Certification of Compliance
ATLAS™ MOBILE Digital TV Transmitter
for
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).

The transmitter tested is referred to by Harris as:

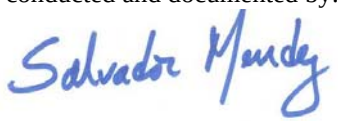
Trade Name: **ATLAS™ MOBILE**

FCC Identifier: **BOIDVF-5000**

Frequency: **719 MHz**

Model:	Rated Power before Filters	
DVF900	900 Watts	
DVF1700	1700 Watts	
DVF3400	3400 Watts	
DVF5000 (Tested)	5000 Watts	**Serial Number DG20000968-01-07**

These tests were conducted and documented by:



October 30, 2007

Sal Mendez (Date)
Project Engineer

The person responsible for testing is:

October 31, 2007

Carl Williams (Date)
Systems Engineer

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.

Rule # **Page**

Rules and Standards Applied in these Measurements

Requirement:	Standard / Procedure
2.1046(a), (c) er Output	The output power at the transmitter output flange and at the output from the output bandpass filter were both measured while operating into a standard test load, using a calibrated RF power meter.
2.1047 27.53(f) Emission Limits Adjacent Bands	Measured and calculated as directed by 27.53(f). Output power from the bandpass filter was used as the reference output power for measurement of out of band emissions.
2.1049 Occupied Bandwidth	Measured directly at the output of the bandpass filter. The displayed signal with markers at the limits of modulation is included in the report.
2.1057 Frequency Spectrum	Measure spectrum below and above the transmitted channel for presence of any spurious emissions.
2.1047 27.53(f) Emission Limits 2.1051 Spurious Emissions	Measured directly and the results are tabulated. The minimum Resolution Bandwidth specified in 27.53(f) was used to optimize sensitivity of the instrument, and a high pass filter was used to lower the carrier level and thus avoid re-generation of harmonics in the instrument. Output power from the bandpass filter was used as the reference output power for measurement of spurious emissions. A results table calculates together the coupler loss, high pass filter loss, measuring cable loss and the measured spurious level, or the instrument noise baseline level at the expected harmonics, to calculate the corrected levels. The spurious levels are referenced to the carrier level. The Pass Margins of each spurious and of the noise floor at each expected harmonic to the tenth are included in the result table.
2.1053 Field Strength of Spurious Radiation 27.53(f)	Output power from the transmitter, before the output filter was used as the reference output power to calculate the radiated spurious emissions. The measurements required by 2.1053(a) were conducted in a large, open factory area, which is documented with photos in the report. The required limit in relation to the reference carrier level was calculated according to the method given in 27.53(f). 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. This was further validated by the substitution method described in TIA-6030C-2004.
2.1055 Frequency Stability	Measurements were conducted as directed by 2.1055(a)(1), (b) and(d).

Test Equipment Used in these Measurements

Equipment:	Manufacturer & Model	Serial Number	Calibrated
Power Meter	Hewlett-Packard Model 438A	3513U06428	6/29/07
RF Load	Bird 8936-115	061200229	N/R
Spectrum Analyzer	Agilent Model E4405B	MY41440082	12/11/06
Spectrum Analyzer	Agilent Model E4443A	MY4100095	1/30/07
EMI Antenna	ETS-LINDGREN Model 3115	00071517	4/27/07
GPS Receiver	Brandywine Communications GPS8	13315	N/R
Frequency Counter:	HP 53132A	08899	6/27/2006
Multimeter:	HP 34401A	00971	9/5/2006
Enviromental Chamber:	Tenny Versa Tenn Model T30RC	12437-51	N/R
Variac:	Powerstat 3PN2168	None	N/R
Exciter:	APEX FLO Exciter.	MSR13798-05-002	N/R

2.938 Retention of records.

(a) Records to be maintained

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

(1) Original Design Drawings and Specifications

(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) Production Testing and Inspection Procedures

(**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) Test Results Demonstrating Compliance

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

(c) Record retention period

(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.

Harris will maintain these records as required, and can make them available upon request. Contact:

Harris Broadcast Communications
3200 Wismann Lane
Quincy, Illinois 62305
(217) 222-8200

2.1033 Application for certification.

(a) Filed on FCC Form 731

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) Contents of Technical Report

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) Name and address of manufacturer

The full name and mailing address of the manufacturer of the device and the applicant for certification.

Harris Broadcast Communications 3200 Wismann Lane Quincy, Illinois 62305 (217) 222-8200

(2) FCC Identifier

FCC identifier	BOIDVF-5000

(3) Installation and operating instructions

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.

Supplied with Form 731.

(4) Type or Types of emission,

6M00W7W	**Single Frequency Network**

(5) Frequency Range

One 6 MHz channel, 716 - 722 MHz (TV channel 55)

(6) Range of operating power

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

Operating powers will be from 900 Watts to 5000 Watts average power.

(7) Maximum Power

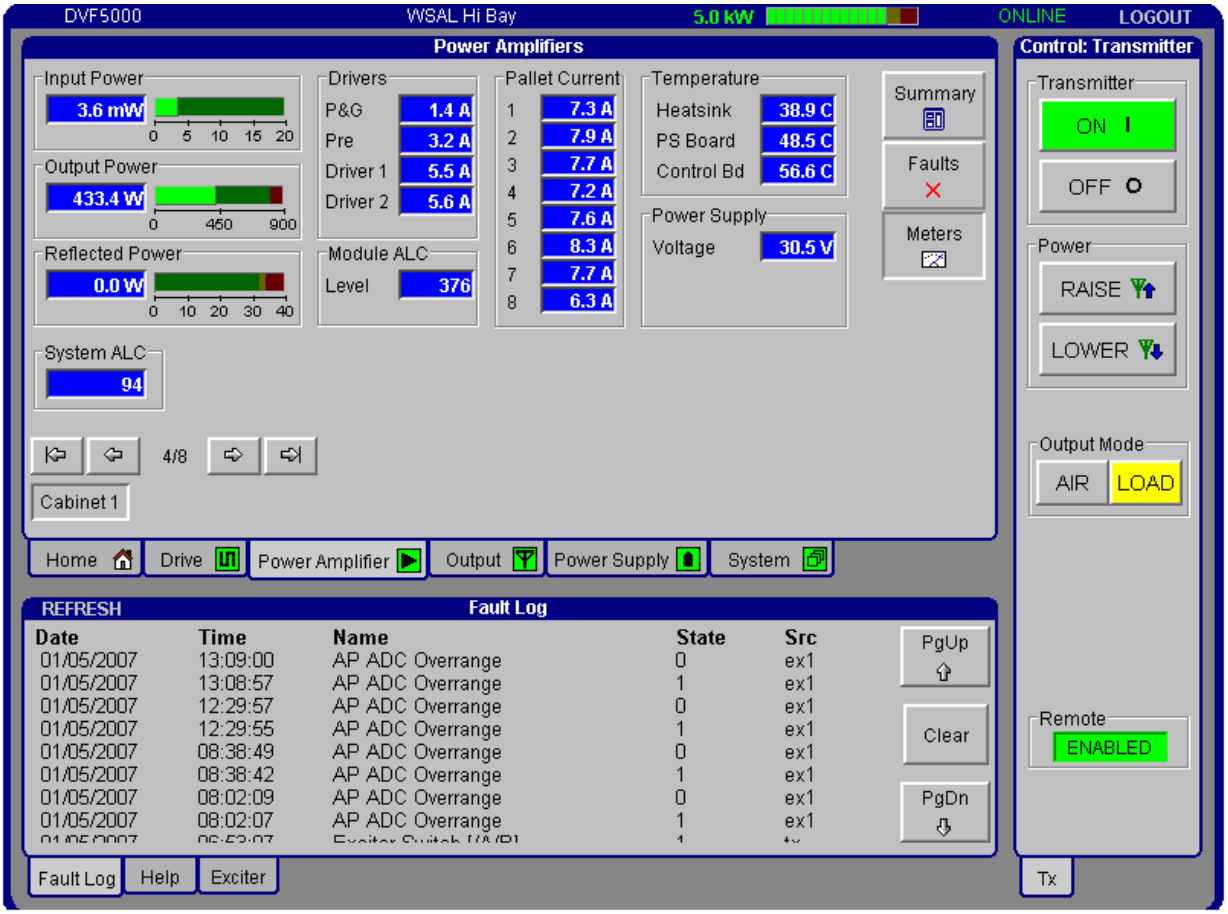
Maximum power rating as defined in the applicable part(s) of the rules.

For this transmitter, the maximum rated power is 5000 Watts.

(8) Final amplifier DC voltages & currents

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.

The DVF5000 transmitter uses 12 solid state power amplifiers in two cabinets. The main cabinet has 8 PAs while the second cabinet has 4 PAs. The operating RF output power per amplifier is 445W. The voltages and currents for one amplifier are shown below,



(9) Tune-up procedure

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

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) Schematics & Circuit descriptions

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.

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 draft 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 COFDM exciter, by an output bandpass filter, as well as a harmonic filter. The specification for the output filter is submitted separately wit this test report.

Modulation of the COFDM signal is inherently constant. Limiting is not applicable.

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 submitted user manuals provide details of the product's operation.

(11) Identification Plate

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

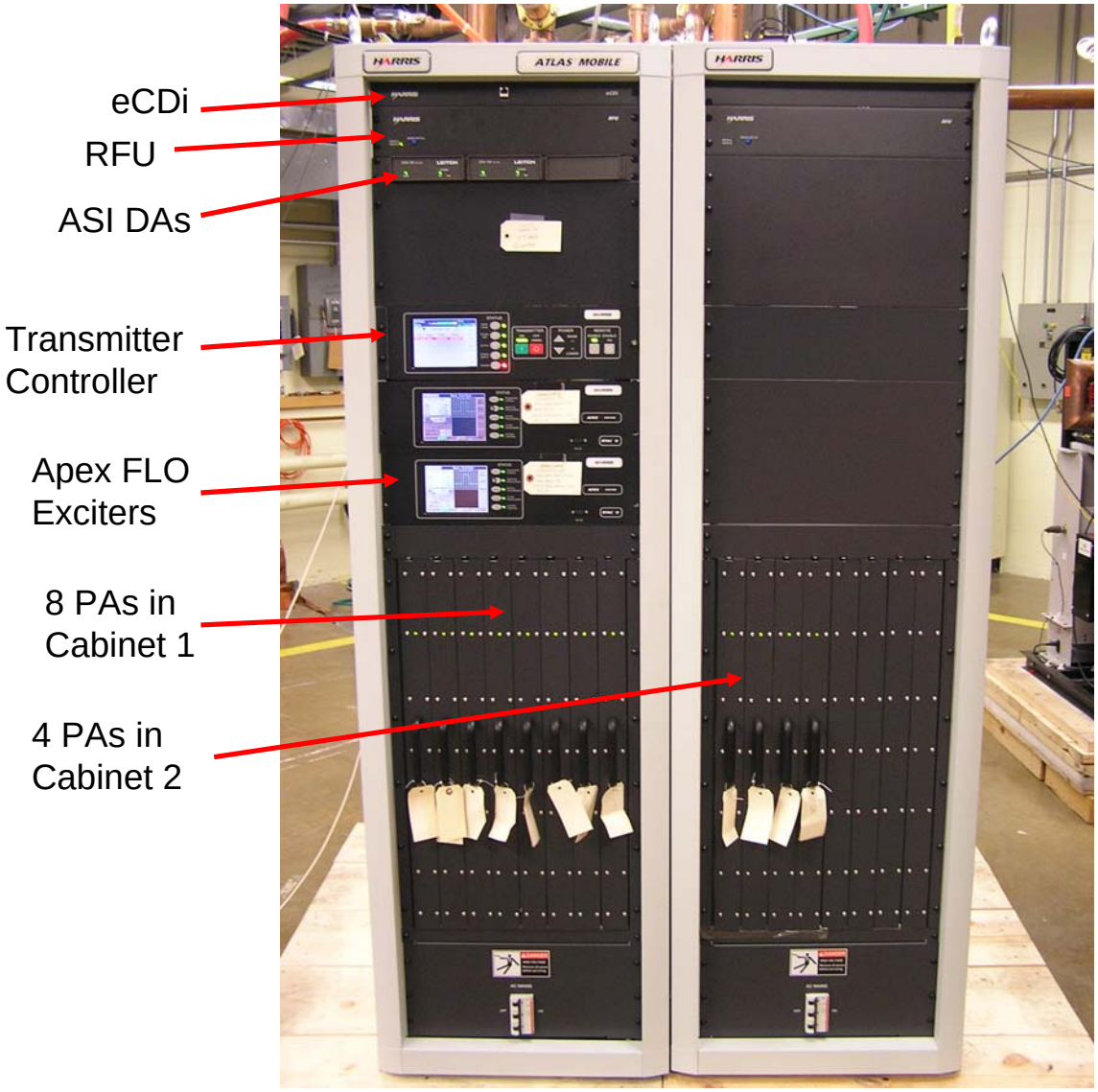
Example of Identification Plate to be Attached to the DVF5000 Transmitter

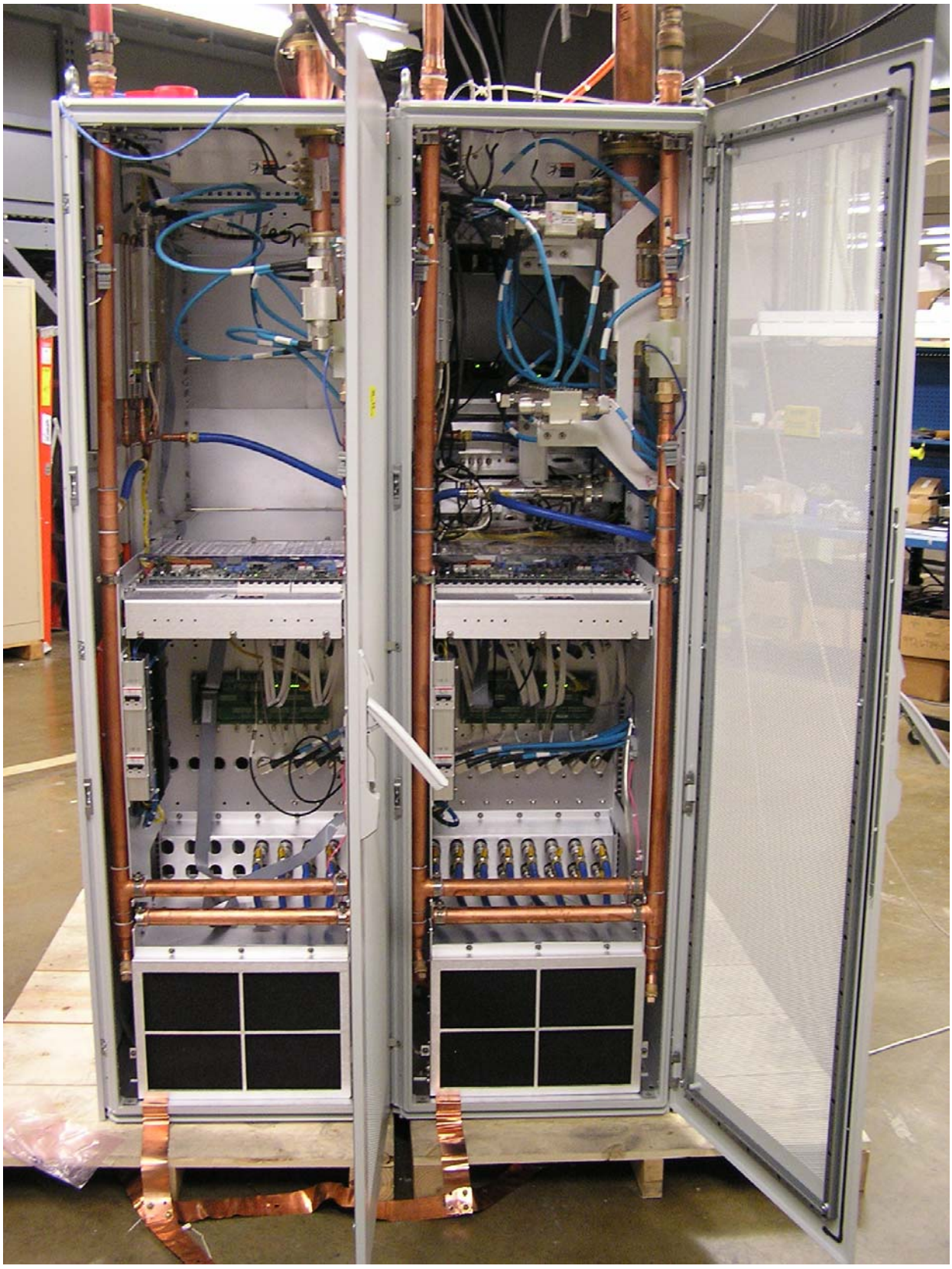
MODEL:	**DVF5000**	**DATE:**	**10/24/07**
PART NO:	**995-0073-001**	**FCC ID:**	**BOIDVF-5000**
SERIAL NO:	**DG20000968-01-07**	**OTHER ID:**	
FREQUENCY:	**716 - 722 MHZ**		
CHANNEL:	**UHF Channel 55**		
POWER OUT:	**5.0 KW X AVG**		**PK**
	208 VAC 3 PHASE		**60 HZ**

(12) Photographs of equipment

Photographs (8 x 10) 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.

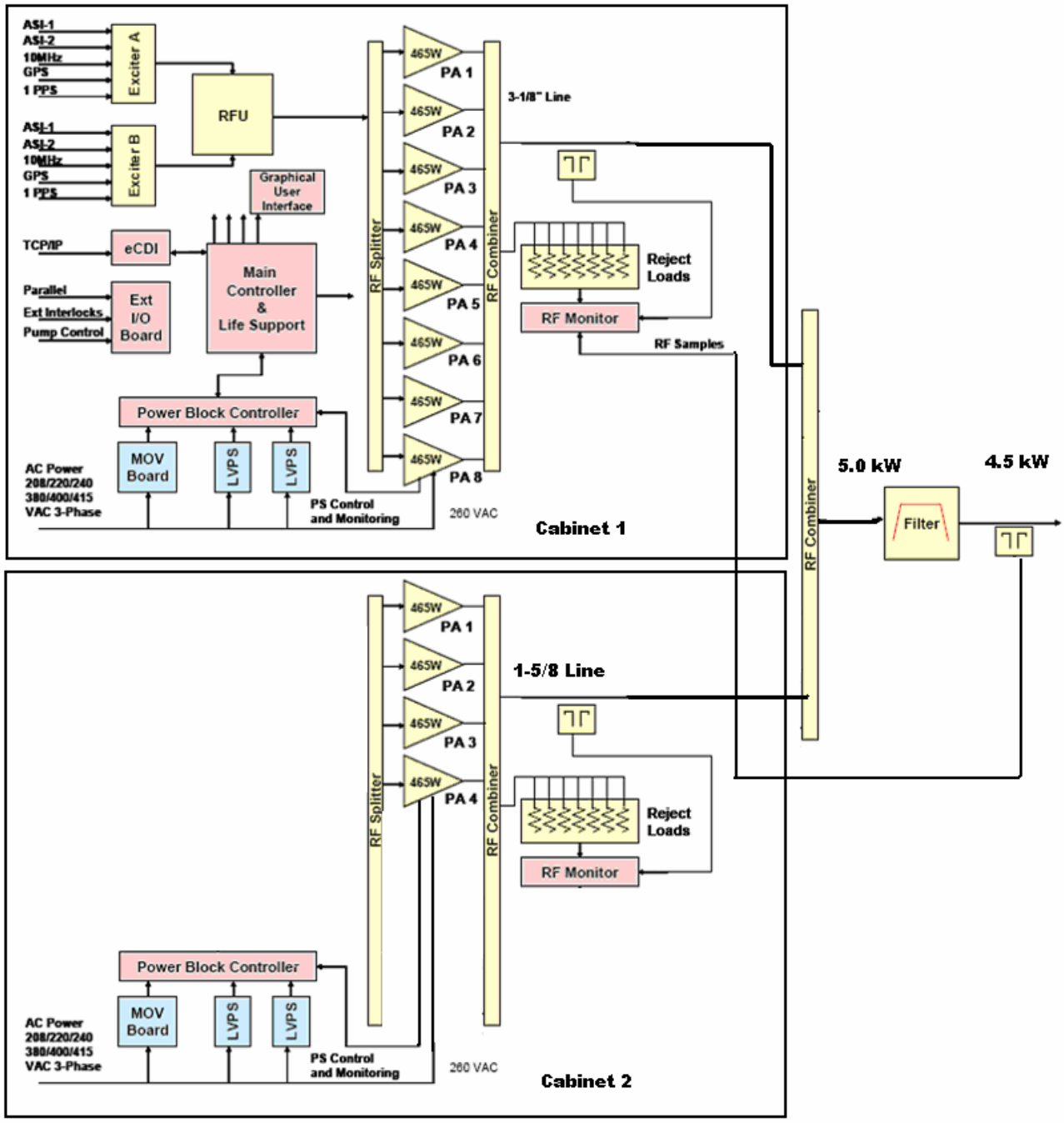
The photo below illustrates the DVF5000 transmitter model.

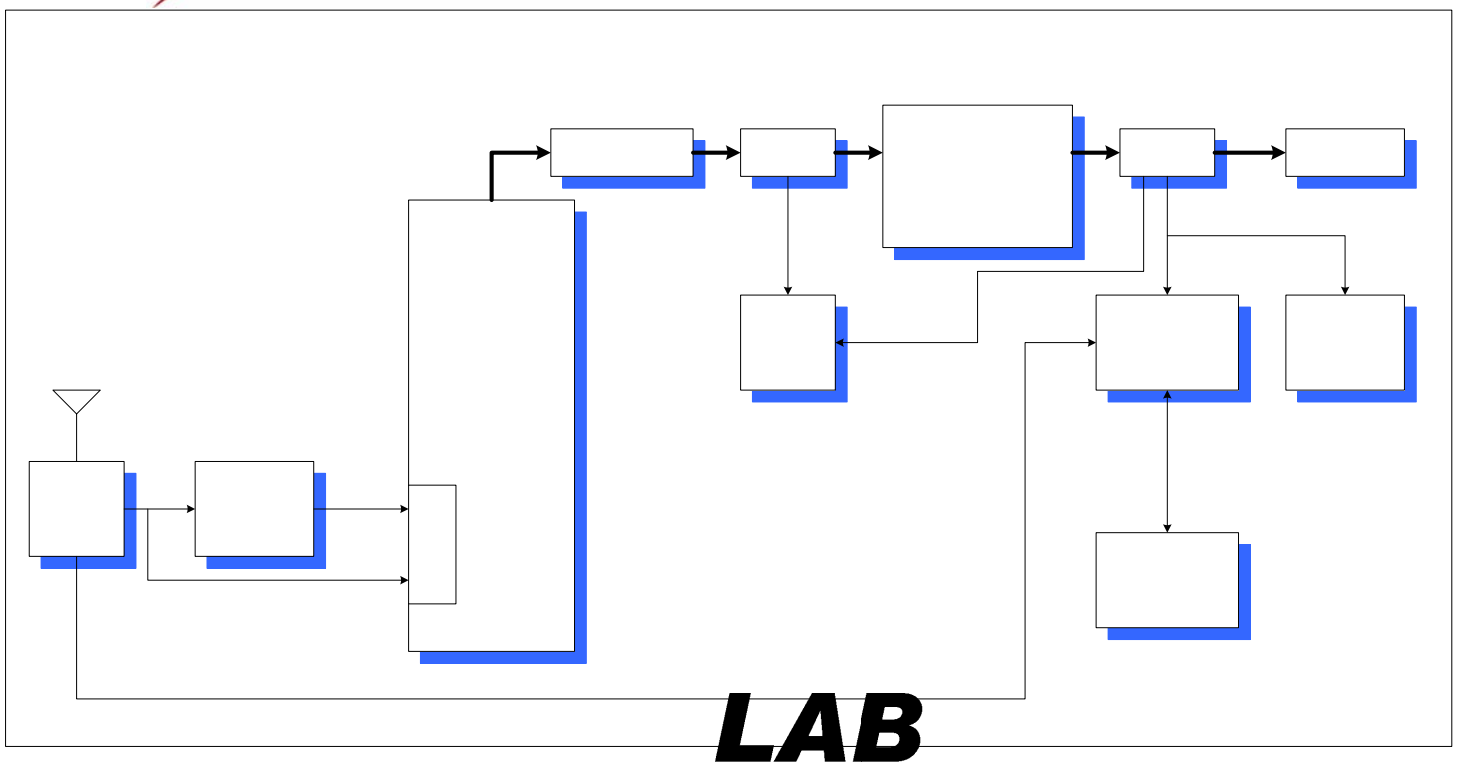




Transmitter Rear View

Transmitter Block Diagram (DVF5000)





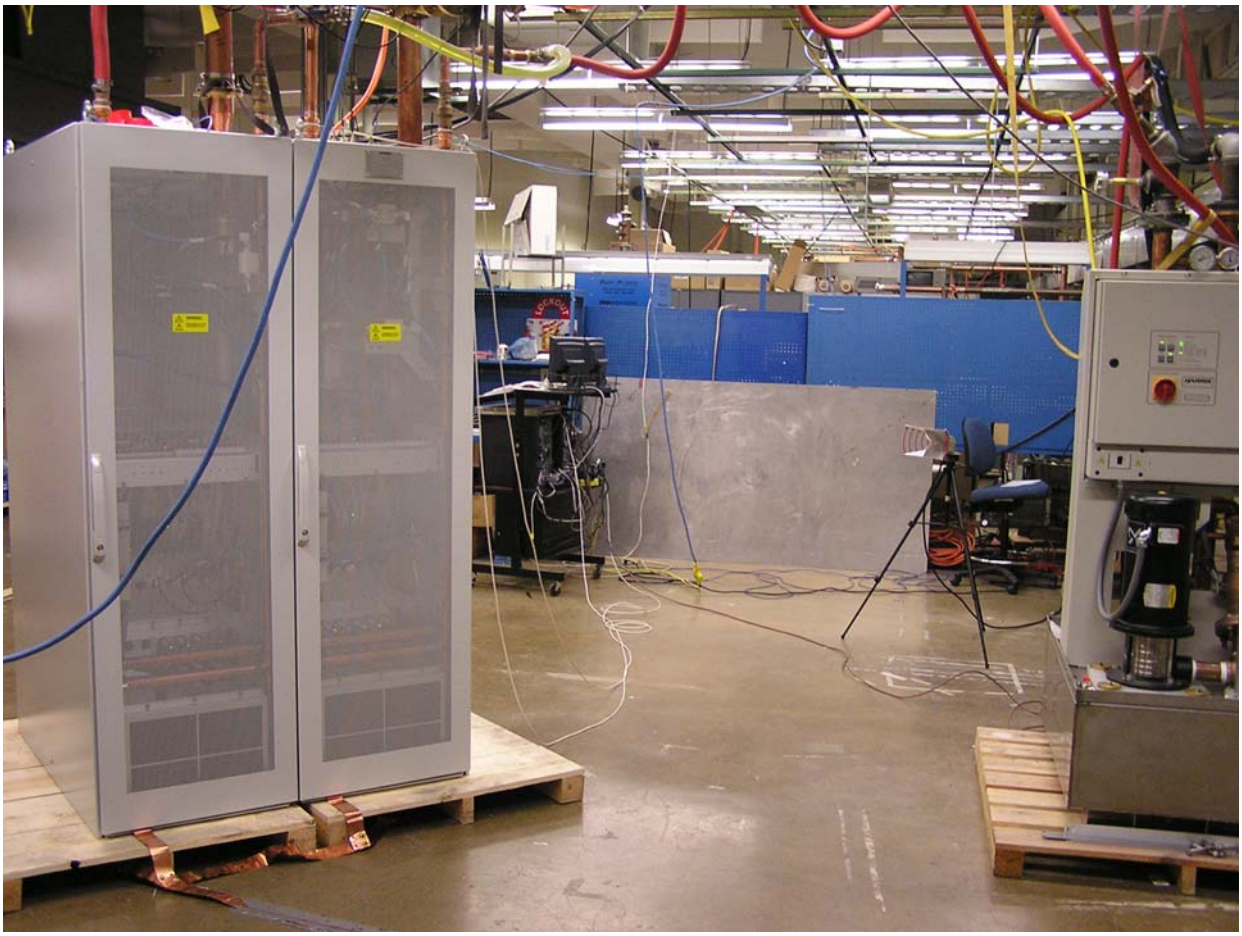
LAB
TEST SETUP

ATLAS MOBIL
DVF5000
TRANSMITTE

Linux PC

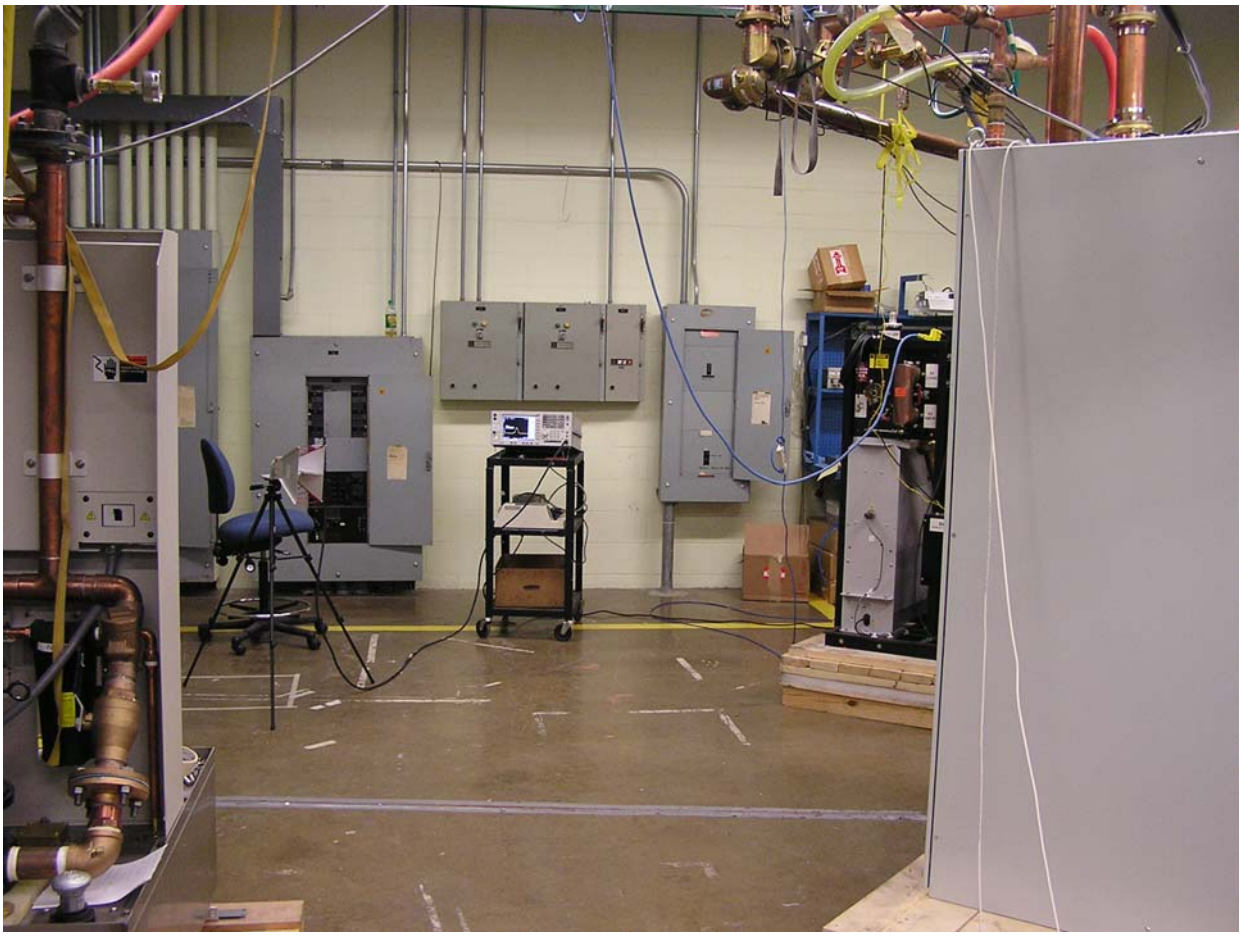
ASI

Transmitter in test room



Transmitter in test room (rear view showing pump module to the right)

Bandpass Filter and horn antenna



Transmitter in Test Room

Bandpass Filter Close Up View

(13) Description of digital modulation

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.

The modulation is a 6 MHz FLO (Forward Link Only) signal. This is a COFDM signal made up of 4000 carriers, designated 6M00W7W. Filter characteristics will be included in the application.

(14) Required Data, 2.1046 through 2.1057

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

2.1046 Measurements required: RF power output.

(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.

(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.

Harris Response

Transmitter power output was measured and calibrated for these tests in accordance with 2.1046.

The transmitter output power before filters is rated at 3400 W. The output was calibrated to 3400 watts. The output from the lowpass and bandpass filters was 3000 Watts when the transmitter output was 3400 watts.

The Bird load is rated at 10 kW maximum, with a maximum VSWR of 1.2:1 from DC to 1 GHz.

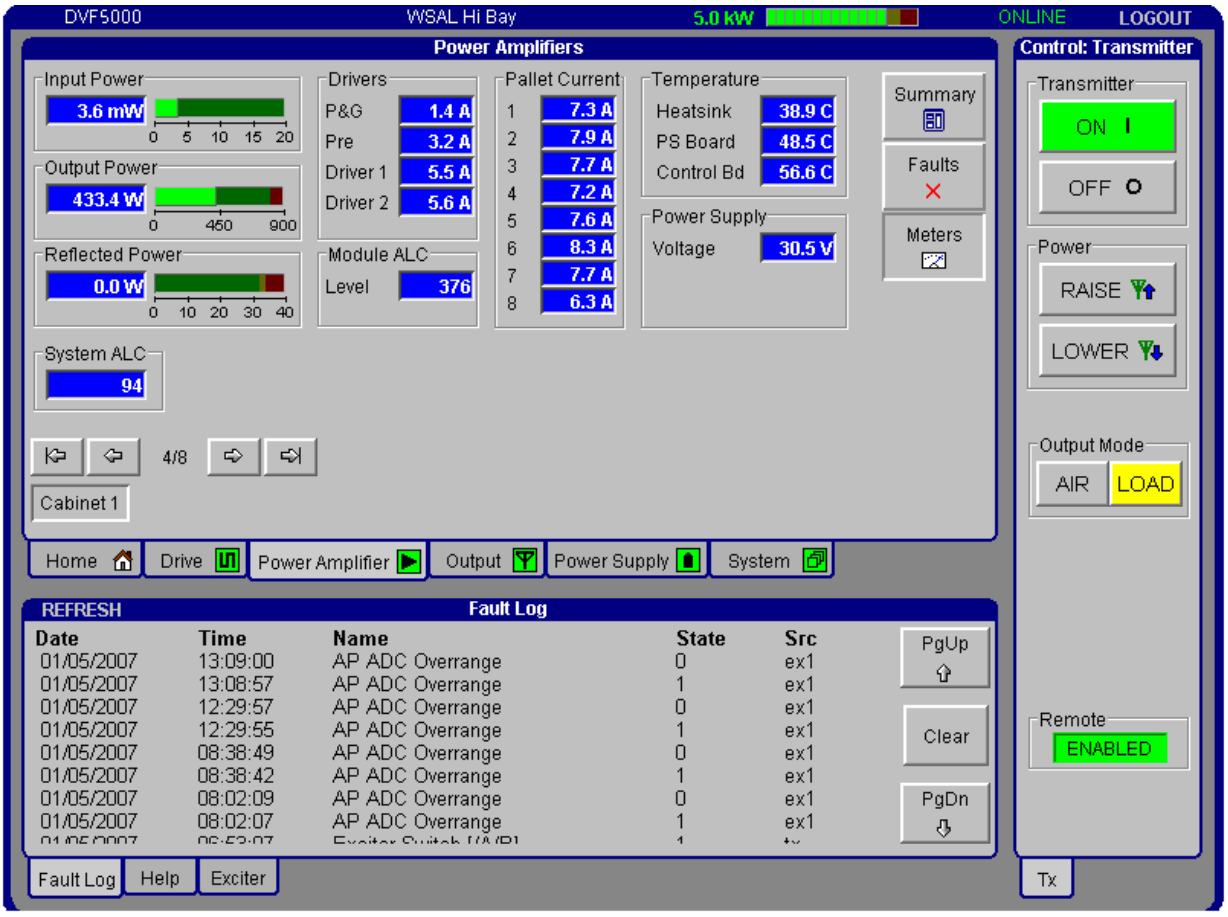
The calibrated RF coupling ratio (offset) in dB of the sample at the operating frequency was added to the measured RF level at the power meter. The results are shown in the table below,

Power Measurement	Coupler Offset Applied	Meter Reading (kW)
Cabinet Output	47.60	5.04
Filter Output	47.02	4.51

Equipment used for this calibration:				
Equipment	Mfr.	Model:	Serial Number:	Calibrated on:
Power Meter	Hewlett-Packard	Model 438A	3513U06428	6/29/07
RF Load	Bird	8936-115	061200229	Not required

Voltage and Current to the final amplifier

The DVF5000 transmitter uses 12 solid state power amplifiers in two cabinets. The main cabinet has 8 PAs while the second cabinet has 4 PAs. The operating RF output power per amplifier is 445W. The voltages and currents for one amplifier are shown below,



27.53 Emission limits.

(f) 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.

Harris Response
27.53(f) provides the emission limits for measurements specified by 2.1047,

2.1047 Measurements required: Modulation characteristics.

. . .
(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.

Harris Response to 2.1047
The modulation is a 6 MHz FLO (Forward Link Only) signal. This is a COFDM signal made up of 4000 carriers, designated 6M00W7W.

This measurement has been made in accord with 2.1047, with limits and methodology defined by 27.53(f).

Harris interprets 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

$$\text{Limit} = -(43 + 10\log(P))$$

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.

Since the actual total power in the channel is the reference for the measurements made at each frequency using a 100 kHz bandwidth, This 17.78 dB difference must be calculated and applied to obtain the actual difference between the in-band and the out-of-band emission levels displayed.

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. Therefore, the correction becomes 23 dB.

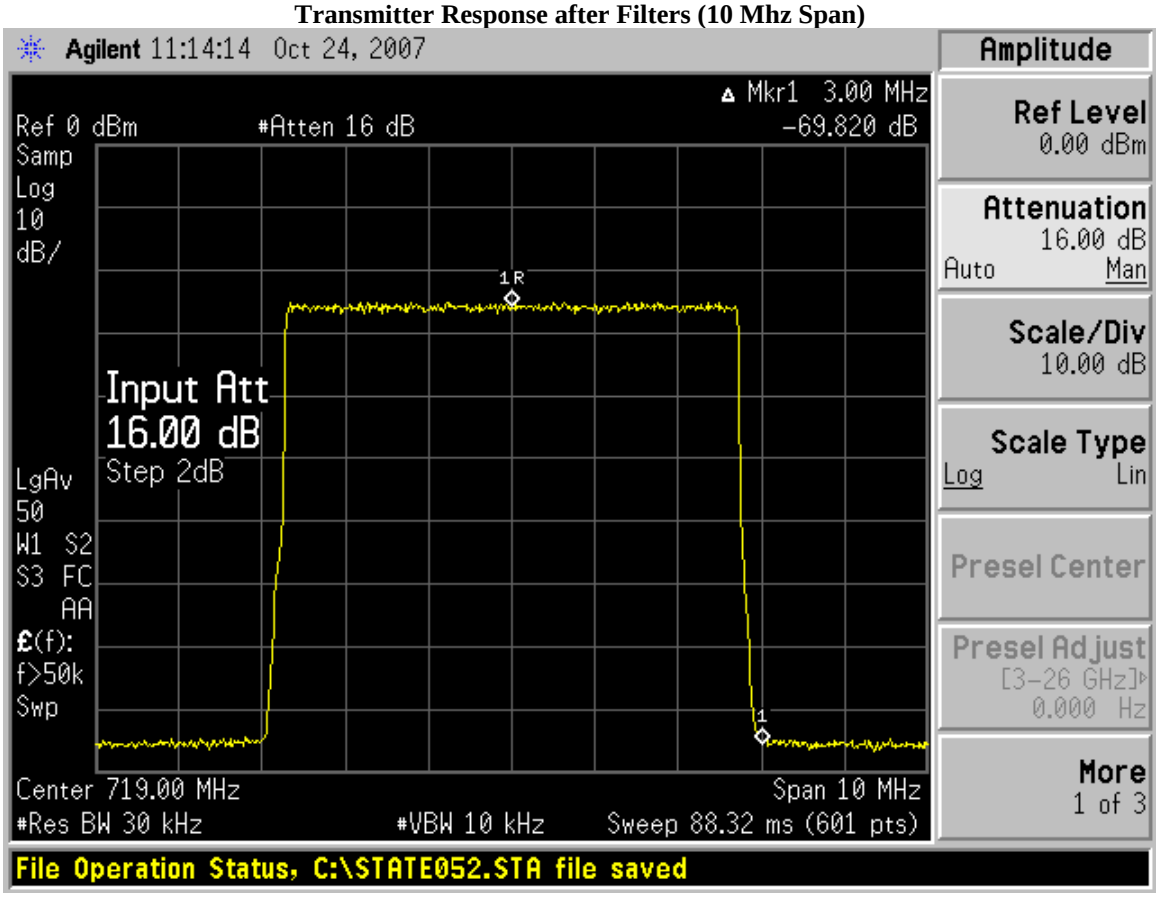
Conducted Out-of-Band and Spurious Emission measurements are taken using the output sample taken after the output filters. The power output at that point is 4500 watts.

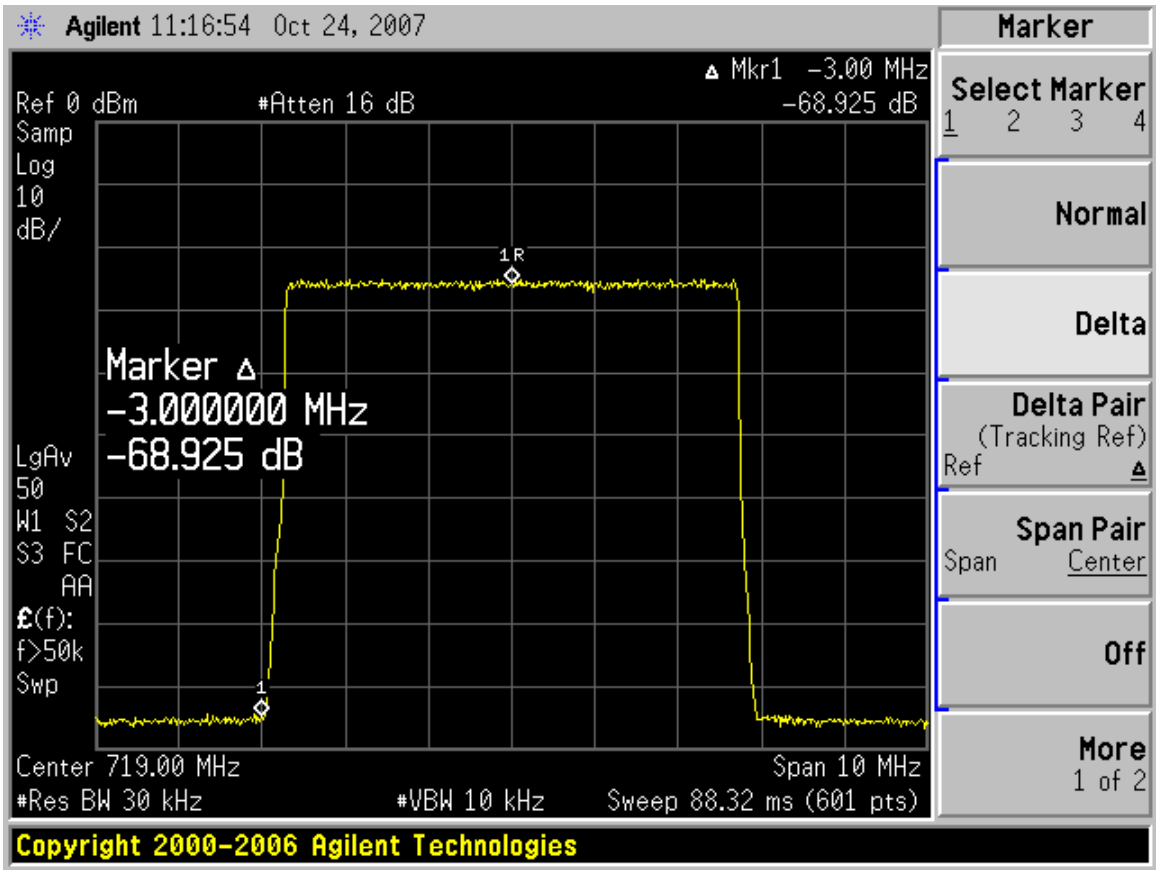
With P=4500 W, the out-of-band limit required is -79.53 dBc/100 kHz

Therefore, all emissions measured in a 100 kHz bandwidth which are 61.75 dB or more below the power output of the transmitter, as displayed in the same 100 kHz bandwidth, are 79.53 dB or more below the total output of the transmitter.

If the resolution bandwidth is reduced to 30 kHz, the in-band amplitude appears to be lowered an additional 5.2 dB from the in-band amplitude seen with 100 kHz bandwidth. The out of band measurement, if it is sufficiently noise-like, would also be lowered, and may need to be integrated over 100 kHz to arrive at a correct measurement, as the measured level in a 100 kHz bandwidth is required.

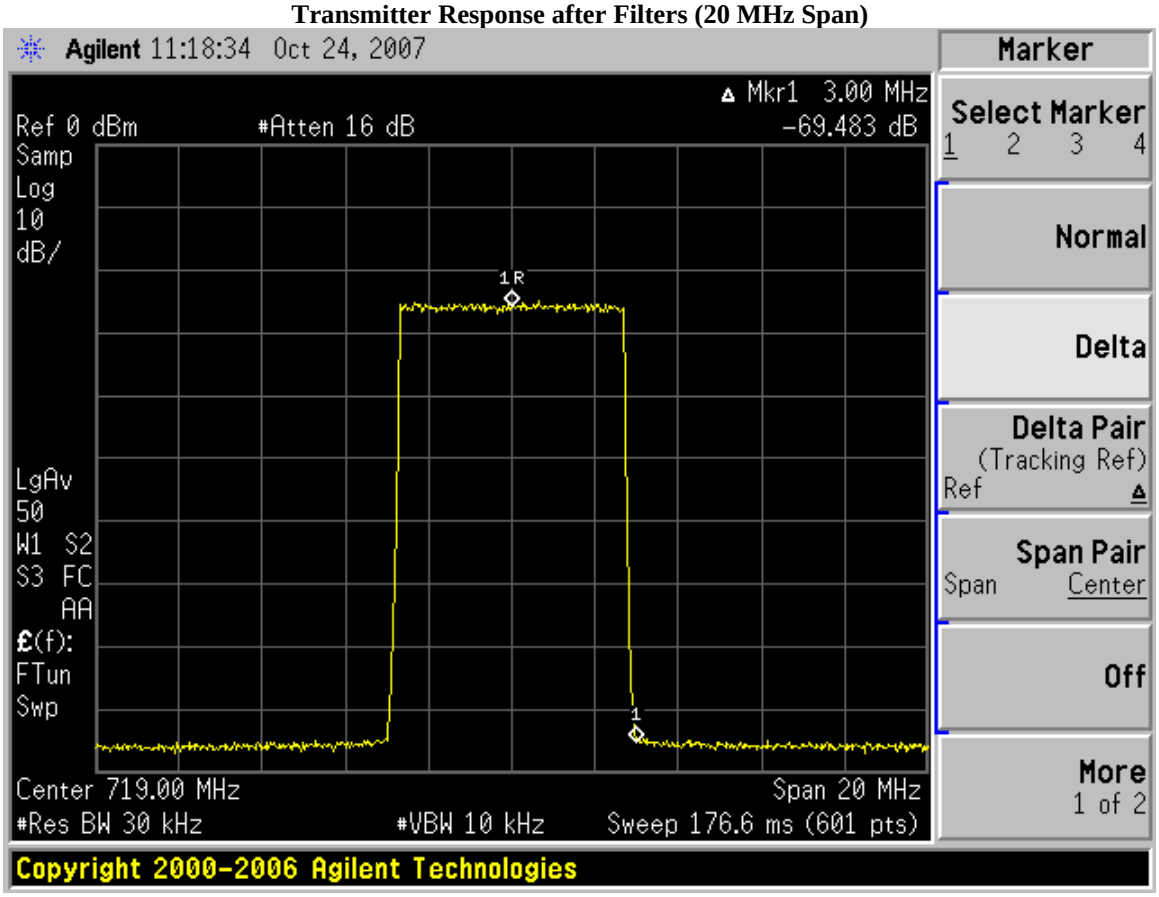
Transmitter Response after Filters (10 Mhz Span)



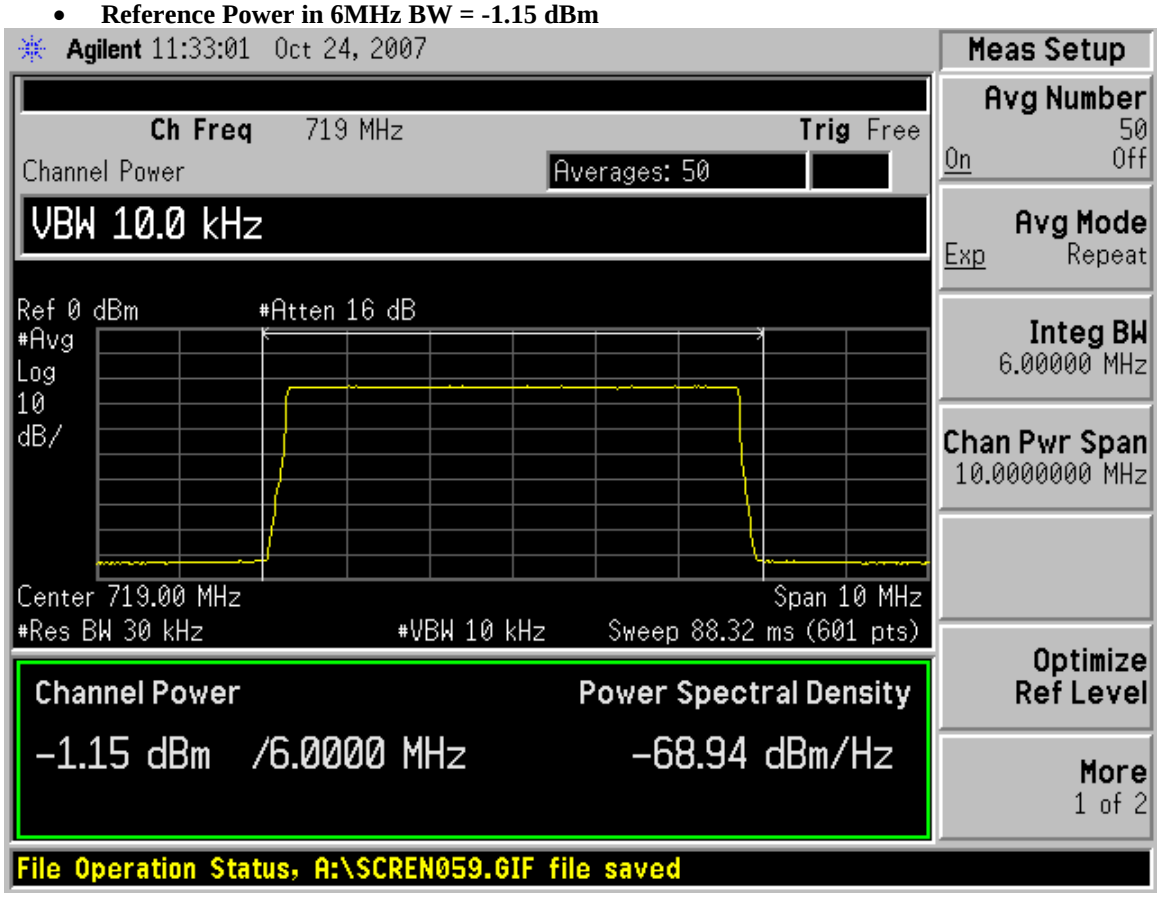


Markers at +/- 3 MHz from center frequency show: Lower Shoulder: -68.92 and Upper Shoulder: -69.82 with respect to the center marker.

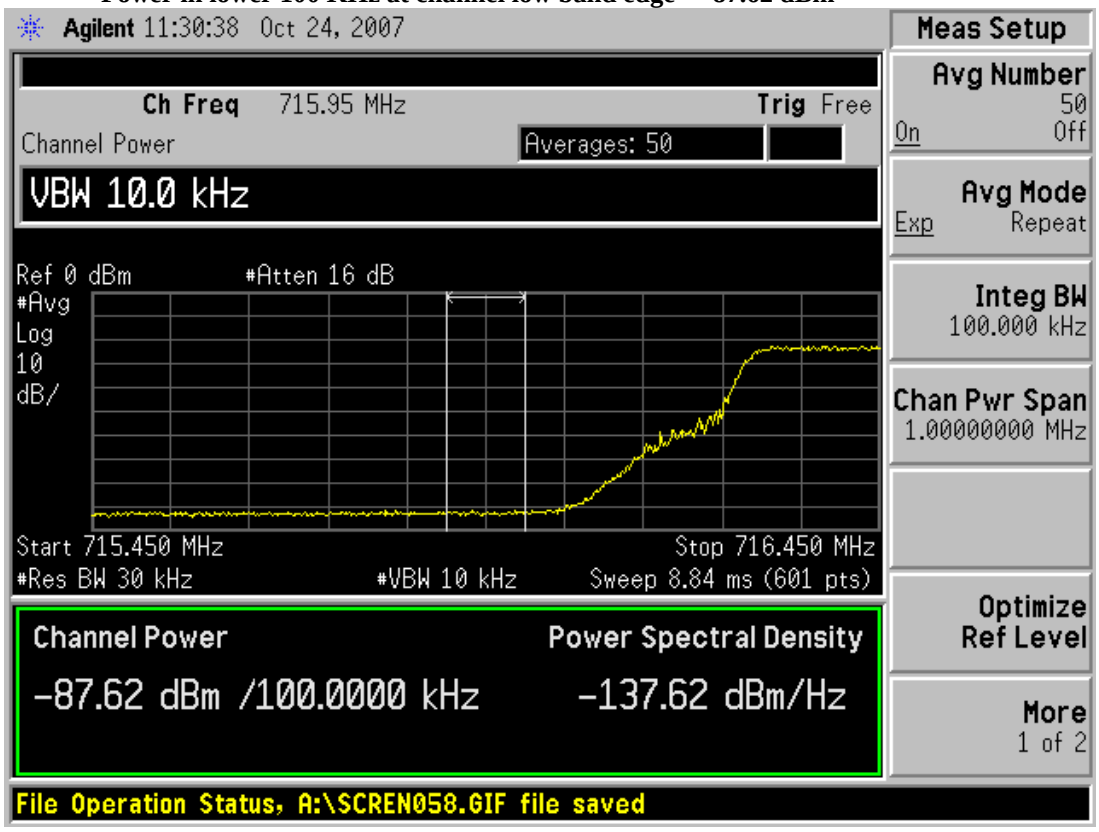
Transmitter Response after Filters (20 MHz Span)



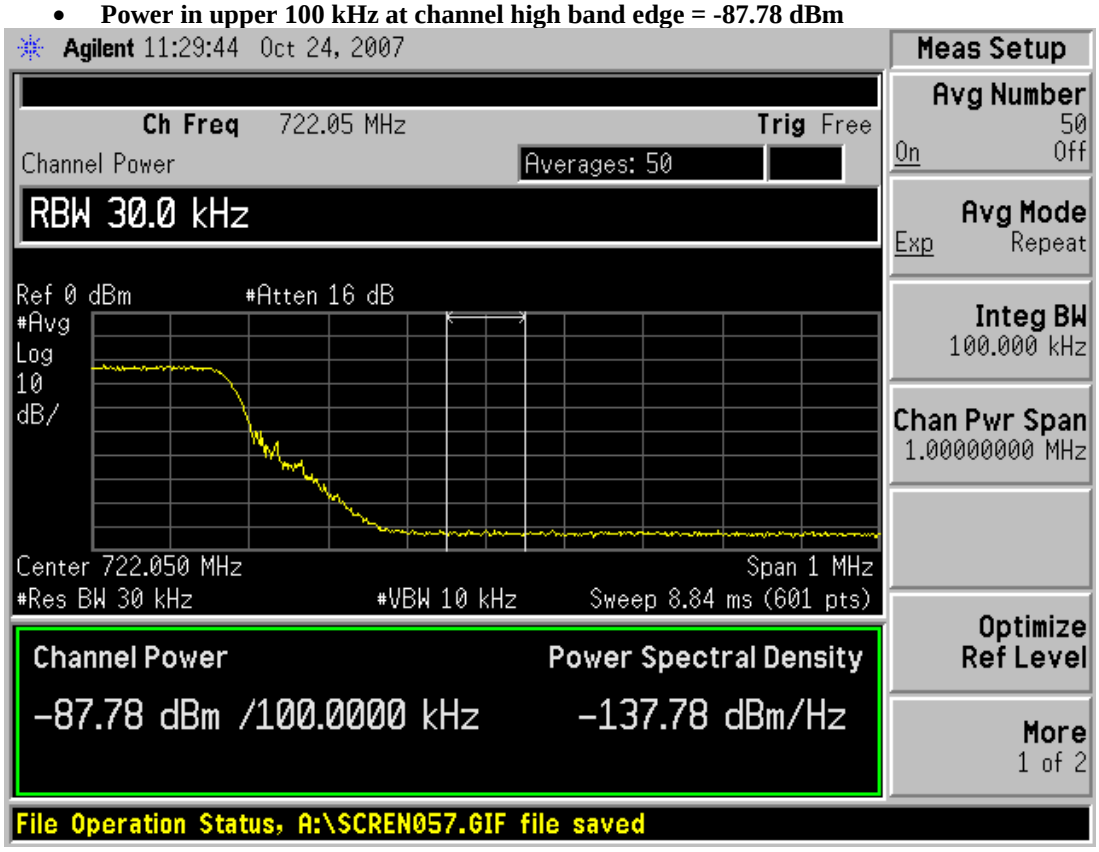
- **Reference Power in 6MHz BW = -1.15 dBm**



- **Power in lower 100 KHz at channel low band edge = -87.62 dBm**



- **Power in upper 100 kHz at channel high band edge = -87.78 dBm**



Summary

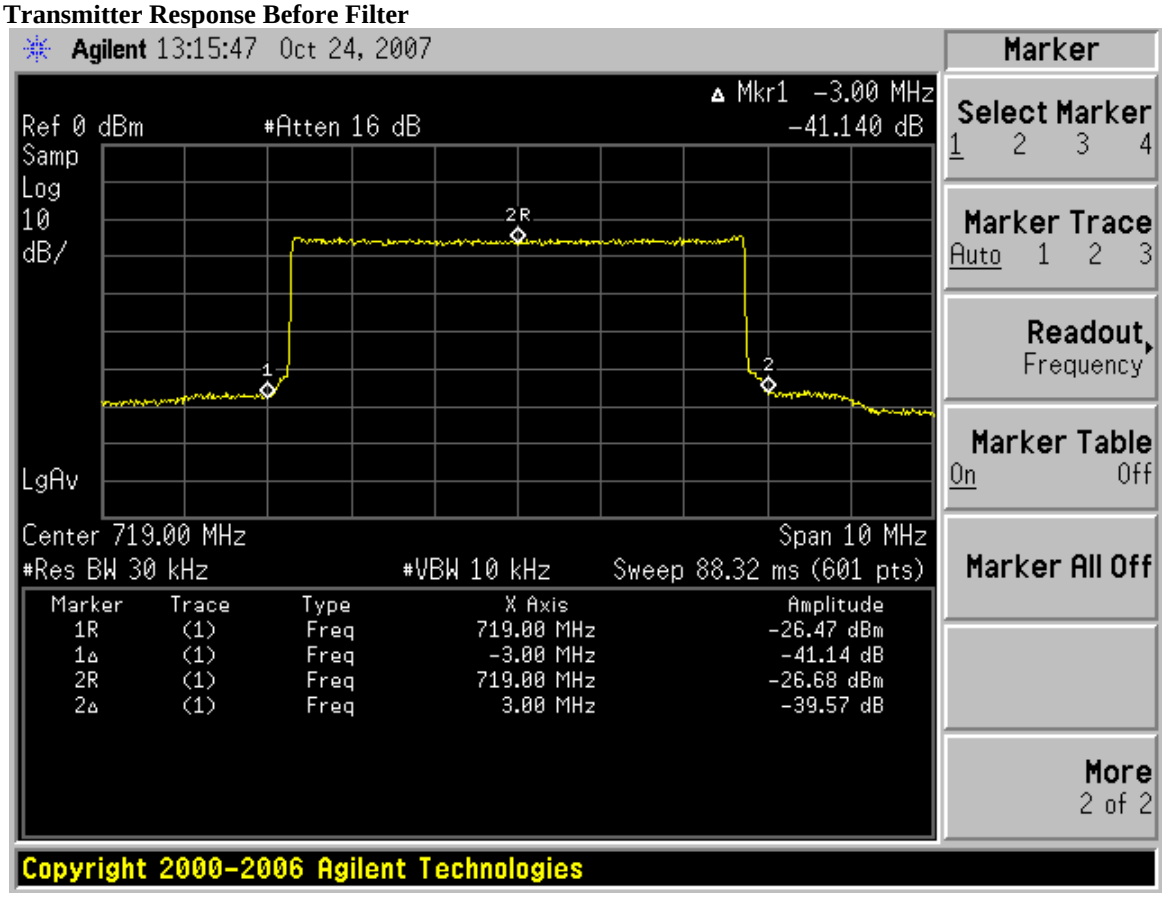
Theoretical Limits			
Transmitter Power (Watts)	**Transmitter Power (dBm)**	**FCC Limit 43+10*LOG(P) in dBc/100Khz**	**Absolute Power Limit of out-of-band emissions (dBm/100Khz)**
4500	66.53	-79.53	-13.00

Measured at Transmitter Filter Output Coupler						
Transmitter Power (mWatts)	**Transmitter Power in 6Mhz BW (dBm)**	**FCC Limit 43+10*LOG(P) in dBc/100Khz**	**Absolute Power Limit of out-of-band emissions (dBm/100Khz)**	**Measured Power in 100Khz at low side band (dBm)**	**Measured Power in 100Khz at high side band (dBm)**	**Pass Margin (dB)**
0.77	-1.15	-79.53	-80.68	-87.62		6.94
					-87.78	7.10

Note that the measured power in the 100 kHz band adjacent to the channel edges is limited by the analyzer noise floor. This can clearly be seen in the plots above. Given the high rejection of the bandpass filter, the true power is much lower than the -87 dBm levels measured by the analyzer.

An estimate of the true power level can be gathered by superposing the filter response to the power of the transmitter before the bandpass filter. The next plot shows the transmitter response before the filter,

Transmitter Response Before Filter



The shoulder levels at +/-3 MHz are -41.14 dB and -39.57 dB down from the mid frequency level. For the purpose of the estimation, we will use the worst case 39dB shoulders.

Band Pass Filter Response

The mask filter specifications and measured data are tabulated below,

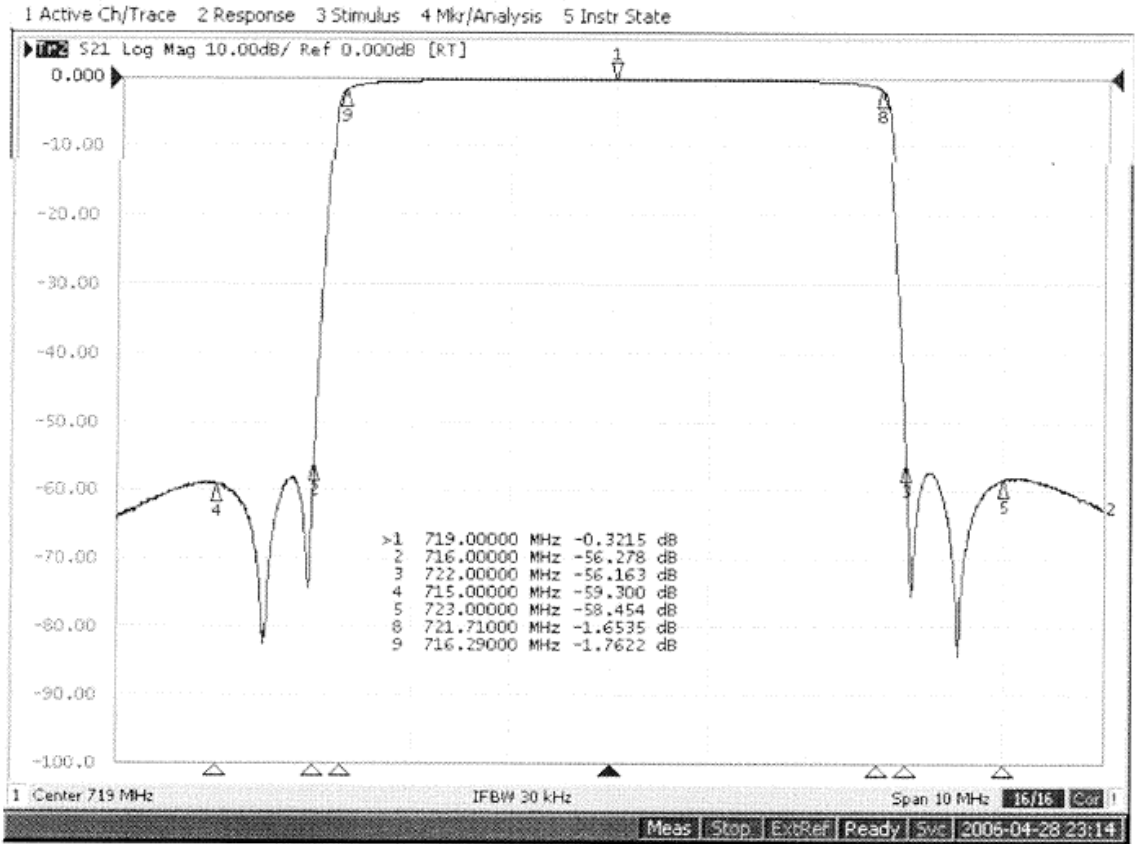
RF FILTER ASSEMBLY CH 55 FACTORY ACCEPTANCE TEST

CUSTOMER PART NUMBER: CV90-T0579-2 REV B S/N: 3045

TEST DATA SUMMARY SHEET

Parameter	Condition	Specification	Measured	Pass	Fail
VSWR	@ fc +2.71MHz	1.1:1 Maximum	1.09:1	x	
	@ fc -2.71MHz	1.1:1 Maximum	1.09:1	x	
Insertion Loss	@fc	<-0.40 dB	.32	x	
	@fc +2.71MHz	<-1.80 dB	1.77	x	
	@fc -2.71MHz	<-1.80 dB	1.66	x	
Group Delay	Passband	<2300 ns	<2300 ns	x	
Rejection	@fc +3.0MHz to +4.0MHz	<-52 dB	<-52 dB	x	
	@fc -3.0MHz to -4.0MHz	<-52dB	<-52dB	x	
Rejection	@fc +4.0 to +15MHz	<57 dB	<57 dB	x	
	@fc –4.0 to -15 MHz	<57 dB	<57 dB	x	

The filter response is shown below,



The filter attenuation is 56 dB at 716 and 722 MHz. Therefore the calculated power in the 100 kHz band adjacent to the channel edges shown in the table below,

Calculated Out-Of-Band Emissions DVF5000							
Transmitter Power (Watts)	**Transmitter Power (dBm)**	**dB Offset 100Khz/6Mhz**	**Shoulder Level**	**Filter Attenuation**	**Calculated Power from +/- 3.0 to +/- 3.1 Mhz from channel center (dBm/100Khz)**	**Absolute Power Limit of out-of-band emissions (dBm/100Khz)**	**Pass Margin (dB)**
4500	**66.53**	**-17.78**	**-39**	**-56**	**-46.25**	**-13.00**	**33.25**

Spectrum Analyzer used for this measurement:

Manufacturer: Agilent
Model: E4443A
Serial Number: MY4100095
Calibration Date: 1/30/07

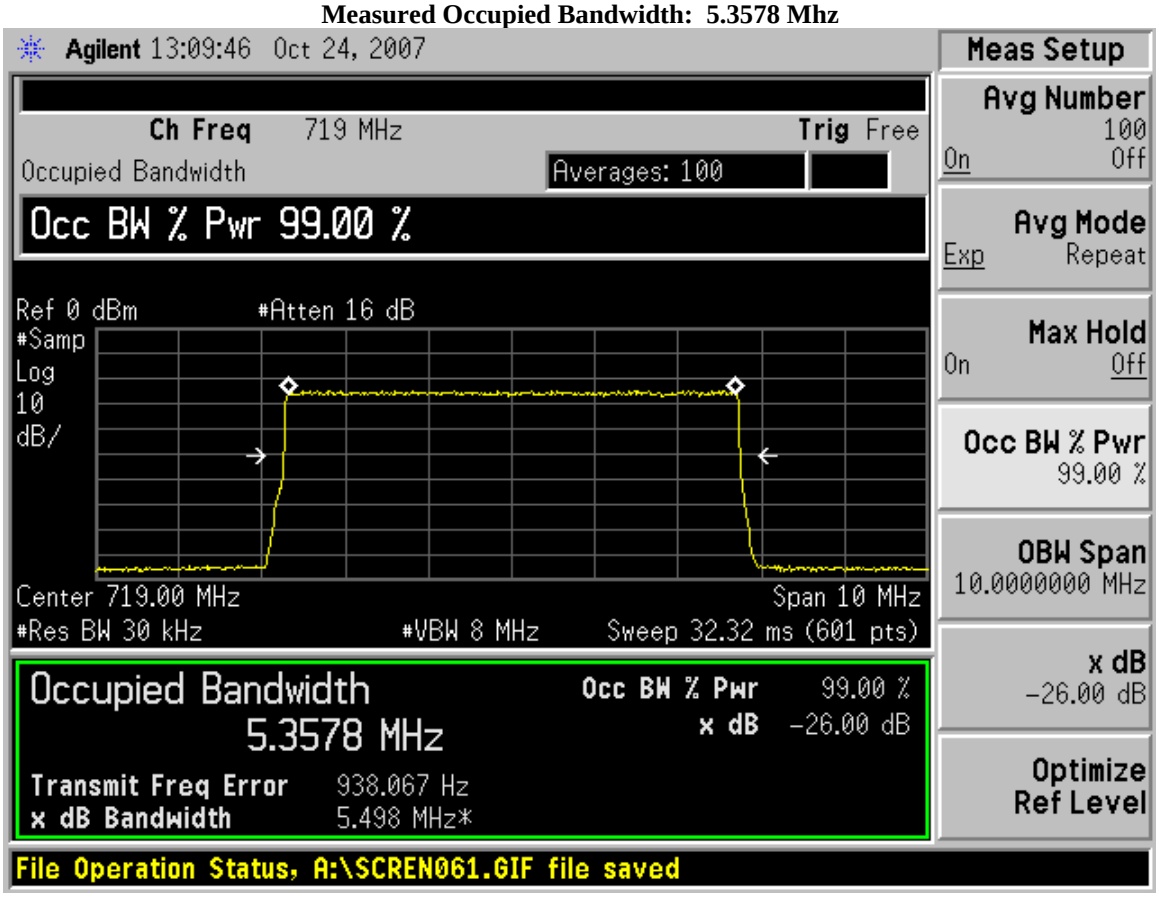
2.1049 Measurements required: Occupied bandwidth.

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.

Measured Occupied Bandwidth: 5.3578 Mhz



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Spectrum Analyzer used for this measurement:

Manufacturer: Agilent
Model: E4443A
Serial Number: MY4100095
Calibration Date: 1/30/07

2.1057 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:

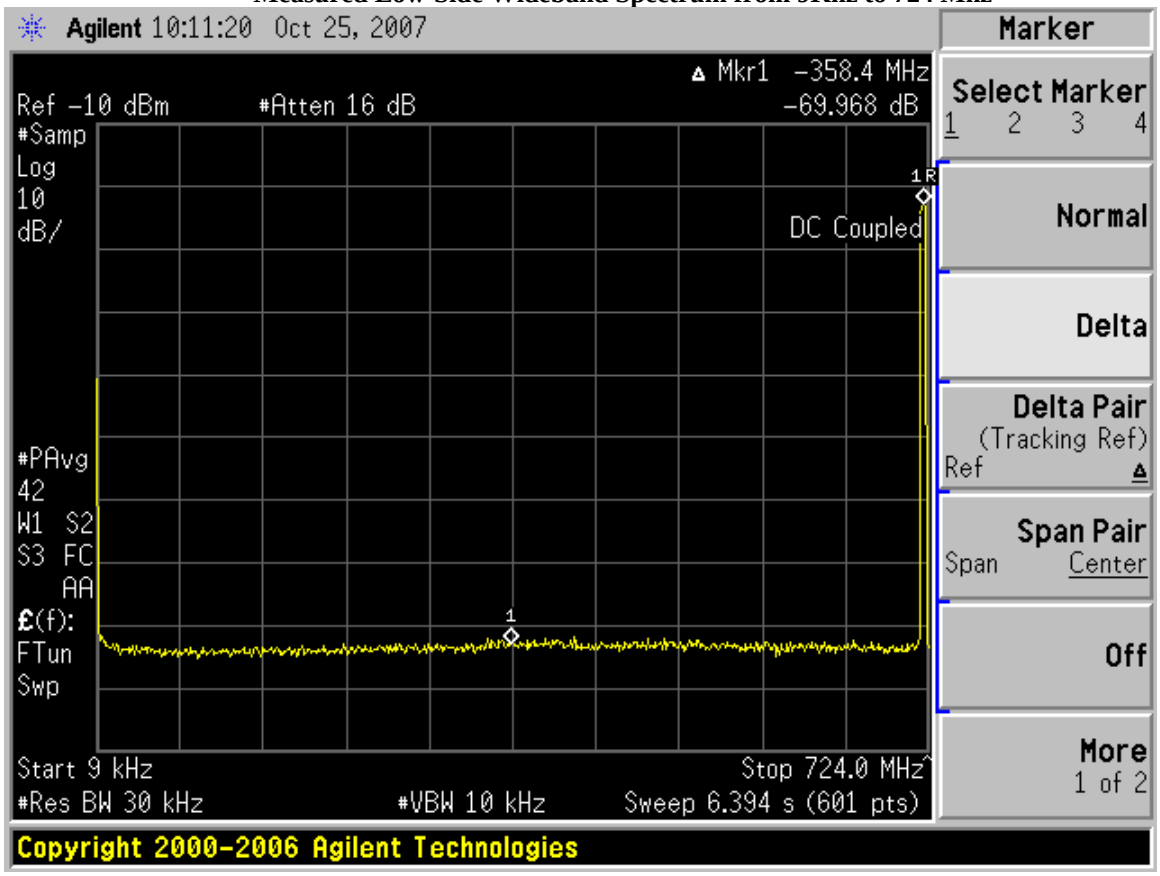
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

. . .

(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.

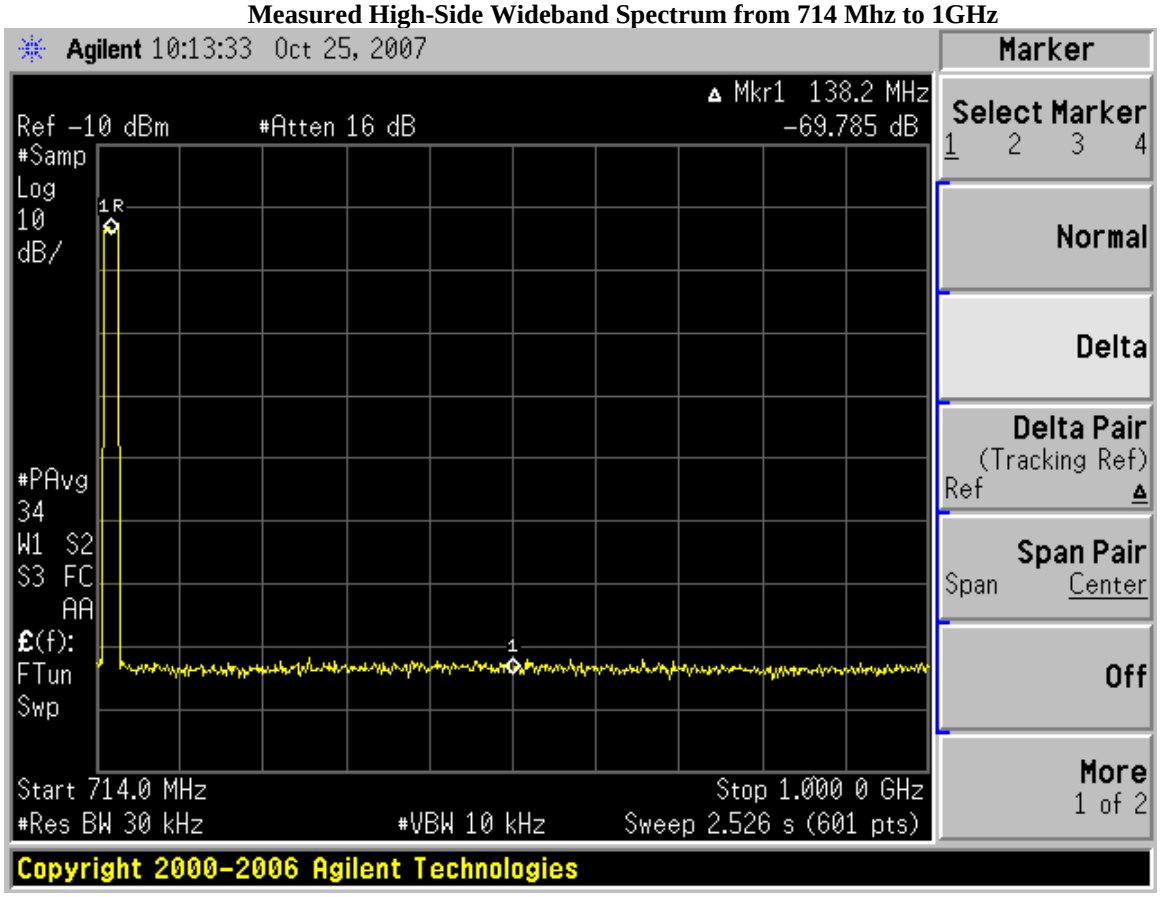
Measured Low-Side Wideband Spectrum from 9Khz to 724 Mhz



In the above plot a resolution bandwidth of 30 kHz was used instead of 100 kHz. However, the signals are so noise like that the delta between marker 1 (fundamental) and marker 2 (noise floor) is the same with either resolution bandwidth.

From the above plot the delta between marker 1 and marker 2 is 69.97 dB. The requirement is 61.75 dB (79.53 – 17.78). **The pass margin is therefore 8.22 dB.**

Measured High-Side Wideband Spectrum from 714 Mhz to 1GHz



From the above plot the delta between marker 1 and marker 2 is 69.79 dB. The requirement is 61.75 dB (79.53 – 17.78). **The pass margin is therefore 8.04 dB.**

Spectrum Analyzer used for this measurement:

Manufacturer: Agilent
Model: E4443A
Serial Number: MY4100095
Calibration Date: 1/30/07

2.1051 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.

27.53 Emission limits.

. . .

(f) 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.

Harris Response:

These tests were conducted in accord with 2.1051, using limits defined by 27.53(f).

Transmitter Harmonics

The transmitter harmonics were measured as follows:

- Transmitter final directional coupler characterized to the 10th harmonic frequency (8 GHz)
- Measurement Cable insertion loss characterized to the 10th harmonic frequency (8 GHz)

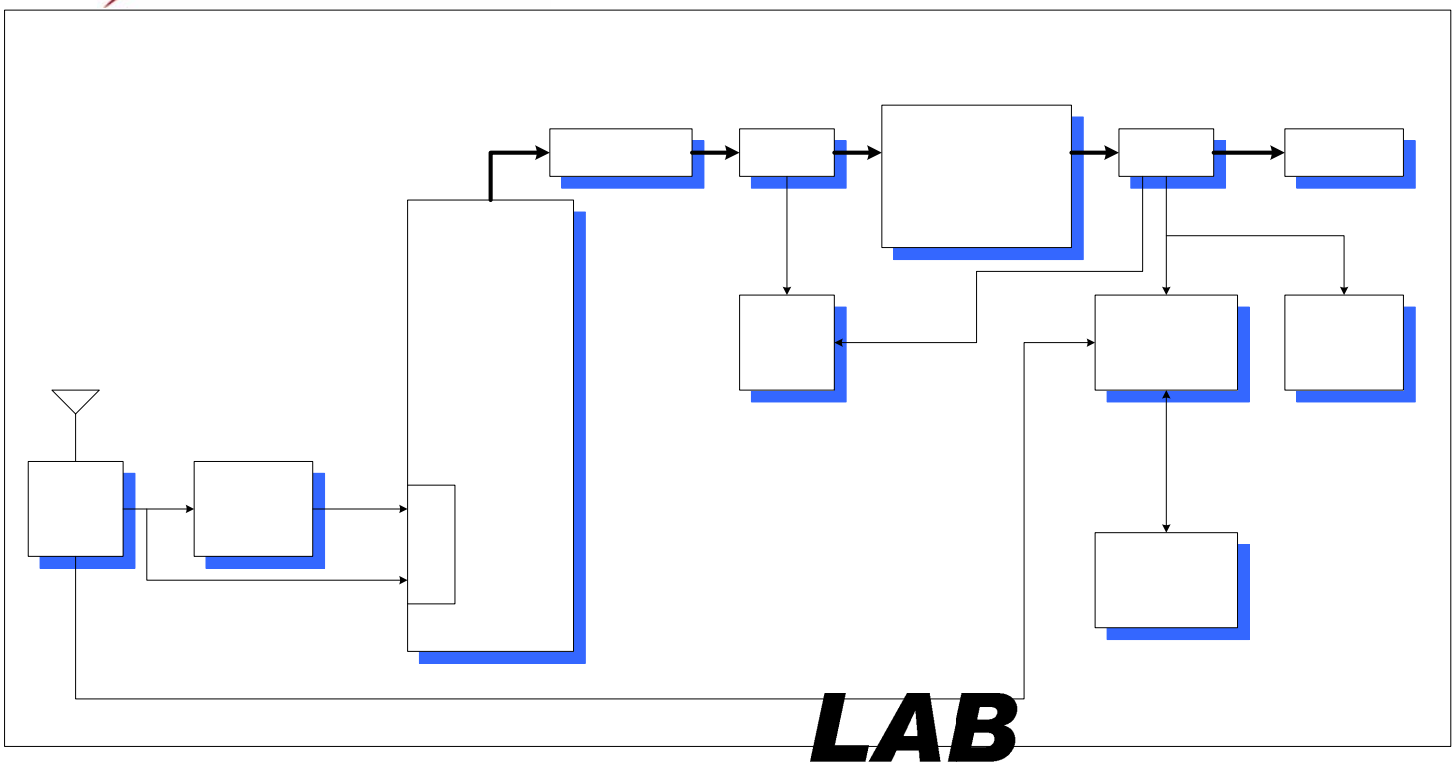
Spectrum Analyzer used for this measurement:

Manufacturer: Agilent
Model: E4443A
Serial Number: MY4100095
Calibration Date: 1/30/07

Network Analyzer used for this measurement:

Manufacturer: HP
Model: 8510A Network Analyzer
Serial Number: 2622A00956
Calibration Date: 11/99

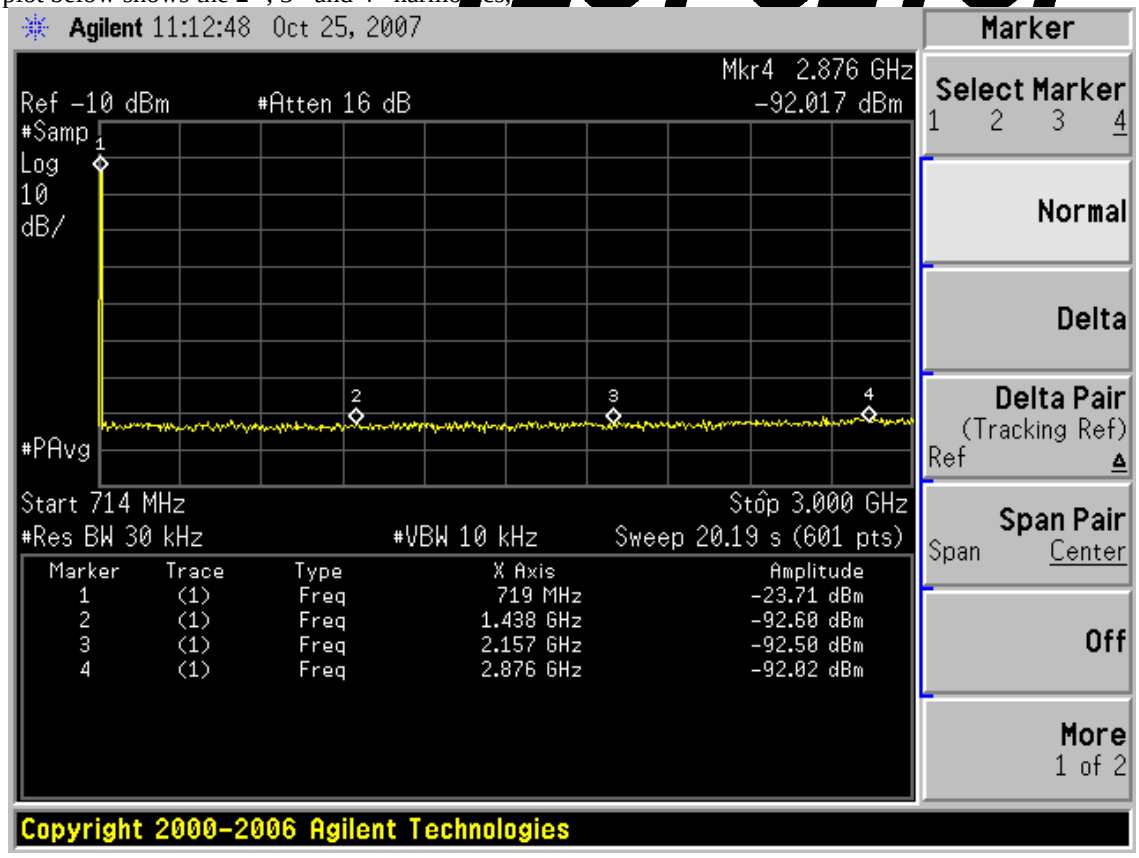
A block diagram of the set up is shown next,



LAB TEST SETUP

Measured Data

The plot below shows the 2nd, 3rd and 4th harmonics,



ATLAS
DVF
TRANS

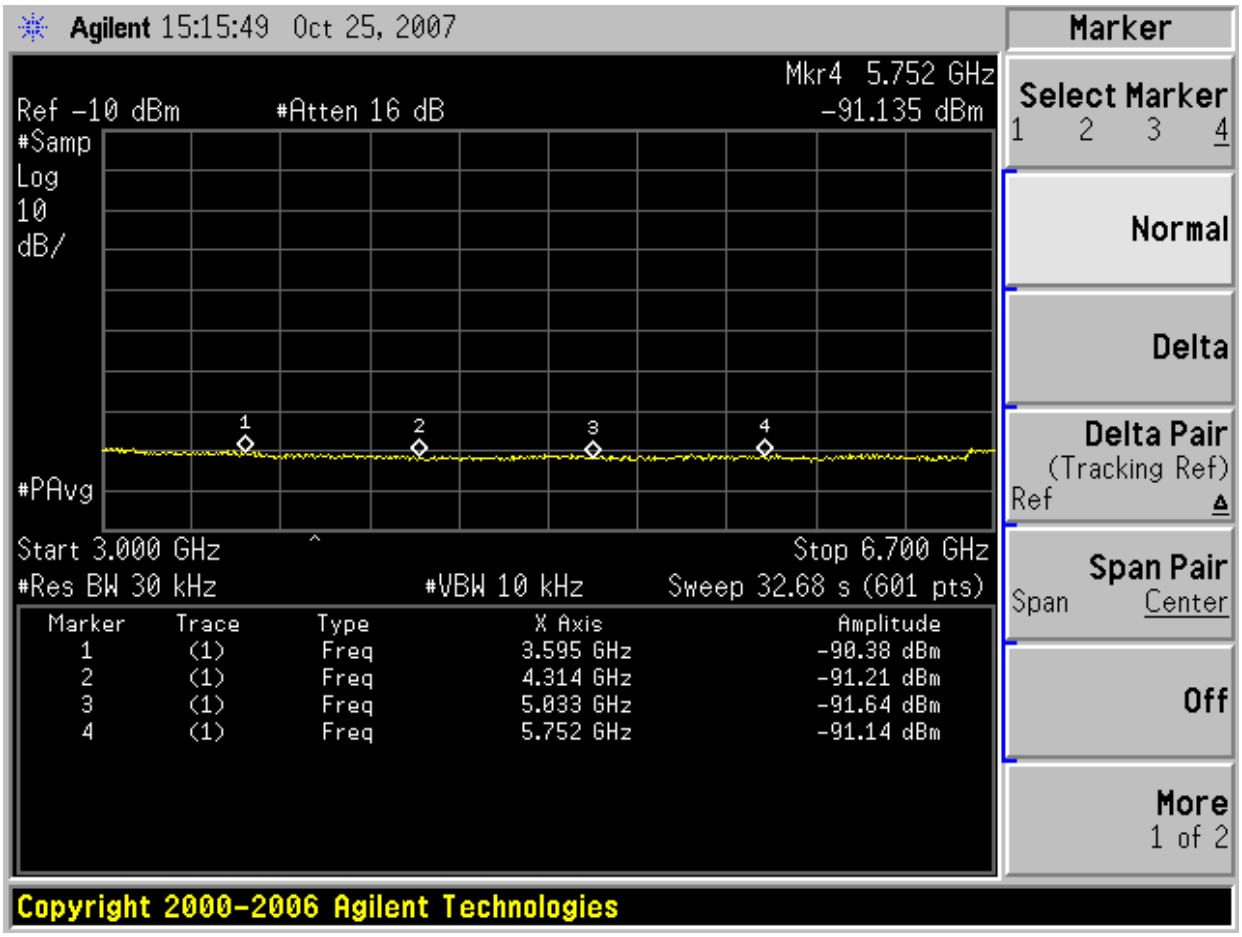
Linux PC

ASI

Note the fundamental amplitude of -23.71 dBm. This value will be used as the reference.

Compliance is assured if the delta between the 719 MHz marker and the markers at the harmonic frequencies is larger than 56.52 dB

The plot below shows markers at harmonics 5, 6, 7, and 8.



The table below summarizes the results,

	Frequency (MHz)	Filter Output Coupler (dB)	Measurement Cable Insertion Loss (dB)	Total Offset (dB)	Offset relative to fundamental Frequency (dB)	Power Measured in 30Khz BW (dBm)	Adjusted Measurement (dBm)	Spurious (dBc)	FCC Requirement (-79.53 + 23.01) (dB)	Pass Margin (dB)
Fundamental	719	47.02	0.73	47.75	0.00	-23.71	-23.71	Reference	Reference	Reference
2nd Harmonic	1438	40.3	1.06	41.36	-6.39	-92.60	-98.99	-93.75	-56.52	37.23
3rd Harmonic	2157	31.8	1.41	33.21	-14.54	-92.50	-107.04	-101.80	-56.52	45.28
4th Harmonic	2876	30.8	1.53	32.33	-15.42	-92.02	-107.44	-102.20	-56.52	45.68
5th Harmonic	3595	27.0	1.72	28.72	-19.03	-90.38	-109.41	-104.17	-56.52	47.65
6th Harmonic	4314	20.0	1.97	21.97	-25.78	-91.21	-116.99	-111.75	-56.52	55.23
7th Harmonic	5033	19.5	2.08	21.58	-26.17	-91.64	-117.81	-112.57	-56.52	56.05
8th Harmonic	5752	20.0	2.45	22.45	-25.30	-91.14	-116.44	-111.20	-56.52	54.68
9th Harmonic	6471	13.0	2.80	15.80	-31.95	-91.55	-123.50	-118.26	-56.52	61.74
10th Harmonic	7190	25.5				not measured				

2.1053 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.

Harris Response

The required spurious radiation level limit is given in 27.53:

(f) 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 these provisions is based on the procedures described in paragraph (a)(4) of this section.

The limit calculated by the above formula for 4500W power after filters is: -79.53 dBc

The calculated reference level (0 dBc) of the theoretical radiated carrier is found as follows:

CP_W	=	4500	Watts
R	=	3	meters
$FI_{dBV/m}$	=	43.9	dBV/m
$FL_{dBuV/m}$	=	163.9	dBuV/m

Terms:

CP_W	Transmitter carrier power output, expressed in Watts.
R	Distance from transmitter to receiving antenna, in meters
FI_{dBV}	Field Intensity of theoretical spurious carrier output $FL_{dBV} = 20 \times \log((1/R) \times (\text{sqrt}(49.2 \times CP_W)))$
$FL_{dBuV/m}$	Field Intensity level expressed in dBuV/m; equals FI_{dBV} + 120 dB $FL_{dBuV/m} = FL_{dBV/m} + 120$

The data in the following Tables are taken as evidence of compliance. The data are organized as measurements taken using Vertical Polarization and measurements taken using horizontal polarization, and according to the antenna position in relation to the transmitter.

Test Site:
The use of an OATS site to test this product is precluded by the size and the service requirements of the product. Therefore, a suitable indoor space is used, of sufficient size to allow adequate separation between the transmitter and surrounding objects. The photo following the test data and additional photos in this report illustrate the space used. The space was chosen because it has a high ceiling, with a sufficient open area to place the Equipment Under Test so that no large reflecting objects are close to the test area.

The EUT was placed at the center of a clear space with area large enough to enable positioning the antenna at a 3 meter measuring distance. The cooling system components, needed to operate the transmitter, and the output filter assembly, needed for some of the required measurements, were placed nearby in positions which would not interfere with measurements at the front, rear, left, and right sides.

The transmitter was operated at 5000 watts cabinet output power (before filter), 4500W (after filter) and the antenna was positioned at each measuring location. The antenna was at a height equal to the vertical centerline of the PA modules (which is the approximate center of radiation of the transmitter cabinet), but then adjusted for maximum signal reception at each frequency. Data were taken using Vertical and Horizontal polarization, and the results were tabulated as shown on the following pages.

Test Equipment Used:

Manufacturer: Agilent
Model: E4443A
Serial Number: MY4100095
Calibration Date: 1/30/07

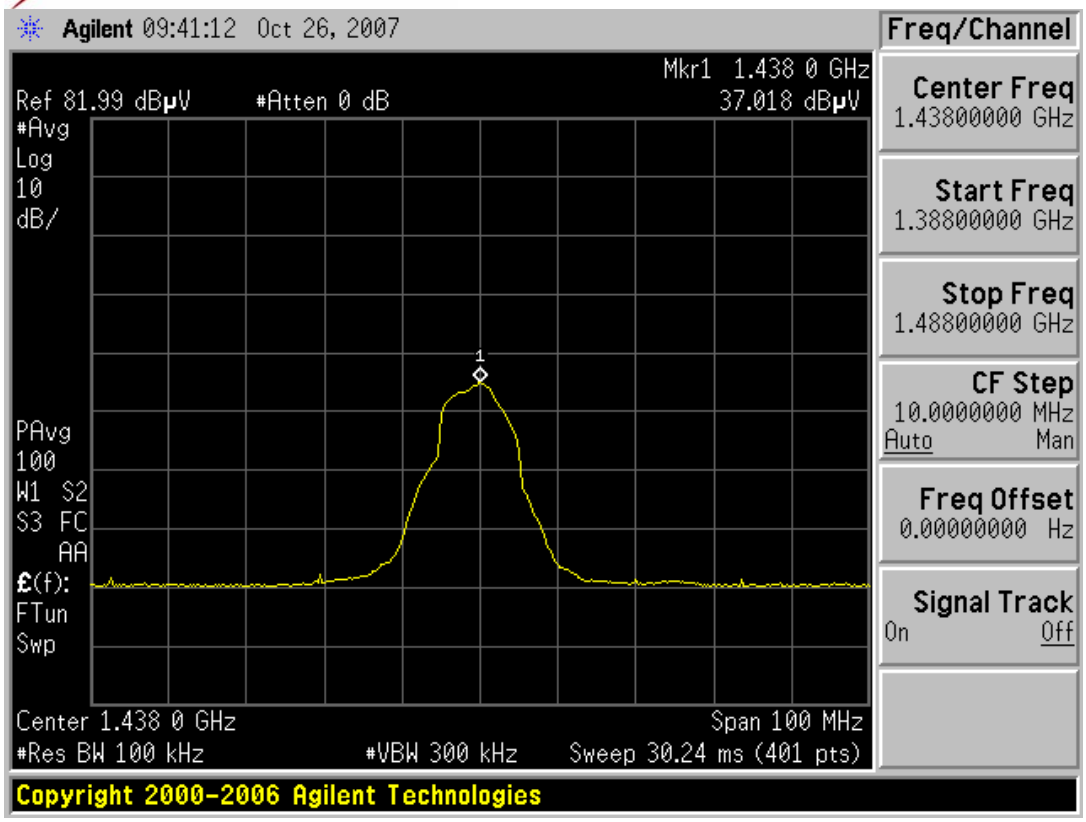
Doubled Ridge Guide Antenna
Manufacturer: ETS-LINDGREN
Model: 3115
S/N: 00071517
Calibrated: 4/27/07

Antenna used for the radiation measurements

The following plots show examples of the measured data at the 2nd and 3rd harmonic frequencies.

The spectrum analyzer settings used were:

Resolution Bandwidth: 100 kHz
Video Bandwidth: 300 kHz
Detector Type: Average
Number of Power Average Readings: 100


Agilent 09:41:12 Oct 26, 2007
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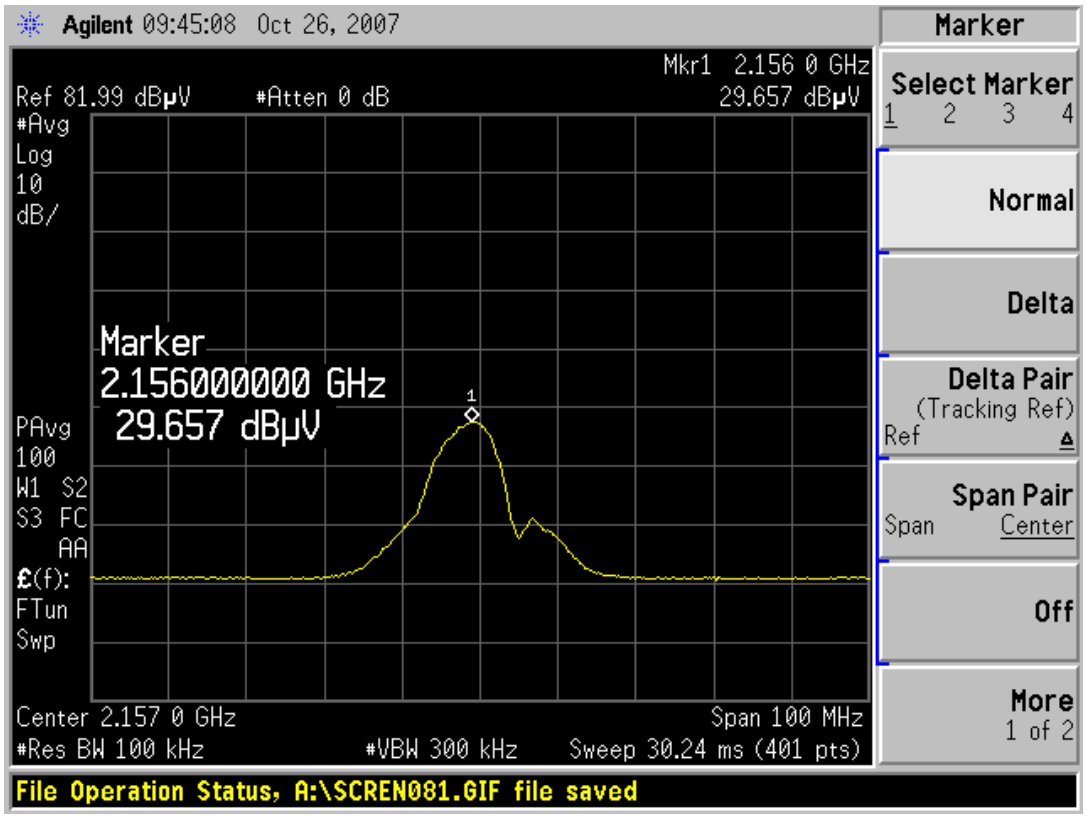
Ref 81.99 dBµV
#Atten 0 dB
37.018 dBµV
#Avg
Log
10
dB/
Center Freq
1.43800000 GHz
Start Freq
1.38800000 GHz
Stop Freq
1.48800000 GHz
CF Step
10.0000000 MHz
Auto
Man
Freq Offset
0.00000000 Hz
Signal Track
On
Off
PAvg
100
W1 S2
S3 FC
AA
£(f):
FTun
Swp
Center 1.438 0 GHz
Span 100 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 30.24 ms (401 pts)
Copyright 2000-2006 Agilent Technologies


Agilent 09:45:08 Oct 26, 2007
Marker
Mkr1 2.156 0 GHz
Ref 81.99 dBµV
#Atten 0 dB
29.657 dBµV
#Avg
Log
10
dB/
Marker
2.156000000 GHz
29.657 dBµV
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span
Center
Off
More
1 of 2
PAvg
100
W1 S2
S3 FC
AA
£(f):
FTun
Swp
Center 2.157 0 GHz
Span 100 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 30.24 ms (401 pts)
File Operation Status, A:\SCREN081.GIF file saved

Cabinet Radiation Summary Table

Transmitter Power	4500	Watts
Measuring Distance	3	Meters
Reference Carrier Power (0 dBc)	163.9	dBuV/m
Required Spurious Limit	-79.53	dBc
Absolute Spurious Limit	84.4	dBuV/m

Tabulated Measurements and Results - Horizontal Polarization

Position 1 Transmitter Front Side

Frequency(MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	37.0	26.8	163.9	-100.1	-79.53	20.6
2157	29.7	29.7		-104.5		25.0
2876	21.7	31.4		-110.9		31.3
3595	23.3	32.8		-107.8		28.2
4314	23.0	34.6		-106.3		26.8
5033	17.4	35.6		-110.9		31.4
5752	10.3	38.4		-115.2		35.7
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Position 2 Transmitter Left Side

Frequency (MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	36.5	26.8	163.9	-100.6	-79.53	21.1
2157	27.8	29.7		-106.4		26.9
2876	15.0	31.4		-117.6		38.0
3595	15.7	32.8		-115.4		35.8
4314	16.4	34.6		-112.9		33.4
5033	12.5	35.6		-115.8		36.3
5752	9.0	38.4		-116.5		37.0
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Position 3 Transmitter Rear Side

Frequency(MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	34.0	26.8	163.9	-103.1	-79.53	23.6
2157	21.3	29.7		-112.9		33.4
2876	13.2	31.4		-119.4		39.8
3595	18.1	32.8		-113.0		33.4
4314	11.9	34.6		-117.4		37.9
5033	5.0	35.6		-123.3		43.8
5752	5.0	38.4		-120.5		41.0
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Position 4 Transmitter Right Side

Frequency (MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	28.1	26.8	163.9	-109.0	-79.53	29.5
2157	21.8	29.7		-112.4		32.9
2876	12.3	31.4		-120.3		40.7
3595	14.0	32.8		-117.1		37.5
4314	14.0	34.6		-115.3		35.8
5033	10.8	35.6		-117.5		38.0
5752	5.0	38.4		-120.5		41.0
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Tabulated Measurements and Results - Vertical Polarization

Position 1 Transmitter Front Side

Frequency(MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	36.6	26.8	163.9	-100.5	-79.53	21.0
2157	20.4	29.7		-113.8		34.3
2876	18.0	31.4		-114.6		35.0
3595	18.3	32.8		-112.8		33.2
4314	12.5	34.6		-116.8		37.3
5033	5.0	35.6		-123.3		43.8
5752	5.0	38.4		-120.5		41.0
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Position 2 Transmitter Left Side

Frequency (MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	31.6	26.8	163.9	-105.5	-79.53	26.0
2157	17.5	29.7		-116.7		37.2
2876	10.6	31.4		-122.0		42.4
3595	13.5	32.8		-117.6		38.0
4314	11.2	34.6		-118.1		38.6
5033	5.0	35.6		-123.3		43.8
5752	5.0	38.4		-120.5		41.0
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Position 3 Transmitter Rear Side

Frequency(MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	24.9	26.8	163.9	-112.2	-79.53	32.7
2157	18.7	29.7		-115.5		36.0
2876	9.5	31.4		-123.1		43.5
3595	10.4	32.8		-120.7		41.1
4314	8.9	34.6		-120.4		40.9
5033	5.0	35.6		-123.3		43.8
5752	5.0	38.4		-120.5		41.0
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Position 4 Transmitter Right Side

Frequency (MHz)	Measured (dBuV)	Antenna Factor + Cable Loss (dB)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1438	25.5	26.8	163.9	-111.6	-79.53	32.1
2157	13.1	29.7		-121.1		41.6
2876	10.0	31.4		-122.6		43.0
3595	13.0	32.8		-118.1		38.5
4314	5.0	34.6		-124.3		44.8
5033	5.0	35.6		-123.3		43.8
5752	5.0	38.4		-120.5		41.0
6471	5.0	39.5		-119.4		39.9
7190	5.0	41.1		-117.8		38.3

Shaded areas are recorded measurements at frequencies where the signal can't be differentiated from the noise floor

The second and third harmonic measurements were validated using the substitution method described in TIA-603-C. The substitution antenna was driven at the harmonic frequencies by a signal generator. The height of both antennas was adjusted to maximize the reading. The generator level was then adjusted to replicate the level observed on the spectrum analyzer in the direct measurements. The level out of the signal generator was then used in conjunction with the cable loss and antenna gain to derive the cabinet radiation. The results with the substitution method matched very closely with the direct readings.

MHz	Pg (dBm)	Cable Loss dB	Ant Gain (dBi)	Pd (dBm)	TX Watts	Radiated (dB)	
1438	-38.00	2.05	6.3	-33.7	4500	100.2	Horizontal
1438	-37.75	2.05	6.3	-33.5	4500	100.0	Vertical
2157	-40.30	2.5	6.1	-36.7	4500	103.2	Horizontal
2157	-50.30	2.5	6.1	-46.7	4500	113.2	Vertical

2.1055 Measurements required: Frequency stability.

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

(1) From -30°C to +50°C for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

NOTE: Paragraphs (a) (2) and (3) do not apply to this Part 27 equipment.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10°C 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.

Harris Response

Measurements were made in accord with 2.1055(a)(1), from -30°C to +50°C, and from -15% to +15% of the nominal AC line voltage.

An Apex Mobile exciter typical of all units to be used in the ATLAS Mobile transmitters was tested 1/18/2007. The following describes the procedure and the results of those tests.

Setup:

The exciter will be locked to a GPS 1pps source and the frequency counter will be locked to the same GPS reviewer 10MHz. The exciter will be placed in the environmental chamber and operated over the specified temp range. At each temperature the AC line voltage will be varied via a variac from nominal (120vac) to 85% (102vac) to 115% (138vac).

Equipment:	**Manufacturer & Model**	**Serial Number**
GPS Receiver	Trimble Thunderbolt P/N 48050-61	832576657
Frequency Counter:	HP 53132A	08899
Multimeter:	HP 34401A	00971
Enviromental Chamber:	Tenny Versa Tenn Model T30RC	12437-51
Variac:	Powerstat 3PN2168	None

Data:

Temp in C	AC Line Voltage		
	102	120	138
-30	718999999.735	718999999.745	718999999.751
-20	718999999.926	718999999.931	718999999.951
-10	718999999.843	718999999.843	718999999.851
0	718999999.926	718999999.931	718999999.926
10	718999999.911	718999999.915	718999999.909
20	718999999.907	718999999.913	718999999.921
30	718999999.983	718999999.981	718999999.982
40	718999999.961	718999999.969	718999999.961
50	718999999.975	718999999.988	718999999.991

Requirement:
Per FLO Minimum Performance Specification the tolerance must be within +/- 1 x 10E-9. At 719MHz this equates to +/-0.719 Hz. The frequency must be within:

Minimum 718999999.281
Maximum 719000000.719

Conclusion:
This exciter and the transmitters using it are able to maintain frequency within the channel, as required by Part 27, and within the specification provided by Qualcomm.

Note:
While the data was taken in accordance with FCC regulations to -30°C, it must be noted that the exciter is not specified to operate below 0°C. Provision should be made to avoid operation below 0°C or shut down the equipment by external means.

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