Certification of Compliance
ULX System TV Transmitter
FCC Title 47

This document is compiled to provide the data and records supporting a Certification of Compliance with FCC Rules set forth in 47CFR Parts 2 and 27. Certification as described in Part 2, Subpart J applies to all subsequent identical units marketed.

Use of the Certification method requires that the required records are filed accompanying FCC Form 731. The test record shall be retained as required by 2.938(c).

This series of transmitters is for use in a single frequency network for mobile video. They will operate in the 722-728 MHz band as authorized under FCC 47CFR27, on a single channel (56) with center frequency of 725 MHz. The Emission Designator is 6M00C7W. The modulation is a 6 MHz ATSC signal.

The power level models differ in the number of power amplifiers that are used to attain that power level, with just two power amplifiers used for 1600W, up to eight for 6300W. The performance of multiple power amplifiers will be very close to the performance of any single power amplifier.

The intention of these tests is to demonstrate, by tests conducted on a ULX-6300AT, the compliance of this series of transmitters. Our basis for this is that the performance of each of the transmitters is entirely governed by the performance of the individual modules. Therefore, measurements of the ULX-6300AT provide a sound basis to project the performance which will be shown by other models.

Manufacturer	Harris Broadcast Communications
Street Address	3200 Wismann Lane
City, State, Zip	Quincy, IL 62305
Product being certified	ULX Transmitter Series for Mobile Video
Models	ULX-6300AT, ULX-4700AT, ULX-3800AT, ULX-3200AT, ULX-2400AT, and ULX-1600AT.
FCC Identifier	BOI-ULXATSC
Type of Emission	6M00C7W, Single Frequency Network
Frequency Range	One 6 MHz channel 722-728 MHz (Channel 56)
Power Range	Adjustable from zero to rated power
Maximum Power	6300 watts ahead of the output filter
Model Tested	ULX-6300AT
Assembly Number	9950225102G
Serial Number Tested	JW30001805-015
Test Location	Harris Bldg 5, 2700 Ellington Road, Quincy, IL

Persons responsible for testing are:

Terry Hollenberg

Digitally signed by Terry Hollenberg
DN: cn=Terry Hollenberg, o, ou, email=thollenb@harris.com, c=US
Date: 2010.03.04 17:17:17 -06'00'

(Date)

Bryce Robertson

Digitally signed by Bryce Robertson
DN: cn=Bryce Robertson, o, ou, email=broberts@harris.com, c=US
Date: 2010.03.04 17:24:53 -06'00'

(Date)

Table of Contents

As an aid to locating needed information in this document, the following Table of Contents links each portion of the record with the appropriate Rule and locates it in this document by page number.

Rules and Standards Applied in these Measurements

Requirement:	Standard/Procedure
2.1046 (a), (c) RF Power Output	The output power of the transmitter was determined while operating into a standard test load, using a calibrated RF power meter.
2.1047 Modulation Characteristics	Show that the modulation requirements are met.
2.1049 Occupied Bandwidth	Measured at the system output.
2.1051 Spurious Emissions	Measured at the system output. The carrier level is reduced from its reference level by using a notch filter to minimize harmonic generation in the spectrum analyzer. The coupling factor of the RF sample, cable loss, and notch filter response are accounted. 27.53(g) provides the emission limits.
2.1053 Field Strength of Spurious Radiation 27.53(g)	Output power from the transmitter was used as the reference output power to calculate the radiated spurious emissions. The measurements were conducted in an open factory area. The required limit in relation to the reference carrier level was calculated according to the method given in 27.53(g). The calculation of the reference transmitted field, and of the required spurious radiation limit, are given in the report, and the measurements and the calculated result are shown in tabular form. Direct readings were validated using the substitution method described in ANSI/TIA-603C:2004.
2.1055 Frequency Stability	Measurements made on the exciter in a temperature-controlled chamber, with a variac controlling the AC input voltage.
2.1057 Frequency Spectrum to be investigated	Measurements are made from the lowest frequency generated to the 10th harmonic.

(Note: The text shown with a gray background was copied from the FCC rules. Some of the answers fulfilling these requirements are provided on the first page of this report.)

1. Rule 47CFR2.938 Retention of records.

(a) For each equipment subject to the Commission's equipment authorization standards, the responsible party shall maintain the records listed as follows:

(1) A record of the original design drawings and specifications and all changes that have been made that may affect compliance with the standards and the requirements of Sec. 2.931.

(2) A record of the procedures used for production inspection and testing to ensure conformance with the standards and the requirements of Sec. 2.931.

(3) A record of the test results that demonstrate compliance with the appropriate regulations in this chapter.

(b) The provisions of paragraph (a) of this section shall also apply to a manufacturer of equipment produced under the provisions of Sec. 2.929(b). The retention of the records by the manufacturer under these circumstances shall satisfy the grantee's responsibility under paragraph (a) of this section.

(c) The records listed in paragraph (a) of this section shall be retained for one year for equipment subject to authorization under the certification procedure or former type acceptance procedure, or for two years for equipment subject to authorization under any other procedure, after the manufacture of said equipment has been permanently discontinued, or until the conclusion of an investigation or a proceeding if the responsible party (or, under paragraph (b) of this section, the manufacturer) is officially notified that an investigation or any other administrative proceeding involving its equipment has been instituted.

(d) If radio frequency equipment is modified by any party other than the original responsible party, and that party is not working under the authorization of the original responsible party, the party performing the modifications is not required to obtain the original design drawings specified in paragraph (a)(1) of this section. However, the party performing the modifications must maintain records showing the changes made to the equipment along with the records required in paragraphs (a)(3) of this section. A new equipment authorization may also be required. See, for example, Sec. Sec. 2.909, 2.924, 2.933, and 2.1043.

2. Rule 47CFR2.1033 Application for certification.

Note: Only the applicable paragraphs are shown.

(a) An application for certification shall be filed on FCC Form 731 with all questions answered. Items that do not apply shall be so noted.

(c) Applications for equipment other than that operating under parts 15 and 18 of the rules shall be accompanied by a technical report containing the following information:
(1) The full name and mailing address of the manufacturer of the device and the applicant for certification.

(2) FCC identifier.

(3) A copy of the installation and operating instructions to be furnished the user. A draft copy of the instructions may be submitted if the actual document is not available. The actual document shall be furnished to the FCC when it becomes available.

(4) Type or types of emission.

(5) Frequency range.

(6) Range of operating power values or specific operating power levels, and description of any means provided for variation of operating power.

(7) Maximum power rating as defined in the applicable part(s) of the rules.

(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

(9) Tune-up procedure over the power range, or at specific operating power levels.

2.1. Harris Response

The amplifiers and signal generating equipment are solid-state and are not tuned. Operational and maintenance adjustments available to the user are described in the technical manuals.

(10) A schematic diagram and a description of all circuitry and devices provided for determining and stabilizing frequency, for suppression of spurious radiation, for limiting modulation, and for limiting power.

2.2. Harris Response

The frequency of operation is locked to an external GPS receiver and is therefore extremely stable. If the source is lost temporarily, the internal frequency stability is ±1 ppm. The submitted user manual for the exciter provides a description of the frequency control method.

Spurious emissions through the output port of the transmitter are limited by the bandwidth shaping of the exciter, and by an output bandpass filter.

The transmitter accepts a SMPTE 310 input from an external source and as such does not create or modify the audio or video standards as outlined in the ATSC specifications.

Power output is variable by an operating adjustment from 0 to the rated power, either by an operator at the transmitter, or by a remotely-connected control system. The power is regulated by the transmitter's control system to ±3% of the level set by the operator. Descriptions in the user manuals provide details of the product's operation.

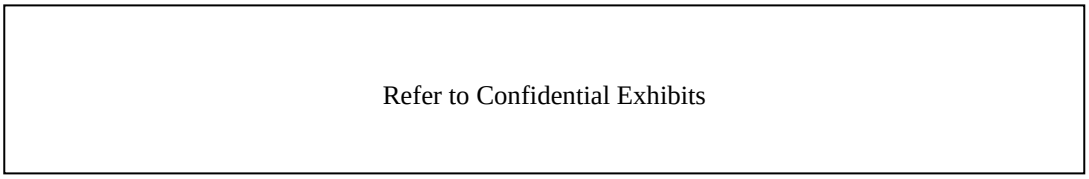


Figure 1, Exciter Block Diagram

(11) A photograph or drawing of the equipment identification plate or label showing the information to be placed thereon.

2.3. Harris Response

An example of an Identification Plate to be attached to the ULX and its location:

HARRIS GATES®

MODEL: ULX-6300AT DATE:

PART NO: 9920225102G FCC ID: BOI-ULXATSC

SERIAL NO: OTHER ID:

FREQUENCY: 722-728 MHz

CHANNEL: 56

POWER OUT: 6.3 KW X AVG ___ PK

208 VAC 3 PHASE 60 HZ 31.5 KW MAX

HARRIS CORPORATION
BROADCAST COMMUNICATIONS DIVISION Quincy, Illinois, USA

Figure 2, Example ID Plate

Figure 3, ID Plate Location

(12) Photographs (8x10) of the equipment of sufficient clarity to reveal equipment construction and layout, including meters, if any, and labels for controls and meters and sufficient views of the internal construction to define component placement and chassis assembly. Insofar as these requirements are met by photographs or drawings contained in instruction manuals supplied with the certification request, additional photographs are necessary only to complete the required showing.

2.4. Harris Response

The photos that follow illustrate the ULX transmitter model.

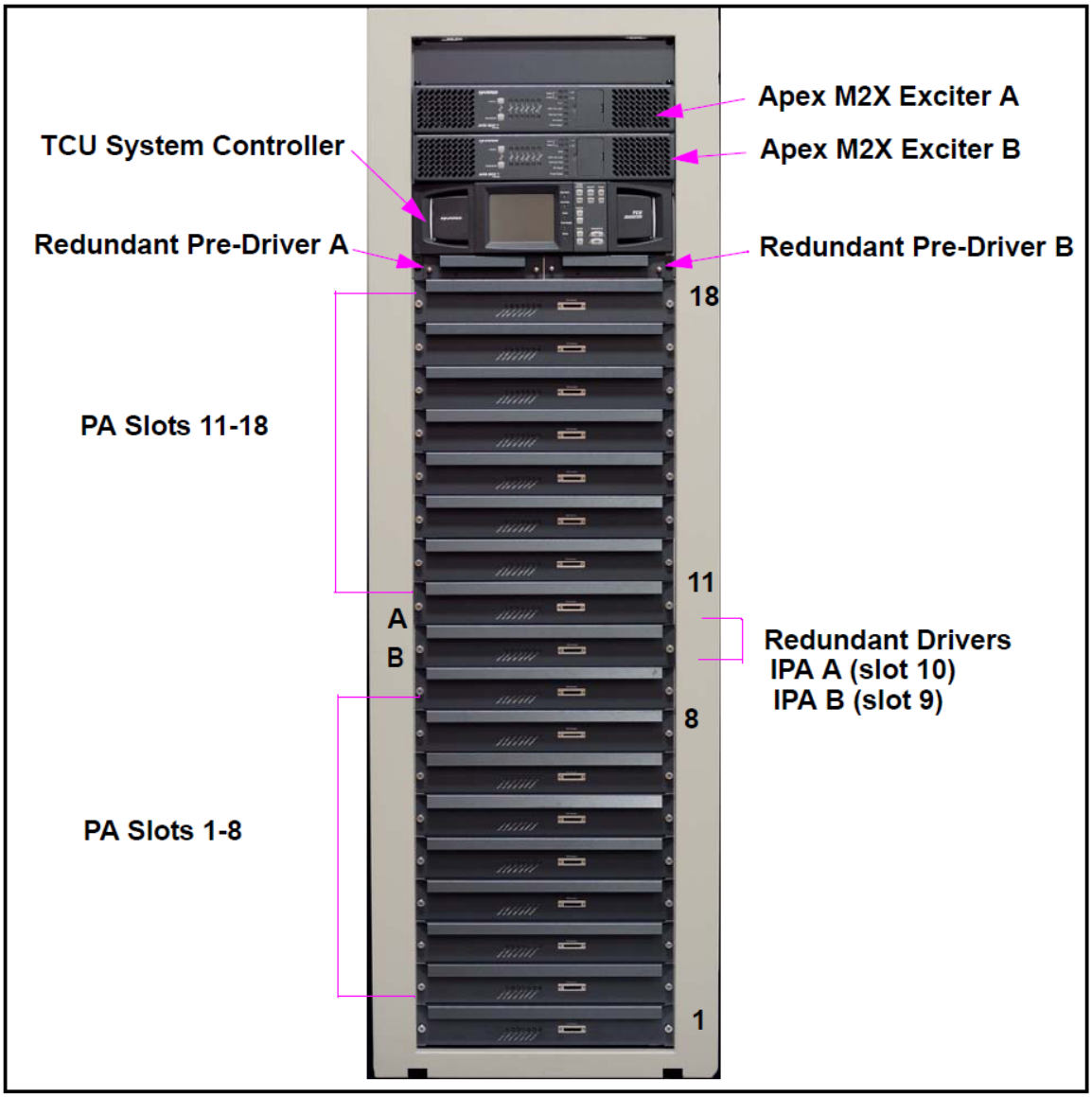


Figure 4, ULX Front View

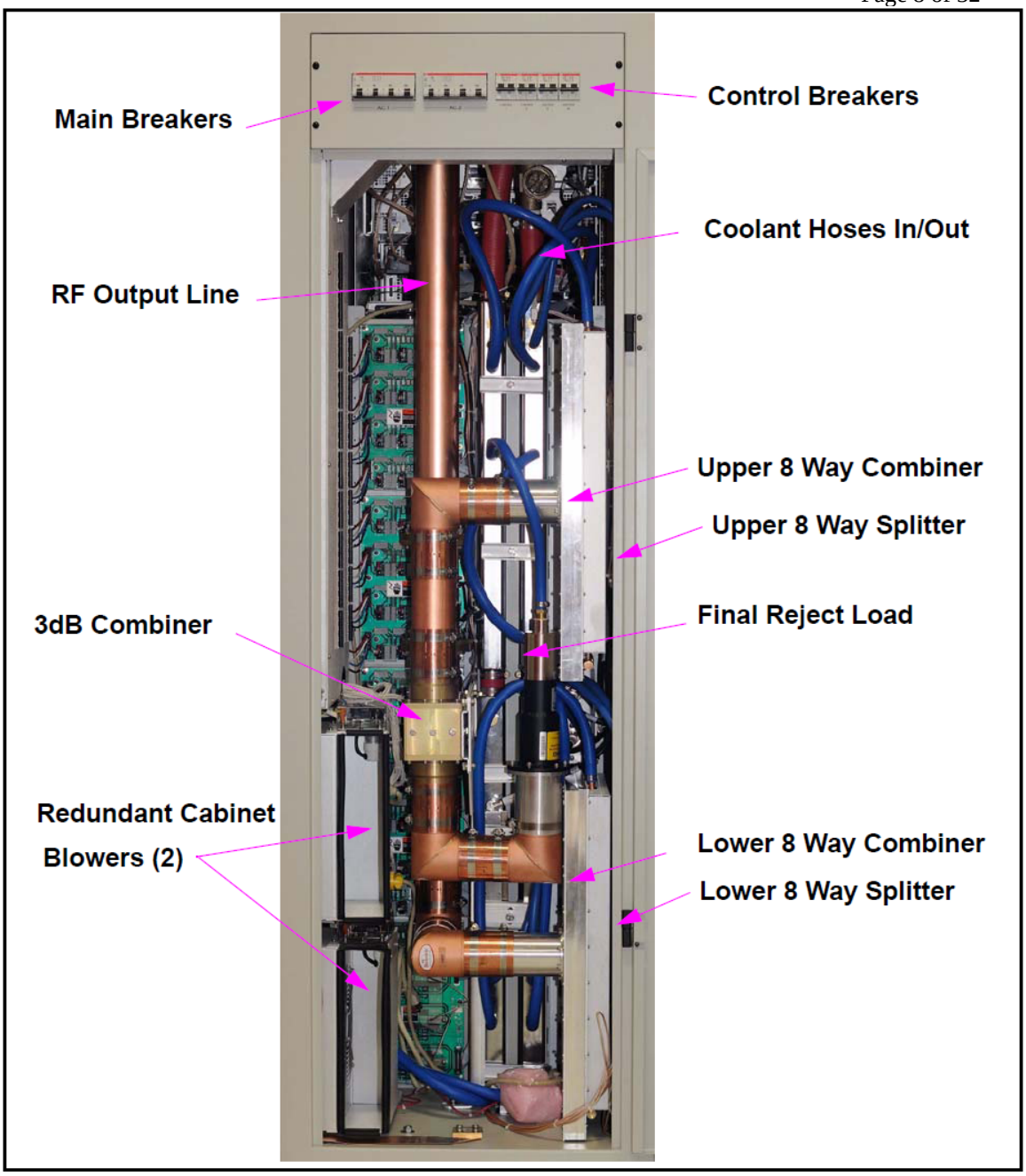


Figure 5, ULX Rear View, Door Removed

Figure 6, Unit Tested: ULX-6300AT

3. General Information

Refer to Confidential Exhibits

Figure 7, ULX Transmitter Block Diagram

Model Number	Power Output	PA Modules	Assembly Number
ULX-1600AT	1600 Watts	2	
ULX-2400AT	2400 Watts	3	
ULX-3200AT	3200 Watts	4	
ULX-3800AT	3800 Watts	5	
ULX-4700AT	4700 Watts	6	9950224120G
ULX-6300AT	6300 Watts	8	9950225102G

(13) For equipment employing digital modulation techniques, a detailed description of the modulation system to be used, including the response characteristics (frequency, phase and amplitude) of any filters provided, and a description of the modulating wavetrain, shall be submitted for the maximum rated conditions under which the equipment will be operated.

3.1. Harris Response

The modulation is a 6 MHz ATSC signal.

(14) The data required by Sec. Sec. 2.1046 through 2.1057, inclusive, measured in accordance with the procedures set out in Sec. 2.1041.

3.2. Harris Response
All data required by Sec. 2.1046 through 2.1057, inclusive, will be provided in the Report.

4. Rule 47CFR 2.1046 Measurements required: RF power output.

Note: Only the applicable paragraphs are shown.

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in Sec. 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

Note: 2.1033(c)(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

4.1. Test Methodology

The pre-filter output coupler of the transmitter was swept with a network analyzer to determine its coupling factor. The transmitter was operated into the test load. The forward sample from the directional coupler was then read on a calibrated power meter, with the calibration factors of the meter set for the transmitter frequency. The power measured was ahead of the output filter.

The RF load was an Altronic 9780E3, which is rated 80,000 watts, DC to 800 MHz, with a VSWR of <1.10:1.

4.2. Test Equipment Used

Equipment	Model	Asset	Cal Date	Cal Due
Agilent ENA Network Analyzer	E5071C	13121	10/7/2009	10/7/2010
Agilent EPM Power Meter	E4418B	10366	2/11/2009	2/11/2010
Altronic dummy load	9780E3	10387		

4.3. Power Output Test Results

Coupler Offset Applied: -47.87 dB

Model	Power (W)	PA V	PA8 (A)	PA7 (A)	PA6 (A)	PA5 (A)	PA4 (A)	PA3 (A)	PA2 (A)	PA1 (A)
ULX-1600AT	1610	50	58.3	61.4						
ULX-2400AT	2410	50	61.9	60.2	62.6					
ULX-3200AT	3240	50	54.4	53.8	54.3	54.3				
ULX-3800AT	3820	50	59.9	61.5	62.8	62.6	61.1			
ULX-4700AT	4770	50	62.7	64.9	63.2	61.4	63.3	62.8		
ULX-6300AT	6330	50	62.2	61.6	63.2	62.4	64.5	63.8	65.6	65.6
ULX-6300AT	6340	50	61.3	59.8	61.6	60.2	62.4	61.2	63.4	64.4

5. Rule 47CFR2.1047 Measurements required: Modulation characteristics.

Note: Only the applicable paragraphs are shown.

(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

5.1. Harris Response

The modulation is a 6 MHz ATSC signal, and as such is only recognizable to an ATSC receiver. Plots included in this report will show that the bandwidth occupied is within the 6 MHz channel.

6. Rule 47CFR2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(h) Transmitters employing digital modulation techniques--when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

6.1. Test Methodology

A sample of the transmitter RF output was taken from the forward output of the post-filter directional coupler and connected to a spectrum analyzer. An internal test signal was used to modulate the transmitter. The reference level on the spectrum analyzer was set with the resolution bandwidth set equal to or greater than the 6 MHz channel. The resolution bandwidth was then reduced in order to provide an accurate presentation of the signal, which was reached at a 10 kHz RBW. Decreasing it further made no apparent difference in the appearance of the signal.

6.2. Occupied Bandwidth Test Setup

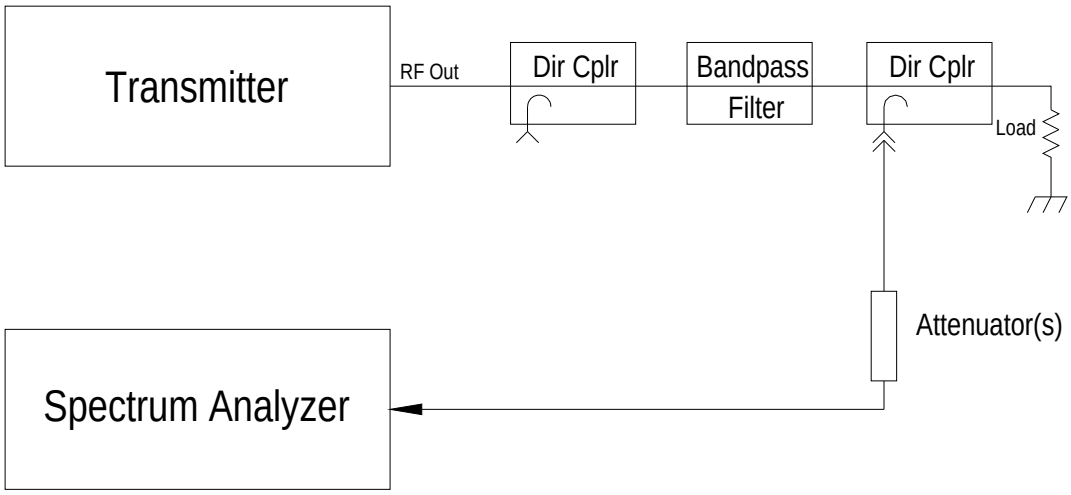


Figure 8, Occupied Bandwidth Setup Diagram

6.3. Test Equipment Used

Equipment	Model	Asset	Cal Date	Cal Due
Anritsu Signal Analyzer	MS2691AA	13128	11/2/2009	11/2/2010
Agilent Signal Analyzer	MXA	13186	1/11/2010	1/11/2011
Agilent ENA Network Analyzer	E5071C	13121	10/7/2009	10/7/2010
Coax RG-316DS, 8 ft long				

6.4. Test Results

The plot that follows shows that the 99% occupied bandwidth of the signal is 5.4271 MHz, which complies with the 6MHz allowed.

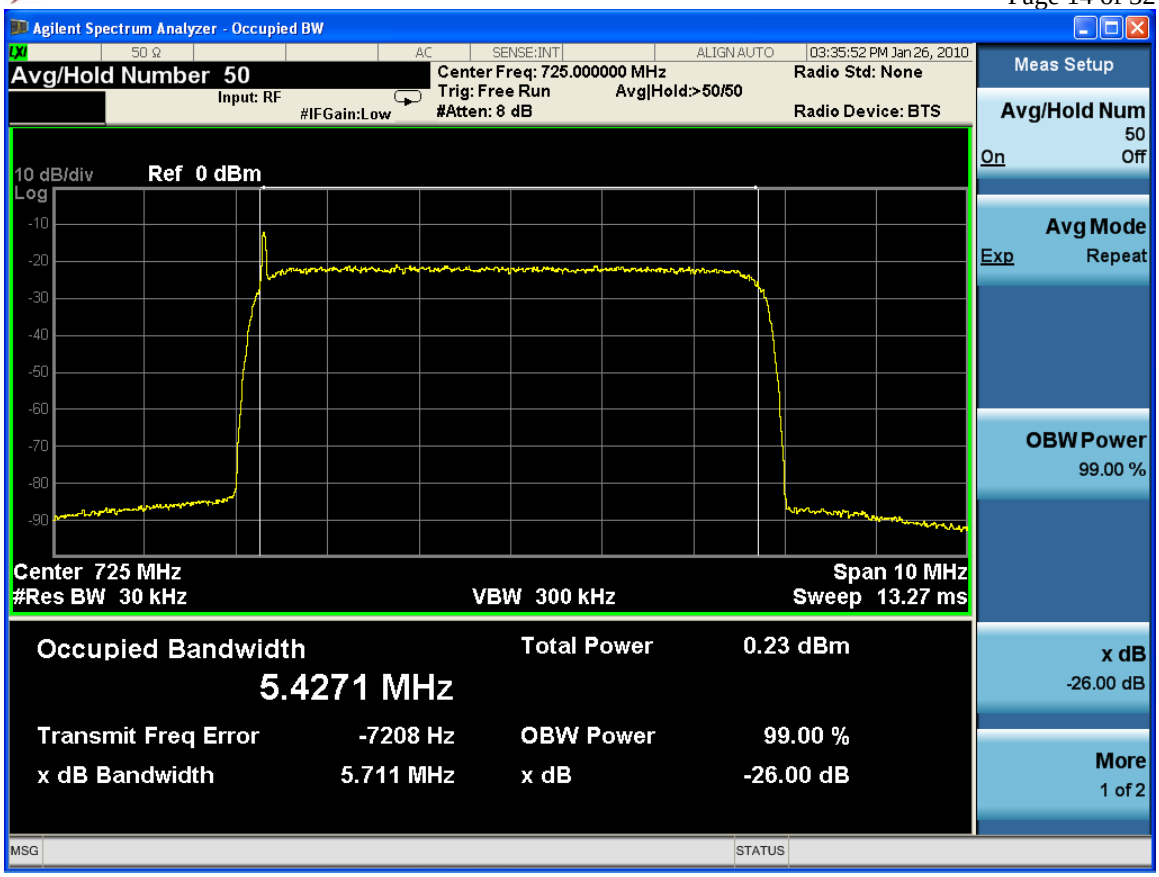


Figure 9, Occupied Bandwidth at System Output

7. *Rule 47CFR2.1051 Measurements required: Spurious emissions at antenna terminals.*

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

7.1. Test Methodology

We refer to the following rule from Part 27:

47CFR27.53(g) For operations in the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

We interpret this requirement to mean the power of emissions at any frequency outside the licensed channel, measured in a 100 kHz bandwidth, must be lower than (P) – (43 + 10log(P)), where (P) is the total power emitted inside the channel.

Use of a lesser resolution bandwidth, but no lower than 30 kHz, may be used immediately adjacent to the channel edges.

The EUT operates with a Necessary Bandwidth of 6 MHz. The measurements are to use a 100 kHz bandwidth. The transmitted signal uses a broad-spectrum modulation whose actual level is only displayed if the instrument bandwidth is equal to or wider than the transmitted channel. If the spectrum is observed using a spectrum analyzer set to 100 kHz resolution bandwidth, the measured amplitude of the in-band signal will appear to be 17.8 dB lower (10 x log(6000/100) than the actual level.

The same calculation must be made for a resolution bandwidth of 30 kHz, if used. The result of the calculation is 23 dB (10 x log(6000/30)), and for measurements using 30 kHz resolution bandwidth the correction becomes 23 dB, meaning the in-band signal will appear 23 dB lower than it actually is.

The Calculated Limit
For the 6300 watt EUT, the required limit (dBc) for out of band emissions limit becomes:

- (43 + 10log(6300)) = -81 dBc

7.2. Spurious Emissions Test Setup

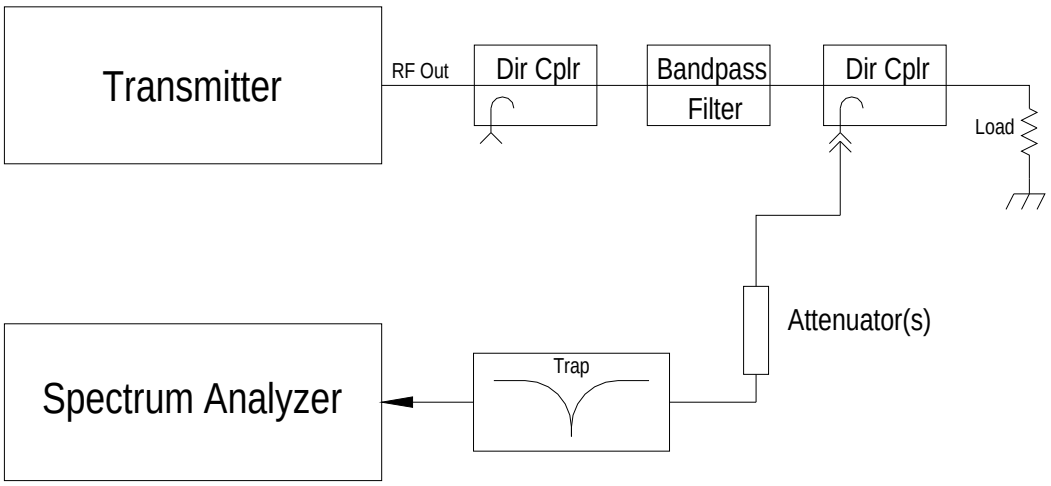


Figure 10, Spurious Setup Diagram

The setup varies slightly, depending on the measurement at hand. Close-in (adjacent channel) spurious emissions are checked without using a notch filter, as this would distort the results. The coupling factor and cable loss are irrelevant in this measurement due to the narrow span. The markers are referenced to the transmitting channel as displayed at the measurement bandwidth. To show the true level of the transmitting channel, a resolution bandwidth equal to or greater than the necessary bandwidth of 6 MHz would be used. With a resolution bandwidth of 30 kHz, the transmitting channel signal level appears 23 db lower than actual. This is determined by the relationship, dB = 10*log(6000/30).

Since the rule specifies 100 kHz resolution bandwidth, the difference between 100 kHz and the bandwidth used must be taken into account. In this case, dB = 10*log(100/30) = 5.2 dB.

Wideband measurements, such as harmonic measurements, utilize a notch filter to minimize harmonic generation in the analyzer. Also the response of the coupler, notch filter, cable and attenuators must be taken into account.

7.3. Test Equipment Used

Equipment	Model	Asset	Cal Date	Cal Due
Anritsu Signal Analyzer	MS2691AA	13128	11/2/2009	11/2/2010
Agilent Signal Analyzer	MXA	13186	1/11/2010	1/11/2011
Agilent ENA Network Analyzer	E5071C	13121	10/7/2009	10/7/2010
Eagle Notch Filter	230NFNF			
Coax Cable RG-316DS, 8 ft				

7.4. Spurious Test Results, Close-In

The Channel Power plots that follow will show that the +/- 100 kHz adjacent bands to be compliant with the emission limitations. For reference, the plot below shows a 6MHz channel centered on 725 MHz. This shows a channel power of 0.21 dBm.

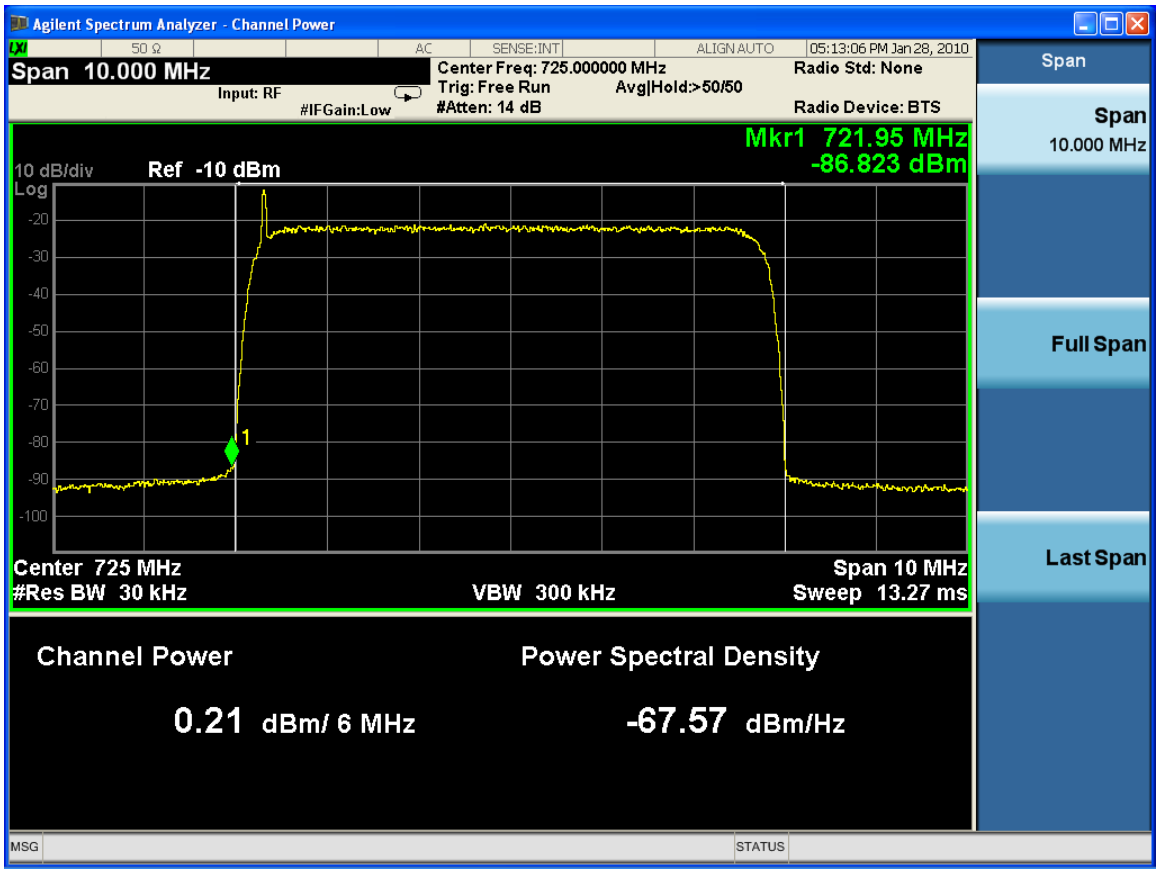


Figure 11, Channel Power Reference

The adjacent 100 kHz below carrier shows a channel power level of -82.06 dBm in 100 kHz bandwidth.

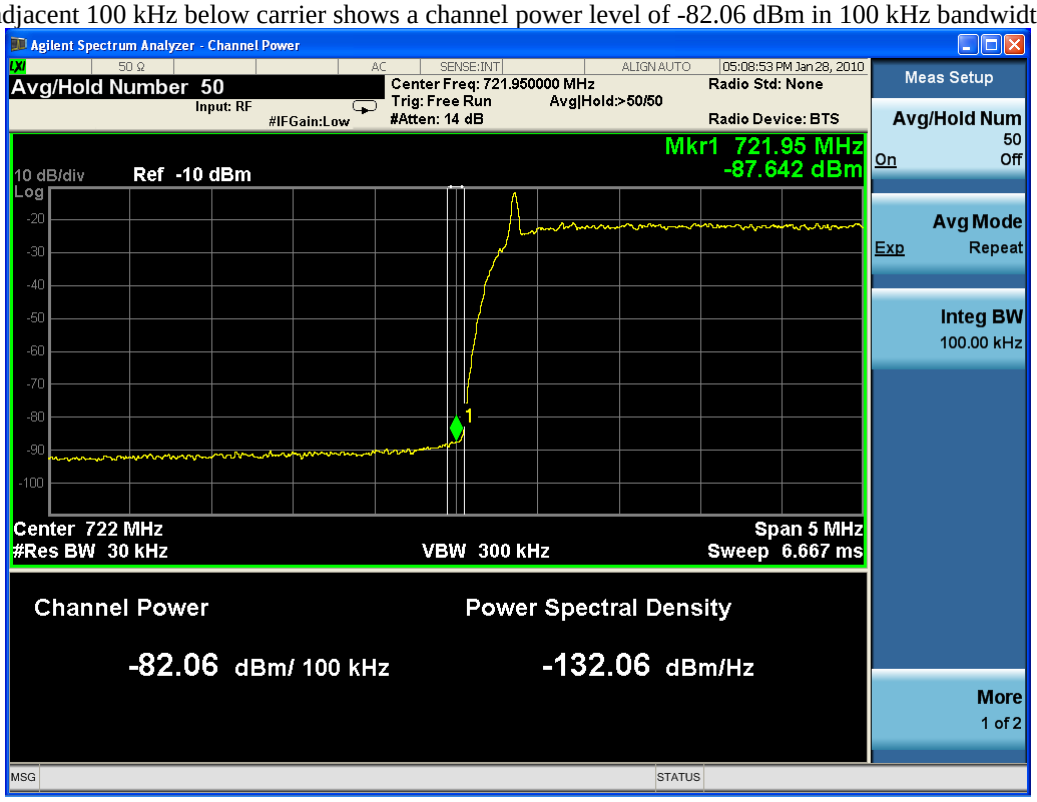


Figure 12, Lower Adjacent Channel Power

The adjacent 100 kHz above carrier shows a channel power of -84.01 dBm in 100 kHz bandwidth.

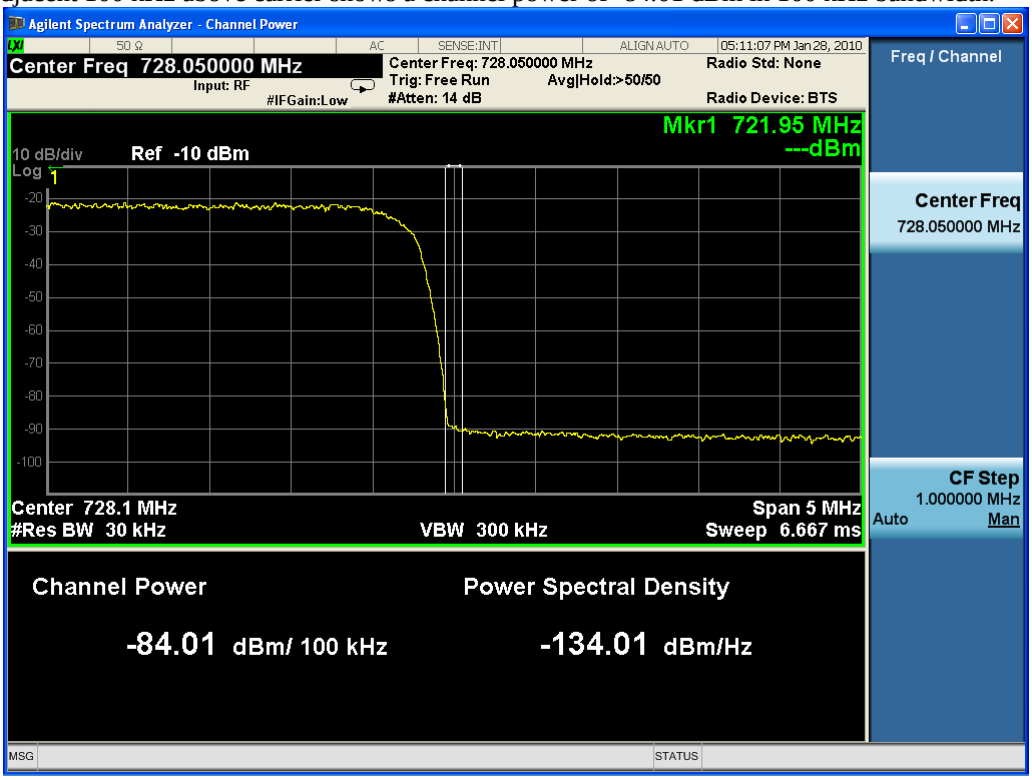


Figure 13, Upper Adjacent Channel Power

7.5. Spurious Test Results, Wideband

The measured data was corrected for the coupling values and notch filter loss to derive the actual levels in the transmission line.

The results are tabulated below. In this table the notch filter and coupler data have been normalized to the carrier level, so that the dBc values can be found from the formula:

dBc = Marker Δ - Coupling Δ - Notch -Cable Δ

MHz	Marker Δ	Coupler	Coupling Δ	Notch	Cable + Pad	Cable Δ	dBc	Limit	Margin
728.0	-92.3	-47.8	0.03	0	-19.77	0.00	-92.3	-81	11.3
898.5	-93.7	-45.9	1.98	-1.69	-19.81	-0.04	-94.0	-81	13.0
1444.0	-85.6	-41.5	6.42	-0.03	-20.17	-0.40	-91.6	-81	10.6
2169.0	-84.8	-31.2	16.66	-0.01	-20.43	-0.66	-100.8	-81	19.8
2894.0	-83.9	-32.5	15.37	-0.04	-20.43	-0.66	-98.6	-81	17.6
3619.0	-84.1	-32.6	15.27	-0.37	-20.92	-1.15	-97.9	-81	16.9
4344.0	-84.7	-18.9	28.94	-0.36	-23.49	-3.72	-109.6	-81	28.6
5069.0	Noise Floor	NA	NA	NA	NA	NA	NA	-81	NA
5794.0	Noise Floor	NA	NA	NA	NA	NA	NA	-81	NA
6519.0	Noise Floor	NA	NA	NA	NA	NA	NA	-81	NA
7244.0	Noise Floor	NA	NA	NA	NA	NA	NA	-81	NA

The sequence of plots that follow show the progression of the test setup, starting with examining the signal at 6 MHz resolution bandwidth, then 100 kHz resolution bandwidth, then notching the signal, and then increasing the level. This is followed by plots that show the spectrum below and above the transmitting channel. Plots such as those were used to obtain the marker delta readings used in the table above.

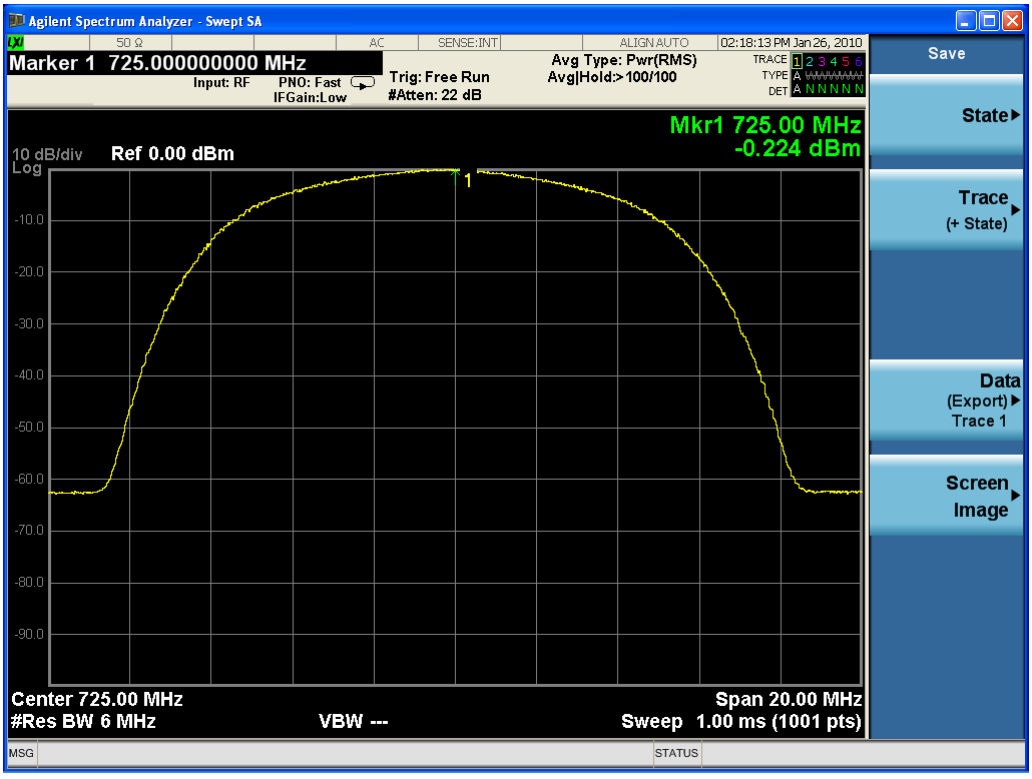


Figure 14, Transmitter Output in 6 MHz BW

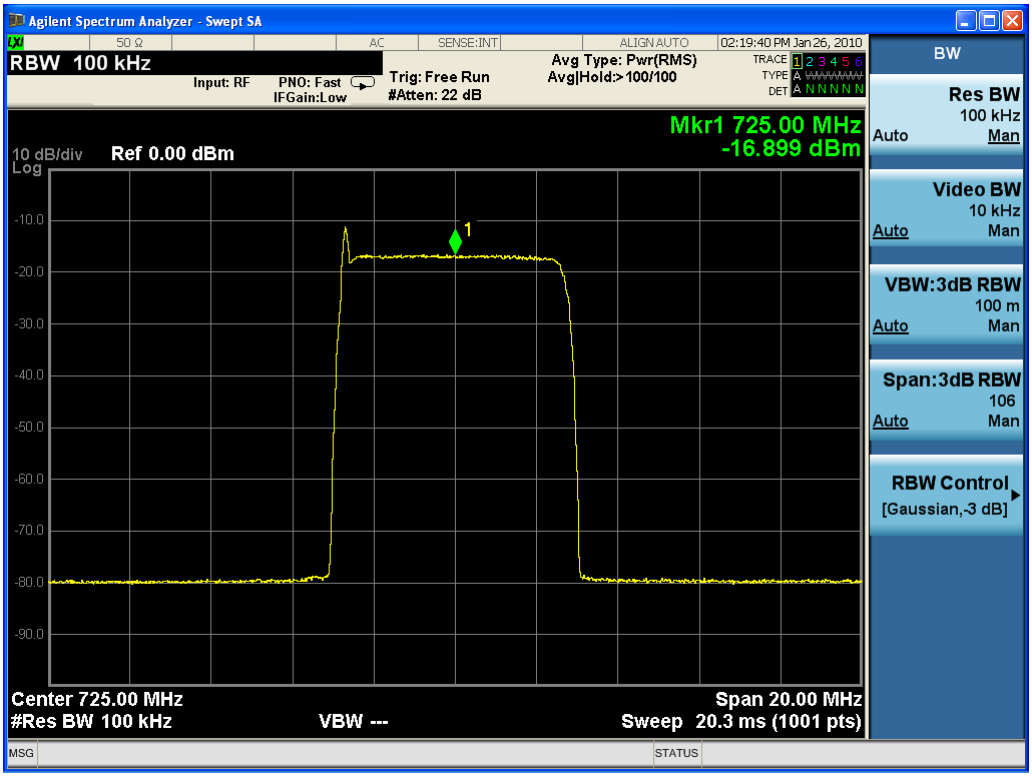


Figure 15, Transmitter Output in 100 kHz BW

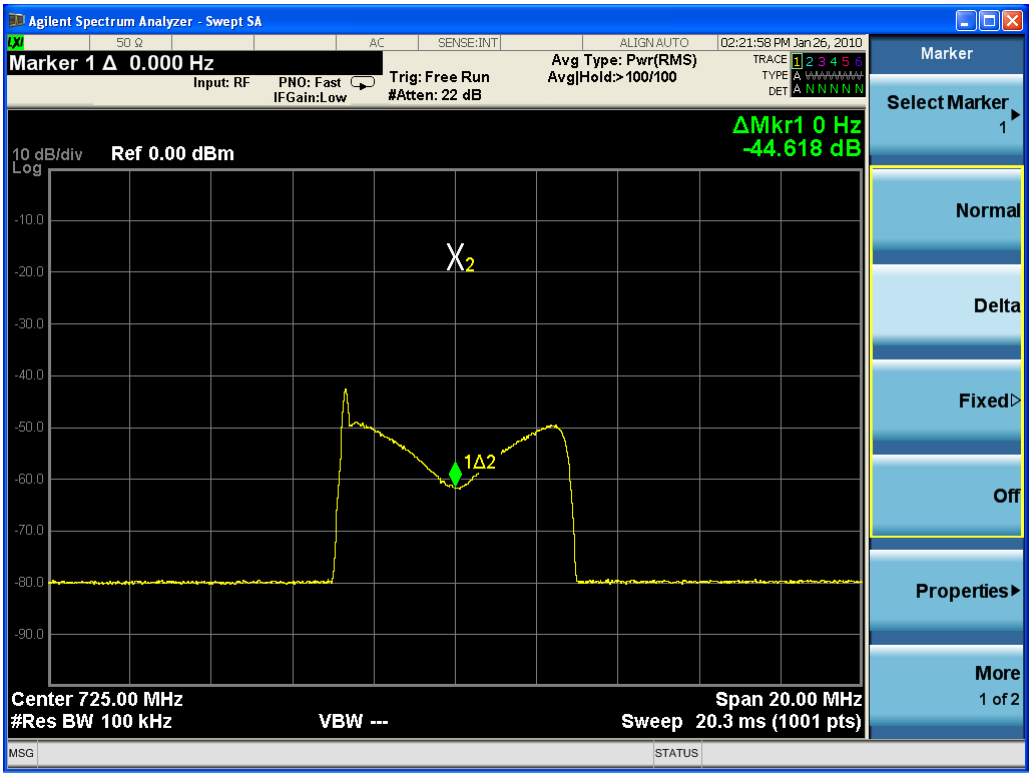


Figure 16, Transmitter Output with Carrier Notch Filter

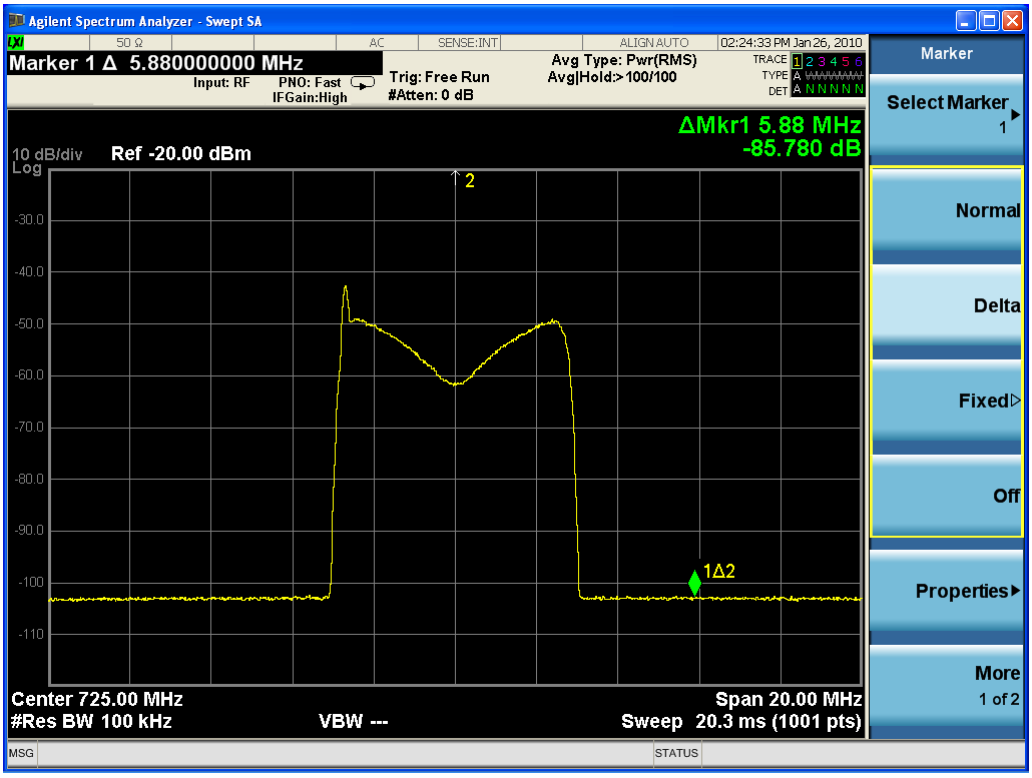


Figure 17, Transmitter Output, with Notch, but 22 dB pad removed

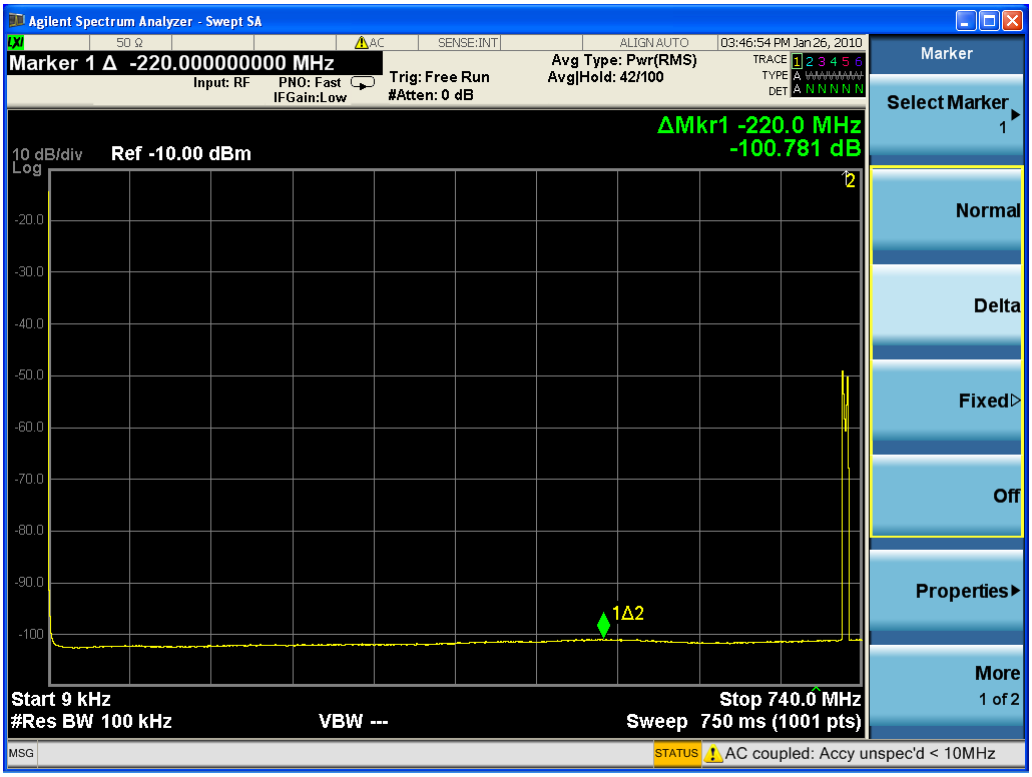


Figure 18, 9 kHz to 740 MHz

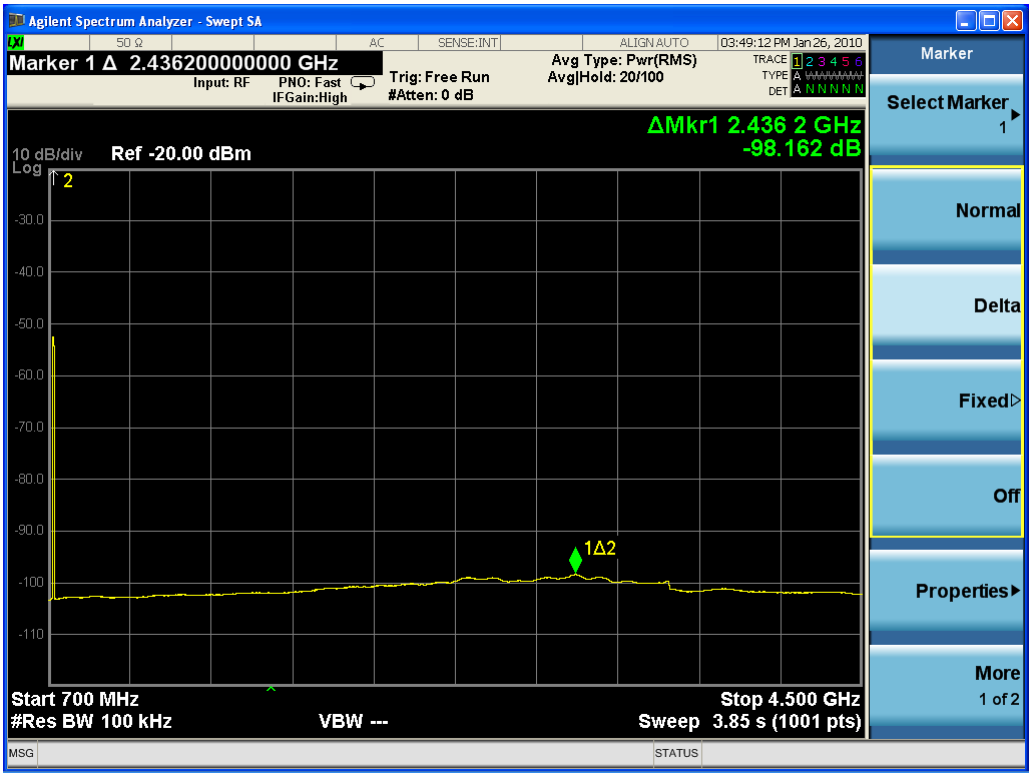


Figure 19, 700 MHz to 4.5 GHz

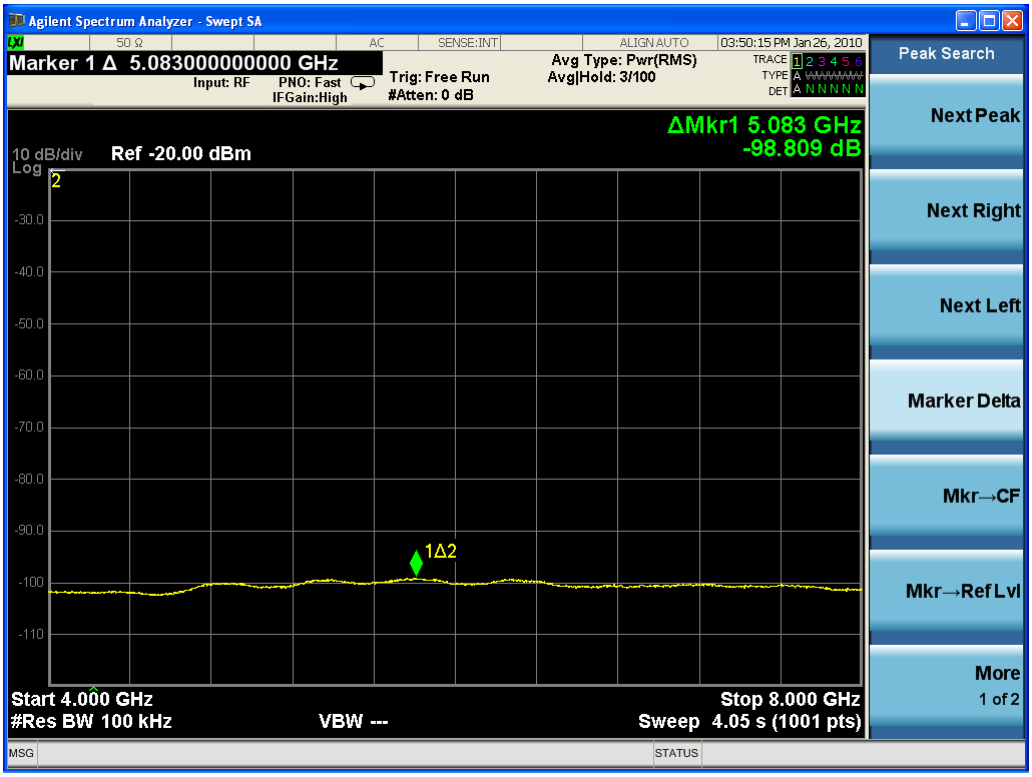


Figure 20, 4 GHz to 8 GHz

8. Rule 47CFR2.1053 Measurements required: Field strength of spurious radiation.

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single side band, independent side band, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of Sec. 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half wave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz.
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

8.1. Test Methodology

We refer to the following rule from Part 27:

47CFR27.53(g) For operations in the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

A suitable indoor open area location in Harris building 5 was chosen for this test.

Measurements were made at a distance of 3 meters, and the antenna height adjusted to maximize the readings of any significant emissions. The antenna was moved around the transmitter as needed to examine the emissions on all sides and diagonals.

Two antennas were used to cover the range of frequencies. Both vertical and horizontal polarization was used. Antenna and cable factors were put into a spreadsheet along with the data. The spreadsheet converts the readings from the EMI receiver to field strength readings, and compares them with the transmitter power as a dipole.

Emission measurements included ones made at the carrier frequency (725 MHz) because it is a useful data point for validation purposes, even though it is excluded from the limits requirement.

The substitution method as described in ANSI/TIA-603C: 2004 was then used to validate the highest emissions measurements, which were taken from the front position. The tracking generator portion of the HP8546A receiver was used as the signal source.

The ULX-6300AT must have spurious emissions limited to less than -81 dBc.

The calculated reference level of the theoretical radiated carrier is found as follows:

Reference E Field (dBuV/m) = 120 + 20log((1/d) x (sqrt(49.2 x P)))

CP_W	=	6300	Watts
R	=	3	meters
$FL_{dBuV/m}$	=	165.4	dBuV/m

Terms:
- CP_W Transmitter carrier power output, expressed in Watts.
- R Distance from transmitter to receiving antenna, in meters
- $FL_{dBuV/m}$ Field Intensity level expressed in dBuV/m

8.2. Radiated Emissions Test Setup

Figure 21, Horn Antenna from Front

8.3. Test Equipment Used

Equipment	Model	Asset	Cal Date	Cal Due
Agilent EMI receiver	E4445A	12694	6/24/2009	6/24/2010
Electro-Metrics BiconicLog Antenna	EM6917-2	8843	2/17/2009	8/17/2010
EMI Receiver	HP8546A	8926	5/19/09	5/19/2010
ETS Lindgren Horn Antenna	3115	71517	4/24/07	
ETS Lindgren Horn Antenna	3115	11500	2/23/2009	2/23/2011
Coax RGS393, Teflon, 295" long	"Brown 2"			
Coax RGS393, Teflon, 285" long	"Brown 1"			

8.4. Test Results

The only emissions of any significance belonging to the EUT were the RF harmonics of the transmitting frequency, as listed in the following table. However the carrier frequency of 725 MHz was measured also in order to have it as a data point.

Frequency	the frequency in MHz of the observed emission
$Meas_{dBuV}$	the measured emission signal level at the instrument input terminal
AF_{dB}	the calibrated antenna factor of the test antenna in dB.
$Cable_{dB}$	the measured attenuation of the test cable connecting the antenna to the instrument.
dBc	The measured level of the observed emission, converted to dBc by the following:

$$dBc = Meas_{dBuV} + AF_{dB} + Cable_{dB} - FL_{dBuV/m}$$

Tabulated Measurements and results - Horizontal Polarization									
Front and Front Angles					Left				
Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc	Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc
725	64	24.1	1.43	-75.84	725	62	24.1	1.43	-77.84
1450	28	25.5	2.17	-109.70	1450	24	25.5	2.17	-113.70
2175	22	27.8	2.80	-112.77	2175	18	27.8	2.80	-116.77
2900	15	29	3.33	-118.04	2900	12	29	3.33	-121.04
3625	15	31.7	4.00	-114.67	3625	13	31.7	4.00	-116.67
4350	12	32.1	4.46	-116.81	4350	11	32.1	4.46	-117.81
5075	12	33.6	4.70	-115.07	5075	12	33.6	4.70	-115.07
5800	12	34.2	4.97	-114.20	5800	12	34.2	4.97	-114.20
6525	12	34.7	5.25	-113.43	6525	12	34.7	5.25	-113.43
7250	15	36	5.52	-108.85	7250	15	36	5.52	-108.85
Rear and Rear Angles					Right				
Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc	Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc
725	64	24.1	1.43	-75.84	725	69	24.1	1.43	-70.84
1450	23	25.5	2.17	-114.70	1450	25	25.5	2.17	-112.70
2175	17	27.8	2.80	-117.77	2175	21	27.8	2.80	-113.77
2900	12	29	3.33	-121.04	2900	11	29	3.33	-122.04
3625	13	31.7	4.00	-116.67	3625	14	31.7	4.00	-115.67
4350	13	32.1	4.46	-115.81	4350	13	32.1	4.46	-115.81
5075	13	33.6	4.70	-114.07	5075	13	33.6	4.70	-114.07
5800	13	34.2	4.97	-113.20	5800	11	34.2	4.97	-115.20
6525	11	34.7	5.25	-114.43	6525	14	34.7	5.25	-111.43
7250	14	36	5.52	-109.85	7250	16	36	5.52	-107.85

Tabulated Measurements and results - Vertical Polarization									
Front and Front Angles					Left				
Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc	Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc
725	58	24.1	1.43	-81.84	725	67	24.1	1.43	-72.84
1450	36	25.5	2.17	-101.70	1450	24	25.5	2.17	-113.70
2175	22	27.8	2.80	-112.77	2175	19	27.8	2.80	-115.77
2900	23	29	3.33	-110.04	2900	13	29	3.33	-120.04
3625	14	31.7	4.00	-115.67	3625	13	31.7	4.00	-116.67
4350	13	32.1	4.46	-115.81	4350	12	32.1	4.46	-116.81
5075	12	33.6	4.70	-115.07	5075	12	33.6	4.70	-115.07
5800	14	34.2	4.97	-112.20	5800	12	34.2	4.97	-114.20
6525	12	34.7	5.25	-113.43	6525	12	34.7	5.25	-113.43
7250	15	36	5.52	-108.85	7250	15	36	5.52	-108.85
Rear and Rear Angles					Right				
Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc	Frequency (MHz)	$Meas_{dBuV}$	AF dB	Cable dB	dBc
725	55	24.1	1.43	-84.84	725	68	24.1	1.43	-71.84
1450	19	25.5	2.17	-118.70	1450	24	25.5	2.17	-113.70
2175	16	27.8	2.80	-118.77	2175	20	27.8	2.80	-114.77
2900	13	29	3.33	-120.04	2900	11	29	3.33	-122.04
3625	13	31.7	4.00	-116.67	3625	14	31.7	4.00	-115.67
4350	12	32.1	4.46	-116.81	4350	12	32.1	4.46	-116.81
5075	11	33.6	4.70	-116.07	5075	13	33.6	4.70	-114.07
5800	11	34.2	4.97	-115.20	5800	12	34.2	4.97	-114.20
6525	12	34.7	5.25	-113.43	6525	12	34.7	5.25	-113.43
7250	14	36	5.52	-109.85	7250	14	36	5.52	-109.85

Figure 22, Substitution Antenna Setup

The worst-case emissions were verified using the substitution method described in ANSI/TIA-603C: 2004. Even though the carrier frequency is excluded from the limits requirement, it is a useful data point for validation purposes.

Substitution Method, Horizontal, Front Pd = Pg – Cable Loss + Antenna Gain				dBc = 10 log (power/0.001) - Pd			
MHz	Pg (dBm)	Cable Loss dB	Antenna Gain (dBi)	Pd (dBm)	TX Watts	dBc	Limit
725	-6.40	1.43	2.3	-5.5	6300	-73.5	NA
1450	-46.00	2.2	8.0	-40.2	6300	-108.2	-81.0
2175	-56.00	2.88	7.9	-51.0	6300	-119.0	-81.0

Substitution Method, Vertical, Front Pd = Pg – Cable Loss + Antenna Gain				dBc = 10 log (power/0.001) - Pd			
MHz	Pg (dBm)	Cable Loss dB	Antenna Gain (dBi)	Pd (dBm)	TX Watts	dBc	Limit
725	-11.00	1.43	2.3	-10.1	6300	-78.1	NA
1450	-37.40	2.2	8.0	-31.6	6300	-99.6	-81.0
2175	-50.50	2.88	7.9	-45.5	6300	-113.5	-81.0

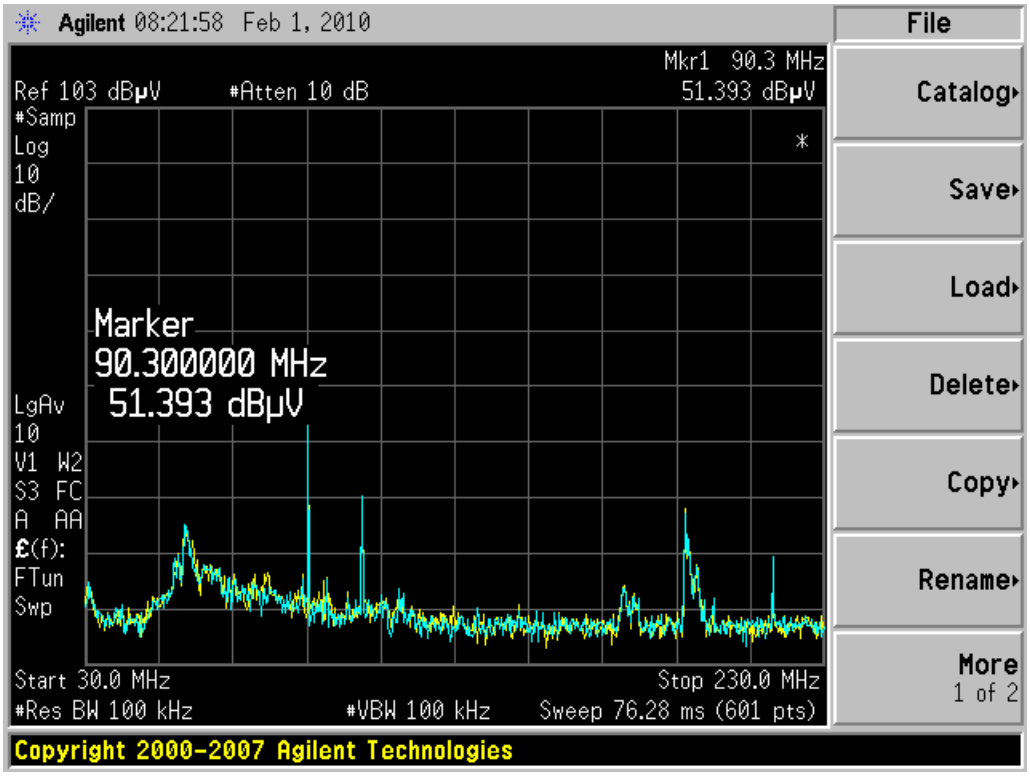


Figure 23, Radiated Emissions 30 MHz to 230 MHz. All are ambient.

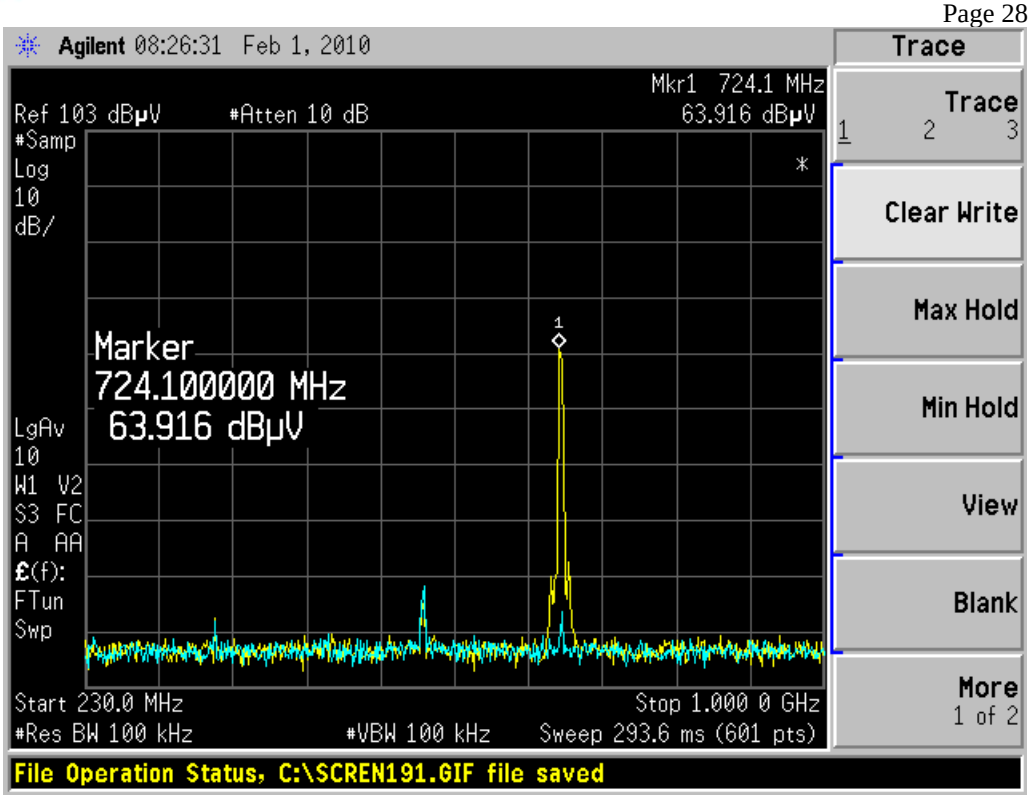


Figure 24, Radiated Emissions, 230 MHz to 1 GHz.

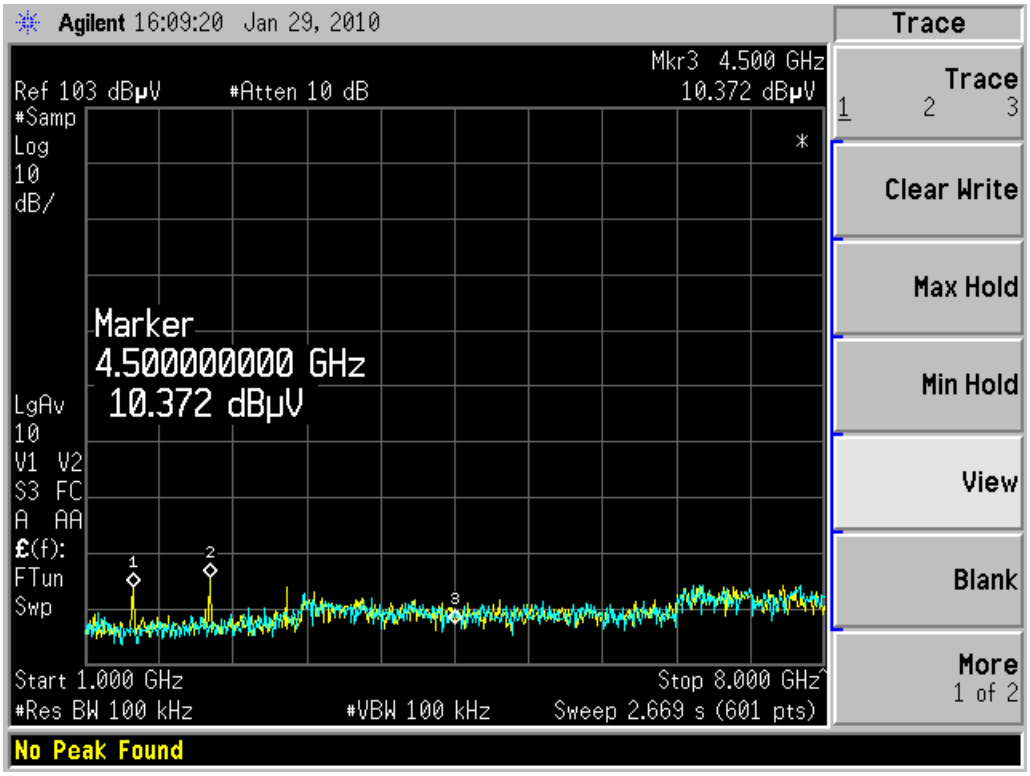


Figure 25, Radiated Emissions 1GHz to 8 GHz

9. Rule 47CFR2.1055 Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

…

(3) From 0 deg. to +50 deg. centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

. . .

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10 deg. centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

. . .

(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

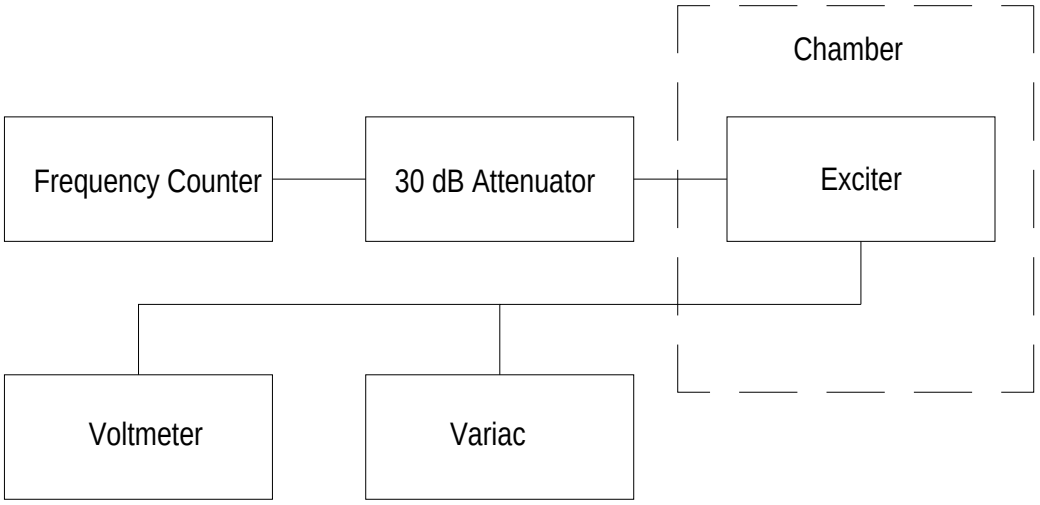
47CFR27.54 Simply states, "The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation."

47CFR73.1545(c) states, "*TV stations.* (1) The departure of the visual carrier frequency of a TV station may not exceed ±1000 Hz from the assigned visual carrier frequency."

9.1. Test Methodology

The exciter was placed in the environmental chamber. The AC line connected to a variac. The exciter was locked to an external SMPTE source, and the internal frequency reference was used to control the exciter frequency. Internal to the exciter the data at the Nyquist filter was turned off, thus allowing the exciter to produce a pilot only. The exciter was connected to a frequency counter and the frequency of the pilot measured. The exciter was allowed to soak at the ambient temperature until the frequency had settled. The line voltage was then varied and the frequency of the pilot recorded.

9.2. Frequency Stability Test Setup



9.3. Test Equipment Used

Note: Following are test results obtained in prior testing on an equivalent unit by Bryce Robertson:

Equipment used. Data taken on 08/31/08

Item	Manufacturer	Model	Serial Number	Calibration Due:
Exciter Tested	Harris	APEX M2X	Eng Unit 1	Not Required
Frequency Counter	HP	53132A	3710A04170	May 27 2009
Variac	Staco	3PN1010V	----	Not Required
Thermometer	Electro-Therm	SH66A	356747	May 31 2010
Temperature Chamber	Tenney	T30RC	12437-5	Not Required
SMPTE Source	Harris	HRX200	----	Not Required

9.4. Test Results

Temp	93.5VAC	110VAC	126.5VAC
0	670999986.3	670999986.5	670999986.5
10	670999986.3	670999986.2	670999986.4
20	670999991.6	670999990.7	670999991.2
30	670999988.2	670999988.7	670999986.7
40	670999988.4	670999988.2	670999986.8
50	670999987.7	670999987.7	670999987.1

Initial Frequency after stabilization:	670999988.7	**Measured at Nominal (℃)**	**30C.**

Initial Frequency	Lowest Frequency Measured (MHz)	Highest Frequency Measured (MHz)	Maximum Deviation(Hz)
670999988.7	670999986.3	670999991.6	5.3Hz

10. Rule 47CFR2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:

(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
. . .
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.

(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

11. Harris Response

RF Conducted and RF Radiated measurements were made to the 10th harmonic (7.25 GHz).

12. Photos of the EUT