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Report Of Intermodulation Product Findings

KMRK, KCRS BROADCAST FACILITY
MIDLAND, TEXAS

February 2003

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REPORT OF FINDINGS
KMRK / KCRS COMBINED BROADCAST FACILITY
MIDLAND, TEXAS

Introduction: This report of findings is based on data collected at the KMRK and KCRS broadcast facility located in Midland, TX. The report includes measurements offered as proof that the combined operations of KMRK (96.1 MHz.) and KCRS (103.3 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). KMCM (96.9 MHz.) operate into separate antenna located on another tower located within 500' of the KMRK and KCRS antenna. Their effects on the stations operating from the combined system has been considered in this report. Mark Steapleton of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on February 28, 2003.

The following exhibits are provided:

Exhibit A:
- A-1 Drawing Depicting Antenna.
- A-2 SHPX-12AC-SP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexing Scheme.
- A-4 963/6 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 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 KMRK, and KCRS multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-12AC-SP antenna and 963/6 TEE combiner unit are products of Electronics Research, Inc, whereas the feed line is manufactured by Cablewave, 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 module was installed. Specifically, the Multiplexer utilizes three ERI Model 963 Bandpass filters for each transmitter. An interconnecting TEE is required to complete the multiplexer module. which is illustrated in the attached Exhibit A-3. The multiplexer, fully assembled, exhibited transmitter port-to-port isolation in excess of -74 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 -56 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
KMRK (96.1)	---	---	120	-1.8	118.2	
KCRS (103.3)	---	---	140	-15.9	124.1	

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)	KMRK 96.1	KCRS 103.3
KMRK 96.1	---	110.5
KCRS 103.3	88.9	---
KMCM 96.9	95.3	109.7

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*
88.9	96.1	103.3	3	6.8	20	-15.5	14.3	118.2	**103.9**	
95.3	96.1	96.9	6	5.9	20	-1.5	30.4	118.2	**87.8**	
109.7	103.3	96.9	6	6.2	20	<-20.0	12.2	124.1	**111.9**	
110.5	103.3	96.1	6	6.2	20	<-20.0	12.2	124.1	**111.9**	

*** NOTES**

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 February 28th. 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 KMRK, and KCRS into the SHPX-12AC-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 KMRK, and KCRS 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 Field Technician

WARRICK COUNTY)
) SS:
STATE OF INDIANA)

I, Mark Steapleton, hereby declare that the following statements are true and correct to the best of my knowledge and belief :

1.) That my qualifications are a matter of record with the Federal Communications Commission;

2.) 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.

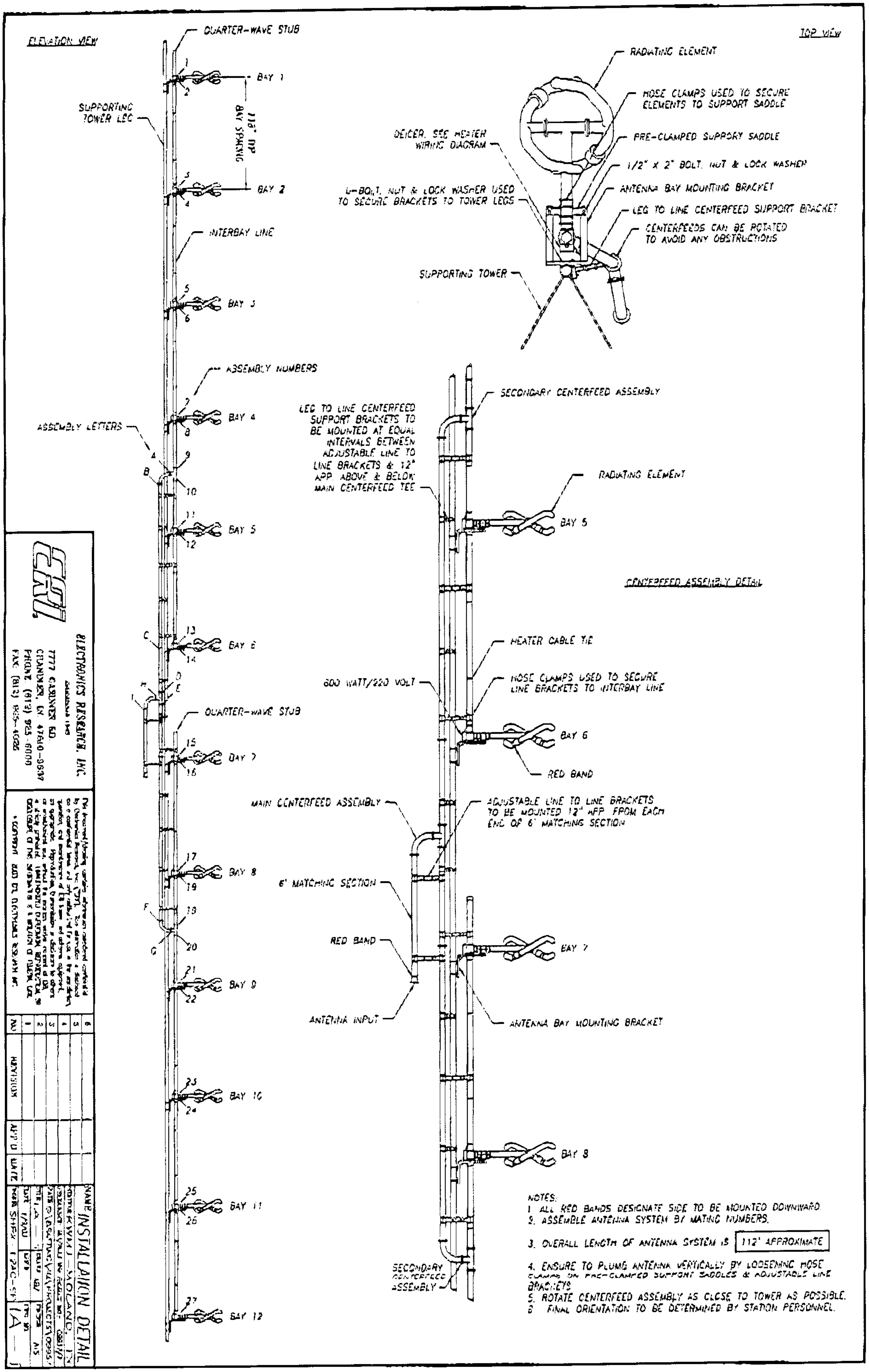
3.) I have either prepared or directly supervised the preparation of all technical information contained in this Report Of Findings and to my knowledge to be accurate and true.

3.) ERI has been requested by Clear Channel Communications, on behalf of radio Stations KMRK, and KCRS in Midland, TX. to prepare this engineering statement.

Mark Steapleton; Field Technician

Subscribed and sworn to before me on this 7th. day of March 2003.

Cindy D. Tomes; Notary Public
My commission expires November 6, 2006


ELEVATION VIEW
QUARTER-WAVE STUB
BAY 1
SUPPORTING TOWER LEG
112" APP BAY SPACING
BAY 2
INTERBAY LINE
BAY 3
ASSEMBLY NUMBERS
ASSEMBLY LETTERS
BAY 4
BAY 5
BAY 6
QUARTER-WAVE STUB
BAY 7
BAY 8
BAY 9
BAY 10
BAY 11
BAY 12
TOP VIEW
RADIATING ELEMENT
HOSE CLAMPS USED TO SECURE ELEMENTS TO SUPPORT SADDLE
DEICER, SEE HEATER WIRING DIAGRAM
PRE-CLAMPED SUPPORT SADDLE
1/2" X 2" BOLT, NUT & LOCK WASHER
U-BOLT, NUT & LOCK WASHER USED TO SECURE BRACKETS TO TOWER LEGS
ANTENNA BAY MOUNTING BRACKET
LEG TO LINE CENTERFEED SUPPORT BRACKET
CENTERFEEDS CAN BE ROTATED TO AVOID ANY OBSTRUCTIONS
SUPPORTING TOWER
SECONDARY CENTERFEED ASSEMBLY
LEG TO LINE CENTERFEED SUPPORT BRACKETS TO BE MOUNTED AT EQUAL INTERVALS BETWEEN ADJUSTABLE LINE TO LINE BRACKETS & 12" APP. ABOVE & BELOW MAIN CENTERFEED TEE
RADIATING ELEMENT
BAY 5
CENTERFEED ASSEMBLY DETAIL
HEATER CABLE TIE
600 WATT/220 VOLT
HOSE CLAMPS USED TO SECURE LINE BRACKETS TO INTERBAY LINE
BAY 6
RED BAND
MAIN CENTERFEED ASSEMBLY
ADJUSTABLE LINE TO LINE BRACKETS TO BE MOUNTED 12" APP FROM EACH END OF 6' MATCHING SECTION
6' MATCHING SECTION
RED BAND
BAY 7
ANTENNA INPUT
ANTENNA BAY MOUNTING BRACKET
BAY 8
NOTES:
1. ALL RED BANDS DESIGNATE SIDE TO BE MOUNTED DOWNWARD.
2. ASSEMBLE ANTENNA SYSTEM BY MATING NUMBERS.
3. OVERALL LENGTH OF ANTENNA SYSTEM IS 112' APPROXIMATE
4. ENSURE TO PLUMB ANTENNA VERTICALLY BY LOOSENING HOSE CLAMPS ON PRE-CLAMPED SUPPORT SADDLES & ADJUSTABLE LINE BRACKETS
5. ROTATE CENTERFEED ASSEMBLY AS CLOSE TO TOWER AS POSSIBLE.
6. FINAL ORIENTATION TO BE DETERMINED BY STATION PERSONNEL.
SECONDARY CENTERFEED ASSEMBLY
ERI
ELECTRONICS RESEARCH, INC.
7777 GARDNER RD.
CHANDLER, IN 47610-9697
PHONE (812) 925-6000
FAX (812) 925-4030
INSTALLATION DETAIL

EXHIBIT, A - 2

A-2 ERI Antenna Specification Sheet
MIDLAND, TEXAS

General Specifications

Antenna Type ..... High Power FM-Broadcast, Suitable For Diplexing
Model Number SHPX-12AC-SP
Number Of Bay Levels ..... Twelve
Polarization ..... Right Hand Circular

Electrical Specifications

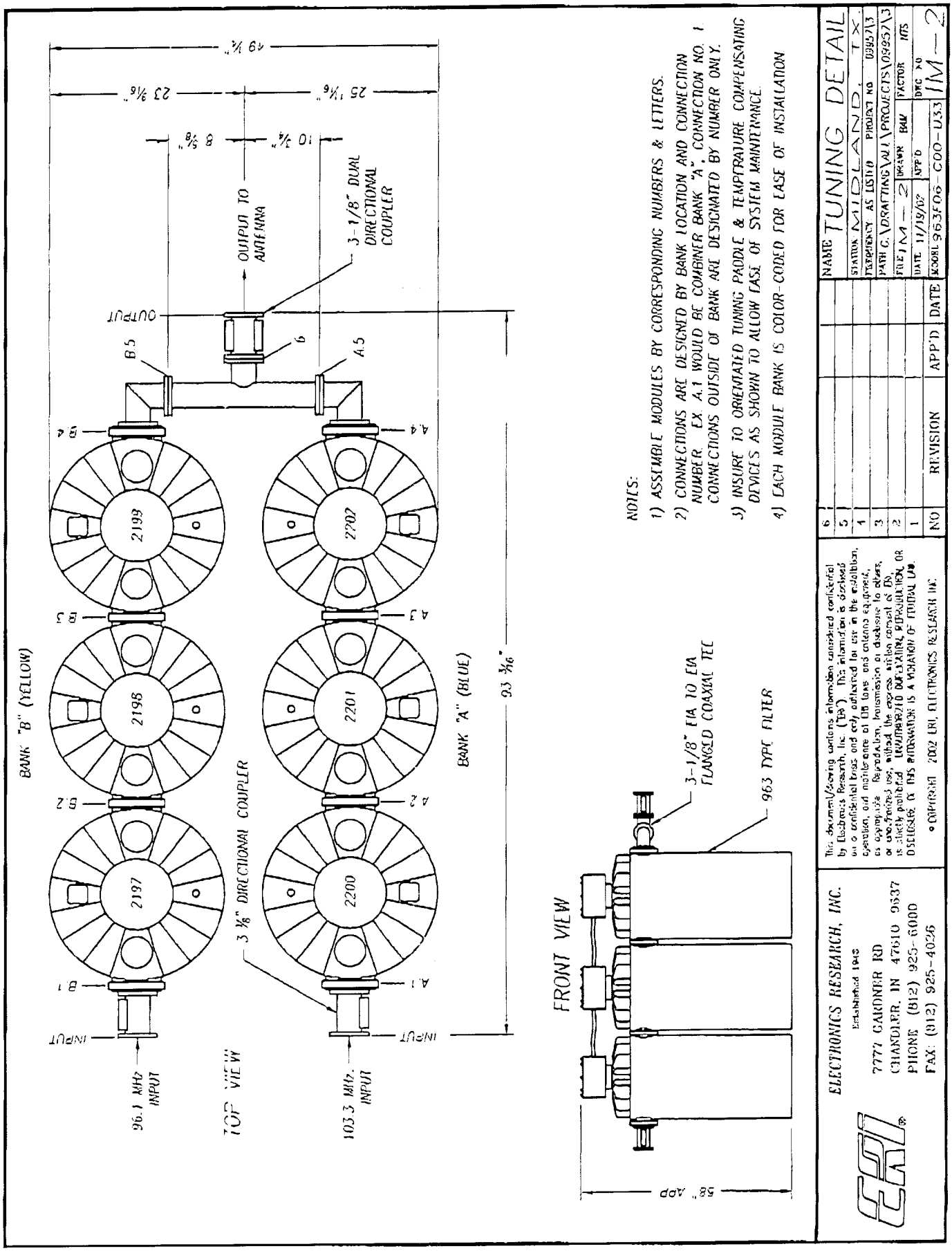
Antenna Input Power Capability ..... 37 KW. Maximum (1)
Operating Frequency Band ..... 96.1 And 103.3 Megahertz.
VSWR ..... 1.1 : 1 @ Operating Frequencies.(2)
Azimuthal Pattern Circularity ..... +/- 2dB From RMS (Free Space)
Power Split ..... 50/50 (Horizontal & Vertical)
Quarter Wave Shorting Stub ..... Yes
Frequency Specific Information:

Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain	Line Loss (3)	Filter Loss (4)	Computed TPO
96.1	29 (KW)	-0.5°	15 %	6%	6.341	.899 dB	.144 dB	21.05 (KW)
103.3	100 (KW)	-0.5°	15 %	6%	6.089	.933 dB	.145 dB	5.81 (KW)

Mechanical Specifications

Antenna Feed System ..... Fed With Single Feed Line
Input Connector ..... 3 1/8 " 50- Ohm EIA Flanged
Element Deicing ..... Heaters
Interbay Spacing ..... 118.000 Inch Center to Center
Array Length ..... 112 Feet
Construction Material (Antenna) ..... All Noncorrosive
Construction Material (Mounting) ..... All Stainless Steel
Mounting ..... Leg Mounted on Tower

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 987 Feet, Myat Type 301-000 Rigid 3 1/8" Coax.
4) Losses Taken, At The Factory, From Actual Multiplexer Measurements.



NOTES:

1) ASSEMBLE MODULES BY CORRESPONDING NUMBERS & LETTERS.
2) CONNECTIONS ARE DESIGNED BY BANK LOCATION AND CONNECTION NUMBER. EX A1 WOULD BE COMBINER BANK "A", CONNECTION NO. 1 CONNECTIONS OUTSIDE OF BANK ARE DESIGNATED BY NUMBER ONLY.
3) INSURE TO ORIENTATED TUNING PADDLE & TEMPERATURE COMPENSATING DEVICES AS SHOWN TO ALLOW EASE OF SYSTEM MAINTENANCE.
4) EACH MODULE BANK IS COLOR-CODED FOR EASE OF INSTALLATION

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

NAME TUNING DETAIL
STATION MIDLAND, TX
FREQUENCY AS LISTED PROJECT NO 02957\3
PATH C:\DRAFTING\ALL\PROJECTS\02957\3
FILE IM-2 DRAWN BAW FACTOR IMS
DATE 11/19/02 APP'D DWG NO
MODEL 963F06-C00-U33 IM-2

ELECTRONICS RESEARCH, INC.
Established 1945
7777 GARDNER RD
CHANDLER, IN 47610 9537
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FAX: (812) 925-4026

EXHIBIT A - 4

A-4 ERI Combiner Specification Sheet
MIDLAND, TEXAS

General Specifications:

Multiplexer Type ..... 963 - 6 TEE Combiner
Number Of Combining Units ..... Two
Injected Port to Injected Port Isolation ..... - 74 dB
Output Connector ..... 6 1/8 " 50 Ohm EIA (Flanged)
Output Power ..... 28 KW
Combiner Units, Size and Weight :

Type 963-3 Tuned To 96.1 MHz. ..... 5' ht. X 2' wd. X 6' lg. & 578 Lbs.
Type 963-3 Tuned To 103.3 MHz. ..... 5' ht. X 2' wd. X 6' lg. & 597 Lbs.

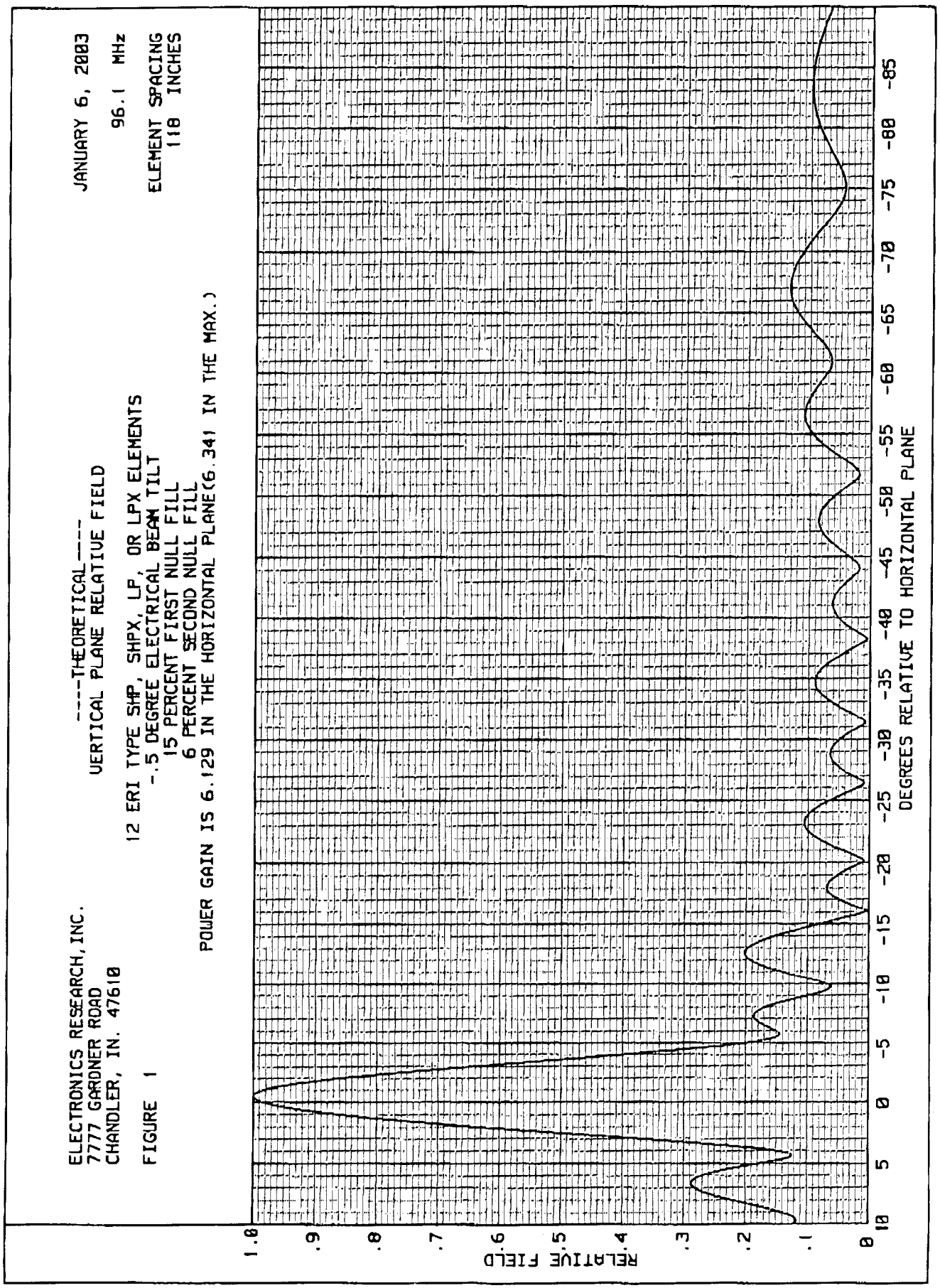
Heat Removal (All Multiplexer Components) ..... 96.1 MHz. - Natural Convection 103.3 MHz. - Forced Air
Physical Arrangement ..... All Components Floor Standing

Injected Port Specifications:

Frequency Assignment ..... 96.1 MHz. And 103.3 MHz.
Power Rating, Each Injected Port (Designed) .. 6 KW @ 96.1 MHz. and 22 KW @ 103.3 MHz.
Input Connector ..... 3-1/8" 50 Ohm EIA (Flanged)
VSWR ..... Less than 1.08:1 @ +/-150 KHz(1)
Group Delay ..... Less than 60 ns Overall Variation, Carrier @ +/- 150 KHz
Insertion Loss (Factory Measured):

96.1 MHz. ..... - 0.144 dB
103.3 MHz. ..... - 0.145 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
12 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
-.5 DEGREE ELECTRICAL BEAM TILT
15 PERCENT FIRST NULL FILL
6 PERCENT SECOND NULL FILL
POWER GAIN IS 6.129 IN THE HORIZONTAL PLANE(6.341 IN THE MAX.)
JANUARY 6, 2003
96.1 MHz
ELEMENT SPACING
118 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

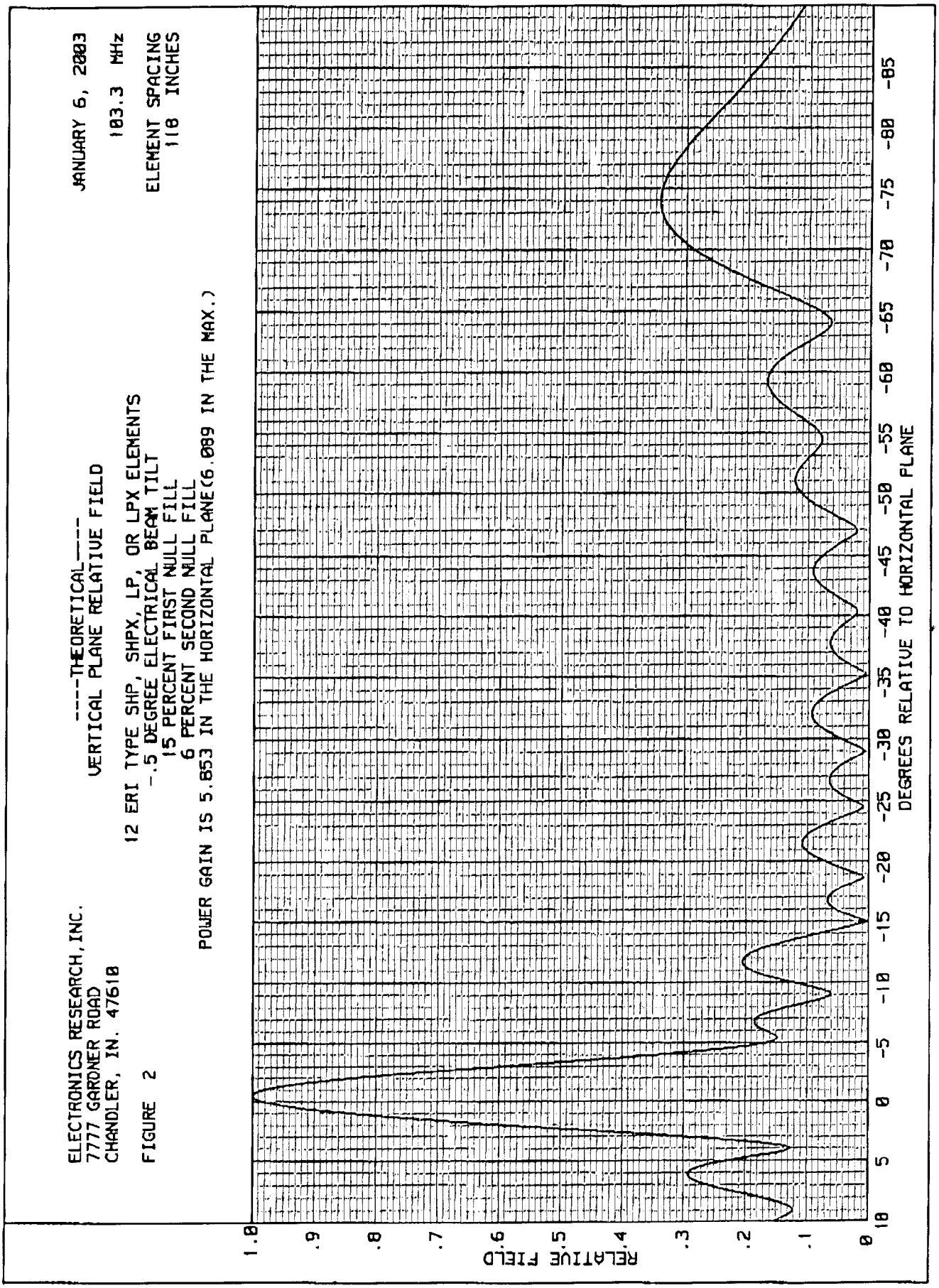

ELECTRONICS RESEARCH, INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610
FIGURE 2
----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD
12 ERI TYPE SHP, SHPX, LP, OR LPX ELEMENTS
-.5 DEGREE ELECTRICAL BEAM TILT
15 PERCENT FIRST NULL FILL
6 PERCENT SECOND NULL FILL
POWER GAIN IS 5.853 IN THE HORIZONTAL PLANE(6.009 IN THE MAX.)
JANUARY 6, 2003
103.3 MHz
ELEMENT SPACING
118 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 B

Broadcasting Scheme and Equipment Employed in Intermodulation Measurements