

Report Of Intermodulation Product Findings

**WMEE 97.3 MHz. Fort Wayne, Indiana
WQHK-FM 105.1 MHz. Hometown, Indiana**

Project# 28677A

February 28, 2012

**Electronics Research Inc.
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REPORT OF FINDINGS

WMEE / WQHK-FM

97.3 MHz. / 105.1 MHz.

Introduction: This report of findings is based on data collected at the WMEE and WQHK-FM broadcast facility located in Fort Wayne, Indiana. The report includes measurements offered as proof that the combined operations of WMEE (97.3 MHz.) and WQHK-FM (105.1) 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). WFWI (92.3 MHz.) operates into separate antenna on the same tower within 200' of the combined antenna. The effects on the stations operating from the multiplexed system have been considered in this report. In brief, the collection of measurements presented in this report shows that all possible third order inter-modulation (IM) products generated by this diplex 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 February 28, 2012.

The following exhibits are provided:

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 SHPX-4AC-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 the combined antenna system. The WMEE and WQHK-FM multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-4AC-SP antenna, rigid 3 1/8" feedline, and combiner units are products of Electronics Research, Inc., while the flex air cable is a Cablewave. Refer to Exhibit B-1, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of two transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a 780-3 and 783-3 "TEE" Combiner was installed. Specifically, the combiner uses one ERI Model 780-3 for 105.1 MHz. and one ERI Model 783-3 97.3 MHz. An interconnecting "T" is required to complete the combiner which is illustrated in the attached Exhibit A-3. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -81 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 -54 dB directivity and a forward signal sample of -40 dB.

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 ZVL Vector Network Analyzer with Spectrum Analyzer serial# 100396 was employed to record the level of all signals investigated. The Rohde & Schwarz was also used for selective tuning of the Band Pass Filter. The Spectrum Analyzer portion of the Rohde & Schwarz 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 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)	Bandpass Filter Loss (dB)	Measured Level (dBm)	Adjusted Level (dBm)	Notes
97.3	3	-	12.52	15.52	
105.1	3	-	6.27	9.27	

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.

Interfering Frequencies	Carrier Frequencies	
	97.3	105.1
92.3 MHz.	102.3	117.9
97.3 MHz.	----	112.9
105.1 MHz.	89.5	----

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.

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 February 28, 2012 as summarized in this document, I, Jeff Taylor, find the subject system, specifically the transmitter and filter system for the operation of WMEE and WQHK-FM 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 WMEE and WQHK-FM 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 15 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 Federated Media on behalf of radio Stations WMEE and WQHK-FM in Fort Wayne, Indiana to prepare this Report of Findings.

Jeff Taylor; Field Technician

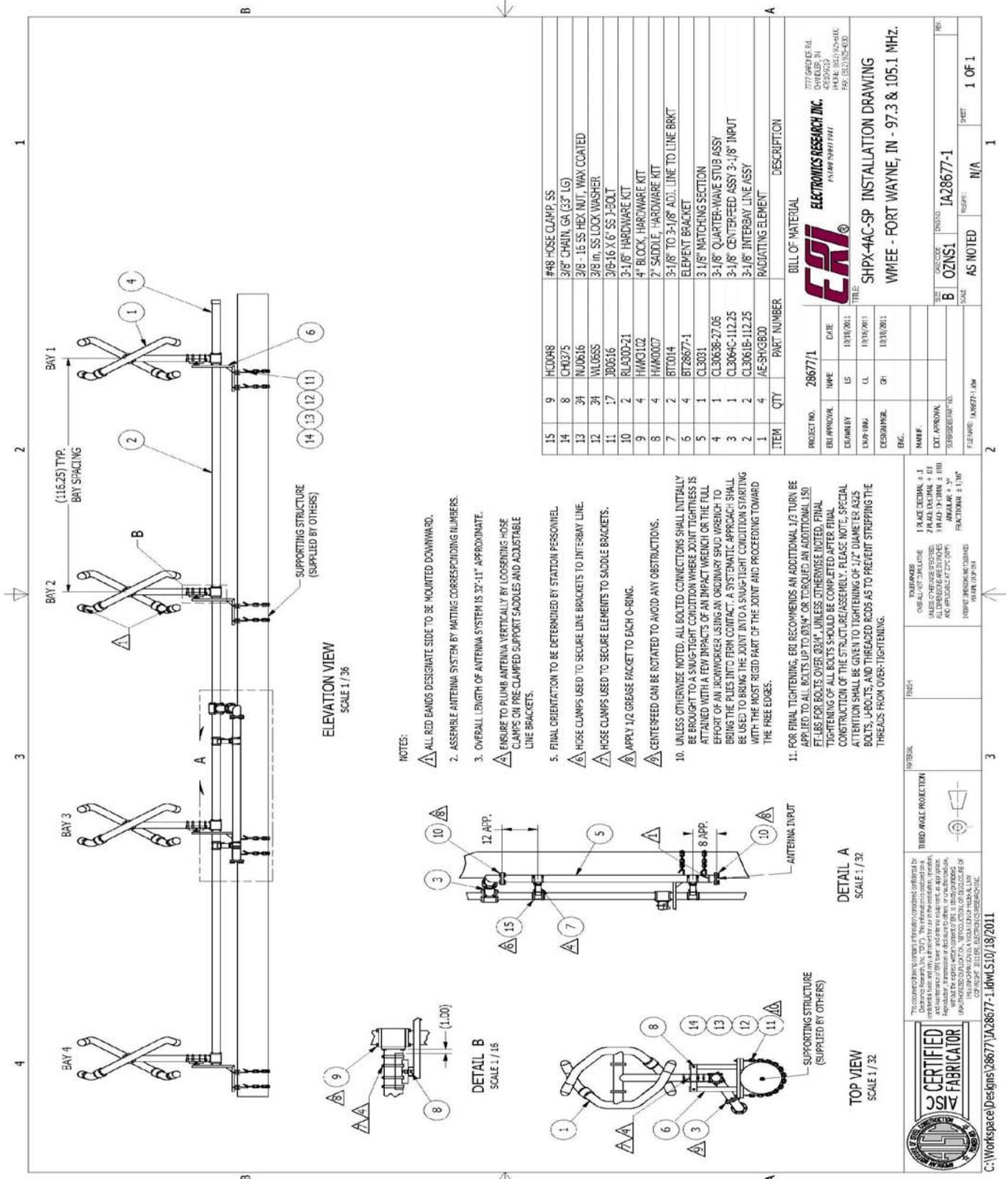
Jeff Taylor

Subscribed and sworn to before me on this 29th, day of February, 2012.

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



Jacquelyn S. Kinney



- NOTES:**
- ALL RED BANDS DESIGNATE SIDE TO BE MOUNTED DOWNWARD.
 - ASSEMBLE ANTENNA SYSTEM BY MATING CORRESPONDING NUMBERS.
 - OVERALL LENGTH OF ANTENNA SYSTEM IS 30"-11" APPROXIMATE.
 - ENSURE TO PLUMB ANTENNA VERTICALLY BY LOOSENING HOSE CLAMPS ON PRE-CLAMPED SUPPORT SADDLES AND ADJUSTABLE LINE BRACKETS.
 - FINAL ORIENTATION TO BE DETERMINED BY STATION PERSONNEL.
 - HOSE CLAMPS USED TO SECURE LINE BRACKETS TO INTERBAY LINE.
 - HOSE CLAMPS USED TO SECURE ELEMENTS TO SADDLE BRACKETS.
 - APPLY 1/2 GREASE PACKET TO EACH O-RING.
 - CENTER-REED CAN BE ROTATED TO AVOID ANY OBSTRUCTIONS.
 - UNLESS OTHERWISE NOTED, ALL BOLTED CONNECTIONS SHALL INITIALLY BE BROUGHT TO A SNUG-TIGHT CONDITION WHERE JOINT TIGHTNESS IS ATTAINED WITH A FEW IMPACTS OF AN IMPACT WRENCH OR THE FULL EFFORT OF ALL WORKMEN USING AN ORDINARY SNUG WRENCH TO BRING THE PILES INTO FIRM CONTACT. A SYSTEMATIC APPROACH SHALL BE USED TO BRING THE JOINT INTO A SNUG-TIGHT CONDITION STARTING WITH THE MOST RIGID PART OF THE JOINT AND PROCEEDING TOWARD THE FREE EDGES.
 - FOR FINAL TIGHTENING, ERI RECOMMENDS AN ADDITIONAL 1/3 TURN BE APPLIED TO ALL BOLTS UP TO 0.34" OR TORQUED AN ADDITIONAL 150 FT-LBS FOR BOLTS OVER 0.34", UNLESS OTHERWISE NOTED. FINAL TIGHTENING OF ALL BOLTS SHOULD BE COMPLETED AFTER FINAL CONSTRUCTION OF THE STRUCTURE IS COMPLETE. PLEASE NOTE, SPECIAL ATTENTION SHALL BE GIVEN TO TIGHTENING OF 1/2" DIAMETER A325 BOLTS, L-BOLTS AND THREADED RODS AS TO PREVENT STRIPPING THE THREADS FROM OVER-TIGHTENING.

DETAIL B
SCALE 1/18

DETAIL A
SCALE 1/32

TOP VIEW
SCALE 1/32

ERAI
ELECTRONICS RESEARCH INC.
7777 GRADY BA
CHABLES IN
430563D
MARIETTA, GA 30067
REV. 03/10/2011

PROJECT NO. 28677/1
ERI APPROVAL NAME DATE 10/18/2011
DESIGNER LS
CHK'D BY CL 10/18/2011
DESIGNED BY GH 10/18/2011

TITLE SHPX-4AC-SP INSTALLATION DRAWING
WMEE - FORT WAYNE, IN - 97.3 & 105.1 MHZ.

DATE 10/18/2011
SCALE AS NOTED
REV. B OZNS1 IA28677-1
DESCRIPTION AS NOTED
PAGE 1 OF 1

CERTIFIED FABRICATOR

THE COMPANY HAS BEEN CERTIFIED BY ELECTRONICS RESEARCH INC. (ERI) TO FABRICATE AND ASSEMBLE ANTENNAS AND SUPPORT STRUCTURES. THIS CERTIFICATION IS VALID FOR A PERIOD OF 12 MONTHS FROM THE DATE OF ISSUANCE. FOR MORE INFORMATION, CONTACT ERI AT 770-426-7777.

THIRD-ANGLE PROJECTION

MATERIAL FINISH

TOLERANCES
 UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS ARE TO BE HOLD TO ± 0.005"
 DIMENSIONS ARE TO BE HOLD TO ± 0.010"
 DIMENSIONS ARE TO BE HOLD TO ± 0.015"

FILE NAME IA28677-1.dwg
PLT FILE IA28677-1.plt

SCALE AS NOTED
REV. B OZNS1 IA28677-1
PAGE 1 OF 1

A-2 ERI Antenna Specification Sheet

MULTIPLEXED TRANSMISSION SITE

Fort Wayne, IN.

General Specifications

Antenna Type High Power FM-Broadcast, Suitable For Multiplexing
 Model Number SHPX-4AC-SP
 Number of Bay Levels Four
 Polarization Right Hand Circular

Electrical Specifications

Antenna Input Power Capability 19 kW Max ⁽¹⁾
 Operating Frequency Band 97.3 ~ 105.1 Megahertz.
 VSWR. <1.02:1 @ Operating Frequencies⁽²⁾
 Azimuthal Pattern Circularity Better Than +/- 1dB 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>
97.3	26 KW	0°	8.0 %	0.0 %	2.114	-0.642 dB	.162 dB	14.80 kW
105.1	5.7 KW	0°	8.0 %	0.0 %	2.051	-0.682 dB	.309 dB	3.492 kW

Mechanical Specifications

Antenna Feed System Fed with One 3 1/8” Line
 Input Connector 3 1/8”-50 Ohm EIA Flanged
 Element Deicing None
 Interbay Spacing 116.25” Center to Center
 Array Length 31.6 Feet
 Construction Material (Antenna) Galvanized Plated Steel and Stainless Steel
 Construction Material (Mounting) Leg Mount

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 74.5 Feet of 3 1/8” ERI Macxline (17.5’ sections) and 614 Feet of Cablewave Flexwell 3 1/2” Air Cable.
 4) Losses Taken From Actual Feedline.

A-4 ERI Combiner Specification Sheet

MULTIPLEXED TRANSMISSION SITE

Fort Wayne, Indiana

General Specifications:

Multiplexer Type “TEE” Combiner
Number of Combining Units Two
Injected Port to Injected Port Isolation < -80 dB
Output Connector 3 1/8 “50 Ohm EIA (Flanged)
Output Power (Designed) 19 kW⁽¹⁾

Heat Removal Convection Cooled
Physical Arrangement All Components Rack Mounted

Injected Port Specifications:

Frequency Assignment 97.3 ~ 105.1 MHz.
Power Rating, Each Injected Port (Designed).....14.8 kW for 97.3 MHz. ~ 3.492 kW for 105.1 MHz.
Input Connector3-1/8" 50 Ohm EIA (Flanged).
VSWR.....< 1.06 @ +/-150 KHz.⁽²⁾
Group DelayLess than 75 ns Overall Variation, Carrier @ +/- 150 KHz.
Insertion Loss (Measured):

97.3 MHz. - 0.162 dB
105.1 MHz. - 0.309 dB

- 1) Power Rating Listed is as Designed Only. Actual Power Capabilities May Vary.
- 2) When Terminated in 50 Ohm Resistive Load.
- 3) Losses Taken From Actual Feedline.

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CHANDLER, IN. 47618

FIGURE 1

----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

4 ERI TYPE SHPX CENTER FED ELEMENTS
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
8 PERCENT FIRST NULL FILL
8 PERCENT SECOND NULL FILL
POWER GAIN IS 2.114 IN THE HORIZONTAL PLANE(2.114 IN THE MAX.)

DECEMBER 17, 2007

97.3 MHz.

ELEMENT SPACING:
116.25 INCHES

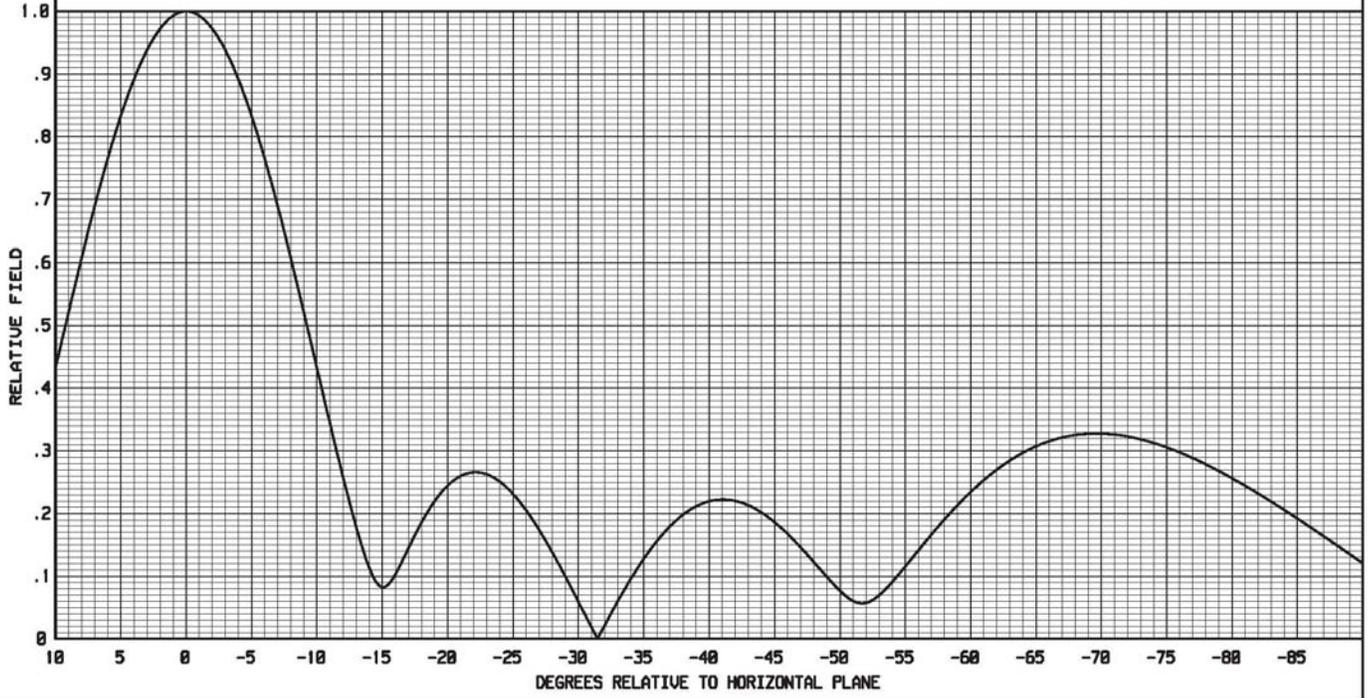


EXHIBIT A - 5

ELECTRONICS RESEARCH, INC.
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CHANDLER, IN. 47610

FIGURE 2

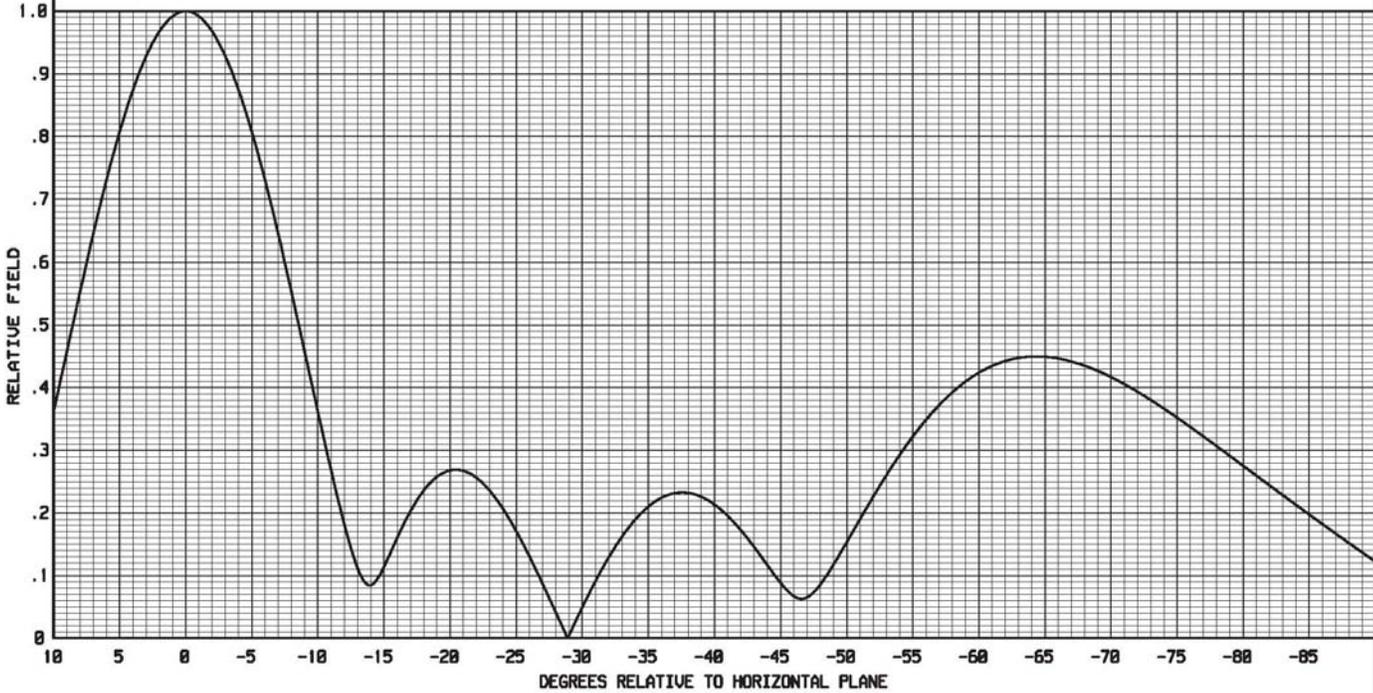
-----THEORETICAL-----
VERTICAL PLANE RELATIVE FIELD

4 ERI TYPE SHPX CENTER FED ELEMENTS
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
0 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
POWER GAIN IS 2.051 IN THE HORIZONTAL PLANE(2.051 IN THE MAX.)

DECEMBER 17, 2007

105.1 MHz.

ELEMENT SPACING:
116.25 INCHES



Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

