

Test Report

Prepared for: Hitachi Kokusai Electric Comark

Models:

EC-701HP-BB2
EC-702HP-BB2
EC-703HP-BB2
EC-704HP-BB2
EC-706HP-BB2

Description: Broadcast Transmitter

FCC ID: LYIEC706HPBB2

To

FCC Part 74

Date of Issue: December 12, 2020

On the behalf of the applicant:

Hitachi Kokusai Electric Comark
104 Feeding Hills Rd
Southwick, MA 0107701077

Attention of:

Thomas Barbeau, VP of Engineering
Ph: (413)998-1124
E-Mail: tbarbeau@comarktv.com

Prepared By
Compliance Testing, LLC
1724 S. Nevada Way
Mesa, AZ 85204
(480) 926-3100 phone / (480) 926-3598 fax
www.compliancetesting.com
Project No: p2060011



Greg Corbin
Project Test Engineer

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Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	December 9, 2020	Greg Corbin	Original Document
2.0	January 29, 2021	Greg Corbin	Corrected typo for rule section in test summary table on page 8

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ANAB

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

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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 (°C)	Humidity (%)	Pressure (mbar)
17.9 – 24.5	23.0 – 35.8	960– 979

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

EUT Description

Model: Refer to Table 1 below

Description: Broadcast Transmitter

Additional Information:

The EC-706HP-BB2 digital transmitter system is an up to 6600W average power (when using ATSC 1.0 8VSB modulation), 5700W 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-8001 Drive controller, six (6) GV 40265A Amplifiers, a passive hybrid combining system, a 40218 Low pass filter, and a Com-Tech A-TC6D200C-NN-06 Stringent Mask Filter. 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.

The system contains 6 identical power amplifier modules that control the output power. The output power can be adjusted from 1100 – 6600 watts by adding or subtracting power amplifier modules. See Table 1 below for the amplifier configuration.

Model	Number of Power amplifier Modules	Rated Output Power Average Power (watts)	
		ATSC 1.0	ATSC 3.0
EC701HP-BB2	1	1100	930
EC702HP-BB2	2	2200	1860
EC703HP-BB2	3	3300	2850
EC704HP-BB2	4	4400	3800
EC706HP-BB2	6	6600	5700

A rack mounted transmitter system with multiple amplifiers can be filed under 1 FCC ID provided that all the amplifier modules are identical and that the addition or deletion of amplifier modules only changes the output power.

Per FCC KDB 754507:

Rack mounted licensed transmitters with multiple amplifiers marketed with one to N amplifier modules can be approved under one FCC Identifier under the following conditions:

- 1) *The amplifier modules must be identical in design;*
- 2) *The addition or deletion of the modules only changes the output power. For each output power version, the Grant must list a separate Equipment Specifications line item. For example, each combination (e.g. 1, 2, or 3 identical "stacked" power amplifiers) must have 3 line items;*
- 3) *The frequency range of different models with different modules must be identical. There can be no changes in the frequency operational range or determining circuitry between the different models with different installed modules;*
- 4) *For Certification submittals, each rack must be tested with the maximum number of modules installed. While only the full rack must be tested and submitted, the Grantee is responsible for compliance of all configurations.*

This system is configured with identical amplifier modules and adding or removing amplifier modules only affects the output power.

The system was tested with the maximum number of amplifiers modules (6) to support the highest output power.

EUT Operation during Tests

A Stringent Mask Filter was supplied for the test.

Conducted RF measurements were recorded after the mask filter, via a RF coupler attached to the filter output unless otherwise stated in this test report.

The coupler thru port was connected to a 10000 watt 50 ohm load.

The EUT has 2 types of modulation, ATSC1.0 (8VSB) and ATSC 3.0 (OFDM).

The system was tuned to 521 MHz (CH 22).

All tests were performed with the tuned frequency set to 521 MHz.

AC power is 208 VAC, 3 phase, 60 Hz.

EC706HP-BB2 System components

Description	Model	S/N
System	EC706HP-BB2	EAJH-0001
CM8001 Control Module	MOD GV 40056	GAOK0168
Exact V2 High End TV Exciter	XTTR-VX20-3002	00198
Power Amplifier	GV 40265A	GARF-0041
Power Amplifier	GV 40265A	GARF-0043
Power Amplifier	GV 40265A	GARF-0044
Power Amplifier	GV 40265A	GARF-0045
Power Amplifier	GV 40265A	GARF-0046
Power Amplifier	GV 40265A	GARF-0050
Low Pass Filter	40218	N/A
Stringent Mask Filter	A-TC6D200C-NN-06	1944-222782
Ethernet Switch	DES-1024D	N/A6612 v

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Precision RF Coupler	N/A	N/A	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 5
74.794(a)(ii)(iii) 2.1051	Emission Mask	Pass	
2.1049	Occupied Bandwidth	Pass	
74.794(a)(ii)(iii) 74.795(b)(2) 2.1051	Digital Emissions (Conducted Spurious)	Pass	
74.794(b)(1) 2.1051	Spurious Emissions, GPS bands	Pass	
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*.

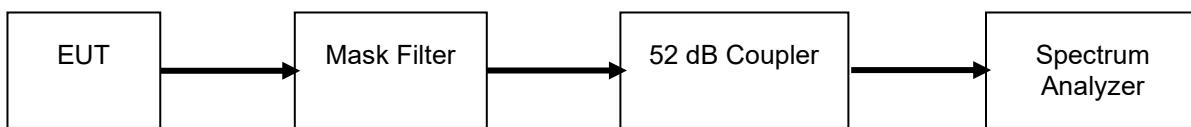
Power Limitations (Output Power)
Engineer: Greg Corbin

Test Date: 11/4/2020

Measurement Procedure

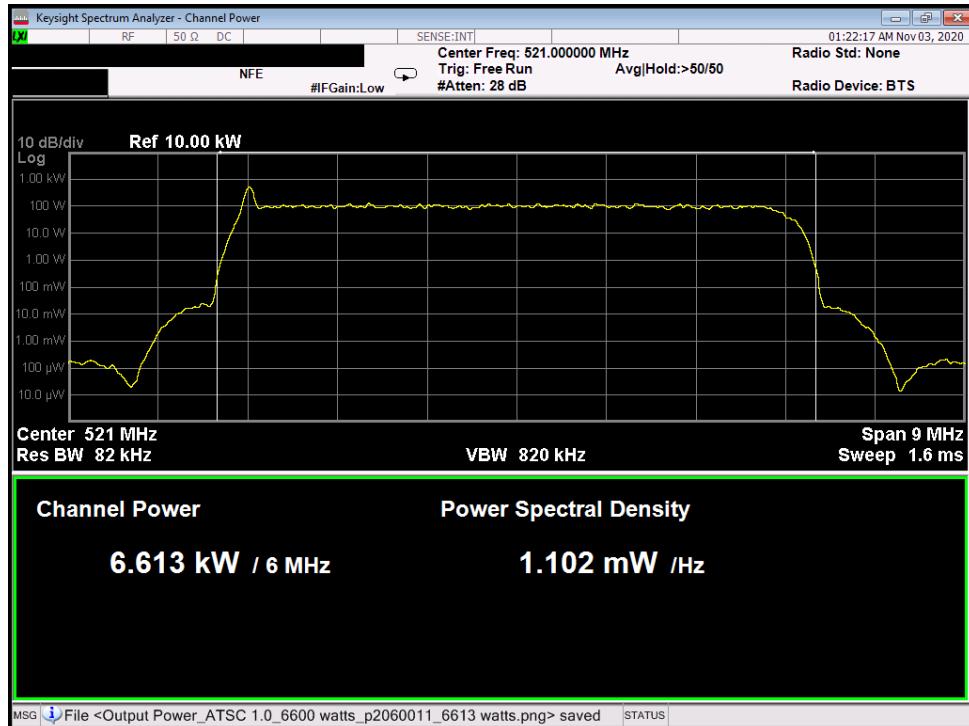
The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 52 dB Precision RF coupler. All cable and coupler losses were input into the spectrum analyzer as a reference level offset to ensure accurate readings were obtained.

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) were recorded.

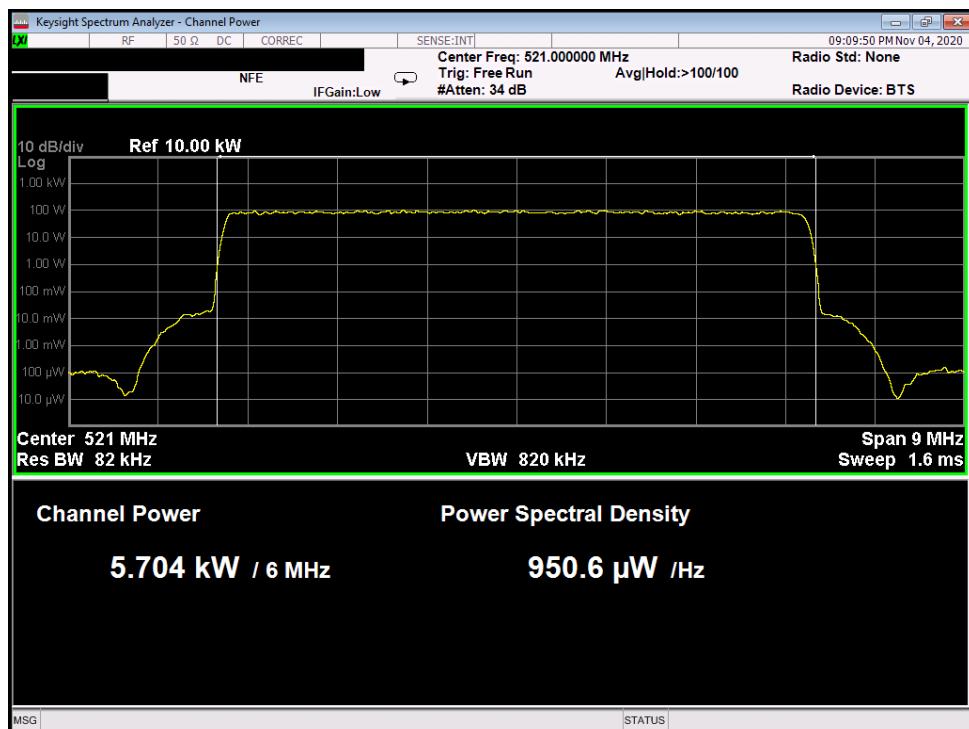
Test Setup

Output Power Test Results

Modulation	Mask Filter	Tuned Frequency (MHz)	Recorded Measurement (watt)	Limit (watt)	Result
ATSC 1.0	Stringent	521	6613	15000	Pass
ATSC 3.0	Stringent	521	5704	15000	Pass

Output Power_ATSC 1.0 modulation_Stringent Mask Filter



Output Power_ATSC 3.0 modulation_Stringent Mask Filter



Emission Mask

Engineer: Greg Corbin

Test Date: 12/14/2020

Measurement Procedure

The EUT was connected as shown in the Test Set-up below.

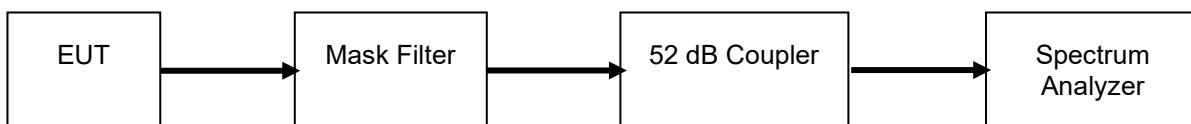
The EUT uses a stringent mask filter.

With the stringent filter installed, the EUT was set to maximum power and the Out of Band emissions were recorded using the stringent mask limit per FCC Part 74.794(a)(ii).

Plots for the stringent mask are provided below.

The Out of Band emissions were recorded for modulations (ATSC 1.0 and ATSC 3.0).

Stringent Emission Mask Test Setup



Stringent Filter Emission Mask_ ATSC 1.0



Stringent Filter Emission Mask_ ATSC 3.0



Occupied Bandwidth

Engineer: Greg Corbin

Test Date: 12/14/20

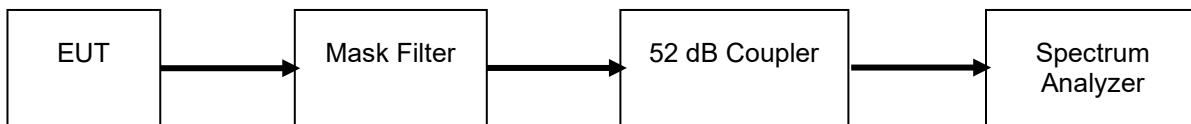
Measurement Procedure

The EUT was connected as shown in the Test Set-up below.

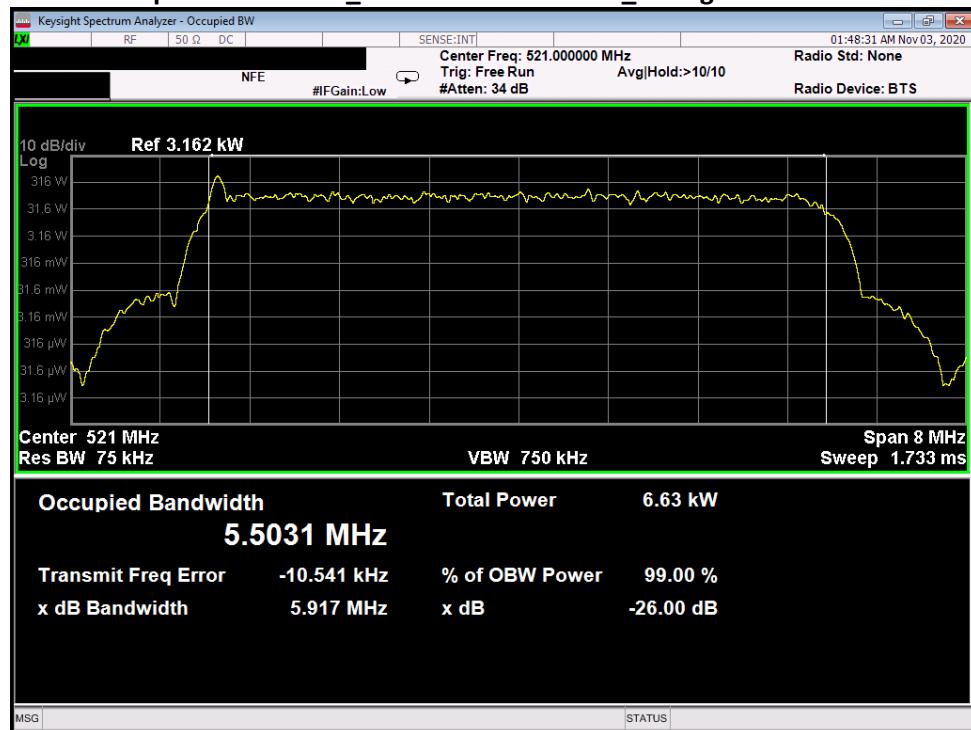
The EUT was set to maximum power and the Occupied Bandwidth was recorded using the spectrum analyzer occupied bandwidth tool.

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

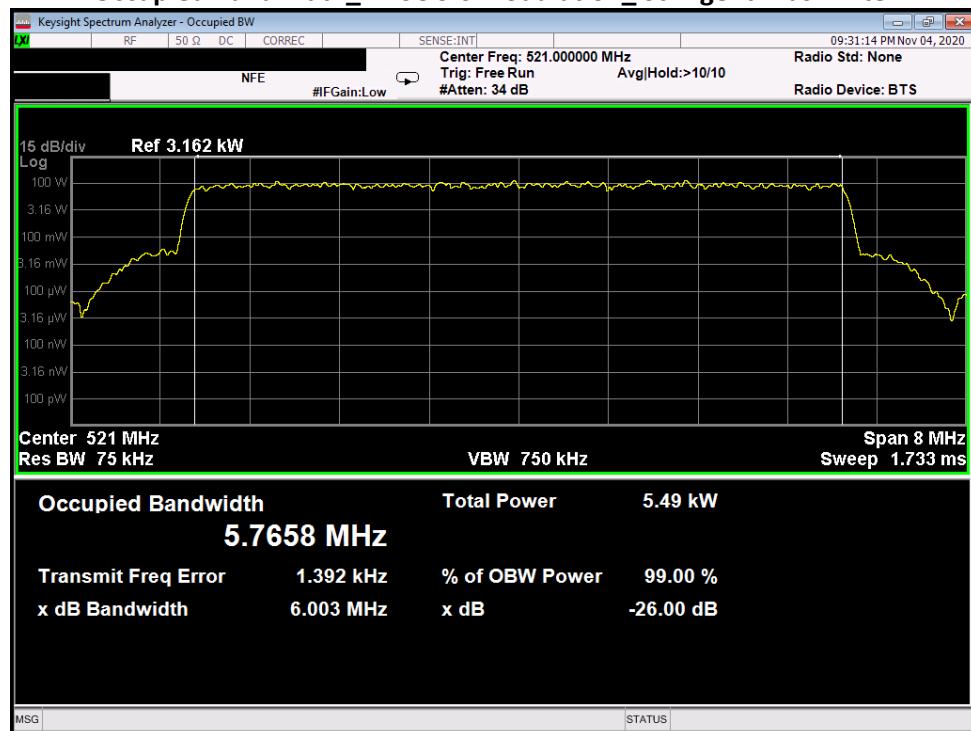
Test Setup



Occupied Bandwidth_ATSC 1.0 modulation_Stringent Mask Filter



Occupied Bandwidth_ATSC 3.0 modulation_Stringent Mask Filter



Conducted Spurious Emissions

Engineer: Greg Corbin

Test Date: 12/14/2020

Test Procedure

The EUT was setup as shown below.

For measurements above 1 GHz, a high pass filter was installed at the spectrum analyzer input.

Conducted spurious emissions from 30 MHz to the 10th harmonic of the fundamental transmitter frequency were recorded and compared to the -75 dBc limit for the stringent mask filter.

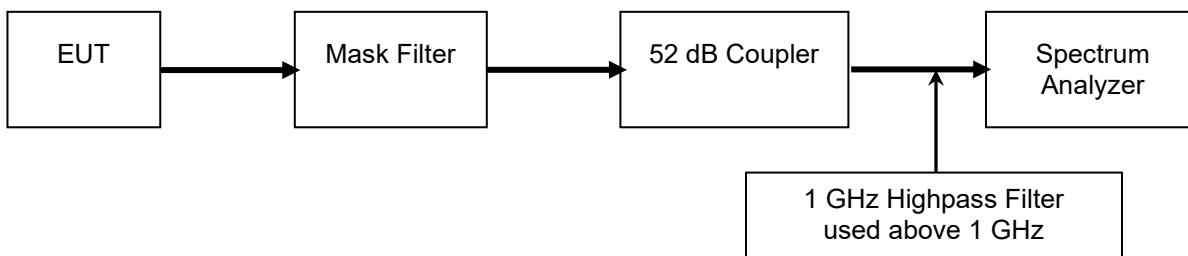
In addition, the GPS bands (1164 – 1610 MHz) were measured separately and compared to the 85 dBc limit for the stringent mask filter.

Conducted spurious emissions were recorded for ATSC 1.0 and ATSC 3.0 modulations.

RBW was set to 100 kHz for 30 – 1000 MHz and 1 MHz from 1 – 7 GHz.

Conducted Emissions with the Stringent Mask Filter test results are shown in the test summary table below and spectrum analyzer plots following the table.

Test Setup

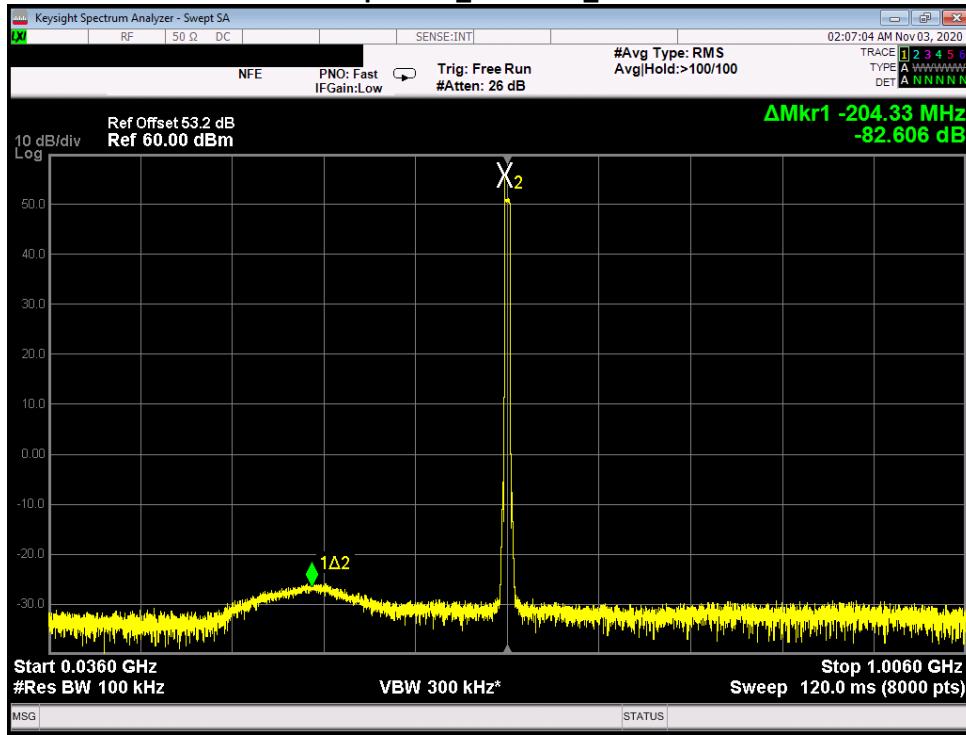


Conducted Spurious Emissions Summary Test Table for the Stringent Mask Filter

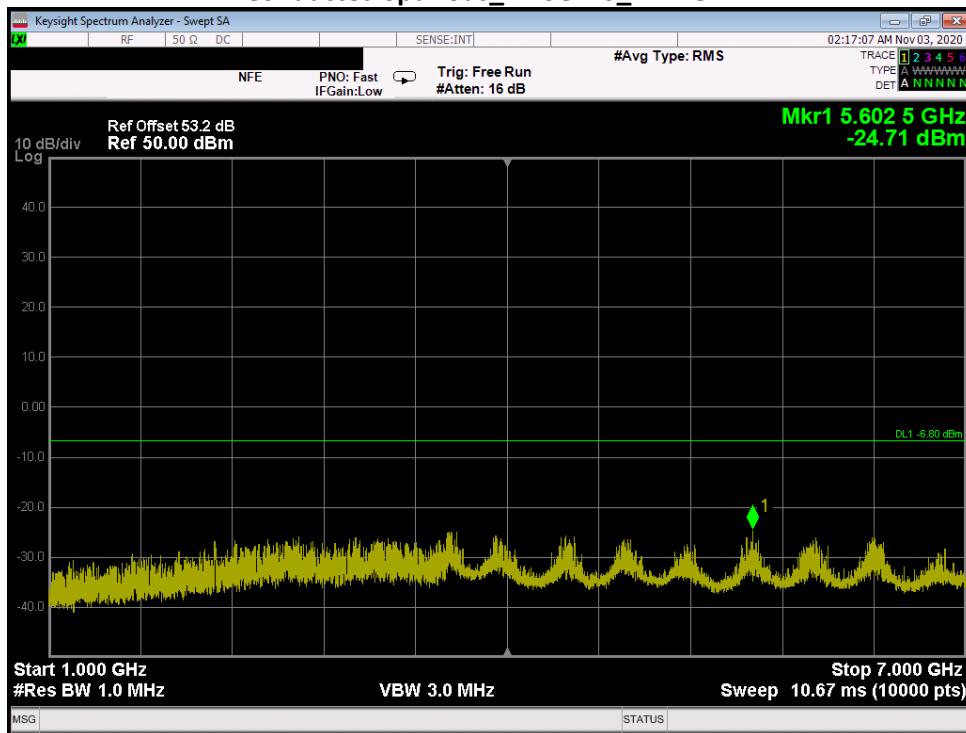
Frequency Range (MHz)	Modulation (N/A)	fundamental Power (dBm)	Spurious Frequency (MHz)	Measured Spurious Level		Specification Limit (dBc)	Margin (dB)
30 - 1000	ATSC 1.0	68.20	316.67	-26	94.2	75	-19.2
30 - 1000	ATSC 3.0	67.56	301.53	-24.9	92.5	75	-17.5
1000 - 7000	ATSC 1.0	68.20	5602.5	-24.7	92.9	75	--17.9
1000 - 7000	ATSC 3.0	67.56	1562.3	-29.3	96.9	75	-21.9
1164 - 1610	ATSC 1.0	68.20	1560.85	-34.3	102.5	85	-17.5
1164 - 1610	ATSC 3.0	67.56	1564.37	-29.0	96.6	85	-11.6

Conducted Spurious Emission Test Data for the Stringent Mask Filter

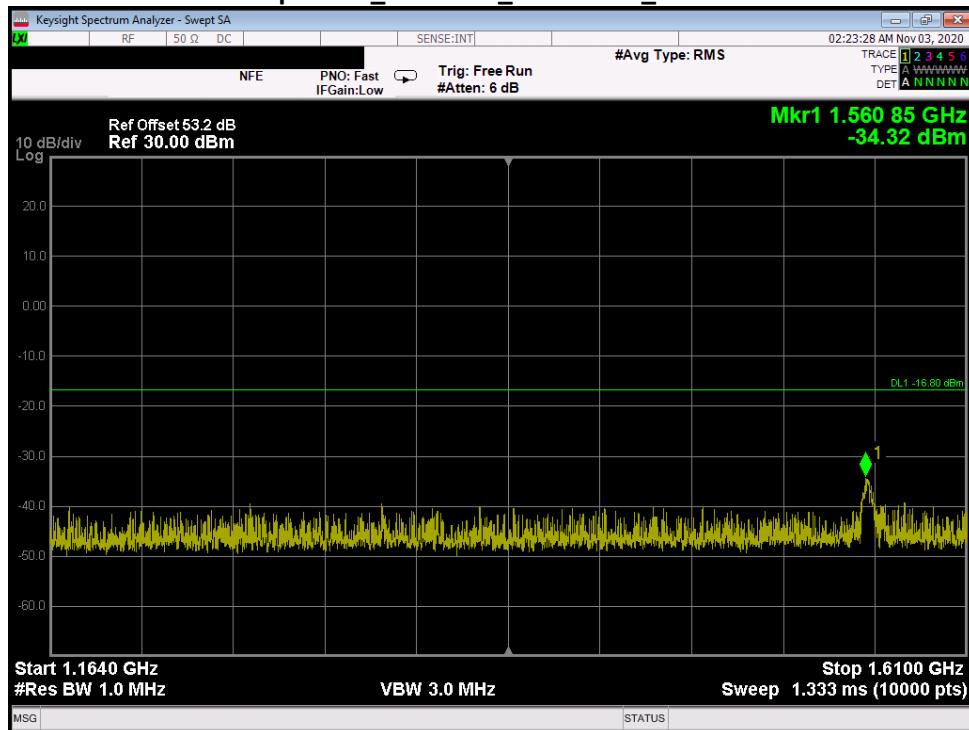
Conducted Spurious_ATSC 1.0_30 - 1000 MHz



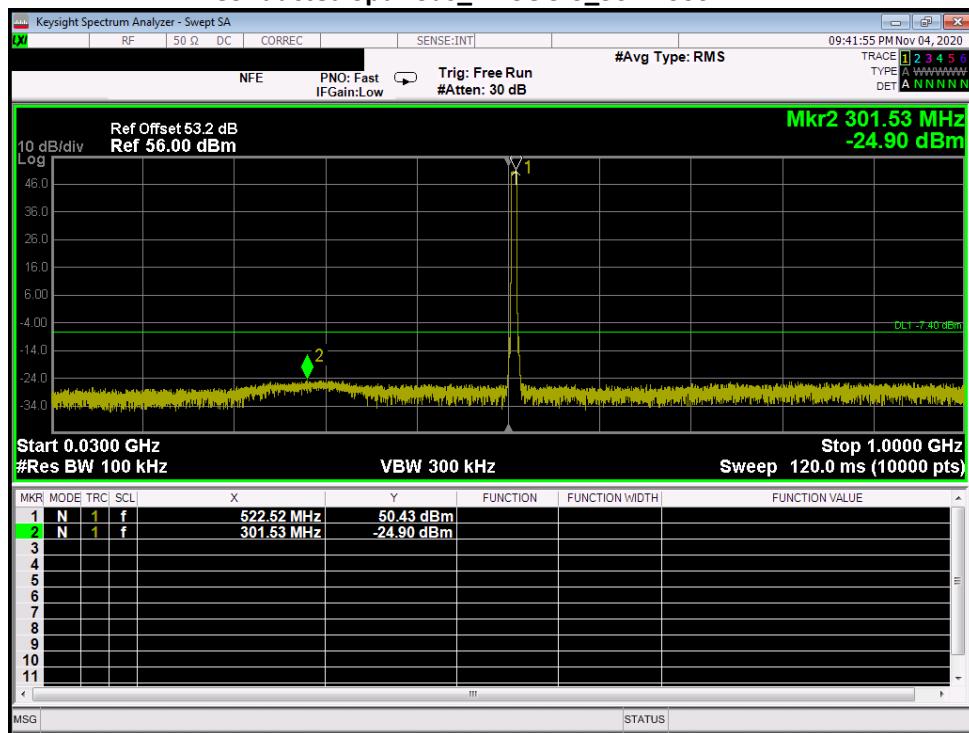
Conducted Spurious_ATSC 1.0_1 - 7 GHz



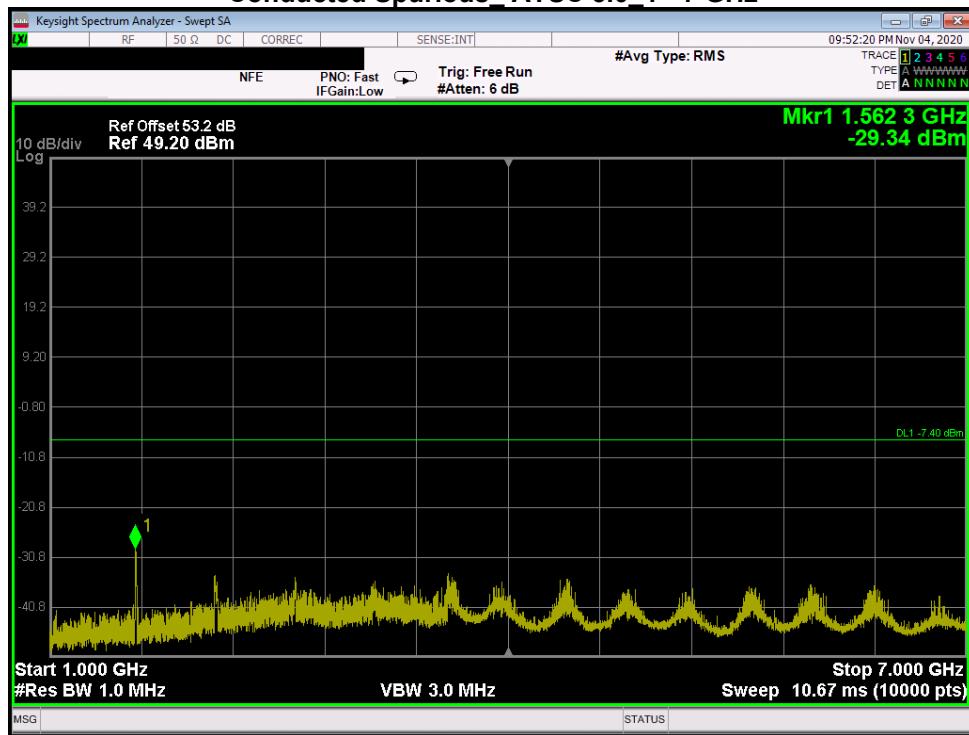
Conducted Spurious_ATSC 1.0_GPS Bands_1164 - 1610 MHz



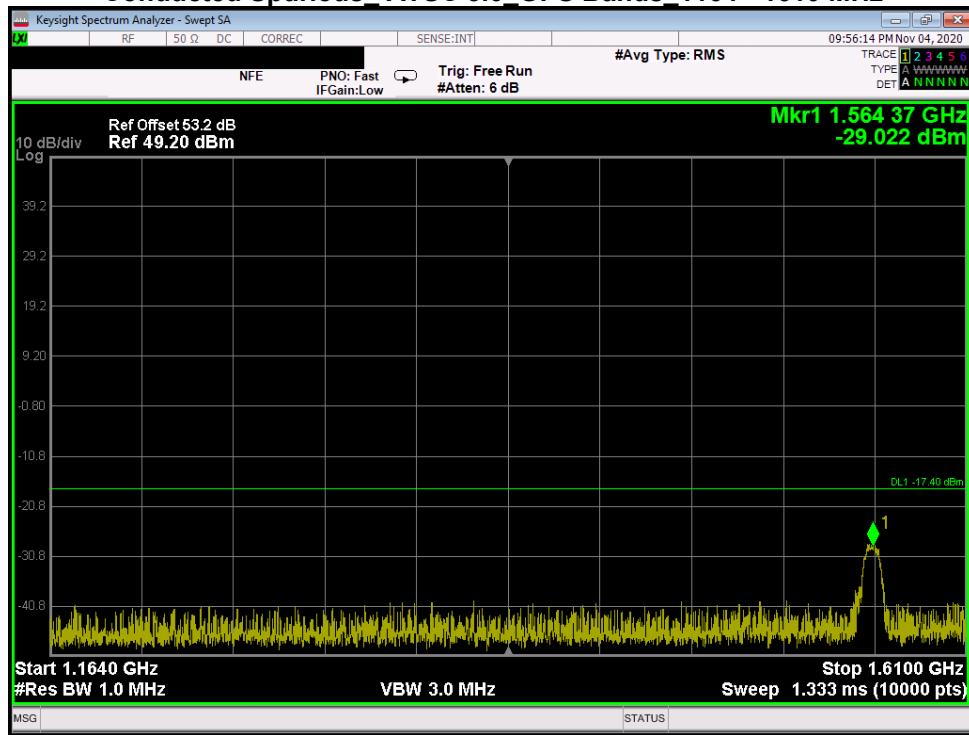
Conducted Spurious_ATSC 3.0_30 - 1000 MHz



Conducted Spurious ATSC 3.0 1 - 7 GHz



Conducted Spurious ATSC 3.0 GPS Bands 1164 - 1610 MHz

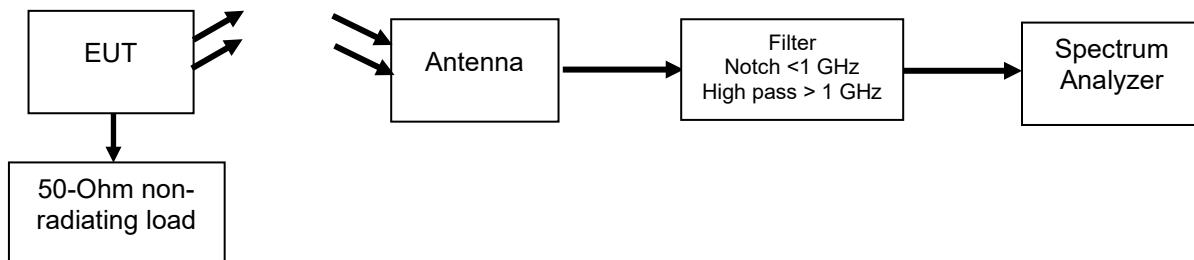


Field Strength of Spurious Radiation

Engineer: Greg Corbin

Test Date: 11/8/2020

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 7 GHz.

From 30 – 1000 MHz, the 3m chamber pre-amplifier was bypassed and a notch filter (tuned to 521 MHz) was used at the receive antenna output.

From 1 – 7 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 A for Radiated Spurious Emission plots.

Frequency Stability (Temperature Variation)

Engineer: Greg Corbin

Test Date: 12/11/2020

Measurement Procedure

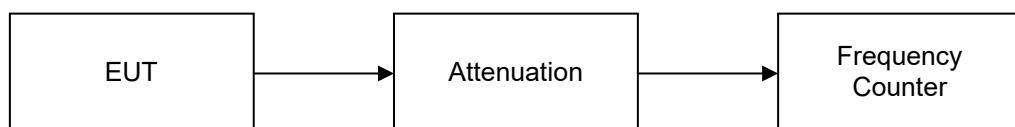
The Exact V2 digital exciter contains the frequency determining electronics and was tested for frequency stability. The exciter was placed in an environmental test chamber and the RF output was connected directly to a spectrum analyzer.

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.

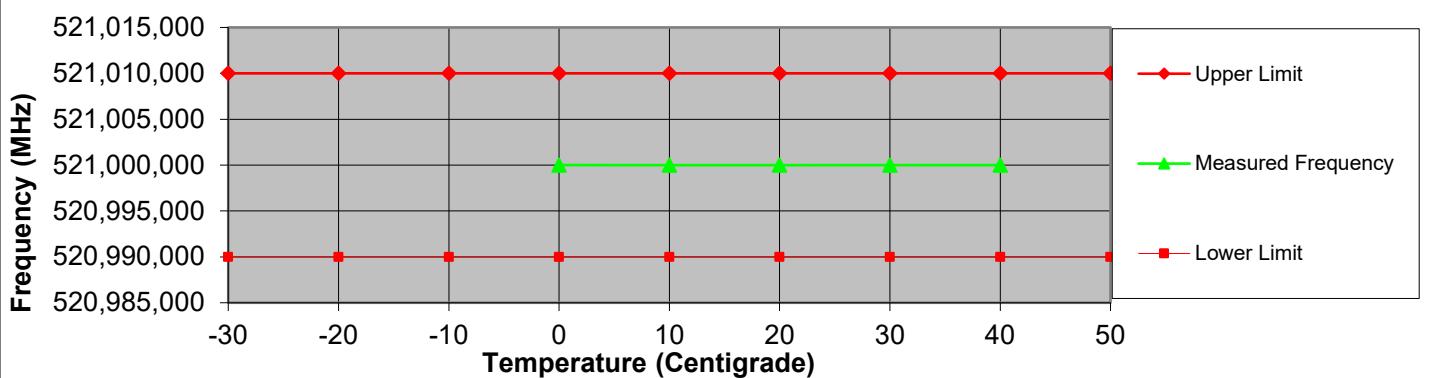
Measurement Setup



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

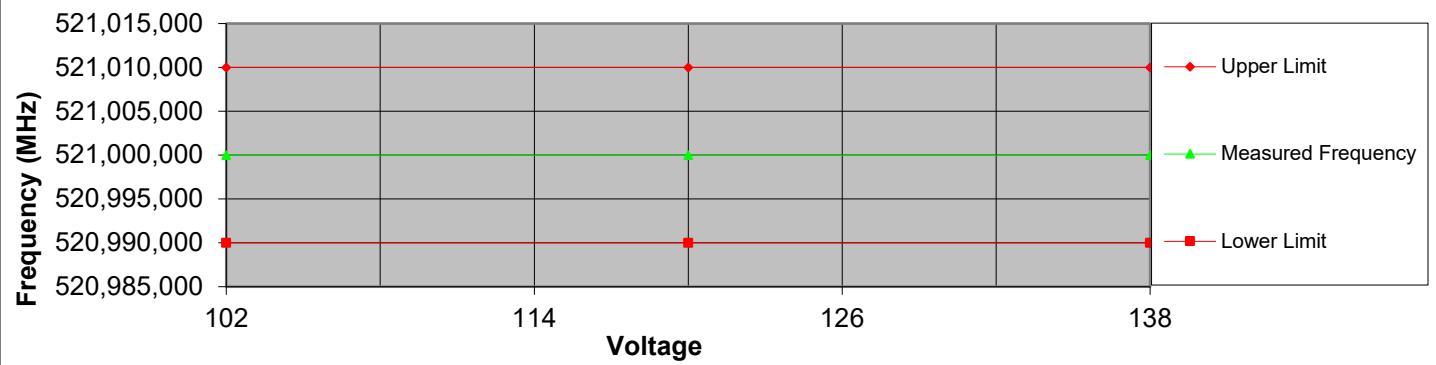
Frequency Stability vs. Temperature



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

Frequency Stability vs. Voltage



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
Horn Antenna	ARA	DRG-118/A	i00271	8/3/20	8/3/21
Spectrum Analyzer	Agilent	E4407B	i00331	12/18/19	12/18/20
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	1/17/19	1/17/21
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	8/28/20	8/28/21
Voltmeter	Fluke	179	i00488	5/18/20	5/18/21
Network Analyzer	Hewlett Packard	8722D	i00521	8/6/20	8/6/21
EMI Receiver	Keysight	N9038A	i00552	11/20/20	11/20/20
Tunable Notch Filter	Eagle	TNF-1-(250-850MHz)	i00124	No Cal Required	
High pass filter	K&L	7IH40-980/T6000-o-o	i00432	No Cal Required	
Coaxial Resistor (10 kw load)	Termaline	8936-115	i01547	N/A	N/A

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