FM Intermodulation Report

Prepared by

iDSi

For

KLBB-FM / KTTU-FM / KXTQ-FM
93.7MHz / 97.3MHz / 106.5MHz

Lubbock, TX

Ramar Communications, Inc.

Date: May 31, 2023

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1. Certification

David Sanderford declares and states that he is a graduate Electrical Engineer with a Bachelor of Science in Electrical Engineering from the Georgia Institute of Technology. He is the President of Intelligent Design and Services, Inc., a Registered Professional Corporation in the State of Texas, and that firm has been retained by **Ramar** to perform the measurements contained in this report.

All facts contained herein are true of his own knowledge except where stated to be on information or belief, and as to those facts, he believes them to be true.

I declare under penalty of perjury that the foregoing is true and correct.

David Sanderford
President
Intelligent Design and Services, Inc.

Executed on this 31st day of May 2023

2. Project Report – Ramar FM Intermodulation Measurements

2.1 Scope of Work

The services provided were as follows:

- Place the three FM stations on the air into the shared combiner/transmission line/wideband antenna at their full, authorized power.
- Perform FM intermodulation measurements with the three stations into the combiner

2.2 Description of Work

FM Antenna Installation –

The new FM antenna was installed and placed on the air 5/17/2023.

- Antenna Specifications: see Section 3.1 Figures 1 & 2
- RF Power Budget: see Section 3.1 Figure 3
    - RF Power Budget Summary:
        - 93.7 MHz .....24.61 kW TPO / 100 kW ERP
        - 97.3 MHz .....5.43 kW TPO / 22.5 kW ERP
        - 106.5 MHz .....5.85 kW TPO / 22.5 kW ERP

FM Intermodulation Measurements –

To satisfy the licensing requirements as specified in the FCC Rules and Regulations CFR Title 47 Section 73.317 (b)-(d) for the three FM stations operating into the new combiner, FM Intermodulation Measurements (IM) were performed looking at the third order products introduced by combining these FM channels into an antenna/line system.

Each FM station was operating at full power required to meet their authorized ERP. Measurements were taken at the combiner output coupler with a forward power sample of -72.4 dB and directivity greater than 30dB. An attenuator and shielded test cable with known losses were used along with a tunable bandpass filter. The bandpass filter was tuned to the desired frequency for each station and product to be measured, and its loss was measured and recorded. Then the attenuator, test cable, and bandpass filter were

inserted between the directional coupler forward power sample and a spectrum analyzer. The measured power level was recorded for each frequency in this manner. The measurements were taken between 5/17-5/18/2023 by Matthew A. Sanderford, P.E. representing iDSi, and the results follow in the tables below:

	Carrier Reference Levels				
Carrier Frequency (MHz	**Pad One (dB)**	**Bandpass Filter Loss (dB)**	**Measured Level (dBm)**	**Adjusted Level (dBm)**	**Notes**
93.7	**6.3**	**4.09**	**-26.24**	**-15.85**	
97.3	**6.3**	**4.04**	**-27.99**	**-17.65**	
106.5	**6.3**	**3.94**	**-30.57**	**-20.33**	

			Third Order Products							
	Carrier Frequencies									
Interfering Frequencies	**93.7**	**97.3**	**106.5**							
93.7	110.1	100.9	119.3							
97.3	90.1	102.9	115.7							
106.5	80.9	88.1	84.5							

BP Filter

Intermodulation Measurements

Product Frequency (MHz)	**Transmitter Frequency**	**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***
80.9	93.7	106.5	6.3	4.6	10.9	-127.9	-117.0	-15.85	**-101.17**	
84.5	106.5	128.5	6.3	4.3	10.6	-120.2	-109.6	-20.33	**-89.26**	
88.1	97.3	106.5	6.3	4.4	10.7	-106.1	-103.4	-17.65	**-85.75**	
90.1	93.7	97.3	6.3	4.1	10.4	-109.7	-99.3	-15.85	**-83.42**	
100.9	97.3	93.7	6.3	4.1	10.4	-124.6	-114.2	-17.65	**-96.56**	
102.9	97.3	91.7	6.3	4.0	10.3	-110.6	-100.3	-17.65	**-82.67**	
115.7	106.5	97.3	6.3	3.9	10.2	-128.2	-118.0	-20.33	**-97.67**	
110.1	93.7	77.3	6.3	4.0	10.3	-126.5	-116.3	-15.85	**-100.40**	
119.3	106.5	93.7	6.3	5.3	11.6	-119.3	-107.7	-20.33	**-87.34**	

2.3 Conclusion

The final level referenced to carrier for each product did not exceed the -80 dB maximum allowable level, therefore the IM products for the system are found to be in compliance.

3. Exhibits

3.1 Antenna Specifications

Dielectric®

Antenna Model: DCRM12DC50 (SP)

Proposal Number:	C-07077-5
Date:	15-Feb-23
Customer:	
Location:	Lubbock, TX

Electrical Specifications

Polarization:	Circular		
Azimuth Pattern:	Omni		
Antenna Input:	4-1/16"	50 Ohm	EIA/DCA
VSWR:	Channel	1.10 : 1	
Rated Input Power:	50 kW	(16.99 dBk)	Maximum combined average power w/3 -14Iboc stations
Rated Input Power:	40 kW	(16.02 dBk)	Maximum combined average power w/3 -10Iboc stations

Mechanical Specifications

Mounting:	Side Mounted			
Environmental Protection:	None			
Height:	91 ft (27.7m)			
Weight:	1200 lb (0.5t)	Excludes Mounts		
Effective Projected Area:	30.5 ft² (2.8m²)	TIA-222-G	Basic Wind Speed:	90 m/h (144.8 km/h)

Channel Specifications

	Call	Freq	Hpol ERP	Vpol ERP	TPO	RMS Main Lobe Hpol Gain	RMS Main Lobe Vpol Gain	RMS at Horizontal Hpol Gain	RMS at Horizontal Vpol Gain
1	KLBB	93.7 MHz	100.0 kW (20.00 dBk)	100.0 kW (20.00 dBk)	23.9 kW (13.78 dBk)	4.90 (6.90dB)	4.90 (6.90dB)	4.90 (6.90dB)	4.90 (6.90dB)
2	KTTU	97.3 MHz	22.5 kW (13.52 dBk)	22.5 kW (13.52 dBk)	5.17 kW (7.13 dBk)	5.10 (7.08dB)	5.10 (7.08dB)	5.10 (7.08dB)	5.10 (7.08dB)
3	KXTQ	106.5 MHz	34.0 kW (15.31 dBk)	34.0 kW (15.31 dBk)	8.50 kW (9.29 dBk)	4.69 (6.71dB)	4.69 (6.71dB)	4.69 (6.71dB)	4.69 (6.71dB)

Figure 1 - Dielectric EZProp - Summary

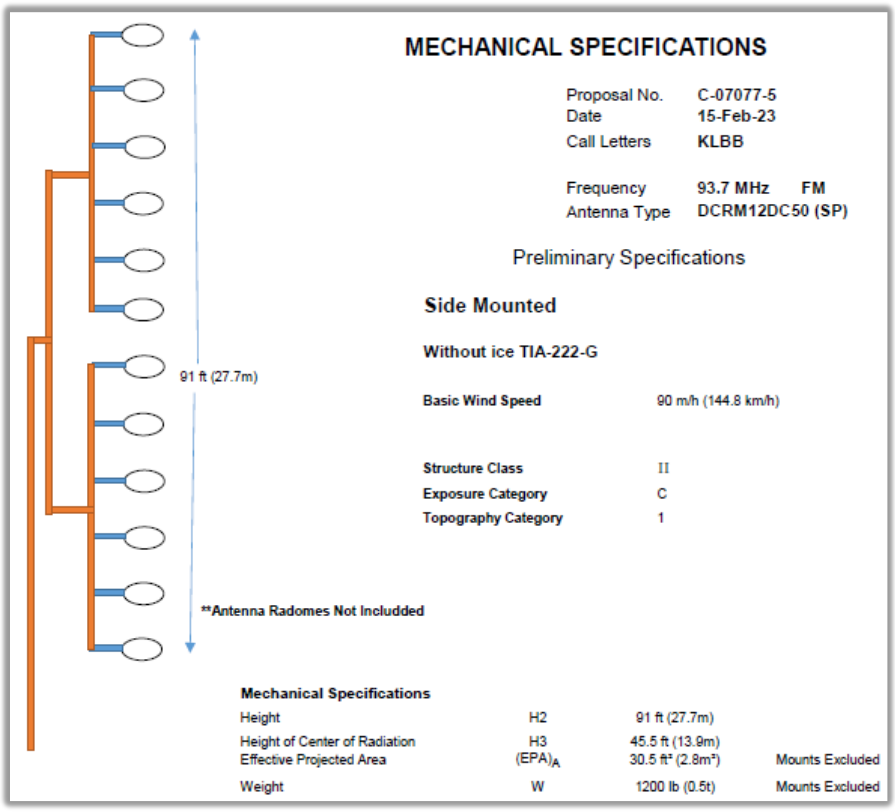

Figure 2 - Dielectric EZProp – Mechanical

	Dielectric DCRM12DC50(SP): RCAGL=756.75 ft.								
	KLBB-FM	**93.7 MHz**		**KTTU-FM**	**97.3 MHz**		**KXTQ-FM**	**106.5 MHz**	
ERP		**100 kW**	20 dBk		**22.5 kW**	13.522 dBk		**22.5 kW**	13.522 dBk
Antenna Gain			6.9 dB			7.08 dB			6.71 dB
Antenna Input Power		20.42 kW	13.1 dBk		4.41 kW	6.442 dBk		4.8 kW	6.812 dBk
Transmission Line	Vertical		0.532 dB	Vertical		0.546 dB	Vertical		0.574 dB
		0.076 dB/100 ft.			0.078 dB/100 ft.			0.082 dB/100 ft.	
		700 ft.			700 ft.			700 ft.	
	Horizontal		0.084 dB	Horizontal		0.084 dB	Horizontal		0.09 dB
		0.076 dB/100 ft.			0.076 dB/100 ft.			0.082 dB/100 ft.	
		110 ft.			110 ft.			110 ft.	
TPO post-combiner		23.53 kW	13.716 dBk		5.1 kW	7.072 dBk		5.59 kW	7.476 dBk
Combiner Loss			0.1951 dB			0.2787 dB			0.1936 dB
TPO		**24.61 kW**	13.9111 dBk		**5.43 kW**	7.3507 dBk		**5.85 kW**	7.6696 dBk
Total Combined into Transmission line		34.22 kW							
Total Combined into Antenna		29.63 kW							

Figure 3 - Combined FM RF Budget Calculations