Spike Technologies, Inc
HighPoint BDS System
(FCC ID MXM–HIGHPOINT200)

Application for Certification

47 CFR Parts 21 and 74

Exhibit K
Test Report

Spike Technologies, Inc
HighPoint BDS System
(FCC ID MXM–HIGHPOINT200)

Technical Report

Application for Certification

47 CFR Parts 21 and 74

Table of Contents

Appendices

Appendix A Field Strength of Spurious Radiation Report

1.0 Test Data

The measured data that follows is presented in a format to show the applicable rule sections which define performance requirements and limits; the measurement procedure; and the test results, including any plotted data obtained in the test.

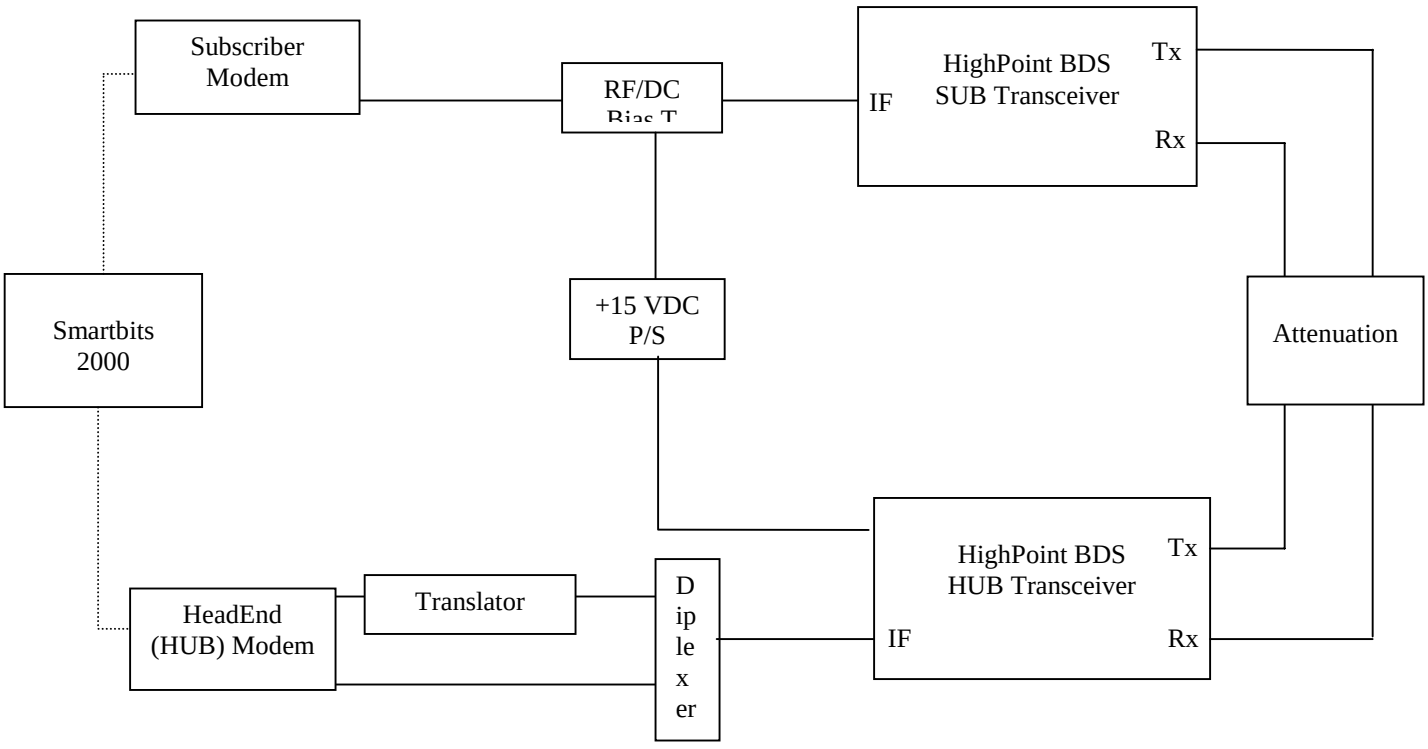
The HighPoint BDS Hub and Sub Transceivers were found to comply with the requirements of 47 CFR Part 21 and Part 74.

1.1 List of tests performed

	47 CFR Part 2	47 CFR Part 21	47 CFR Part 74
RF Power Output	2.1046	21.107, 21.904	74.935
Modulation Characteristics	2.1047	21.122	74.970
Occupied Bandwidth	2.1049	21.105	74.936
Spurious Emissions at antenna terminals	2.1051	21.908	74.936
Field Strength of Spurious Radiation	2.1053	21.908	74.936
Frequency Stability	2.1055	21.101	74.961

1.2 Test Configuration

One base station transceiver; HUB s/n N938670024, and one subscriber transceiver; SUB s/n N931530003 were subjected to the above tests. The HUB transceiver was built to transmit on ITFS channel A3 at 2527 MHz. The SUB transceiver was built to transmit on ITFS channel G3 at 2671 MHz.



1.3 Test Equipment List

Type	Manufacturer	Model
Signal Generator	Hewlett Packard	8648D
Signal Generator	Hewlett Packard	83752A
Spectrum Analyzer	Hewlett Packard	8593E
Spectrum Analyzer	Hewlett Packard	E4407B
Frequency Counter	Hewlett Packard	5342A
Wattmeter	Boonton	4200
Power Supply (2)	ELPAC Power Systems	2700
Hub Modem	Integrity	Neptune
Sub Modem	Integrity	Atlas
Translator	Wavecom	UC4040D
Variable Attenuators	Hewlett Packard	8494A, 8496A
Power Divider	NARDA	4456-4
Fixed Pads	MA/COM	2082-6194-xx
Plotter	Hewlett Packard	DeskJet 600C
Temperature Chamber	Associated Environmental Systems	----
Multi Performance Analysis System	NetCom Systems	Smartbits 2000

1.4 Description of Measurement Facilities

The testing, as recorded herein, was performed at two facilities. The Field Strength of Spurious Radiation was performed at National Technical Systems (NTS) in Boxborough, MA. NTS is an independent test laboratory in the area of Environmental and Electromagnetic Compatibility testing. NTS operates an outdoor Open Area Test Site (OATS) and a full 3m anechoic chamber both of which meet the site attenuation requirements ANSI C63.4. NTS's facilities are accredited by NVLAP. The remaining tests were performed at Spike Technologies, Inc. regulatory and systems Lab in Nashua, NH. This lab includes the necessary signal sources, analyzers and environmental chambers to perform the required tests.

1.5 Frequency of Investigation

1.5.1 Requirement

2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in §§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.

The lowest generated frequency in the transceivers is the 500 kHz derivated clock for RS 232 communication with the radio. This allows for remote frequency selection and gain setting. The sub transceiver is built to transmit at 2671 MHz. Therefore, testing was performed to the 10^{th} harmonic of this or 26.71 GHz. The frequency range of investigation was:

500 kHz to 26.71 GHz.

1.6 RF Power Output

1.6.1 Requirement

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 §2.983(d)(5). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(b) For single sideband, independent sideband and single channel, controlled carrier radiotelephone transmitters, the procedure specified in paragraph (a) of this paragraph shall be employed and, in addition, the transmitter shall be modulated during the test as follows. In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

(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.

21.107 Transmitter power.

(a) The power which a station will be permitted to use in these services will be the minimum required for satisfactory technical operation commensurate with the size of the area to be served and local conditions which affect radio transmission and reception. In cases of harmful interference, the Commission may, after notice and opportunity for hearing, order a change in the effective radiated power of a station.

(b) The EIRP of a transmitter station employed in this radio service shall not exceed the values shown in the following tabulation:

Frequency range (MHz)	Maximum allowable EIRP for a fixed station (Watts)	
2,150 to 2,162	2000	(63dBm –24 dBi sub ant= 39dBm or 8 Watts)
2,596 to 2,680	2000	same

21.904 Transmitter power.

(a) The maximum EIRP of an MDS main or booster station shall not exceed 33 dBW (or, when digital modulation with uniform power spectral density and subchannels or superchannels, or 125 kHz channels, are used the appropriately adjusted value based upon the ratio of 6 MHz to the subchannel or superchannel or 125 kHz, bandwidth), except as provided in paragraph (b) of this section

1.6.2 Measurement Procedure

The RF power at the antenna terminals was measured with a spectrum analyzer using a 3 MHz resolution bandwidth. The RF power level was then adjusted to account for test setup losses and the difference in measurement and modulated signal bandwidth

1.6.3 Test Results

HUB Transceiver Transmit power **24.1** dBm

SUB Transceiver Transmit power **21.6** dBm

1.7 Modulation Characteristics

1.7.1 Requirement

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.

21.122 Microwave digital modulation.

(a) Microwave transmitters employing digital modulation techniques and operating below 15 GHz shall, with appropriate multiplex equipment, comply with the following additional requirement: The bit rate, in bits per second, shall be equal to or greater than the bandwidth specified by the emission designator in Hertz (e.g., to be acceptable, equipment transmitting at a 6 Mb/s rate must not require a bandwidth of greater than 6 MHz), except the bandwidth used to calculate the minimum rate shall not include any authorized guard band.

(b) For purposes of compliance with the emission limitation requirements of §21.106(a)(2) of this part and the requirements of paragraph (a) of this section, digital modulation techniques are considered as being employed when digital modulation contributes 50 percent or more to the total peak frequency deviation of a transmitted radio frequency carrier. The total peak frequency deviation shall be determined by adding the deviation produced by the digital modulation signal and the deviation produced by any frequency division multiplex (FDM) modulation used. The deviation (D) produced by the FDM signal shall be determined in accordance with §2.202(f) of Part 2 of this chapter.

(c Transmitters employing digital modulation techniques shall effectively eliminate carrier spikes or single frequency tones in the output signal to the degree which would be obtained without repetitive patterns occurring in the signal.

1.7.2 Measurement Procedure and Results

HUB Transceiver emission designator: 6M00D7W

The HUB Transceiver operating with a QAM16, 6 MHz wide, modulated signal is capable of transmitting up to 20 Mbits/s of data.

SUB Transceiver emission designator: 3M200D7W

The SUB Transceiver operating with a QAM-4 (QPSK), 3.2 MHz wide, modulated signal is capable of transmitting up to 5 Mbit/s of data

1.8 Occupied Bandwidth

1.8.1 Requirement

2.1049 Measurement 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.

21.105 Bandwidth- Each authorization issued pursuant to these rules will show, as the emission designator, a symbol representing the class of emission which shall be prefixed by a number specifying the necessary bandwidth. This figure does not necessarily indicate the bandwidth actually occupied by the emission at any instant. In those cases where Part 2 of this chapter does not provide a formula for the computation of the necessary bandwidth, the occupied bandwidth may be used in the emission designator.

1.8.2 Measurement Procedure

Apply a modulated signal at the transceiver input. On the spectrum analyzer select the occupied bandwidth measurement on the Meas./User menu. Measure for 99% channel power. Obtain occupied bandwidth. Plot trace.

1.8.3 Test Results

See Figures 13.8.1 and 13.8.2 below.

HUB Transceiver: 5.003 MHz

SUB Transceiver: 2.713 MHz

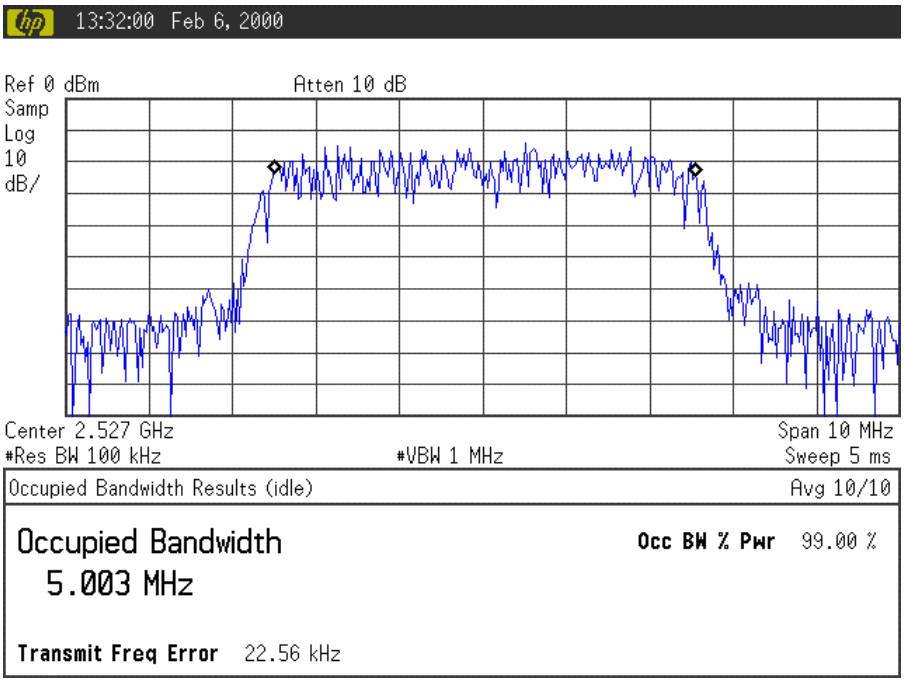


Figure 1.8.1: HUB Transceiver, Occupied Bandwidth

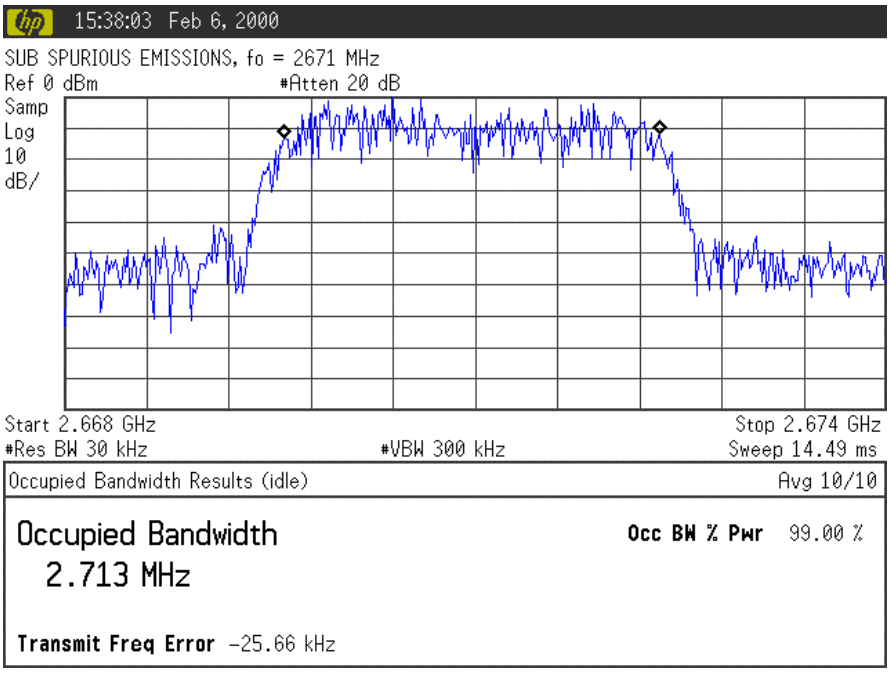


Figure 1.8.2: SUB Transceiver, Occupied Bandwidth

1.9 Spurious Emissions at Antenna Terminals

1.9.1 Requirement

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 §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

21.908 Transmitting Equipment – …….The maximum out-of-band power of an MDS station transmitter or booster transmitting on a single 6 MHz channel or a portion thereof with an EIRP in excess of –9 dBW (or, when subchannels are used, the appropriately adjusted value based upon the ratio of channel-to-subchannel bandwidths) employing digital modulation shall be attenuated at the 6 MHz channel edges at least 25 dB relative to the licensed average 6 MHz channel power level, then attenuated along a linear slope to at least 40 dB at 250 kHz beyond the nearest channel edge, then attenuated along a linear slope from that level to at least 60 dB at 3 MHz above the upper and below the lower licensed channel edges, and attenuated at least 60 dB at all other frequencies……

1.9.2 Measurement Procedure

21.909 Transmitting Equipment

(e) In measuring compliance with the out-of-band emissions limitations, the licensee shall employ one of two methods in each instance: (1) absolute power measurement of the average signal power with one instrument, with measurement of the spectral attenuation on a separate instrument; or (2) relative measurement of both the average power and the spectral attenuation on a single instrument. ….

For absolute power measurements:

$$\text{Attenuation in dB (below channel power)} = A + 10\text{Log}(C_{BW}/R_{BW})$$

For relative power measurements:

$$\text{Attenuation in dB (below flat top)} = A + 10\text{Log}\,(R_{BW1}/R_{BW2})$$

Measure the average power of the modulated signal using an average power meter. Measure the out-of-band emissions using either one of the methods described above.

1.9.3 Test Results

All spurious emissions at the antenna terminals of the HighPoint BDS transceivers meet the requirements of Part 21 and 74.

Average Power:

Hub Transceiver: 19.78 dBm

Sub Transceiver: 17.54 dBm

Out-of-Band Emissions: See the results in figures 13.9.1 through 13.9.12.

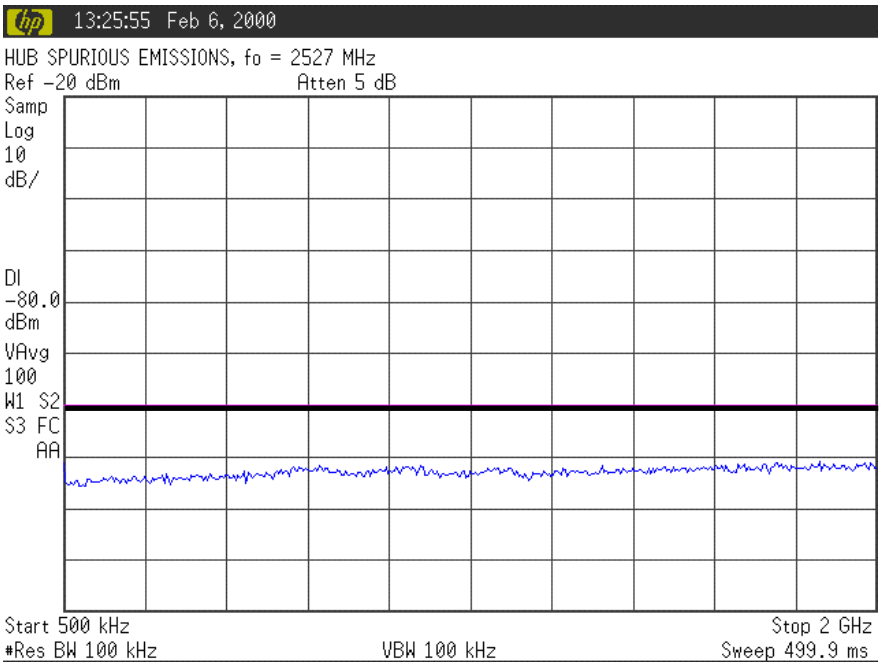


Figure 1.9.1: Hub Spurious Emissions, 500 kHz – 2000 MHz

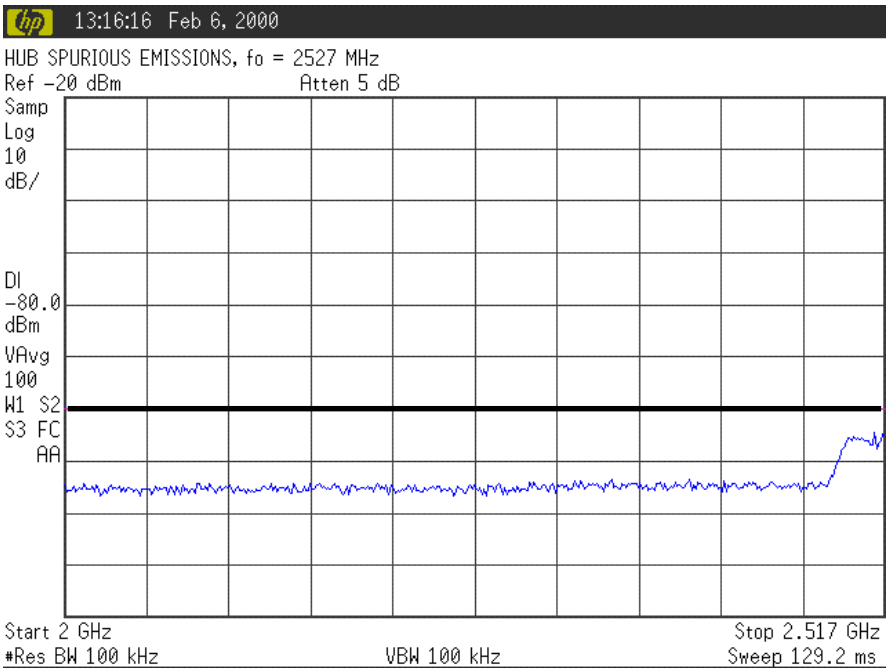


Figure 1.9.2: Hub Spurious Emissions, 2000 MHz – 2517 MHz

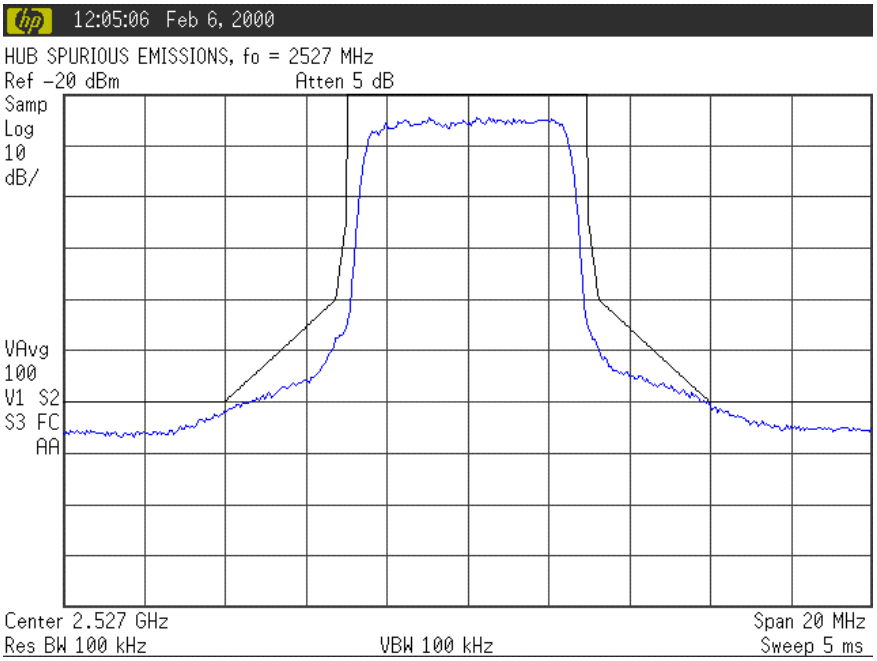


Figure 1.9.3: Hub Spurious Emissions, 2517 – 2537 MHz

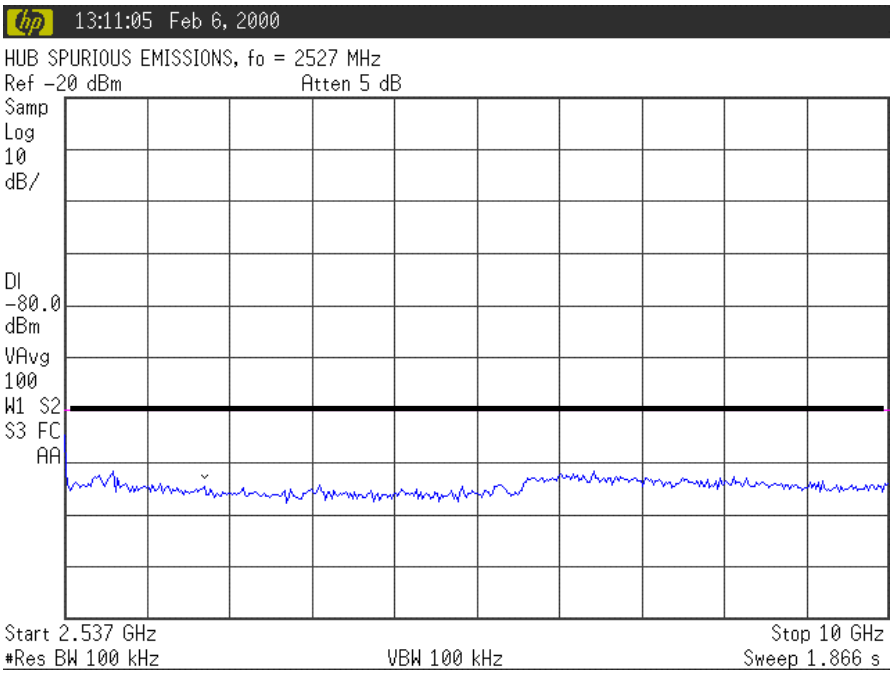


Figure 1.9.4: Hub Spurious Emissions, 2537 MHz – 10 GHz

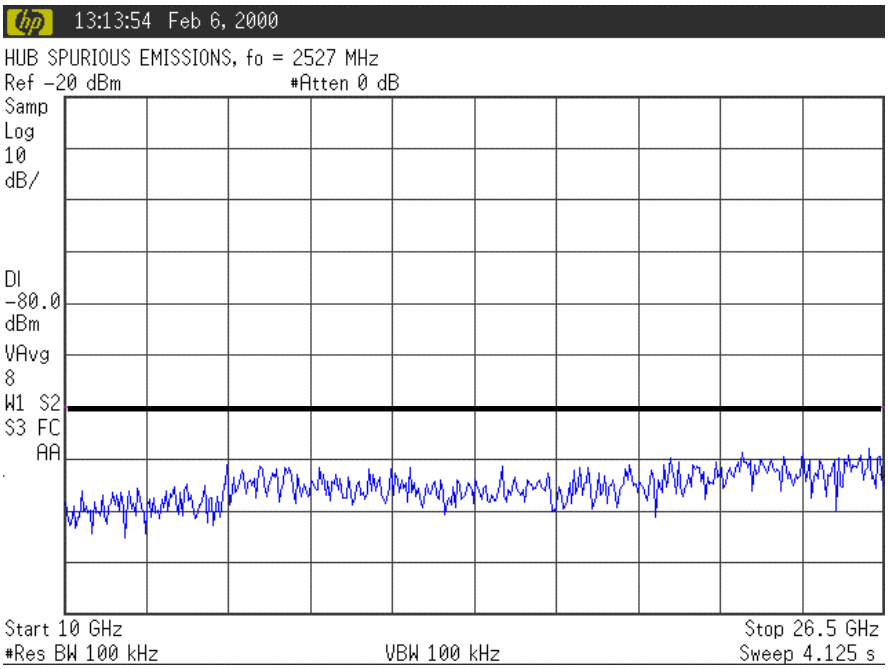


Figure 1.9.5: Hub Spurious Emissions, 10 GHz – 26.5 GHz

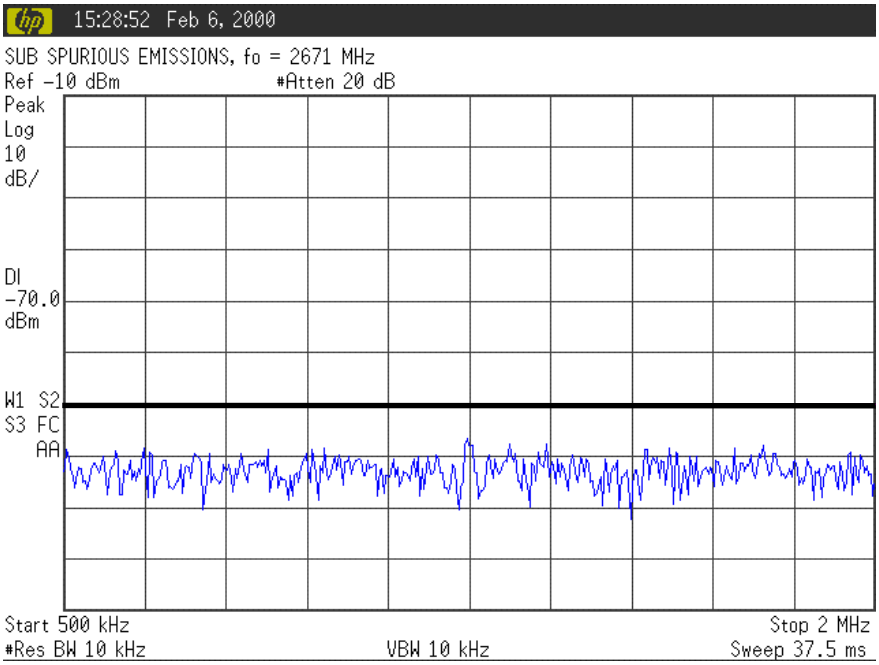


Figure 1.9.6: Sub Spurious Emissions, 500 kHz – 2 MHz

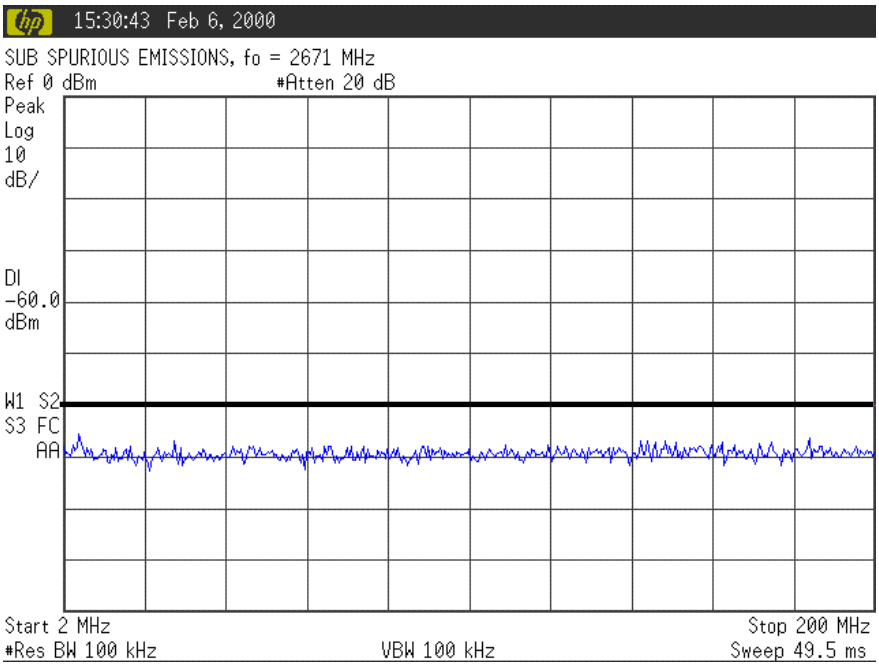


Figure 1.9.7: Sub Spurious Emissions, 2 MHz – 200 MHz

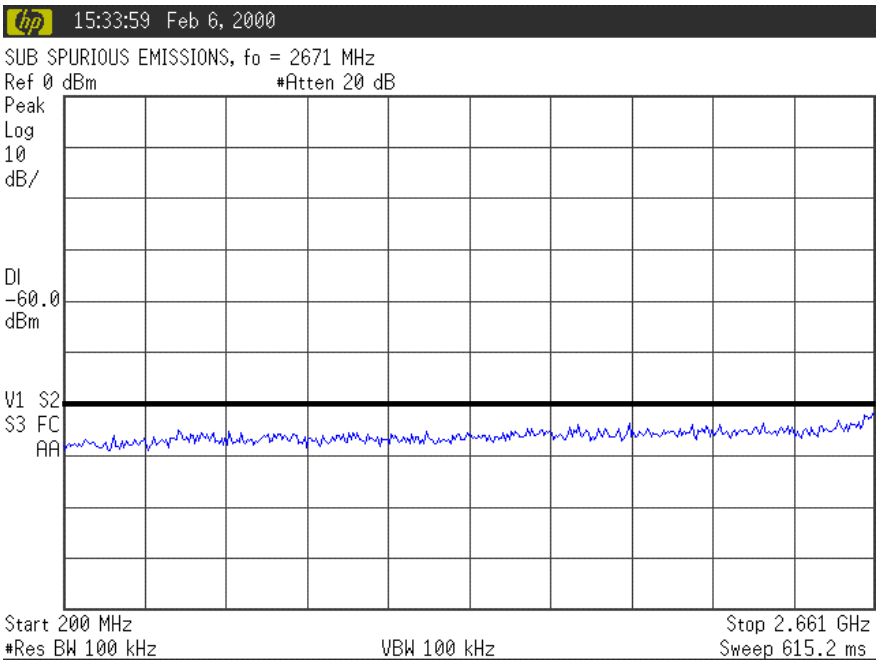


Figure 1.9.8: Sub Spurious Emissions, 200 MHz – 2661 MHz

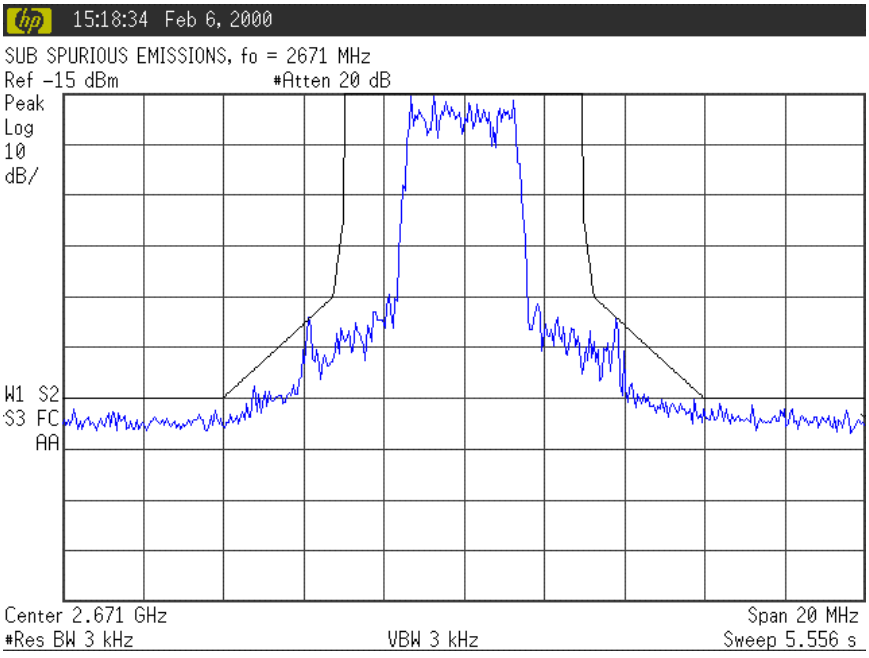


Figure 1.9.9: Sub Spurious Emissions, 2661 – 2681 MHz

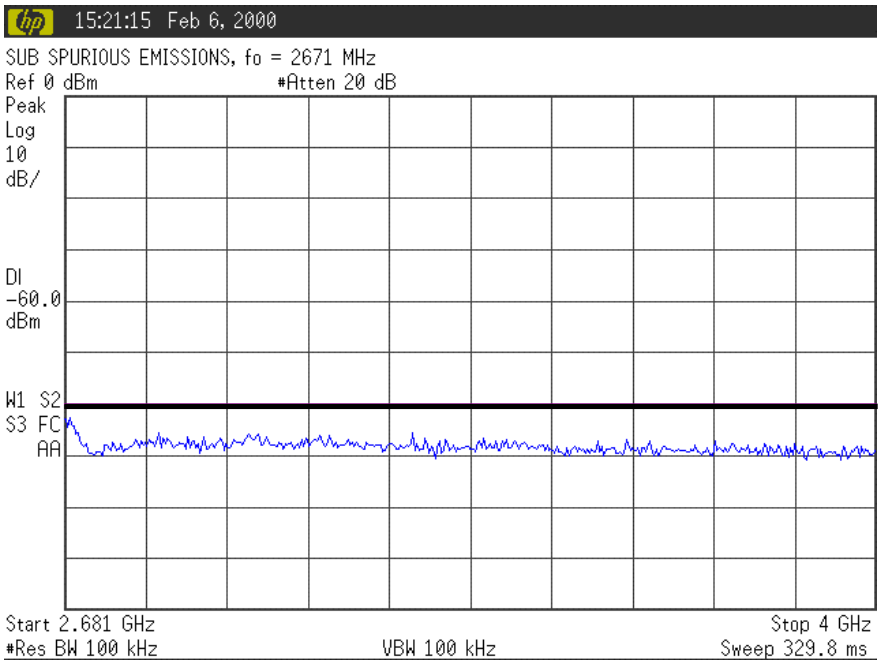


Figure 1.9.10: Sub Spurious Emissions, 2681 MHz – 4 GHz

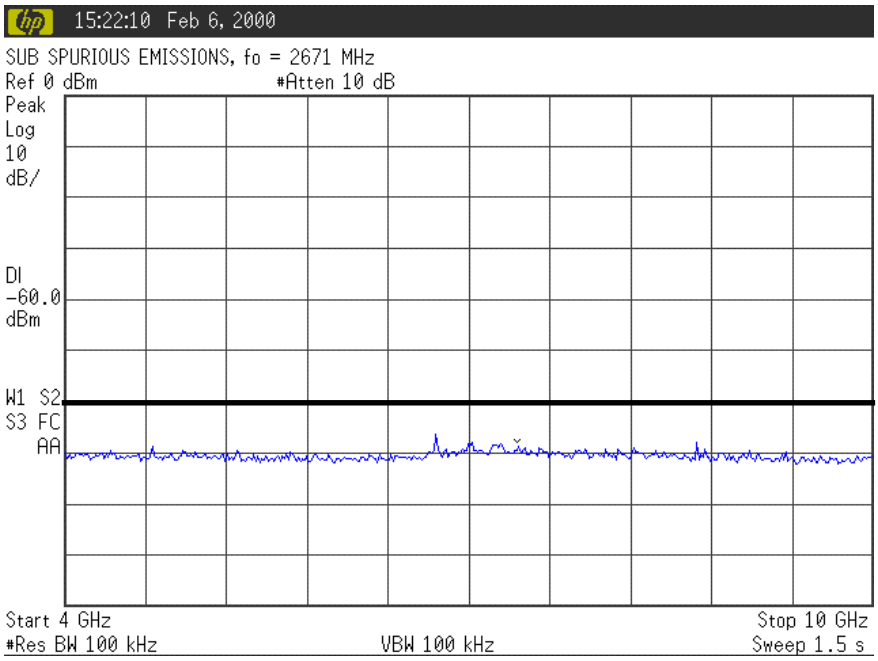


Figure 1.9.11: Sub Spurious Emissions, 4 GHz – 10 GHz

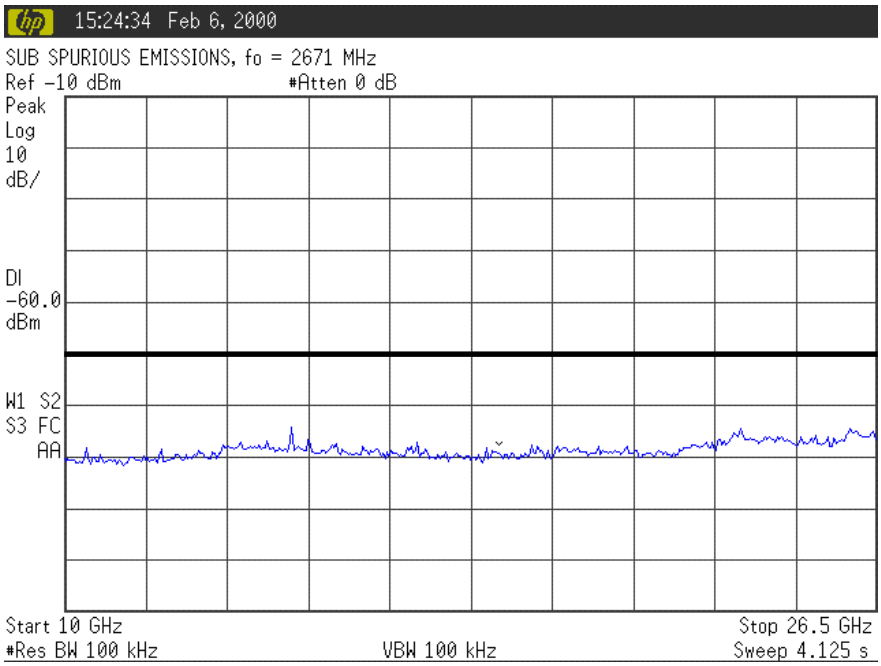


Figure 1.9.12: Sub Spurious Emissions, 10 GHz – 26.5 GHz

1.10 Field Strength of Spurious Radiation

1.10.1 Requirement

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 sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §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 emission 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.

21.908 Transmitting Equipment – …….The maximum out-of-band power of an MDS station transmitter or booster transmitting on a single 6 MHz channel or a portion thereof with an EIRP in excess of –9 dBW (or, when subchannels are used, the appropriately adjusted value based upon the ratio of channel-to-subchannel bandwidths) employing digital modulation shall be attenuated at the 6 MHz channel edges at least 25 dB relative to the licensed average 6 MHz channel power level, then attenuated along a linear slope to at least 40 dB at 250 kHz beyond the nearest channel edge, then attenuated along a linear slope from that level to at least 60 dB at 3 MHz above the upper and below the lower licensed channel edges, and attenuated at least 60 dB at all other frequencies……

1.10.2 Measurement Procedure

Testing was performed in a 3m anechoic chamber which met full site attenuation requirements of ANSI C63.4. located at National Technical Systems (NTS) in Boxborough, MA.

1.10.3 Test Results

See test report No. FR-36316-00CA, Rev. 0 included in Appendix D.

No spurious emissions in excess of the allowable limits were observed. It should be noted that the emission detected in the 2-18 GHz plot (page A-9 of the report) and the 2-3 GHz plot (page A-12 of the report) was in fact the fundamental transmit frequency of the HUB transceiver. This emission was not subject to the 60 dBc requirement as it is the fundamental.

1.11 Frequency Stability

1.11.1 Requirement

2.1055 Measurements required: Frequency stability.

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

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

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. ….. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(1) Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and +30° centigrade with no primary power applied.

21.101 Frequency tolerance.

(a) The carrier frequency of each transmitter authorized in these services shall be maintained within the following percentage of the reference frequency except as otherwise provided in paragraph (b) of this section or in the applicable subpart of this part (unless otherwise specified in the instrument of station authorization the reference frequency shall be deemed to be the assigned frequency):

Frequency range (MHz)	Frequency tolerance for fixed stations(percent)
2,150 to 2,162	0.001
2,596 to 2,680	0.005

74.961 Frequency tolerance.

(a) The frequency of any ITFS station, or of any ITFS booster station authorized pursuant to § 74.985(e), shall be maintained within ±1 kHz of the assigned frequency at all times when the station is in operation.

Report and Order on Reconsideration FCC 99-178

III. C. Interference 3. Technical Standards B. Frequency Tolerance

49. With few exceptions, the Commission has routinely imposed frequency tolerance requirements on transmitters used in all services, including MDS and ITFS. This requirement has been imposed as a means for assuring that the signal from the transmitter will stay within its assigned channel or bandwidth …. In absolute terms, a 0.001% tolerance would amount to 26 kHz for a transmitter operating on a frequency of 2600 MHz. Within a 6 MHz wide MDS or ITFS channel, a variation of 26 kHz is insignificant and should have no impact on the interference environment. We are applying this rule amendment to all currently-approved digital emissions for MDS and ITFS stations.

1.11.2 Measurement Procedure

The HUB and SUB transceivers were placed in the temperature chamber. The IF and RF cables were run from the transceivers to outside the chamber and connected to the test equipment. DC input power was also routed into the chamber to the transceivers as shown in the test setup diagram presented below. The RF output of the SUB was connected to the input of the E4407 Spectrum Analyzer set up in its frequency counter mode. The RF output of the HUB was connected to a microwave frequency counter. The temperature chamber was operated from –30° C to +50° C, in 10 degree steps, and was allowed to stabilize at least 10 minutes at each temperature increment before frequency tolerance was measured. Additionally frequency tolerance measurements were performed with the temperature chamber stabilized at + 25° C.

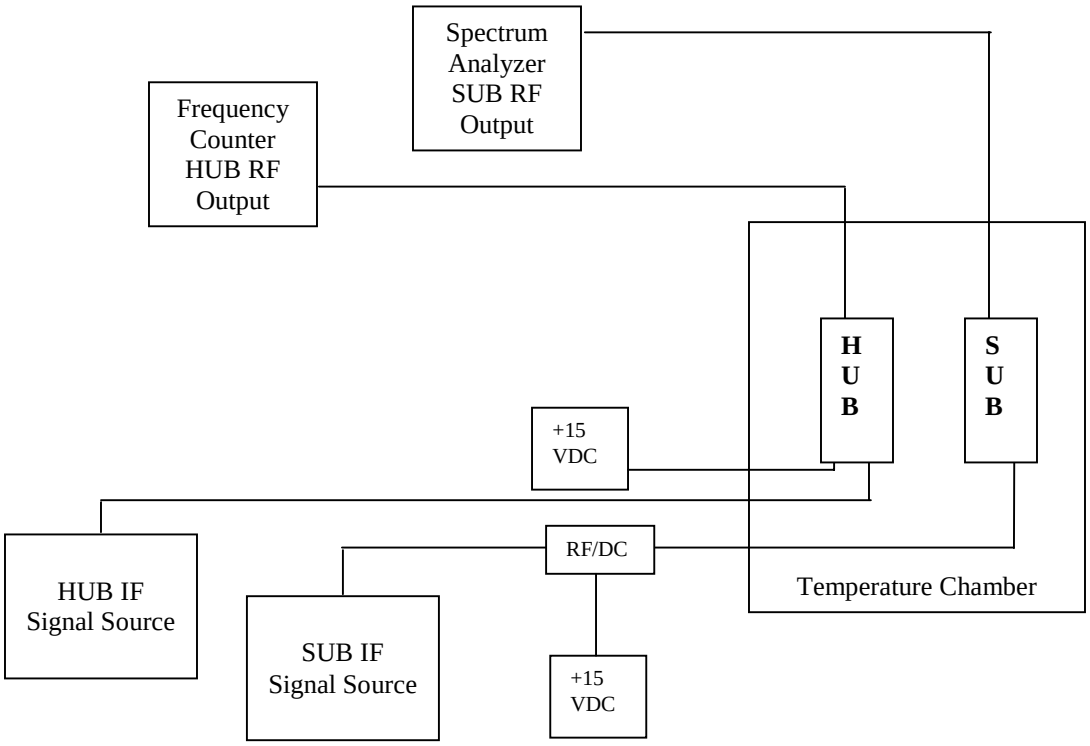


Figure 1.11.1 Frequency Stability Test Setup Diagram

1.11.3 Test Results

The worst case SUB transceiver frequency deviation of 998 Hz was measured at -30°C as reported on the attached data sheet presented in Figure 1.11.2.

The worst case HUB transceiver frequency deviation of 2.38 kHz was measured at -30°C as detailed on data sheet in Figure 1.11.3 .

FREQUENCY STABILITY
DATA SHEET

UUT: SUB Date: February 8, 2000

S/N: N931530003 Tester: RAS / AS

Configuration: SUB transceiver in temperature chamber with power and IF supplied from equipment outside of chamber. SUB RF output connected to HP E4407B and IF input supplied from HP 8648D generator.

Transmit Center Frequency: 2671 MHz

Temperature. °C	Frequency Deviation Hz	Deviation (% of Channel Frequency)
-30	998	< 0.001
-20	24	< 0.001
-10	200	< 0.001
0	200	< 0.001
10	50	< 0.001
20	50	< 0.001
25	434	< 0.001
30	149	< 0.001
40	50	< 0.001
50	350	< 0.001

Figure 1.11.2. SUB Transceiver Frequency Stability
FREQUENCY STABILITY

UUT: HUB Date: February 8, 2000

S/N: N938670024 Tester: RAS / AS

Configuration: HUB transceiver in temperature chamber with power and IF supplied from equipment outside of chamber. HUB RF output connected to HP 8342A and IF input supplied from HP 83752A generator.

Transmit Center Frequency: 2527 MHz

Temperature. °C	Frequency Deviation Hz	Deviation % of Channel Frequency
-30	2380	< 0.001
-20	24	< 0.001
-10	14	< 0.001
0	437	< 0.001
10	3	< 0.001
20	62	< 0.001
25	800	< 0.001
30	68	< 0.001
40	133	< 0.001
50	758	< 0.001

Figure 1.11.3. HUB Transceiver Frequency Stability

Appendix D

Field Strength of Spurious Radiation Test Report

Hardcopy Report Mailed Under Separate Cover