Report of Inter-Modulation Product Measurements

for

Operation of the Combined FM System for

KHIC, 98.5 MHz
KFXX, 99.5 MHz

Located at "KAGO Hill"
Klamath Falls, Oregon

Measurements collected on
June 15, 2017

Prepared By	Prepared For
Wavepoint Research, Inc. PO Box 96 Crane, IN 47522 Eric Wandel, P.E. eric@wavepointresearch.com (812) 453-2544 (mobile)	BASIN MEDIACTIVE LLC LOCAL.COMMUNITY.ENGAGED BASIN MEDIACTIVE, LLC 404 Main Street, Suite 4 Klamath Falls, OR 97601 Attn: Rob Siems, General Manager rob@mybasin.com (541) 850-7114 (office)

Table of Contents

List of Figures

List of Tables

1 Introduction

This report of findings provides evidence to show that the operation of the two-station combined facility for KHIC-FM 98.5 MHz and KFXX-FM 99.5 MHz at "KAGO Hill" in Klamath Falls, Oregon, is in compliance with the FCC Rules and Regulations as required by the Code of Federal Regulations (CFR) Title 47 Section 73.317, and specifically as related to potential intermodulation products that may occur and must be below the limit specified by 73.317 paragraph (d).

Intermodulation (IM) products can potentially violate section 73.317 paragraph (d) requirements and are commonly generated from radio stations operating into multiplexed facilities and at congested antenna broadcast sites when inadequate transmitter to transmitter isolation is provided.

In brief, the collection of measurements presented in this report shows that all possible third order IM products generated by the operation of these stations in the presence of the FM stations operating in the vicinity are less than the maximum allowable level as required by section 73.317(d). Further, the present study investigated possible spurious emissions up to 1 GHz and found no spurious emissions exceeding allowable levels. Eric Wandel of Wavepoint Research, Inc. performed the measurements summarized herein on June 15, 2017.

A variety of equipment was employed to collect the data recorded herein, including:

- Anritsu Sitemaster S332E, Spectrum Analyzer
- Bandpass and bandstop filters for suppressing high power signals
- Attenuators for adjusting the signal levels to optimize the dynamic range of the instrumentation without exceeding input power limits
- A directional coupler installed at output of combiner

Measurements to verify compliance with section 73.317 (d) were made at the directional coupler installed at the output of the combiner system.

2 Transmission System

The layout of the KHIC-KFXX combined transmission system is illustrated in Exhibit A. KHIC and KFXX operated at licensed power for the duration of compliance measurements. The TPO calculations are shown in Exhibit B. The antenna is a Shively Model 6810 six-bay, full wave spaced antenna as shown in Figure 1.

Figure 1 - Antenna Mounting Location on Tower

The installed Shively filter/combiner system was designed to provide adequate isolation to ensure that interfering signals and any resulting intermodulation products are sufficiently attenuated to satisfy the section 73.317 paragraph (d) requirement. The directional coupler used for signal sampling are located at the output of the Shively filter/combiner system.

The inter-modulation products were measured with both transmitters operating at licensed TPO into their respective systems. Rob Meadows, Engineer for Basin Mediactive, confirmed the operational status of both transmitters during the course of measurements.

The directional coupler used for measurements was factory calibrated with a typical directivity of >30 dB and a coupling level that has generally a flat response across the FM band within approximately +/- 0.5 dB. The exact coupling level is not critical since the evaluation of intermodulation products compares relative levels, but the nominal coupling level for this directional coupler is -60.61 dB and was chosen to ensure signal levels can be adequately measured within the dynamic range of the spectrum analyzer.

The forward ports of the output directional coupler was used for sampling the outgoing carrier levels and IM products. The sampled signal was fed by shielded cable into an Anritsu Sitemaster S332E spectrum analyzer. Various attenuation pads were included as needed to ensure adequate signal levels for measurement without overloading the measurement equipment. The measurement setup is illustrated in the attached Exhibit A.

3 Product Measurements

Measurements were made to determine the level of third order IM products (of the type $2F_1 - F_2$) for the operation of the combined system in the presence of strong interfering signals that have potential to couple into the transmitters. The collection of measurements presented in this report shows that all possible third order inter-modulation (IM) products generated by the operation of these stations are less than the maximum allowable level as required by section 73.317(d).

Further, the present study investigates possible spurious emissions up to 1 GHz and found no spurious emissions exceeding allowable levels.

The relative output signal levels for the system carriers are measured first to establish reference levels for other measurements. As stated in CFR Title 47, Section 73.317, measurements of spectral emissions are compared to the level of the unmodulated carrier.

It is sometimes inconvenient to establish this carrier reference level using the actual unmodulated carrier during operation of the station. As an approximation to this, it is generally accepted that the power of the transmitter output can be estimated from the modulated signal using a 300 kHz resolution bandwidth (RBW)[1] which serves to integrate the power in the modulated signal. This method of establishing the carrier reference level is used here as a basis for comparing the potential IM product levels.

The potential third-order product frequencies for the KHIC-KFXX combined system are calculated and listed in Table 1.

Table 1 - Potential Third Order IM Products - KHIC-KFXX System

F1 MHz (Transmitter Frequency)	F2 MHz (Interfering Frequency)	2F1 - F2 MHz (Product Frequency)
98.5	99.5	97.5
99.5	98.5	100.5

The reference signal level for the KHIC and KFXX transmitters as recorded at the output directional coupler are listed in Table 2. The Adjusted Level shown in the last column of the table will be used as the reference level for possible IM products.

[1] *NRSC-G201-A, NRSC-5 RF Mask Compliance: Measurement Methods and Practice,* National Radio Systems Committee, April 2010.

Table 2 - KHIC and KFXX Carrier Reference Levels

Call Sign	Carrier Frequency (MHz)	Pad One (dB)	Bandpass Filter Loss (dB)	Reading (dBm) 300 kHz RBW	Adjusted Level (dBm)*
KHIC	98.5	20	0	-13.21	6.79
KFXX	99.5	20	0	-9.37	10.63

*The adjusted level does not correct for the coupling level of the directional coupler since measurements are relative.

The IM product measurements using the measurement setup shown in Exhibit A were recorded and are listed in Table 3. The signal level referenced to the carrier level is shown in the last column. Additionally, the spectrum was scanned up to 1 GHz in search of potentially high levels; a possible third order harmonic was the only level found above the noise floor with the measured values recorded in Table 4.

All product levels for the KHIC-KFXX combined system meet requirements.

Table 3 - Product Measurements - KHIC-KFXX Combined System

Carrier Frequency (MHz)	Interfering Frequency (MHz)	Product Frequency (MHz)	Pad One (dB)	Bandpass/ Notch Insertion Loss at Product Frequency (dB)	Bandpass/ Notch Attenuation 98.5 MHz (dB)	Bandpass/ Notch Attenuation 99.5 MHz (dB)	IM Level Displayed, With BP Filter 1 kHz RBW (dBm)	Adjusted Reading (dBm)	Carrier Reference Level (dBm)	Level Referenced to Carrier (dB)	Notes
98.5	99.5	**97.5**	30	-9.60	-42.10	-70.00	-113.1	-73.5	6.79	**-80.3**	BP filter 97.5, notch on 99.5
99.5	98.5	**100.5**	20	-13.20	-87.45	-92.73	-106.1	-72.9	10.63	**-83.6**	BP filter 100.5, notches on 98.5 and 99.5

Table 4 - Spectral Measurements to 1 GHz - KHIC-KFXX Combined System

Measured Frequency (MHz)	DC Coupling for Reference Frequency	DC Coupling at Measured Frequency	DC Correction (dB)	Pad One (dB)	IM Level Displayed, With BP Filter 1 kHz RBW (dBm)	Adjusted Reading (dBm)	Carrier Reference Level (dBm) (lowest in system)	Level Referenced to Carrier (dB)	Notes
297.53	**-60.6**	**-51.0**	**-9.6**	23	-114.9	-101.5	6.79	**-108.3**	Notches on 98.5 and 99.5

4 Conclusions

Based upon the observations and measurements recorded in this document, I, Eric R. Wandel, find the operation of the KHIC-KFXX combined FM system to be in compliance with the requirements of CFR Title 47, Section 73.317 as related to generation of intermodulation products due to transmitter to transmitter coupling.

Respectfully submitted by Eric R. Wandel, P.E.

AFFIDAVIT

I, Eric R. Wandel, employed by Wavepoint Research, Inc. and under contract with Basin Mediactive, LLC, in Klamath Fall, Oregon, have performed the preparation of all technical information contained in this document and to my knowledge have made no misrepresentations or false claims.

My qualifications to perform this work are supported as follows:

1. Education includes:
   a) The degree of Bachelor of Science in Electrical Engineering from Rose-Hulman Institute of Technology, Terre Haute, Indiana
   b) The degree of Bachelor of Science in Applied Optics from Rose-Hulman Institute of Technology, Terre Haute, Indiana
   c) The degree of Master of Science in Electrical Engineering from Rensselaer Polytechnic Institute, Troy, New York
2. Experience includes:
   a) 25 years of experience in systems engineering work related to RF engineering, signal processing, antenna and filter design, including design, installation and field checkout of high power broadcast systems involving combined operation of multiple stations.
3. Licensed Professional Engineer
   a) State of Indiana, Registration No. 19900140

Eric R Wandel

Eric R. Wandel, P.E.

7/12/2017

Date

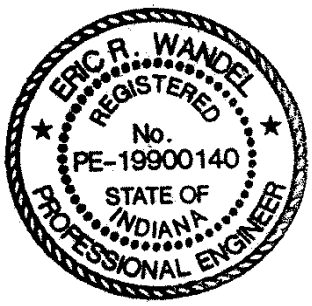


Exhibit A – KHIC-KFXX Transmission System Layout

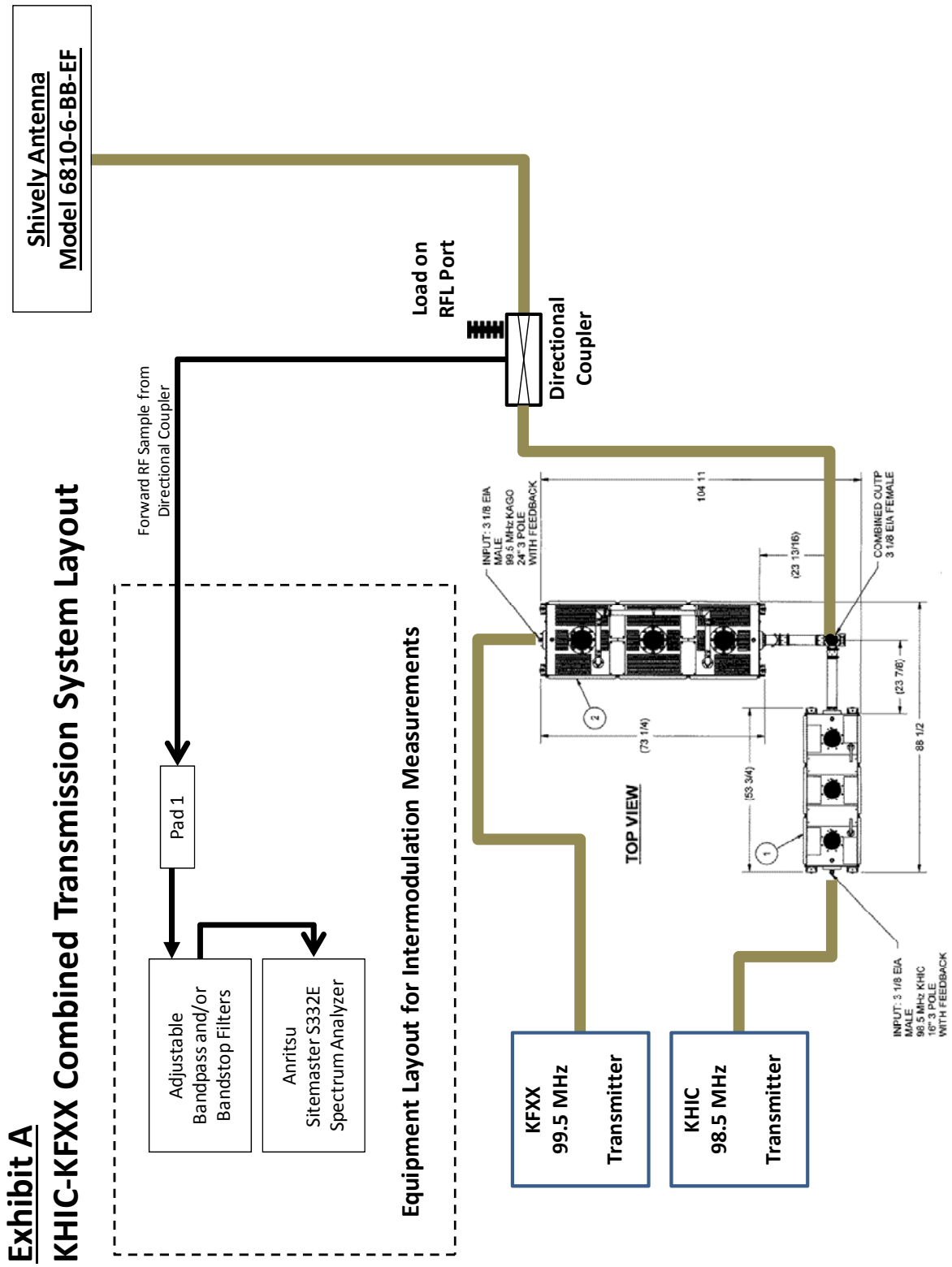


Exhibit B – Calculation of TPO for KHIC-KFXX Main Facility

KHIC-KFXX Combined System
TPO Calculations

	KHIC	KFXX
Station Call Sign	**KHIC**	**KFXX**
Frequency (MHz)	**98.5**	**99.5**
	Analog	**Analog**
ERP (W)	**20000**	**60000**
Antenna Model	Shively 6-bay	Shively 6-bay
Antenna gain elevation	3.291	3.268
Antenna azimuth gain	1	1
Antenna Gain, peak of beam (multiplier)	3.2910	3.2680
Antenna input power (W)	**6077**	**18360**
Vertical Line Run	HCA300-50J 3" Heliflex	HCA300-50J 3" Heliflex
Line Length (feet)	200	200
Line loss per hundred feet (dB/100')	0.126	0.127
Vertical Line loss total (dB)	0.2520	0.2540
Power out of Isocoupler (W)	**6440**	**19466**
Isocoupler Insertion Loss (dB) (factory meas)	0.2948	0.2302
Power Input to Isocoupler (W)	**6893**	**20525**
Horizontal Line Run	HCA300-50J 3" Heliflex	HCA300-50J 3" Heliflex
Line Length (feet)	20	20
Line loss per hundred feet (dB/100')	0.126	0.127
Horizontal Line loss total (dB)	0.0252	0.0254
Power Into Transmission Line (W)	**6933**	**20646**
Filter Insertion Loss (dB) (factory measurements)	0.1701	0.2385
TPO (W)	**7210**	**21811**

Exhibit C – Citation from CFR Title 47, Section 73.317

Code of Federal Regulations

TITLE 47 - TELECOMMUNICATION
CHAPTER I - FEDERAL COMMUNICATIONS COMMISSION
SUBCHAPTER C - BROADCAST RADIO SERVICES
PART 73 - RADIO BROADCAST SERVICES
Subpart B - FM Broadcast Stations

§ 73.317 FM transmission system requirements.

a) FM broadcast stations employing transmitters authorized after January 1, 1960, must maintain the bandwidth occupied by their emissions in accordance with the specification detailed below. FM broadcast stations employing transmitters installed or type accepted before January 1, 1960, must achieve the highest degree of compliance with these specifications practicable with their existing equipment. In either case, should harmful interference to other authorized stations occur, the licensee shall correct the problem promptly or cease operation.

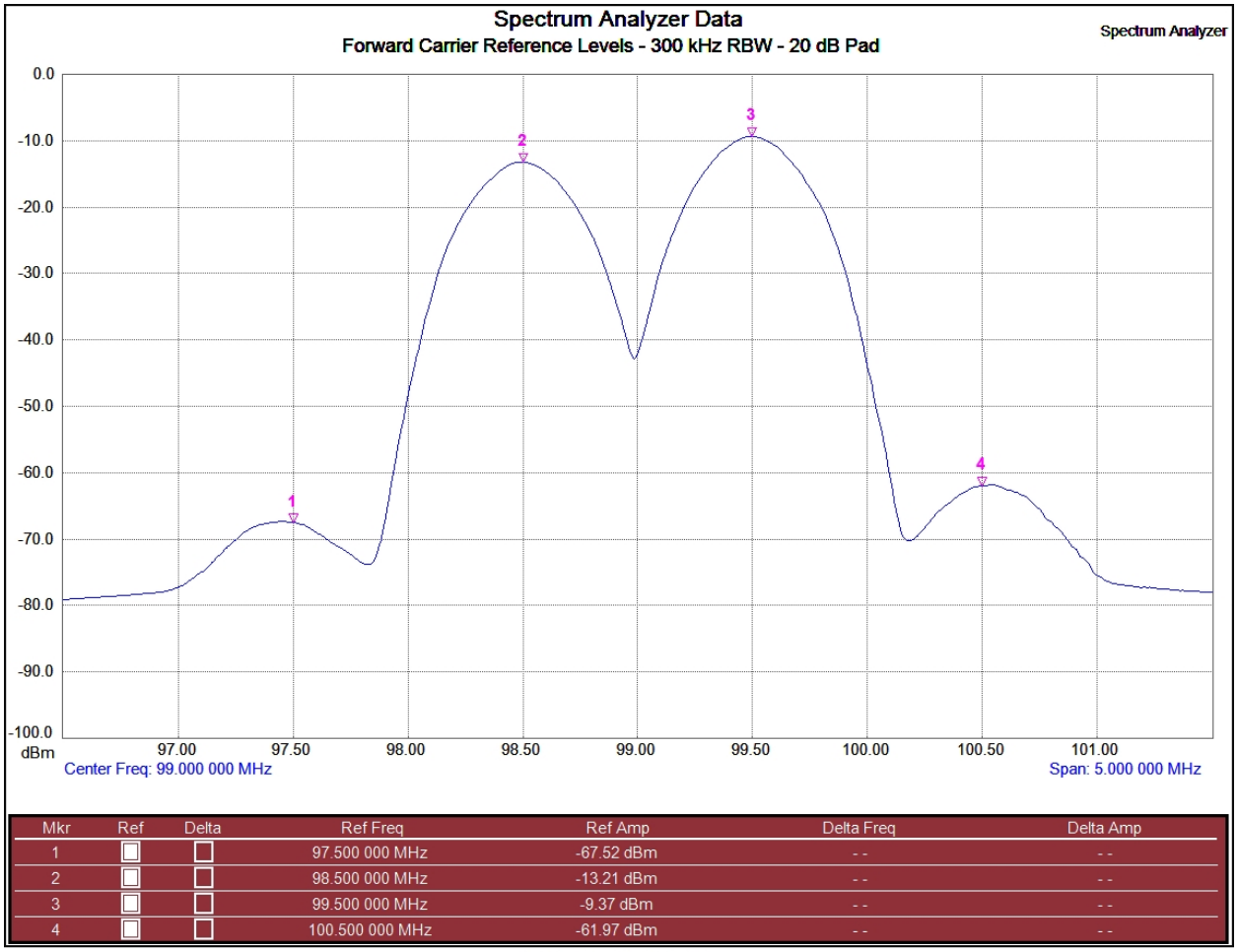
b) Any emission appearing on a frequency removed from the carrier by between 120 kHz and 240 kHz inclusive must be attenuated at least 25 dB below the level of the unmodulated carrier. Compliance with this requirement will be deemed to show the occupied bandwidth to be 240 kHz or less.

c) Any emission appearing on a frequency removed from the carrier by more than 240 kHz and up to and including 600 kHz must be attenuated at least 35 dB below the level of the unmodulated carrier.

d) Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least $43 + 10 \text{ Log}_{10}$ (Power, in watts) dB below the level of the unmodulated carrier, or 80 dB, whichever is the lesser attenuation.

e) Preemphasis shall not be greater than the impedance-frequency characteristics of a series inductance resistance network having a time constant of 75 microseconds. (See upper curve of Figure 2 of § 73.333.)

Exhibit D – Spectrum Analyzer Screen Images

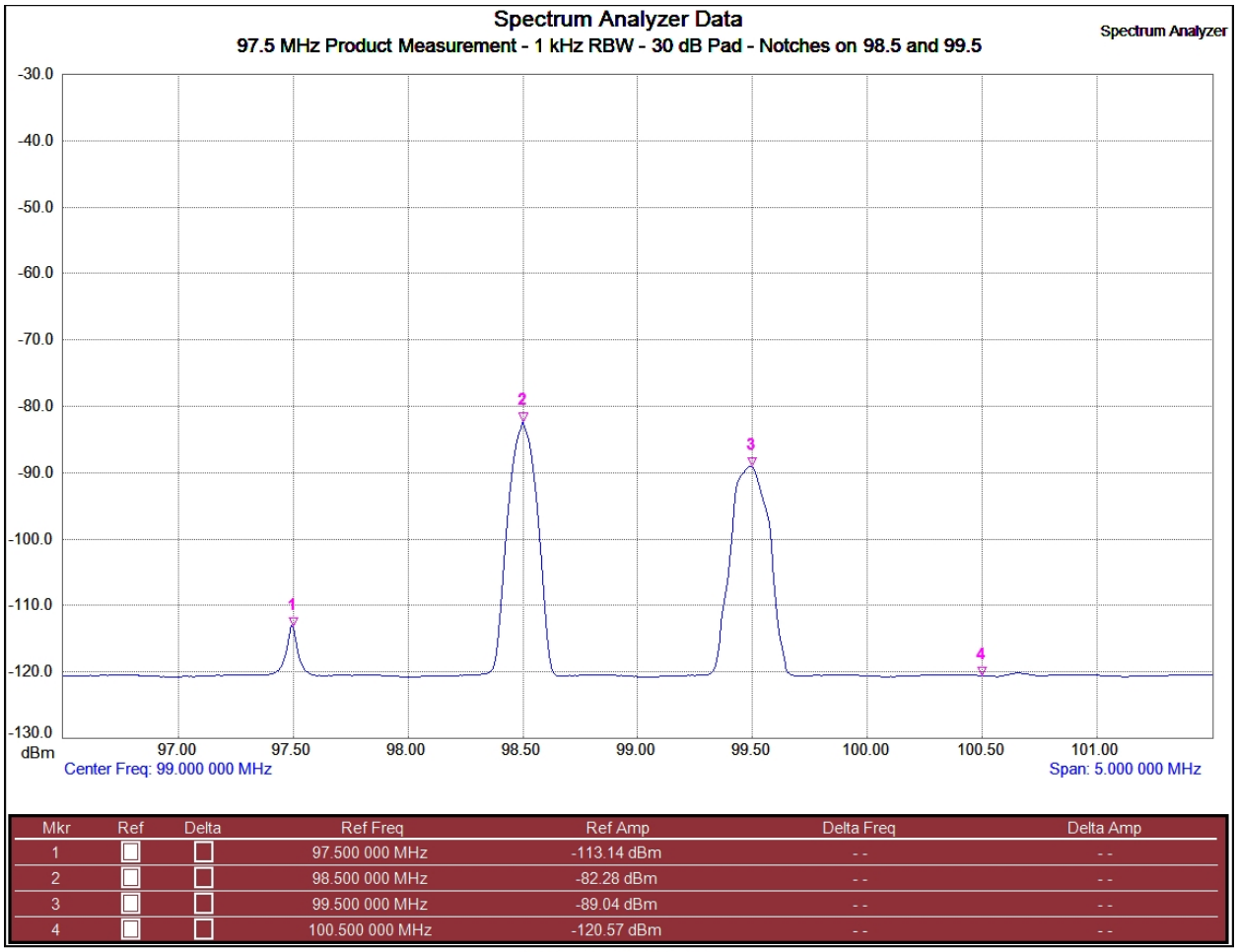


Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1			97.500 000 MHz	-67.52 dBm	- -	- -
2			98.500 000 MHz	-13.21 dBm	- -	- -
3			99.500 000 MHz	-9.37 dBm	- -	- -
4			100.500 000 MHz	-61.97 dBm	- -	- -

Measurement Parameters

Trace A data:Trace Average	50	Stop Frequency	101.500 000 MHz
Trace Mode	Average	Frequency Span	5.000 000 MHz
Preamp	OFF	Reference Level	0.000 dBm
Min Sweep Time	1 S	Scale	10.0 dB/div
Reference Level Offset	0 dB	Serial Number	1104062
Input Attenuation	5.0 dB	Base Ver.	V4.69
RBW	300.0 kHz	App Ver.	V6.11
VBW	1.0 kHz	Model	S332E
Detection	RMS	Options	
Center Frequency	99.000 000 MHz	Date	6/15/2017 14:31:04
Start Frequency	96.500 000 MHz	Device Name	

Forward Carrier Reference Levels - 300 kHz RBW

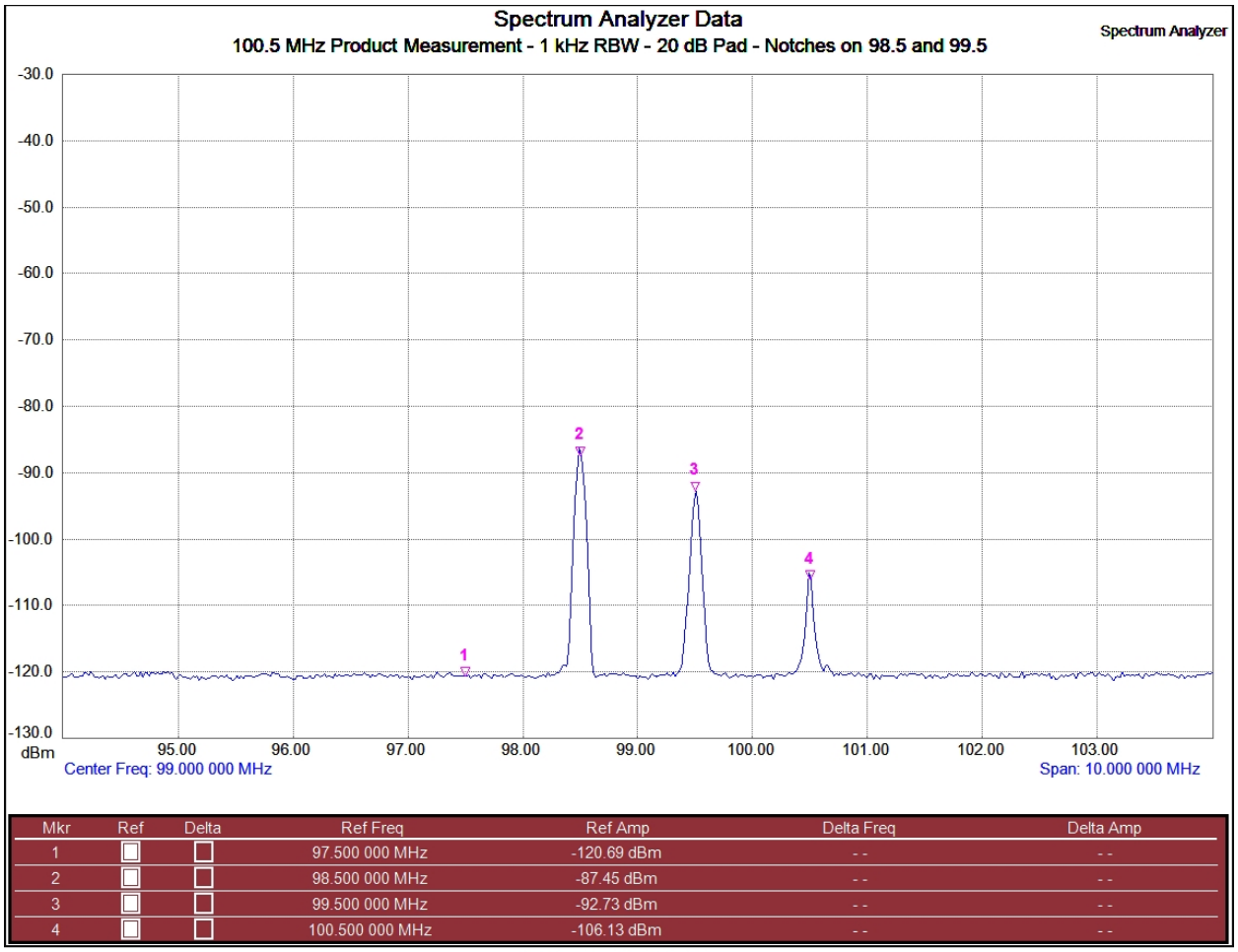


Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	97.500 000 MHz	-113.14 dBm	- -	- -
2	☐	☐	98.500 000 MHz	-82.28 dBm	- -	- -
3	☐	☐	99.500 000 MHz	-89.04 dBm	- -	- -
4	☐	☐	100.500 000 MHz	-120.57 dBm	- -	- -

Measurement Parameters

Trace A data:Trace Average	50	Stop Frequency	101.500 000 MHz
Trace Mode	Average	Frequency Span	5.000 000 MHz
Preamp	OFF	Reference Level	-30.000 dBm
Min Sweep Time	1 S	Scale	10.0 dB/div
Reference Level Offset	0 dB	Serial Number	1104062
Input Attenuation	0.0 dB	Base Ver.	V4.69
RBW	1.0 kHz	App Ver.	V6.11
VBW	1.0 kHz	Model	S332E
Detection	RMS	Options	
Center Frequency	99.000 000 MHz	Date	6/15/2017 15:55:33
Start Frequency	96.500 000 MHz	Device Name	

97.5 Product Measurement - 1 kHz RBW

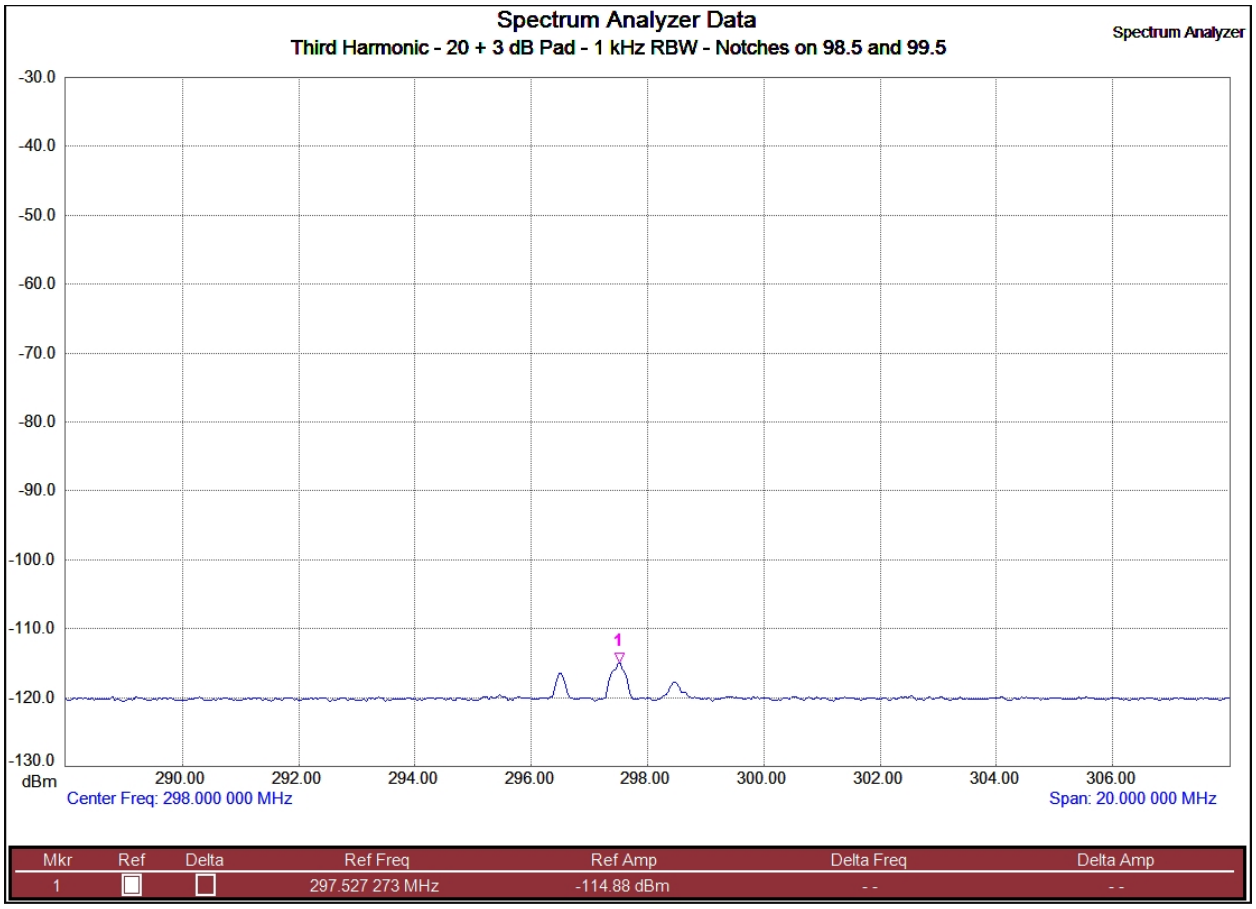


Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	97.500 000 MHz	-120.69 dBm	- -	- -
2	☐	☐	98.500 000 MHz	-87.45 dBm	- -	- -
3	☐	☐	99.500 000 MHz	-92.73 dBm	- -	- -
4	☐	☐	100.500 000 MHz	-106.13 dBm	- -	- -

Measurement Parameters

		Stop Frequency	104.000 000 MHz
Trace Mode	Normal	Frequency Span	10.000 000 MHz
Preamp	OFF	Reference Level	-30.000 dBm
Min Sweep Time	1 S	Scale	10.0 dB/div
Reference Level Offset	0 dB	Serial Number	1104062
Input Attenuation	0.0 dB	Base Ver.	V4.69
RBW	1.0 kHz	App Ver.	V6.11
VBW	1.0 kHz	Model	S332E
Detection	RMS	Options	
Center Frequency	99.000 000 MHz	Date	6/15/2017 19:24:31
Start Frequency	94.000 000 MHz	Device Name	

100.5 Product Measurement - 1 kHz RBW



Measurement Parameters

Trace A data:Trace Average	50	Stop Frequency	308.000 000 MHz
Trace Mode	Average	Frequency Span	20.000 000 MHz
Preamp	OFF	Reference Level	-30.000 dBm
Min Sweep Time	1 S	Scale	10.0 dB/div
Reference Level Offset	0 dB	Serial Number	1104062
Input Attenuation	0.0 dB	Base Ver.	V4.69
RBW	1.0 kHz	App Ver.	V6.11
VBW	1.0 kHz	Model	S332E
Detection	RMS	Options	
Center Frequency	298.000 000 MHz	Date	6/15/2017 20:05:59
Start Frequency	288.000 000 MHz	Device Name	

Measurement of Third Harmonic Level