

REPORT OF FINDINGS

WDCH / WLZL

99.1 MHz. / 107.9 MHz.

Introduction: This report of findings is based on data collected at the WDCH and WLZL broadcast facility located in, Gambrills, MD. The report includes measurements offered as proof that the combined operations of WDCH (99.1 MHz.) and WLZL (107.9 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 multiplexed system are less than the maximum allowable level as required by section 73.317 (b) through (d). Troy Knotts of Electronics Research, Inc. located in Chandler, Indiana performed the measurements summarized herein on April 15, 2017.

The following exhibits are provided:

Exhibit A:

- A-1 Drawing Depicting Antenna.
- A-2 1183-6CP-COG-DA Antenna Specification Sheet.
- A-3 Drawing Depicting Multiplexed Scheme.
- A-4 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 both FM stations operating from the combined antenna system. The WDCH and WLZL multiplexed system is fundamentally comprised of antenna, feed line and multiplexer unit. The 1183-6CP-COG-DA (antenna), combiner units, are products of Electronics Research, Inc., while the feedline is Andrew 3” coaxial. Refer to Exhibit B-1, for an illustration of the Broadcasting Scheme of these stations.

The combining of two transmitter signals into the antenna was completed by designing two antenna feeds, one for left hand circular polarization of the antenna, and one for right hand circular polarization of the antenna along with two filter modules to provide transmitter-to-transmitter isolation. Specifically, the combiner uses one ERI Model 783-3 Band-Pass filter module for each frequency (99.1 MHz. and 107.9 MHz.). 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 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 -41 dB directivity and a forward signal sample of -46 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. A Rohde & Schwarz ZVL 3 Vector Network Analyzer with Spectrum Analyzer serial #100396 was employed to record the level of all signals investigated. A Copper Mountain VNA serial #15077025 was also used for selective tuning of the Band Pass Filter. The Spectrum Analyzer portion of the Rohde & Schwarz 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 both transmitters were operating at maximum power. 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)	Scale Range (dB)	Scale Reading (dB)	Adjusted Level (dBm)	Notes
99.1	6	----	15.9	21.9	
107.9	6	----	17.9	23.9	

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.

Interfering Frequencies	Carrier Frequencies	
	99.1	107.9
WDCH 99.1 MHz.	----	116.7
WLZL 107.9 MHz.	90.3	----

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

IM Measurements Taken in Gambrills, MD.										
Product Frequency (MHz)	Transmitter Frequency (MHz)	Interfering Frequency (MHz)	Pad (dB)	Bandpass Filter Loss (dB)	Total Loss	Measured Level (dBm)	Adjusted Level (dBm)	Carrier Reference Level (dBm)	Level Referenced to Carrier (dBm)	Notes*
Transmitter Mixes										
	99.1		6			15.9	21.9	21.9		
	107.9		6			17.9	23.9	23.9		
90.3	99.1	107.9	6	8.95	14.95	-92.2	-77.25	21.9	-99.15	
116.7	107.9	99.1	6	8.23	14.23	-92.8	-78.57	23.9	-102.47	

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 April 15, 2017 as summarized in this document, I, Troy Knotts, find the subject system, specifically the transmitter and filter system for the operation of WDCH and WLZL 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 WDCH and WLZL 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.

Troy Knotts, Field Technician

State of Indiana)
) SS:
County of Warrick)

AFFIDAVIT

I, Troy Knotts, 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 10 years. I am familiar with and have assisted in the 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 CBS Radio on behalf of radio Stations WDCH and WLZL in Gambrills, MD. to prepare this Report Of Findings.

Troy Knotts; Field Technician



Subscribed and sworn to before me on this 20th, day of April, 2017.

Jacquelyn Glenn; Notary Public
My commission expires July 5, 2023

