Test Report

Prepared for: Hitachi Kokusai Electric Comark

Models:
EC-704MP-BB3

Description: Broadcast Transmitter

FCC ID: LYIEC704MPBB3

To

FCC Part 74

Date of Issue: March 22, 2022

On the behalf of the applicant:	**Hitachi Kokusai Electric Comark** **104 Feeding Hills Rd** **Southwick, MA 01077**
Attention of:	**Thomas Barbeau, VP of Engineering** **Ph: (413)998-1124** **E-Mail: tbarbeau@comarktv.com**

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Project No: p2210008

Greg Corbin
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	March 22, 2022	Greg Corbin	Original Document

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ANAB

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

Testing Certificate Number: **2152.01**

FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

Test and Measurement Data

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Volume II, Part 2, Subpart J, Sections 2.947, 2.1033(c), 2.1041, 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, and the following individual Parts: FCC Part 74.

Standard Test Conditions and Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing.

In accordance with ANSI/TIA 603C, and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Environmental Conditions		
Temp (ºC)	**Humidity (%)**	**Pressure (mbar)**
20.5 – 26.7	21.1 – 26.1	965.1 - 977.4

Measurement results, unless otherwise noted, are worst-case measurements.

EUT Description
Model: EC704MP-BB3
Description: Broadcast Transmitter

Additional Information:

The EC-704MP-BB3 digital transmitter system is an up to 500W average power (when using ATSC 1.0 8VSB modulation), 420W average power (when using ATSC 3.0 COFDM modulation) that consists of a Hitachi Kokusai Electric Comark Exact V2 digital exciter, Hitachi Kokusai Electric Linear CM-9001 Drive controller, GV 40298 Amplifier, a passive hybrid combining system, a LC39XC low pass filter.

The system was tested with a Full Service Mask Filter (Com-Tech P/N: A-FC6D80C-A026). This system is used to provide an ATSC 1.0 or ATSC 3.0 modulated signal over the UHF channels 14 through 36 in a manner consistent with FCC Part 74.

EUT Operation during Tests

The system was tested with the full service mask filter.

The power amplifier output is connected directly to the mask filter and the low pass filter is connected to the mask filter output. The low pass filter output is connected to a high power 50 ohm termination.

A RF coupler that is installed at the pow pass filter output was used to measure the final RF output power.
The mask filter, low pass filter, and test couplers were measured individually then summed together for the conducted spurious measurements.
A test coupler was inserted between the power amplifier output and the mask filter input to measure the output power before the mask filter for the conducted spurious measurements.

The EUT has 2 types of modulation, ATSC1.0 (8VSB) and ATSC 3.0 (OFDM).
The system was tuned to 509 MHz (CH 20).
All tests were performed with the tuned frequency set to 509 MHz.
The system is powered by 230 VAC 60 Hz.

EC704MP-BB3 System components

Description	Model	S/N
System	EC704MP-BB3	N/A
CM9001 Control Module	MOD GV 40288	GARX-0107
Exact V2 High End TV Exciter	XTTR-VX20-3102	00159 H100
Power Amplifier	GV40298	GASH0041/21
Low Pass Filter	A-LC39XC-A001	2105-213324
Full Service Mask Filter	A-FC6D80C-A026	2052-225666
Ethernet Switch	SG 1002 MR L2+	N/A

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	UHF/VHF 2 kW Directional Coupler	Com-Tech	C-DC2A23/2C-EE	N/A
1	1000 watt RF Termination	Bird Electronics	8251T-230	N/A

Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Termination
1	manufacturer supplied cable set	N/A	N/A	N/A	N/A

Modifications: None

Test Result Summary

Specification	Test Name	Pass, Fail, N/A	Comments
74.735 2.1046	Power Limitations(Output Power)	Pass	
2.1047	Modulation Characteristics	Pass	Refer to page 6
74.794(a)(2)(iii) 74.795(b)(2) 2.1051	Digital Emissions (Conducted Spurious)	Pass	
2.1049	Occupied Bandwidth	Pass	
74.794(b)(1) 2.1051	Spurious Emissions, GPS bands	N/A	N/A for Full Service Mask
74.794(b) 2.1053	Field Strength of Spurious Radiation	Pass	
74.795(b)(4) 2.1055	Frequency Stability (Temperature Variation)	Pass	
74.795(b)(4) 2.1055	Frequency Stability (Voltage Variation)	Pass	

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

Power Limitations (Output Power)

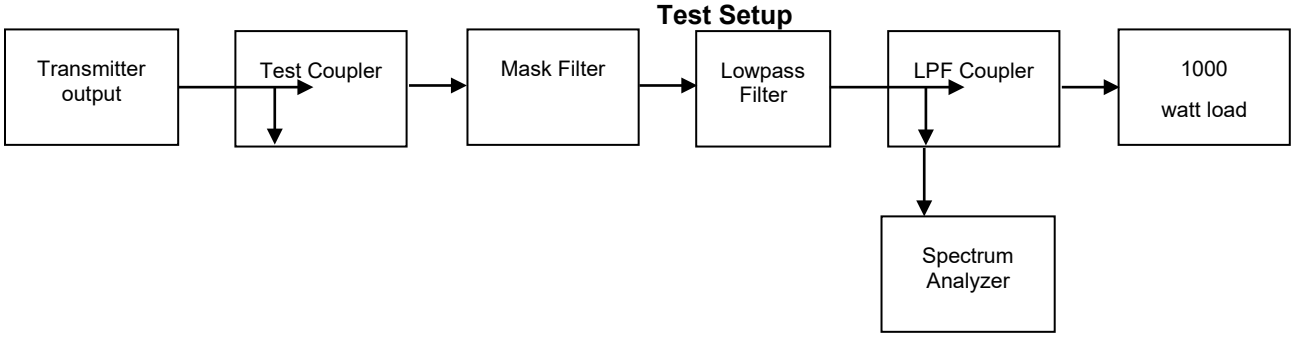
Engineer: Greg Corbin

Test Date:3/8/2022

Measurement Procedure

The Equipment Under Test (EUT) was connected to a spectrum analyzer through the RF coupler connected to the Lowpass filter output. All cable and coupler losses were input into the spectrum analyzer as a reference level offset to ensure accurate readings were obtained.
The channel power measurement tool on the spectrum analyzer was used to record the output power.
Output power for both modulations (ATSC 1.0 and ATSC 3.0) was recorded.

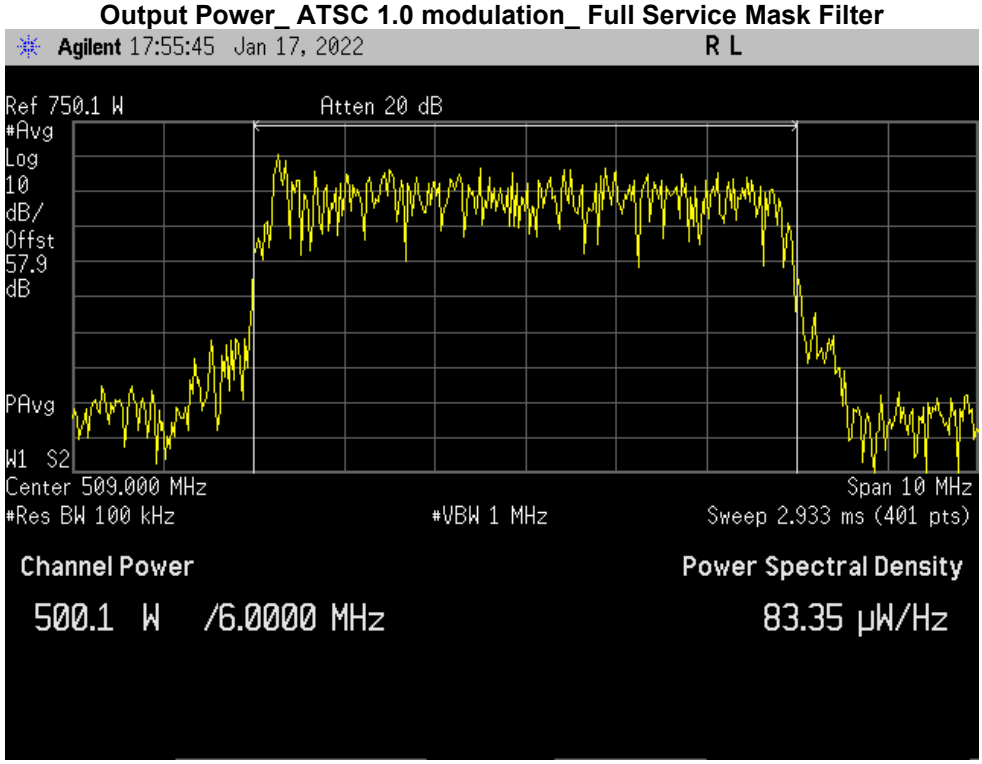
Test Setup



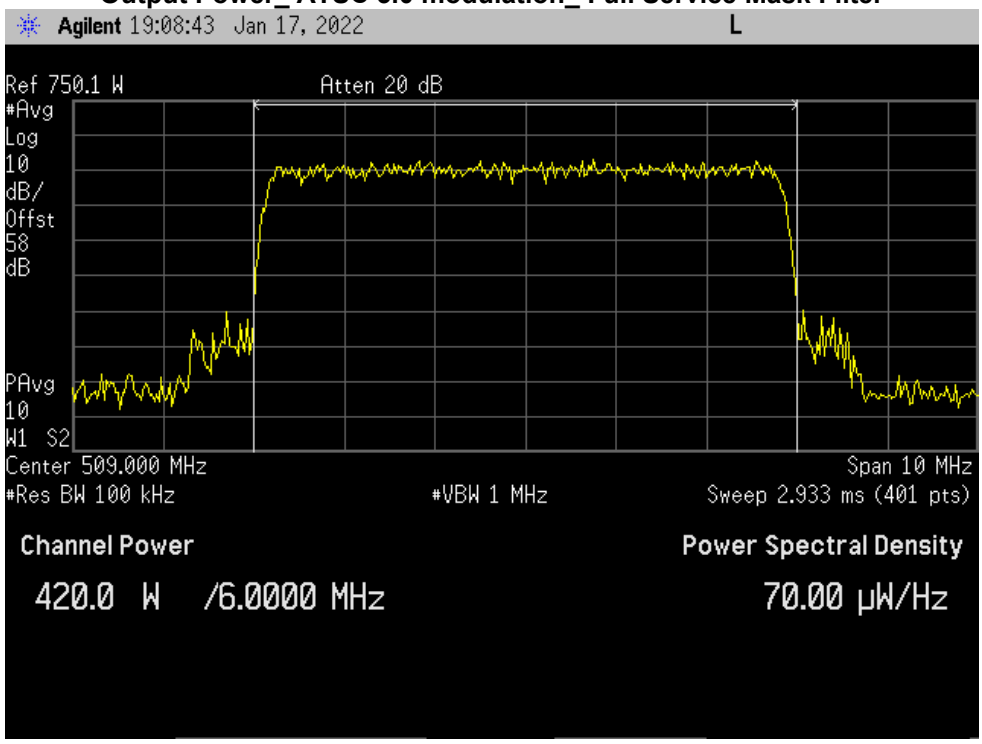
Output Power Test Results

Mask Filter	Modulation	Tuned Frequency (MHz)	Recorded Measurement (watt)	Limit (watt)	Result
Full Service	ATSC 1.0	509	500.1	15000	Pass
Full Service	ATSC 3.0	509	420.0	15000	Pass

Output Power_ ATSC 1.0 modulation_ Full Service Mask Filter



Output Power_ ATSC 3.0 modulation_ Full Service Mask Filter



Conducted Spurious Emission

Engineer: Greg Corbin

Test Date: 3/16/2022

Measurement Procedure

This transmitter system was tested with full service mask filter.

When using the full service mask filter the transmitter needs to meet the full service mask filter requirements per FCC CFR 74.794(a)(1)(iii)
FCC CFR 74.794(a)(2)(iii)

Full service mask:

(A) The power level of emissions on frequencies outside the authorized channel of operation must be attenuated no less than the following amounts below the average transmitted power within the authorized channel. In the first 500 kHz from the channel edge the emissions must be attenuated no less than 47 dB. More than 6 MHz from the channel edge, emissions must be attenuated no less than 110 dB. At any frequency between 0.5 and 6 MHz from the channel edge, emissions must be attenuated no less than the value determined by the following formula:

Attenuation in dB = −11.5([Delta]f + 3.6);

Where:
[Delta] f = frequency difference in MHz from the edge of the channel.

(B) This attenuation is based on a measurement bandwidth of 500 kHz. Other measurement bandwidths may be used as long as appropriate correction factors are applied. Measurements need not be made any closer to the band edge than one half of the resolution bandwidth of the measuring instrument. Emissions include sidebands, spurious emissions and radio frequency harmonics. Attenuation is to be measured at the output terminals of the transmitter (including any filters that may be employed). In the event of interference caused to any service, greater attenuation may be required.

To show the transmitter system meets the emission requirements, the RF spectrum was measured before any filtering at the test coupler installed at the power amplifier output before the mask filter.

The insertion loss of the test cable, test coupler, lowpass filter and mask filter was measured and summed together in a spreadsheet with the RF spectrum measurements to show the system meets the full service mask requirements.

The rule states that the limit is based on the measurement bandwidth of 500 kHz for the fundamental signal output power. Since the signal bandwidth is 6 MHz, the output power was measured in a 6 MHz bandwidth. Per the FCC rule 74.794(a)(2)(iii)(B) the following correction factor needs to be applied.

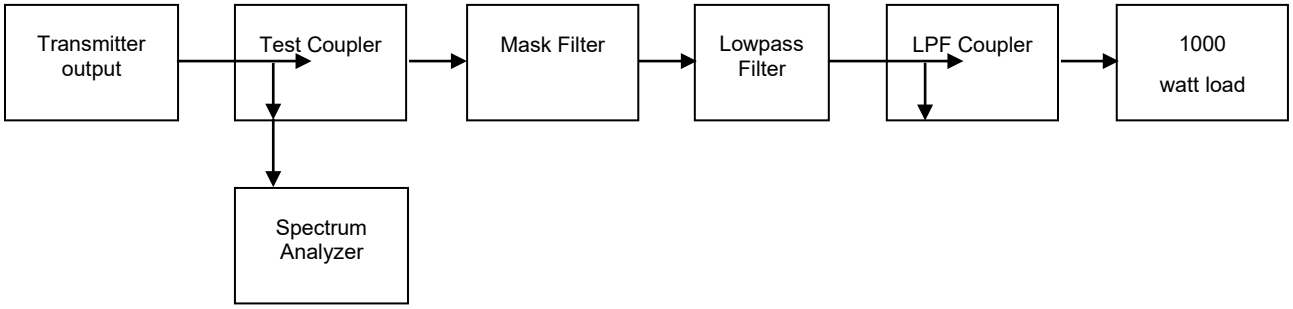
In this test report this correction factor is referred to as the Measurement Bandwidth Correction Factor (MBCF).
Attenuation (dB) = 10*log(BW alternate/500)
MBCF (dB) = 10*log(6000/500) = 10.79 dB
This attenuation is applied to all emissions outside of the 6 MHz channel bandwidth.

The final level of the emissions outside of the 6 MHz Channel is calculated using the following formula.
Emissions (dBm) = Output Power before mask filter (dBm) + MBCF (dB) + Input Test Coupler Insertion Loss (dB) + Lowpass Filter insertion loss + Mask Filter Insertion Loss +Test cable Insertion Loss.

To present the results with enough resolution the test results are broken down into 3 frequency ranges.
542 - 560 MHz (6 MHz Passband +/- 6 MHz).
50 – 1000 MHz (excluding 542 - 560 MHz)
1000 – 6000 MHz
A peak detector with trace averaging was used. Trace averaging was used to reduce the noise bounce of the signal at very low signal levels.

A resolution bandwidth of 100 kHz was used. This was the optimum RBW to provide the resolution required without affecting the signal amplitude.
A 1 GHz high pass filter (HPF) was used for the 1000 – 6000 MHz test data.
The HPF were installed at the spectrum analyzer input.
The Out of Band emissions were recorded for modulations (ATSC 1.0 and ATSC 3.0) for the full service mask filter

Conducted Spurious Emissions Test Setup



Refer to Annex A for Conducted Spurious Emissions with the Full Service Mask Filter

Occupied Bandwidth

Engineer: Greg Corbin

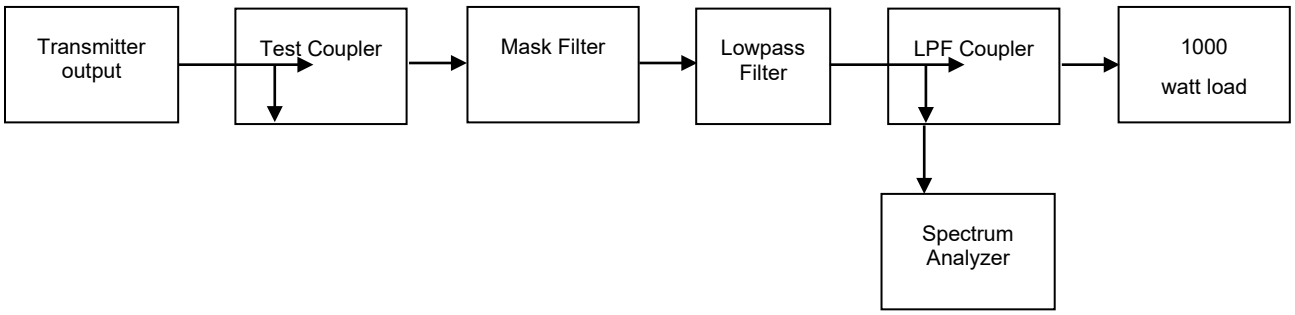
Test Date: 3/8/2022

Measurement Procedure

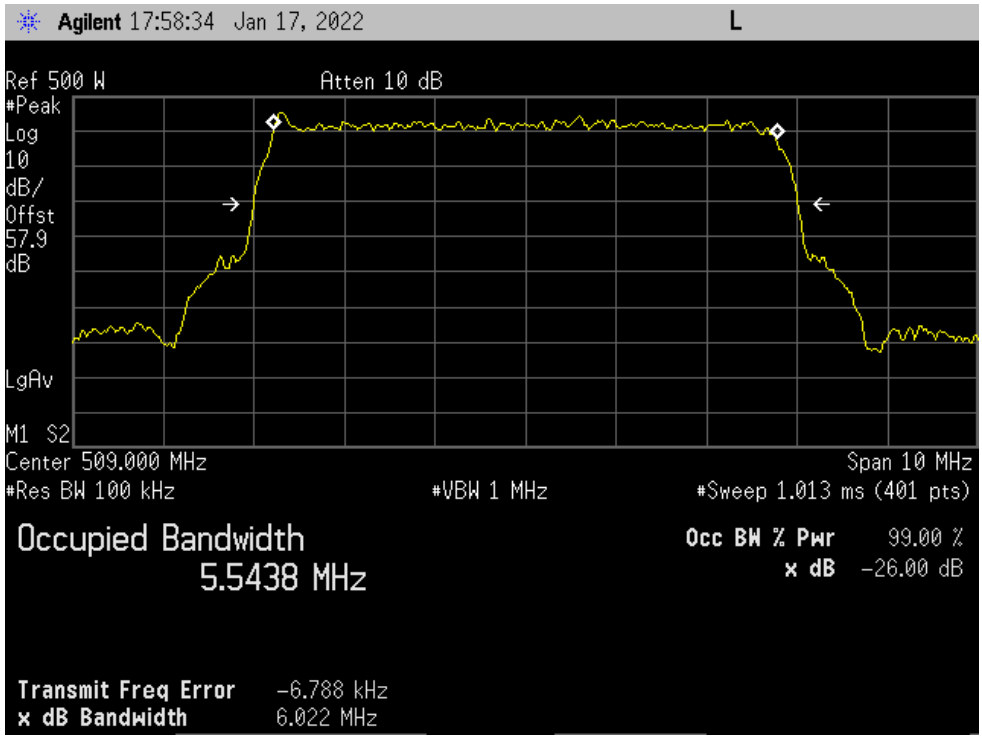
The EUT was connected as shown in the Test Set-up below.
The EUT was set to maximum power and the Occupied Bandwidth was recorded using the spectrum analyzer occupied bandwidth tool.

The occupied bandwidth was recorded for both modulations (ATSC 1.0 and ATSC 3.0).

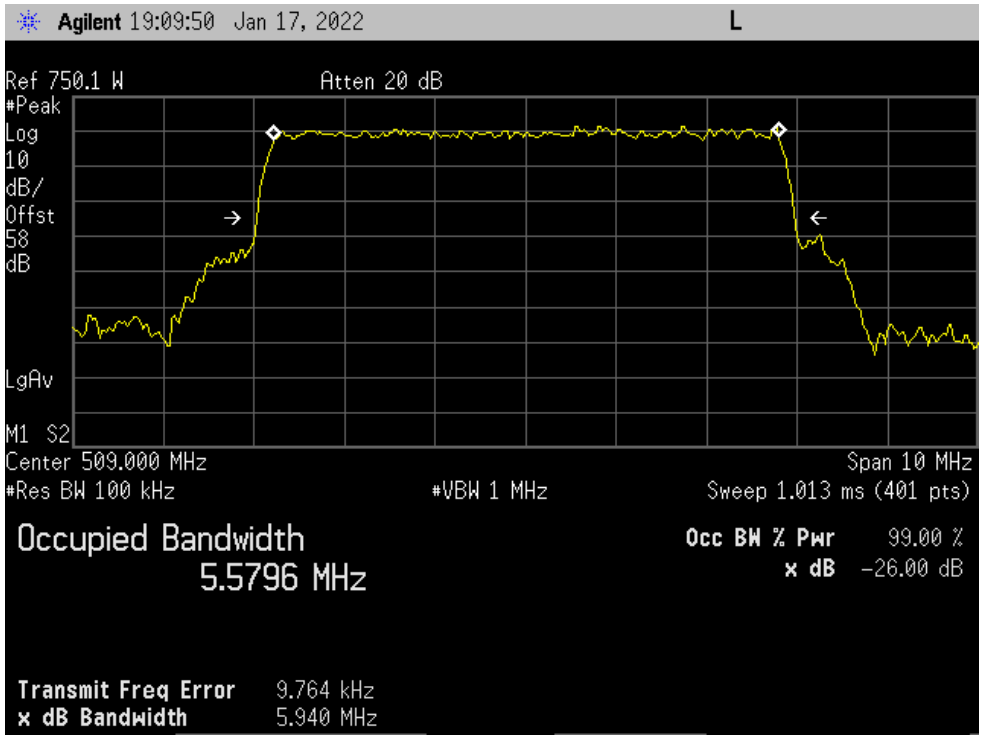
Test Setup



Occupied Bandwidth_ ATSC 1.0 modulation_ Full Service Mask Filter



Occupied Bandwidth_ ATSC 3.0 modulation_ Full Service Mask Filter

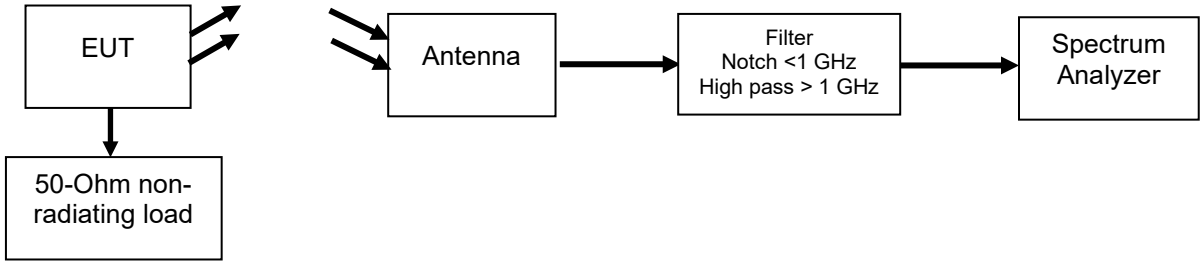


Field Strength of Spurious Radiation

Engineer: Greg Corbin

Test Date: 3/9/2022

Test Setup



Test Procedure

The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna.
The EUT output was terminated into 50 ohm non-radiating termination.
Spurious emissions were recorded for ATSC 1.0 and ATSC 3.0 modulations.
The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure that the signal levels were maximized.
The radiated spurious emissions were measured from 30 MHz to 6 GHz.
From 30 – 1000 MHz, the 3m chamber pre-amplifier was bypassed and a notch filter (tuned to 509 MHz) was used at the receive antenna output.
From 1 – 6 GHz, a high pass filter (cutoff freq = 1 GHz) was used at the receive antenna output.
All cable and antenna correction factors were input into the spectrum analyzer before recording spurious measurement.

There is no limit for radiated emissions.
The spurious emissions limit is a conducted limit measured at the output of the transmitter after the mask filter.
Per FCC 74.795 (b)(2), Emissions on frequencies outside the authorized channel, measured at the output terminals of the transmitter (including any filters that may be employed), shall meet the requirements of §74.794, as applicable.
Spectrum analyzer plots are provided for reference only.

Note: The transmitter is not marketed with an antenna so the antenna gain = 0 dBi (numerical gain = 1)

Refer to Annex B for Radiated Spurious Emission plots.

Frequency Stability (Temperature Variation)

Engineer: Greg Corbin

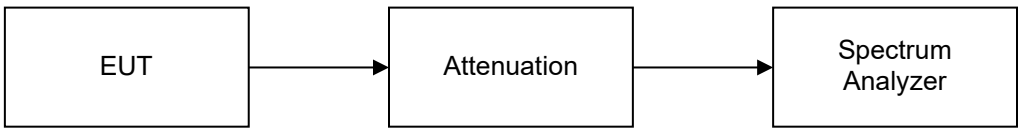
Test Date: 12/11/2020

Measurement Procedure

The Exact V2 digital exciter contains the frequency determining electronics and was tested for frequency stability. The exciter was placed in an environmental test chamber and the RF output was connected directly to a spectrum analyzer.
The temperature was varied from 0°C to 40°C in 10°C increments.
After a sufficient time for temperature stabilization the RF output frequency was measured.
At 20°C the power supply voltage to the EUT was varied from 85% to 115% of the nominal value and the RF output frequency was measured.

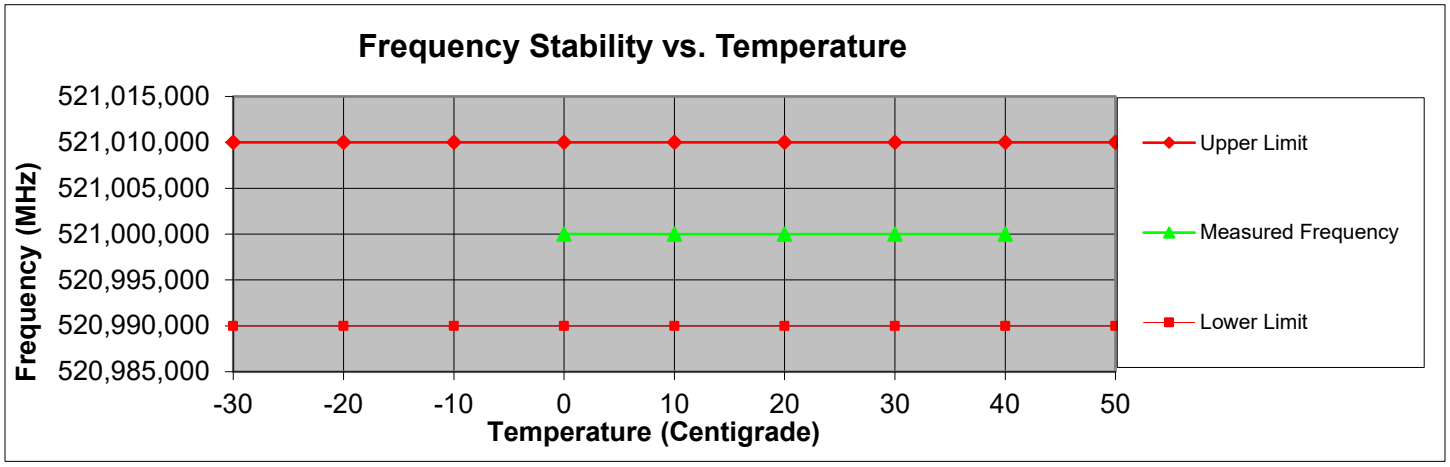
The Exact V2 exciter which contains the frequency determining components for this transmitter system operates from 470 – 862 MHz. The same exciter was used for certifying another broadcast transmitter FCC ID: LYIEC706HPBB2 at 521 MHz. The Frequency Stability test data from FCC ID: LYIEC706HPBB2 was used for this certification.

Measurement Setup



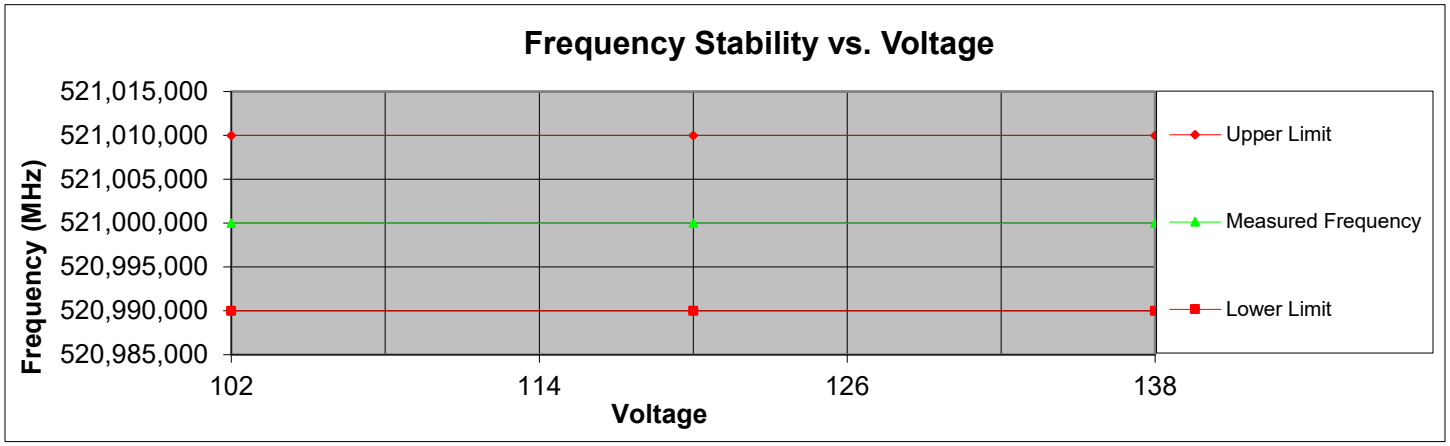
Frequency Stability vs Temperature

Tuned Frequency (Hz)	Temperature (deg C)	Tolerance (Hz)	Measured Frequency (Hz)	Upper Limit (Hz)	Lower Limit (Hz)	Upper Margin (Hz)	Lower Margin (Hz)
521,000,000	0	10000	521,000,006	521,010,000	520,990,000	-9,994	10,006
521,000,000	10	10000	520,999,992	521,010,000	520,990,000	-10,008	9,992
521,000,000	20	10000	520,999,992	521,010,000	520,990,000	-10,008	9,992
521,000,000	30	10000	520,999,994	521,010,000	520,990,000	-10,006	9,994
521,000,000	40	10000	520,999,994	521,010,000	520,990,000	-10,006	9,994



Frequency Stability vs Voltage

Tuned Frequency (Hz)	Tolerance (PPM)	Voltage (PPM)	Measured Frequency (Hz)	Upper Limit (Hz)	Lower Limit (Hz)	Upper Margin (Hz)	Lower Margin (Hz)
521,000,000	10000	102	521,000,000	521,010,000	520,990,000	-10,000	10,000
521,000,000	10000	120	520,999,992	521,010,000	520,990,000	-10,008	9,992
521,000,000	10000	138	520,999,992	521,010,000	520,990,000	-10,008	9,992



Measurement Uncertainty

Measurement Uncertainty for Compliance Testing is listed in the table below.

The reported expanded uncertainty has been estimated at a 95% confidence level (k=2)

Measurement Type	Expanded Uncertainty
Conducted Emissions, AC Powerline	± 3.28 dB
Radiated Emissions_30 – 1000 MHz	± 4.82 dB
Radiated Emissions_1 – 18 GHz	± 5.73 dB
Frequency Error	± 22 Hz
Conducted RF Power	± 0.98 dB
Conducted Spurious Emission	± 2.49 dB
AC Voltage	± 2.3 %
DC Voltage	± 0.12 %
Temperature	± 1.0 deg C
Humidity	± 4.32 %

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Bi-Log antenna	Chase	CBL6111C	i00267	8/28/20	8/28/22
Horn Antenna	ARA	DRG-118/A	i00271	8/3/20	8/3/22
Signal Generator	Hewlett Packard	83650A	i00353	12/7/20	12/7/22
Voltmeter	Fluke	179	i00488	5/24/21	5/24/23
Network Analyzer	Hewlett Packard	8722D	I00521	10/11/2021	10/11/2022
EMI Receiver	Keysight	N9038A	i00552	2/24/22	2/24/23
Tunable Notch Filter	Eagle	TNF-1-(250-850MHz)	i00124	Verified on 3/9/22	
High pass filter	K&L	7IH40-980/T6000-o-o	i00432	Verified on 3/9/22	
PSA Spectrum Analyzer	Agilent	E4445A	i00471	12/27/21	12/27/22
Temp./humidity/pressure monitor (ESD room)	Omega Engineering	iBTHX-W-5	i00629	11/3/21	11/3/22

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT