



ELECTRONICS RESEARCH, INC.

7777 Gardner Road, Chandler, Indiana 47610, (812) 925-6000, Fax (812) 925-4030

Report Of Intermodulation Product Findings

*CEDAR HILL COMBINED BROADCAST FACILITY
DALLAS, TEXAS*

<i>KDGE</i>	<i>102.1</i>
<i>KDMX</i>	<i>102.9</i>

August 2005

**Electronics Research Inc.
7777 Gardner Road
Chandler, Indiana 47610
Phone (812) 925-6000 Fax (812) 925- 4030**

TABLE OF CONTENTS

DALLAS, TEXAS

Report of Findings for Intermodulation Product Measurements

Page 1	Introduction
Page 3	Carrier Reference Levels
Page 3	Table of Second order Products Expected
Page 4	Intermodulation Product Measurements
Page 5	Conclusion
Page 6	Affidavit

Exhibits Accompanying This Report

EXHIBIT A	Antenna and Combiner Specification Sheet and Drawing
A-1	Drawing Depicting Antenna
A-2	ERI Antenna Specification Sheet
A-3	Drawing Depicting Combiner Module
A-4	ERI Combiner Specification Sheet
A-5	Theoretical Vertical Plane Relative Field Antenna Plots
EXHIBIT B-1	Intermodulation Product Measurement Equipment Layout
B-2	Broadcasting Scheme of the Multiplexed System

REPORT OF FINDINGS

KDGE / KDMX CEDAR HILL COMBINED BROADCAST FACILITY

DALLAS, TEXAS

Introduction: This report of findings is based on data collected at the KDGE and KDMX Cedar Hill FM broadcast facility located in Dallas, TX. The report includes measurements offered as proof that the to the combined operations of KDGE (102.1) MHz. and KDMX (102.9) 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). In brief, the collection of measurements presented in this report shows that all possible third order inter-modulation (IM) products generated by this multiplex system are less than the maximum allowable level as required by section 73.317 (b) through (d). KPLX (99.5 MHz.) operate into a separate side mounted antenna located 30' above the combined antenna on the same tower. Their effects on the stations operating from the multiplexed system has been considered in this report. Jon Adams of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized here.

The following exhibits are provided:

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 SHPX-10AC6-SP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexing Scheme.
- A-4 973-8 TEE 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 : At the time of my measurements 2 FM stations were operating from the combined antenna system. The KDGE, and KDMX multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-10AC6-SP antenna and 973-8 TEE multiplexer *units* are products of Electronics Research, Inc, whereas the feed line is manufactured by Andrew and Dielectric Inc., Refer to Exhibit B-1, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of 2 transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a Tee Combiner module was installed. Specifically, the Multiplexer utilizes four ERI Model 973 Bandpass filters with non adjacent coupling for each transmitter. An interconnecting TEE is required to complete the multiplexer module as 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 multiplexers 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 33 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 FIM71 to ensure an adequate signal level for measurements without overloading the measurement equipment. A Potomac Instruments FIM-71 Field Strength Receiver 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 signal generator was used. An IFR Model 2399A 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-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 stations of concern were operating at their full licensed power level. 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)	Full Scale Range (dB:)	Scale Reading (dB)	Adjusted Level (dB:)	Notes
KDGE (102.1)	6	---	120	-6.2	119.8	
KDMX (102.9)	6	---	120	-5.9	120.1	

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 Frequency (MHz)	Carrier Frequency (MHz)	
	KDGE 102.1	KDMX 102.9
KDGE 102.1	---	103.7
KDMX 102.9	101.3	---
KPLX 99.5	104.7	106.3

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 for a layout of the measurement equipment.

Table 3 Intermodulation Measurements

Product Frequency (MHz)	Carrier Frequency (MHz)	Interfering Frequency (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Full Scale Range (dBμ)	Scale reading (dB)	Adjusted Level (dBμ)	Carrier Reference Level (dBμ) (See Table 1)	Level Referenced to Carrier (dB)	Notes*
101.3	102.1	102.9	6	9.3	20	-4.5	30.8	119.8	-89.0	1
103.7	102.9	102.1	6	9.0	20	-4.9	30.1	120.1	-90.0	2
104.7	102.1	99.5	6	8.9	20	-20.0	14.9	119.8	-104.9	3
106.3	102.9	99.5	6	9.1	20	-20.0	15.1	120.1	-105.0	4

*** NOTES**

- 1) Local Transmitter WRR transmitting at 101.1 MHz was turned off for this measurement.
- 2) Local transmitter KIVL transmitting at 103.7 MHz. was turned off for this measurement.
- 3) Local transmitter KKDA transmitting at 104.5 MHz. was turned off for this measurement.
- 4) Local transmitter KHKS transmitting at 106.1 MHz. was turned off for this measurement.

The Spectrum Analyzer was used to check the close in spectral attenuation of each carrier to confirm the operation of these transmitters are 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 as summarized in this document, I, Jon Adams, find the subject multiplexed system- specifically the transmitters and combiner system for the operation of the KDGE and KDMX into the SHPX-10AC6-SP antenna- to be in proper working order. Furthermore, based on the measured isolation of the filters and the calculated product isolation, it is my opinion that there are no inter-modulation products in excess of 80 dB below carrier levels generated from or within the stations operating on the installed system. Also, 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,
Electronics Research, Inc.

By: Jon Adams, ERI Field Technician

A-2 ERI Antenna Specification Sheet
DALLAS, TEXAS

General Specifications

Antenna Type High Power FM-Broadcast, Suitable For Diplexing
 Model Number SHPX-10AC6-SP
 Number Of Bay Levels 10
 Polarization Right Hand Circular

Electrical Specifications

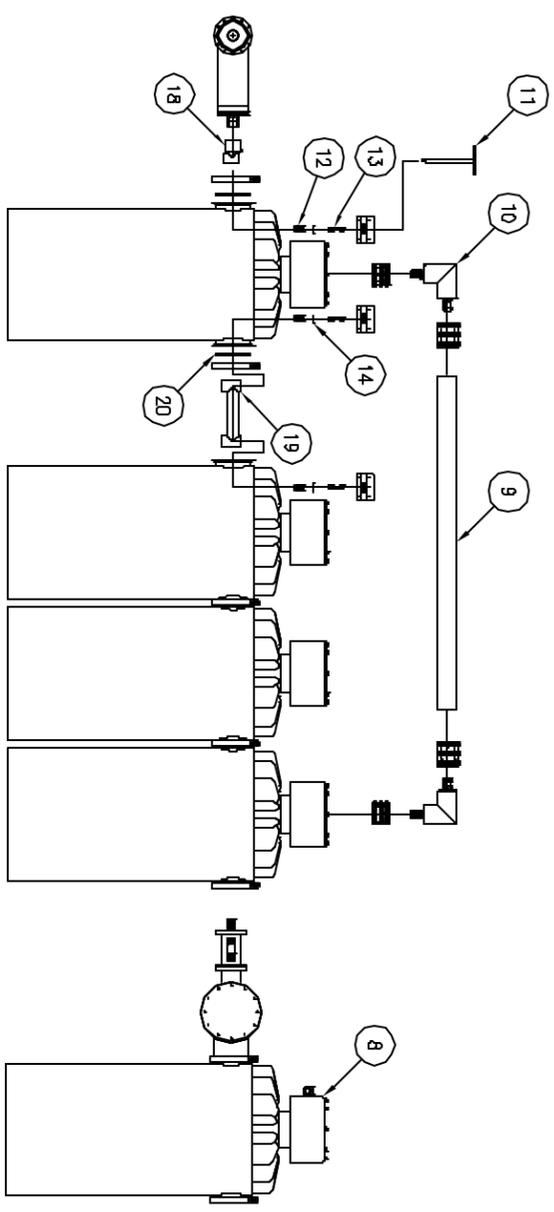
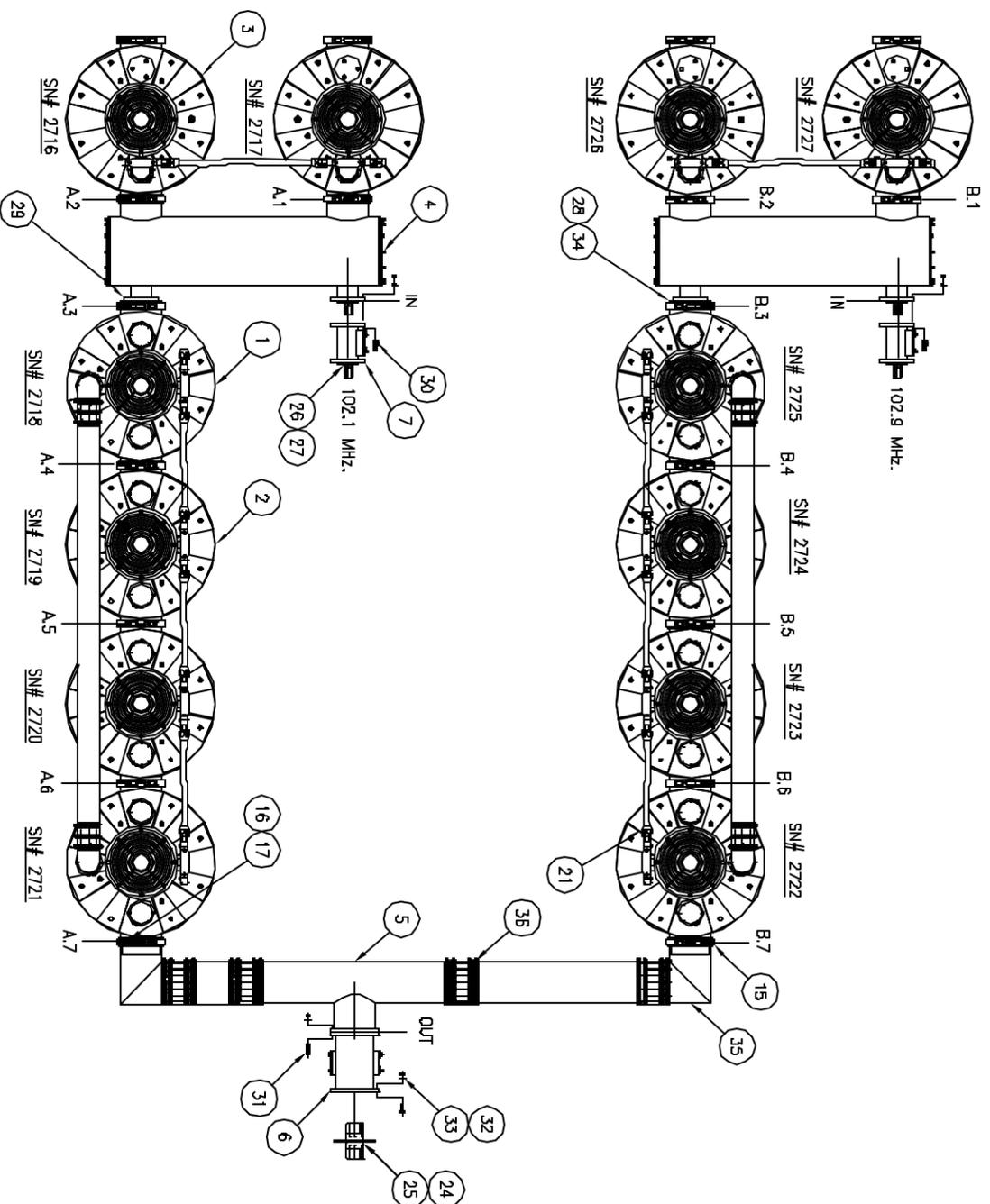
Antenna Input Power Capability 60 KW. Designed ⁽¹⁾
 Operating Frequency Band 102.1, 102.9 and Megahertz.
 VSWR 1.1 : 1 @ Operating Frequencies.⁽²⁾
 Azimuthal Pattern Circularity +/- 2dB From RMS (Free Space)
 Power Split 50/50 (Horizontal & Vertical)
 Quarter Wave Shorting Stub Yes
 Frequency Specific 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>
102.1	100 (KW)	0.0°	2 %	00%	5.683	1.072 dB	.495 dB	25.24 (KW)
102.9	100 (KW)	0.0°	3 %	00%	5.658	1.075 dB	.420 dB	24.94 (KW)

Mechanical Specifications

Antenna Feed System Fed With Single Feed Line
 Input Connector 6-1/8" 50- Ohm EIA Flanged
 Element Deicing Not Ordered
 Interbay Spacing 114.75 Inch Center to Center
 Array Length 90.5 Feet
 Construction Material (Antenna) All Noncorrosive
 Construction Material (Mounting) Galvanized Plated Steel and All Stainless Steel
 Mounting Face mounted on Tower
 Antenna Center of Radiation 1,418 Feet HAGL

- 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 An Approx. Feed Run Of 1,014 Feet, of 5" Andrew Type HJ9-50 Helix, 420 Feet Of 4 1/16" Dielectric Type 475 Rigid Coax. Each Transmitter Incorporates Approx 33 Feet of 3" Rigid Line Between The Transmitter And Combiner.
- 4) Losses Taken At The Factory From Actual Multiplexer Measurements.
- 5) With Low Q Element Design, Moderate Icing Will Not Cause Appreciable VSWR Rise.



11	F10004	FILTER TUNING TOOL	1
10	CL3020	3-1/8" UNFLANGED ELBOW	4
9	CL3073	3-1/8" UNFLANGED LINE SECTION	2
8	F10100	973 BLOWER ASSEMBLY	12
7	DC3003	3-1/8" SINGLE DIRECTIONAL COUPLER	2
6	DC6005	6-1/8" DUAL DIRECTIONAL COUPLER	1
5	CT-1	6-1/8" UNFLANGED TO FLANGED TEE ASSEMBLY	1
4	HY0041	918 TYPE HYBRID ASSEMBLY	2
3	F10253	973 GROUP DELAY FILTER ASSEMBLY	4
2	F10250	973 DOUBLE LOOP FILTER ASSEMBLY	4
1	F10254	973 NON-ADJACENT FILTER ASSEMBLY	4

21	EF0036	1/2" CONDUIT ADAPTER	20
20	F10001	CONTACT RING	8
19	F10147	INNER CONNECTOR ASSEMBLY	6
18	F10148	6" PORT ADAPTER	6
17	NU0518BZ	5/16-18 BRONZE HEX NUT	14
16	SC0518T0450	T-BOLT 5/16-18 X 4-1/2"	14
15	CM0036	6" MARMAN CLAMP	14
14	WF08SSA	1/2" FENDER WASHER	20
13	F10220	1/2-13 X 2" CAP SCREW	20
12	SG0001	TUNING SPRING	20

36	CS6001	6 1/8" COAXIAL SLEEVE	4
35	CEB025	6 1/8" MARMAN UNFLANGED ELBOW	2
34	F10145	3" PORT ADAPTER	2
33	NU0616	3/8-16 SS HEX NUT	48
32	WLD6SS	3/8 LOCK WASHER SS	60
31	SC0616H0175	3/8-16 X 1.75 LG. SS HEX HEAD BOLT	24
30	SC0616H0150	3/8-16 X 1.50 LG. SS HEX HEAD BOLT	24
29	SC0616H0100	3/8-16 X 1.00 LG. SS HEX HEAD BOLT	12
28	CF0099	6" MARMAN TO 3-1/8" EIA PORT ADAPTER	2
27	IND028	3" SPLIT WAFER INSULATOR	2
26	CC0021	3-1/8" INLINE BULLET CONNECTOR	2
25	IND029	6" SPLIT WAFER INSULATOR	1
24	CC0033	6-1/8" INLINE BULLET CONNECTOR	1
23	ED0050F-PVC	1/2" FLEX CONDUIT (6) 18" (2) 25"	158
22	CO0111	1/2" PVC PIPE PLUG	4

ITEM NO.	PART NO.	DESCRIPTION	QTY
BILL OF MATERIAL			

BILL OF MATERIAL

BILL OF MATERIAL

ELECTRONICS RESEARCH, INC.
 Established 1945
 7777 GARDNER RD.
 CHANDLER, IN 47610-9637
 PHONE: (812) 925-6000
 FAX: (812) 925-4030

This document/working contains information considered confidential by Electronics Research, Inc. (ERI). This information is developed on a confidential basis and only authorized for use in the installation, operation, and maintenance of ERI tower and antenna equipment, as appropriate. Reproductions, transmission or disclosure to others, or unauthorized use, without the express written permission of ERI is strictly prohibited. UNAUTHORIZED REPRODUCTION OR DISCLOSURE OF THIS INFORMATION IS A VIOLATION OF FEDERAL LAW.
 © COPYRIGHT 2005 ERI, ELECTRONICS RESEARCH, INC.

SUPERSEDES DWG #: APPROVED DATE DATE
SUPERSEDES FILE #: ERM
MATERIALS AS LISTED IN BOM: NAME MANUF.
TOLERANCES: ± .03 ± .010 ± .010 ± .003 ± 1/32" ± .5°
NAME COMBINER INSTALLATION DRAWING: STRAYING-KOBE-KOMK-FORT WORTH-DALLAS, TX
DATE: 6/07/05
SCALE: FULL
DATE: 6/07/05
SCALE: FULL
DATE: 6/07/05
SCALE: FULL

A-4 ERI Combiner Specification Sheet

DALLAS, TEXAS

General Specifications:

Multiplexer Type TB 973-8 TEE with Group Delay Compensation
 Number Of Combining Units 2
 Injected Port to Injected Port Isolation - 52 dB
 Output Connector 6 1/8 " 50 Ohm EIA (Flanged)
 Output Power 60 KW
 Combiner Units, Size and Weight :

Type 973-4GD Tuned To 102.1 MHz. (With Non-Adjacent coupling) 5' ht. X 4' wd. X 6' lg. & 770 Lbs.

Type 973-4GD Tuned To 102.9 MHz. (With Non-Adjacent coupling) 5' ht. X 4' wd. X 8' lg. & 770 Lbs.

Heat Removal (All Multiplexer Components) Forced Air
 Physical Arrangement All Components Upright on a Mezzanine

Injected Port Specifications:

Frequency Assignment 102.1 and 102.9 MHz.
 Power Rating, Each Injected Port (Maximum) 28 KW
 Input Connector 3-1/8" 50 Ohm EIA (Flanged)
 VSWR Less than 1.08:1 @ +/-150 KHz⁽¹⁾
 Group Delay Less than 100 ns Overall Variation, Carrier @ +/- 150 KHz
 Insertion Loss (Measured):

102.1 MHz. - 0.495 dB

102.9 MHz. - 0.420 dB

1) When Terminated in 50 Ohm Resistive Load.

ELECTRONICS RESEARCH, INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610

FIGURE 1

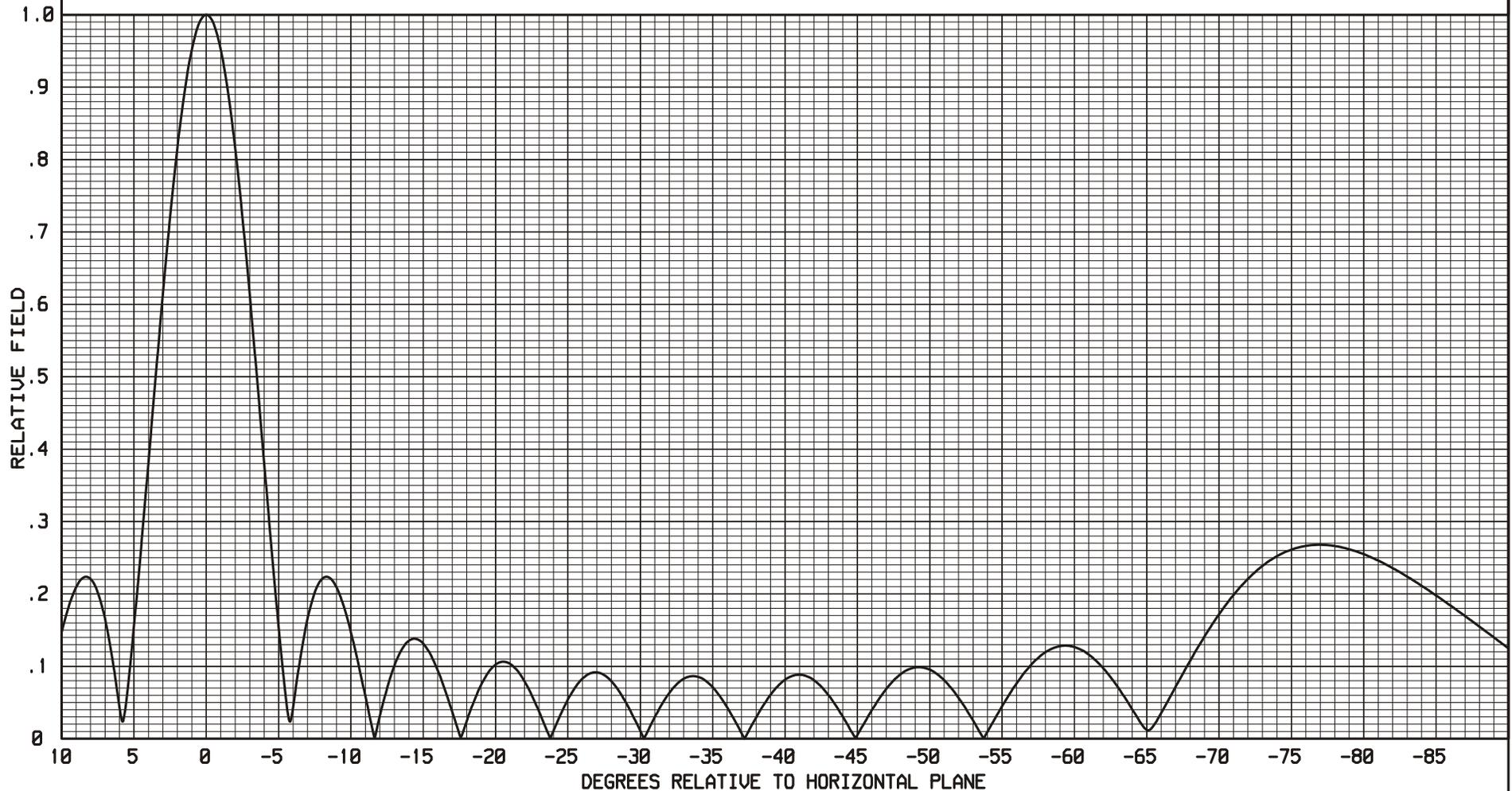
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

10 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
0.00 DEGREE(S) ELECTRICAL BEAM TILT
2 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
POWER GAIN IS 5.683 IN THE HORIZONTAL PLANE(5.683 IN THE MAX.)

JUNE 10, 2004

102.1 MHz.

ELEMENT SPACING:
114.75 INCHES



ELECTRONICS RESEARCH, INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610

FIGURE 2

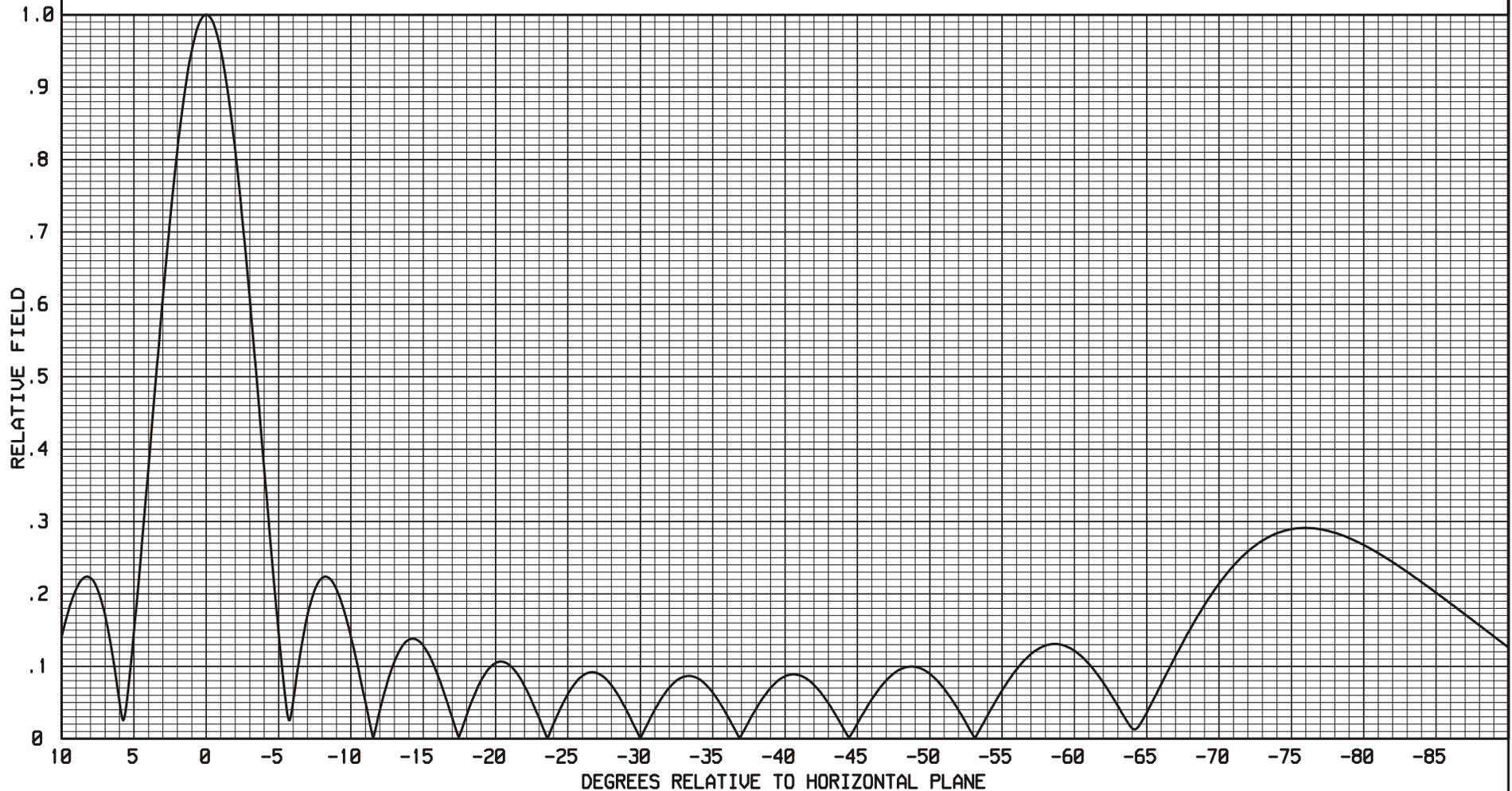
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

10 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
0.00 DEGREE(S) ELECTRICAL BEAM TILT
3 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
POWER GAIN IS 5.658 IN THE HORIZONTAL PLANE(5.658 IN THE MAX.)

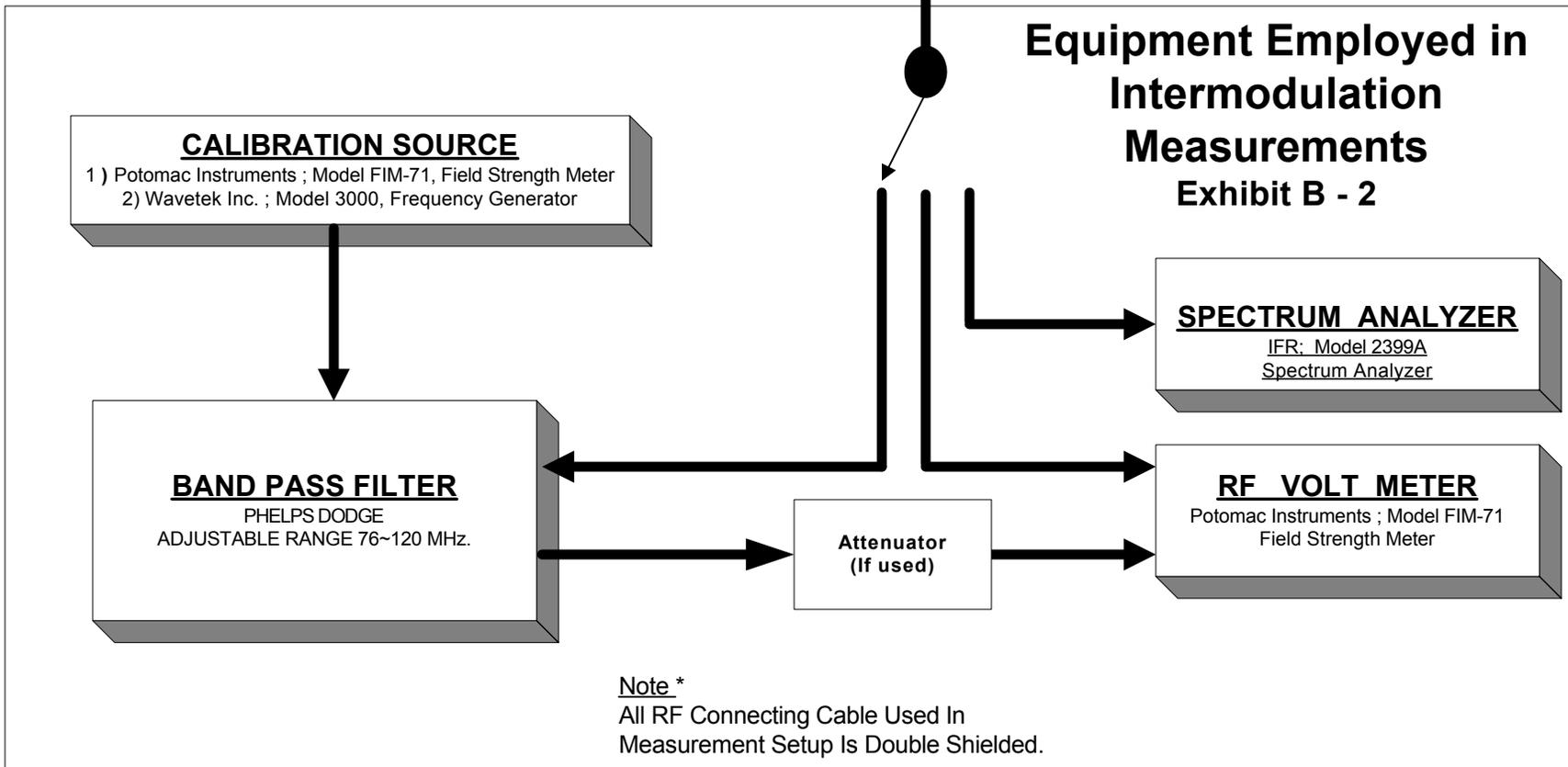
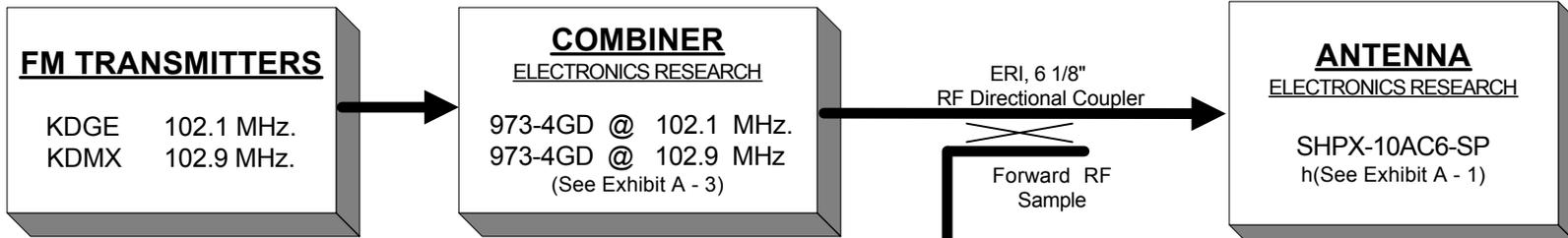
JUNE 10, 2004

102.9 MHz.

ELEMENT SPACING:
114.75 INCHES



KDGE ~ KDMX Broadcasting Scheme EXHIBIT - B1



Broadcasting Scheme and Equipment Employed in Intermodulation Measurements