

InterLab[®]

**Final Report on
Comarch Beacon
FCC ID 2AEN7-CB001
IC: 20295-CB001**

Report Reference: MDE_COMARCH_1501_FCCa_rev1
acc. Title 47 CFR chapter I part 15 subpart C

Date: August 11, 2015

Test Laboratory:

7 layers AG
Borsigstrasse 11
40880 Ratingen
Germany



Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in part without the written approval of the test laboratory.

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Peter Mertel
Vorstand Board:
Dr. H. Ansorge

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USt-IdNr VAT No.:
DE 203159652
TAX No. 147/5869/0385
A Bureau Veritas Group Company

1 Administrative Data

1.1 Project Data

Project Responsible: Dirk Bratsch
Date Of Test Report: 2015/08/11
Date of first test: 2015/03/26
Date of last test: 2015/04/16

1.2 Applicant Data

Company Name: Comarch S.A.
Street: Al. Jana Pawla II 39A
City: 31-864 Krakow
Country: Poland
Contact Person: Mr. Michael Strug

1.3 Test Laboratory Data

The following list shows all places and laboratories involved for test result generation:


7 layers DE

Company Name : 7 layers AG
Street : Borsigstrasse 11
City : 40880 Ratingen
Country : Germany
Contact Person : Mr. Michael Albert
Phone : +49 2102 749 201
Fax : +49 2102 749 444
E Mail : Michael.Albert@7Layers.com

Laboratory Details

Lab ID	Identification	Responsible	Accreditation Info
Lab 1	Radiated Emissions	Mr. Marco Kullik Mr. Robert Machulec	DAkkS-Registration no. D-PL-12140-01-01
Lab 2	Regulatory Bluetooth RF Test Solution	Mr. Jimmy Chatheril Mr. Sören Berentzen	DAkkS-Registration no. D-PL-12140-01-01

1.4 Signature of the Testing Responsible



Imad Hjije
responsible for tests performed in: Lab 1, Lab 2

1.5 Signature of the Accreditation Responsible



Accreditation scope responsible person
responsible for Lab 1, Lab 2

2 Test Object Data

2.1 General OUT Description

The following section lists all OUTs (Object's Under Test) involved during testing.

OUT: Comarch Beacon
FCC ID 2AEN7-CB001
IC: 20295-CB001

Product Category: Others
Manufacturer:
Company Name: Please see applicant data
Contact Person: -

Parameter List:

Parameter name	Value
Parameter for Scope FCC_v2:	
Antenna Gain	0.5 (dBi)
DC Power Supply	6 (V)
highest channel (BT)	2480 (MHz)
lowest channel (BT)	2402 (MHz)
mid channel (BT)	2441 (MHz)

2.2 Detailed Description of OUT Samples

Sample : aa01

<i>OUT Identifier</i>	Comarch Beacon FCC ID 2AEN7-CB001 IC: 20295-CB001		
<i>Sample Description</i>	Comarch Beacon RF PHY		
<i>Serial No.</i>	E00389		
<i>HW Status</i>	rev0.5		
<i>SW Status</i>	1.0		
<i>Low Voltage</i>	2.5 V	<i>Low Temp.</i>	-10 °C
<i>High Voltage</i>	3.6 V	<i>High Temp.</i>	+55 °C
<i>Nominal Voltage</i>	3.3 V	<i>Normal Temp.</i>	+23 °C

Parameter List:

<i>Parameter Description</i>	<i>Value</i>
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Parameter for Scope FCC_v2

Antenna Gain	0.5 (dBi)
Frequency_high	2480 (MHz)
Frequency_low	2402 (MHz)
Frequency_mid	2441 (MHz)

Sample : ab01

<i>OUT Identifier</i>	Comarch Beacon FCC ID 2AEN7-CB001 IC: 20295-CB001		
<i>Sample Description</i>	Comarch FCC		
<i>Serial No.</i>	E00374		
<i>HW Status</i>	rev0.5		
<i>SW Status</i>	1.0		
<i>Low Voltage</i>	2.5 V	<i>Low Temp.</i>	-10 °C
<i>High Voltage</i>	3.6 V	<i>High Temp.</i>	+55 °C
<i>Nominal Voltage</i>	3.3 V	<i>Normal Temp.</i>	+23 °C

Parameter List:

<i>Parameter Description</i>	<i>Value</i>
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Parameter for Scope FCC_v2

Antenna Gain	0.5 (dBi)
Frequency_high	2480 (MHz)
Frequency_low	2402 (MHz)
Frequency_mid	2441 (MHz)

2.3 OUT Features

Features for OUT: Comarch Beacon
FCC ID 2AEN7-CB001
IC: 20295-CB001

Designation	Description	Allowed Values	Supported Value(s)
Features for scope: FCC_v2			
BTLE	Support of Bluetooth Low Energy		
DC	The OUT is powered by or connected to DC		
Iant	Integral Antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment		
TantC	temporary antenna connector, which may be only built-in for testing, designed as an example part of the equipment		

2.4 Auxiliary Equipment

AE No.	Type Designation	Serial No.	HW Status	SW Status	Description
AE AE2					RF Cable 1
AE AE3					RF Cable 2
AE AE1		0147090101-0213			UART

2.5 Setups used for Testing

For each setup a relation is given to determine if and which samples and auxiliary equipment is used. The left side list all OUT samples and the right side lists all auxiliary equipment for the given setup.

Setup No.	List of OUT samples		List of auxiliary equipment	
	Sample No.	Sample Description	AE No.	AE Description
S01_AA01	(BT RF PHY)			
	Sample: aa01	Comarch Beacon RF PHY	AE AE2	RF Cable 1
			AE AE3	RF Cable 2
			AE AE1	UART
S02_AB01	(FCC)			
	Sample: ab01	Comarch FCC		

3 Results

3.1 General

Documentation of tested devices:

Available at the test laboratory.

Interpretation of the test results:

The results of the inspection are described on the following pages, where 'Conformity' or 'Passed' means that the certification criteria were verified and that the tested device is conform to the applied standard.

In cases where 'Declaration' is printed, the required documents are available in the manufacturers product documentation.

In cases where 'not applicable' is printed, the test case requirements are not relevant to the specific equipment implementation.

Note:

1. All tests are performed under environmental conditions within the requirements of the specifications. Environmental conditions are available at the laboratory.
2. The device is a remot control containing a BTLE Transceiver operating in the 2.4 GHz ISM band.
3. This report replace report MDE_COMARCH_1501_FCCa.

3.2 List of the Applicable Body

(Body for Scope: FCC_v1)

<i>Designation</i>	<i>Description</i>
FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES	Subpart C - Intentional Radiators; 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(Body for Scope: FCC_v2)

<i>Designation</i>	<i>Description</i>
FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES	Subpart C - Intentional Radiators; 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

3.3 List of Test Specification

<i>Test Specification:</i>	FCC part 2 and 15
<i>Version</i>	10-1-13 Edition
<i>Title:</i>	PART 2 - GENERAL RULES AND REGULATIONS PART 15 - RADIO FREQUENCY DEVICES

3.4 Summary

<i>Test Case Identifier / Name</i>	<i>Result</i>	<i>Date of Test</i>	<i>Lab</i>	<i>Setup</i>
<i>Test (condition)</i>			<i>Ref.</i>	
15c.10 Power density §15.247 (e)				
15c.10; Frequency = Low/Mid/High	Passed	2015/03/30	Lab 2	S01_AA01
15c.11 6dB Bandwidth §15.247 (a) (2)				
15c.11; Frequency = Low/Mid/High	Passed	2015/03/30	Lab 2	S01_AA01
15c.2 Spurious radiated emissions §15.247 (d), §15.35 (b), §15.209				
15c.2 Spurious radiated emissions, highest channel, BT	Passed	2015/04/07	Lab 1	S02_AB01
15c.2 Spurious radiated emissions, lowest channel, BT	Passed	2015/04/07	Lab 1	S02_AB01
15c.2 Spurious radiated emissions, mid channel, BT	Passed	2015/04/07	Lab 1	S02_AB01
15c.4 Peak power output §15.247 (b) (3) (4)				
15c.4; Peak power output Summary	Passed	2015/03/30	Lab 2	S01_AA01
15c.5 Spurious RF conducted emissions §15.247 (d)				
15c.5 Spurious RF conducted emissions, highest channel, BT	Passed	2015/03/26	Lab 2	S01_AA01
15c.5 Spurious RF conducted emissions, lowest channel, BT	Passed	2015/03/26	Lab 2	S01_AA01
15c.5 Spurious RF conducted emissions, mid channel, BT	Passed	2015/03/26	Lab 2	S01_AA01
15c.6 Band edge compliance §15.247 (d)				
15c.6 Band edge compliance, highest channel, BT	Passed	2015/03/26	Lab 2	S01_AA01
15c.6 Band edge compliance, lowest channel, BT	Passed	2015/03/26	Lab 2	S01_AA01
15c.6; Frequency = 2480, Mode = Bluetooth Low Energy	Passed	2015/04/16	Lab 1	S02_AB01

3.5 Detailed Results

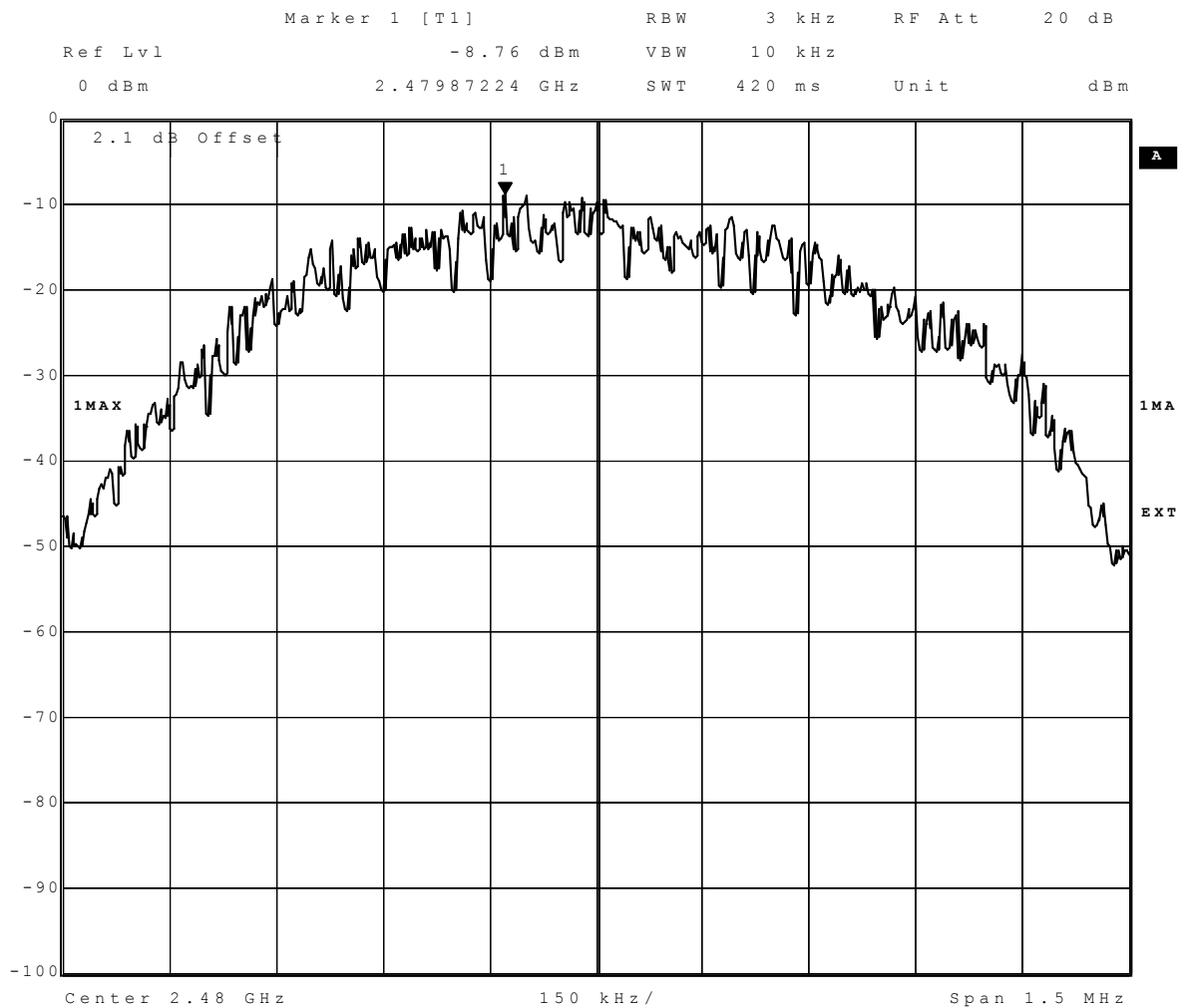
3.5.1 15c.10 Power density §15.247 (e)

Test: 15c.10; Frequency = Low/Mid/High

<i>Result:</i>	Passed
<i>Setup No.:</i>	S01_AA01
<i>Date of Test:</i>	2015/03/30 17:57
<i>Body:</i>	FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
<i>Test Specification:</i>	FCC part 2 and 15

Detailed Results:

TEST CONDITIONS	Maximum Spectral Power Density (RMS) (including antenna gain and correction factor)		
	lowest frequency	mid frequency	highest frequency
Bluetooth Low Energy (GFSK)	2402 MHz	2440 MHz	2480 MHz
	-11.04	-10.67	-8.76
	per 3 kHz	per 3 kHz	per 3 kHz



Date: 30.MAR.2015 11:25:33

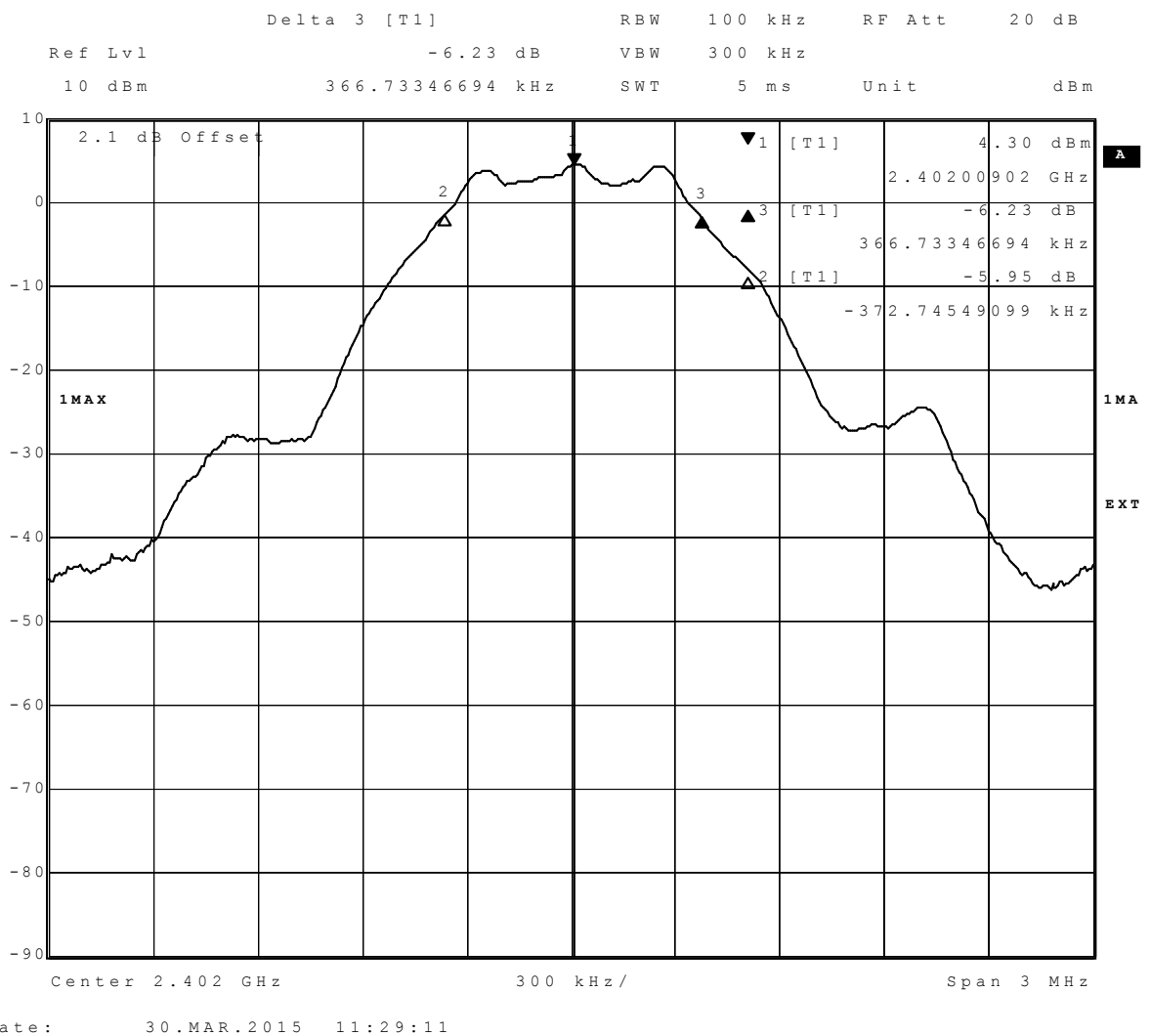
3.5.2 15c.11 6dB Bandwidth §15.247 (a) (2)

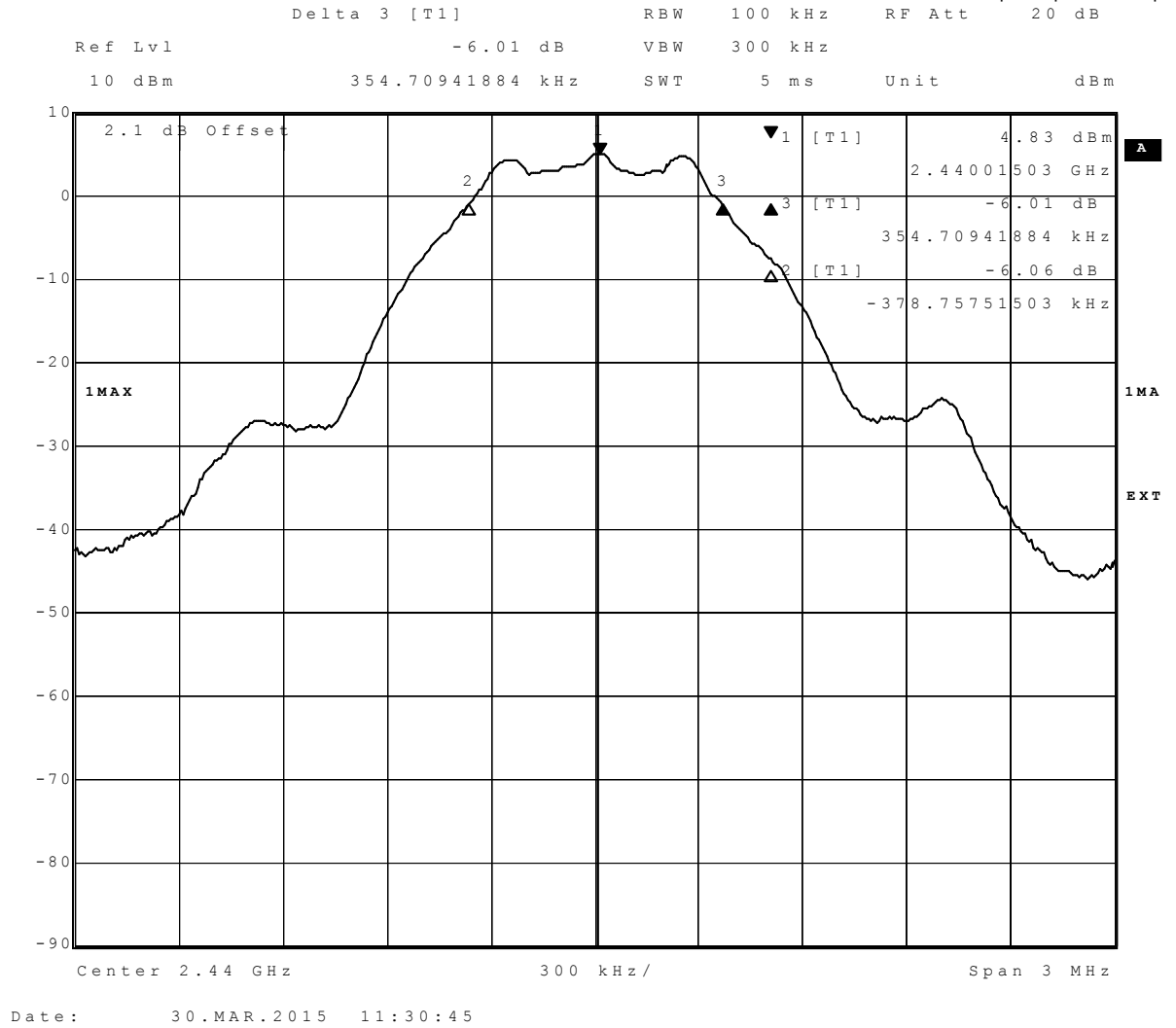
Test: 15c.11; Frequency = Low/Mid/High

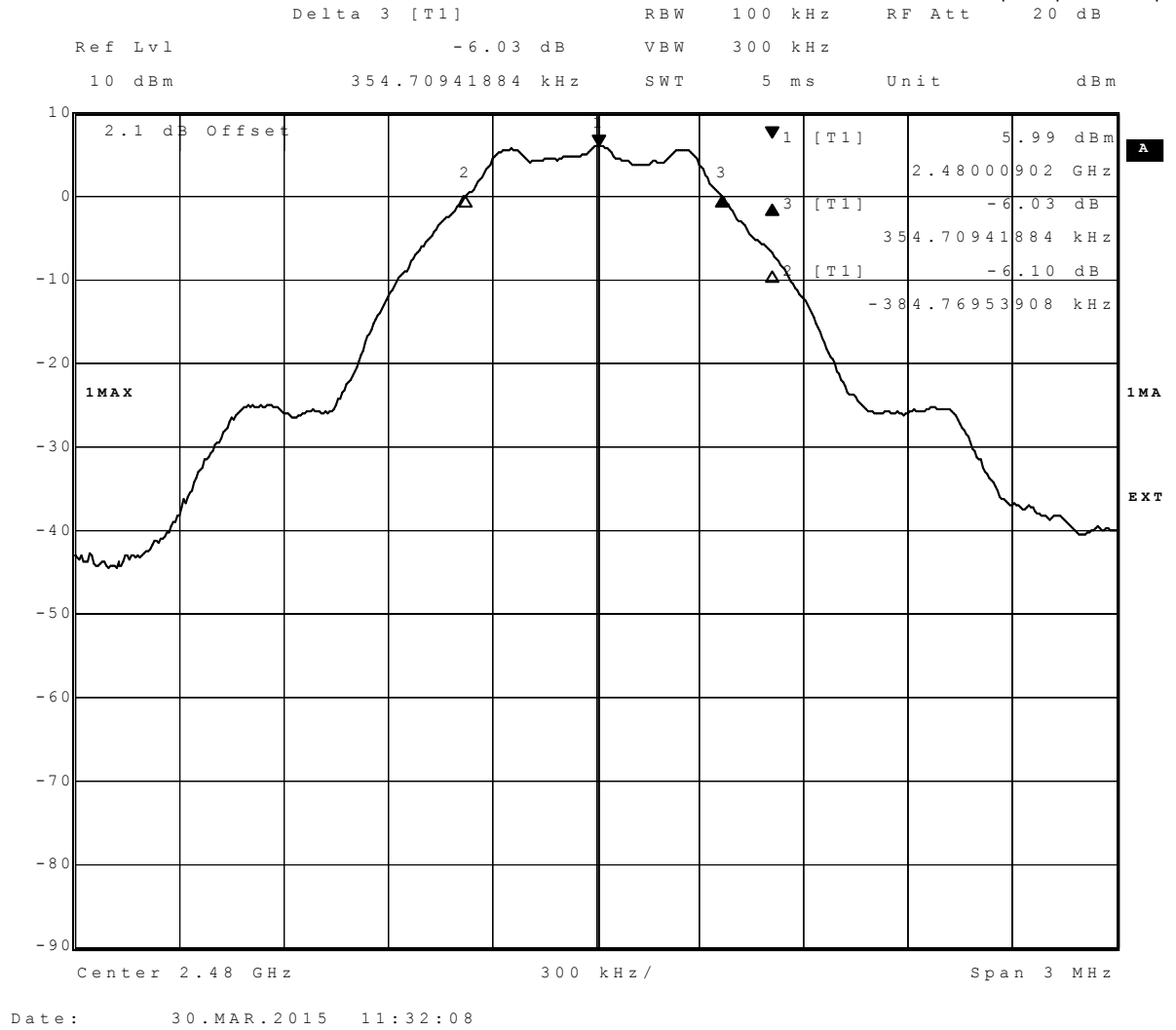
<i>Result:</i>	Passed
<i>Setup No.:</i>	S01_AA01
<i>Date of Test:</i>	2015/03/30 18:28
<i>Body:</i>	FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
<i>Test Specification:</i>	FCC part 2 and 15

Detailed Results:

Modulation	Frequency	6dB Bandwidth KHz
GFSK	2402 MHz	739.479
	2426 MHz	
	2440 MHz	733.467
	2480 MHz	739.479







3.5.3 15c.2 Spurious radiated emissions §15.247 (d), §15.35 (b), §15.209

Test: 15c.2 Spurious radiated emissions, highest channel, BT

Result: Passed

Setup No.: S02_AB01

Date of Test: 2015/04/07 13:46

Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209)					TX on 2480 MHz		1-DH1	
Frequency range 30 MHz - 1 GHz								
Ant. Polar.	Limit QPK [dBµV]	Frequency [MHz]	Corrected value QPK [dBµV]	Margin QPK [dB]	Result			
Ver + Hor					Passed			
Frequency range 1 GHz - 25 GHz								
Ant. Polar.	Limit PK [dBµV]	Limit AV [dBµV]	Frequency [MHz]	Corrected value PK [dBµV]	Corrected value AV [dBµV]	Margin PK [dB]	Margin AV [dB]	Result
Ver + Hor	74	54	2483	56.07	41.95	17.93	12.05	Passed
Ver + Hor	74	54	4960	45.52	32.40	28.48	21.60	Passed

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

Test: 15c.2 Spurious radiated emissions, lowest channel, BT

Result: Passed

Setup No.: S02_AB01

Date of Test: 2015/04/07 13:43

Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209)					TX on 2402 MHz		1-DH1	
Frequency range 30 MHz - 1 GHz								
Ant. Polar.	Limit QPK [dBµV]	Frequency [MHz]	Corrected value QPK [dBµV]	Margin QPK [dB]	Result			
Ver + Hor					Passed			
Frequency range 1 GHz - 25 GHz								
Ant. Polar.	Limit PK [dBµV]	Limit AV [dBµV]	Frequency [MHz]	Corrected value PK [dBµV]	Corrected value AV [dBµV]	Margin PK [dB]	Margin AV [dB]	Result
Ver + Hor	74	54						Passed

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

Test: 15c.2 Spurious radiated emissions, mid channel, BT

Result: Passed

Setup No.: S02_AB01

Date of Test: 2015/04/07 13:45

Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209)					TX on 2441 MHz		1-DH1	
Frequency range 9 kHz - 1 GHz								
Ant. Polar.	Limit QPK [dBµV]	Frequency [MHz]	Corrected value QPK [dBµV]	Margin QPK [dB]	Result			
Ver + Hor					Passed			
Frequency range 1 GHz - 25 GHz								
Ant. Polar.	Limit PK [dBµV]	Limit AV [dBµV]	Frequency [MHz]	Corrected value PK [dBµV]	Corrected value AV [dBµV]	Margin PK [dB]	Margin AV [dB]	Result
Ver + Hor	74	54	2480	52.47	44.14	21.53	9.86	Passed
Ver + Hor	74	54	4880	42.84	30.85	31.16	23.15	Passed

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

3.5.4 15c.4 Peak power output §15.247 (b) (3) (4)

Test: 15c.4; Peak power output Summary

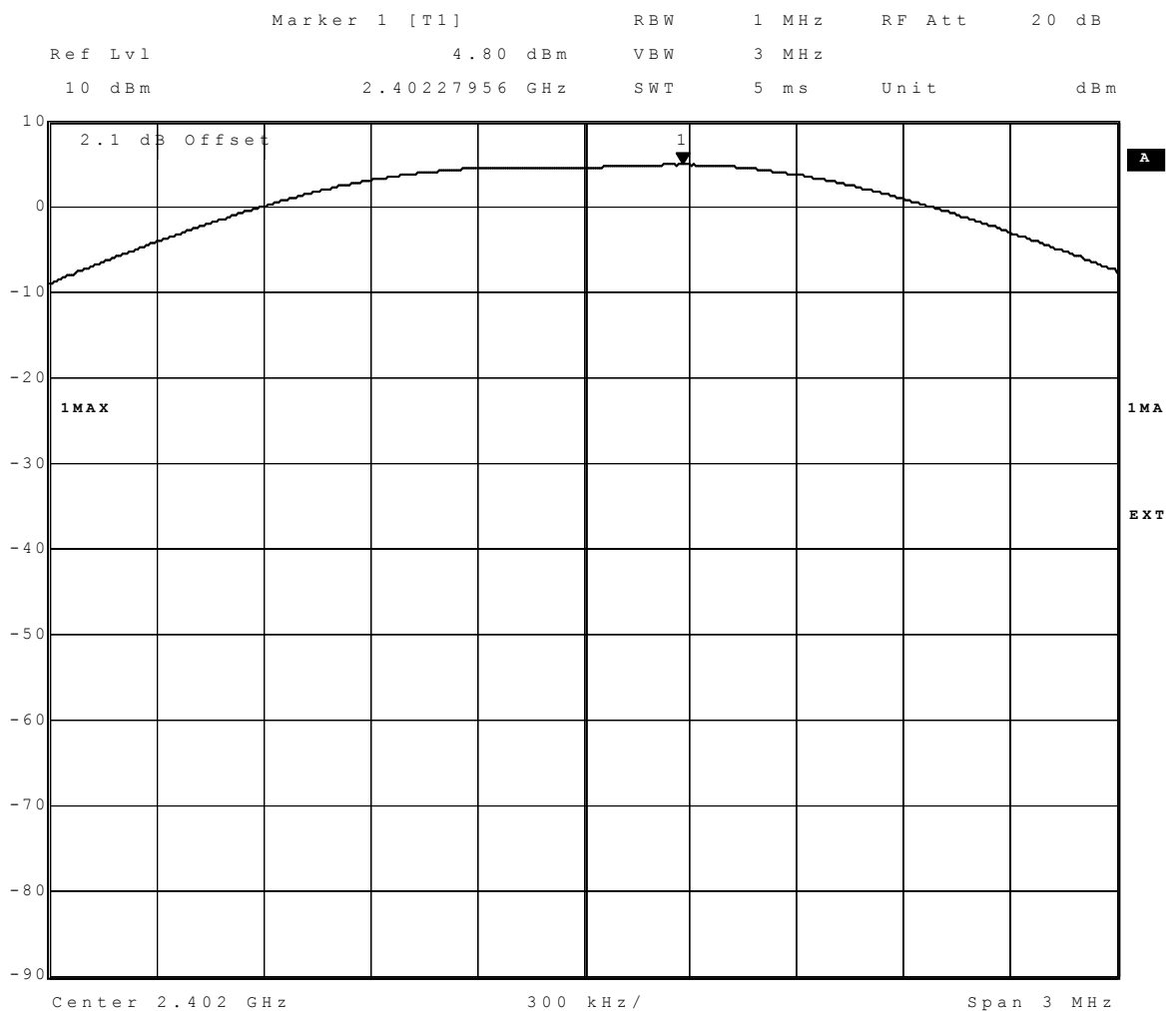
Result:	Passed
Setup No.:	S01_AA01
Date of Test:	2015/03/30 18:01
Body:	FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification:	FCC part 2 and 15

Detailed Results:

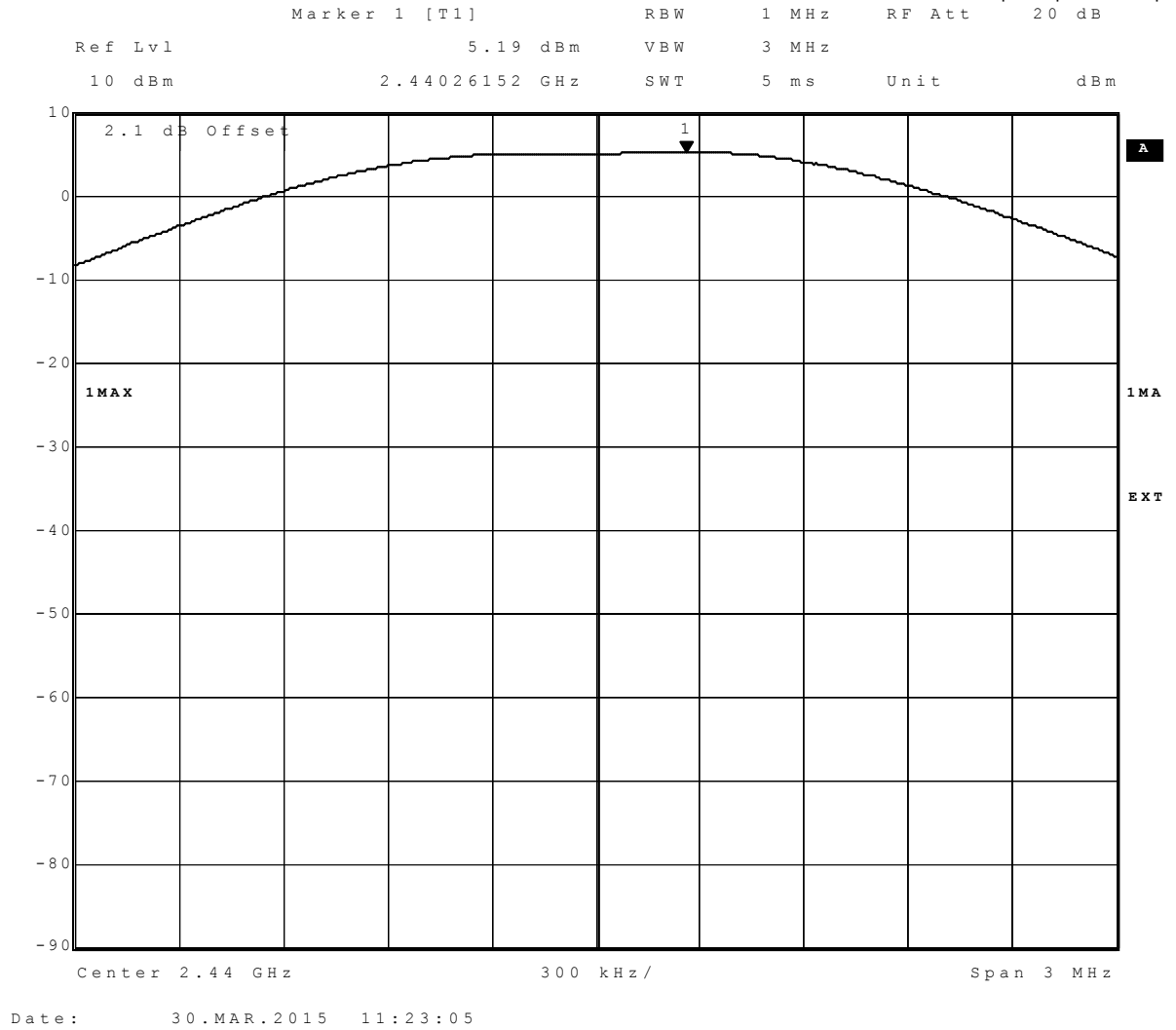
		Conducted Transmitter Power					
		2402 MHz		2440 MHz		2480 MHz	
Modulation	Conditions	Output Power (dBm)	Output Power (mW)	Output Power (dBm)	Output Power (mW)	Output Power (dBm)	Output Power (mW)
GFSK	TN, VN	4.80	3.02	5.19	3.30	6.41	4.38

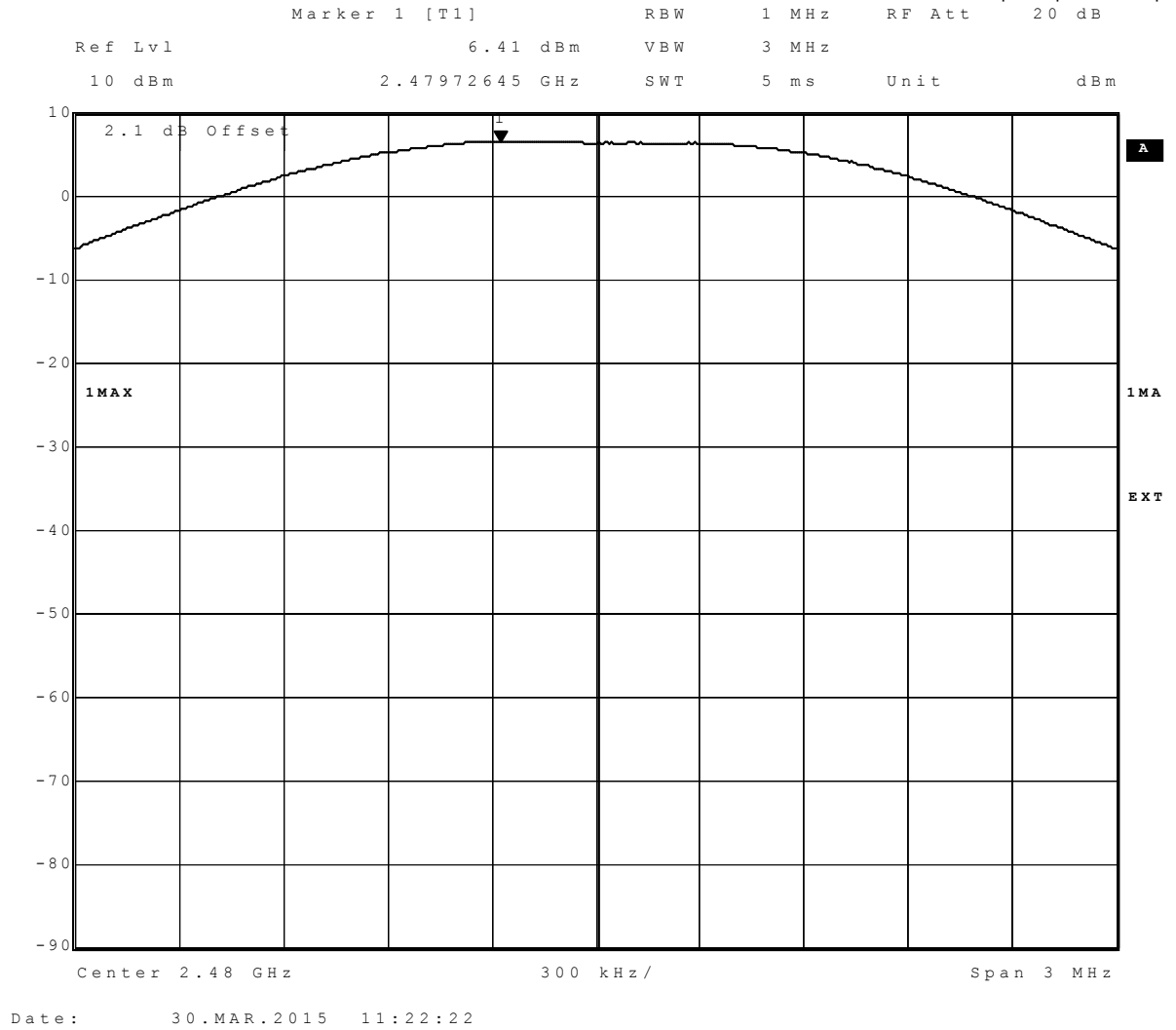
Max Conducted Output Power (FSK Modulation)	6.41	dBm	4.38	mW
EIRP Conducted	6.91	dBm	4.91	mW

Antena Gain (dBi)	0.5
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Date: 30.MAR.2015 11:23:46



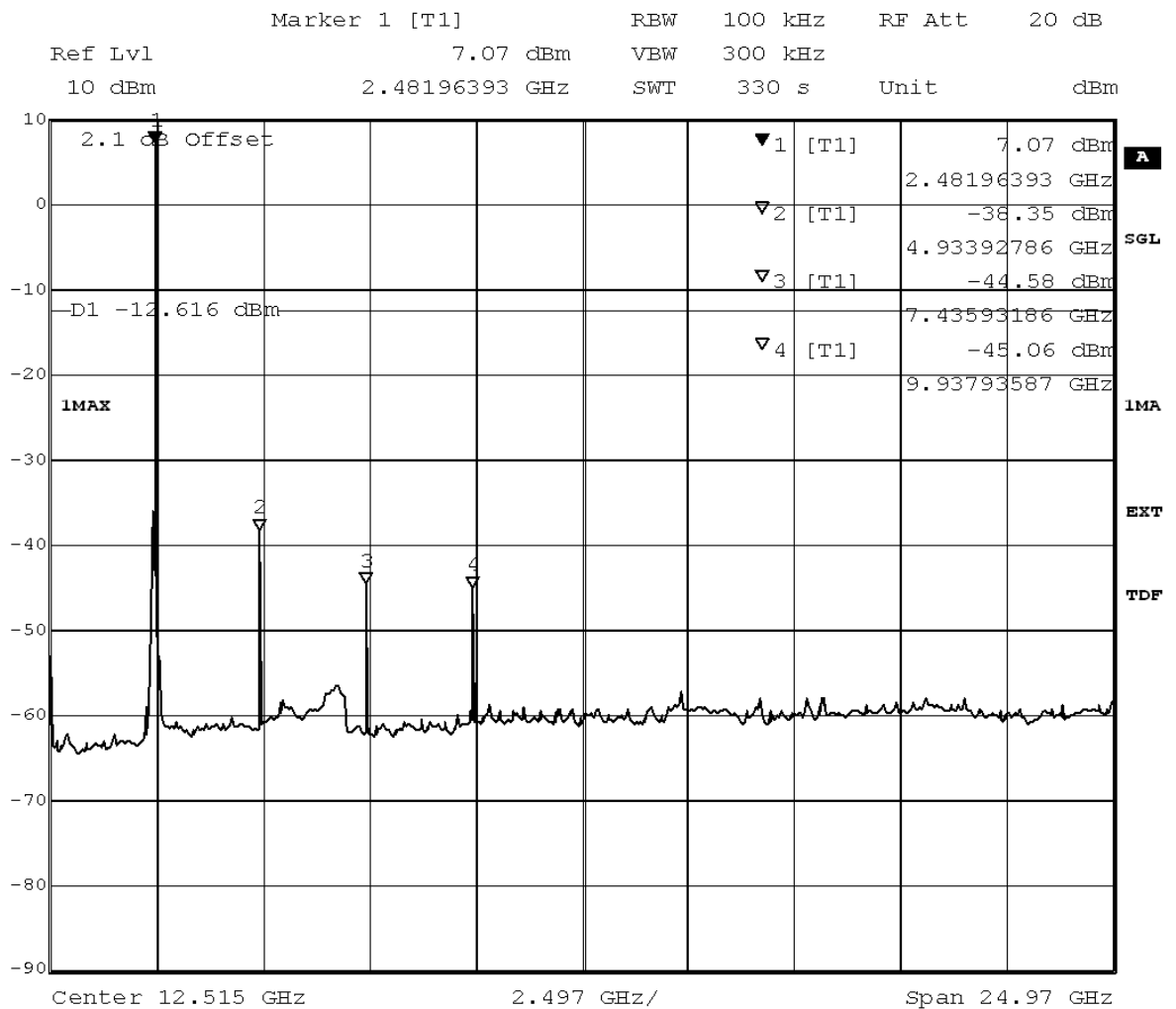


3.5.5 15c.5 Spurious RF conducted emissions §15.247 (d)

Test: 15c.5 Spurious RF conducted emissions, highest channel, BT

Result: Passed
Setup No.: S01_AA01
Date of Test: 2015/03/26 22:10
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

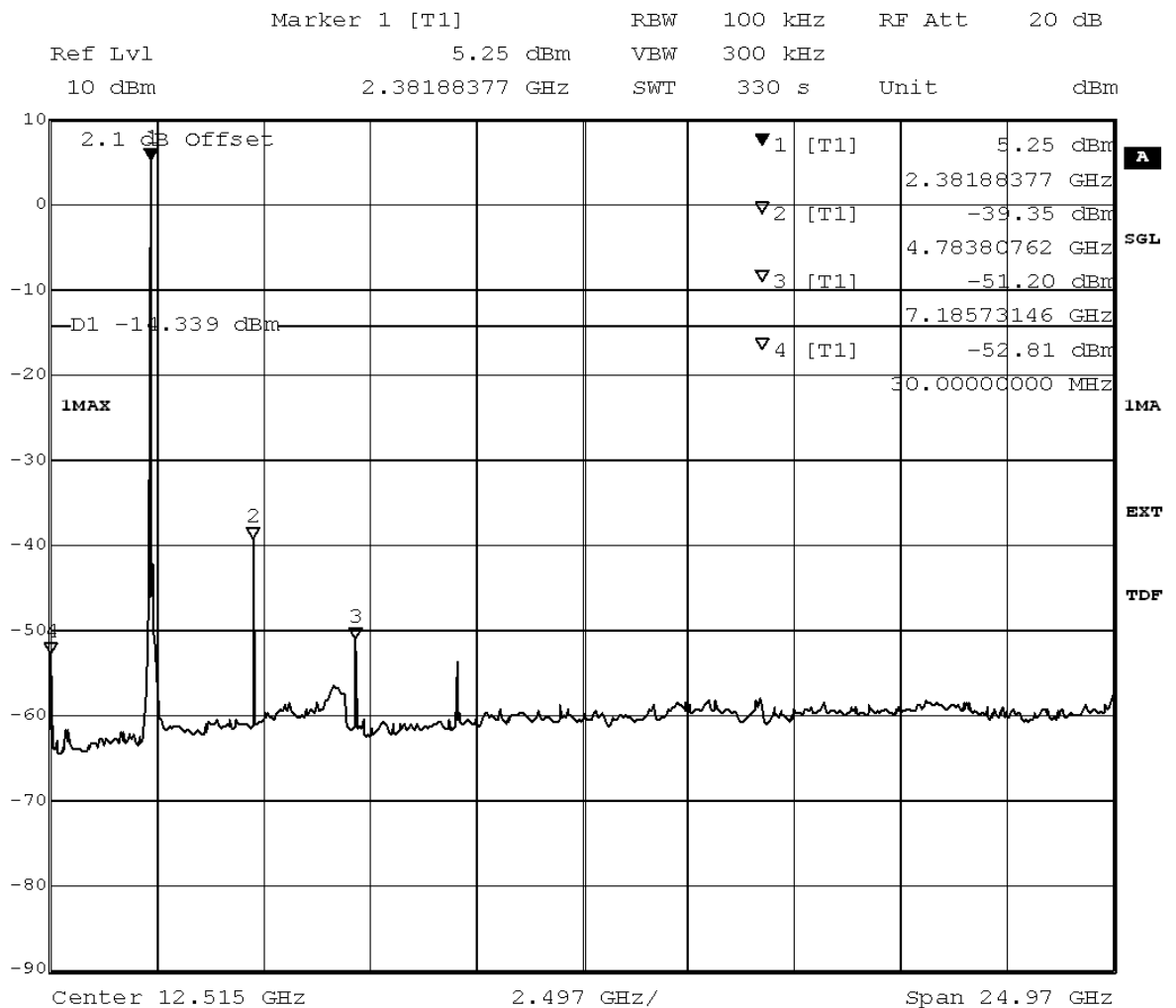


Title: spurious emissions
Comment A: CH T:2480 MHz
Date: 30.MAR.2015 11:10:05

Test: 15c.5 Spurious RF conducted emissions, lowest channel, BT

Result: Passed
Setup No.: S01_AA01
Date of Test: 2015/03/26 22:05
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

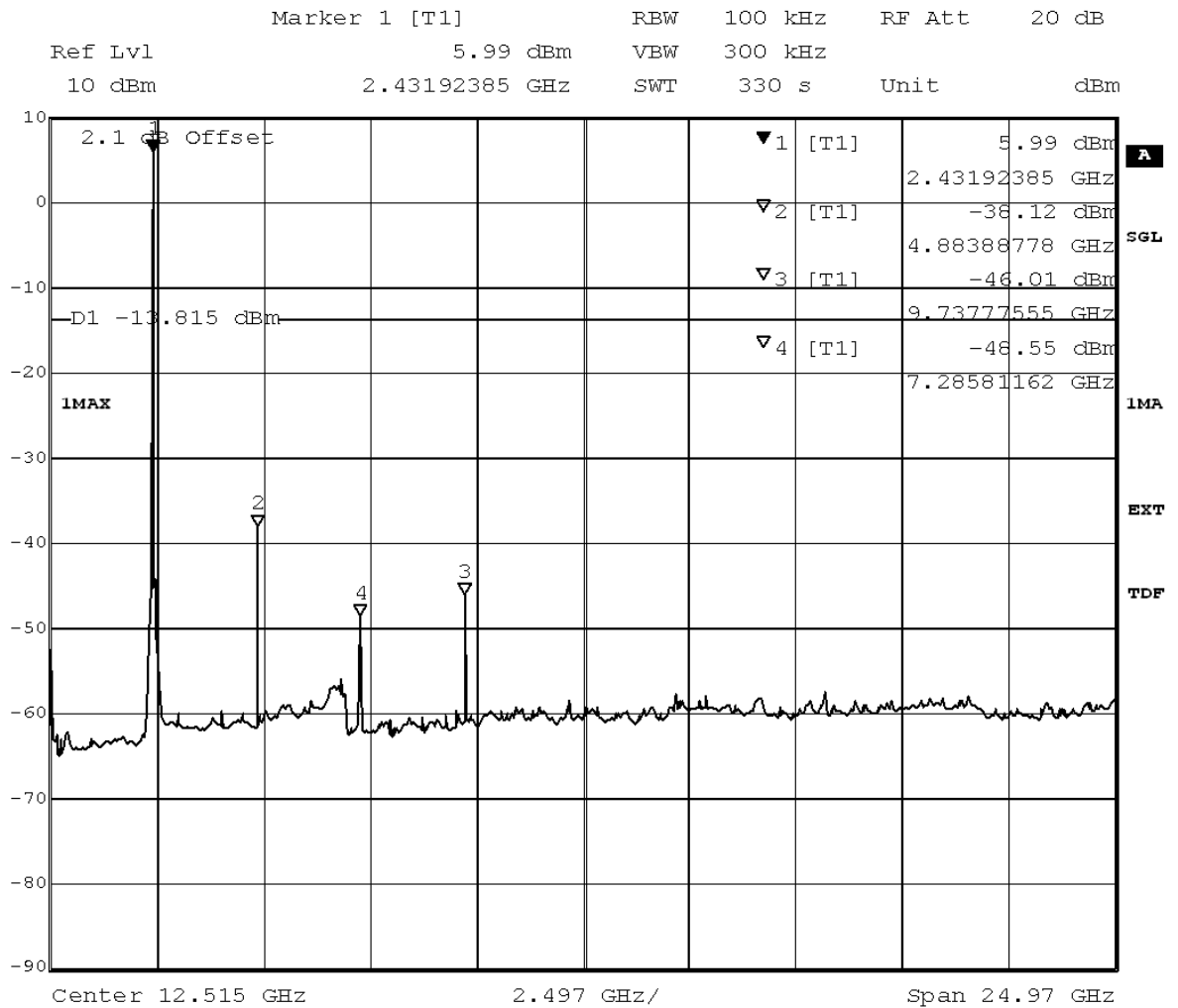


Title: spurious emissions
Comment A: CH B: 2402 MHz
Date: 26.MAR.2015 13:09:27

Test: 15c.5 Spurious RF conducted emissions, mid channel, BT

Result: Passed
Setup No.: S01_AA01
Date of Test: 2015/03/26 22:09
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:



Title: spurious emissions
Comment A: CH M2: 2440 MHz
Date: 26.MAR.2015 13:25:40

3.5.6 15c.6 Band edge compliance §15.247 (d)

Test: 15c.6 Band edge compliance, highest channel, BT

Result: Passed

Setup No.: S01_AA01

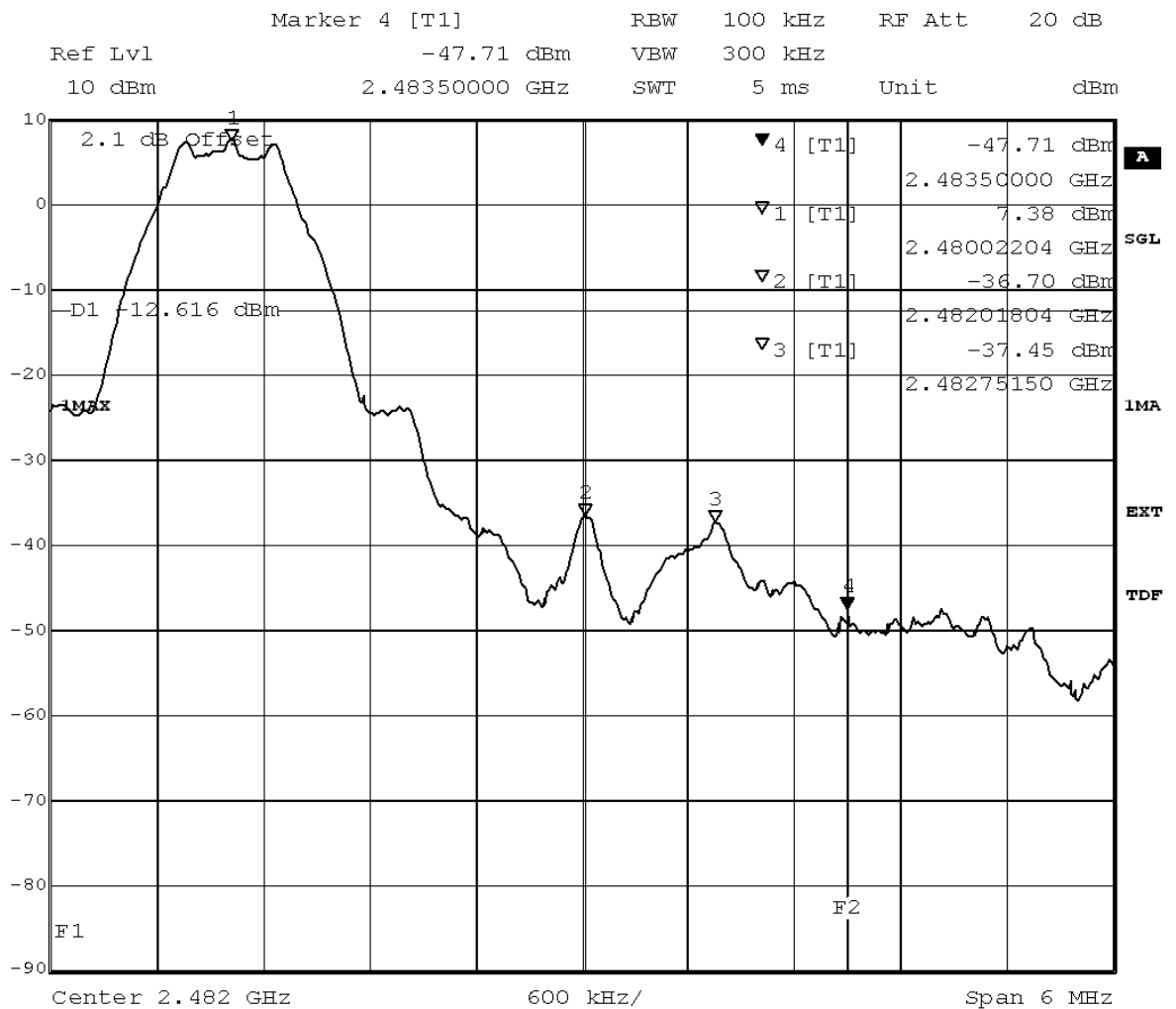
Date of Test: 2015/03/26 18:58

Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2484	-47.71	7.38	-12.62	35.09



Title: Band Edge Compliance

Comment A: CH T:2480 MHz

Date: 30.MAR.2015 10:58:09

Test: 15c.6 Band edge compliance, lowest channel, BT

Result: Passed

Setup No.: S01_AA01

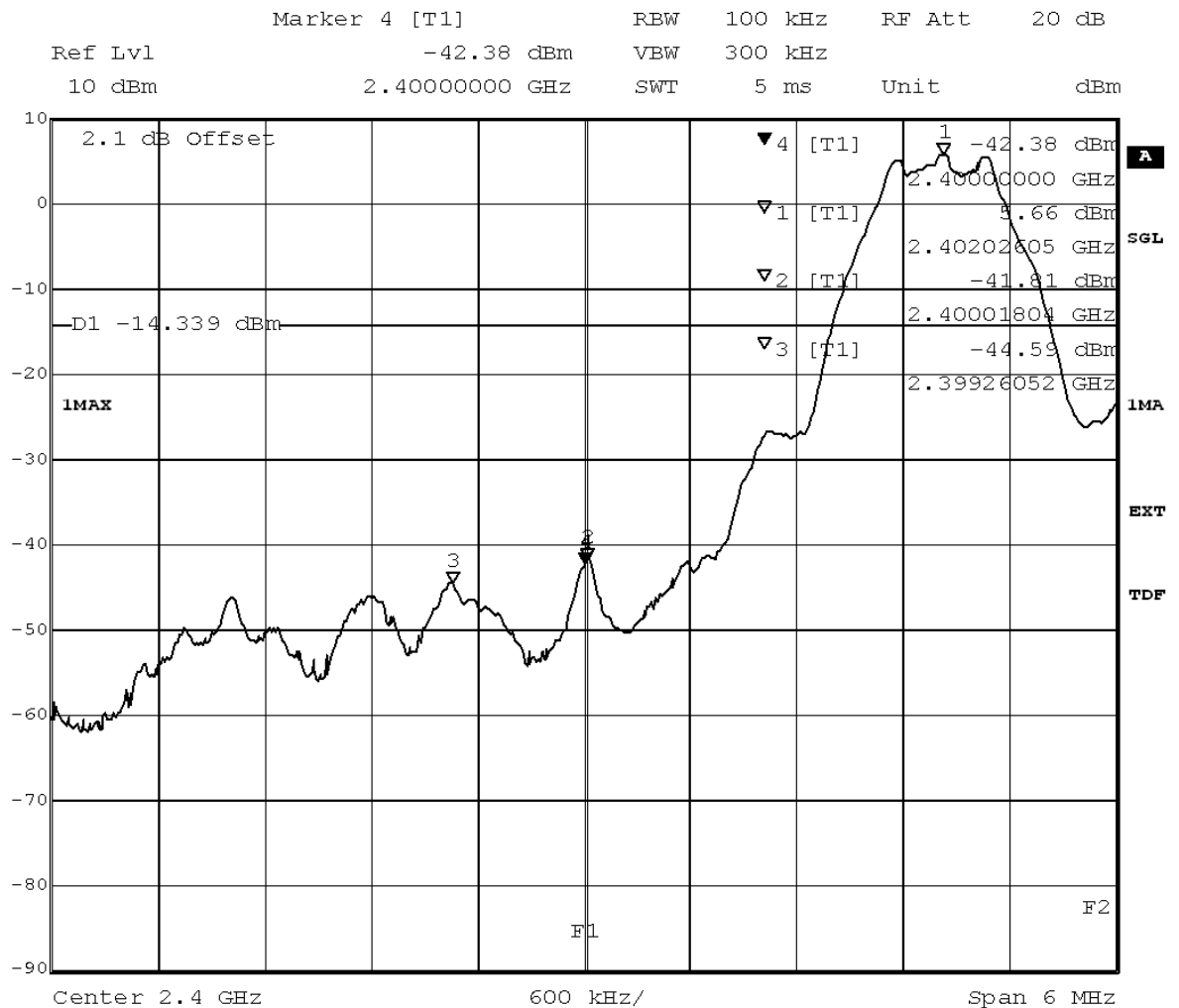
Date of Test: 2015/03/26 18:57

Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2400	-42.38	5.66	-14.34	28.04



Title: Band Edge Compliance

Comment A: CH B: 2402 MHz

Date: 26.MAR.2015 12:57:29

Test: 15c.6; Frequency = 2480, Mode = Bluetooth Low Energy

Result: Passed

Setup No.: S02_AB01

Date of Test: 2015/04/16 18:35

Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

TX on	Ant. Polar.	Limit PK [dBμV]	Limit AV [dBμV]	Frequency [MHz]	Corrected value PK [dBμV]	Corrected value AV [dBμV]	Margin PK [dB]	Margin AV [dB]	Result
2480 MHz	Ver + Hor	74	54	2483.5	56.07	41.95	17.93	12.05	Passed

4 Test Equipment Details

4.1 List of Used Test Equipment

The hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	Lab 1
Manufacturer:	Frankonia
Description:	Anechoic Chamber for radiated testing
Type:	10.58x6.38x6.00 m ³

Single Devices for Anechoic Chamber

Single Device Name	Type	Serial Number	Manufacturer
Air compressor	none	-	Atlas Copco
Anechoic Chamber	10.58 x 6.38 x 6.00 m ³	none	Frankonia
Controller Maturo	MCU	961208	Maturo GmbH
EMC camera	CE-CAM/1	-	CE-SYS
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi
Filter ISDN	B84312-C110-E1		Siemens&Matsushita
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita

Test Equipment Auxiliary Equipment for Radiated emissions

Lab ID:	Lab 1
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

Single Device Name	Type	Serial Number	Manufacturer
Antenna mast	AM 4.0	AM4.0/180/11920 513	Maturo GmbH
Biconical Broadband Antenna	SBA 9119	9119-005	Schwarzbeck Mess-Elektronik OHG
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck Mess-Elektronik OHG
Broadband Amplifier 1 GHz - 4 GHz	AFS4-01000400-1Q-10P-4	-	Miteq
Broadband Amplifier 18 GHz - 26 GHz	JS4-18002600-32-5P	849785	Miteq
Broadband Amplifier 30 MHz - 18 GHz	JS4-00101800-35-5P	896037	Miteq
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01- 2+W38.01-2	Kabel Kusch
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02- 2+W38.02-2	Rosenberger Micro-Coax
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG
Double-ridged horn- duplicated 2015-07- 15 10:47:55	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

<i>Single Device Name</i>	<i>Type</i>	<i>Serial Number</i>	<i>Manufacturer</i>
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic
High Pass Filter	5HC3500/18000-1.2-KK	200035008	Trilithic
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright
Horn Antenna Schwarzbeck 15-26.5 GHz BBHA 9170	BBHA 9170	BBHA9170262	Schwarzbeck Mess- Elektronik OHG
Log.-per. Antenna	HL 562 Ultralog	100609	Rohde & Schwarz GmbH & Co. KG
Log.-per. Antenna (upgraded)	HL 562 Ultralog new refelector	830547/003	Rohde & Schwarz GmbH & Co. KG
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG
Standard Gain / Pyramidal Horn Antenna 26.5 GHz	3160-09	00083069	EMCO Elektronik GmbH
Standard Gain / Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5- 10kg/024/379070 9	Maturo GmbH

Test Equipment Auxiliary Test Equipment

Lab ID:	Lab 1
<i>Manufacturer:</i>	see single devices
<i>Description:</i>	Single Devices for various Test Equipment
<i>Type:</i>	various
<i>Serial Number:</i>	none

Single Devices for Auxiliary Test Equipment

<i>Single Device Name</i>	<i>Type</i>	<i>Serial Number</i>	<i>Manufacturer</i>
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorenwerke GmbH
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright
Signal Analyzer	FSV30	103005	Rohde & Schwarz GmbH & Co. KG
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG
Spectrum Analyser	FSU26	200418	Rohde & Schwarz GmbH & Co.KG
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID:

Lab 1

Description:

Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	Type	Serial Number	Manufacturer	
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG	
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
		<i>HW/SW Status</i>	<i>Date of Start</i>	<i>Date of End</i>
		Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---	2007/07/16	
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG	
		<i>HW/SW Status</i>	<i>Date of Start</i>	<i>Date of End</i>
		HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 --- SW: K62, K69	2007/01/02	
Vector Signal Generator	SMU200A	100912	Rohde & Schwarz GmbH & Co. KG	
			2008/11/03	

Test Equipment Emission measurement devices

Lab ID: **Lab 1**
Description: Equipment for emission measurements
Serial Number: see single devices

Single Devices for Emission measurement devices

Single Device Name	Type	Serial Number	Manufacturer
EMI Receiver / Spectrum Analyser	ESR 7	101424	Rohde & Schwarz
Personal Computer	Dell	30304832059	Dell
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG
Spectrum Analyser	FSW 43	103779	Rohde & Schwarz
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG
<i>HW/SW Status</i>			<i>Date of Start</i> <i>Date of End</i>
Firmware-Update 4.34.4 from 3.45 during calibration			2009/12/03

Test Equipment Multimeter 03

Lab ID: **Lab 1**
Description: Fluke 177
Serial Number: 86670383

Single Devices for Multimeter 03

Single Device Name	Type	Serial Number	Manufacturer
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.

Test Equipment Multimeter 12

Lab ID: **Lab 2**
Description: Ex-Tech 520
Serial Number: 05157876

Single Devices for Multimeter 12

Single Device Name	Type	Serial Number	Manufacturer
Digital Multimeter 12 (Multimeter)	EX520	05157876	Extech Instruments Corp.

Test Equipment Regulatory Bluetooth RF Test Solution

Lab ID: Lab 2
Description: Regulatory Bluetooth RF Tests
Type: Bluetooth RF
Serial Number: 001

Single Devices for Regulatory Bluetooth RF Test Solution

Single Device Name	Type	Serial Number	Manufacturer
ADU 200 Relay Box 7	Relay Box	A04380	Ontrak Control Systems Inc.
Bluetooth Signalling Unit CBT	CBT	100302	Rohde & Schwarz GmbH & Co.KG
Power Meter NRVD	NRVD	832025/059	
Power Sensor NRV Z1 A	PROBE	832279/013	
Power Supply	NGSM 32/10	2725	
Rubidium Frequency Normal MFS	Datum MFS	002	Datum GmbH
Signal Analyser FSIQ26	1119.6001.26	832695/007	Rohde & Schwarz GmbH & Co.KG
Vector Signal Generator SMIQ03B	SMIQ03B	832870/017	

Test Equipment Shielded Room 07

Lab ID: Lab 2
Description: Shielded Room 4m x 6m

Test Equipment T/A Logger 13

Lab ID: Lab 1
Description: Lufft Opus10 TPR
Type: Opus10 TPR
Serial Number: 13936

Single Devices for T/A Logger 13

Single Device Name	Type	Serial Number	Manufacturer
ThermoAirpressure Datalogger 13 (Environ)	Opus10 TPR (8253.00)	13936	Lufft Mess- und Regeltechnik GmbH

Test Equipment T/H Logger 12

Lab ID: Lab 1
Description: Lufft Opus10
Serial Number: 12482

Single Devices for T/H Logger 12

Single Device Name	Type	Serial Number	Manufacturer
ThermoHygro Datalogger 12 (Environ)	Opus10 THI (8152.00)	12482	Lufft Mess- und Regeltechnik GmbH

Test Equipment T/H Logger 15

Lab ID: Lab 2
Description: Lufft Opus10
Serial Number: 13985

Single Devices for T/H Logger 15

Single Device Name	Type	Serial Number	Manufacturer
ThermoHygro Datalogger 15 (Environ)	Opus10 THI (8152.00)	13985	Lufft Mess- und Regeltechnik GmbH

Test Equipment Temperature Chamber 01

Lab ID: Lab 2
Manufacturer: see single devices
Description: Temperature Chamber KWP 120/70
Type: Weiss
Serial Number: see single devices

Single Devices for Temperature Chamber 01

Single Device Name	Type	Serial Number	Manufacturer
Temperature Chamber Weiss 01	KWP 120/70	59226012190010	Weiss Umwelttechnik GmbH

5 Annex

5.1 Additional Information for Report

Summary of Test Results

The EUT complied with all performed tests as listed in the summary section of this report.

Technical Report Summary

Type of Authorization :

Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15. The following subparts are applicable to the results in this test report:

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C - Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

Additional documents

The tests were selected and performed with reference to the FCC Public Notice "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, 558074 D01 DTS Meas Guidance v03r03, 2015-06-09".

ANSI C63.10-2013 is applied.

***** FCC and IC Correlation of measurement requirements *****

The following table shows the correlation of measurement requirements for FHSS equipment (e.g. Bluetooth) from FCC and IC Standards.

Measurement	FCC reference	IC reference
Conducted emissions on AC mains	§ 15.207	RSS-Gen Issue 4: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-210 Issue 8: A8.2 (a)
Peak power output	§ 15.247 (b) (3),(4)	RSS-210 Issue 8: A8.4 (4)
Spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13/8.9/8.10; RSS-210 Issue 8: A8.5
Spurious radiated emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-210 Issue 8: A8.5
Band edge compliance	§ 15.247 (e)	RSS-210 Issue 8: A8.2 (b)
Power Density	§ 15.247 (a)(1)(iii)	RSS-210 Issue 8: A8.1 (d)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	- - -	RSS-210 Issue 8: 2.3; RSS Gen Issue 4: 5 / 7 *)

*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30-960 MHz or if these are scanner receivers.

Description of Methods of Measurements

Conducted emissions (AC power line)

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10,

Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.10.

The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50 μ H || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads. The measurement procedure consists of two steps. It is implemented into the EMI test software ES-K1 from R&S.

Step 1: Preliminary scan

Intention of this step is, to determine the conducted EMI-profile of the EUT.

EMI receiver settings:

- Detector: Peak - Maxhold
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF-Bandwidth: 9 kHz
- Measuring time / Frequency step: 20 ms
- Measurement on phase + neutral lines of the power cords.

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement

Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.

EMI receiver settings:

- Detector: Quasi-Peak
- IF - Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:

- 1) Neutral lead - reference ground (PE grounded)
- 2) Phase lead - reference ground (PE grounded)
- 3) Neutral lead - reference ground (PE floating)
- 4) Phase lead - reference ground (PE floating)

The highest value is reported.

Test Requirements / Limits

FCC Part 15, Subpart C, §15.207

Frequency Range (MHz)	QP Limit (dB μ V)	AV Limit (dB μ V)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

Used conversion factor: Limit (dB μ V) = 20 log (Limit (μ V)/1 μ V).

Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements. The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 3
- Detector: Peak / Sample (6 dB bandwidth / 99% bandwidth)

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (2)

Systems using digital modulation techniques may operate in the 902-928 MHz and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Used conversion factor: Output power (dBm) = $10 \log (\text{Output power (W)} / 1\text{mW})$

Peak power output

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT. The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Detector: Peak

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (b) (3)

For systems using digital modulation techniques in the 902-928 MHz and 2400-2483.5 MHz bands: 1 watt.

=> Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).

Used conversion factor: Limit (dBm) = $10 \log (\text{Limit (W)}/1\text{mW})$

Spurious RF conducted emissions

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Detector: Peak-Maxhold
- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: 330 s

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance" (cf. chapter 3.6). This value is used to calculate the 20 dBc limit.

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (c)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10,

Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration.

The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

The measurement procedure is implemented into the EMI test software ES-K1 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT.

The final test on all kind of EUTs is performed at 2 axes. A pre-check is also performed while the EUT is powered from both AC and DC (battery) power in order to find the worst-case operating condition.

1. Measurement up to 30 MHz

The Loop antenna HFH2-Z2 is used.

Step 1: pre-measurement

- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 – 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF-Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: final measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.

- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF-Bandwidth: 200 Hz – 10 kHz
- Measuring time / Frequency step: 100 ms

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan

Preliminary test to identify the highest amplitudes relative to the limit.

Settings for step 1:

- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 μ s (BT Timing 1.25 ms)
- Turntable angle range: -180 to $+180^\circ$
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: second measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: -180 to $+180^\circ$
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will be slowly varied by $\pm 22.5^\circ$ around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by ± 25 cm around the antenna height determined. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: -22.5° to $+22.5^\circ$ around the determined value
- Height variation range: -0.25 m to $+0.25$ m around the determined value

Step 4: final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:

- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

The measurement distance was reduced to 1.4 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a standard gain horn antenna (18–25 GHz) are used, the steps 2–4 are omitted. Step 1 was performed with one height of the receiving antenna only.

EMI receiver settings:

- Detector: Peak, Average
- IF Bandwidth = 1 MHz

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.
For the enhanced data rate packets the test is performed as worst-case-check in order to verify that emissions have a comparable level as found at basic data rate. Typically, the measurement for these packets is performed in the frequency range 1 to 8 GHz but it depends on the emissions found during the test for the basic data rate. Please refer to the results for the used frequency range.

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (d)

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

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency (MHz)	Limit (μV/m)	Measurement distance (m)	Limit @ 10 m distance (dBμV/m)
0.009 – 0.49	2400/F(kHz)	300	48.5..13.8 + 59.1 dB = 107.6..72.9
0.49 – 1.705	24000/F(kHz)	30	33.8..23.0 + 19.1 dB = 52.9..42.1
1.705 – 30	30	30	29.5 + 19.1 = 48.6

Frequency (MHz)	Limit (μV/m)	Measurement distance (m)	Limit (dBμV/m)
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
above 960	500	3	54.0

§15.35(b)

..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit...

Used conversion factor: Limit (dBμV/m) = 20 log (Limit (μV/m)/1μV/m)

Band edge compliance

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10, FCC §15.31

Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements:

1. Show compliance of the lower band edge by a conducted measurement and
2. show compliance of the higher band edge by a radiated and conducted measurement.

For the first measurement the EUT is set to transmit on the lowest channel (2402 MHz). The lower band edge is 2400 MHz.

Analyzer settings:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

For the second measurement the EUT is set to transmit on the highest channel (2480 MHz). The higher band edge is 2483.5 MHz.

Analyzer settings for conducted measurement:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

EMI receiver settings for radiated measurement:

- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Test Requirements / Limits

FCC Part 15.247 (d)

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

...

Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c))."

For the measurement of the lower band edge the RF power at the band edge shall be "at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power..."

For the measurement of the higher band edge the limit is "specified in Section 15.209(a)".

Power Density

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Detector: Peak-Maxhold
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

Test Requirements / Limits

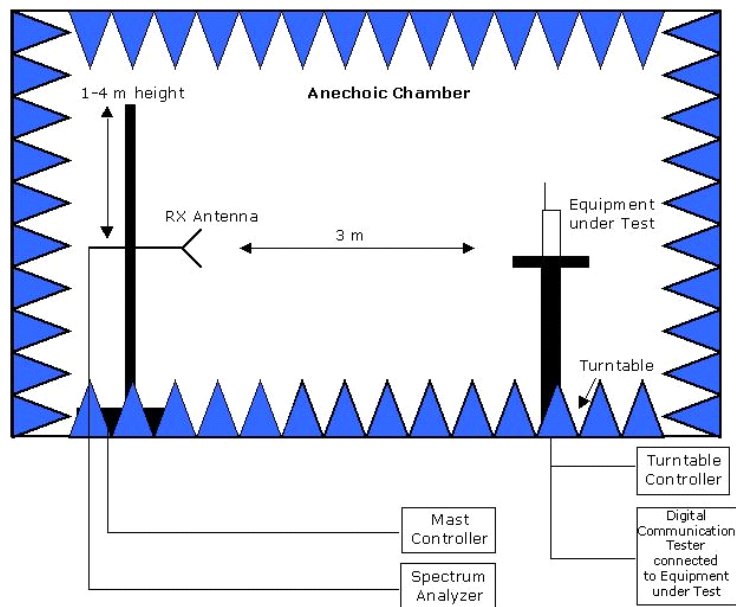
FCC Part 15, Subpart C, §15.247 (e)

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

...

The same method of determining the conducted output power shall be used to determine the power spectral density.

Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces

November, 2014

To Whom This May Concern

**Correlation of measurement requirements for
DTS (e.g. WLAN 2.4 GHz, BT LE) equipment
from
FCC and IC**

DTS equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-210 Issue 8: A8.2 (a)
Peak conducted output power	§ 15.247 (b) (3), (4)	RSS-210 Issue 8: A8.4 (4)
Transmitter spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-210 Issue 8: A8.5
Transmitter spurious radiated emissions	§ 15.247 (d); § 15.209 (a)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-210 Issue 8: A8.5
Band edge compliance	§ 15.247 (d)	RSS-210 Issue 8: A8.5
Power density	§ 15.247 (e)	RSS-210 Issue 8: A8.2 (b)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	RSS-210 Issue 8: 2.3 RSS Gen Issue 4: 5 / 7 *)

*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30–960 MHz or if these are scanner receivers.

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