



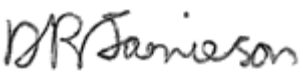


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Test Report for Axiom Wi-Fi and Bluetooth Module

To FCC CFR 47 Part 15 Subpart C and Industry Canada RSS-247

Model Number	Wi-Fi / Bluetooth module applicable to: E70363, E70364, E70365, E70366, E70367, E70368 & E70369		
Product Description	Axiom Wi-Fi and Bluetooth Module		
Project Number	0905		
Report Number	EMC2036/001		
Report Version	V1.00		
Report Author David Jamieson EMC Engineer		Date	3 rd March 2017
Technical Check Mike Thompson Senior EMC Engineer		Date	7 th March 2017
Approval Andy Little Compliance Manager		Date	8 th March 2017

Test Date Range	16 th February to 3 rd March 2017
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Product Status	PASS
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The test data and results contained within this report relate only to the items tested.

1 Report History

Version	Date	Reason for change
1.00	As cover sheet	Initial Issue

2 FCC CFR 47 Part 15 Subpart C and Industry Canada RSS-247 Test Summary


Test Name	FCC CFR 47 Part 15	Industry Canada RSS-247	Report Section	Result
Radiated Emissions	15.209(a)	RSS-GEN 8.9	6.1	Pass
20dB Bandwidth	15.247(a)(1)	5.1(1)	6.2	Pass
Hopping Carrier Frequency Separation	15.247(a)(1)	5.1(2)	6.3	Pass
Hopping Channels	15.247(a)(1)(iii)	5.1(4)	6.4	Pass
Hopping Dwell Time	15.247(a)(1)(iii)	5.1(4)	6.5	Pass
6dB Bandwidth	15.247(a)(2)	5.2(1)	6.6	Pass
Peak Output Power	15.247(b)	5.4(2) & 5.4(4)	6.7	Pass
Spurious Emissions	15.247(d)	5.5	6.8	Pass
Frequency Band Edges	15.247(d)	N/A	6.9	Pass
Directional Antenna with >6dBi	15.247(c)	N/A	6.10	N/A
Power Spectral Density	15.247(e)	5.2(2)	6.11	Pass

3 Attestations

This equipment has been tested in accordance with the standards identified in this report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in these reports.

All measuring instruments used to determine the status of the product's compliance to the identified standards are calibrated regularly in accordance with UKAS requirements.

A comprehensive system of traceable calibration in accordance with ISO9001 is maintained.

Name/Position	Signature	Date
David Jamieson EMC Engineer		3 rd March 2017

I attest that the necessary measurements were made, under my supervision at Raymarine UK Ltd, Marine House, Cartwright Drive, Fareham, PO15 5RJ.



Andy Little
Compliance Manager

Date: 8th March 2017

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4 Test Information

4.1 Test Facilities

Area	Site ID	Room Type	Test	Room Dimensions	Comments
A	Site 5	Screened Room	Conducted	2m x 3m x 2.5m	
B	Site 1	Semi Anechoic Chamber	Radiated Emissions	9m x 6m x 5.5m	FCC ID: 371673 IC Certification: 4069B-2
ET	N/A	Thermal Chamber	Conducted	N/A	

4.2 Overall Test Conditions

Area	Date	Ambient Temperature (°C)		Relative Humidity (%)		Air Pressure (mbar)	
		Max	Min	Max	Min	Max	Min
A	16/02/2017	25.5	21.5	38.7	30.1	1025.9	1023.5
A	17/02/2017	24.7	22.4	37.3	32.5	1023.6	1021.9
A	20/02/2017	24.8	22	46.6	37.9	1015.4	1013.5
A	21/02/2017	24.8	21.9	44.5	37.9	1013.6	1011.1
A	22/02/2017	24.6	22.2	43.5	36.8	1006.2	1004.2
B	23/02/2017	19.4	19.2	50	39.5	994.8	989.7
B	24/02/2017	23	20.8	35.2	31.5	1013.3	1010.1
ET	27/02/2017	N/A as in thermal chamber.					
ET	28/02/2017						
ET	01/03/2017						
A	03/03/2017						

4.3 Test Methods

The objective of the report is to perform tests according to the United States of America FCC (Federal Communications Commission) Title 47 CFR (Code of Federal Regulations) Part 15 Subpart C (Bluetooth and WIFI, 2.4GHz ISM band radiators) for the EUT FCC ID Certification and to the Canadian, RSS-247 for the Industry Canada certification:

#	Standard Number	Document Title
1	FCC 47 CFR Part 15 (February, 2017)	Radio Frequency Devices
2	RSS-247 Issue 1 May 2015	Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

4.3.1 Deviations from Test Methods

None.

5 EUT Information

5.1 Test Rationale

Wi-Fi and Bluetooth Module level compliance.

5.2 Description of Equipment under Test (EUT)

Date of Receipt:	15/02/2017
Client:	Stephen Grant
Brand Name:	Raymarine
Product Range:	Axiom MFD
Country of Manufacture:	China
Nominal Voltage:	12V DC (8V to 16V)

Unit 1

Model Name or Number:	Axiom Wi-Fi/Bluetooth Module
Unique Type Identification:	SK03933 Issue 1
FCC ID	PJ5-AX905
IC ID	4069B-AX905
Serial Number:	EMC2036/001
CCT Diagram Number(s) & Issue:	SK03924-1
PCB Assembly Number(s) & Issue:	SK03935-1
Software Version:	N/A
Modifications to Unit:	To convert into a conducted only unit: R4 rotated 45 degrees. R9 removed.

Unit 2

Model Name or Number:	Axiom Wi-Fi/Bluetooth Module
Unique Type Identification:	SK03933 Issue 1
FCC ID	PJ5-AX905
IC ID	4069B-AX905
Serial Number:	EMC2036/002
CCT Diagram Number(s) & Issue:	SK03924-1
PCB Assembly Number(s) & Issue:	SK03935-1
Software Version:	N/A
Modifications to Unit:	None

5.3 Additional information

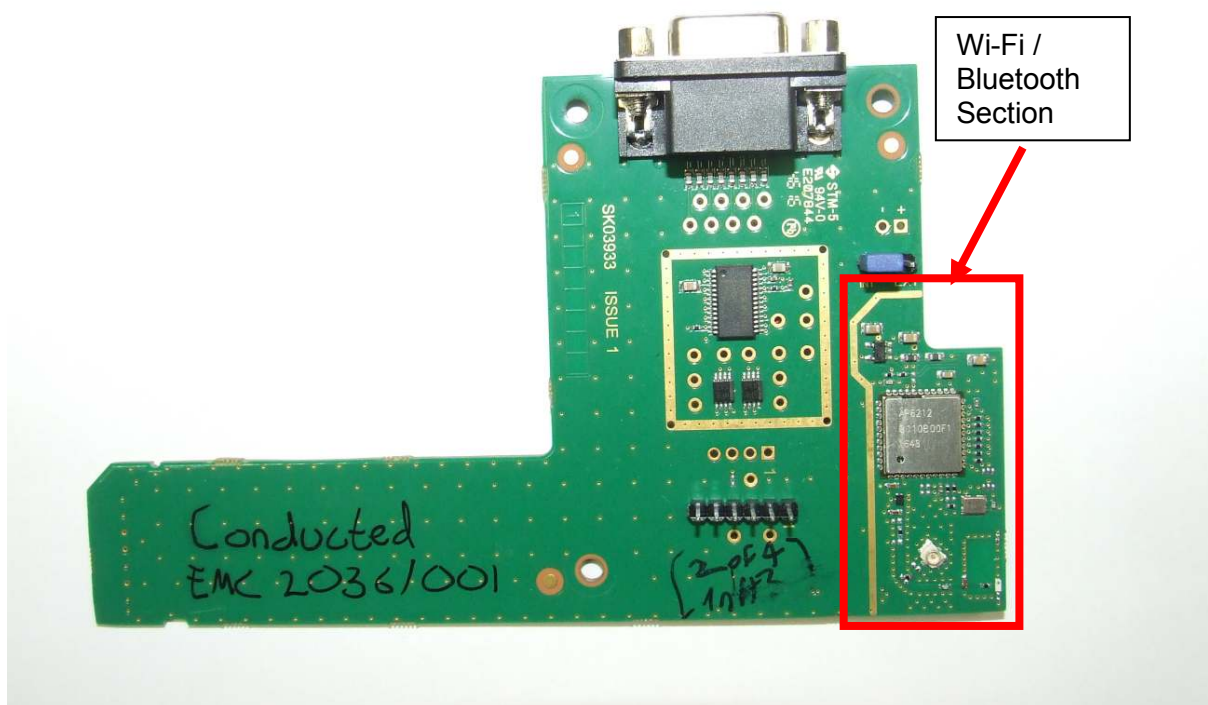
A separate PCB had to be made up to enable full control of Wi-Fi and Bluetooth RF parameters (details in section 5.3.1). The Axiom platform was provided from the SMARC (details in section 5.4.1).

Unit 1 was configured to supply full power to the on-board RF connector and was used for conducted tests only.

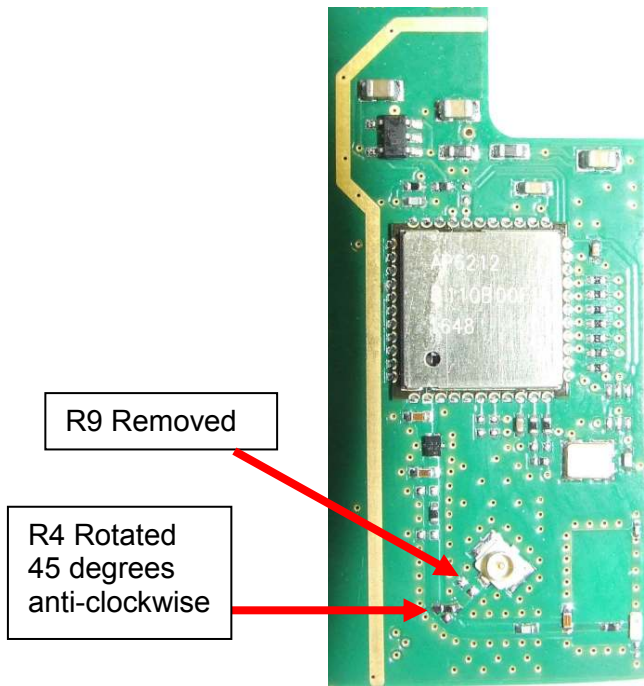
Unit 2 was standard with full power going to the on-board antenna and was used for radiated tests only.

5.3.1 Photos of Module under test

5.3.1.1 Wi-Fi / Bluetooth Module SK03933 Issue 1



5.3.1.2 Unit 001 (Conducted) Showing Modifications



5.3.1.3 Unit 002 (Radiated)



5.4 Description of Auxiliary Equipment

System Setup 1

Product Type	Manuf.	Part Number	Serial Number
HDMI Monitor	LG	IPS237LY	208NDHBKL057
USB Mouse	Kensington	1500151	B0723015372
Laptop	HP	PU982AW#ABU	CNU6061ZW4
SMARC Reference Carrier Board	Details in section 5.4.1		

5.4.1 SMARC Reference Carrier Board Details

The SMARC (System Mobility ARChitecture) reference carrier board is fitted with Raymarine RK3288 SoM (System on Module).

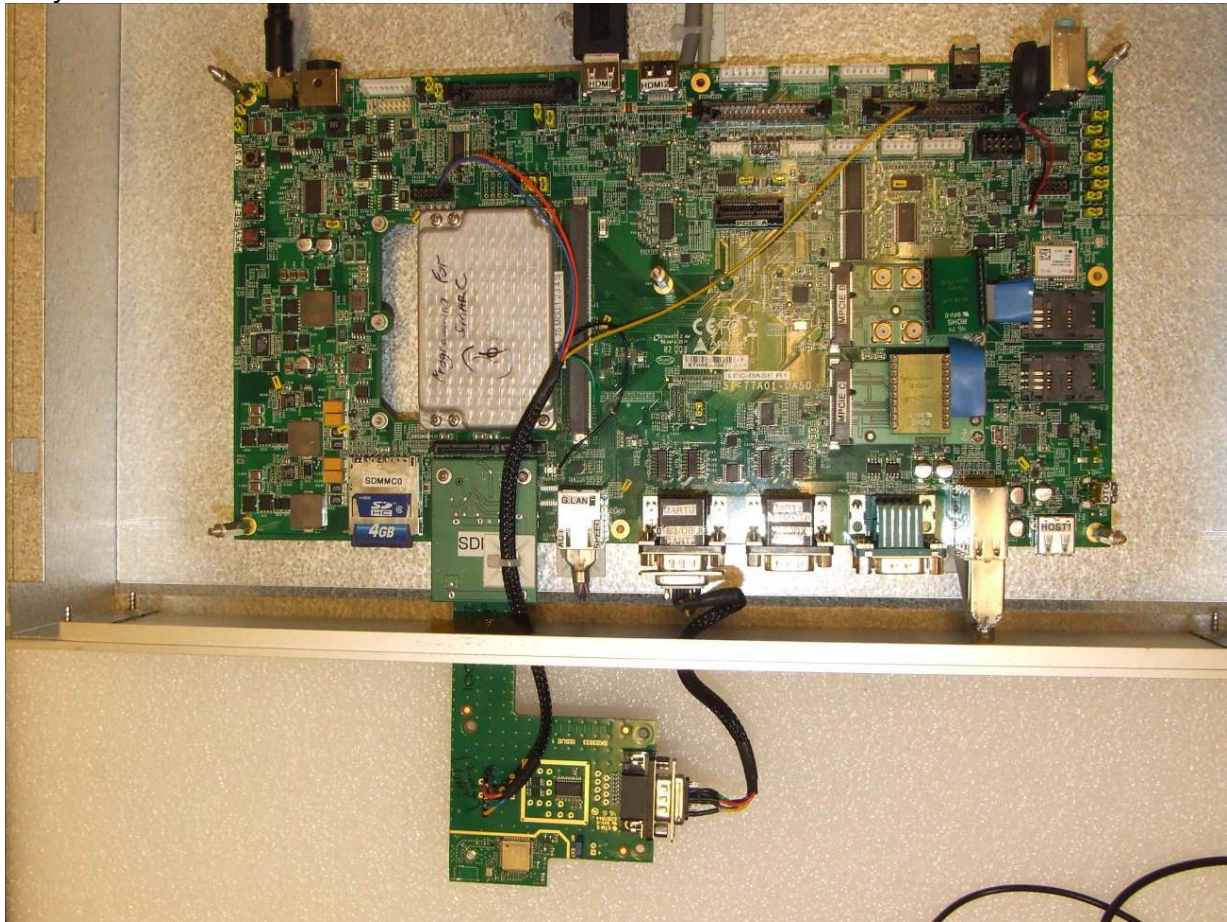
Detail	Comment
Manufacturer	ADLINK Technology Inc.
Model number	LEC-BASE-R01
Part number	50-1Z157-1010

A full list of modifications to bring this board inline to Raymarine specifications can be obtained upon request.

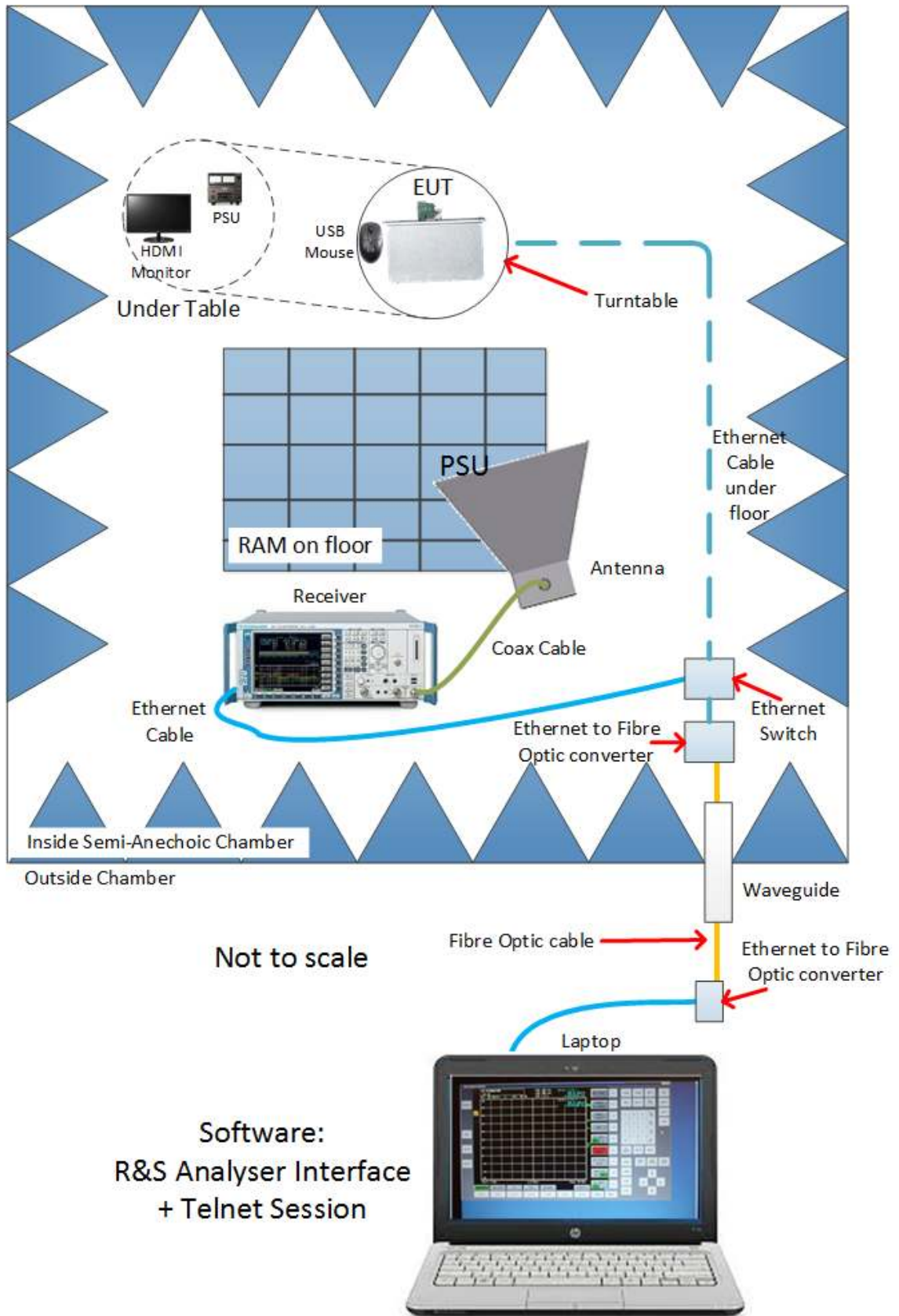
Bare board:



Fully connected:



5.5.3 Setup C - Radiated



5.5.4 *Operating Modes*

The following operating modes were used:

Mod. ID	Full Name	Data Speed	Modulation Technique	Extra Comments
11b	Wi-Fi 802.11b	11Mbps	CCK with QPSK	None.
11g	Wi-Fi 802.11g	54Mbps	OFDM with 64-QAM	20MHz Channel BW. 800ns Guard Interval.
11n	Wi-Fi 802.11n	65Mbps	MCS 7 (Channel BW 20MHz)	20MHz Channel BW. 800ns Guard Interval.
BT1	Bluetooth	1Mbps	DH1 with GFSK	ACL Basic
BT2	Bluetooth	2Mbps	2-DH1 with $\pi/4$ -DQPSK	ACL EDR
BT3	Bluetooth	3Mbps	3-DH1 with 8DPSK	ACL EDR

Wi-Fi modulation was set to full power for all tests.

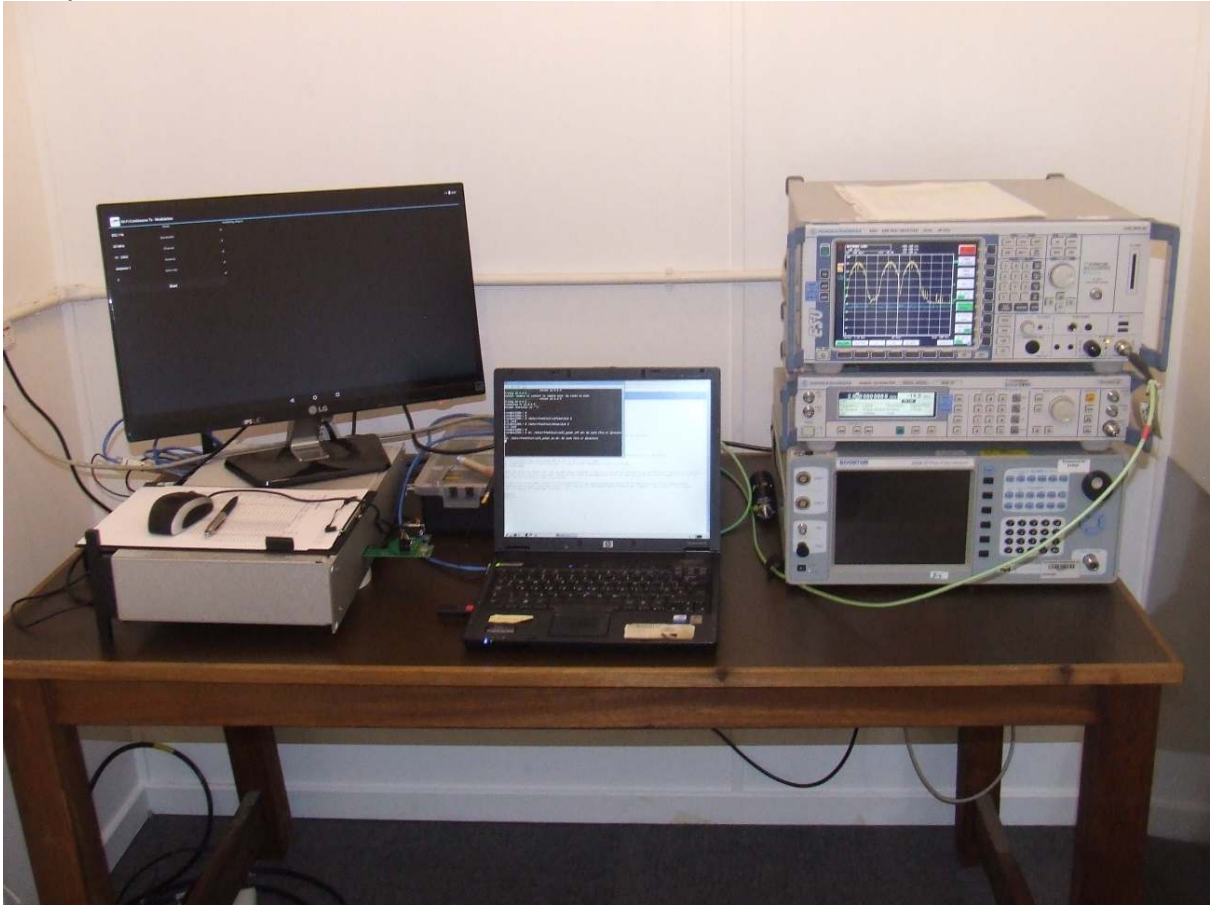
Bluetooth was set to full power for power level related tests, and to 0dBm output level for the others.

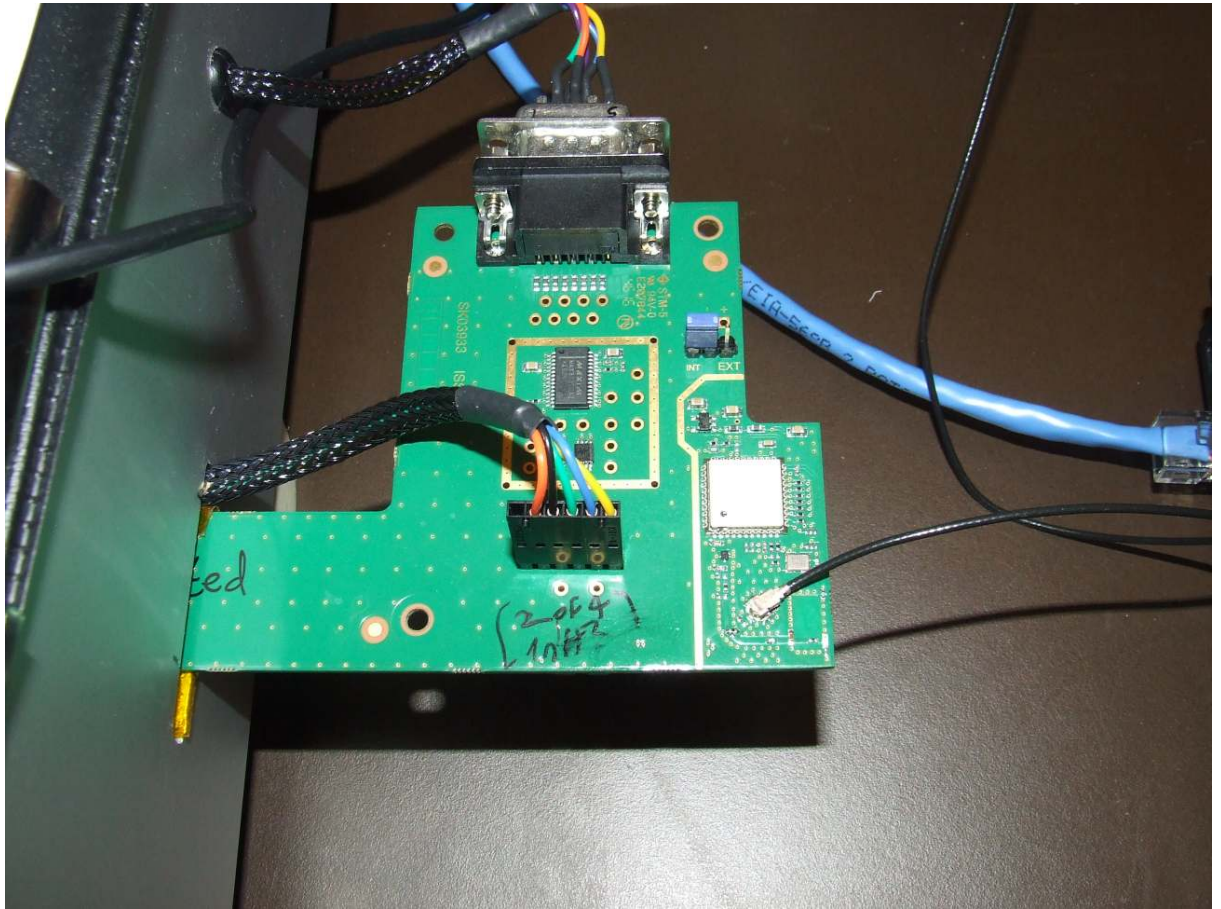
5.5.4.1 Wi-Fi Acronyms

Acronym	Detail
CCK	Complementary Code Keying
QPSK	Quadrature Phase Shift Keying
OFDM	Orthogonal Frequency Division Multiplex
64-QAM	64-Quadrature Amplitude Modulation
MCS	Modulation Coding Scheme
DH1	Data-High Rate, Single Packet
GFSK	Gaussian Frequency Shift Keying
2-DH1	2Mbps - Data-High Rate, Single Packet
$\pi/4$ -DQPSK	Differential Quarternary Phase Shift Keying
3-DH1	3Mbps - Data-High Rate, Single Packet
8DPSK	8-ary Differential Phase Shift Keying
MHz	Mega-Hertz (1×10^6 Hz)
BW	Bandwidth
ACL	Asynchronous Connectionless Link
EDR	Extended Data Rate

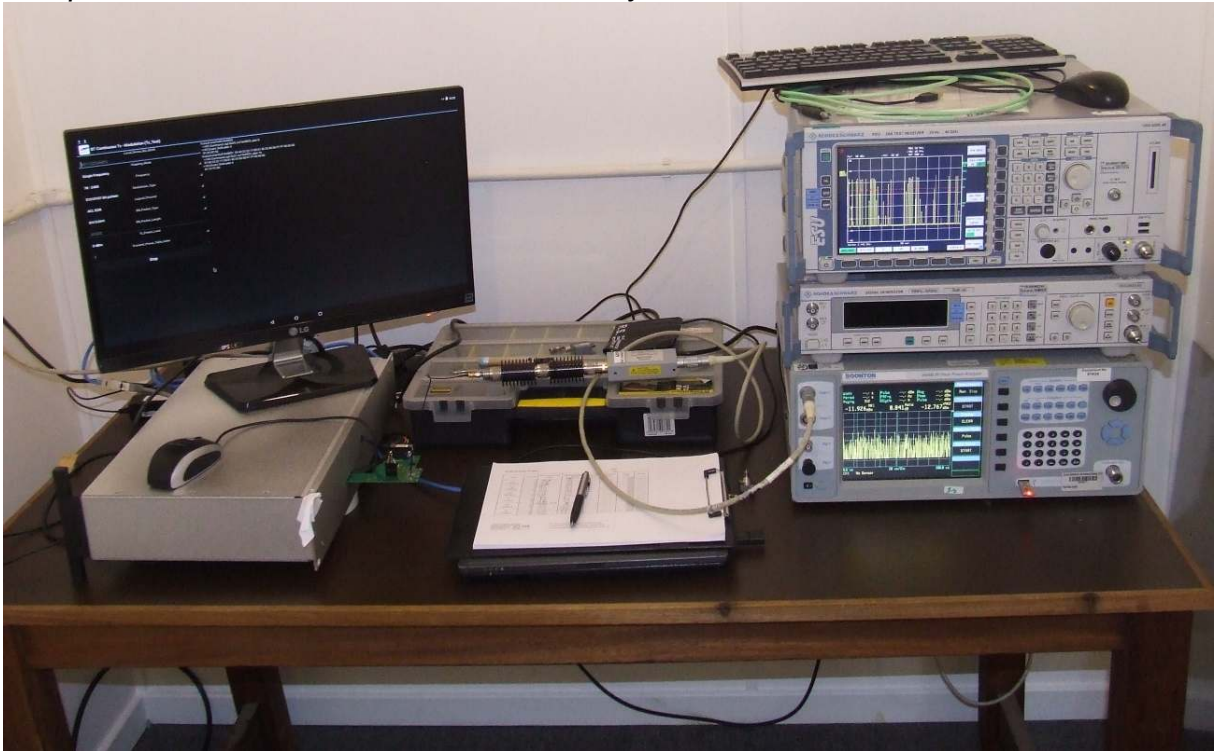
5.6 Test Photographs

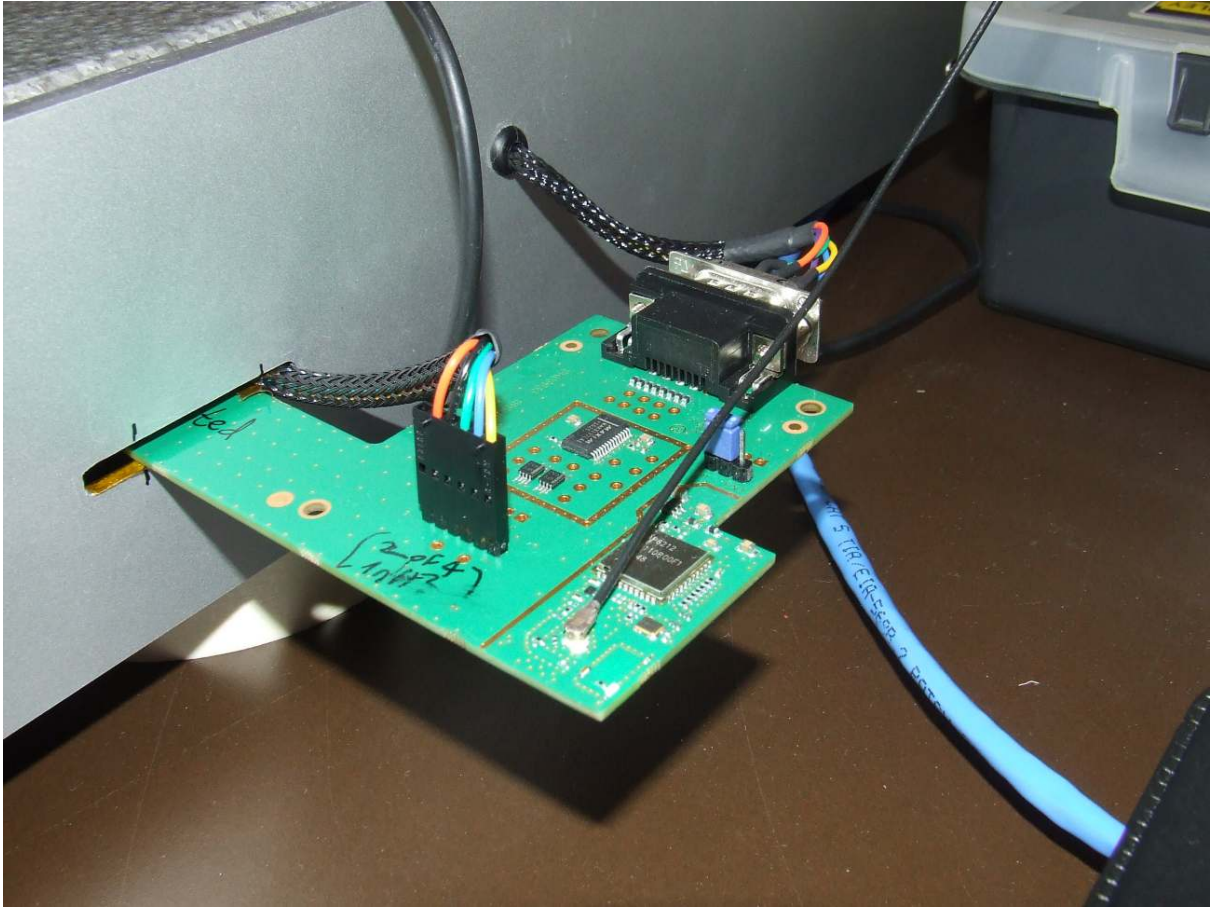
5.6.1 Setup A – Conducted with receiver





5.6.2 Setup B – Conducted with Peak Power Analyser

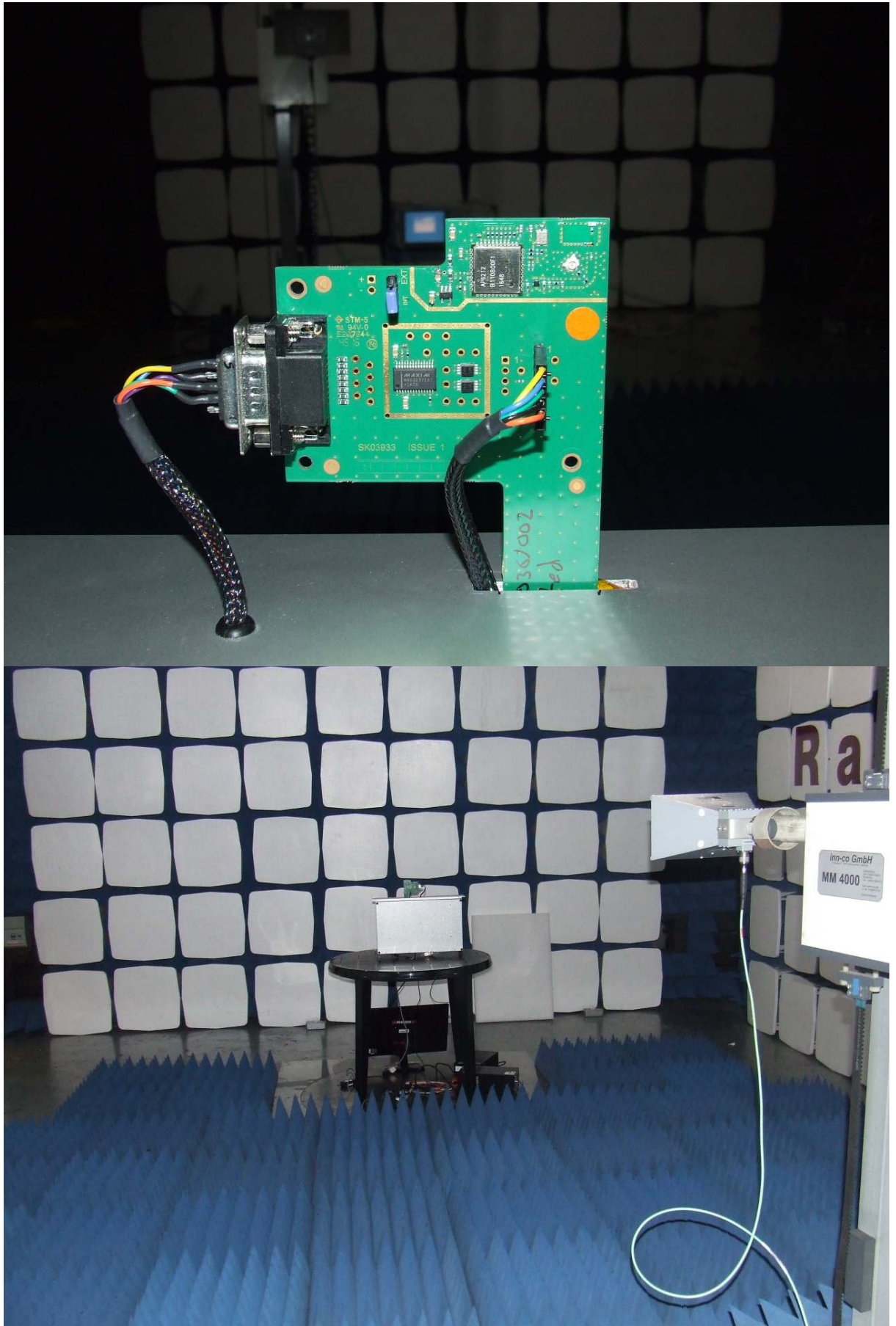




5.6.3 Setup C (Radiated)







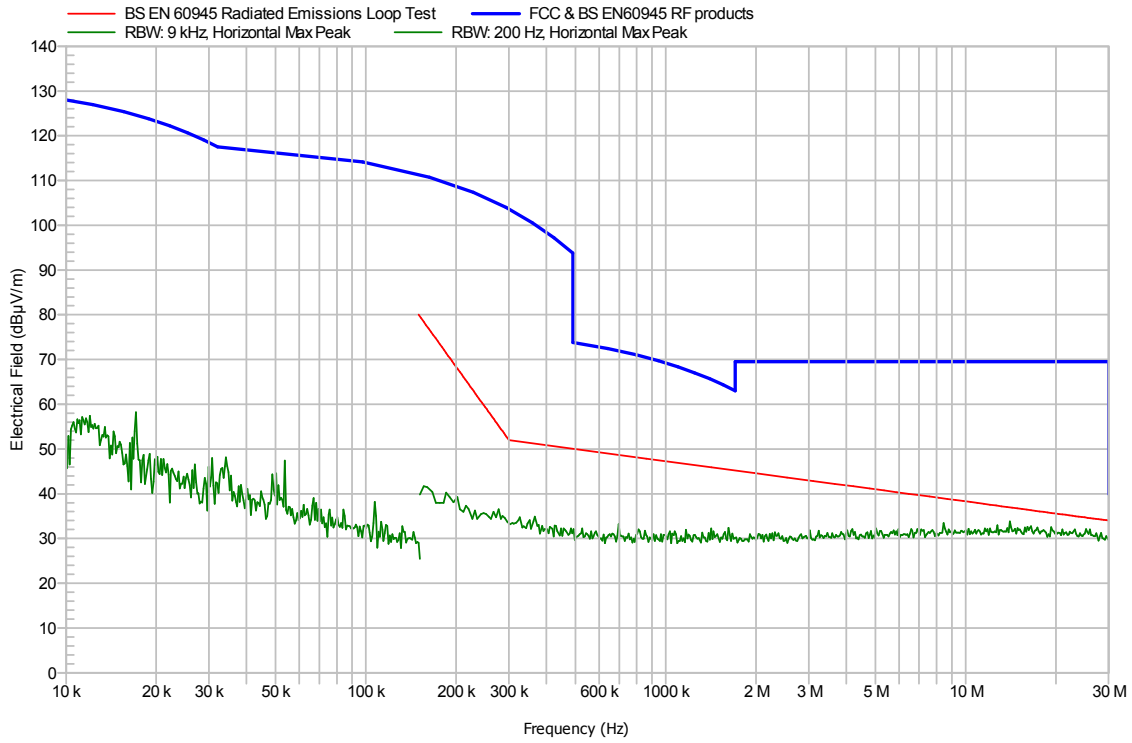




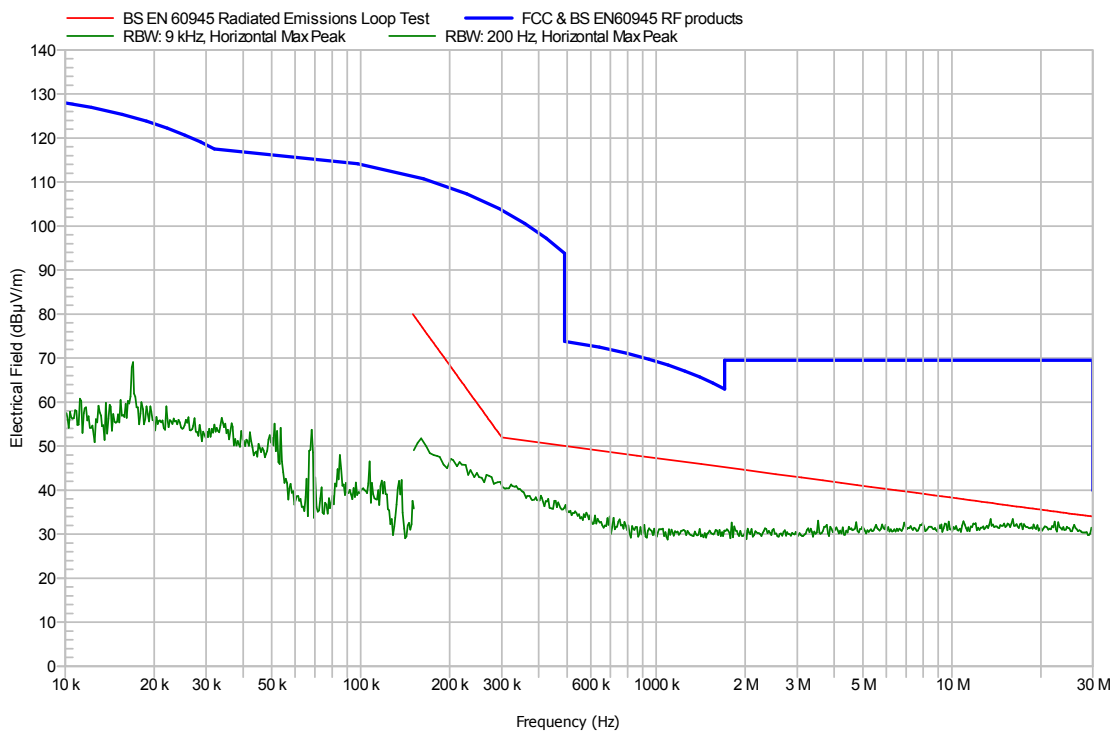
6 Test Results

6.1 Radiated Emissions

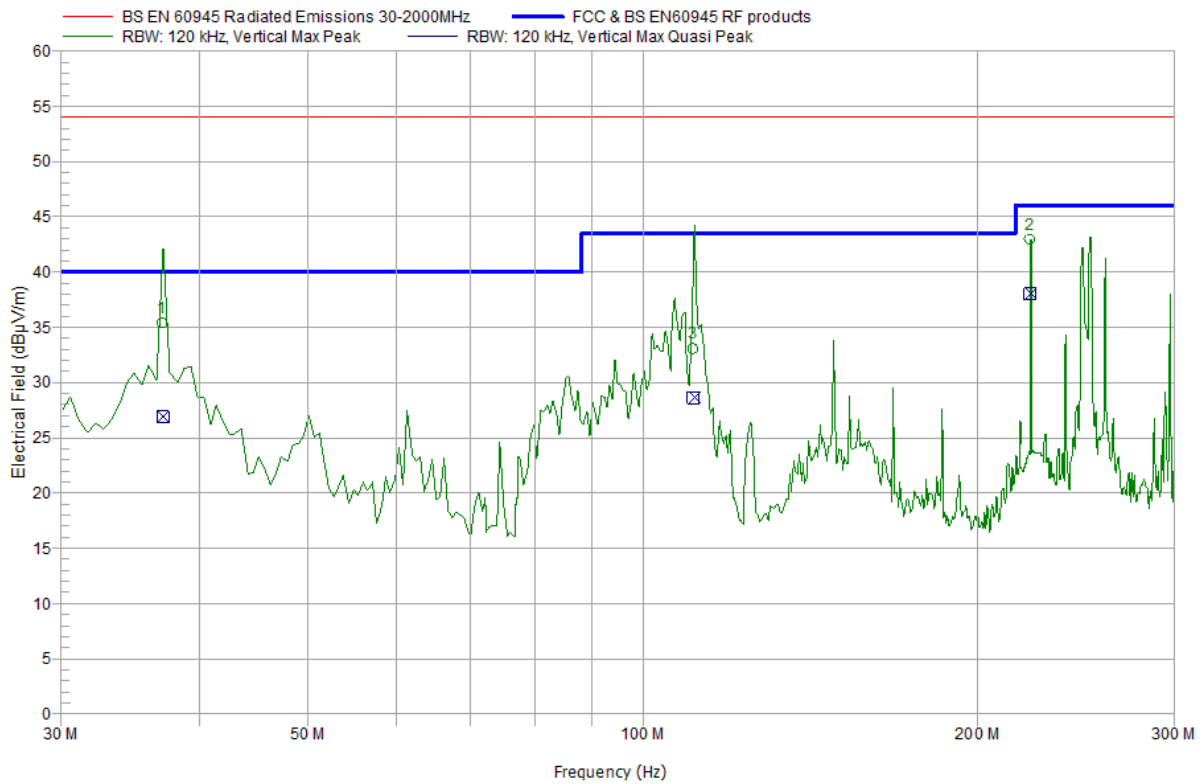
6.1.1.1 10kHz to 30MHz – X Polarity (Side on)



6.1.1.2 10kHz to 30MHz – Y Polarity (Face on)

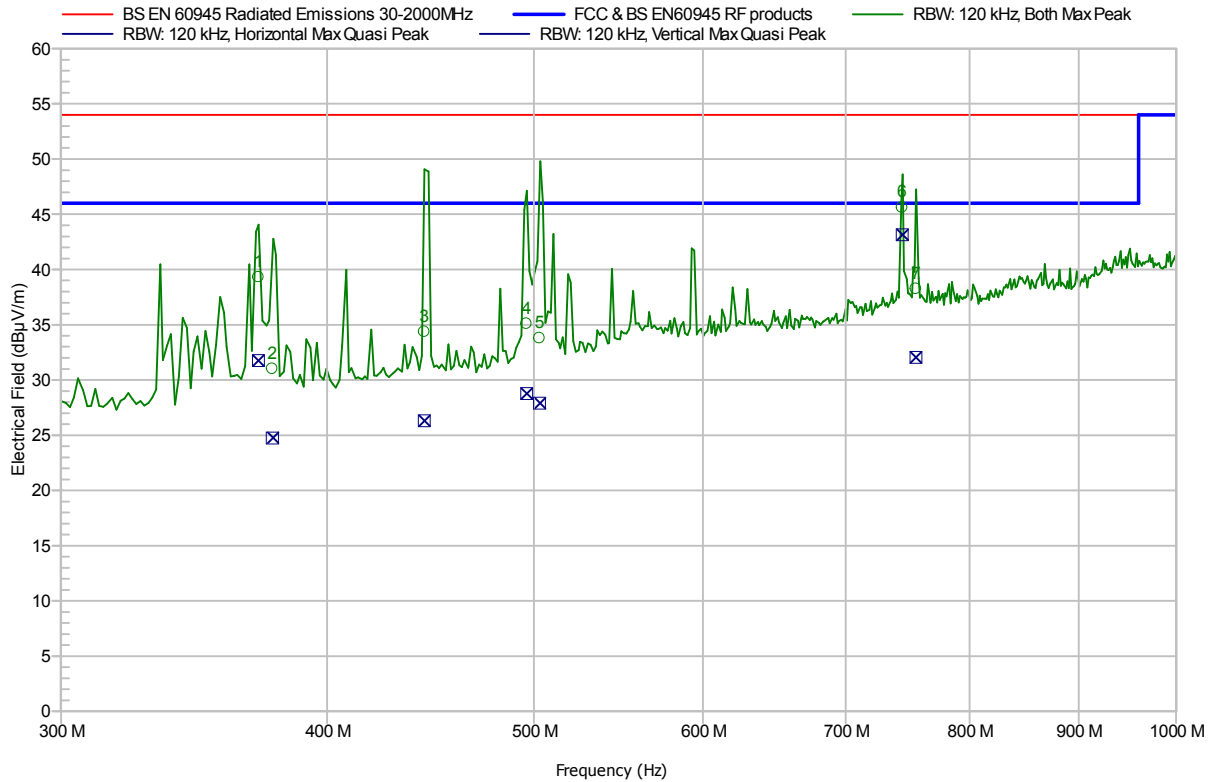


6.1.1.3 30MHz to 300MHz



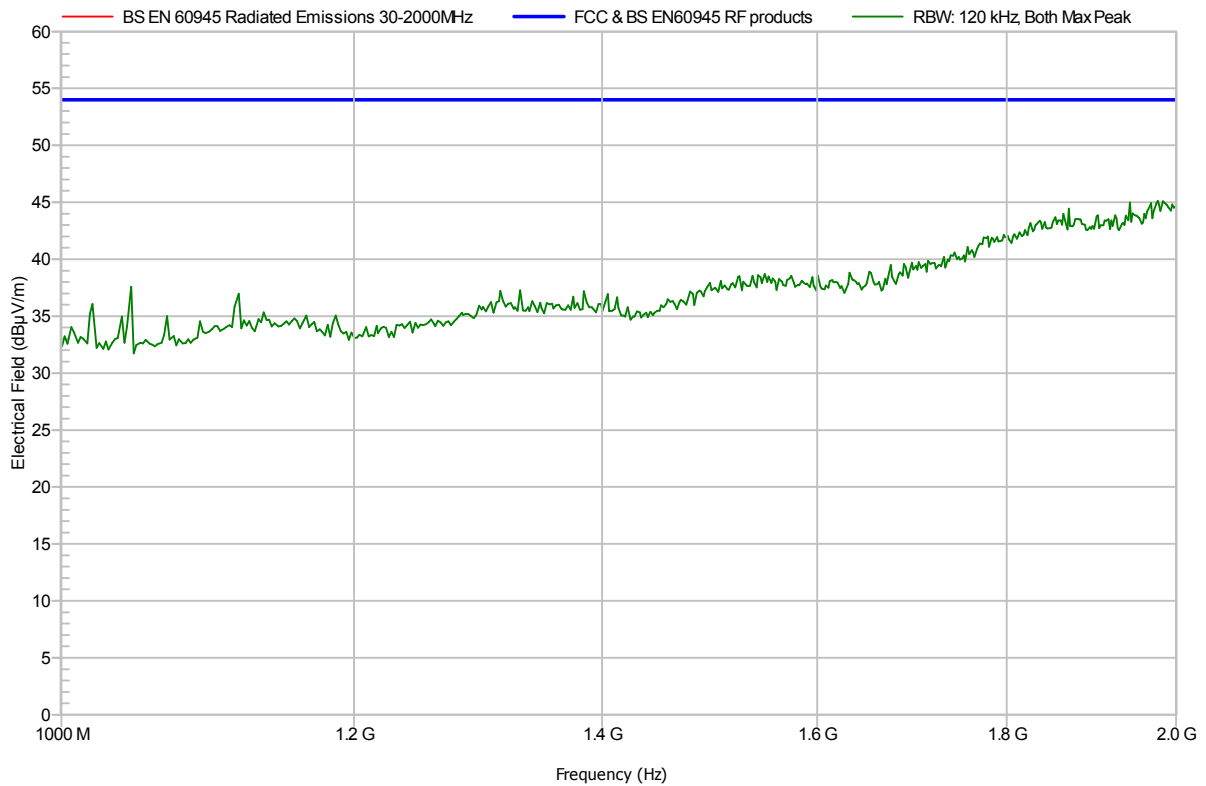
Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Polarization
1	37.02 MHz	35.35 dBµV/m	26.89 dBµV/m	-13.11 dB	Pass	180 Degree	Vertical
2	222.78 MHz	42.94 dBµV/m	38.03 dBµV/m	-7.97 dB	Pass	45 Degree	Vertical
3	111 MHz	33 dBµV/m	28.65 dBµV/m	-14.85 dB	Pass	135 Degree	Vertical

6.1.1.4 300MHz to 1GHz

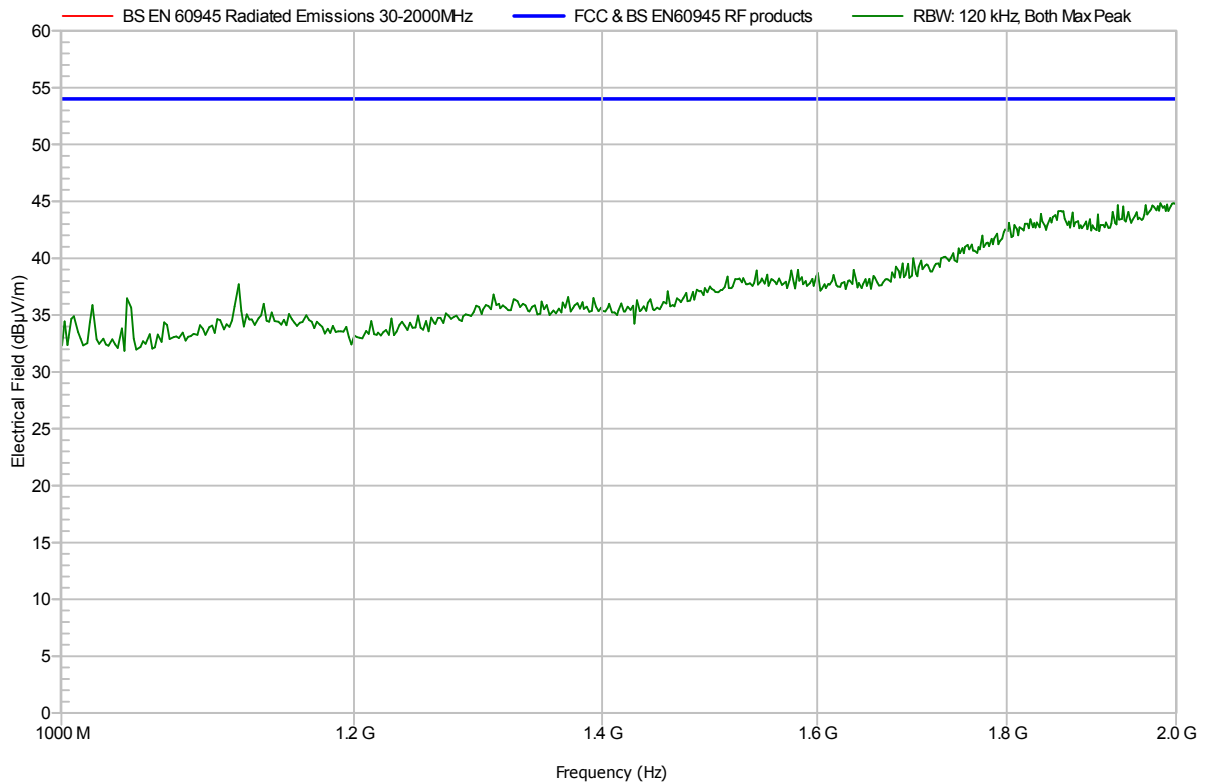


Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Polarization
1	371.4 MHz	39.3 dBµV/m	31.76 dBµV/m	-14.24 dB	Pass	0 Degree	Vertical
2	377 MHz	31.01 dBµV/m	24.75 dBµV/m	-21.25 dB	Pass	0 Degree	Vertical
3	444.2 MHz	34.35 dBµV/m	26.29 dBµV/m	-19.71 dB	Pass	225 Degree	Vertical
4	496 MHz	35.09 dBµV/m	28.78 dBµV/m	-17.22 dB	Pass	135 Degree	Horizontal
5	503 MHz	33.78 dBµV/m	27.9 dBµV/m	-18.1 dB	Pass	135 Degree	Horizontal
6	743.8 MHz	45.61 dBµV/m	43.14 dBµV/m	-2.86 dB	Pass	315 Degree	Horizontal
7	755 MHz	38.25 dBµV/m	32.04 dBµV/m	-13.96 dB	Pass	315 Degree	Horizontal

6.1.1.5 1GHz to 2GHz – 12V nom – Wi-Fi 11B Ch07



6.1.1.6 1GHz to 2GHz – 12V nom Bluetooth ACL Basic DH1 Ch40



Comments: In the range 150kHz to 30MHz the measurement is performed as a receiver type, with a 5kHz step size and 20ms dwell time. The measuring receiver dwell time was always in excess of the pulse period duration.

In the ranges from 30MHz to 2GHz the measurement is performed as a spectrum analyser type, with 5 scans of 5 seconds across a given band.

In the range 1GHz to 2GHz, RAM was placed on the floor.

When peak levels were measured with quasi-peak, the dwell would be 1 second.

Test Unit: 002 (Radiated)

Test Setup: C (Radiated)

Tested by: D. Jamieson

Test Date/s: 24th February 2017

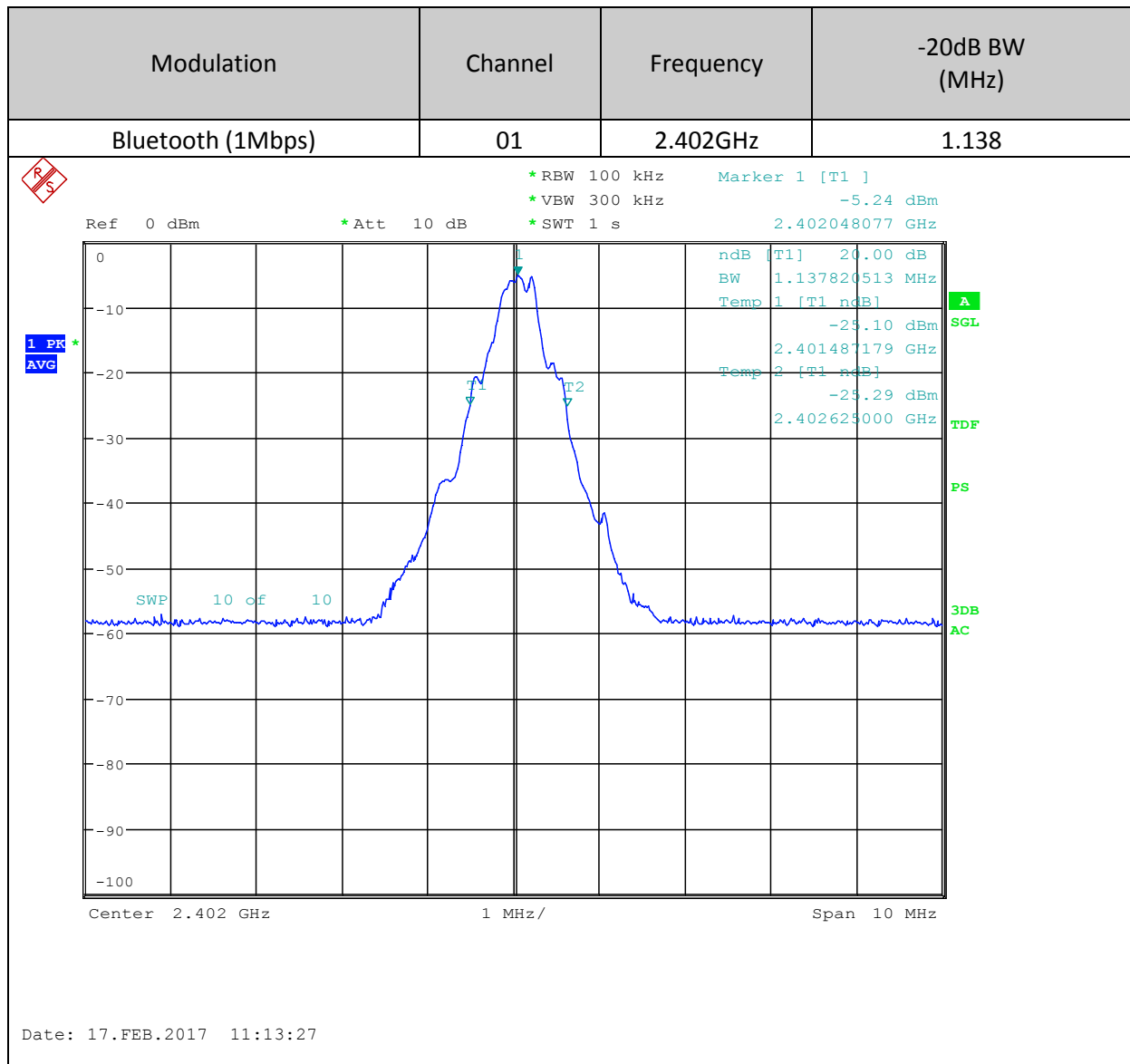
Test Status: **PASS**

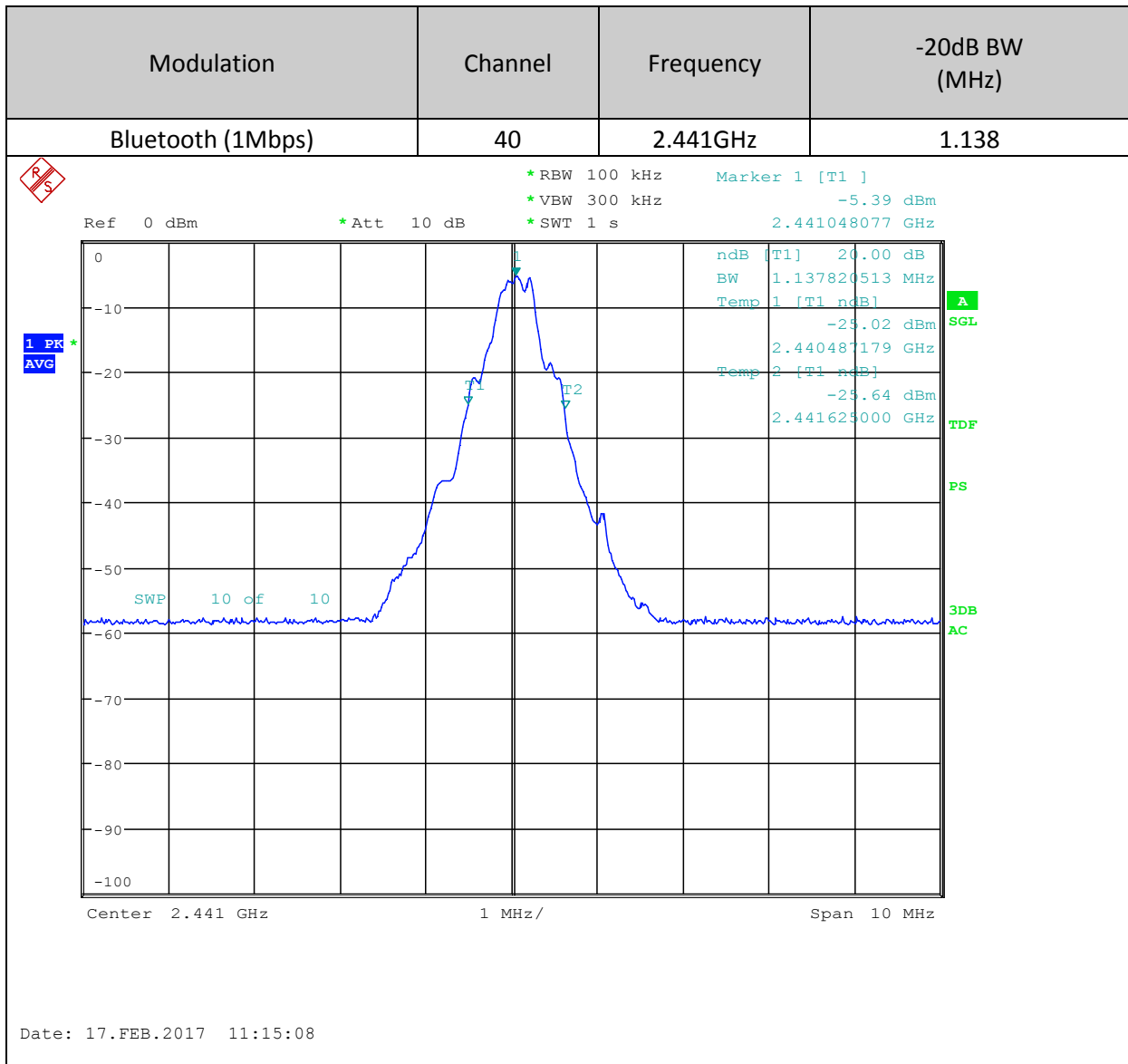
6.2 20dB Bandwidth

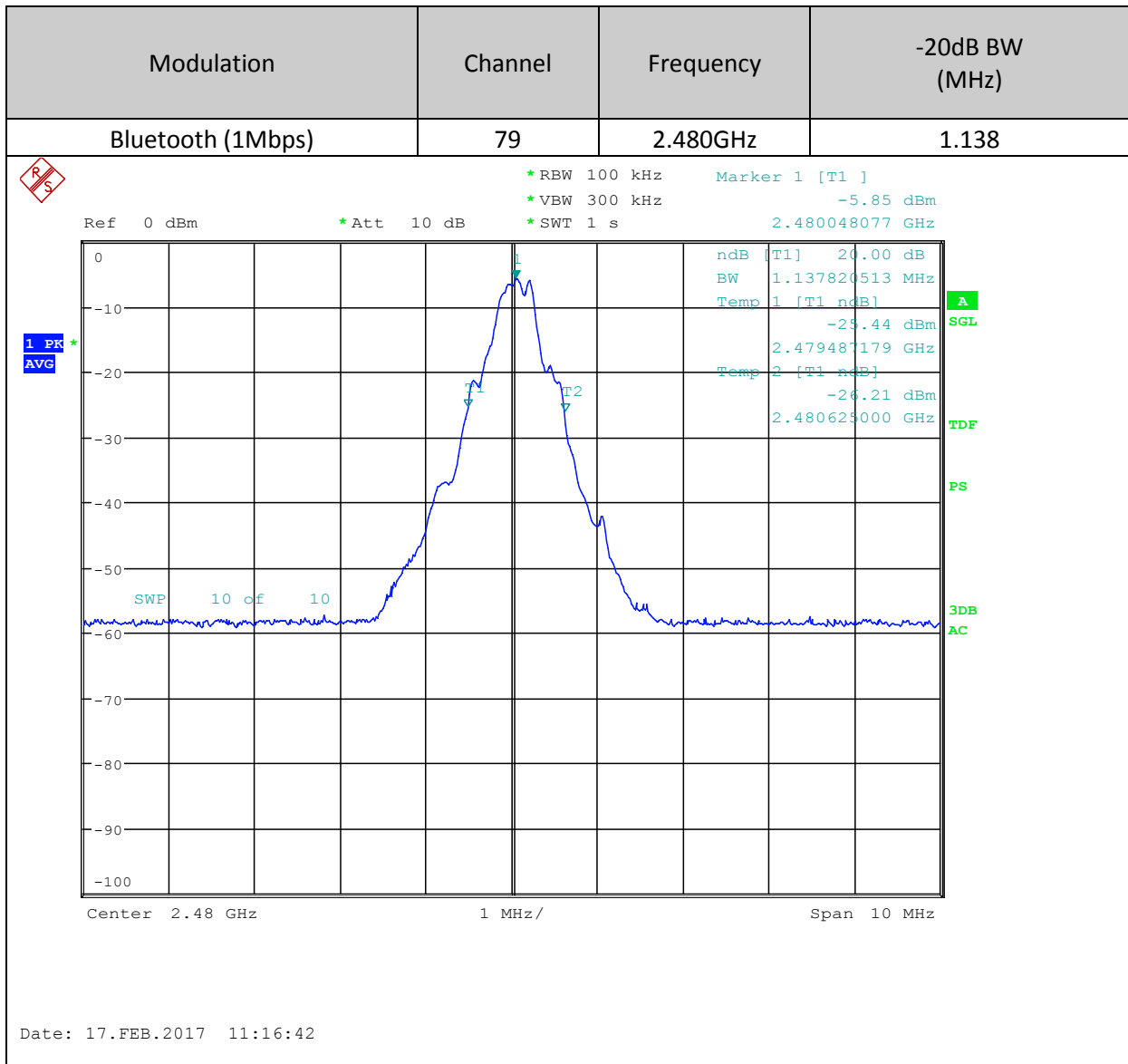
6.2.1 20dB Bandwidth – Test Result Summary

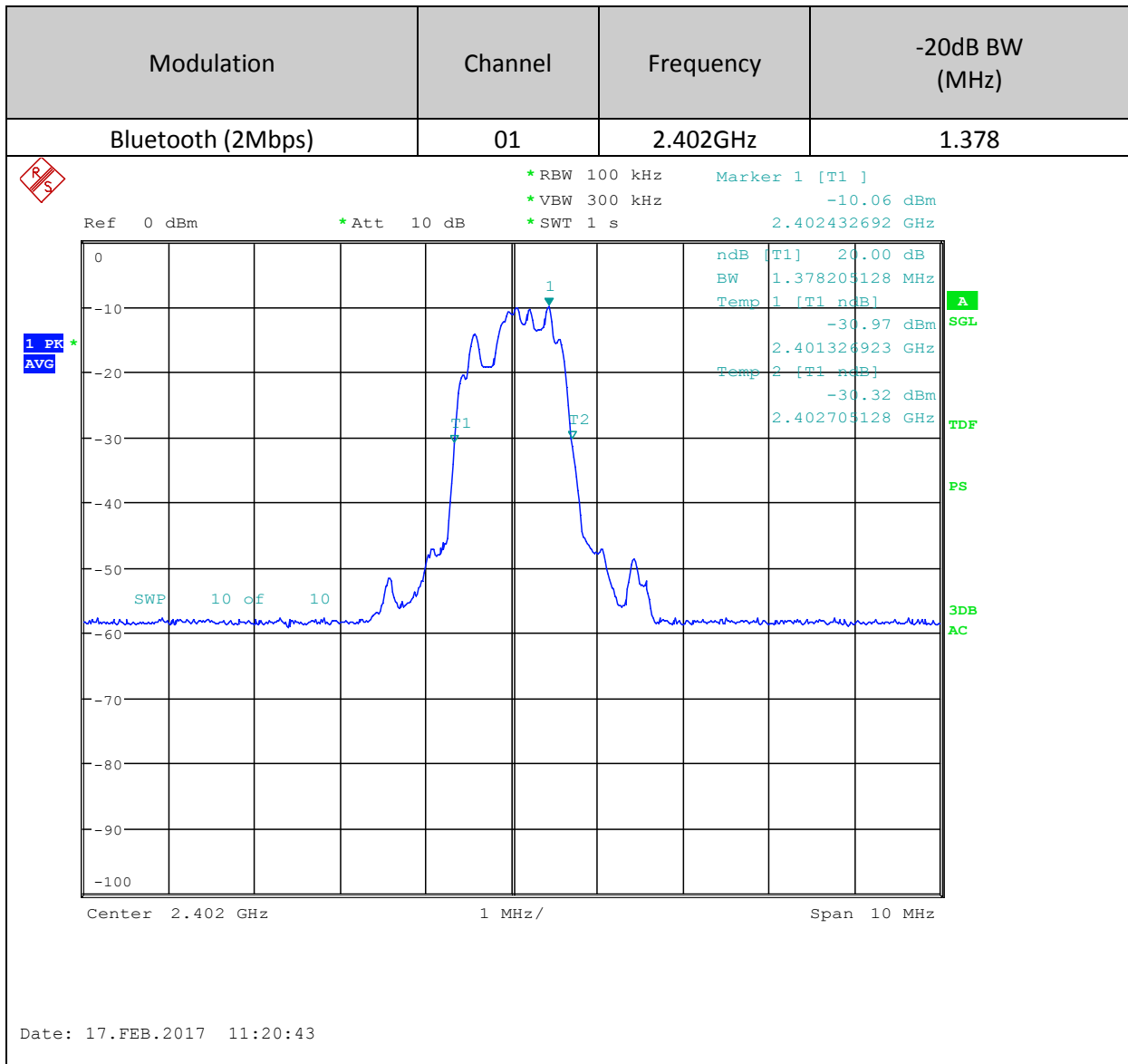
Type	Channel	20dB Channel Bandwidth (MHz)	Limit (MHz)	Result
Bluetooth (1MB/s)	1	1.138	0.5	Pass
	40	1.138	0.5	Pass
	79	1.138	0.5	Pass
Bluetooth (2MB/s)	1	1.378	0.5	Pass
	40	1.378	0.5	Pass
	79	1.378	0.5	Pass
Bluetooth (3MB/s)	1	1.378	0.5	Pass
	40	1.378	0.5	Pass
	79	1.378	0.5	Pass

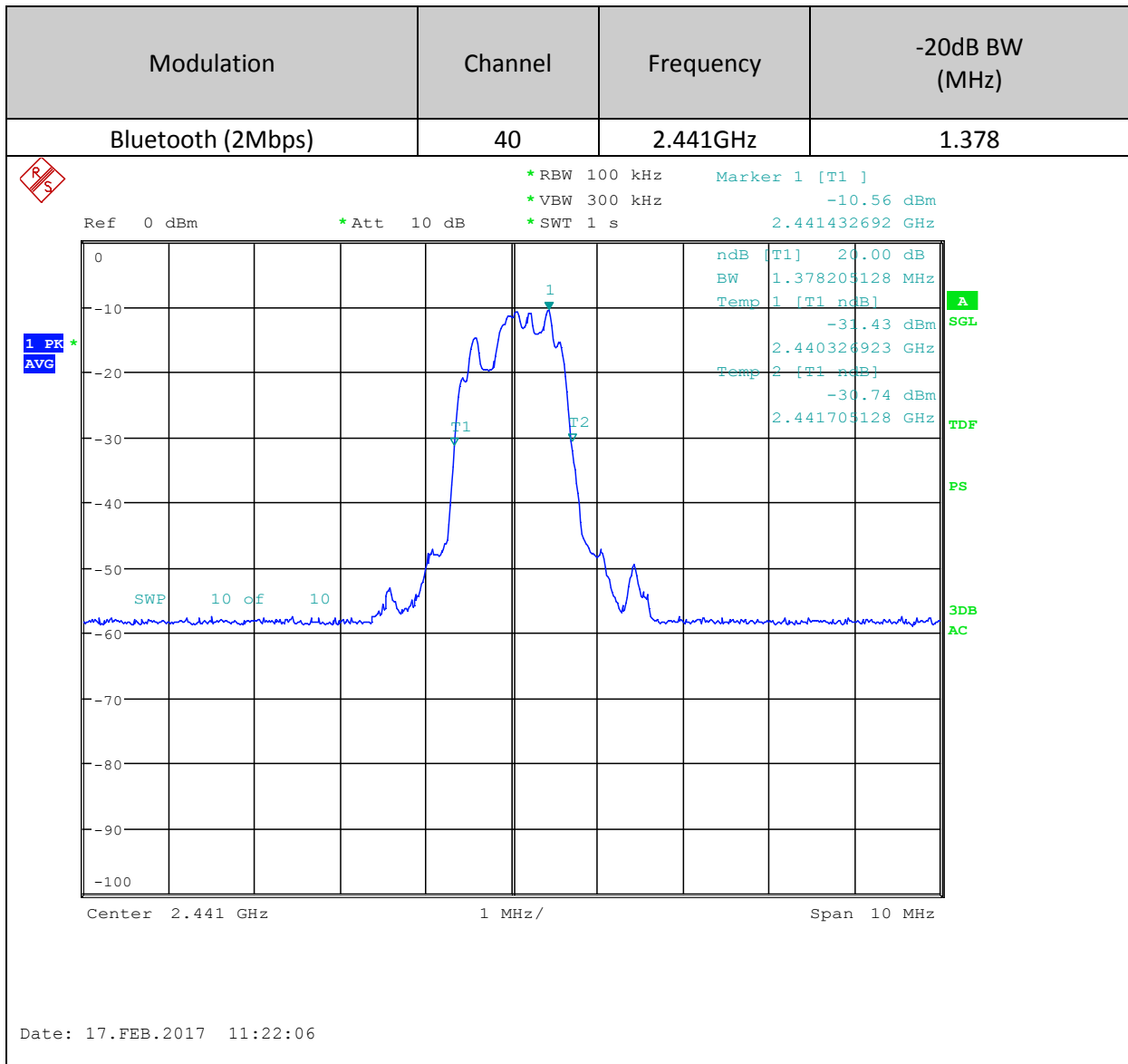
6.2.2 20dB Bandwidth – Result Plots

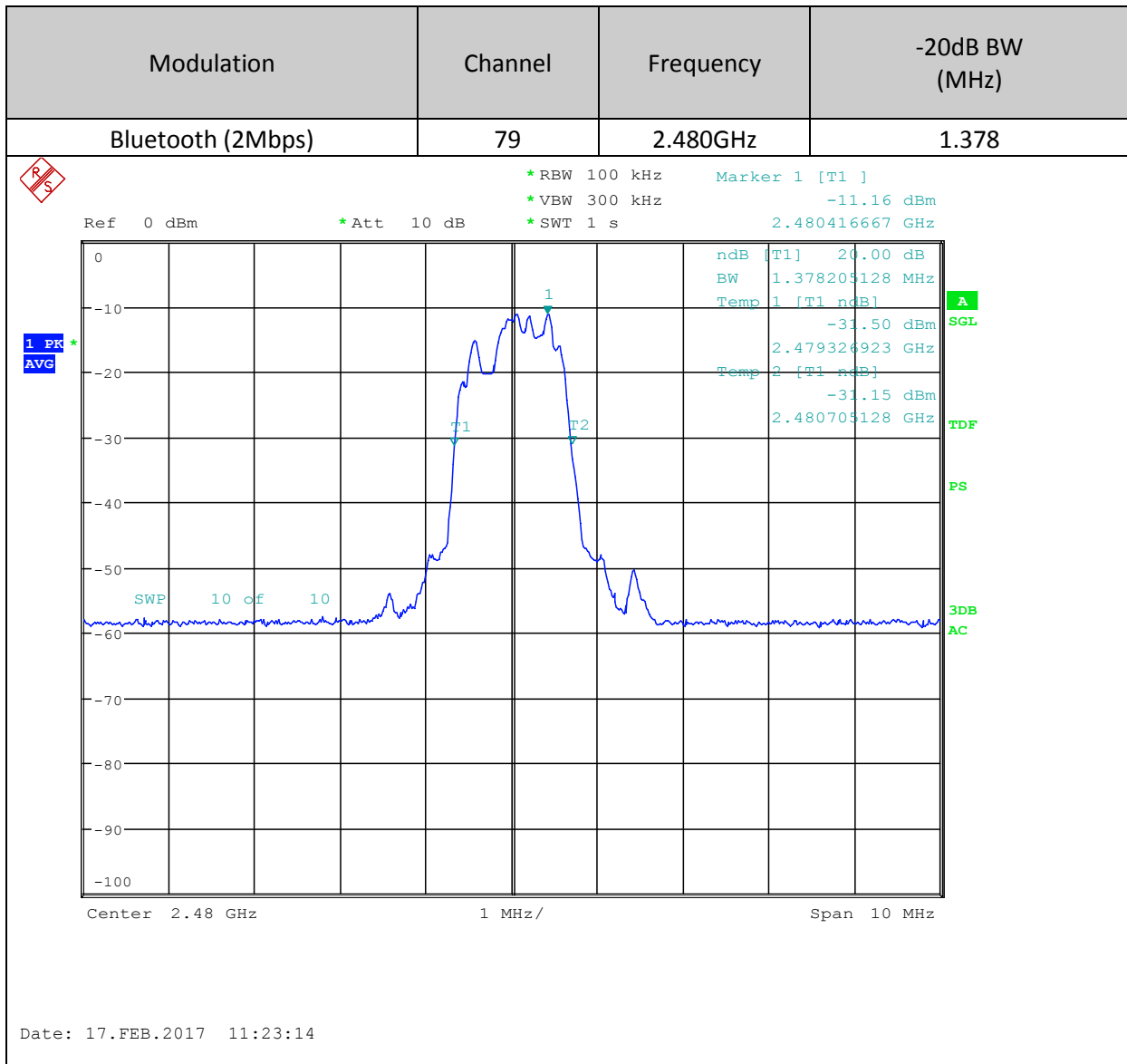


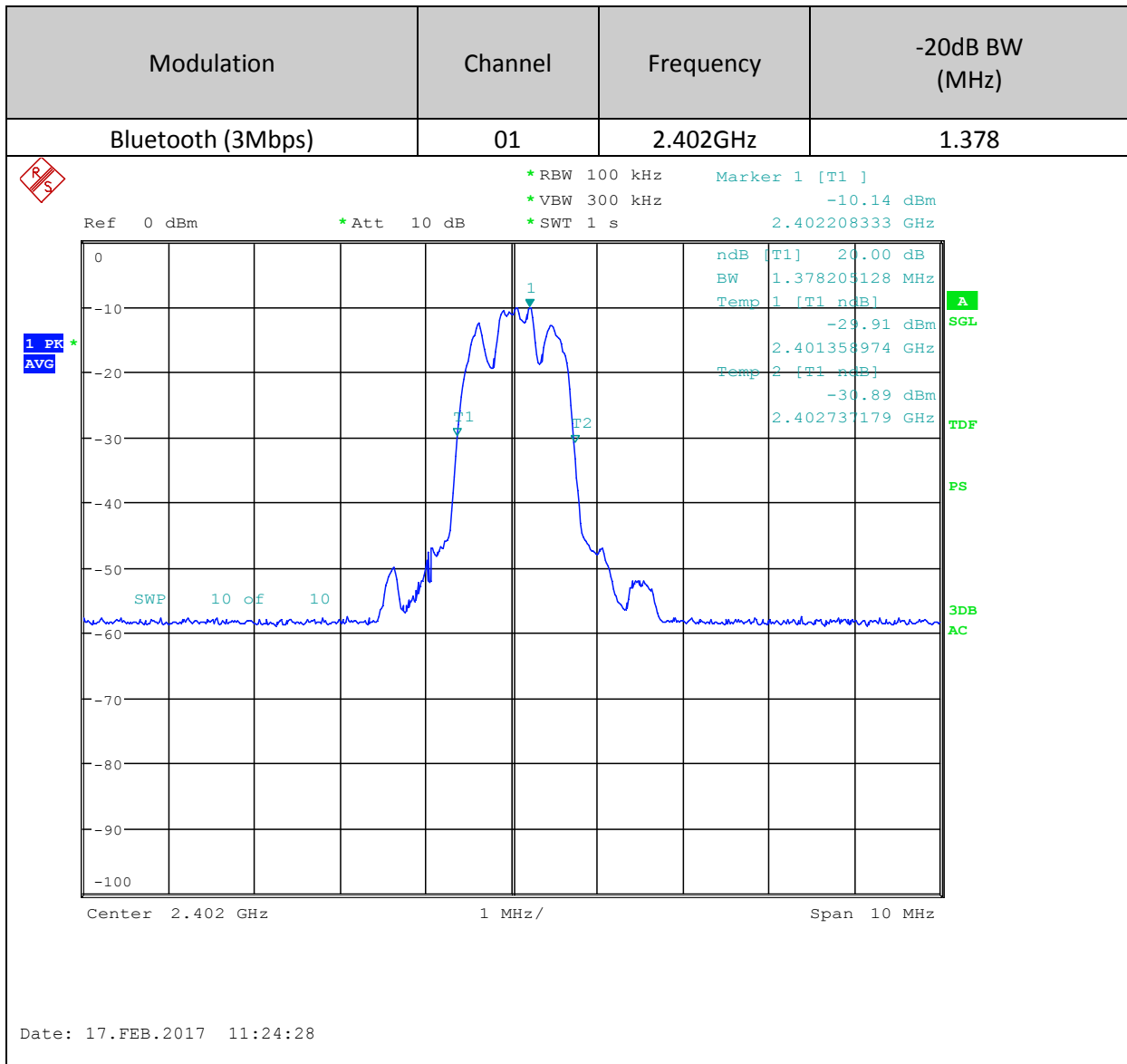


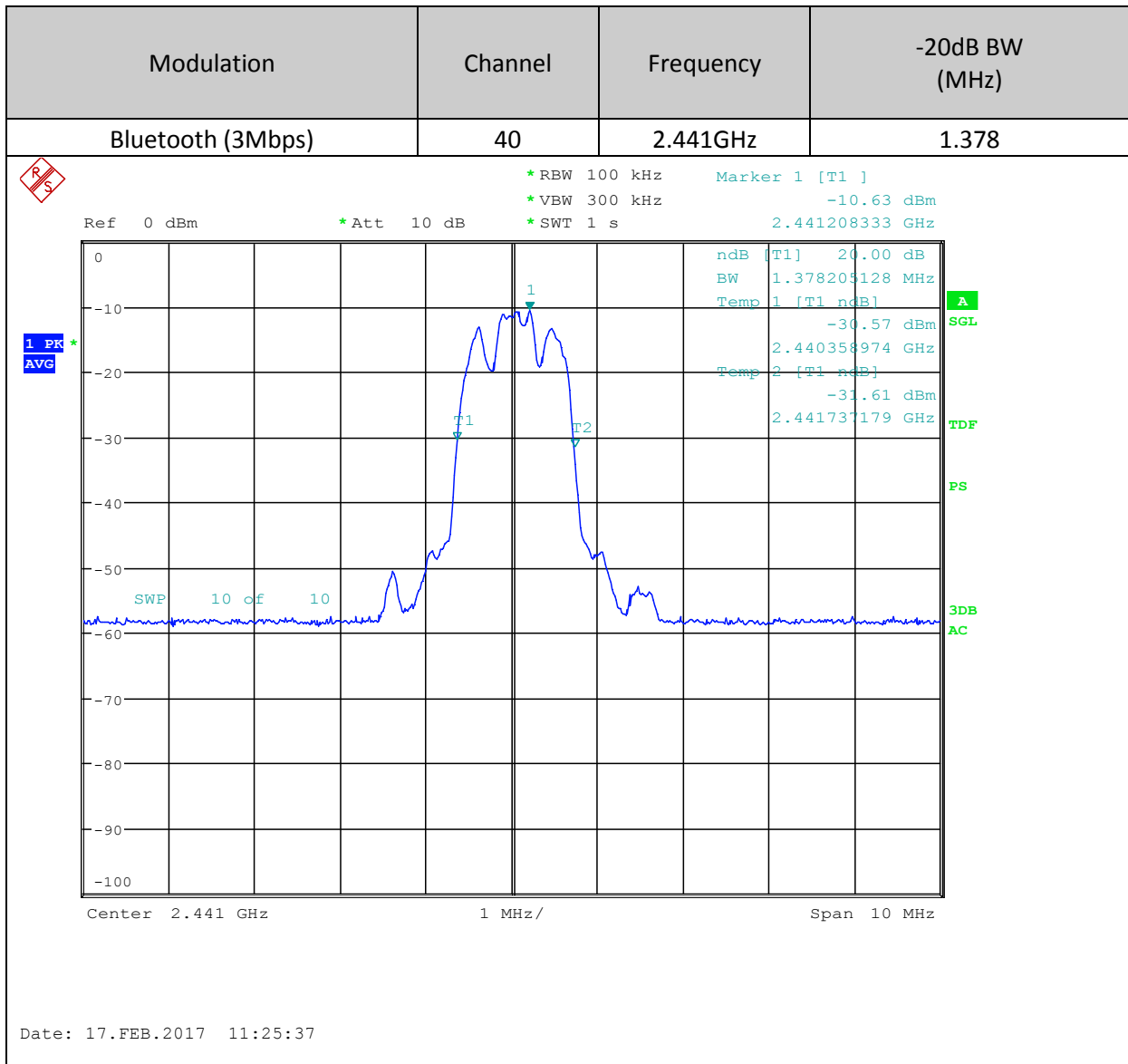


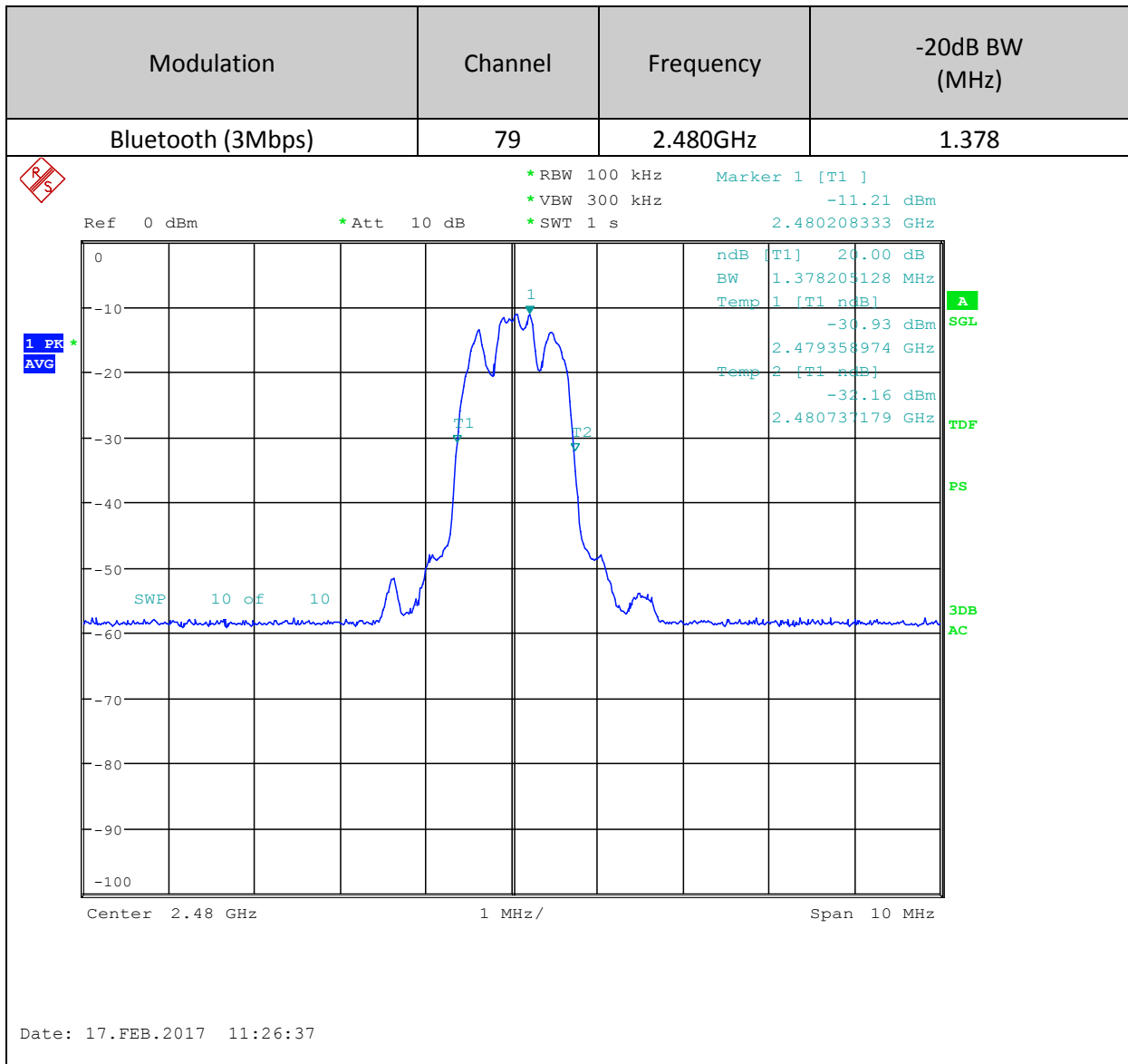












Comments:

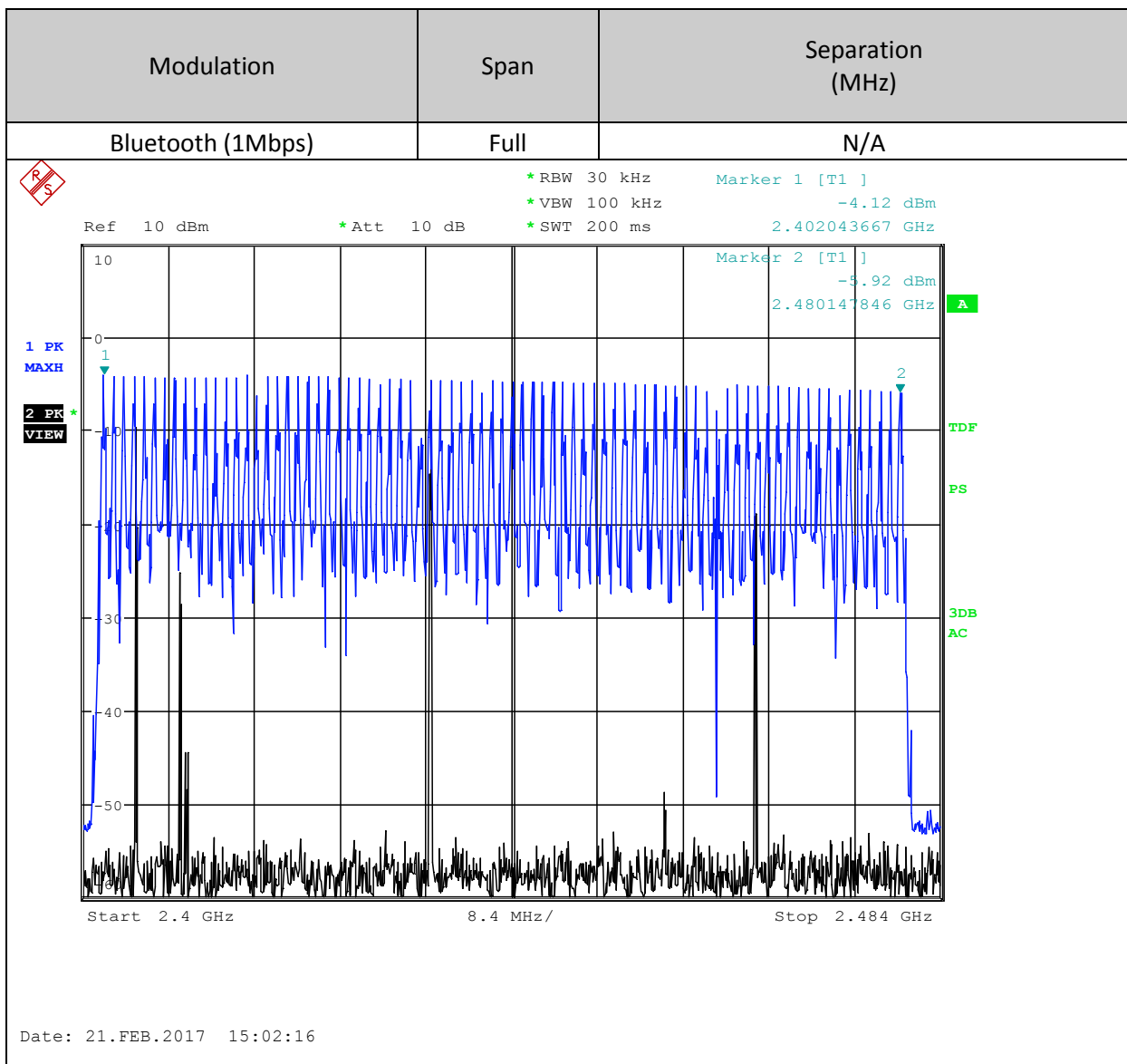
Test Unit: 001
Test Setup: A (Conducted)
Tested by: D. Jamieson
Test Date/s: 17th February 2017
Test Status: **PASS**

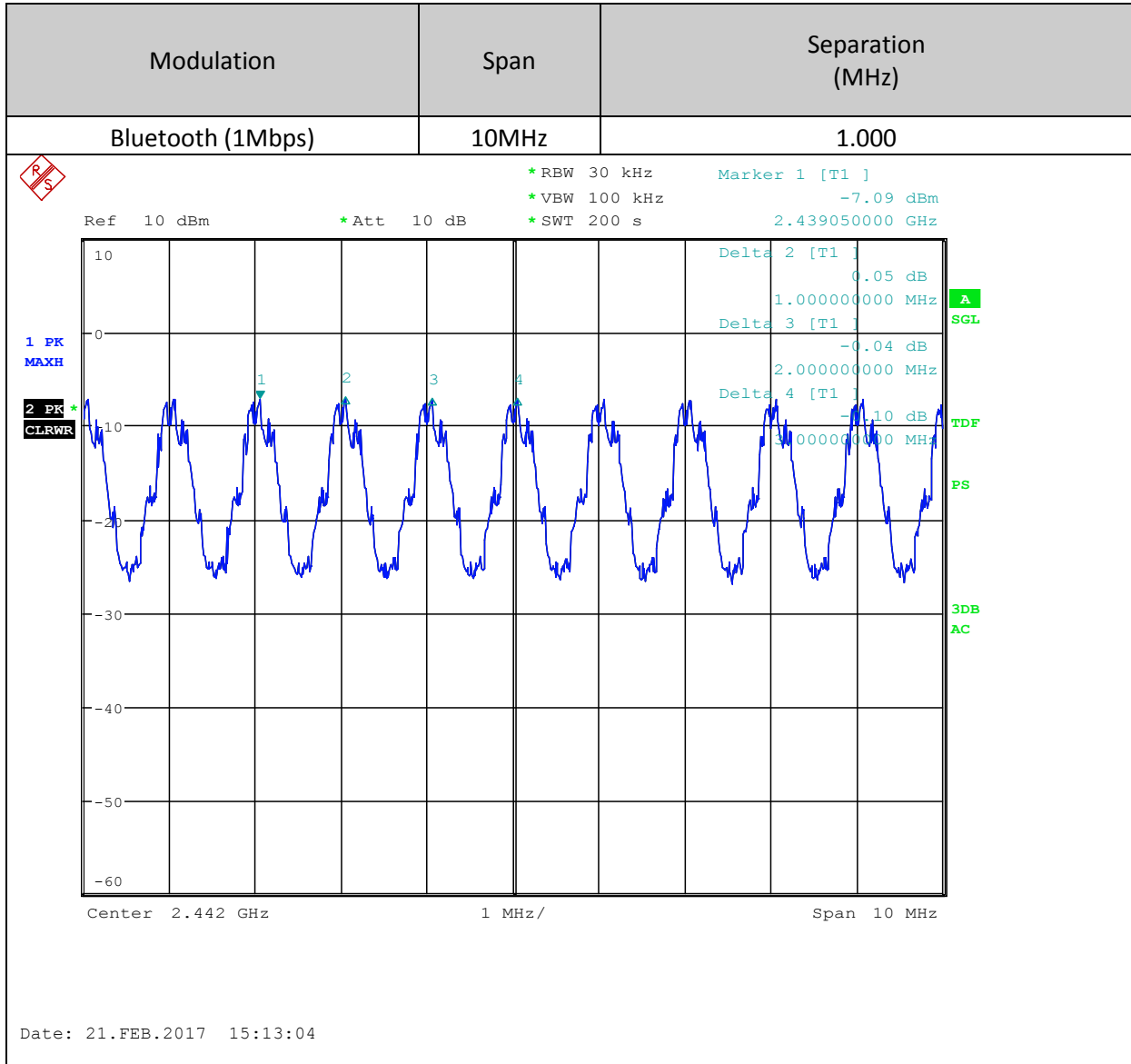
6.3 Hopping Carrier Frequency Separation

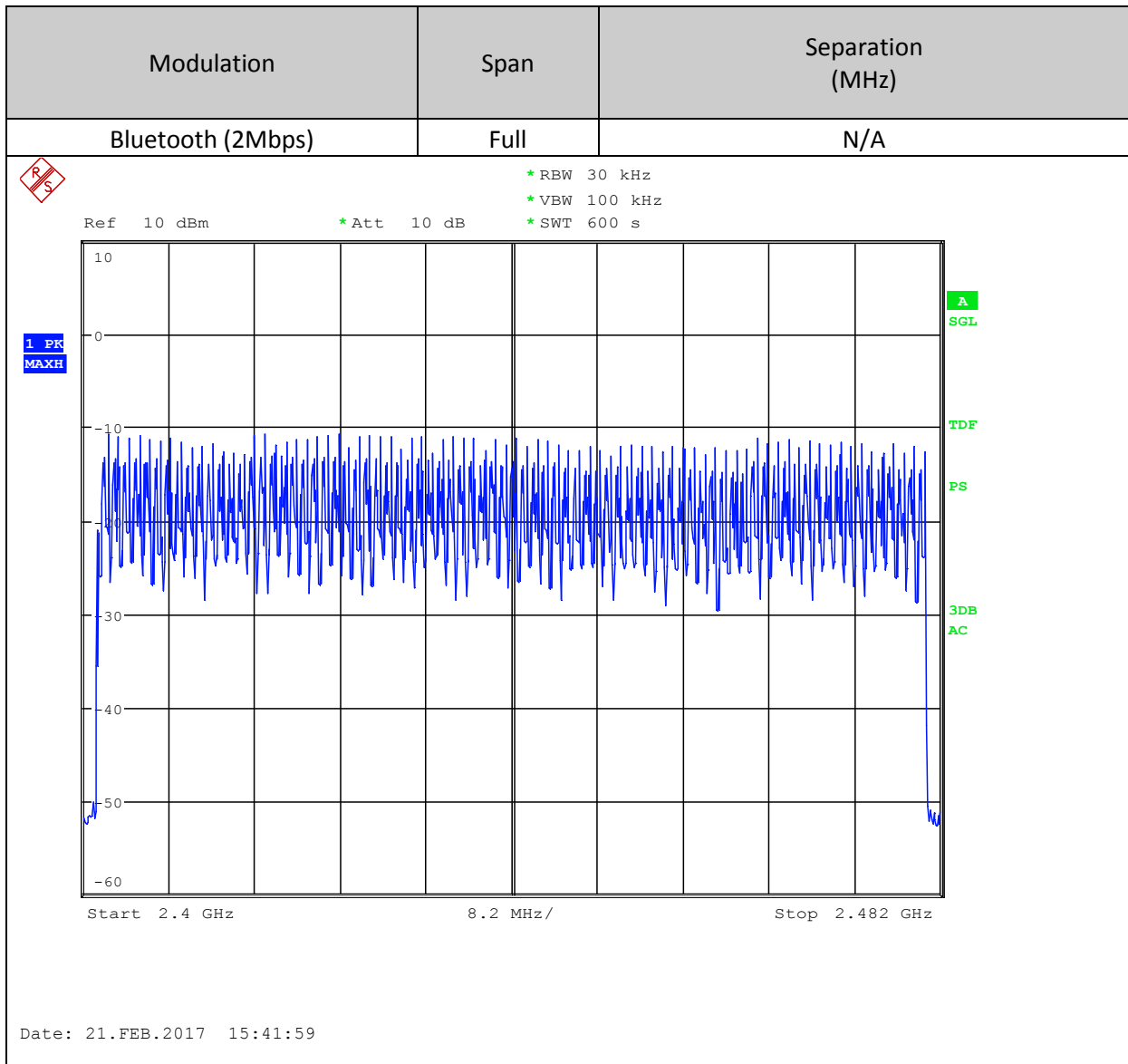
6.3.1 Hopping Carrier Frequency Separation – Test Summary

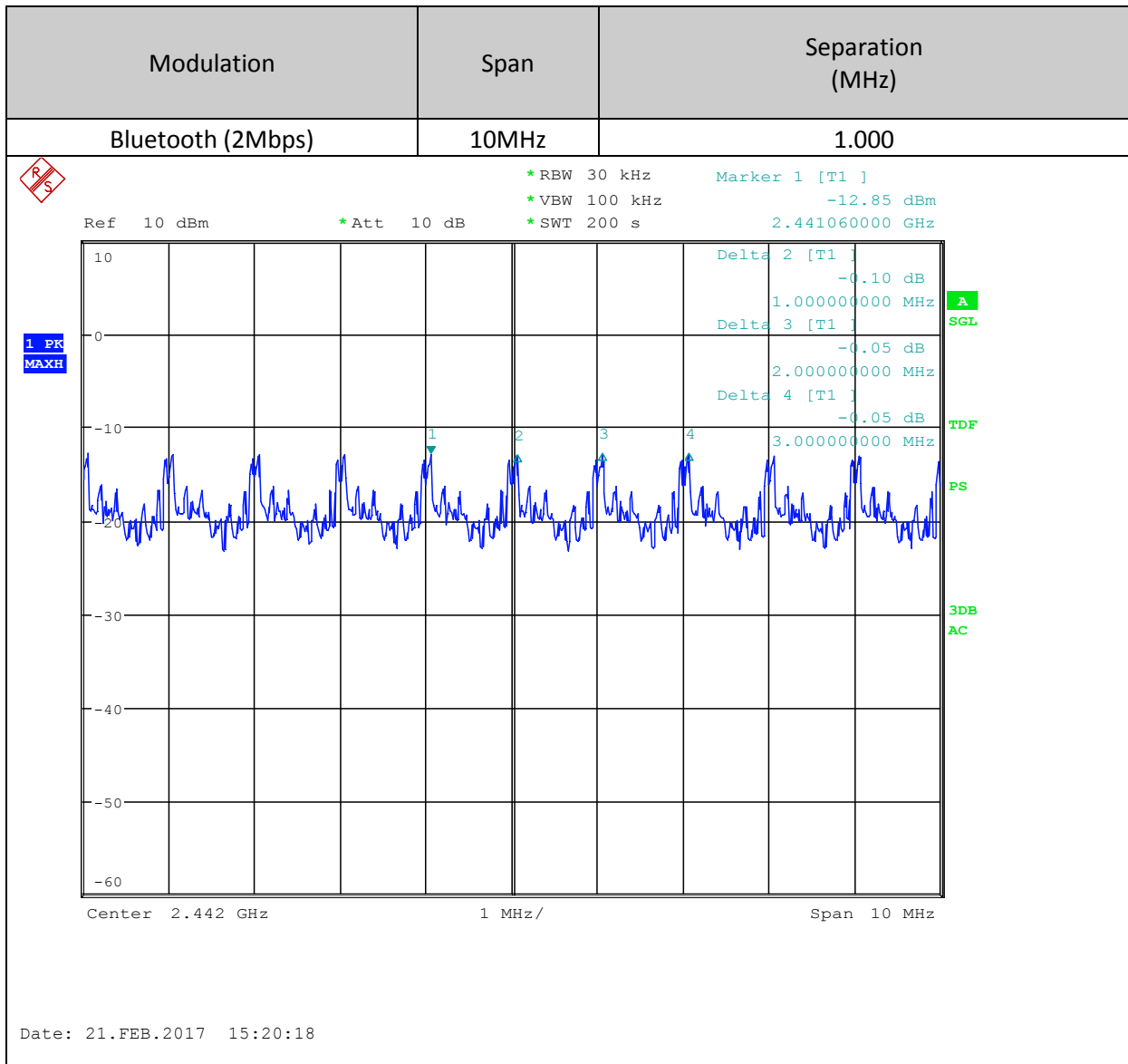
Type	Span	Separation (MHz)	Limit	Result
Bluetooth (1Mbps)	10MHz	1.000	>=1MHz	Pass
Bluetooth (2Mbps)	10MHz	1.000	>=1MHz	Pass
Bluetooth (3Mbps)	10MHz	1.000	>=1MHz	Pass

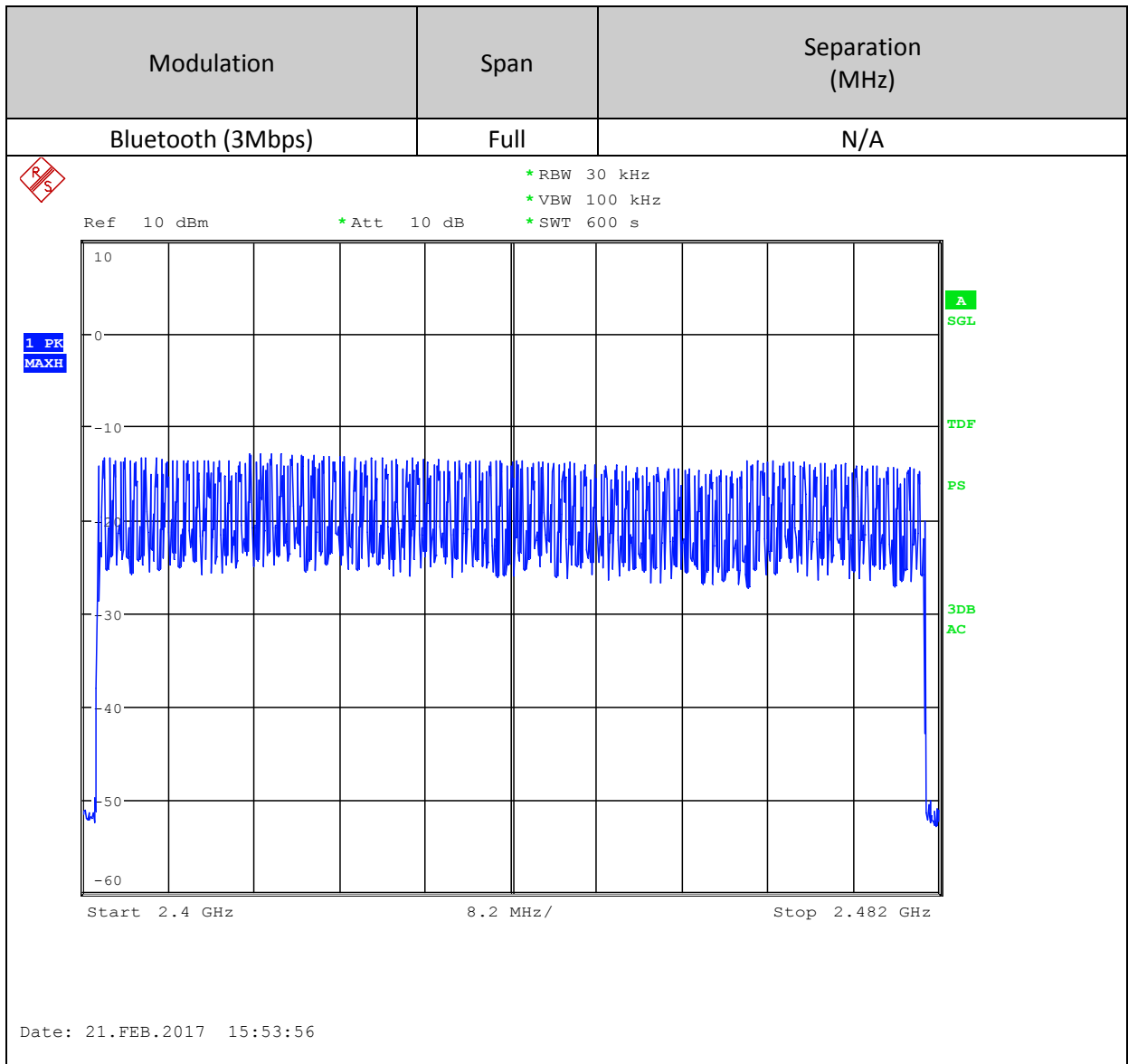
6.3.2 Hopping Carrier Frequency Separation – Test Plots

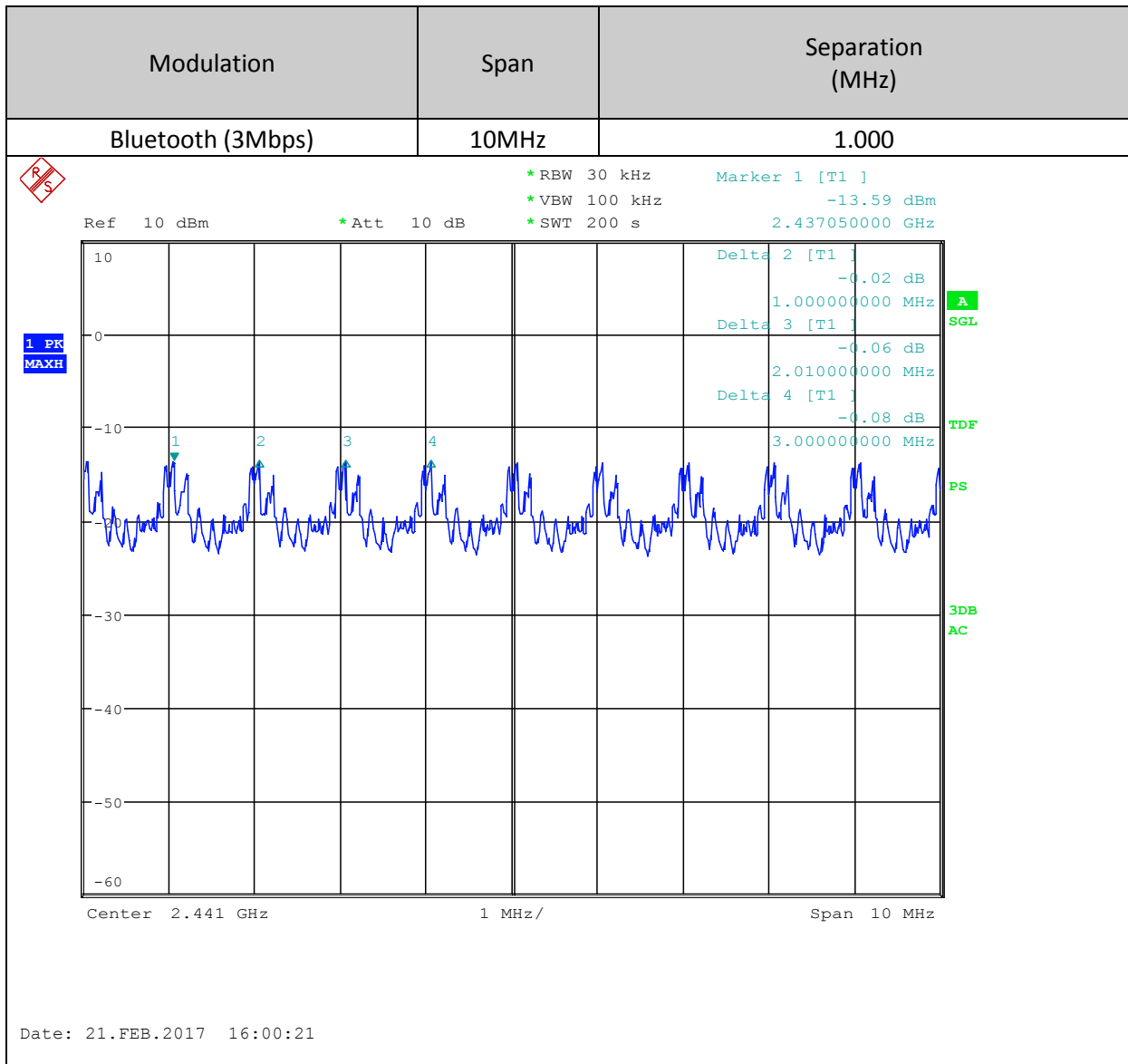












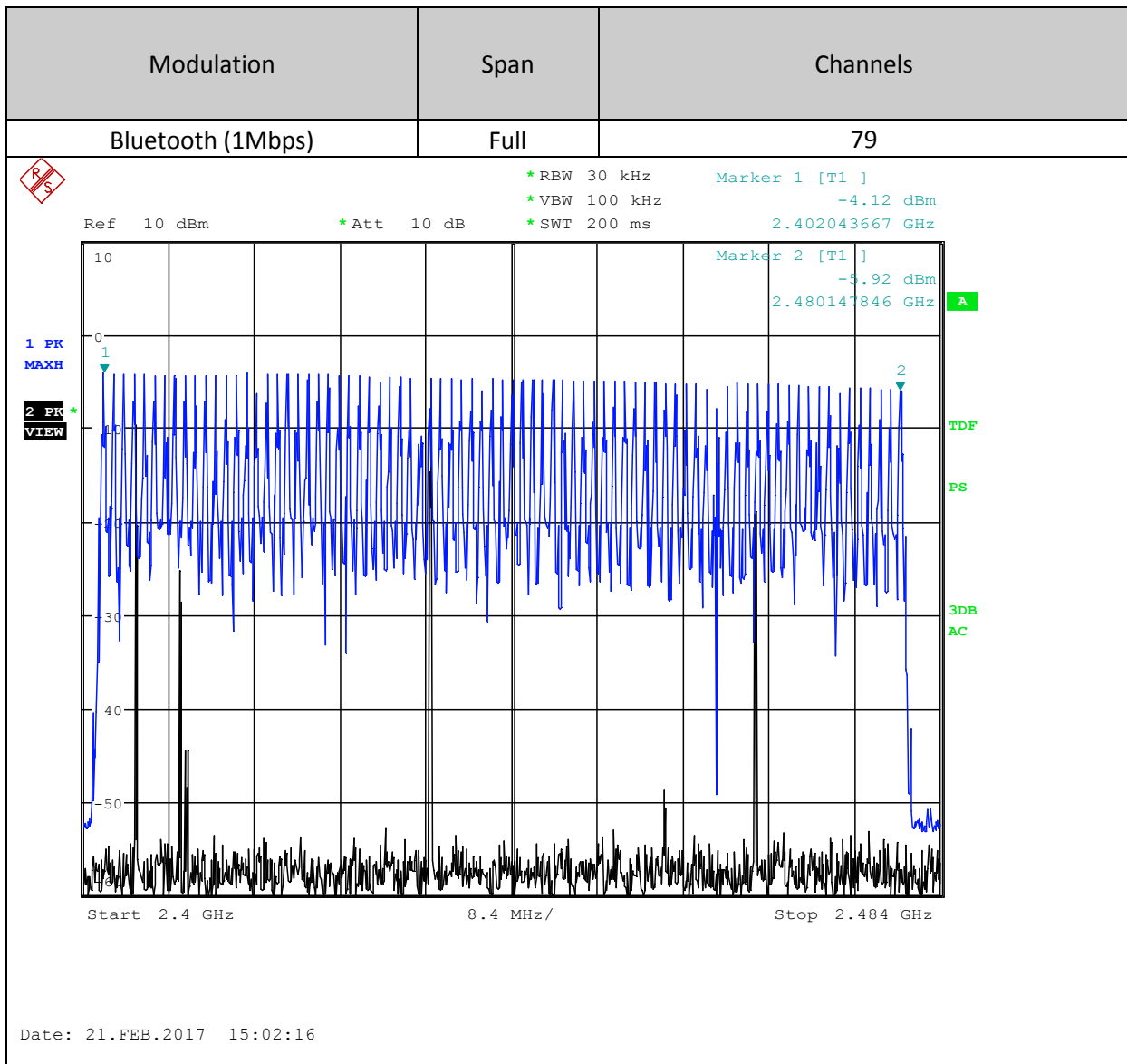
Comments: None.
Test Unit: 001
Test Setup: A (Conducted)
Tested by: D. Jamieson
Test Date/s: 21st February 2017
Test Status: **PASS**

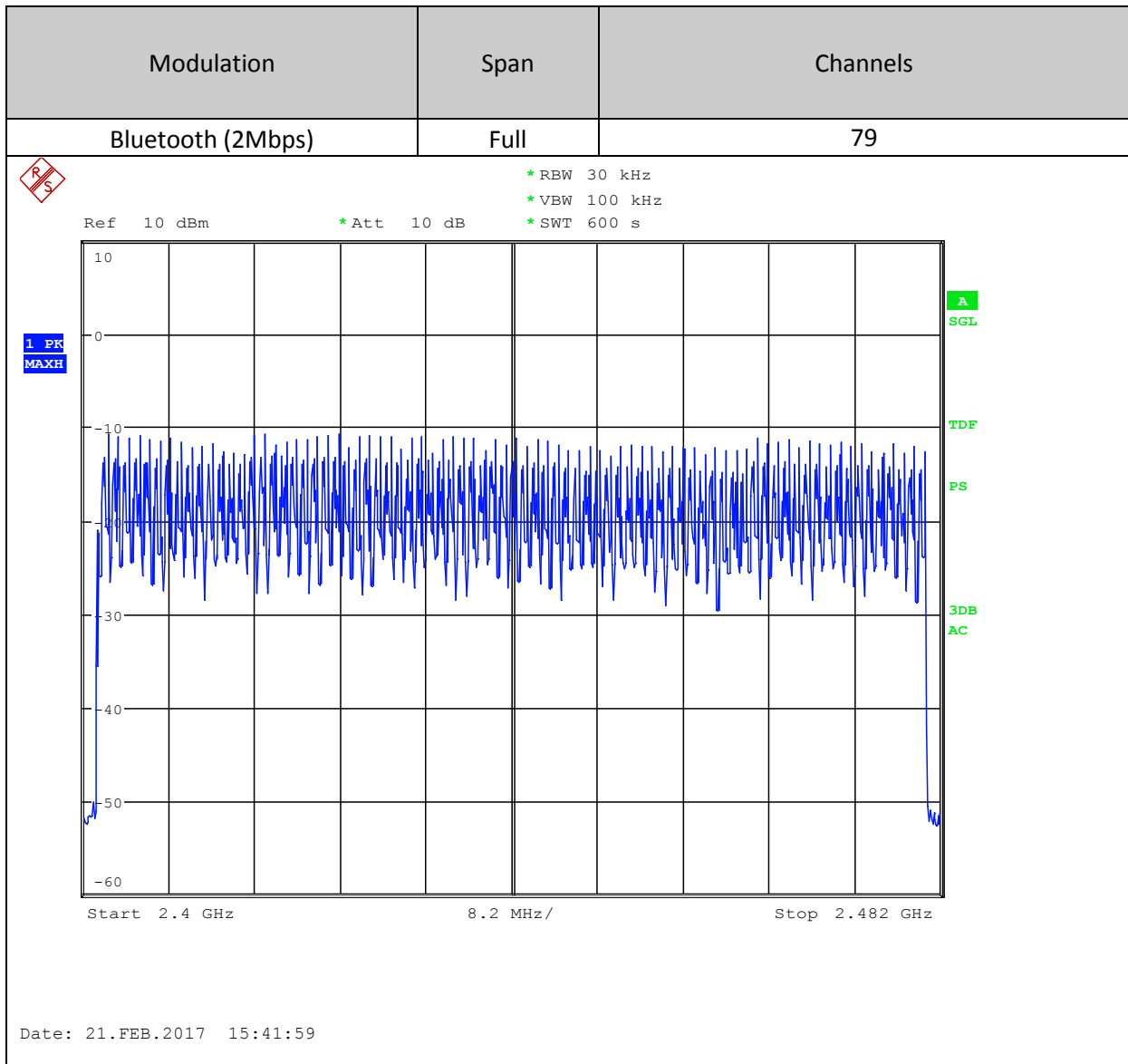
6.4 Hopping Channels

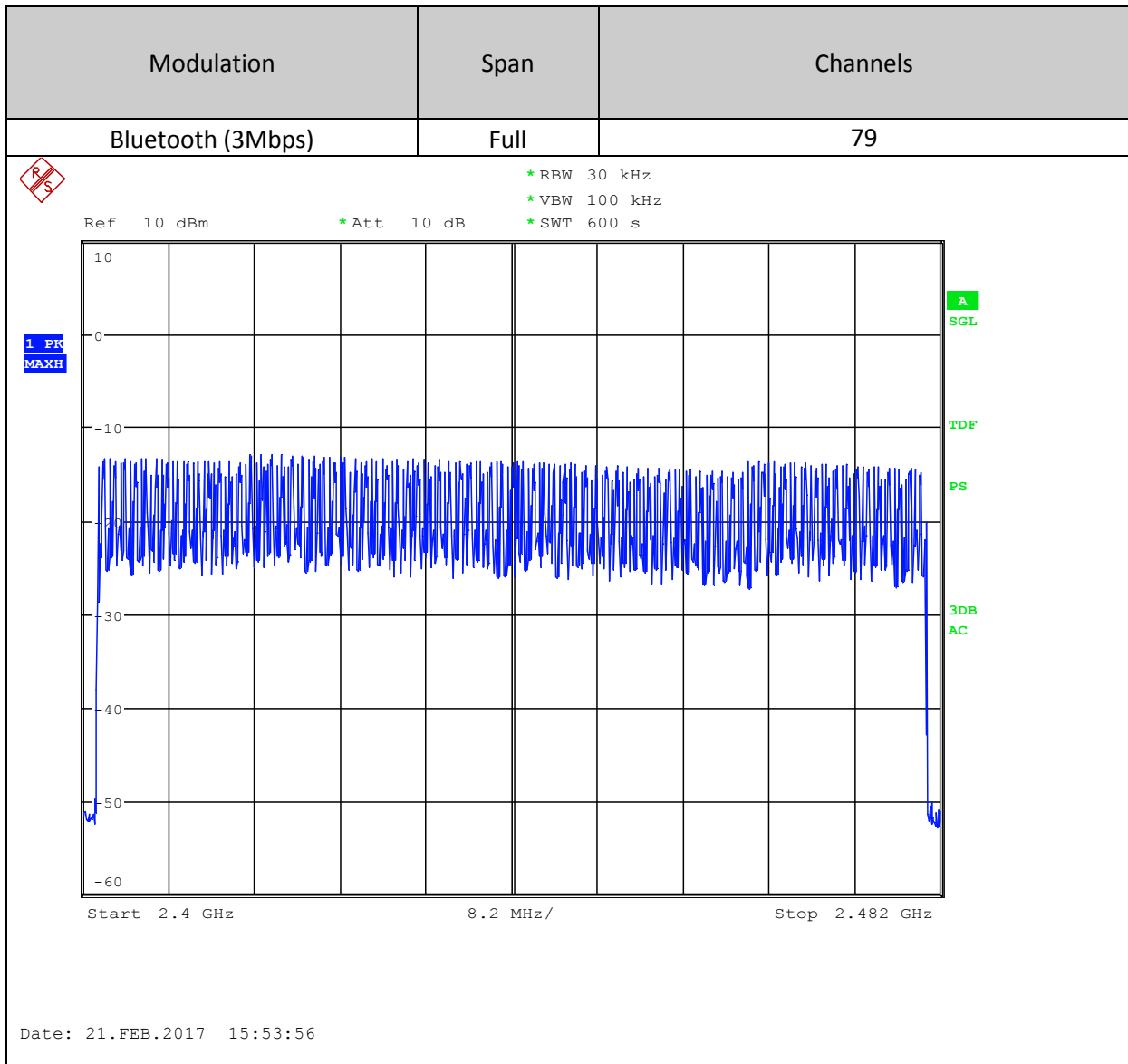
6.4.1 Hopping Channels – Results Summary

Type	Channels
Bluetooth (1Mbps)	79
Bluetooth (2Mbps)	79
Bluetooth (3Mbps)	79

6.4.2 Hopping Channels – Result Plots







Comments: None.
Test Unit: 001
Test Setup: A (Conducted)
Tested by: D. Jamieson
Test Date/s: 21st February 2017
Test Status: PASS

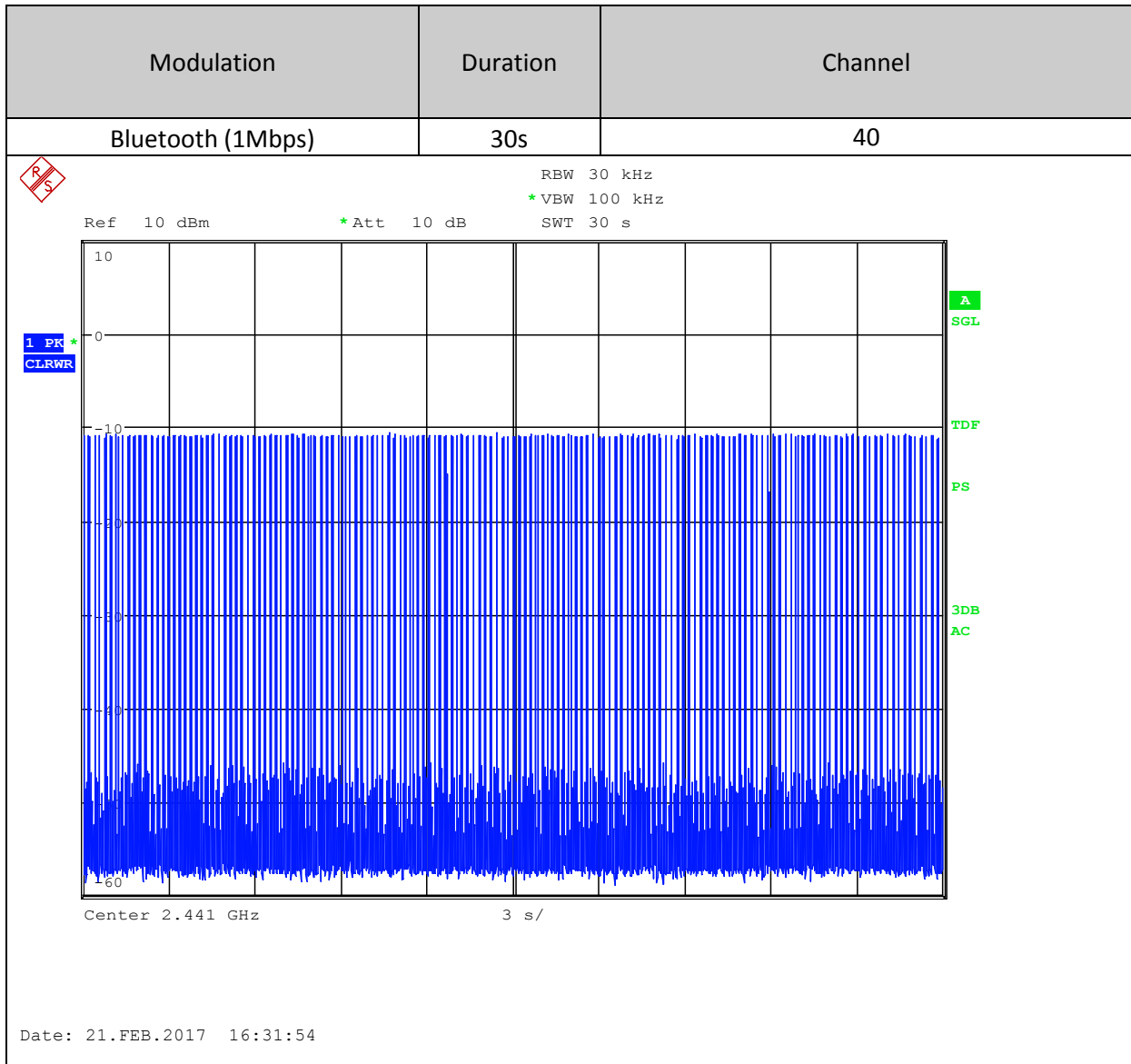
6.5 Hopping Dwell Time

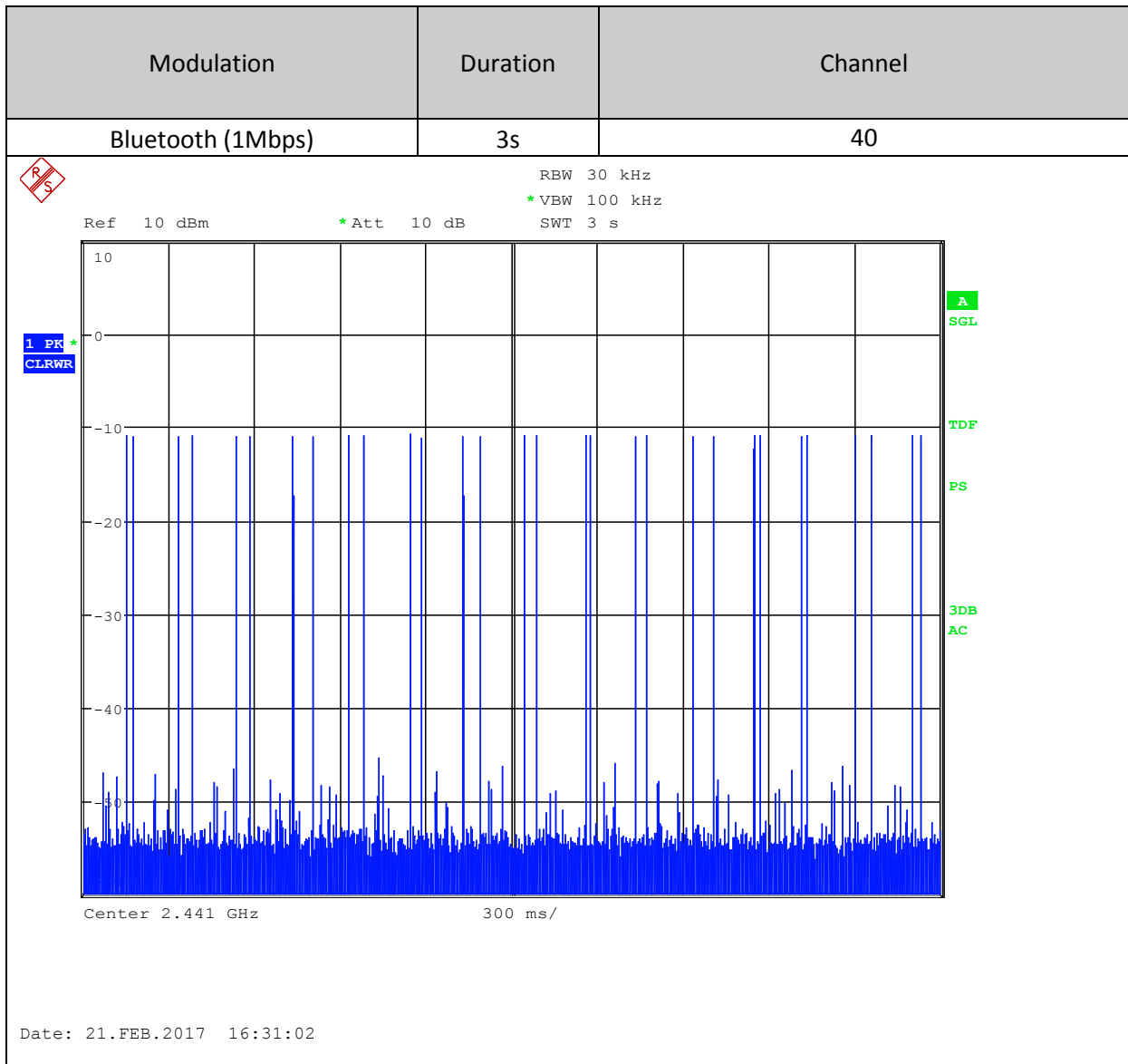
6.5.1 Hopping Dwell Time – Results Summary

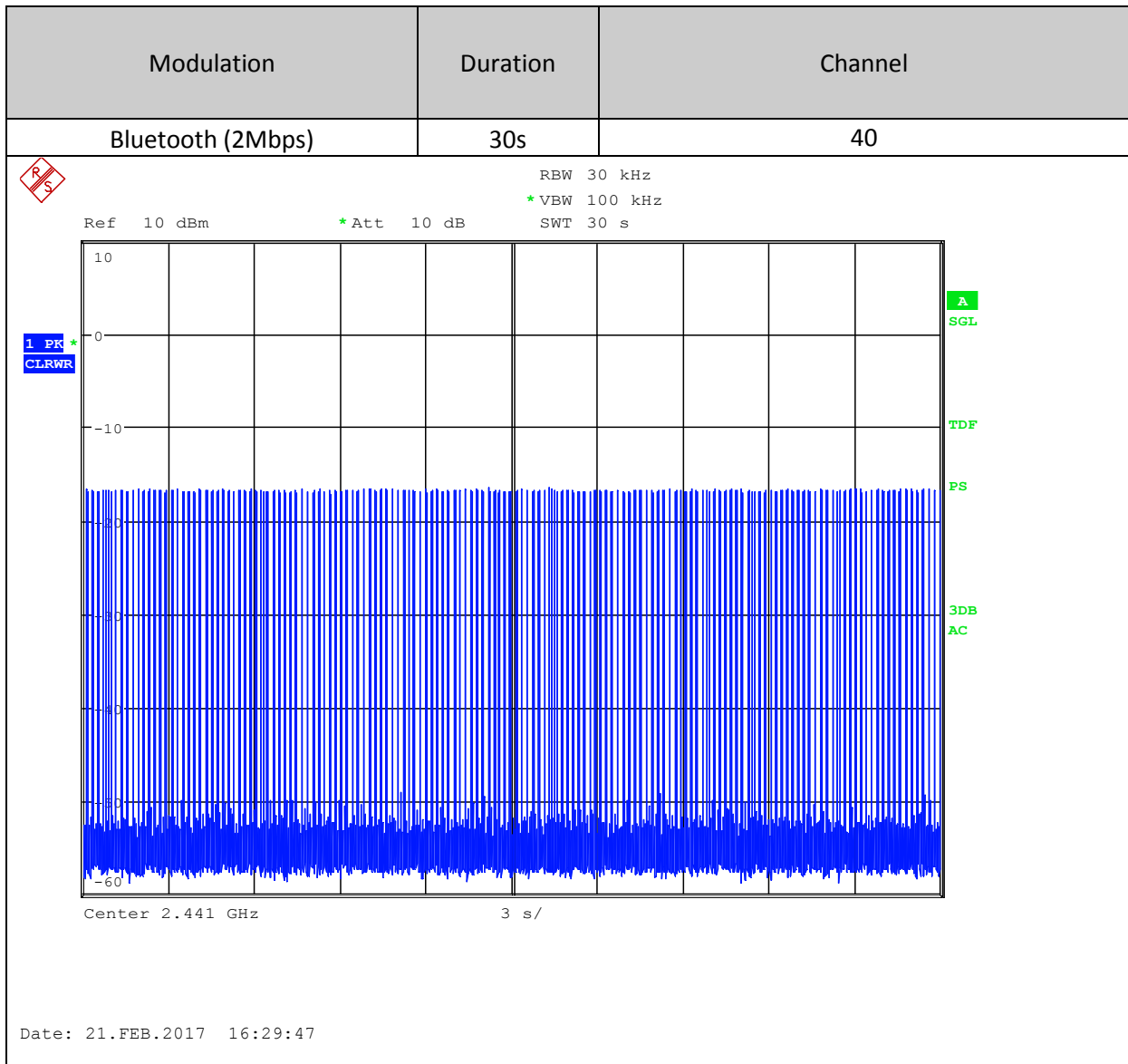
Note, maximum dwell time for 78 channels = $0.4s * 78 = 31.2s$.

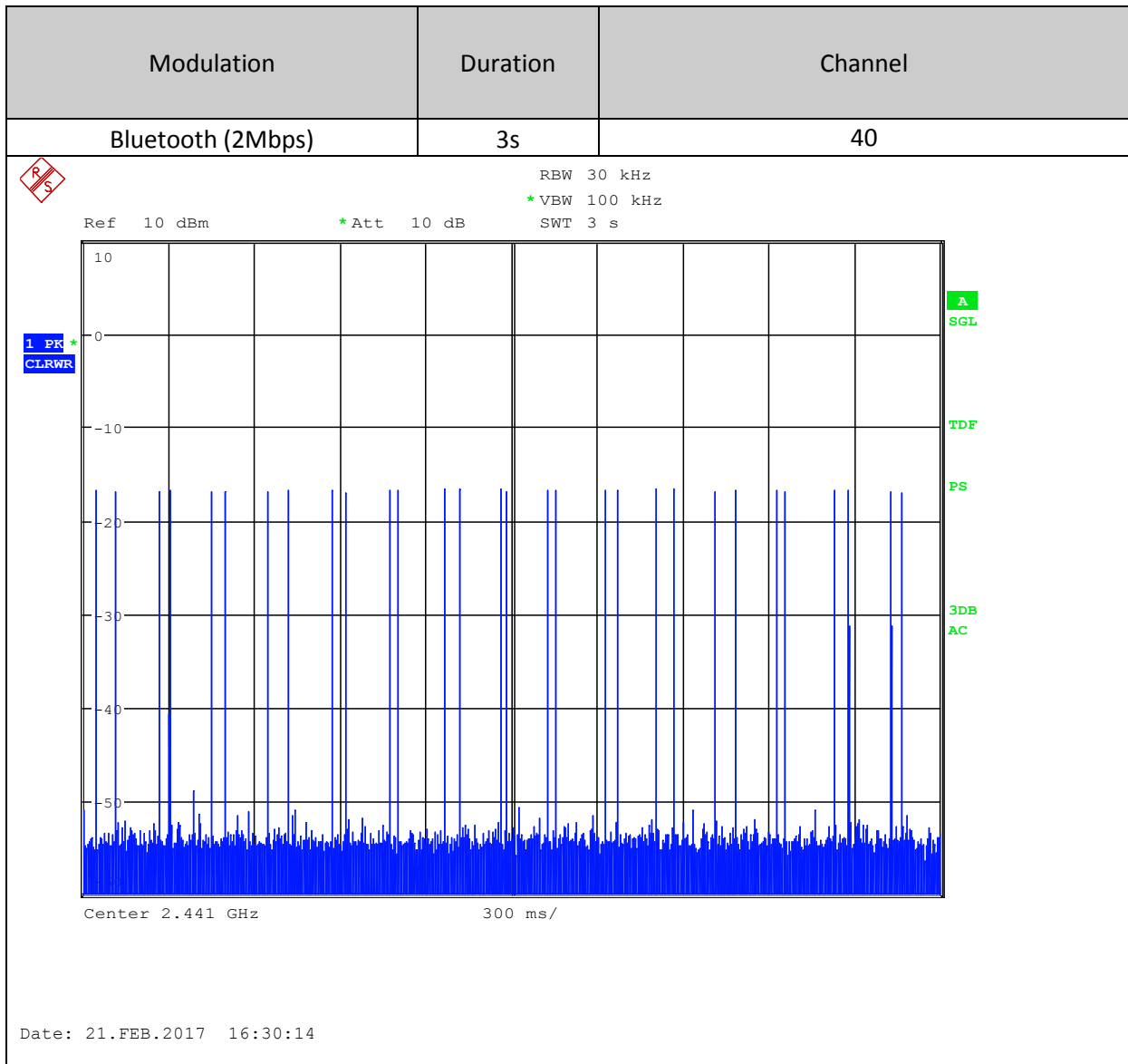
Type	Sweep	Dwell Time	Dwell Time for 31.2s	Limit	Result
BT (1MB/s)	30s	0.1210	0.126	0.4s	Pass
	3s	0.0124	0.129	0.4s	Pass
BT (2MB/s)	30s	0.1210	0.126	0.4s	Pass
	3s	0.0065	0.068	0.4s	Pass
BT (3MB/s)	30s	0.1190	0.124	0.4s	Pass
	3s	0.0059	0.061	0.4s	Pass

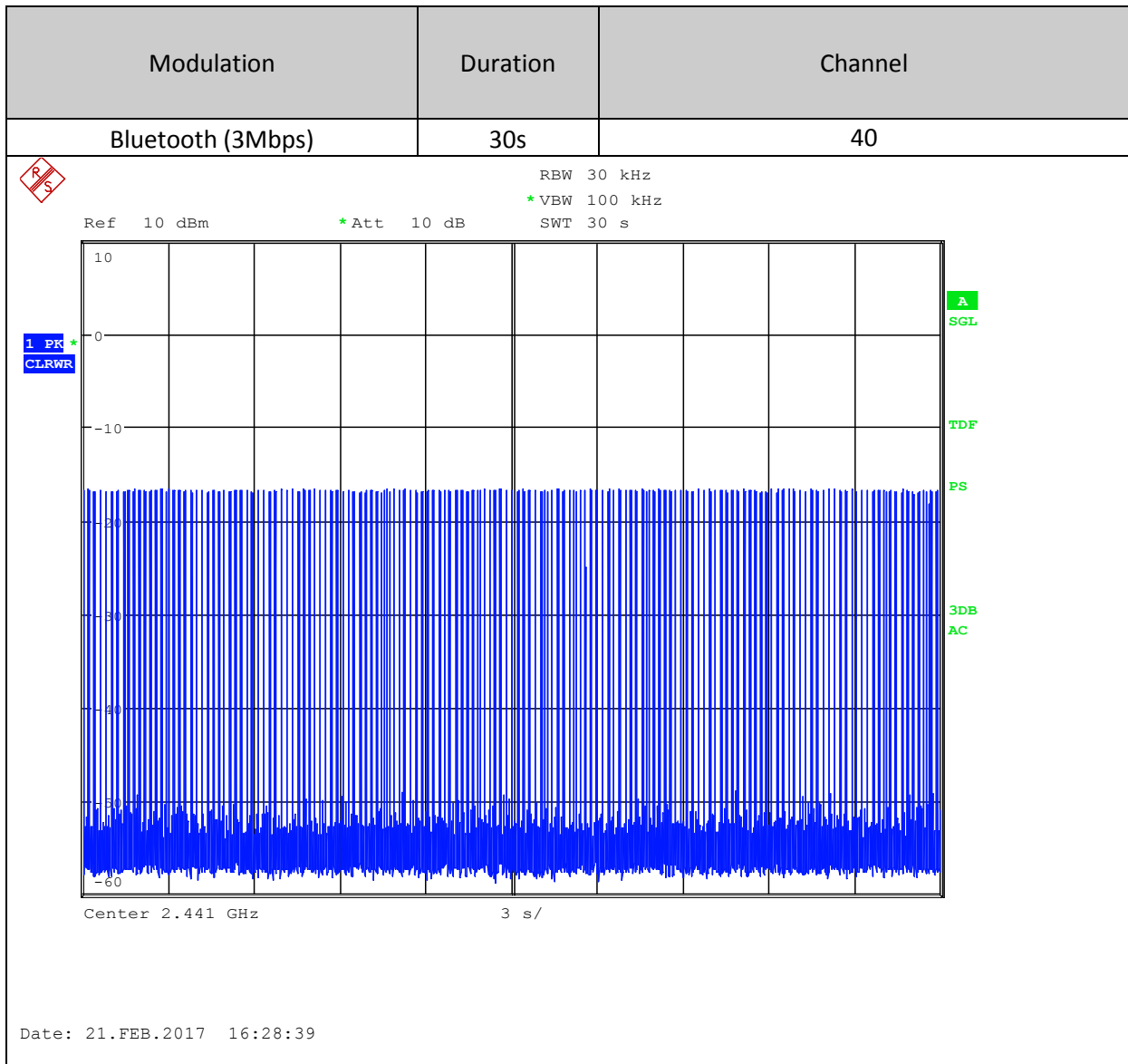
6.5.2 Hopping Dwell Time – Result Plots

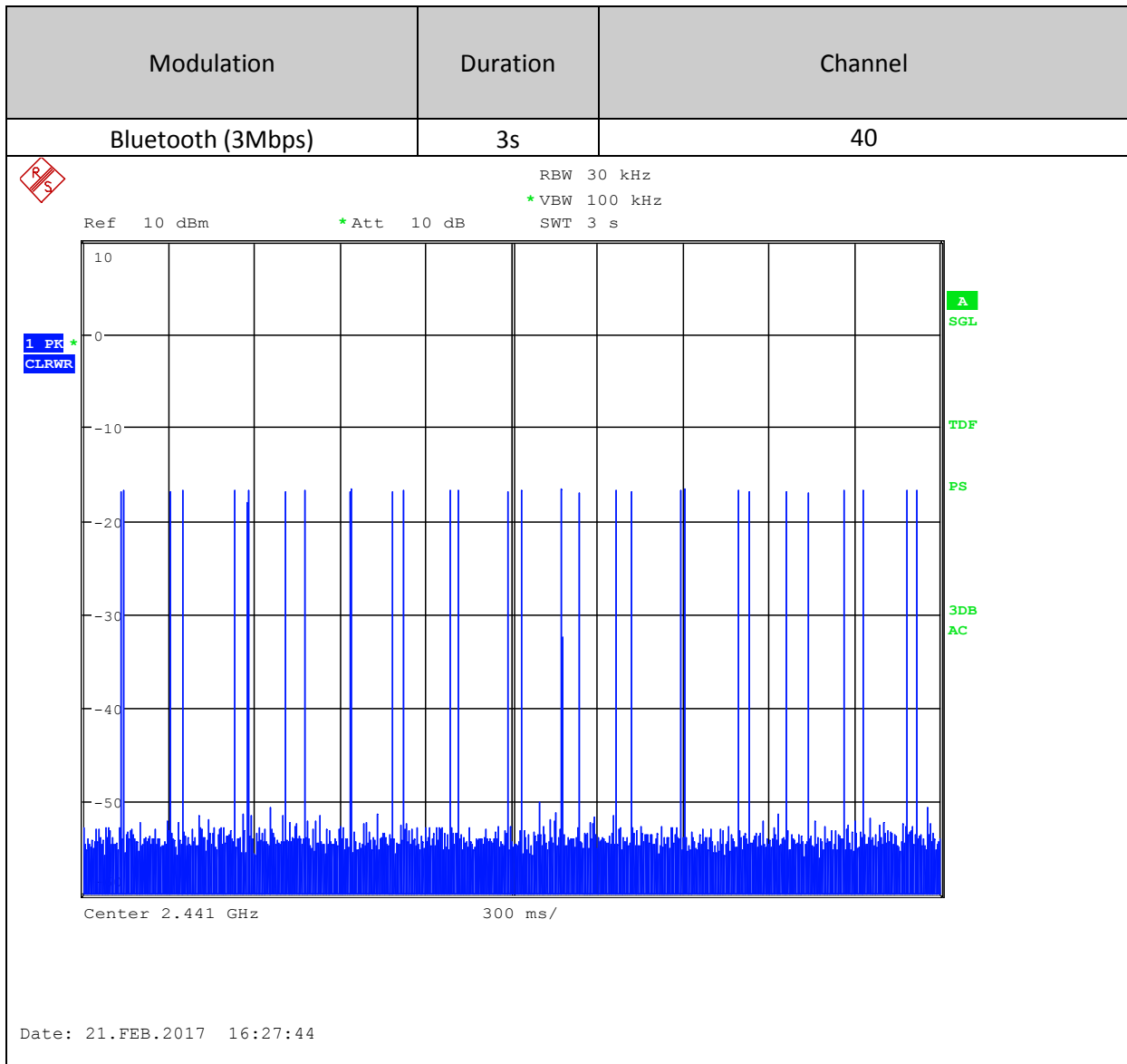












Comments: None.
Test Unit: 001
Test Setup: A (Conducted)
Tested by: D. Jamieson
Test Date/s: 21st February 2017
Test Status: PASS

6.6 6dB Bandwidth

6.6.1 6dB Bandwidth – Results Summary

Type	Channel	6dB Channel Bandwidth (MHz)	Limit (MHz)	Result
11b (11Mbps)	1	8.413	>0.5	Pass
	7	7.852	>0.5	Pass
	11	8.093	>0.5	Pass
11g (54Mbps)	1	16.266	>0.5	Pass
	7	16.186	>0.5	Pass
	11	16.266	>0.5	Pass
11n (MCS 7)	1	16.907	>0.5	Pass
	7	16.587	>0.5	Pass
	11	16.987	>0.5	Pass

6.6.2 6dB Bandwidth – Result Plots

