



LS RESEARCH LLC
Wireless Product Development



TESTING CERT #1255.01

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TEST REPORT #: 312296
LSR Job #: C-1605

Compliance Testing of:

CapTel 2400i

Test Date(s):

December 26th, 2012, February 1st-20th, and July 15th, 2013

Prepared For:

Ultratec

Attn: Dean Hofstetter
450 Science Drive
Madison, WI 53711

This Test Report is issued under the Authority of:

Signature:

Date: 9/27/2013

Quality Assurance by:

Signature:

Date: 9/27/2013

Project Engineer:

Shane D. Rismeyer, EMC Engineer

Signature:

Date: 9/17/13

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1.
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15.
Purpose of Test:	To gain FCC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	Business Residential

1.2 – Normative References

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2008-13	Code of Federal Regulations - Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	2006-03 A1: 2006-09 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003 A1: 2004-04 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Procedures 558074 V3.01	2013	Measurement of Digital Transmission Systems operating under Section 15.247.

1.3 - LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756



Industrie
Canada

Industry
Canada



Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1

File Number: IC 3088-A

On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1

File Number: IC 3088



U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).

Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

Date of Validation: November 20, 2002

Notified Body Identification Number: 1243

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Ultratec
Address:	450 Science Drive
Contact Name:	Dean Hofstetter

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	CapTel 2400i
Model Number:	CT2400i
Serial Number:	Prototype

2.3 - Associated Antenna Description

Please see Appendix D for a description of the antenna.

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2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2412-2462
ERP (in mW)	
Minimum:	802.11b:18.88 802.11g: 65.77 802.11n: 67.61
Maximum:	802.11b: 22.03 802.11g: 99.08 802.11n:73.62
Occupied Bandwidth	802.11b: 10.1 802.11g: 16.5 802.11n:17.7
Type of Modulation	802.11b: DSSS 802.11g: OFDM 802.11n: OFDM
Emission Designator	802.11b: 10M1G1D 802.11g: 16M5F1D 802.11n: 17M7F1D
Transmitter Spurious (worst case) at 3 meters	42.1 dB μ V/m at 151.99 MHz
Receiver Spurious (worst case) at 3 meters	45.94 dB μ V/m at 6565 MHz
Stepped (Y/N)	No
Step Value:	N/A
Frequency Tolerance	Better than 100 ppm
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Custom
Gain (in dBi)	1.3 dBi
EUT will be operated under FCC Rule Part(s)	15.247
Modular Filing	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Portable or Mobile?	Mobile

RF Technical Information:

Type of Evaluation (check one)	SAR Evaluation: Device Used in the Vicinity of the Human Head
	SAR Evaluation: Body-worn Device
	X RF Evaluation

The EUT was evaluated against the SAR test exclusion threshold listed in KDB 447498 D01 General RF Exposure Guidance v05r01. The EUT was found to be compliant with the SAR exclusion threshold for 100MHz to 6GHz at a minimum separation distance of >50mm.

Frequency = 2.437 GHz

Antenna gain = 1.3 dBi

EIRP (dBm) = 19.96 dBm + 1.3 dBi = 21.26 dBm

EIRP (mW) = 133.66 mW

Minimum separation distance = 100 mm

Threshold in Appendix B for 2450 MHz at 50mm is 596 mW.

133.66 mW \leq 596 mW

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2.5 - Product Description

The EUT is a caption telephone which uses an internet connection (WiFi or Ethernet) to provide captions to the user.

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EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	68-70°F
Humidity:	35-40%
Pressure:	745-750 mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247(a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC : 15.247(b)(3) & 1.1310	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091	RF Exposure Limit	Yes
FCC : 15.247(d)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(e)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(d), 15.209 & 15.205	Transmitter Radiated Emissions	Yes

The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.

3.3 - Modifications Incorporated In the EUT for Compliance Purposes

None Yes (explain below)

For the MCS (0-7) data rates the power setting used for all channels will be 9. A Fair-Rite 0446167281 ferrite will be used on the Ethernet cable. Display Board Rev. B used.

3.4 - Deviations & Exclusions from Test Specifications

None Yes (explain below)

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247 for a Digital Spread Spectrum (DTS) Transmitter.

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

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EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in transmit and receive modes separately. The unit has the capability to operate on 12 channels (1-11), controllable via touchpad interface.

The applicable limits apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (2412 MHz), middle (2437 MHz) and high (2462 MHz) to comply with FCC Part 15.35.

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in 3 meter Semi-Anechoic and Compact Semi-Anechoic FCC listed Chambers. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. For the lower frequency ranges the EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber with the antenna mast placed so that the separation distance between the antenna and EUT was 3 meters. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz, a Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 4 GHz in the 3 meter Semi-Anechoic Chamber. The remaining measurements were taken in the Compact Semi-Anechoic Chamber at a separation distance of 1 meter. The Double-Ridged Waveguide Horn Antenna used from 4 GHz to 18 GHz and a Standard Gain Horn Antenna was used from 18 GHz to 25 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 8MHz) average measurements used a 10 Hz video bandwidth.

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 8, Annex 8 for a DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

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5.5 - Calculation of Radiated Emissions Limits

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3) and RSS 210 A8.4 is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d) and RSS 210 A8.2 (b), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c) for FCC and section 2.2, 2.6 and 2.7 of RSS 210 for IC.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS 210 section 2.7.

Frequency (MHz)	3 m Limit μ V/m	3 m Limit (dB μ V/m)	1 m Limit (dB μ V/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength (μ V/m to dB μ V/m):

$$\text{dB}\mu\text{V/m} = 20 \log_{10} (100) = 40 \text{ dB}\mu\text{V/m} \text{ (from 30-88 MHz)}$$

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

$$\begin{aligned} & 960 \text{ MHz to 10,000 MHz} \\ & 500\mu\text{V/m or } 54.0 \text{ dB}\mu\text{V/m at 3 meters} \\ & 54.0 + 9.5 = 63.5 \text{ dB}\mu\text{V/m at 1 meter} \end{aligned}$$

For measurements made at 0.3 meter, a 20 dB correction has been invoked.

$$\begin{aligned} & 960 \text{ MHz to 10,000 MHz} \\ & 500\mu\text{V/m or } 54.0 \text{ dB}\mu\text{V/m at 3 meters} \\ & 54.0 + 20 = 74 \text{ dB}\mu\text{V/m at 0.3 meters} \end{aligned}$$

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample reported data:

$$\text{Raw Data} + \text{Antenna Factor} + \text{Cable Factor} = \text{Reported Data}$$

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5.6 - Radiated Emissions Test Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions
Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	Ultratec				
Date(s) of Test:	12/26/12, 2/12/13, 2/18/13				
Test Engineer(s):	Aidi Zainal, Peter Feilen and Adam Alger				
Voltage:	120VAC				
Operation Mode:	Continuous Transmit/Receive				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %				
EUT Power:	<input checked="" type="checkbox"/>	Single Phase _____VAC		3 Phase _____VAC	
		Battery		Other:	
EUT Placement:	<input checked="" type="checkbox"/>	80cm non-conductive table		10cm Spacers	
EUT Test Location:	<input checked="" type="checkbox"/>	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS	
Measurements:		Pre-Compliance		Preliminary	<input checked="" type="checkbox"/>
Detectors Used:	<input checked="" type="checkbox"/>	Peak	<input checked="" type="checkbox"/>	Quasi-Peak	<input checked="" type="checkbox"/>
				Average	

The following table depicts the level of significant spurious radiated RF emissions found:

Frequency (MHz)	Ant Polarity	Height (meters)	Azimuth (degrees)	Quasi-Peak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
36.14	V	1.00	40	35.5	40.0	4.5
51.07	V	1.00	282	32.4	40.0	7.6
55.93	V	1.00	24	36.6	40.0	3.4
121.59	V	1.00	158	41.5	43.0	1.5
151.99	V	1.00	98	42.1	43.0	0.9
212.75	V	1.00	71	38.8	43.0	4.2
243.14	V	1.00	205	40.9	43.0	2.1
151.99	H	3.17	191	41.7	43.0	1.3
212.75	H	1.59	265	39.3	43.0	3.7

RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 1:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4824	H/Side	1.00	191	56.5	43.7	63.5	19.8

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 6:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4874	H/Side	1.00	235	58.3	43.8	63.5	19.7

The following table depicts the level of significant radiated RF harmonic emissions seen on Channel 11:

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (degrees)	Peak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4924	H/Side	1.11	239	57.9	43.1	63.5	20.4

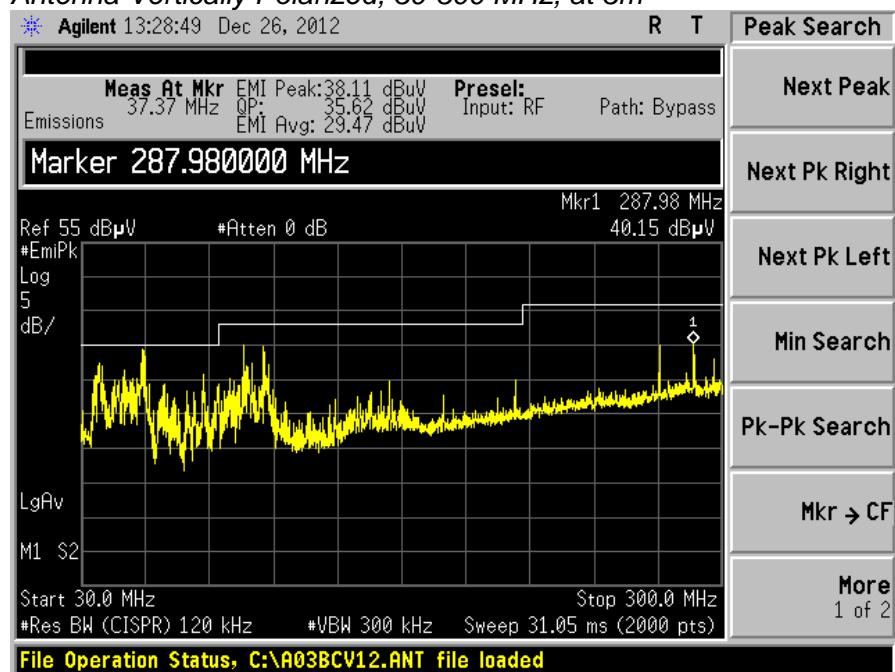
Notes:

- A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
- Measurements above 4 GHz were made at 1 meters of separation from the EUT.
- 54 Mbps was used for this testing due to it having the highest output power.

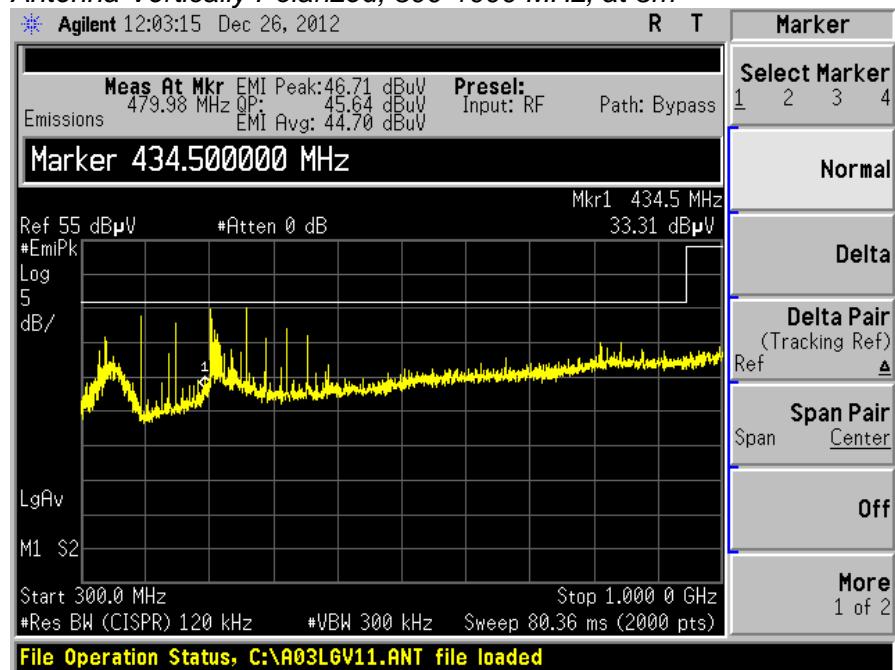
5.7 - Screen Captures - Radiated Emissions Test

These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

Antenna Vertically Polarized, 30-300 MHz, at 3m

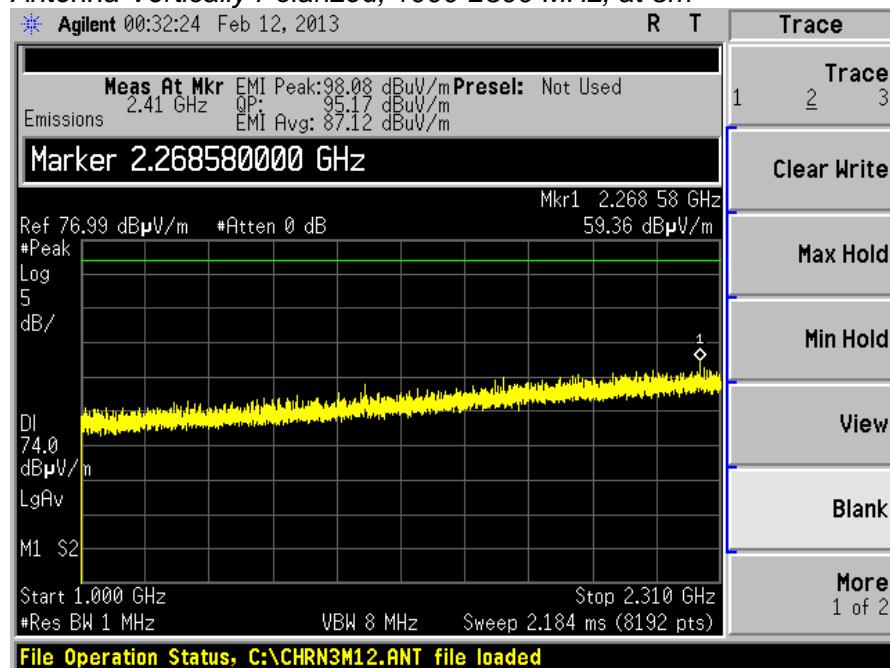


Antenna Vertically Polarized, 300-1000 MHz, at 3m

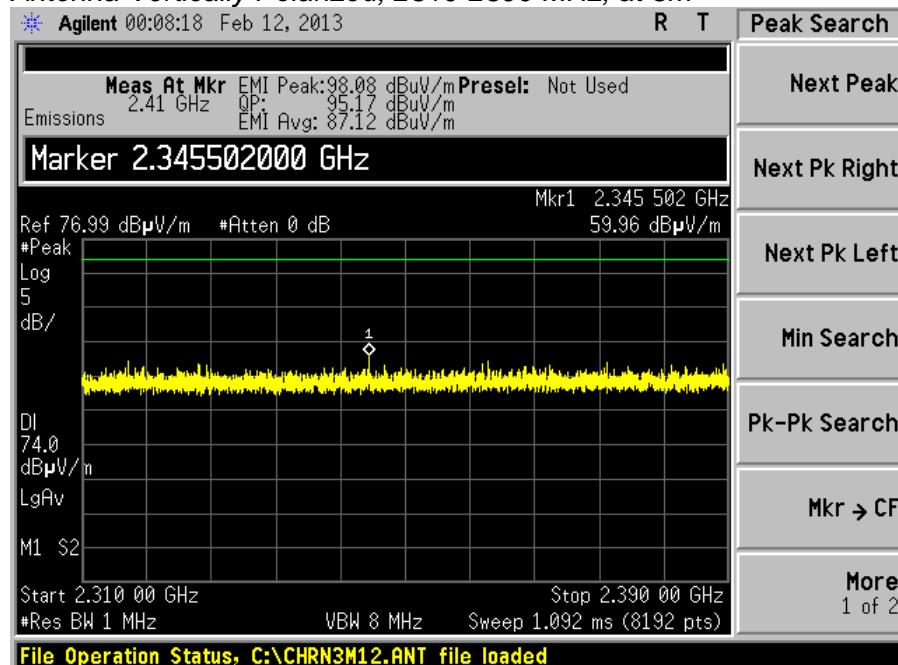


Screen Captures - Radiated Emissions Testing (continued)

Antenna Vertically Polarized, 1000-2300 MHz, at 3m

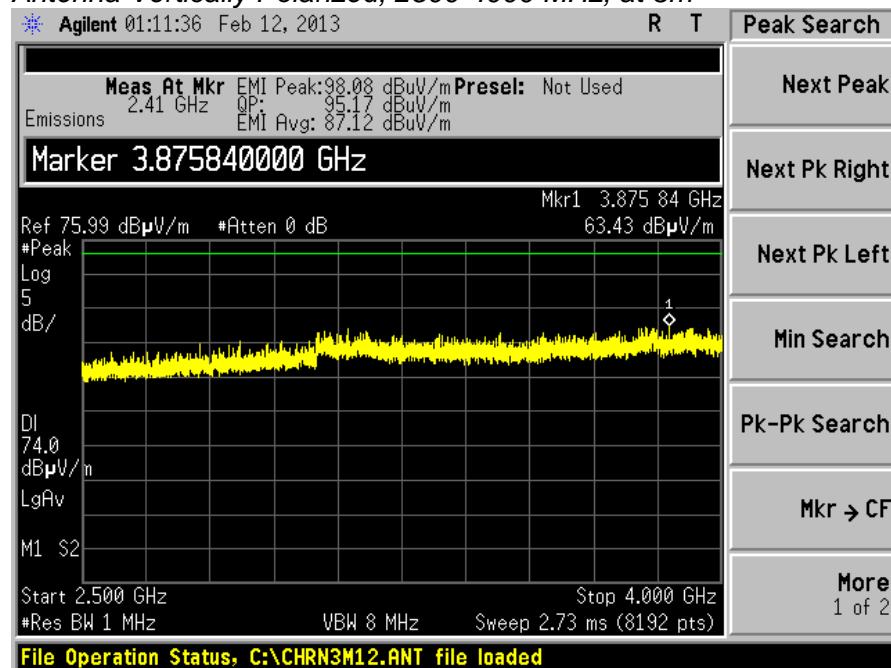


Antenna Vertically Polarized, 2310-2390 MHz, at 3m

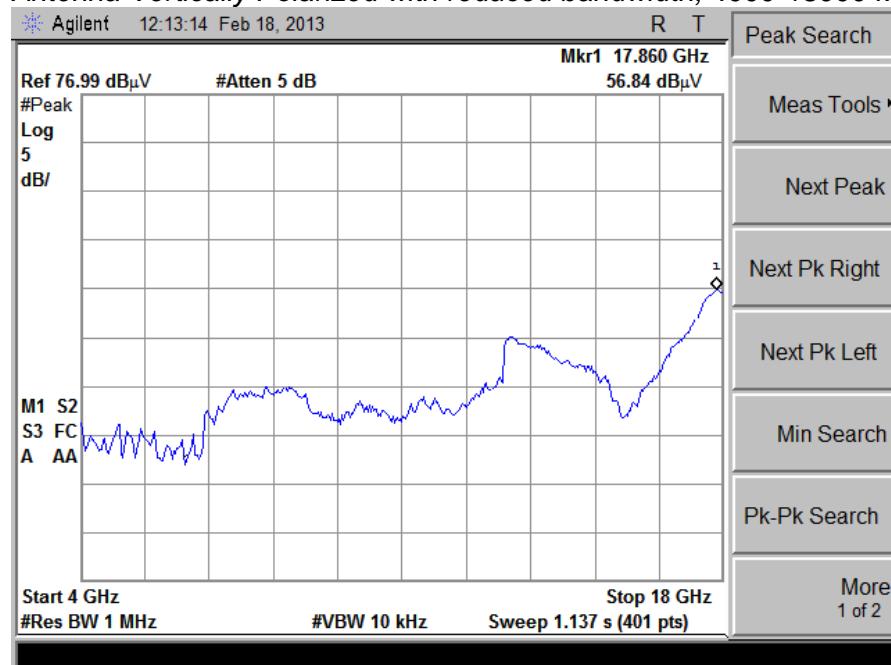


Screen Captures - Radiated Emissions Testing (continued)

Antenna Vertically Polarized, 2500-4000 MHz, at 3m

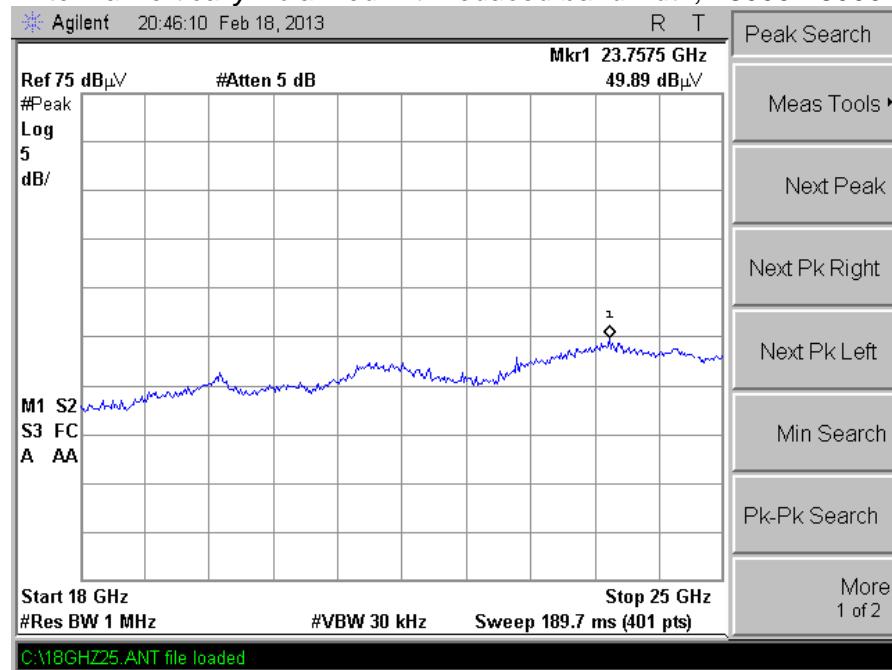


Antenna Vertically Polarized with reduced bandwidth, 4000-18000 MHz, at 1m



Screen Captures - Radiated Emissions Testing (continued)

Antenna Vertically Polarized with reduced bandwidth, 18000-25000 MHz, at 1m



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EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

6.1 - Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the EMI Receiver. The LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

6.2 - Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1-2, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

6.3 - Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A.

6.4 - Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

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6.5 - FCC Limits of Conducted Emissions at the AC Mains Ports

The following table represents the limits for Conducted Emissions Class B taken from CFR 15.207:

Frequency Range (MHz)	Quasi-Peak Limit (dB μ V)	Average Limit (dB μ V)
0.150 - 0.50 *	66-56	56-46
0.5 - 5.0	56	46
5.0 - 30	60	50

* The limit decreases linearly with the logarithm of the frequency in this range.

Sample calculation for the limits in the 0.15 to 0.5 MHz:

$$\text{Limit} = -19.12 (\log_{10} (F [\text{MHz}] / 0.15 [\text{MHz}])) + 66.0 \text{ dB}\mu\text{V}$$

For a frequency of 200 kHz for example:

$$\text{Quasi-Peak Limit (F=200 kHz)} = -19.12 (\log_{10} (0.2[\text{MHz}] / 0.15 [\text{MHz}])) + 66.0 \text{ dB}\mu\text{V}$$

$$\text{Quasi-Peak Limit (F=200 kHz)} = 63.6 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F=200 kHz)} = -19.12 (\log_{10} (0.2[\text{MHz}] / 0.15 [\text{MHz}])) + 56.0 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F = 200 kHz)} = 53.6 \text{ dB}\mu\text{V}$$

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample reported data:

Raw Data + Antenna Factor (LISN) + Transient Limiter = Reported Data

6.6 – Conducted Emissions Test Data Chart

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 Class B

IC RSS GEN 7.2.2

Manufacturer:	Ultratec			
Date(s) of Test:	2/20/13			
Test Engineer:	Peter Feilen			
Voltage:	120VAC			
Operation Mode:	Continuous Transmit/Receive			
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %			
Test Location:	<input checked="" type="checkbox"/>	Conducted Test Area		Chamber
EUT Placed On:	<input checked="" type="checkbox"/>	40cm from Vertical Ground Plane		10cm Spacers
	<input checked="" type="checkbox"/>	80cm above Ground Plane		Other:
Measurements:	Pre-Compliance		Preliminary	<input checked="" type="checkbox"/> Final
Detector Used:	Peak	<input checked="" type="checkbox"/>	Quasi-Peak	<input checked="" type="checkbox"/> Average

		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Reading (dB μ V)	Limit (dB μ V)	Margin (dB)	Reading (dB μ V)	Limit (dB μ V)	Margin (dB)
0.254	L1	44.580	61.626	17.046	33.200	51.626	18.426
0.380	L1	39.200	58.281	19.081	27.000	48.281	21.281
4.647	L1	36.700	56.000	19.300	24.300	46.000	21.700
0.269	L2	41.300	61.150	19.850	27.300	51.150	23.850
4.970	L2	32.400	56.000	23.600	20.300	46.000	25.700
0.398	L2	37.200	57.897	20.697	22.500	47.897	25.397

Notes:

- 1) All other emissions were better than 20 dB below the limits.
- 2) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.

6.7 - Test Setup Photo(s) – Conducted Emissions Test



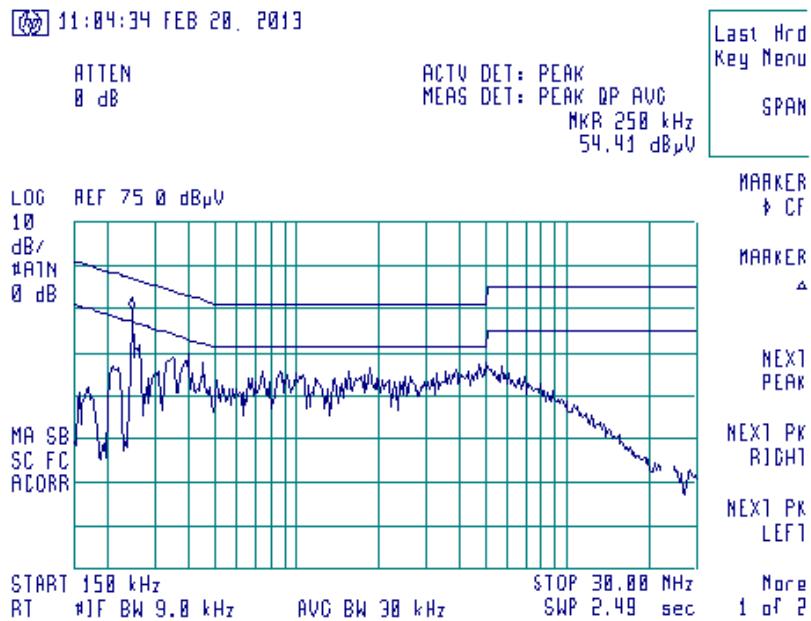
Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

6.8 - Screen Captures – Conducted Emissions Test

Line 1



Line 2

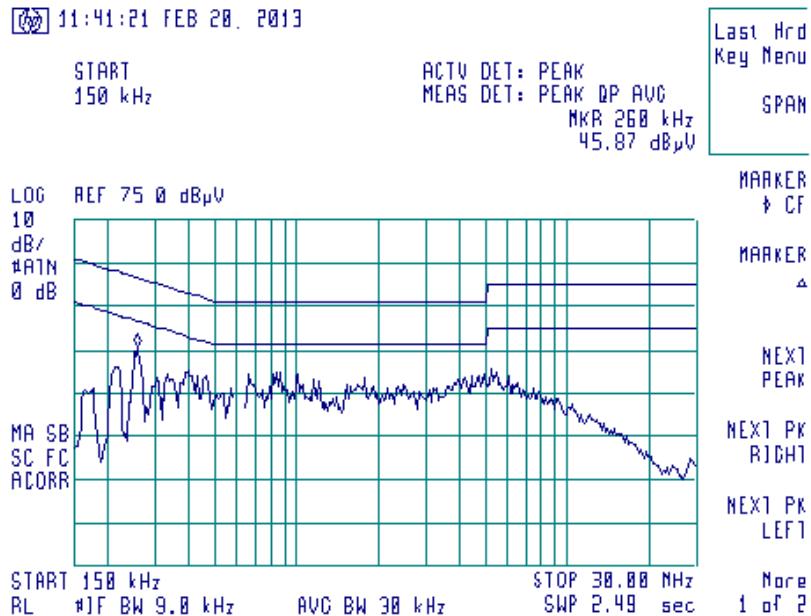


EXHIBIT 7. OCCUPIED BANDWIDTH

7.1 - Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

7.2 - Method of Measurements

FCC Procedures KDB 558074 for Digital Transmission Systems operating under 15.247.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth requirement found in FCC Part 15.247(a)(2) and RSS 210 A8.2(a) requires a minimum -6dBc occupied bandwidth of 500 kHz. In addition, Industry Canada (IC RSS GEN 4.6.1) requires the measurement of the 99% occupied bandwidth. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

7.3 - Test Equipment List

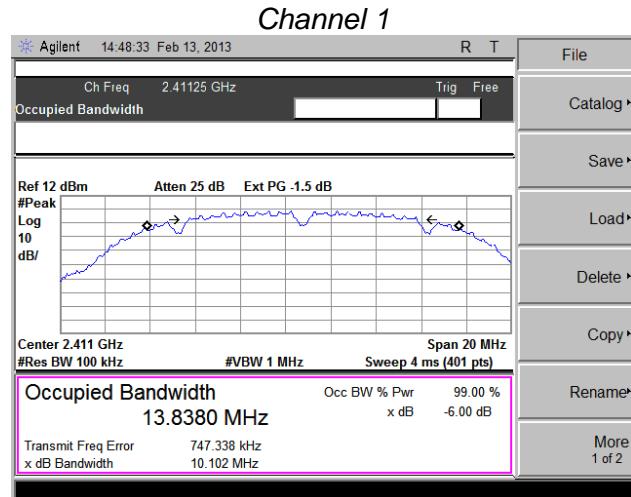
A complete list of test equipment that was used for this test can be found in Appendix A.

7.4 - Test Data

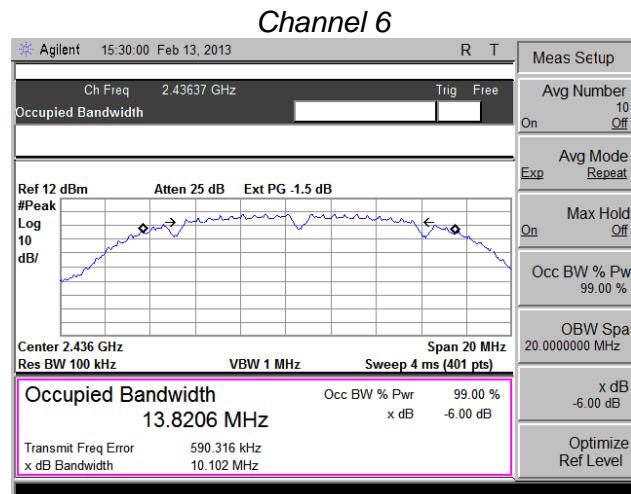
Channel	6 dB (MHz)	Modulation
1	10.10	1 Mbps
6	10.10	
11	10.11	
1	16.35	6 Mbps
6	16.35	
11	16.35	
1	16.47	24 Mbps
6	16.42	
11	16.46	
1	16.51	54 Mbps
6	16.51	
11	16.50	
1	17.60	MCS7
6	17.68	
11	17.71	

7.5 - Screen Captures - Occupied Bandwidth

1 Mbps Modulation



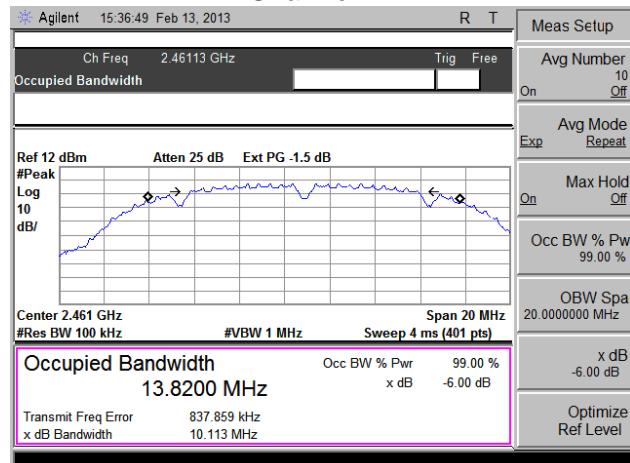
6 dB



6 dB

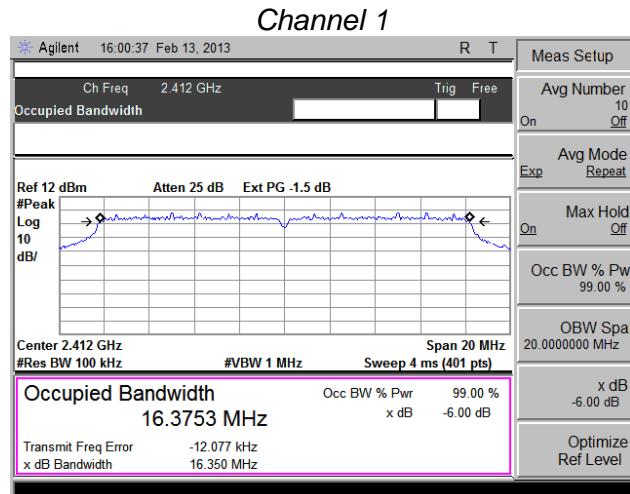
Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

Channel 11



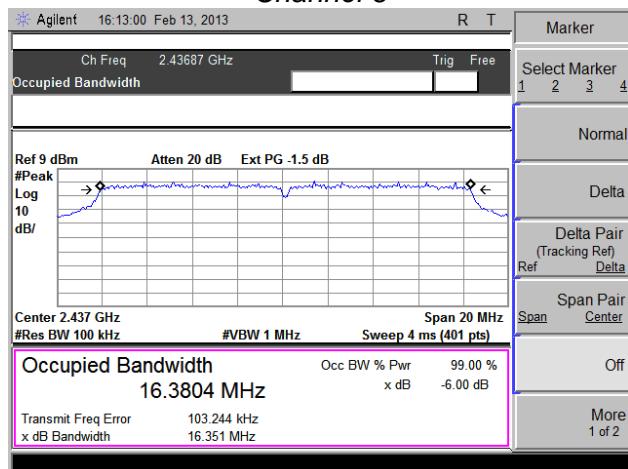
6Mbps

6 Mbps Modulation



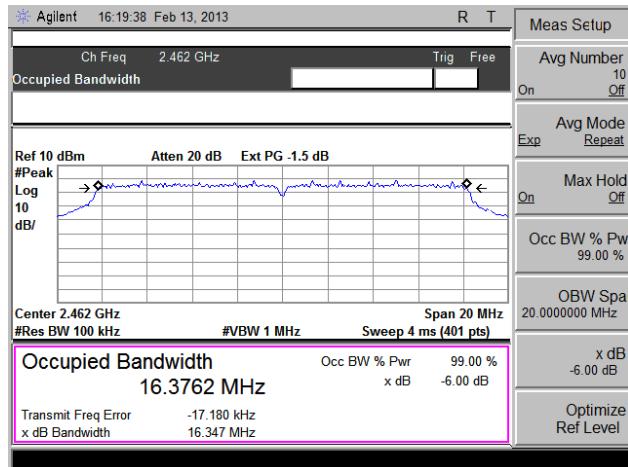
6 dB

Channel 6



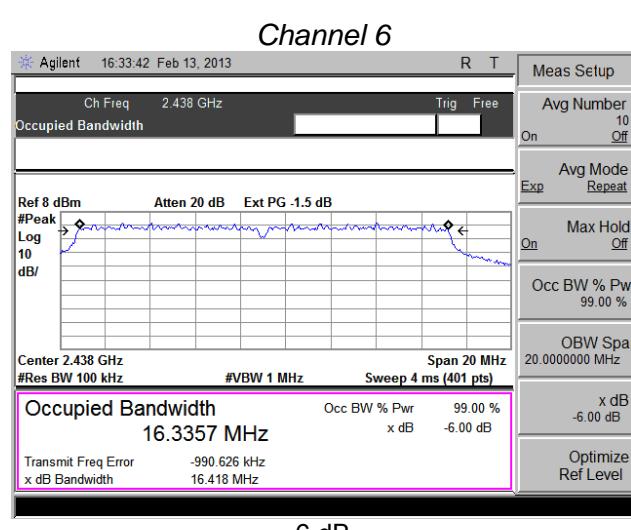
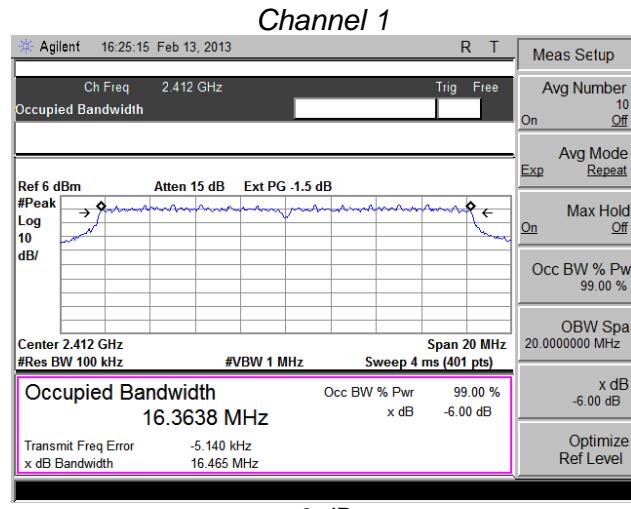
6 dB

Channel 11



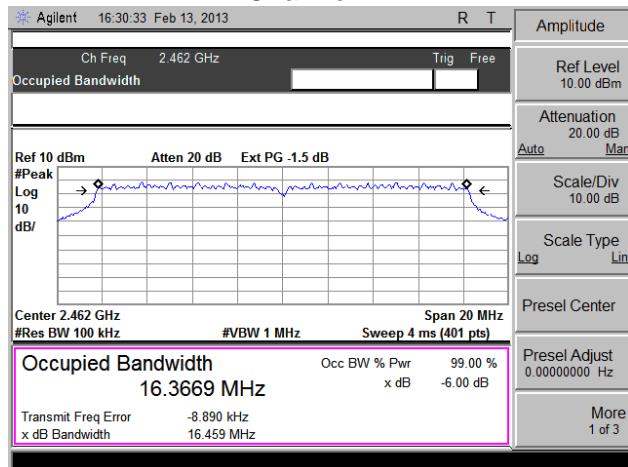
6 dB

24 Mbps Modulation



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

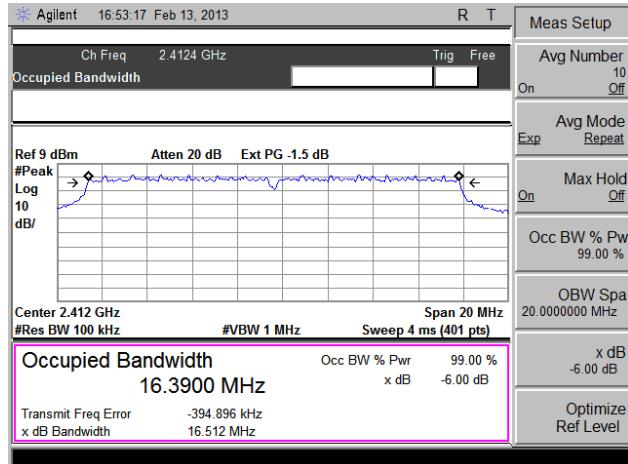
Channel 11



6 dB

54 Mbps Modulation

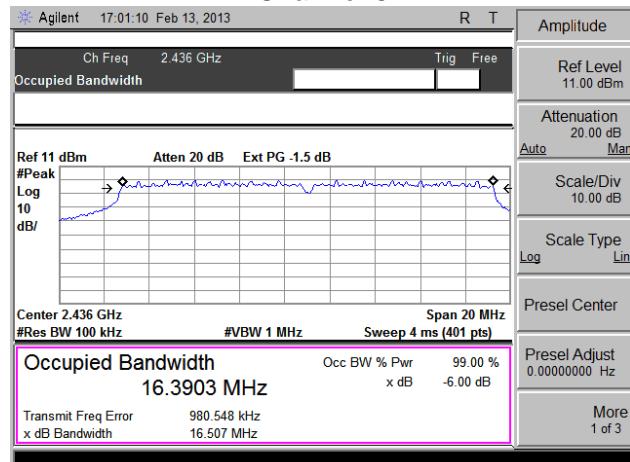
Channel 1



6 dB

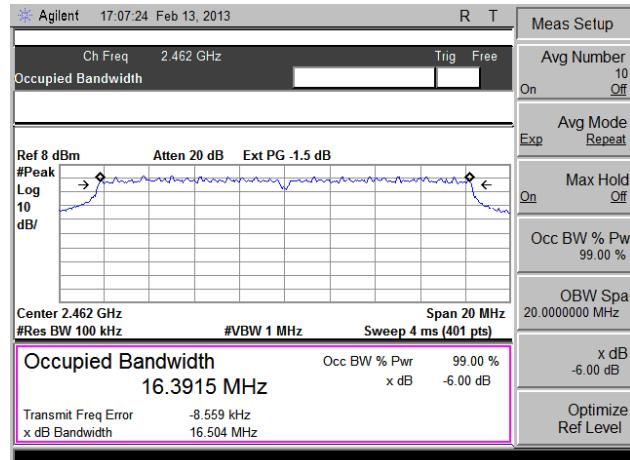
Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

Channel 6



6 dB

Channel 11

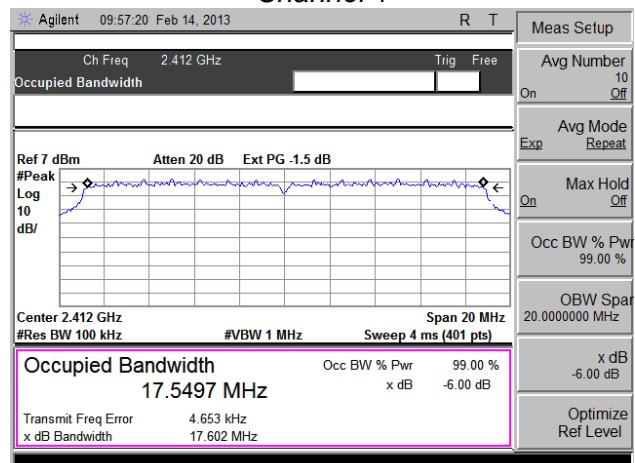


6 dB

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

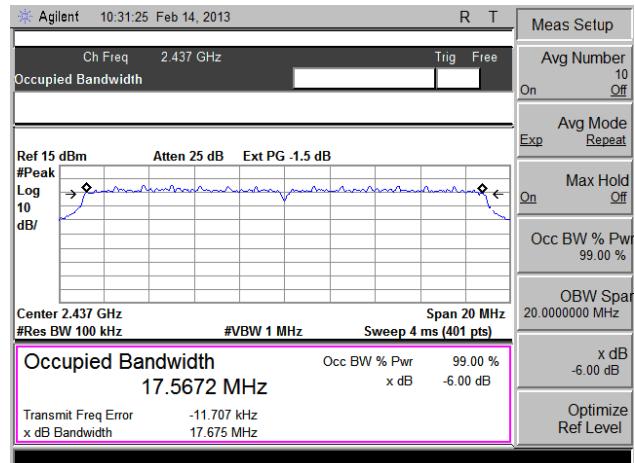
MCS7 Modulation

Channel 1



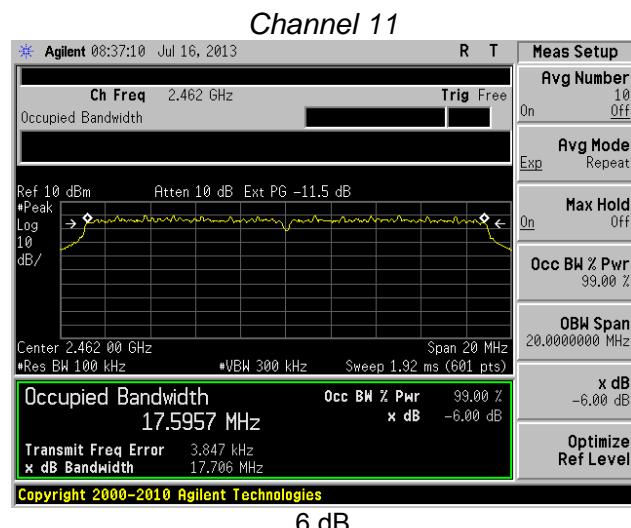
6 dB

Channel 6



6 dB

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

EXHIBIT 8. BAND EDGE MEASUREMENTS

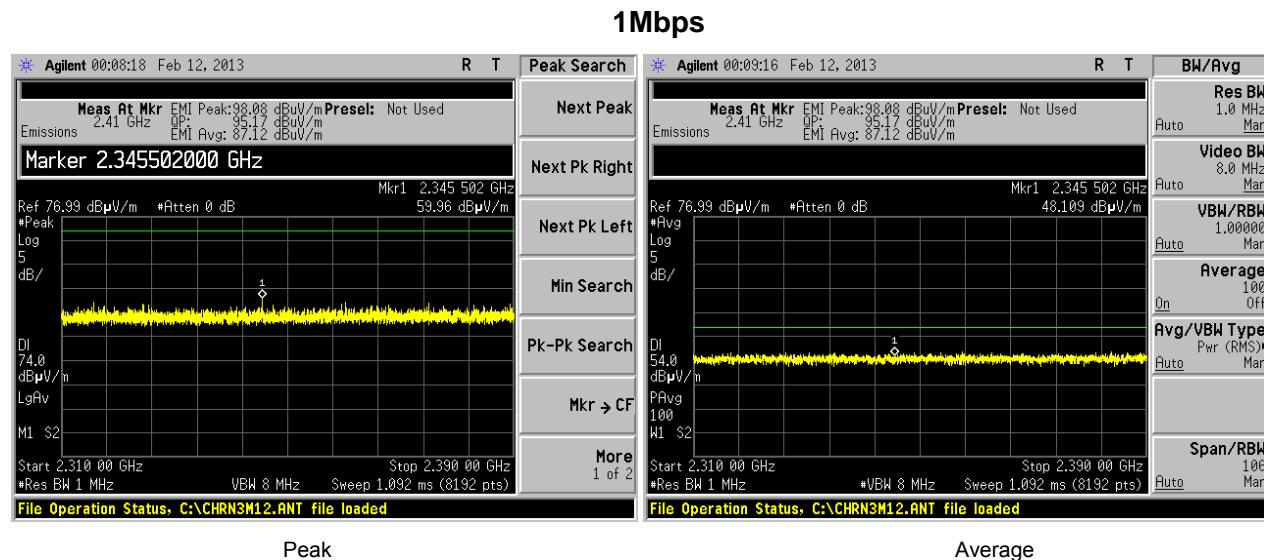
8.1 - Method of Measurements

FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in tables 2 and 3 of the same standard and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge. Measurements were made in accordance with ANSI C63.4.

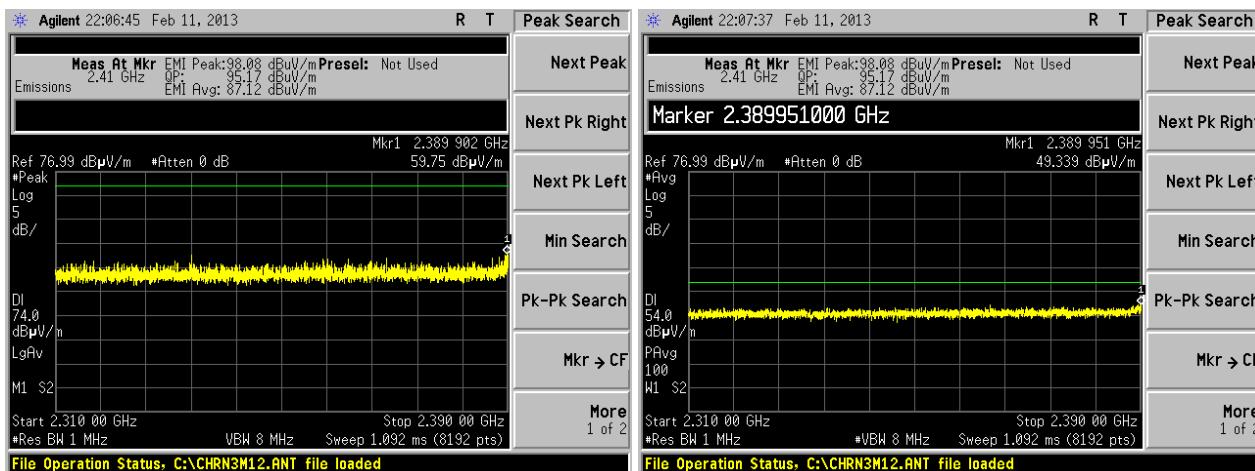
The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

The Upper Band-Edge limit, in this case, would be + 54 dB μ V/m at 3m.

Screen Captures Demonstrating Compliance at the Lower Band-Edge



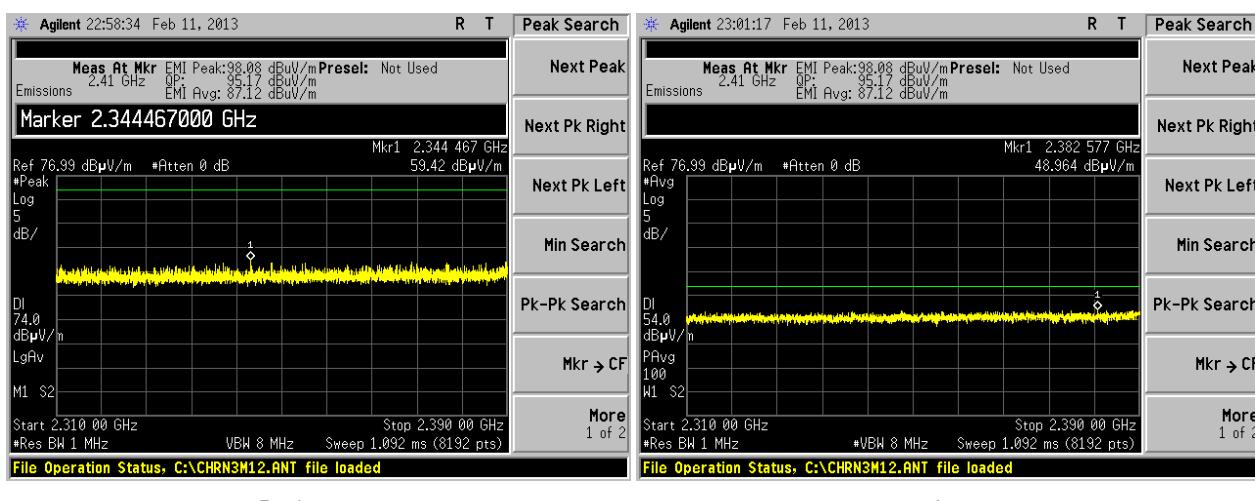
6 Mbps



Peak

Average

24Mbps

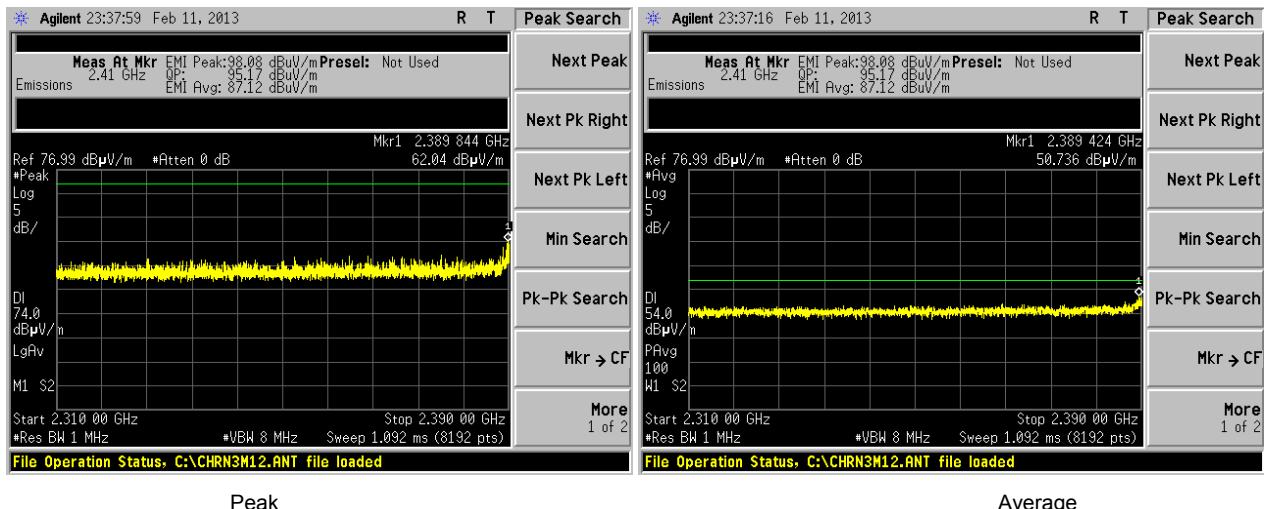


Peak

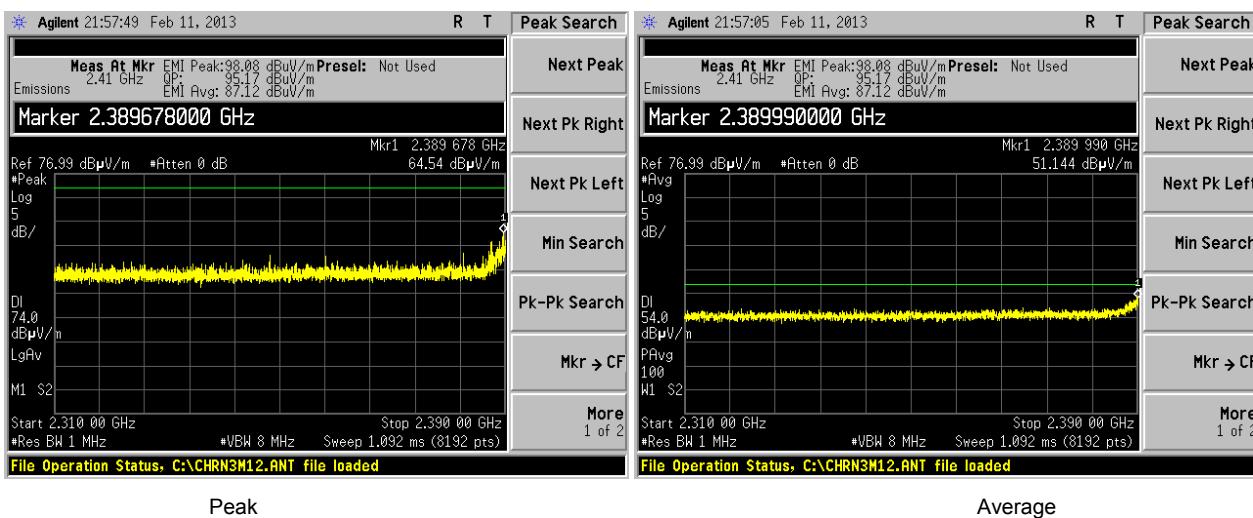
Average

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

54 Mbps



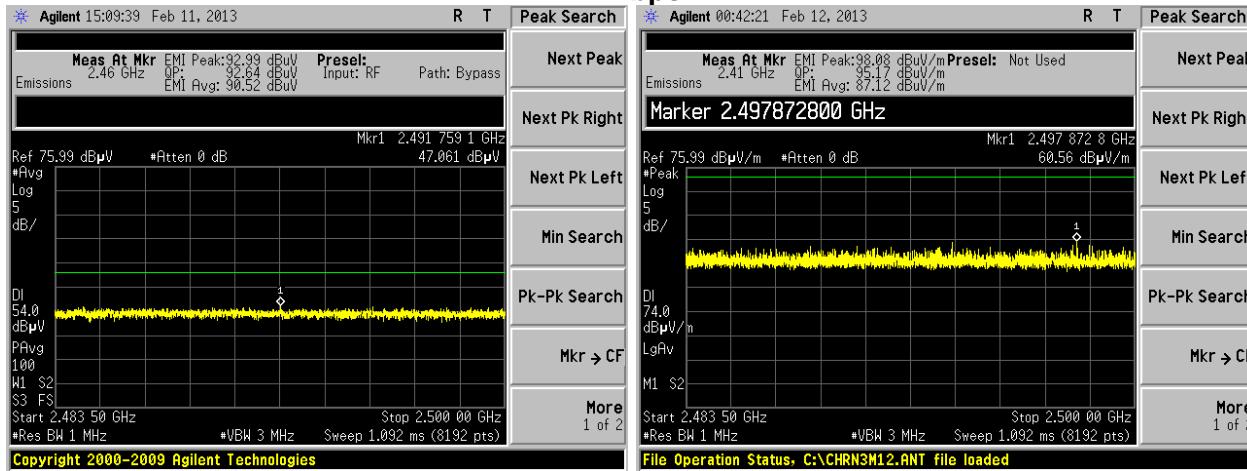
MCS7



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

Screen Captures Demonstrating Compliance at the Higher Band-Edge

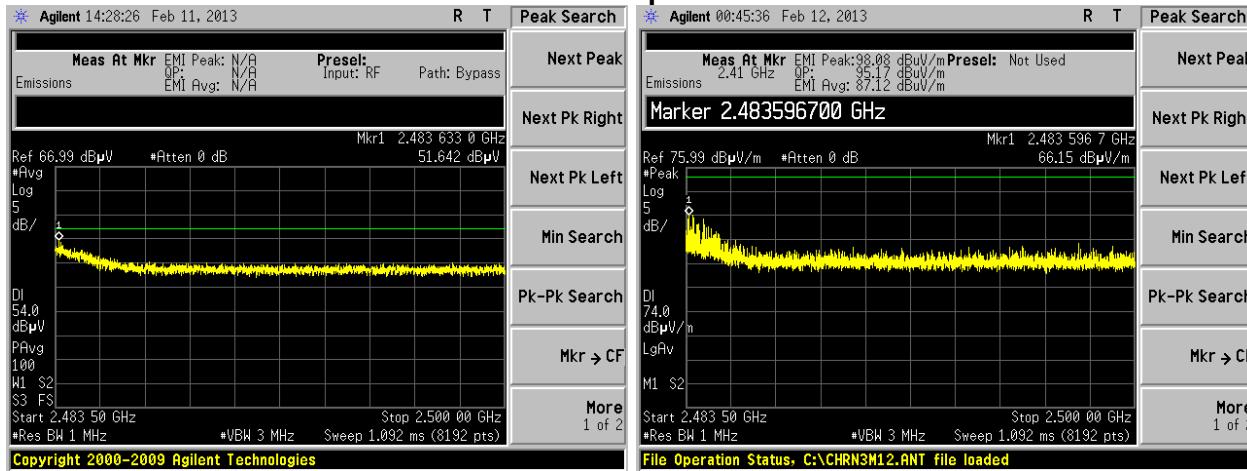
1 Mbps



Peak

Average

6 Mbps

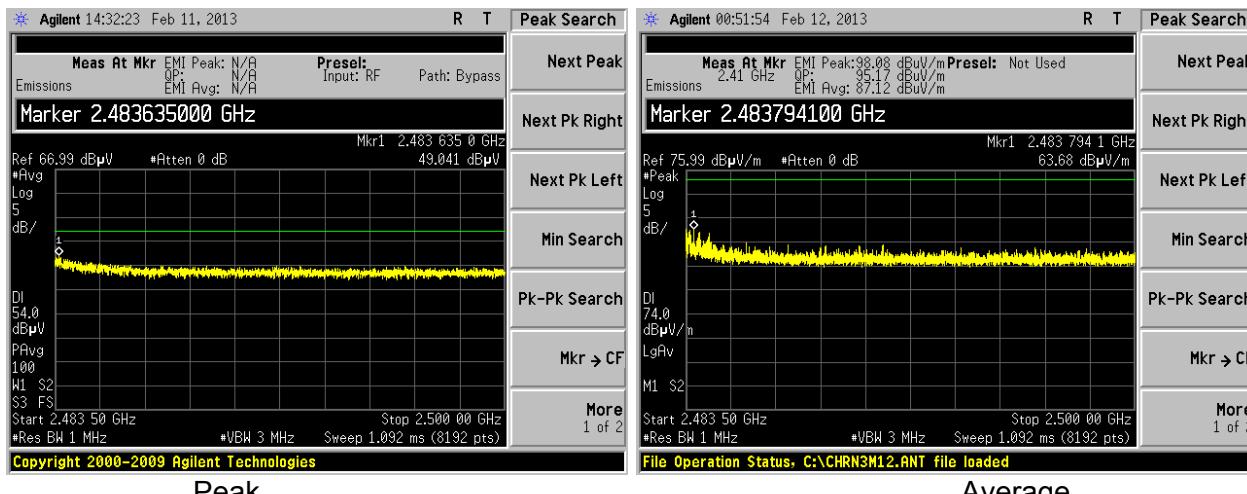


Peak

Average

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

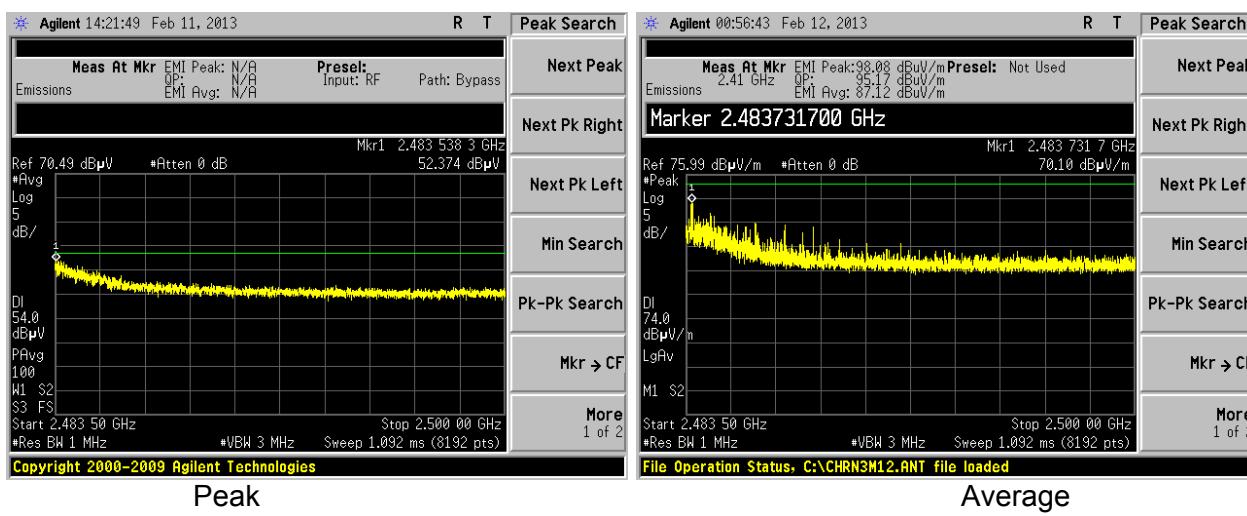
24 Mbps



Peak

Average

54 Mbps

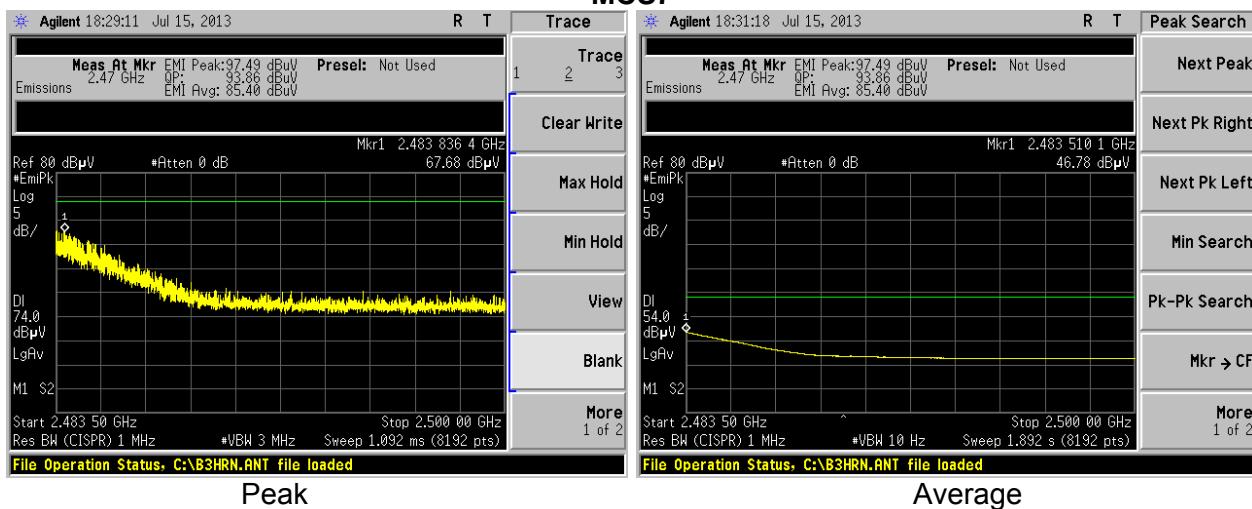


Peak

Average

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

MCS7



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 50 MHz, with measurements from a peak detector with the band power marker function used presented in the chart below. Measurements were made in accordance with FCC KDB 558074.

9.2 - Test Equipment List

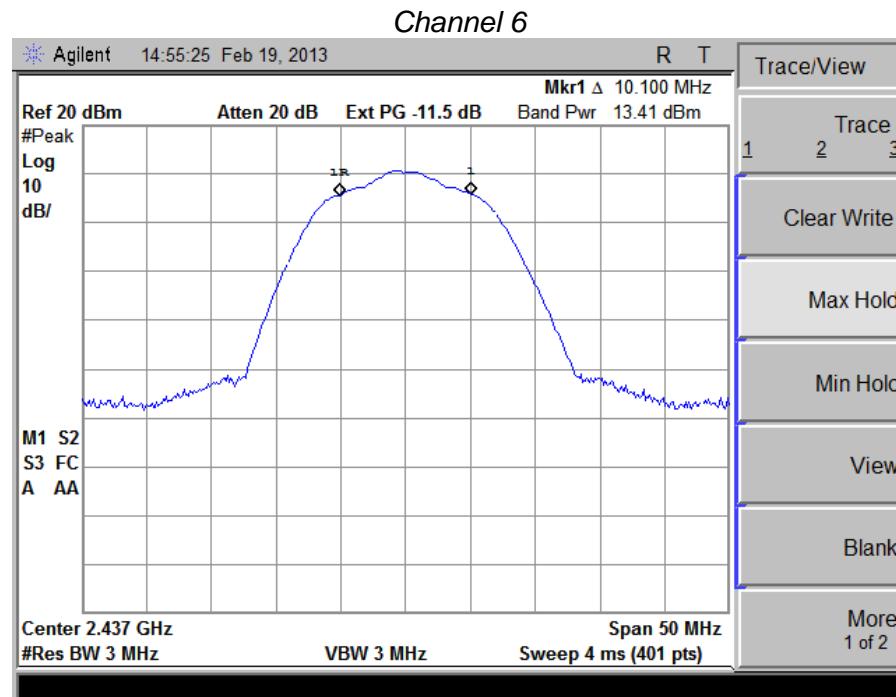
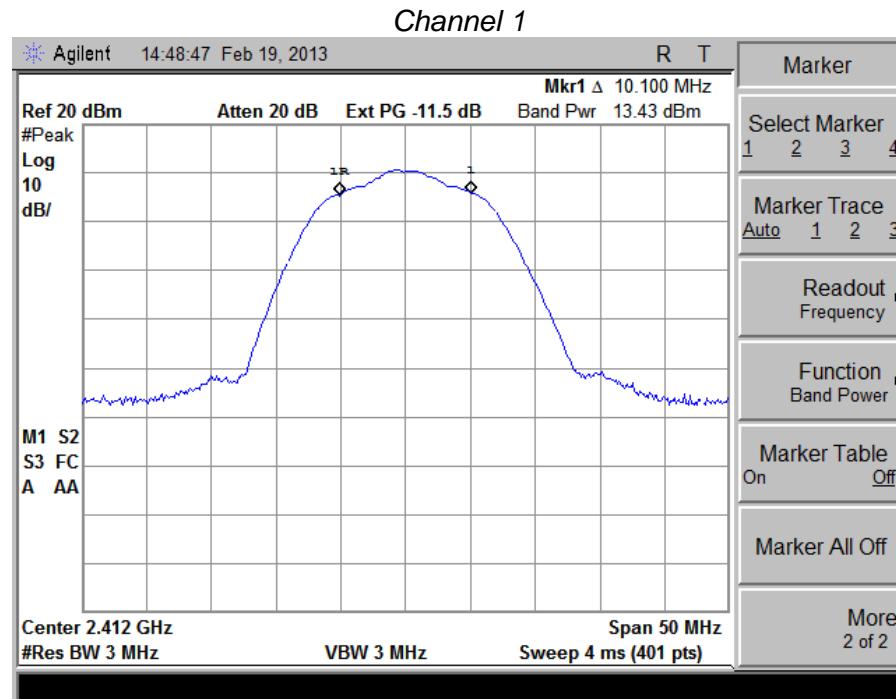
A complete list of test equipment that was used for this test can be found in Appendix A.

9.3 - Test Data

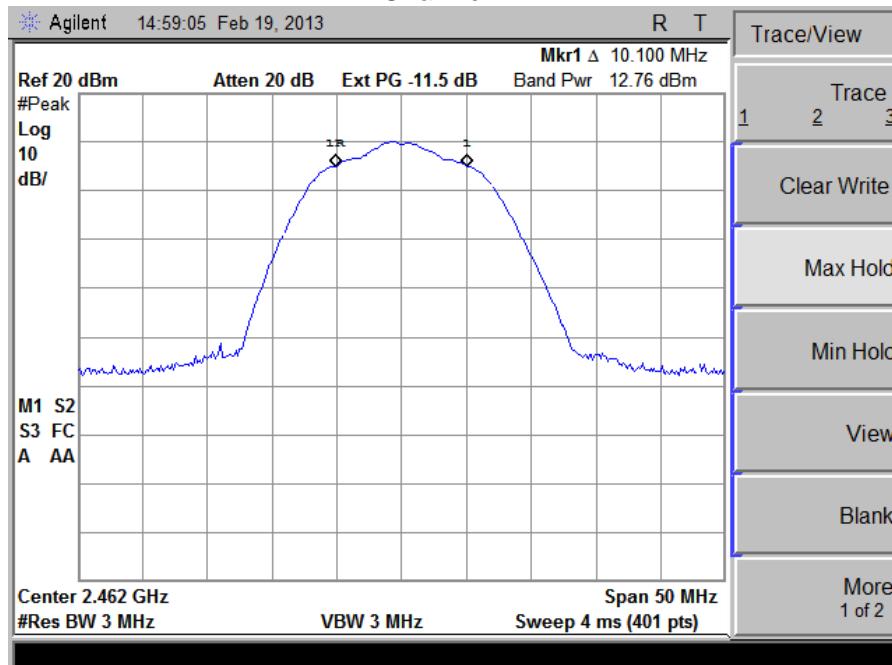
Channel	Power (dBm)	Modulation
1	13.43	1 Mbps
6	13.41	
11	12.76	
1	19.15	6 Mbps
6	18.82	
11	18.29	
1	19.19	24 Mbps
6	19.08	
11	18.18	
1	19.60	54 Mbps
6	19.96	
11	18.90	
1	18.67	MCS7
6	18.65	
11	18.30	

9.4 - Screen Captures - Power Output (Conducted)

1 Mbps

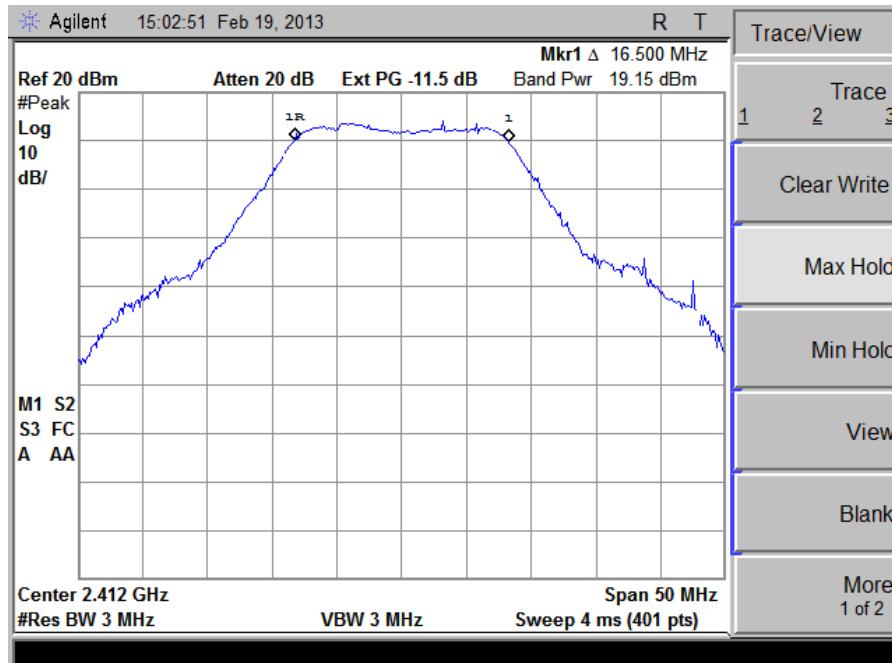


Channel 11

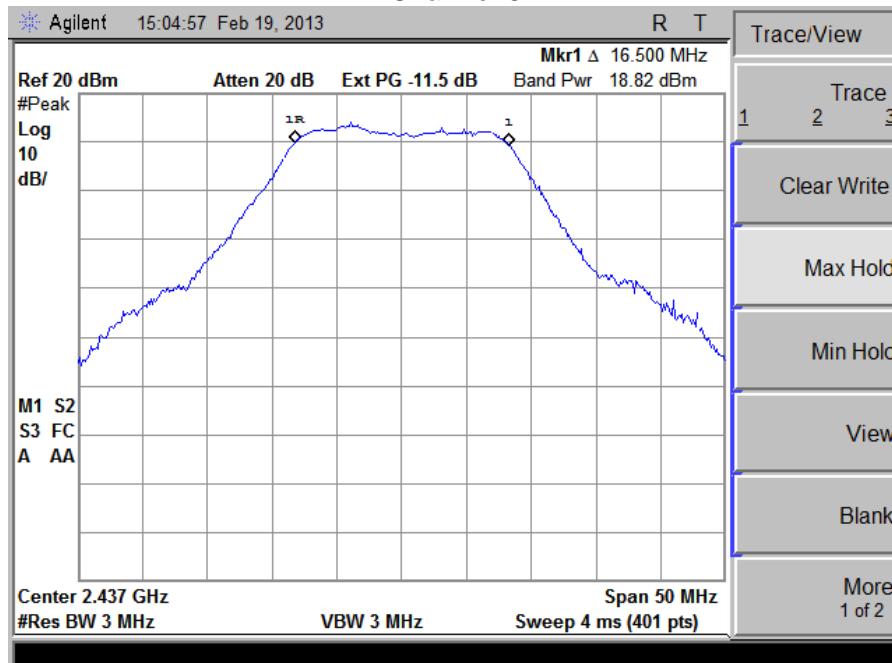


6 Mbps

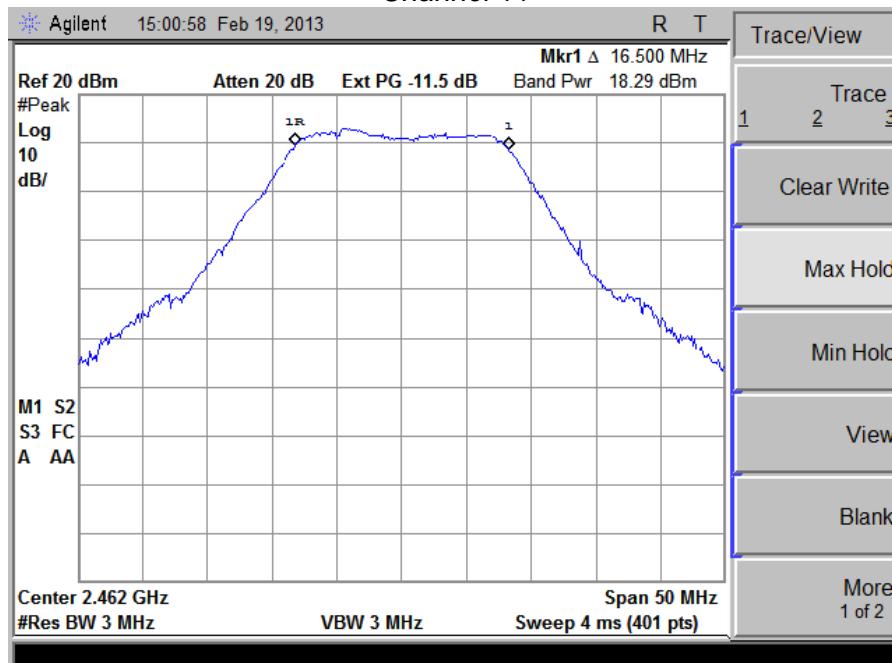
Channel 1



Channel 6

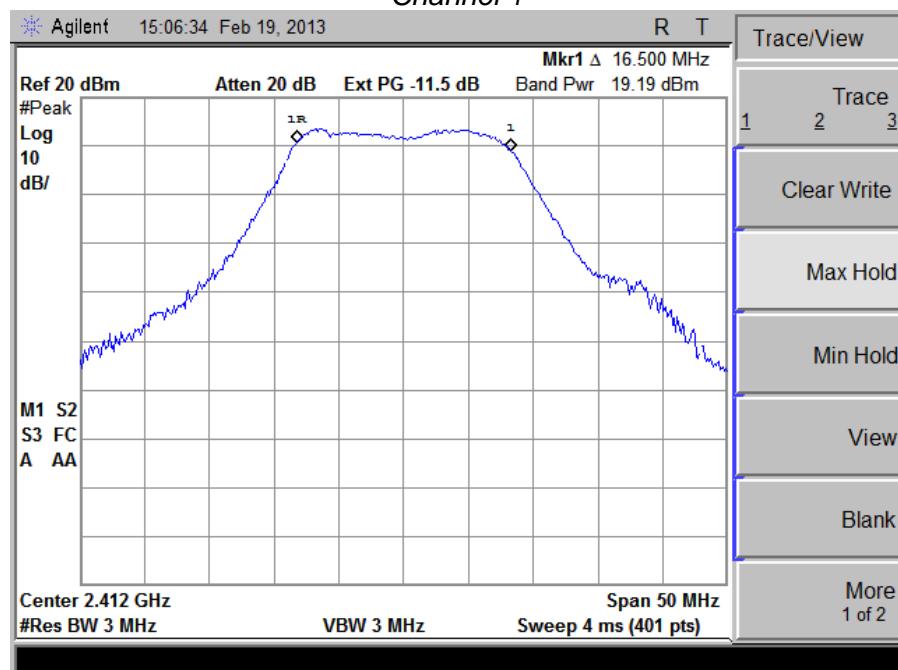


Channel 11

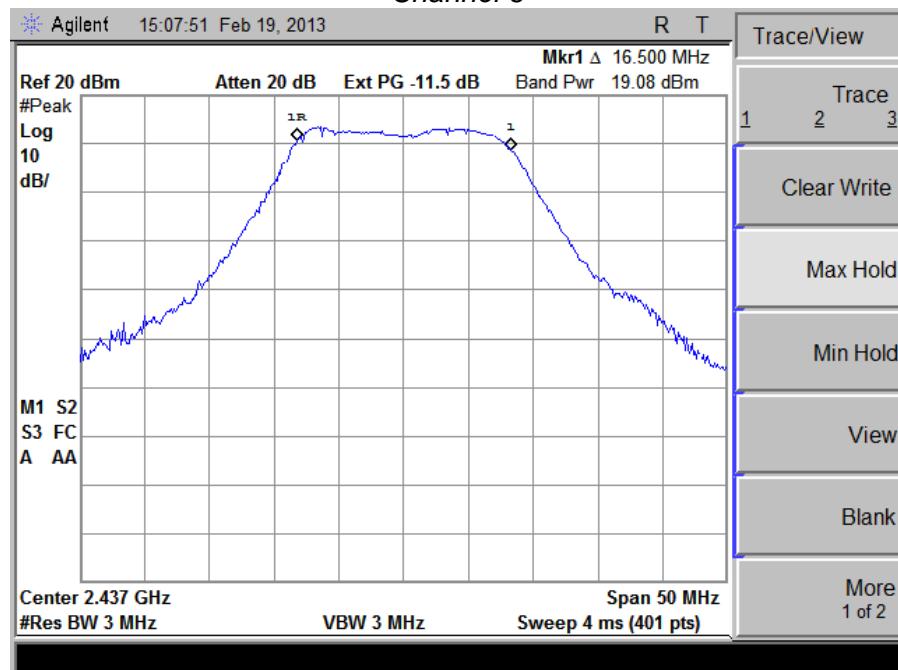


24 Mbps

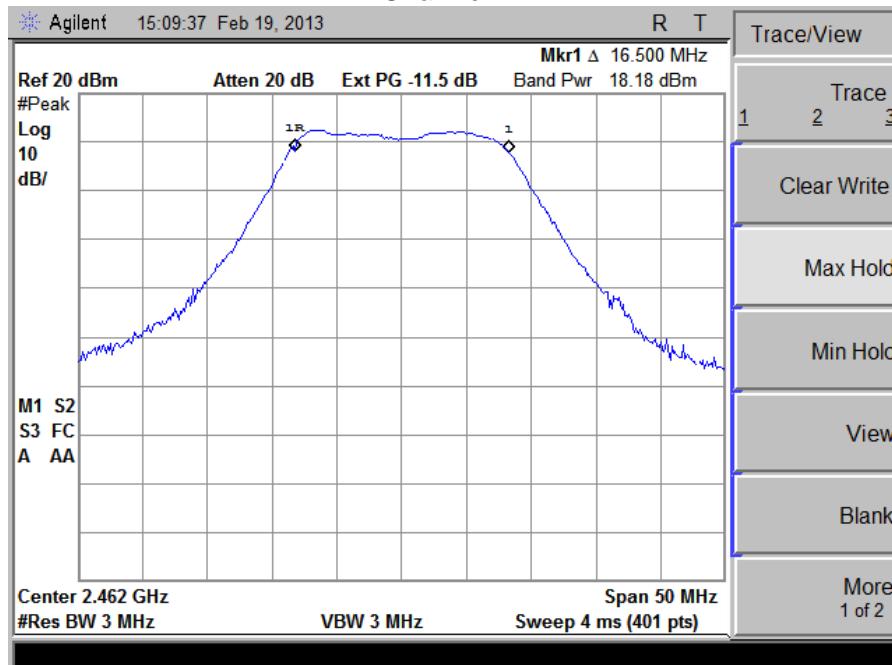
Channel 1



Channel 6

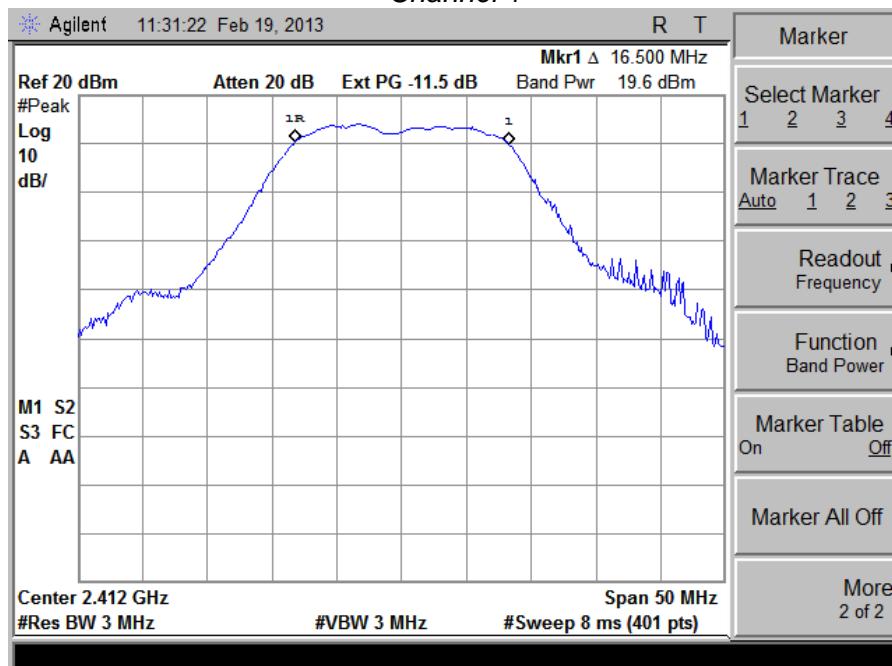


Channel 11

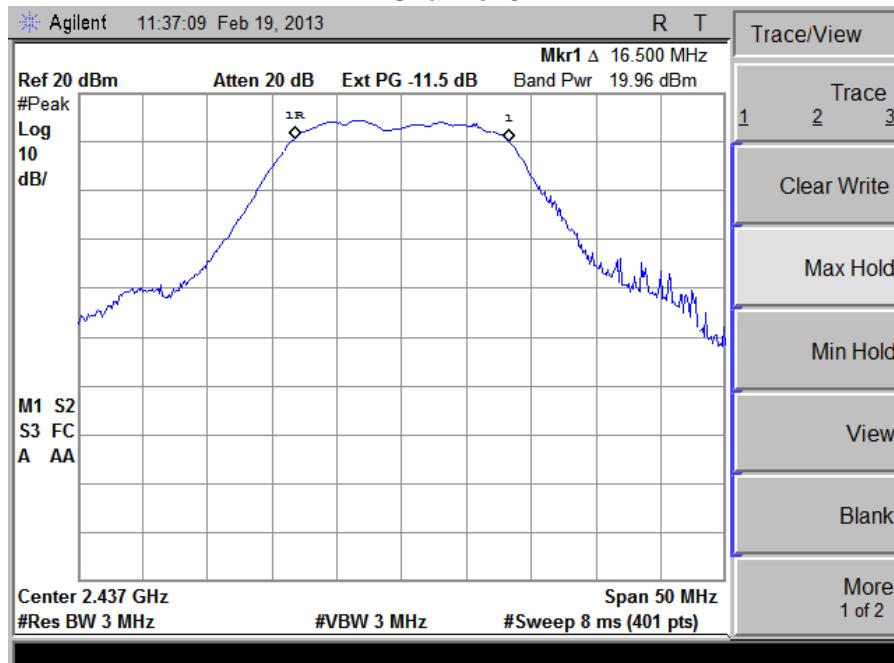


54 Mbps

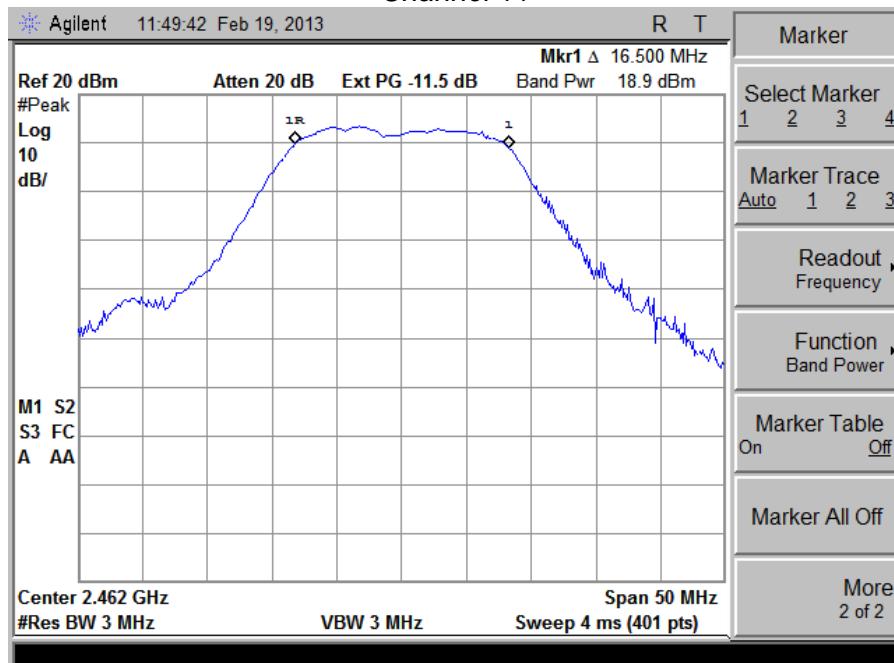
Channel 1



Channel 6

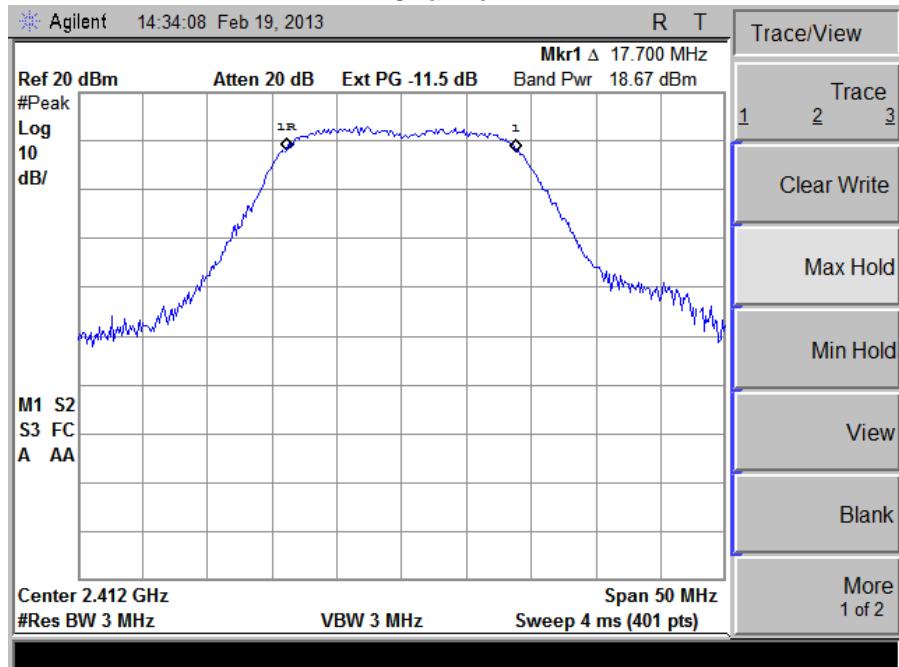


Channel 11

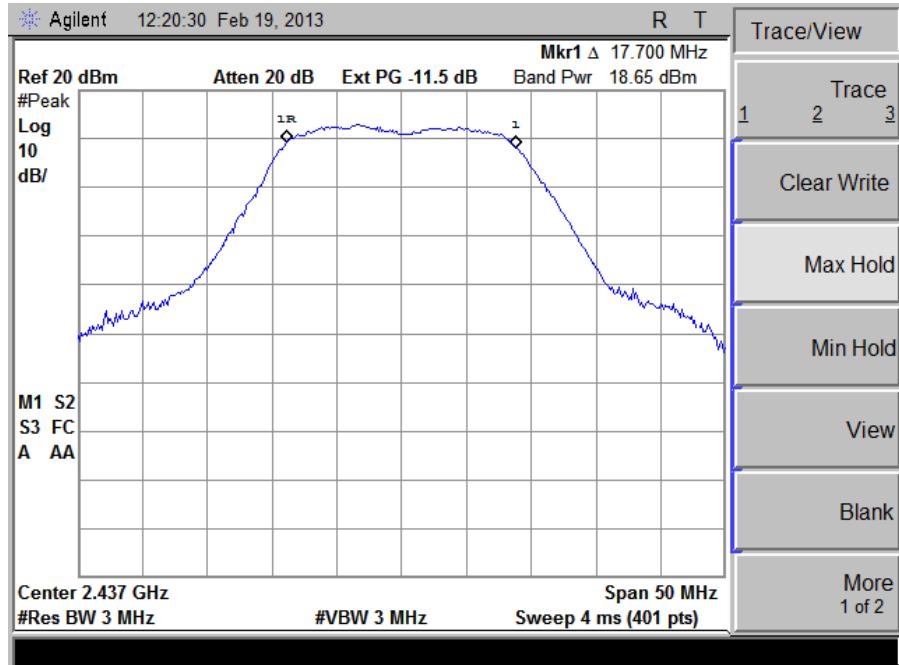


MCS7

Channel 1

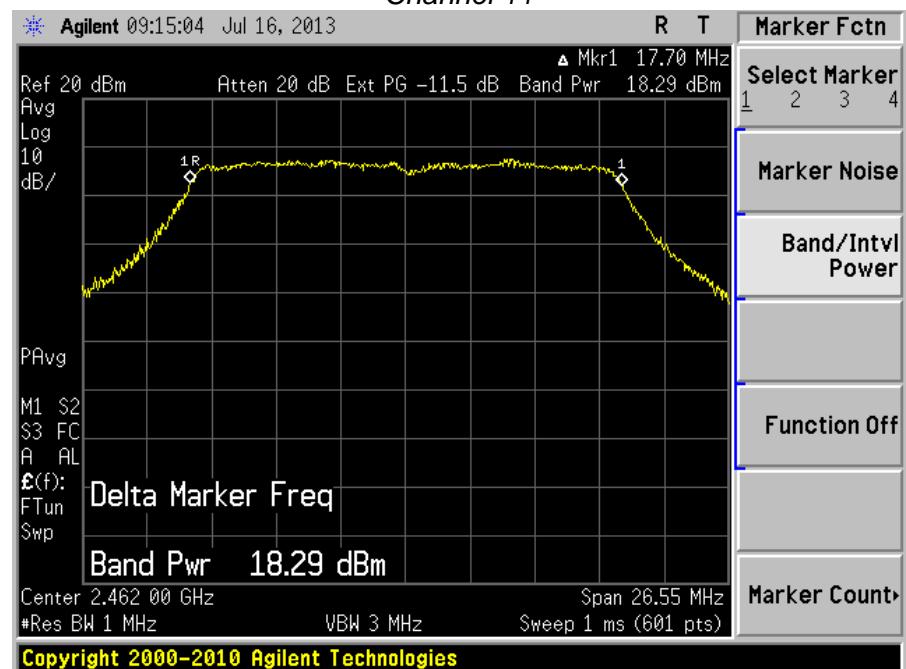


Channel 6



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

Channel 11



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

10.1 - Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e) and RSS 210 A8.2(b), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed. Measurements were in accordance with FCC KDB 558074.

10.2 - Test Equipment List

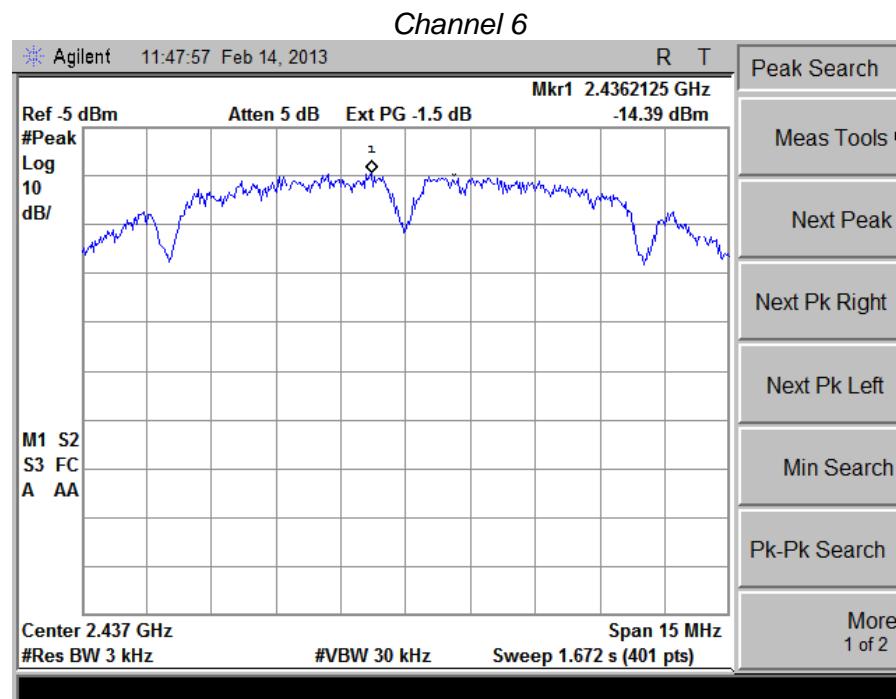
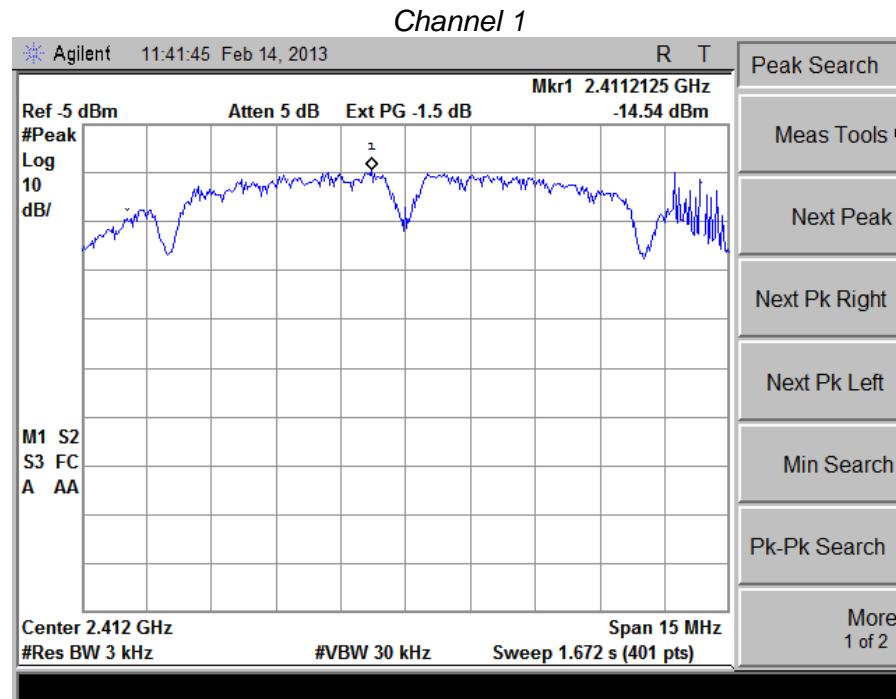
A complete list of test equipment can be found in Appendix A.

10.3 - Test Data

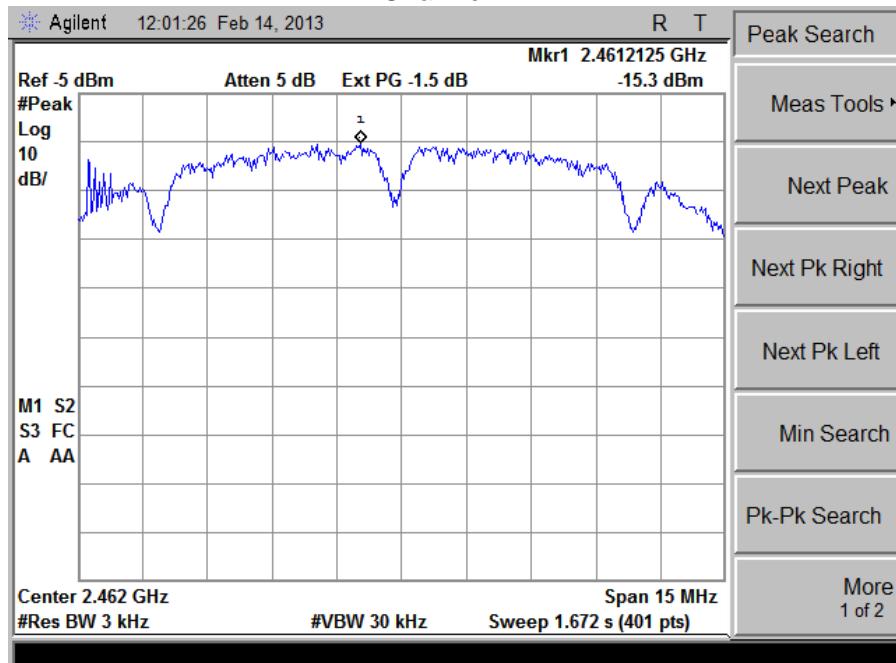
Channel	Power Density (dBm)	Limit (dBm)	Margin (dB)	Modulation
1	-14.54	8.00	22.54	1 Mbps
6	-14.39	8.00	22.39	
11	-15.30	8.00	23.30	
1	-15.09	8.00	23.09	6 Mbps
6	-15.56	8.00	23.56	
11	-14.41	8.00	22.41	
1	-14.24	8.00	22.24	24 Mbps
6	-13.67	8.00	21.67	
11	-14.73	8.00	22.73	
1	-13.73	8.00	21.73	54 Mbps
6	-13.60	8.00	21.60	
11	-14.44	8.00	22.44	
1	-14.36	8.00	22.36	MCS7
6	-12.26	8.00	20.26	
11	-13.86	8.00	21.86	

10.4 - Screen Captures – Power Spectral Density

1 Mbps

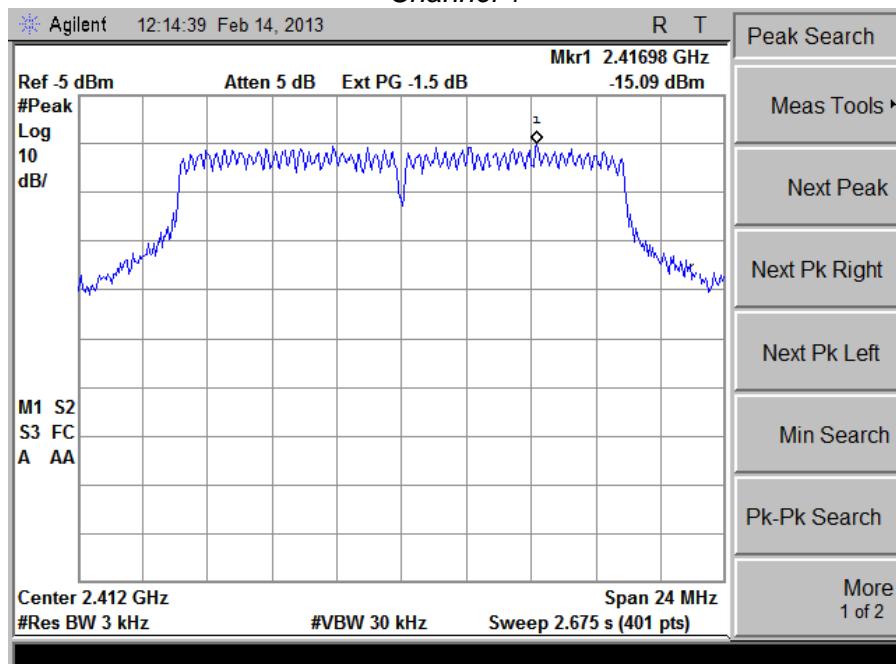


Channel 11

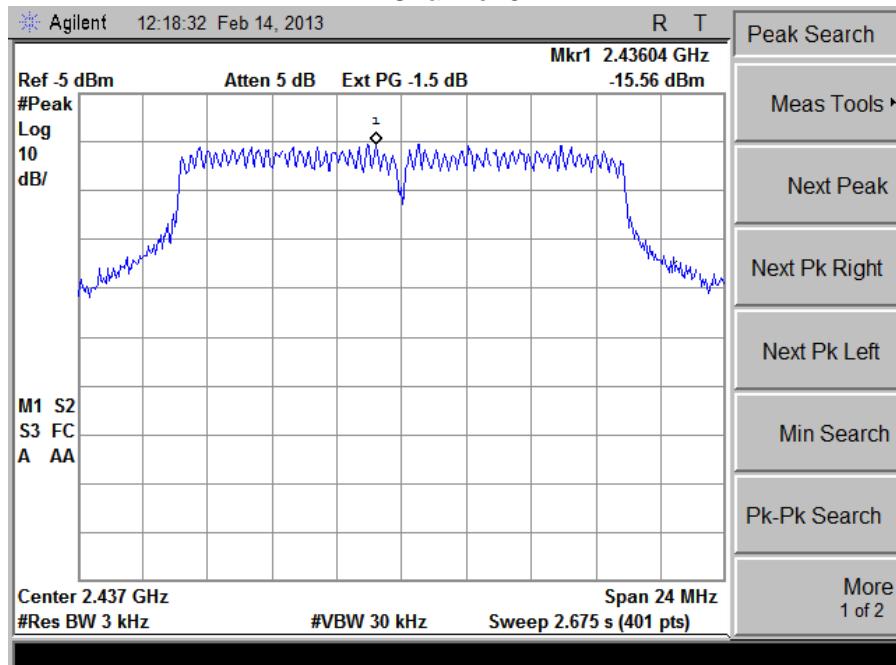


6 Mbps

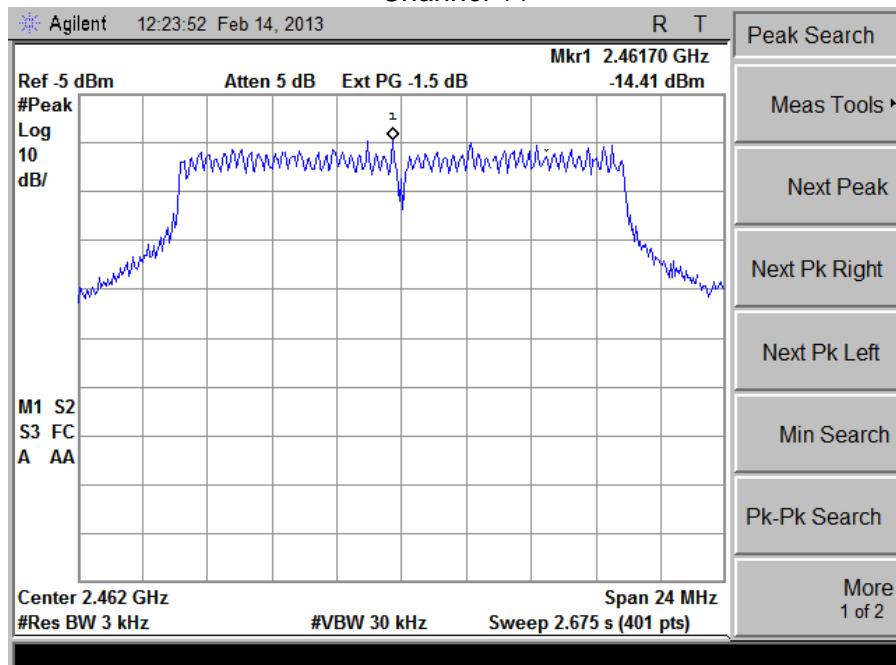
Channel 1



Channel 6

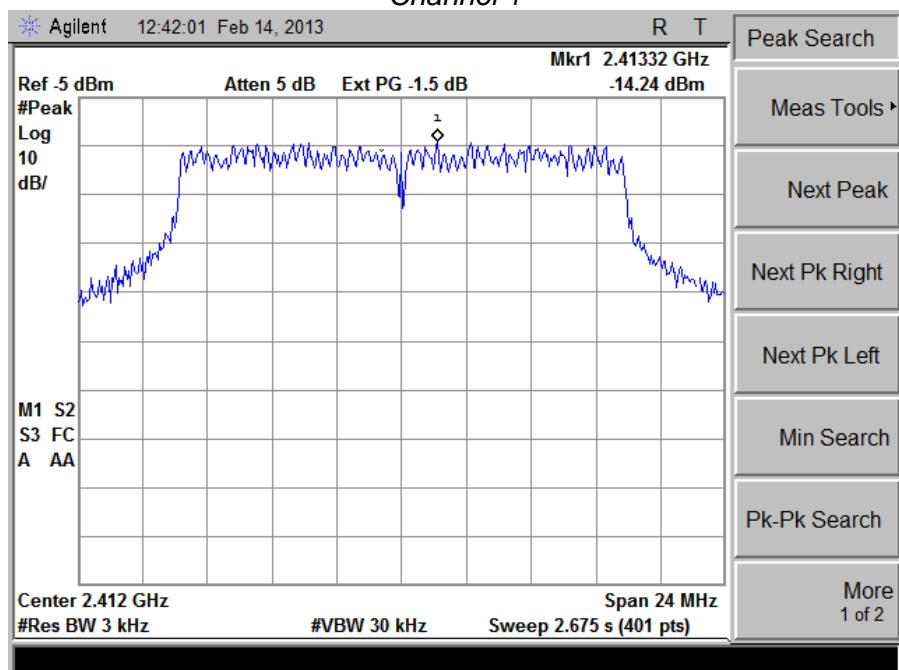


Channel 11

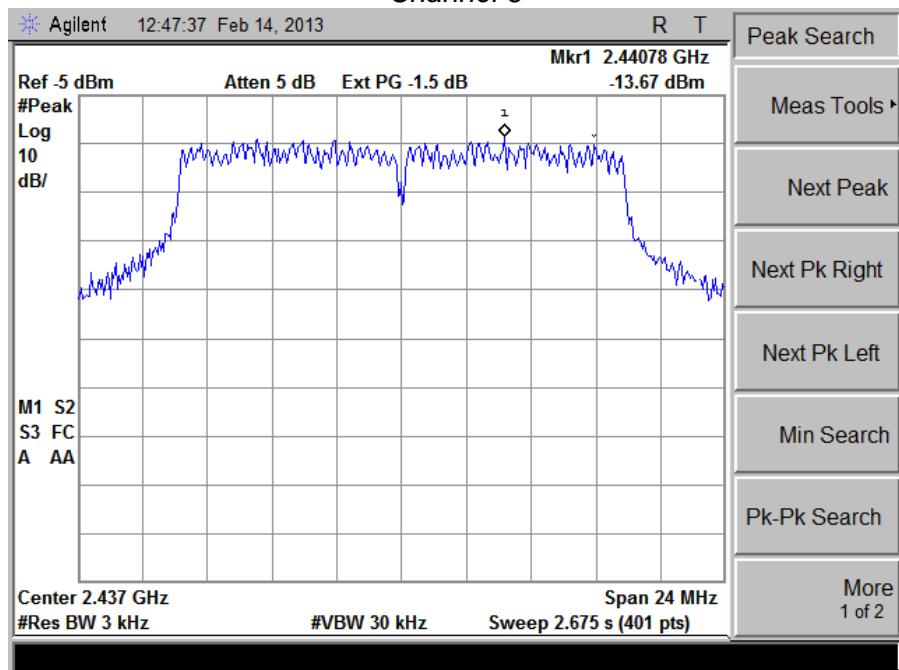


24 Mbps

Channel 1

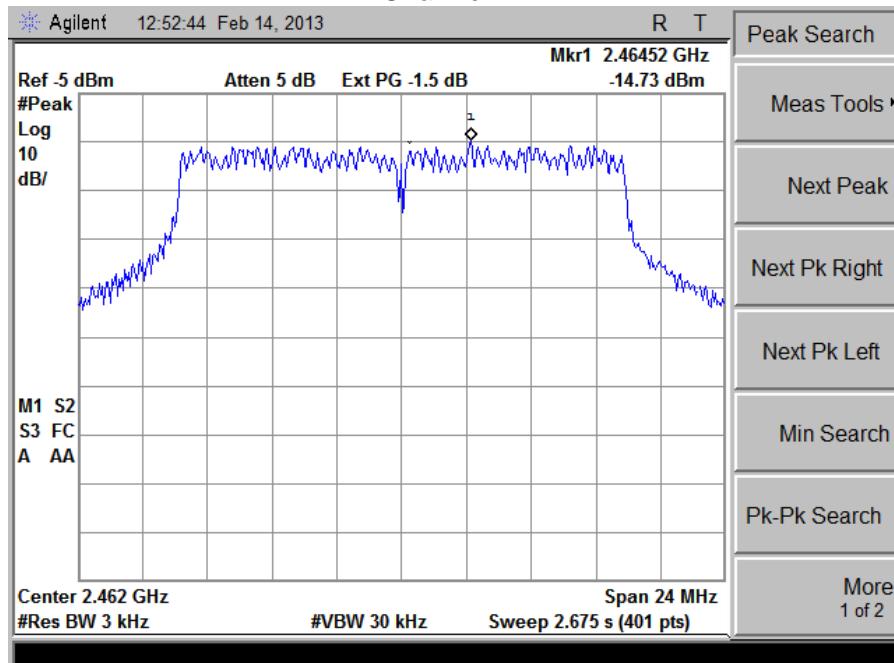


Channel 6



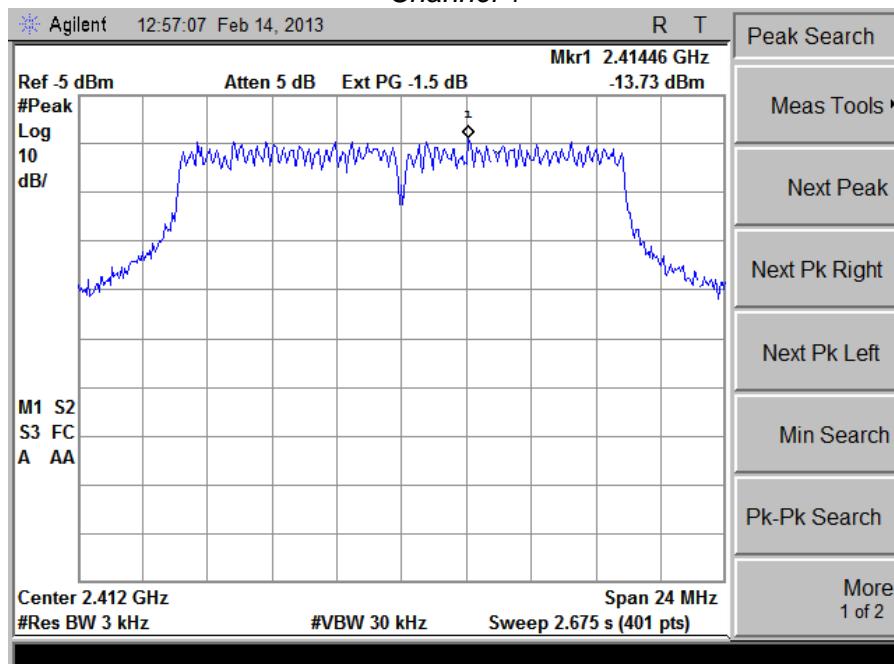
Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

Channel 11

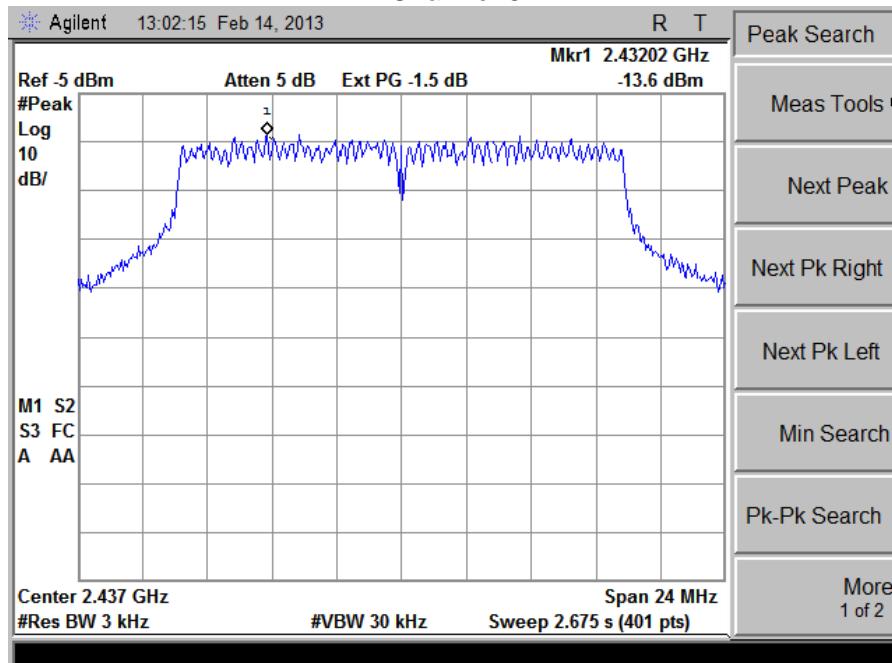


54 Mbps

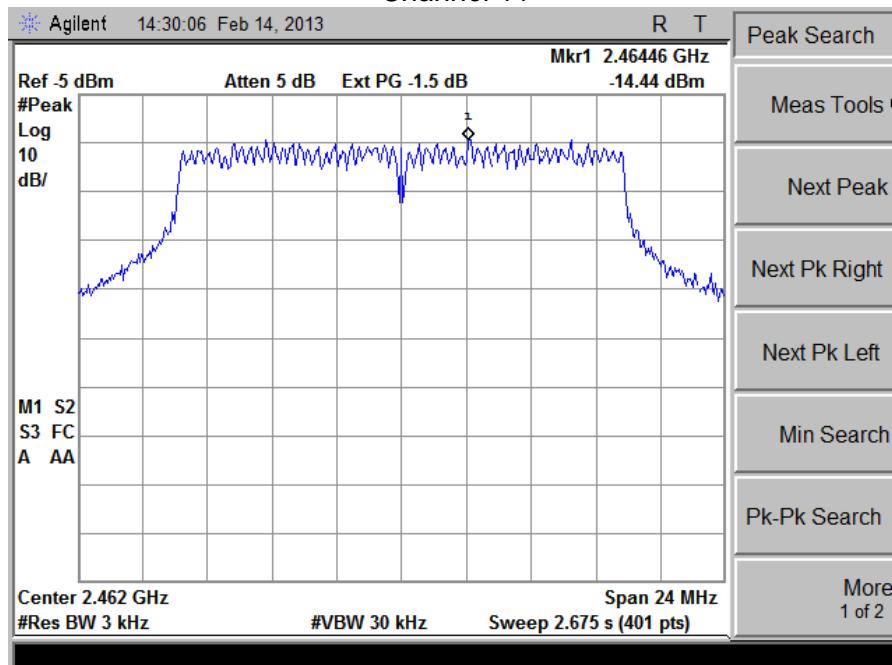
Channel 1



Channel 6

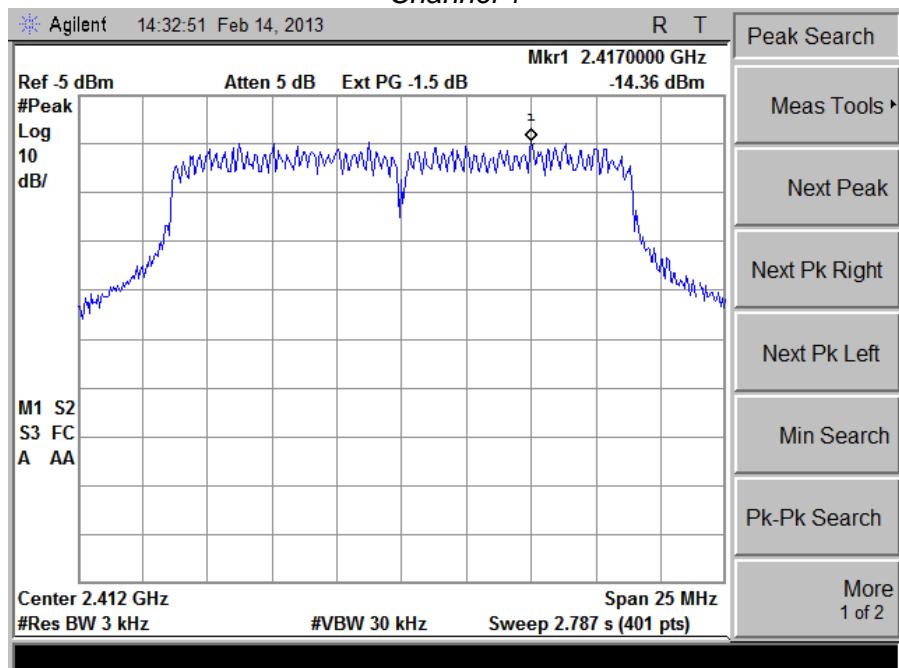


Channel 11

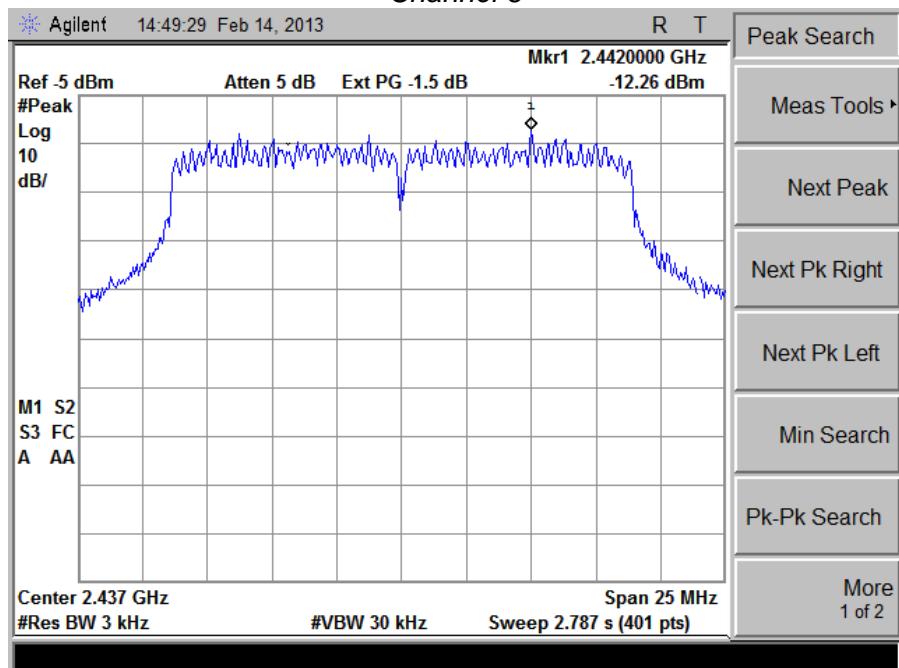


MCS7

Channel 1

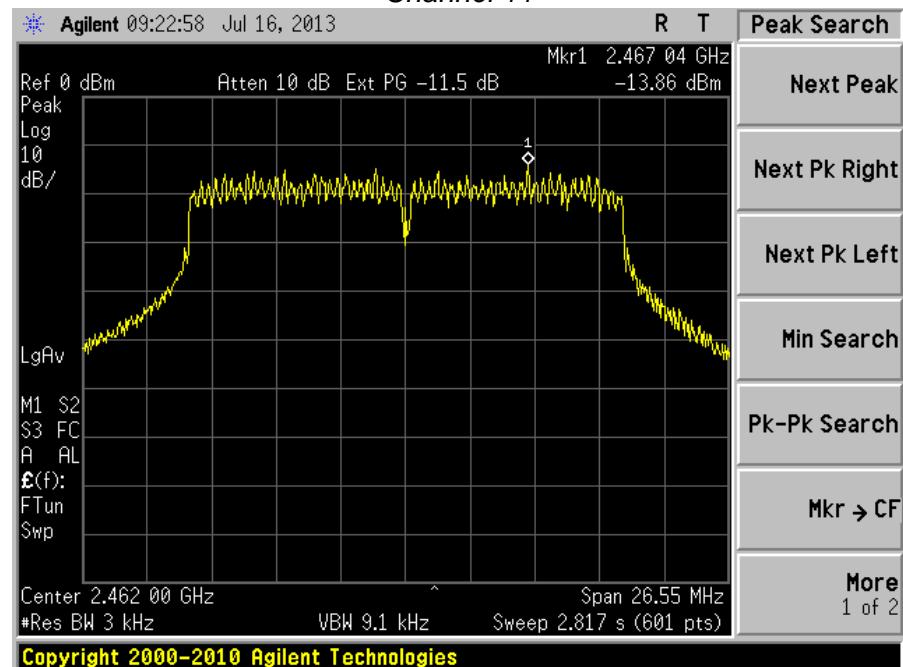


Channel 6



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

Channel 11



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

11.1 - Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

In addition, radiated emissions, which fall in the restricted band, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(e)

Remarks:

Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205.

The maximum permitted average field strength is listed in Section 15.209.

The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in Section 15.35 for limiting peak emissions apply.

FCC 47 CFR 15.205(a) – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 – 0.110	162.0125 – 167.17	2310 – 2390	9.3 – 9.5
0.49 – 0.51	167.72 – 173.2	2483.5 – 2500	10.6 – 12.7
2.1735 – 2.1905	240 – 285	2655 – 2900	13.25 – 13.4
8.362 – 8.366	322 – 335.4	3260 – 3267	14.47 – 14.5
13.36 – 13.41	399.9 – 410	3332 – 3339	14.35 – 16.2
25.5 – 25.67	608 – 614	3345.8 – 3358	17.7 – 21.4
37.5 – 38.25	960 – 1240	3600 – 4400	22.01 – 23.12
73 – 75.4	1300 – 1427	4500 – 5250	23.6 – 24.0
108 – 121.94	1435 – 1626.5	5350 – 5460	31.2 – 31.8
123 – 138	1660 – 1710	7250 – 7750	36.43 – 36.5
149.9 – 150.05	1718.8 – 1722.2	8025 – 8500	Above 38.6
156.7 – 156.9	2200 – 2300	9000 – 9200	

Reported data is the raw data corrected for all applicable factors such as antenna factors, cable loss, etc.

Sample reported data:

Raw Data + Cable Factor = Reported Data

11.2 - Conducted Harmonic And Spurious RF Measurements

FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable. An Agilent E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured. Measurements were made in accordance with FCC KDB 558074.

Freq(MHz)	Chan/Mod	Level(dBm)	Limit (dBm)	Margin (dB)
476.2	6/1 Mbps	-47.41	-19.4	28.01
3250	6/1 Mbps	-55.88	-19.4	36.48
922.4	6/1 Mbps	-57.64	-19.4	38.24
451.95	1/1 Mbps	-52.56	-19.4	33.16
924.83	1/1 Mbps	-57.3	-19.4	37.9
3227.5	1/1 Mbps	-53.45	-19.4	34.05
502.875	11/1 Mbps	-53.25	-19.4	33.85
922.4	11/1 Mbps	-56.13	-19.4	36.73
3295	11/1 Mbps	-56.97	-19.4	37.57
709	1/6 Mbps	-53.87	-20.8	33.07
451.95	1/6 Mbps	-57.15	-20.8	36.35
3227.5	1/6 Mbps	-55.3	-20.8	34.5
478.6	6/6 Mbps	-54.5	-20.8	33.7
3250	6/6 Mbps	-55.19	-20.8	34.39
924.8	11/6 Mbps	-58.37	-20.8	37.57
502.9	11/6 Mbps	-59.52	-20.8	38.72
3295	11/6 Mbps	-54.77	-20.8	33.97
919.98	1/24 Mbps	-57.69	-20.2	37.49
3227.5	1/24 Mbps	-55.7	-20.2	35.5
476.2	6/24 Mbps	-54.99	-20.2	34.79
3250	6/24 Mbps	-56.79	-20.2	36.59
500.5	11/24 Mbps	-61.78	-20.2	41.58
3295	11/24 Mbps	-56.59	-20.2	36.39

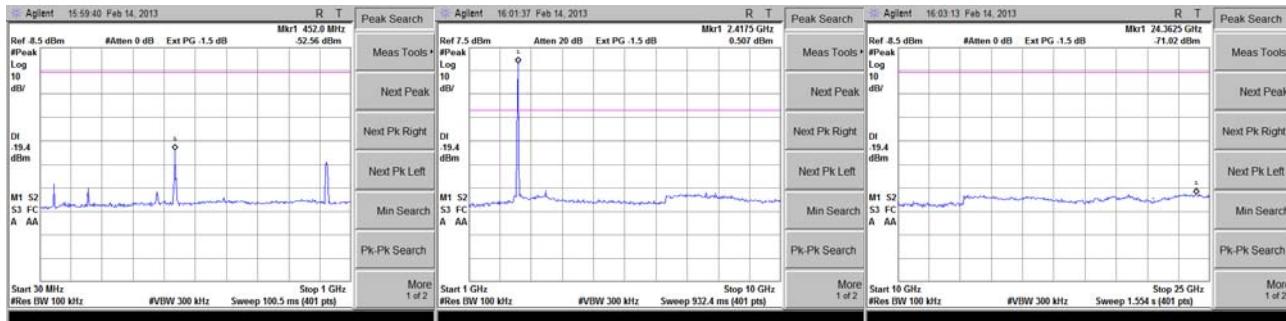
11.3 - Test Equipment List

A complete list of test equipment that was used for this test can be found in Appendix A.

11.4 - Screen Captures - Spurious Radiated Emissions

1 Mbps

Channel 1

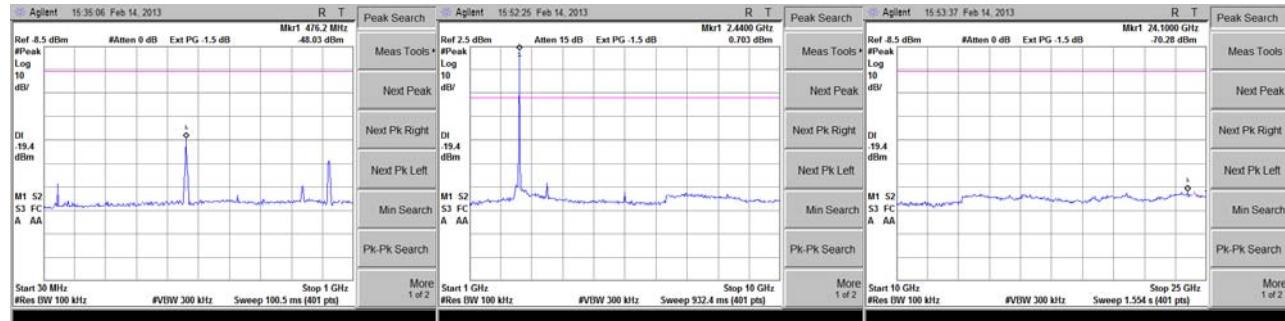


30-1000 MHz

1-10 GHz

10-25 GHz

Channel 6

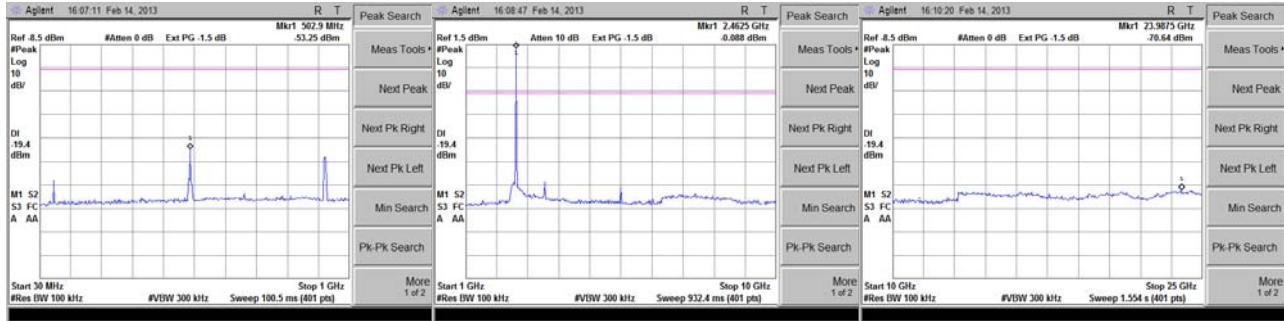


30-1000 MHz

1-10 GHz

10-25 GHz

Channel 11



30-1000 MHz

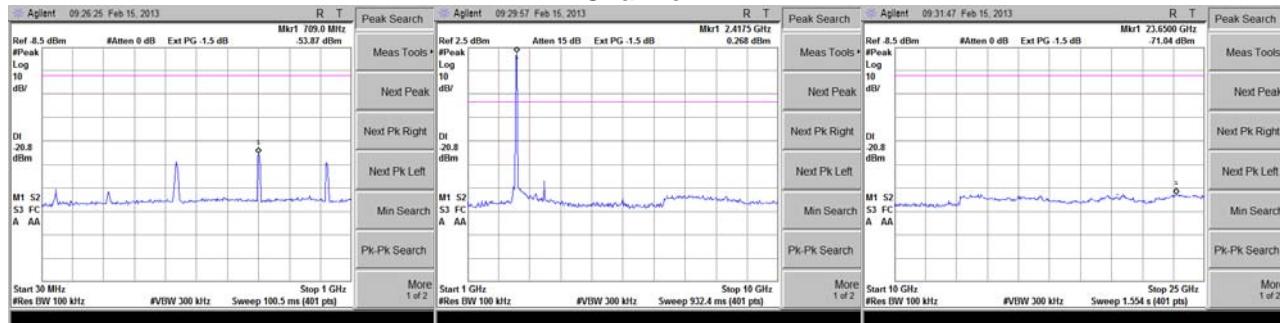
1-10 GHz

10-25 GHz

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

6 Mbps

Channel 1

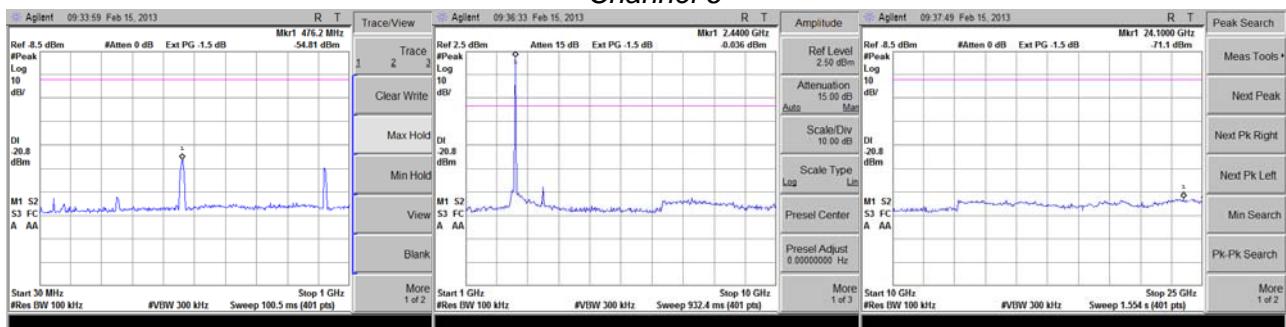


30-1000 MHz

1-10 GHz

10-25 GHz

Channel 6

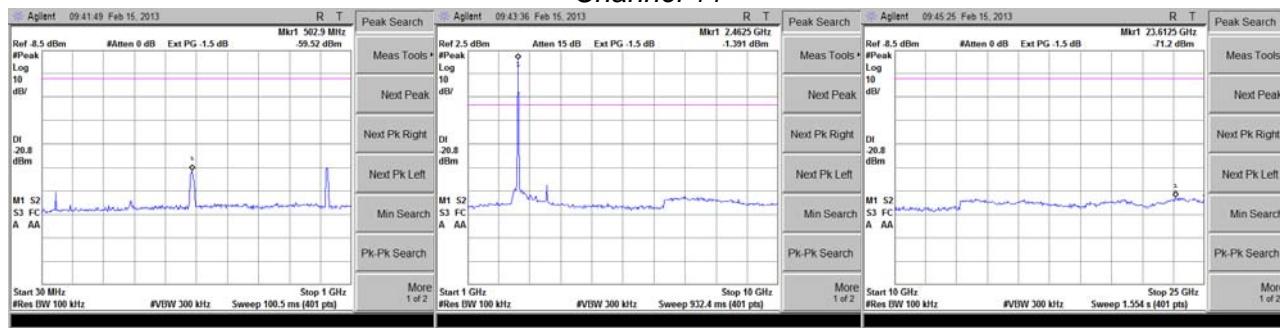


30-1000 MHz

1-10 GHz

10-25 GHz

Channel 11



30-1000 MHz

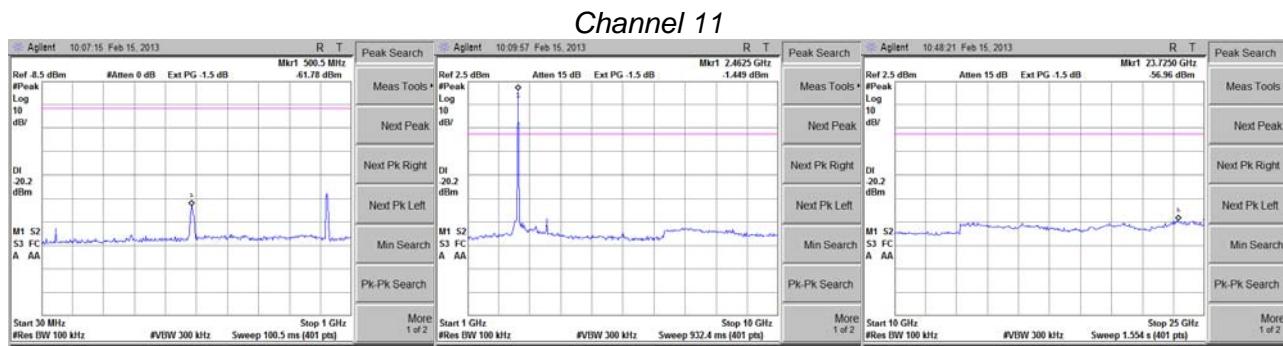
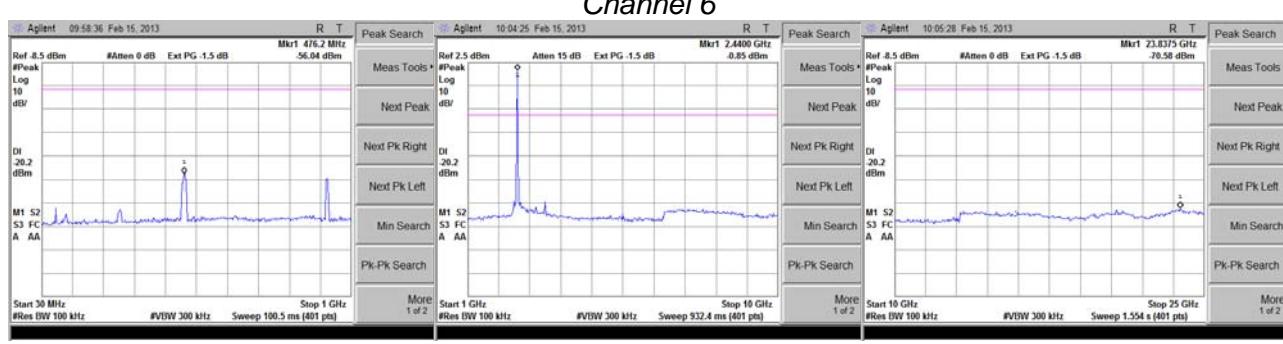
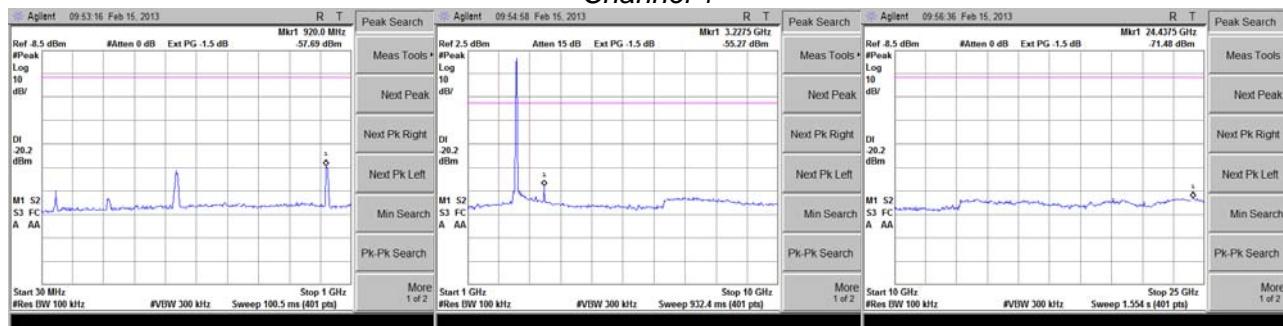
1-10 GHz

10-25 GHz

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

24 Mbps

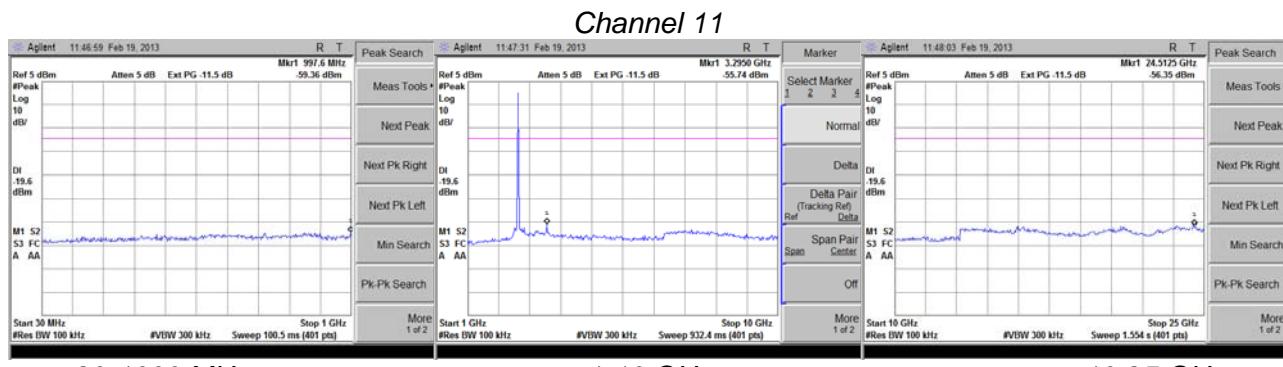
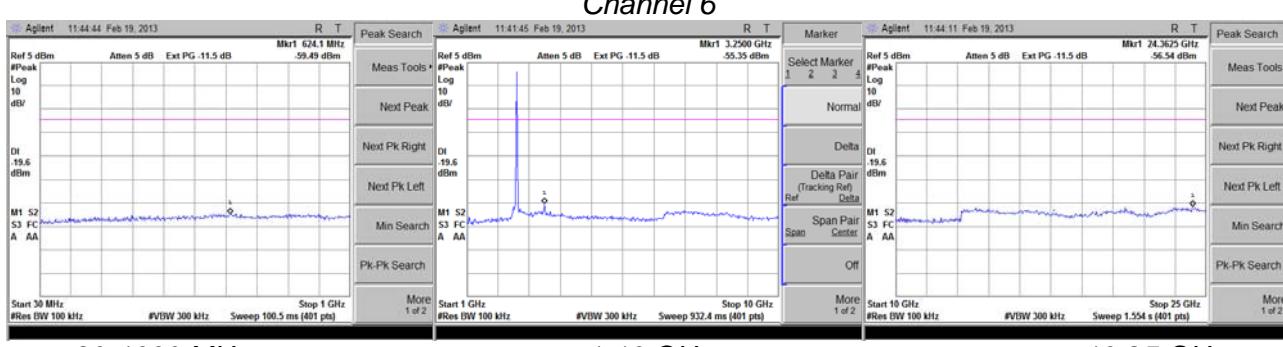
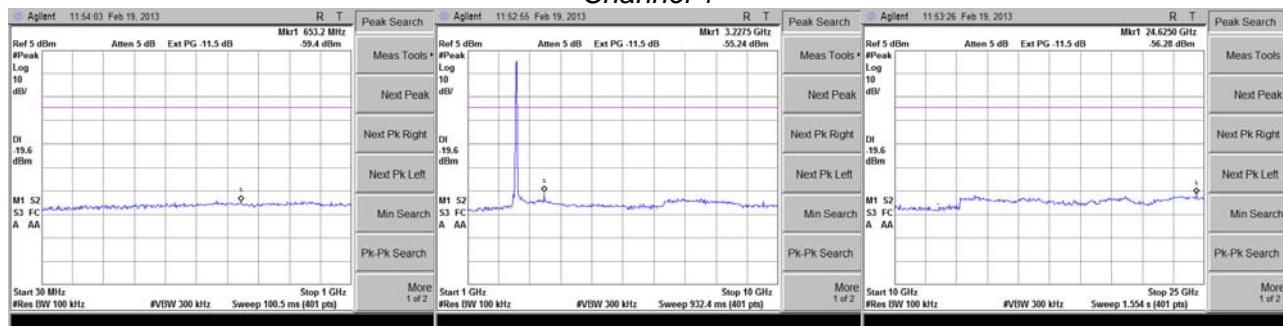
Channel 1



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EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

54 Mbps

Channel 1



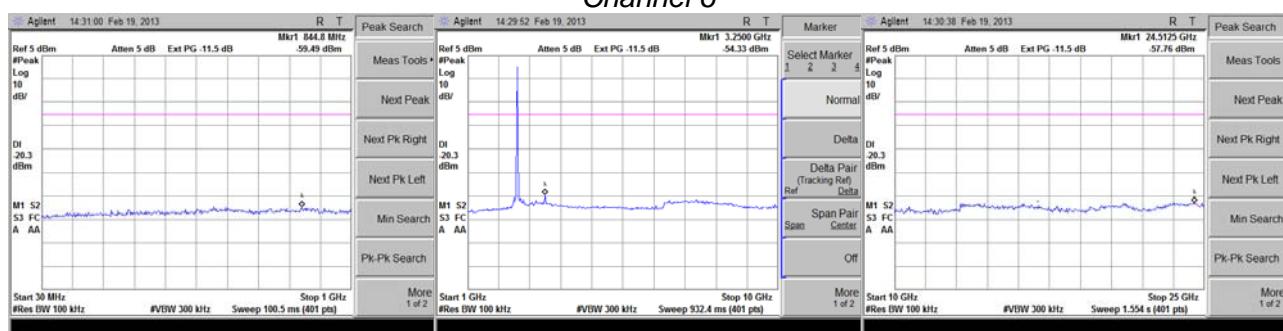
Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

MCS7

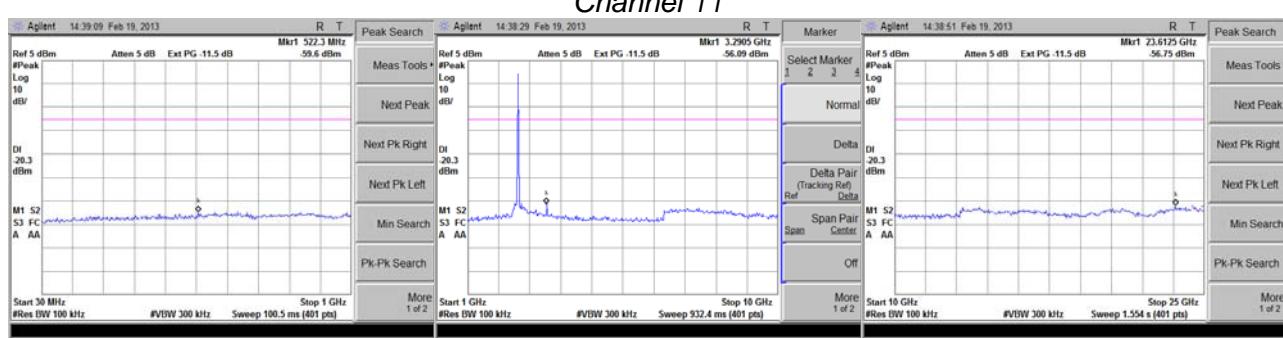
Channel 1



Channel 6



Channel 11



Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE & TEMPERATURE VARIATIONS

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=1 kHz settings while the voltage was varied. The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=3 MHz setting while the voltage was varied.

102 VAC		120 VAC		138 VAC		Channel
Power	Frequency	Power	Frequency	Power	Frequency	
13.47	2412003906	13.43	2412003886	13.25	2412003412	1
13.33	2437004145	13.41	2437003886	13.42	2437003997	6
12.74	2462007763	12.76	2462007773	12.81	2462007787	11

Channel	Maximum (Hz)	Minimum (Hz)	Freq drift (Hz)
1	2412003906	2412003412	494
6	2437004145	2437003886	259
11	2462007787	2462007763	24

APPENDIX A - Test Equipment List



Date : 28-Jan-2013

Type Test : Radiated Emissions

Job # : C-1605

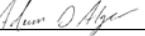
Prepared By: Adam

Customer : Ultratec

Quote # : 312296

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960147	Pre-Amp	Adv. Micro	VLA612	123101	1/6/2012	1/6/2013	Active Calibration
2	AA 960154	2.4GHz High Pass Filter	KVM	HPF-L-14186	7272-02	6/28/2012	6/28/2013	Active Calibration
3	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/6/2012	1/6/2013	Active Calibration
4	CC 000221C	Spectrum Analyzer	HP	E4407B	US39160256	6/5/2012	6/5/2013	Active Calibration
5	EE 960158	RF Preselector	Agilent	N9039A	MY46520110	6/29/2012	6/29/2013	Active Calibration
6	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/29/2012	6/29/2013	Active Calibration
7	AA 960004	Log Periodic Antenna	EMCO	93146	9512-4276	9/19/2012	9/19/2012	Active Calibration
8	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	1/15/2011	1/15/2012	Active Calibration
9	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	5/16/2012	5/16/2013	Active Calibration
10	EE 960147	Pre-Amp	Adv. Micro	VLA612	123101	1/6/2012	1/6/2013	Active Calibration
11	EE 960156	100kHz-1GHz Analog Signal Generator	Agilent	N5181A	MY49060062	6/30/2012	6/30/2013	Active Calibration
12	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro	VLA622-4	123001	1/3/2011	1/3/2012	Active Calibration

Project Engineer: 

Quality Assurance: 



Date : 28-Jan-2013

Type Test : Conducted Measurements

Job # : C-1605

Prepared By: Shane Rismeyer

Customer : Ultratec

Quote # : 312296

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaselllex	Gore	EKD00D01048.0	5546519	6/1/2011	6/1/2013	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/9/2012	5/9/2013	Active Calibration

Project Engineer: 

Quality Assurance: 



Date : 28-Jan-2013

Type Test : Conducted Emissions

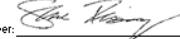
Job # : C-1605

Prepared By: Shane Rismeyer

Customer : Ultratec

Quote # : 312296

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960008	LISN	EMCO	301612NM	9701-1057	1/3/2012	1/3/2013	Active Calibration
2	EE 960158	RF Preselector	Agilent	N9039A	MY46520110	6/29/2012	6/29/2013	Active Calibration
3	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/29/2012	6/29/2013	Active Calibration
4	AA 960072	Transient Limiter	HP	11947A	3107A02515	1/3/2012	1/2/2013	Active Calibration

Project Engineer: 

Quality Assurance: 

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15	2013		
FCC Public Notice DA 00-705	2000		
RSS GEN	2010		
RSS 210	2010		

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605

APPENDIX C - Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V

APPENDIX D - Antenna Specification(s)

Godzilla Custom Antenna

Peak Gain: 1.3 dBi

VSWR: < 3 across 2.4 GHz Band

Application: CapTel Touch Phone Specific

	Flat	Side	Vertical
Low Channel	-5.7 dBi	-4.4 dBi	-1.9 dBi
Mid Channel	-5.6 dBi	-4.2 dBi	-3.1 dBi
High Channel	-4.8 dBi	-3 dBi	-2.9 dBi
Total Average Gain	-5.3 dBi	-3.8 dBi	-2.6 dBi

Table 1: Average Gain Measurements

Prepared For: Ultratec	Model Number: CT2400i	Report #: 312296
EUT: CapTel 2400i	Serial Number: Prototype	LSR Job #: C-1605