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Report Of Intermodulation Product Findings

WBTT – WCKT FM BROADCAST FACILITY
LEHIGH ACRES, FLORIDA

March 2002

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REPORT OF FINDINGS
WBTT / WCKT BROADCAST FACILITY
LEHIGH ACRES, FLORIDA

Introduction : This report of findings is based on data collected at the WBTT and WCKT, FM broadcast facility located in Bonita Springs, FL. This report includes measurements offered as proof that the combined operations of WBTT, (105.5 MHz.) and WCKT, (107.1 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 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). WTLT (93.5 MHz.) WWWD (92.5 MHz.) and WAYJ (88.7 MHz.) operate into separate side mounted antennas located lower on the same tower. 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 March 17, 2002.

The following exhibits are provided:

Exhibit A:
- A-1 Drawing Depicting Antenna.
- A-2 SHPX-4AC6-SP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexing Scheme.
- A-4 TB63-8/6 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 WBTT and WCKT multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The SHPX-4AC6-SP antenna and TB63-8/6 multiplexer unit are products of Electronics Research, Inc, whereas the feed line is manufactured by Cablewave Systems. Refer to Exhibit B-2, for an illustration of the Broadcasting Scheme of these stations.

To accomplish the aggregation of 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 963 Bandpass filters for each transmitter. An interconnecting TEE is required to complete the multiplexer module, witch 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 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 32 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 Spectrum Analyzer to ensure an adequate signal level for measurements without overloading the measurement equipment. An Anritsu, Sitemaster Model S114B Spectrum Analyzer was employed to record the level of all signals investigated. To facilitate the selective tuning of the Band Pass Filter a Hewlett Packard Model 8712C network analyzer was used. 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)	Measured Level (dBm)	Adjusted Level (dBm)	Notes
WBTT (105.5)	-20.0	---	6.4	26.4	
WCKT (107.1)	-20.0	---	4.5	24.5	

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)	WBTT 105.5	WCKT 107.1
WBTT 105.5	---	108.7
WCKT 107.1	103.9	---
WAYJ 88.7	122.3	125.5
WWWD 92.5	118.5	121.7
WTLT 93.5	117.5	120.7

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 Freq. (MHz)	Carrier Freq. (MHz)	Interfering Freq. (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Measured Level (dBm)	Carrier Reference Level (dBm) (See Table 1)	**Level Referenced to Carrier (dB)**	Notes*
103.9	105.5	107.1	0.0	6.5	-66.7	26.4	**86.6**	
108.7	107.1	105.5	20	6.5	-95.9	24.5	**93.9**	
117.5	105.5	93.5	20	5.9	-96.7	26.4	**97.2**	
118.5	105.5	92.5	20	5.9	-96.2	26.4	**96.7**	
120.7	107.1	93.5	20	5.9	-93.0	24.5	**91.6**	
121.7	107.1	92.5	20	5.9	-95.8	24.5	**94.4**	
122.3	105.5	88.7	20	6.0	-94.9	26.4	**95.3**	
125.5	107.1	88.7	0.0	0.0	-56.4	24.5	**80.9**	1

*** NOTES**

1) Level measured is limited by the noise floor of the Spectrum Analyzer.

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 resulted in no additional investigations.

Conclusion : Based upon my observations and measurements taken March 17th. 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 WBTT and WCKT into the SHPX-4AC-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 WBTT and WCKT 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

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 21 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.

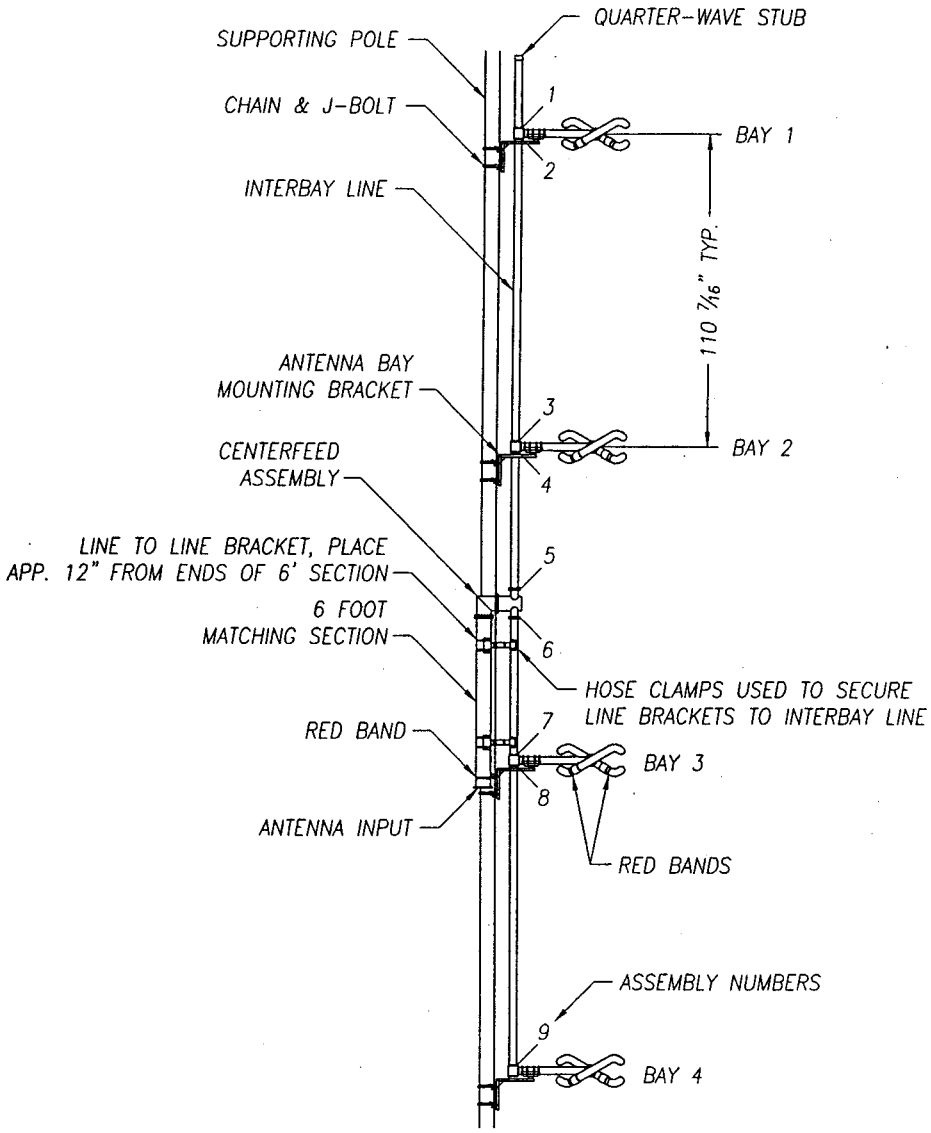
2.) I have either prepared and/or directly supervised the preparation of all technical information contained in this Report Of Findings and to my knowledge to be accurate and true.

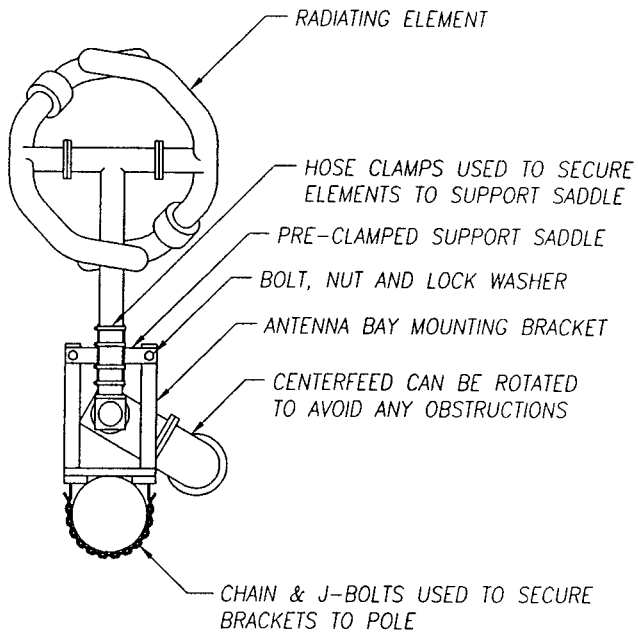
3.) ERI has been requested by Clear Channel Communications on behalf of radio Stations WBTT and WCKT in Lehigh Acres, FL. to prepare this Report Of Findings.

Mark Steapleton; Field Technician

Subscribed and sworn to before me on this 4th. day of April 2002.

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





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 30'-1" APPROXIMATE.
4. ENSURE TO PLUMB ANTENNA VERTICALLY BY LOOSENING HOSE CLAMP ON PRE-CLAMPED SUPPORT SADDLES AND ADJUSTABLE LINE BRACKETS.
5. ROTATE CENTERFEED ASSEMBLY AS CLOSE TO POLE AS POSSIBLE.
6. DETAILS DEPICT MODIFICATION OF SYSTEM TO POLE MOUNT LOCATION.
7. FINAL ORIENTATION TO BE DETERMINED BY STATION PERSONNEL.

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

NAME INSTALLATION DRAWING
STATION: WCKT - LEHIGH ACRES, FL.
FREQUENCY: 106.5 MHz. PROJECT NO.: 292/4564
PATH G:\DRAFTING\ALL\PROJECTS\292-4564
FILE 1A-7 DRAWN R.R.H. FACTOR ...NTS
DATE 3/25/02 APP'D DWG. NO.
MODEL SHPX-4AC6

EXHIBIT A - 1

SHPX-4AC6-SP ERI Antenna Specification Sheet

WBTT / WCKT Lehigh Acres, Florida

General Specifications

Antenna Type ..... High Power FM-Broadcast, Suitable For Diplexing
Model Number SHPX-4C6-SP
Number Of Bay Levels ..... Four
Polarization ..... Right Hand Circular

Electrical Specifications

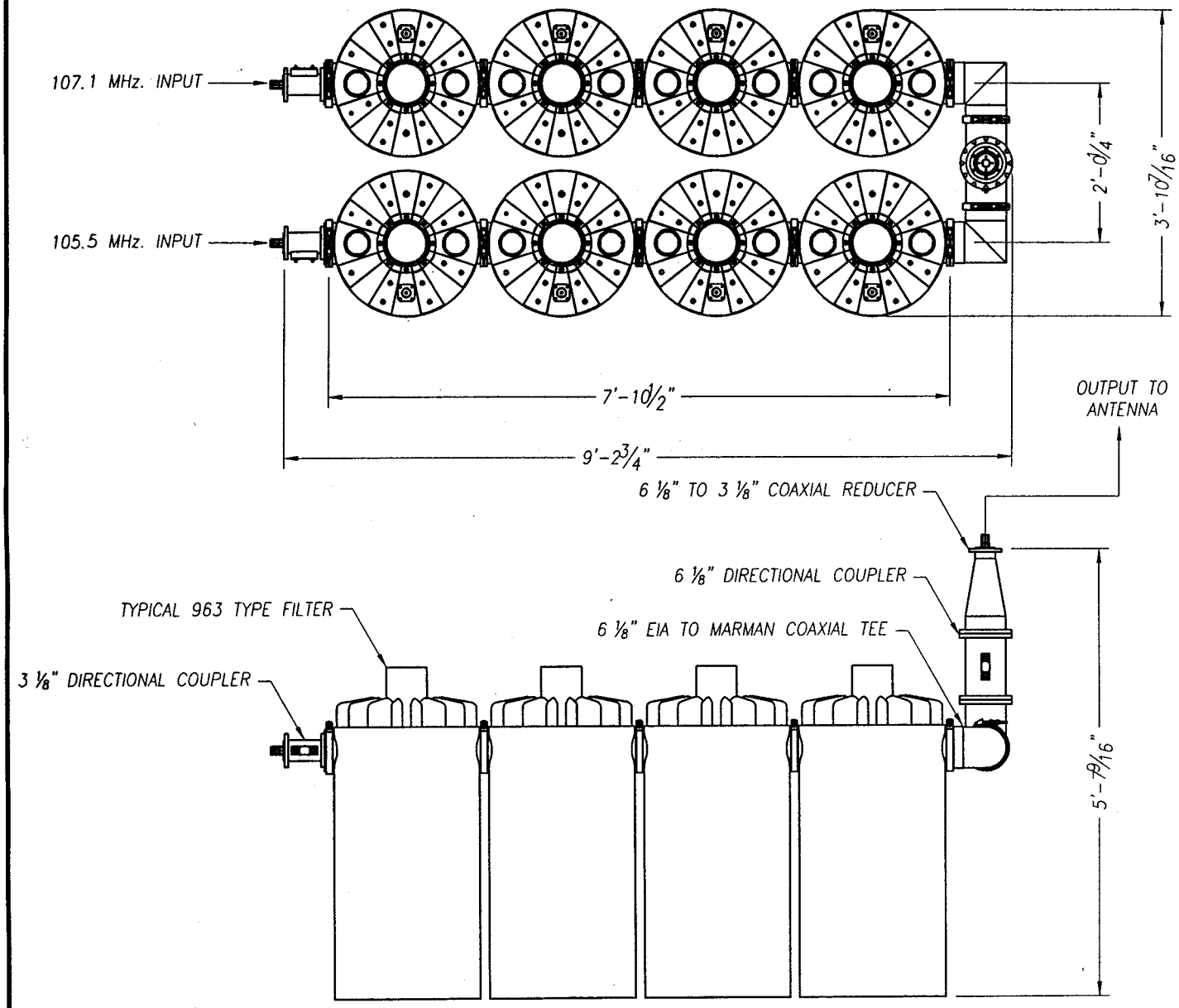
Antenna Input Power Capability ..... 64 KW. Maximum (1)
Operating Frequency Band ..... 105.5 and 107.1 Megahertz.
VSWR ..... 1.10 : 1 @ Operating Frequencies.(2)
Azimuthal Pattern Circularity ..... +/- 2dB From RMS (Free Space)
Power Split ..... 50/50 (Horizontal & Vertical)
Quarter Wave Shorting Stub ..... Yes
Frequency Specific Information:

Frequency	Station ERP	Beam Tilt	First Null Fill	Second Null Fill	Power Gain Horizontal	Power Gain Maximum	Line Loss (3)	Filter Loss (4)	Computed TPO
105.5	23.5 KW	-0.0°	2.0 %	0.0 %	2.138	2.138	0.825 dB	0.287 dB	14.20 KW
107.1	23.5 KW	-0.0°	1.0 %	0.0 %	2.127	2.127	0.830 dB	0.303 dB	14.34 KW

Mechanical Specifications

Antenna Feed System ..... Fed With Single Feed Line
Input Connector ..... 6 1/8" 50- Ohm EIA Flanged
Interbay Line size ..... 3" Rigid
Element Deicing ..... None
Interbay Spacing ..... 110.437 Inch Center to Center
Array Length ..... 30 Feet - 7/8 Inch
Construction Material (Antenna) ..... All Noncorrosive
Construction Material (Mounting) ..... Stainless Steel
Mounting ..... Pole Mounted
Weight (Antenna No Ice) ..... 541 Lbs.
CaAa Wind Load (Antenna No Ice) ..... 23.09 sq. ft.(5)

NOTES:
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 726 Feet, 3" Cablewave Type 1-318-50 Rigid Coax. Each transmitter Incorporates a 3" Dielectric Type 5000 Motorized Coax Switches.
4) Losses Taken From Actual Multiplexer Measurements.
5) The surface area is calculated per EIA standard RS-222-F (CaAa).



NOTE:

1) DETAILS DEPICT MODIFICATIONS MADE TO COMBINER SYSTEM 3/2002.

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

NAME COMBINER INSTALLATION DETAILS
STATION: WCKT – LEHIGH ACRES, FL.
FREQUENCY: AS LISTED PROJECT NO.: 902/478
PATH G:\DRAFTING\ALL\PROJECTS\292-4564\902-478
FILE IM — 1 DRAWN R.R.H. FACTOR N.T.S.
DATE 3/25/02 APP'D DWG. NO. IM — 1
MODEL 963F08-000-U36

EXHIBIT A - 3

TB 63-8/6 ERI TEE Combiner Specification Sheet

WBTT / WCKT Lehigh Acres, Florida

General Specifications:

Multiplexer Type ..... TB 63-8/6 TEE Combiner
Number Of Combining Units ..... Two
Injected Port to Injected Port Isolation ..... - 53 dB
Output Connector ..... 6 1/8 " 50 Ohm EIA (Flanged)
Output Power (Maximum) ..... 65 KW
Combiner Units, Size and Weight :(1)

Type 963-4 Tuned To 105.5 MHz. ..... 58" ht. X 24" wd. X 100" lng. & 780 Lbs.
Type 963-4 Tuned To 107.1 MHz ..... 58" ht. X 24" wd. X 100" lng. & 780 Lbs.

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

Injected Port Specifications:

Frequency Assignment ..... 105.5, And 107.1 MHz.
Power Rating, Each Injected Port (Maximum) ..... 32 KW
Input Connector ..... 3-1/8" 50 Ohm EIA (Flanged)
VSWR ..... Less than 1.07:1 @ +/-150 KHz(2)
Group Delay ..... Less than 80 ns Overall Variation, Carrier @ +/- 150 KHz

Insertion Loss (Measured):

Frequency	Insertion Loss
105.5 MHz.	- 0.287 dB
107.1 MHz.	- 0.303 dB

Notes:
1) Filter Modules Size and Weight are Approximate.
2) When Terminated in 50 Ohm Resistive Load.
3) The Combiner room ambient temperature should be maintained between 60 and 70 degrees Fahrenheit.

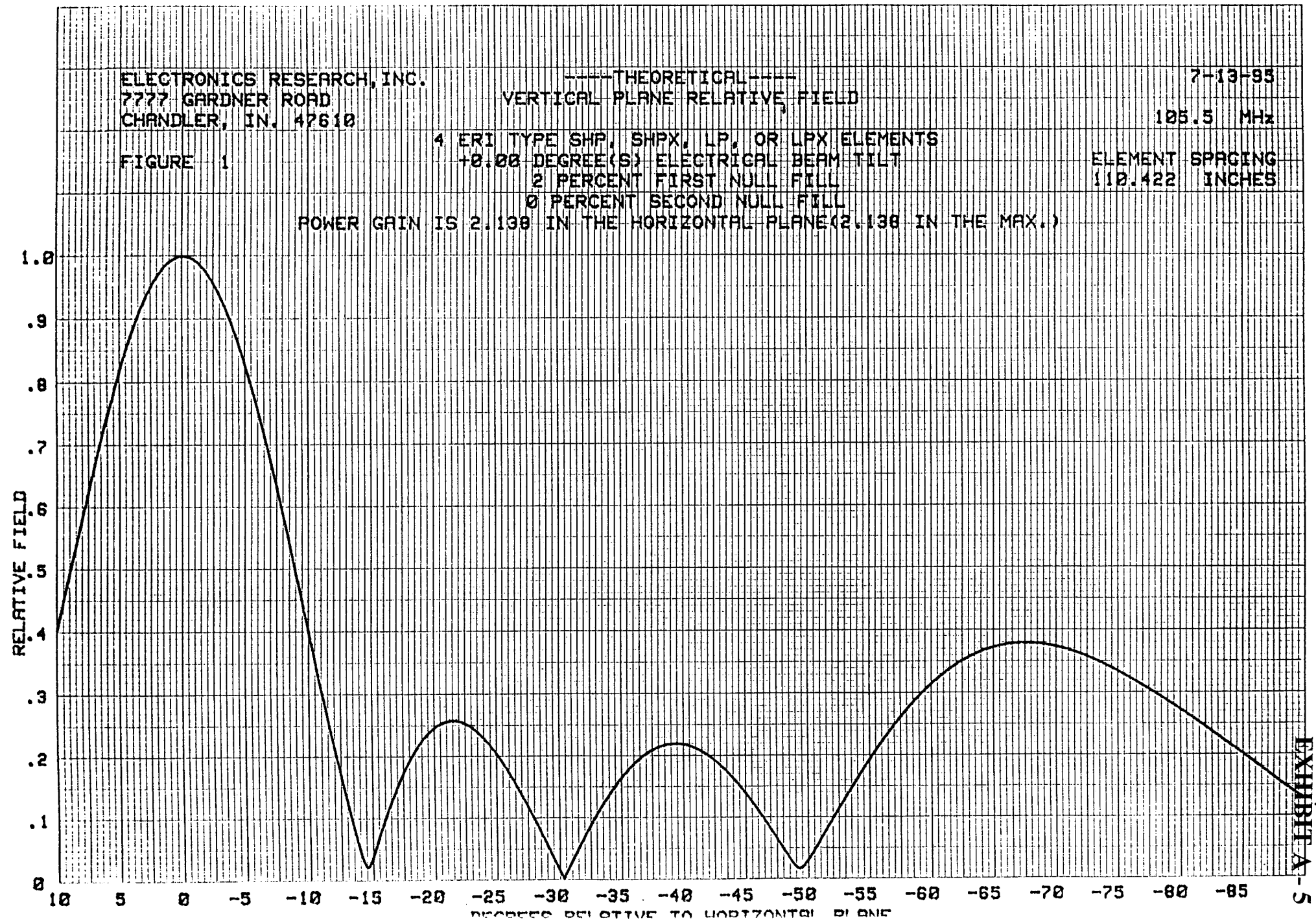


EXHIBIT A-5

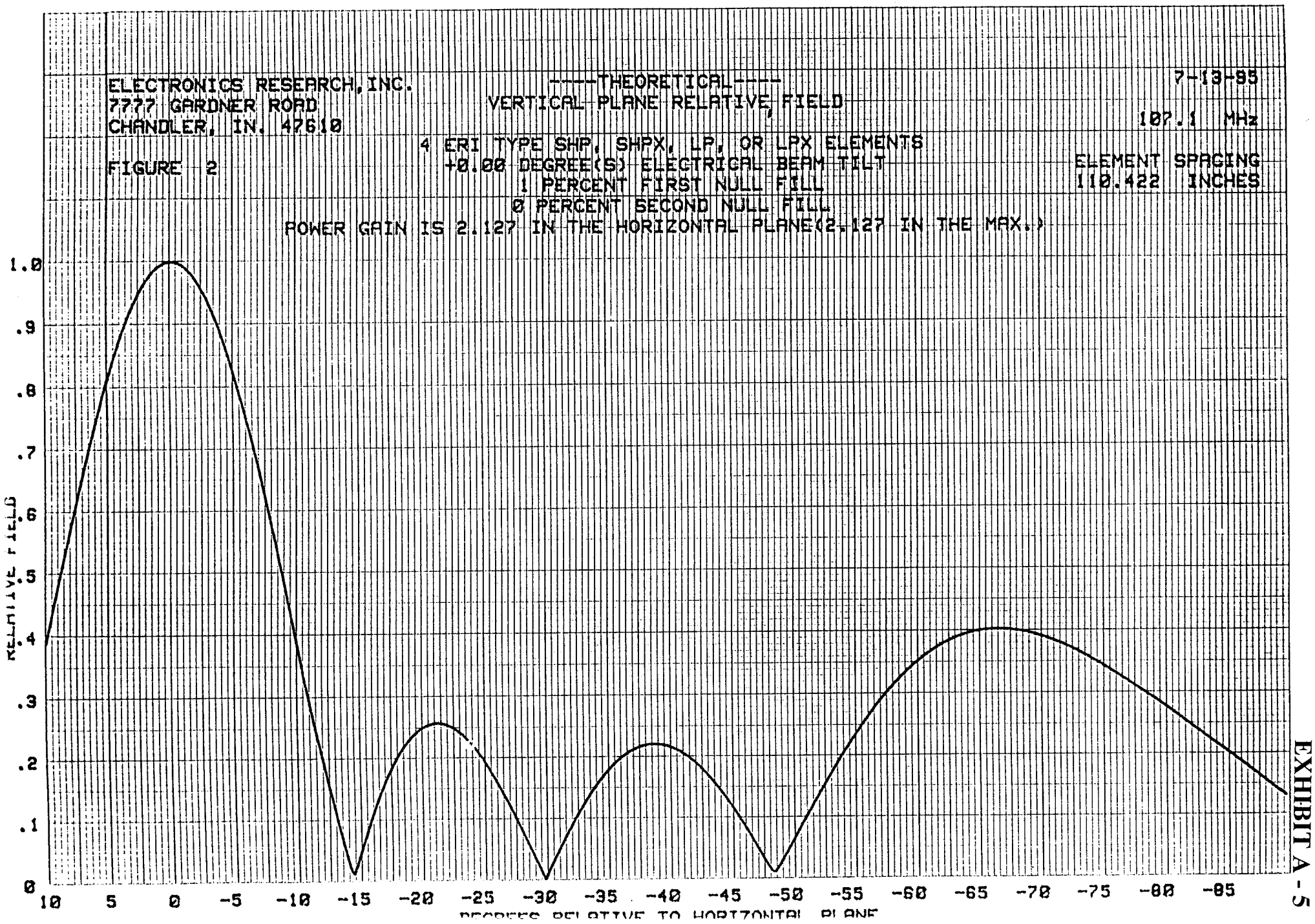
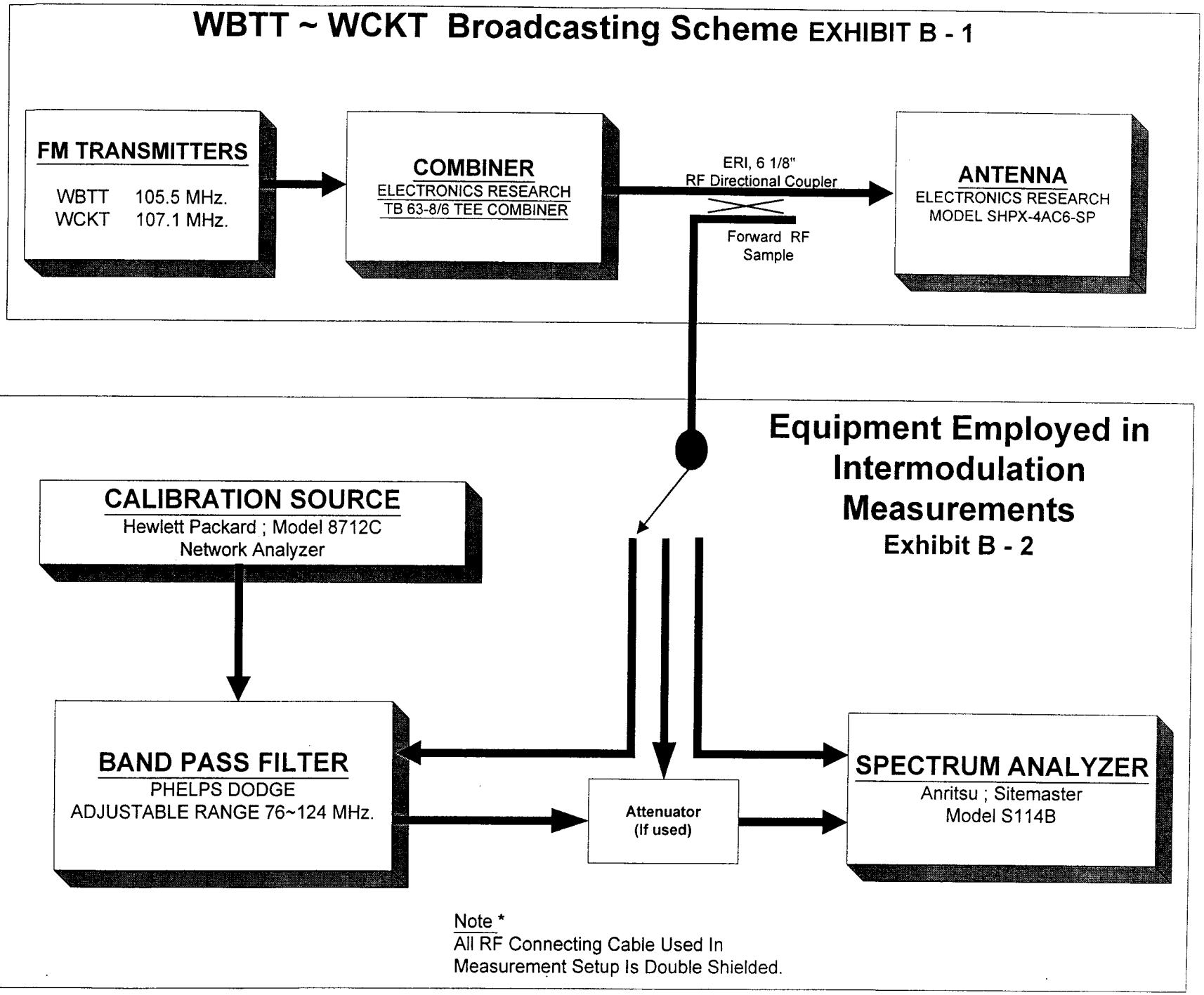


EXHIBIT A -5



Broadcasting Scheme and Equipment Employed in Intermodulation Measurements

EXHIBIT B