Washington Laboratories, Ltd.

7560 Lindbergh Drive Gaithersburg, Maryland 20879 (301) 216-1500 Fax (301) 216-1590

website: http://www.wll.com email: info@wll.com

FCC & Industry Canada
Supplemental Radio Test Report
For the
Symbol Technologies
(a Division of Motorola Inc.)
BCM2046 Bluetooth Module
FCC ID: H9P2070
IC ID: 1549D-2070

WLL JOB# **10814**
June 29, 2009

Prepared for:

Symbol Technologies
(a division of Motorola Inc.)
One Motorola Plaza
Holtsville, NY 11742

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

ACCREDITED
Testing Certificate 2675.01

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Prepared by: James Ritter
EMC Compliance Engineer

Reviewed by: Steven D. Koster
EMC Operations Manager

Abstract

This report has been prepared on behalf of Symbol Technologies (a division of Motorola Inc.) to support the attached Application for Equipment Authorization. The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (10/2008) of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 of Industry Canada. This Test Report documents the test configuration and test results for a Symbol Technologies (a division of Motorola Inc.) BCM2046 Bluetooth Module. Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by the American Association for Laboratory Accreditation (A2LA) under Certificate 2675.01 as an independent FCC test laboratory.

The Symbol Technologies (a division of Motorola Inc.)BCM2046 Bluetooth Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 and Industry Canada RSS-210.

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Test Report Scope

This test report is to verify the compliance of the Extended Data Rate (EDR) modes of operation. These modes are in accordance with the Bluetooth core spec V2.0+EDR and include 2Mb data rate π/4QPSK and 3Mb 8-DPSK modes. The GFSK mode was tested in the original test report and is not tested here.

1.2 Compliance Statement

The Symbol Technologies (a division of Motorola Inc.) BCM2046 Bluetooth Module EDR modes comply with the limits for a Frequency Hopping Spread Spectrum Transmitter Module under FCC Part 15.247 (10/2008) and Industry Canada RSS-210e issue 7. The module unit fulfills the requirements of 15.212 for use as a limited module.

1.3 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with "FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems".

Contract Information

Customer:	Symbol Technologies (a division of Motorola Inc.) One Motorola Plaza Holtsville, NY 11742
Purchase Order Number	NP4519577
Quotation Number	64092

1.4 Test Dates

Testing was performed on the following date(s):	6/24/29/2009-6/26/2009

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, Steve Dovell
Client Representative	Mark S. Luksich

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**eres
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**C**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**decibel**
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**M**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification & Description

The Symbol Technologies (a division of Motorola Inc.) BCM2046 Bluetooth Module is a low power Bluetooth (FHSS) radio operating in the 2402-2480MHz band that incorporates the Bluetooth core spec V2.0+EDR.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Symbol Technologies (a division of Motorola Inc.)
FCC ID:	H9P2070
IC:	1549D-2070
Model:	BCM2046 Bluetooth Module
FCC Rule Parts:	§15.247
Industry Canada:	RSS210
Frequency Range:	2402-2480MHz
Maximum Output Power:	In MT2070 Host 7.59mW (8.8dBm) Conducted at antenna port In STB2078 Host 2.4mW(3.8dBm) Conducted at antenna port
Modulation:	GFSK , π/4 QPSK, 8-DPSK
Occupied Bandwidth:	1.025MHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	79
Power Output Level	Fixed
Antenna Connector	Integral Antenna
Antenna Type	1.88dBi Monopole (MT2070 Host) & 2.7 dBi Omni (STB2078 Host)
Interface Cables:	None
Power Source & Voltage:	(MT2078 Host) 3.7VDC Battery (rechargeable via USB connection or cradle) (STB2078 Host) 120VAC
Emission Designator	1M40GXD

2.2 Test Configuration

The Symbol Technologies (a division of Motorola Inc.) BCM2046 Bluetooth Module had the Bluetooth antenna replaced by a temporary antenna port that was used to connect to test measurement devices. Radiated emissions had the Normal antenna installed terminated. An Ethernet to USB cable was connected to a support laptop PC to control the transmitters.

The BCM2046 Bluetooth Module was tested for conducted and radiated emissions in a host MT2070 Scanner unit with an internal 1.88 dBi Monopole Antenna. The BCM2046 Bluetooth Module was also tested for Conducted Power, conducted spurious and radiated emissions in a STB2078 scanner cradle unit with an integral 2.5dBi Omni antenna.

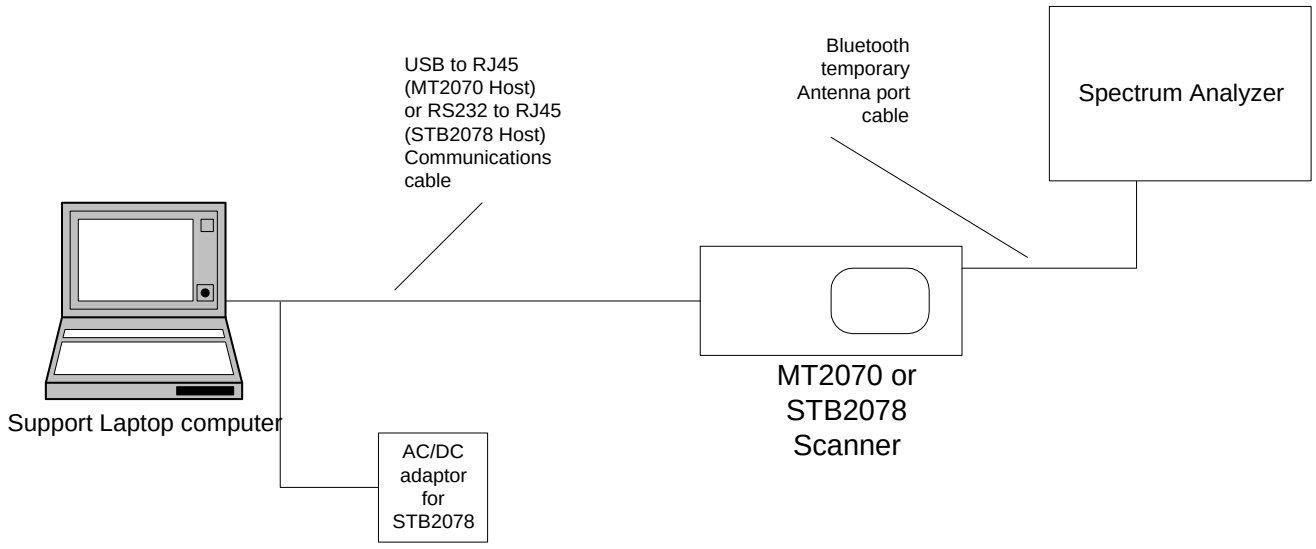

Figure 1 Test Configuration

2.3 Testing Algorithm

The Model MT2070 Scanner was connected via a communications cable. Microsoft Active Sync and remote display were installed on the laptop PC in order to remotely control the MT2070. A program (BTRegTest1.3.exe for Bluetooth radio) was pre-installed on the MT2070 unit. This program allowed setting the desired modes of operation required in this standard.

For the Model STB2078 cradle was connected via a RS232 communications cable. A custom program (STB2078 Regulatory Test app 1.10) was loaded onto the support laptop. This program allowed setting the desired modes of operation required in this standard. The STB2078 was tested for power, conducted spurious and radiated emissions.

2Mb data rate π/4QPSK and 3Mb 8-DPSK modes were tested.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by the American Association for Laboratory Accreditation (A2LA) under Certificate 2675.01 as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 4.55$ dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Typical Equipment List

Test Name: **Radiated Emissions**		Test Date: **6/26/2009**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
71	HP, 85685A	Preselector, RF	07/09/2009
73	HP, 8568B	Analyzer, Spectrum	07/08/2009
69	HP, 85650A	Adapter, QP	07/09/2009
644	Sunol Science JB1	BiConalog Antenna	12/29/2009
4	ARA, DRG-118/A	Antenna, DRG, 1-18GHz	02/06/2011
667	MegaPhase, LLC EM18-S1NK5-600	Test cable for OATS testing DC to 18 GHz SMA male	04/23/2010
66	HP, 8449B	Pre-Amplifier, RF. 1-26.5GHz	07/15/2009
288	IWI, SPS-3051-790-SPS	Cable, HF, B	09/29/2009
474	HP, 8563E	Analyzer, Spectrum	02/03/2011
Test Name:	**Bench Emissions**	:	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00067	HP 8564E	Analyzer, Spectrum	10/10/2010

4 Test Summary

The Table Below shows the results of testing for compliance of the EDR modes for a Frequency Hopping System in accordance with FCC Part 15.247:2008 and RSS210e issue 7. Full results are shown in section 5.

Table 3: Test Summary Table

TX Test Summary (Frequency Hopping Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247 (a)(1)(iii)	RSS-210 [A8. 1]	20dB Bandwidth	Pass
15.247 (b)(1)	RSS-210 [A8.4 (2)]	Transmit Output Power	Pass
15.247 (a)(1)	RSS-210 [A8.1 (2)]	Channel Separation	Pass
15.247 (a)(1)(iii)	RSS-210 [A8. 1 (4)]	Number of Channels >15	Pass
15.247 (a)(1)(iii)	RSS-210 [A8. 1 (4)]	Time of Occupancy	Pass
15.247 (d)	RSS-210 [A8. 5]	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	RSS-210 [A8. 5]	Restricted Bands & RE Limits	Pass

5 Test Results

5.1 Time of Occupancy

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

The following plots show the time of Occupancy for π/4QPSK 2-DH1, 2-DH3, 2-DH3 and 8-DPSK 3-DH1, 3-DH3, and 3-DH5 Modes.

Symbol BCM2046 Bluetooth, Job 10814, FCC Part 15.247, Dwell time per hop, QPSK, 2-DH1 Mode
Dwell time per hop = 406.7us

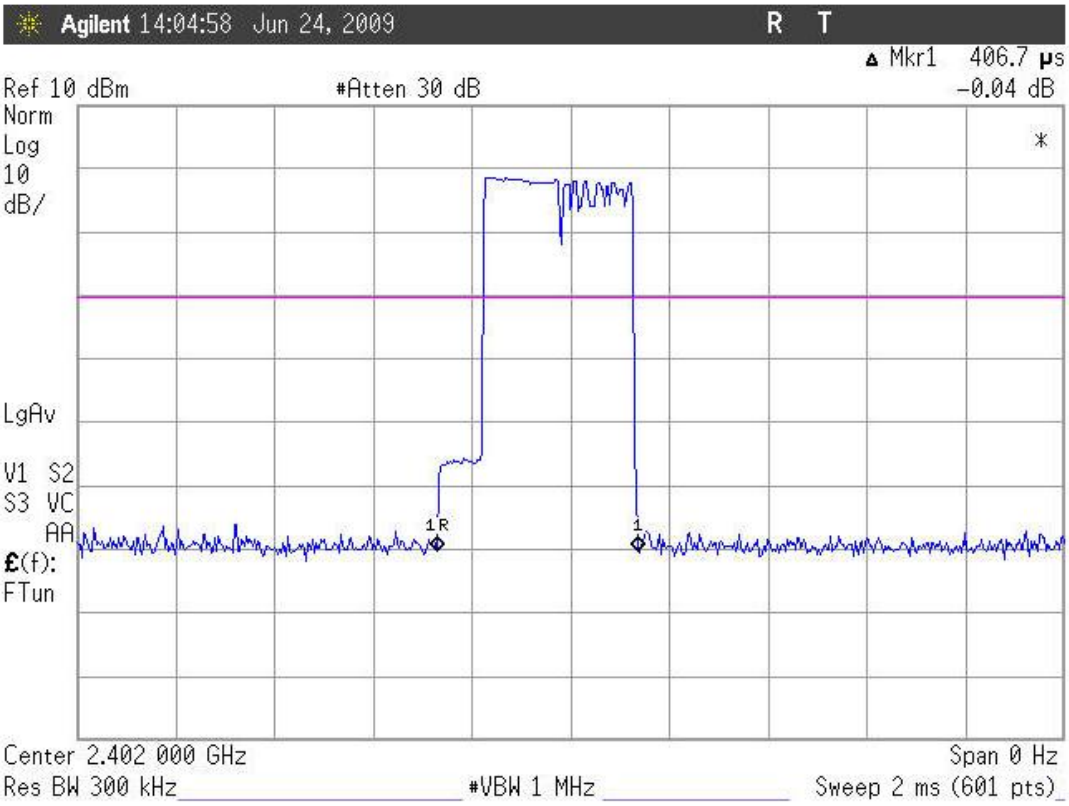

Figure 2. Single Hop Dwell Time 2-DH1 Mode

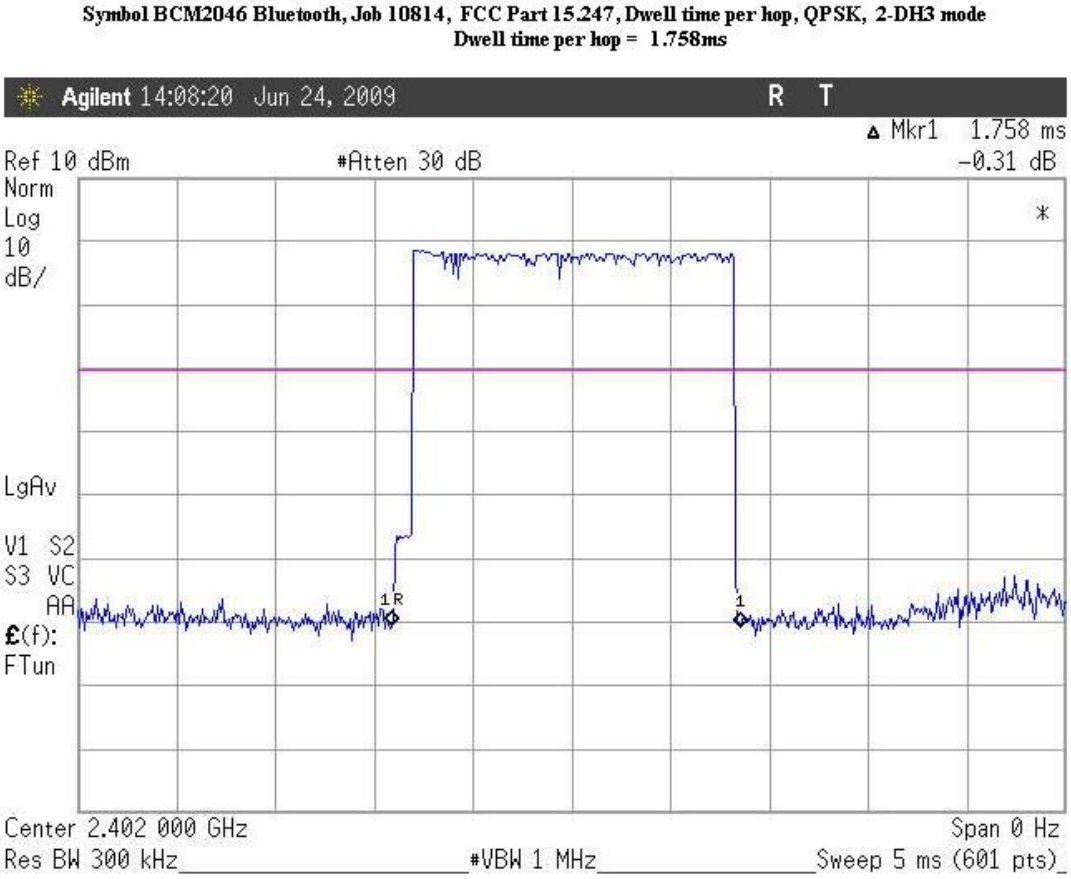

Figure 3. Single Hop Dwell Time 2-DH3 Mode

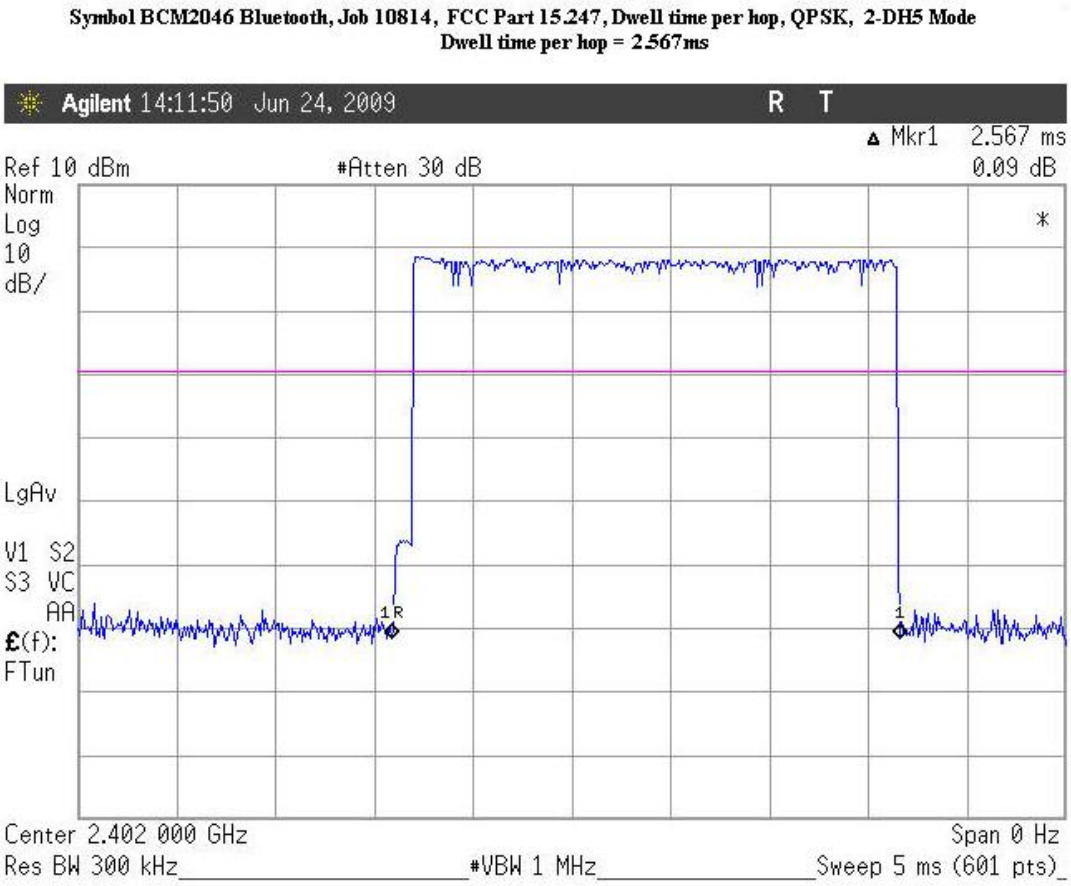

Figure 4. Single Hop Dwell Time 2-DH5 Mode

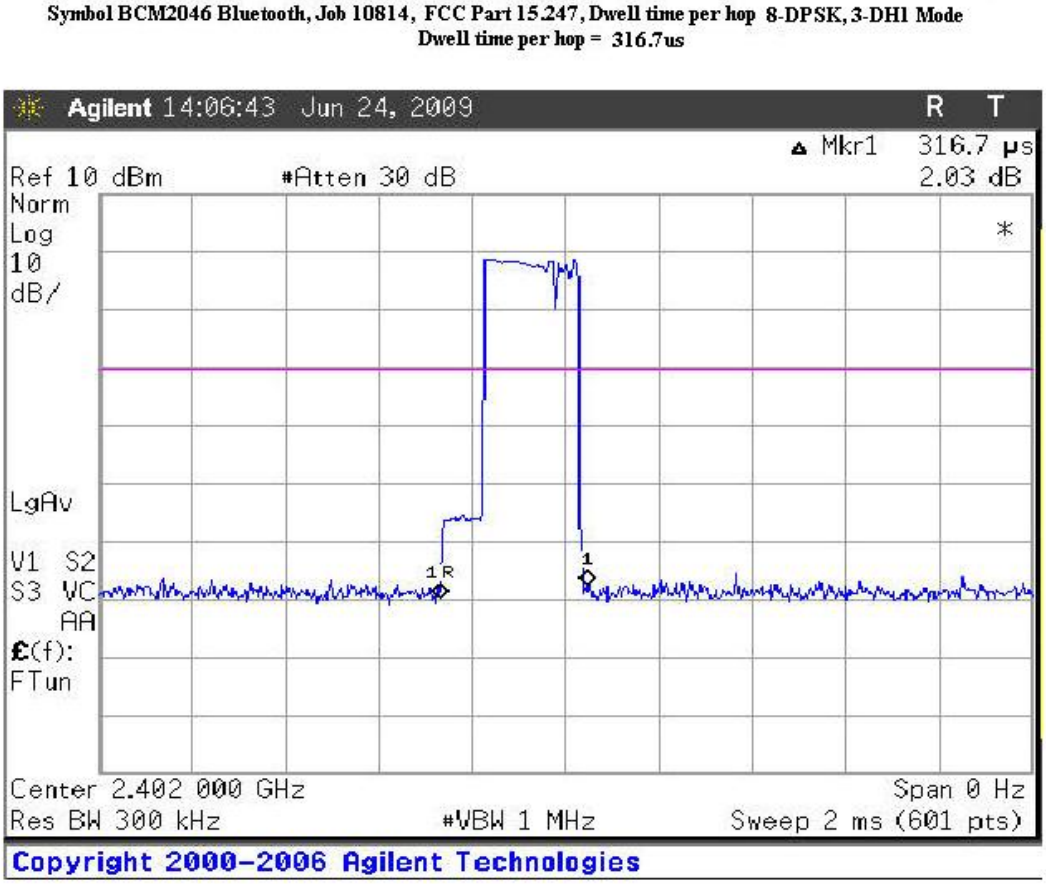

Figure 5. Single Hop Dwell Time 3-DH1 Mode

Symbol BCM2046 Bluetooth, Job 10814, FCC Part 15.247, Dwell time per hop, 8-DPSK, 3-DH3 Mode
Dwell time per hop = 1.733ms

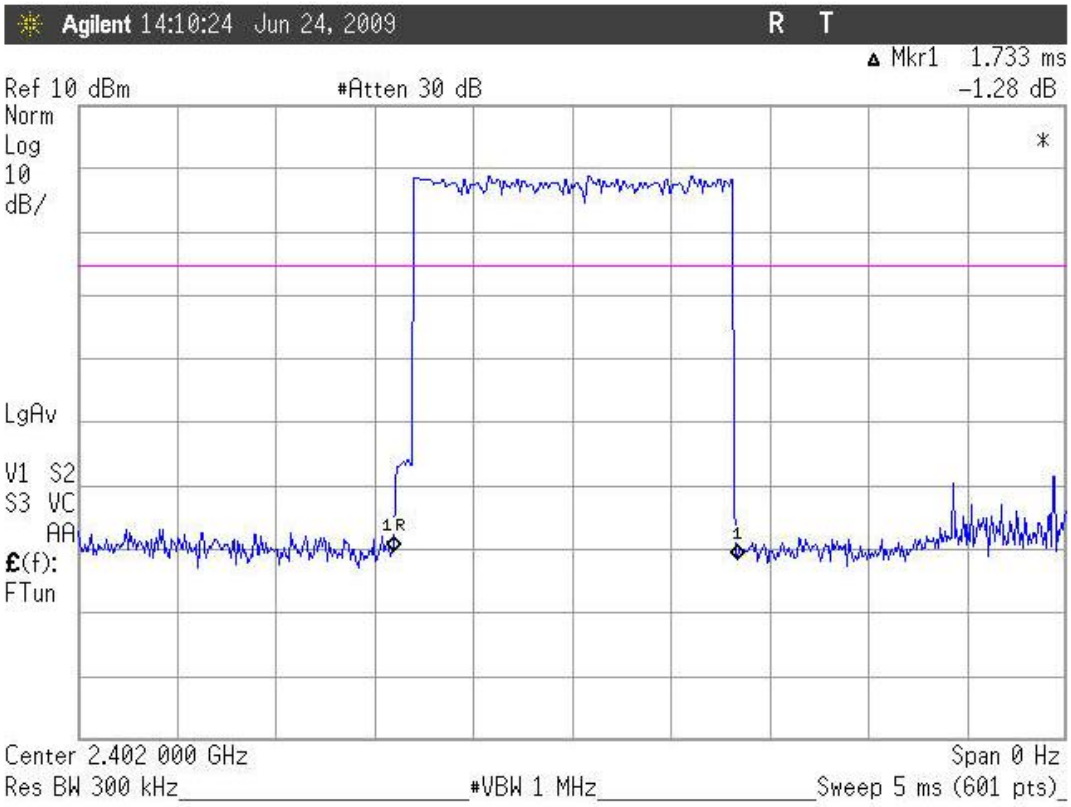

Figure 6. Single Hop Dwell Time 3-DH3 Mode

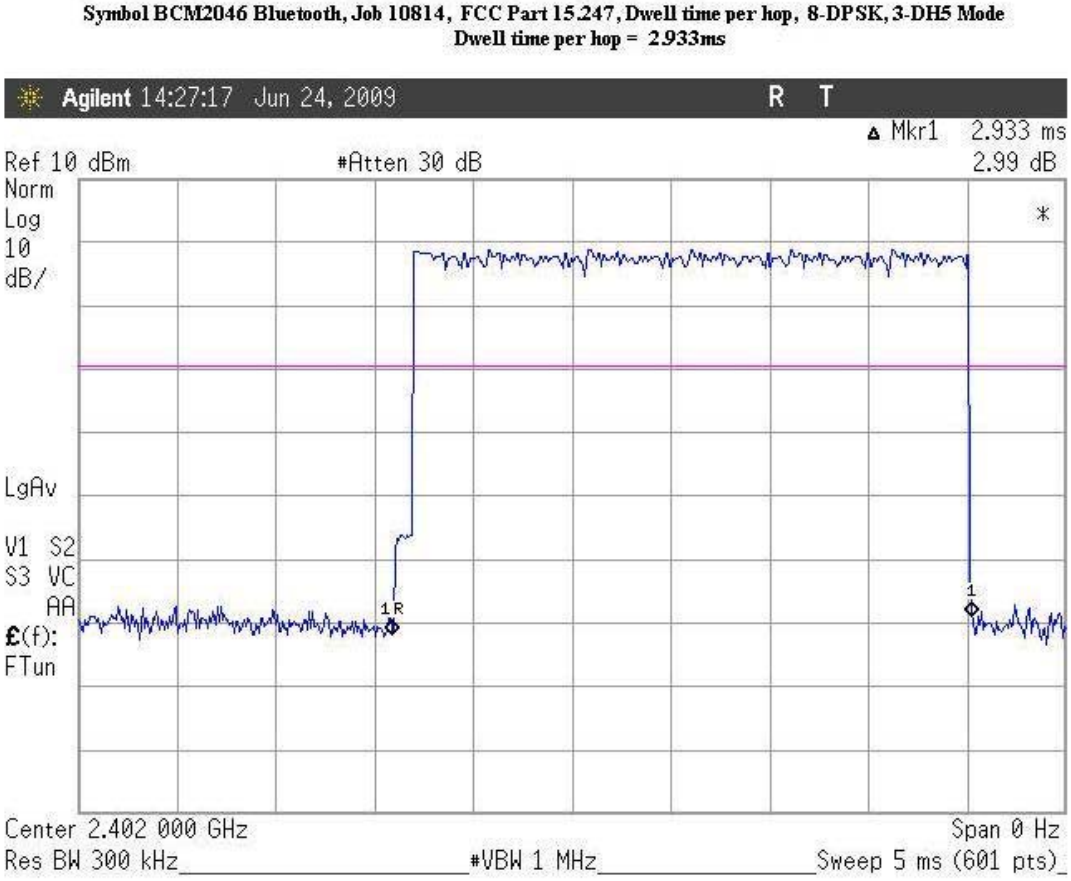

Figure 7. Single Hop Dwell Time 3-DH5 Mode

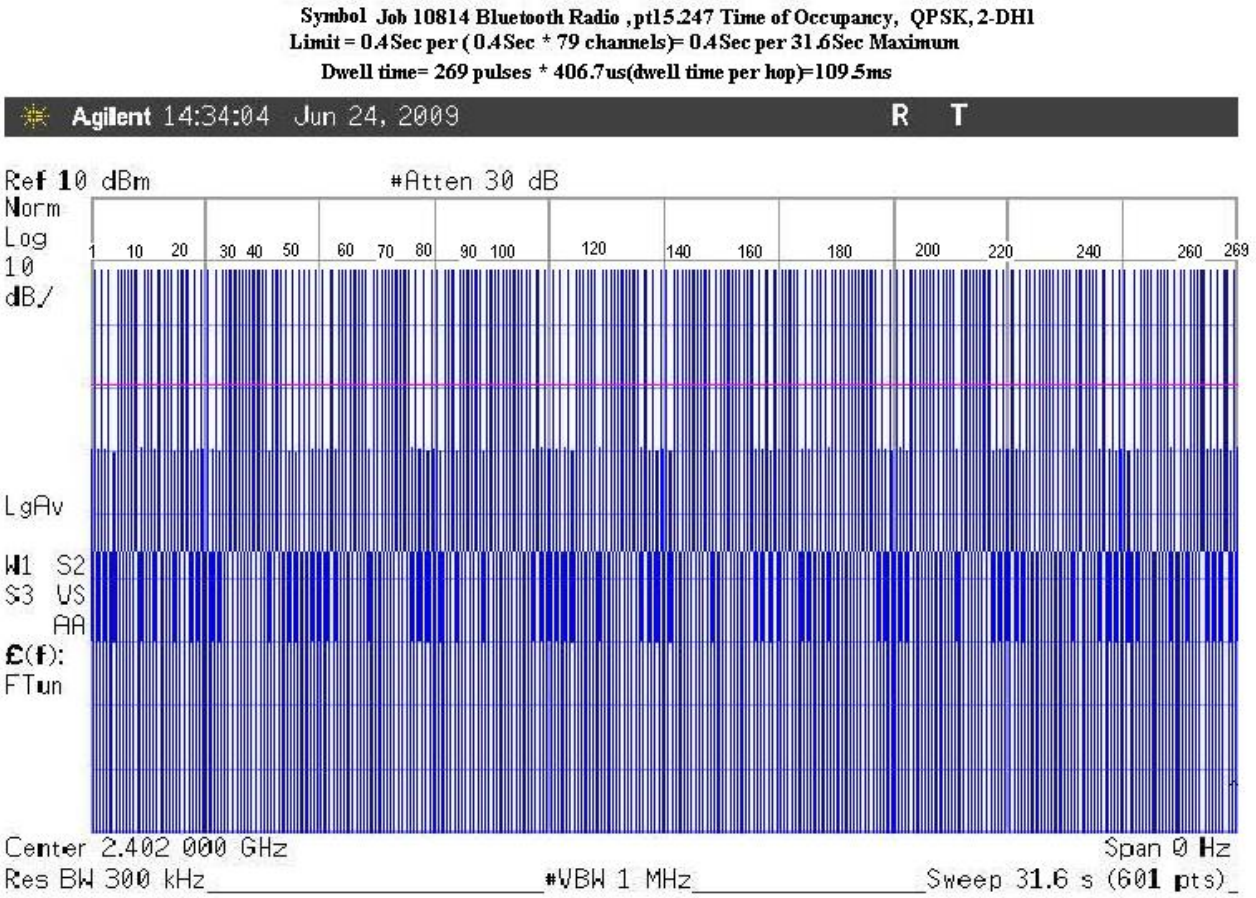

Figure 8. Dwell time per channel over 31.6 Seconds, 2-DH1 Mode

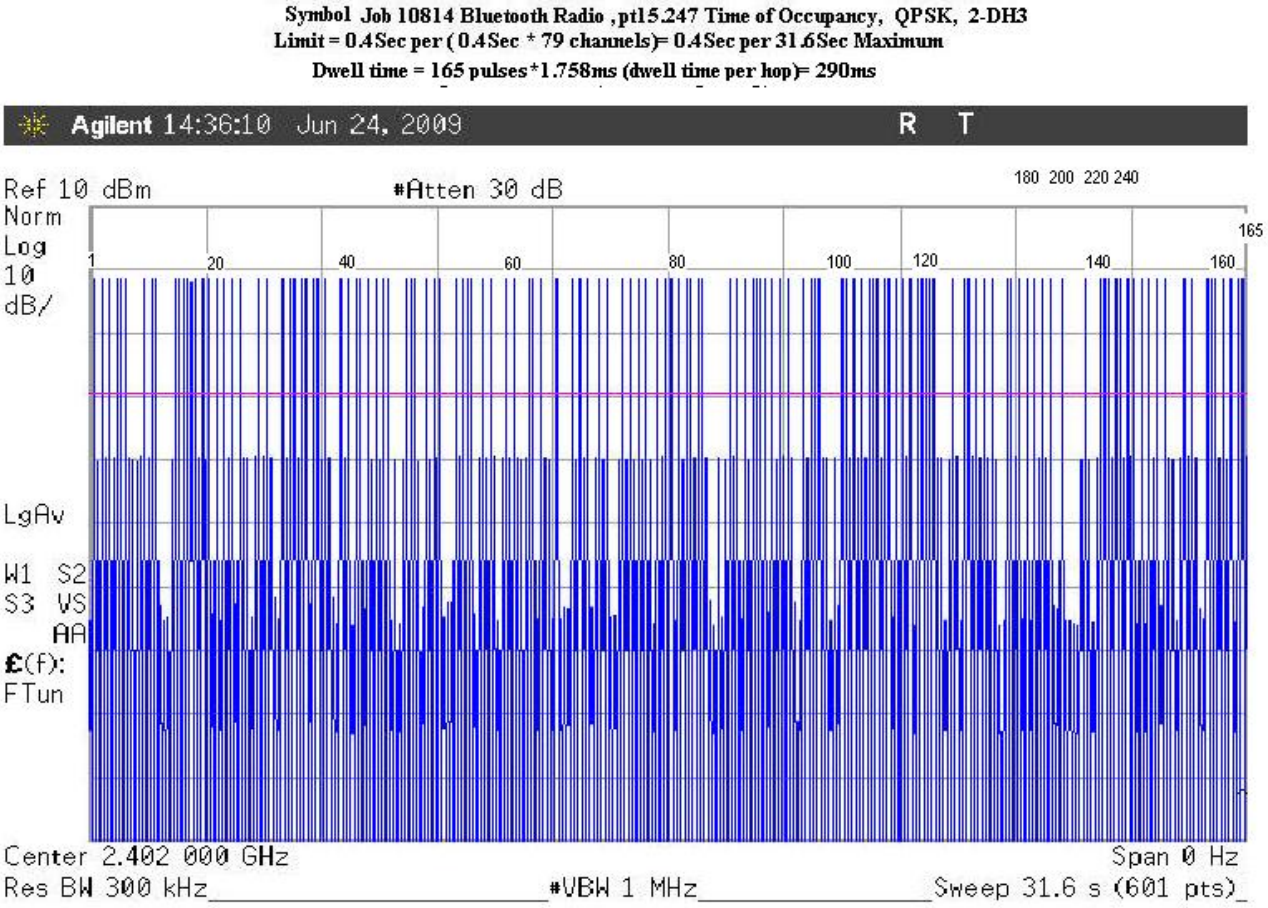

Figure 9. Dwell time per channel over 31.6 Seconds, 2-DH3 Mode

Symbol Job 10814 Bluetooth Radio ,pt15.247 Time of Occupancy, QPSK, 2-DH5
Limit = 0.4Sec per (0.4Sec * 79 channels)= 0.4Sec per 31.6Sec Maximum
Dwell time= 139 pulses*2.567ms = 356.8ms

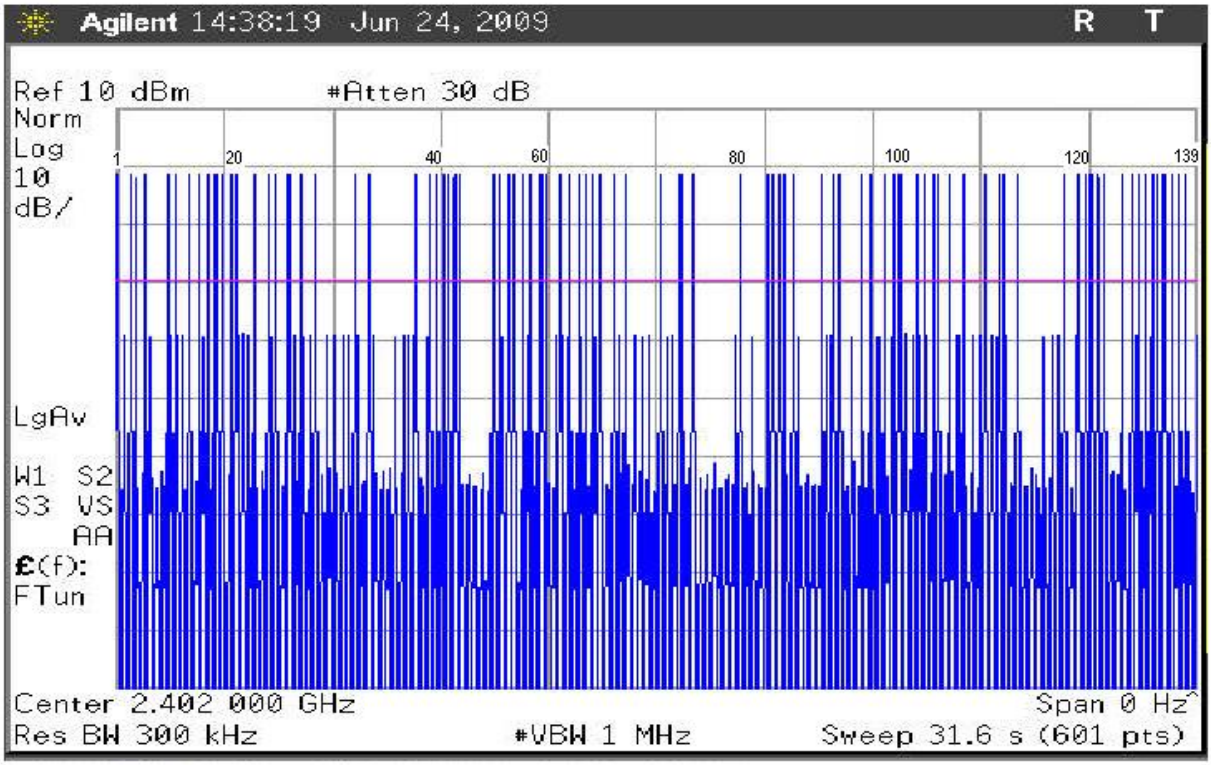

Figure 10. Dwell time per channel over 31.6 Seconds, 2-DH5 Mode

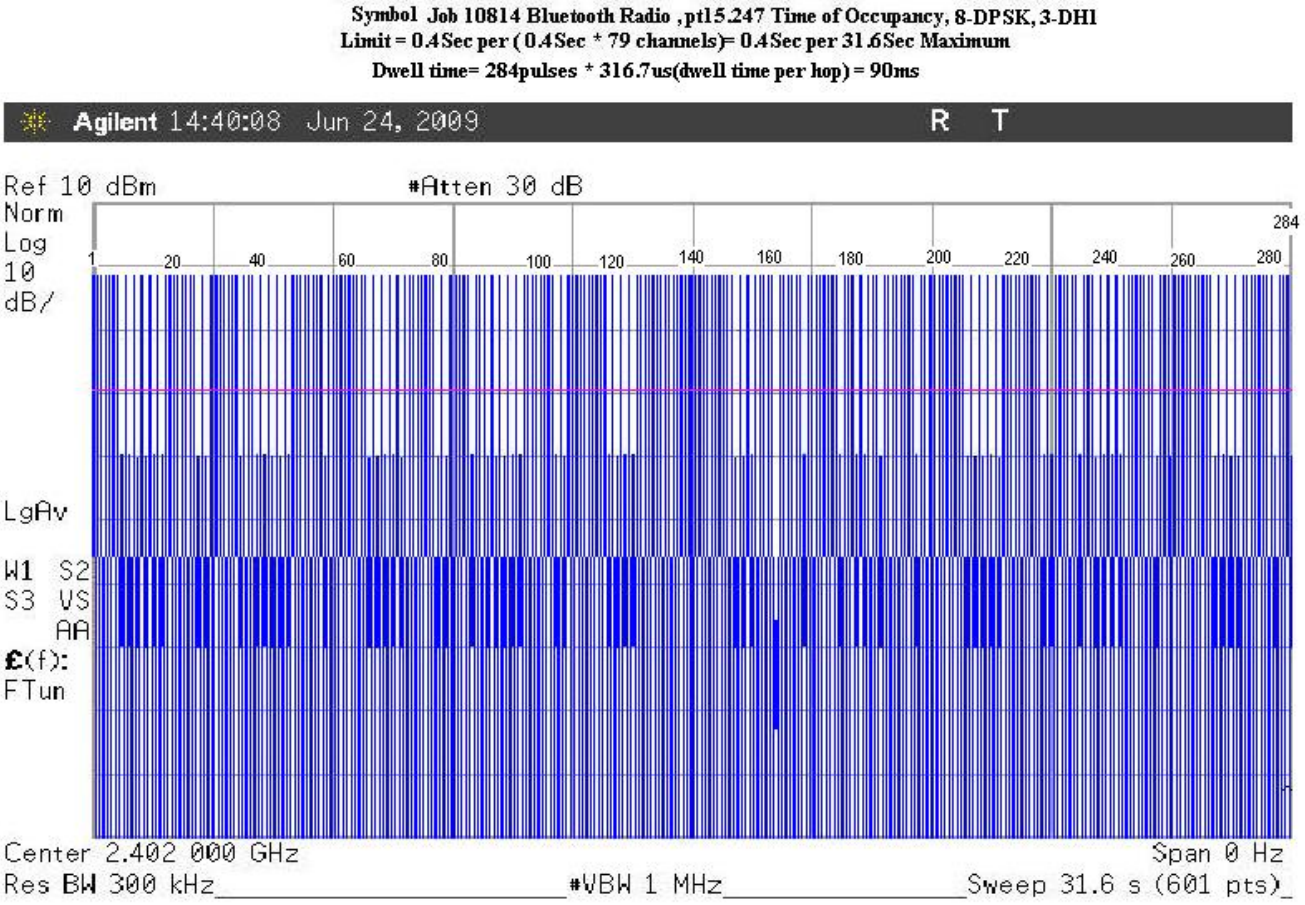

Figure 11. Dwell time per channel over 31.6 Seconds, 3-DH1 Mode

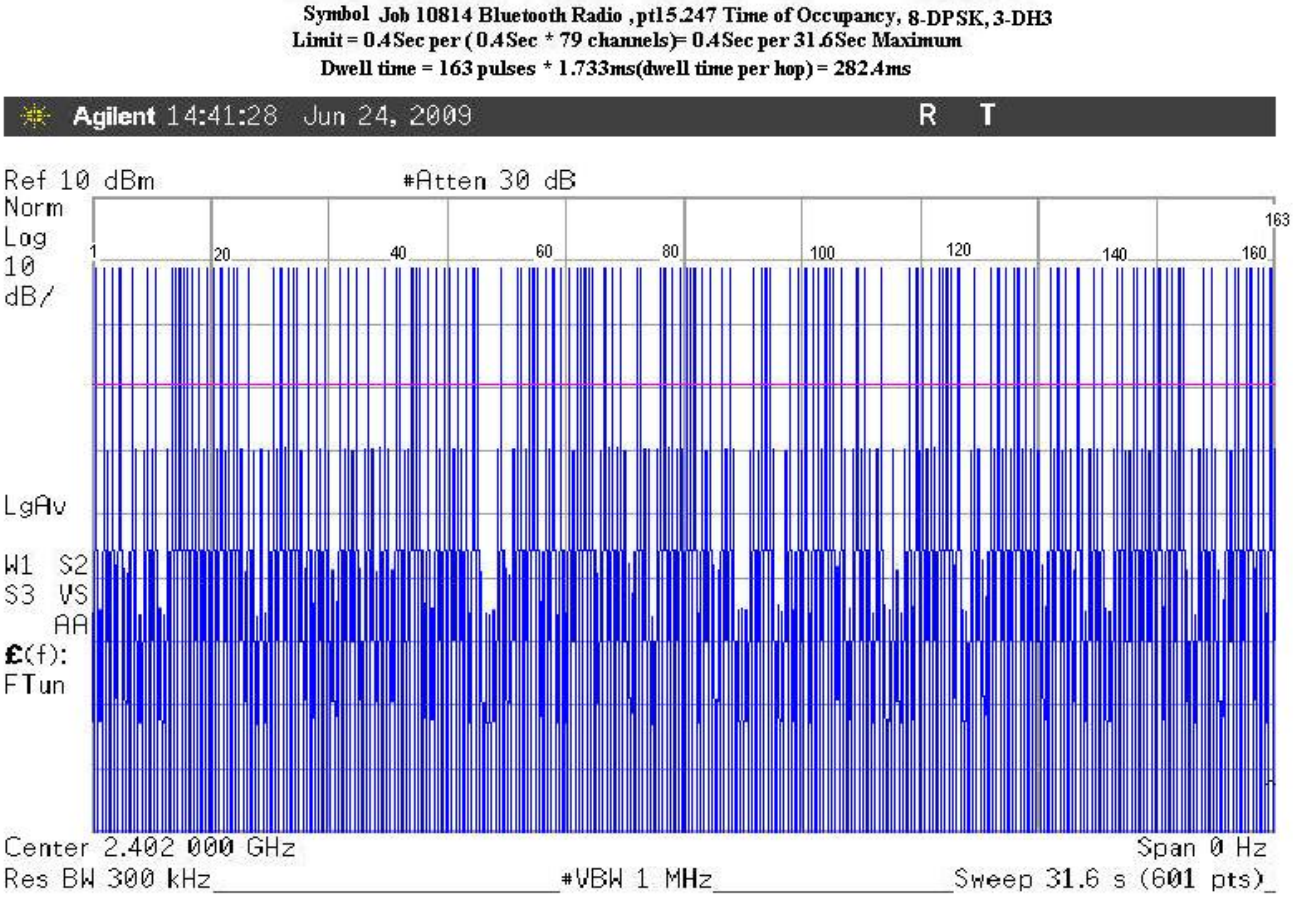

Figure 12. Dwell time per channel over 31.6 Seconds, 3-DH3 Mode

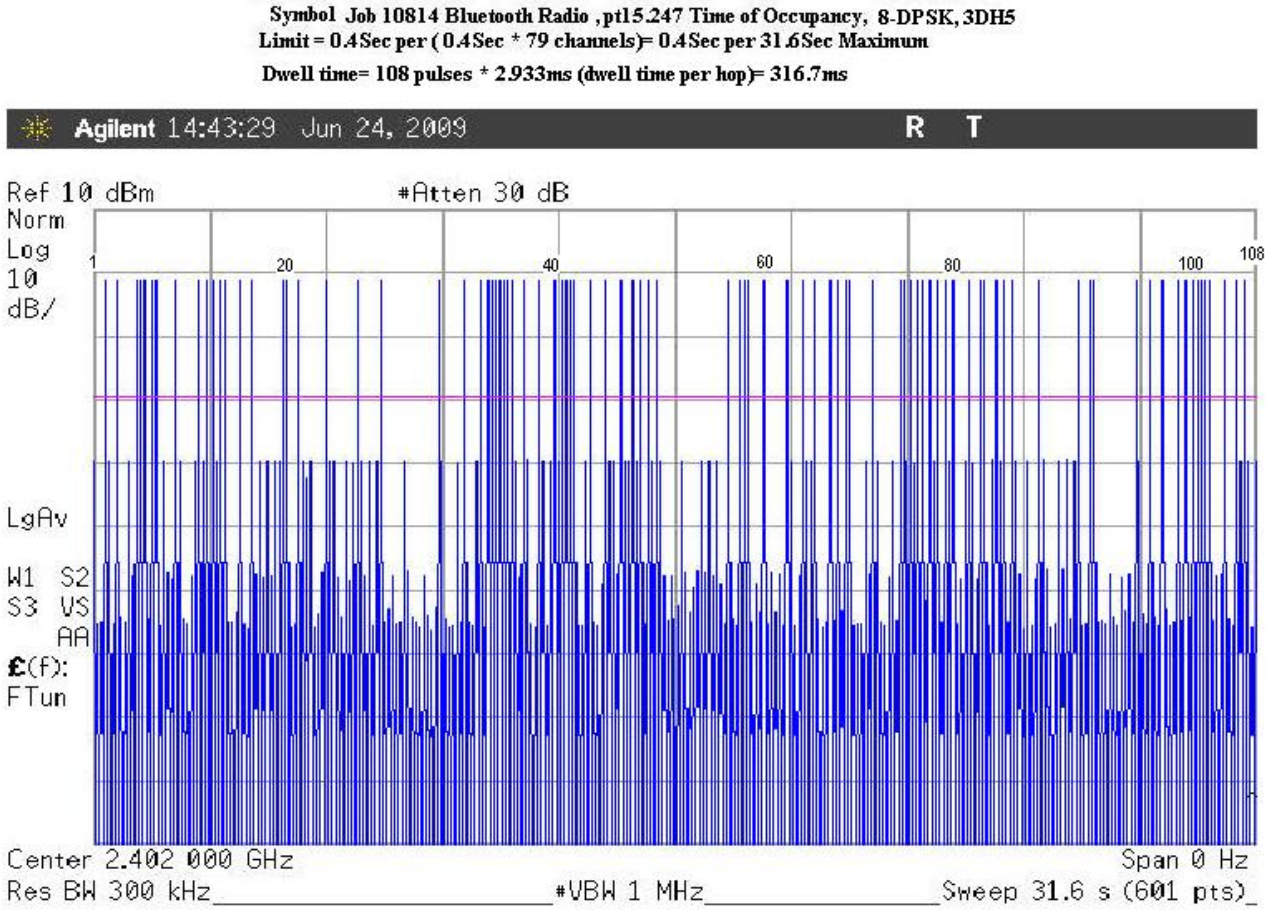

Figure 13. Dwell time per channel over 31.6 Seconds, 3-DH5 Mode

5.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the hopping sequence was stopped while the frequency dwelled on a low, high and center channel. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

Table 4. RF Power Output (In MT2070 Host)

QPSK Mode

Frequency	Level	Limit	Pass/Fail
Low Channel: 2402MHz	9.8dBm	30dBm	Pass
Mid Channel: 2441MHz	9.5dBm	30dBm	Pass
High Channel: 2480MHz	8.3dBm	30dBm	Pass

8-DPSK Mode

Frequency	Level	Limit	Pass/Fail
Low Channel: 2402MHz	9.7dBm	30dBm	Pass
Mid Channel: 2441MHz	9.6dBm	30dBm	Pass
High Channel: 2480MHz	8.4dBm	30dBm	Pass

Table 5. RF Power Output (In STB2078 Host)

QPSK Mode

Frequency	Level	Limit	Pass/Fail
Low Channel: 2402MHz	4.7dBm	30dBm	Pass
Mid Channel: 2441MHz	4.7dBm	30dBm	Pass
High Channel: 2480MHz	3.5dBm	30dBm	Pass

8-DPSK Mode

Frequency	Level	Limit	Pass/Fail
Low Channel: 2402MHz	4.8dBm	30dBm	Pass
Mid Channel: 2441MHz	4.7dBm	30dBm	Pass
High Channel: 2480MHz	3.7dBm	30dBm	Pass