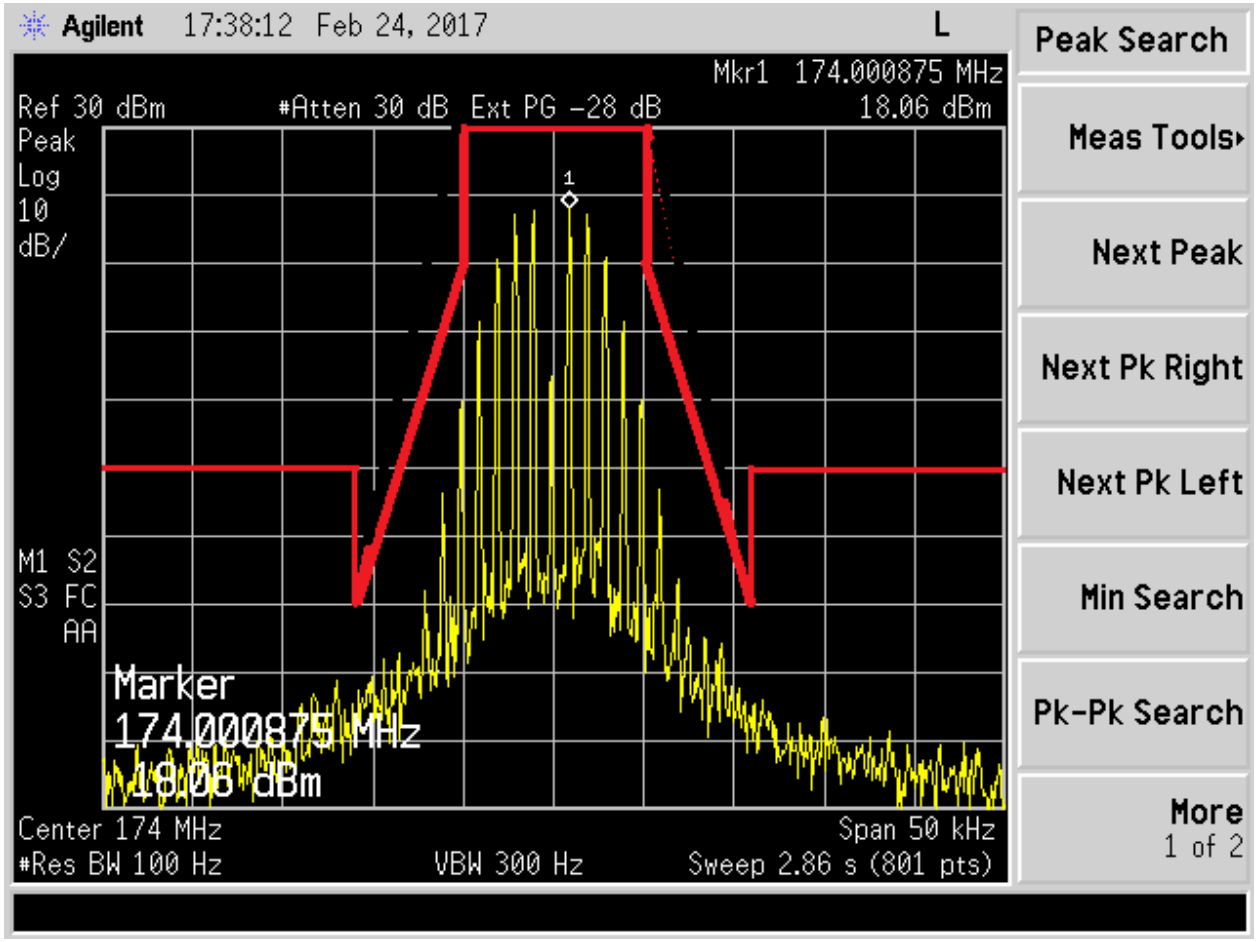

Figure 40. 174 MHz @ 12.5 kHz +3.0 dB, Mask D

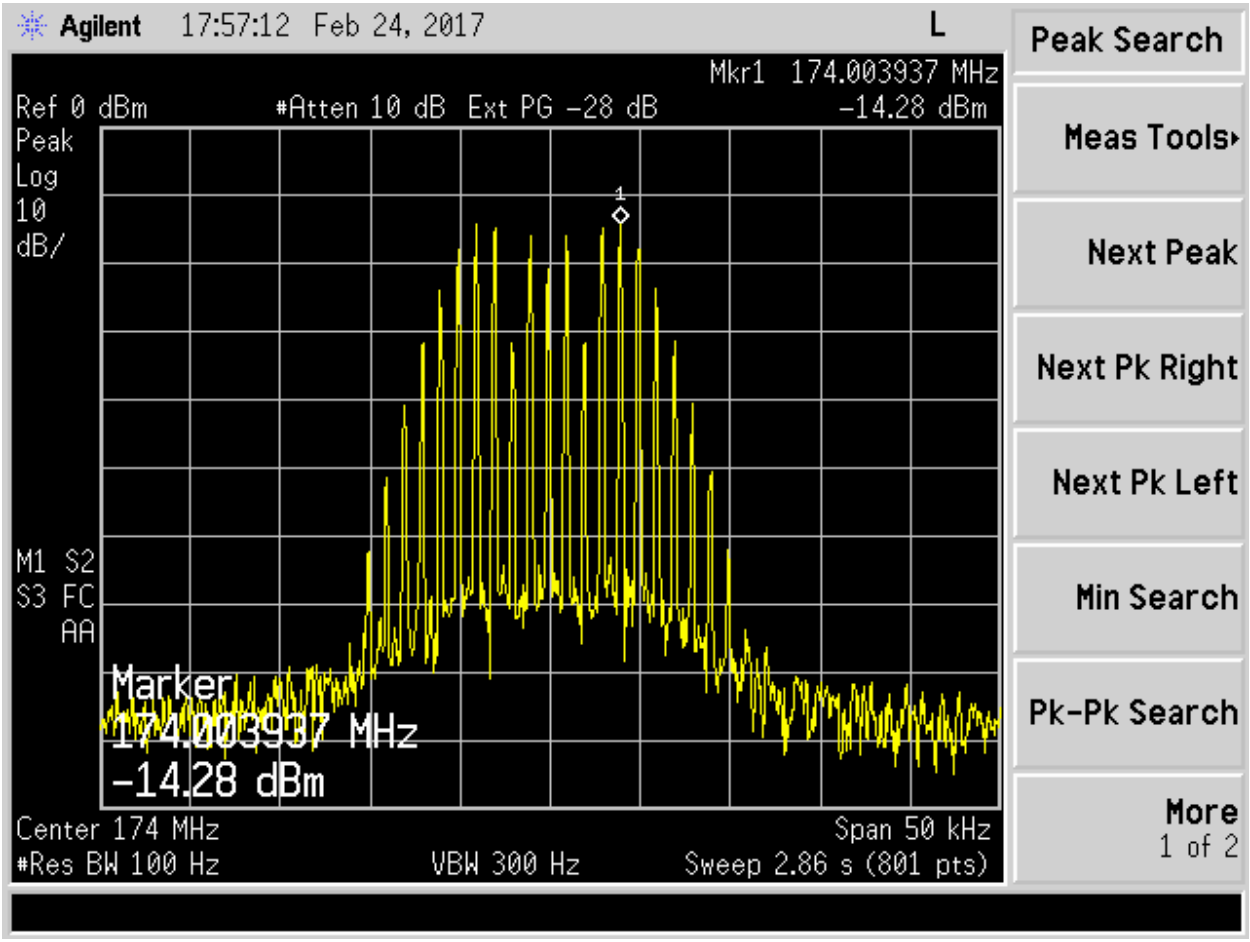

Figure 41. Input 174 MHz @ 25 kHz

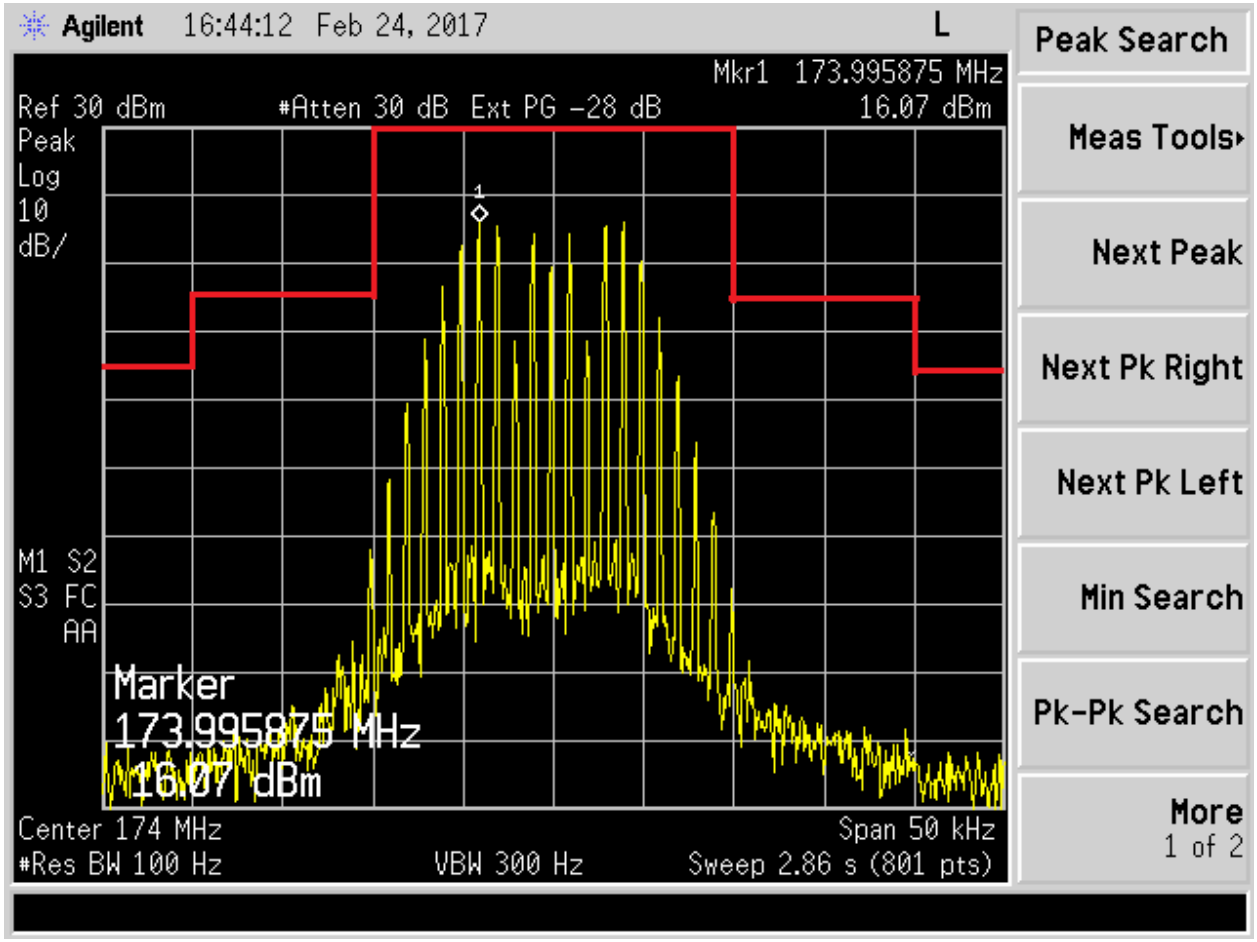

Figure 42. 174 MHz @ 25 kHz, Mask B

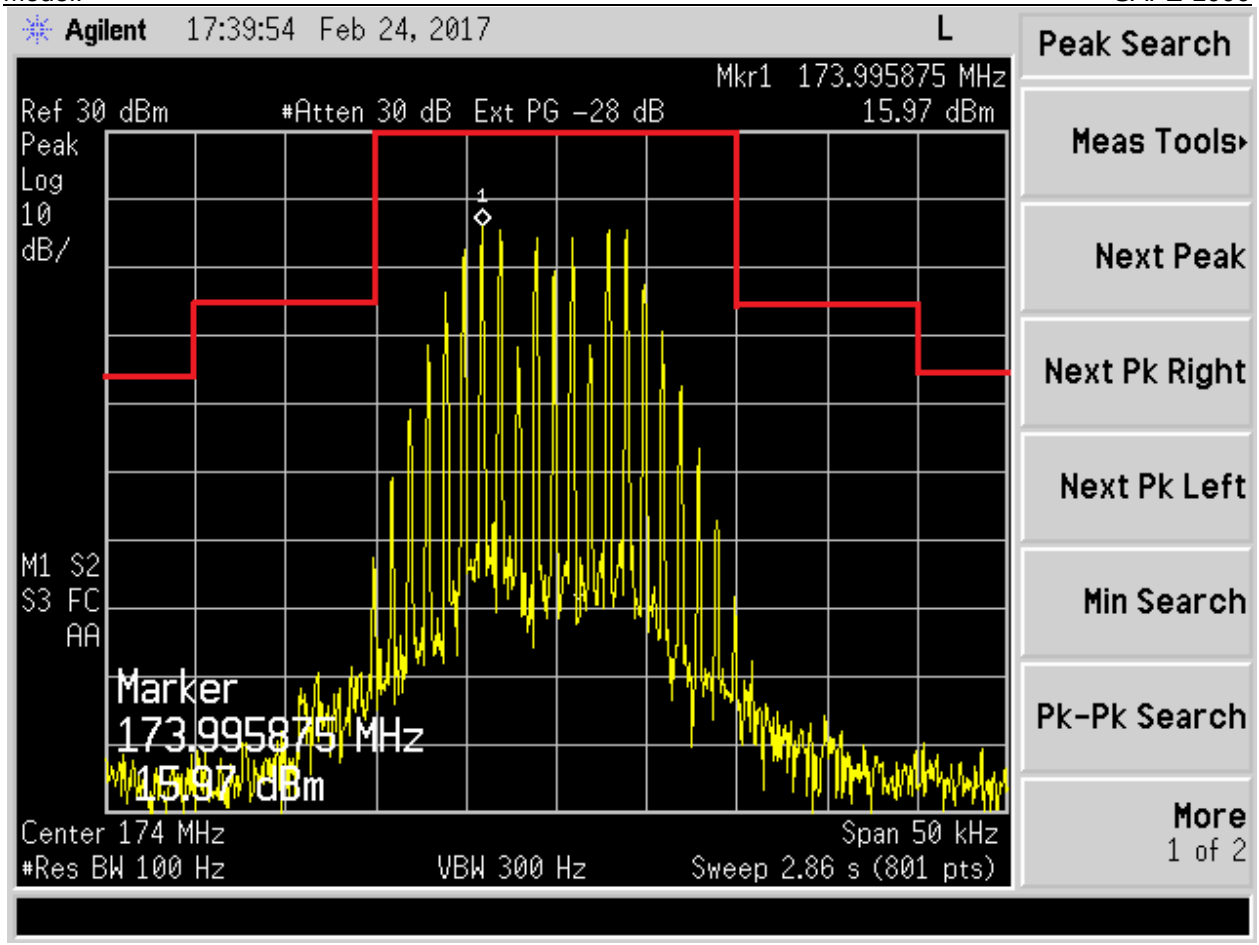

Figure 43. 174 MHz @ 25 kHz +3.0 dB, Mask B