ELECTRONICS RESEARCH, INC. ERI

Report Of

Intermodulation Product Findings

Washington, D.C.

WAMU – 88.5 MHz.
WPFW – 89.3 MHz.
WETA – 90.9 MHz.
WTOP – 103.5 MHz.

Project# 36240

February 18, 2020

Electronics Research Inc.
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Chandler, Indiana 47610
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Report of Findings for Intermodulation Product Measurements

Exhibits Accompanying This Report

REPORT OF FINDINGS
WASHINGTON, D.C.
BROADCAST FACILITY

Introduction: This report of findings is based on data collected at the FM broadcast facility located in Washington, D.C. The report includes measurements offered as proof that the combined operations of WAMU (88.5 MHz.), WPFW (89.3 MHz.), WETA (90.9 MHz.), and WTOP (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). WPCG (95.5 MHz.), and WMMJ (102.3 MHz.), operate into separate antennas that are 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 February 18, 2020.

The following exhibits are provided:

Exhibit A:
- A-1 Drawing Depicting Cog Antenna.
- A-2 Cog 1084-9CP 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 their respective antenna systems. The WAMU, WPFW, WETA, and WTOP, multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The 1183-4CP-DA-SP Cog antenna, 783-8 Constant Impedance combiner units, MACXLine 650 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 four transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of: (4) 783-8 Constant Impedance combiner modules were installed for frequencies, 88.5, 89.3, 90.9, and 103.5 MHz. Interconnecting "u-links" are 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 -72 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 -32 dB directivity and a forward signal sample of -47 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. An IFR 2399A Spectrum Analyzer serial# 02113071 was employed to record the level of all signals investigated. A Copper Mountain S5048 Network Analyzer serial# 15077029 was used for selective tuning of the Band Pass Filter. The IFR 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
WAMU 88.5	**10**	**---**	**17.24**	**27.24**	
WPFW 89.3	**10**	**---**	**15.25**	**25.25**	
WETA 90.0	**10**	**---**	**15.53**	**25.53**	
WTOP 103.5	**10**	**---**	**13.62**	**23.62**	

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	**88.5**	**89.3**	**90.9**	**103.5**
88.5 MHz.	----	90.1	93.3	118.5
89.3 MHz.	87.7	----	92.5	117.7
90.9 MHz.	86.1	87.7	----	116.1
95.5 MHz.	81.5	83.1	86.3	111.5
102.3 MHz.	74.7	76.3	79.5	104.7
103.5 MHz.	73.5	75.1	78.3	----

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 Washington, D.C.										
Product Frequency (MHz)	**Transmitter Frequency (MHz)**	**Interfering Frequency (MHz)**	**Pad (dB)**	**Bandpass Filter Loss (dB)**	**Total Loss**	**Measured Level (dB)**	**Adjusted Level (dB)**	**Carrier Reference Level (dB)**	**Level Referenced to Carrier (dB)**	**Notes***
Transmitter Mixes										
	88.5	**Ref.**	10		10	17.24	27.24	**27.24**		
	89.3	**Ref.**	10		10	15.25	25.25	**25.25**		
	90.9	**Ref.**	10		10	15.53	25.53	**25.53**		
	103.5	**Ref.**	10		10	13.62	23.62	**23.62**		
73.5	88.5	103.5	10	11.73	21.73	-92.75	-71.02	27.24	**-98.26**	
74.7	88.5	102.3	10	11.83	21.83	-90.33	-68.5	27.24	**-95.74**	
75.1	89.3	103.5	10	11.61	21.61	-91.77	-70.16	25.25	**-95.41**	
76.3	89.3	102.3	10	11.51	21.51	-91.43	-69.92	25.25	**-95.17**	
78.3	90.9	103.5	10	11.73	21.73	-90.61	-68.88	25.53	**-94.41**	
79.5	90.9	102.3	10	11.46	21.46	-92.02	-70.56	25.53	**-96.09**	
81.5	88.5	95.5	10	11.35	21.35	-92.44	-71.09	27.24	**-98.33**	
83.1	89.3	95.5	10	11.19	21.19	-90.67	-69.48	25.25	**-94.73**	
86.1	88.5	90.9	10	11.28	21.28	-90.73	-69.45	27.24	**-96.69**	
86.3	90.9	95.5	10	11.04	21.04	-89.94	-68.9	25.53	**-94.43**	
87.7	89.3	90.9	10	11.21	21.21	-89.88	-68.67	25.25	**-93.92**	
87.7	88.5	89.3	10	11.21	21.21	-89.88	-68.67	27.24	**-95.91**	
90.1	89.3	88.5	10	10.98	20.98	-90.27	-69.29	25.25	**-94.54**	
92.5	90.9	89.3	10	11.12	21.12	-89.73	-68.61	25.53	**-94.14**	
93.3	90.9	88.5	10	10.97	20.97	-89.52	-68.55	25.53	**-94.08**	
104.7	103.5	102.3	10	10.44	20.44	-90.38	-69.94	23.62	**-93.56**	
111.5	103.5	95.5	10	10.53	20.53	-91.58	-71.05	23.62	**-94.67**	
116.1	103.5	90.9	10	10.46	20.46	-91.3	-70.84	23.62	**-94.46**	
117.7	103.5	89.3	10	10.37	20.37	-89.85	-69.48	23.62	**-93.1**	
118.5	103.5	88.5	10	10.48	20.48	-89.36	-68.88	23.62	**-92.5**	

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 February 18, 2020 as summarized in this document, I, Jeff Taylor, find the subject system, specifically the transmitters and filter systems for the operation of WAMU, WPFW, WETA, and WTOP 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 WAMU, WPFW, WETA, and WTOP, 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 American University on behalf of radio Stations WAMU, WPFW, WETA, and WTOP in Washington, D.C. to prepare this Report of Findings.

Jeff Taylor; Field Technician

Jeff Taylor

Subscribed and sworn to before me on this 24th, day of February, 2020.

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

Tabitha Lynne Heilman

NOTARY PUBLIC SEAL INDIANA
TABITHA LYNNE HEILMAN
Notary Public, State of Indiana
Warrick County
Commission Number 649993
My Commission Expires
January 02, 2022

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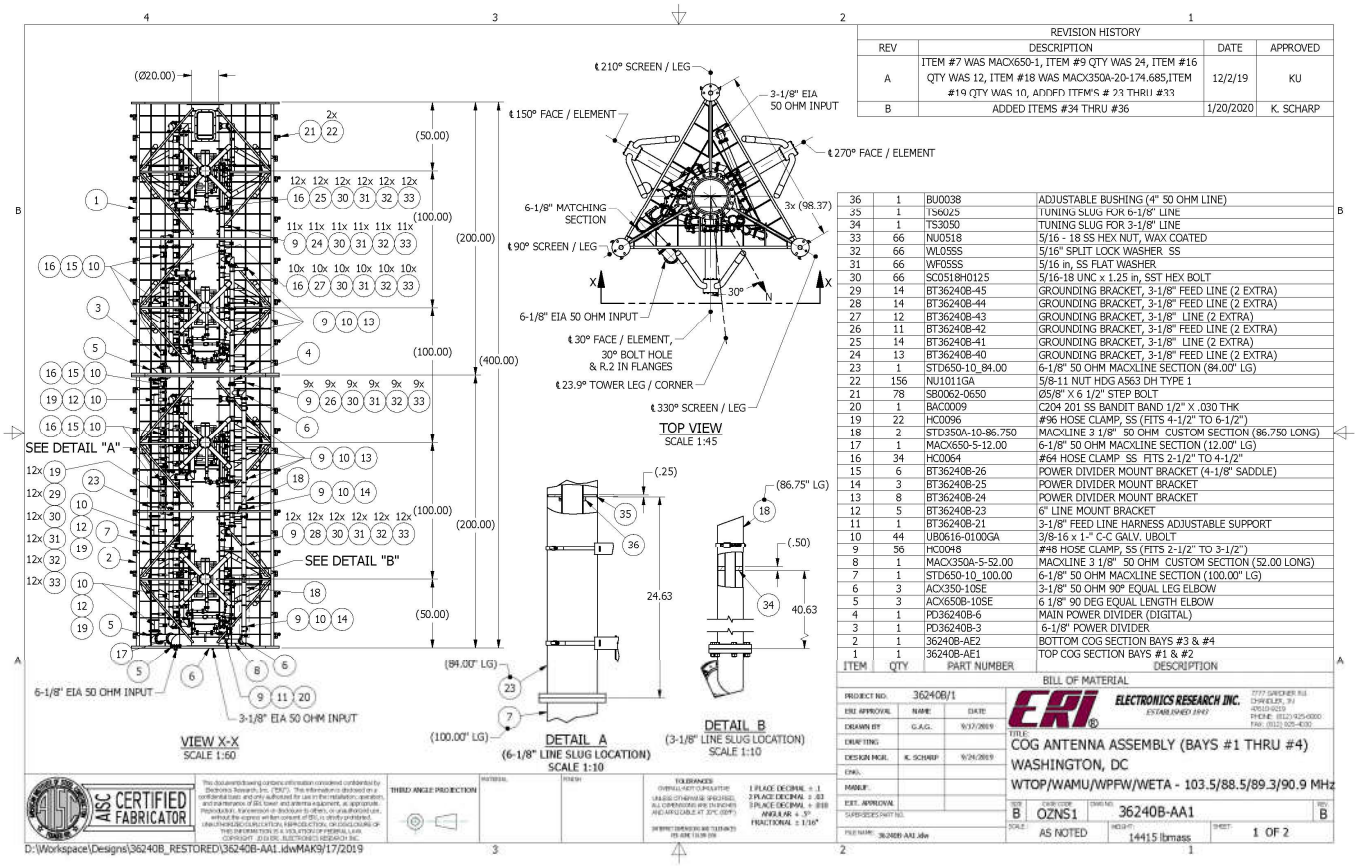
EXHIBIT, A-1


REVISION HISTORY
REV | DESCRIPTION | DATE | APPROVED
A | ITEM #7 WAS MACX650-1, ITEM #9 QTY WAS 24, ITEM #16 QTY WAS 12, ITEM #18 WAS MACX350A-20-174.685,ITEM #19 QTY WAS 10, ADDED ITEMS # 33 THRU #33 | 12/2/19 | KU
B | ADDED ITEMS #34 THRU #36 | 1/20/2020 | K. SCHARP
TOP VIEW
SCALE 1:45
VIEW X-X
SCALE 1:60
DETAIL A
(6-1/8" LINE SLUG LOCATION)
SCALE 1:10
DETAIL B
(3-1/8" LINE SLUG LOCATION)
SCALE 1:10
SEE DETAIL "A"
SEE DETAIL "B"
6-1/8" EIA 50 OHM INPUT
3-1/8" EIA 50 OHM INPUT
ITEM | QTY | PART NUMBER | DESCRIPTION
36 | 1 | BU0038 | ADJUSTABLE BUSHING (4" 50 OHM LINE)
35 | 1 | TS6025 | TUNING SLUG FOR 6-1/8" LINE
34 | 1 | TS3050 | TUNING SLUG FOR 3-1/8" LINE
33 | 66 | NU0518 | 5/16 - 18 SS HEX NUT, WAX COATED
32 | 66 | WL05SS | 5/16" SPLIT LOCK WASHER SS
31 | 66 | WF05SS | 5/16 in, SS FLAT WASHER
30 | 66 | SC0518H0125 | 5/16-18 UNC x 1.25 in, SST HEX BOLT
29 | 14 | BT36240B-45 | GROUNDING BRACKET, 3-1/8" FEED LINE (2 EXTRA)
28 | 14 | BT36240B-44 | GROUNDING BRACKET, 3-1/8" FEED LINE (2 EXTRA)
27 | 12 | BT36240B-43 | GROUNDING BRACKET, 3-1/8" LINE (2 EXTRA)
26 | 11 | BT36240B-42 | GROUNDING BRACKET, 3-1/8" FEED LINE (2 EXTRA)
25 | 14 | BT36240B-41 | GROUNDING BRACKET, 3-1/8" LINE (2 EXTRA)
24 | 13 | BT36240B-40 | GROUNDING BRACKET, 3-1/8" FEED LINE (2 EXTRA)
23 | 1 | STD650-10_84.00 | 6-1/8" 50 OHM MACXLINE SECTION (84.00" LG)
22 | 156 | NU1011GA | 5/8-11 NUT HDG A563 DH TYPE 1
21 | 78 | SB0062-0650 | Ø5/8" X 6 1/2" STEP BOLT
20 | 1 | BAC0009 | C204 201 SS BANDIT BAND 1/2" X .030 THK
19 | 22 | HC0096 | #96 HOSE CLAMP, SS (FITS 4-1/2" TO 6-1/2")
18 | 2 | STD350A-10-86.750 | MACXLINE 3 1/8" 50 OHM CUSTOM SECTION (86.750 LONG)
17 | 1 | MACX650-5-12.00 | 6-1/8" 50 OHM MACXLINE SECTION (12.00" LG)
16 | 34 | HC0064 | #64 HOSE CLAMP SS FITS 2-1/2" TO 4-1/2"
15 | 6 | BT36240B-26 | POWER DIVIDER MOUNT BRACKET (4-1/8" SADDLE)
14 | 3 | BT36240B-25 | POWER DIVIDER MOUNT BRACKET
13 | 8 | BT36240B-24 | POWER DIVIDER MOUNT BRACKET
12 | 5 | BT36240B-23 | 6" LINE MOUNT BRACKET
11 | 1 | BT36240B-21 | 3-1/8" FEED LINE HARNESS ADJUSTABLE SUPPORT
10 | 44 | UB0616-0100GA | 3/8-16 x 1-" C-C GALV. UBOLT
9 | 56 | HC0048 | #48 HOSE CLAMP, SS (FITS 2-1/2" TO 3-1/2")
8 | 1 | MACX350A-5-52.00 | MACXLINE 3 1/8" 50 OHM CUSTOM SECTION (52.00 LONG)
7 | 1 | STD650-10_100.00 | 6-1/8" 50 OHM MACXLINE SECTION (100.00" LG)
6 | 3 | ACX350-10SE | 3-1/8" 50 OHM 90° EQUAL LEG ELBOW
5 | 3 | ACX650B-10SE | 6 1/8" 90 DEG EQUAL LENGTH ELBOW
4 | 1 | PD36240B-6 | MAIN POWER DIVIDER (DIGITAL)
3 | 1 | PD36240B-3 | 6-1/8" POWER DIVIDER
2 | 1 | 36240B-AE2 | BOTTOM COG SECTION BAYS #3 & #4
1 | 1 | 36240B-AE1 | TOP COG SECTION BAYS #1 & #2
BILL OF MATERIAL
PROJECT NO: 36240B/1
ELECTRONICS RESEARCH INC.
ESTABLISHED 1947
COG ANTENNA ASSEMBLY (BAYS #1 THRU #4)
WASHINGTON, DC
WTOP/WAMU/WPFW/WETA - 103.5/88.5/89.3/90.9 MHz
SIZE B | CAGE CODE OZNS1 | DWG NO. 36240B-AA1 | REV B
SCALE: AS NOTED | WEIGHT: 14415 lbmass | SHEET: 1 OF 2
ASC CERTIFIED FABRICATOR
THIRD ANGLE PROJECTION
D:\Workspace\Designs\36240B_RESTORED\36240B-AA1.idwMAK9/17/2019

A-2 ERI 1183 Antenna Specification Sheet

TRANSMISSION SITE
WASHINGTON, D.C.

General Specifications

Antenna Type ……High Power FM-Broadcast, Suitable For Multiplexing
Model Number 1183-4CP-DA-SP
Number of Bay Levels .....Four
Polarization..... Circular Polarized

Electrical Specifications

Antenna Input Power Capability . . . . . 82 kW Max (1)
Operating Frequency Band ..... 88.5 ~ 103.5 Megahertz.
VSWR. . . . . <1.06:1 @ Operating Frequencies(2)
Azimuthal Pattern Circularity ..... Better Then +/- 2dB From RMS (Free Space)
Power Split ..... 50/50 (Horizontal & Vertical)
Frequency Specific Information:

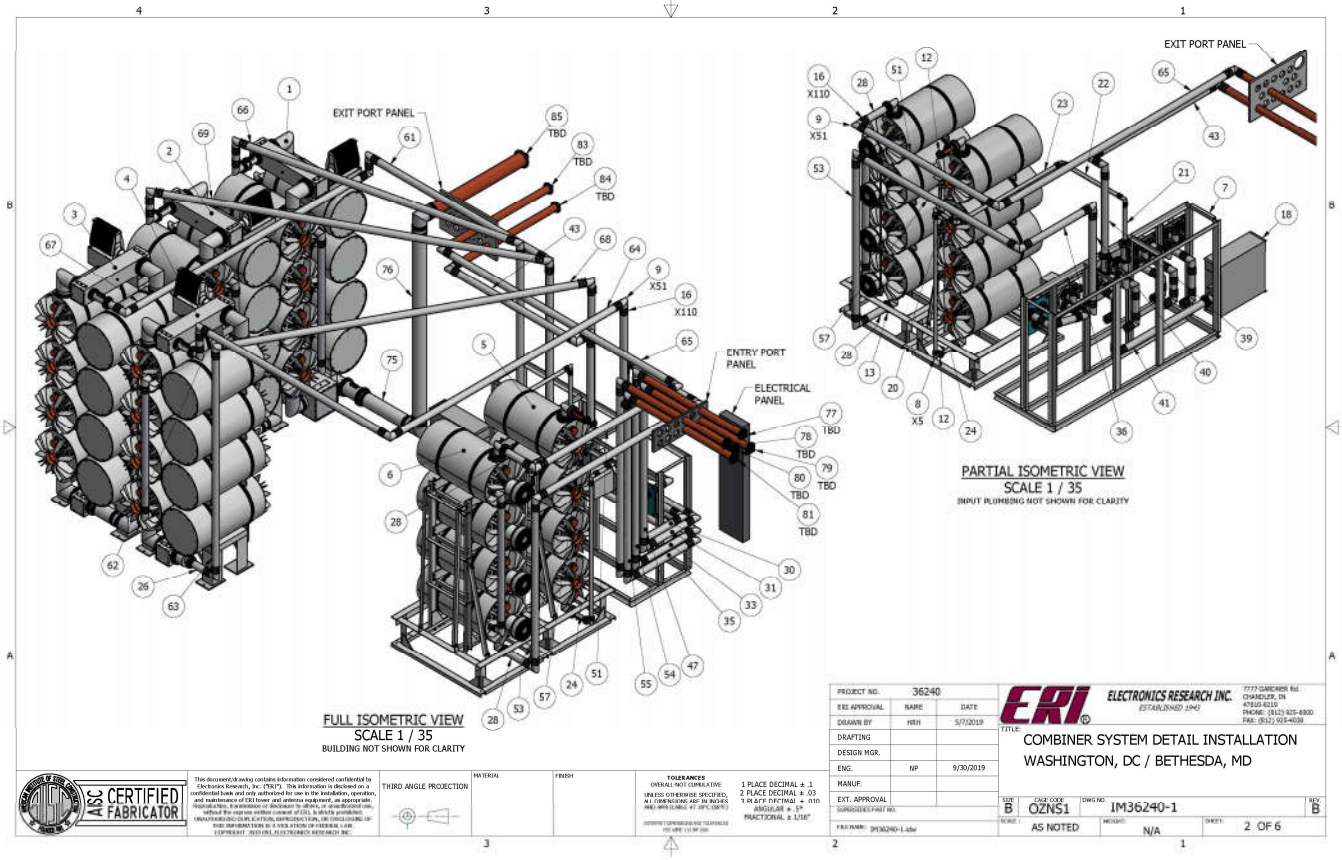
Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
85.5	**47 KW**	**-0.40°**	**6.9 %**	**8.2 %**	**1.775**	**-0.371 dB**	**-0.282 dB**	**30.75 kW**
89.3	**34 KW**	**-0.40°**	**6.9 %**	**8.3 %**	**1.786**	**-0.281 dB**	**-0.281 dB**	**21.68 kW**
90.9	**31 KW**	**-0.40°**	**6.9 %**	**8.4 %**	**1.809**	**-0.382 dB**	**-0.275 dB**	**20.21 kW**
103.5	**15 KW**	**-0.41°**	**6.9 %**	**9.1 %**	**1.980**	**-0.424 dB**	**-0.266 dB**	**8.877 kW**

Mechanical Specifications

Antenna Feed System..... Dual Input
Input Connector …….. 6 1/8 & 3 1/8”50-Ohm EIA Flanged
Element Deicing .....None
Interbay Spacing..... 100” Center to Center
Array Length ..... 33.33 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 405 Feet of ERI MACXLine 6 1/8” Rigid 17.5 Foot Sticks.
4) Losses Taken from Actual Combiner.

EXHIBIT A-3


EXIT PORT PANEL
ENTRY PORT PANEL
ELECTRICAL PANEL
FULL ISOMETRIC VIEW
SCALE 1 / 35
BUILDING NOT SHOWN FOR CLARITY
PARTIAL ISOMETRIC VIEW
SCALE 1 / 35
INPUT PLUMBING NOT SHOWN FOR CLARITY
ELECTRONICS RESEARCH INC.
COMBINER SYSTEM DETAIL INSTALLATION
WASHINGTON, DC / BETHESDA, MD
PROJECT NO. 36240
DRAWN BY HRH 5/7/2019
ENG. NP 9/30/2019
CAGE CODE OZNS1
DWG NO. IM36240-1
AS NOTED
N/A
2 OF 6
ASC CERTIFIED FABRICATOR
THIRD ANGLE PROJECTION

A-4 ERI Combiner Specification Sheet

TRANSMISSION SITE
WASHINGTON, D.C.

General Specifications:

Multiplexer Type ..... Constant Impedance
Number of Combining Units ..... Four
Injected Port to Injected Port Isolation ..... < - 72 dB
Output Connector ..... 6 1/8 "50 Ohm EIA (Flanged)
Output Power (Designed) ..... 82 kW(1)

Heat Removal .....Natural Convection Cooling
Physical Arrangement ..... Rack Mounted

Injected Port Specifications:

Frequency Assignment .....88.5 ~ 103.5 MHz.
Power Rating, Each Injected Port (Designed).....30.7 kW 88.5 MHz, 21.6 kW 89.3 MHz.
Power Rating, Each Injected Port (Designed).....20.2 kW 90.9 MHz, 8.87 kW 103.5 MHz.
Input Connector .....3-1/8" 50 Ohm EIA (Flanged).
VSWR.....< 1.09:1 @ +/-200 KHz.(2)
Group Delay .....Less than 280 ns Overall Variation, Carrier @ +/- 150 KHz.
Insertion Loss (Measured):

88.5 MHz. ..... - 0.282 dB
89.3 MHz. ..... - 0.286 dB
90.9 MHz. ..... - 0.275 dB
103.5 MHz. ..... - 0.266 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

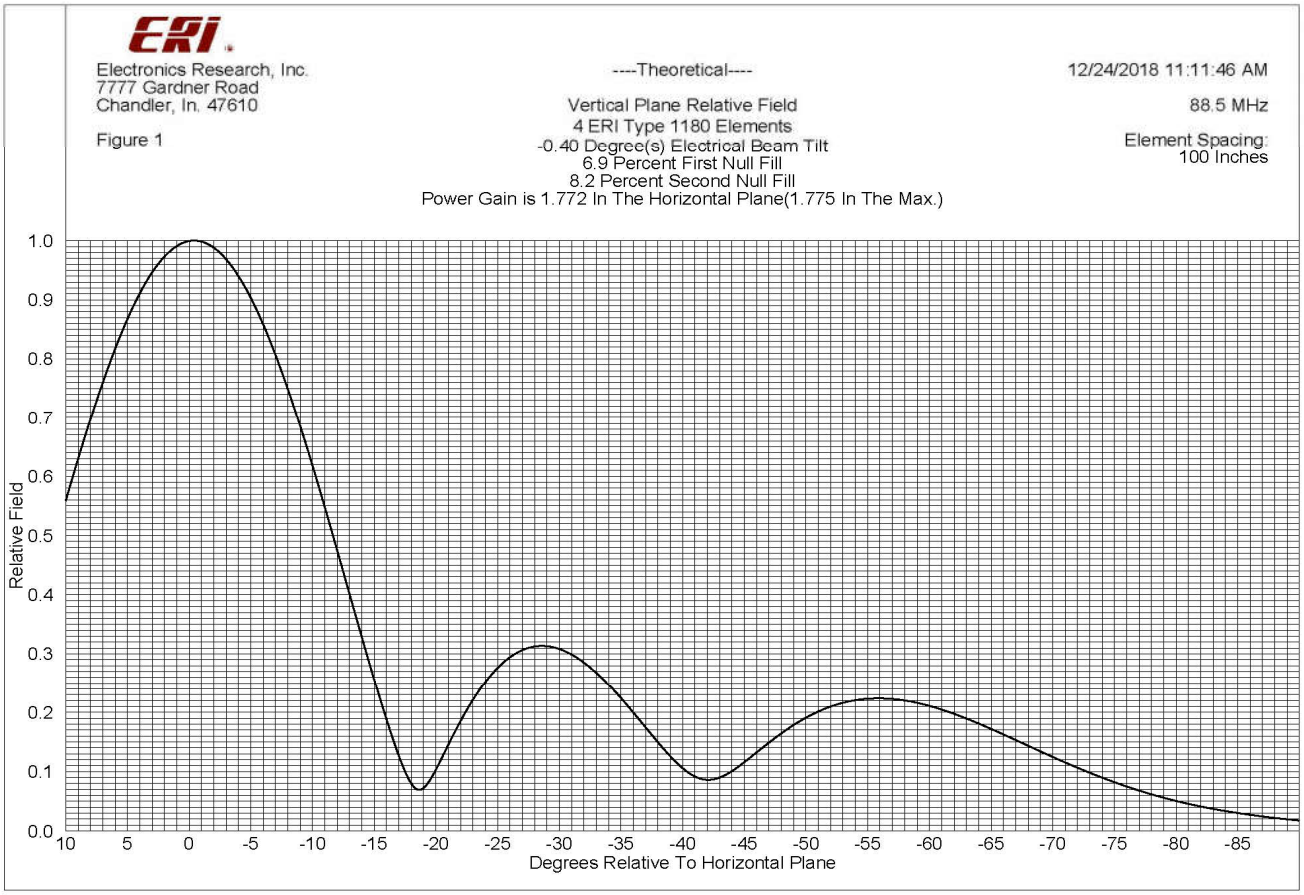

Electronics Research, Inc.
7777 Gardner Road
Chandler, In. 47610
Figure 1
----Theoretical----
Vertical Plane Relative Field
4 ERI Type 1180 Elements
-0.40 Degree(s) Electrical Beam Tilt
6.9 Percent First Null Fill
8.2 Percent Second Null Fill
Power Gain is 1.772 In The Horizontal Plane(1.775 In The Max.)
12/24/2018 11:11:46 AM
88.5 MHz
Element Spacing:
100 Inches
Relative Field
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
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

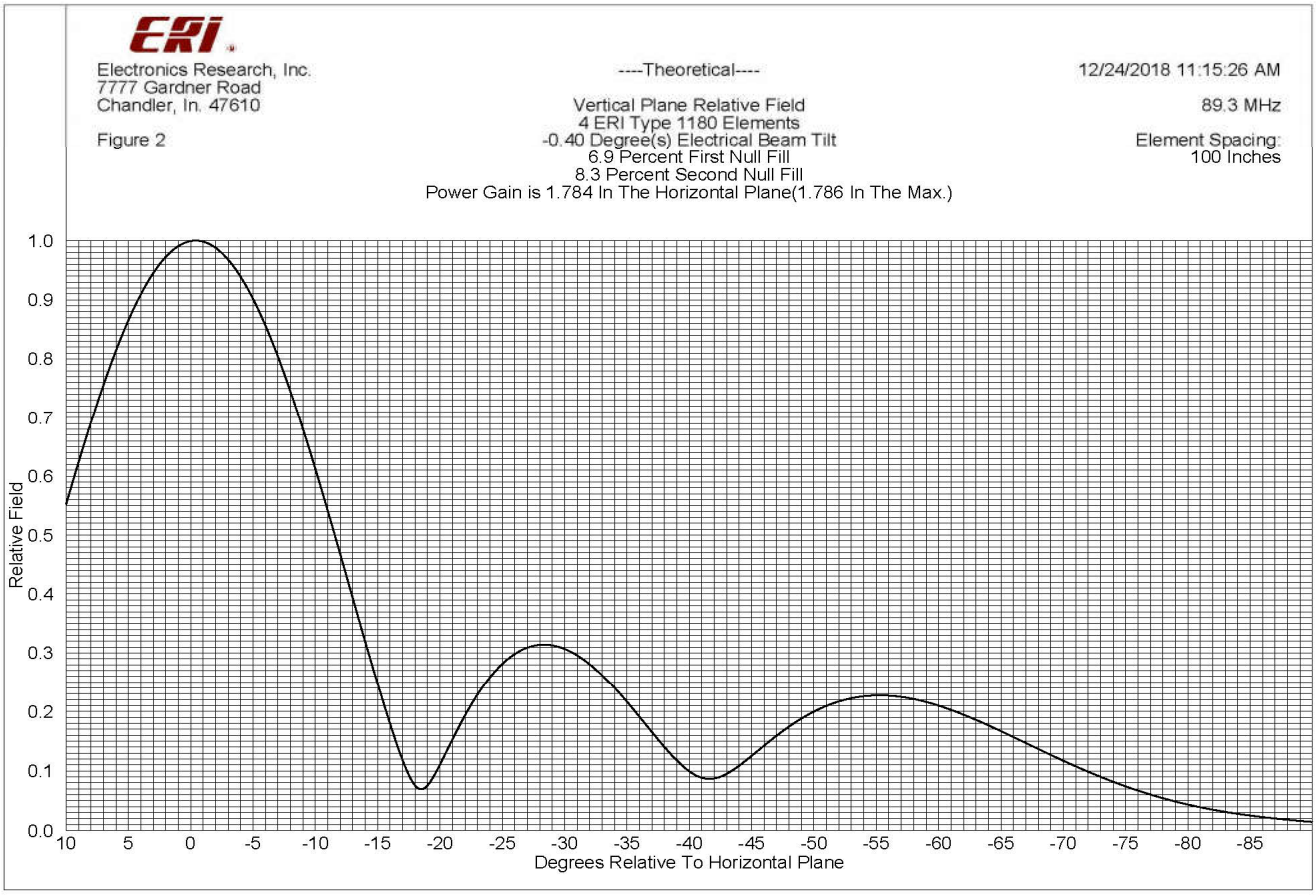
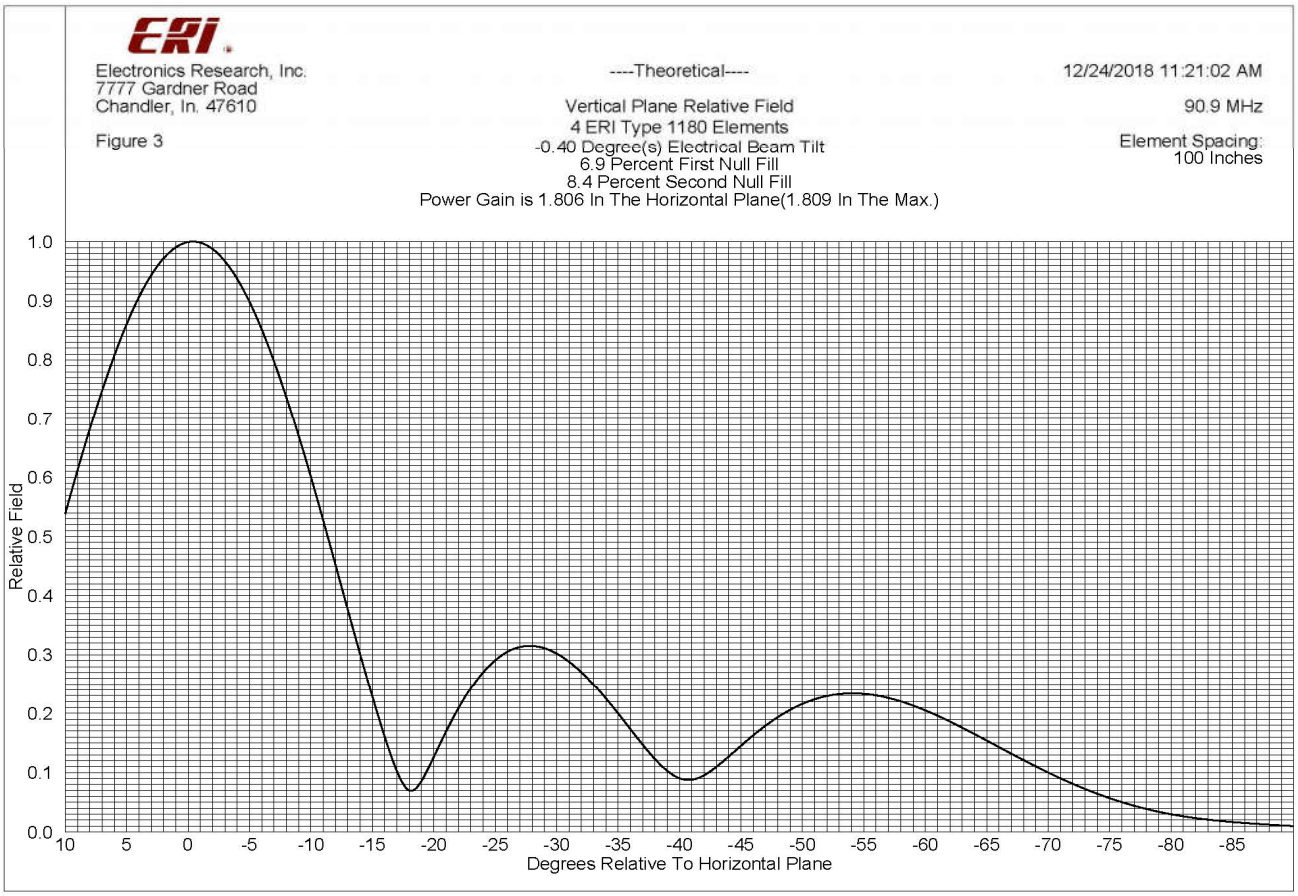
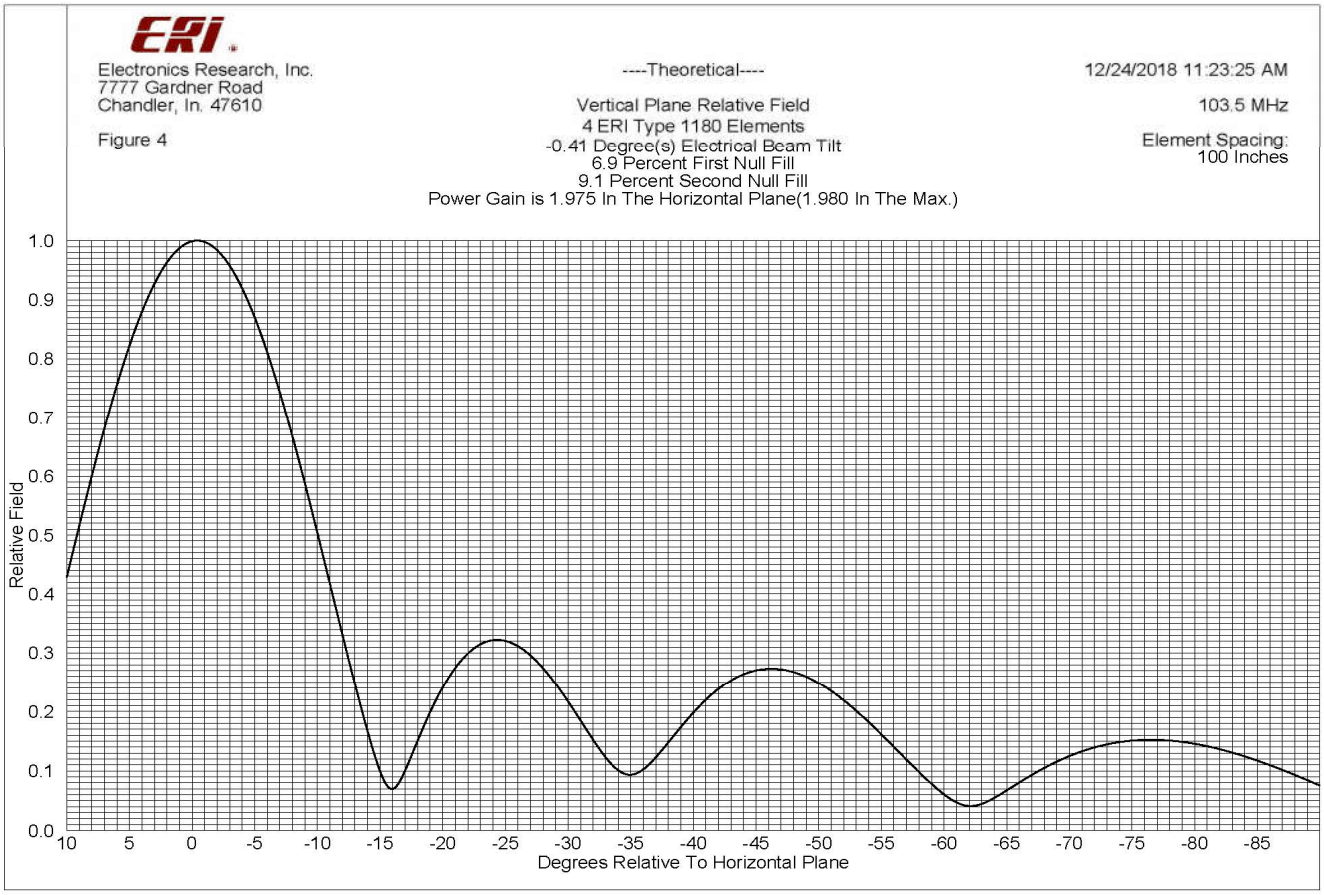
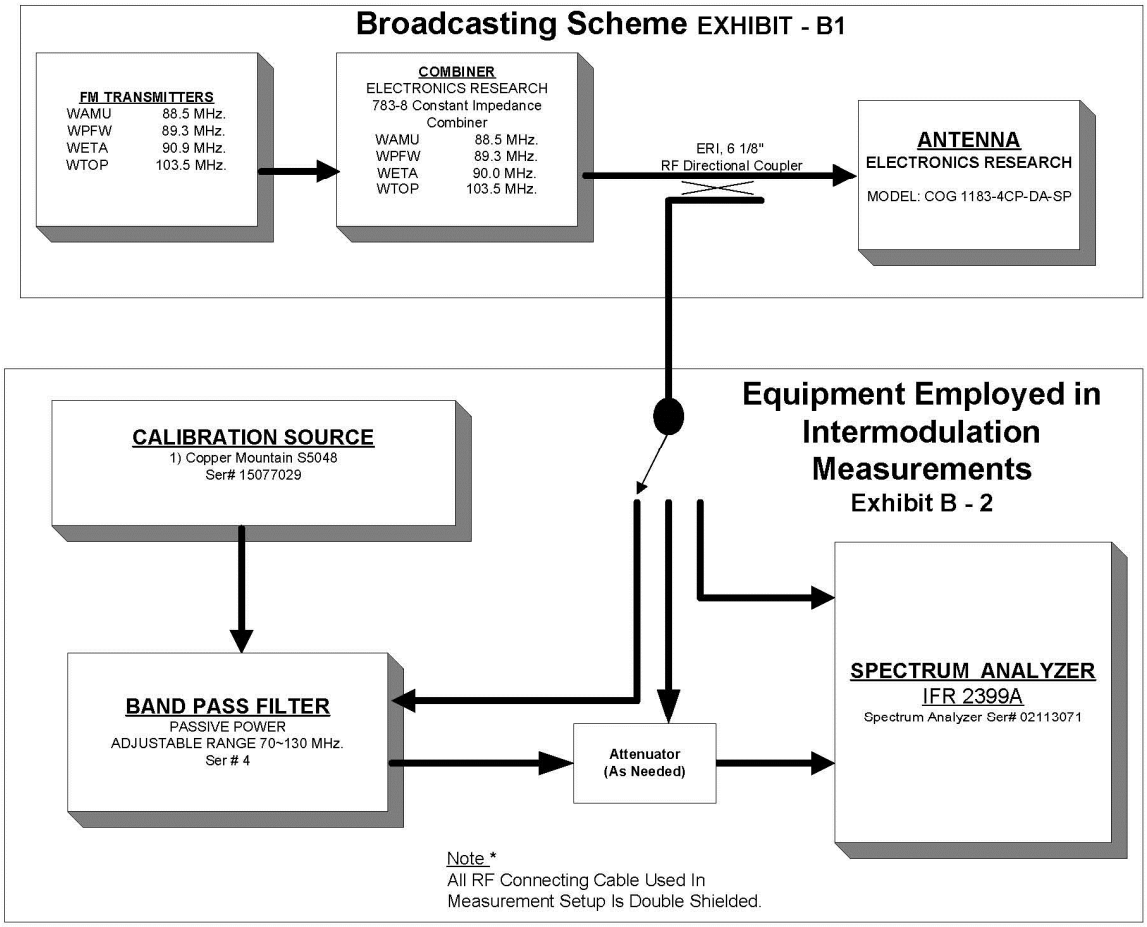

Electronics Research, Inc.
7777 Gardner Road
Chandler, In. 47610
Figure 2
----Theoretical----
Vertical Plane Relative Field
4 ERI Type 1180 Elements
-0.40 Degree(s) Electrical Beam Tilt
6.9 Percent First Null Fill
8.3 Percent Second Null Fill
Power Gain is 1.784 In The Horizontal Plane(1.786 In The Max.)
12/24/2018 11:15:26 AM
89.3 MHz
Element Spacing:
100 Inches
Relative Field
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
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 3
----Theoretical----
Vertical Plane Relative Field
4 ERI Type 1180 Elements
-0.40 Degree(s) Electrical Beam Tilt
6.9 Percent First Null Fill
8.4 Percent Second Null Fill
Power Gain is 1.806 In The Horizontal Plane(1.809 In The Max.)
12/24/2018 11:21:02 AM
90.9 MHz
Element Spacing:
100 Inches
Relative Field
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
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


Electronics Research, Inc.
7777 Gardner Road
Chandler, In. 47610
Figure 4
----Theoretical----
Vertical Plane Relative Field
4 ERI Type 1180 Elements
-0.41 Degree(s) Electrical Beam Tilt
6.9 Percent First Null Fill
9.1 Percent Second Null Fill
Power Gain is 1.975 In The Horizontal Plane(1.980 In The Max.)
12/24/2018 11:23:25 AM
103.5 MHz
Element Spacing:
100 Inches
Relative Field
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
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



Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

EXHIBIT B