Certification of Compliance
DTV640/200T-E10 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 / Model	DTV640/200T-E10	
FCC Identifier	BOIDTV640-200	
Frequency	701 MHz	
Rated Power	200 Watts at transmitter output	
	145 Watts at mask filter output	
Serial Numbers	0764	All tests except Spurious Radiation
	0052	Spurious Radiation Tests

The person responsible for testing is:

Karl Black
Compliance Engineer

June 6, 2007
(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 PowerOutput	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. Measured at the output of the output bandpass filter.
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 and the measured spurious level, 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) EIA/TIA 603C	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). Supplemental measurements was taken according to EIA/TIA 603C to confirm the direct measurements.
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
Power Meter	Hewlett-Packard 436A	2347A17946
Power Sensor	Hewlett-Packard 8482H	1545A00392
Spectrum Analyzer	Rohde & Schwarz FSEA	842111/027
EMI Antenna #1	ETS-Lindgren 3115	28914
EMI Antenna #2	ETS-Lindgren 3115	71517
EMI Receiver	HP 8546A	3710A00387
Frequency Counter:	Hewlett-Packard 53132A	3710A04170
Signal Generator	Agilent E4420B	US384405

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 the records as required and can make them available upon request. Contact:

Harris BroadcastCommunications
3200 Wismann Lane
Quincy, Illinois 62305-4290
(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.

Form 731 with the required information is filed along with this report.

(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 BroadcastCommunications 3200 Wismann Lane Quincy, Illinois 62305-4290 (217) 222-8200

(2) FCC Identifier

FCC identifier	BOI
Equipment Product Code:	DTV640-200

(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.

Copies of the transmitter and the exciter instruction manuals are submitted.

(4) Type or Types of emission,

6M00W7W	Single Frequency Network

(5) Frequency Range

One 6 MHz channel, 698 - 704 MHz

(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 power will be 145 Watts average power at the output of the mask bandpass filter.

(7) Maximum Power

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

The maximum rated power for this transmitter is 200 Watts at the transmitter output flange. The transmitter produces 145 Watts at the output of the output bandpass filter.

(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.

This data is supplied as part of the response to 2.1046 – RF Power Output

(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 manual.

(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.

Stabilizing Frequency
The DTV640/200T-E10 transmitter uses the FAB66 Frequency Processing module to receive external reference frequency and 1 PPS clock from GPS satellites. This is needed for the functioning of the Single Frequency Network.

The FAB66 module's connection inside the transmitter can be seen in the DTV660 Operating Manual, Page 2-19, Drawing **DTV Transmitter 200 W UHF, 250 W BIII**.

The front panel and connections of the FAB66 module can be seen on page 2-24 of the manual.

A technical description of the FAB66 Frequency Processing module is in a separate document, **Frequency Processing fab66**.

Suppression of Spurious Radiation
Spurious Radiation from the transmitter structure is controlled by the design of the transmitter enclosure and the circuits within. The photos accompanying this application for certification illustrate the physical construction.

Spurious Radiation from the antenna, which is separated from the transmitter, is controlled by the shaping of the modulated bandpass, and also by use of a bandpass filter at the output of the transmitter. The combined effect of these two measures is to cause spurious emissions conducted from the RF output connection of the transmitter, filtered by the bandpass filter, to be below the required spurious emission limits for the service.

Limiting Modulation
Modulation of the DTV640/200T-E10 transmitter is COFDM, and does not vary due to any change in or lack of content. Limiting is inherent in the process.

Limiting Power
The average nominal output power will be adjusted and limited automatically by means of an Automatic Gain Control function in the exciter. The AGC function maintains the output power within ±0.5dB of the power setting.

The output peak power will be limited by means of Peak reduction function in the digital precorrection unit, also part of the exciter. The crest factor values can be controlled in this way.

(11) Identification Plate

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

Identification Label to be placed on the transmitter

TRANSMITTING EQUIPMENT
FCC ID: BOI _DTV640-200___ FREQUENCY: _701 MHZ_
CANADA: _____ OUTPUT POWER: _145 W___
MODEL: _DTV640/200T-E10_ P/N: _977 295 500_____
HARRIS CORPORATION
BROADCAST DIVISION, QUINCY, IL USA

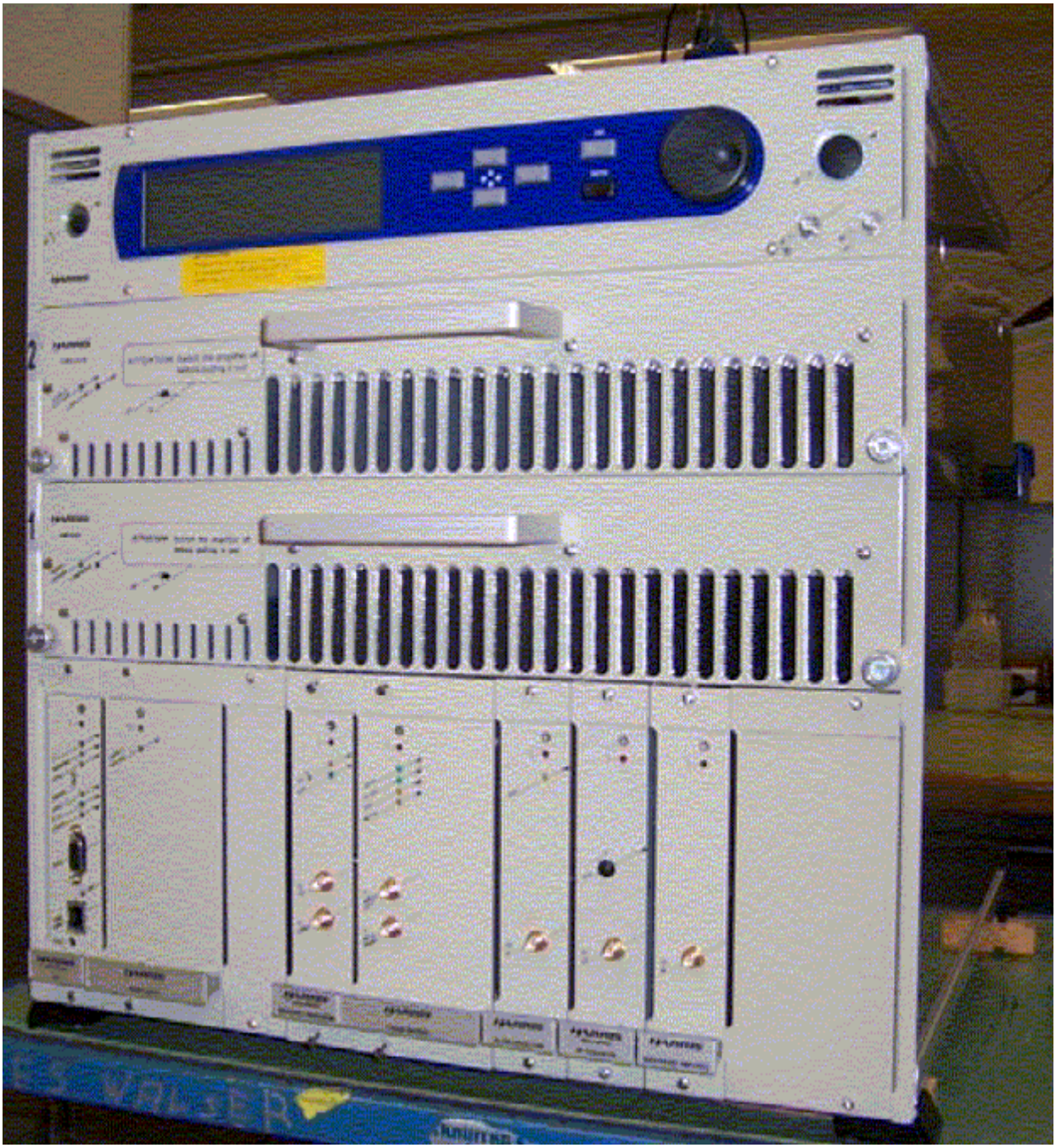
The ID label is placed on the lower rear surface of the transmitter.

(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.

A collection of photos will be included with the application. These photos below show the front and rear of the transmitter.

Front View of DTV640/.200T-E10 Transmitter



Rear View of DTV640/.200T-E10 Transmitter

(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.

In this use of the DTV640/200 transmitter for DVH-H service, the modulation is QPSK, 16-QAM, and is a COFDM signal. Framing structure, channel coding and modulation are described in ETSI document EN 300744, Digital Video Broadcasting (DVB) - Framing structure, channel coding and modulation for digital terrestrial television. The "4K" mode defined in EN 300744 for DVB-H service is to be used for this licensed service.

(14) Required Data, 2.1046 through 2.1057

All data required by Sec. 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

The transmitter was operated into a test load for the purpose of measuring the RF output at the transmitter output flange. The output filter was not installed during this test.

A calibrated RF power meter was connected to a calibrated RF sample taken at the input to the load. The calibrated RF coupling ratio in dB of the sample at the operating frequency was added to the measured RF level at the power meter and the transmitter output was adjusted to produce the rated output level of 200 Watts.

The measured coupling value of the transmitter output coupler was -34.6 dB.

The transmitter's rated output power (200 watts) in dBm is equal to 53.01 dBm.

10 x log(200,000) = 53.01

This desired level was combined with the measured value of the coupler to find the RF power meter level which should be seen when the transmitter output was 200 watts.

53.01 dBm – 34.6 dB = 18.41 dBm

The transmitter output power was adjusted to produce 18.41 dBm as displayed by the RF power meter. While transmitting this power level into the load, the transmitter's metering was adjusted to show 53.0 dBm output level.

The DTV640-200T-E10 transmitter can be selected to display either the output power directly in Watts, or the dBm value of the output power. Therefore, once calibrated, either selected display may be used to check and to maintain the correct output power level.

Output from this transmitter must be filtered by an external RF bandpas filter to comply with out of band emission requirements. When the DTV640-200T-E10 transmitter is transmitting its full 200 watt rated power into the filter, the output from the filter is measured to be 145 Watts.

Equipment used for this calibration:				
Equipment	Mfr.	Model:	Serial Number:	Calibration due:
Power Meter	Hewlett-Packard	436A	2347A17946	April, 2007
Power Sensor	Hewlett-Packard	8482H	1545A00392	June, 2007

Calibration performed by B. Müller, February 1, 2007

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.

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.

(i) Transmitters designed for other types of modulation--when modulated by an appropriate signal of sufficient amplitude to be representative of the type of service in which used. A description of the input signal should be supplied.

Harris Response:
The modulation used for this service is a COFDM signal compliant with the DVBH standard, with a Necessary Bandwidth of 6 MHz. Occupied Bandwidth and Out of Band emissions were measured with the standard DVBH signal transmitted.

A Rohde & Schwarz FSEA spectrum analyzer, Serial number 842111/027 was used for these tests. The analyzer is due for calibration in June of 2007.

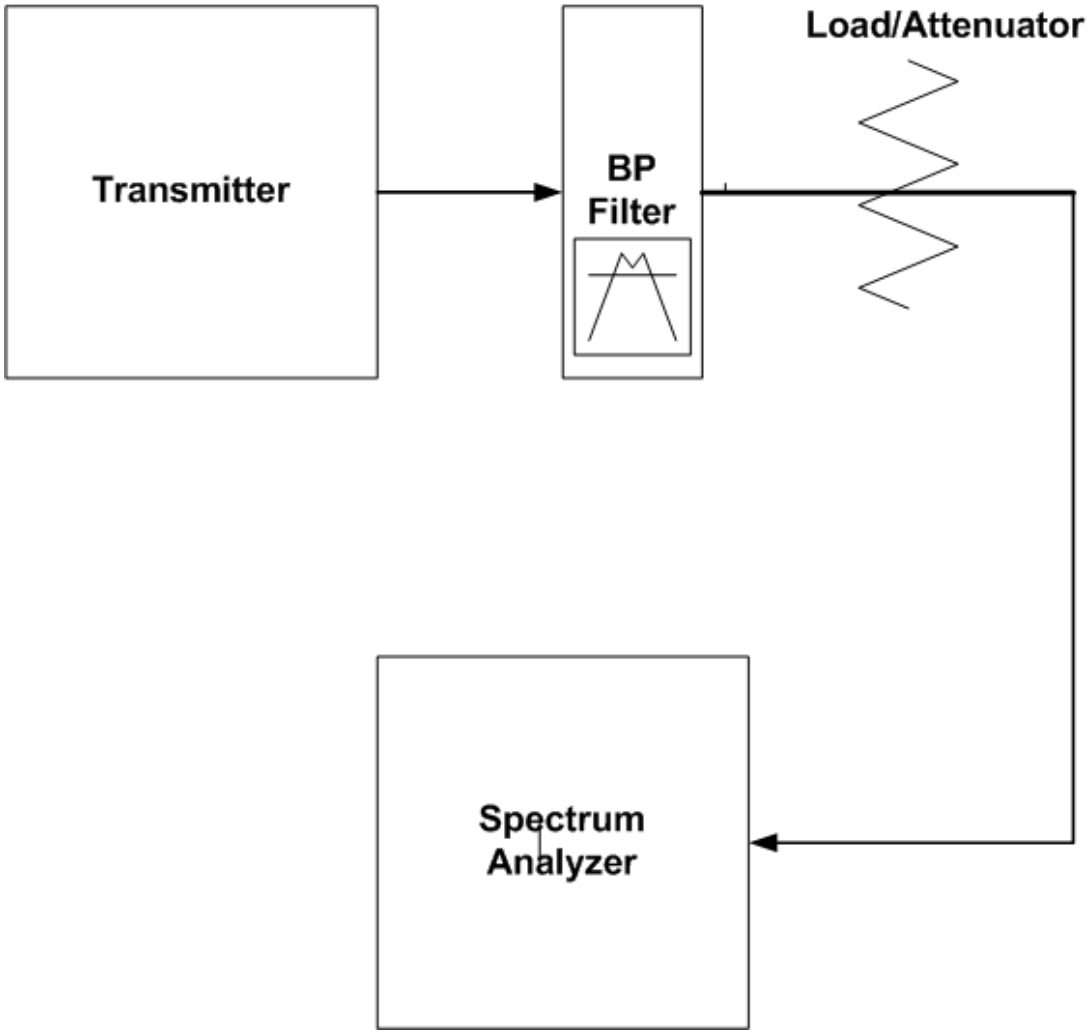
Spectrum analyzer settings:

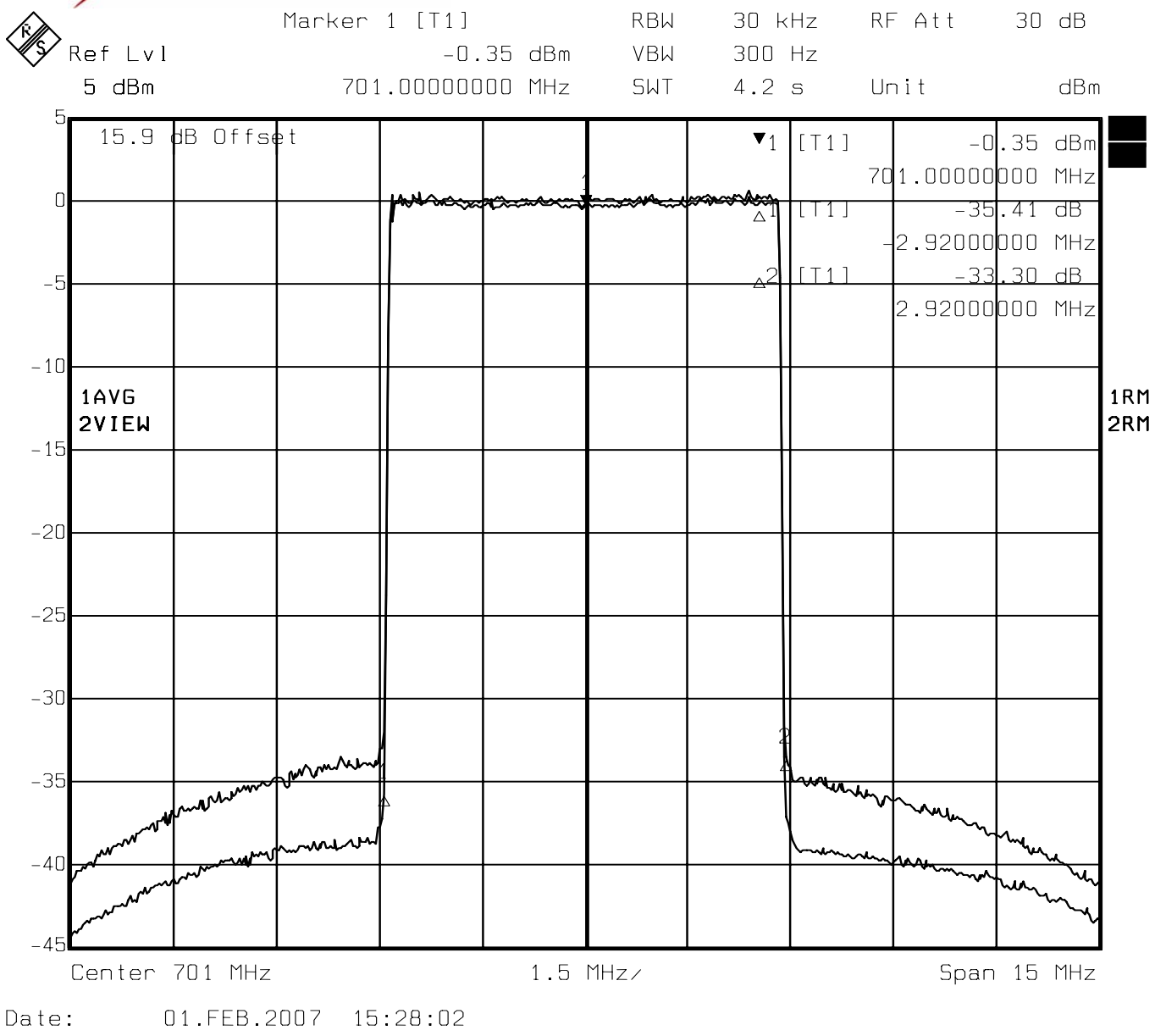
Span: 15 MHz	Detector: RMS
RBW: 30 kHz	Marker 1: Center frequency
VBW: 300 Hz	Delta: +/- 2,92 MHz

These plots below were taken before the output filter, with and without precorrection. Markers are set at the lower and the upper edges of the transmitted signal. The frequency difference between the two markers is the Occupied Bandwidth.

Tests performed by B. Müller, February 1, 2007

Test Setup for Modulation Characteristics and Occupied Bandwidth Measurements





Conclusion:
This plot shows the Occupied Bandwidth to be 5.84 MHz. This is demonstrated by the difference between the lower marker (-2.92 MHz), and the upper marker (+2.92 MHz).

Occupied Bandwidth = 2.92 + 2.92 = 5.84 MHz

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 interprets this requirement to mean the power of emissions at any frequency outside the licensed channel, measured in a 1 MHz bandwidth. From 27.53(f), these adjacent out of band emissions must be lower than

$$\textbf{Emission Limit} = (P_{dBm}) - (43 + 10\log(P))\ \text{dB}$$

where (P) is the total power (watts) emitted inside the channel. For this measurement, 0 dBc = P.

For this measurement, the output of the transmitter output bandpass filter is 145 dBm. The emission limit is -64.6 dBc, which is equal to -13 dBm.

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.

If the spectrum is observed using a spectrum analyzer set to 30 kHz resolution bandwidth, the measured amplitude of the in-band signal will appear to be 23.0 dB lower (10 x log(6000/30) than the actual level, and 5.2 dB lower than when observed with the 100 kHz bandwidth.

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

Equipment used for this measurement:				
Equipment	Mfr.	Model:	Serial Number:	Calibration due:
Spectrum Analyzer	Rohde & Schwarz	FSEA	842111/027	06/2007

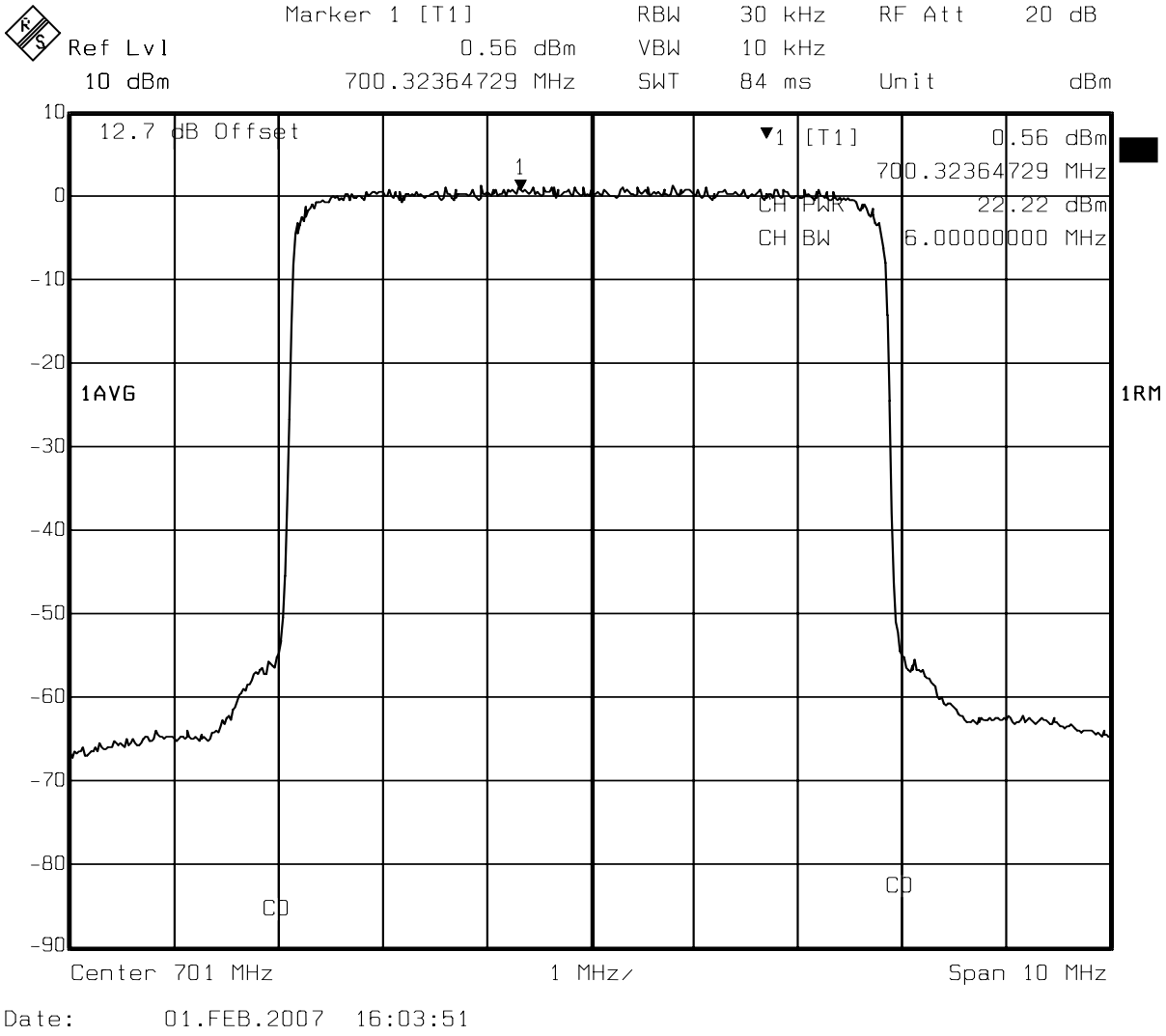
Data taken by B. Müller, February 1, 2007.

To develop the measured adjacent channel power data, three plots are taken on the following pages.

First, the output signal bandpass is displayed using a 10 MHz span. The total output power is measured and is found to be 22.22 dBm in the 6 MHz bandwidth, at the input of the instrument.

Second, the upper and the lower edges of the channel are each displayed, using a 5 MHz span. Markers are set at the channel edge and 1 MHz away from the channel edge in each plot, and the power in these 1 MHz adjacent bands is measured.

Measurement of Power in the Channel

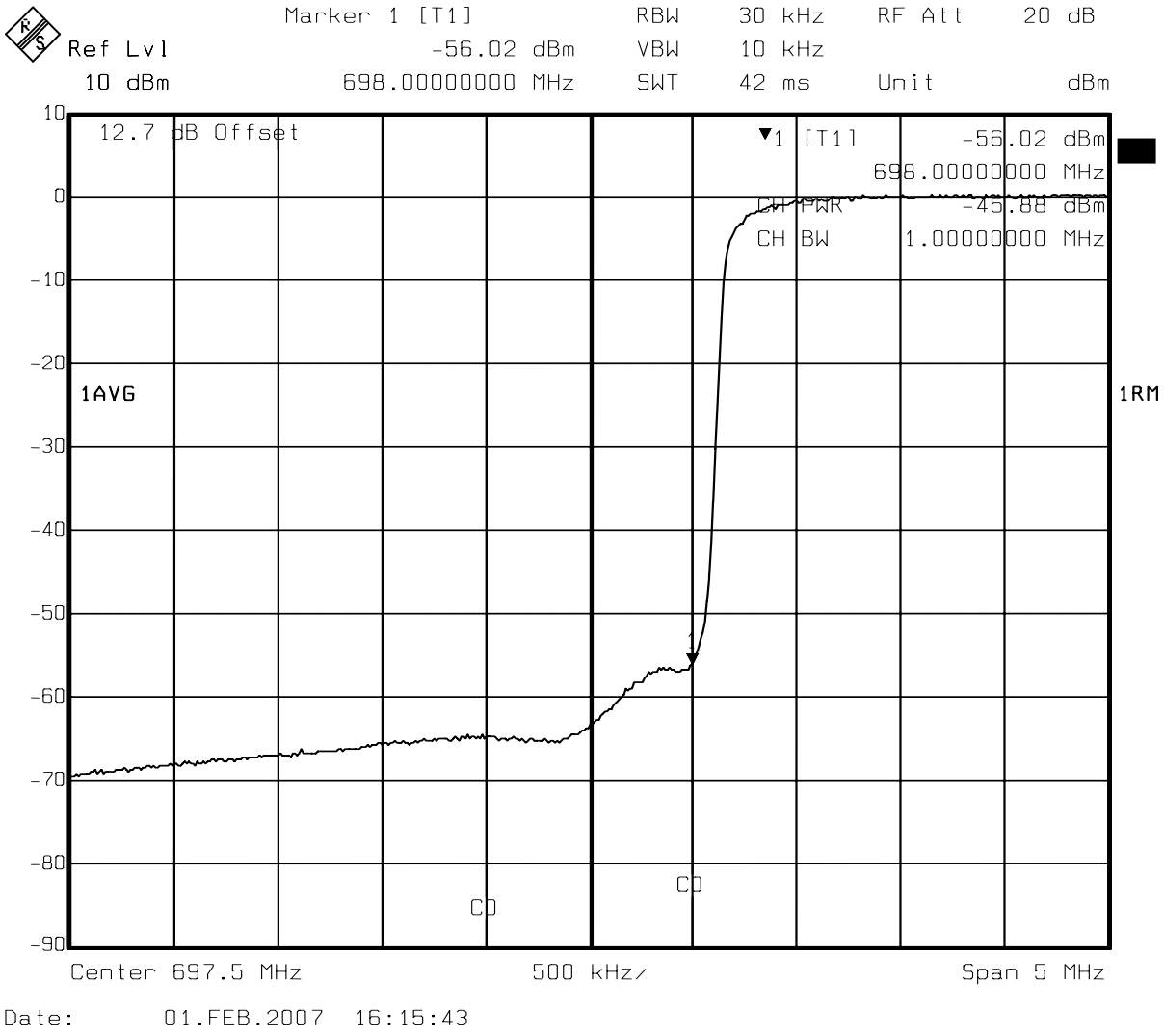


Measured Channel power: 22,22 dBm (at directional coupler after Filter)

The spectrum analyzer settings used were:

Span: 10 MHz Detector: RMS
RBW: 30 kHz Marker 1: 700.32 MHz
VBW: 10 kHz Power Band Measure Limits: 698 MHz and 704 MHz.

Measurement of Lower 1 MHz Adjacent Band

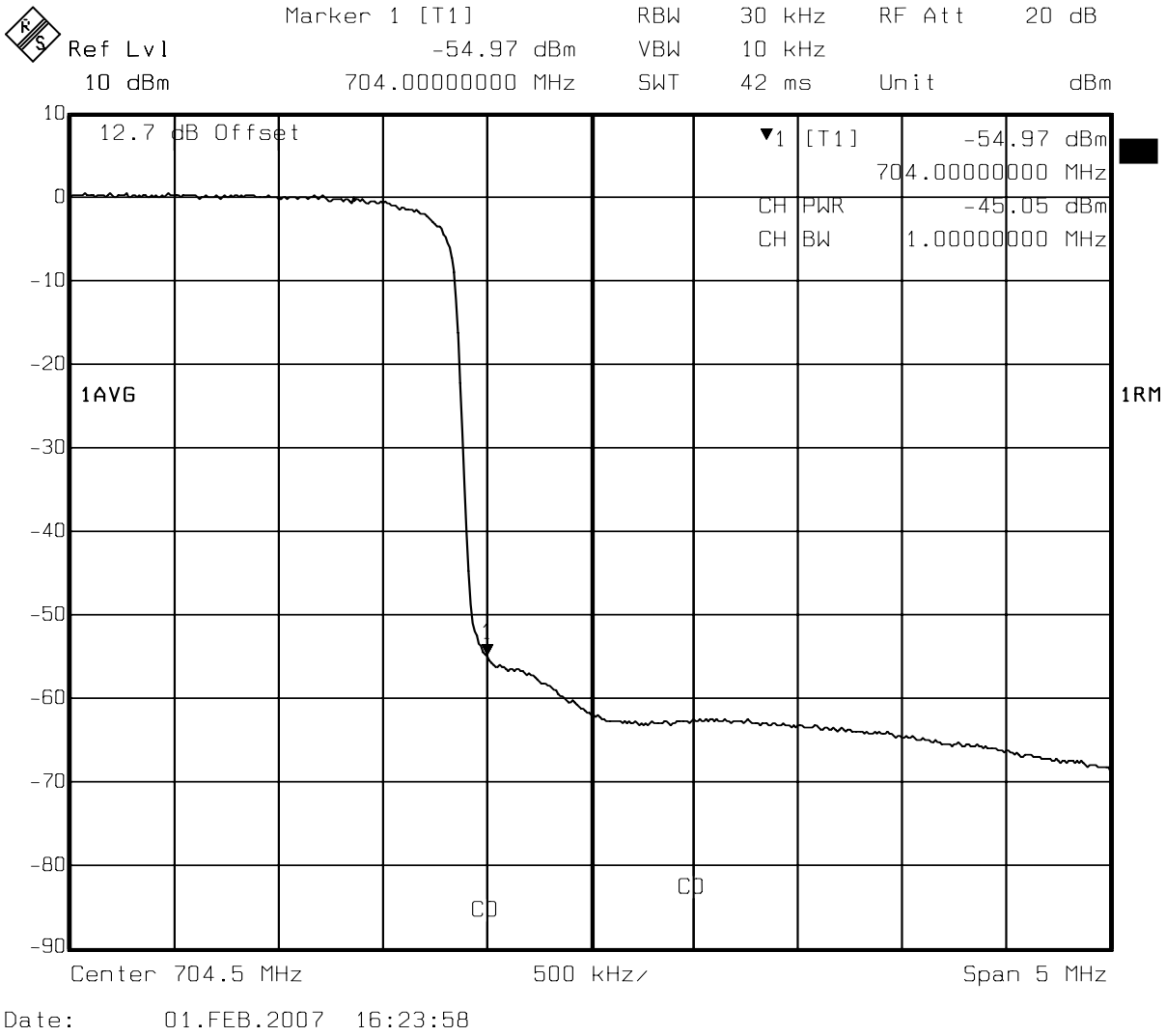


Measured Power at lower adjacent Channel: -45,9 dBm

The spectrum analyzer settings used were:

Span: 10 MHz	Detector: RMS
RBW: 30 kHz	Marker 1: Lower Channel Edge
VBW: 10 kHz	Channel Power Limits set to 1 MHz band adjacent to the lower channel edge.

Measurement of Upper 1 MHz Adjacent Band



Measured Power at upper adjacent Channel: -45,0 dBm

The spectrum analyzer settings used were:
Span: 10 MHz Detector: RMS
RBW: 30 kHz Marker 1: Upper Channel Edge
VBW: 10 kHz Channel Power limits set to 1 MHz band adjacent to the upper channel edge.

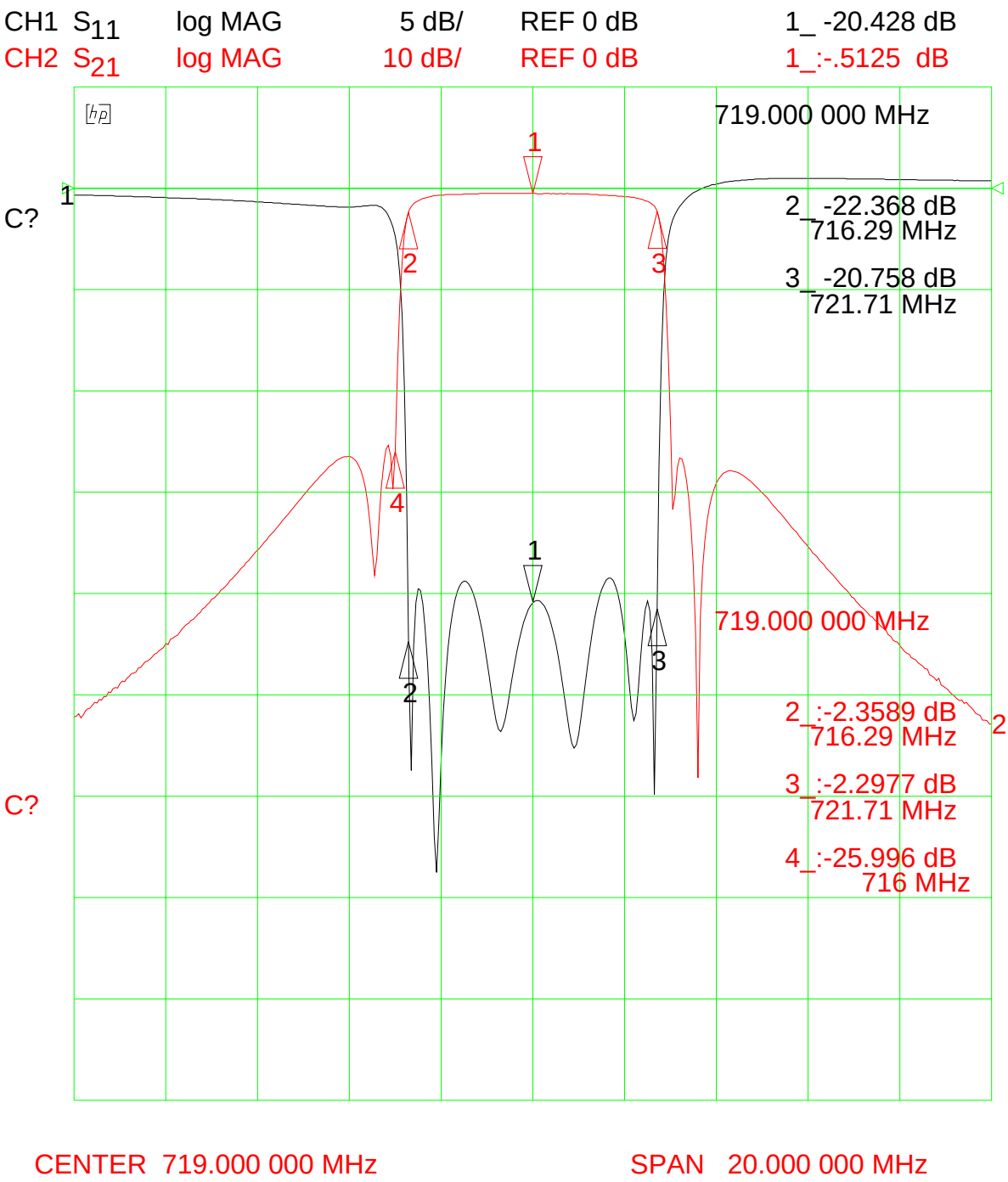
Calculated Limits:
Nominal Power: 145 W
FCC-Limit -43-10 * log(Nominal Power) -> -64.6 dBc

Measured at Power attenuator after Filter:
Transmitter Power: 0,17 W -> 22,22 dBm
FCC-Limit -64.6 dBc -42.38 dBm

Measured Power at lower side: -45,9 dBm -> 3.52 dB below the required limit
Measured Power at upper side: -45,1 dBm -> 2.72 below the required limit

Output Bandpass Filter Characteristic

The output bandpass filter specified for use with the DTV640/200T-E10 transmitter is a Harris-built filter constructed and tested to a Harris design. This plot below shows the filter characteristic. The channel tuned in this plot has a center frequency of 719.000 MHz, but this characteristic is achieved by this filter on each channel to which it is tuned.



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.

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.

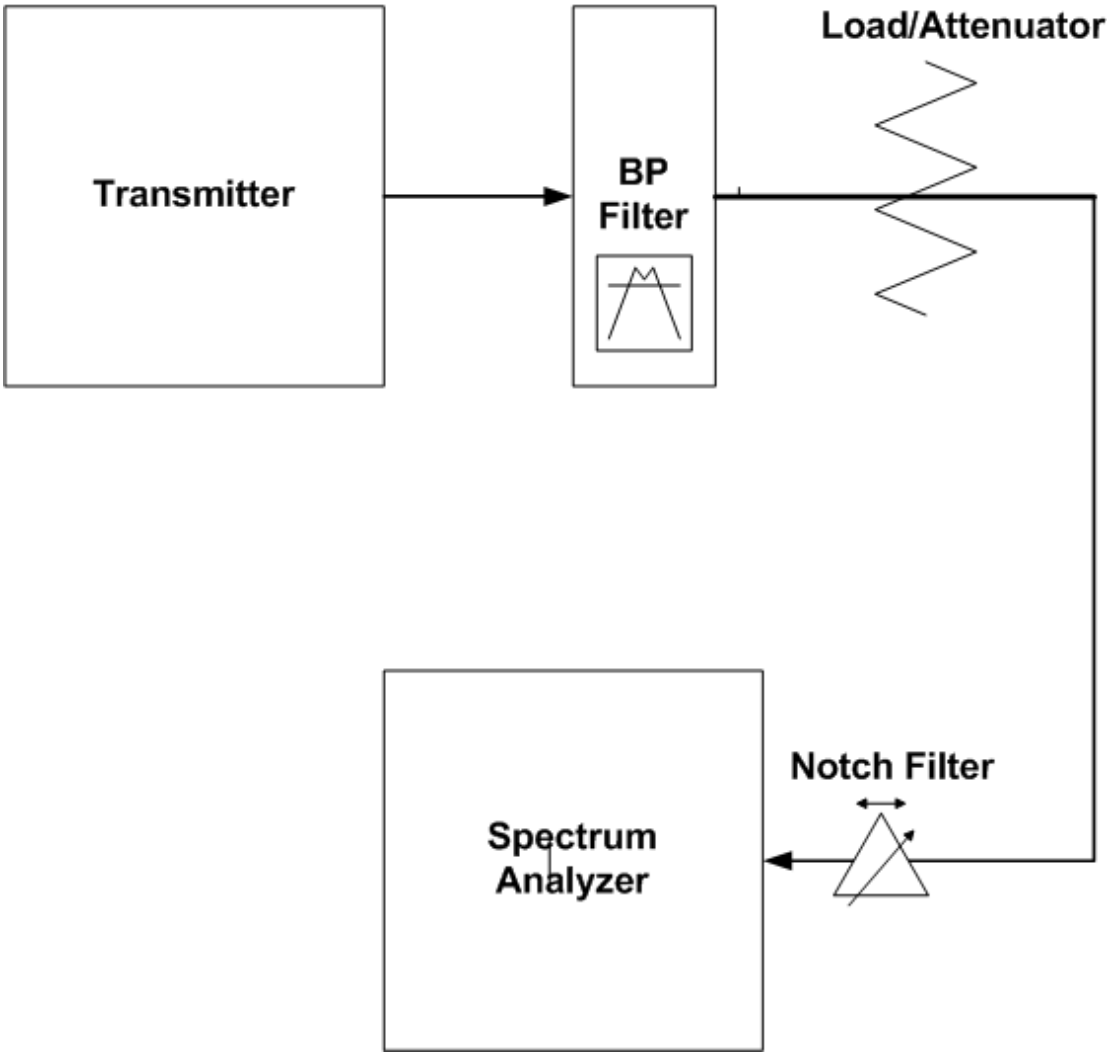
27.53 Emission limits.
. . .
(f) For operations in the 698–746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance 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
For this 200 watt transmitter, with an output from the output filter of 145 watts, the emission limit is -64.6 dBc, which is equal to -13 dBm.

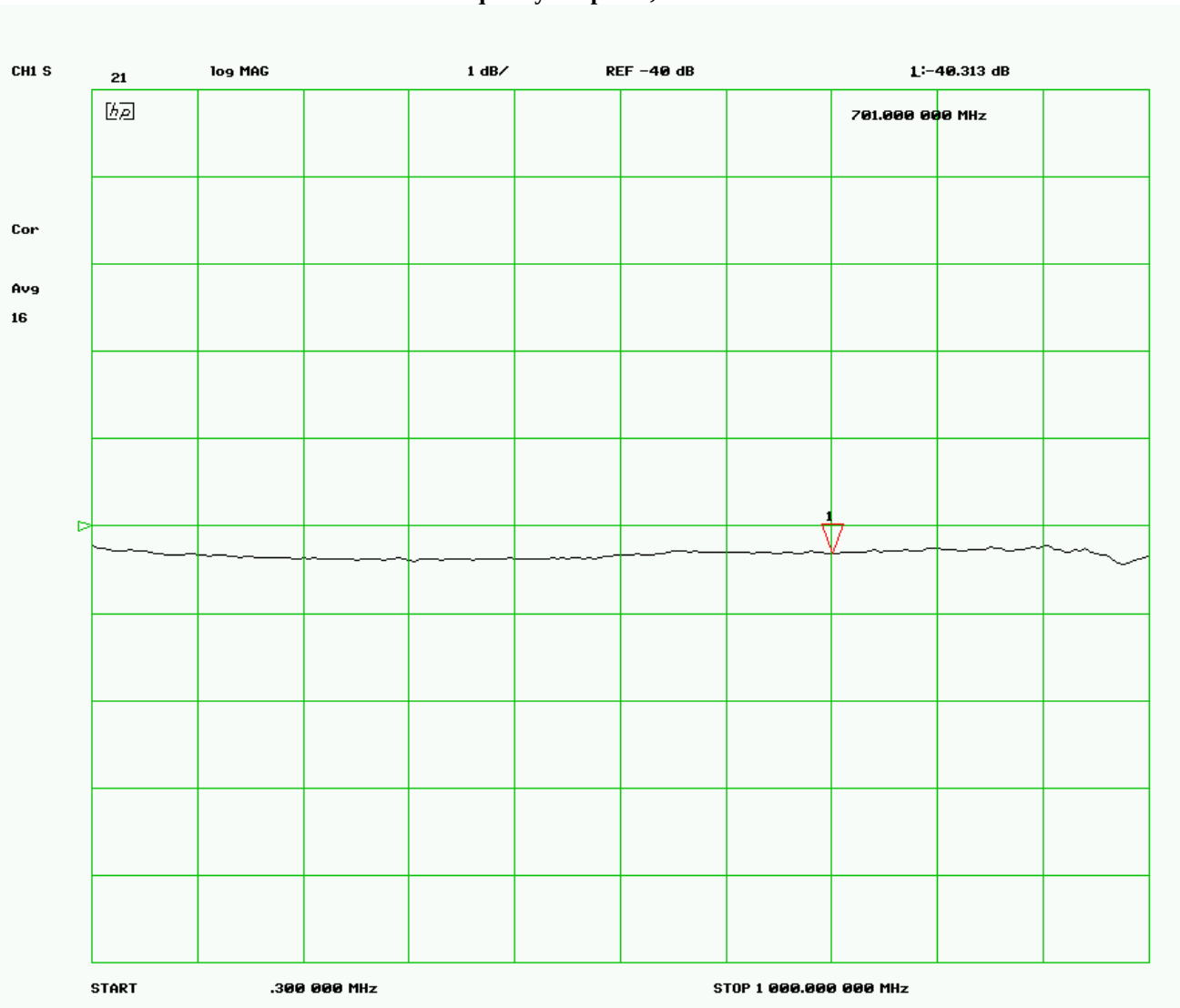
The measured levels of the carrier, all harmonics and spurious were recorded.

The transmitter was operated into an RF Load/Attenuator. The swept frequency response of the load/attenuator is shown on the following pages.

Test Setup for Spurious Emission measurements

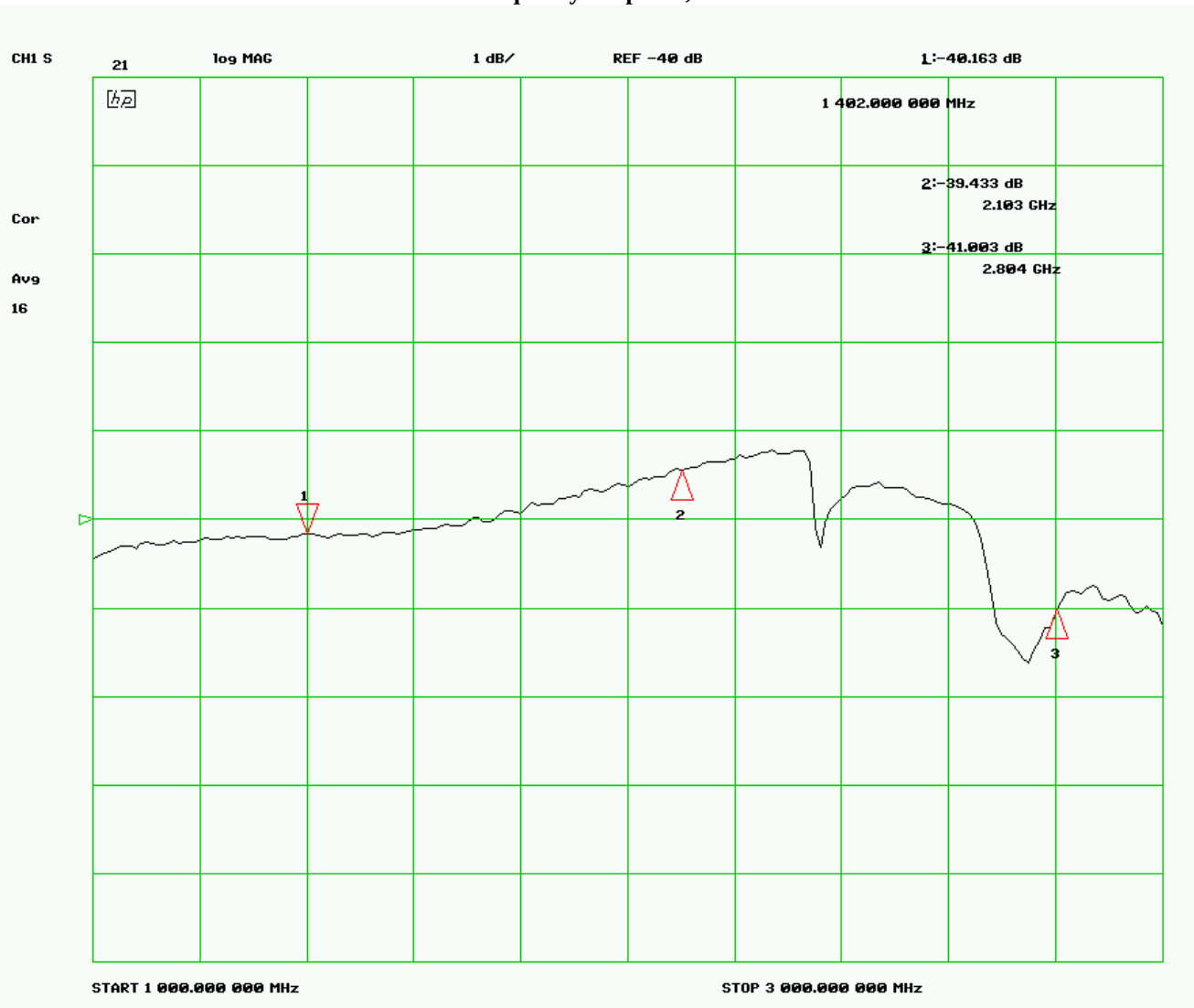


Load/Attenuator Frequency Response, 30 MHz to 1GHz



Spectrum analyzer settings:
RBW: 30 kHz Marker 1: Center frequency
VBW: 10 kHz
Detector: RMS

Load/Attenuator Frequency Response, 1 to 3 GHz



In this plot, markers have been set to the second, third and fourth harmonic frequencies of the 701 MHz transmitter to provide data to correct the measured values to include the attenuator insertion loss.

Next, the spectrum analyzer was connected to observe the transmitter conducted output at the bandpass filter output. The spectrum analyzer used was the Rohde & Schwarz FSEA, Serial number 842111/027. The analyzer is due for calibration in June of 2007. The following two plots show the transmitter output from 30 MHz to 3.5 GHz.

30 MHz to 1 GHz:

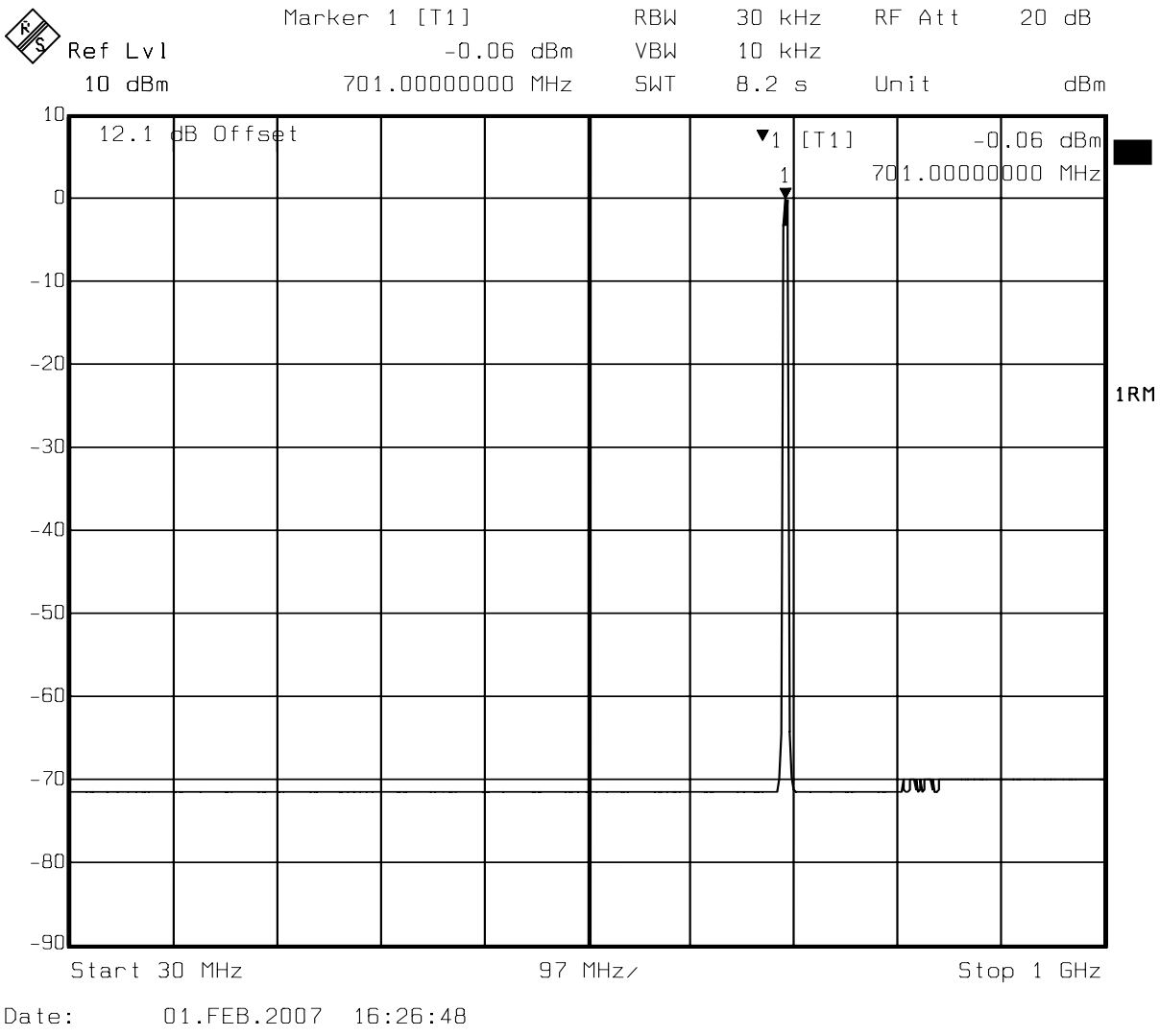
Spectrum analyzer settings:

RBW: 30 kHz Marker 1: Channel Center frequency

VBW: 10 kHz

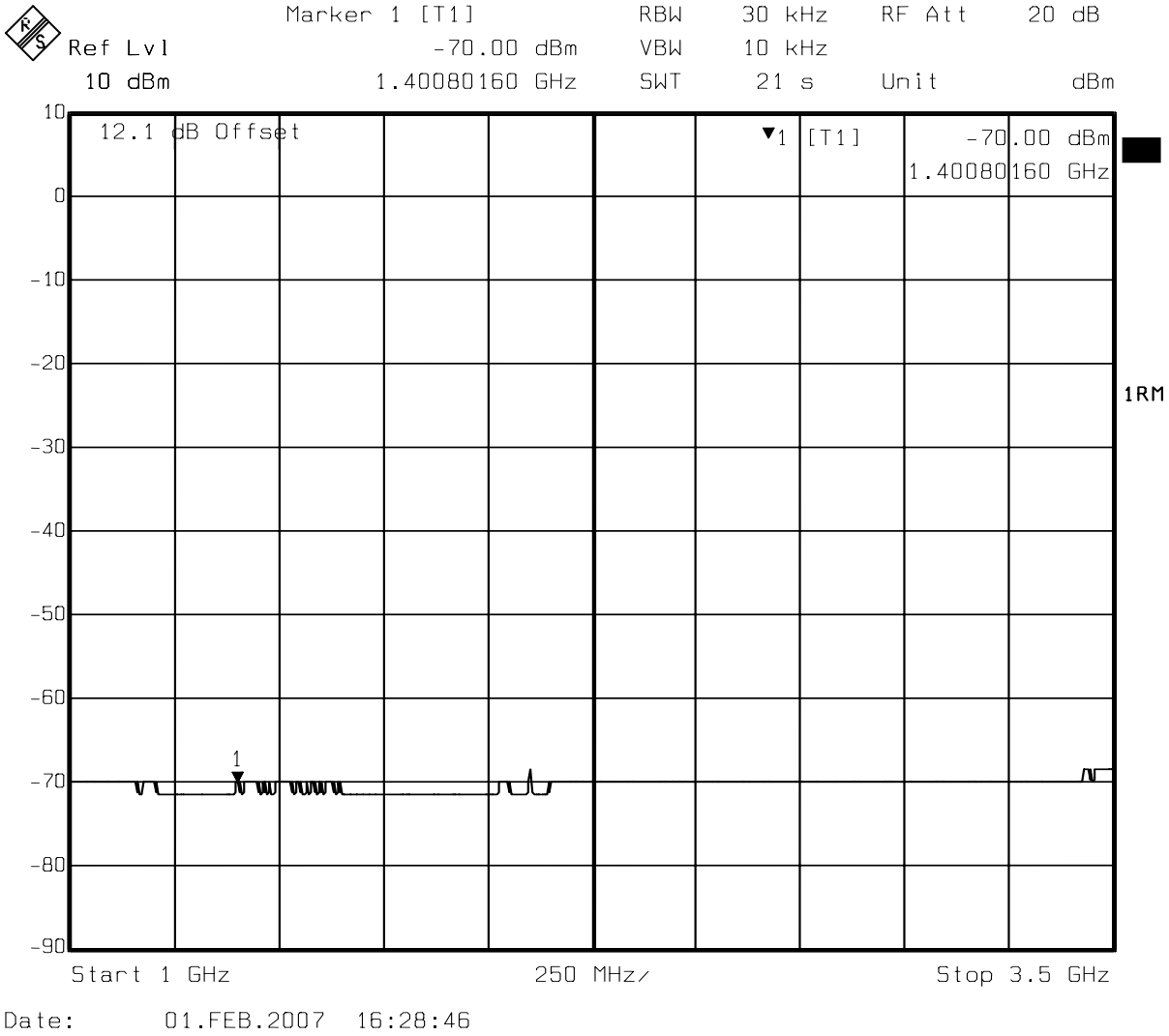
Detector: RMS

Conducted Emissions, 30 MHz to 1 GHz



1 GHz to 3,5 GHz
Spectrum analyzer settings:
RBW: 30 kHz Marker 1: Second Harmonic Frequency
VBW: 10 kHz
Detector: RMS

Conducted Emissions, 1 GHz to 3 GHz



Conclusions:
The measurements were taken using a Resolution Bandwidth of 30 kHz. The measured level of the 701 MHz signal, -0.06 dBm at the input to the instrument, was in fact 23 dB higher if the power in the whole band were measured. Therefore, the reference level for the spurious emission measurement is 22.94 dBm.

The absolute limit level for spurious emissions is 22.94 dBm – 64.6 dB, or -41.66 dBm.

In the 30 MHz to 1 GHz plot, the highest emission level shown outside the transmitted band is -70 dBm, more than 28 dB below the required limit.

In the 1 GHz to 3.5 GHz plot, the highest emission shown is lower than -68 dBm, more than 26 dB below the required limit. There appears to be third-harmonic emission at this level.

The following table is constructed from this data. The formula used for the calculation in the table is:

Spurious Level = (Measured Spurious) – (Load Response – dB) – (Measured 701 MHz)

Frequency	Measured Level	Load Response		Spurious Level
MHz	dBm	dBm	dB	dBm
701	22.94	-40.31	Ref	Ref
1402	-70.0	-40.16	0.15	-93.09
2103	-68.0	-39.43	0.88	-91.82
2804	-70.0	-41.00	-0.69	-92.25
Required spurious emission limit:				-41.66

Conclusion:
The measured spurious emissions are more than 50 dB lower than required.

Data taken by B. Müller, February 1, 2007

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.

The required spurious radiation level limit is given in 27.53 (f):

(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
The testing location and the measuring positions are demonstrated in the photos and drawing which follow.

Procedure
The EUT was operated at an output of 200 watts, average power. Measurements were taken using Horizontal and Vertical polarization of the receiving antenna, with the EUT turned to expose the Front, the Right side, the Rear and the Left Side to the measuring antenna.

Where any spurious radiation was observed, the antenna was moved vertically to obtain a maximum signal, which was recorded in the results spreadsheet.

Test Results:

The following Table shows the calculated reference carrier level and the measured and calculated results.

Cabinet Radiation Measurements												
Ref: FCC 47 Part 27.53 (f)												
Transmitter Output Power		200	Watts									
Measuring Distance		10	meters		**Calculations:**							
Reference carrier power (0 dBc)		124.0	dBuV/m		= 120 + (20 x log(sqrt(49.2 x Pwatts))/Distance)							
Required spurious limit		-66.0	dBc		= -43-(10 x log(Pwatts))							
Spurious Limit in dBuV/m		58.0	dBuV/m		= Reference Carrier Power - Spurious Limit							

Tabulated Measurements and Results - Horizontal Polarization

Position 1 Transmitter Front Side						Position 2 Transmitter Left Side					
Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin	Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1402	54.6	124.0	-69.4	-66.0	3.4	1402	53.5	124.0	-70.5	-66.0	4.5
2103	52.0		-72.0		6.0	2103	52.1		-71.9		5.9
2804	48.9		-75.1		9.0	2804	49.7		-74.3		8.3
3505	53.2		-70.8		4.8	3505	53.5		-70.5		4.5
4206	55.6		-68.4		2.4	4206	55.5		-68.5		2.5
Position 3 Transmitter Rear Side						Position 4 Transmitter Right Side					
Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin	Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1402	49.2	124.0	-74.8	-66.0	8.7	1402	53.0	124.0	-71.0	-66.0	5.0
2103	52.2		-71.8		5.8	2103	52.0		-72.0		6.0
2804	49.6		-74.4		8.4	2804	49.3		-74.7		8.7
3505	53.3		-70.7		4.7	3505	53.0		-71.0		5.0
4206	55.3		-68.7		2.7	4206	55.6		-68.4		2.4

Tabulated Measurements and Results - Vertical Polarization

Position 1 Transmitter Front Side						Position 2 Transmitter Left Side					
Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin	Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1402	51.0	124.0	-73.0	-66.0	7.0	1402	47.5	124.0	-76.5	-66.0	10.5
2103	52.1		-71.9		5.9	2103	51.5		-72.5		6.5
2804	49.7		-74.3		8.3	2804	49.4		-74.6		8.5
3505	53.2		-70.8		4.8	3505	52.9		-71.1		5.1
4206	56.1		-67.9		1.9	4206	55.7		-68.3		2.3
Position 3 Transmitter Rear Side						Position 4 Transmitter Right Side					
Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin	Frequency (MHz)	Measured (dBuV)	Fundamental Power (dBuV/m)	Spurious Radiation (dBc)	FCC Limit (dBc)	Pass Margin
1402	51.9	124.0	-72.1	-66.0	6.1	1402	49.7	124.0	-74.3	-66.0	8.3
2103	52.9		-71.1		5.1	2103	51.6		-72.4		6.4
2804	49.2		-74.8		8.8	2804	49.6		-74.4		8.4
3505	53.9		-70.1		4.1	3505	52.4		-71.6		5.6
4206	56.1		-67.9		1.8	4206	55.2		-68.8		2.8

Shaded areas are recorded measurements at frequencies where the signal can't be differentiated from the noise floor. Results calculated for those frequencies indicate the actual spurious level is in each case "lower than" the calculated level.

The only spurious emission which could be observed was at the 2nd harmonic frequency of the channel. The worst-case emission, measuring with horizontal polarization at the front of the transmitter, was 3.4 dB lower than the required limit, after moving the test antenna to the height producing the highest level of emissions.

Above the second harmonic frequency, there were no observed harmonics.

Dipole Substitution - EIA/TIA 603C

The dipole substitution method was used to confirm these results. The EUT was removed from the shelter and in its' place, a second 3115 antenna was installed, aimed toward the measuring tower. The height of the antenna was set to the center of radiation of the EUT.

The signal generator was connected to the antenna and set to the second-harmonic frequency, the frequency of the only observed spurious. The signal generator output was set to the level which produced approximately the same measured level in the EMI receiver as the observed second harmonic from the transmitter. The generator output level required to obtain this result was recorded.

This result was then calculated to give the equivalent power required into a half-wave dipole to produce the same signal level.

For this calculation, the Dipole Equivalent Power and the Required Limit are expressed in absolute units, as dBm. The Dipole Equivalent Power is the power input required in a standard dipole substituted for the transmitter, in order to produce the same field strength at the measuring antenna as was observed from the transmitter.

To convert the Required Limit to Absolute dBm:

Output Power of EUT: 200 Watts

Output Power in dBm: (30 + 10log(200)) dBm = 53 dBm

Spurious Limit in dBm: 53 dBm – 66 dB = -13 dBm

The measured Dipole Equivalent Power is calculated as follows:

Dipole Equivalent Output = [Generator output] – [Cable Loss] + [Antenna gain] + [Digital Factor]

The Digital Factor is a correction required because of the digital modulation dispersion of the transmitter power over the whole channel, as compared with the CW test generator signal, which has all the power concentrated at the center frequency.

The spurious measurements were taken at a BW of 120 kHz, which is standard for the EMI receiver. The reference power is the whole output power of the transmitter, which is distributed over a 6 MHz bandwidth. At the second harmonic the modulation bandwidth would be 12 MHz. This can be seen in the reduced span plot on Page 38.

The CW signal from the signal generator during the substitution test, since it exists entirely within the 120 kHz bandwidth of the receiver, is displayed at it's full level, but if an equivalent digitally modulated signal with 12 MHz bandwidth were substituted, the signal would need to be raised to a 20 dB higher level to produce the same amplitude in the EMI receiver, which would "see" only 1% of the total power in the 12 MHz bandwidth:

Power Bandwidth Ratio = 12000 kHz / 120 kHz = 100 = 20 dB = Digital Factor

The substitution measurement was taken with the generator set to produce 52 dBμV/m at the receive antenna, which is a nominal value in the range of second-harmonic levels observed. Only the second harmonic was visible in the above measurements of the transmitter. Therefore, one single substitution measurement was taken to represent these, using the same path used for all the measurements, but with the second antenna substituted in place of the transmitter.

Measured Results:

Frequency	Reference Field Strength	Generator Output	Cable Loss	Antenna Gain	Digital Factor	Dipole Equivalent Power
MHz	dBμV/m	dBm	dB	dB	dB	dBm
1402	52	-42	2.4	6.34	20	-18.1

Using this result, it is possible to calculate the Dipole Equivalent Powers and the pass margins of the highest and the lowest 2nd harmonic spurious observed.

	Measured Field Strength	Difference from Measured Reference	Calculated Dipole Equivalent Power	Required Limit	Pass Margin
	dBμV/m	dB	dBm	dBm	dB
Highest Spurious	54.6	2.6	-15.5	-13	2.5
Lowest Spurious	47.5	-4.5	-22.6	-13	9.6

Conclusion:
The only observed spurious radiations from the EUT were at the second harmonic frequency. The amplitude of the emissions varied as polarization was changed between vertical and horizontal, and as different faces of the EUT were directed to the receive antenna.

The highest measured spurious, from the front of the EUT, using Horizontal polarization, was 3.4 dB under the required limit by the direct measurement data on page 28. Using the dipole substitution method, the pass margin computes to 2.5 dB.

The lowest measured spurious, from the Left side of the EUT, using Vertical Polarization, was 10.5 dB under the required limit. Using dipole substitution, the pass margin computes to be 9.6 dB.

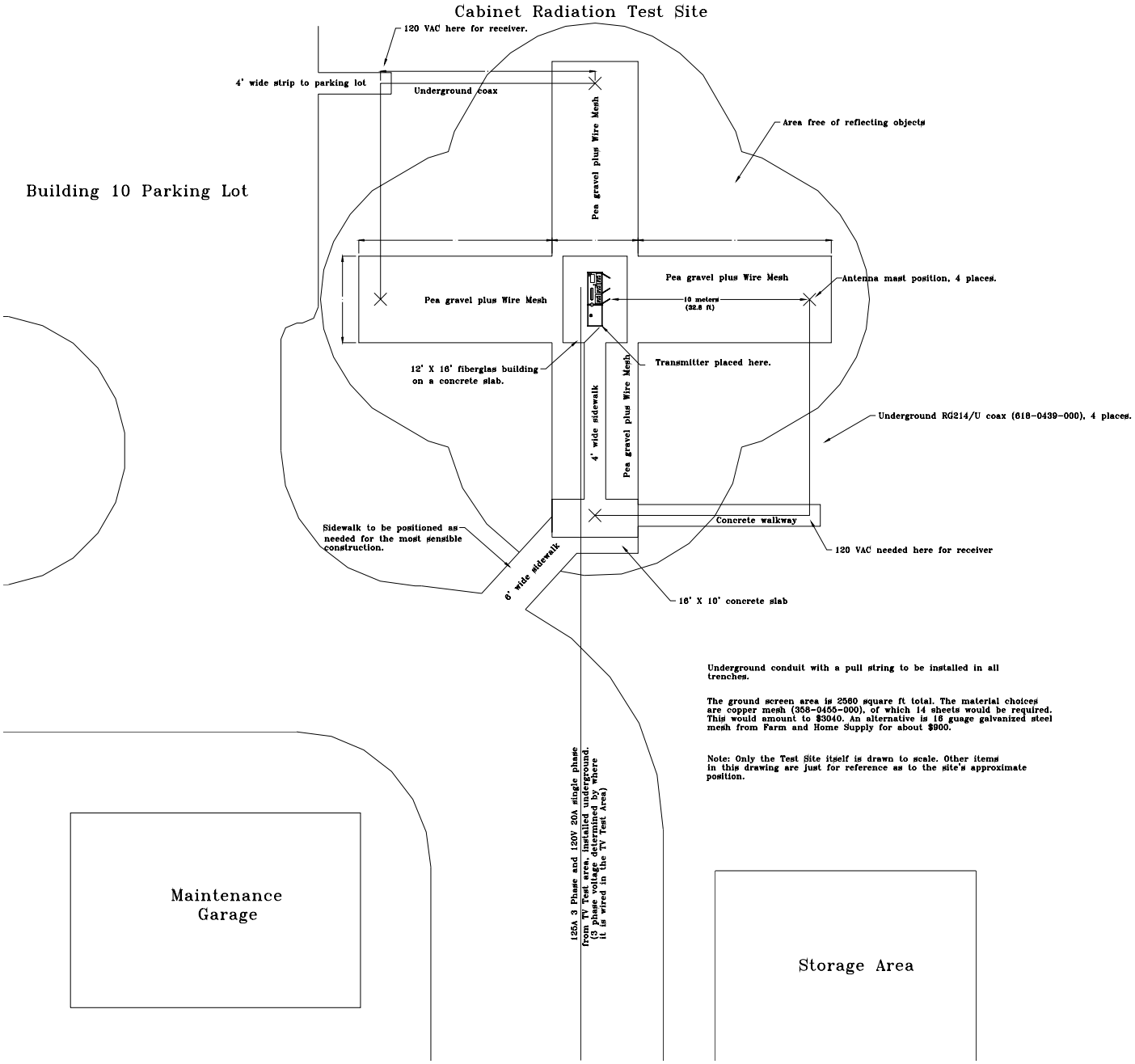
The results obtained using dipole substitution confirm the the direct measurement results within 1 dB.

Our conclusion is that the EUT does operate within the spurious radiation limit imposed by FCC Part 27.53 (f).

Equipment used for this measurement:				
Equipment	Mfr.	Model:	Serial Number:	Calibration due:
EMI Antenna #1	ETS-Lindgren	3115	28914	As needed
EMI receiver	HP	8546A	3710A00387	3/10/08
EMI Antenna #2	ETS-Lindgren	3115	71517	Fall, 2008
Signal Generator	Agilent	E4420B	US384405	5/11/09

Data taken by: David Motley Date: May 31 to June 4, 2007

Top View of Test Site



This overhead view of the Harris OATS site shows the general layout and the position in relation to nearby structures.

OATS Shelter Building, as viewed by Measuring Antenna

OATS Shelter Building, showing EMI Antenna Mast

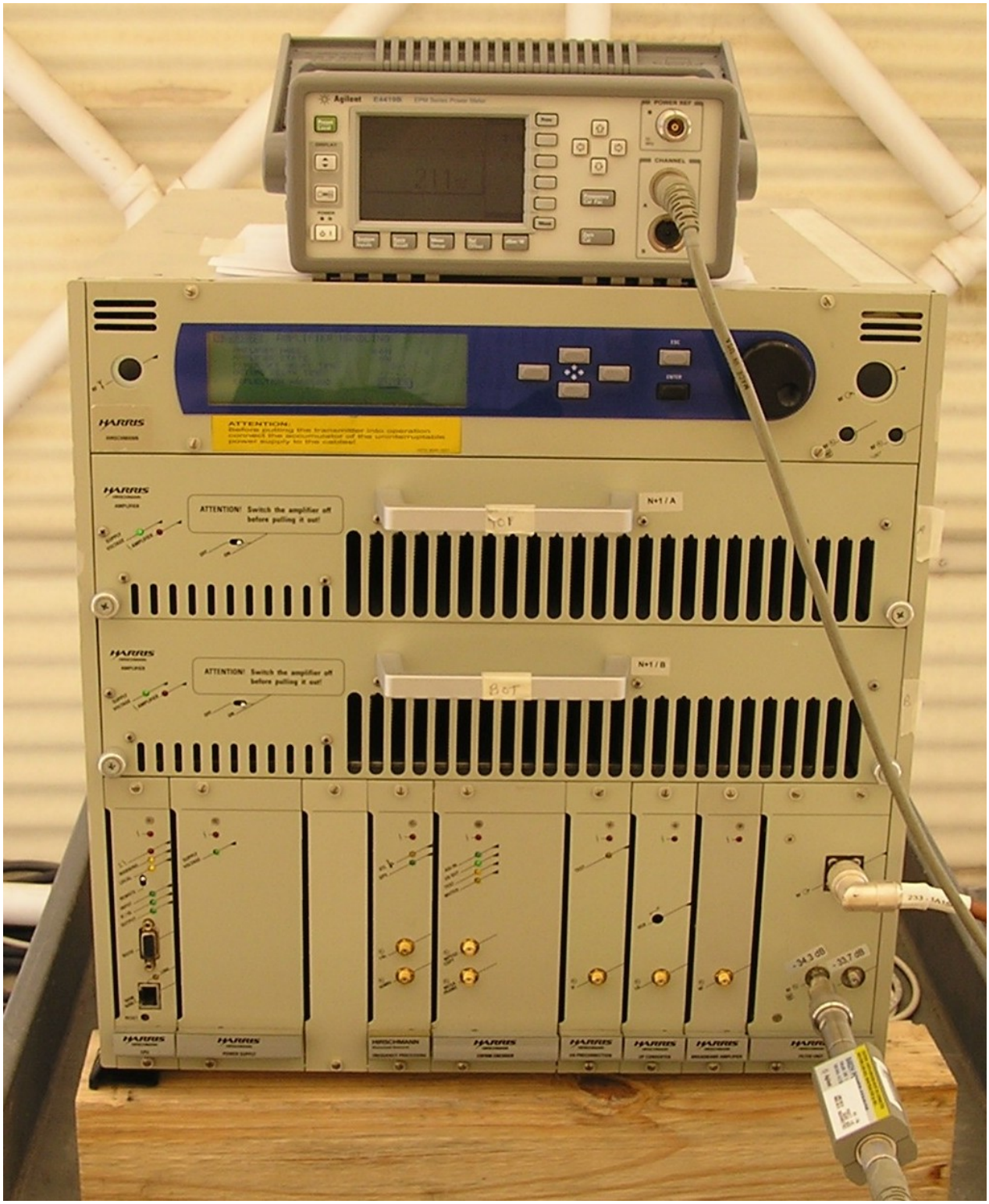
DTV640-200 Transmitter in OATS Shelter

The Harris OATS site has no turntable. In Lieu of this, the EUT is placed on a suitable device to allow it to be rotated. In this case, a non-metallic service cart was used.

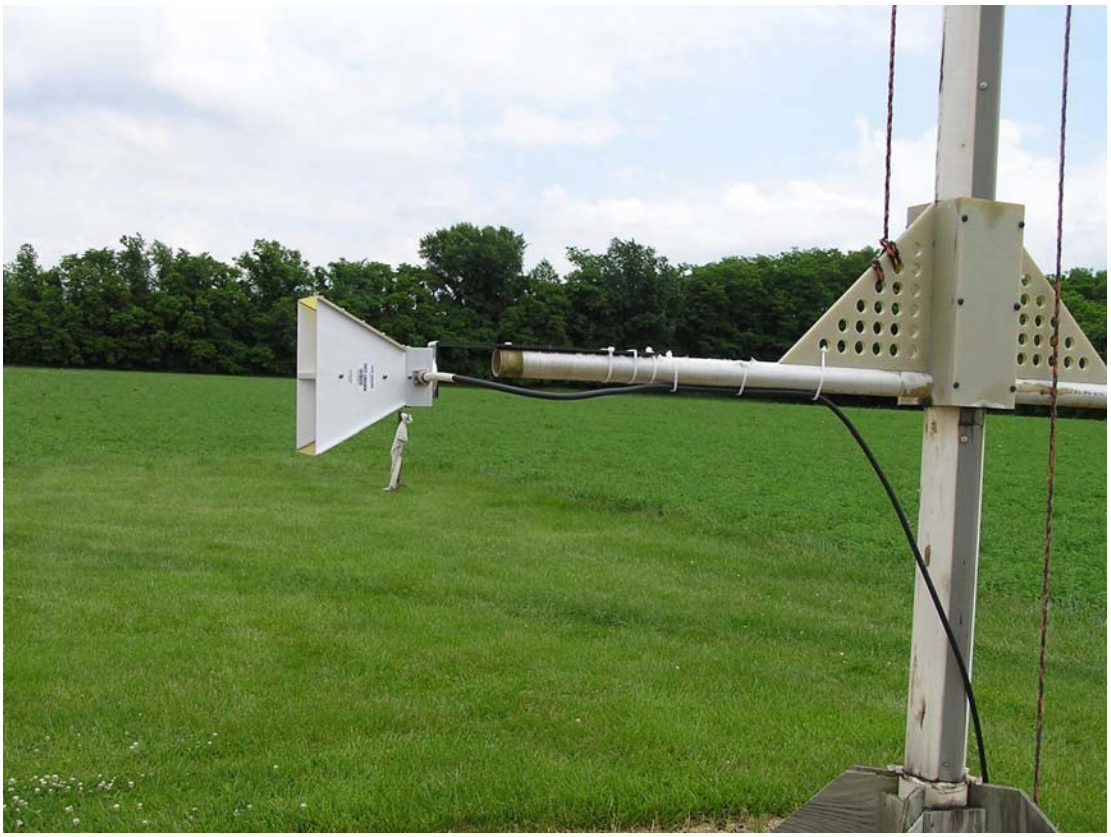
The instrument on top of the EUT is the RF Power Meter.

Measurements were taken at the front, both sides and at the rear, by rotating the cart.

Front View of EUT and Power Meter



Receive Antenna, Horizontally Polarized



The EMI receiving antenna is mounted to a carrier on a motorized mast, permitting the antenna to be positioned vertically to find the highest radiated signal. This is done for each observation.

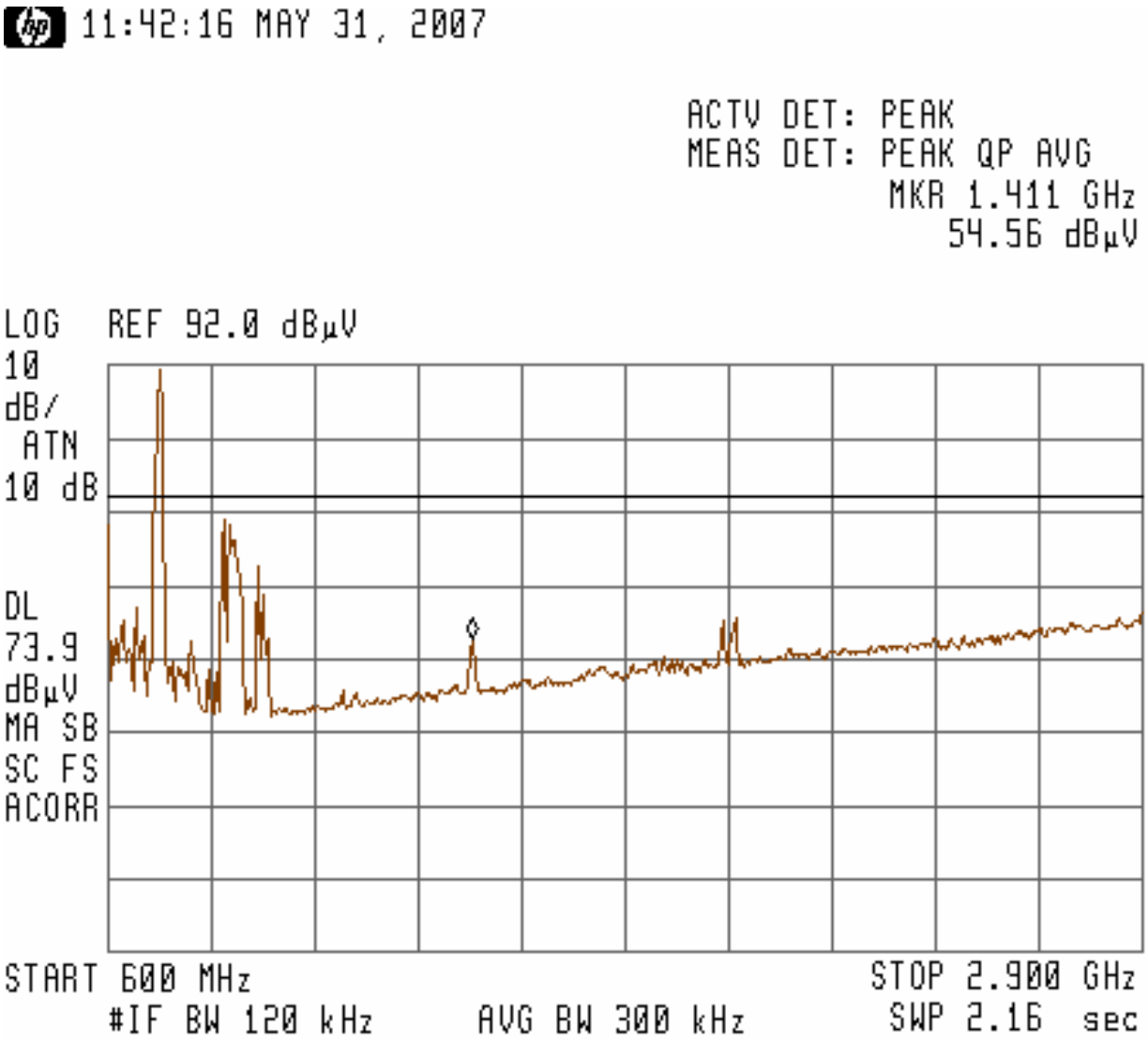
Substitution Antenna in EUT location

In the photo above, the substitution antenna can be seen inside the shelter. The EMI receiver is in the foreground, and the Agilent test generator is atop the EMI receiver.

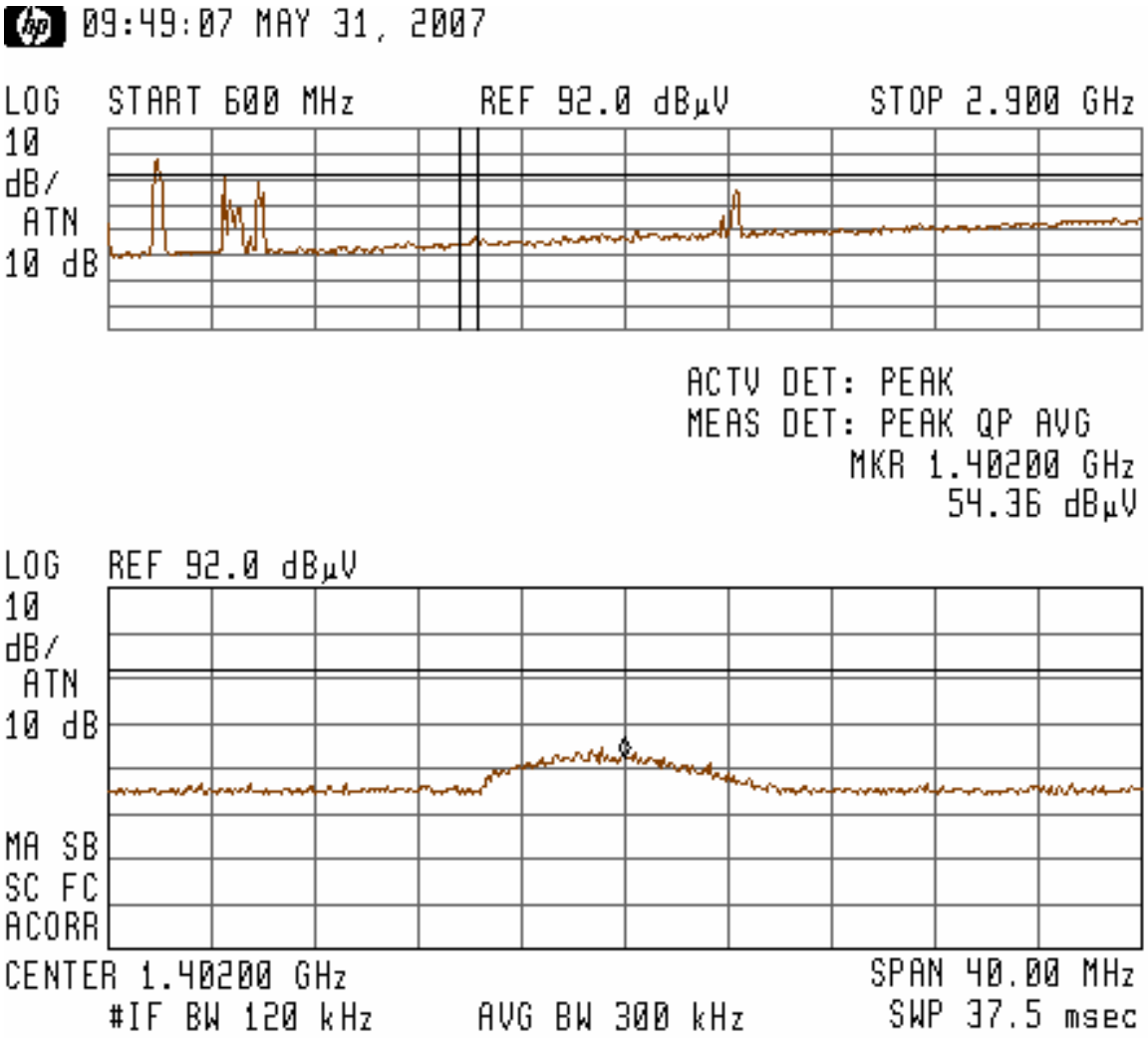
Example Plot Data

The following plots are those taken from the front, with Horizontal Polarization. They are included here to show the way in which the data was collected.

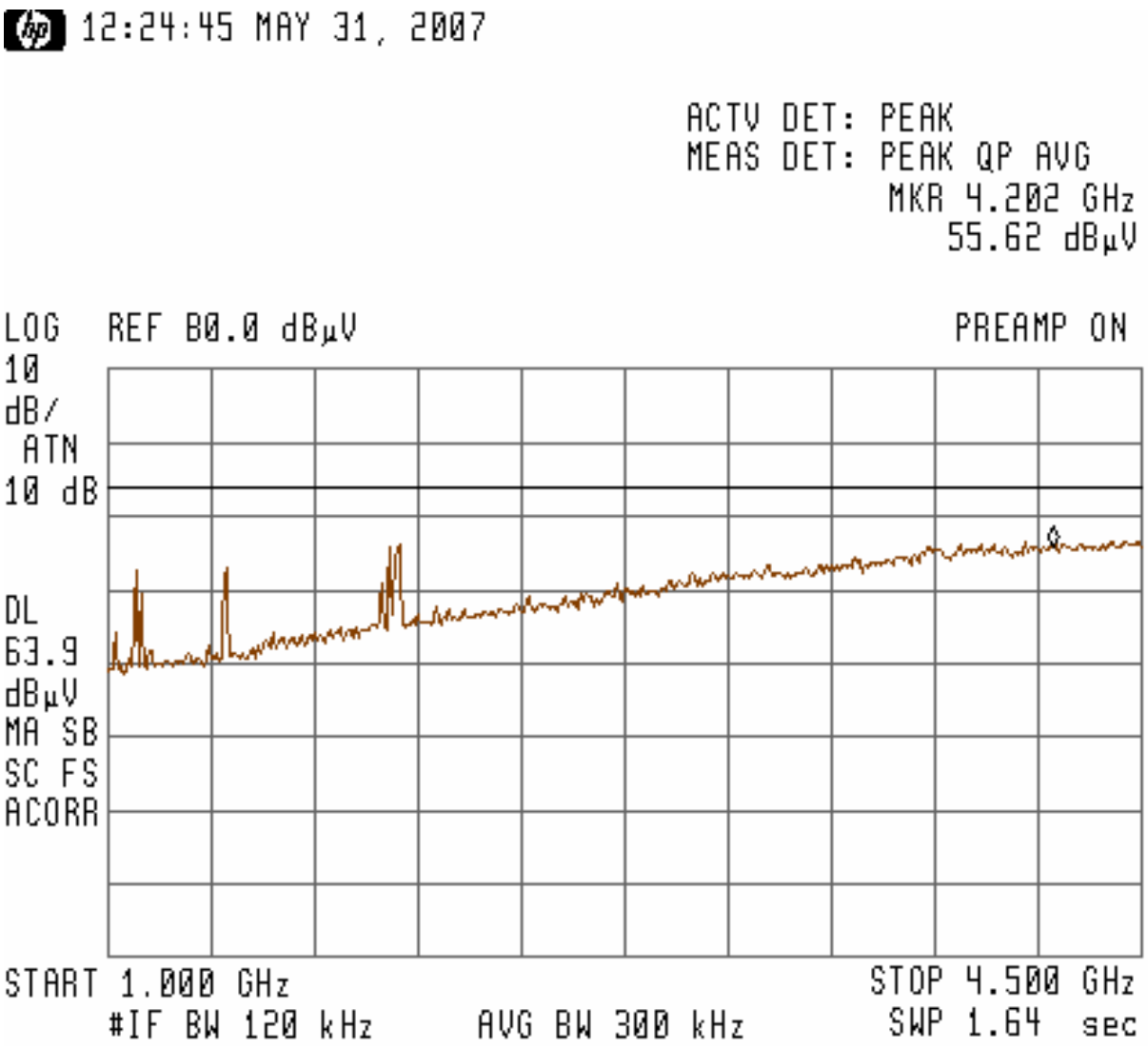
Front, Horizontal, 600 MHz to 2.9 GHz



Front, Horizontal, Reduced Span



Front, Horizontal, 1 GHz to 4.5 GHz



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.

Procedure:
The same model of this exciter-transmitter unit, with frequency control circuits identical to those in the EUT, was tested in 2004. The results of these tests are fully representative of performace which will be obtained in operation with the EUT.

The equipment was set up in a temperature controlled chamber, and the exciter was arranged to allow a single frequency to be transmitted to allow measurement. Measurements were taken over the 0°C to +50°C temperature range, and over a -15% to +15% range of mains voltage.

Temp	93.5VAC	110VAC	126.5VAC
0 C	686311901.444	686311901.393	**686311901.471**
10 C	686311899.123	686311899.046	686311899.030
20 C	686311897.265	686311897.223	686311897.246
25 C	686311896.641	686311896.550	686311896.557
30 C	686311896.055	**686311895.988**	686311896.031
40 C	686311896.133	686311896.176	686311896.176
50 C	686311900.140	686311900.133	686311900.209

Conclusion:
The highest pilot frequency measured during this test was 686,311,901.471 Hz. The lowest frequency measured was 686,311,895.988 Hz. Both readings are highlighted in the table above. This represents a total frequency deviation of slightly less than 5 Hz over the entire test. Therefore, the exciter operated well within the tolerance required to remain within the channel.

Equipment used:
Frequency Counter HP 53132A S/N 3710A04170

Data taken on May 14, 2004 by Sal Mendez.

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