Report Of Intermodulation Product Findings

KKPR 98.9 MHz
KKJK 103.1 MHz

May 26, 2006

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

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Kearney~Ravenna, Nebraska

Report of Findings for Intermodulation Product Measurements

Exhibits Accompanying This Report

REPORT OF FINDINGS
KKPR/KKJK LEGACY COMMUNICATIONS
98.9 MHz. Kearney, NE. / 103.1 MHz. Ravenna, NE.

Introduction: This report of findings is based on data collected at the KKPR, KKJK broadcast facility. The report includes measurements offered as proof that the combined operations of KKPR (98.9 MHz.) and KKJK (103.1) 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). 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). Jeff Taylor of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on …….....

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 TB-73-6/6 “TEE” Combiner 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 two FM stations operating from the combined antenna system. The KKPR and KKJK multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-10AC6-SP (antenna) and TB-73-6/6 ("TEE" combiner) multiplexer unit and 4 1/6" MACXLINE are products of Electronics Research, Inc, whereas the flex line is manufactured by 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 "TEE" Combiner was installed. Specifically, the combiner utilizes two ERI Model 973-3 filter modules for each transmitter. An interconnecting "TEE" is required to complete the multiplexer which is illustrated in the attached Exhibit A-3. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -60 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 -30dB directivity and a forward signal sample of -45 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 Serial # 242 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 Serial # 7512028 signal generator was used. A Anritsu Model S114B Spectrum Analyzer Serial # 033089 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 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 (dBµ)	Scale Reading (dB)	**Adjusted Level (dBµ)**	Notes
KKPR (98.9)	3	-	140	10.4	**132.6**	
KKJK (103.1)	3	-	140	9.9	**133.1**	

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.

	Carrier Frequency (MHz.)	
Interfering Frequency (MHz.)	**KKPR 98.9 MHz.**	**KKJK 103.1 MHz.**
KKPR 98.9 MHz.	—	**107.3 MHz.**
KKJK 103.1 MHz.	**94.7 MHz.**	—

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)	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 *
94.7	98.9	103.1	+3	6.4	40	18.5	30.9	132.6	**-101.7**	
107.3	103.1	98.9	+3	6.9	20	.5	29.4	133.1	**-103.7**	

*** NOTES**

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 May 26, 2006 as summarized in this document, I, Jeff Taylor, find the subject system- specifically the transmitter and filter system for the operation of KKPR and KKJK into the antenna to be in proper working order. Furthermore, based on the measured data, it is my opinion that there is 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 KKPR and KKJK is 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 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"). I am familiar with and have assisted in the design, manufacturing and installation of FM Antennas and FM Filters with ERI.

2.) I have either prepared and/or directly supervised the preparation of all technical information contained in the Report of Findings and to my knowledge to be accurate and true.

3.) ERI has been requested by Legacy Communications, on behalf of KKPR and KKJK to prepare this report of findings.

Jeff Taylor; Field Technician Jeff Taylor

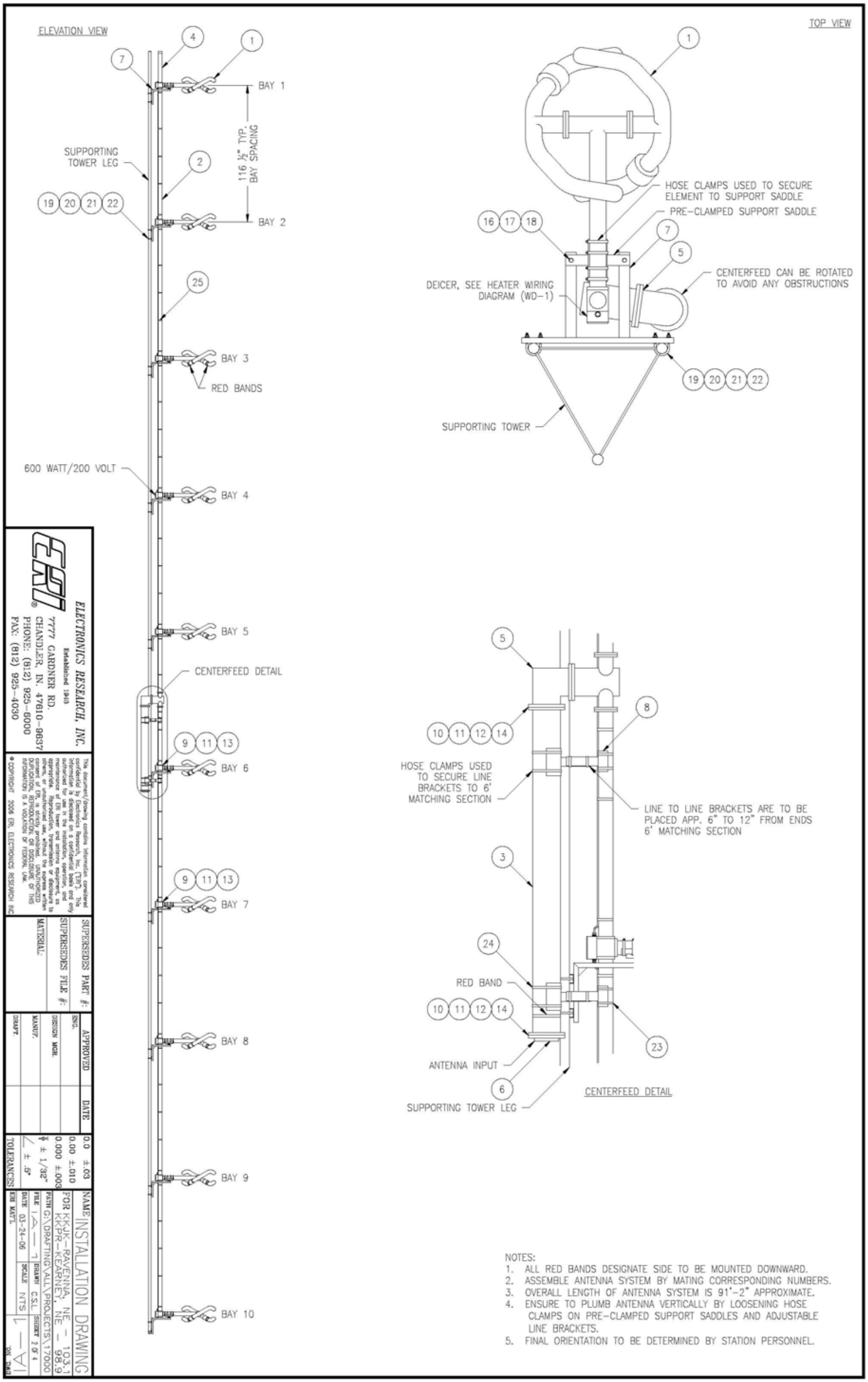
Subscribed and sworn to before me on this 30th day of May, 2006.

Jacquelyn Kinney; Notary Public

My Commission expires July 5th 2007

Jacquelyn S. Kinney

NOTARY PUBLIC SEAL INDIANA


ELEVATION VIEW
BAY 1
116 ½" TYP. BAY SPACING
SUPPORTING TOWER LEG
BAY 2
BAY 3
RED BANDS
600 WATT/200 VOLT
BAY 4
BAY 5
CENTERFEED DETAIL
BAY 6
BAY 7
BAY 8
BAY 9
BAY 10
TOP VIEW
HOSE CLAMPS USED TO SECURE ELEMENT TO SUPPORT SADDLE
PRE-CLAMPED SUPPORT SADDLE
CENTERFEED CAN BE ROTATED TO AVOID ANY OBSTRUCTIONS
DEICER, SEE HEATER WIRING DIAGRAM (WD-1)
SUPPORTING TOWER
HOSE CLAMPS USED TO SECURE LINE BRACKETS TO 6' MATCHING SECTION
LINE TO LINE BRACKETS ARE TO BE PLACED APP. 6" TO 12" FROM ENDS 6' MATCHING SECTION
RED BAND
ANTENNA INPUT
SUPPORTING TOWER LEG
CENTERFEED DETAIL
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 91'-2" 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.
ELECTRONICS RESEARCH, INC.
Established 1943
7777 GARDNER RD.
CHANDLER, IN. 47610-9637
PHONE: (812) 925-6000
FAX: (812) 925-4030
SUPERSEDES PART #:
SUPERSEDES FILE #:
MATERIAL:
APPROVED
DATE
TOLERANCES
NAME INSTALLATION DRAWING
FOR KKJK-RAVENNA, NE - 103.1
KKPR-KEARNEY, NE - 98.9
DATE 03-24-06
SCALE NTS
SHEET 2 OF 4

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A-2 ERI Antenna Specification Sheet

Legacy Communication
Kearney ~ Ravenna, Nebraska

General Specifications

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

Electrical Specifications

Antenna Input Power Capability (Single Feed) . . . . . 45 KW Max (1)
Operating Frequency Band..... 98.9 and 103.1 Megahertz.
VSWR. . . . . <1.07:1 @ Operating Frequencies(2)
Azimuthal Pattern Circularity ..... Less Than +/- 1.5 dB from RMS (Free Space)
Power Split ..... 50/50 (Horizontal & Vertical)
Quarter Wave Shorting Stub..... Yes
Frequency Specific Information:

Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
98.9	**100 KW**	**0°**	**13 %**	**0%**	**5.504**	**.721 db**	**.128 db**	**22.1 KW**
103.1	**100 KW**	**0°**	**13 %**	**0%**	**5.363**	**.733 db**	**.121 db**	**22.7 KW**

Mechanical Specifications

Antenna Feed System .....Fed With Single Line
Input Connector …… 6”-50 Ohm EIA Flanged
Element Deicing..... Yes
Interbay Spacing ..... 116 1/2” Center to Center
Array Length..... 97.08’
Construction Material (Antenna)..... All Noncorrosive
Construction Material (Mounting)..... All Stainless Steel

.

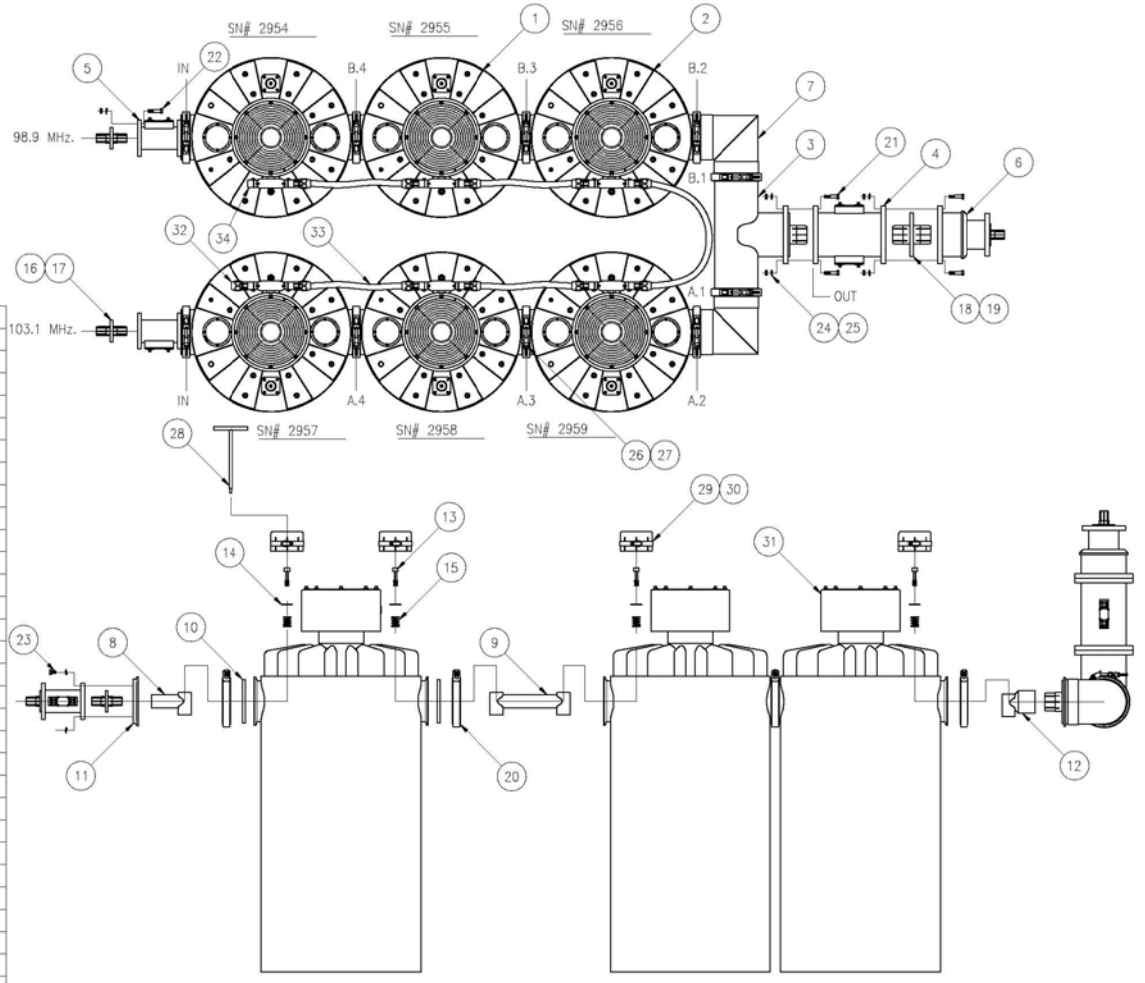
1) Power Capability Has Been Rated Assuming an Operating Transmission VSWR of 1.5:1
2) VSWR Specification Achieved After On Site Tuning For User Specific Frequencies.
3) Line Loss Assumes A Feed Run Of 566 Feet, 4" Andrew Heliax HJ11-50 and 102.25’ Feet of ERI MACXLINE Rigid 4 1/16" Coax.
4) Losses Taken From Actual “TEE” Combiner.

NOTES:

1) ASSEMBLE MODULES BY CORRESPONDING NUMBERS & LETTERS.

2) CONNECTIONS ARE DESIGNED BY BANK LOCATION AND CONNECTION NUMBER. EX. A.1 WOULD BE BANK "A", CONNECTION NO. 1.

3) EACH MODULE BANK IS COLOR-CODED FOR EASE OF INSTALLATION.



ITEM NO.	PART NO.	SUPERSEDED NO.	DESCRIPTION	QTY
34	CO0111		1/2" PVC CAP	1
33	ED0050F-PVC		1/2" FLEX (4) 18" PIECES & (1) 36"	5
32	EF0036		1/2" FLEXIBLE CONDUIT ADAPTER	11
31	FI0100		FILTER COOLING UNIT ASSEMBLY	6
30	HC0048		HOSE CLAMP	12
29	CO0073		3" SPLIT LINE CAP	12
28	FI0004		"T" HANDLE TOOL, 1/2" SOCKETHEAD	1
27	NU0518BZ		5/16"-18 BRONZE HEX NUT	8
26	SC0518T0450		5/16"-18 X 4-1/2" LONG "T" BOLT	8
25	NU0616		3/8"-16 HEX NUT	36
24	WL06SS		3/8" LOCKWASHER, SPLIT TYPE	48
23	SC0616H0100		3/8"-16 X 1" LONG HEXHEAD BOLT	12
22	SC0616H0150		3/8"-16 X 1-1/2" LONG HEXHEAD BOLT	12
21	SC0616H0175		3/8"-16 X 1-3/4" LONG HEXHEAD BOLT	24
20	CM0036		6" MARMAN CLAMP	8
19	IN0029		6" "S" SPLIT WAFER INSULATOR	1
18	CC0033		6-1/8" IN-LINE BULLET	1
17	IN0028		3" "S" SPLIT WAFER INSULATOR	4
16	CC0021		3-1/8" IN-LINE BULLET	4
15	SG0001		SPRING	12
14	WF08SSA		1/2" FLATWASHER	12
13	FI0220		1/2"-13 X 2" LONG STEPPED BOLT	12
12	FI0148		6" INNER PORT CONNECTOR	2
11	CF0099		6" MARMAN TO 3-1/8" EIA PORT ADAPTER	2
10	FI0001		6" CONTACT RING	6
9	FI0147		INNER CONNECTING ASSEMBLY	4
8	FI0145		3" INNER PORT CONNECTOR	2
7	CE6024		6-1/8" MARMAN, 90° COAXIAL ELBOW	2
6	CR0006		6-1/8" TO 4-1/16" COAXIAL REDUCER	1
5	DC3003		3-1/8" SINGLE DIRECTIONAL COUPLER	2
4	DC6005		6-1/8" DUAL DIRECTIONAL COUPLER	1
3	CT6005		6-1/8" EIA TO MARMAN COAXIAL TEE	1
2	FI0251		973 BAND PASS FILTER W/TRIPLE LOOP	4
1	FI0250		973 BAND PASS FILTER 2 DOUBLE LOOPS	2

BILL OF MATERIAL

ELECTRONICS RESEARCH, INC.
Established 1943
7777 GARDNER RD.
CHANDLER, IN. 47610-9637
PHONE: (812) 925-6000
FAX: (812) 925-4030

SUPERSEDES PART #:		
SUPERSEDES FILE #:		
MATERIAL:		

	APPROVED	DATE
DRAFT.		
ENG.		
MANUF.		

TOLERANCES: 0.0 ±.03; 0.00 ±.010; 0.000 ±.003; ∜ ± 1/32"; ∠ ± .5°

NAME COMBINER INSTALLATION DRAWING
FOR KKJK-RAVENNA, NE. & KKPR-KEARNEY, NE.
PATH G:\DRAFTING\ALL\PROJECTS\17000\3
FILE IM-1 | DRAWN BAM | SHEET 1 OF 1
DATE 3/28/06 | SCALE NTS | IM-1
ERI PART AS LISTED IN BOM

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A-4 ERI Combiner Specification Sheet

Legacy Communication
Kearney ~ Ravenna, Nebraska

General Specifications:

Multiplexer Type……...TB-73-6/6 "TEE" Combiner
Number of Combining Units .....Two
Injected Port to Injected Port Isolation ..... > - 60 dB
Output Connector .....6 1/8 "50 Ohm EIA (Flanged)
Output Power (Designed) .....45 KW(1)
Combiner Units, Size and Weight :

Type 973-3 Tuned To 98.9 MHz. .....Length (86"), Width (24"), Height (52")
Type 973-3 Tuned To 103.1 MHz. .....Length (86"), Width (24"), Height (52")

Heat Removal (All Multiplexer Components) .....Forced Air
Physical Arrangement.....All Components floor standing

Injected Port Specifications:

Frequency Assignment ..... 98.9 and 103.1 MHz.
Power Rating, Each Injected Port (Designed) ..... 23 KW
Input Connector ..... 3-1/8" 50 Ohm EIA (Flanged)
VSWR.....< 1.04:1 @ +/-150 KHz(2
Group Delay..... Less than 75 ns Overall Variation, Carrier @ +/- 150 KHz
Insertion Loss (Measured):

98.9 MHz. ..... - 0.128 dB
103.1 MHz. ..... - 0.121 dB

1) Power Rating Listed is as Designed Only. Actual Power Capabilities May Vary.
2) When Terminated in 50 Ohm Resistive Load.

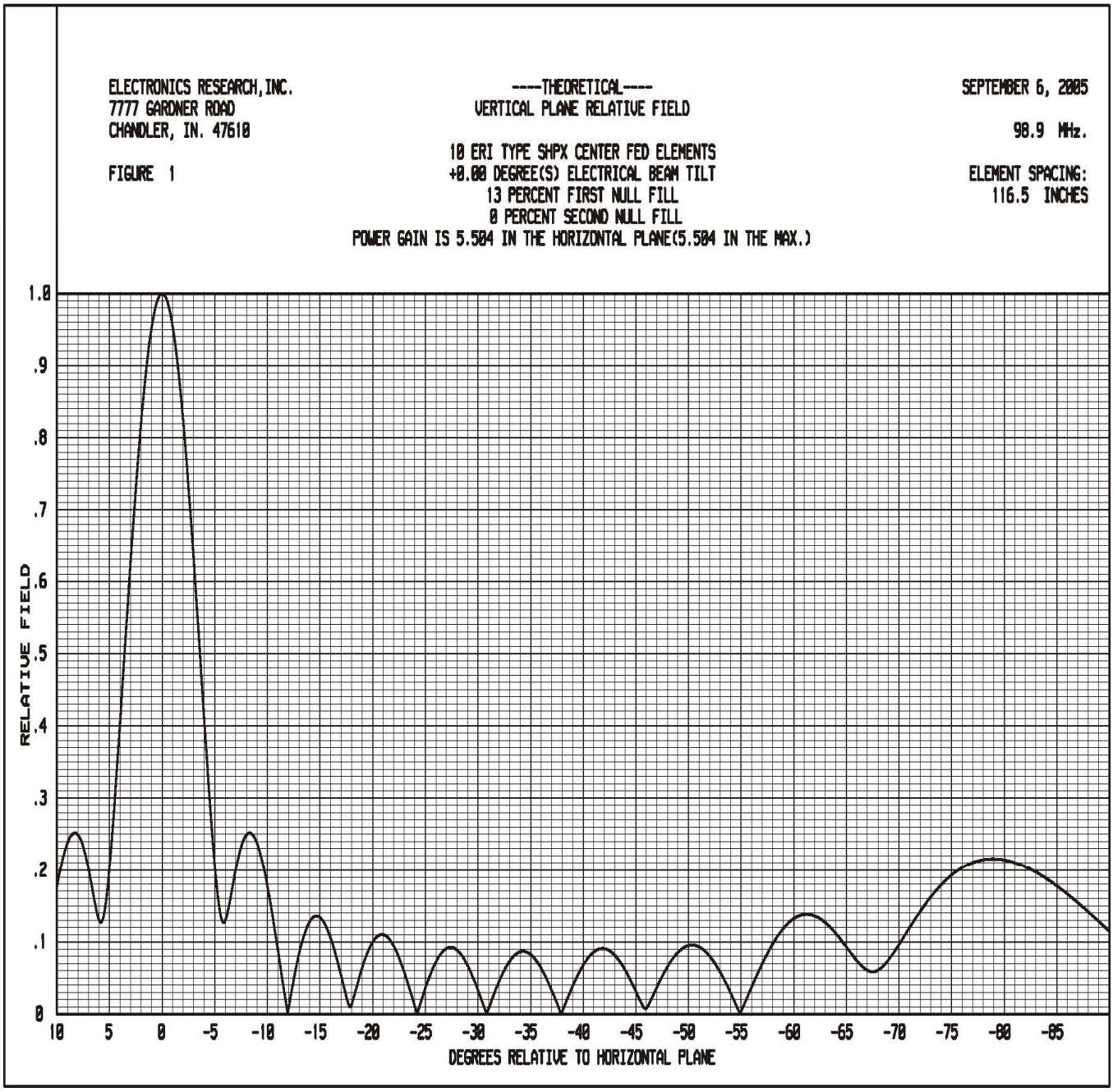

ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 1
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
10 ERI TYPE SHPX CENTER FED ELEMENTS
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
13 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
POWER GAIN IS 5.504 IN THE HORIZONTAL PLANE(5.504 IN THE MAX.)
SEPTEMBER 6, 2005
98.9 MHz.
ELEMENT SPACING:
116.5 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

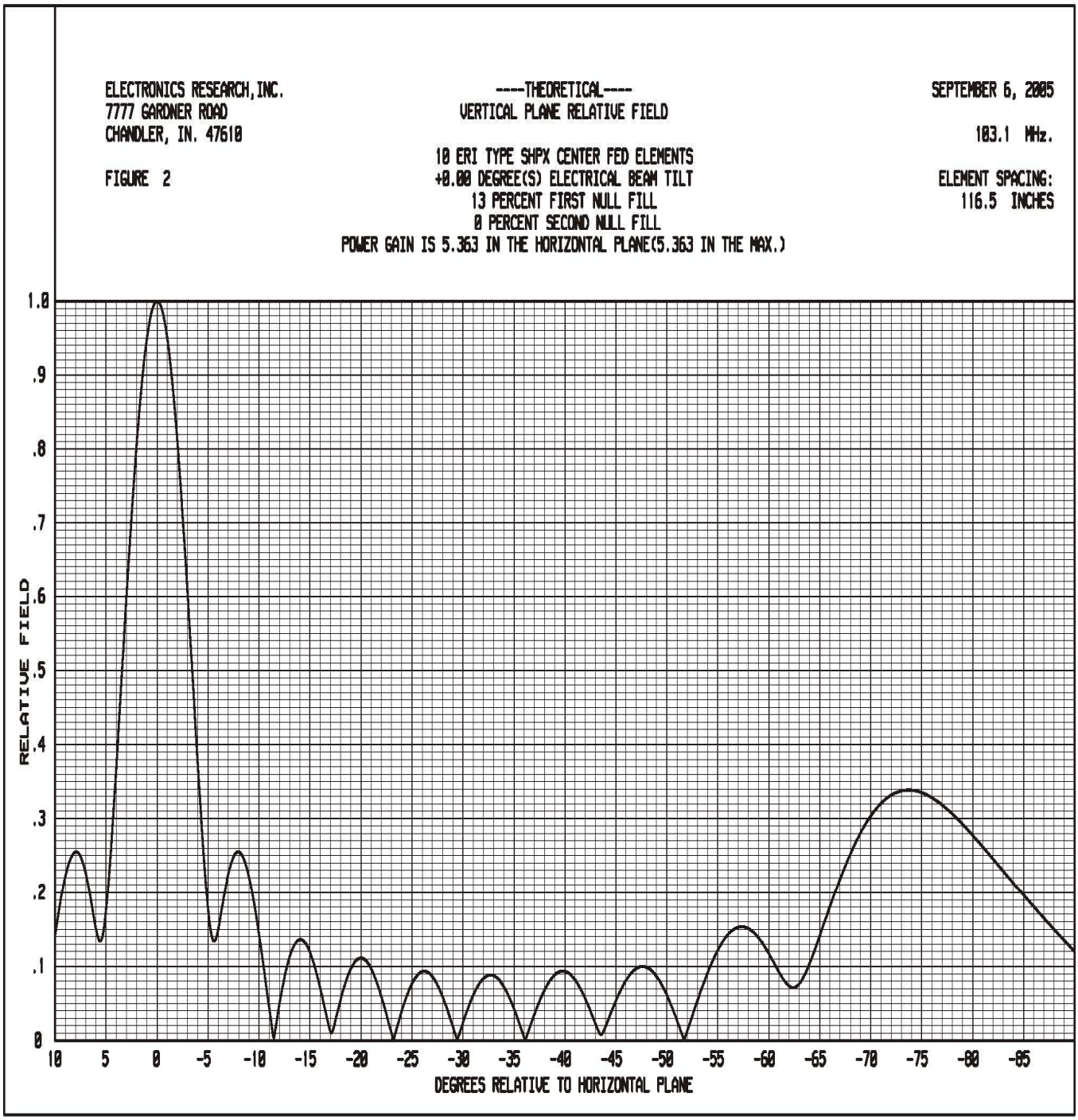
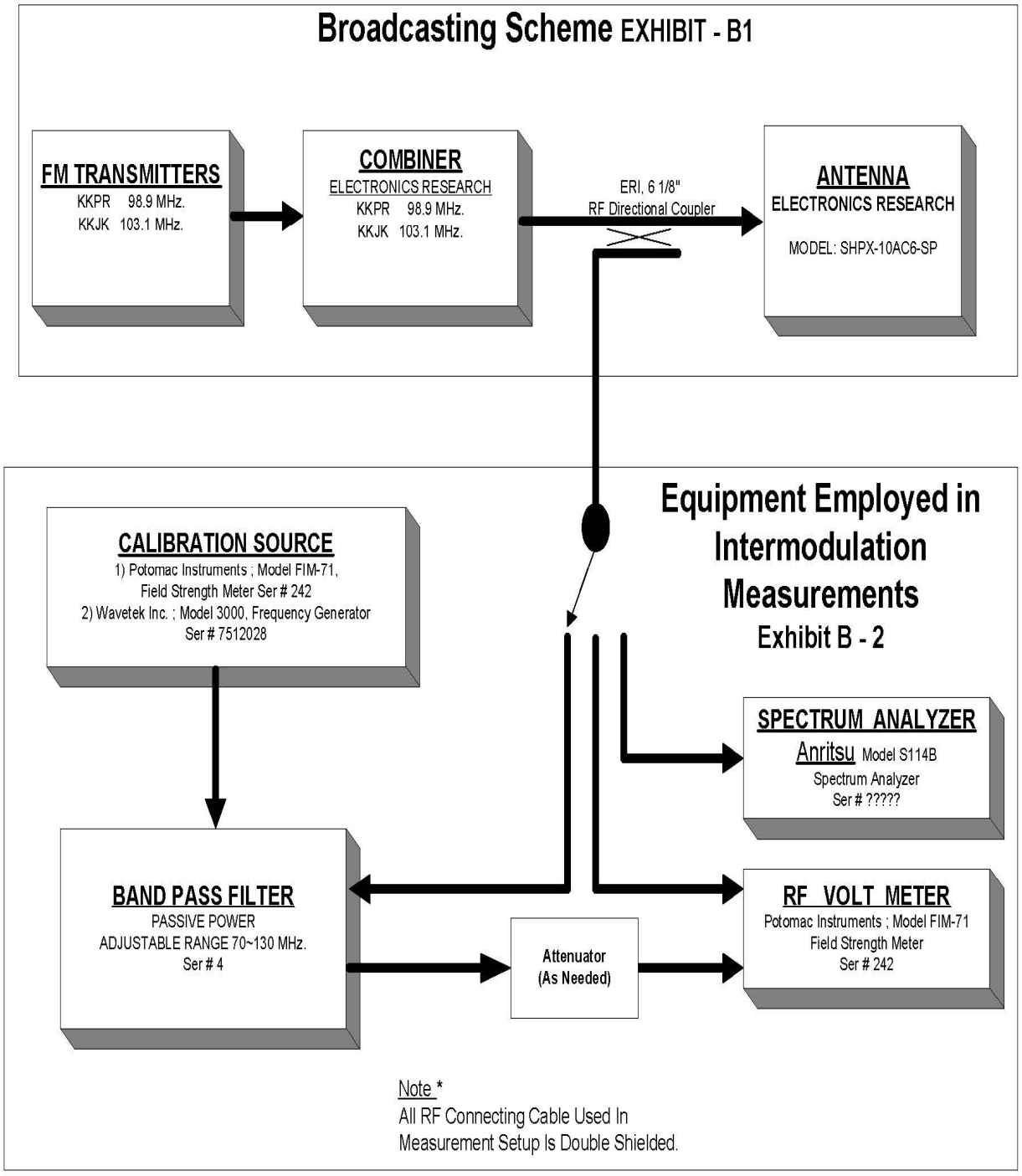

ELECTRONICS RESEARCH, INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 2
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
10 ERI TYPE SHPX CENTER FED ELEMENTS
+0.00 DEGREE(S) ELECTRICAL BEAM TILT
13 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
POWER GAIN IS 5.363 IN THE HORIZONTAL PLANE(5.363 IN THE MAX.)
SEPTEMBER 6, 2005
183.1 MHz.
ELEMENT SPACING:
116.5 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



Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

EXHIBIT B