Report Of Intermodulation Product Findings

WGLX-FM 103.3 MHz. Wisconsin Rapids, Wisconsin.
WYTE 106.5 MHz. Marshfield, Wisconsin.

Project# 29317

April 6, 2012

Electronics Research Inc.
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Report of Findings for Intermodulation Product Measurements

Exhibits Accompanying This Report

REPORT OF FINDINGS
WGLX-FM / WYTE
103.3 MHz. / 106.5 MHz.

Introduction: This report of findings is based on data collected at the WGLX-FM and WYTE broadcast facility located in Marshfield, Wisconsin. The report includes measurements offered as proof that the combined operations of WGLX-FM (103.3 MHz.) and WYTE (106.5) 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). WHTQ (96.7 MHz.) operates into separate antenna on the same tower within 200' of the diplexed 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 April 6, 2012.

The following exhibits are provided:

Exhibit A:
- A-1 Drawing Depicting Antenna.
- A-2 SHPX-10AC-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 F2 signifies the frequency causing the interference.

The Multiplexed System: These measurements were taken with all FM stations operating from the combined antenna system. The WGLX-FM and WYTE multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-10AC-SP (antenna), rigid feedline and combiner units, are products of Electronics Research, Inc. While the Flex air cable 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 two transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a 783-3 “TEE” Combiner was installed. Specifically, the combiner uses two ERI Model 783-3 modules for each frequency (103.3 MHz. and 106.5 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 -62 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 -60 dB directivity and a forward signal sample of -30 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
103.3	**6**	**-**	**19.11**	**25.11**	
106.5	**6**	**-**	**21.24**	**27.24**	
96.7	**6**	**-**	**6.54**	**12.54**	

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	**103.3**	**106.5**
96.7 MHz.	109.9	116.3
103.3 MHz.	----	109.7
106.5 MHz.	100.1	----

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										
Product Frequency (MHz)	**Transmitter Frequency (MHz)**	**Interfering Frequency (MHz)**	**Pad (dB)**	**Bandpass Filter Loss (dB)**	**Total Loss**	**Measured Level (dBm)**	**Adjusted Level (dBm)**	**Carrier Reference Level (dBm)**	**Level Referenced to Carrier (dBm)**	**Notes***
Transmitter Mixes										
	103.3		6		6	19.11	25.11	**25.11**		
	106.5		6		6	21.24	27.24	**27.24**		
	96.7		6		6	6.54	12.54	**12.54**		
100.1	103.3	106.5	6	10.3	16.3	-86.84	-70.54	25.11	**-95.65**	
109.7	106.5	103.3	6	8.8	14.8	-85.78	-70.98	27.24	**-98.22**	
109.9	103.3	96.7	6	9.04	15.04	-90.25	-75.21	25.11	**-100.32**	
116.3	106.5	96.7	6	7.7	13.7	-87.39	-73.69	27.24	**-100.93**	
90.1	96.7	103.3	6	8.43	14.43	-85.47	-71.04	12.54	**-83.58**	
86.9	96.7	106.5	6	8.46	14.46	-86.54	-72.08	12.54	**-84.62**	

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 April 6, 2012 as summarized in this document, I, Jeff Taylor, find the subject system, specifically the transmitter and filter system for the operation of WGLX-FM and WYTE 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 WGLX-FM and WYTE 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 NRG Media on behalf of radio Stations WGLX-FM and WYTE in Marshfield, WI. to prepare this Report Of Findings.

Jeff Taylor; Field Technician

Jeff Taylor

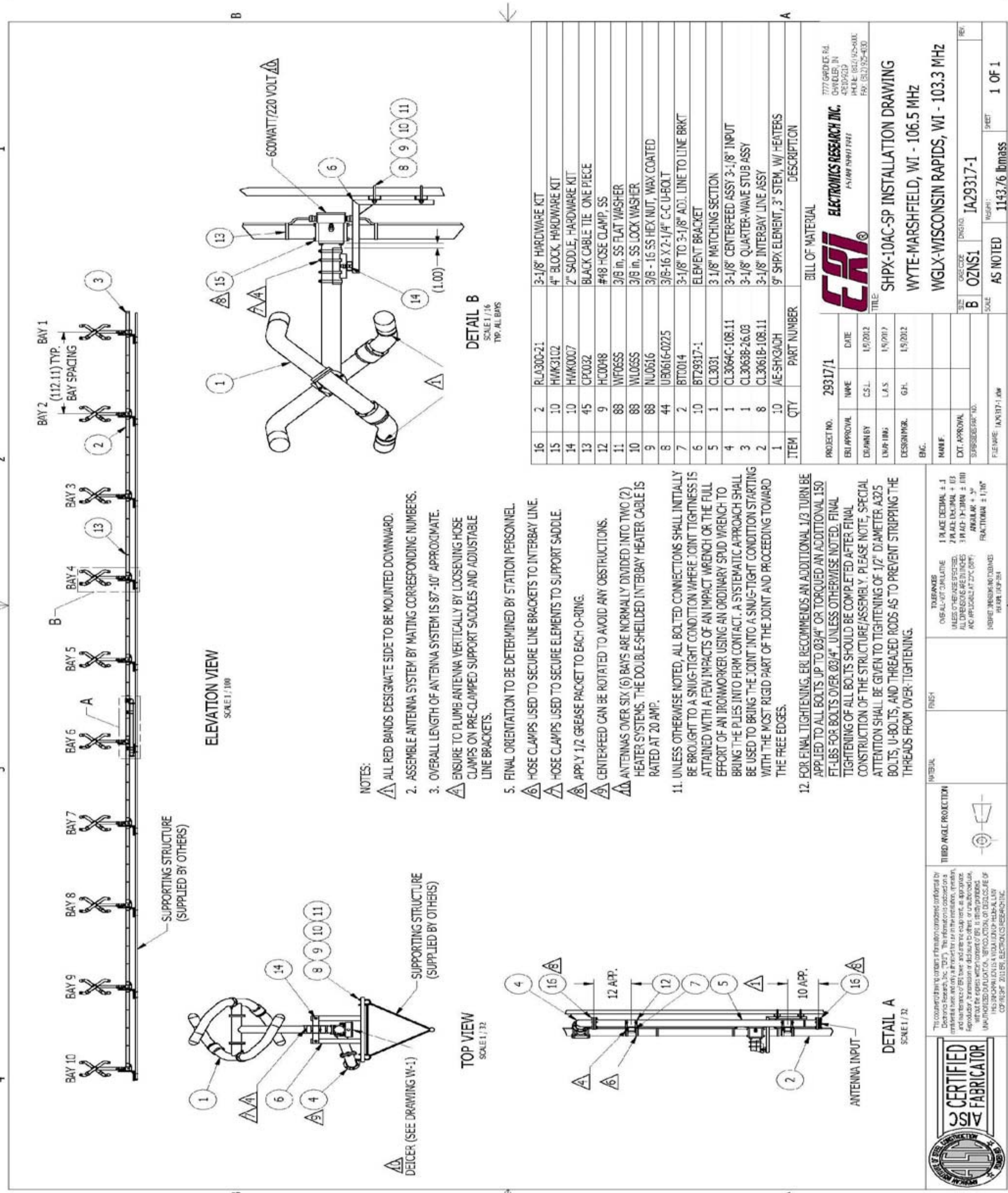
Subscribed and sworn to before me on this 9th, day of April, 2012.

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

JACQUELYN S. KINNEY
Notary Public, State of Indiana
Vanderburgh County
My Commission Expires
July 05, 2015

Jacquelyn S Kinney

EXHIBIT, A-1


BAY 10
BAY 9
BAY 8
BAY 7
BAY 6
BAY 5
BAY 4
BAY 3
BAY 2
BAY 1
(112.11) TYP.
BAY SPACING
SUPPORTING STRUCTURE (SUPPLIED BY OTHERS)
ELEVATION VIEW
SCALE 1 / 100
DEICER (SEE DRAWING W-1)
SUPPORTING STRUCTURE (SUPPLIED BY OTHERS)
TOP VIEW
SCALE 1 / 32
12 APP.
10 APP.
ANTENNA INPUT
DETAIL A
SCALE 1 / 32
600WATT/220 VOLT
(1.00)
DETAIL B
SCALE 1 / 16
TYP. ALL BAYS
NOTES:
1. ALL RED BANDS DESIGNATE SIDE TO BE MOUNTED DOWNWARD.
2. ASSEMBLE ANTENNA SYSTEM BY MATING CORRESPONDING NUMBERS.
3. OVERALL LENGTH OF ANTENNA SYSTEM IS 87'-10" APPROXIMATE.
4. ENSURE TO PLUMB ANTENNA VERTICALLY BY LOOSENING HOSE CLAMPS ON PRE-CLAMPED SUPPORT SADDLES AND ADJUSTABLE LINE BRACKETS.
5. FINAL ORIENTATION TO BE DETERMINED BY STATION PERSONNEL.
6. HOSE CLAMPS USED TO SECURE LINE BRACKETS TO INTERBAY LINE.
7. HOSE CLAMPS USED TO SECURE ELEMENTS TO SUPPORT SADDLE.
8. APPLY 1/2 GREASE PACKET TO EACH O-RING.
9. CENTERFEED CAN BE ROTATED TO AVOID ANY OBSTRUCTIONS.
10. ANTENNAS OVER SIX (6) BAYS ARE NORMALLY DIVIDED INTO TWO (2) HEATER SYSTEMS. THE DOUBLE-SHEILDED INTERBAY HEATER CABLE IS RATED AT 20 AMP.
11. 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 AN IRONWORKER USING AN ORDINARY SPUD WRENCH TO BRING THE PLIES 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.
12. FOR FINAL TIGHTENING, ERI RECOMMENDS AN ADDITIONAL 1/3 TURN BE APPLIED TO ALL BOLTS UP TO Ø3/4" OR TORQUED AN ADDITIONAL 150 FT-LBS FOR BOLTS OVER Ø3/4", UNLESS OTHERWISE NOTED. FINAL TIGHTENING OF ALL BOLTS SHOULD BE COMPLETED AFTER FINAL CONSTRUCTION OF THE STRUCTURE/ASSEMBLY. PLEASE NOTE, SPECIAL ATTENTION SHALL BE GIVEN TO TIGHTENING OF 1/2" DIAMETER A325 BOLTS, U-BOLTS, AND THREADED RODS AS TO PREVENT STRIPPING THE THREADS FROM OVER-TIGHTENING.
16 | 2 | RLA300-21 | 3-1/8" HARDWARE KIT
15 | 10 | HWK3102 | 4" BLOCK, HARDWARE KIT
14 | 10 | HWK0007 | 2" SADDLE, HARDWARE KIT
13 | 45 | CP0032 | BLACK CABLE TIE ONE PIECE
12 | 9 | HC0048 | #48 HOSE CLAMP, SS
11 | 88 | WF06SS | 3/8 in, SS FLAT WASHER
10 | 88 | WL06SS | 3/8 in, SS LOCK WASHER
9 | 88 | NU0616 | 3/8 - 16 SS HEX NUT, WAX COATED
8 | 44 | UB0616-0225 | 3/8-16 X 2-1/4" C-C U-BOLT
7 | 2 | BT0014 | 3-1/8" TO 3-1/8" ADJ. LINE TO LINE BRKT
6 | 10 | BT29317-1 | ELEMENT BRACKET
5 | 1 | CL3031 | 3 1/8" MATCHING SECTION
4 | 1 | CL3064C-108.11 | 3-1/8" CENTERFEED ASSY 3-1/8" INPUT
3 | 1 | CL3063B-26.03 | 3-1/8" QUARTER-WAVE STUB ASSY
2 | 8 | CL3061B-108.11 | 3-1/8" INTERBAY LINE ASSY
1 | 10 | AE-SHX3A0H | 9" SHPX ELEMENT, 3" STEM, W/ HEATERS
ITEM | QTY | PART NUMBER | DESCRIPTION
BILL OF MATERIAL
PROJECT NO. 29317/1
ERI APPROVAL | NAME | DATE
DRAWN BY | C.S.L. | 1/9/2012
CHECKING | L.A.S. | 1/9/2012
DESIGN MGR. | G.H. | 1/9/2012
ENG.
MANUF.
EXT. APPROVAL
ELECTRONICS RESEARCH INC.
7777 GARDNER Rd.
CHANDLER, IN
47610-9219
TITLE:
SHPX-10AC-SP INSTALLATION DRAWING
WYTE-MARSHFIELD, WI - 106.5 MHz
WGLX-WISCONSIN RAPIDS, WI - 103.3 MHz
SIZE B
CAGE CODE 0ZNS1
DWG NO. IA29317-1
SCALE AS NOTED
WEIGHT: 1143.76 lbmass
SHEET 1 OF 1
THIRD ANGLE PROJECTION
MATERIAL
FINISH
TOLERANCES
AISC CERTIFIED FABRICATOR
C:\Workspace\Designs\29317\IA29317-1.idwC.S.L.1/9/2012

A-2 ERI Antenna Specification Sheet

MULTIPLEXED TRANSMISSION SITE
Marshfield, WI.

General Specifications

Antenna Type . . . . . .High Power FM-Broadcast, Suitable For Multiplexing
Model Number SHPX-10AC-SP
Number of Bay Levels ..... Ten
Polarization ..... Right Hand Circular

Electrical Specifications

Antenna Input Power Capability . . . . . 39 kW Max (1)
Operating Frequency Band ..... 103.3 ~ 106.5 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:

Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
103.3	**65 KW**	**0°**	**9.0 %**	**0.0 %**	**5.593**	**-0.896 dB**	**.199 dB**	**14.903 kW**
106.5	**100 KW**	**0°**	**10.0 %**	**0.0 %**	**5.499**	**-0.881 dB**	**.296 dB**	**23.929 kW**

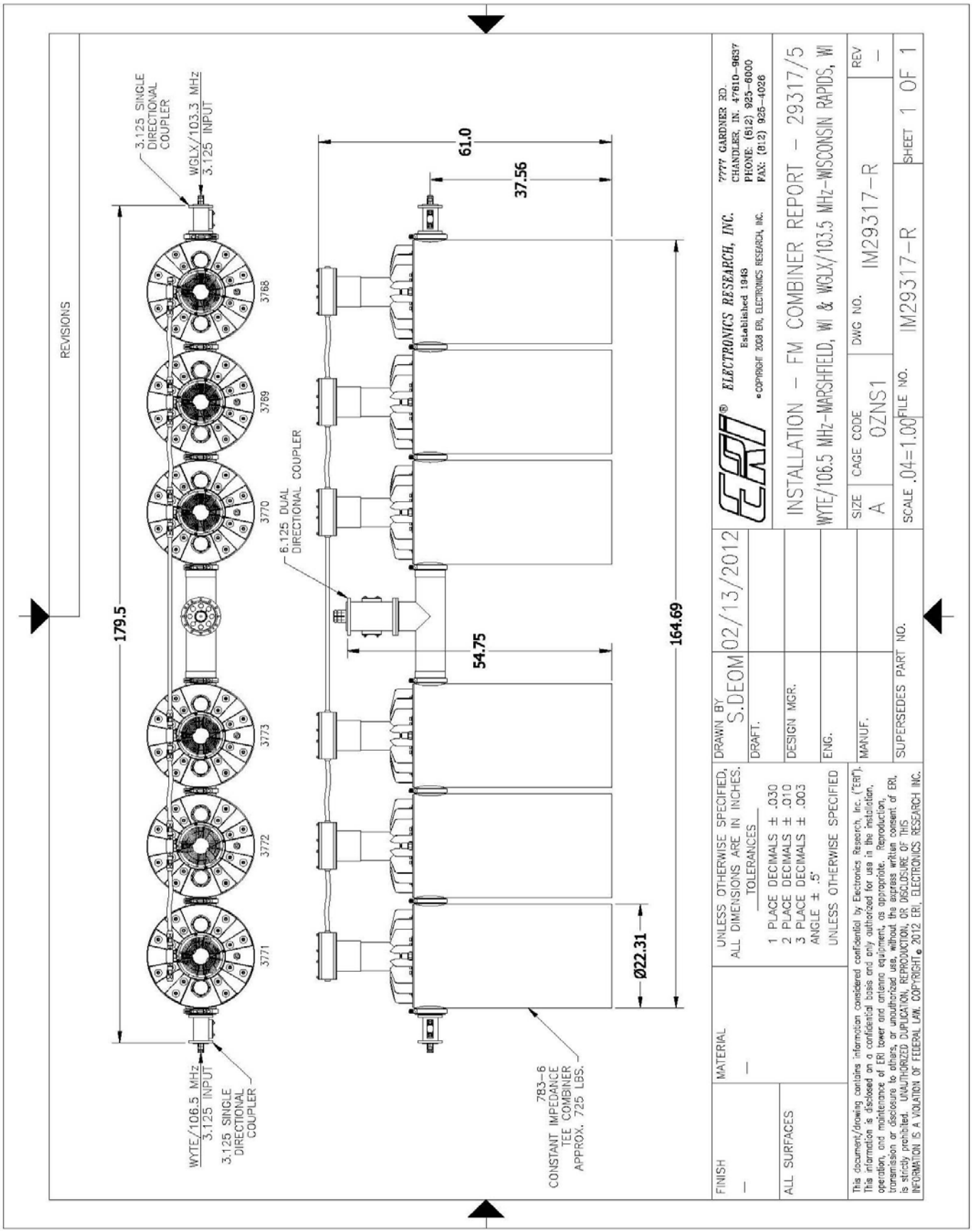
Mechanical Specifications

Antenna Feed System ..... Fed with One 3 1/8” Line
Input Connector …… . 3 1/8”-50 Ohm EIA Flanged
Element Deicing.....Electric Deicers
Interbay Spacing ..... 112.125” Center to Center
Array Length..... 86.6 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 141 Feet of ERI Line STD-350 3 1/8” Rigid. Section Lengths 17.5 and 645’ of Andrew HJ11-50.
4) Losses Taken From Actual Feedline.

EXHIBIT A-3


REVISIONS
3.125 SINGLE DIRECTIONAL COUPLER
WGLX/103.3 MHz 3.125 INPUT
WYTE/106.5 MHz 3.125 INPUT
3.125 SINGLE DIRECTIONAL COUPLER
6.125 DUAL DIRECTIONAL COUPLER
783-6 CONSTANT IMPEDANCE TEE COMBINER APPROX. 725 LBS.
3768
3769
3770
3773
3772
3771
179.5
61.0
37.56
54.75
164.69
Ø22.31
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Established 1948
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7777 GARDNER RD.
CHANDLER, IN. 47610-9637
PHONE: (812) 925-6000
FAX: (812) 925-4026
INSTALLATION - FM COMBINER REPORT - 29317/5
WYTE/106.5 MHz-MARSHFIELD, WI & WGLX/103.3 MHz-WISCONSIN RAPIDS, WI
DRAWN BY S.DEOM 02/13/2012
DRAFT.
DESIGN MGR.
ENG.
MANUF.
SUPERSEDES PART NO.
SIZE A
CAGE CODE 0ZNS1
DWG NO. IM29317-R
REV -
SCALE .04=1.00
FILE NO. IM29317-R
SHEET 1 OF 1
FINISH -
MATERIAL -
ALL SURFACES
UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES.
TOLERANCES
1 PLACE DECIMALS ± .030
2 PLACE DECIMALS ± .010
3 PLACE DECIMALS ± .003
ANGLE ± .5°
UNLESS OTHERWISE SPECIFIED
This document/drawing contains information considered confidential by Electronics Research, Inc. ("ERI"). This information is disclosed on a confidential basis and only authorized for use in the installation, operation, and maintenance of ERI tower and antenna equipment, as appropriate. Reproduction, transmission or disclosure to others, or unauthorized use, without the express written consent of ERI, is strictly prohibited. UNAUTHORIZED DUPLICATION, REPRODUCTION, OR DISCLOSURE OF THIS INFORMATION IS A VIOLATION OF FEDERAL LAW. COPYRIGHT © 2012 ERI, ELECTRONICS RESEARCH INC.

A-4 ERI Combiner Specification Sheet

MULTIPLEXED TRANSMISSION SITE
Marshfield, Wisconsin

General Specifications:

Multiplexer Type ..... "TEE" Combiner
Number of Combining Units ..... Two
Injected Port to Injected Port Isolation ..... < -62 dB
Output Connector ..... 6 1/8 "50 Ohm EIA (Flanged)
Output Power (Designed) ..... 39 kW(1)

Heat Removal .....Forced Air Cooling
Physical Arrangement .....All Components Free Standing

Injected Port Specifications:

Frequency Assignment .....103.3 ~ 106.5 MHz.
Power Rating, Each Injected Port (Designed).....14.9 kW 103.3 MHz. & 24 kW 106.5 MHz.
Input Connector .....3-1/8" 50 Ohm EIA (Flanged).
VSWR.....< 1.04:1 @ +/-150 KHz.(2)
Group Delay .....Less than 90 ns Overall Variation, Carrier @ +/- 150 KHz.
Insertion Loss (Measured):

103.3 MHz. ..... - 0.199 dB
106.5 MHz. ..... - 0.296 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.

EXHIBIT A – 5

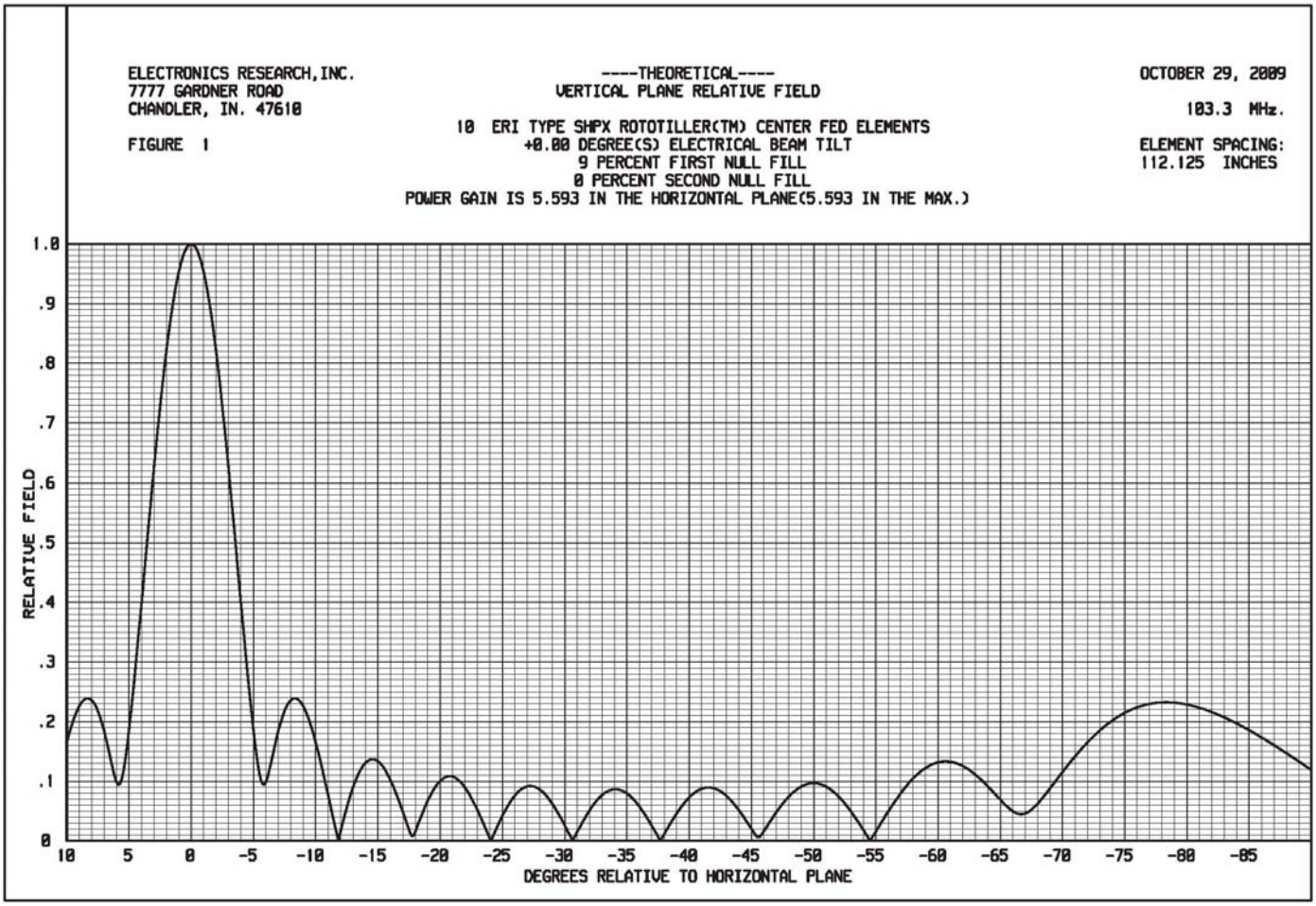
ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 1
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
10 ERI TYPE SHPX ROTOTILLER(TM) CENTER FED ELEMENTS
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
9 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
POWER GAIN IS 5.593 IN THE HORIZONTAL PLANE(5.593 IN THE MAX.)
OCTOBER 29, 2009
103.3 MHz.
ELEMENT SPACING:
112.125 INCHES
RELATIVE FIELD
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85
DEGREES RELATIVE TO HORIZONTAL PLANE

EXHIBIT A – 5

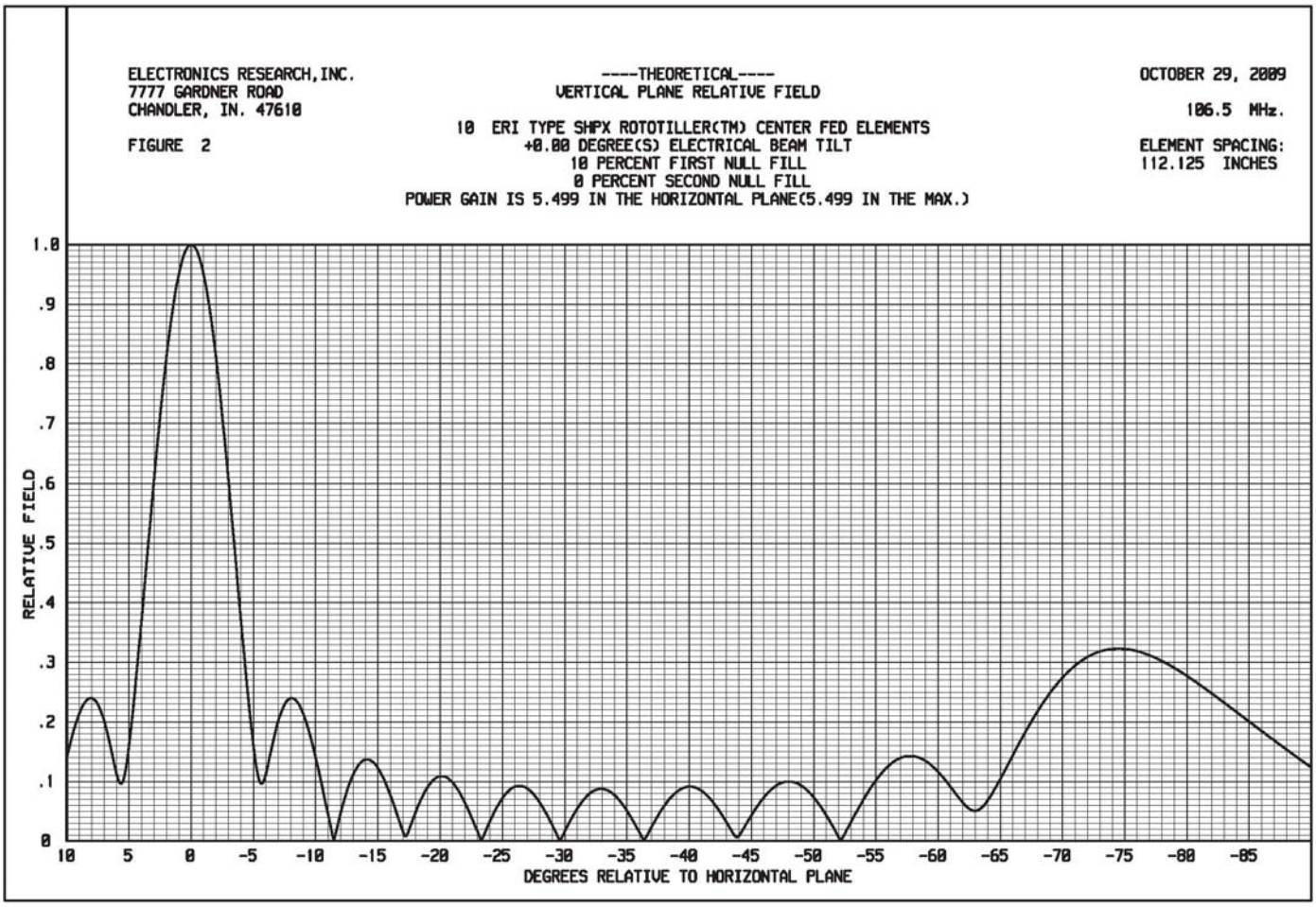
ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 2
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
10 ERI TYPE SHPX ROTOTILLER(TM) CENTER FED ELEMENTS
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
10 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
POWER GAIN IS 5.499 IN THE HORIZONTAL PLANE(5.499 IN THE MAX.)
OCTOBER 29, 2009
106.5 MHz.
ELEMENT SPACING:
112.125 INCHES
RELATIVE FIELD
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85
DEGREES RELATIVE TO HORIZONTAL PLANE

EXHIBIT B

Broadcasting Scheme and Equipment Employed in Intermodulation Measurements