



MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313



October 26, 2004

Ubisense Limited
1 Quayside
Bridge St.
Cambridge
CB5 8AB
ENGLAND

Reference: Ubitag V1.0
FCC ID: **SEAUBITAG10-U**

Dear Dr Andy Ward:

Enclosed is the EMC Test Report for the Ubisense Limited Ubitag V1.0. The Ubisense Limited Ubitag V1.0 was tested to the requirements of the FCC Rules and Regulations, Part 15 Subpart F, of Title 47 of the CFR, for a Part 15 Ultra-Wideband Device.

Thank you for using the testing services of MET Laboratories. If you have any questions regarding these results or if MET can be of further assistance to you, please feel free to contact me. We appreciate your business and look forward to working with you again soon.

Kindest Regards,
MET LABORATORIES, INC.

Marianne T. Bosley
Documentation Department

DOCTEM-23 Jan 02

Certificates and reports shall not be reproduced except in full, without the written permission of MET Laboratories, Inc. While use of the National Voluntary Laboratory Accreditation Program (NVLAP) letters or the NVLAP Logo in this report reflects the MET Accreditation under the NVLAP Program, these letters, logo, or Statements do not claim product endorsement by NVLAP or any Agency of the U.S. Government.



Electro-Magnetic Compatibility

Test Report

for the

**Ubisense Limited
Ubitag V1.0**

Tested Under

FCC Part 15 Subpart F
Section 15.517
Title 47 of the CFR
for Ultra-Wideband Operation

MET REPORT:

October 26, 2004

PREPARED FOR:

Ubisense Limited
1 Quayside
Bridge Street
Cambridge
CB5 8AB
ENGLAND

PREPARED BY:

MET Laboratories, Inc.
914 West Patapsco Avenue
Baltimore, Maryland 21230-3432



Electro-Magnetic Compatibility

Test Report

for the

Ubisense Limited
Ubitag V1.0

Tested Under

FCC Part 15 Subpart F
Section 15.517
Title 47 of the CFR
for Ultra-Wideband Operation

MET REPORT: **EMC15813-FCC517**

October 26, 2004

PREPARED FOR:

Ubisense Limited
1 Quayside Bridge Street
Cambridge CB5 8AB
ENGLAND

Gaylon Morris, General Manager
Electromagnetic Compatibility Testing

Marianne T. Bosley
Administer

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15, Subpart F, Section 15.517, of the FCC Rules under normal use and maintenance.

Liming Xu
Project Engineer



Table of Contents

I.	Executive Summary	1
	A. Purpose of Test	2
	B. Executive Summary	2
II	General	4
	A. Test Site	5
	B. Description of Test Sample	5
	C. General Test Setup	5
	D. Mode of Operation	5
	E. Modifications	7
III.	Electromagnetic Compatibility Antenna Requirements	8
	A. Antenna Evaluation Criteria	9
IV	Electromagnetic Compatibility Emissions Requirements	10
	A. AC Line Conducted Emissions	11
	B. Operational Restrictions	14
	C. UWB Bandwidth	15
	D. Average Radiated Emissions - Broadband	20
	E. Average Radiated Emissions - Narrowband	31
	F. Peak Radiated Emissions	33
V.	Labeling & Instructional Manual Requirements	35
VI.	Test Equipment	38
VII.	Certification Information - 47 CFR Part 2	40



List of Tables

Table 1.	Summary of Test Results	v
Table 2.	Summary of Test Data	v
Table 3.	EUT Compliance	2
Table 4.	References	3
Table 5.	Limits for Conducted Emissions from Intentional Radiators - §15.207(a)	11
Table 6.	Limits for Radiated Emissions from Intentional Radiators - §15.209(a)	20
Table 7.	Radiated Emissions Results - Average Broadband Measurements(low)	20
Table 8.	Limits for Radiated Emissions (RBW=1MHz)	21
Table 9.	Radiated Emissions Results - Average Broadband Measurements - Fundamental	23
Table 10.	Radiated Emissions Results - Average Broadband Measurements - Spurious	24
Table 11A/ B.	Limits for Radiated Emissions (RBW>=1kHz)	31
Table 12.	Radiated Emissions Results - Peak Measurements - Fundamental	33
Table 14.	Test Equipment for Intentional Radiators - §15.517	39

List of Figures

Figure 1.	FCC Intentional Radiators Tests Setup Photo	29
-----------	---	----



List of Terms and Abbreviations

AC	Alternating Current
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB μ A	Decibels above one microamp
dB μ V	Decibels above one microvolt
dB μ A/m	Decibels above one microamp per meter
dB μ V/m	Decibels above one microvolt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
CISPR	Comite International Special des Perturbations Radioelectriques (International Special Committee on Radio Interference)
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
μ H	microhenry
μ F	microfarad
μ s	microseconds
NEBS	Network Equipment-Building System
OATS	Open Area Test Site
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane



Summary of Test Results

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart F, Section 15.517. All tests were conducted using measurement procedure ANSI C63.4-1992, CISPR 16-1: 1993, and CFR 47 Part 15, Subpart F.

Type of Submission/Rule Part:	Original Filing/Part 15
EUT:	Ubisense Limited Ubitag V1.0, pre-production unit, serial no. 10003
FCC ID:	SEAUBITAG10-U
Equipment Code:	UWB
UWB Bandwidth:	2025 MHz

Table 1.

Summary of Test Data

Name of Test	FCC Rule Part/Section	Results
Conducted Emissions (If AC)	15.207(a)	N/A
Radiated Emissions	15.209(a)	Complies
Operational Restrictions	15.517(a)	Applicant has been advised of these requirements
UWB Bandwidth	15.517(b)	Complies
Average Radiated Emissions - Broadband	15.517(c)	Complies
Average Radiated Emissions - Narrowband	15.517(d)	Complies
Peak Radiated Emissions	15.517(e)	Complies
Labeling Requirements	15.517(f)	Applicant has been advised of these requirements

Table 2.



I. Executive Summary



I. Executive Summary

A. Purpose of Test

An EMC evaluation to determine compliance of the Ubitag V1.0 In-Building Location System Tag with the requirements of Part 15, Subpart F, Section 15.517 was conducted. (All references are to the most current version of Title 47 of the Code of Federal Regulations in effect). In accordance with §2.1033, the following data is presented in support of the Certification of the Ubitag V1.0 In-Building Location System Tag. Ubisense Limited should retain a copy of this document should be kept on file for at least five years after the manufacturing of the Ubitag V1.0 has been **permanently** discontinued.

B. Executive Summary

The following tests were performed in accordance with Purchase Order and Agreement with Ubisense Limited

Specifications	Description	Compliance
Title 47 of the CFR, Part 15, Subpart C, §15.207(a)	Conducted Emissions Requirements	N/A
Title 47 of the CFR, Part 15, Subpart C and F, §15.209(a)	Radiated Emissions Requirements	Complies
Title 47 of the CFR, Part 15, Subpart F, §15.517(a)	Operational Restrictions	Applicant Notified of Requirements
Title 47 of the CFR, Part 15, Subpart F, §15.517(b)	UWB Bandwidth	Complies
Title 47 of the CFR, Part 15, Subpart F, §15.517(c)	Average Radiated Emissions - Broadband	Complies
Title 47 of the CFR, Part 15, Subpart F, §15.517(d)	Average Radiated Emissions - Narrowband	Complies
Title 47 of the CFR, Part 15, Subpart F, §15.517(e)	Peak Radiated Emissions Requirements	Complies
Title 47 of the CFR, Part 15, Subpart F, §15.517(f)	Electromagnetic Compatibility - Labeling Requirements	Applicant Notified of Requirements

Table 3. EUT Compliance



I. Executive Summary

The EUT, as supplied to MET Laboratories, complied with the requirements stated in this test report.

References	Description
ANSI-C63.4:1992	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
FCC 47CFR, Chapter 1, Part 2	Title 47 Code of Federal Regulations Part 2 - Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
FCC 47CFR, Chapter 1, Part 15	Title 47 Code of Federal Regulations Part 15 - Radio Frequency Devices

Table 4. References



II. General



II. General

A. Test Site

All testing was conducted at MET Laboratories, Inc., 914 West Patapsco Avenue, Baltimore, Maryland 21230-3432. Radiated Emissions measurements were performed inside of a Semi Anechoic Chamber. In accordance with §2.948(a)(2), a complete site description is filed with the Commission's Laboratory in Columbia, Maryland. MET Laboratories has been accredited by the National Voluntary Laboratory Accreditation Program (Lab Code: 100273-0)

B. Description of Test Sample

The Ubitag V1.0 is a wireless device intended to be used for the real-time location of objects within buildings. It transmits ultra-wideband (UWB) pulses which are picked up by a network of basestations placed inside the building, allowing the 3D position of the tag to be found to an accuracy of six inches (15cm). The use of UWB technology enables greater positioning accuracy within buildings than other wireless technologies, because it is much less susceptible to multipath interference effects. Applications of the system include healthcare, workplace productivity, security, retail management and manufacturing.

C. General Test Configuration

The battery-operated Ubitag V1.0 was tested stand-alone. In normal operation, the Ubitag V1.0's UWB transmitter is quiescent for periods that are long compared to the nominal pulse repetition interval. For the purposes of testing, the EUT (which represented the final hardware configuration) was supplied with a firmware test mode which allowed it to transmit a continuous train of UWB pulses for the purposes of accurately measuring the UWB signal characteristics, in accordance with §15.521(d).

D. Mode of Operation and Monitoring Method

The Ubitag V1.0 was configured in accordance with the manufacturer's instructions and was operated in the continuous pulse transmission mode (detailed above in "General Test Configuration") unless stated otherwise.



II. General

Frequency determining parameters

The highest frequency employed in §15.33 to determine the frequency range over which radiated emissions are made were based on the center frequency, f_c , unless a higher frequency was generated within the UWB device. For measuring emission levels, the spectrum were investigated from the lowest frequency generated in the UWB, without going below 9 kHz, up to the frequency range shown in Section 15.33(a) of the CFR 47 or up to $f_c + 3/(\text{pulse width in seconds})$, whichever was higher. There is no requirement to measure emissions beyond 40 GHz provided f_c was less than 10 GHz; beyond 100 GHz if f_c was at or above 10 GHz and below 30 GHz; or beyond 200 GHz if f_c was at or above 30 GHz.

The center frequency f_m was found to be 5963 MHz.

The pulse width of the EUT was 2 ns.

Therefore, the highest frequency to be measured was 40 GHz.



II. General

EUT

Reference to Test Configuration	Description/Nomenclature	Model #	Serial #
EUT	Ubitag	V1.0	10003

Support Equipment - None

Port and Cables - None

E. Modifications

No modifications were made during testing.



III. Electromagnetic Compatibility Antenna Requirements



III. Electromagnetic Compatibility Antenna Requirements

A. Antenna Evaluation Criteria

Requirements: The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- A. Antenna be permanently attached to the unit.
- B. Antenna must use a unique type of connector to attach to the EUT.
- C. Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

See Photograph in Exhibits

Results: The Ubisense Limited Ubitag V1.0 meets the criteria of this rule by virtue of having a permanently attached internal antenna. The EUT is therefore compliant with §15.203.



IV. Electromagnetic Compatibility Emissions Requirements



IV. Electromagnetic Compatibility Emission Requirements

A. AC Line Conducted Emissions

Requirements: The EUT shall meet the limits shown below:

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56*	56 to 46*
0.5 - 5	56	46
5 - 30	60	50

Table 5. Limits for Intentional Radiators from FCC Part 15 §15.207(a) *Decreases with the logarithm of the frequency

Test Equipment: Test equipment for this test is in Section VI of this report.

Test Configuration: The EUT was installed SETUP inside a shielded enclosure. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the shielded enclosure, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω /50 μ H Line Impedance Stabilization Network (LISN).

Procedure: The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with ANSI C63.4-1992 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz." The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω /50 μ H LISN as the input transducer to an EMC/Field Intensity Meter. The tests were conducted in a RF shielded enclosure.

Results: The EUT is battery-powered. Therefore, the requirements of §15.207 of the FCC Rules and Regulations does not apply to this device.

Test Engineer: N/A

Test Date: N/A (Battery operated only)



IV. Electromagnetic Compatibility Emission Requirements

Subject: Conducted Emissions - Voltage, Data Plot

Port: AC Power Phase

Requirements: FCC Part 15 Subpart C, §15.207(a)

Results: Equipment is battery-powered, and therefore, the specifications of §15.207(a) do not apply.

Test Engineer: N/A

Test Date: N/A



IV. Electromagnetic Compatibility Emission Requirements

Subject: Conducted Emissions - Voltage, Data Plot

Port: AC Power Neutral

Requirements: FCC Part 15 Subpart C, §15.207(a)

Results: Equipment is battery powered, and therefore, the specifications of §15.207(a) do not apply.

Test Engineer: N/A

Test Date: N/A



IV. Electromagnetic Compatibility Emission Requirements

B. Operational Restrictions - §15.517(a)

Requirements: Section 15.517 Technical Requirements for indoor UWB systems.

- (a) Operation under the provisions of this section is limited to UWB transmitters employed solely for indoor operation.
 - (1) Indoor UWB devices, by the nature of their design, must be capable of operation only indoors. The necessity to operate with a fixed indoor infrastructure, e.g., a transmitter that must be connected to the AC power lines, may be considered sufficient to demonstrate this.
 - (2) The emissions from equipment operated under this section shall not be intentionally directed outside of the building in which the equipment is located, such as through a window or a doorway, to perform an outside function, such as the detection of persons about to enter a building.
 - (3) The use of outdoor mounted antennas, e.g., antennas mounted on the outside of a building or on a telephone pole, or any other outdoors infrastructure is prohibited.
 - (4) Field disturbance sensors installed inside of metal or underground storage tanks are considered to operate indoors provided the emissions are directed towards the ground.
 - (5) A communications system shall transmit only when the intentional radiator is sending information to an associated receiver.

Results:

- The Ubitag V1.0 is a wireless device intended to be used for the real-time location of objects within buildings (applications include healthcare, workplace productivity, security, retail management and manufacturing), and will be marketed as such.
- The Ubitag V1.0 will not transmit ultra-wideband signals unless it receives suitable trigger commands (over a separate §15.249 conventional radio link) from an associated basestation (FCC ID SEAUBISENSOR10). Basestations will be professionally installed, in accordance with instructions detailing procedures for adjusting the power of the basestations' conventional radio signals to ensure that they cannot trigger Ubitags outside the building.
- The Ubitag V1.0 User's Guide (see Exhibits) also stresses the requirement for indoor use, and reiterates the technical requirements for indoor UWB systems listed in §15.517.
- Furthermore, each Ubitag V1.0 is clearly marked with a label indicating that it is for indoor use only.



IV. Electromagnetic Compatibility Emission Requirements

C. Ultra-Wideband Bandwidth - §15.517(b)

Requirements: The UWB bandwidth of a UWB system operating under this section must be contained between 3100 MHz and 10,600 MHz.

Test Equipment: Test equipment for this test is in Section VI of this report.

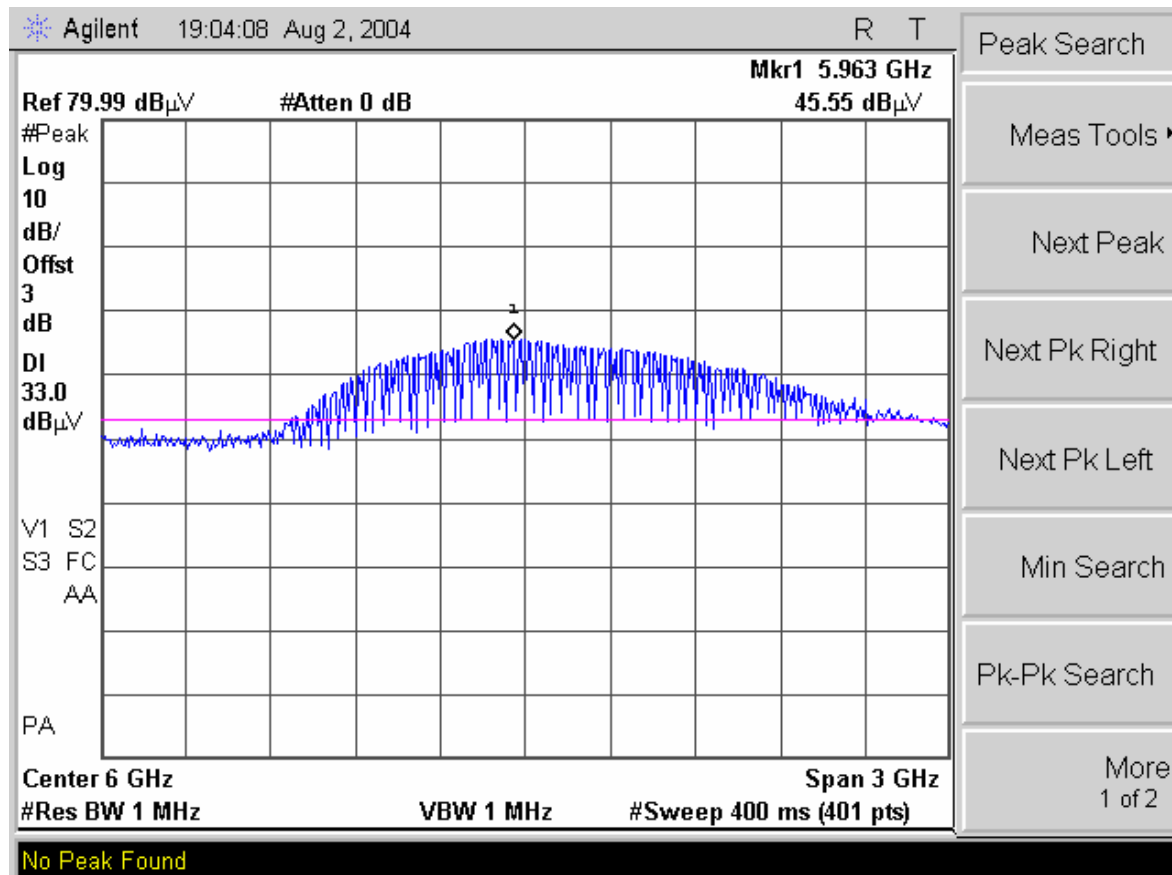
**Test Configuration
/Procedure:**

Emissions were measured similar to the procedure used in the Radiated Emissions test section. Due to the extremely wide nature of UWB emissions, special considerations were taken to make the bandwidth measurements. The RBW was set to 1MHz and the VBW to 1 MHz. The test distance was 1 meter. Emissions from the EUT between 3100 MHz and 10600 MHz were maximized by rotating the EUT and adjusting the height of the measurement antenna.

Results: The EUT was found to comply with the requirements of §15.517(b). A bandwidth plot follows:
 $f_L = 5.250$ GHz, $f_H = 7.223$ GHz, $f_M = 5.963$ GHz, and UWB Bandwidth = 2.025 GHz



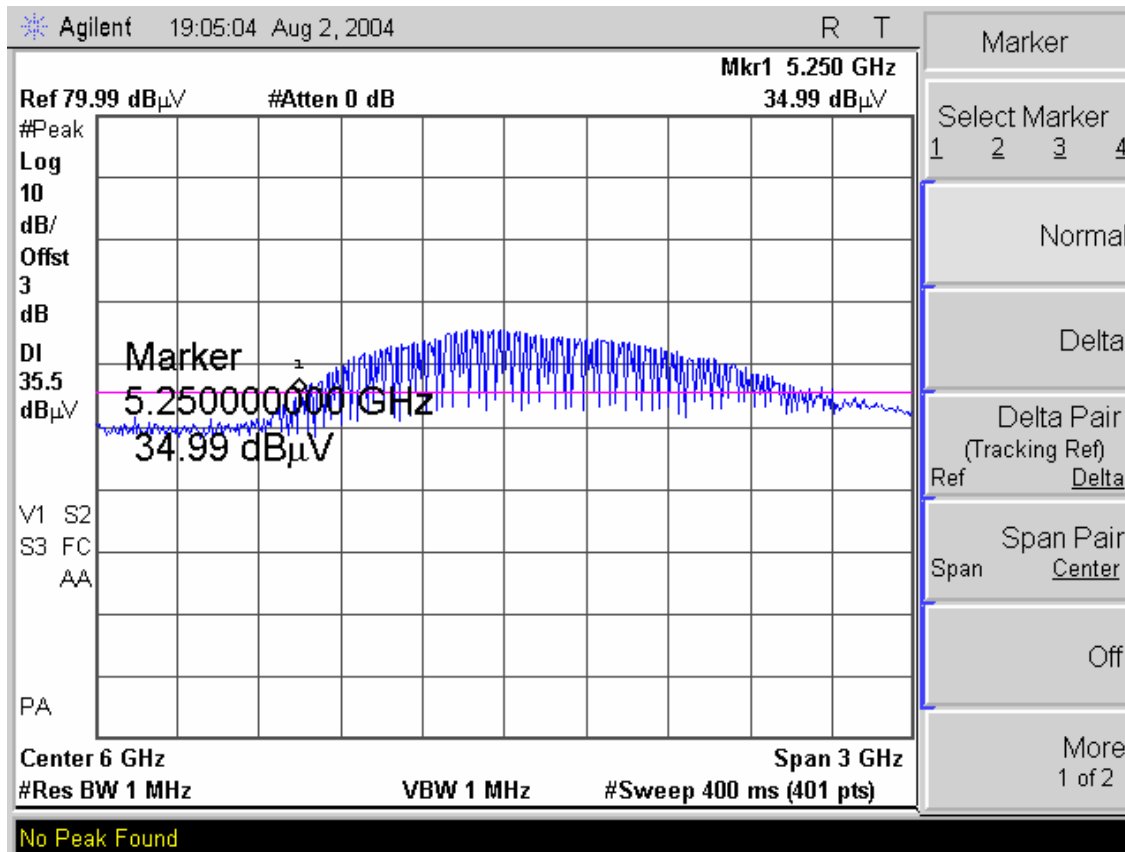
IV. Electromagnetic Compatibility Emission Requirements



Marker placed at center frequency (frequency of highest emission)



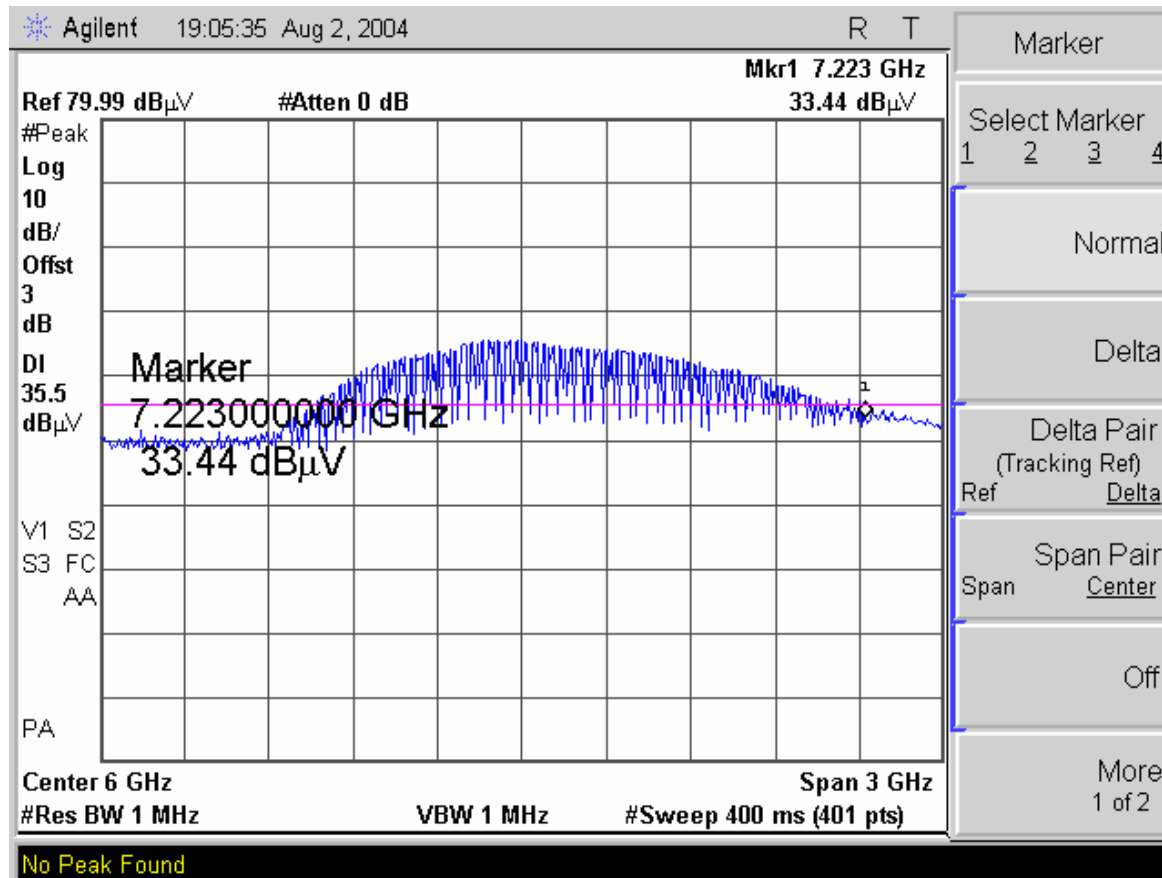
IV. Electromagnetic Compatibility Emission Requirements



Display line placed 10dB below highest emission



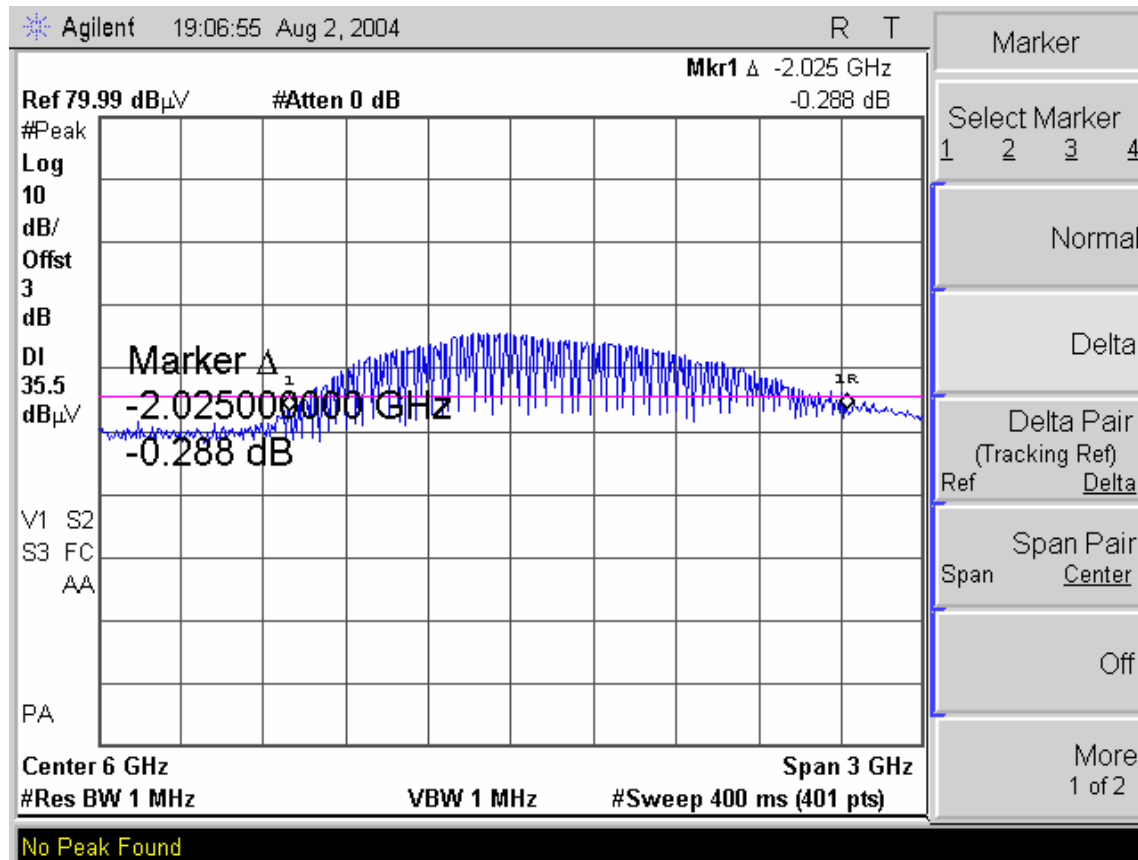
IV. Electromagnetic Compatibility Emission Requirements



Marker placed at high-side -10dB point



IV. Electromagnetic Compatibility Emission Requirements



Delta marker placed at low-side -10dB point – marker difference is 2.025GHz

Test Engineer: Liming Xu

Test Date: August 2, 2004



IV. Electromagnetic Compatibility Emission Requirements

D. Radiated Emissions - §15.209(a); §15.517(c)

Low - Below 960 MHz -

Requirements: The EUT shall meet the limits shown below for emissions at or below 960 MHz:

Frequency (MHz)	Limit (microvolts/meter) @ 3 m
30 - 88	100**
88 - 216	150**
216 - 960	200**
Above 960	500

Table 6. Limits for Spurious Emissions from Intentional Radiators from FCC Part 15 § 15.209(a)

**Except perimeter protection systems operating under paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Subpart.

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuv)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuv)	Limit (dBuv)	Margin (dB)
34	0	H	1	16.5	8.42	1.36	0	26.28	40	-13.72
34	0	V	1	16.2	7.96	1.36	0	25.52	40	-14.48
56.75	0	H	1	16.1	9.77	1.72	0	27.59	40	-12.41
56.75	0	V	1	16.2	8.04	1.72	0	25.95	40	-14.05
100	0	H	1	16.7	7.80	2.29	0	26.79	43.5	-16.71
100	0	V	1	16.9	7.60	2.29	0	26.79	43.5	-16.71
250	0	H	1	14.2	12.20	3.33	0	29.73	46	-16.27
250	0	V	1	14.1	12.90	3.33	0	30.33	46	-15.67
530	0	H	1	8.9	17.70	4.64	0	31.24	46	-14.76
530	0	V	1	8.4	17.80	4.64	0	30.84	46	-15.16
820	0	H	1	6.8	21.50	5.50	0	33.80	46	-12.20
820	0	V	1	6.3	21.30	5.50	0	33.10	46	-12.90

Table 7. Radiated Emissions Results / w QP detector RBW=100KHz (all test points are noise floor)

***Test Procedure:** Please see Page 21 of 44

Test Engineer: Liming Xu

Test Date: August 8, 2004



IV. Electromagnetic Compatibility Emission Requirements

High - Above 960 MHz -

Requirements: Radiated Emissions above 960 MHz from a device operating under this section shall not exceed the following average limits when measured using a RBW of 1 MHz.

Frequency in MHz	EIRP in dBm
960 - 1610	-75.3
1610 - 1990	-53.3
1990 - 3100	-51.3
3100 - 10600	-41.3
Above 10600	-51.3

Table 8. Limits for Radiated Emissions (RBW = 1MHz)

Test Equipment: Test equipment for this test is in Section VI of this report.

**Test Conditions/
Procedure:**

The EUT was placed on a 0.8 m high wooden table inside a shielded enclosure. An antenna was placed near the EUT and measurements of frequencies and amplitudes of field strengths were recorded for reference during final measurements. For final radiated testing, measurements were performed in a semi-anechoic chamber or OATS. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst case orientation for maximum emissions.

Measurements of the radiated field were made with the measurement antenna located at a distance of 1 meter from the EUT unless specified otherwise in the measurement results. The antenna was adjusted between 1 m and 4 m in height above the ground plane for maximum meter reading at each test frequency. The antenna -to-EUT azimuth was varied from zero to 360 degrees during the measurement to find the maximum field strength readings. The antenna polarization was varied



IV. Electromagnetic Compatibility Emission Requirements

(horizontal to vertical) during the measurements to find the maximum field strength readings. The EUT, where intended for tabletop use, was placed on a table whose top is 0.8m above the ground plane. The table was constructed of non-conductive materials. Its dimensions were 1m X 1.5m. Equipment setup followed the guidelines of ANSI C63.4:1992.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth. RE measurements for frequencies from 30 MHz to 1 GHz were made at 3 meters. For frequencies above 1 GHz, peak measurements were made with a resolution bandwidth of 1 MHz and a video bandwidth equal to or greater than 1MHz. Results were compared to the limit mathematically corrected pursuant to Section 15.521(g). Broadband average measurements were made with $RBW = 1\text{MHz}$, $VBW \geq RBW$, using the RMS average detector available on the spectrum analyzer. Narrowband average measurements were made with $RBW \geq 1\text{kHz}$, $VBW \geq RBW$, using the RMS average detector available on the spectrum analyzer. The “signal substitution method”, as used by the FCC Laboratory, was employed. Once the emission under investigation was maximized, the reading shown on the analyzer was recorded. The cable was removed at the antenna and connected to a signal generator. The output of the signal generator was adjusted until the level of the signal on the analyzer was equal to the recorded reading. This adjusted output level now takes cable loss and pre-amp gain into account, and is added to the measurement horn antenna factor in order to obtain the field strength. Because measurements were performed @ 1 meter, the field strength was adjusted to obtain the 3 meter equivalent field strength.

For pre-scanning, the EMI receiver scanned the frequency range from 30 MHz to 10 GHz, per §15.33(a)(4) to obtain an Emission profile of the EUT. For each point of measurement, the turntable was rotated, the positions of the interface cables were varied, and the antenna height was varied between 1 m and 4 m, in order to find the maximum radiated Emissions. Measurements were taken using this technique with the antenna in two polarizations: horizontal and vertical.

Frequency determining parameters

The highest frequency employed in §15.33 to determine the frequency range over which radiated emissions are made were based on the center frequency, f_c , unless a higher frequency was generated within the UWB device. For measuring emission levels, the spectrum were investigated from the lowest frequency generated in the UWB, without going below 9 kHz, up to the frequency range shown in Section 15.33(a) of the CFR 47 or up to $f_c + 3/(\text{pulse width in seconds})$, whichever was higher. There is no requirement to measure emissions beyond 40 GHz provided f_c was less than 10 GHz; beyond 100 GHz if f_c was at or above 10 GHz and below 30 GHz; or beyond 200 GHz if f_c was at or above 30 GHz.

Calculation of Limit: The EIRP limit is mathematically converted to the equivalent 3 m field strength using the following equation from §15.521(g): **$E(\text{dB}\mu\text{V/m}) = P(\text{dBm EIRP}) + 95.2$**

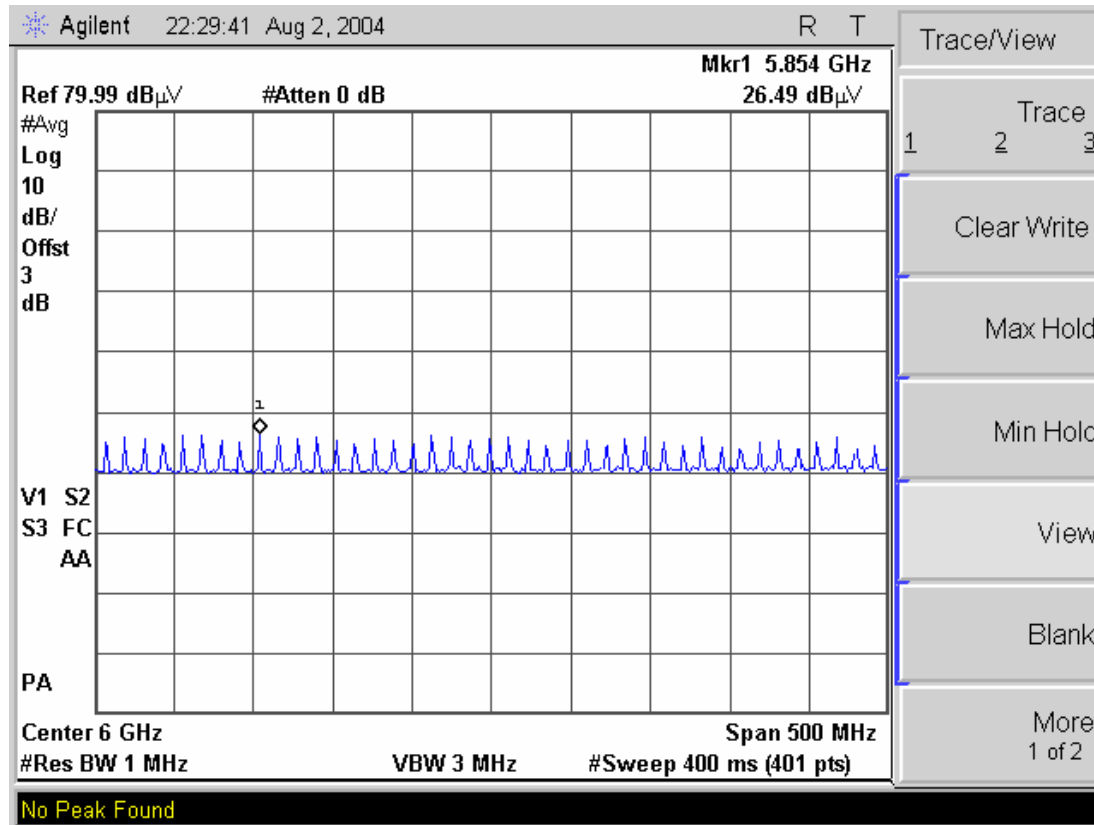


IV. Electromagnetic Compatibility Emission Requirements

Results: The EUT was found to comply with the emissions requirements of §15.209(a) and §15.517(c). There were no measurable emissions between the highest reported emission in the table below and 40 GHz. The measurement noise floor is well below the specified limit.

Frequency (GHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	System Gain (dB) (-)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV)	Limit (dBuV)	Margin (dB)
5.854		V	1	26.49	35.8	0	9.54	52.75	53.9	-1.15

Table 9. Results - Average Radiated Emissions - Broadband - Fundamental





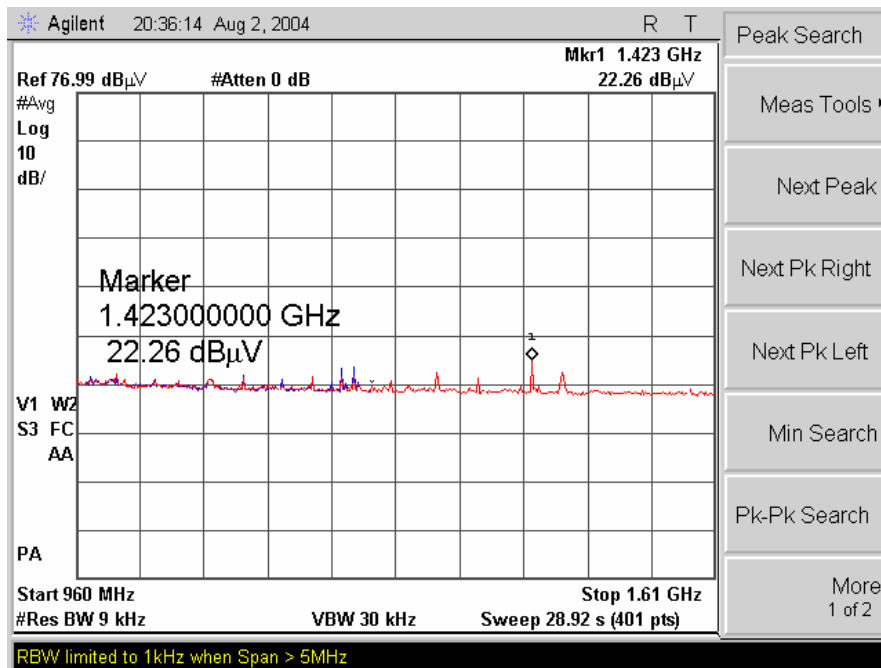
Frequency (GHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuv)	Antenna Correction Factor (dB) (+)	System Gain (dB) (-)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuv)	Limit (dBuv)	Margin (dB)
*1.423	0	V	1	22.26	27.68	30.06	9.54	10.33	19.9	-9.57
*1.972	0	V	1	32.96	28.96	26.51	9.54	25.87	41.9	-16.03
*2.422	0	V	1	23.49	30.02	25.27	9.54	18.70	43.9	-25.20
*6.04	0	V	1	43.05	36.11	25.32	9.54	44.30	53.9	-9.60

Table 10. Results - Average Radiated Emissions - Broadband - Spurious

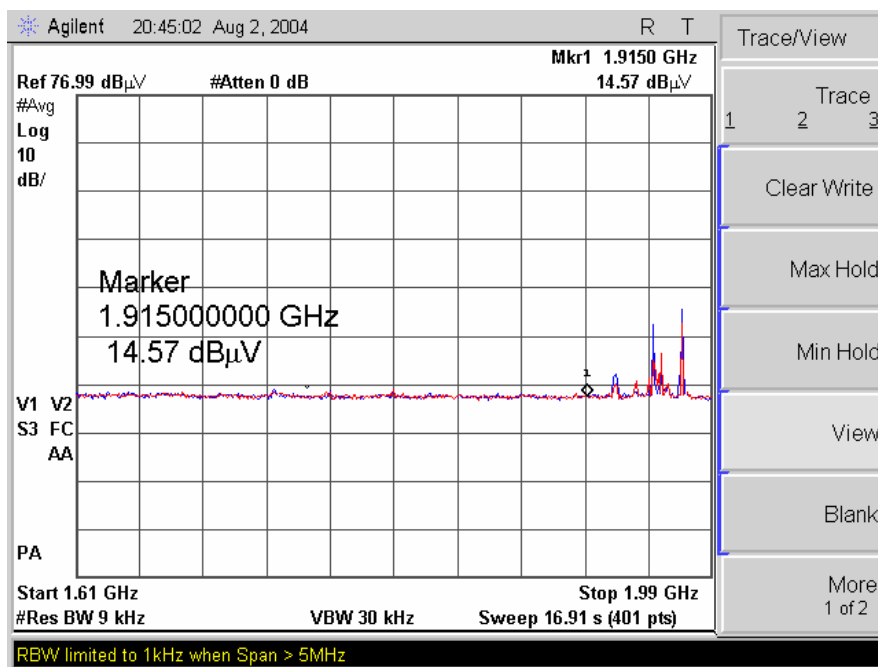
Note 1: Outside of the ~6GHz region there were no emissions detected from the Ubitag, and all the peaks on the graphs actually correspond to the ambient noise sources.

Note 2: The Plots between 960MHz and 3.1 GHz were taken using RBW=9kHz and the plot between 10.6GHz and 26.5GHz was taken using RBW=30kHz (rather than RBW=1MHz mandated by the rules) because the noise floor with RBW=1MHz would have been far too high to detect any signals.

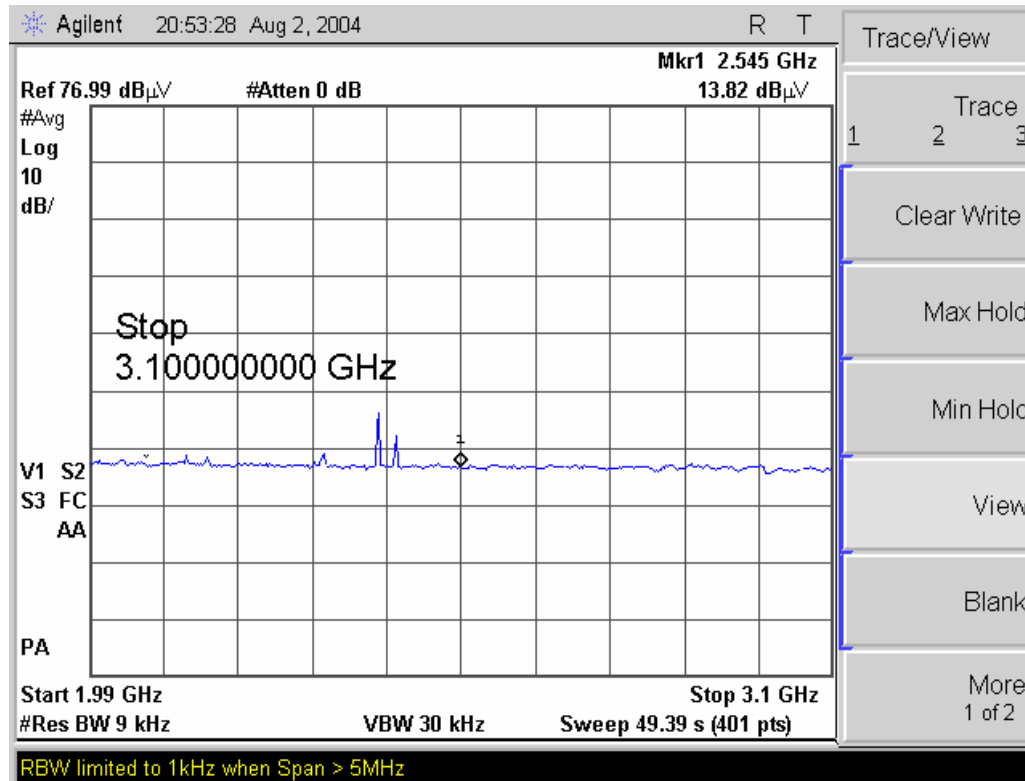
Note 3: *These emissions were pre-amplified.



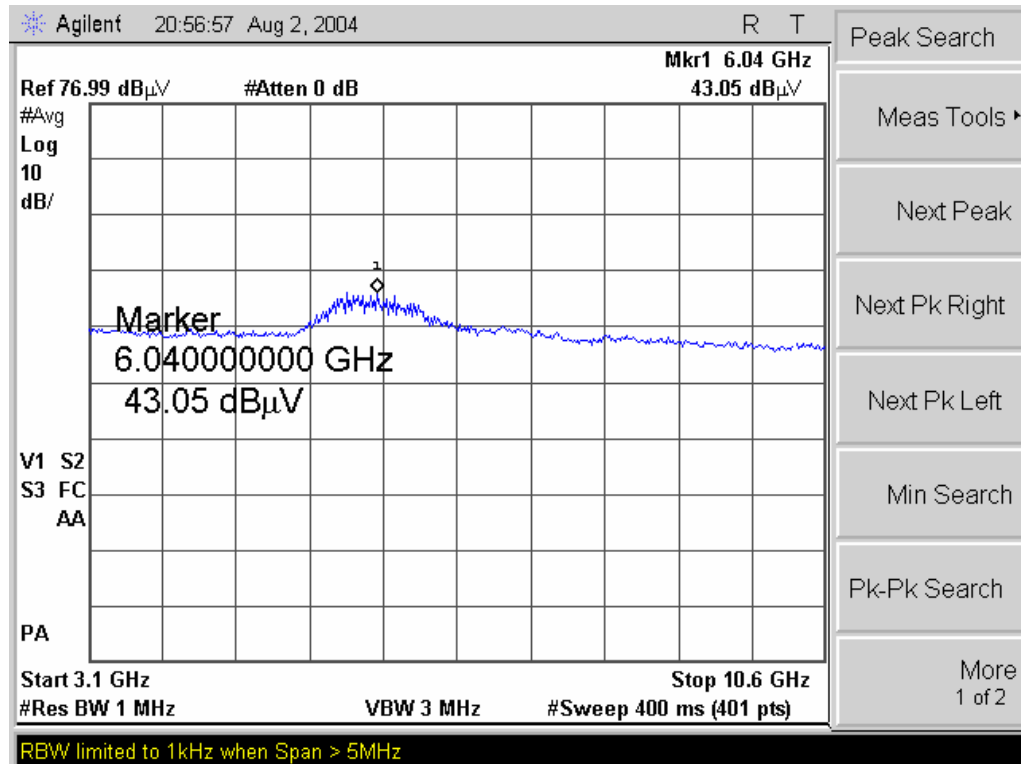
Highest uncorrected emission: 22.26 dBuV @ 1.423 GHz



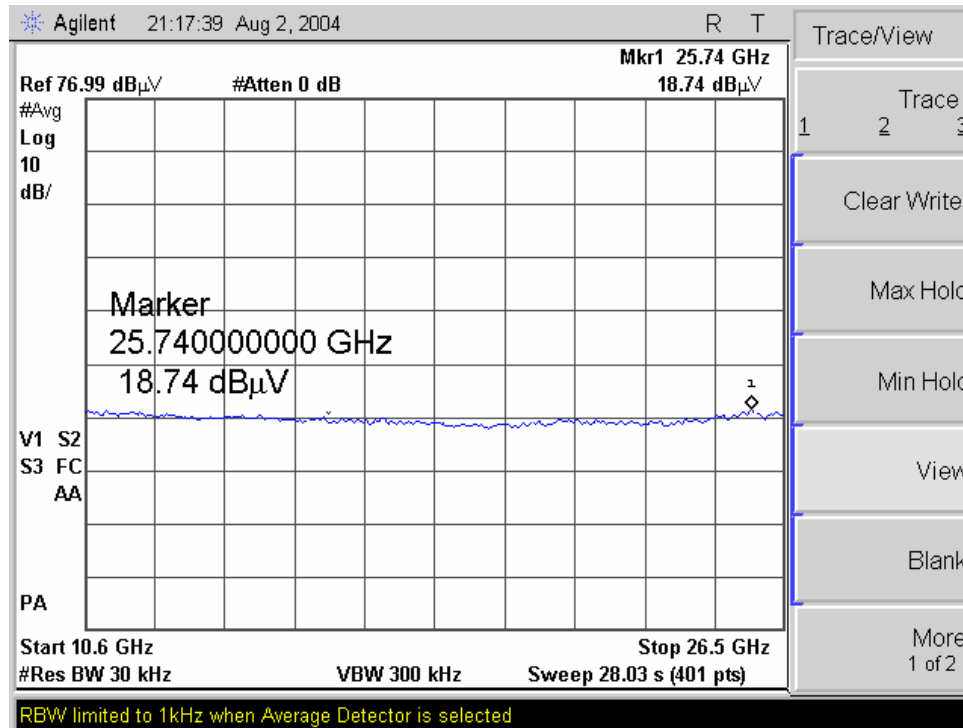
Highest uncorrected emission: 32.96 dBuV @ 1.972 GHz



Highest uncorrected emission: 23.49 dBuV @ 2.422 GHz



Highest uncorrected emission: 43.05 dBuV @ 6.04 GHz



No detectable emissions in range 10.6 GHz - 26.5 GHz, or in range 26.5 GHz - 40 GHz (not shown)

IV. Electromagnetic Compatibility Emission Requirements



Figure 1. FCC Intentional Radiators Test Setup Photo

Test Engineers: Liming Xu

Test Date: August 2, 2004



IV. Electromagnetic Compatibility Emission Requirements

E. Average Radiated Emissions - Narrowband - §15.517(d)

Requirements: Radiated Emissions above 960 MHz from a device operating under this section shall not exceed the following average limits when measured using a RBW of no less than 1 kHz.

Frequency in MHz	EIRP in dBm
1164 - 1240	-85.3 (9.9 dBuV)
1559 - 1610	-85.3 (9.9 dBuV)

Table 11A. Limits for Radiated Emissions (RBW >= 1kHz)

Test Equipment: Test equipment for this test is in Section VI of this report.

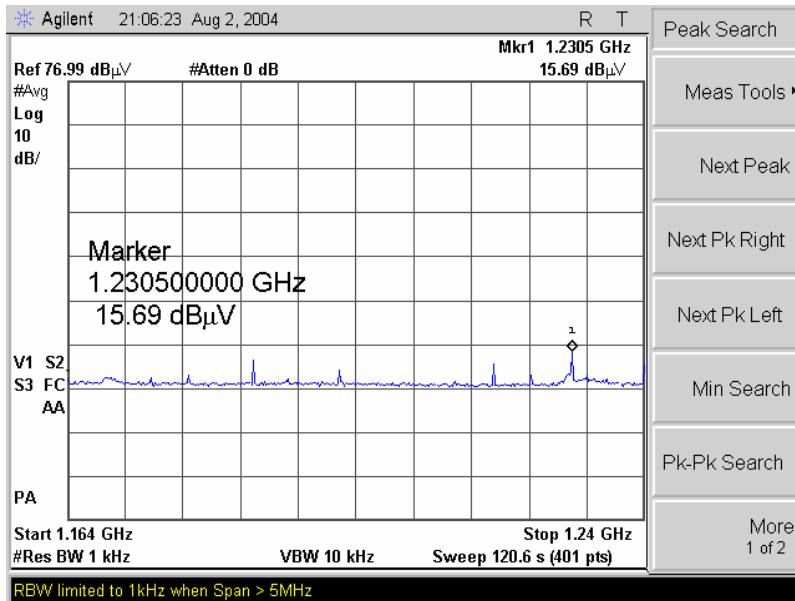
Calculation of Limit: The EIRP limit is mathematically converted to the equivalent 3 m field strength using the following equation from §15.521(g): **$E(\text{dBuV/m}) = P(\text{dBm EIRP}) + 95.2$**

Results: The EUT was found to comply with the requirements of §15.517(d). There were no intentional emissions above the measurement noise floor within these bands. The measurement system noise floor is well below the specified limit.

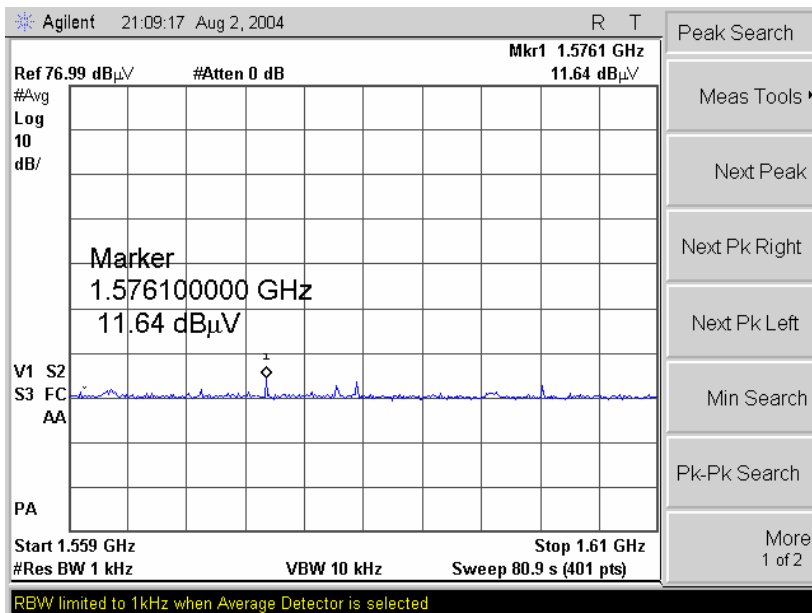
Frequency (GHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	System Gain (dB) (-)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV)	Limit (dBuV)	Margin (dB)
*1.2305	0	V	1	15.69	26.87	30.22	9.54	2.80	9.9	-7.10
*1.5761	0	V	1	11.64	28.06	29.44	9.54	0.72	9.9	-9.18

Table 11B. Limits for Radiated Emissions (RBW >= 1kHz)

Note: *These emissions were pre-amplified.



Low GPS



High GPS

Test Engineer: Liming Xu

Test Date: August 2, 2004



IV. Electromagnetic Compatibility Emission Requirements

F. Peak Radiated Emissions - §15.517(e)

Requirements: There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emissions occurs, f_M . That limit is 0 dBm EIRP. It is acceptable to employ a different RBW, and a correspondingly different peak emission limit, following the procedures in §15.521.

Test Equipment: Test equipment for this test is in Section VI of this report.

Calculation of Limit: Pursuant to §15.521(g), the peak EIRP limit = $20\log(3\text{MHz}/50) = -24.4\text{dBm}$. The equivalent field strength at 3m = $(-24.4) + 95.2 = 70.8\text{ dBuV/m}$.

***Results:** The EUT was found to comply with the requirements of §15.517(e).

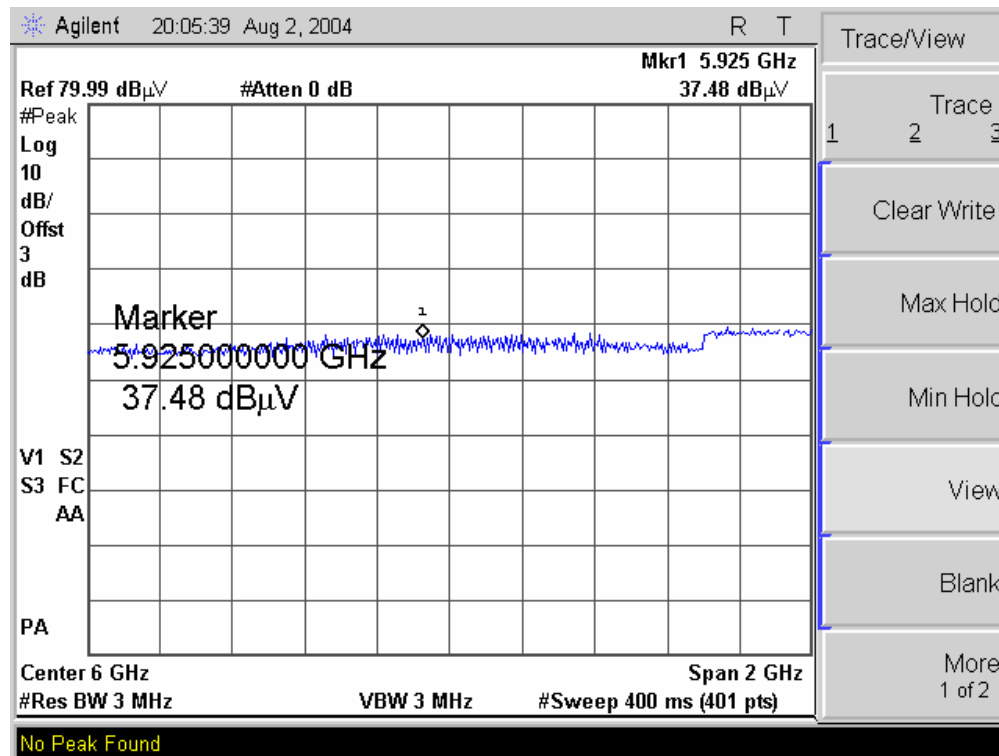
Frequency (GHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	System Gain (dB) (-)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV)	Limit (dBuV)	Margin (dB)
5.925		V	1	37.48	35.8	0	9.54	63.47	70.8	-7.06

Table 12. Results - Peak Radiated Emissions - Fundamental (§15.517e)

*Note: RBW of 3MHz were chosen to measure the peak power of Peak Radiated Emissions

Test Engineer: Liming Xu

Test Date: August 2, 2004



Test Engineer: Liming Xu

Test Date: August 2, 2004



V. Labeling and Instruction Manual Requirements



V. Labeling and Instruction Manual Requirements

§15.517(f) Labeling and Instruction Manual Requirements.

UWB systems operating under the provisions of this section shall bear the following or similar statement in a conspicuous location on the device or in the instruction manual supplied with the device:

“This equipment may only be operated indoors. Operation outdoors is in violation of 47 U.S.C. 301 and could subject the operator to serious penalties.”

§ 15.19 Labeling requirements.

- (a) In addition to the requirements in Part 2 of this chapter, a UWB device subject to certification shall be labeled as follows:

The following statement shall appear in a **conspicuous location on the device**:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

- (1) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.
- (2) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user to appear in the manual.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment



V. Labeling and Instruction Manual Requirements

§ 15.105 Information to the user to appear in the manual.

- (a) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help



VI. Test Equipment



VI. Test Equipment

MET #	Equipment	Manufacturer	Model	Cal Date	Cal Due
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	5/3/2004	5/3/2005
1T4303	ANTENNA; BILOG	SCHAFNER - CHASE EMC	CBL6140A	4/9/2004	4/9/2005
1T4302	EMI reveiver	HP	8546A	10/6/03	10/6/04
1T-2665	Double-ridge waveguide antenna	EMCO	3115	3/12/04	3/12/05
1T4351	EMC Analyzer	Agilent	E7405A	8/21/03	8/21/04
1T4102	Microwave System Amplifier	HP	83017A	See Note	

Table 13. Test Equipment for UWB Tests - Part 15 Subpart F

Note: Functionally verified test equipment is verified at the time of testing.



VII. Certification Information - 47 CFR Part 2



A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
 - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
 - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.
- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
 - (i) Compliance testing;



- (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
 - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.



The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.¹ In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, or the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant, whichever is applicable.

§ 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

¹In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart C (of Part 15), which deals with intentional radiators.

**§ 2.948 Description of measurement facilities.**

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
 - (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
 - (i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.
 - (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
 - (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.



END OF REPORT
