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Test Report

Prepared for: Hitachi Kokusai Electric Comark

Model: EC 704MP, Exact V2 Exciter

Description: Broadcast Transmitter

FCC ID: LYIEC704MP

To

FCC Part 74

Date of Issue: October 6, 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.comtbarbeau@comarktv.com**

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Project No: p2080009

Greg Corbin
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	October 6, 2020	Greg Corbin	Original Document
2.0	October 20, 2020	Greg Corbin	Corrected reference to rule section in test summary table and added comment for emission mask

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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.

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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)**
24.8 – 29.6	12 – 26	963.1 – 964.9

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

EUT Description
Model: EC 704MP, Exact V2 Exciter
Description: Broadcast Transmitter

Additional Information:

The EC-704MP digital transmitter system is an up to 350W average power (when using ATSC 1.0 8VSB modulation), 300W 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, one (1) GV40010 Amplifier, a passive hybrid combining system, a 40243 Low pass filter, and a Com-Tech FC6D60C 6 Pole Mask Filter (or equivalent or more stringent 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.

EUT Operation during Tests

Conducted RF measurements were recorded after the 6 pole mask filter, via a RF coupler attached to the filter output.
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 tested with the manufacturer supplied Stringent Mask filter was tuned to 491 MHz (CH 14).
All tests were performed with the tuned frequency set to 491 MHz.
AC power is 230 VAC at 60 Hz.

EC704MP System components

Description	Model	S/N
System	EC704MP	EAHP0173
CM8001 Control Module	MOD GV 40056	GAOK0174
Exact V2 High End TV Exciter	XTTR-VX20-3002	00198
PA704MP Power Amplifier	GV40010	GALP0246/19
Low Pass Filter	40243	N/A
6-Pole Stringent Mask Filter	6PPXX80E	93731
Ethernet Switch	DES-1024D	N/A

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Precision RF Coupler	Dielectric	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) 2.1051	Emission Masks (Stringent Mask)	Pass	Manufacturer supplied a stringent mask filter
2.1049	Occupied Bandwidth	Pass	
74.794(a)(ii) 74.975(b)(2) 2.1051	Digital Emissions (Conducted Spurious)	Pass	
74.974(b) 2.1051	Spurious Emissions, GPS bands	Pass	
74.974(b) 2.1053	Field Strength of Spurious Radiation	Pass	
74.794(b)(4) 2.1055	Frequency Stability (Temperature Variation)	Pass	
74.794(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*.

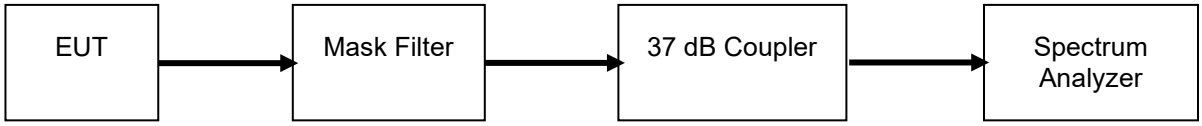
Power Limitations (Output Power)

Engineer: Greg Corbin
Test Date: 10/1/2020

Measurement Procedure

The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 37 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.

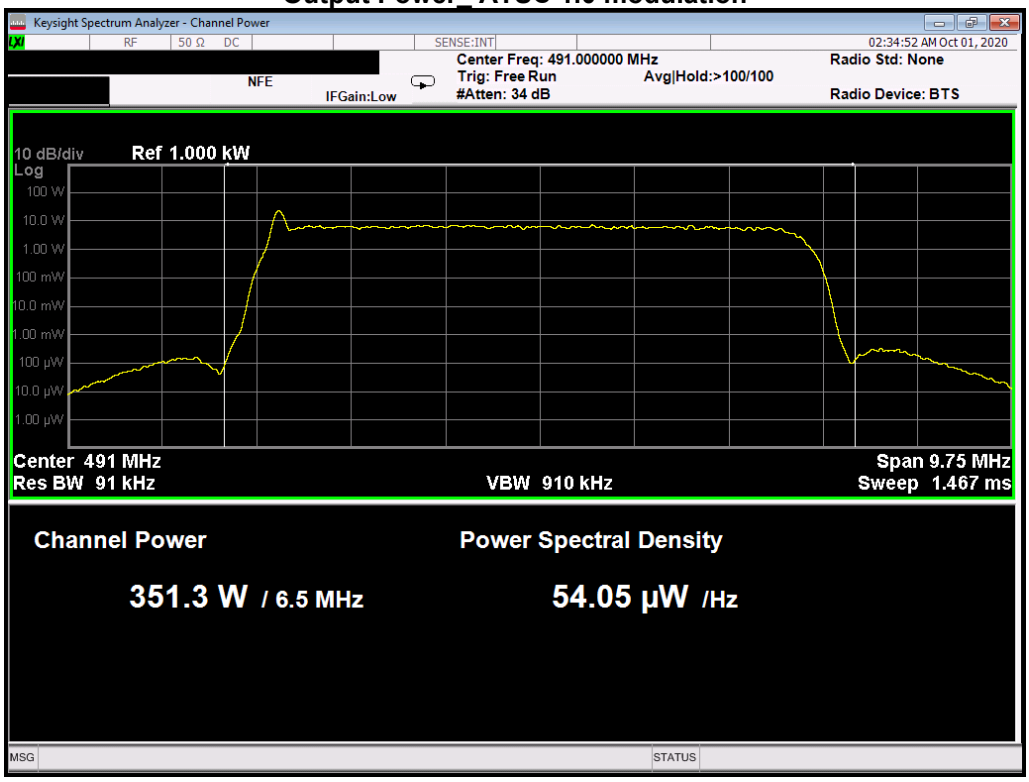
Test Setup



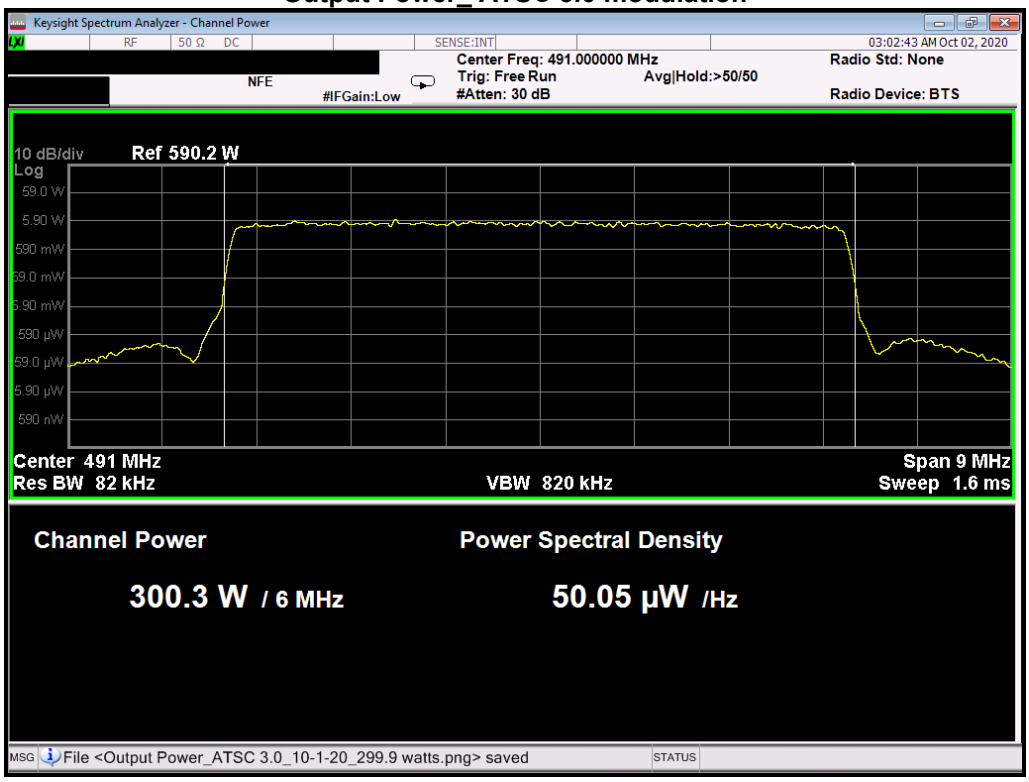
High Power Transmitter Peak Output Power

Modulation	Tuned Frequency (MHz)	Recorded Measurement (watt)	Limit (watt)	Result
ATSC 1.0	491	351.3	15000	Pass
ATSC 3.0	491	300.3	15000	Pass

Output Power_ ATSC 1.0 modulation



Output Power_ ATSC 3.0 modulation



Emission Mask

Engineer: Greg Corbin

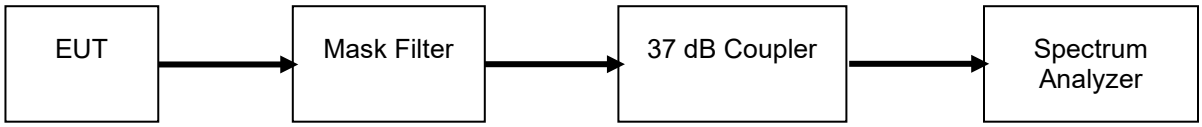
Test Date: 10/1/2020

Measurement Procedure

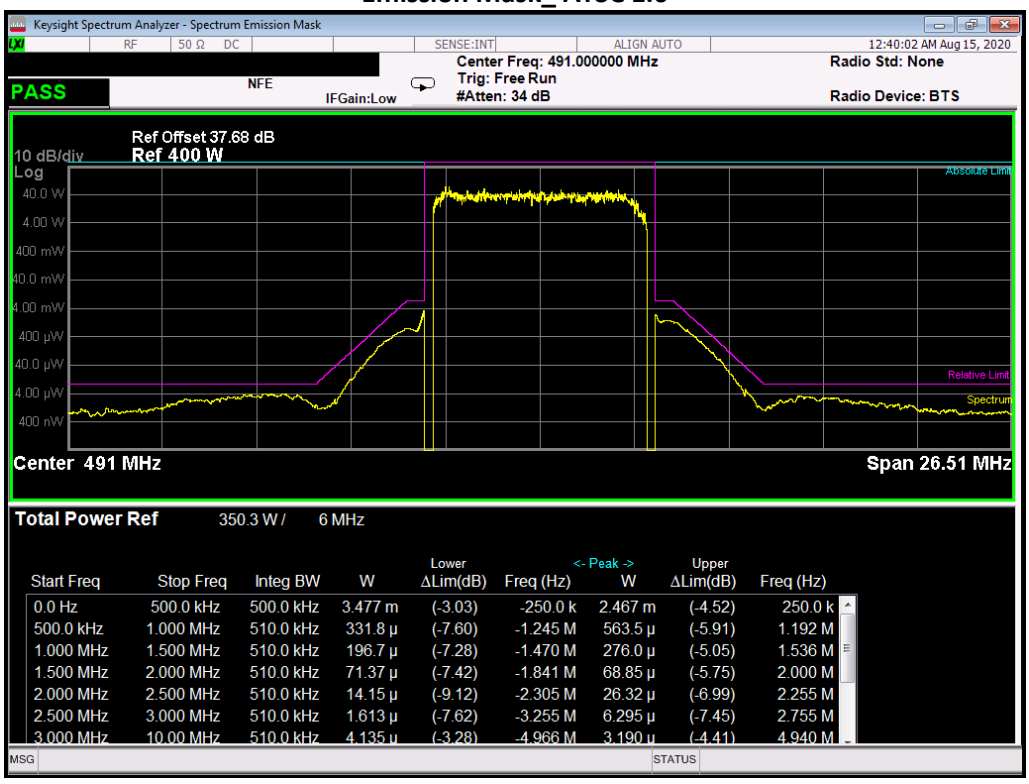
The EUT was connected as shown in the Test Set-up below.
The EUT uses a stringent mask filter.
The EUT was set to maximum power and the Out of Band emissions were recorded using the stringent mask limit per FCC Part 74.794(a)(ii).

The Out of Band emissions were recorded for modulations (ATSC 1.0 and ATSC 3.0).
RBW = 510 kHz
VBW = 1.5 MHz

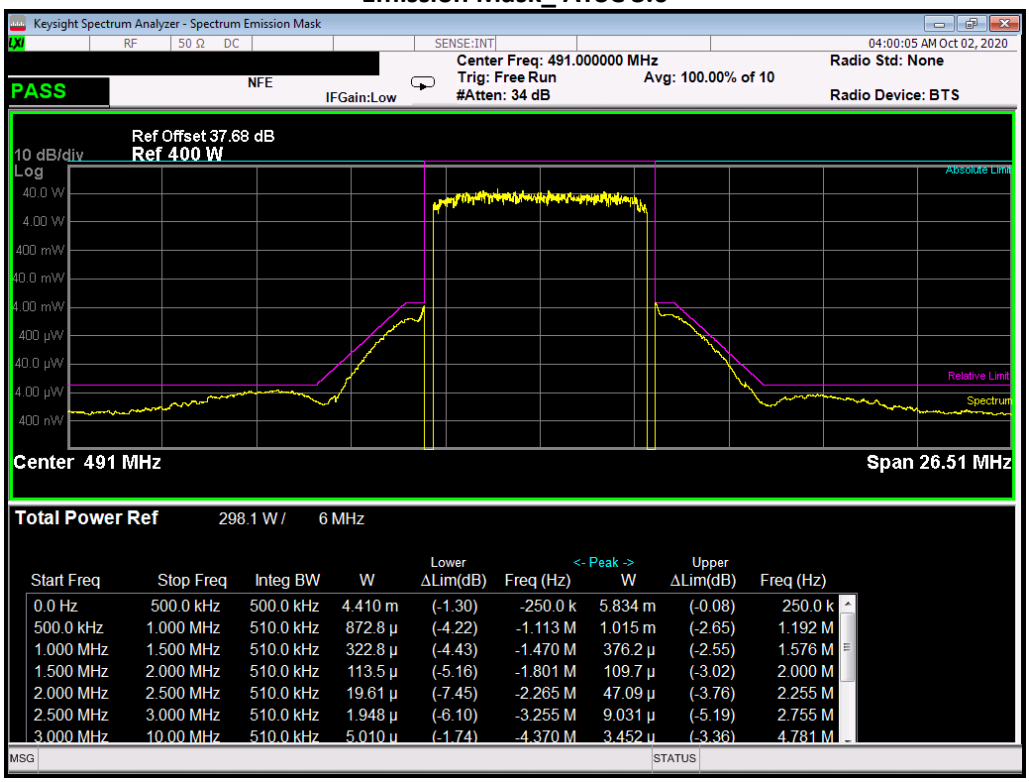
Test Setup



Emission Mask_ ATSC 1.0



Emission Mask_ ATSC 3.0



Occupied Bandwidth

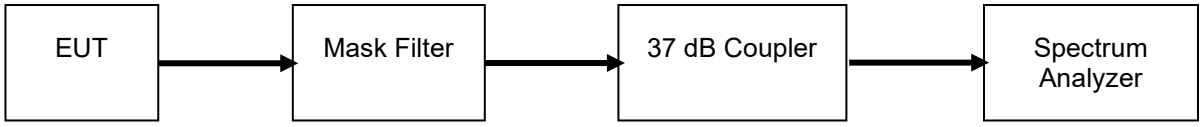
Engineer: Greg Corbin
Test Date: 10/1/2020

Measurement Procedure

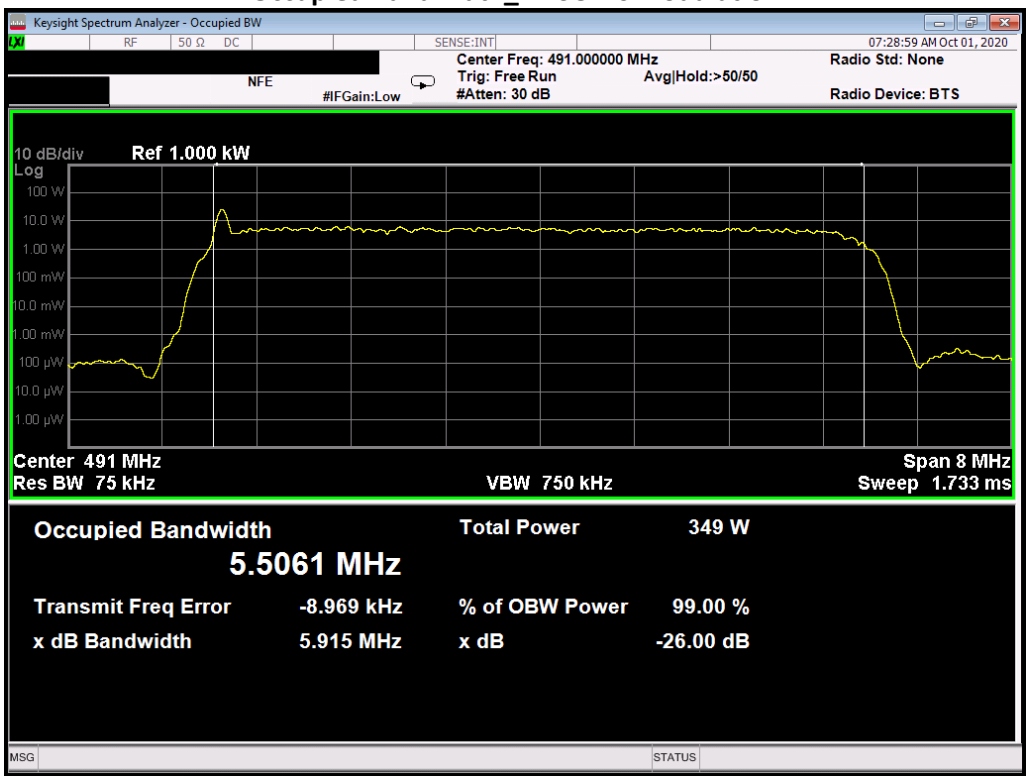
The EUT was connected as shown in the Test Set-up below.
The EUT was set to maximum power and the Occupied Bandwidth was recorded using the spectrum analyzer occupied bandwidth tool.

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

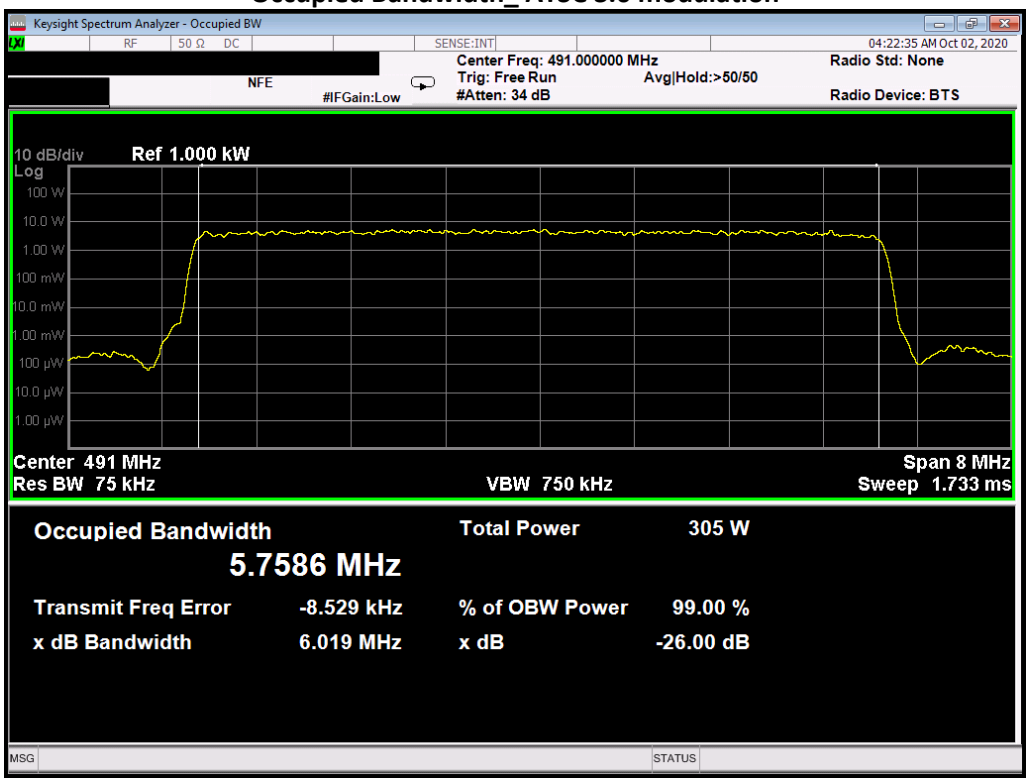
Test Setup



Occupied Bandwidth_ ATSC 1.0 modulation



Occupied Bandwidth_ ATSC 3.0 modulation



Conducted Spurious Emissions

Engineer: Greg Corbin

Test Date: 10/1/2020

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.

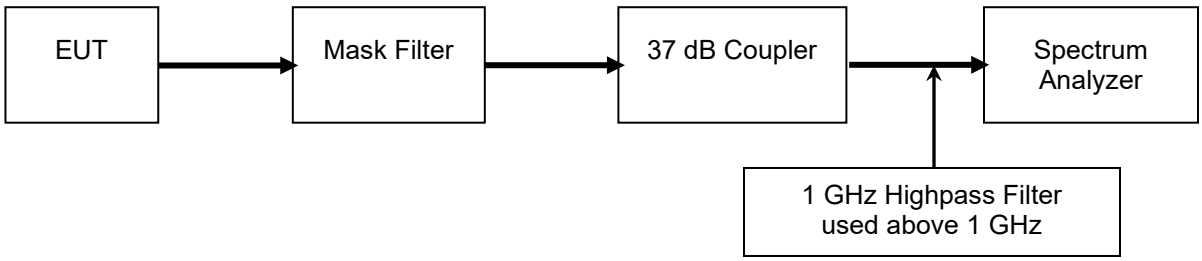
Conducted spurious emissions from 30 MHz to the 10th harmonic of the fundamental transmitter were recorded and compared to the 75 dBc limit.

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

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

RBW was set to100 kHz for 30 – 1000 MHz and 1 MHz from 1 – 7 GHz.

Test Setup

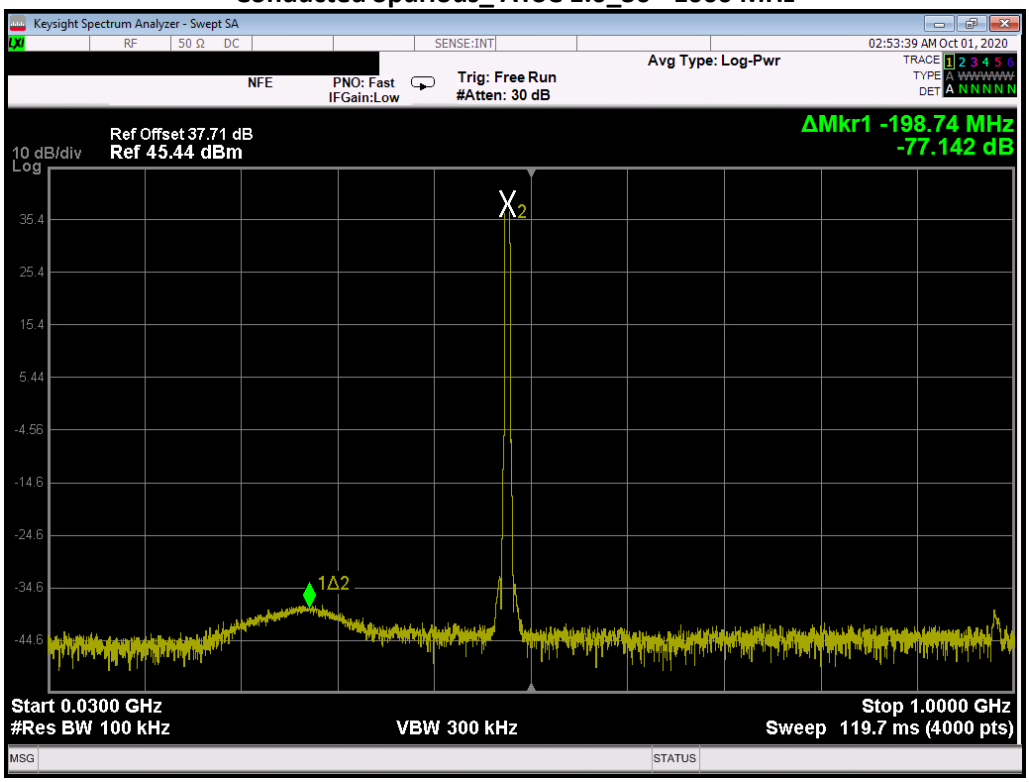


Conducted Spurious Emissions Summary Test Table

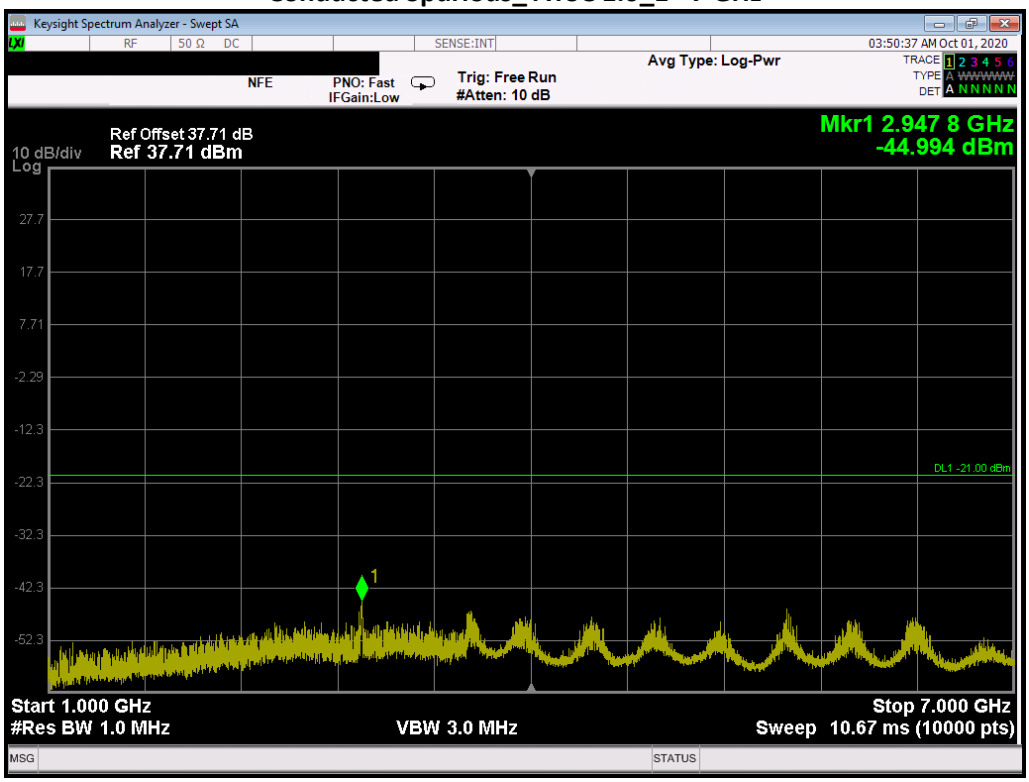
Frequency Range	Modulation	fundamental Power	Spurious Frequency	Measured Spurious Level		Specification Limit	Margin
(MHz)	(N/A)	(dBm)	(MHz)	(dBm)	(dBc)	(dBc)	(dB)
30 - 1000	ATSC 1.0	55.44	292.26	-21.7	77.14	75	-2.14
30 - 1000	ATSC 3.0	54.77	292.79	-21.69	76.46	75	-1.46
1000 - 7000	ATSC 1.0	55.44	2947.8	-44.99	100.43	75	-25.43
1000 - 7000	ATSC 3.0	54.77	3606.7	-36.22	90.99	75	-24.99
1164 - 1610	ATSC 1.0	55.44	1578.29	-51.13	106.57	85	-21.57
1164 - 1610	ATSC 3.0	54.77	1433.01	-50.64	105.41	85	-20.41

Conducted Spurious Emission Test Data

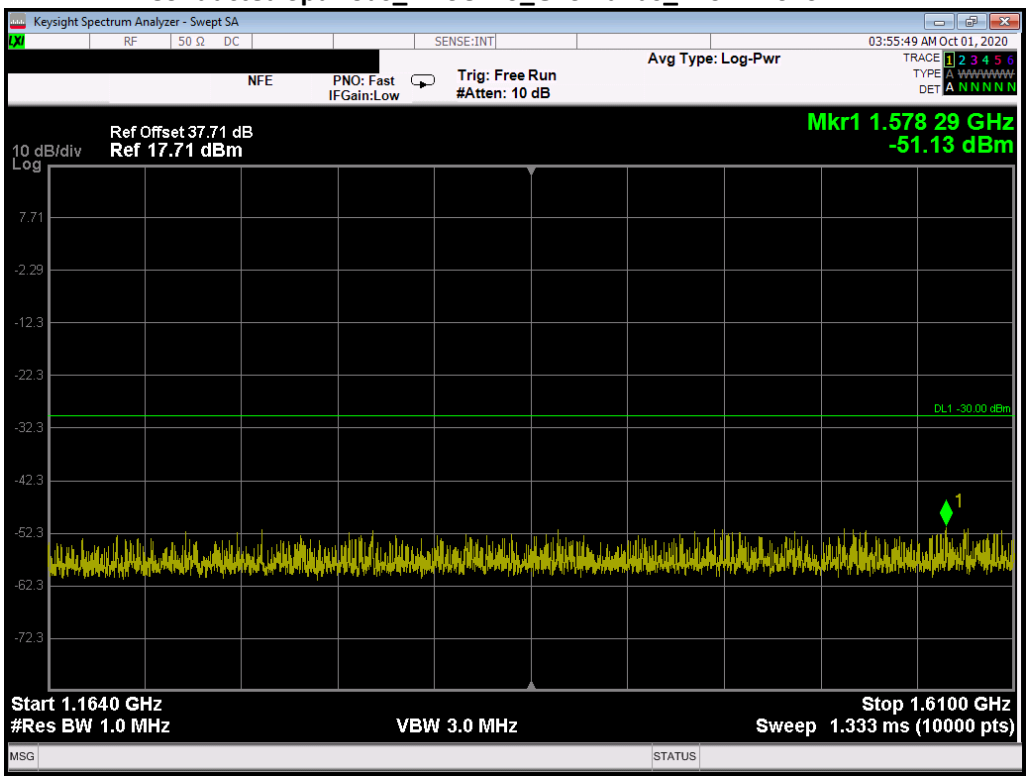
Conducted Spurious_ ATSC 1.0_30 - 1000 MHz



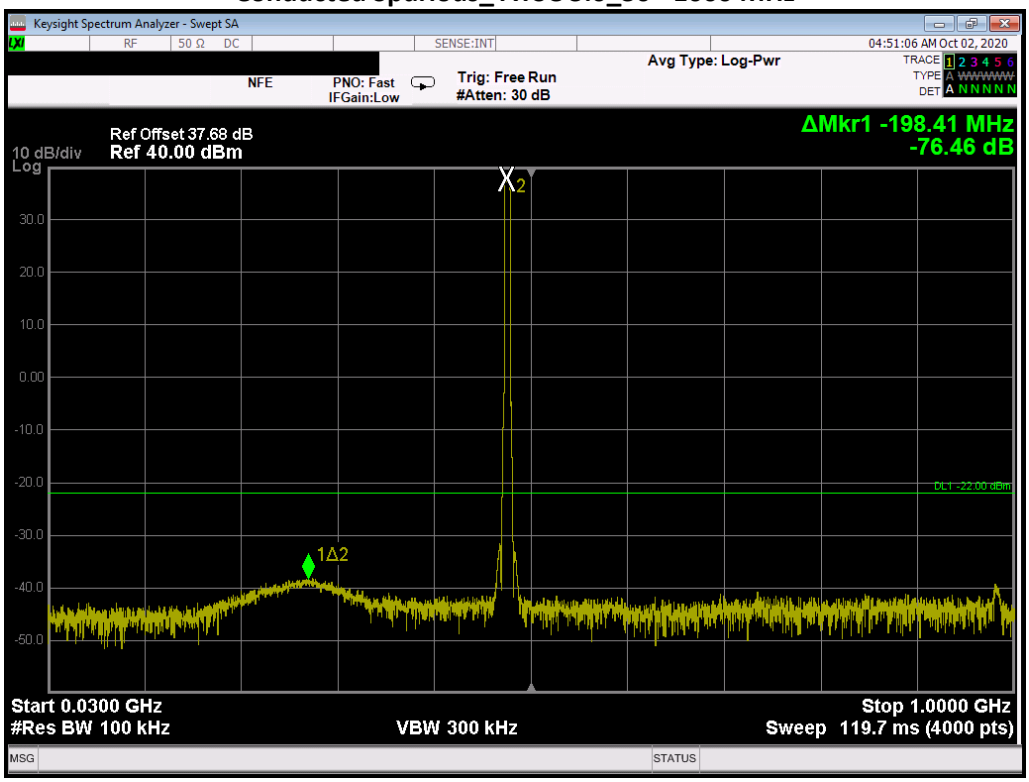
Conducted Spurious_ ATSC 1.0_1 - 7 GHz



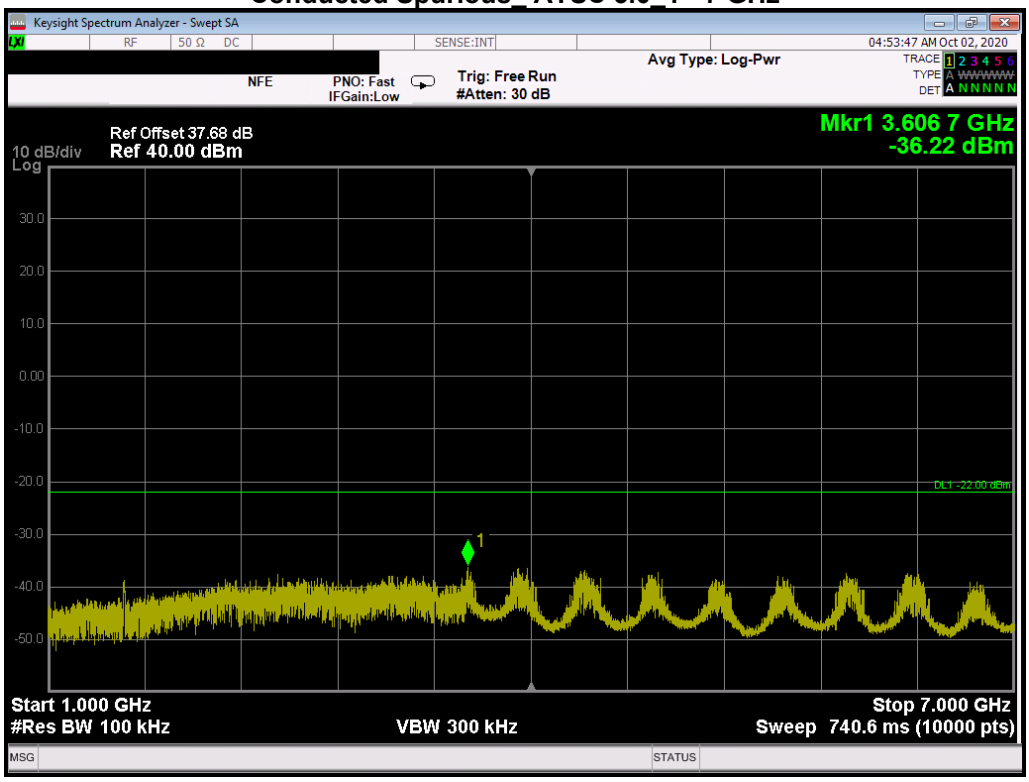
Conducted Spurious_ ATSC 1.0_GPS Bands_1164 - 1610 MHz



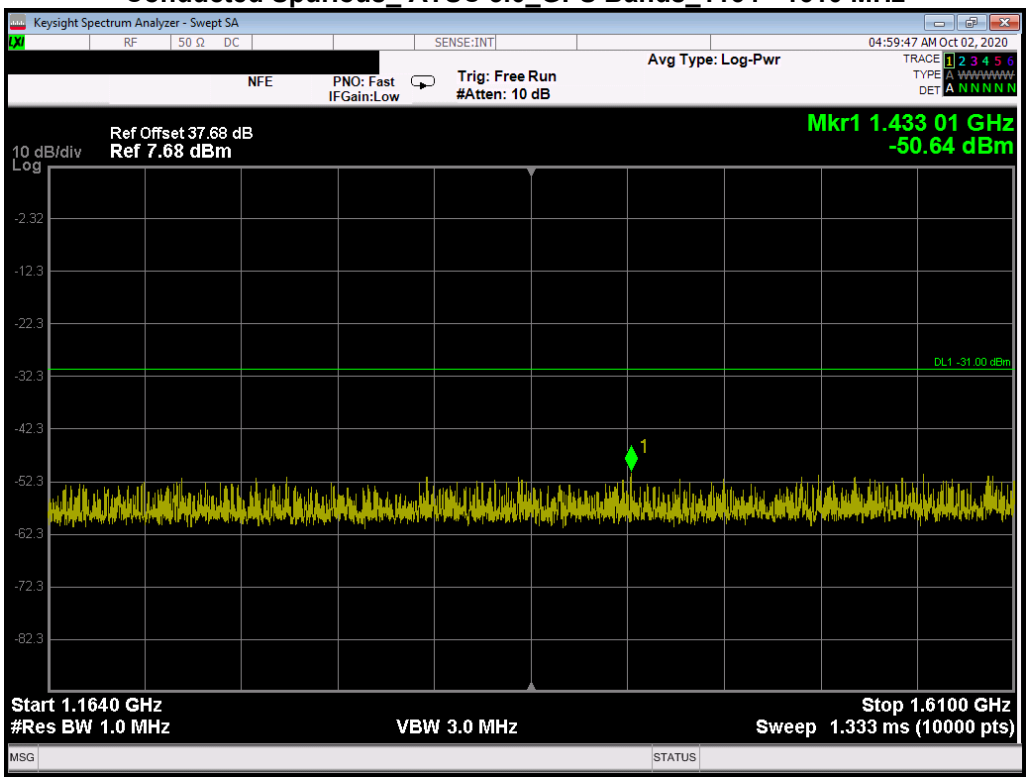
Conducted Spurious_ ATSC 3.0_30 - 1000 MHz



Conducted Spurious_ ATSC 3.0_1 - 7 GHz



Conducted Spurious_ ATSC 3.0_GPS Bands_1164 - 1610 MHz

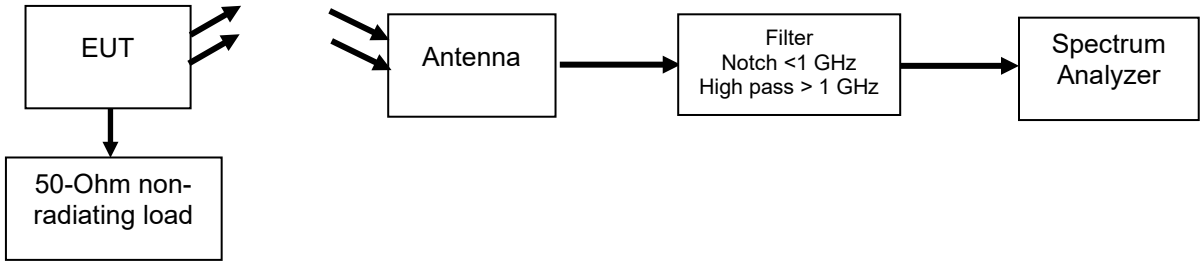


Field Strength of Spurious Radiation

Engineer:

Test Date:

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.
A spectrum analyzer was used to verify that the EUT met the requirements for radiated emissions.
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 491 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.
RBW = 500 kHz
VBW = 1.5 MHz
A pre-scan was performed using a peak detector and then final measurements were performed using an average detector.

Per FCC part 74.735(b) the output power is referenced as ERP.

Using the formulas in C63.26-2015, Annex C, the transmit power in watts was converted to electric field strength in dBuV/m.

Convert power in watts to field strength in V/m using the following formula.

$$ERP = pt \times gt = (E \times d)^2/49.2$$

$$E=(\text{sqrt}(pt*gt\text{x}49.2))/d$$

*p*t = transmitter output power in watts
*g*t = transmitting antenna numeric gain (see note)
E= electric field strength in V/m
d = measurement distance in meters

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

Convert field strength in V/m to field strength in dBuV/m using the following formula.

$$E(\text{dBuV/m}) = 20*\text{LOG}(E)$$

Spurious Level (dBc) = Referenced Output Power (dBuV/m) – Spurious Level (dBuV/m)

Radiated Spurious Emissions Test Results

ATSC 1.0 Modulation	Referenced Output Power		Spurious Frequency	Spurious Level		Spurious Limit (Stringent mask)	Margin
	watt	dBuV/m	MHz	dBuV/m	dBc	dBc	dB
Spurious_ below 1 GHz	351.3	152.83	40.987	64.46	88.374	76	-12.374
Spurious_ below 1 GHz	351.3	152.83	63.982	71.58	81.254	76	-5.254
Spurious_ below 1 GHz	351.3	152.83	99.587	56.56	96.274	76	-20.274
Spurious_ below 1 GHz	351.3	152.83	981.542	73.88	78.954	76	-2.954
Spurious_ above 1 GHz	351.3	152.83	1332.869	46.06	106.774	76	-30.774
Spurious_ above 1 GHz	351.3	152.83	1473.132	58.03	94.804	76	-18.804
Spurious_ above 1 GHz	351.3	152.83	1959.855	61.75	88.92	76	-12.92
Spurious_ above 1 GHz	351.3	152.83	2455.543	53.56	99.274	76	-23.274
Spurious_ above 1 GHz	351.3	152.83	2946.695	54.98	97.854	76	-21.854
Spurious_ above 1 GHz	351.3	152.83	4420.494	47.7	105.134	76	-29.134
GPS Band_1164 - 1215	351.3	152.83	1188.047	41.31	111.524	85	-26.524
GPS Band_1215 - 1240	351.3	152.83	1221.027	31.7	121.134	85	-36.134
GPS Band_1559 - 1610	351.3	152.83	1584.035	48.33	104.504	85	-19.504

ATSC 3.0 Modulation	Referenced Output Power		Spurious Frequency	Spurious Level		Spurious Limit (Stringent mask)	Margin
	watt	dBuV/m	MHz	dBuV/m	dBc	dBc	dB
Spurious_ below 1 GHz	300.3	152.15	41.299	66.77	85.383	76	-9.383
Spurious_ below 1 GHz	300.3	152.15	64.002	72.78	79.373	76	-3.373
Spurious_ below 1 GHz	300.3	152.15	981.543	74.25	77.903	76	-1.903
Spurious_ above 1 GHz	300.3	152.15	1472.255	65.92	86.233	76	-10.233
Spurious_ above 1 GHz	300.3	152.15	1966.657	65.31	86.843	76	-10.843
Spurious_ above 1 GHz	300.3	152.15	2455.593	60.62	91.533	76	-15.533
Spurious_ above 1 GHz	300.3	152.15	2948.558	51.25	98.75	76	-22.75
Spurious_ above 1 GHz	300.3	152.15	3928.92	50.99	101.163	76	-25.163
Spurious_ above 1 GHz	300.3	152.15	4422.77	47.5	104.653	76	-28.653
GPS Band_1164 - 1215	300.3	152.15	1187.984	47.42	104.733	85	-19.733
GPS Band_1215 - 1240	300.3	152.15	1220.976	30.92	121.233	85	-36.233
GPS Band_1559 - 1610	300.3	152.15	1584.009	47.57	104.583	85	-19.583

Annex A – Radiated Spurious Emission

Refer to Annex A for Radiated Spurious Emission plots.

Frequency Stability (Temperature Variation)

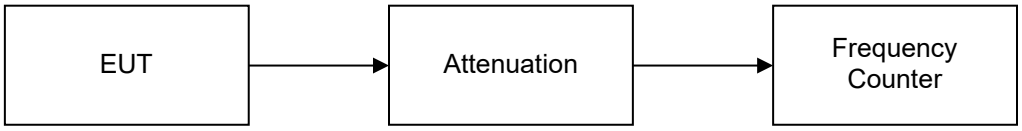
Engineer: Greg Corbin

Test Date: 10/6/2020

Measurement Procedure

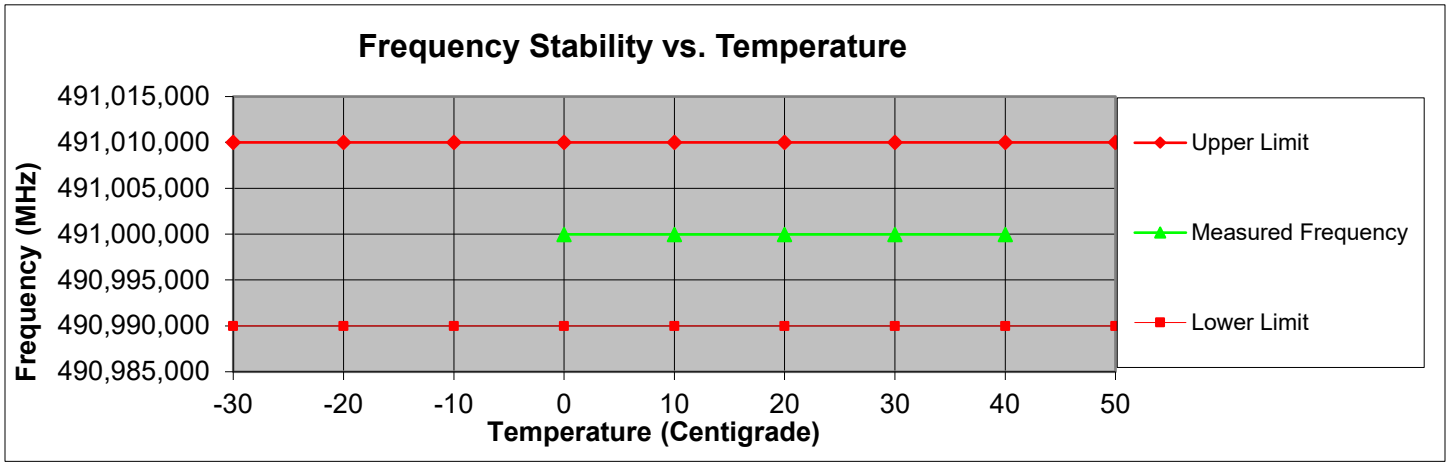
The Exact V2 digital exciter contains the frequency determining electronics and was tested for frequency stability. The exciter was placed in an environmental test chamber and the RF output was connected directly to a spectrum analyzer.
The temperature was varied from 0°C to 40°C in 10°C increments.
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



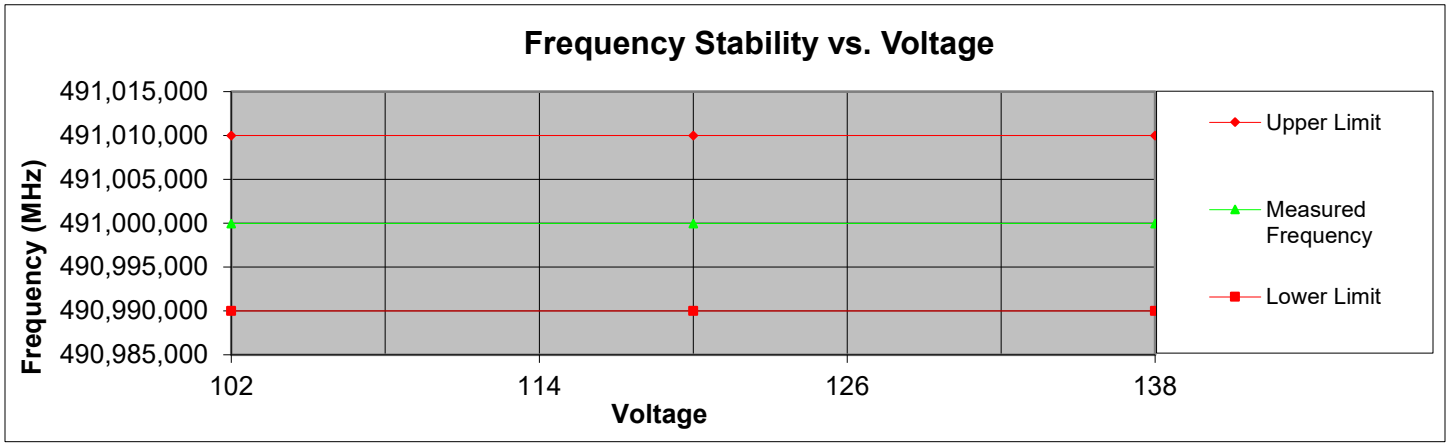
Frequency Stability vs Temperature

Tuned Frequency	Temperature	Tolerance	Measured Frequency	Upper Limit	Lower Limit	Upper Margin	Lower Margin
(MHz)	(deg C)	(Hz)	(MHz)	(MHz)	(MHz)	(MHz)	(MHz)
491	0	10000	490,999,979	491,010,000	490,990,000	-10,022	9,979
491	10	10000	490,999,978	491,010,000	490,990,000	-10,022	9,978
491	20	10000	490,999,977	491,010,000	490,990,000	-10,023	9,977
491	30	10000	490,999,975	491,010,000	490,990,000	-10,025	9,975
491	40	10000	490,999,977	491,010,000	490,990,000	-10,023	9,977



Frequency Stability vs Voltage

Tuned Frequency	Tolerance	Voltage	Measured Frequency	Upper Limit	Lower Limit	Upper Margin	Lower Margin
(MHz)	(PPM)	(PPM)	(MHz)	(MHz)	(MHz)	(MHz)	(MHz)
491	10000	102	490,999,976	491,010,000	490,990,000	-10,024	9,976
491	10000	120	490,999,977	491,010,000	490,990,000	-10,023	9,977
491	10000	138	490,999,976	491,010,000	490,990,000	-10,024	9,976



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
EMI Receiver	Keysight	N9038A	i00552	9/9/2019	9/9/20 **
Horn Antenna	ARA	DRG-118/A	i00271	8/3/20	8/3/21
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
Coaxial Resistor (10 kw load)	Termaline	8936-115	i01547	N/A	N/A

** 30 day calibration extension approved by lab manager

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