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Report Of Intermodulation Product Findings

KISQ, KEAR BROADCAST FACILITY
SAN FRANCISCO, CALIFORNIA

October 2002

Electronics Research Inc.
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SAN FRANCISCO, CALIFORNIA

Report of Findings for Intermodulation Product Measurements

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REPORT OF FINDINGS
KISQ / KEAR BROADCAST FACILITY
SAN FRANCISCO, CALIFORNIA

Introduction: This report of findings is based on data collected at the KISQ and KEAR broadcast facility located in San Francisco, CA. The report includes measurements offered as proof that the combined operations of KISQ (98.1) and KEAR (106.9) 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 second 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). KLLC (97.3 MHz.) and KDFC (102.1 MHz.) operate into separate antennas located on other towers in close proximity to the KISQ and KEAR antenna. Their effects on the stations operating from the multiplexed system has been considered in this report. Mark Steapleton of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on October 26, 2002.

The following exhibits are provided:

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 Three SHPX-2AC-HW-SP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexing Scheme.
- A-4 Constant Impedance 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 Second 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 second 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 second 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 two FM stations were operating from the combined antenna system. The KISQ, and KEAR multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The three SHPX-2AC-HW-SP antenna and 963-6 Constant Impedance multiplexer are products of Electronics Research, Inc and Shively Labs., whereas the feed line is manufactured by Myat, 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 Combiner module is used. Specifically, one ERI 963-6 combiner modules were installed. The existing Shively bandpass filters were installed into the broad port of the ERI 963-6 combiner module which is illustrated in the attached Exhibit A-3 and B-1a. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -90 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 Anritsu Model S114B 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 (dBμ)	Scale Reading (dB)	Adjusted Level (dBμ)	Notes
KISQ (98.1)	3	---	140	-8.9	**134.1**	
KEAR (106.9)	3	---	140	-8.6	**134.4**	

Predictable second-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 - Second order Products.

	Carrier Frequency (MHz)	
Interfering Frequency (MHz)	KISQ 98.1	KEAR 106.9
KISQ 98.1	---	115.7
KEAR 106.9	89.3	---
KLLC 97.3	98.9	116.5
KDFC 102.1	94.1	111.7

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 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 *
89.3	98.1	106.9	3	6.9	20	-.5	29.4	134.1	**104.7**	
94.1	98.1	102.1	13	5.9	40	-8.9	50.0	134.1	**84.1**	1
98.9	98.1	97.3	3	5.8	20	-3.1	25.7	134.1	**108.4**	
111.7	106.9	102.1	3	6.2	20	-10.4	18.8	134.4	**115.6**	
115.7	106.9	98.1	13	6.2	20	-15.2	24.0	134.4	**110.4**	
116.5	106.9	97.3	3	6.0	20	-20.0	9.0	134.4	**125.4**	

*** NOTES**

1) Measured signal is a local carrier KPFA transmitting at 94.1 MHz: No discernable signal was measured.

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 taken October 25th. 2002 as summarized in this document, I, Mark Steapleton, find the subject multiplexed system- specifically the transmitters and combiner system for the operation of the KISQ and KEAR into the (Three) SHPX-2AC-HW-SP 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 stations operating on the installed system. Also, based on this recorded data. I conclude that KISQ and KEAR 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 Mark Steapleton
Mark Steapleton Field Technician

State of Indiana)
) SS:
County of Warrick)

AFFIDAVIT

I, Mark Steapleton, 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 22 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 Clear Channel Communications on behalf of radio Stations KISQ and KEAR in San Francisco, CA. to prepare this Report Of Findings.

Mark Steapleton

Mark Steapleton; Field Technician

Subscribed and sworn to before me on this 5th. day of November 2002.

Jacquelyn J Kinney

Jacquelyn Kinney; Notary Public
My commission expires July 5, 2007

State of Indiana)
) SS:
County of Warrick)

AFFIDAVIT

I, Mark Steapleton, 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 22 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 Clear Channel Communications on behalf of radio Stations KISQ and KEAR in San Francisco, CA. to prepare this Report Of Findings.

Mark Steapleton

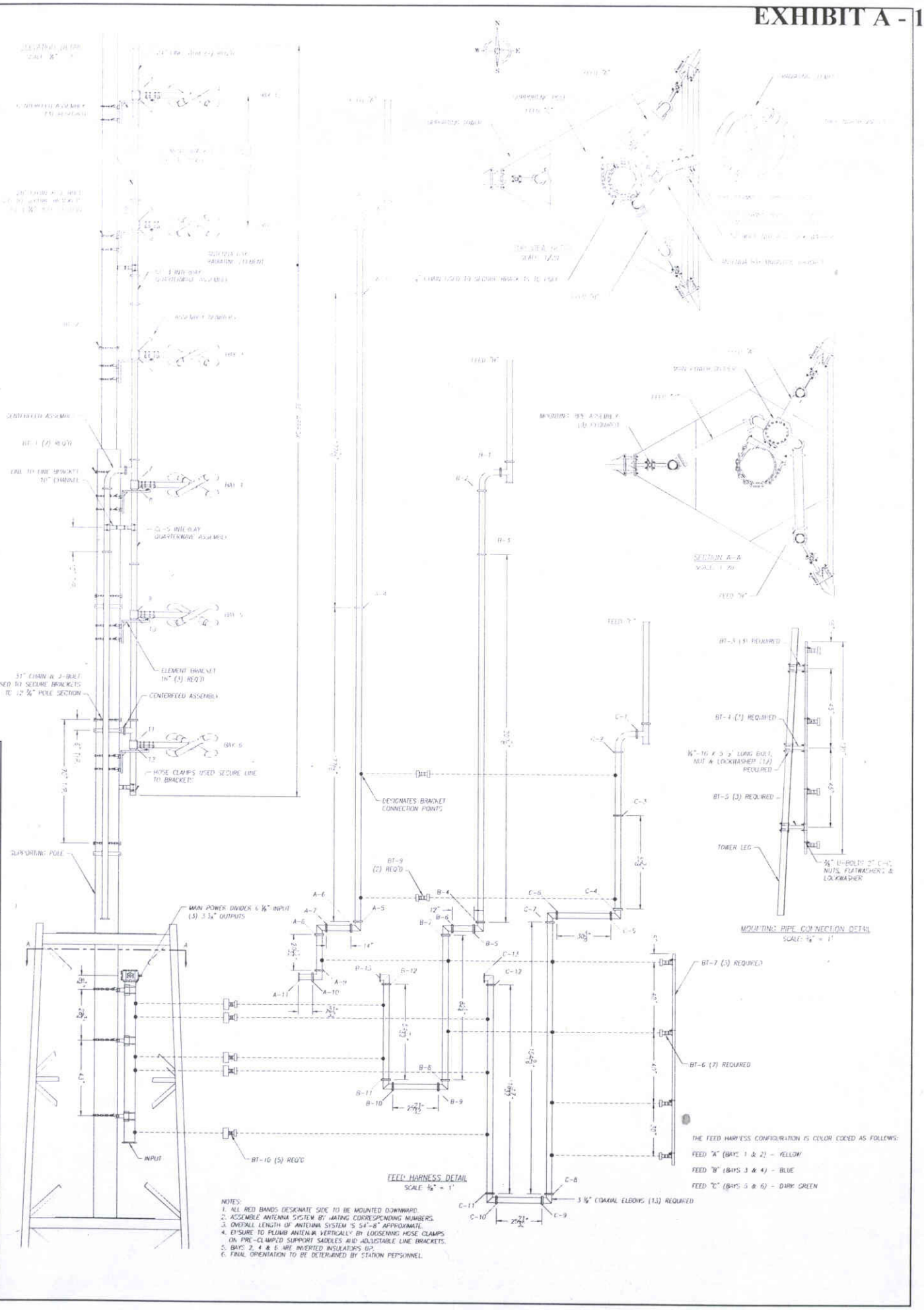
Mark Steapleton; Field Technician

Subscribed and sworn to before me on this 5th. day of November 2002.

Jacquelyn J Kinney

Jacquelyn Kinney; Notary Public
My commission expires July 5, 2007

EXHIBIT A - 1



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NAME: INSTALLATION DRAWING

A-2 ERI Antenna Specification Sheet
SAN FRANCISCO, CALIFORNIA

General Specifications

Antenna Type ..... High Power FM-Broadcast, Suitable For Diplexing
Model Number ..... (Three) SHPX-2AC-HW-SP
Number Of Bay Levels ..... Six
Polarization ..... Right Hand Circular

Electrical Specifications

Antenna Input Power Capability ..... 80 KW. Design (1)
Operating Frequency Band ..... 98.1 And 106.9 Megahertz.
VSWR ..... 1.05 : 1 @ Operating Frequencies.(2)
Azimuthal Pattern Circularity ..... +/- 2dB From RMS (Free Space)
Power Split ..... 50/50 (Horizontal & Vertical)
Quarter Wave Shorting Stubs ..... Three
Frequency Specific Information:

Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
98.1	75 (KW)	0.0°	0 %	00%	2.186	.075 dB	.298 dB	37.39 (KW)
106.9	80 (KW)	0.0°	0 %	00%	2.360	.123 dB	.160 dB	36.18 (KW)

Mechanical Specifications

Antenna Feed System ..... Fed With Single Feed
Input Connector ..... 6-1/8" 50- Ohm EIA Flanged
Element Deicing ..... Not Ordered
Interbay Spacing ..... 73.5 Inch Center to Center
Array Length (Approximate) ..... 54.8 Feet
Construction Material (Antenna) ..... All Noncorrosive
Construction Material (Mounting) ..... All Stainless Steel
Mounting ..... Pole

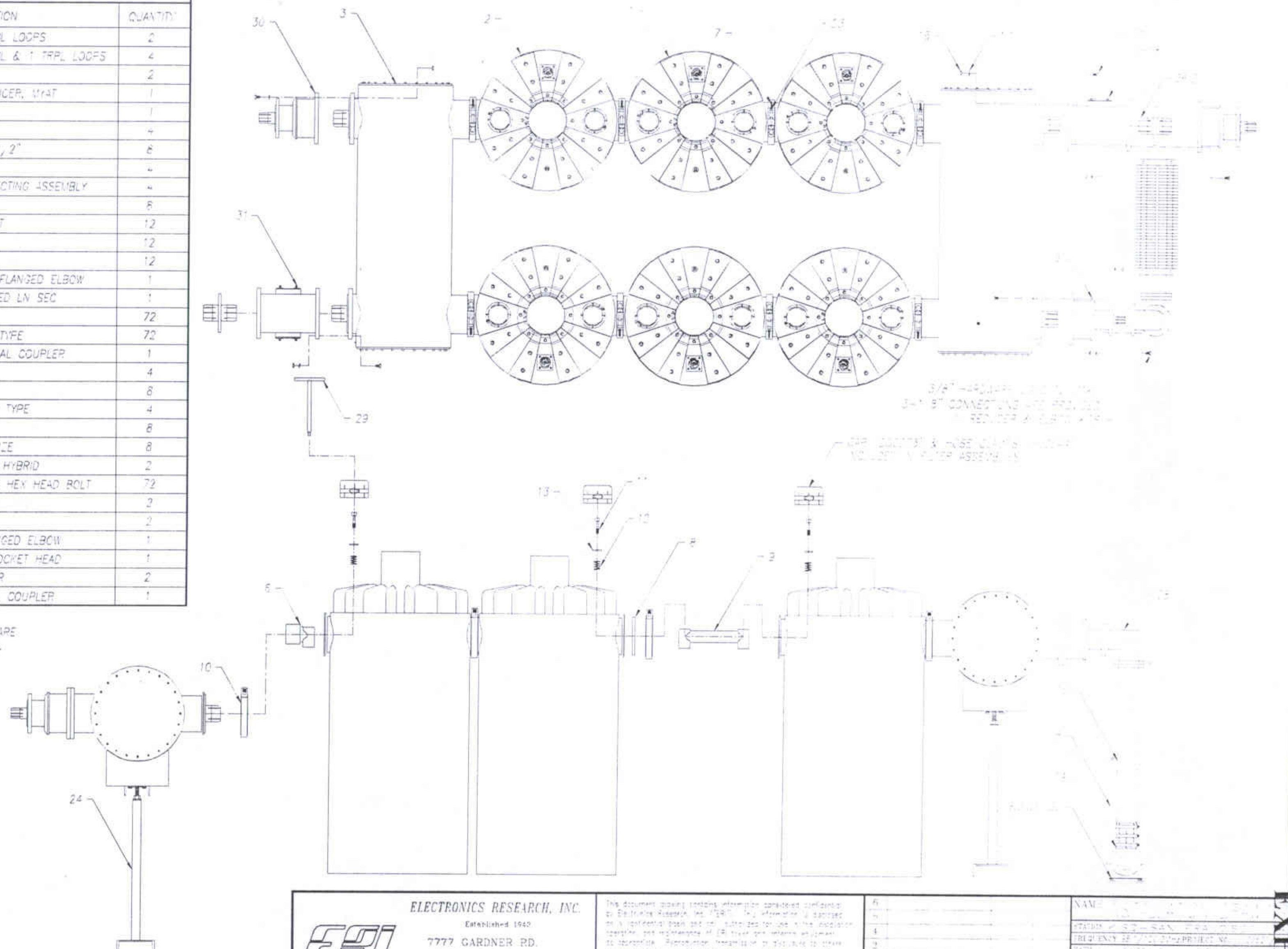
1) Power Capability Has Been Rated Assuming An Operating Transmission VSWR Of 1.5:1
2) VSWR Specification Achieved After On Site Tuning For User Specific Frequencies.
3) Line Loss From Combiner Output To Antenna Assumes A Feed Run Of 89 Feet, Myat Type 601 Rigid 6 1/8" Coax. The Feed Line Between The Transmitter and The Combiner for 98.1 MHz.: 17 Feet, Myat Type 601 Rigid 6 1/8" Coax and 40 Feet, Myat Type 401 Rigid 4 1/8" Coax. The Line Between The Transmitter And Combiner For 106.9 MHz. 32 Feet, Myat Type 301 Rigid 3 1/8" Coax And 66 Feet, 5" Andrew Type HJ9-50 Flex Coax.
4) The Loss The ERI Combiner Are Actual Multiplexer Measurements. The Shively Bandpass Filter Loss Was Not Measured. See Exhibit A-4 for Multiplexer Specifications.

EXHIBIT A - 3

BILL OF MATERIAL

ITEM NO.	ERI PART NO.	DESCRIPTION	QUANTITY
1	FI0073	963 BAND PASS, W/ 2 DBL LOOPS	2
2	FI0075	963 BAND PASS, W/ 1 DBL & 1 TRPL LOOPS	4
3	HY0051	15" HYBRID	2
4	CR0015	6-1/8" TO 3-1/8" REDUCER, MTAT	1
5	LD0002	2.5 KW DUMP LOAD	1
6	FI0148	6" PORT ADAPTER	4
7	SC0518T0450	T-BOLT 5/16"-18 X 4-1/2"	8
8	FI0001	CONTACT RING	4
9	FI0147	INNER CONNECTOR CONNECTING ASSEMBLY	4
10	CM0036	6" MARMAN CLAMP	8
11	FI0220	1/2"-13 X 2" LONG BOLT	12
12	SG0001	SPRING	12
13	WF08SSA	1/2" FLATWASHER	12
14	CE3021	3-1/8" FLANGED TO UNFLANGED ELBOW	1
15	CL3034	3-1/8" FLGED TO UNFLGED LN SEC	1
16	*NU0616	3/8" HEX NUT	72
17	*WL06SS	3/8" LOCKWASHER SPLIT TYPE	72
18	DC6003	6-1/8" SINGLE DIRECTIONAL COUPLER	1
19	FI0223	DUMPLOAD LEGS	4
20	WF05SS	5/16" FLATWASHER	8
21	WL05SS	5/16" LOCKWASHER SPLIT TYPE	4
22	NU0518	5/16"-18 HEX NUT	8
23	NU0518BZ	5/16"-18 HEX NUT BRONZE	8
24	HY0100	SUPPORT STAND FOR 15" HYBRID	2
25	*SC0616H0175	3/8"-16 X 1-3/4" LONG HEX HEAD BOLT	72
26	*CC0033	6-1/8" INLINE BULLET	2
27	*IN0029	6-1/8" INSULATOR	2
28	CE3022	3-1/8" FLANGED TO FLANGED ELBOW	1
29	FI0004	"T" HANDLE TOOL 1/2" SOCKET HEAD	1
30	CP0006	6 1/8"-4 1/16" REDUCER	2
31	DC6005	6-1/8" DUAL DIRECTIONAL COUPLER	1

NOTES: * QTY'S IN BILL OF MATERIAL REFLECT HARDWARE NECESSARY TO ASSEMBLE ALL CONNECTIONS.



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NO.	REVISION	APP'D	DATE
6			
5			
4			
3			
2			
1			

A-4 ERI Combiner Specification Sheet
SAN FRANCISCO, CALIFORNIA

General Specifications:

Multiplexer Type ..... 963-6 Constant Impedance Module
Number Of Combining Units ..... One
Injected Port to Broad Port Isolation ..... - 30 dB
Output Connector ..... 6 1/8 " 50 Ohm EIA (Flanged)
Output Power (Designed) ..... 80 KW
Combiner Units, Size and Weight :

Type 963-6 Tuned To 106.9 MHZ. ..... 5' ht. X 4.5' wd. X 9' lng. & 1,400 Lbs.

Heat Removal (All Multiplexer Components) ..... Natural Convection[1]
Physical Arrangement ..... All Components Floor Standing

Injected Port Specifications:

Frequency Assignment ..... 106.9 MHz.
Power Rating, Injected Port (Designed) ..... 37 KW
Input Connector ..... 6-1/8" 50 Ohm EIA (Flanged)
VSWR ..... Less than 1.08:1 @ +/-150 KHz[2]
Group Delay ..... Less than 100 ns Overall Variation, Carrier @ +/- 150 KHz
Insertion Loss (ERI Combiner only):

98.1 MHz. ..... - 0.160 dB

Broad Port Specifications:

Frequency Assignment ..... 106.9 MHz.
Power Rating (Designed) ..... 38 KW
Input Connector ..... 6 1/8" 50 Ohm (Flanged)
VSWR @ 106.9 MHz. ..... 1.07:1 @ 106.9 MHz.[2]
Group Delay ..... Less than 25 ns overall Variation, Carrier @=/- 150 KHz.
Insertion Loss:
ERI Combiner Broad Port @ 106.9 MHz. ..... - 0.028 dB
Shively Bandpass Filters @ 106.9 MHz. ..... 0.270 dB

1) Ambient Combiner Room Temperature Should be Maintained Between 70 - 80 Degrees Fahrenheit
2) When Terminated in 50 Ohm Resistive Load.

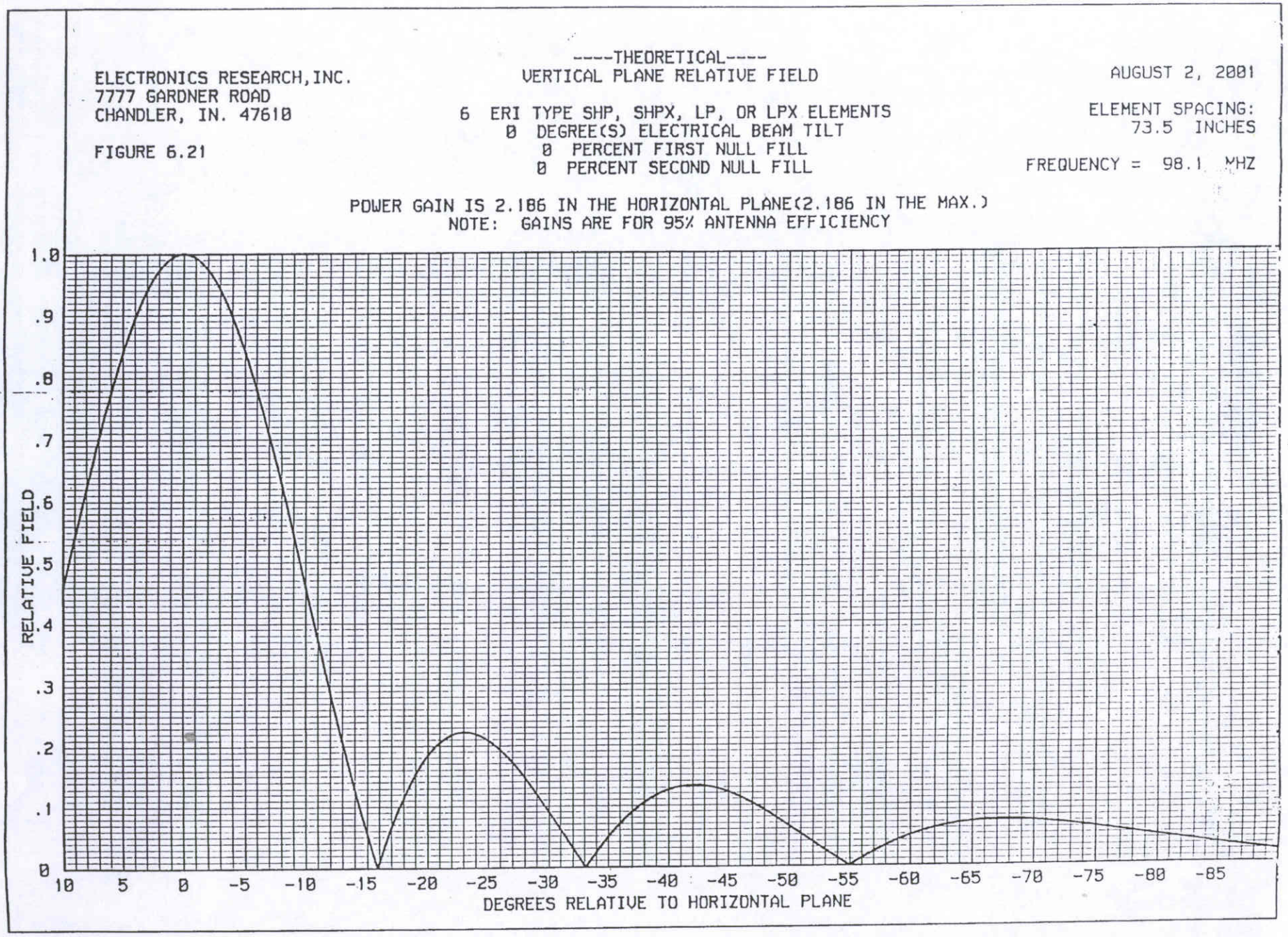
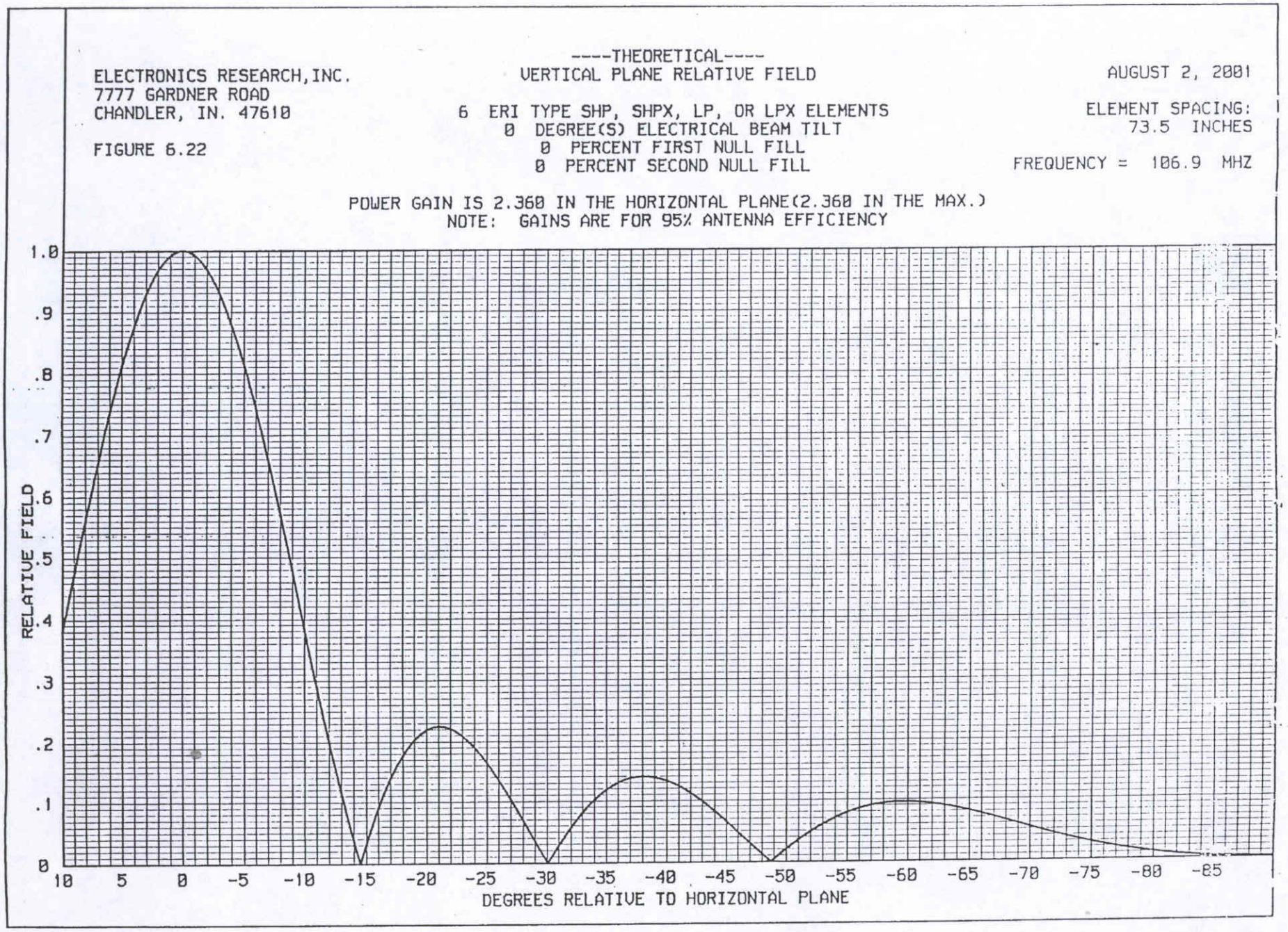

----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 6.21
6 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
0 DEGREE(S) ELECTRICAL BEAM TILT
0 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
AUGUST 2, 2001
ELEMENT SPACING:
73.5 INCHES
FREQUENCY = 98.1 MHZ
POWER GAIN IS 2.186 IN THE HORIZONTAL PLANE(2.186 IN THE MAX.)
NOTE: GAINS ARE FOR 95% ANTENNA EFFICIENCY
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 6.22
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
6 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
0 DEGREE(S) ELECTRICAL BEAM TILT
0 PERCENT FIRST NULL FILL
0 PERCENT SECOND NULL FILL
AUGUST 2, 2001
ELEMENT SPACING:
73.5 INCHES
FREQUENCY = 106.9 MHZ
POWER GAIN IS 2.360 IN THE HORIZONTAL PLANE(2.360 IN THE MAX.)
NOTE: GAINS ARE FOR 95% ANTENNA EFFICIENCY
RELATIVE FIELD
1.0
.9
.8
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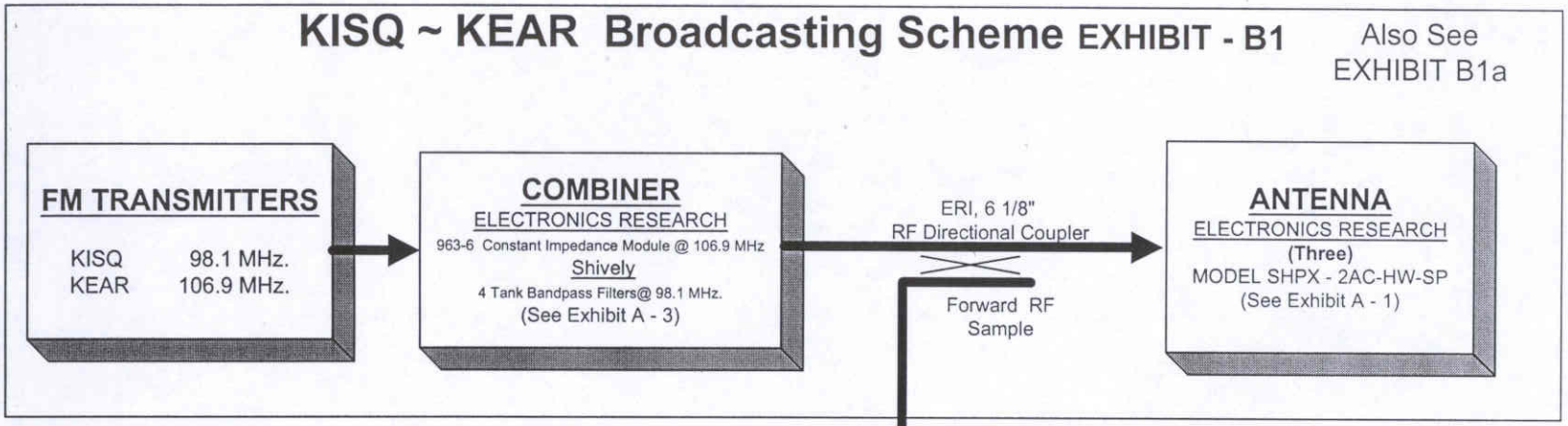
.6
.5
.4
.3
.2
.1
0
10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85
DEGREES RELATIVE TO HORIZONTAL PLANE

EXHIBIT A - 5

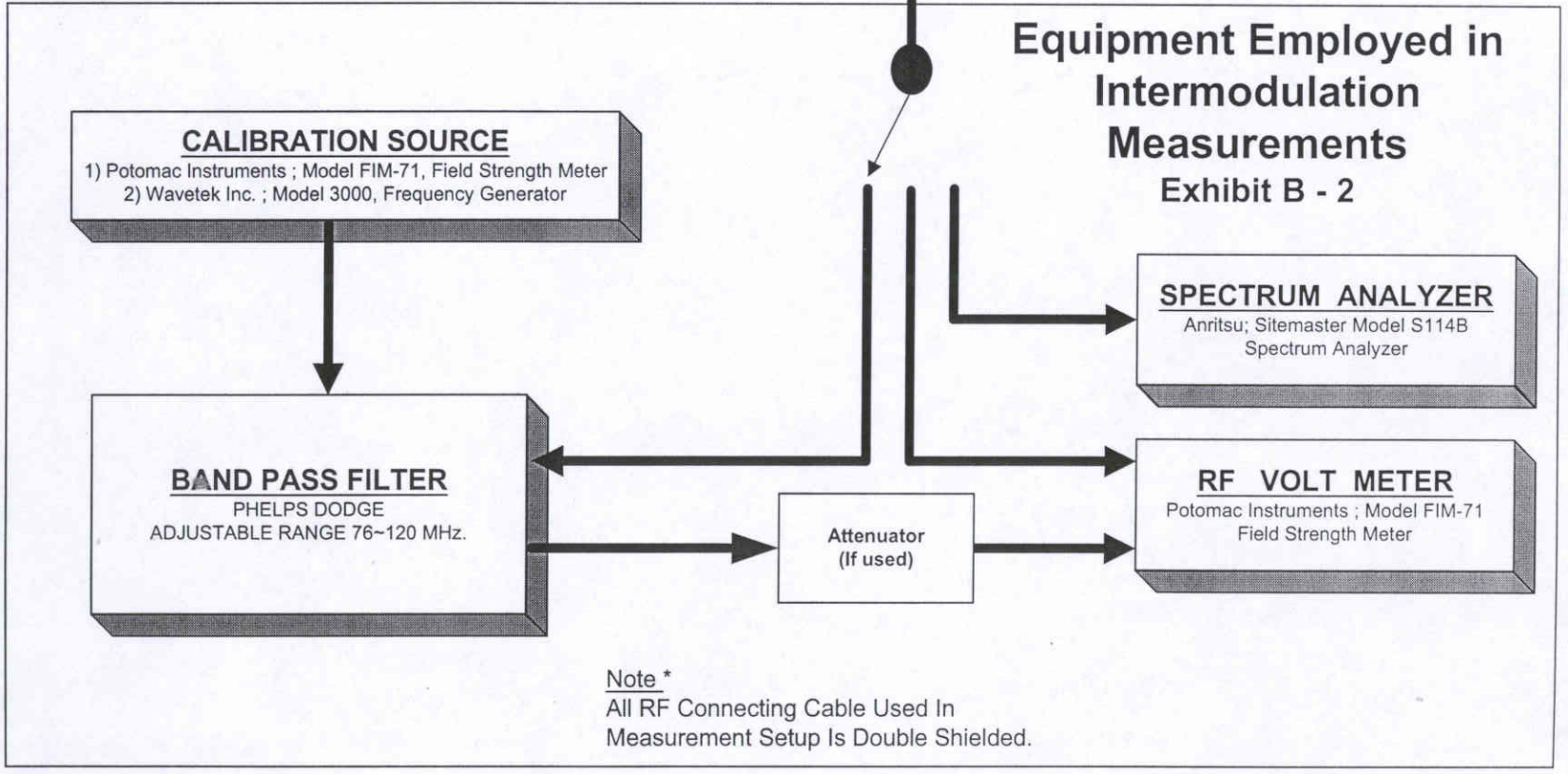
KISQ ~ KEAR Broadcasting Scheme EXHIBIT - B1

Also See EXHIBIT B1a



Equipment Employed in Intermodulation Measurements

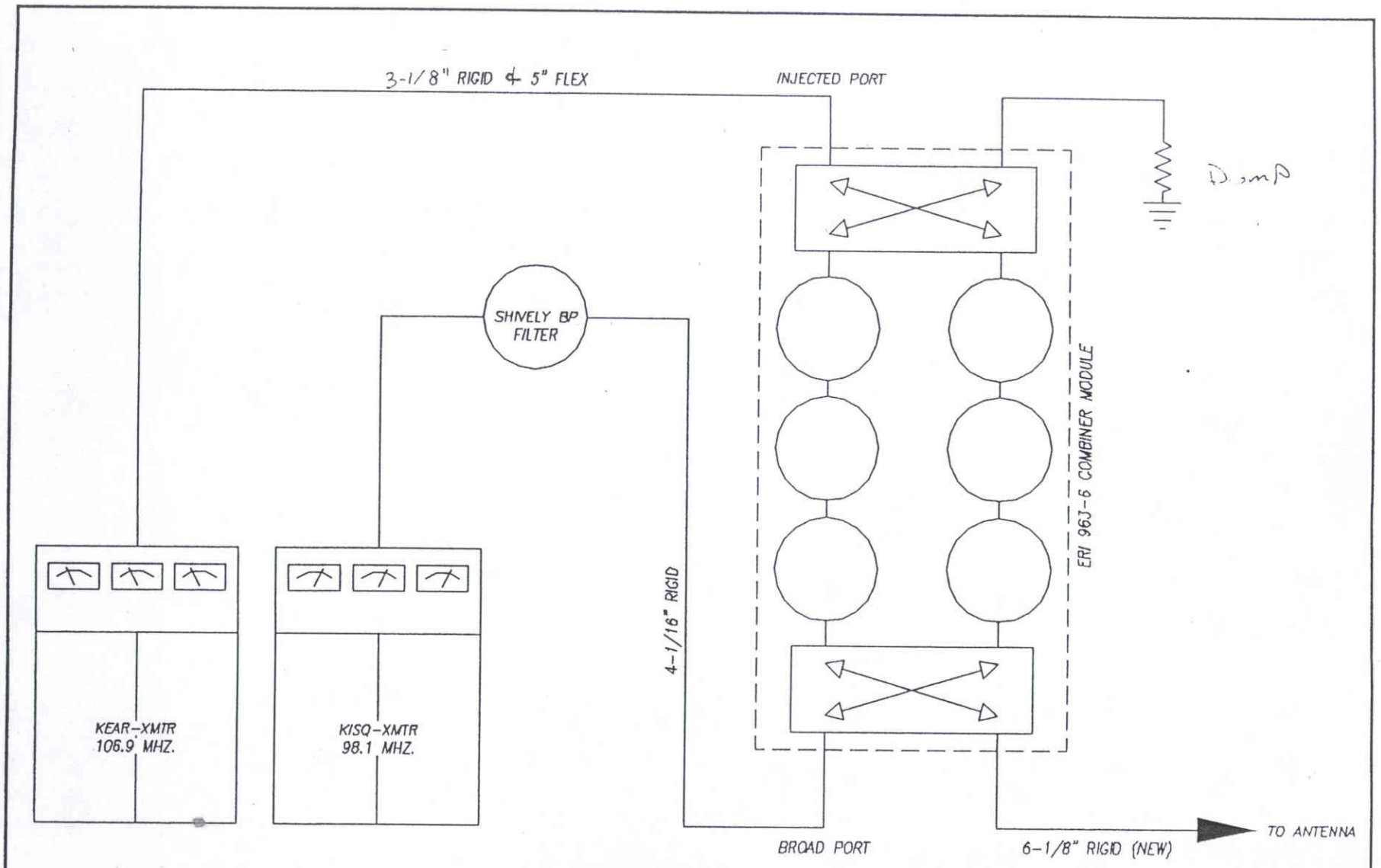
Exhibit B - 2



Note *
All RF Connecting Cable Used In
Measurement Setup Is Double Shielded.

Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

EXHIBIT B



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NO	REVISION	APP'D	DATE
6			
5			
4			
3			
2			
1			

NAME PROPOSED BLOCK DIAGRAM
FOR KISQ-KEAR
PATH G:\DRAFTING\ANTENNA\ROBERT
FILE KISQ-KEAR SCHEMATIC | DRAWN R.R.H. | FACTOR N/A
DATE 3/18/02 | APP'D
MATL N/A | CUT N/A
L-WO
DWG. NO.

EXHIBIT B - 1a