

COMPAQ COMPUTER CORPORATION

COMPAQ CONFIDENTIAL

ELECTROMAGNETIC COMPATIBILITY (EMC)

TEST REPORT

Project Number: 01145

DATE OF REPORT: April 13, 2001

Product Series Number: PE3012
Product: Multiport Wireless Bluetooth Module



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1.0 SCOPE

This document details the test results and the measurement procedures and equipment in use at the time the device described in section 3.0 was tested for radio frequency emissions.

2.0 COMPLIANCE STATEMENT

This product has been tested and found to comply with the applicable limits of CFR 47 Part 15 Subparts B and C and CISPR 22; (CNS13438; AS/NZS3548; EN55022).

3.0 DEVICE UNDER TEST/PRODUCT DESCRIPTION

Model:

Compaq/Ambit U98H011.00

FCC ID:

CNTWPE3012 (proposed)

Form Factor:

Multiport Module

Serial Number:

CAT000030556

Detail:

BLUETOOTH Wireless LAN Module for Multiport equipped PC.

4.0 TEST LOCATION

Tests were performed at COMPAQ COMPUTER CORPORATION Emission Control Laboratory located at 10320 Rodgers Road, Houston, Texas.

Information regarding this test site is currently on file with the FCC.

This test site meets the requirements of ANSI C63.4 and CISPR Publication 22 (EN55022; AS/NZS 3548; CNS 13438), and CENELEC EN55024.

5.0 CALIBRATION

All measurement equipment used in performing these tests have been calibrated in accordance with manufacturers recommendations and is traceable to the United States National Institute of Standards and Technology. All calibrations were current when the tests were performed.

MEASUREMENT UNCERTAINTIES

Measurement uncertainties for 10-meter radiated emission measurements are estimated to be +/- 3.39dB.

Measurement uncertainties for conducted emission measurements is estimated to be +/- 1.34dB.

A coverage factor of K = 2 was used in the calculation of the measurement uncertainties.

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6.0 MEASUREMENT EQUIPMENT

The following equipment was used in the measurement of the radiated and/or conducted emissions, and immunity from the device under test.

All equipment is calibrated in 1-year intervals unless noted in parenthesis.

Conducted Emissions - Conducted

Model #	Type	Manufacturer	Serial #	Next Calibration
NSLK8127	LISN	Rhode & Schwarz	8127181	10/21/2001
LISN-2	LISN	Fisher	919998	5/8/2001
338.5219.53	LISN	Rhode & Schwarz	838641/001	10/21/2001
ESH3-Z5	LISN	Rhode & Schwarz	861189/022	2/8/2002
ESH3-Z5	LISN	Rhode & Schwarz	892475/016	2/7/2002
ESHS 10	Test Receiver	Rhode & Schwarz	832809/004	12/1/2001

Radiated Emissions

Model #	Type	Manufacturer	Serial #	Next Calibration
ESMI	Test Receiver	Rhode & Schwarz	833181/008	9/8/2001
8447A	< 1GHz - PreAmplifier	Hewlett Packard	2727A02364	8/11/2001
ESBI	Test Receiver	Rhode & Schwarz	834633/004	3/15/2002
8449B	> 1GHz - PreAmplifier (2 Yr)	Hewlett Packard	3008A01233	3/21/2002
8449B	> 1GHz - PreAmplifier (2 Yr)	Hewlett Packard	3008A00239	6/13/2002
CBL6112	< 1GHz Bilog Antenna	Chase	2020	5/5/2001
3115	> 1GHz - Linearly Polarized Horn Antenna	Electro-Mechanics	5513/9807	3/13/2002
3116	> 18GHz - Linearly Polarized Horn Antenna	Electro-Mechanics	9909-2449	3/14/2002

Conducted Emissions - Antenna

Model #	Type	Manufacturer	Serial #	Next Calibration
ESMI	Test Receiver	Rhode & Schwarz	833181/008	9/8/2001
ESBI	Test Receiver	Rhode & Schwarz	834633/004	3/15/2002

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7.0 EQUIPMENT UNDER TEST CONFIGURATION - EMISSIONS

The DUT was installed on the Multiport of a Compaq Evo N400c Notebook PC, Series Number PP2070, Serial Number J11P700P1002, FCC Declaration with one PIII 700 MHz Processor, 128mb RAM, 20.0gb HDD, 10/100 Net / 56k Modem, Smart Card Slot, 12.1" XGA Display, PP2051A Battery Pack, Composite Video Output, 3 wire PPP003D P.S. with Non-Ferrited D.C. cord and , unshielded 3 wire AC power cord 1.8 meters in length, CPN 213349-002. The modem and NIC cables used were non-shielded and non-ferrited.

The following peripherals were connected to the Host:

A COMPAQ P700 - Video Graphics Color Monitor, Series Number PE1020, Serial Number 038CA45VD886, FCC Declaration, was connected to the system VGA connector by means of its associated shielded cable which incorporates a ferrite. AC power was provided by an unshielded 3 wire A.C. power cord 1 meter in length, CPN# 121565-002.

A Logitech Model M-UB48 USB Mouse, Serial Number LZA82851786, FCC ID : DZL211137, was connected to the system USB port by means of its associated USB cable.

A U.S. Robotics Sportster 33.6 Modem, Serial Number 223128I8S9CC, FCC ID : F-DOC, was connected to the serial output connector of the system unit by means of a shielded Serial Modem Cable 2 meters in length, Belkin, P/N F2L088-06. Power was provided by a U.S. Robotics Modem A.C. Adapter, 9.5vac 700ma, Model 1-015-12386.

A Logitech Model V-UB2 USB Camera/Cable Assembly, Serial Number LZA01754312, FCC ID : OEM/F-DOC, was connected to the system USB port by means of its associated 2 meter shielded Ferrited USB cable.

A COMPAQ Headphone/Microphone, Assembly Number 220460-001, was attached to the system audio connectors by means of its associated cable.

A RCA CAT# 16-3001 T.V., Serial Number 1705391, FCC ID : N/A, External D.C. Power Supply, RCA Model FB13100 (13.5vdc Output @ 1amp) with Non-Ferrited D.C. cable, was connected to the video output connector of the system unit by means of a shielded Non-Ferrited cable 1 meter in length.

The system was connected by means of CAT5 cable to a Network Server external to the test field.

Unless noted, all peripheral cables mentioned above contained no Ferrite cores.

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8.0 RADIATED EMISSION TEST

All radiated testing was performed on the site referenced in section 4.0 in accordance with ANSI C63.4: 1992 and CISPR 22: 1993 (EN55022; AS/NZS 3548; CNS 13438, ICES-003)

8.1 TEST CONFIGURATION

The device under test, installed in a representative system as described in section 7.0, was placed on a non-conductive table/rotator assembly whose total height equaled 80 cm.

The measurement antenna was mounted to a non-conductive mast capable of moving the antenna through a vertical range of 1 to 4 meters. This mast was positioned such that the distance from the antenna to the system under test was 10 meters, except required testing above 1 GHz which is performed at a distance of 3 meters.

8.2 TEST CONDITION

The system under test was programmed to output a continuous stream of the capital letter "H" to the video display device and alternately to any attached or included peripheral or any combination thereof.

The Intentional radiator was placed in test mode (Frequency Hopping enabled, DH1 packet, Psuedorandom 9 test pattern)

8.3 FREQUENCY RANGE

Radiated emissions were investigated over the frequency range of 30 MHz through 1000 MHz using a receiver bandwidth of 120 KHz, unless otherwise noted. Above 1000 MHz testing used a receiver bandwidth of 1 MHz, unless otherwise noted.

8.4 TEST PROCEDURE

For each predominate emission frequency, the following were varied as noted to achieve the maximum emission amplitude.

- a) Horizontal and vertical antenna polarization were evaluated.
- b) Antenna height was varied from 1 meter to 4 meters.
- c) System under test was rotated from 0 degrees through 360 degrees relative to the antenna position.
- d) Interface cable positions were varied (excluding positions which would result in cables laying over or under peripherals or the system unit).
- e) The Host contained a network interface controller, the controller was active during the test.

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8.5 TEST DATA 30 MHz – 1 GHz & Above 1 GHz (Part B Digital Device)

This personal computer was tested in each of its supported configurations/processor speeds. The readings presented below are from the configuration which produced the maximum emission levels for this personal computer.

The test voltage of the DUT was set at: 110VAC

The results stated in this section are for the Device specified in Section 3.0 of this report.

All readings are CISPR quasi-peak, unless otherwise noted.

The Intentional radiator was powered but not transmitting during the test.

10 meter (CISPR)

Frequency MHz	Level dB(mV/m)	Height cm	Azimuth deg	Polarity
30.000	28.00	100	352	V QP
31.490	27.96	100	309	V QP
60.054	24.00	200	189	V QP
65.138	27.60	300	258	V QP
84.630	28.90	132	106	V QP
144.060	25.40	100	153	V QP
146.564	26.30	100	198	V QP
179.139	23.80	100	169	V QP
192.107	22.40	100	296	H QP
198.586	25.30	100	120	V QP
228.016	28.20	100	67	V QP
368.360	30.60	266	0	H QP
746.727	27.60	100	265	H QP
998.280	28.30	100	235	H QP

3 Meter (FCC)

Frequency MHz	Level dB(mV/m)	Height cm	Azimuth deg	Polarity
1000.000	38.10	100	129	H AV
1099.760	36.10	100	334	V AV
1257.460	34.40	203	110	H AV
1295.670	37.60	113	0	V AV
1500.660	36.60	100	0	V AV
1586.030	27.90	347	0	V AV
1790.470	33.90	200	73	V AV
2198.410	33.30	147	252	V AV
2798.530	37.20	230	33	V AV

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8.6 TEST DATA 30 MHz – 1 GHz & Above 1 GHz (Intentional Radiator)

This Digital Device was tested in each of its supported configurations/processor speeds. The readings presented below are from the configuration which produced the maximum emission levels for this personal computer.

The test voltage of the DUT was set at: 110VAC

The results stated in this section are for the Device specified in Section 3.0 of this report.

All readings are CISPR quasi-peak, unless otherwise noted.

The Intentional radiator was powered, frequency hopping, using DH1 packets and transmitting during the test.

10 Meter (CISPR)

Frequency MHz	Level dB(mV/m)	Height cm	Azimuth deg	Polarity
30.000	28.00	100	352	V QP
31.490	27.96	100	309	V QP
65.138	27.60	300	258	V QP
84.630	28.90	132	106	V QP
146.564	26.30	100	198	V QP
228.016	28.20	100	67	V QP
368.360	30.60	266	0	H QP
998.280	28.30	100	235	H QP

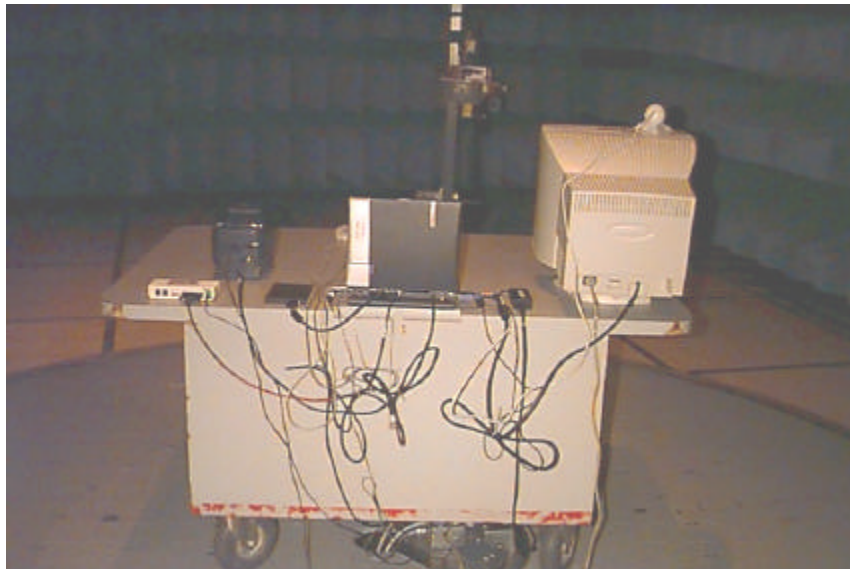
3 Meter (FCC)

Frequency MHz	Level dB(mV/m)	Height cm	Azimuth deg	Polarity
2432.000	97.00	100	180	V AV (Max. in Band)
1099.760	36.10	100	334	V AV
1295.670	37.60	113	0	V AV
1500.660	36.60	100	0	V AV
1790.470	33.90	200	73	V AV
2798.530	37.20	230	33	V AV
4863.910	49.10	100	180	V AV

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8.7 MAXIMUM EMISSION CONDITION

The attached photograph depicts the condition at which the maximum radiated emission was encountered.



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9.0 CONDUCTED EMISSION TEST – Power Line

All Power Line conducted emissions testing was performed in accordance with ANSI C63.4 1992 and CISPR Publication 22 1993 (EN55022; AS/NZS 3548; CNS 13438, ICES-003) inside a shielded room.

9.1 TEST CONFIGURATION

The device under test, installed in a representative system as described in Section 7.0 of this report, was placed on a non-conductive table 80 cm. in height, and located 40 cm. from the closest vertical grounded surface.

The system under test was connected to the power supply mains through a Line Impedance Stabilization Network (LISN) constructed in accordance with ANSI C63.4 (1992) and CISPR 16-1.

9.2 TEST CONDITION

The system under test was programmed to output a continuous stream of the capital letter "H" to the video display device and alternately to any attached or included peripheral or any combination thereof.

The Intentional radiator was placed in test mode (Frequency Hopping enabled, DH1 packet, Psuedorandom 9 test pattern)

9.3 FREQUENCY RANGE

Conducted emissions were investigated over the frequency range of 150 KHz through 30 MHz using a receiver bandwidth of not less than 9 KHz.

9.4 TEST PROCEDURE

A test receiver was connected to the signal output of the LISN. The test receiver was tuned through the band 150 KHz to 30 MHz, all predominate emissions were recorded.

For each predominate emission frequency, the following were varied as noted to achieve the maximum emission amplitude.

- a.) Interface cable positions were varied (excluding positions which would result in cables laying over or under peripherals or the system unit).
- b.) The Device Under Test was a multiple processor speed device, all user accessible speeds were investigated.

The unused output of the LISN was terminated into a 50 ohm resistance.

The input to the test receiver was switched to the other line of the LISN and the above procedure repeated.

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9.5 TEST DATA

This Digital Device was tested in each of its supported configurations/processor speeds. The readings presented below are from the configuration which produced the maximum emission levels for this personal computer. Line and Neutral test data has been recorded. The highest levels from both lines have been recorded and represented here.

The results stated in this section are for the Device specified in Section 3.0 of this report.

All readings are CISPR quasi-peak, unless otherwise noted.

110 VAC

Frequency MHz	Level dBµV	Detector	Limit dBµV	Delta dB	Line
0.1605	51.90	QP	65	13.6	N
0.2685	33.70	QP	61	27.4	N
4.5595	30.30	QP	56	25.8	N
5.9380	32.00	QP	60	28.0	N
9.8075	32.40	QP	60	27.6	N
10.3375	32.60	QP	60	27.4	N
11.0265	31.50	QP	60	28.5	N
11.1855	31.90	QP	60	28.1	N
11.3970	33.30	QP	60	26.7	N
11.5560	33.20	QP	60	26.8	N
11.7145	33.90	QP	60	26.1	N
12.0855	32.20	QP	60	27.8	N

220VAC

Frequency MHz	Level dBµV	Detector	Limit dBµV	Delta dB	Line
0.1715	43.20	QP	65	21.7	N
0.2625	39.60	QP	61	21.8	N
0.2985	31.40	QP	60	28.9	N
0.5300	34.70	QP	56	21.3	L1
10.8585	36.10	QP	60	23.9	L1
11.0170	37.10	QP	60	22.9	L1
11.0710	34.80	QP	60	25.2	L1
11.2285	38.00	QP	60	22.0	L1
11.2820	37.40	QP	60	22.6	L1
11.3865	37.80	QP	60	22.2	N
11.5990	38.50	QP	60	21.5	L1
11.7575	37.00	QP	60	23.0	N

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9.6 MAXIMUM EMISSION CONDITION

The attached photograph depicts the condition at which the maximum conducted emission was encountered.



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10.0 CONDUCTED EMISSION TEST – Antenna

All antenna output conducted emissions testing was performed in accordance with CFR47 Part 15 Subpart C Section 15.247.

10.1 TEST CONFIGURATION

The device under test was installed on a representative system as described in Section 7.0 of this report. The DUT's internal antenna was bypassed to an alternate connector specifically installed for the purpose of this test. The test receiver was connected through a step attenuator to the test antenna connector of the DUT.

10.2 TEST CONDITION

A Bluetooth exercise test program was run. The device was configured for hopping or non-hopping as required for each test. The test pattern was pseudorandom 9, and packet sizes of DH1, DH3 and DH5 were investigated. Data for DH1 packets (worst case) are included except for where noted.

10.3 FREQUENCY RANGE

Conducted emissions were investigated over the frequency range of 150 KHz through 25 GHz. Receiver bandwidth was varied according to the requirements of each test and are noted the Figure supplied for each test.

10.4 TEST PROCEDURE

Tests were performed per the instructions outlined in "Filing and Measurement Guidelines for Frequency Hopping Spread spectrum Systems", FCC Document DA 00-705 (Released March 30, 2000). Settings for each test are specified and represented in the included Figures.

Preliminary investigation was performed to determine worst case conditions for test pattern and packet size. DH1 packets and Psuedorandom 9 test pattern were used for final testing when either worst case or equivalent to other cases.

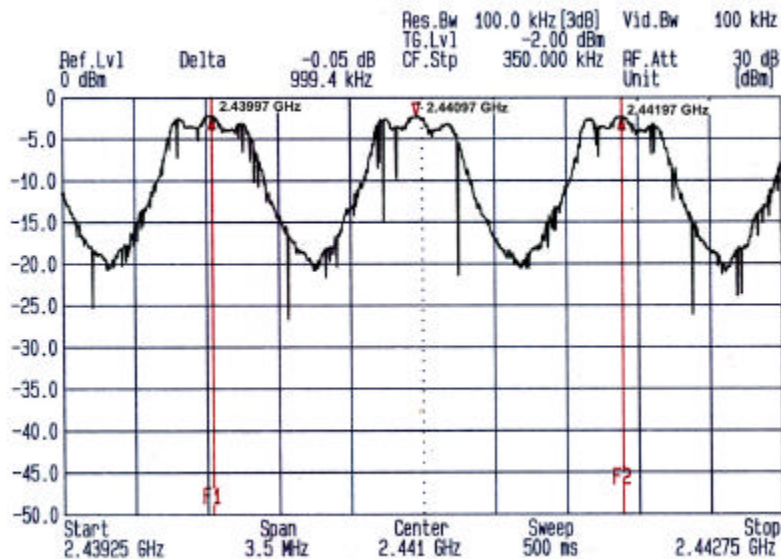
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10.5 Test Result

10.5.1 Section 15.247 (a) - Carrier Frequency Separation (Hopping)

Limit = 1 MHz max. Measured at the center frequency 2.441 GHz, separation to the next lower frequency was 999.4 KHz. Separation to the next higher frequency was 999.4 KHz.

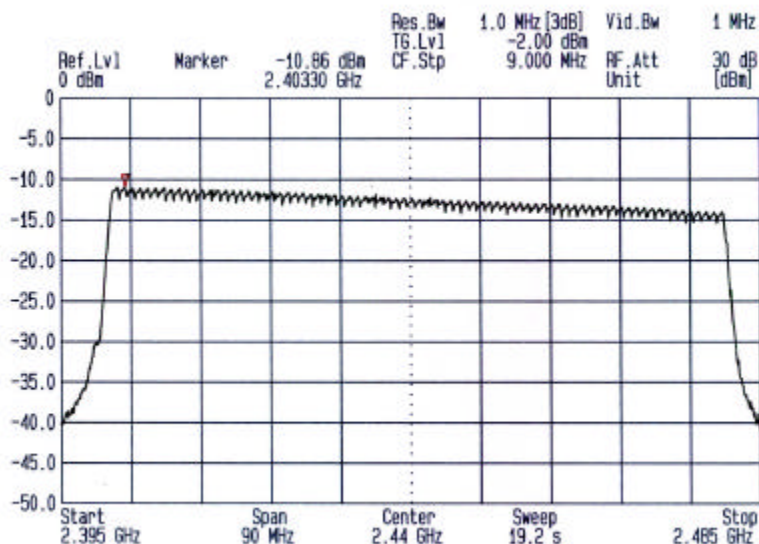
Inline Attenuation = 10 dB ; Peak Detector; Max hold



10.5.2 Section 15.247 (a) (ii) – Number of Hopping Channels

Limit = 75 min. There are 79 Hopping Channels

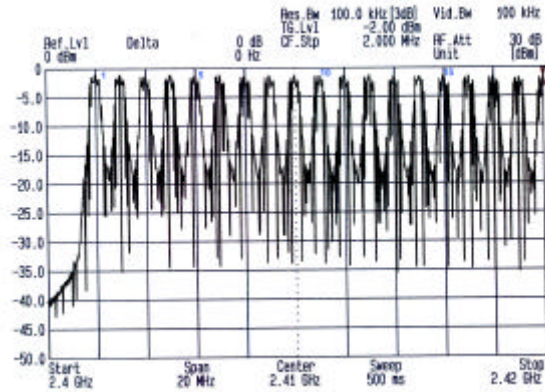
Inline Attenuation = 20 dB ; Peak Detector; Max hold



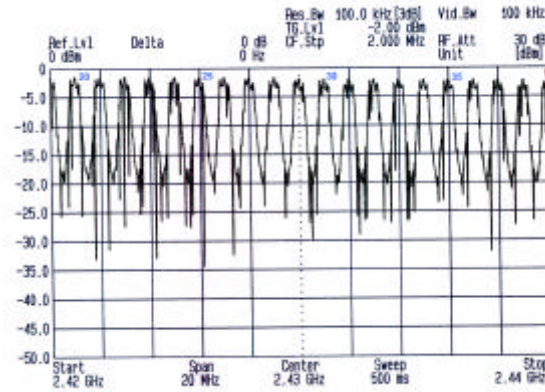
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Inline Attenuation = 10 dB ; Peak Detector; Max hold

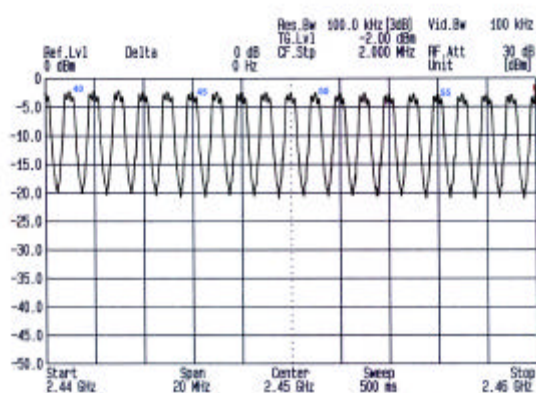
Lower Quarter



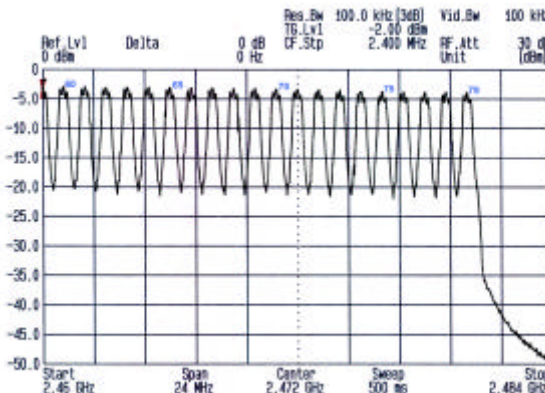
Mid Lower Quarter



Upper Mid Quarter



Upper Quarter



10.5.3 Section 15.247 (a) (ii)- Time of Occupancy [Dwell Time]

Limit = 400 ms max in a 30 second span. Dwell time has been demonstrated by indirect measurement. The Bluetooth system makes a maximum of 1600 hops per second. With 79 channels, one time slot has a length of 625 μ s. The DH1 packet needs 1 time slot for transmit per 1 time slot for receiving. This means a system with 79 channels makes 800 hops per second. The DH3 packet needs 3 time slots for transmit per 1 time slot for receive, thus making 400 hops per second. The DH5 packet needs 5 time slots for transmit per 1 time slot for receive, thus making 266.7 hops per second. The total times a channel is occupied in a 30 second period can be computed as follows.

$$\text{DH1: } 800 \div 79 \times 30 = 303.8$$

$$\text{DH3: } 400 \div 79 \times 30 = 151.9$$

$$\text{DH5: } 266.7 \div 79 \times 30 = 101.3$$

The time per occurrence on a channel

$$\text{DH1} = 1.255 \text{ ms}$$

$$\text{DH3} = 2.488 \text{ ms}$$

$$\text{DH5} = 3.73$$

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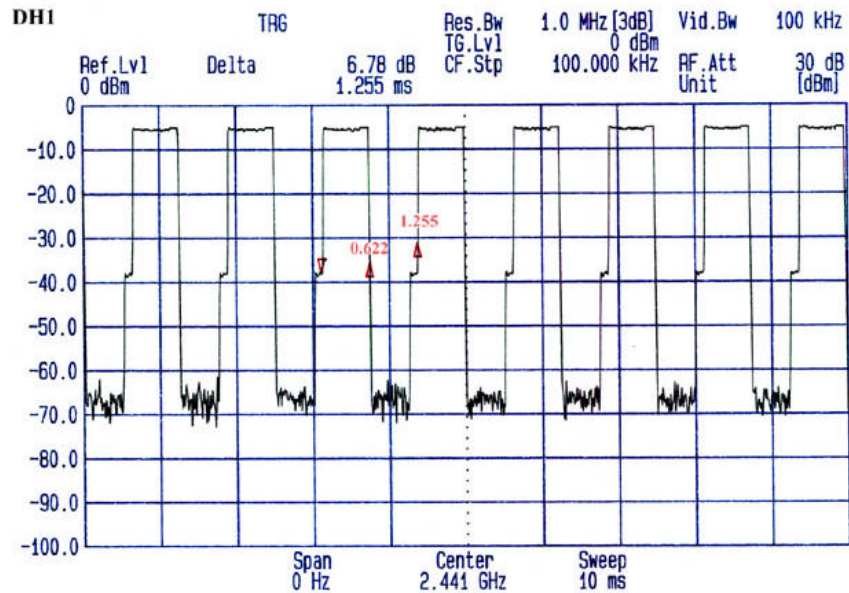
Dwell time per Channel per 30 seconds

DH1: $303.8 \times 1.255 = 381.3 \text{ ms}$

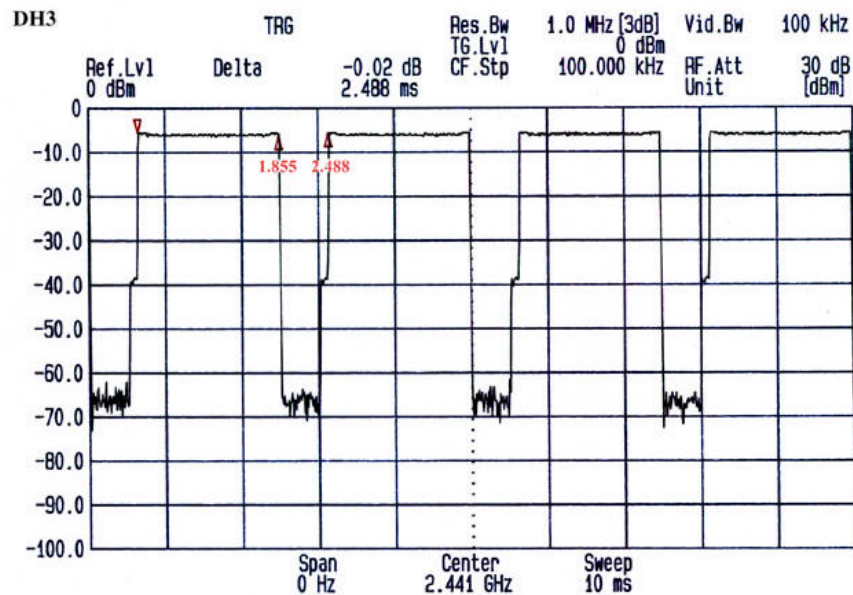
DH3: $151.9 \times 2.488 = 377.9 \text{ ms}$

DH5: $101.3 \times 3.73 = 377.9 \text{ ms}$

Inline Attenuation = 10 dB ; Peak Detector; Max hold

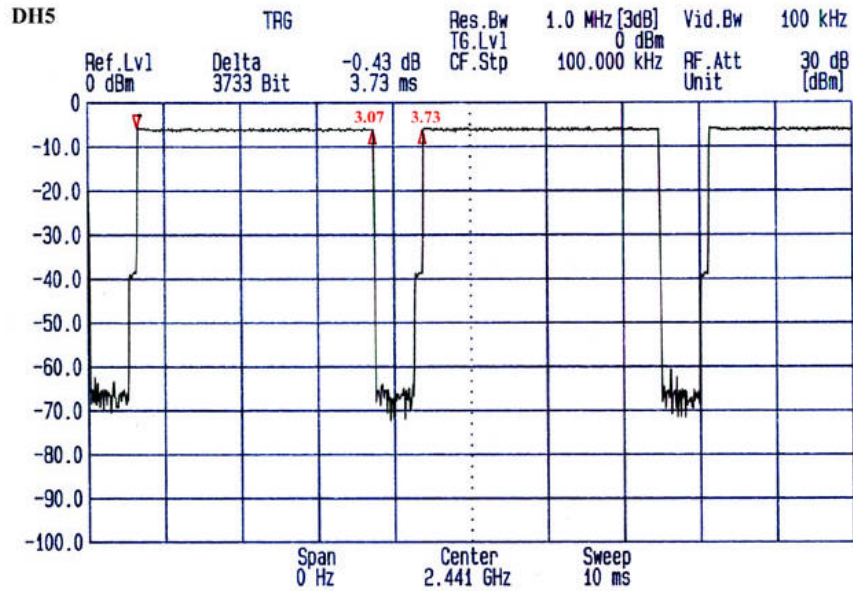


Inline Attenuation = 10 dB ; Peak Detector; Max hold



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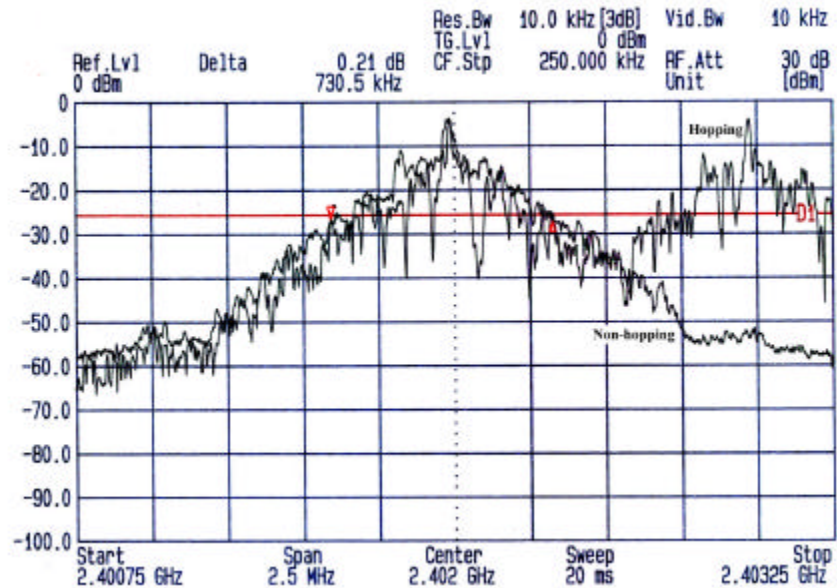
Inline Attenuation = 10 dB ; Peak Detector; Max hold



10.5.4 Section 15.247 (a) (ii) – 20 dB Bandwidth

Limit = 1 MHz max. The maximum 20 dB bandwidth measured was 730.5 KHz for the 2.402 GHz channel while hopping was enabled.

Inline Attenuation = 10 dB ; Peak Detector; Max hold

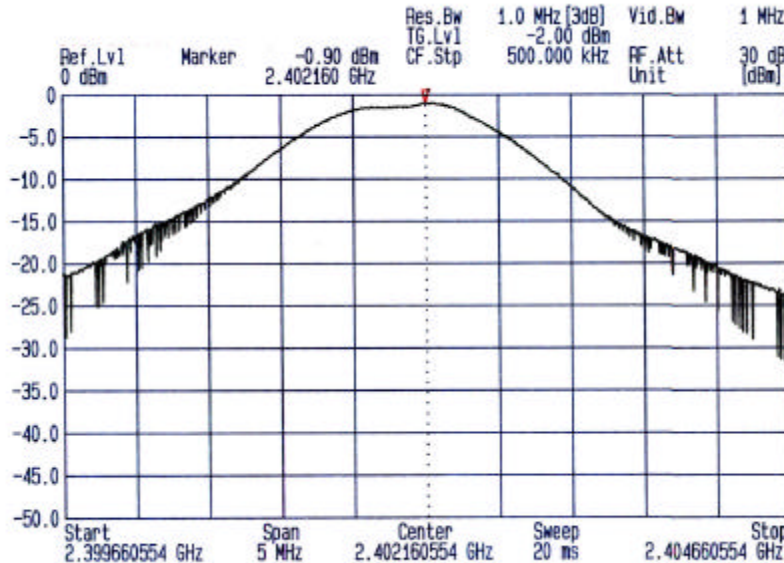


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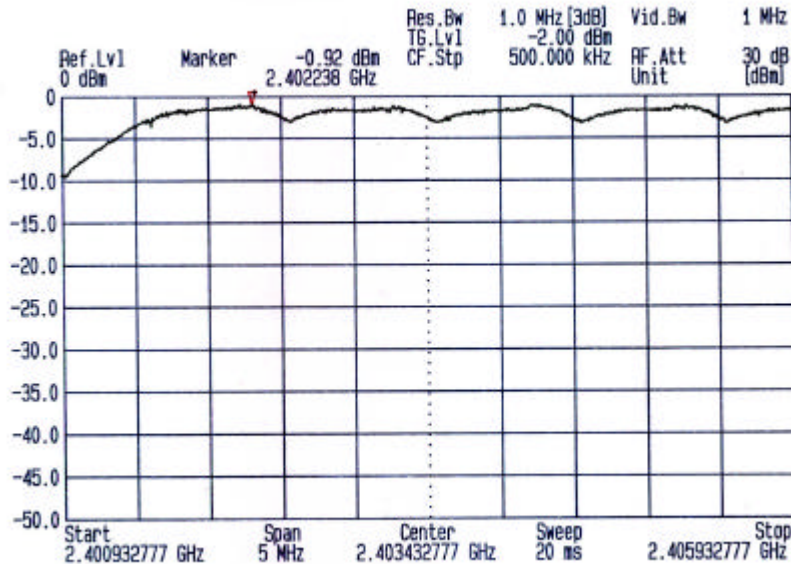
10.5.5 Section 15.247 (b) (1) – Peak Output Power

Limit = 1 watt max (+30 dBm) . The measured peak output power while hopping was +9.92 dBm. The peak output power while hopping was disabled was +9.9 dBm.

Non-Hopping; Inline Attenuation = 10 dB ; Peak Detector; Max hold



Hopping enabled; Inline Attenuation = 10 dB ; Peak Detector; Max hold

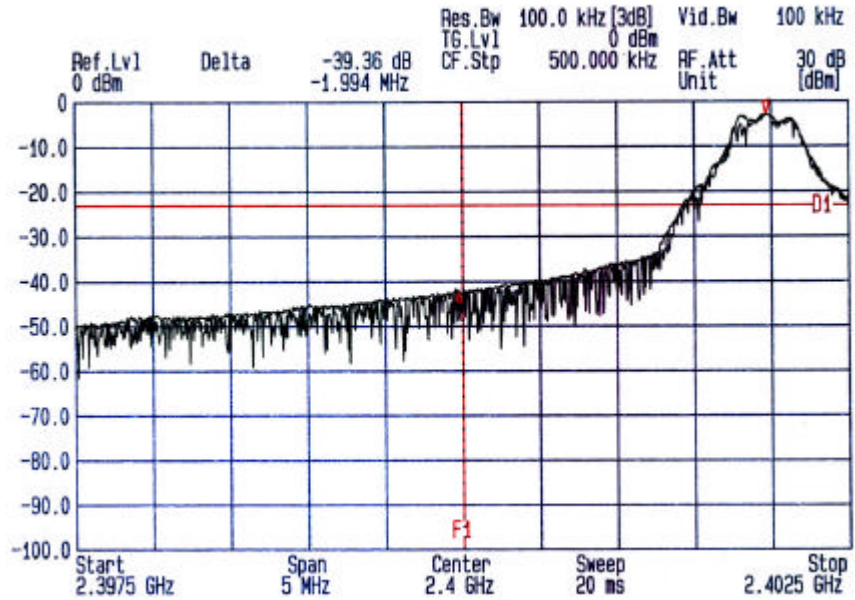


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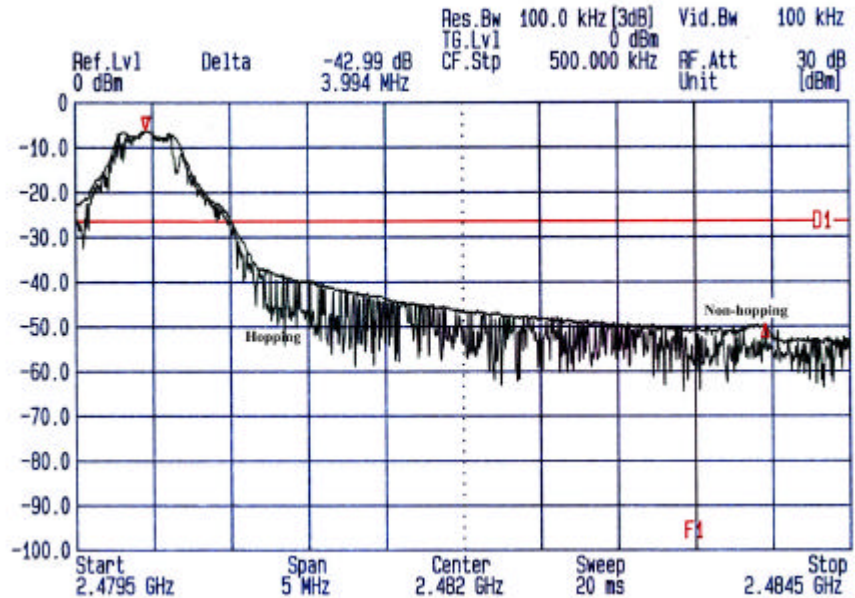
10.5.6 Section 15.247 (c) – Band Edge Compliance

Limit = 20 dB minimum below peak in-band transmission. The peak measured band edge emission was 39 dB below the peak in-band emission.

Inline Attenuation = 10 dB ; Peak Detector; Max hold



Inline Attenuation = 10 dB ; Peak Detector; Max hold

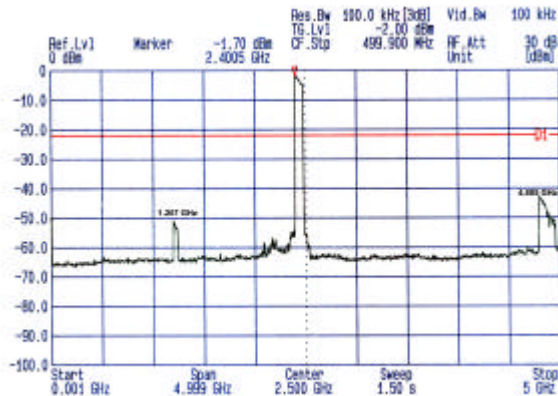


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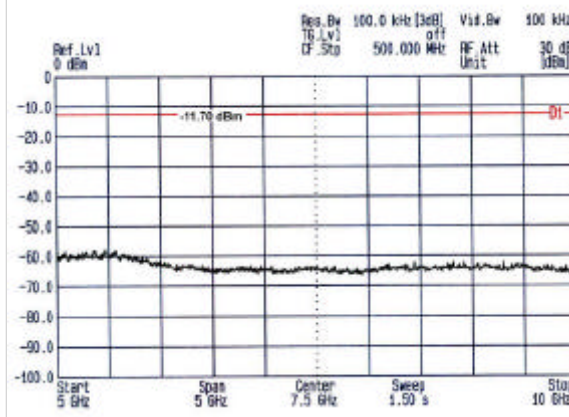
10.5.7 Section 15.247 (C) – Spurious RF Conducted Emissions

Limit = 20 dB below the peak in band emission level. The peak out of band emissions 4.805 GHz was greater than 40dB below the peak in band emission level

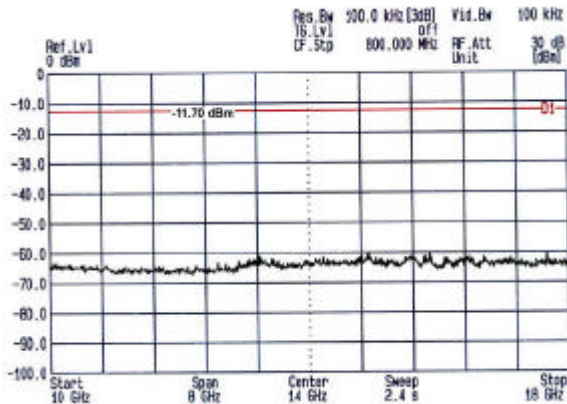
Inline Attenuation = 10 dB ; Peak Detector; Max hold
10 KHz – 5 GHz



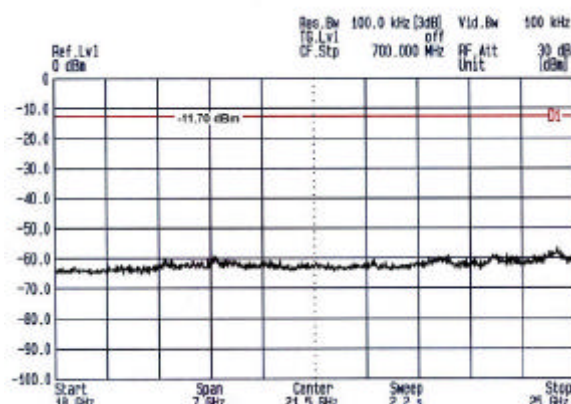
Inline Attenuation = 0 dB ; Peak Detector; Max hold
5 GHz – 10 GHz



Inline Attenuation = 0 dB ; Peak Detector; Max hold
10 GHz – 18 GHz



Inline Attenuation = 0 dB ; Peak Detector; Max hold
18 GHz – 25 GHz



10.6 DATE OF TEST

All tests detailed in this document were performed on or about April 6, 2001.

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11.0 TEST PERSONNEL

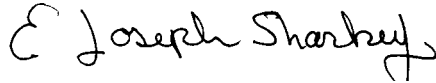
The below signed personnel, having been directly involved in the collection of the test data contained in this report, do, by their signatures, declare the contents of this report to be true and correct to the best of their knowledge.

Prepared by



Name: Christopher G. McIntyre
Title: EMC Technician

I attest to the accuracy of this report



Name: E. Joseph Sharkey
Title: Supervisor, EMC Services