
REPORT ON

Limited FCC CFR 47: Part 15 C Testing in support of an
Application for Grant of Equipment Authorisation
of a Symbol Bluetooth Module, Type 21-64381

FCC ID: H9P2164381

Report No OR612327/02 Issue 1

June 2004

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support of an Application for Grant of Equipment Authorisation
of a Symbol Bluetooth Module, Type 21-64381

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DATED:

1st July 2004

2nd July 2004

DISTRIBUTION

Symbol Technologies
BABT

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ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC CFR 47: Part 15 C. The sample tested was found to comply with the requirements defined in the applied rules.

Test Engineers;



A Guy



G Lawler



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SECTION 1

REPORT SUMMARY

Limited FCC CFR 47: Part 15 C Testing in support of an
Application for Grant of Equipment Authorisation
of a Symbol Bluetooth Module, Type 21-64381



1.1 STATUS

EQUIPMENT UNDER TEST	Symbol Bluetooth Module, Type 21-64381
OBJECTIVE	To undertake measurements to determine the Equipment Under Test's (EUT's) compliance with the specification.
NAME AND ADDRESS OF CLIENT	Symbol Technologies Inc One Symbol Plaza Holtsville 11742-1300, New York United States of America
TYPE NUMBER	21-64381
PART NUMBER	21-64381-02
SERIAL NUMBER	NB02
HARDWARE VERSION	Rev A
DECLARED VARIANTS	None
TEST SPECIFICATION ISSUE/DATE	FCC CFR 47: Part 15, Subpart C August 2002
NUMBER OF ITEMS TESTED	One
SECURITY CLASSIFICATION OF EUT	Unclassified
INCOMING RELEASE DATE	Declaration of Build Status 13 th April 2004
DISPOSAL REFERENCE NUMBER DATE	Held pending disposal Not Applicable Not Applicable
ORDER NUMBER DATE	EMEA 14211 6 th May 2004
START OF TEST	27 th April 2004
FINISH OF TEST	28 th May 2004
RELATED DOCUMENTS	ANSI C63.4 2001. Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. FCC Public Notice document (DA 00-705 released 30 March 2000)



1.2 INTRODUCTION

The information contained within this report is intended to show limited verification of compliance of the Symbol Technologies Inc Bluetooth Module, Type 21-64381 to the requirements of FCC Specification Part 15.

Testing was carried out in support of an application for Grant of Equipment Authorisation in the name of Symbol Technologies Inc.



1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Symbol Bluetooth Module Type: 21-64381 is a modular Class 1 Bluetooth Solution based on the Silicon Wave SiW3000 single chip radio IC. This module is designed for use in Symbol host products.

The FCC ID number is detailed in Section 1.3.4 "Declaration of Build Status".

1.3.2 Modes of Operation

Modes of operation of the EUT during testing were as follows in section 1.3.3:

Applicable testing was carried out with the EUT transmitting at maximum power as detailed in Section 1.3.3 "Test Configuration".

1.3.3 Test Configuration

Bluetooth Mode

The test software in the EUT enabled selection of full power and continuous transmit on the following channels;

Bottom Channel:	2402MHz
Middle Channel:	2441MHz
Top Channel:	2480MHz



1.3 PRODUCT INFORMATION - continued

1.3.4 Declaration of Build Status

MAIN EUT	
MANUFACTURING DESCRIPTION	Symbol Bluetooth Module
MANUFACTURER	Symbol Technologies Inc
TYPE	21-64381
PART NUMBER	21-64381-02
SERIAL NUMBER	NB02, NB03, NB05, NB08
HARDWARE VERSION	Rev 1 (to be released as Rev A)
COUNTRY OF ORIGIN	USA
TRANSMITTER OPERATING RANGE	2400 – 2483.5MHz
POWER	100mW (+20dBm - Class 1)
RECEIVER OPERATING RANGE	2400 – 2483.5MHz
INTERMEDIATE FREQUENCIES	Not Applicable (Direct conversion)
ITU DESIGNATION OF EMISSION	1M00F1D
POWER	3.3V
FCC ID	H9P2164381
INDUSTRY CANADA ID	1549D-2164381
DHSS/FHSS/COMBINED OR OTHER	FHSS
TECHNICAL DESCRIPTION	The Symbol Bluetooth Module Type: 21-64381 is a modular Class 1 Bluetooth Solution based on the Silicon Wave SiW3000 single chip radio IC. This module is designed for use in Symbol host products.

Signature

Date
D of B S Serial No

13 April 2004
OS612327-01

BABT formally certifies that the manufacturer's declaration as reproduced in this report, is a true and accurate record of the original received from the applicant.



1.4 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out is shown below.

This report relates only to the actual item/items tested.

Test	Spec Clause	Test Description	Result	Levels/Comments
2.1	15.205	Measurement at Band Edge	Pass	
2.2	15.207	Conducted Emissions on Power Lines	Pass	
2.3	15.247(a)(1)	20dB Bandwidth	Pass	
2.4	15.247(a)(iii)	Channel Dwell Time (DH1)	Pass	
2.5	15.247(a)(iii)	Channel Dwell Time (DH3)	Pass	
2.6	15.247(a)(iii)	Channel Dwell Time (DH5)	Pass	
2.7	15.247(a)(1)	Channel Separation	Pass	
2.8	15.247(a)(1)	Number of Hopping Channels	Pass	
2.9	15.247(b)(1)	Maximum Peak Output Power	Pass	
2.10	15.247(c)	Spurious Conducted Emissions	Pass	
2.11	15.247(c)	Spurious Radiated Emissions	Pass	



1.5 OPINIONS AND INTERPRETATIONS

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

1.6 TEST CONDITIONS

The EUT was set-up simulating a typical user installation on the Alternative Open Field Test Site identified in Appendix A, and tested in accordance with the applicable specification.

For all tests, the Symbol Bluetooth Module, Type 21-64381 was connected to a Marlin development board, Symbol Part Number 21-64381-02 and powered by an external 120V, 60Hz AC Power Supply, Symbol Part Number 50-14000-008.

1.7 DEVIATIONS FROM THE STANDARD

Not Applicable

1.8 MODIFICATION RECORD

Not Applicable

1.9 ALTERNATIVE TEST SITE

Under our group UKAS Accreditation, BABT conducted all the tests at our Titchfield, Fareham site and no alternative test site was used.



SECTION 2

TEST DETAILS

Limited FCC CFR 47: Part 15 C Testing in support of an
Application for Grant of Equipment Authorisation
of a Symbol Bluetooth Module, Type 21-64381



2.1 MEASUREMENT AT THE BAND EDGE (MARKER DELTA METHOD)

2.1.1 Specification Reference

FCC CFR 47: Part 15 Subpart C, Section 15.205

2.1.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.1.3 Date of Test

29th April 2004

2.1.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as “Section 2.1” within the Test Equipment Used table shown in Section 3.1.

2.2.5 Test Procedure

Test Performed in accordance with FCC Public Notice document (DA 00-705 released 30 March 2000).



2.1 MEASUREMENT AT THE BAND EDGE (MARKER DELTA METHOD) - continued

2.1.6 Test Results

The EUT met the requirements of FCC CFR 47: Part 15 Subpart C, Section 15.205 for Band Edge Measurements.

Measurements were made with the EUT in Bluetooth Mode (as described in Section 1.3.3).

Step 1

Bottom Channel Fundamental Field Strength Measurement.

Peak measurements performed utilising a Resolution Bandwidth and Video Bandwidth of 1MHz.
Average measurements performed utilising a Resolution Bandwidth of 1MHz and Video Bandwidth of 10Hz.

Frequency	Antenna Polarisation	Height	Azimuth	Peak Field Strength	Average Field Strength
MHz	H/V	cm	deg	dB μ V/m	dB μ V/m
2402.0	V	101	219	115.1	101.7

Step 2

Determine Marker delta amplitude between 2402.0MHz (the fundamental) and 2390MHz (the Band Edge under investigation).

Using a span of 30MHz with Resolution Bandwidth and Video Bandwidth of 300kHz.

Marker Delta Amplitude = 62.2dB

Step 3

Subtracting the Marker Delta obtained from Step 2 from the 2402.0MHz Field Strength measurement from Step 1, gives following Result:

Peak of 52.9dB μ V/m (Limit is 74.0dB μ V/m)

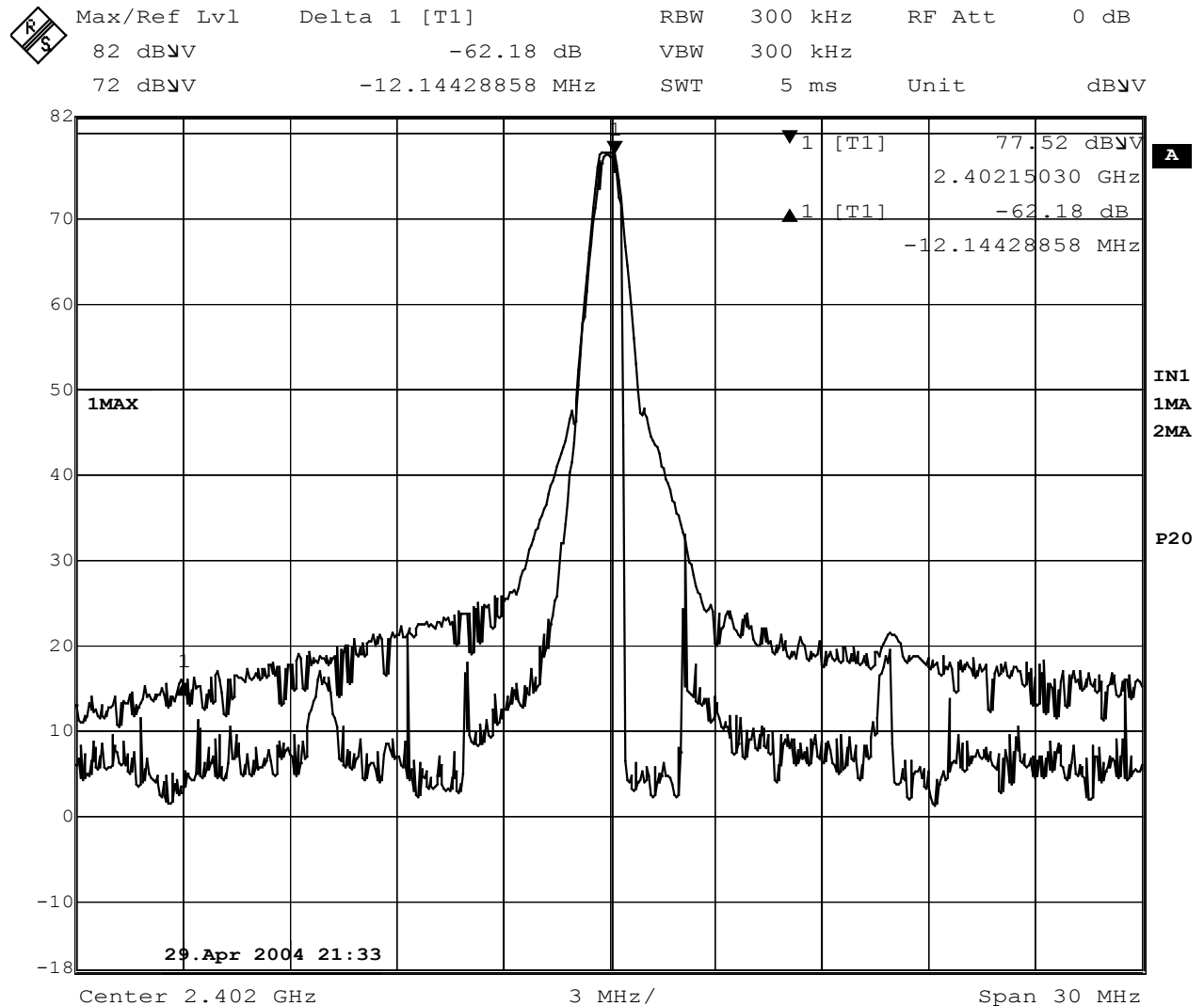
Average of 39.5dB μ V/m (Limit is 54.0dB μ V/m)



2.1 MEASUREMENT AT THE BAND EDGE (MARKER DELTA METHOD) - continued

2.1.6 Test Results - continued

Plot for Bottom Channel 2402.0MHz



Date: 29.APR.2004 21:33:17



2.1 MEASUREMENT AT THE BAND EDGE (MARKER DELTA METHOD) - continued

2.1.6 Test Results - continued

The EUT met the requirements of FCC CFR 47: Part 15 Subpart C, Section 15.205 for Band Edge Measurements.

Measurements were made with the EUT in Bluetooth Mode (as described in Section 1.3.3).

Step 1

Top Channel Fundamental Field Strength Measurement.

Peak measurements performed utilising a Resolution Bandwidth and Video Bandwidth of 1MHz.
Average measurements performed utilising a Resolution Bandwidth of 1MHz and Video Bandwidth of 10Hz.

Frequency	Antenna Polarisation	Height	Azimuth	Peak Field Strength	Average Field Strength
MHz	H/V	cm	deg	dBμV/m	dBμV/m
2480.0	V	100	219	114.6	101.4

Step 2

Determine Marker delta amplitude between 2480.0MHz (the fundamental) and 2483.5MHz (the Band Edge under investigation).

Using a span of 30MHz with Resolution Bandwidth and Video Bandwidth of 300kHz.

Marker Delta Amplitude = 58.8dB

Step 3

Subtracting the Marker Delta obtained from Step 2 from the 2483.5MHz Field Strength measurement from Step 1, gives following Result

Peak of 55.8dBμV/m (Limit is 74.0dBμV/m)

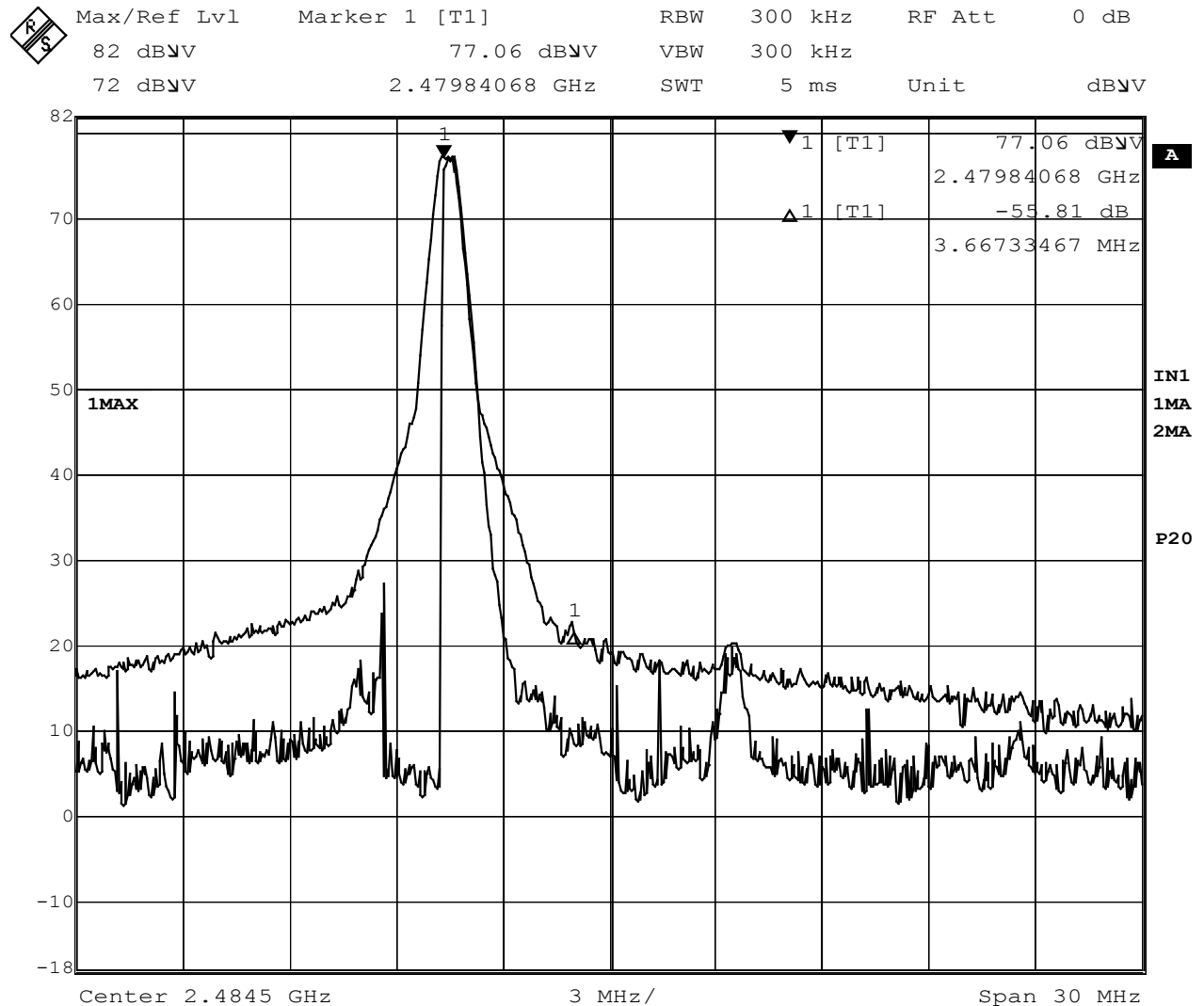
Average of 45.6dBμV/m (Limit is 54.0dBμV/m)



2.1 MEASUREMENT AT THE BAND EDGE (MARKER DELTA METHOD) - continued

2.1.6 Test Results - continued

Plot for Top Channel 2480.0MHz



Date: 30.APR.2004 02:18:18



2.2 CONDUCTED EMISSIONS ON POWER LINES

2.2.1 Specification Reference

FCC CFR 47: Part 15 Subpart C, Section 15.207

2.2.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.3.3 Date of Test

27th April 2004

2.2.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as “Section 2.2” within the Test Equipment Used table shown in Section 3.1.

2.2.5 Test Procedure

Test performed in accordance with ANSI C63.4.

Conducted Emission Measurements were undertaken within the semi-anechoic chamber. Emissions were measured on the Live and Neutral Lines in turn.

Emissions were formally measured using a Quasi-Peak and Average Detectors, which meet the CISPR requirements. The details of the worst-case emissions for the Live and Neutral Lines are presented in the tables below.

The EUT was supplied from a 120V, 60Hz supply.



2.2 CONDUCTED EMISSIONS ON POWER LINES - continued

2.2.6 Test Results

The EUT met the Class B requirements of FCC CFR 47: Part 15 Subpart C, Section 15.207 for Conducted Emissions on the Live and Neutral Lines.

Measurements were made with the EUT in Bluetooth Mode (as described in Section 1.3.3).

EUT Tx on Bottom Channel (2402.0MHz) – Live Line

Emission Frequency (MHz)	Quasi-Peak Level (dBμV)	Quasi-Peak Limit (dBμV)	Average Level (dBμV)	Average Limit (dBμV)
0.151	44.8	65.9	22.8	55.9
0.181	38.6	64.4	15.6	54.4
0.188	38.1	64.1	15.2	54.1
0.193	37.7	63.9	14.8	53.9
0.220	33.9	62.8	12.8	52.8
0.245	28.5	61.9	5.5	51.9

The margin between the specification requirements and all other emissions were 33.4dB or more below the specified Quasi-Peak limit and 64.5dB or more below the Average limit.

EUT Tx on Bottom Channel (2402.0MHz) – Neutral Line

Emission Frequency (MHz)	Quasi-Peak Level (dBμV)	Quasi-Peak Limit (dBμV)	Average Level (dBμV)	Average Limit (dBμV)
0.155	41.2	65.7	22.2	55.7
0.156	41.0	65.7	22.2	55.7
0.170	39.3	65.0	16.0	55.0
0.178	38.8	64.6	15.6	54.6
0.214	35.1	63.0	13.9	53.0
0.235	31.2	62.2	12.3	52.2

The margin between the specification requirements and all other emissions were 31.2dB or more below the specified Quasi-peak limit and 40.0dB or more below the specified Average limit.



2.2 CONDUCTED EMISSIONS ON POWER LINES - continued

2.2.6 Test Results - continued

EUT Tx on Middle Channel (2441.0MHz) – Live Line

Emission Frequency (MHz)	Quasi-Peak Level (dBμV)	Quasi-Peak Limit (dBμV)	Average Level (dBμV)	Average Limit (dBμV)
0.151	41.6	65.9	22.8	55.9
0.159	40.5	65.5	22.1	55.5
0.160	40.3	65.5	22.1	55.5
0.166	39.8	65.2	16.0	55.2
0.198	37.0	63.7	14.8	53.7
0.228	32.0	62.5	12.3	52.5

The margin between the specification requirements and all other emissions were 30.3dB or more below the specified Quasi-Peak limit and 40.2dB or more below the Average limit.

EUT Tx on Middle Channel (2441.0MHz) – Neutral Line

Emission Frequency (MHz)	Quasi-Peak Level (dBμV)	Quasi-Peak Limit (dBμV)	Average Level (dBμV)	Average Limit (dBμV)
0.151	41.7	65.9	22.8	55.9
0.164	39.9	65.3	16.4	55.3
0.187	38.3	64.2	15.2	54.2
0.219	34.2	62.9	13.4	52.9
0.227	32.7	62.6	12.2	52.6
0.255	25.1	61.6	3.8	51.6

The margin between the specification requirements and all other emissions were 36.5dB or more below the specified Quasi-peak limit and 47.7dB or more below the specified Average limit.



2.2 CONDUCTED EMISSIONS ON POWER LINES - continued

2.2.6 Test Results - continued

EUT Tx on Top Channel (2480.0MHz) – Live Line

Emission Frequency (MHz)	Quasi-Peak Level (dBμV)	Quasi-Peak Limit (dBμV)	Average Level (dBμV)	Average Limit (dBμV)
0.151	40.3	65.9	22.1	55.9
0.156	39.6	65.7	16.3	55.7
0.181	38.8	64.4	15.6	54.4
0.197	37.4	63.7	14.8	53.7
0.202	36.8	63.5	15.0	53.5
0.234	31.0	62.2	12.3	52.2

The margin between the specification requirements and all other emissions were 31.4dB or more below the specified Quasi-Peak limit and 40.0dB or more below the Average limit.

EUT Tx on Top Channel (2480.0MHz) – Neutral Line

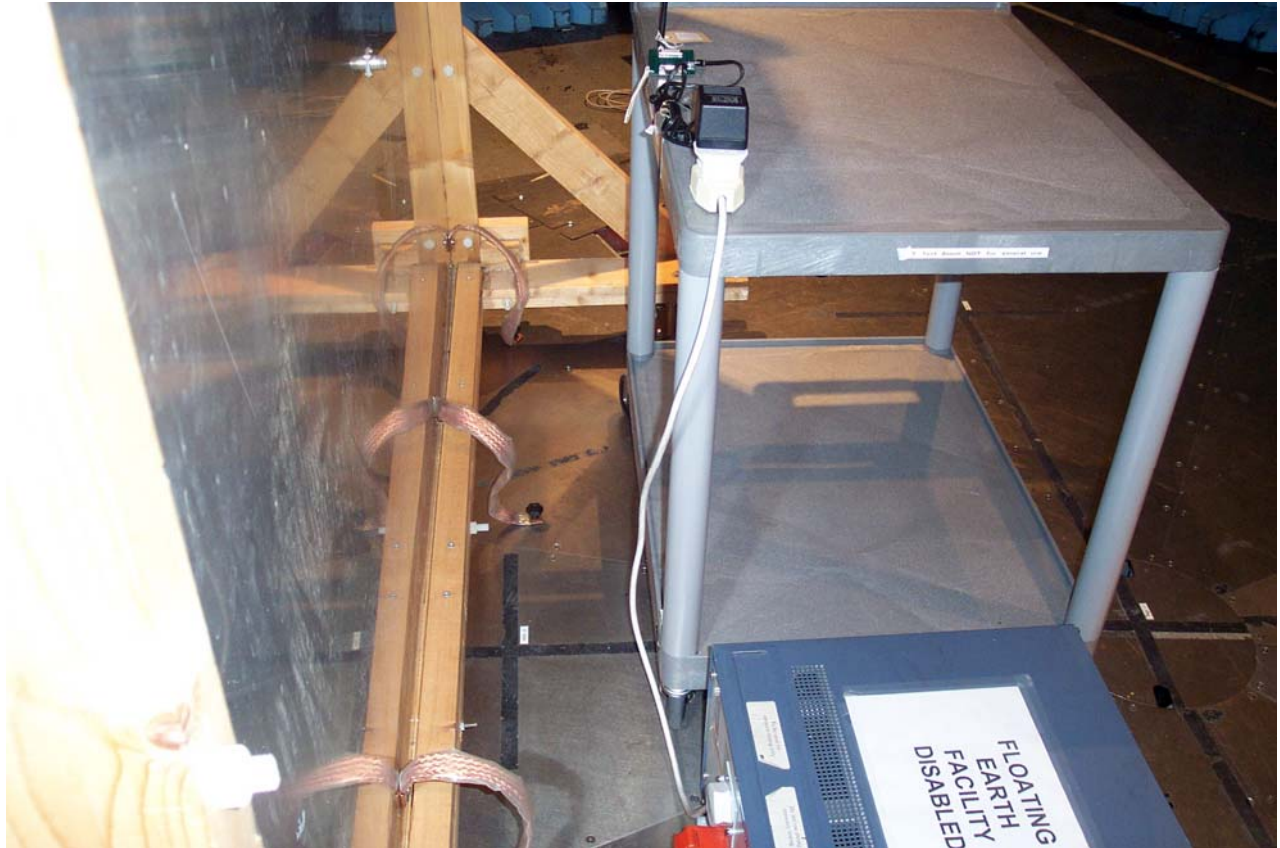
Emission Frequency (MHz)	Quasi-Peak Level (dBμV)	Quasi-Peak Limit (dBμV)	Average Level (dBμV)	Average Limit (dBμV)
0.156	40.9	65.7	22.2	55.7
0.162	40.2	65.4	22.0	55.4
0.169	39.6	65.0	15.3	55.0
0.177	39.1	64.6	16.3	54.6
0.195	37.5	63.8	14.8	53.8
0.234	31.2	62.2	12.3	52.2

The margin between the specification requirements and all other emissions were 31.2dB or more below the specified Quasi-peak limit and 40.0dB or more below the specified Average limit.



2.2 CONDUCTED EMISSIONS ON POWER LINES - continued

2.2.7 Set Up Photographs -



Conducted Emissions Set Up Photograph



2.3 20dB BANDWIDTH

2.3.1 Specification Reference

FCC Part 15.247(a)(1)

2.3.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.3.3 Date of Test

18th May 2004

2.3.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as "Section 2.3" within the Test Equipment Used table shown in Section 3.1.

2.3.5 Test Procedure

Test Performed in accordance with 15.247.

The EUT was transmitted at maximum power at all data rates via a cable to the Spectrum Analyser. The Analyser settings were adjusted to display the resultant trace on screen. The peak point of the trace was measured and the markers positioned to give the –20dBc points of the displayed spectrum.

The measurement plots can be seen on the following pages.

2.3.6 Test Results

Frequency (MHz)	Data Rate	20dB Bandwidth (kHz)
2402.0	DH1	875.125
2441.0	DH1	961.360
2480.0	DH1	964.554

Frequency (MHz)	Data Rate	20dB Bandwidth (kHz)
2402.0	DH3	967.748
2441.0	DH3	977.330
2480.0	DH3	967.748

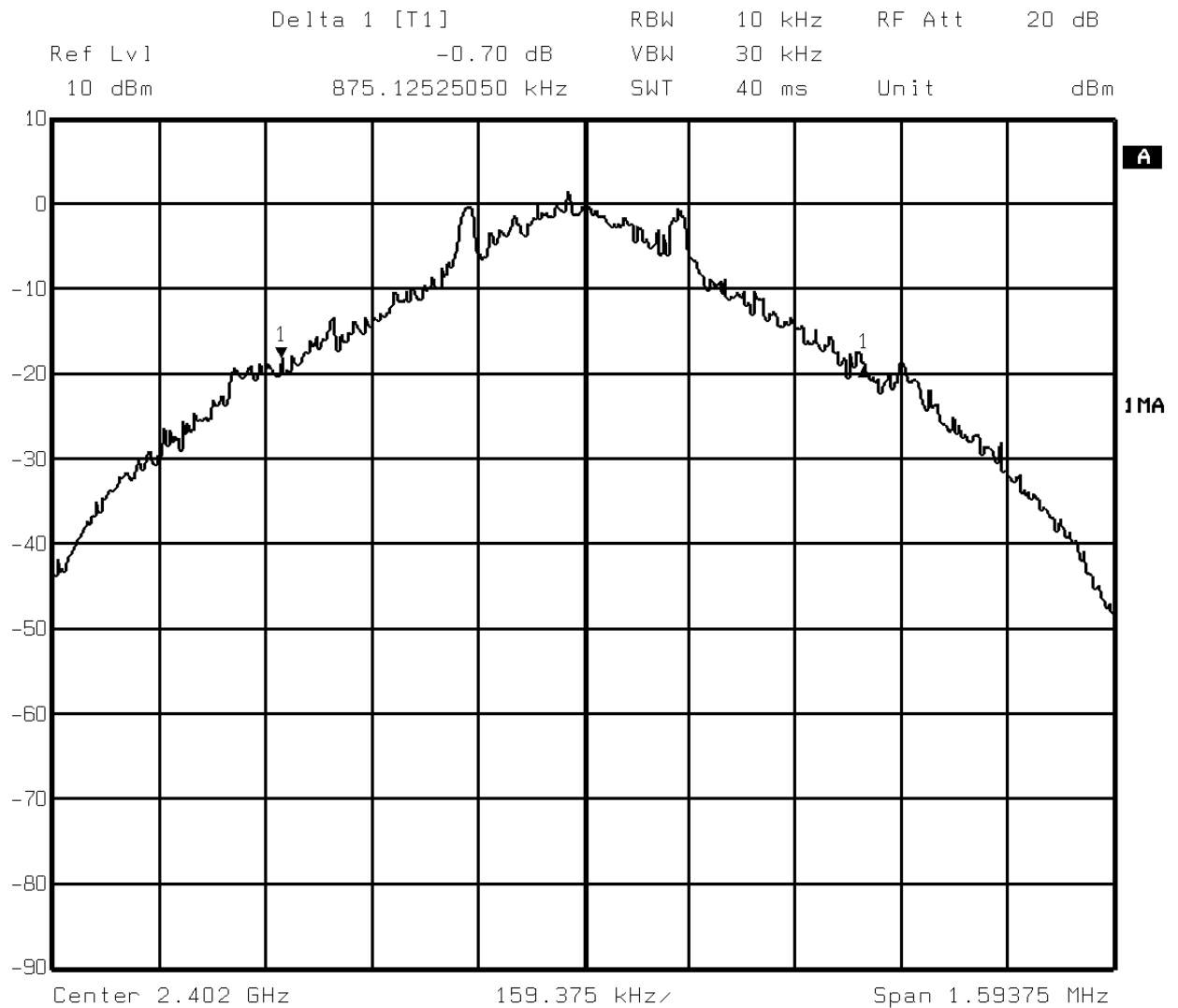
Frequency (MHz)	Data Rate (Mbps)	20dB Bandwidth (kHz)
2402.0	DH5	945.391
2441.0	DH5	967.748
2480.0	DH5	970.942



2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2402.0MHz – Maximum Power DH1



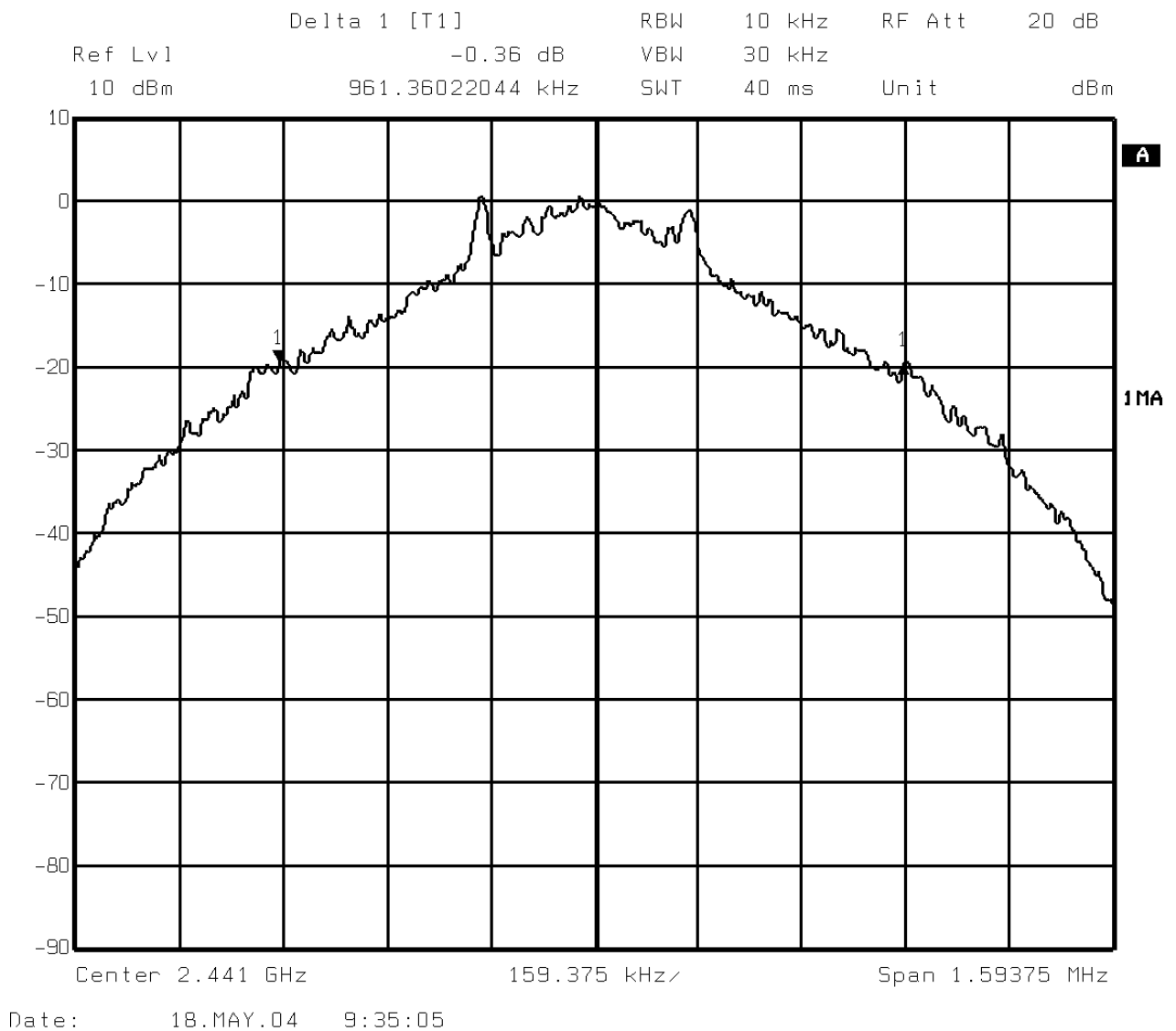
Date: 18.MAY.04 9:19:27



2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2441.0MHz – Maximum Power DH1

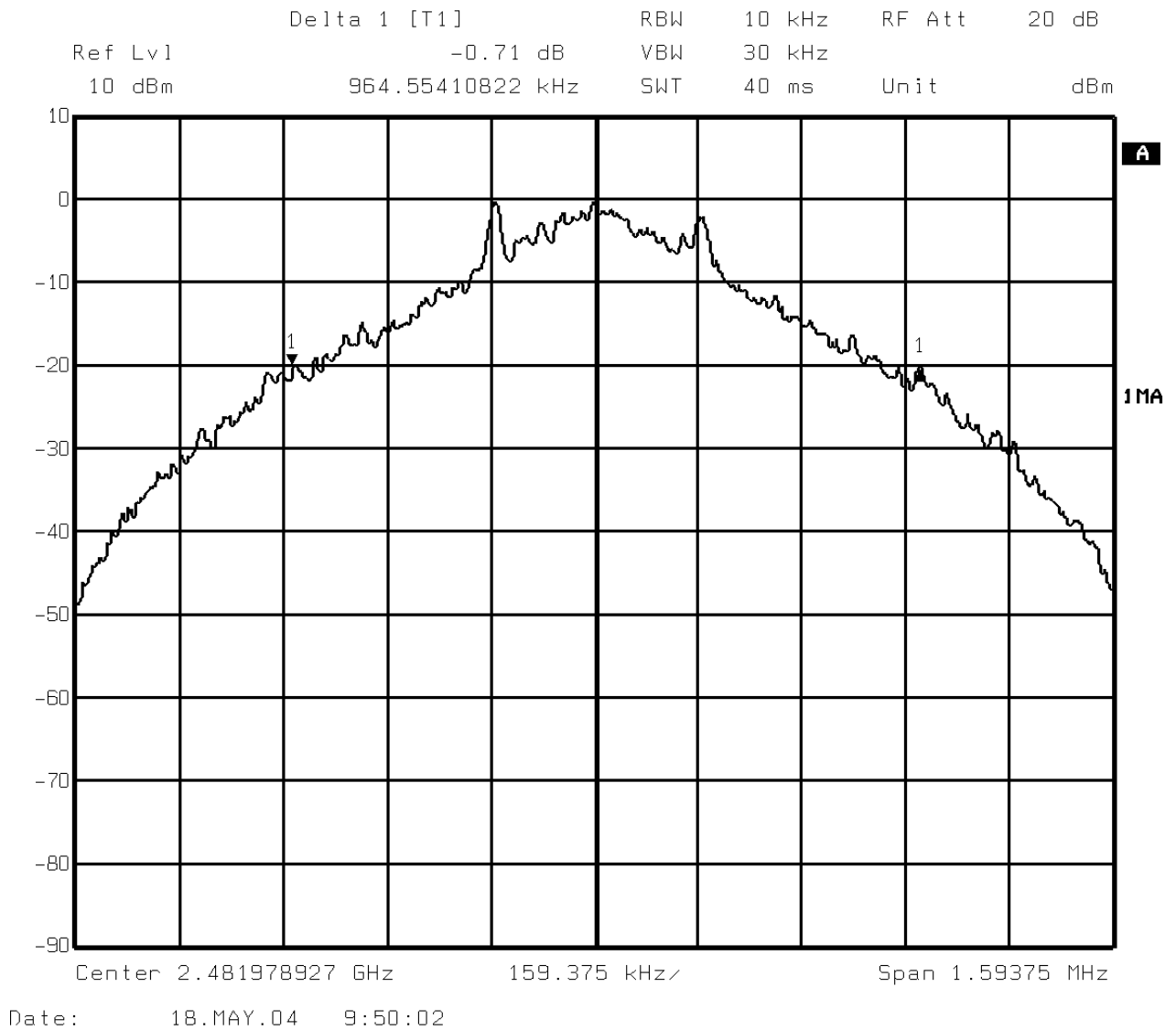




2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2480.0MHz – Maximum Power DH1

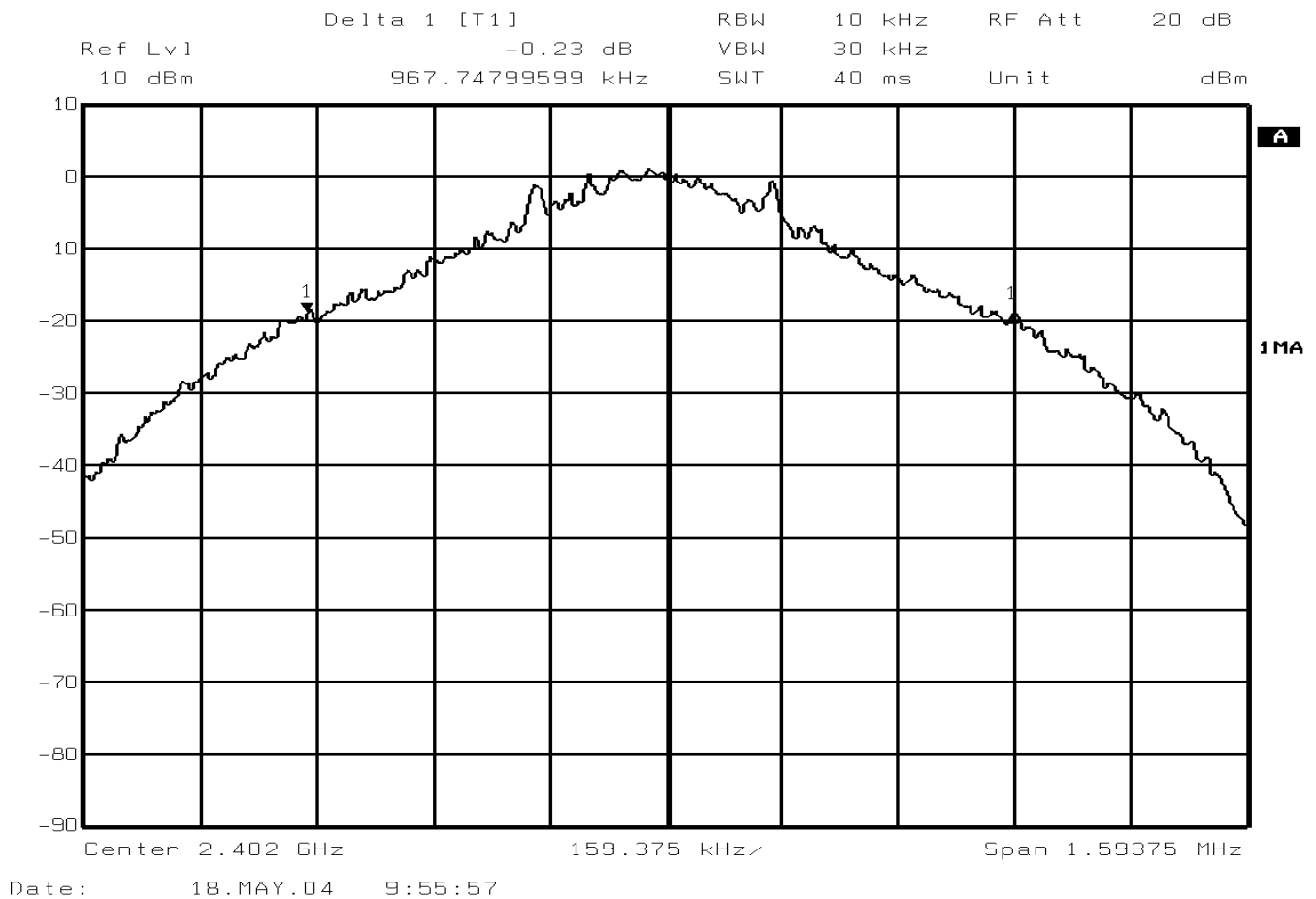




2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2402.0MHz – Maximum Power DH3

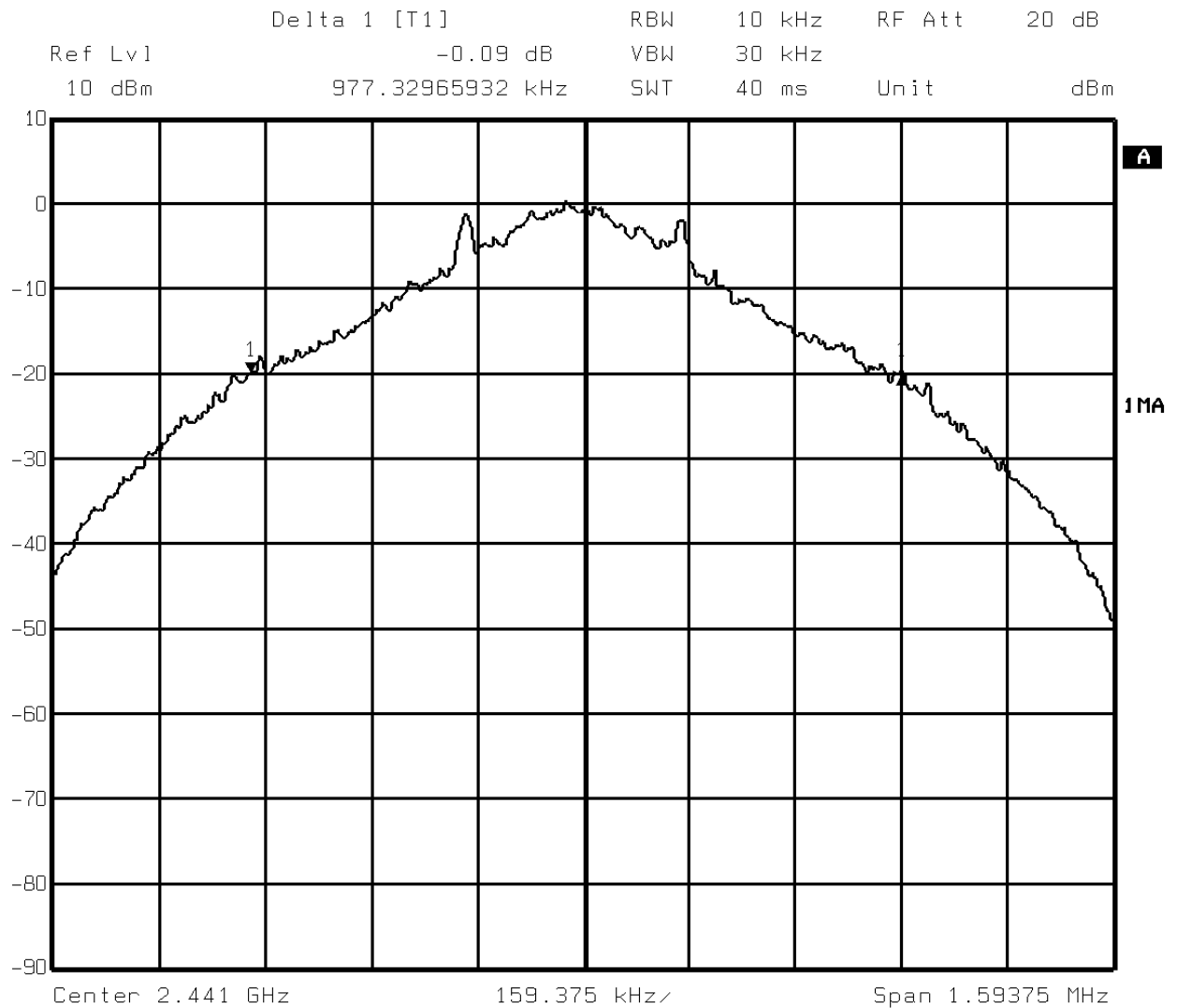




2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2441.0MHz – Maximum Power DH3



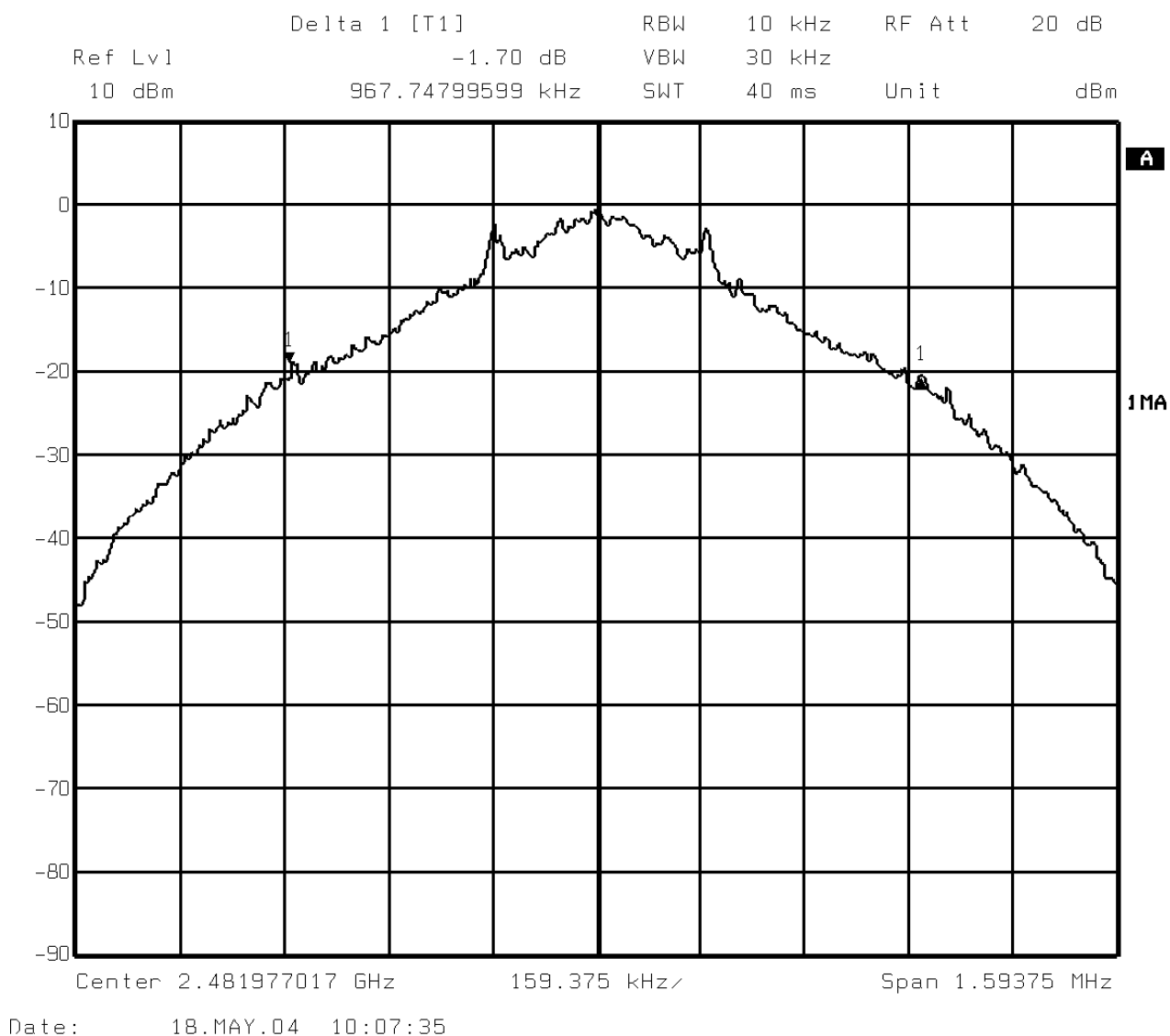
Date: 18.MAY.04 10:03:37



2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2480.0MHz – Maximum Power DH3

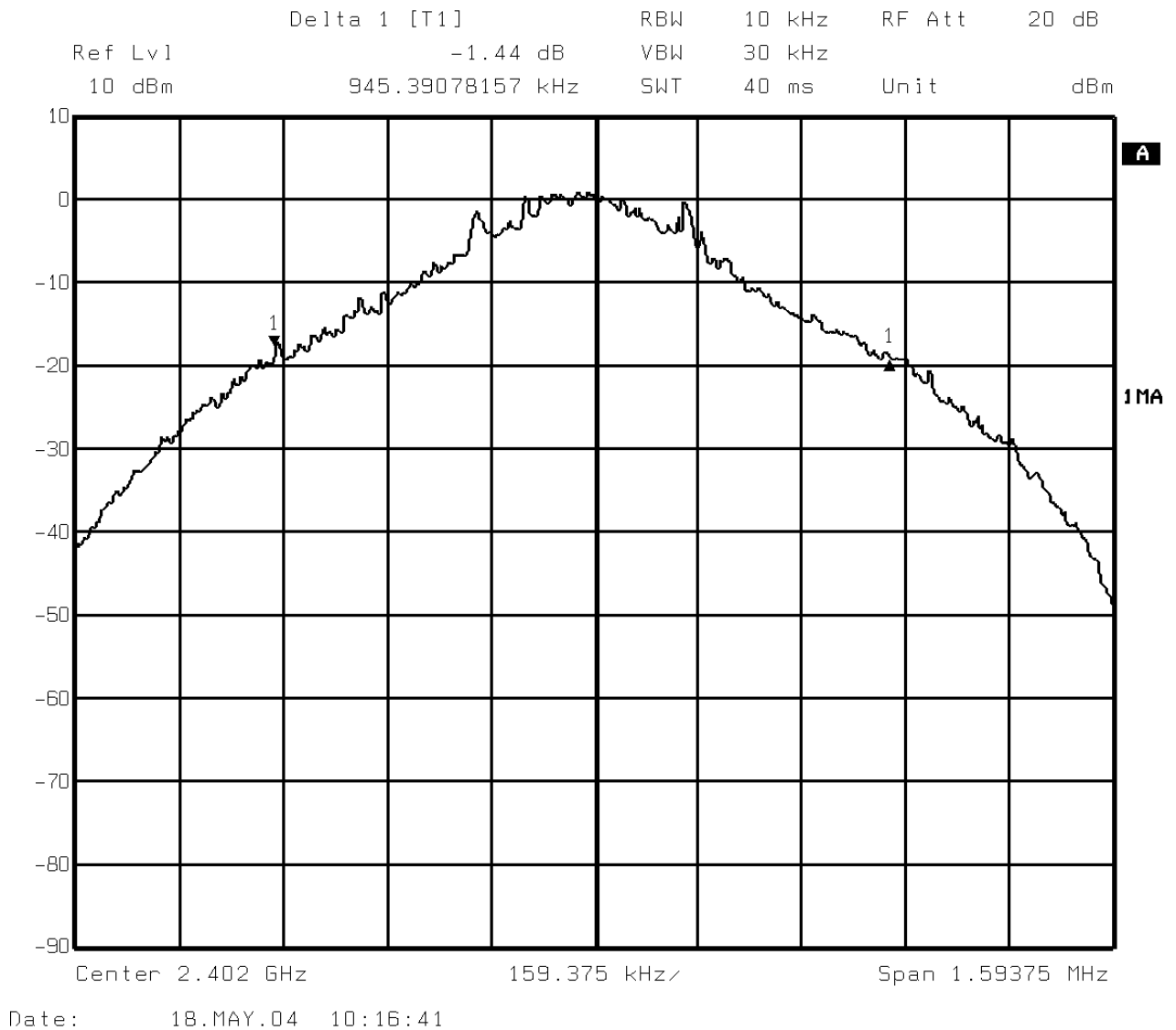




2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2402.0MHz – Maximum Power DH5

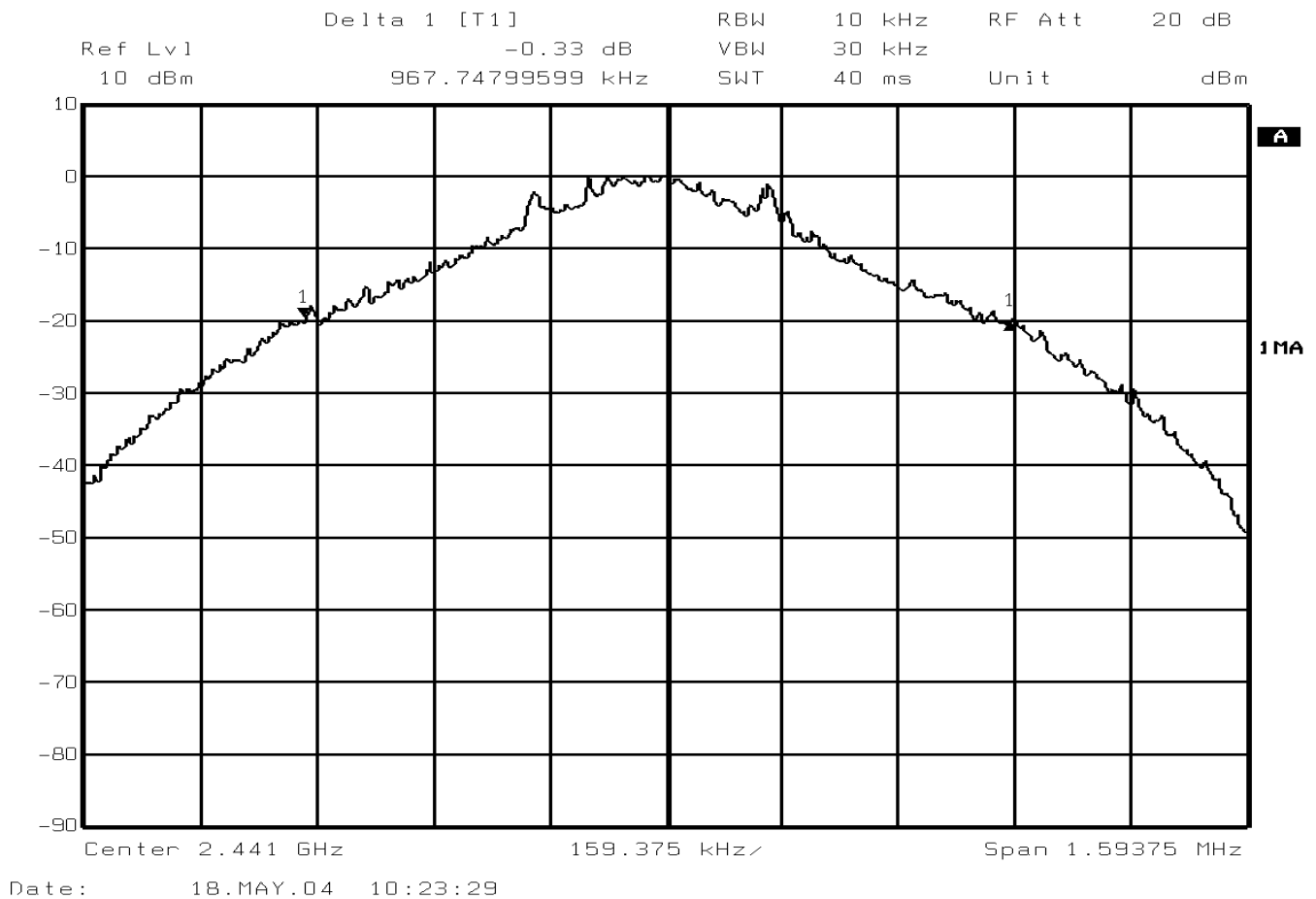




2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2441.0MHz – Maximum Power DH5

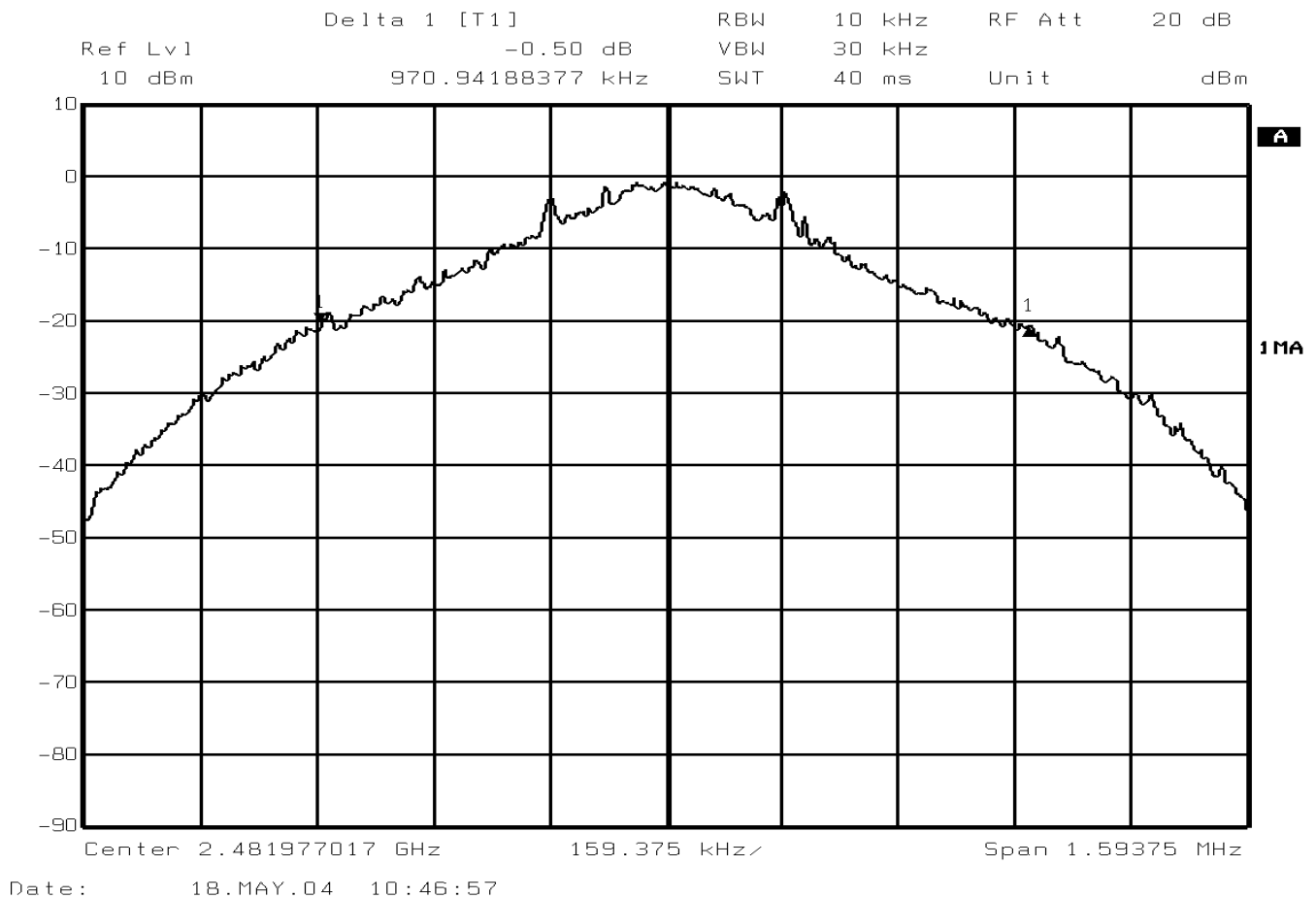




2.3 20dB BANDWIDTH - continued

2.3.6 Test Results- Continued

2480.0MHz – Maximum Power DH5





2.4 CHANNEL DWELL TIME (DH1)

2.4.4 Specification Reference

FCC Part 15.247(a)(iii)

2.4.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.4.3 Date of Test

18th May 2004

2.4.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as "Section 2.4" within the Test Equipment Used table shown in Section 3.1.

2.4.5 Test Procedure

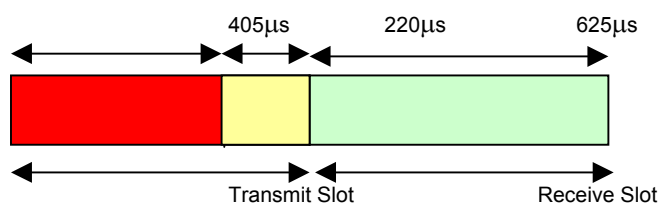
Procedure: Test Performed in accordance with 15.247.

The Bluetooth system hops at a rate of 1600 times per second. Thus, this equates to 1600 timeslots in 1 second. The DH1 data rate operates on a Transmit on 1 timeslot and Receive on 1 timeslot basis. Thus, in 1 second, there are 800 Transmit timeslots and 800 Receive timeslots.

Thus:

$$1 \text{ Timeslot} = \frac{1}{1600} = 625\mu\text{s}$$

In 1 transmit timeslot, the transmit on time is only 405μs. 220μs is reserved as off time for the synthesizer to re-tune ready for the next transmit frequency. The following timeslot is a receive slot. This process continues assuming the data rate remains the same.



DH1 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle

So, with 800 Tx and 800 Rx timeslots, the transmitter is on for $800 \times 405\mu\text{s} = 0.324$ seconds.

$$\therefore \frac{\text{Total Tx Time On}}{\text{No Of Channels}} = \frac{0.324}{80} = 4.05\text{ms}$$

So, in 32 seconds, the transmitter dwell time per channel is:

$$32 \times 4.05\text{ms} = 0.1296 \text{ seconds}$$



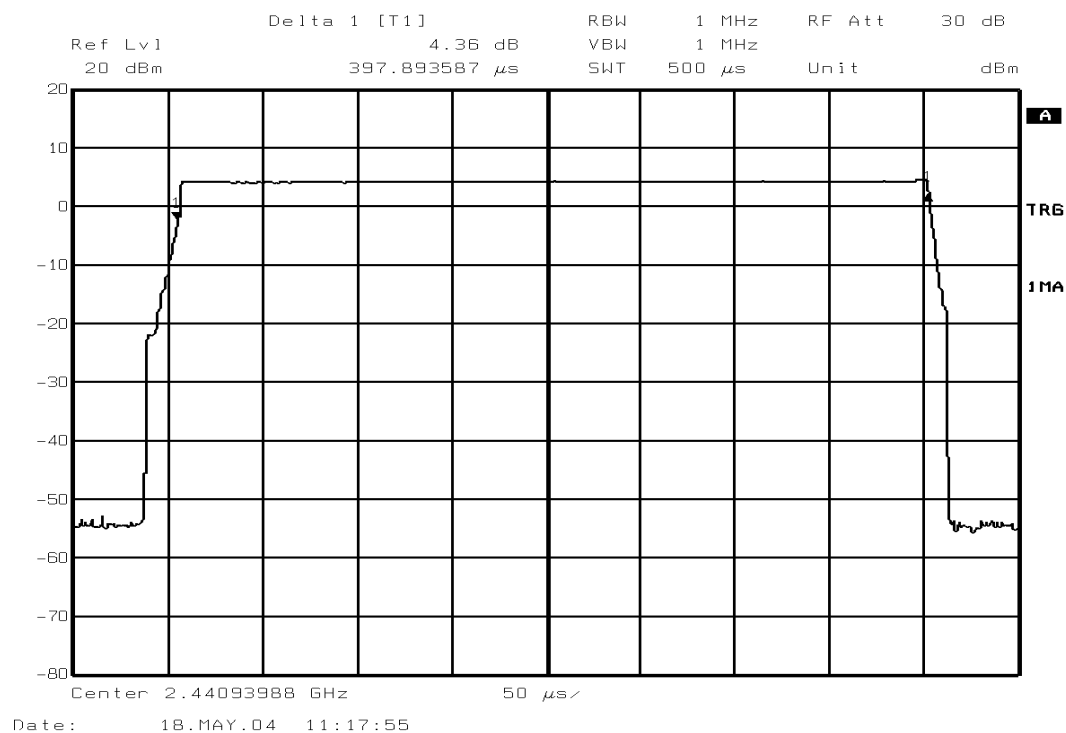
2.4 CHANNEL DWELL TIME (DH1) - continued

2.4.5 Test Procedure - continued

Remarks

Thus, the transmitter dwell time for data rate DH1 is meets the requirements specified in 15.247(a)(iii)

2.4.6 Test Results



Plot Showing DH1 Timeslot



2.5 CHANNEL DWELL TIME (DH3)

2.5.1 Specification Reference

FCC Part 15.247(a)(iii)

2.5.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.5.3 Date of Test

18th May 2004

2.5.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as "Section 2.5" within the Test Equipment Used table shown in Section 3.1.

2.5.5 Test Procedure

Test Performed in accordance with 15.247.

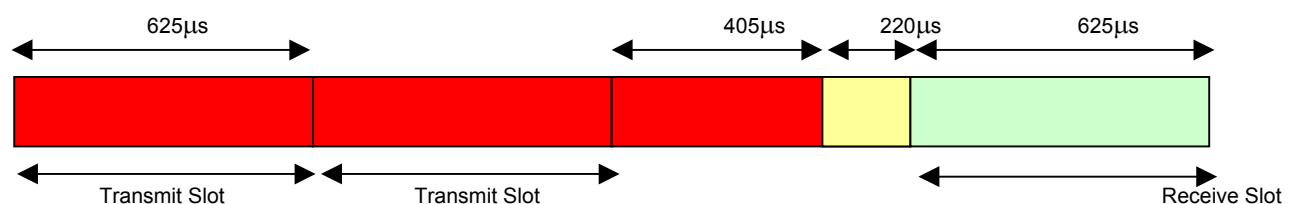
The Bluetooth system hops at a rate of 1600 times per second. Thus, this equates to 1600 timeslots in 1 second. With data rate DH3, the data payload is higher and can use up to 3 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 3 slots, (i.e. no receive slot in-between the 3 transmit slots). The 220 μ s off time for synthesizer re-tuning at the end of a slot is only used on the final slot. Thus, for one cycle, there are 3 transmit timeslots. 2 are 625 μ s long and the final slot is transmitting for 405 μ s.

The DH3 data rate operates on a Transmit on 3 timeslots and Receives on 1 timeslot basis, (assuming maximum data payload). The frequency-hopping rate is the same. Thus, in 1 second, there are 1200 Transmit timeslots and 400 Receive Timeslots.

Thus:

$$1 \text{ Timeslot} = \frac{1}{1600} = 625\mu\text{s}$$

The first 2 Transmit timeslots are transmitting for the complete 625 μ s. In the third transmit slot, the transmit on time is only 405 μ s. 220 μ s is reserved as off time for the synthesizer to re-tune ready for the next transmit frequency. The following timeslot is a receive slot. This process continues assuming the data rate remains the same.



DH3 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle, (Maximum Payload)



2.5 CHANNEL DWELL TIME (DH3) - continued

2.5.5 Test Procedure – Continued

Thus, the transmitter for one complete transmit and receive cycle would be on for:

$$Tx \quad (2 \times 625\mu s) + (1 \times 405\mu s) = 1.655ms$$

So:

$$\begin{aligned} 800 \times 625\mu s &= 0.5 \text{ seconds} \\ 400 \times 405\mu s &= 0.162 \text{ seconds} \end{aligned}$$

$$\text{Thus:} \quad 0.5 + 0.162 = 0.662 \text{ seconds}$$

$$\therefore \frac{\text{Total Tx Time On}}{\text{No Of Channels}} = \frac{0.662}{80} = 8.275ms$$

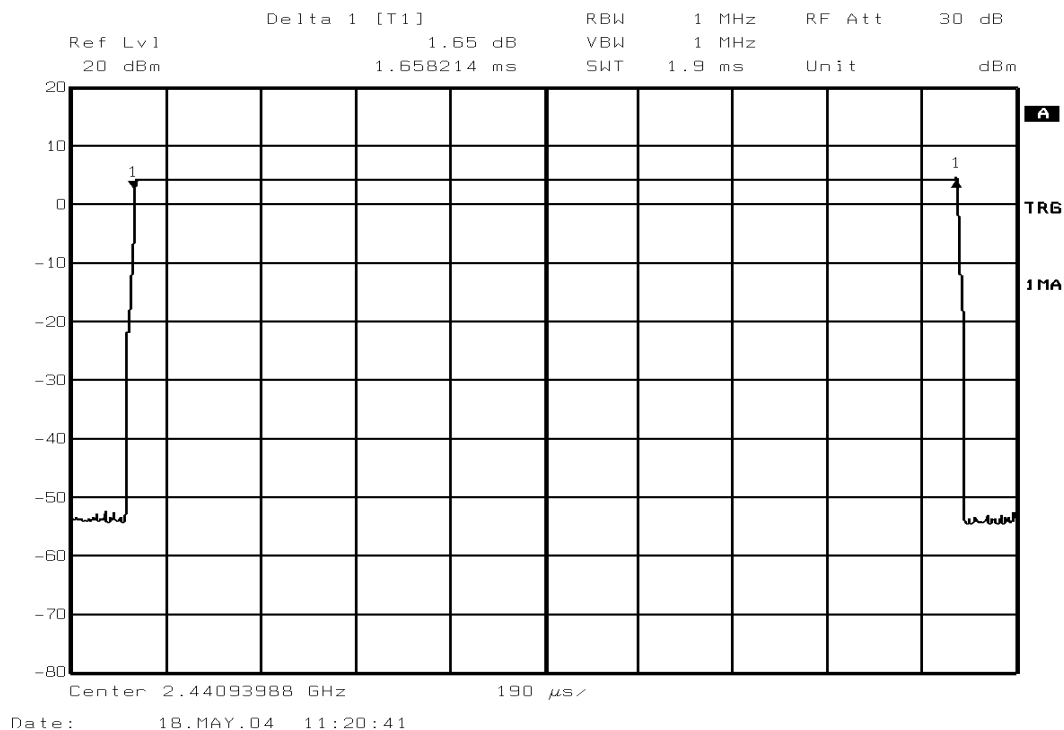
So, in 32 seconds, the transmitter dwell time per channel is:

$$32 \times 8.275ms = 0.2648 \text{ seconds}$$

Remarks

Thus, the transmitter dwell time for data rate DH3 meets the requirements specified in 15.247(a)(iii)

2.5.6 Test Results



Plot Showing DH3 Timeslot



2.6 CHANNEL DWELL TIME (DH5)

2.6.1 Specification Reference

FCC Part 15.247(a)(iii)

2.6.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.6.3 Date of Test

18th May 2004

2.6.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as "Section 2.6" within the Test Equipment Used table shown in Section 3.1.

2.6.5 Test Procedure

Test Performed in accordance with 15.247.

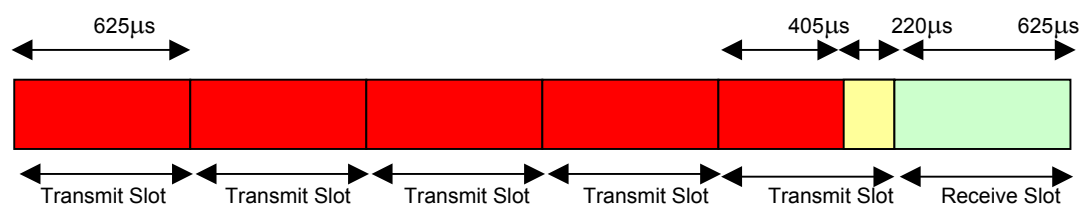
The Bluetooth system hops at a rate of 1600 times per second. Thus, this equates to 1600 timeslots in 1 second. With data rate DH5, the data payload is higher and can use up to 5 timeslots. When more than one timeslot is used, the frequency does not hop and transmission is continuous on all 5 slots, (i.e. no receive slot in-between the 5 transmit slots). The 220 μ s off time for synthesizer re-tuning at the end of a slot is only used on the final slot. Thus, for one cycle, there are 5 transmit timeslots. 4 are 625 μ s long and the final slot is transmitting for 405 μ s.

The DH5 data rate operates on a Transmit on 5 timeslots and Receives on 1 timeslot basis, (assuming maximum data payload). The frequency-hopping rate is the same. Thus, in 1 second, there are 1333.3 Transmit timeslots and 266.7 Receive Timeslots.

Thus:

$$1 \text{ Timeslot} = \frac{1}{1600} = 625\mu\text{s}$$

The first 4 Transmit timeslots are transmitting for the complete 625 μ s. In the fifth transmit slot, the transmit on time is only 405 μ s. 220 μ s is reserved as off time for the synthesizer to re-tune ready for the next transmit frequency. The following timeslot is a receive slot. This process continues assuming the data rate remains the same.



DH5 Timeslot Arrangement Showing One Complete Transmit and Receive Cycle, (Maximum Payload)



2.6 CHANNEL DWELL TIME (DH5) - continued

2.6.5 Test Procedure - continued

Thus, the transmitter for one complete transmit and receive cycle would be on for:

$$\text{Tx} \quad (2 \times 625\mu\text{s}) + (1 \times 405\mu\text{s}) = 2.905\text{ms}$$

So:

$$1066.7 \times 625\mu\text{s} = 0.666 \text{ seconds}$$

$$266.7 \times 405\mu\text{s} = 0.108 \text{ seconds}$$

$$\text{Thus:} \quad 0.666 + 0.108 = 0.774 \text{ seconds}$$

$$\therefore \quad \frac{\text{Total Tx Time On}}{\text{No Of Channels}} = \frac{0.774}{80} = 9.675\text{ms}$$

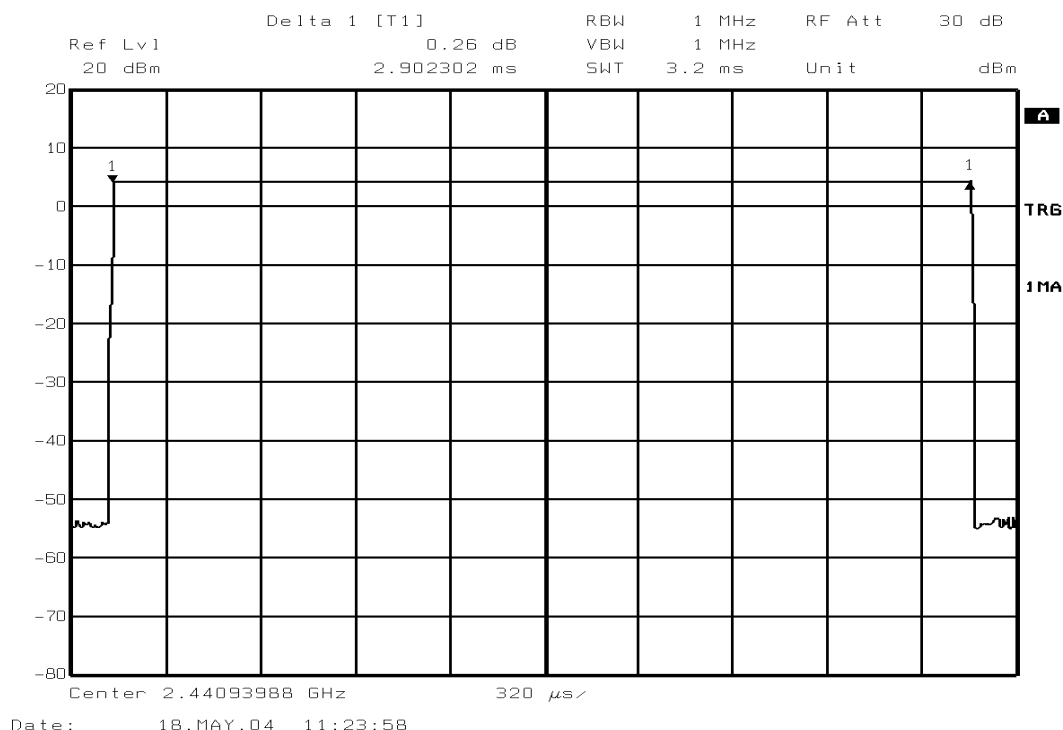
So, in 32 seconds, the transmitter dwell time per channel is:

$$32 \times 9.675\text{ms} = 0.31 \text{ seconds}$$

Remarks

Thus, the transmitter dwell time for data rate DH5 meets the requirements specified in 15.247(a)(iii)

2.6.6 Test Results



Plot Showing DH5 Timeslot



2.7 CHANNEL SEPARATION

2.7.1 Specification Reference

FCC Part 15.247(a)(1)

2.7.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.7.3 Date of Test

18th May 2004

2.7.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as “Section 2.7” within the Test Equipment Used table shown in Section 3.1.

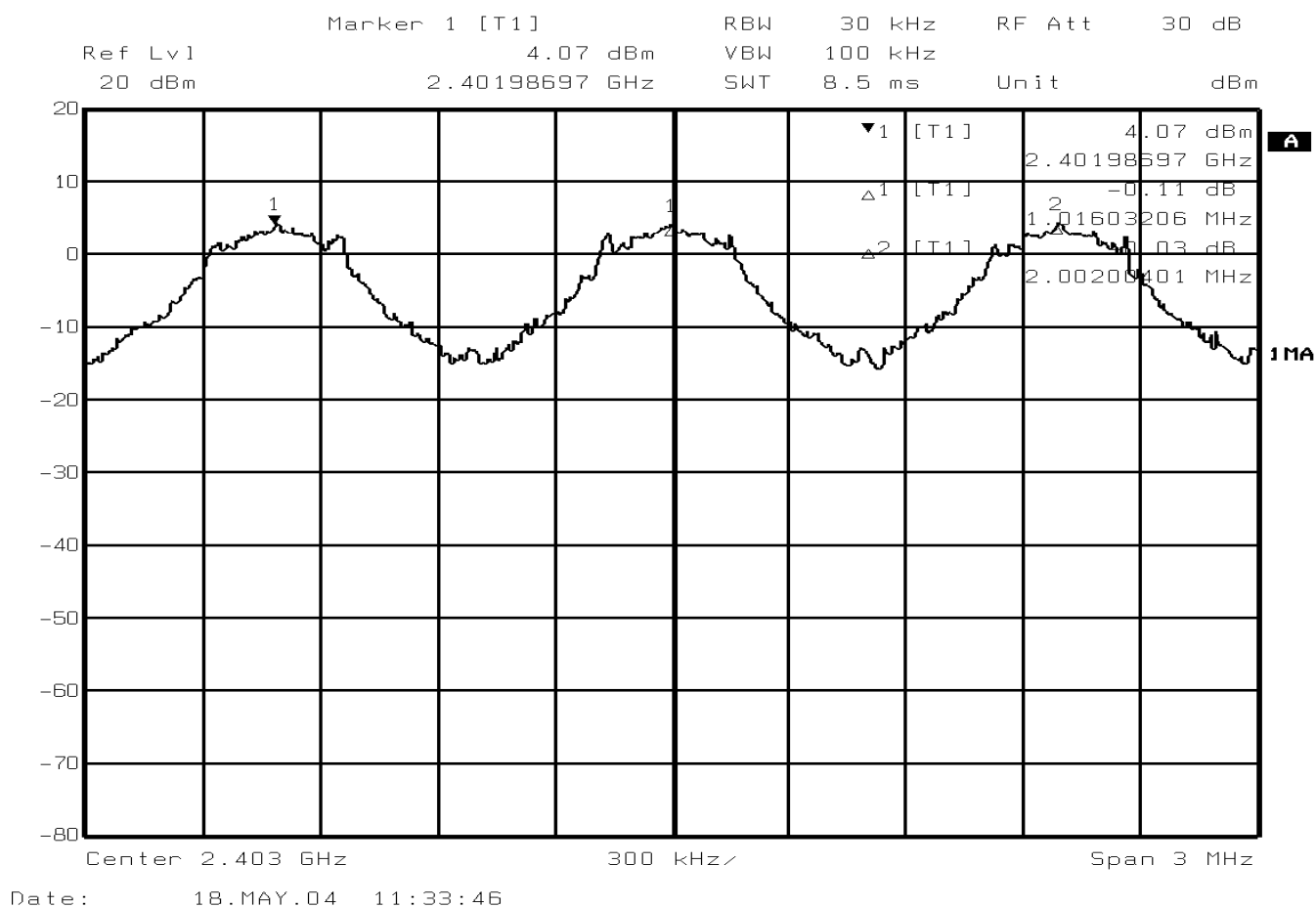
2.7.5 Test Procedure

The EUT was transmitted at maximum power into a Spectrum Analyser. The trace was set to Max Hold to store several adjacent channels on screen. Using the marker delta function, the markers were positioned to show the separation between adjacent channels.



2.7 CHANNEL SEPARATION - continued

2.7.5 Test Result - continued



The system channel separation is specified as being 1MHz. The measured channel separation from the plot above is: 1.01613206MHz.

Limit	>25kHz
-------	--------

Remarks

The equipment met the requirements outlined in 15.247(a)(1).



2.8 NUMBER OF HOPPING CHANNELS

2.8.1 Specification Reference

FCC Part 15.247(a)(1)

2.8.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.8.3 Date of Test

18th May 2004

2.8.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as “Section 2.8” within the Test Equipment Used table shown in Section 3.1.

2.8.5 Test Procedure

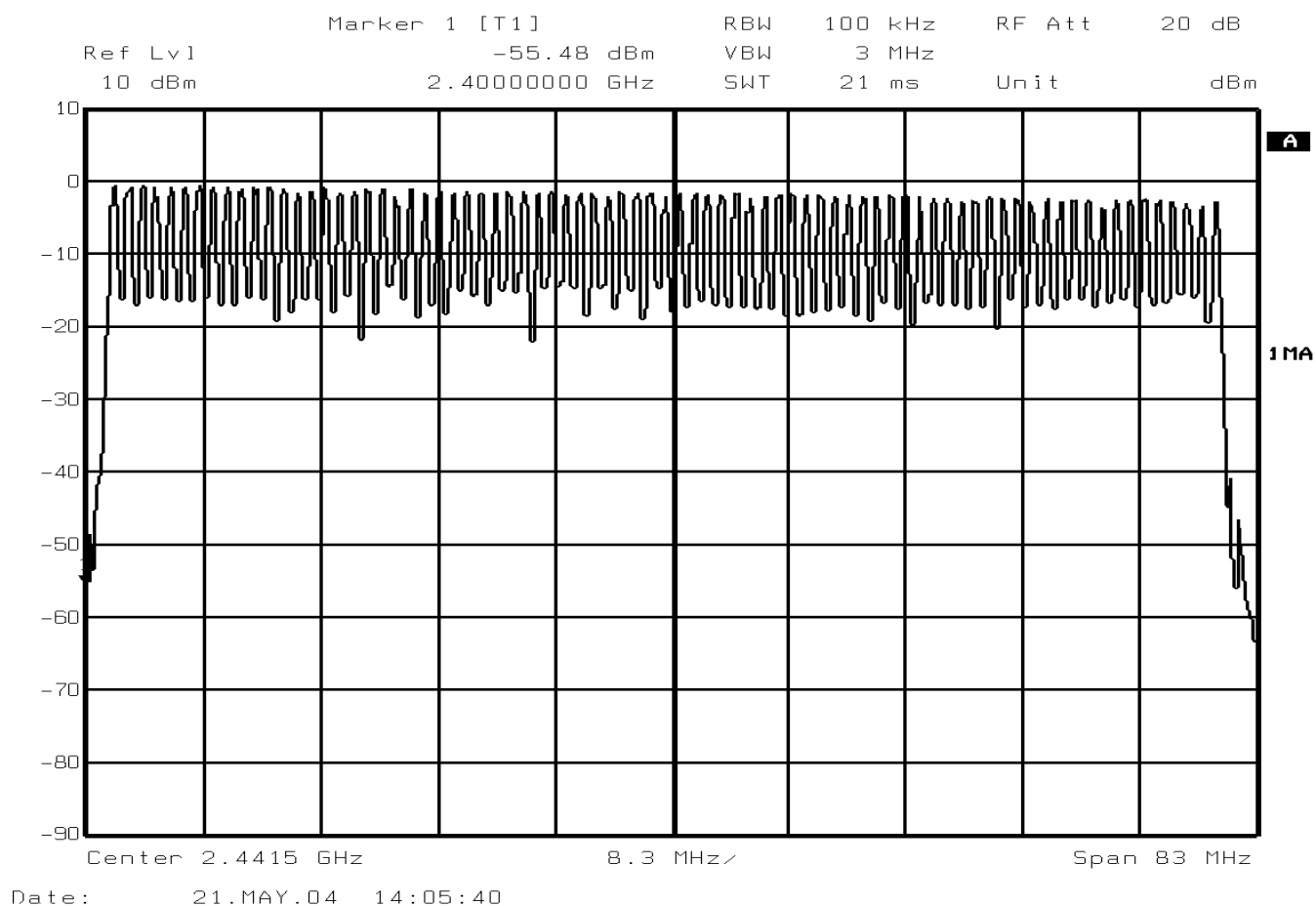
Test Performed in accordance with 15.247.

The EUT was connected to a Spectrum Analyser via a cable. The EUT was set to transmit on maximum power and hopping on all channels. The span was adjusted to show the individual channels. To reasonably display the number of channels, the occupied band was split into four traces. The display trace was set to Max Hold and the plots recorded.



2.8 NUMBER OF HOPPING CHANNELS - continued

2.8.6 Test Results



Trace Showing Channels 1 - 79

Limit	≥75 channels
-------	--------------

Remarks

EUT complies with CFR 47 15.247(a)(1)(iii). The EUT utilises more than 75 channels.



2.9 MAXIMUM PEAK OUTPUT POWER

2.9.1 Specification Reference

FCC Part 15.247(b)(1)

2.9.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.9.3 Date of Test

29th April 2004

2.9.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as "Section 2.9" within the Test Equipment Used table shown in Section 3.1.

2.9.5 Test Procedure

Test Performed in accordance with 15.247.

The EUT was connected to a Peak Power Analyser, (8990A), via an RF cable. Using a Signal Generator and the 8990A, the path loss of the cable was measured and entered as an offset adjustment into the 8990A. The peak level was recorded and compared with the test limits.

2.9.6 Test Results

DH1

Frequency (MHz)	Output Power (dBm)	Result (mW)
2402.0	10.81	12.05
2441.0	10.31	10.74
2480.0	9.58	9.08

DH3

Frequency (MHz)	Output Power (dBm)	Result (mW)
2402.0	13.91	24.60
2441.0	13.35	21.63
2480.0	12.71	18.66

**2.9 MAXIMUM PEAK OUTPUT POWER** - continued**2.9.6 Test Results** - continuedDH5

Frequency (MHz)	Output Power (dBm)	Result (mW)
2402.0	15.86	38.55
2441.0	15.24	33.42
2480.0	14.55	28.51

Limit	<1W or <+30dBm
-------	----------------

Remarks

EUT complies with CFR 47 15.247(b)(1). The EUT does not exceed 1W or +30dBm at the measured frequencies.



2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT

2.10.1 Specification Reference

FCC CFR 47: Part 15 Subpart C, Section 15.247(c)

2.10.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.10.3 Date of Test

28th May 2004

2.10.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as "Section 2.10 within the Test Equipment Used table shown in Section 3.1.

2.10.5 Test Procedure

Test Performed in accordance with FCC CFR 47: Part 15 Subpart C, Section 15.247(c).

In accordance with Part 15.247(c), Spurious Conducted Emissions from the antenna terminal were measured within the frequency spectrum investigated from 9kHz to 25 GHz. The transmitter output power was attenuated using a combination of filters and attenuators and. The EUT was set to transmit on full power, at all data rates and then the EUT was tested hopping on all channels. The resolution and video bandwidths were set to 100kHz in accordance with Part 15.247. The spectrum analyser detector was set to Max Hold.

For measuring the range 9kHz to 4GHz, a 10dB attenuator was used. From 4 to 25GHz, a 10dB attenuator and a high pass filter were used

The Maximum "fundamental peak" level measured was used to determine the limit line as displayed on the following plots.

The maximum path loss across each measurement band was used as the reference level offset to ensure worst case

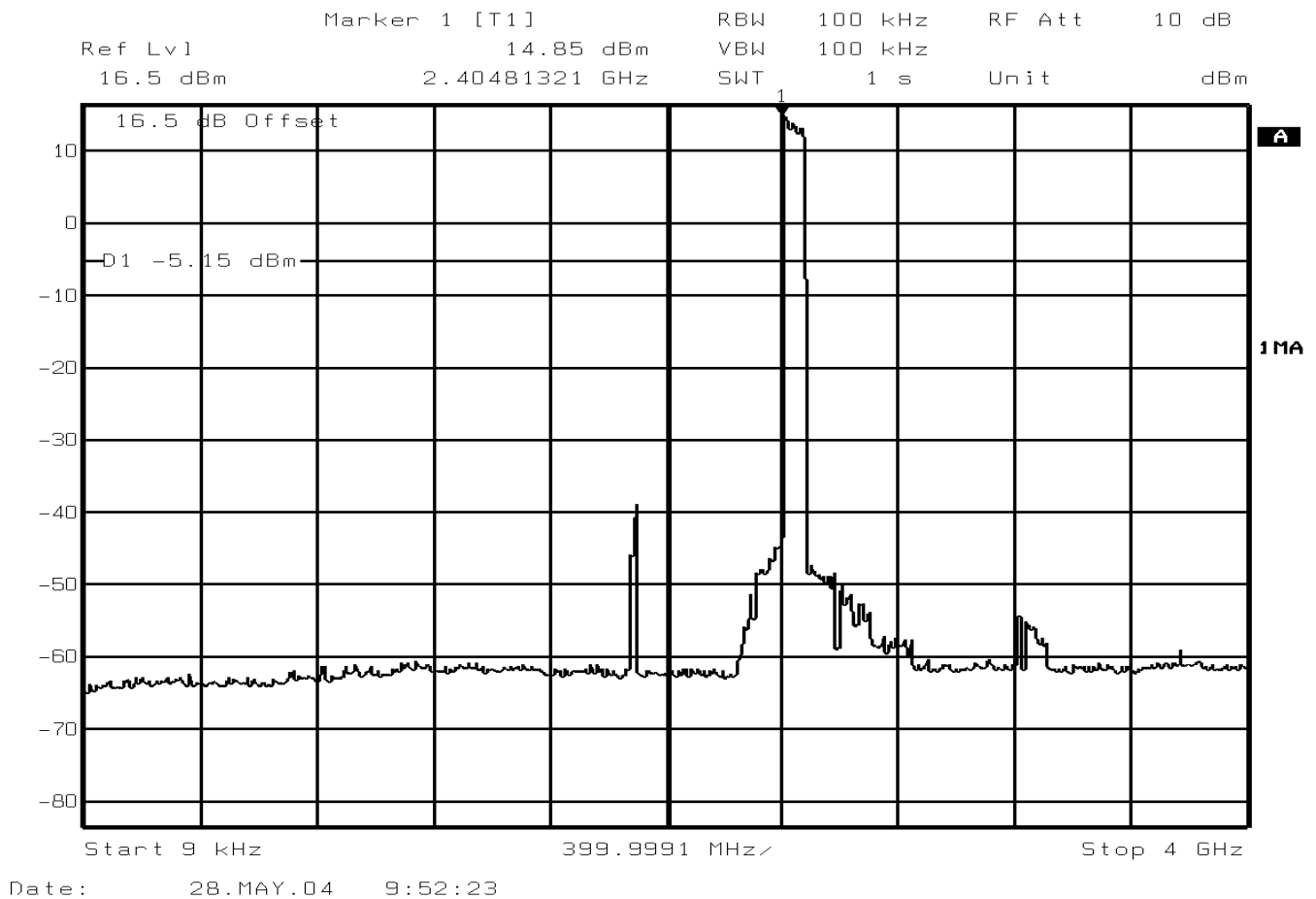


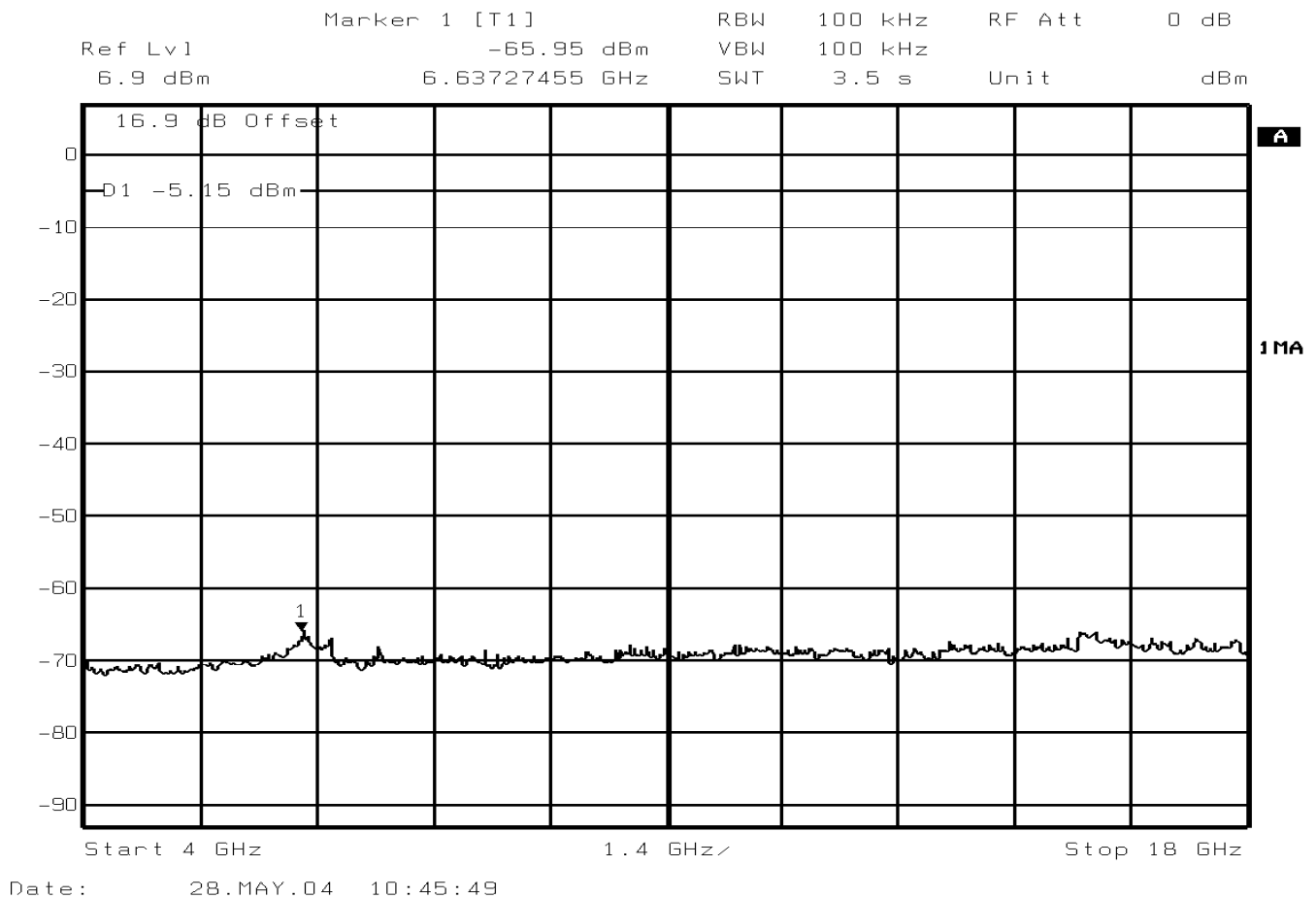
2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued

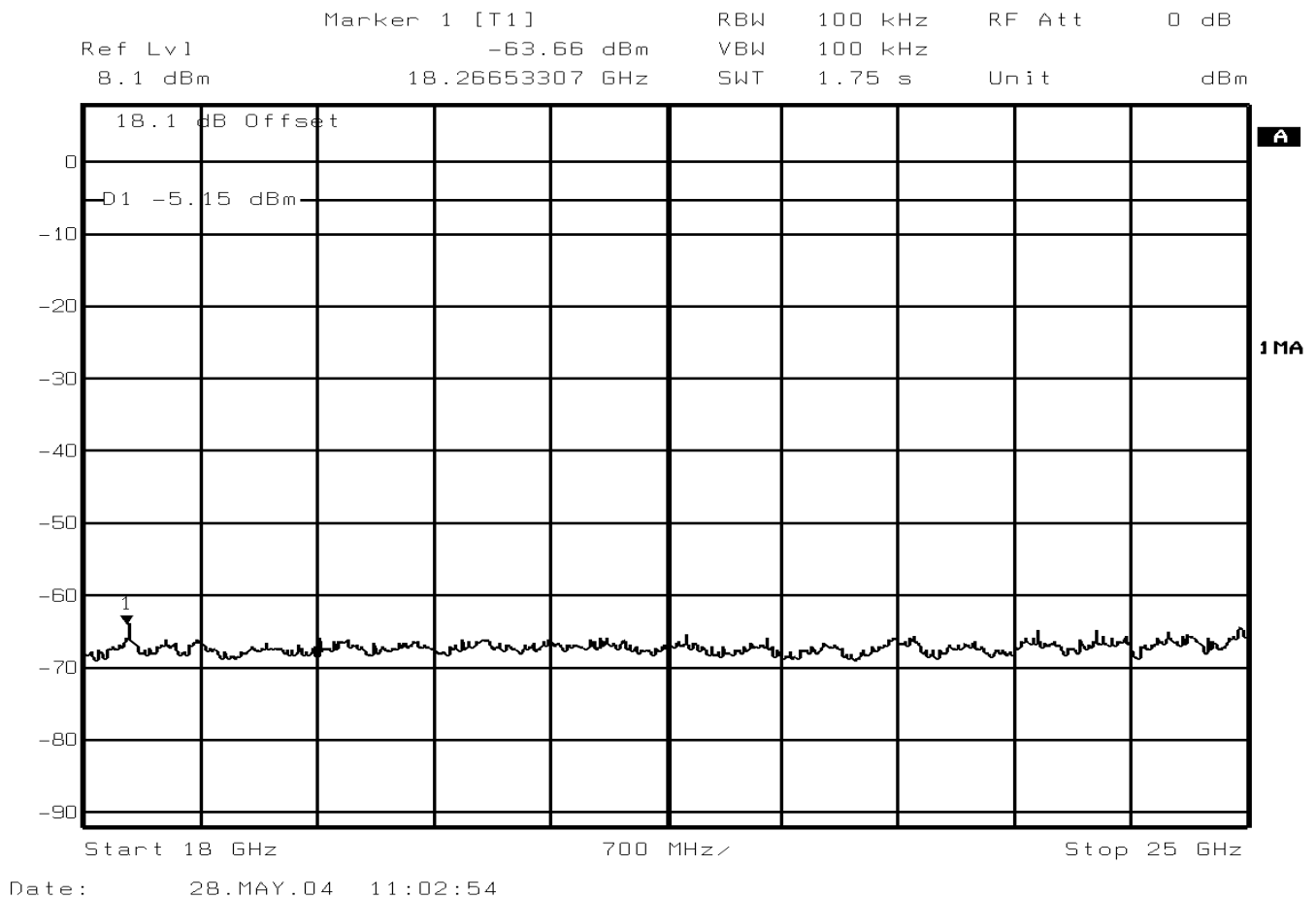
2.10.6 Test Results

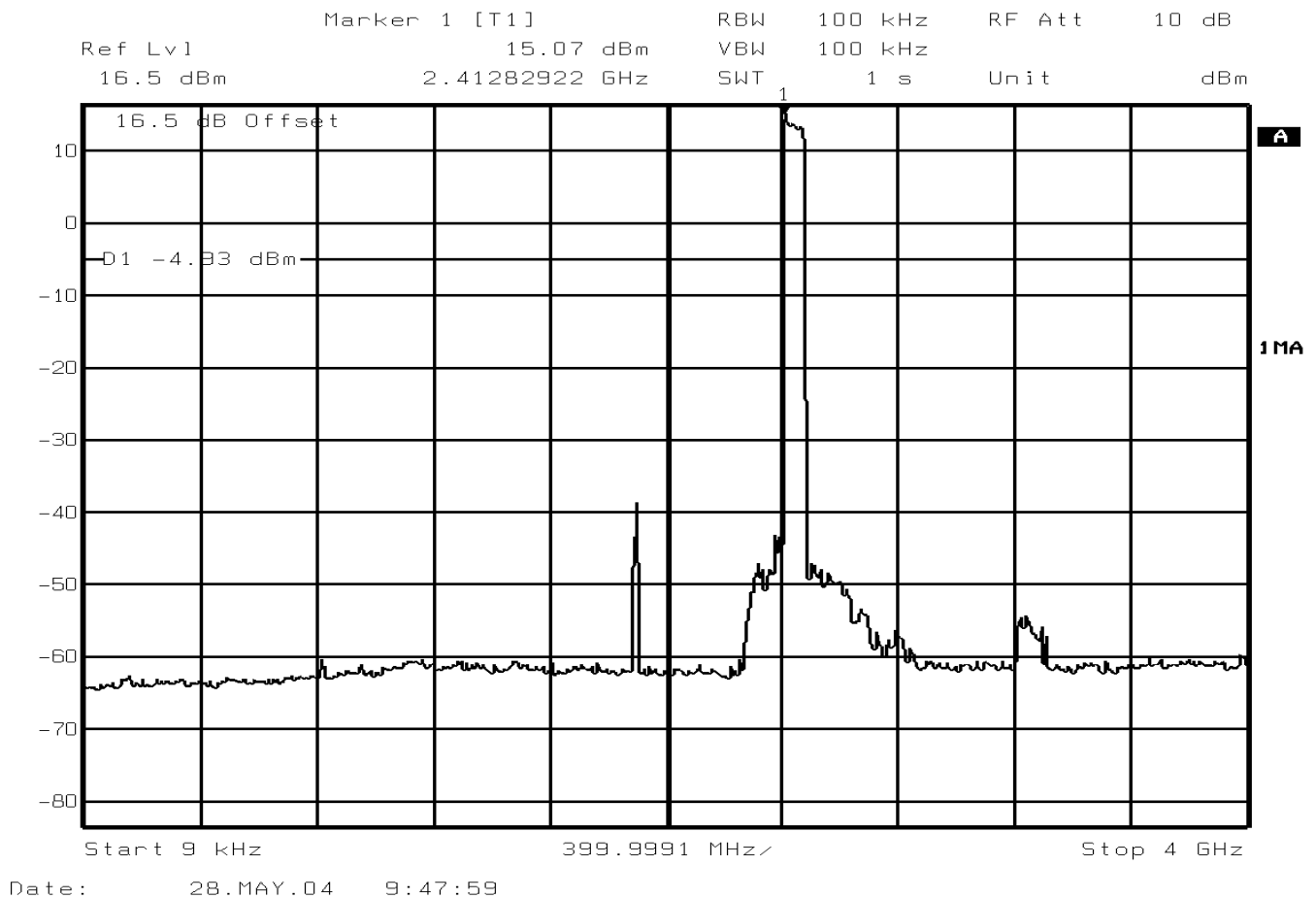
The EUT met the requirements of FCC CFR 47: Part 15 Subpart C, Section 15.247(b)(1) for Spurious Conducted Emissions on the Antenna Port.

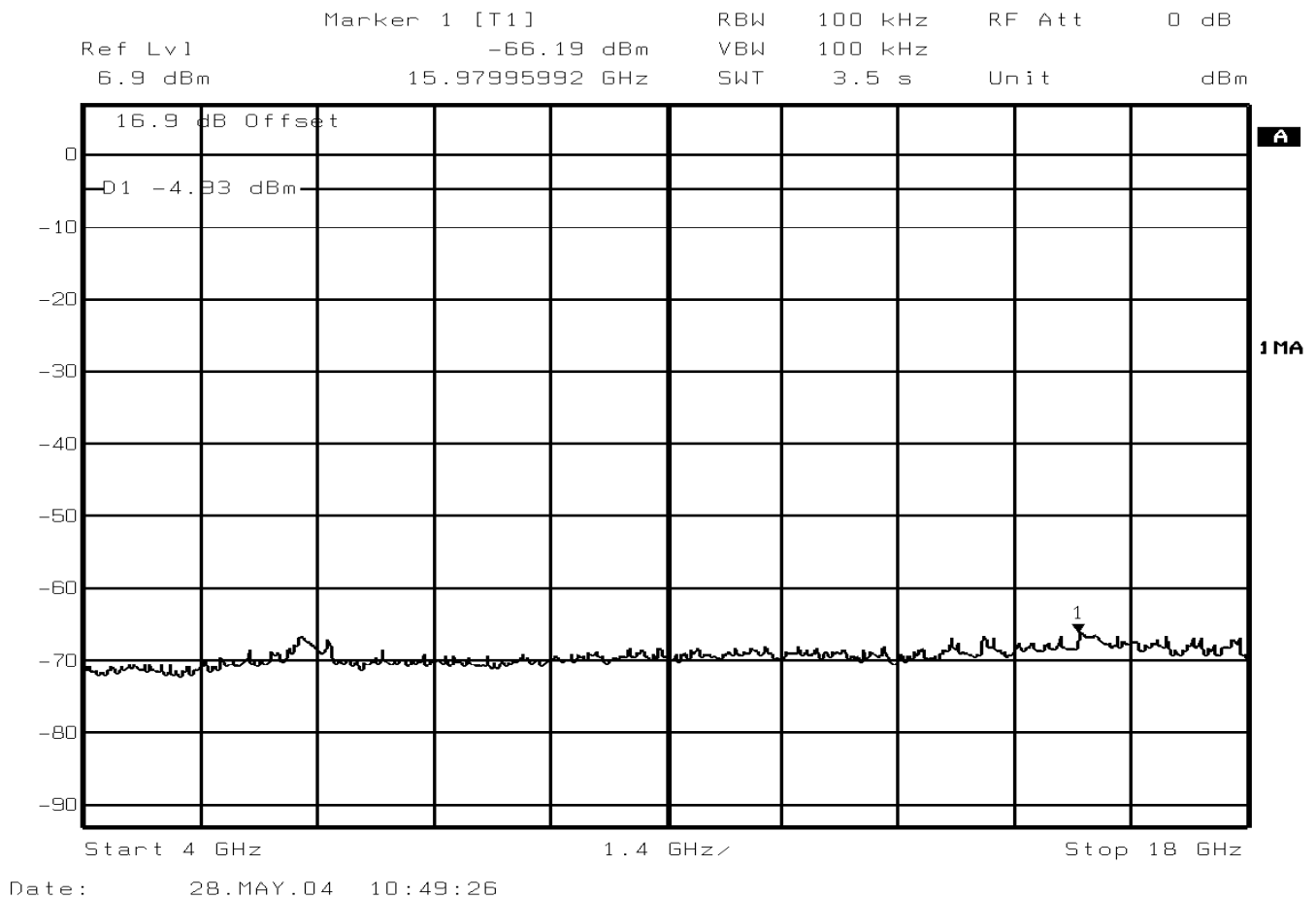
The plots on the following pages show the EUT's Antenna Ports Spurious Conducted Emissions over the frequency range 9kHz to 25GHz.

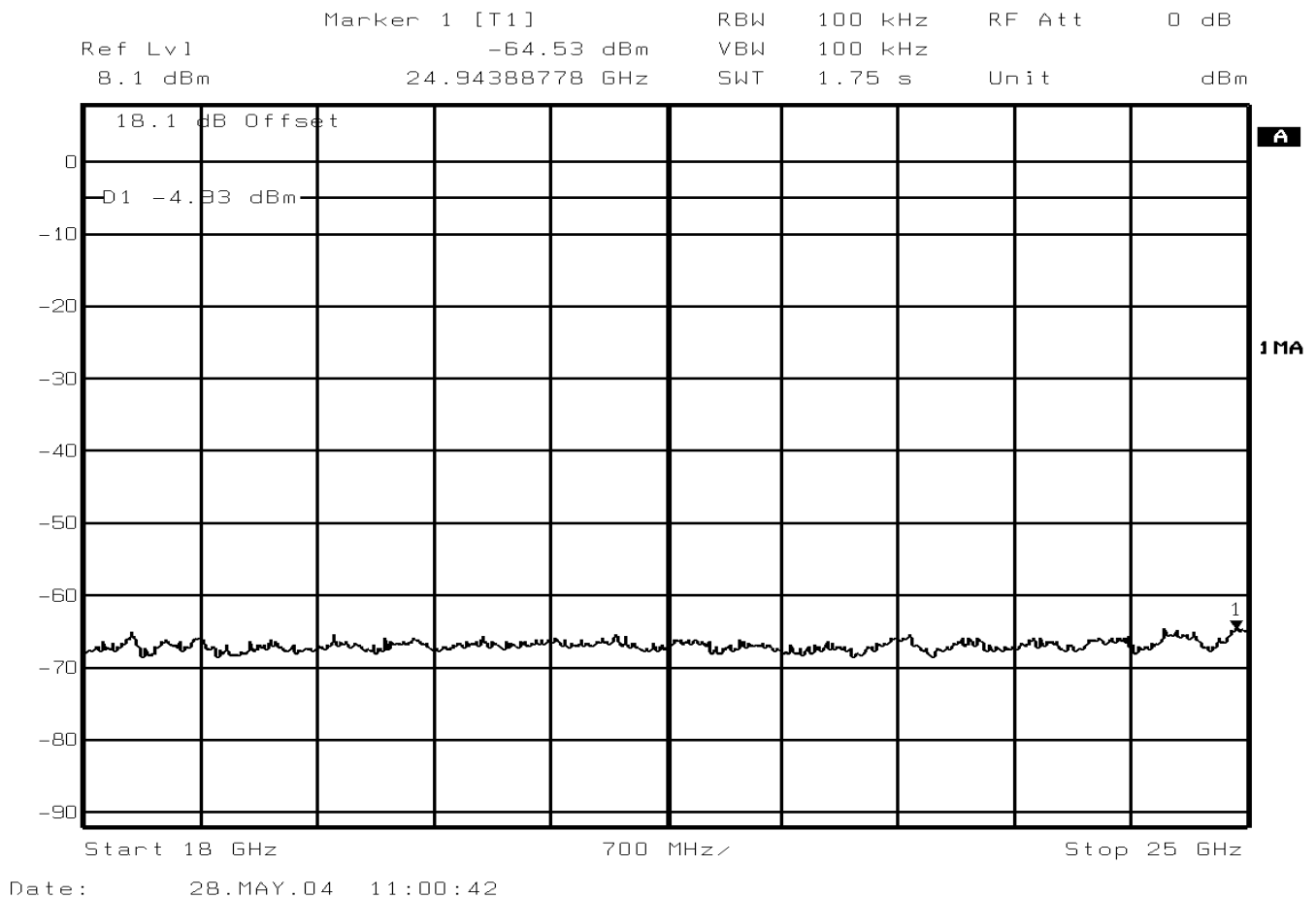
**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (9kHz – 4GHz) – Maximum Power DH1

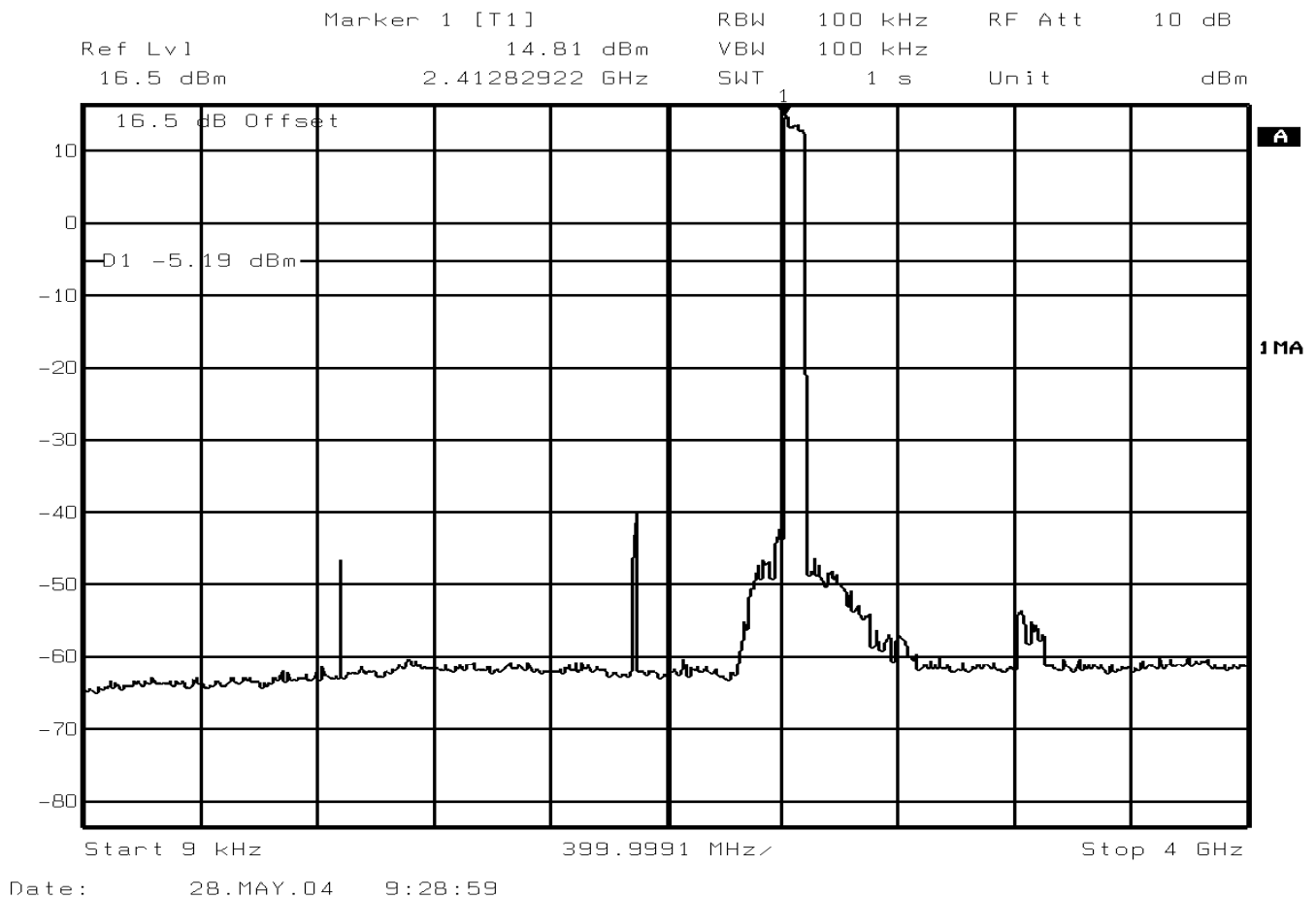
**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (4GHz – 18GHz) – Maximum Power DH1

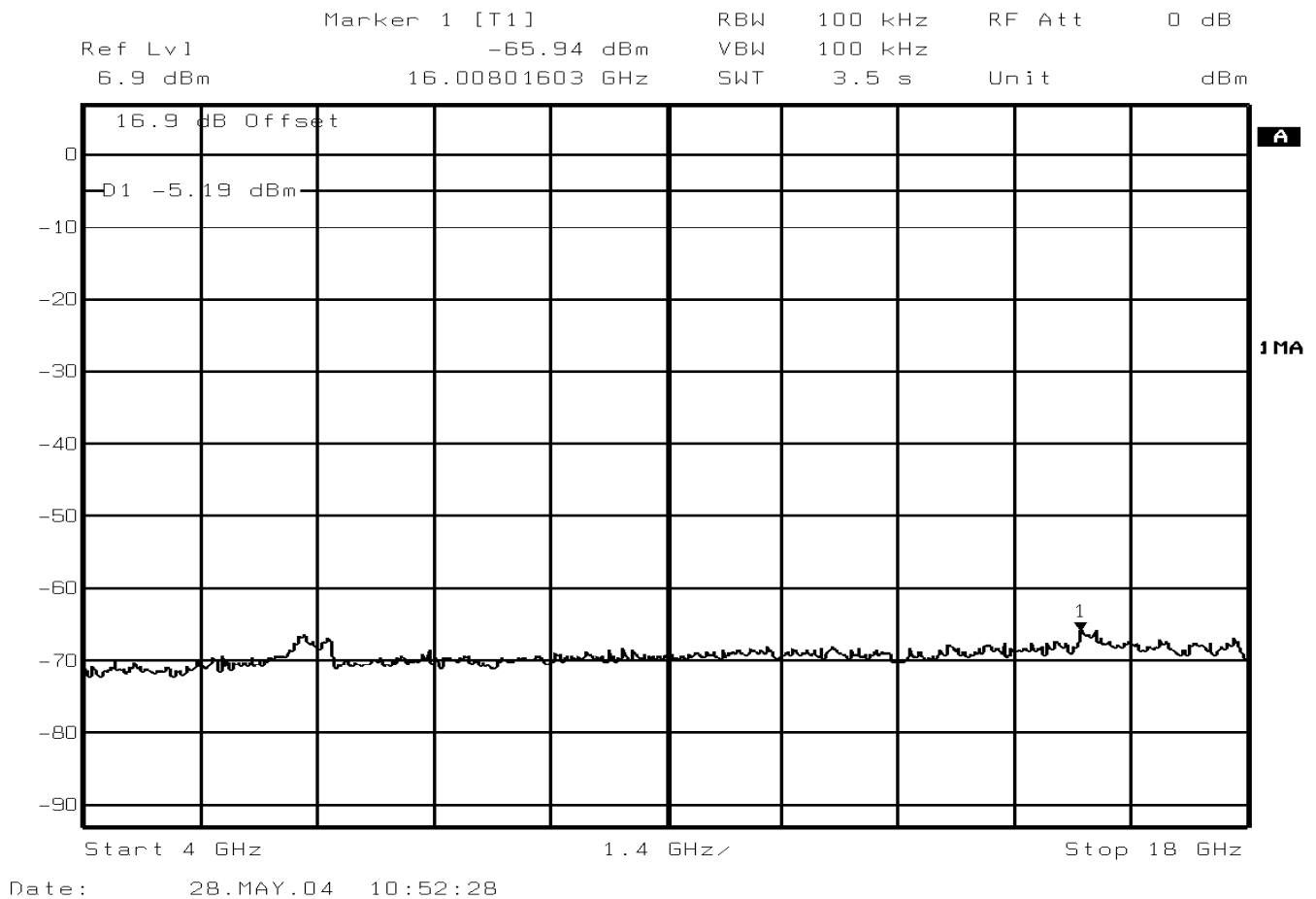
**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (18GHz – 25GHz) – Maximum Power DH1

**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (9kHz – 4GHz) – Maximum Power DH3

**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (4GHz – 18GHz) – Maximum Power DH3

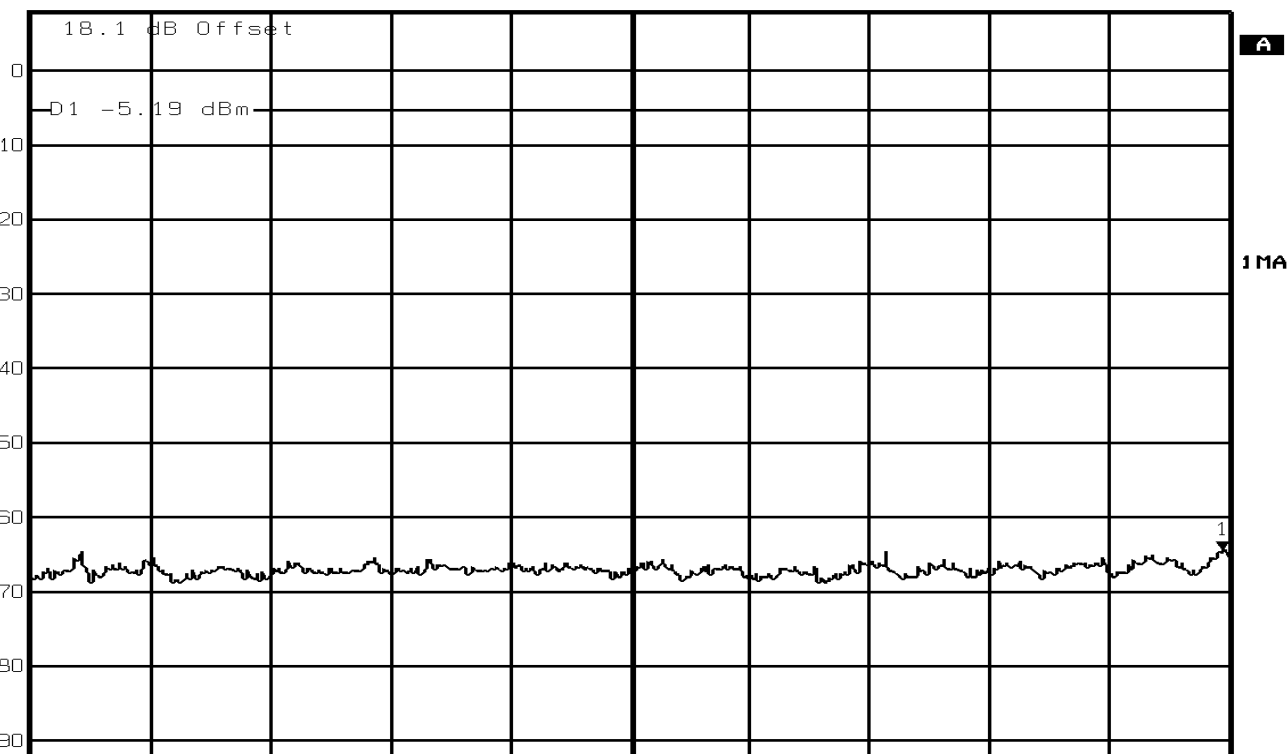
**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (18GHz – 25GHz) – Maximum Power DH3

**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (9kHz – 4GHz) – Maximum Power DH5

**2.10 SPURIOUS CONDUCTED EMISSIONS ON ANTENNA PORT - continued****2.10.6 Test Results – continued**Spurious Conducted Emissions (4GHz – 18GHz) – Maximum Power DH5

2.10.6 Test Results – continued

Ref Lvl	Marker 1 [T1]	RBW	100 kHz	RF Att	0 dB
8.1 dBm	-64.37 dBm	VBW	100 kHz		
	24.97194389 GHz	SWT	1.75 s	Unit	dBm





2.11 SPURIOUS RADIATED EMISSIONS

2.11.1 Specification Reference

FCC CFR 47: Part 15 Subpart B, Section 15.247(c)

2.11.2 Equipment Under Test

Bluetooth Module, Type 21-64381

2.11.3 Date of Test

28th April 2004

2.11.4 Test Equipment Used

The major items of test equipment used for the above tests are identified as “Section 2.11” within the Test Equipment Used table shown in Section 3.1.

2.11.5 Test Procedure

Test Performed in accordance with ANSI C63.4.

A preliminary profile of the Spurious Radiated Emissions was obtained by operating the EUT on a remotely controlled turntable within a semi-anechoic chamber. Measurements of emissions from the EUT were obtained with the Measurement Antenna in both Horizontal and Vertical Polarisations. The profiling produced a list of the worst-case emissions together with the EUT azimuth and antenna polarisation.

Using the information from the preliminary profiling of the EUT. The list of emissions was then confirmed or updated under Alternative Open Site conditions. Emission levels were maximised by adjusting the antenna height, antenna polarisation and turntable azimuth.

Emissions identified within the range 30MHz – 10GHz were then formally measured using a CISPR Quasi-Peak detector.

The measurements were performed at a 3m distance unless otherwise stated.



2.11 SPURIOUS RADIATED EMISSIONS - continued

2.11.5 Test Procedure - continued

The limits for Spurious Emissions Outside the Restricted Bands have been measured and calculated as shown in the table below:

Test Mode	Carrier Frequency GHz	Carrier Field Strength dBμV/m	Limit for Spurious Outside Restricted Band (Carrier F S -20dB) dBμV/m
Mode 1 (Bluetooth)	2402	114.5	94.5
Mode 1 (Bluetooth)	2441	115.5	95.5
Mode 1 (Bluetooth)	2480	114.2	94.2

In accordance with FCC Public Notice DA 00-705, Released 30th March 2000, Section 15.247(c) Spurious Radiated Emissions "If the dwell time per channel of the hopping signal is less than 100ms, then the reading obtained with the 10Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{dwell time}/100\text{ms})$, in an effort to demonstrate compliance with the 15.209 limit the following adjustment has been calculated for use with Average Measurements only;

Dwell Time = 5.81ms this is derived from;

Total slot time per time slot for DH5 packet $625\mu\text{s} \times 5 = 3.125\text{ms}$

Actual transmit time during this time slot is 2.905ms and the reply time slot after each DH5 packet is 625μs.

Total time slot length per channel $3.125 + 0.625 = 3.75\text{ms}$.

Multiply Total time slot length per channel by 32 channels per hop sequence $32 \times 3.75 = 120\text{ms}$

It is therefore possible to have a maximum of two hop sequences in any given 100ms period, a single channel could occur twice within any 100ms time window. $2 \times 2.905 = 5.81\text{ms}$

Therefore; the Bluetooth Duty Cycle Correction Factor for the EUT is $20 \log (5.81/100) = -24.7\text{dB}$



2.11 SPURIOUS RADIATED EMISSIONS - continued

2.11.6 Test Results

30MHz – 1000MHz Frequency Range

Equipment Designation: Unintentional Radiator.

The EUT met the requirements of FCC CFR 47: Part 15 Subpart B, Section 15.247(c) for Spurious Radiated Emissions (30MHz – 1GHz).

Measurements were made with the EUT in Bluetooth Mode (as described in Section 1.3.3).

EUT Rx on Bottom Channel (2402.0MHz)

The levels of the highest emissions measured in accordance with the specification are presented below: -

Emission Frequency	Polarisation	Height	Azimuth	Field Strength		Limit	
MHz	Horizontal/ Vertical	cm	degree	dBµV/m	µV/m	dBµV/m	µV/m
35.0	V	100	0	16.5	6.68	40.0	100.0
500.0	V	100	0	15.8	6.17	40.0	100.0
995.0	V	100	0	29.5	29.85	40.0	100.0

EUT Rx on Middle Channel (2441.0MHz)

The levels of the highest emissions measured in accordance with the specification are presented below: -

Emission Frequency	Polarisation	Height	Azimuth	Field Strength		Limit	
MHz	Horizontal/ Vertical	cm	degree	dBµV/m	µV/m	dBµV/m	µV/m
35.0	V	100	0	16.5	6.68	40.0	100.0
500.0	V	100	0	15.8	6.17	40.0	100.0
995.0	V	100	0	29.5	29.85	40.0	100.0



2.11 SPURIOUS RADIATED EMISSIONS - continued

2.11.6 Test Results - continued

EUT Rx on Top Channel (2480.0MHz)

The levels of the highest emissions measured in accordance with the specification are presented below: -

Emission Frequency	Polarisation	Height	Azimuth	Field Strength		Limit	
MHz	Horizontal/ Vertical	cm	degree	dB μ V/m	μ V/m	dB μ V/m	μ V/m
35.0	V	100	0	16.5	6.68	40.0	100.0
500.0	V	100	0	15.8	6.17	40.0	100.0
995.0	V	100	0	29.5	29.85	40.0	100.0



2.11 SPURIOUS RADIATED EMISSIONS - continued

2.11.6 Test Results - continued

1GHz - 25GHz Frequency Range

Equipment Designation: Intentional Radiator.

The EUT met the requirements of FCC CFR 47: Part 15 Subpart C, Section 15.247(c), 15.205 and 15.209 for Radiated Emissions (1GHz – 25GHz).

Measurements were made with the EUT in RLAN Mode (see Section 1.3.3 for details).

EUT Tx on Bottom Channel (2402MHz)

Frequency	Antenna		Turntable	Peak Field Strength	Peak Limit	Average Field Strength	Average Limit
	Pol	Height	Azimuth				
GHz	H/V	cm	deg	dBμV/m	dBμV/m	dBμV/m	dBμV/m
2.370	V	103	215	60.3	74.0	25.3*	54.0
4.804	V	100	266	48.8	74.0	13.6*	54.0

EIRP Results are only taken for frequencies that fall Outside the Restricted Band in accordance 15.247(c.)

* Note these results have been corrected using the Bluetooth Duty Cycle Correction Factor for the EUT, as calculated on page 55 of this report.

EUT Tx on Middle Channel (2441MHz)

Frequency	Antenna		Turntable	Peak Field Strength	Peak Limit	Average Field Strength	Average Limit
	Pol	Height	Azimuth				
GHz	H/V	cm	deg	dBμV/m	dBμV/m	dBμV/m	dBμV/m
2.344	V	121	219	57.6	74.0	21.3*	54.0
4.882	V	100	216	43.2	74.0	7.2*	54.0

EIRP Results are only taken for frequencies that fall Outside the Restricted Band in accordance 15.247(c.)

* Note these results have been corrected using the Bluetooth Duty Cycle Correction Factor for the EUT, as calculated on page 55 of this report.



2.11 SPURIOUS RADIATED EMISSIONS - continued

2.11.6 Test Results – continued

1GHz - 25GHz Frequency Range

EUT Tx on Top Channel (2480MHz)

Frequency	Antenna		Turntable	Peak Field Strength	Peak Limit	Average Field Strength	Average Limit
	Pol	Height	Azimuth				
GHz	H/V	cm	deg	dBμV/m	dBμV/m	dBμV/m	dBμV/m
2.385	V	100	216	58.1	74.0	46.6	54.0
2.487	V	122	219	64.3	74.0	50.4	54.0
4.960	V	100	221	49.9	74.0	41.1	54.0

EIRP Results are only taken for frequencies that fall Outside the Restricted Band in accordance 15.247(c.)

ABBREVIATIONS FOR ABOVE TABLES

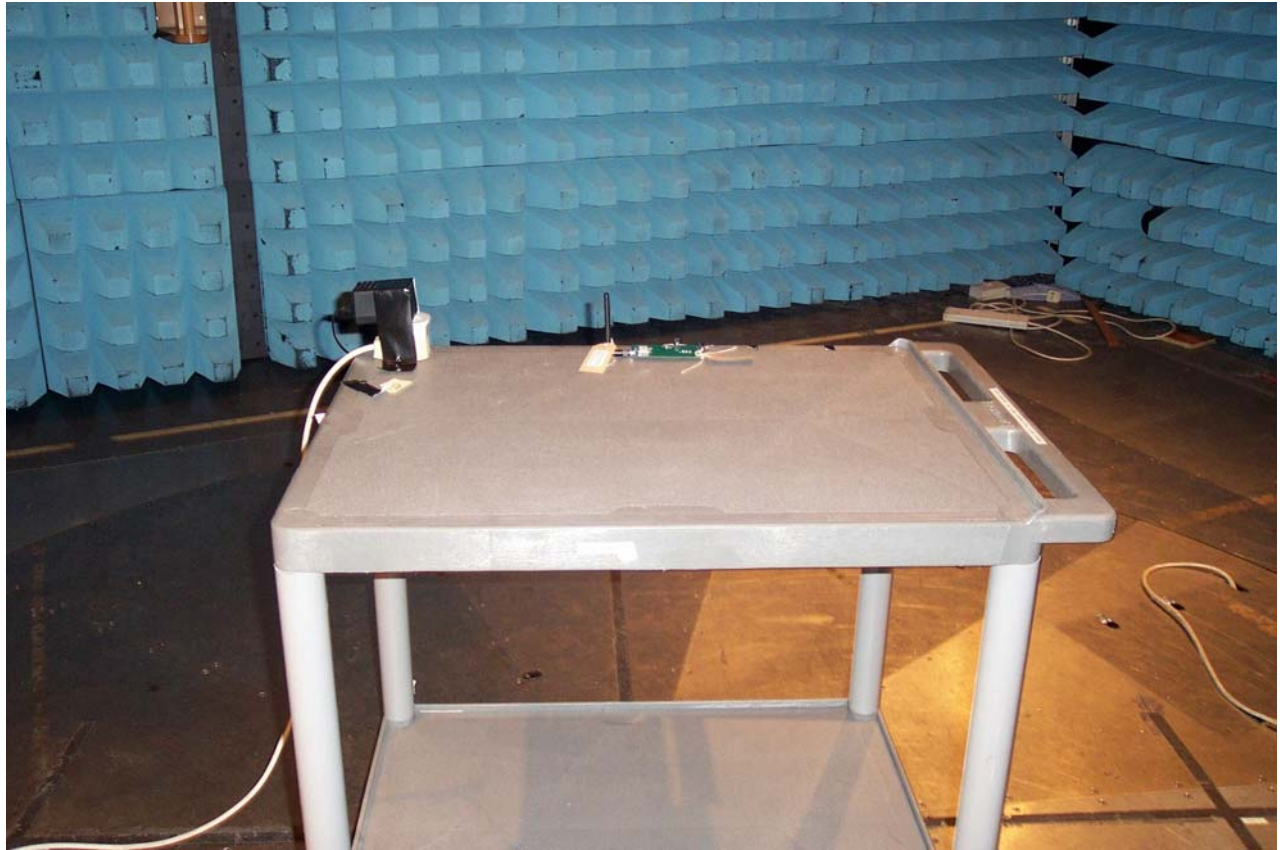
H Horizontal Polarisation
 Pol Polarisation
 deg degree

V Vertical Polarisation
 Hgt Height
 Azm Azimuth



2.11 SPURIOUS RADIATED EMISSIONS - continued

2.11.7 Set Up Photograph



Set Up Photograph



SECTION 3

TEST EQUIPMENT USED



3.1 TEST EQUIPMENT USED

Item	Instrument	Manufacturer	Type No	Serial No	EMC / INV No	Cal. Due
Section 2.1						
1	Turntable Controller	HD Gmbh	HD 050	050/396	2528	TU
2	Antenna Mast	Emco	1051-2	9101-1570	2182	TU
3	Antenna	Emco	3115	97015079	2397	04/07/2004
4	Signal Generator	Hewlett Packard	8672A	2016A01097	411	02/03/2005
5	Test Receiver	Rohde & Schwarz	ESIB26	100212	2988	08/04/2005
6	Attenuator 10dB	Marconi	6534/3	2954	1494	TU
7	Screened Room 5	Siemens	EAC54300	NA	2533	TU
Section 2.2						
8	Test Receiver	Rohde & Schwarz	ESH3	872742/002	1020	16/08/2004
9	LISN	Rohde & Schwarz	ESH2-Z5	892107-019	1584	02/10/2004
10	Transient Limiter	Hewlett Packard	11947A	3107A01649	2244	13/05/2005
Sections 2.3, 2.4, 2.5, 2.6, 2.7 and 2.8						
11	Hygrometer	Rotronic	I-1000	-	INV 3232	07/04/2005
12	Meter	Fluke	87	53150339	INV 2025	06/04/2005
13	Power Supply	Farnell	LT30-2	3949	EMC 1706	TU
14	Attenuator	Texscan	HFP-50N	N/S	EMC 1602	28/07/2004
15	High Pass Filter	Sematron UK Ltd	F-100-4000-5-R	0012	INV 4468	TU
16	Cable	TUV	CS 0575	-	CS 0575	TU
Section 2.9						
17	Hygrometer	Rotronic	I-1000	-	INV 3232	07/04/2005
18	Meter	Fluke	87	53150339	INV 2025	06/04/2005
19	Attenuator	Texscan	HFP-50N	N/S	EMC 1602	28/07/2004
20	Cable	TUV	CS 0575	-	CS 0575	TU
21	Power Supply Unit	Farnell	LT30/2	003949	EMC 1702	TU
22	Power Sensor	8481ZA	Hewlett Packard	3113A00126	EMC 1662	14/08/04
23	Peak Power Analyser	8990A	Hewlett Packard	3107A00124	EMC 1670	14/08/04



3.1 TEST EQUIPMENT USED

Item	Instrument	Manufacturer	Type No	Serial No	EMC / INV No	Cal. Due
Section 2.10						
24	Hygrometer	Rotronic	I-1000	-	INV 3232	07/04/2005
25	Meter	Fluke	87	53150339	INV 2025	06/0420/05
26	Power Supply	Farnell	LT30-2	3949	EMC 1706	TU
27	Attenuator	Texscan	HFP-50N	N/S	EMC 1602	28/07/2004
28	Filter	Fylde Modular		11.E055.031.1	INV 4043	TU
29	Termination Box	Weinschel	1506A	LF996	INV 4038	01/08/2004
30	High Pass Filter	Sematron UK Ltd	F-100-4000-5-R	0012	INV 4468	TU
31	Cable	TUV	CS 0575	-	CS 0575	TU
Section 2.11						
32	Turntable Controller	HD Gmbh	HD 050	050/396	2528	TU
33	Antenna Mast	Emco	1051-2	9101-1570	2182	TU
34	Screened Room 5	Siemens	EAC54300	NA	2533	TU
35	Test Receiver	Rohde & Schwarz	ESIB26	100212	2988	08/04/2005
36	Low Noise Amplifier	Miteq Corp	AMF-3d-001080-18-13P	UNK	2457	TU
37	Solid State Amplifier	Avantek	AWT-18036	F13365 8452	1081	26/06/2004
38	Antenna	Emco	3115	97015079	2397	04/07/2004
39	Attenuator 10dB	Marconi	6534/3	2954	1494	TU
40	Signal Generator	Hewlett Packard	8672A	2016A01097	411	02/03/2005



3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are: -

IN THE FREQUENCY RANGE 30MHz TO 1000MHz		
TEST	FREQUENCY	AMPLITUDE
For 6dB Bandwidth	$\pm 210.894\text{kHz}$	$\pm 0.5\text{dB}$
For Maximum Output Power	Not Applicable	$\pm 0.5\text{dB}$
For Spurious Conducted Emissions	Not Applicable	$\pm 3.0\text{dB}$
For Radiated Emissions, Quasi-Peak Measurements taken in Zero Span using the Hewlett Packard EMI Receiver and Bilog Antenna	$\pm 2 \times 10^{-7} \times \text{Centre Frequency}$	5.15dB calculated in accordance with CISPR 16-4
IN THE FREQUENCY RANGE 1GHz TO 10GHz		
TEST	FREQUENCY	AMPLITUDE
For Spurious Radiated Emissions measurements	$\pm 2 \times 10^{-7} \times \text{Centre Frequency}$	$\pm 3.4\text{dB}$
For Peak Power Spectral Density	Not Applicable	$\pm 1.8\text{dB}$
For Effective Radiated Power (ERP) measurements	Not Applicable	$\pm 1.45\text{dBm}$



SECTION 4

EUT PHOTOGRAPH



4.1 EUT PHOTOGRAPH



Front View



SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT



5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA
(Not UKAS Accredited).

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APPENDIX A

TITCHFIELD FCC SITE COMPLIANCE LETTER



FCC Compliance Letter

FEDERAL COMMUNICATIONS COMMISSION

**Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046**

October 18, 2002

Registration Number: 90987

TUV Product Service Ltd
Segensworth Road
Titchfield
Fareham, Hampshire, PO15 5RH
United Kingdom
Attention: Kevan Adsetts

Re: Measurement facility located at Titchfield
Anechoic chamber (3 meters) and 3 & 10 meter OATS
Date of Listing: October 18, 2002

Gentlemen:

Your request for registration of the subject measurement facility has been reviewed and found to be in compliance with the requirements of Section 2.948 of the FCC rules. The information has, therefore, been placed on file and the name of your organization added to the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Thomas W Phillips
Electronics Engineer