

# **Report Of Intermodulation Product Findings**

***OKLAHOMA CITY, OKLAHOMA***

**K225BN – 92.9 MHz.  
K276EX – 103.1 MHz.  
KMGL – 104.1 MHz.**

**Project# 32592**

***August 19, 2014***

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## REPORT OF FINDINGS OKLAHOMA CITY, OKLAHOMA BROADCAST FACILITY

**Introduction:** This report of findings is based on data collected at the FM broadcast facility located in Oklahoma City, OK. The report includes measurements offered as proof that the combined operations of K225BN (92.9 MHz.) and K276EX (103.1 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). Several other stations operate into another antenna that is collocated on the tower structure within close proximity to the 92.9 MHz. and 103.1 MHz. antenna. Their effects on the stations operating from this system have been considered in this report. The table of the other frequencies can be found on page 5 of this report. In brief, the collection of measurements presented in this report shows that all possible third order intermodulation (IM) products generated by this multiplexed system 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 August 19, 2014.

**The following exhibits are provided:**

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 SHP-8AC-HW-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 two of the FM stations operating from the combined antenna system. A second visit will be conducted after the third transmitter installation is completed reserved for an auxiliary station. The K225BN, K276EX, and KMGL multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHP-8AC-HW-SP (antenna), 955 Constant Impedance ~ Branch combiner units, and rigid feedline, are products of Electronics Research, Inc while the 3" HJ8-50B Air Heliac is a product of Andrew. Refer to Exhibit B-1, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of three transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of (1) 955 Constant Impedance Combiner and (2) 955 Bandpass, filter system were installed. Specifically, the combiner utilizes one ERI Model 955 module for frequency (104.1 MHz.) and two ERI Model 955 Bandpass modules for frequency (92.9 MHz. and 103.1 MHz.). An "Interconnecting T" is used to combine the 92.9 MHz. and 103.1 MHz. into the broad port hybrid of the 104.1 MHz. Constant Impedance module. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -67 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 insure 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 -36 dB directivity and a forward signal sample of -40 dB.

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 FIM71 to ensure an adequate signal level for measurements without overloading the measurement equipment. A Potomac Instruments FIM-71 Field Strength Receiver Serial # 686 was employed to record the level of all signals investigated. To facilitate the selective tuning of the Receiver and Band Pass Filter a Wavetek Model 3000 Serial # 5362199 signal generator was used. A Rhode & Schwarz ZVL3 Spectrum Analyzer Serial # 100396 was 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 A-2 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.**

<b>Carrier Frequency (MHz)</b>	<b>Pad One (dB)</b>	<b>Full Scale Range (dBu)</b>	<b>Scale Reading (dBu)</b>	<b>Carrier Level (dBu)</b>	<b>Notes</b>
<b>92.9</b>	<b>3</b>	<b>120</b>	<b>8.7</b>	<b>114.3</b>	
<b>103.1</b>	<b>3</b>	<b>120</b>	<b>9.7</b>	<b>113.3</b>	
<b>104.1</b>	<b>3</b>				

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.**

		<b>Carrier Frequencies</b>		
<b>Interfering Frequencies</b>		<b>92.9</b>	<b>103.1</b>	<b>104.1</b>
KOMA	92.5 MHz.	93.3	113.7	115.7
K225BN	92.9 MHz.	----	113.3	115.3
K243BJ	96.5 MHz.	89.3	109.7	111.7
K276EX	103.1 MHz.	82.7	----	105.1
KMGL	104.1 MHz.	81.7	102.1	----
K238BW	104.5 MHz.	81.3	101.7	103.7
KRXO	107.7 MHz.	78.1	98.5	100.5

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 Oklahoma City, OK.											
Product Frequency (MHz)	Transmitter Frequency (MHz)	Interfering Frequency (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Total Loss	Full Scale Range (dBμ)	Scale Reading (dBμ)	Adjusted Level (dBμ)	Carrier Reference Level (dBμ)	Level Referenced to Carrier (dB)	Notes*
<b>Transmitter Mixes</b>											
	<b>92.9</b>	<b>Ref.</b>	<b>3</b>		<b>3</b>	<b>120</b>	<b>8.7</b>		<b>114.3</b>		3 Station System
	<b>103.1</b>	<b>Ref.</b>	<b>3</b>		<b>3</b>	<b>120</b>	<b>9.7</b>		<b>113.3</b>		3 Station System
	<b>104.1</b>	<b>Ref.</b>	<b>3</b>		<b>3</b>	<b>120</b>	<b>0</b>		<b>123</b>		Reserved for Aux
	<b>92.5</b>	<b>Ref.</b>	<b>3</b>		<b>3</b>	<b>120</b>	<b>9.8</b>		<b>113.2</b>		4 Station System
	<b>96.5</b>	<b>Ref.</b>	<b>3</b>		<b>3</b>	<b>120</b>	<b>7.1</b>		<b>115.9</b>		4 Station System
	<b>104.5</b>	<b>Ref.</b>	<b>3</b>		<b>3</b>	<b>120</b>	<b>3.3</b>		<b>119.7</b>		4 Station System
	<b>107.7</b>	<b>Ref.</b>	<b>3</b>		<b>3</b>	<b>120</b>	<b>3.3</b>		<b>117.1</b>		4 Station System
78.1	92.9	107.7	3	10.8	13.8	20	20	13.8	114.3	-100.5	
81.3	92.9	104.5	3	10.7	13.7	20	20	13.7	114.3	-100.6	
82.7	92.9	103.1	3	10.6	13.6	20	20	13.6	114.3	-100.7	
89.3	92.9	96.5	3	10.3	13.3	20	6.1	27.2	114.3	-87.1	
93.3	92.9	92.5	3	10.2	13.2	60	9.2	64	114.3	-50.3	Local KJKE
98.5	103.1	107.7	3	10.1	13.1	20	14.5	18.6	113.3	-94.7	
101.7	103.1	104.5	3	9.8	12.8	40	15.9	36.9	113.3	-76.4	Local KKZU 104.5 Off
109.7	103.1	96.5	3	9.2	12.2	20	20	12.2	113.3	-101.1	
113.3	103.1	92.9	3	9.1	12.1	20	20	12.1	113.3	-101.2	
113.7	103.1	92.5	3	8.9	11.9	20	20	11.9	113.3	-101.4	
81.9	92.5	103.1	3	10.7	13.7	20	20	13.7	113.2	-99.5	
89.9	96.5	103.1	3	10.3	13.3	20	13.8	19.5	115.9	-96.4	
92.1	92.5	92.9	3	10.3	13.3	20	17.5	15.8	113.2	-97.4	
100.1	96.5	92.9	3	9.9	12.9	20	19.2	13.7	115.9	-102.2	
105.9	104.5	103.1	3	9.6	12.6	20	20	12.6	119.7	-107.1	
112.3	107.7	103.1	3	9.1	12.1	20	20	12.1	117.1	-105	
116.1	104.5	92.9	3	8.9	11.9	20	20	11.9	119.7	-107.8	
122.5	107.7	92.9	3	8.9	11.9	20	20	11.9	117.1	-105.2	

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 August 19, 2014 as summarized in this document, I, Jeff Taylor, find the subject system, specifically the transmitter and filter system for the operation of K225BN and K276EX into the antenna 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 K225BN and K276EX 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 :

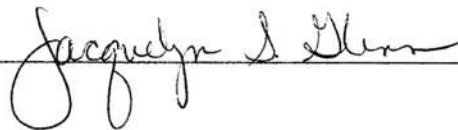
- 1.) I am a Field Technician for Electronics Research, Inc ("ERI ") and have been employed by ERI for 18 years. I am familiar with and have assisted in the design, manufacturing and installation of FM Antennas and FM Multiplexers in my long tenure with ERI.
- 2.) I have either prepared and/or directly 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 Tyler Media on behalf of radio Stations K225BN and K276EX in Oklahoma City, OK. to prepare this Report Of Findings.

Jeff Taylor; Field Technician



*Subscribed and sworn to before me on this 21st, day of August, 2014.*

Jacquelyn Glenn; Notary Public  
My commission expires July 5, 2015









**A-2 ERI Antenna Specification Sheet****TRANSMISSION SITE****OKLAHOMA CITY, OKLAHOMA****General Specifications**

Antenna Type ..... High Power FM-Broadcast, Suitable for Multiplexing  
 Model Number ..... SHPX-8AC-HW-SP  
 Number of Bay Levels ..... Eight  
 Polarization ..... Left Hand Circular

**Electrical Specifications**

Antenna Input Power Capability ..... 11 kW Max <sup>(1)</sup>  
 Operating Frequency Band ..... 92.9 ~ 103.1 ~ 104.1 Megahertz.  
 VSWR ..... <1.01:1 @ Operating Frequencies <sup>(2)</sup>  
 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> <sup>(3)</sup>	<u>Filter Loss</u> <sup>(4)</sup>	<u>Computed TPO</u>
92.9	200 Watts	0°	14 %	0 %	2.300	-1.1365 dB	-0.500 dB	127 Watts
103.1	99 Watts	0°	11 %	0 %	2.563	-1.2017 dB	-0.516 dB	57 Watts
104.1	17.225 KW	0°	14 %	0 %	2.555	-1.2075 dB	-0.504 dB	10 kW

**Mechanical Specifications**

Antenna Feed System ..... Single Input  
 Input Connector ..... 3 1/8"-50 Ohm EIA Flanged  
 Element Deicing ..... None  
 Interbay Spacing ..... 59.6875" Center to Center  
 Array Length ..... 37.31 Feet  
 Construction Material ( Antenna ) ..... Galvanized Plated Steel and Stainless Steel  
 Construction Material ( Mounting ) ..... Leg

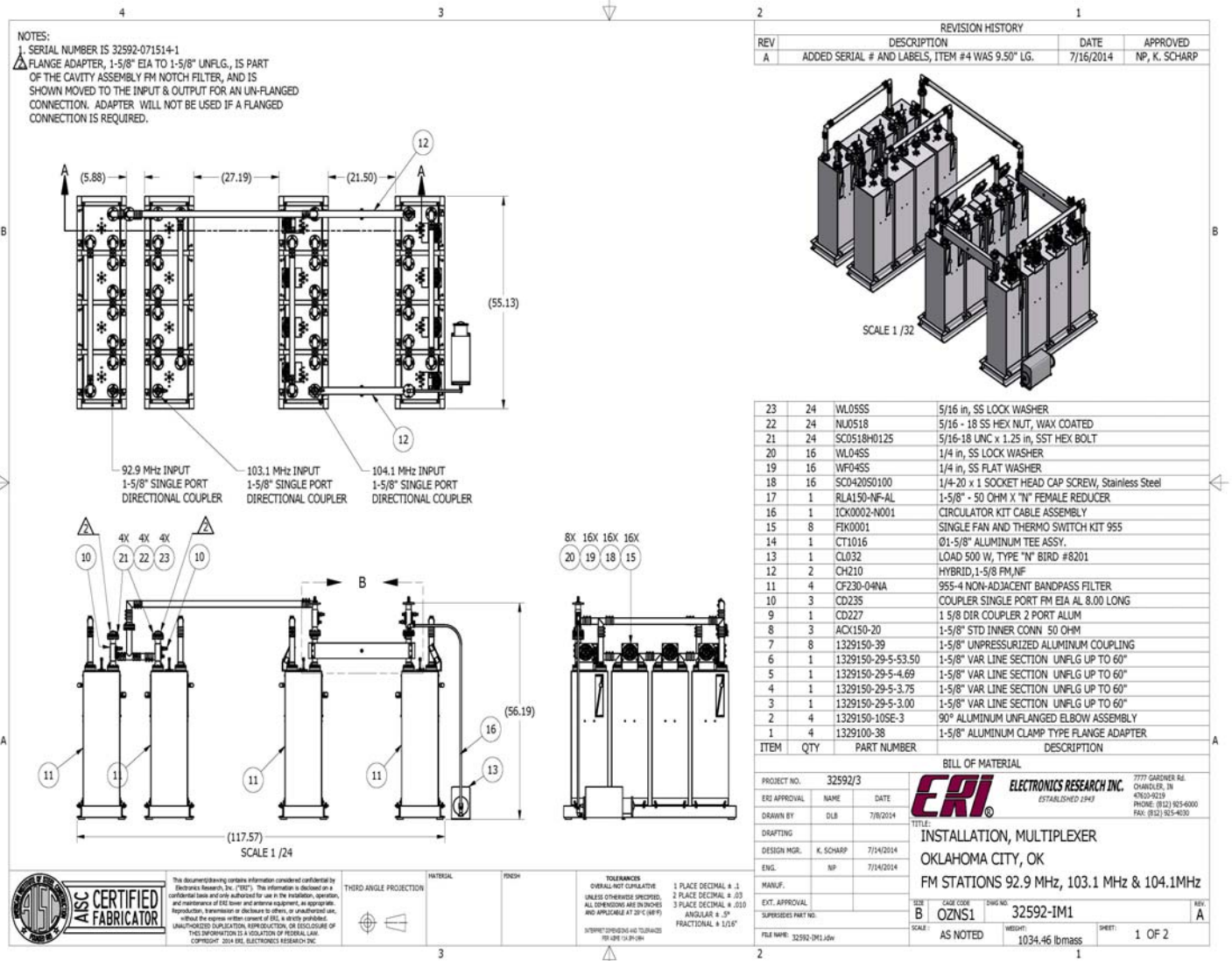
1) Power Capability Has Been Rated Assuming an Operating Transmission VSWR of 1.5:1

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

3) Line Loss Assumes A Feed Run of 371 Feet of MACXLine-350 3 1/8" Rigid and 582 Feet of Andrew HJ8-50B 3" Heliax.

4) Losses Taken From Actual Combiner.

# EXHIBIT A-3



**A-4 ERI Combiner Specification Sheet**

TRANSMISSION SITE

OKLAHOMA CITY, OKLAHOMA

**General Specifications:**

Multiplexer Type ..... Band Pass and Constant Impedance  
Number of Combining Units ..... Three  
Injected Port to Injected Port Isolation ..... < - 67 dB  
Output Connector ..... 1 5/8 "50 Ohm EIA (Flanged)  
Output Power (Designed) ..... 11 kW<sup>(1)</sup>

Heat Removal ..... Forced Air cooling  
Physical Arrangement ..... All Components Floor Standing

**Injected Port Specifications:**

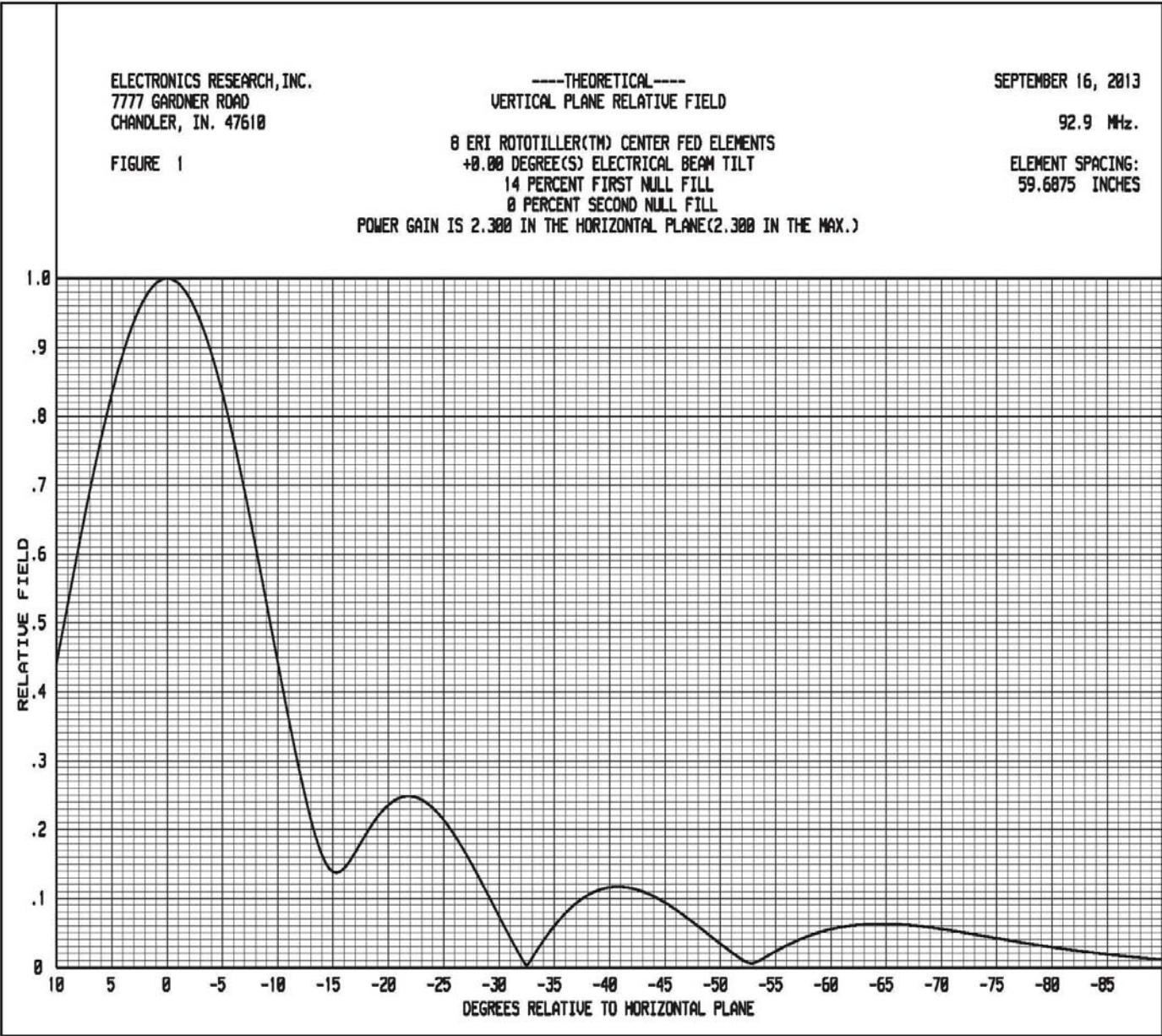
Frequency Assignment ..... 92.9 ~ 103.1, and 104.1 MHz.  
Power Rating, Each Injected Port (Designed)..... 127 Watts 92.9 ~ 57 Watts 103.1 ~ 10.0 kW 104.1  
Input Connector ..... 1-5/8" 50 Ohm EIA (Flanged).  
VSWR..... < 1.15:1 @ +/-200 KHz.<sup>(2)</sup>  
Group Delay ..... Less than 250 ns Overall Variation, Carrier @ +/- 150 KHz.  
Insertion Loss (Measured):

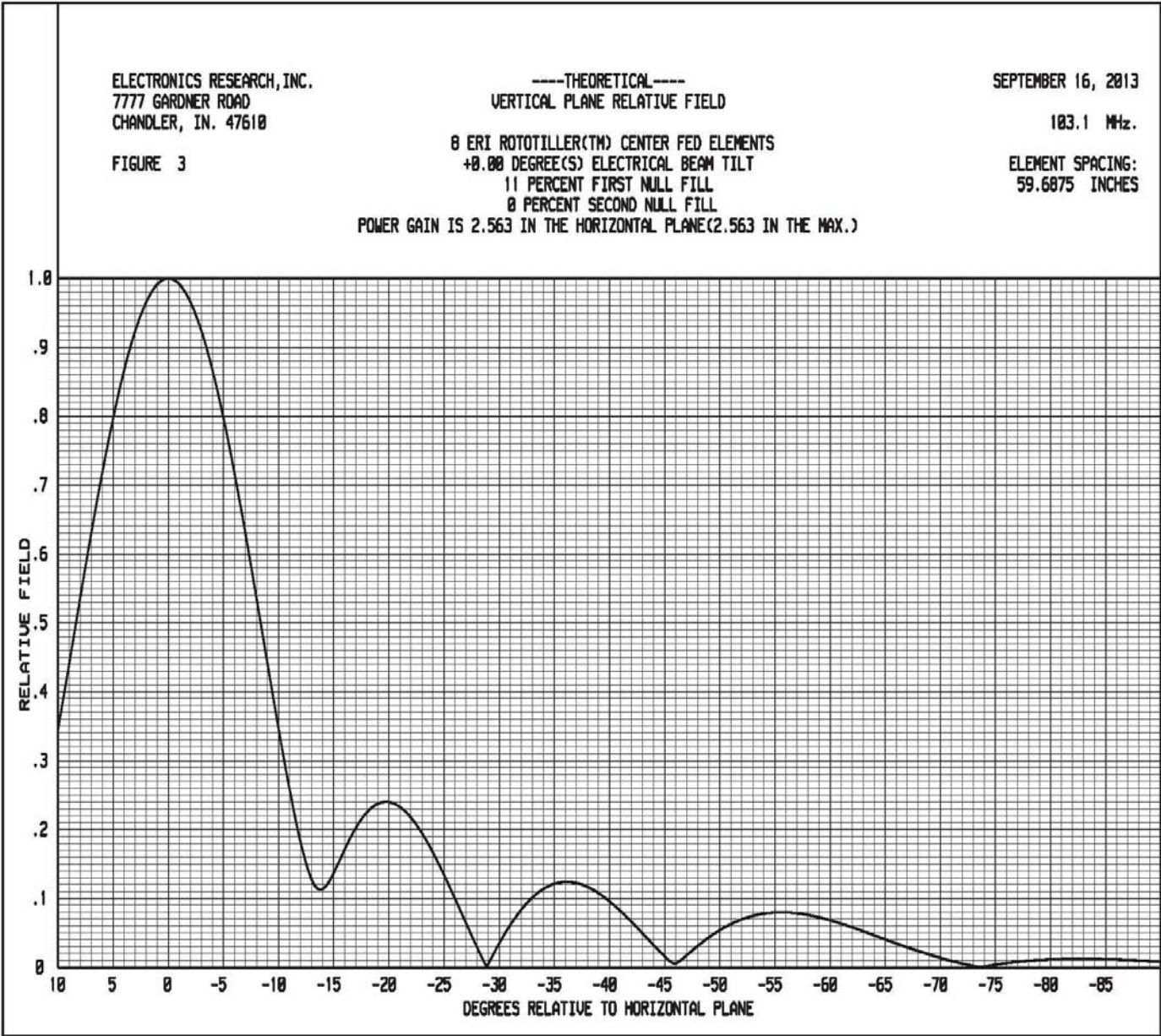
92.9 MHz. .... - 0.500 dB  
103.1 MHz. .... - 0.516 dB  
104.1 MHz. .... - 0.504 dB

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

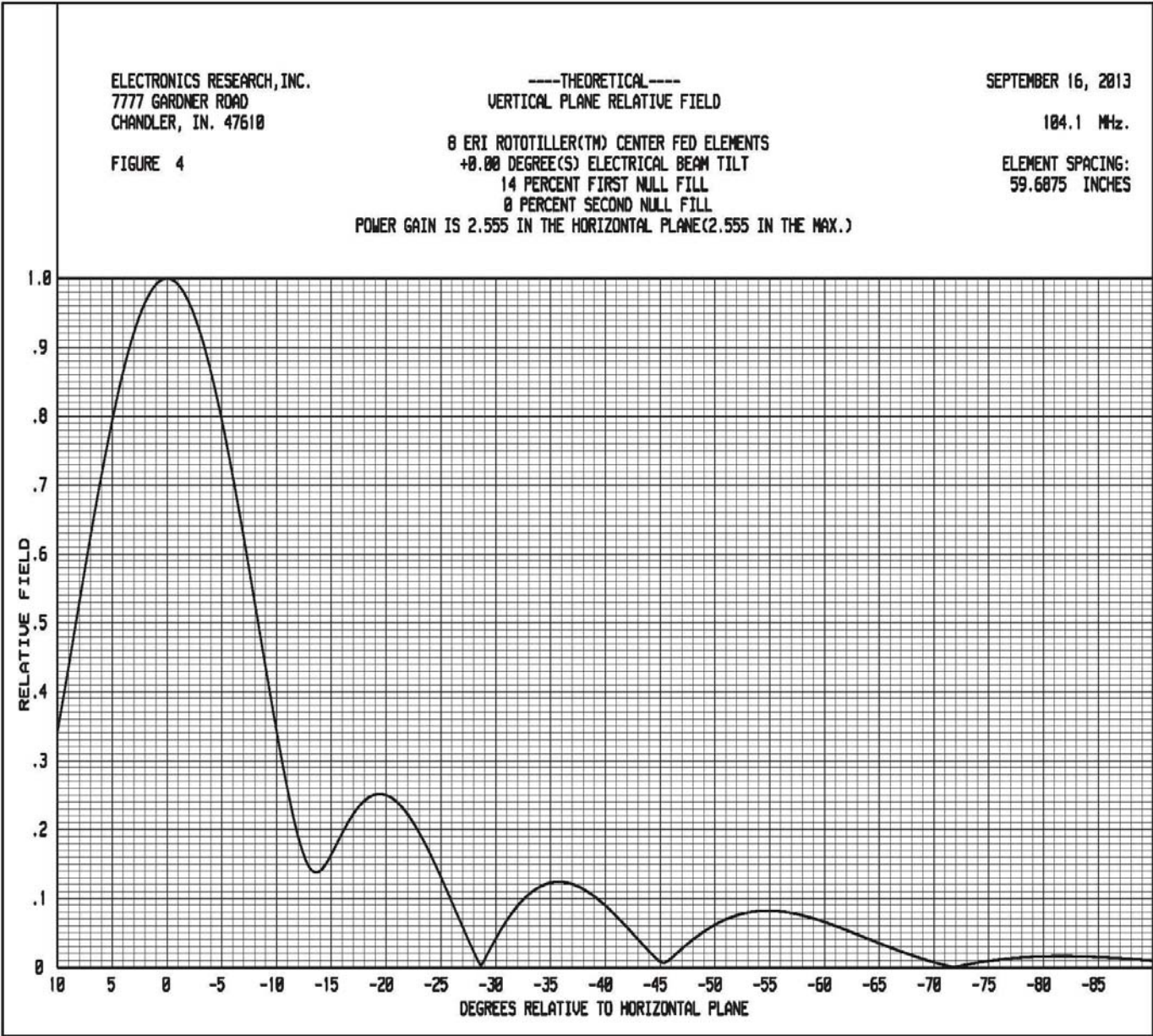
2) When Terminated in 50 Ohm Resistive Load.











Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

