

# Report Of Intermodulation Product Findings

Philadelphia, PA.  
Domino Lane  
American Tower Site  
WYSP 94.1 MHz.  
WRDW 96.5 MHz.  
WOGL 98.1 MHz.  
WPPZ 103.9 MHz.

Job # 15765G

*May 8, 2007*

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**REPORT OF FINDINGS**  
**WYSP/WRDW/WOGL/WPPZ**  
94.1 MHz. /96.5 MHz. /98.1 MHz. /103.9 MHz.

**Introduction:** This report of findings is based on data collected at the WYSP, WRDW, WOGL, and WPPZ Domino Lane American Tower broadcast facility located in Philadelphia, Pennsylvania. The report includes measurements offered as proof that the combined operations of WYSP (94.1 MHz), WRDW (96.5 MHz), WOGL (98.1 MHz), and WPPZ (103.9) 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 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). Mark Garrison 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 1087-4CP Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexing Scheme.
- A-4 CI970-32/8-GD Constant Impedance Combiner 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:** These measurements were taken with four FM stations operating from the combined antenna system. The WYSP, WRDW, WOGL, and WPPZ multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The 1087-4CP (antenna) and CI970-32/8-GD constant impedance combiner units are products of Electronics Research, Inc, 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 four transmitter signals into a common antenna feed and provide transmitter-to-transmitter isolation, a multiplexing scheme consisting of a Constant Impedance Combiner was installed. Specifically, the Multiplexer utilizes three ERI Model CI970-8-GD and one ERI Model CI970-8 constant impedance modules for each transmitter. An interconnecting U-link 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 -65 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 -35 dB directivity and a forward signal sample of -60 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 IFR Model 2399A Spectrum Analyzer Serial # 02113071 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
WYSP 94.1 MHz.	6	-	120	12	114	
WRDW 96.5 MHz.	6	-	120	16	110	
WOGL 98.1 MHz.	6	-	120	12.2	113.8	
WPPZ 103.9 MHz.	6	-	120	10.8	95.2	

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.**

	94.1	96.5	98.1	103.9
87.7	100.5	105.3	108.5	120.1
88.5	99.7	104.5	107.7	119.3
90.1	98.1	102.9	106.1	117.7
90.9	97.3	102.1	105.3	116.9
92.5	95.7	100.5	103.7	115.3
94.1	---	98.9	102.1	113.7
95.7	92.5	97.3	100.5	112.1
96.5	91.7	---	99.7	111.3
98.1	90.1	94.9	---	109.7
98.9	89.3	94.1	97.3	108.9
100.3	87.9	92.7	95.9	107.5
101.1	87.1	91.9	95.1	106.7
102.1	86.1	90.9	94.1	105.7
102.9	85.3	90.1	93.3	104.9
103.9	84.3	89.1	92.3	---
104.5	83.7	88.5	91.7	103.3
105.3	82.9	87.7	90.9	102.5

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.



# IM Measurements Taken in

Product Frequency (MHz)	Transmitter Frequency (MHz)	Interfering Frequency (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Total Loss	Full Scale Range (dBμ)	Scale Reading (dBμ)	Adjusted Level (dBμ)	Carrier Reference Level (dBμ)	Level Referenced to Carrier (dB)	Notes*
<b>Transmitter Mixes</b>											
	92.5	Ref.	6		6	120			126		Not operational from this site.
	94.1	Ref.	6		6	120	12		114		
	96.5	Ref.	6		6	120	16		110		
	98.1	Ref.	6		6	120	12.2		113.8		
	103.9	Ref.	6		6	100	10.8		95.2		
82.9	94.1	105.3	6	12.8	18.8	20	16	22.8	114	-91.2	
83.7	94.1	104.5	6	11.9	17.9	20	20	17.9	114	-96.1	
84.3	94.1	103.9	6	11.8	17.8	20	20	17.8	114	-96.2	
85.3	94.1	102.9	6	12	18	20	20	18	114	-96	
86.1	94.1	102.1	6	12	18	20	20	18	114	-96	
87.1	94.1	101.1	6	12	18	20	20	18	114	-96	
87.7	96.5	105.3	6	12	18	40	12.2	45.8	110	-64.2	Channel 6 Television
87.9	94.1	100.3	6	12	18	20	12	26	114	-88	Channel 6 Television
88.5	96.5	104.5	6	12	18	20	7	31	110	-79	Local Carrier 88.5 MHz. WXPB
89.1	96.5	103.9	6	11.9	17.9	20	20	17.9	110	-92.1	
89.3	94.1	98.9	6	11.9	17.9	20	20	17.9	114	-96.1	
90.1	94.1	98.1	6	12	18	40	19	39	114	-75	Local Carrier 90.1 MHz. WRTI
90.1	96.5	102.9	6	12	18	40	19	39	110	-71	Local Carrier 90.1 MHz. WRTI
90.9	98.1	105.3	6	12	18	40	4	54	113.8	-59.8	Local Carrier 90.9 MHz. WHYY
90.9	96.5	102.1	6	12	18	40	6	52	110	-58	Local Carrier 90.9 MHz. WHYY
91.7	94.1	96.5	6	12	18	20	20	18	114	-96	
91.7	98.1	104.5	6	12	18	20	20	18	113.8	-95.8	
91.9	96.5	101.1	6	11.8	17.8	20	20	17.8	110	-92.2	
92.3	98.1	103.9	6	11.9	17.9	20	9	28.9	113.8	-84.9	
92.5	94.1	95.7	6	11.9	17.9	40	5	52.9	114	-61.1	Local Carrier 92.5 MHz. WXTU
92.7	96.5	100.3	6	11.8	17.8	20	11	26.8	110	-83.2	
93.3	98.1	102.9	6	11.8	17.8	20	10.5	27.3	113.8	-86.5	Local Carrier 93.3 MHz. WMMR
94.1	96.5	98.9	6	11.7	17.7	20	20	17.7	110	-92.3	

94.1	98.1	102.1	6	11.7	17.7	20	20	17.7	113.8	-96.1	
94.9	96.5	98.1	6	11.6	17.6	20	20	17.6	110	-92.4	
95.1	98.1	101.1	6	11.8	17.8	20	20	17.8	113.8	-96	
95.7	94.1	92.5	6	11.8	17.8	40	7	50.8	114	-63.2	Local Carrier 95.7 MHz. WBEN
95.9	98.1	100.3	6	11.9	17.9	20	5	32.9	113.8	-80.9	
97.3	94.1	90.9	6	11.5	17.5	20	20	17.5	114	-96.5	
97.3	98.1	98.9	6	11.5	17.5	20	20	17.5	113.8	-96.3	
97.3	96.5	95.7	6	11.5	17.5	20	20	17.5	110	-92.5	
98.1	94.1	90.1	6	11.6	17.6	100	6.5	111.1	114	-2.9	Local Carrier 98.1 MHz. WOGL
98.9	96.5	94.1	6	11.5	17.5	40	12	45.5	110	-64.5	Local Carrier 98.9 MHz. WUSL
99.7	94.1	88.5	6	11.5	17.5	20	20	17.5	114	-96.5	
99.7	98.1	96.5	6	11.5	17.5	20	20	17.5	113.8	-96.3	
100.5	94.1	87.7	6	11.5	17.5	20	15.5	22	114	-92	Local Carrier 100.3 MHz. WPHI
100.5	98.1	95.7	6	11.5	17.5	20	15.5	22	113.8	-91.8	Local Carrier 100.3 MHz. WPHI
100.5	96.5	92.5	6	11.5	17.5	20	15.5	22	110	-88	Local Carrier 100.3 MHz. WPHI
102.1	96.5	90.9	6	11.3	17.3	40	8.5	48.8	110	-61.2	Local Carrier 102.1 MHz. WIOQ
102.1	98.1	94.1	6	11.3	17.3	40	8.5	48.8	113.8	-65	Local Carrier 102.1 MHz. WIOQ
102.5	103.9	105.3	6	11.3	17.3	20	20	17.3	95.2	-77.9	Local Carrier 102.1 MHz. WIOQ
102.9	96.5	90.1	6	11.1	17.1	40	4	53.1	110	-56.9	Local Carrier 102.9 MHz. WMGK
103.3	103.9	104.5	6	11.3	17.3	20	19	18.3	95.2	-76.9	Local Carrier 103.9 MHz. WPPZ
103.7	98.1	92.5	6	11	17	60	2	75	113.8	-38.8	Local Carrier 103.9 MHz. WPPZ
104.5	96.5	88.5	6	11	17	40	10	47	110	-63	Local Carrier 104.5 MHz. WUBA
104.9	103.9	102.9	6	11	17	20	20	17	95.2	-78.2	Local Carrier 104.5 MHz. WUBA
105.3	98.1	90.9	6	10.9	16.9	40	8	48.9	113.8	-64.9	Local Carrier 105.3 MHz. WDAS
105.3	96.5	87.7	6	10.9	16.9	40	8	48.9	110	-61.1	Local Carrier 105.3 MHz. WDAS
105.7	103.9	102.1	6	11	17	20	20	17	95.2	-78.2	Local Carrier 106.1 MHz. WISX
106.1	98.1	90.1	6	11	17	40	16	41	113.8	-72.8	Local Carrier 106.1 MHz. WISX
106.7	103.9	101.1	6	10.8	16.8	20	20	16.8	95.2	-78.4	See Notes
107.5	103.9	100.3	6	11	17	20	20	17	95.2	-78.2	Local Carrier 107.3 MHz. WBYN
107.7	98.1	88.5	6	10.8	16.8	20	20	16.8	113.8	-97	
108.5	98.1	87.7	6	10.7	16.7	20	20	16.7	113.8	-97.1	
108.9	103.9	98.9	6	10.6	16.6	20	20	16.6	95.2	-78.6	See Notes
109.7	103.9	98.1	6	10.6	16.6	20	20	16.6	95.2	-78.6	See Notes
111.3	103.9	96.5	6	10.6	16.6	20	20	16.6	95.2	-78.6	See Notes
112.1	103.9	95.7	6	10.6	16.6	20	20	16.6	95.2	-78.6	See Notes
113.7	103.9	94.1	6	10.6	16.6	20	20	16.6	95.2	-78.6	See Notes
115.3	103.9	92.5	6	10.5	16.5	20	20	16.5	95.2	-78.7	See Notes
116.9	103.9	90.9	6	10.4	16.4	20	20	16.4	95.2	-78.8	See Notes
117.7	103.9	90.1	6	10.4	16.4	20	20	16.4	95.2	-78.8	See Notes
119.3	103.9	88.5	6	10.3	16.3	20	20	16.3	95.2	-78.9	See Notes

120.1	103.9	87.7	6	<b>10.4</b>	16.4	20	20	16.4	<b>95.2</b>	-78.8	See Notes
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Notes: FCC Sec.# 73.317 paragraph(d)



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.

Please note that on the combiner drawing there is a 92.5 MHz.(WXTU) combiner module incorporated into the multiplexed system. This station is not operational from the multiplexed site at this time.

**Conclusion:** Based upon my observations and measurements taken on May 8, 2007 as summarized in this document, I, Mark Garrison, find the subject system- specifically the transmitter and filter system for the operation of WYSP, WRDW, WOGL and WPPZ into the 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 station operating on the installed system. Based on this recorded data, I conclude that WYSP, WRDW, WOGL, and WPPZ 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.

Mark Garrison, Field Technician

State of Indiana)

) SS;

County of Warrick)

**AFFIDAVIT**

I, Mark Garrison, 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 5 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 American Tower on behalf of radio Stations WYSP, WRDW, WOGL, and WPPZ to prepare this Report Of Findings.

Mark Garrison: Field Technician

*Mark Garrison*

*Subscribed and sworn to before me on this 10th day of May, 2007*

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

*Jacquelyn A. Kinney*

