Report Of Intermodulation Product Findings

KDGE 102.1 MHz. Dallas, Texas
KDMX 102.9 MHz. Dallas, Texas

Project# 29928

September 28, 2014

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Report of Findings for Intermodulation Product Measurements

Exhibits Accompanying This Report

REPORT OF FINDINGS
KDGE / KDMX
102.1 MHz. / 102.9 MHz.

Introduction: This report of findings is based on data collected at the KDGE and KDMX broadcast facility located in Dallas, Texas. The report includes measurements offered as proof that the combined operations of KDGE (102.1 MHz.) and KDMX (102.9) 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). 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). KCBI (90.9MHz), KZPS (92.5 MHz), KLNO (94.1MHz), KLTY (94.9 MHz), KSCS (96.3 MHz), KEGL (97.1 MHz), KLUV (98.7 MHz), WRR (101.1 MHz), KVIL (103.7 MHz), KKDA (104.5 MHz) and KHKS (106.1 MHz). operate into separate antennas located on the same tower or other nearby towers. Their effects on the stations operating from the multiplexed system are considered in this report. David Sanderford of Marsand Inc. located in Alvarado, Texas, performed the measurements summarized herein on September 28, 2014.

The following exhibits are provided:

Exhibit A:
- A-1 Drawing Depicting Antenna.
- A-2 SHPX-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 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 KDGE and KDMX multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-8AC6-SP antenna, rigid 6 1/8" feed line, and combiner units 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 two transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a 783-8 Constant Impedance Combiner was installed. Specifically, the combiner uses two ERI Model 783-8 modules, with non-adjacent coupling loops, for 102.1 MHz. and 102.9 MHz. An interconnecting "u-link" 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 -52 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 -30 dB directivity and a forward signal sample of -44 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 Microwave Band Pass Filter 3634B50-FM and a Microwave Band Stop Filter 3367B50-FM 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 HP E4402B Spectrum Analyzer serial# US4144338 was employed to record the level of all signals investigated. The tracking generator built into the spectrum analyzer was also used for selective tuning of the Band Pass Filter. The Spectrum Analyzer 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 both transmitters operating into the combined antenna 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)	Level Referenced to Carrier (dBm)	Notes
102.1	**59.96**	**-**	**13.35**	**73.31**	**73.31**	**11**
102.9	**59.96**	**-**	**12.56**	**72.52**	**72.52**	**11**

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	**102.1**	**102.9**
90.9	113.3	114.9
92.5	111.7	113.3
94.1	110.1	111.7
94.9	109.3	110.9
96.3	107.9	109.5
97.1	107.1	108.7
98.7	105.5	107.1
101.1	103.1	104.7
102.1	---	103.7
102.9	101.3	---
103.7	100.5	102.1
104.5	99.7	101.3
106.1	98.1	99.7

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

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*
98.1	102.1	106.1	50.96	5.6	56.56	-95	-38.44	73.31	**-111.75**	1
99.7	102.1	104.5	50.96	5.5	56.46	-109	-52.54	73.31	**-125.85**	4
99.7	102.9	106.1	50.96	5.5	56.46	-109	-52.54	72.52	**-125.06**	4
100.5	102.1	103.7	50.96	4.5	55.46	-109	-53.54	73.31	**-126.85**	2
101.3	102.1	102.9	50.96	4.2	55.16	-95	-39.84	73.31	**-113.15**	3,4
101.3	102.9	104.5	50.96	4.3	55.26	-96	-40.74	72.52	**-113.26**	3,4
102.1	102.9	103.7	50.96	4.3	55.26	-96	-40.74	72.52	**-113.26**	5
103.1	102.1	101.1	50.96	4.5	55.46	-101	-45.54	73.31	**-118.85**	6
103.7	102.9	102.1	50.96	4.1	55.06	-88	-32.94	72.52	**-105.46**	7
104.7	102.9	101.1	50.96	4.8	55.76	-109	-53.24	72.52	**-125.76**	
105.5	102.1	98.7	50.96	4.5	55.46	-109	-53.54	73.31	**-126.85**	
107.1	102.1	97.1	50.96	4.6	55.56	-108	-52.44	73.31	**-125.75**	4
107.1	102.9	98.7	50.96	4.6	55.56	-108	-52.44	72.52	**-124.96**	4
107.9	102.1	96.3	50.96	4.6	55.56	-109	-53.44	73.31	**-126.75**	
108.7	102.9	97.1	50.96	4.5	55.46	-110	-54.54	72.52	**-127.06**	
109.3	102.1	94.9	50.96	4.6	55.56	-110	-54.44	73.31	**-127.75**	
109.5	102.9	96.3	50.96	4.5	55.46	-110	-54.54	72.52	**-127.06**	
110.1	102.1	94.1	50.96	4.4	55.36	-110	-54.64	73.31	**-127.95**	
110.9	102.9	94.9	50.96	4.3	55.26	-110	-54.74	72.52	**-127.26**	
111.7	102.1	92.5	50.96	4.4	55.36	-110	-54.64	73.31	**-127.95**	4
111.7	102.9	94.1	50.96	4.4	55.36	-110	-54.64	72.52	**-127.16**	4
113.3	102.1	90.9	50.96	4.4	55.36	-100	-44.64	73.31	**-117.95**	4
113.3	102.9	92.5	50.96	4.4	55.36	-100	-44.64	72.52	**-117.16**	4
114.9	102.9	90.9	50.96	4.3	55.26	-110	-54.74	72.52	**-127.76**	

Notes:

(1) Measured signal is a local carrier KHKS-FM, 106.1 MHz. No Discernable signal was detected.
(2) Measured signal is a local carrier KVIL-FM, 103.7 MHz. No Discernable signal was detected.
(3) System Transmitter KWRR-FM was left on for this product measurement.
(4) Product frequency repeated.
(5) System Transmitter KDGE-FM 102.1 was turned off for this product measurement.
(6) System Transmitter KDMX-FM 102.9 was turned off for this product measurement.
(7) System Transmitter KVIL-FM 103.7 was turned off for this product measurement.
(8) System output directional coupler value: -45 dB.
(9) 102.1 Input directional coupler value: -54 dB.
(10) 102.9 Input directional coupler value: -54 dB.
(11) Modulation removed (except pilot).
(12) Pad used measured 5.96 dB across the span in question.

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 September 28, 2014 as summarized in this document, I, David Sanderford, find the subject system, specifically the transmitter and filter system for the operation of KDGE and KDMX 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 KDGE and KDMX are in compliance with the requirements of Section 73.317 paragraph (b) through (d) of the FCC Rules and Regulations.

Respectfully submitted,

David Sanderford

David Sanderford, E.I.T. – VP Marsand, Inc.

ELECTRONICS RESEARCH, INC. ERI

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 American Tower on behalf of radio Stations KDGE and KDMX in Dallas, TX. to prepare this Report Of Findings.

Jeff Taylor; Field Technician

Jeff Taylor

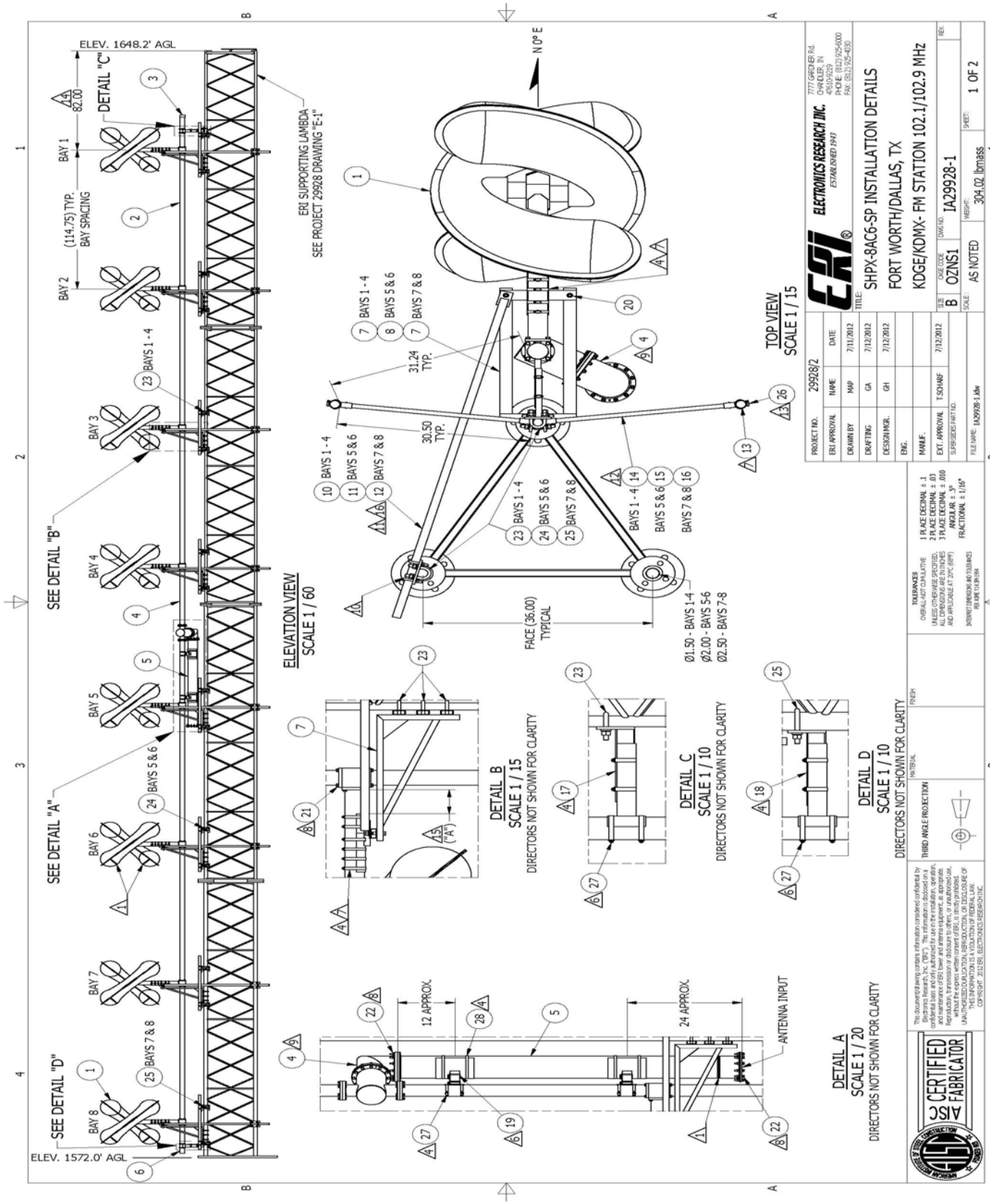
Subscribed and sworn to before me on this 29th, day of September, 2014.

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

Jacquelyn S. Glenn

JACQUELYN GLENN
Notary Public, State of Indiana
Vanderburgh County
My Commission Expires
July 05, 2015

EXHIBIT, A-1


ELEV. 1648.2' AGL
ELEV. 1572.0' AGL
DETAIL "C"
SEE DETAIL "B"
SEE DETAIL "A"
SEE DETAIL "D"
BAY 1
BAY 2
BAY 3
BAY 4
BAY 5
BAY 6
BAY 7
BAY 8
82.00
(114.75) TYP. BAY SPACING
ERI SUPPORTING LAMBDA
SEE PROJECT 29928 DRAWING "E-1"
N 0° E
ELEVATION VIEW
SCALE 1 / 60
TOP VIEW
SCALE 1 / 15
BAYS 1 - 4
BAYS 5 & 6
BAYS 7 & 8
31.24 TYP.
30.50 TYP.
FACE (36.00) TYPICAL
Ø1.50 - BAYS 1-4
Ø2.00 - BAYS 5-6
Ø2.50 - BAYS 7-8
DETAIL A
SCALE 1 / 20
DIRECTORS NOT SHOWN FOR CLARITY
12 APPROX.
24 APPROX.
ANTENNA INPUT
DETAIL B
SCALE 1 / 15
DIRECTORS NOT SHOWN FOR CLARITY
DETAIL C
SCALE 1 / 10
DIRECTORS NOT SHOWN FOR CLARITY
DETAIL D
SCALE 1 / 10
DIRECTORS NOT SHOWN FOR CLARITY
ELECTRONICS RESEARCH INC.
ESTABLISHED 1947
7777 GARDNER Rd.
CHANDLER, IN
46518-9290
PHONE: (812) 925-6000
FAX: (812) 925-4030
SHPX-8AC6-SP INSTALLATION DETAILS
FORT WORTH/DALLAS, TX
KDGE/KDMX- FM STATION 102.1/102.9 MHz
PROJECT NO. 29928/2
CAGE CODE OZNS1
DWG NO. IA29928-1
SIZE B
SCALE: AS NOTED
WEIGHT: 304.02 lbmass
SHEET: 1 OF 2
FILE NAME: IA29928-1.idw
THIRD ANGLE PROJECTION
CERTIFIED FABRICATOR

A-2 ERI Antenna Specification Sheet

MULTIPLEXED TRANSMISSION SITE
Dallas, Texas.

General Specifications

Antenna Type . . . . . .High Power FM-Broadcast, Suitable For Multiplexing
Model Number SHPX-8AC6-SP
Number of Bay Levels .....Eight
Polarization ..... Right Hand Circular

Electrical Specifications

Antenna Input Power Capability . . . . . 61 kW Max (1)
Operating Frequency Band ..... 102.1 ~ 102.9 Megahertz.
VSWR. . . . . <1.05:1 @ Operating Frequencies(2)
Azimuthal Pattern Circularity ..... Better Than +/- 1dB From RMS (Free Space)
Power Split ..... 50/50 (Horizontal & Vertical)
Frequency Specific Information:

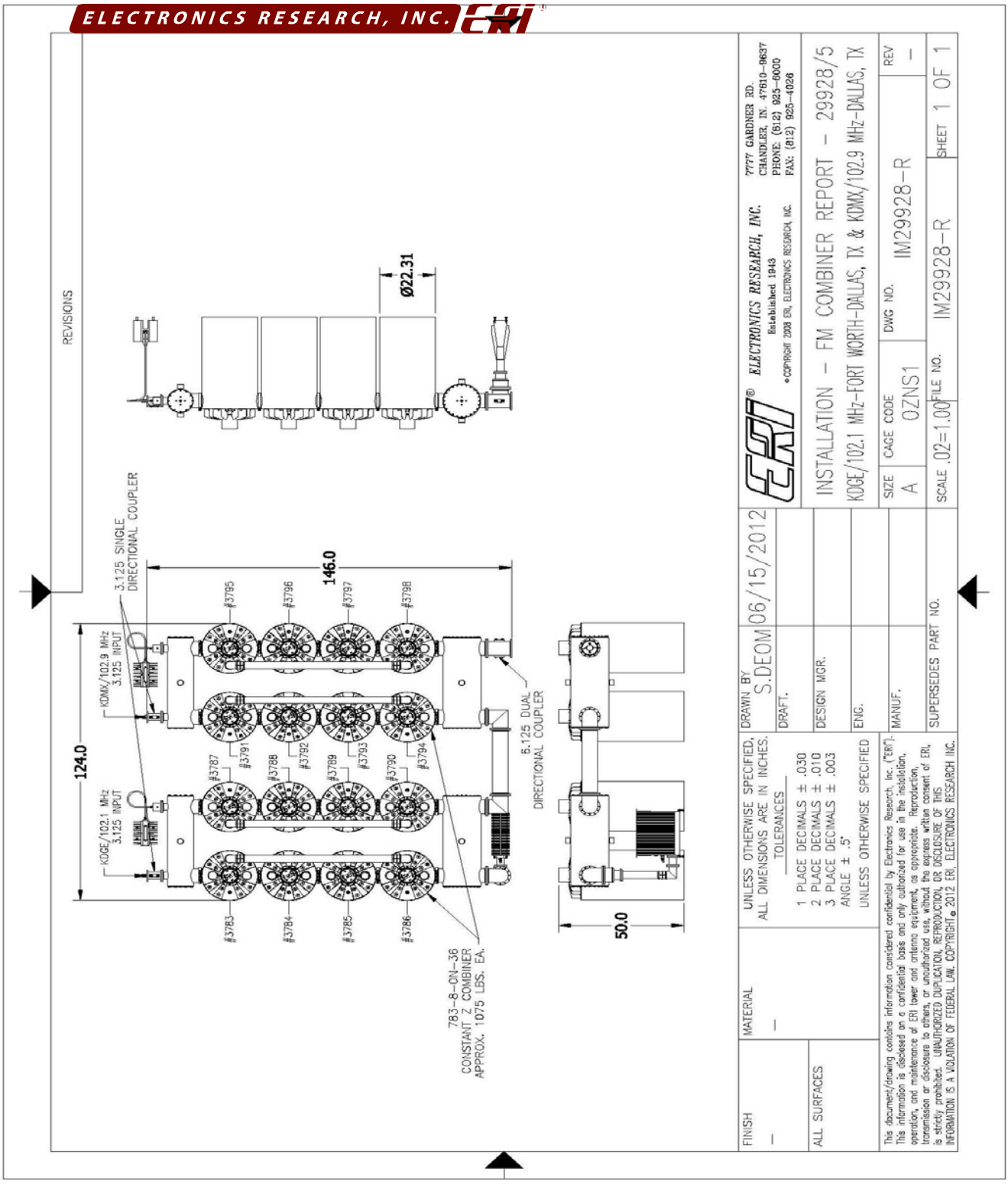
Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
102.1	**100 KW**	**-0.5°**	**2.0 %**	**0.2 %**	**4.460**	**-0.8633 dB**	**.3740 dB**	**29.8124 kW**
102.9	**100 KW**	**-0.5°**	**2.0 %**	**0.2 %**	**4.442**	**-0.8668 dB**	**.2956 dB**	**29.4210 kW**

Mechanical Specifications

Antenna Feed System ..... Fed with One 6 1/8" Line
Input Connector …… . 6 1/8"-50 Ohm EIA Flanged
Element Deicing.....Radomes
Interbay Spacing ..... 114.75" Center to Center
Array Length..... 69.5 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 1757 Feet of 6 1/8" ERI Macxline
4) Losses Taken From Actual Combiner.


ELECTRONICS RESEARCH, INC.
REVISIONS
Ø22.31
3.125 SINGLE DIRECTIONAL COUPLER
KDMX/102.9 MHz 3.125 INPUT
KOGE/102.1 MHz 3.125 INPUT
124.0
146.0
#3795
#3796
#3797
#3798
#3787
#3791
#3788
#3792
#3789
#3793
#3790
#3794
#3783
#3784
#3785
#3786
6.125 DUAL DIRECTIONAL COUPLER
50.0
783-8-ON-36
CONSTANT Z COMBINER
APPROX. 1075 LBS. EA.
DRAWN BY S.DEOM 06/15/2012
DRAFT.
DESIGN MGR.
ENG.
MANUF.
SUPERSEDES PART NO.
ELECTRONICS RESEARCH, INC.
Established 1943
©COPYRIGHT 2008 ERI, ELECTRONICS RESEARCH INC.
7777 GARDNER RD.
CHANDLER, IN. 47610-9637
PHONE: (812) 925-6000
FAX: (812) 925-4026
INSTALLATION - FM COMBINER REPORT - 29928/5
KOGE/102.1 MHz-FORT WORTH-DALLAS, TX & KDMX/102.9 MHz-DALLAS, TX
SIZE A
CAGE CODE 0ZNS1
DWG NO. IM29928-R
REV -
SCALE .02=1.00
FILE NO. IM29928-R
SHEET 1 OF 1
FINISH —
ALL SURFACES
MATERIAL —
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
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A-4 ERI Combiner Specification Sheet

MULTIPLEXED TRANSMISSION SITE
Dallas, Texas

General Specifications:

Multiplexer Type ..... Constant Impedance Combiner
Number of Combining Units, with Non-Adjacent coupling ..... Two
Injected Port to Injected Port Isolation ..... < -52 dB
Output Connector ..... 6 1/8 "50 Ohm EIA (Flanged)
Output Power (Designed) ..... 61 kW(1)

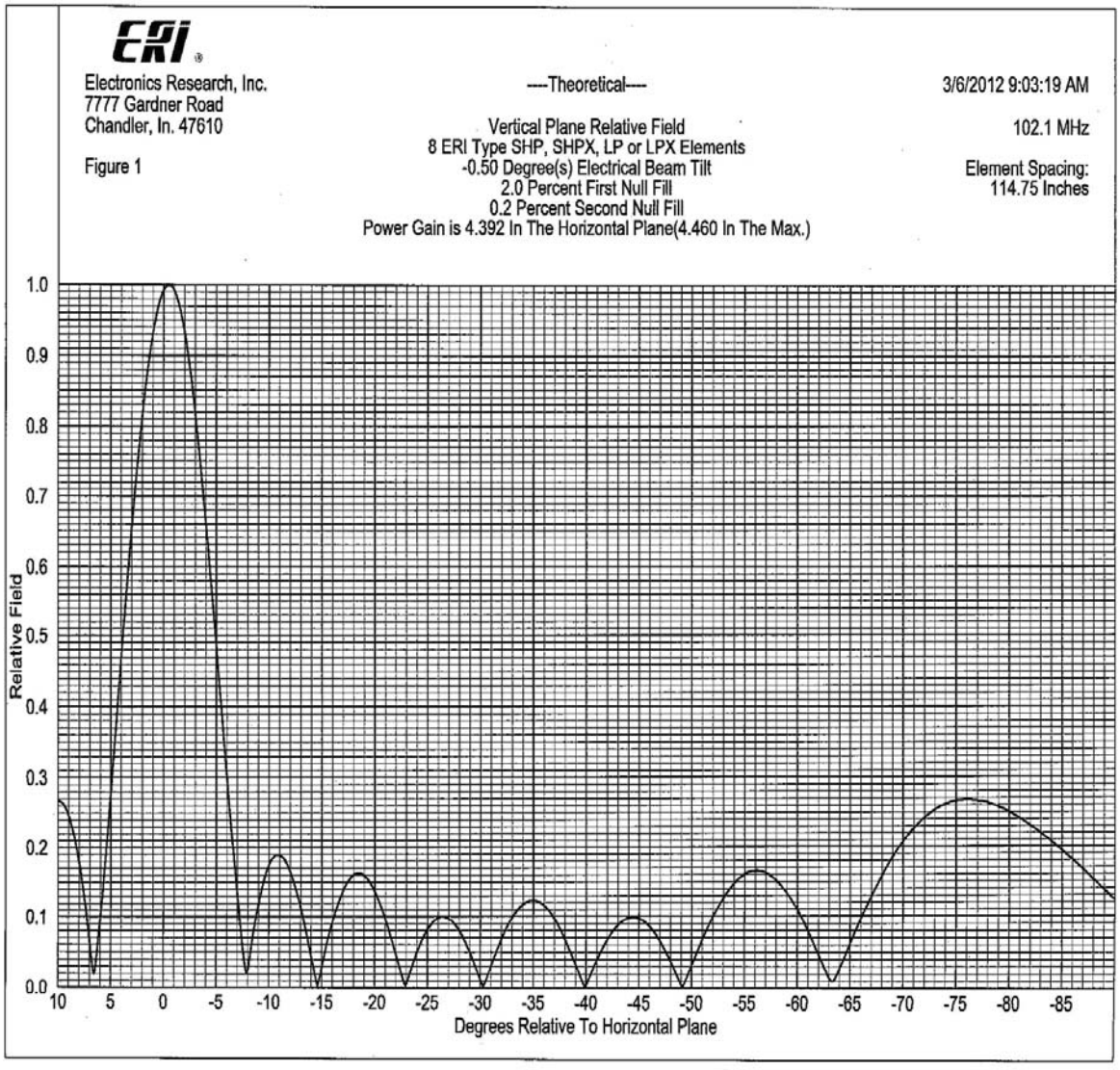
Heat Removal ..... Convection Cooled
Physical Arrangement ..... All Components Floor Standing

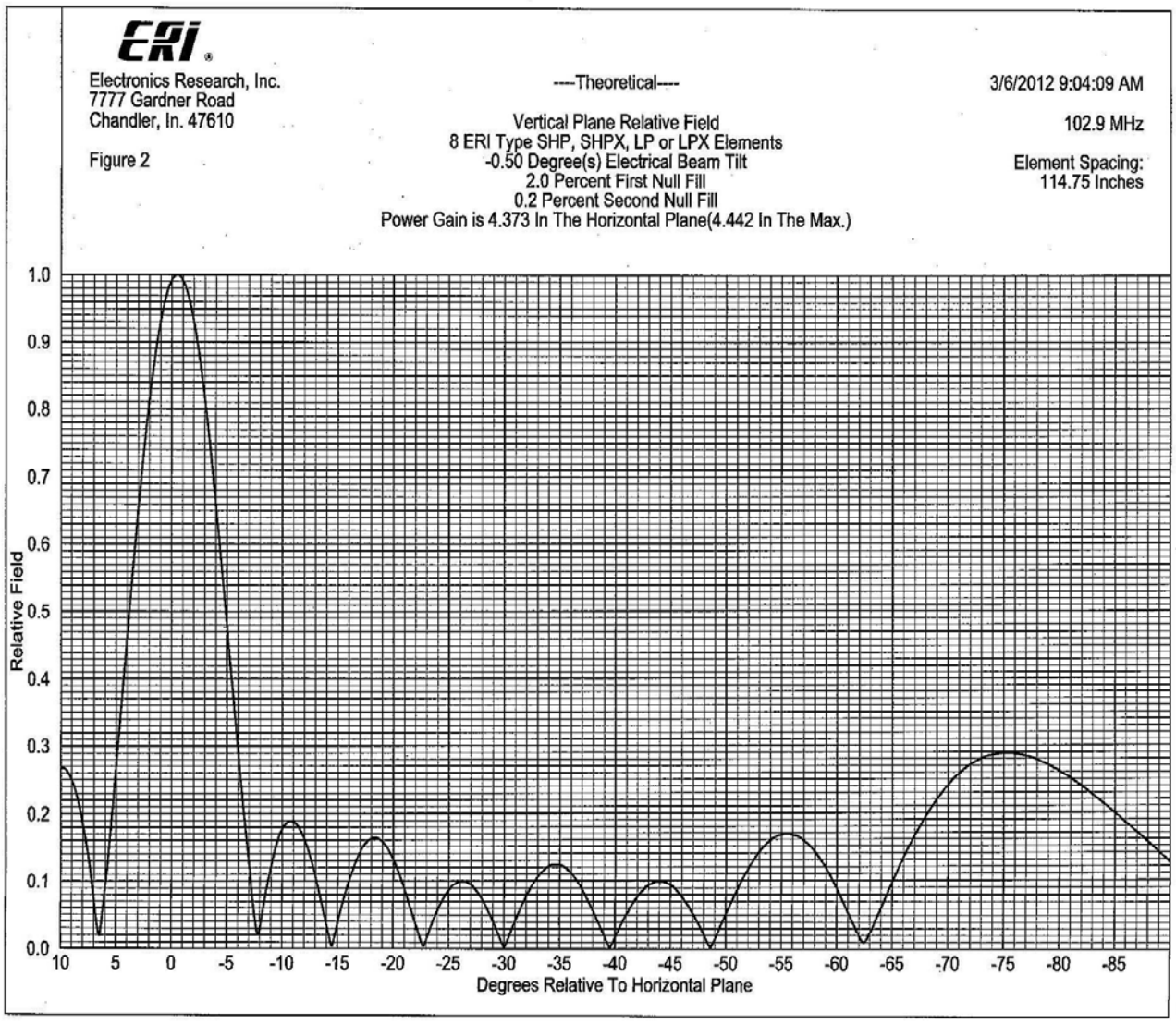
Injected Port Specifications:

Frequency Assignment ..... 102.1 ~ 102.9 MHz.
Power Rating, Each Injected Port (Designed) ..... 29.8 kW for 102.1 MHz. ~ 29.4 kW for 102.9 MHz.
Input Connector ..... 3-1/8" 50 Ohm EIA (Flanged).
VSWR ..... < 1.07 @ +/-200 KHz.(2)
Group Delay ..... Less than 250 ns Overall Variation, Carrier @ +/- 150 KHz.
Insertion Loss (Measured):

102.1 MHz. ..... - 0.3740 dB
102.9 MHz. ..... - 0.2956 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 Combiner.


ERI
Electronics Research, Inc.
7777 Gardner Road
Chandler, In. 47610
Figure 1
----Theoretical----
Vertical Plane Relative Field
8 ERI Type SHP, SHPX, LP or LPX Elements
-0.50 Degree(s) Electrical Beam Tilt
2.0 Percent First Null Fill
0.2 Percent Second Null Fill
Power Gain is 4.392 In The Horizontal Plane(4.460 In The Max.)
3/6/2012 9:03:19 AM
102.1 MHz
Element Spacing:
114.75 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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Chandler, In. 47610
Figure 2
----Theoretical----
Vertical Plane Relative Field
8 ERI Type SHP, SHPX, LP or LPX Elements
-0.50 Degree(s) Electrical Beam Tilt
2.0 Percent First Null Fill
0.2 Percent Second Null Fill
Power Gain is 4.373 In The Horizontal Plane(4.442 In The Max.)
3/6/2012 9:04:09 AM
102.9 MHz
Element Spacing:
114.75 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 B

Broadcasting Scheme and Equipment Employed in Intermodulation Measurements