PCTEST ENGINEERING LABORATORY, INC.
6660-B Dobbin Road, Columbia, MD 21045 USA
Tel. 410.290.6652 / Fax 410.290.6554
http://www.pctestlab.com

CERTIFICATE OF COMPLIANCE
FCC PART 15.247 Bluetooth Certification

Applicant Name:
Matsushita Electric
5770 Amber Drive
Mississauga, Ontario
Canada L4W 2T3

Date of Testing:
September 08, 2009
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
0909041660.ACJ

FCC ID:	**ACJ9TGCF-U15**
APPLICANT:	**Matsushita Electric**

Model(s):	CF-U1
EUT Type:	Toughbook Model: CF-U1
Max. RF Output Power:	23.276mW (13.67dBm) Conducted
Frequency Range:	2402 – 2480MHz (Bluetooth for US)
FCC Classification:	FCC Part 15 Spread Spectrum Transmitter (DSS)
FCC Rule Part(s):	Part 15 Subpart C (15.247)

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.4-2003. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Grant Conditions: Power output listed is conducted.

PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.

Randy Ortanez
President

ACCREDITED
TESTING LABORATORY
CERTIFICATE #2041.01

TABLE OF CONTENTS

FCC PART 15.247 MEASUREMENT REPORT 3

1.0 INTRODUCTION 4

1.1 SCOPE 4

1.2 PCTEST TEST LOCATION 4

2.0 PRODUCT INFORMATION 5

2.1 EQUIPMENT DESCRIPTION 5

2.2 EMI SUPPRESSION DEVICE(S)/MODIFICATIONS 5

2.3 LABELING REQUIREMENTS 5

3.0 DESCRIPTION OF TEST 6

3.1 EVALUATION PROCEDURE 6

3.2 CONDUCTED EMISSIONS 6

3.3 RADIATED EMISSIONS 7

4.0 ANTENNA REQUIREMENTS 8

5.0 TEST EQUIPMENT CALIBRATION DATA 9

6.0 TEST RESULTS 10

6.1 SUMMARY 10

6.2 20DB BANDWIDTH MEASUREMENT 11

6.3 OUTPUT POWER MEASUREMENT 13

6.4 BAND EDGE COMPLIANCE 14

6.5 CARRIER FREQUENCY SEPARATION 16

6.6 TIME OF OCCUPANCY 17

6.7 NUMBER OF HOPPING CHANNELS 18

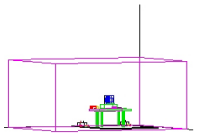
6.8 CONDUCTED SPURIOUS EMISSIONS 19

6.9 RADIATED SPURIOUS EMISSION MEASUREMENTS 22

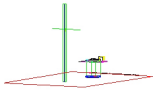
6.10 RADIATED RESTRICTED BAND EDGE MEASUREMENTS 26

6.11 LINE-CONDUCTED TEST DATA 27

7.0 CONCLUSION 29



MEASUREMENT REPORT
FCC Part 15.247



§ 2.1033 General Information

APPLICANT:	Matsushita Electric
APPLICANT ADDRESS:	5770 Amber Drive
	Mississauga, Ontario, Canada L4W 2T3
TEST SITE:	PCTEST ENGINEERING LABORATORY, INC.
TEST SITE ADDRESS:	6660-B Dobbin Road, Columbia, MD 21045 USA
FCC RULE PART(S):	Part 15 Subpart C (15.247)
BASE MODEL:	CF-U1
FCC ID:	ACJ9TGCF-U15
Test Device Serial No.:	9GKSA00076 ☐ Production ☒ Pre-Production ☐ Engineering
FCC CLASSIFICATION:	FCC Part 15 Spread Spectrum Transmitter (DSS)
Method/System:	Frequency Hopping Spread Spectrum (FHSS)
DATE(S) OF TEST:	September 08, 2009
TEST REPORT S/N:	0909041660.ACJ

Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Columbia, MD 21045, U.S.A.

- PCTEST facility is an FCC registered (PCTEST Reg. No. 90864) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (2451A-1).
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing Aid Compatibility (HAC) testing, CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.

- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (2451A-1) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS, CDMA, and EvDO wireless devices and for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO, and CDMA 1xRTT.

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission.

1.2 PCTEST Test Location

The map below shows the location of the PCTEST LABORATORY, its proximity to the FCC Laboratory, the Columbia vicinity are, the Baltimore-Washington Internt'l (BWI) airport, the city of Baltimore and the Washington, DC area. (*see Figure 1-1*).

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility in New Concept Business Park, Guilford Industrial Park, Columbia, Maryland. The site address is 6660-B Dobbin Road, Columbia, MD 21045. The test site is one of the highest points in the Columbia area with an elevation of 390 feet above mean sea level. The site coordinates are 39° 11'15" N latitude and 76° 49'38" W longitude. The facility is 1.5 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. There are no FM or TV transmitters within 15 miles of the site. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4-2003 on January 27, 2006.

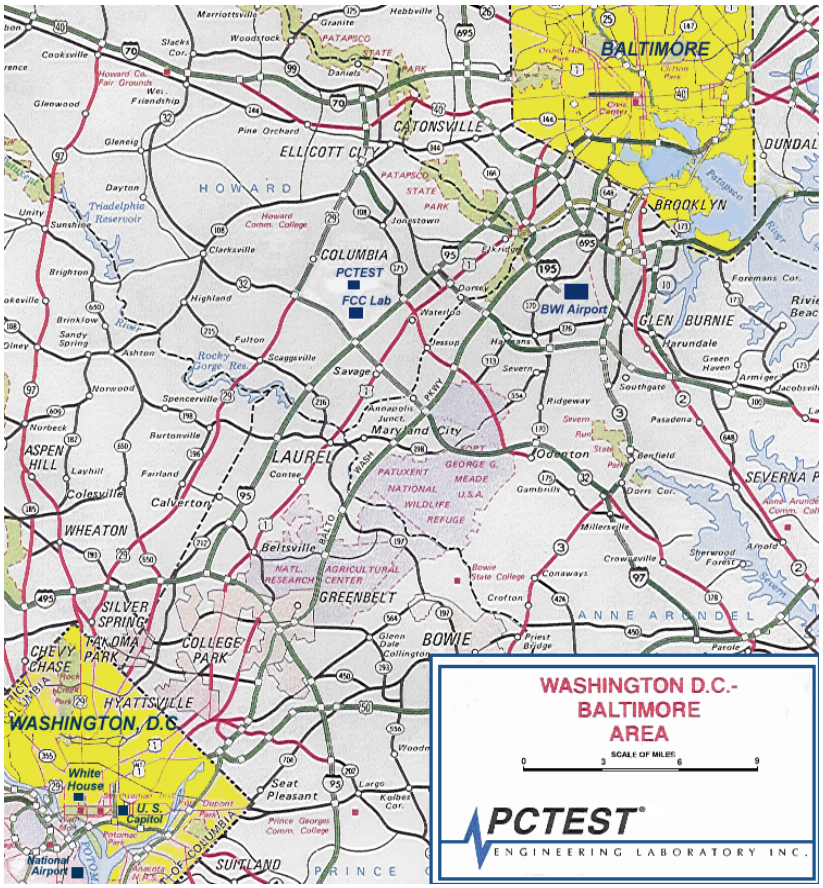


Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Panasonic Toughbook Model: CF-U1 FCC ID: ACJ9TGCF-U15**. This unit supports Bluetooth version 2.0 with enhanced data rates. The test data contained in this report pertains only to the emissions due to the EUT's Bluetooth transmitter.

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:

  A) The hopping sequence is pseudorandom
  B) All channels are used equally on average
  C) The receiver input bandwidth equals the transmit bandwidth
  D) The receiver hops in sequence with the transmit signal

- 15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

- 15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

- The EUT consisted of the following component(s):

Manufacturer / Base Model	FCC ID	Description
Panasonic / Model: CF-U1	ACJ9TGCF-U15	Toughbook Model: CF-U1
Alps / Model: UGNZA	N/A	Bluetooth Module
Sierra / Model: Gobi2000	N7NGOBI2	WWAN EVDO rev. A and HSPA unified module
Intel / Model: 512AN_MMW	N/A	802.11a/b/g/n Wireless LAN Module

Table 2-1. EUT Equipment Description

2.2 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

2.3 Labeling Requirements

Per 15.19; Docket 95-19

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphlet supplied to the user and be readily visible to the purchaser at the time of purchase. However, when the device is so small wherein placement of the label with specified statement is not practical, only the trade name and FCC ID must be displayed on the device per Section 15.19(b)(2).

Please see attachment for FCC ID label and label location.

3.0 DESCRIPTION OF TEST

3.1 Evaluation Procedure

The measurement procedure described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz (ANSI C63.4-2003) and FCC Public Notice DA 00-705 dated March 30, 2000 entitled "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems" were used in the measurement of the **Panasonic Toughbook Model: CF-U1 FCC ID: ACJ9TGCF-U15.**

Deviation from measurement procedure…….....None

3.2 Conducted Emissions

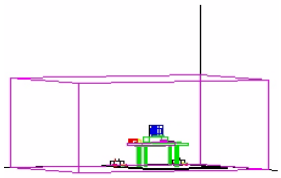


Figure 3-1. Shielded Enclosure Line-Conducted Test Facility

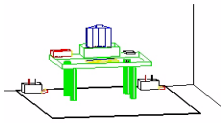


Figure 3-2. Line Conducted Emission Test Set-Up

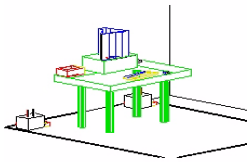


Figure 3-3. Wooden Table & Bonded LISNs

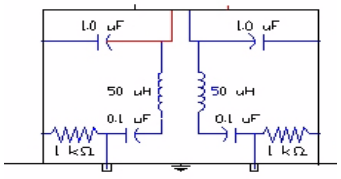


Figure 3-4. LISN Schematic Diagram

The line-conducted facility is located inside a 16'x20'x10' shielded enclosure, manufactured by Ray Proof Series 81 (*see Figure 3-1*). The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-5. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 1.5m away from the sidewall of the shielded room (*see Figure 3-2*). Solar Electronics and EMCO Model 3725/2 (10kHz-30MHz) 50Ω/50μH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room (*see Figure 3-3).* The EUT is powered from the Solar LISN and the support equipment is powered from the EMCO LISN. Power to the LISNs are filtered by a high-current high-insertion loss Ray Proof power line filter (100dB 14Hz-10GHz). The purpose of the filter is to attenuate ambient signal interference and this filter is also bonded to the shielded enclosure. All electrical cables are shielded by braided tinned copper zipper tubing with an inner diameter of ½". If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the Solar LISN. The LISN schematic diagram is shown (*see Figure 3-4*). All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion). Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer to determine the frequency producing the maximum EME from the EUT.

The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to CISPR quasi-peak and average mode. The bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each EME emission. Each emission was maximized by: switching power lines; varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and/or support equipment, and powering the monitor from the floor mounted outlet box and the computer aux AC outlet, if applicable; whichever determined the worst-case emission. Photographs of the worst-case emission can be seen in the test setup photographs. Each EME reported was calibrated using the Agilent E8257D (250kHz – 20GHz) PSG Signal Generator.

3.3 Radiated Emissions

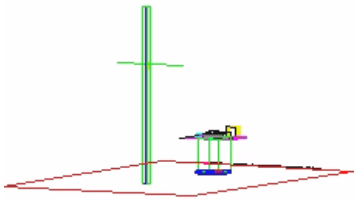


Figure 3-5. 3-Meter Test Site

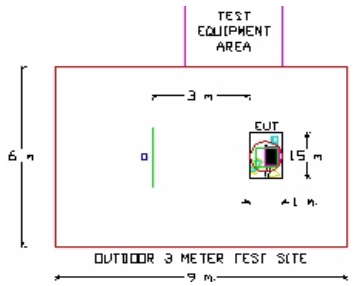


Figure 3-6. Dimensions of Outdoor Test Site

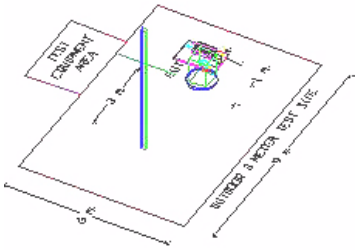


Figure 3-7. Turntable and System Setup

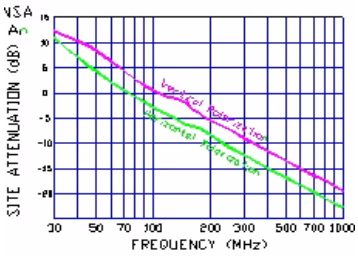


Figure 3-8. Normalized Site Attenuation Curves (H&V)

Preliminary measurements were made indoors at 1-meter using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequency producing the maximum EME. Appropriate precaution was taken to ensure that all EME from the EUT were maximized and investigated. The system configuration, clock speed, mode of operation or video resolution, and turntable azimuth with respect to the antenna was noted for each frequency found. The spectrum was scanned from 30 to 200 MHz using a bi-conical antenna and from 200 to 1000 MHz using a log-spiral antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used.

Final measurements were made outdoors at 3-meter test range using Roberts™ Dipole antennas or horn antennas (*see Figure 3-5*). The test equipment was placed on a wooden and plastic bench situated on a 1.5m x 2m area adjacent to the measurement area (*see Figure 3-6*). Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The detector function was set to CISPR quasi-peak mode and the bandwidth of the spectrum analyzer was set to 100kHz for frequencies below 1GHz or 1MHz for frequencies above 1GHz. Above 1GHz the detector function was set to average mode (RBW = 1MHz, VBW = 10Hz).

The half-wave dipole antenna was tuned to the frequency found during preliminary radiated measurements. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8-meter high non-metallic 1 x 1.5 meter table (*see Figure 3-7*). The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each EME emission. The turntable containing the system was rotated and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by: varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and/or support equipment, and powering the monitor from the floor mounted outlet box and the computer aux AC outlet, if applicable; and changing the polarity of the antenna, whichever determined the worst-case emission. Photographs of the worst-case emission can be seen in the test setup photographs. Each EME reported was calibrated using the Agilent E8257D (250kHz – 20GHz) PSG Signal Generator. The Theoretical Normalized Site Attenuation Curves for both horizontal and vertical polarization are shown in Figure 3-8.

4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

- The antennas of the Panasonic Toughbook Model: CF-U1 are **permanently attached.**
- There are no provisions for connection to an external antenna.

Conclusion:

The **Panasonic Toughbook Model: CF-U1 FCC ID: ACJ9TGCF-U15** unit complies with the requirement of §15.203.

Ch.	Frequency (MHz)
00	2402
:	:
39	2441
:	:
78	2480

Table 4-1. Frequency/ Channel Operations

5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST).

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	263-10dB	(DC-18GHz) 10 dB Attenuator	N/A		N/A	N/A
-	No.165	(30MHz - 1000MHz) RG58 Coax Cable	N/A		N/A	N/A
-	No.166	(1000-26500MHz) Microwave RF Cable	N/A		N/A	N/A
-	No.167	(100kHz - 100MHz) RG58 Coax Cable	N/A		N/A	N/A
Agilent	11713A	Attenuation/Switch Driver	12/4/2008	Annual	12/4/2009	3439A02645
Agilent	8447D	Broadband Amplifier	N/A		N/A	1937A03348
Agilent	8447D	Broadband Amplifier	N/A		N/A	2443A01900
Agilent	8449B	(1-26.5GHz) Pre-Amplifier	12/4/2008	Annual	12/4/2009	3008A00985
Agilent	8495A	(0-70dB) DC-4GHz Attenuator	N/A		N/A	N/A
Agilent	85650A	Quasi-Peak Adapter	12/4/2008	Annual	12/4/2009	3303A01872
Agilent	85650A	Quasi-Peak Adapter	3/24/2009	Annual	3/24/2010	2043A00301
Agilent	8566B	(100Hz-22GHz) Spectrum Analyzer	3/24/2009	Annual	3/24/2010	2618A02866
Agilent	8566B	(100Hz-22GHz) Spectrum Analyzer	3/24/2009	Annual	3/24/2010	2542A11898
Agilent	8566B	(100Hz-22GHz) Spectrum Analyzer	12/5/2008	Annual	12/5/2009	3638A08713
Agilent	E4407B	ESA Spectrum Analyzer	3/24/2009	Annual	3/24/2010	US39210313
Agilent	E4448A	PSA (3Hz-50GHz) Spectrum Analyzer	12/5/2008	Annual	12/5/2009	US42510244
Agilent	E8257D	(250kHz-20GHz) Signal Generator	3/25/2009	Biennial	3/25/2011	MY45470194
Agilent	N9020A	MXA Signal Analyzer	9/17/2008	Annual	9/17/2009	US46470561
Agilent	N4010A	Wireless Connectivity Test Set	4/29/2009	Annual	4/29/2010	GB46170464
Emco	3115	Horn Antenna (1-18GHz)	9/24/2007	Biennial	9/24/2009	9704-5182
Emco	3115	Horn Antenna (1-18GHz)	10/4/2007	Biennial	10/4/2009	9205-3874
Emco	3116	Horn Antenna (18 - 40GHz)	9/9/2008	Triennial	9/9/2011	9203-2178
MiniCircuits	VHF-3100+	High Pass Filter	N/A		N/A	30721
Pasternack	PE2209-10	Bidirectional Coupler	N/A		N/A	N/A
Pasternack	PE7000-6	6 dB Attenuator	N/A		N/A	N/A
Rohde & Schwarz	NRVD	Dual Channel Power Meter	8/20/2008	Biennial	8/20/2010	101695
Rohde & Schwarz	NRV-Z32	Peak Power Sensor (100uW-2W)	12/5/2008	Biennial	12/5/2010	100155
Rohde & Schwarz	NRV-Z33	Peak Power Sensor (1mW-20W)	12/5/2008	Biennial	12/5/2010	100004
Solar Electronics	8012-50-R-24-BNC	LISN	11/8/2007	Biennial	11/8/2009	310233
Sunol	DRH-118	Horn Antenna (1 - 18GHz)	5/14/2009	Biennial	5/14/2011	A050307
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	7/17/2009	Biennial	7/17/2011	A051107
Rohde & Schwarz	CMU200	Base Station Simulator	6/12/2009	Annual	6/12/2010	836536/0005
Rohde & Schwarz	FSQ 26	Spectrum Analyzer	9/29/2008	Annual	9/29/2009	200452

Table 5-1. Annual Test Equipment Calibration Schedule

6.0 TEST RESULTS

6.1 Summary

Company Name: Matsushita Electric

FCC ID: ACJ9TGCF-U15

Method/System: Frequency Hopping Spread Spectrum (FHSS)

Number of Channels: 79

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
TRANSMITTER MODE (Tx)					
15.247(a)(1)(iii)	20dB Bandwidth	< 1 MHz only if using less than 15 non-overlapping channels	CONDUCTED	PASS	Section 6.2
15.247(b)(1)	Peak Transmitter Output Power	< 1 Watt if ≥ 75 non-overlapping channels used		PASS	Section 6.3
15.247(a)(1)	Channel Separation	> 2/3 of 20 dB BW for systems with Output Power < 125mW		PASS	Section 6.5
15.247(a)(1)(iii)	Number of Channels	> 15 Channels		PASS	Section 6.7
15.247(a)(1)(iii)	Time of Occupancy	< 0.4 sec in 31.6 sec period		PASS	Section 6.6
15.247(d)	Band Edge / Out-of-Band Emissions	Conducted < 20dBc		PASS	Section 6.4, Section 6.8
15.205 15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209 (RSS-210 table 3 limits)	RADIATED	PASS	Section 6.9, Section 6.10
15.207	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits or < RSS-Gen table 2 limits	LINE CONDUCTED	PASS	Section 6.11

Table 6-1. Summary of Test Results

6.2 20dB Bandwidth Measurement

§15.247 (a)(1)(iii)

The bandwidth at 20dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies. All data rates were investigated and the greatest 20dB bandwidth was found with the EUT transmitting at a data rate of 2.0Mbps. ***The maximum permissible 20dB bandwidth is 1 MHz, unless more than 15 non-overlapping channels are employed.***

Frequency [MHz]	Data Rate [Mbps]	Channel No.	20dB Bandwidth Test Results	
			[kHz]	Pass/Fail
2402	2.0	0	1266	Pass
2441	2.0	39	1260	Pass
2480	2.0	78	1257	Pass

Table 6-2. Conducted 20dB Bandwidth Measurements

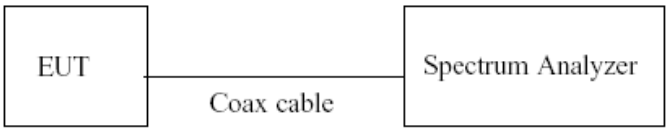
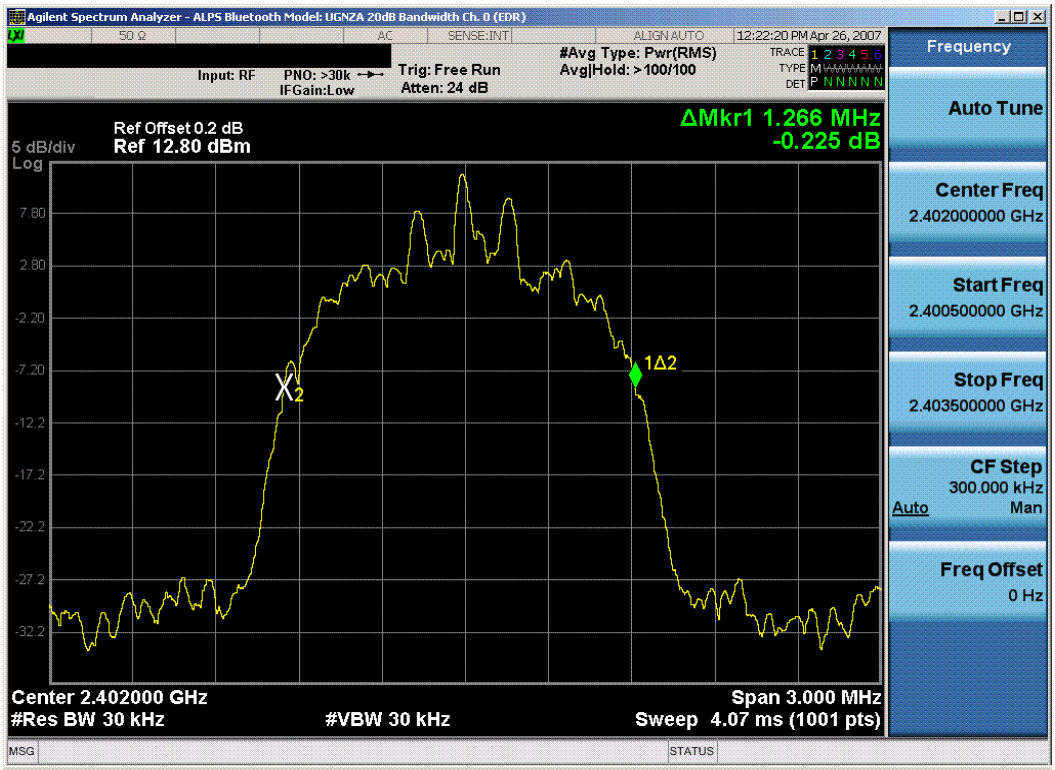
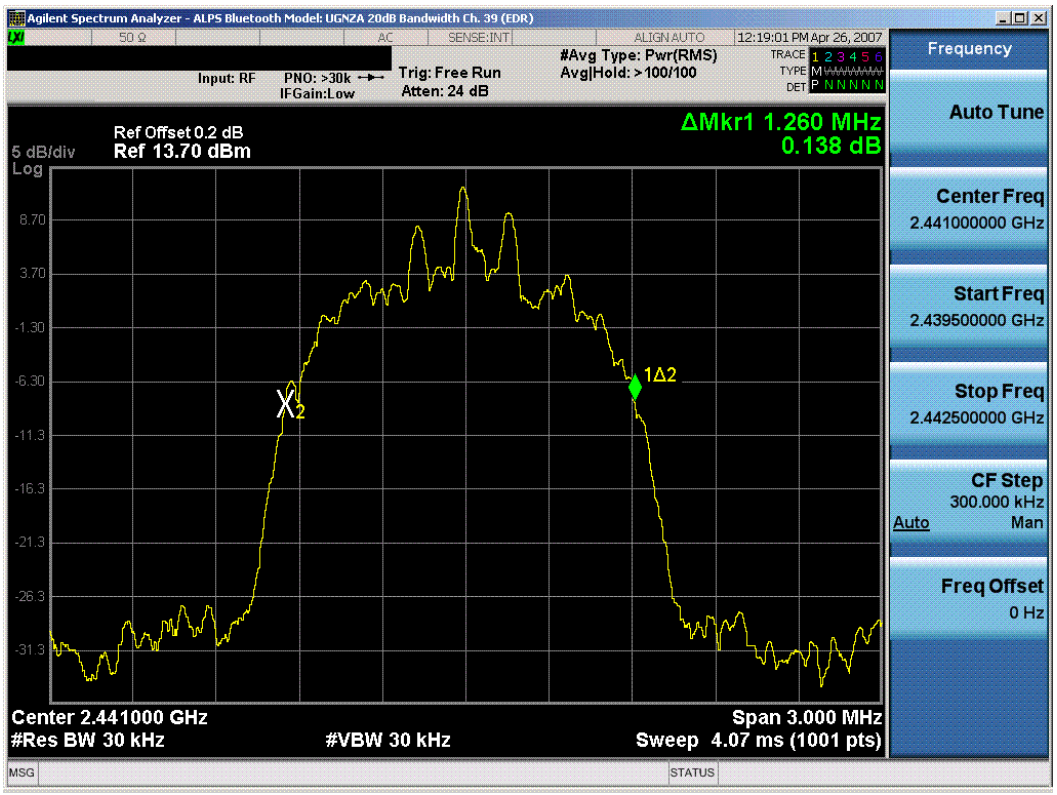


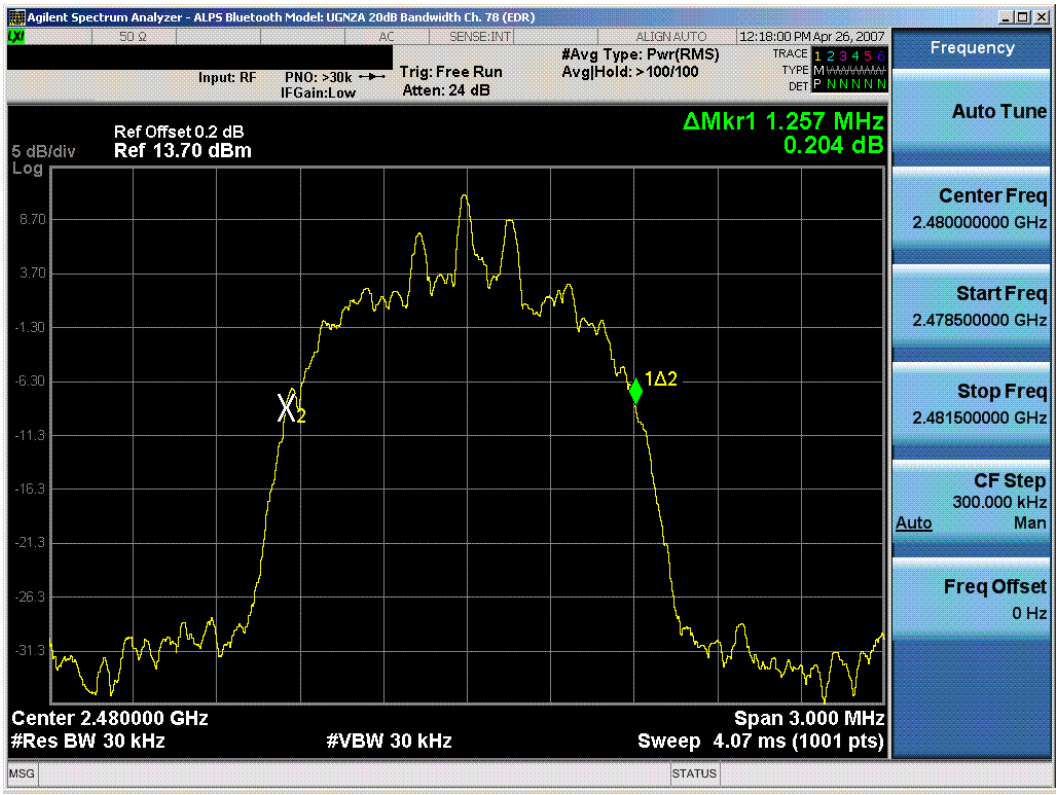
Figure 6-1. Test Instrument & Measurement Setup



Plot 6-1. 20dB Bandwidth Plot (Bluetooth 2.0 with Enhanced Data Rates – Ch. 0)



Plot 6-2. 20dB Bandwidth Plot (Bluetooth 2.0 with Enhanced Data Rates – Ch. 39)



Plot 6-3. 20dB Bandwidth Plot (Bluetooth 2.0 with Enhanced Data Rates – Ch. 78)

6.3 Output Power Measurement

§15.247 (b)(1)

Measurement is made while the EUT is operating in non-hopping transmission mode. The powers shown below are peak powers measured using a Bluetooth signaling test set (Agilent Model: N4010A). ***The maximum permissible output power is 1 Watt.***

Note:

This unit was tested with all possible data rates, bit schemes and packet type combinations and the highest power is reported with the unit transmitting with a DH5 packet type and a pattern type set to 10101010 at 1.0Mbps.

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Conducted Power [DH5 Packet Type]	
			[dBm]	[mW]
2402	1.0	0	12.81	19.094
2441	1.0	39	13.67	23.254
2480	1.0	78	13.67	23.276

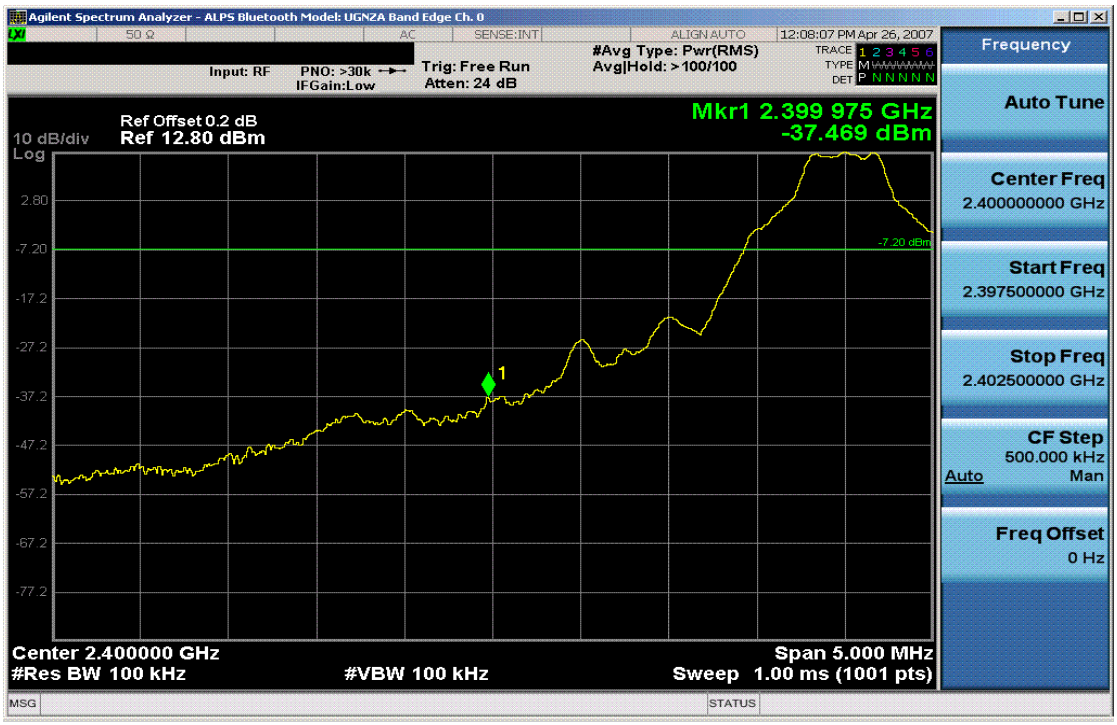
Table 6-3. Conducted Output Power Measurements

Figure 6-2. Test Instrument & Measurement Setup

6.4 Band Edge Compliance

§15.247 (d)

Measurement is taken at the highest point located outside of the emission bandwidth. ***The maximum permissible emission level is 20 dBc. Any emission lying outside of the emission bandwidth and in a restricted band is subject to a field strength limit specified in Section 15.209 of the Title 47 CFR.***



Plot 6-4. Band Edge Plot (Bluetooth – Ch. 0)

Plot 6-5. Band Edge Plot (Bluetooth – Ch. 78)

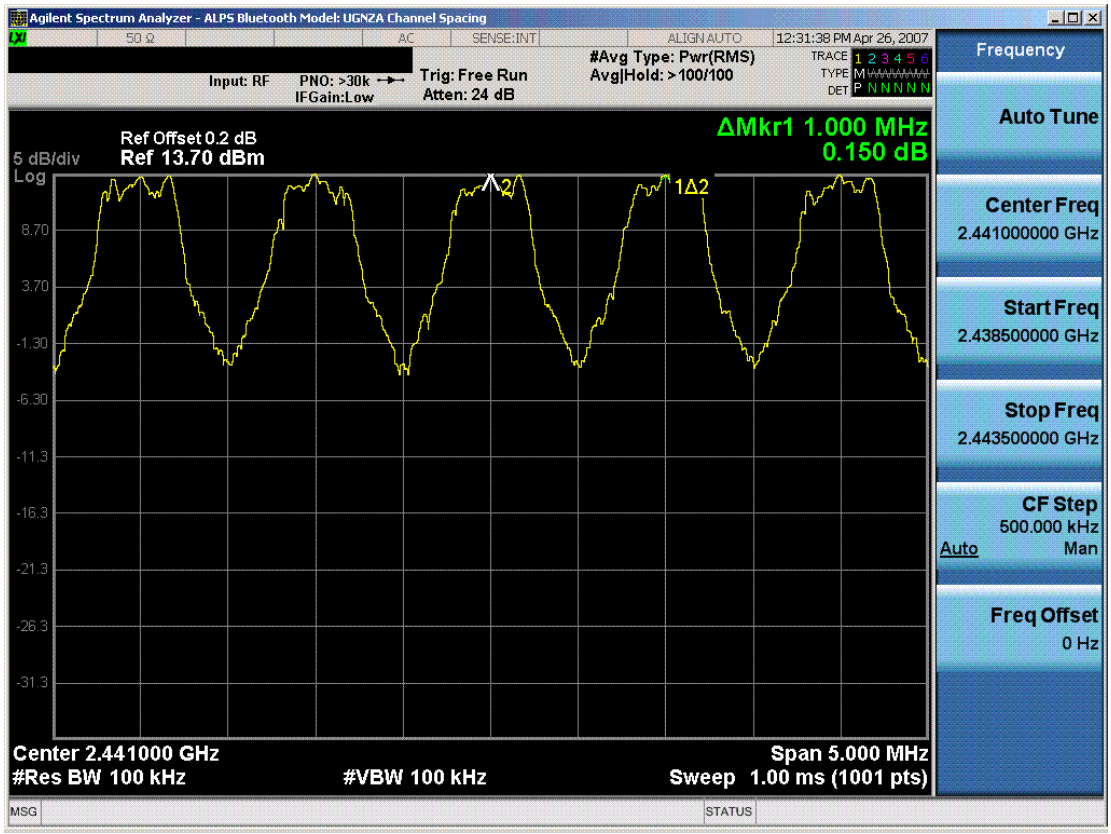
Plot 6-6. Band Edge Plot (Bluetooth 2.0 with Enhanced Data Rates – Ch. 0)

Plot 6-7. Band Edge Plot (Bluetooth 2.0 with Enhanced Data Rates – Ch. 78)

6.5 Carrier Frequency Separation

§15.247 (a)(1)

Measurement is made with EUT operating in hopping mode. ***The minimum permissible channel separation for this system is 2/3 the value of the 20dB BW, which is equal to (2/3) x [1266 kHz] = 0.844 MHz.***

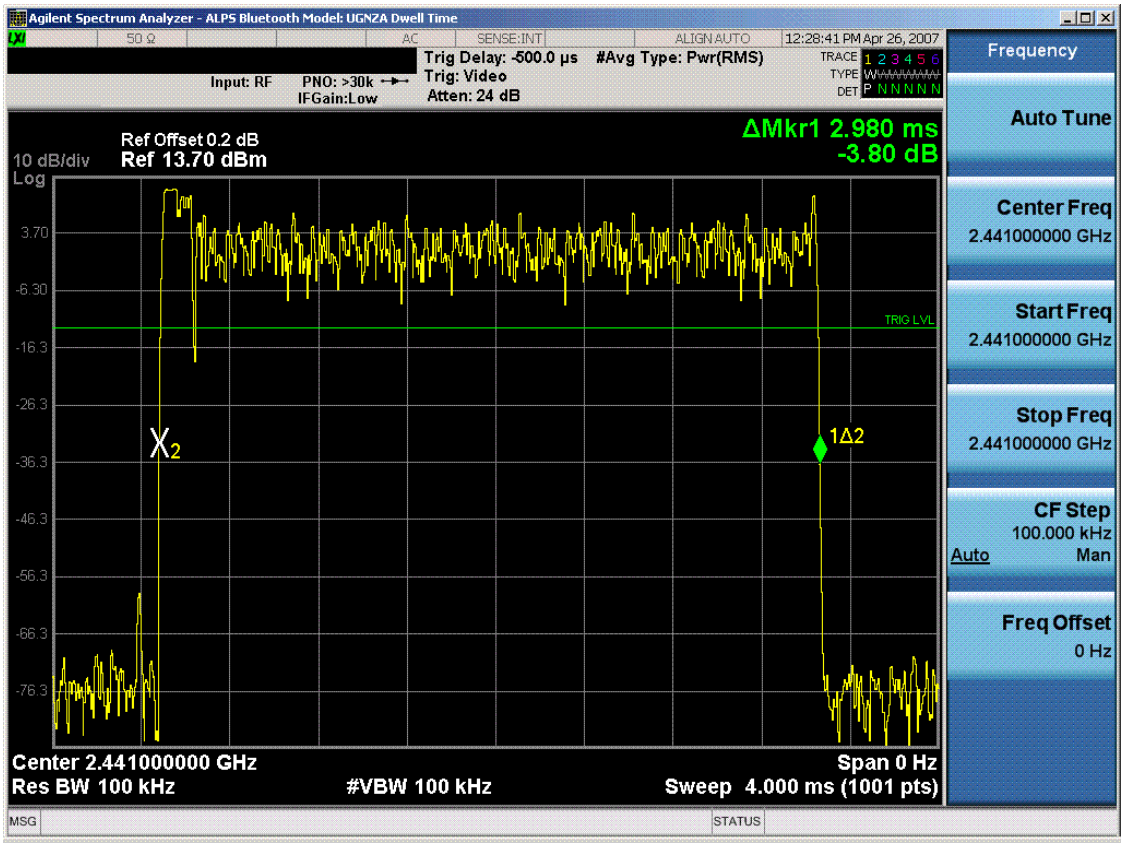


Plot 6-8. Channel Spacing Plot (Bluetooth)

6.6 Time of Occupancy

§15.247 (a)(1)(iii)

Measurement is made while EUT is operating in hopping mode with the spectrum analyzer set to zero span. ***The maximum permissible time of occupancy is 400 ms within a period of 400ms multiplied by the number of hopping channels employed.***



Plot 6-9. Time of Occupancy Plot (Bluetooth)

Sample Calculation

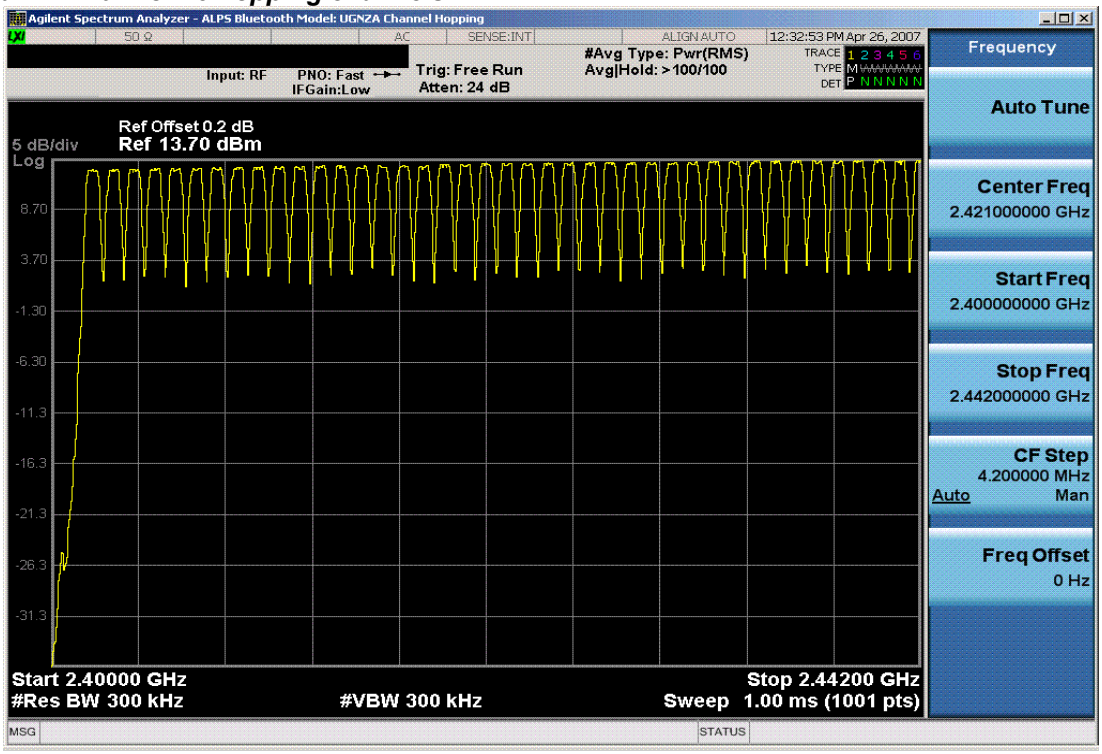
Time of Occupancy for one pulse width = 2ms.

- 400ms x 79 hopping channels = 31.6sec
- 2ms x 79 hopping channels = 158ms (total duration of all channels)
- 31.6sec / 158ms = 200 (number of times one channel transmits within a 31.6sec time frame)
- 200 x 2ms = 400ms (total duration of time that one channel transmits within a 31.6sec time frame)

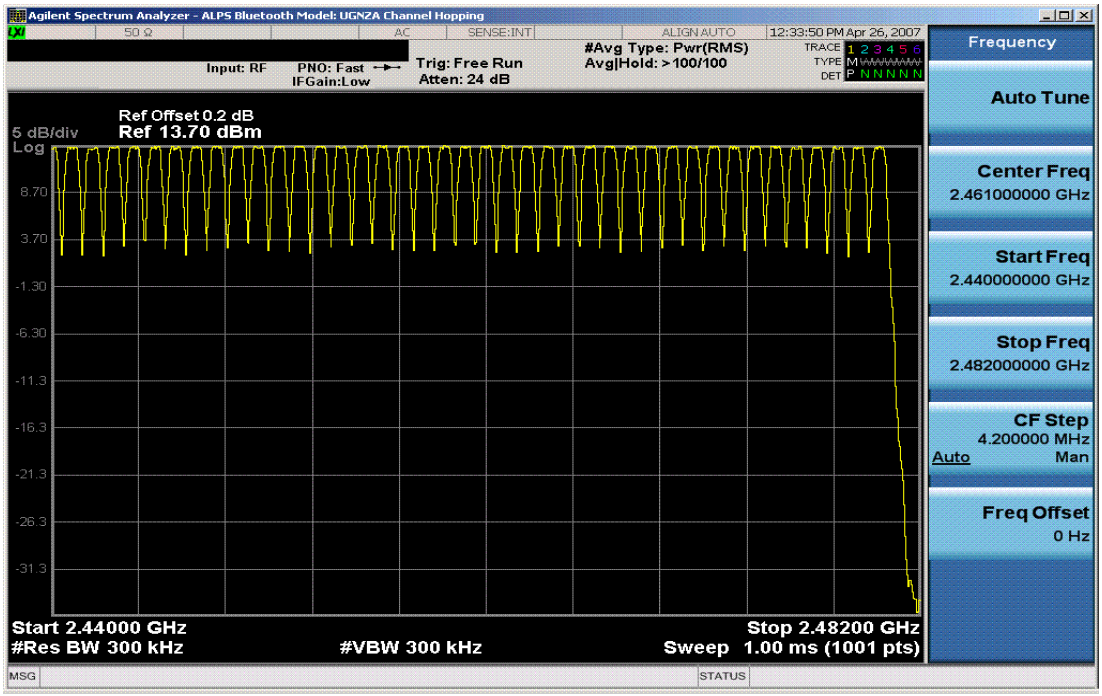
6.7 Number of Hopping Channels

§15.247 (a)(1)(iii)

Measurement is made while EUT is operating in hopping mode. ***This frequency hopping system must employ a minimum of 15 hopping channels.***



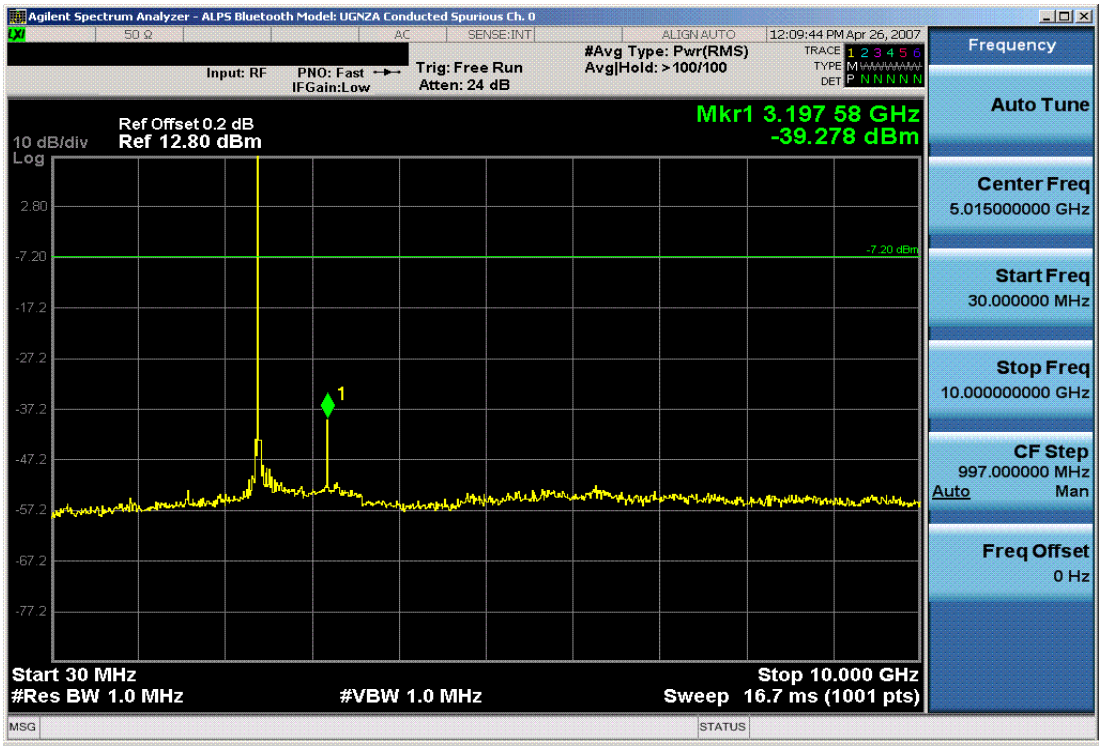
Plot 6-10. Low End Spectrum Channel Hopping Plot (Bluetooth)



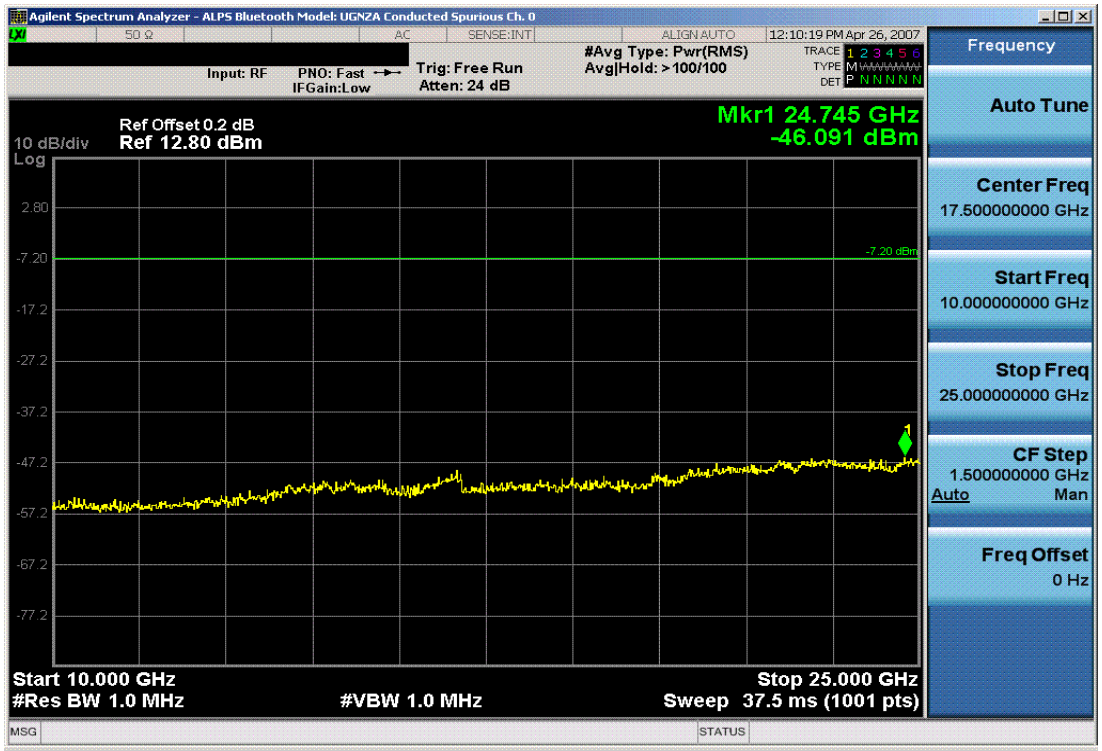
Plot 6-11. High End Spectrum Channel Hopping Plot (Bluetooth)

6.8 Conducted Spurious Emissions

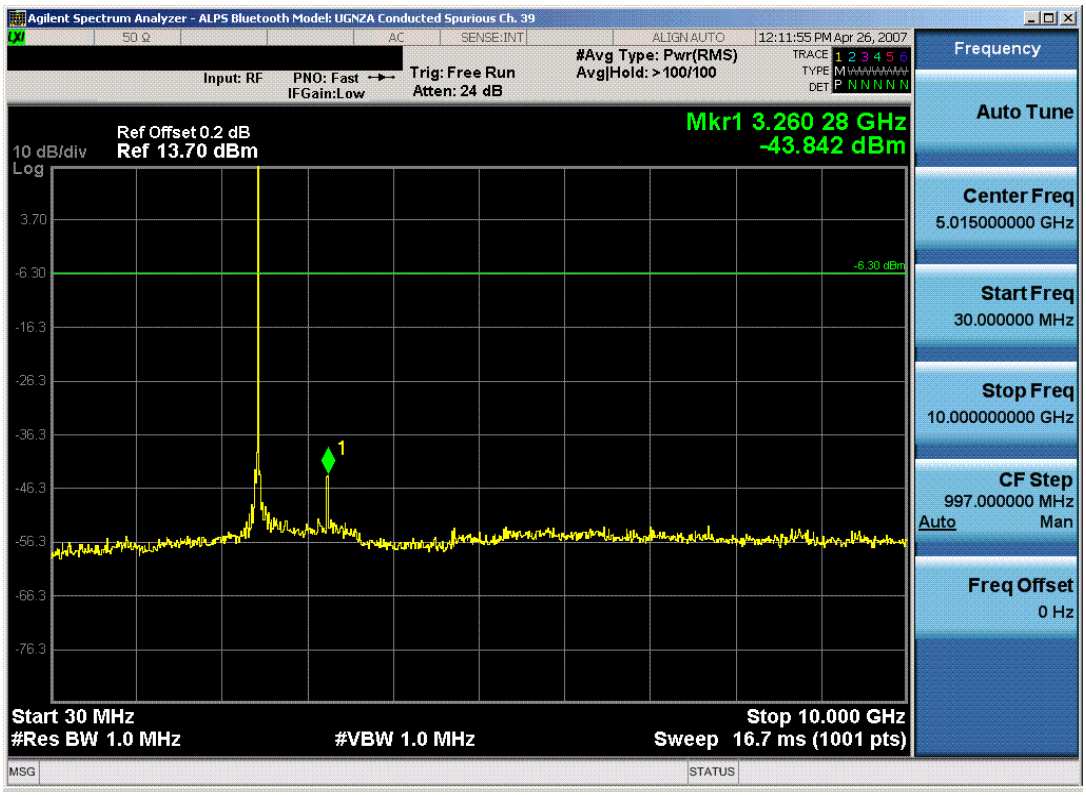
§15.247 (d)



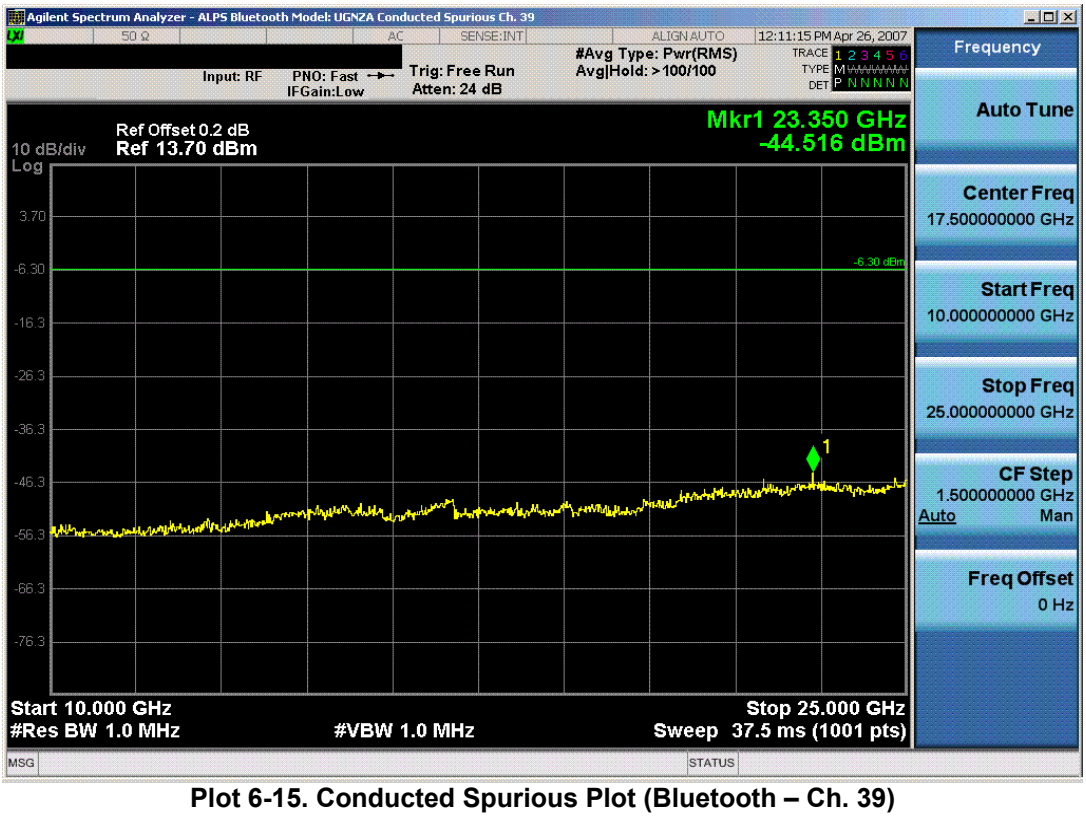
Plot 6-12. Conducted Spurious Plot (Bluetooth – Ch. 0)



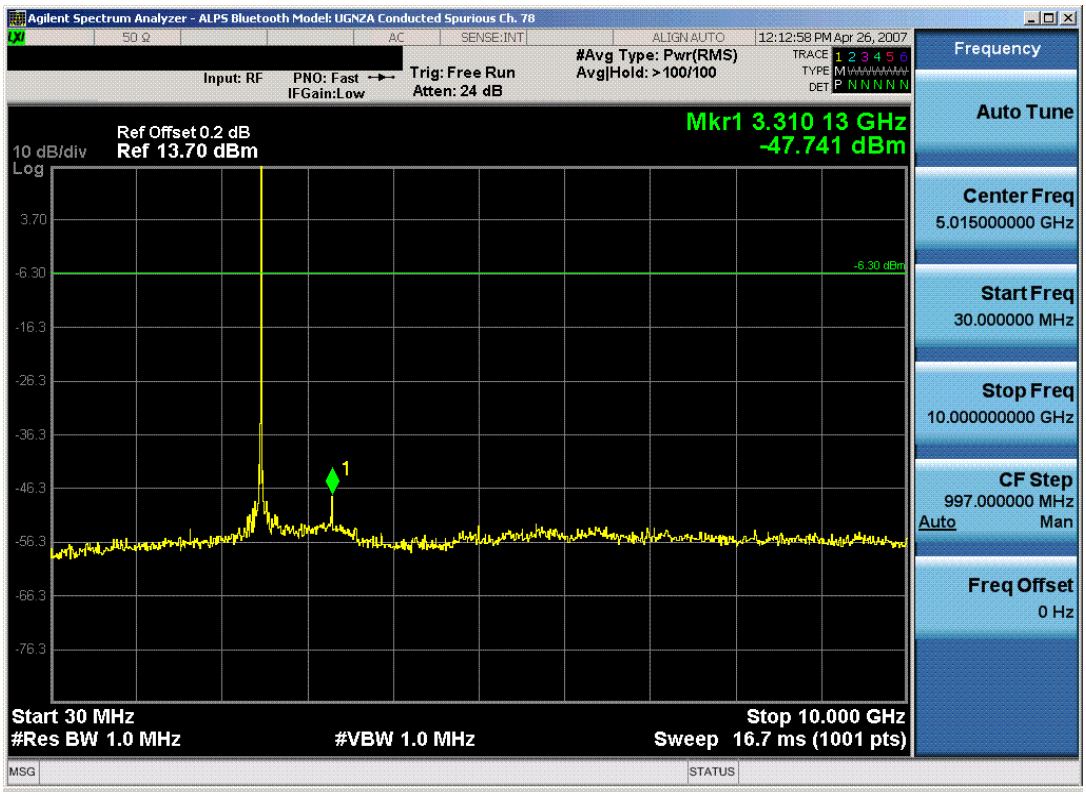
Plot 6-13. Conducted Spurious Plot (Bluetooth – Ch. 0)



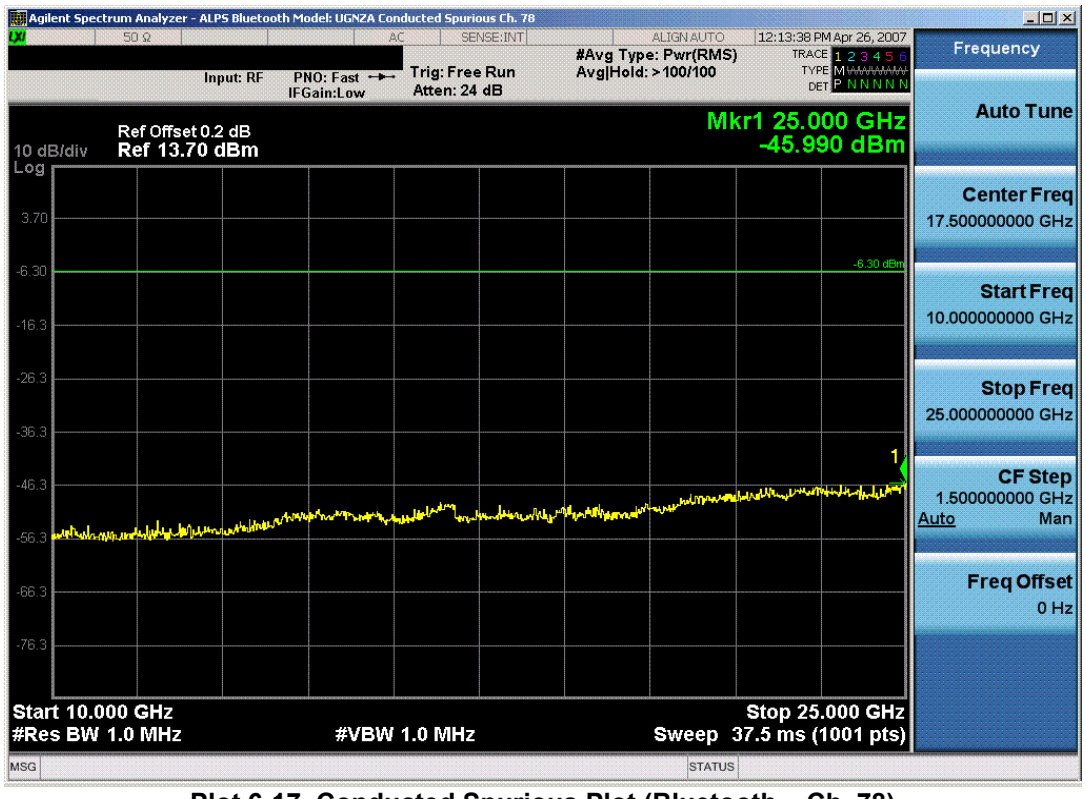
Plot 6-14. Conducted Spurious Plot (Bluetooth – Ch. 39)



Plot 6-15. Conducted Spurious Plot (Bluetooth – Ch. 39)



Plot 6-16. Conducted Spurious Plot (Bluetooth – Ch. 78)



Plot 6-17. Conducted Spurious Plot (Bluetooth – Ch. 78)

6.9 Radiated Spurious Emission Measurements

§15.247 (d) / §15.205 & §15.209

The EUT was tested from 9kHz and up to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average measurement was used, using RBW = 1MHz, VBW = 1/τ Hz, where τ is the Bluetooth pulse width in seconds, and linearly polarized horn antennas. All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 6-4 per Section 15.209. This unit was tested with all possible data rates, bit schemes and packet type combinations and the highest power is reported with the unit transmitting with a DH5 packet type and a pattern type set to 10101010 at 1.0Mbps.

Frequency	Field Strength [μV/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 6-4. Radiated Limits

Sample Calculation

- Field Strength Level $_{[dB\mu V/m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB]}$ + Duty Cycle Correction $_{[dB]}$

Notes:

- AFCL = Antenna Factor $_{[dB]}$ + Cable Loss $_{[dB]}$
- Duty Cycle Correction Factor Calculation:
  - Time to cycle through all channels = $\Delta t = \tau_{[ms]}$ x 79 channels = 235.42ms, where τ = pulse width
  - 100ms / $\Delta t_{[ms]}$ = *H* → Round up to next highest integer, to account for worst case, *H'* = *1*
  - Worst Case Dwell Time = $\tau_{[ms]}$ x *H'* = 2.98ms
  - Duty Cycle Correction = 20log(Worst Case Dwell Time/100ms) $_{[dB]}$ = -30.516dB

Radiated Spurious Emission Measurements (Cont'd)

§15.247 (d) / §15.205 & §15.209

Mode: Bluetooth

Measurement Distance: 3 Meters

Operating Frequency: 2402MHz

Channel: 0

Frequency [MHz]	Analyzer Level [dBm]	Detector	Pol [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBμV/m]	Limit [dBμV/m]	Margin [dB]
4804.00	-87.11	Avg	H	41.33	-30.52	30.70	53.98	-23.28
4804.00	-76.41	Peak	H	41.33	0.00	71.92	73.98	-2.06
12010.00	-135.00	Avg	H	51.86	0.00	23.86	53.98	-30.12
12010.00	-125.00	Peak	H	51.86	0.00	33.86	73.98	-40.12

Table 6-5. Radiated Measurements

NOTES:

1. All emissions shown lie in the restricted bands specified in §15.205 and are below the limit shown in Table 6-4.

2. Average Measurements > 1GHz using RBW = 1MHz and VBW = 1/τ Hz, where τ = pulse width in seconds.

3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.

4. The EUT is supplied with nominal AC voltage and/or a new/fully-recharged battery.

5. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported. No significant emissions were found beyond the fifth harmonic for this device.

6. Levels at - 135 dBm represent the analyzer noise floor and signify that no emission was detected.

7. Above 960MHz the limit is 500 μV/m (54dBμ/m) at 3 meters radiated.

Radiated Spurious Emission Measurements (Cont'd)

§15.247 (d) / §15.205 & §15.209

Mode: Bluetooth

Measurement Distance: 3 Meters

Operating Frequency: 2441MHz

Channel: 39

Frequency [MHz]	Analyzer Level [dBm]	Detector	Pol [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBμV/m]	Limit [dBμV/m]	Margin [dB]
4882.00	-84.18	Avg	H	41.58	-30.52	33.89	53.98	-20.09
4882.00	-79.58	Peak	H	41.58	0.00	69.00	73.98	-4.98
7323.00	-94.07	Avg	H	46.66	-30.52	29.08	53.98	-24.90
7323.00	-83.27	Peak	H	46.66	0.00	70.39	73.98	-3.59
12205.00	-135.00	Avg	H	51.80	0.00	23.80	53.98	-30.18
12205.00	-125.00	Peak	H	51.80	0.00	33.80	73.98	-40.18

Table 6-6. Radiated Measurements

NOTES:

1. All emissions shown lie in the restricted bands specified in §15.205 and are below the limit shown in Table 6-4.

2. Average Measurements > 1GHz using RBW = 1MHz and VBW = 1/τ Hz, where τ = pulse width in seconds.

3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.

4. The EUT is supplied with nominal AC voltage and/or a new/fully-recharged battery.

5. The spectrum is measured from 9kHz to the 10^{th} harmonic and the worst-case emissions are reported. No significant emissions were found beyond the fifth harmonic for this device.

6. Levels at - 135 dBm represent the analyzer noise floor and signify that no emission was detected.

7. Above 960MHz the limit is 500 μV/m (54dBμ/m) at 3 meters radiated.

Radiated Spurious Emission Measurements (Cont'd)

§15.247 (d) / §15.205 & §15.209

Mode: Bluetooth

Measurement Distance: 3 Meters

Operating Frequency: 2480MHz

Channel: 78

Frequency [MHz]	Analyzer Level [dBm]	Detector	Pol [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBμV/m]	Limit [dBμV/m]	Margin [dB]
4960.00	-82.25	Avg	H	41.83	-30.52	36.07	53.98	-17.91
4960.00	-78.25	Peak	H	41.83	0.00	70.59	73.98	-3.39
7440.00	-92.33	Avg	H	46.72	-30.52	30.87	53.98	-23.10
7440.00	-82.83	Peak	H	46.72	0.00	70.89	73.98	-3.09
12400.00	-135.00	Avg	H	51.74	0.00	23.74	53.98	-30.24
12400.00	-125.00	Peak	H	51.74	0.00	33.74	73.98	-40.24

Table 6-7. Radiated Measurements

NOTES:

1. All emissions shown lie in the restricted bands specified in §15.205 and are below the limit shown in Table 6-4.

2. Average Measurements > 1GHz using RBW = 1MHz and VBW = 1/τ Hz, where τ = pulse width in seconds.

3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.

4. The EUT is supplied with nominal AC voltage and/or a new/fully-recharged battery.

5. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported. No significant emissions were found beyond the fifth harmonic for this device.

6. Levels at - 135 dBm represent the analyzer noise floor and signify that no emission was detected.

7. Above 960MHz the limit is 500 μV/m (54dBμ/m) at 3 meters radiated.

6.10 Radiated Restricted Band Edge Measurements

§15.205 / §15.209

Mode: Bluetooth

Measurement Distance: 3 Meters

Operating Frequency: 2480MHz

Channel: 78

Frequency [MHz]	Analyzer Level [dBm]	Detector	Pol [H/V]	AFCL [dB]	Duty Cycle Correction [dB]	Field Strength [dBμV/m]	Limit [dBμV/m]	Margin [dB]
2483.60	-91.51	Avg	H	34.70	-30.52	19.68	53.98	-34.30
2483.60	-79.01	Peak	H	34.70	0.00	62.70	73.98	-11.28
2484.95	-103.81	Avg	H	34.70	-30.52	7.38	53.98	-46.60
2484.95	-89.71	Peak	H	34.70	0.00	52.00	73.98	-21.98
2492.23	-104.10	Avg	H	34.70	-30.52	7.08	53.98	-46.89
2492.23	-93.20	Peak	H	34.70	0.00	48.50	73.98	-25.48

Table 6-8. Radiated Restricted Band Edge Measurements at 3-meters

NOTES:

1. All emissions shown lie in the restricted bands specified in §15.205 and are below the limit shown in Table 6-4.

2. Average Measurements > 1GHz using RBW = 1MHz and VBW = 1/τ Hz, where τ = pulse width in seconds.

3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.

4. The EUT is supplied with nominal AC voltage and/or a new/fully-recharged battery.

5. The spectrum is measured from 9kHz to the 10th harmonic and the worst-case emissions are reported. No significant emissions were found beyond the fifth harmonic for this device.

6. Levels at - 135 dBm represent the analyzer noise floor and signify that no emission was detected.

7. Above 960MHz the limit is 500 μV/m (54dBμ/m) at 3 meters radiated.

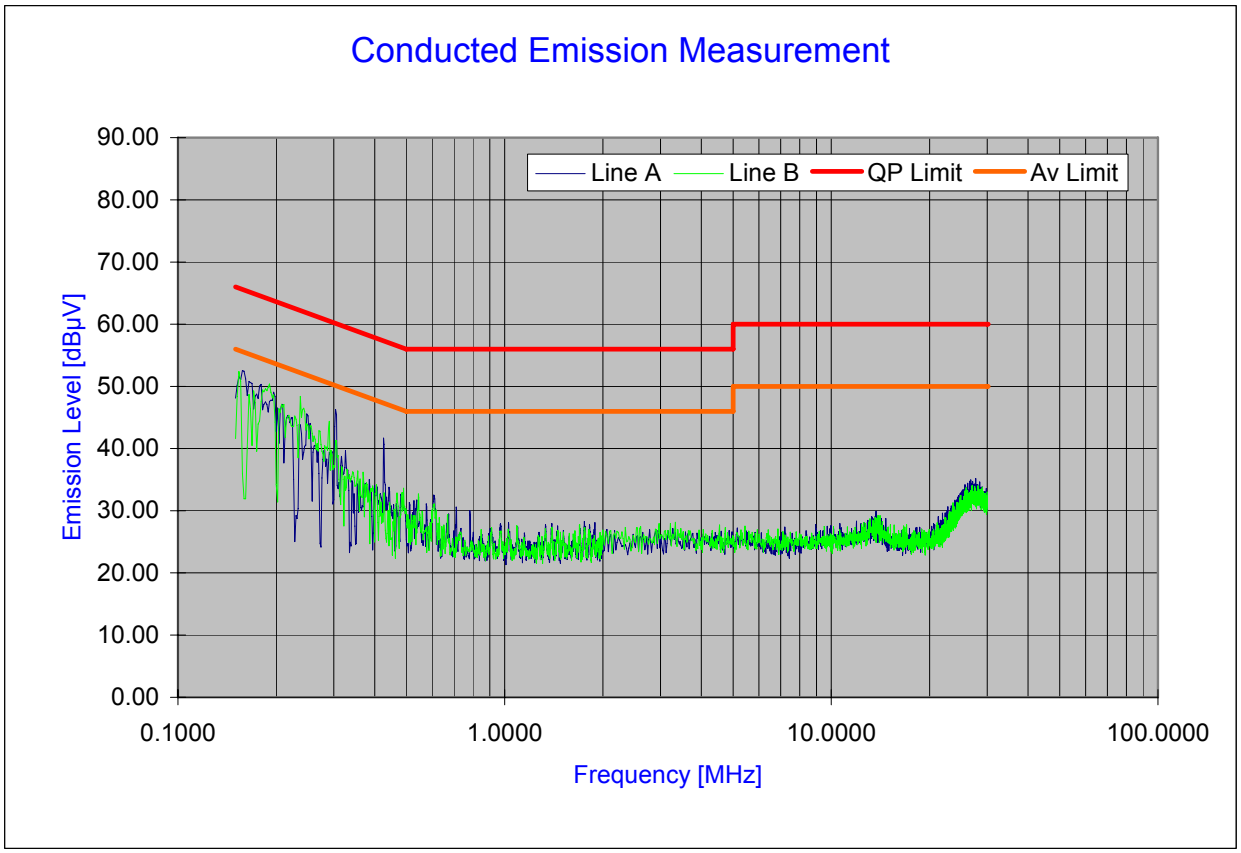
6.11 Line-Conducted Test Data

§15.207

PCTEST Engineering Laboratory Inc.

Company : Panasonic Corporation of North America
Model Number : CF-U1
FCC ID Code : ACJ9TGCF-U15
Standard : FCC Part 15C, 15.207

Power Source : AC120V/60Hz
Tested Date : 09/08/2009
Note : Tested with Bluetooth ON



Ver.1.1 ©PCTEST 2006.08

Plot 6-18. Line Conducted Plot with Bluetooth

Notes:

1. All Modes of operation were investigated and the worst-case emissions are reported.
2. The limit for Class B device(s) from 150kHz to 30MHz are specified in Section 15.207 of the Title 47 CFR.
3. Line A = Phase; Line B = Neutral
4. Traces shown in plot are made using a peak detector.
5. Deviations to the Specifications: None.

Line-Conducted Test Data (Cont'd)

§15.207

No.	Line	Frequency [MHz]	Factor [dB]	QP [dBµV]	Limit [dBµV]	Margin [dB]	Average [dBµV]	Limit [dBµV]	Margin [dB]
1	A	0.150	8.20	47.48	66.00	-18.52	33.27	56.00	-22.73
2	A	0.184	8.01	44.64	64.33	-19.69	35.42	54.33	-18.91
3	A	0.204	7.91	39.64	63.44	-23.80	27.23	53.44	-26.21
4	A	0.213	7.88	38.37	63.10	-24.73	25.81	53.10	-27.29
5	A	0.243	7.77	38.15	61.98	-23.83	30.56	51.98	-21.42
6	A	0.244	7.77	38.07	61.97	-23.90	30.95	51.97	-21.02
7	A	0.253	7.74	34.82	61.67	-26.85	22.75	51.67	-28.92
8	A	0.305	7.57	33.36	60.12	-26.76	26.75	50.12	-23.37
9	A	0.308	7.57	32.54	60.02	-27.48	20.17	50.02	-29.85
10	A	0.426	7.47	26.77	57.34	-30.57	21.04	47.34	-26.30
11	B	0.150	8.20	49.00	66.00	-17.00	34.23	56.00	-21.77
12	B	0.154	8.18	46.63	65.78	-19.15	35.95	55.78	-19.83
13	B	0.183	8.01	46.59	64.33	-17.74	36.22	54.33	-18.11
14	B	0.194	7.96	41.25	63.86	-22.61	26.48	53.86	-27.38
15	B	0.205	7.91	40.17	63.42	-23.25	26.25	53.42	-27.17
16	B	0.215	7.87	38.79	63.02	-24.23	25.52	53.02	-27.50
17	B	0.243	7.77	40.01	61.97	-21.96	32.60	51.97	-19.37
18	B	0.244	7.77	40.27	61.97	-21.70	31.43	51.97	-20.54
19	B	0.274	7.66	34.16	61.00	-26.84	21.50	51.00	-29.50
20	B	0.304	7.57	34.11	60.15	-26.04	26.66	50.15	-23.49

Table 6-9. Line Conducted Data with Bluetooth

Notes:

1. All Modes of operation were investigated and the worst-case emissions are reported.
2. The limit for Class B device(s) from 150kHz to 30MHz are specified in Section 15.207 of the Title 47 CFR.
3. Line A = Phase; Line B = Neutral
4. Traces shown in plot are made using a peak detector.
5. Deviations to the Specifications: None.

7.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Panasonic Toughbook Model: CF-U1 FCC ID: ACJ9TGCF-U15** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.