

Report Of

Intermodulation Product Findings

Austin, TX.

KLBJ-FM – 93.7 MHz.
K259AJ – 99.7 MHz.
KROX – 101.5 MHz.
K274AX – 102.7 MHz.
KBPA – 103.5 MHz.

Project# 38094

October 25, 2020

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REPORT OF FINDINGS AUSTIN, TEXAS BROADCAST FACILITY

Introduction: This report of findings is based on data collected at the FM broadcast facility located in Austin, TX. The report includes measurements offered as proof that the combined operations of KLBK-FM (93.7 MHz.), K259AJ (99.7 MHz.), KROX (101.5 MHz.), K274AX (102.7 MHz.), and KBPA (103.5 MHz.), transmitters are in compliance with the FCC Rules and Regulations as required by the Code of Federal Regulations (CFR) Title 47 section 73.317 paragraph (b) through (d). K259AJ (99.7 MHz.), and K274AX (102.7 MHz.), have the ability to operate into a separate antenna that is co-located on the tower. There affects have been considered in this report as well. In brief, the collection of measurements presented in this report shows that all possible third order inter-modulation (IM) products generated by this multiplexed and single station systems are less than the maximum allowable level as required by section 73.317 (b) through (d). Jeff Taylor of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on October 25, 2020.

The following exhibits are provided:

Exhibit A:

- A-1 Drawing Depicting Cog Antenna.
- A-2 SHP-8AC6-SP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexed Scheme.
- A-4 Multiplexer Specification Sheet.
- A-5 Theoretical Vertical Plane Relative Field Antenna Plots

Exhibit B:

- B-1 Equipment Employed In Intermodulation Product Measurement.
- B-2 Broadcasting Scheme of the Multiplexed Systems.
- Table 1. Carrier Reference Levels.
- Table 2. Calculated Third Order Products.
- Table 3. Intermodulation Analysis Measurements.

Exhibits Accompanying Report: Exhibit A provides comprehensive information on both antenna and filters used by these radio stations. Exhibit B illustrates the broadcasting scheme of each station, the layout of the equipment used to isolate and measure potential intermodulation products and forward carrier reference levels. Found within Table 1 are the narrow band carrier frequency measurements that provide relative output signal levels for the IM analysis. Table 2 lists the calculated third order products that can be generated from FM transmitters broadcasting from the multiplexed system. The IM Analysis Measurements, in Table 3, provides detailed information obtained from the product frequency investigation.

The Nature of Intermodulation Products (IM): Intermodulation products result from inadequate transmitter-to-transmitter isolation. Intermodulation products are commonly generated from radio stations operating into multiplexed facilities and congested antenna broadcast sites. The mechanics associated with the phenomenon have been well documented. When two or more transmitters are coupled to each other, new spectral components are produced by the mixing of the station frequencies in the active circuits of each transmitter. The common term used to describe this phenomenon is third order product denoted by the mathematical expression $[2(F_1)-(F_2)]$, where F_1 signifies the frequency of the transmitter that is generating the intermodulation product, and F_2 signifies the frequency causing the interference.

The Multiplexed System: These measurements were taken with all FM stations operating from their respective antenna systems. The KLBJ-FM, K259AJ, KROX, K274AX, and KBPA, multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHP-8AC6-SP antenna, combiner units, MACXLine 450 feedline, are products of Electronics Research, Inc. Refer to Exhibit B-1, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of 3 or 4 transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of: (1) 783-8 Constant Impedance combiner module for 93.7 MHz., (1) 780-6 Constant Impedance combiner module for 101.5 MHz., (1) 783-4 Band Pass Filter for 103.5 MHz., (1) 955-4 "T" combiner was installed for frequencies, 99.7, and 102.7 MHz. Interconnecting "u-links", "T", and 3" switch are required to complete the combiner which is illustrated in the attached Exhibit A-3. Note: At this time the combiner is designed to operate as either a three station combined system or as a four station combined system depending on the position of the 3 1/8" switch. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -50 dB. Other performance measurements, such as match, loss, group-delay, etc, revealed that the multiplexer unit was in proper working condition. Refer to Exhibit A-4 for the Combiner Specification Sheet.

The IM Investigation: Directional Couplers were placed at key locations throughout the combiner to monitor and maintain the multiplexer's performance. All couplers furnished with the system are factory calibrated and capable of delivering accurate and repeatable RF measurements. To facilitate the taking of the measurements, the coupler located at the antenna output of the multiplexed system was used. Care was taken in the selection of the measurement location to ensure that the measurements would be made far removed from transmitters and any filtering used to reduce broadcast emissions. The coupler selected would normally be used for antenna reflection measurements and thus would provide greater than -38 dB directivity and a forward signal sample of -45 dB for the high-power stations and greater than -35 dB and a forward signal sample of -40 dB for the low-power stations.

The forward port of the coupler was used for sampling the outgoing carrier levels and IM products. The IM sampled signal was fed by shielded cable into a Band Pass Filter where all extraneous energy was steeply attenuated. Various attenuation pads were used, when needed, on the band pass filter and/or the Spectrum Analyzer to ensure an adequate signal level for measurements without overloading the measurement equipment. A Rohde & Schwarz Spectrum Analyzer serial# 103069 was employed to record the level of all signals investigated. A Rohde & Schwarz Network Analyzer serial# 100396 was used for selective tuning of the Band Pass Filter. The Rohde & Schwarz Spectrum Analyzer was also used to measure the close in spectral attenuation of each carrier and wide band search for any anomalies that may need further investigation. See attached Exhibit B-1 for an illustration of the measurement equipment.

Prior to recording measurements, all pertinent broadcasting equipment including Transmitters, Multiplexer, Feed Line and Antenna were adjusted to optimal performance. Also, it was confirmed before taking any measurements that all transmitters were operating at full licensed power. From the equipment setup described above, the relative output signal level of each stations forward carrier was made. The resulting signal levels of these measurements are listed in Table 1, column labeled "Adjusted Level". This level will be used as the reference level for possible IM products of each carrier and was necessary to confirm that no significant levels of spurious energy, referenced to each carrier, were present from any transmitter operating from the multiplexed system.

Table 1 - Carrier Reference Levels.

Carrier Frequency (MHz)	Pad One (dB)	Full Scale Range (dB)	Scale Reading (dBm)	Carrier Level (dBm)	Notes
KLBJ-FM 93.7	10	---	16.7	26.7	
K259AJ 99.7	10	---	-0.3	9.7	
KROX 101.5	10	---	9.2	19.2	
K274AX 102.7	10	---	-0.2	9.8	
KBPA 103.5	10	---	15.7	25.7	

Predictable third-order products due to system harmonics mixed with all on-site interfering frequencies that could be generated from the multiplexed system are calculated and listed in Table 2.

Table 2 - Third order Products.

Carrier Frequencies					
Interfering Frequencies	93.7	99.7	101.5	102.7	103.5
93.7 MHz.	----	105.7	109.3	111.7	113.3
99.7 MHz.	87.7	----	103.3	105.7	107.3
101.5 MHz.	85.9	97.9	----	103.9	105.5
102.7 MHz.	84.7	96.7	100.3	----	104.3
103.5 MHz.	83.9	95.9	99.5	101.9	----

Using the equipment previously described the IM product measurements were recorded and are listed in Table 3. The signal levels referenced to the carriers are calculated and listed in the column labeled "Level Referenced to Carrier". Refer to Exhibit B-2 for a layout of the measurement equipment.

Table 3 – Intermodulation Measurements

IM Measurements Taken in Austin, Texas										
Product Frequency (MHz)	Transmitter Frequency (MHz)	Interfering Frequency (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Total Loss	Measured Level (dBm)	Adjusted Level (dB)	Carrier Reference Level (dBm)	Level Referenced to Carrier (dB)	Notes*
Transmitter Mixes										
	93.7	Ref.	10		10	16.7	26.7	26.7		
	99.7	Ref.	10		10	-0.3	5.1	9.7		
	101.5	Ref.	10		10	9.2	19.2	19.2		
	102.7	Ref.	10		10	-0.2	9.8	9.8		
	103.5	Ref.	10		10	15.7	25.7	25.7		
84.7	93.7	102.7	10	12.7	22.7	-95.1	-72.4	26.7	-99.1	
85.9	93.7	101.5	10	13.6	23.6	-94.8	-71.2	26.7	-97.9	
87.7	93.7	99.7	10	13.2	23.2	-97.1	-73.9	26.7	-100.6	
96.7	99.7	102.7	10	12.8	22.8	-88.89	-66.09	9.7	-75.79	2
97.9	99.7	101.5	10	12.7	22.7	-96.2	-73.5	9.7	-80.2	1
100.3	101.5	102.7	10	12.5	22.5	-95.9	-73.4	19.2	-92.6	
103.3	101.5	99.7	10	12.6	22.6	-95.2	-72.6	19.2	-91.8	
103.9	102.7	101.5	10	12.6	22.6	-94.8	-72.2	9.8	-82.0	
105.7	99.7	93.7	10	12.5	22.5	-94.9	-72.4	9.7	-82.1	1
105.7	102.7	99.7	10	12.5	22.5	-94.9	-72.4	9.8	-82.2	
109.3	101.5	93.7	10	12.9	22.9	-95.2	-72.3	19.2	-91.5	
111.7	102.7	93.7	10	12.5	22.5	-95.4	-72.9	9.8	-82.7	

(1) Low Power rule Section 73.317 paragraph D.

(2) Local Carrier 96.7 MHz. KHFI

IM Measurements Taken in Austin, Texas

Product Frequency (MHz)	Transmitter Frequency (MHz)	Interfering Frequency (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Total Loss	Measured Level (dBm)	Adjusted Level (dB)	Carrier Reference Level (dBm)	Level Referenced to Carrier (dB)	Notes*
Transmitter Mixes										
	93.7	Ref.	10		10	16.7	26.7	26.7		
	99.7	Ref.	10		10	-0.3	9.7	9.7		
	101.5	Ref.	10		10	9.2	19.2	19.2		
	102.7	Ref.	10		10	-0.2	9.8	9.8		
	103.5	Ref.	10		10	15.7	25.7	25.7		
83.9	93.7	103.5	10	13.6	23.6	-95.6	-72.0	26.7	-98.7	
84.7	93.7	102.7	10	12.7	22.7	-95.1	-72.4	26.7	-99.1	
85.9	93.7	101.5	10	13.6	23.6	-94.9	-71.3	26.7	-98.0	
87.7	93.7	99.7	10	13.2	23.2	-97.1	-73.9	26.7	-100.6	
99.5	101.5	103.5	10	12.7	22.7	-94.3	-71.6	19.2	-90.8	
100.3	101.5	102.7	10	12.7	14.1	-95.9	-81.8	19.2	-101	
103.3	101.5	99.7	10	12.6	22.6	-89.9	-67.3	19.2	-86.5	
104.3	103.5	102.7	10	14.1	24.1	-93.8	-69.7	25.7	-95.4	
105.5	103.5	101.5	10	14.1	24.1	-96.5	-72.4	25.7	-98.1	
107.3	103.5	99.7	10	13.5	23.5	-95.2	-71.7	25.7	-97.4	
109.3	101.5	93.7	10	12.9	22.9	-95.2	-72.3	19.2	-91.5	
113.3	103.5	93.7	10	12.9	22.9	-94.7	-71.8	25.7	-97.5	

The Spectrum Analyzer was used to check the close in spectral attenuation of the carrier to confirm the operation of the transmitter, is in compliance with Sections (b) and (c) of the FCC Rules and Regulations.

As a final proof of the systems IM Product performance, a wide band search was undertaken using the Spectrum Analyzer. The purpose for this measurement was to look for suspicious anomalies that may warrant further investigation. My search ranged the complete frequency span of the receiver and resulted in no additional investigations.

Conclusion: Based upon my observations and measurements taken on October 25, 2020 as summarized in this document, I, Jeff Taylor, find the subject system, specifically the transmitters and filter systems for the operation of KLBJ-FM, K259AJ, KROX, K274AX, and KBPA into their respective antennas to be in proper working order. Furthermore, based on the measured data, it is my opinion that there are no inter-modulation products in excess of 80 dB below carrier levels generated from or within the station operating on the installed system. Based on this recorded data, I conclude that of KLBJ-FM, K259AJ, KROX, K274AX, and KBPA, are in compliance with the requirements of Section 73.317 paragraph (b) through (d) of the FCC Rules and Regulations.

Respectfully submitted,
Electronics Research, Inc.

Jeff Taylor, Field Technician

State of Indiana)
) SS:
County of Warrick)

AFFIDAVIT

I, Jeff Taylor, hereby declare that the following statements are true and correct to the best of my knowledge and belief :

- 1.) I am a Field Technician for Electronics Research, Inc ("ERI ") and have been employed by ERI for 24 years. I am familiar with and have assisted in the design, manufacturing and installation of FM Antennas and FM Multiplexers in my long tenure with ERI.
- 2.) I have either prepared and/or directly supervised the preparation of all technical information contained in this Report of Findings and to my knowledge to be accurate and true.
- 3.) ERI has been requested by Waterloo Media, L.P. on behalf of radio Stations KLBJ-FM, K259AJ, KROX K274AX, and KBPA in Austin, TX. to prepare this Report Of Findings.

Jeff Taylor; Field Technician

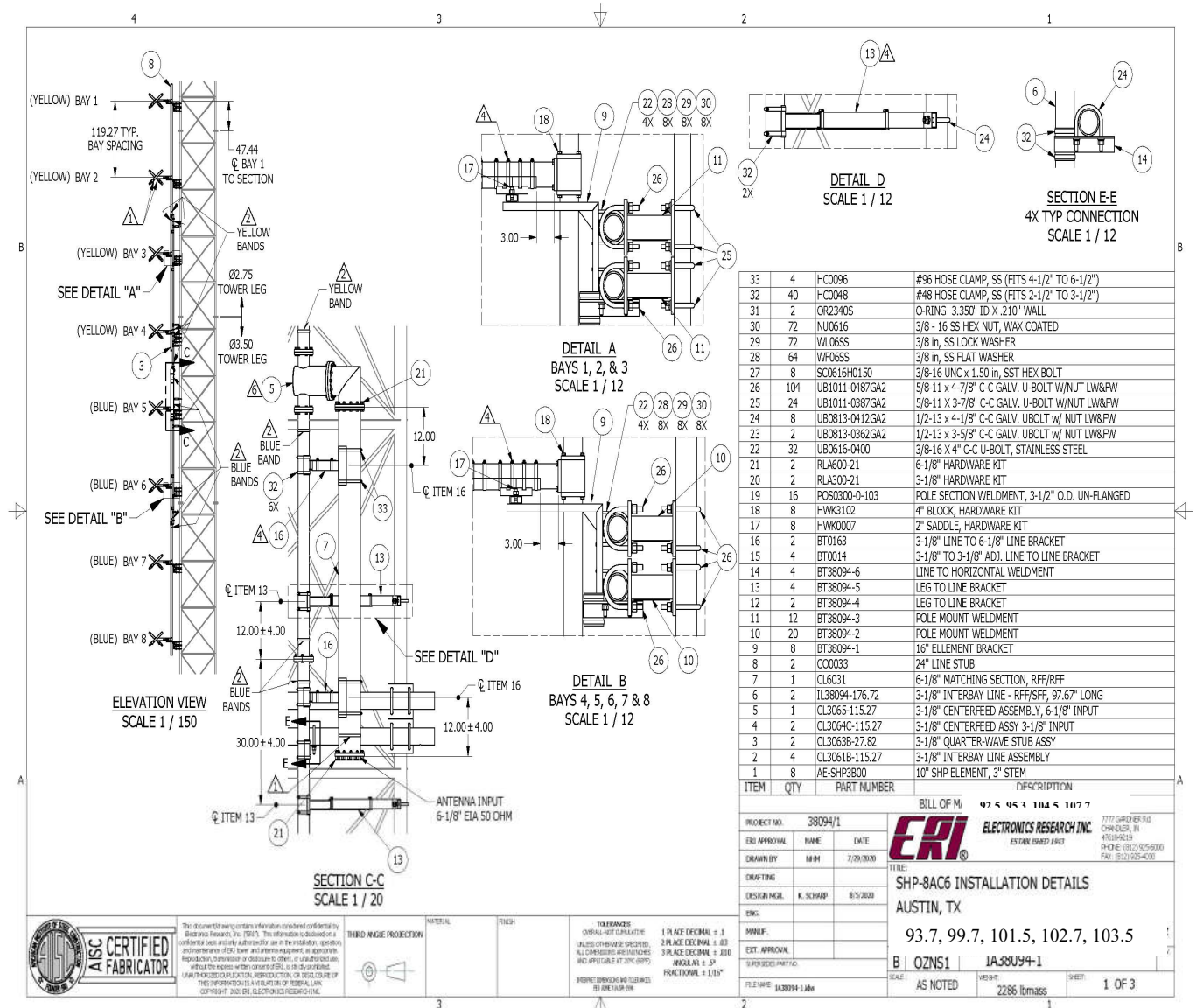
Subscribed and sworn to before me on this 28th, day of October, 2020.

Tabitha Heilman; Notary Public
My commission expires January 2, 2022

Tabitha Heilman



EXHIBIT, A-1



A-2 ERI 1183 Antenna Specification Sheet

TRANSMISSION SITE

AUSTIN, TEXAS

General Specifications

Antenna TypeHigh Power FM-Broadcast, Suitable For Multiplexing
 Model NumberSHP-8AC6-SP
 Number of Bay LevelsEight
 Polarization..... Right Hand Circular Polarized

Electrical Specifications

Antenna Input Power Capability 51 kW Max ⁽¹⁾
 Operating Frequency Band 93.7 ~ 103.5 Megahertz.
 VSWR. <1.20:1 @ Operating Frequencies⁽²⁾
 Azimuthal Pattern Circularity Better Than +/- 2dB From RMS (Free Space)
 Power Split 50/50 (Horizontal & Vertical)
 Frequency Specific Information:

<u>Frequency</u>	<u>Station ERP</u>	<u>Beam Tilt</u>	<u>First Null Fill</u>	<u>Second Null Fill</u>	<u>Power Gain</u>	<u>Line Loss</u> ⁽³⁾	<u>Filter Loss</u> ⁽⁴⁾	<u>Computed TPO</u>
93.7	100 KW	0.0°	0.0 %	10.8 %	4.342	-0.623 dB	-0.278 dB	28.33 kW
99.7	250 Watts	0.0°	5.5 %	0.0 %	4.424	-0.640 dB	-1.263 dB	93 Watts
101.5	12.5 KW	0.0°	14.6 %	0.4 %	4.176	-0.649 dB	-0.325 dB	3.746 kW
102.7	250 Watts	0.0°	20.7 %	1.1 %	3.930	-0.649 dB	-0.732 dB	92 Watts
103.5	62 KW	0.0°	0.0 %	10.8 %	4.154	-0.657 dB	-0.313 dB	18.66 kW

Mechanical Specifications

Antenna Feed System..... Fed with one Line
 Input Connector 6 1/8 "50-Ohm EIA Flanged
 Element Deicing None
 Interbay Spacing..... 119.27" Center to Center
 Array Length 74.5 Feet
 Construction Material (Antenna)..... Galvanized Plated Steel and Stainless Steel

1) Power Capability Has Been Rated Assuming an Operating Transmission VSWR of 1.5:1

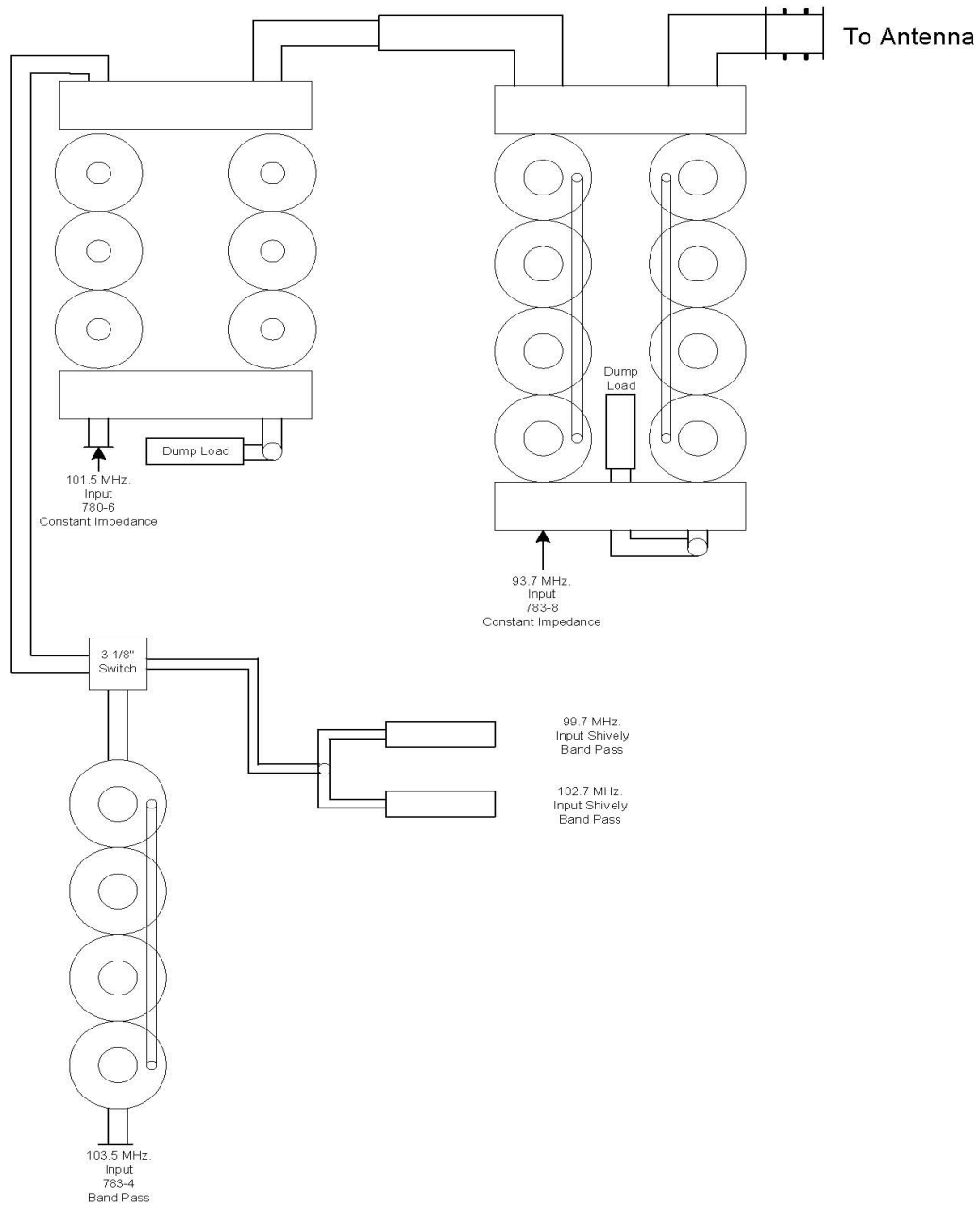
2) VSWR Specification Achieved After on Site Tuning For User Specific Frequencies.

3) Line Loss Assumes A Feed Run of 865 Feet of ERI MACXLine 4 1/16" Rigid 20 Foot Sticks.

3) Line Loss Assumes A Feed Run of 35 Feet of LDF4-50 Andrew Foam for 99.7 and 102.7 MHz.

4) Losses Taken from Actual Combiner.

Combiner Layout Austin, TX.
Project # 38094



A-4 ERI Combiner Specification Sheet

TRANSMISSION SITE

AUSTIN, TEXAS

General Specifications:

Multiplexer Type Constant Impedance, Band Pass, and "T" Combiner
 Number of Combining Units Four
 Injected Port to Injected Port Isolation < - 50 dB
 Output Connector 6 1/8 "50 Ohm EIA (Flanged)
 Output Power (Designed) 51 kW⁽¹⁾

Heat Removal Natural Convection Cooling
 Physical Arrangement Free Standing and Mezzanine

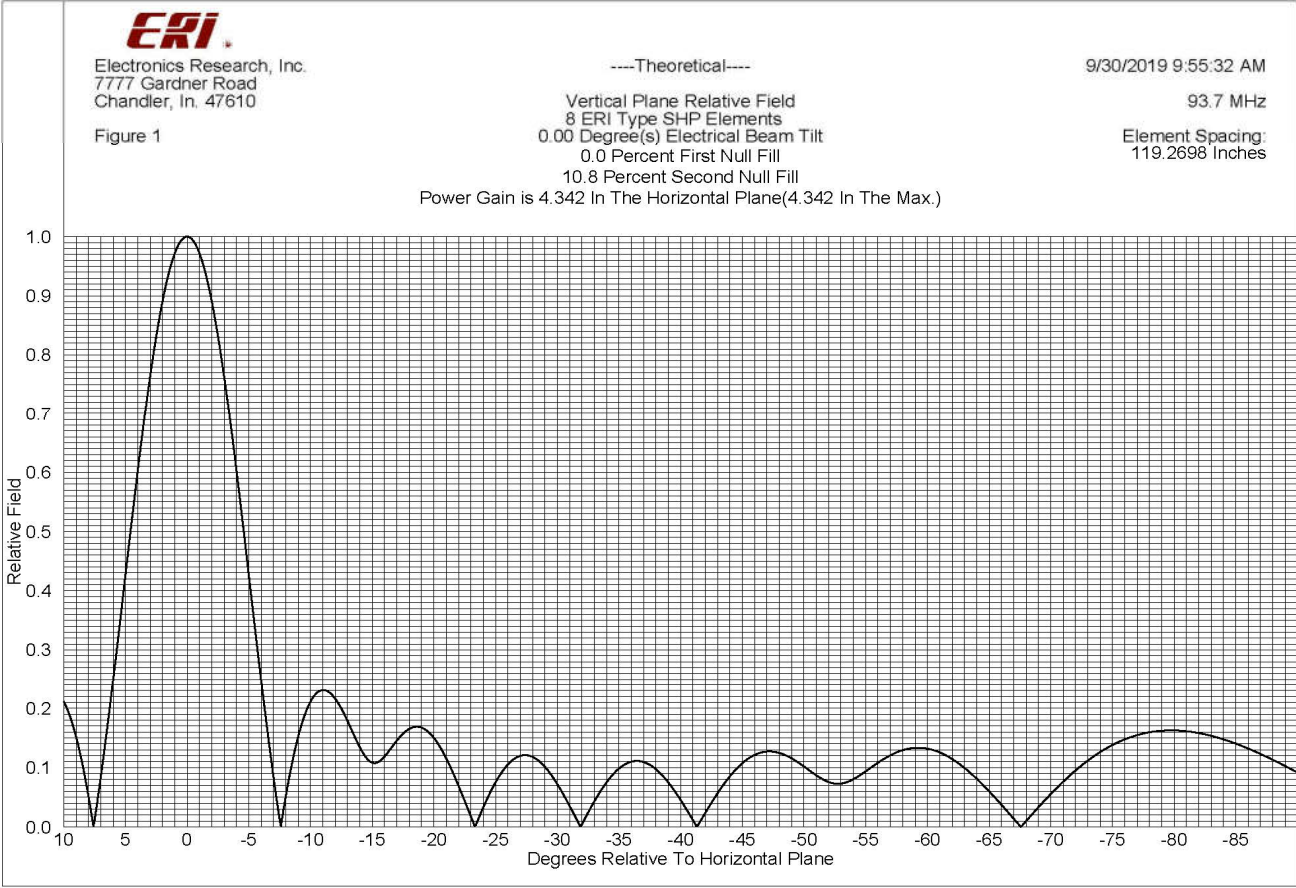
Injected Port Specifications:

Frequency Assignment 93.7 ~ 103.5 MHz.
 Power Rating, Each Injected Port (Designed)..... 28.3 kW 93.7 MHz, 93 Watts 99.7 MHz.
 Power Rating, Each Injected Port (Designed)..... 3.74 kW 101.5 MHz, 92 Watts 102.7 MHz.
 Power Rating, Each Injected Port (Designed)..... 18.6 kW 103.5 MHz.
 Input Connector 3-1/8" 50 Ohm EIA (Flanged) 93.7, 101.5, and 105.3 MHz.
 Input Connector 7/8" 50 Ohm EIA (Flanged) 99.7, and 102.7 MHz.
 VSWR..... < 1.20:1 @ +/-100 KHz.⁽²⁾
 Group Delay Less than 200 ns Overall Variation, Carrier @ +/- 150 KHz.
 Insertion Loss (Measured):

93.7 MHz. - 0.278 dB
 99.7 MHz. - 1.263 dB
 101.5 MHz. - 0.325 dB
 102.7 MHz. - 0.732 dB
 103.5 MHz. - 0.313 dB

1) Power Rating Listed is as Designed Only. Actual Power Capabilities May Vary.

2) When Terminated in 50 Ohm Resistive Load.



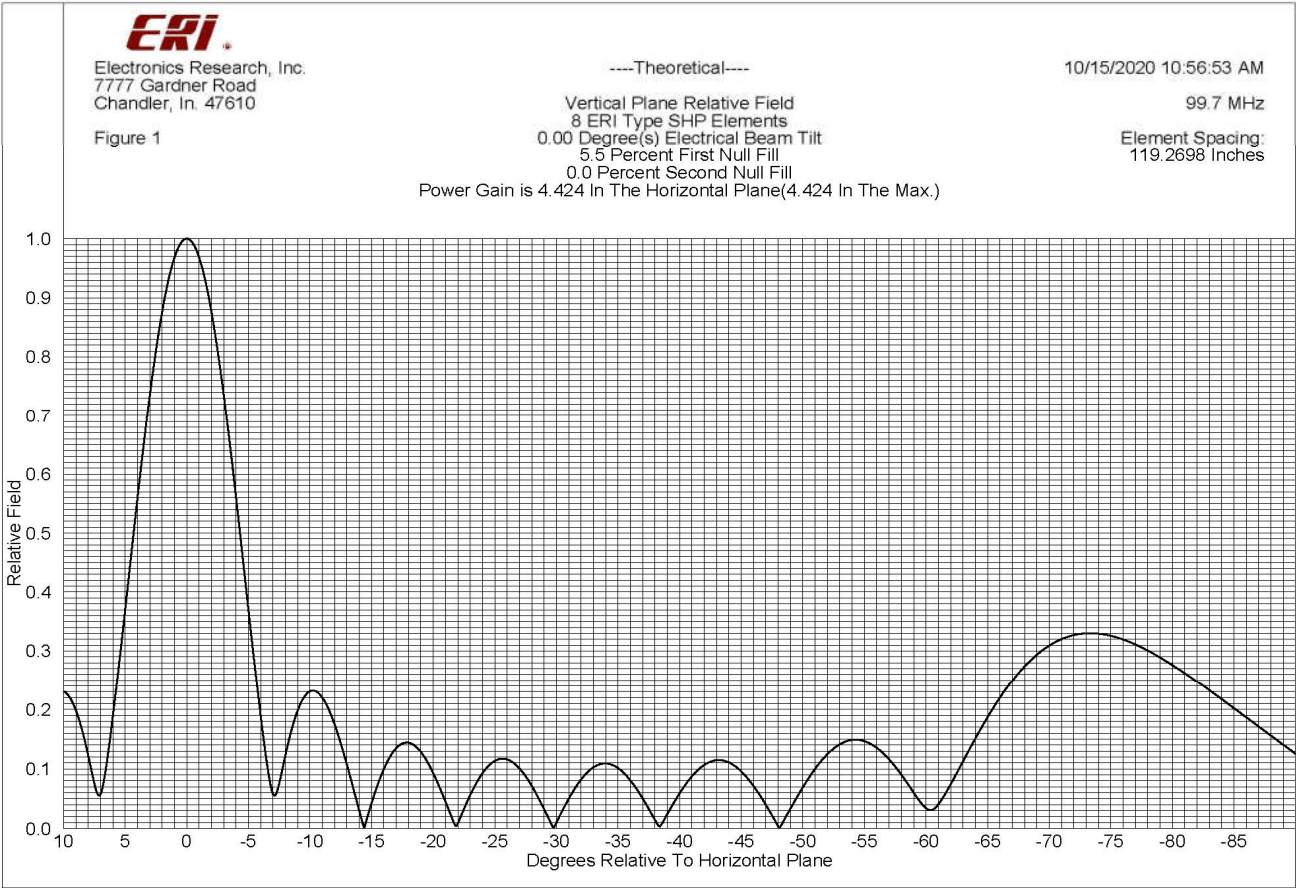
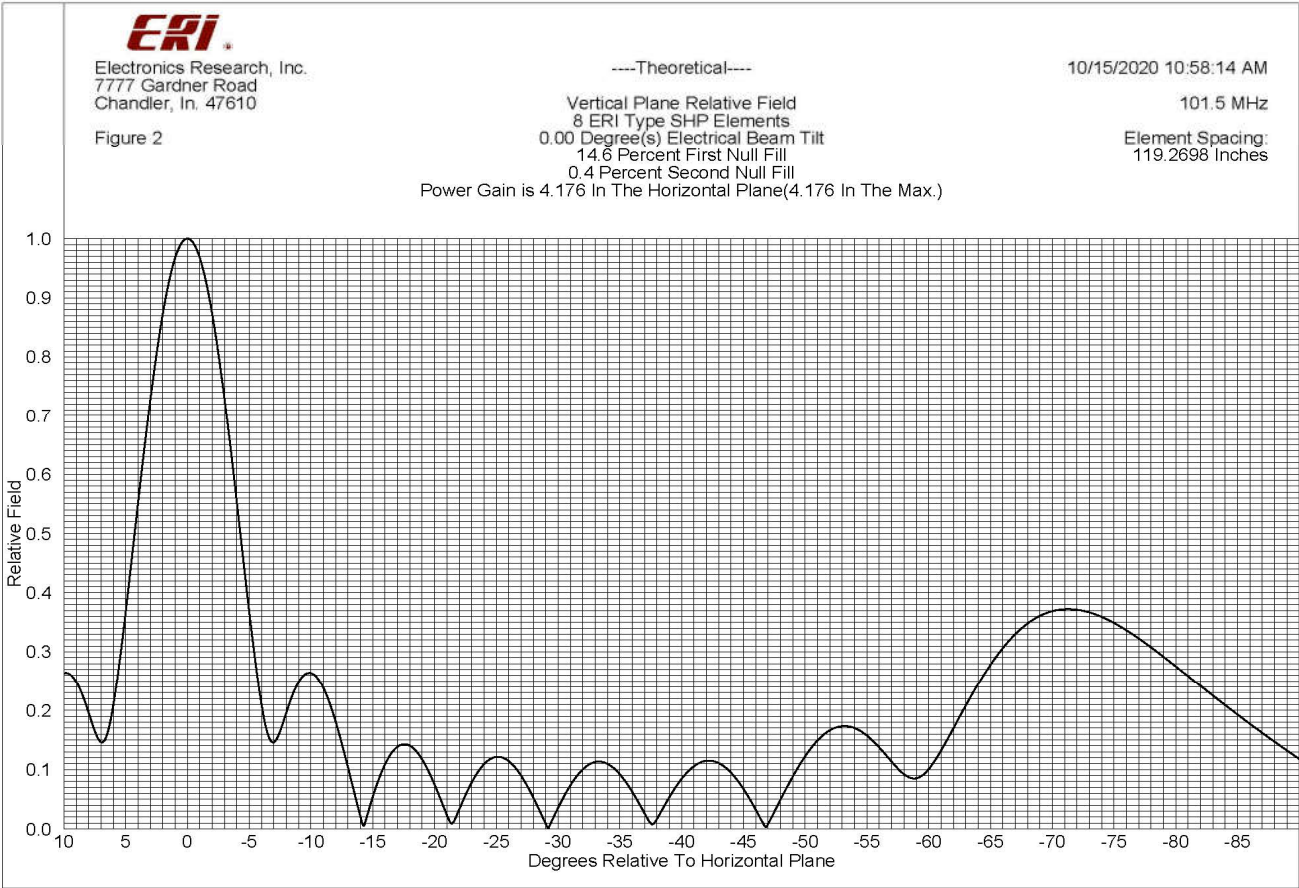
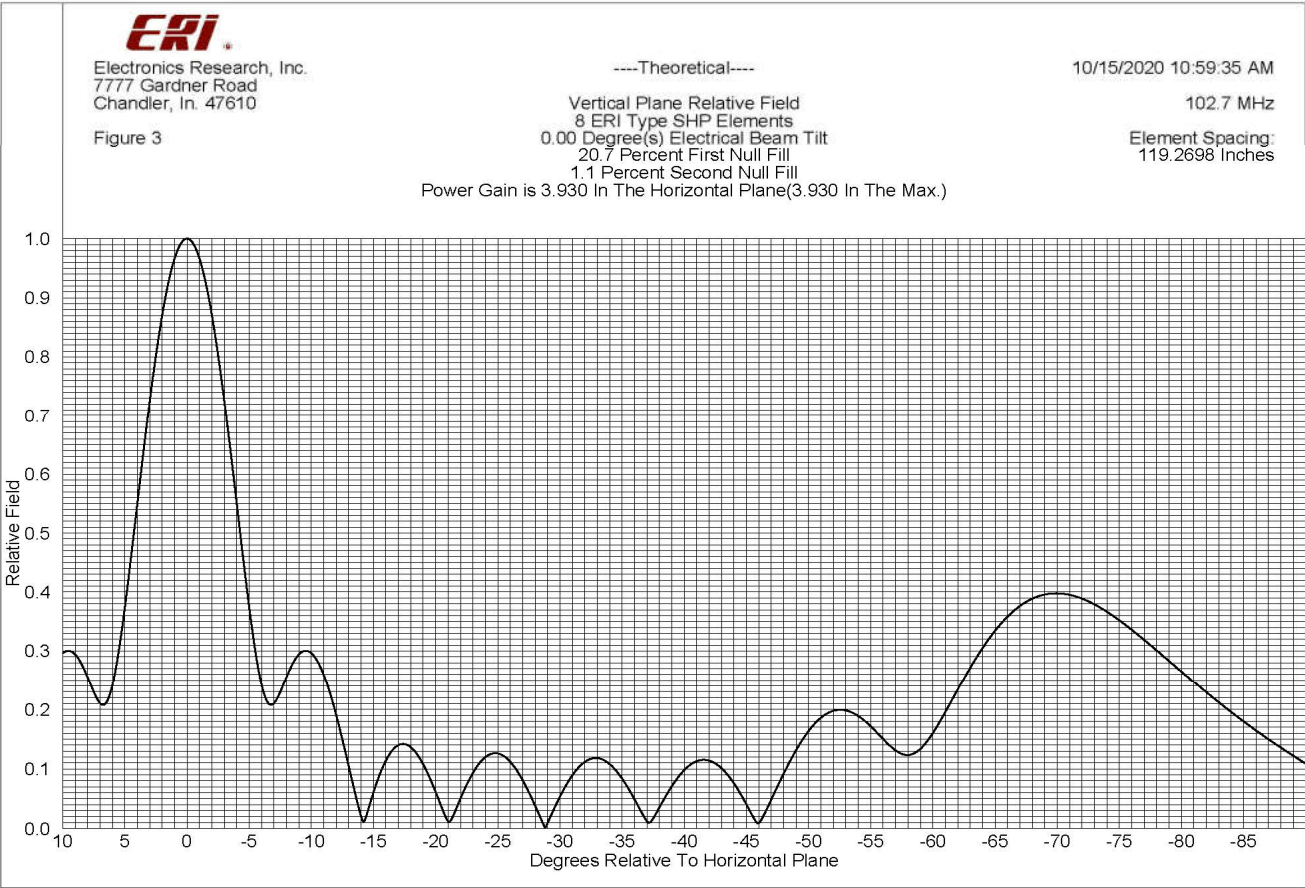
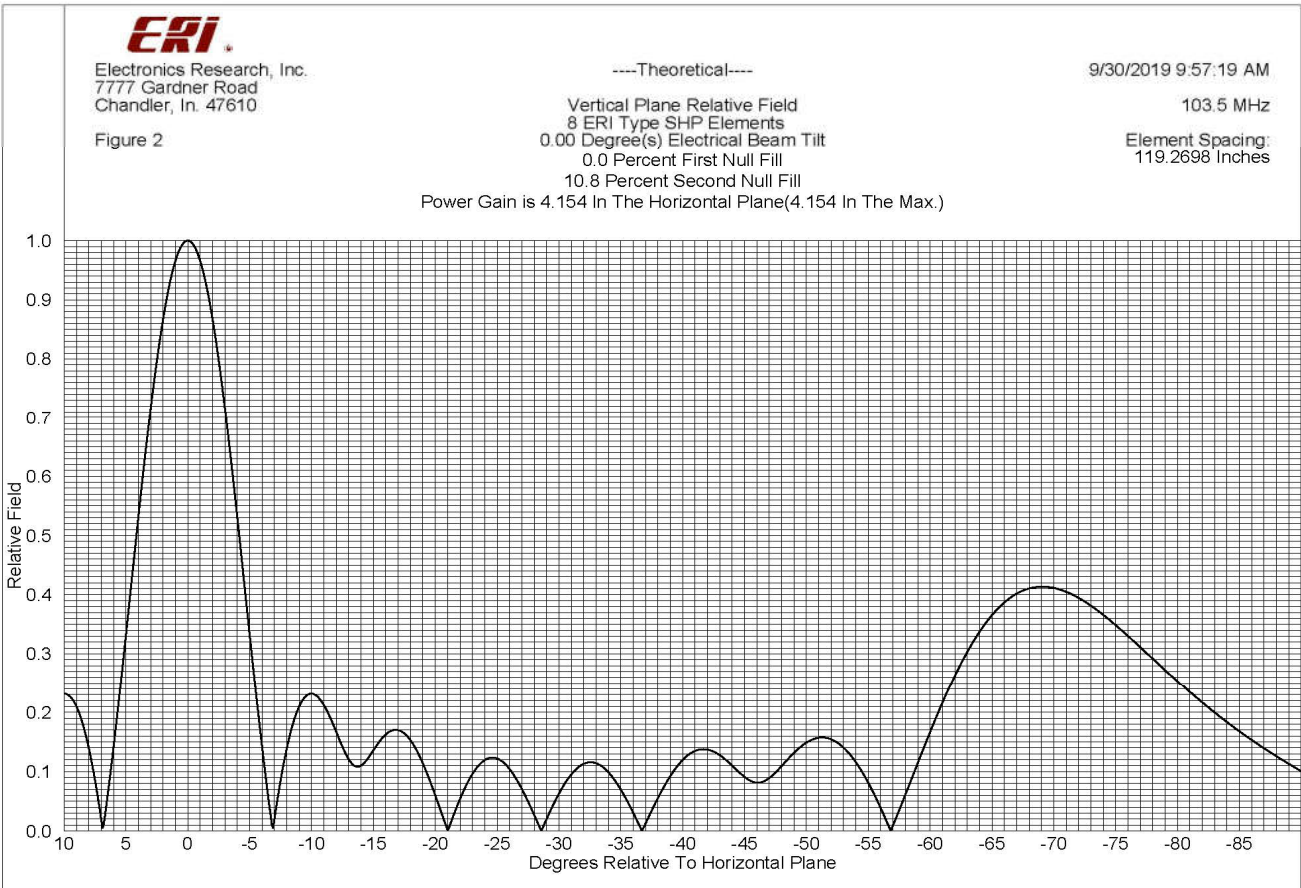


EXHIBIT A – 5







Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

