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Precisely Right.

Test Report No.:	**14103002.fcc01**		*Page 1 of 34*
Client:	**Tacx b.v.** Rijksstraatweg 52, 2241BW Wassenaar, Netherlands		
Test Item:	**Digital Transmission System (DTS)** **ANT**		
Identification:	**T2780 Bushido**	*Serial Number:*	**84140602 (conducted tests) and 84146420 (radiated tests)**
Project No.:	**14103002**	*Date of Receipt:*	**January 23, 2015**
Testing Location:	**TÜV Rheinland Nederland B.V.** Eiberkamp 10 9351VT Leek		
Test Specification:	FCC 47 CFR Part 15, Subpart C, Section 15.247 (10-1-13 Edition) ANSI C63.10-2009 KDB Publication No. 558074 D01 V3.02: Measurement of Digital Transmission Systems Operating under Section 15.247 (06/05/14)		
Test Result:	*The test item **passed** the test specification(s).*		
Testing Laboratory:	**TÜV Rheinland Nederland B.V.** Eiberkamp 10 9351 VT Leek		

Tested by:			*Reviewed by:*		
2015-02-11	R. van der Meer / Inspector		2015-02-11	P. de Beer / Reviewer	
Date	*Name/Position*	*Signature*	*Date*	*Name/Position*	*Signature*

Other Aspects:-.

Abbreviations:

P(ass)	=	***passed***
F(ail)	=	***failed***
N/A	=	***not applicable***
N/T	=	***not tested***

TEST SUMMARY

5.1.1 CONDUCTED MEASUREMENTS AT ANTENNA PORT
RESULT: PASS

5.1.2 6DB BANDWIDTH
RESULT: PASS

5.1.3 PEAK POWER SPECTRAL DENSITY
RESULT: PASS

5.1.4 BAND EDGE CONDUCTED EMISSIONS
RESULT: Pass

5.1.5 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER
RESULT: PASS

5.1.6 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER IN RESTRICTED BANDS
RESULT: PASS

5.2.1 AC POWER LINE CONDUCTED EMISSION OF TRANSMITTER
RESULT: Not Applicable

Contents

1. General Remarks

1.1 Complementary Materials

There is no attachment to this test report.

2. Test Sites

2.1 Test Facilities

The Federal Communications Commission and Industry Canada has reviewed the technical characteristics of the test facilities at TÜV Rheinland Nederland B.V., located in Leek, 9351VT Eiberkamp 10, The Netherlands, and has found these test facilities to be in compliance with the requirements of 47 CFR Part 15, section 2.948.

The description of the test facilities has been filed at the Office of the Federal Communications Commission under registration number 90828. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

The description of the test facilities has been filed to Industry Canada under registration number 2932G-2. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

Normal test conditions:

Temperature (*) : +15°C to +35°C
Relative humidity(*) : 20 % to 75 %
Supply voltage : Not Applicable, EUT is not operable on AC mains voltage.

When it was impracticable to carry out the tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests are stated separately.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Inventory number	Calibration date (mm/yyyy)	Calibration due date (mm/yyyy)
For Antenna Port Conducted Emissions					
Temperature-Humiditymeter	Extech	SD500	A00446	03/2014	03/2015
Spectrum Analyzer	Rohde & Schwarz	FSV	A00337	08/2014	08/2015
RF Cable	H+S	Secuflex	A00347	04/2014	04/2015
For Radiated Emissions					
Measurement Receiver	Rohde & Schwarz	ESCI	A00314	03/2014	03/2015
RF Cable S-AR	Gigalink	APG0500	A00447	01/2014	01/2015
Controller	Maturo	SCU/088/ 8090811	A00450	N/A	N/A
Controller	EMCS	DOC202	A00257	N/A	N/A
Test facility	Comtest	FCC listed: 90828 IC: 2932G-2	A00235	04/2014	04/2017
Spectrum Analyzer	Rohde & Schwarz	FSV	A00337	08/2014	08/2015
Antenna mast	EMCS	AP-4702C	A00258	N/A	N/A
Temperature-Humiditymeter	Extech	SD500	A00444	03/2014	03/2015
Guidehorn 1-18 GHz	EMCO	3115	A00009	04/2014	04/2015
Guidehorn 18-40 GHz	EMCO	RA42-K-F-4B-C	A00012	04/2014	04/2015
Biconilog Testantenna	Teseq	CBL 6111D	A00466	06/2014	06/2015
2.4 GHz bandreject filter	BSC	XN-1783	A00065	N/A	N/A
Bandpass filter 4-10 GHz	Reactel	7AS-7G-6G-511	A00131	N/A	N/A
Bandpass filter 10-26 GHz	Reactel	9HS-10G/26.5G-S11	A00151	N/A	N/A
Preamplifier 0.5 - 18 GHz	Miteq	AMF-5D-005180-28-13p	A00247	N/A	N/A
Filterbox	EMCS	RFS06S	A00255	08/2014	08/2015

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025:2005 has been confirmed before testing. NA= Not Applicable

2.3 Measurement Uncertainty

Table 2: Emission Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
Antenna Port Conducted Emission	< 1GHz	±0.5dB
	> 1GHz	±0.7dB
Radiated Emission	150kHz - 30MHz	±5.0dB
	30MHz - 1GHz	±5.0dB
	> 1GHz	±5.5dB

3. General Product Information

3.1 Product Function and Intended Use

The brand Tacx model T2780 Bushido, hereafter referred to as EUT, is a transmitter used in an Interactive Smart Trainer with Electric Motor Brake for bicycles to transmit performance data to PC, Tablet or smartphone. The transmitter will support and utilizes GFSK modulation techniques. Although the chip used is capable of multiple data-rates only 1 Mbps is used. The system also incorporates a BLE transceiver but both transmitters never transmit at the same time. The BLE transceiver is covered in a separate testreport.

The content of this report and measurement results have not been changed other than the way of presenting the data.

3.2 System Details

Details and an overview of the system and all of its components, as it has been tested, may be found below.

EUT	:	Digital Transmission System, ANT
Manufacturer	:	Tacx b.v.
Brand	:	Tacx
Model(s)	:	T2780 Bushido
Serial Number	:	841402602 (conducted tests) and 841406420 (radiated tests)
Voltage input rating	:	EUT is self-powered
Voltage output rating	:	--
Current input rating	:	--
Antenna	:	Internal, integrated on the PCB
Antenna Gain	:	+ 2dBi
Operating frequency	:	2403 MHz-2480 MHz.
Modulation	:	GFSK
Data-rate	:	1 Mbps
Remarks	:	n.a.

Table 3: Interfaces present on the EUT

There are no interface ports present on the EUT.

3.3 Countermeasures to achieve EMC Compliance

No additional measures were employed to achieve compliance.

4. Test Set-up and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of 47 CFR Part 15, Sections 15.31, 15.33, 15.35, 15.205, 15.207, 15.209, 15.247.

The test methods, which have been used, are based on KDB 558074 D01 and ANSI C63.10-2009**.**

For details, see under each test item.

4.2 Operation Modes

Testing was performed at the lowest operating frequency (2403 MHz), at the operating frequency in the middle of the specified frequency band (2442 MHz) and at the highest operating frequency (2480 MHz). These operation modes were selected after review of the capabilities and characteristics of the EUT. The test software as mentioned in section 4.4 enabled the settings of these modes.

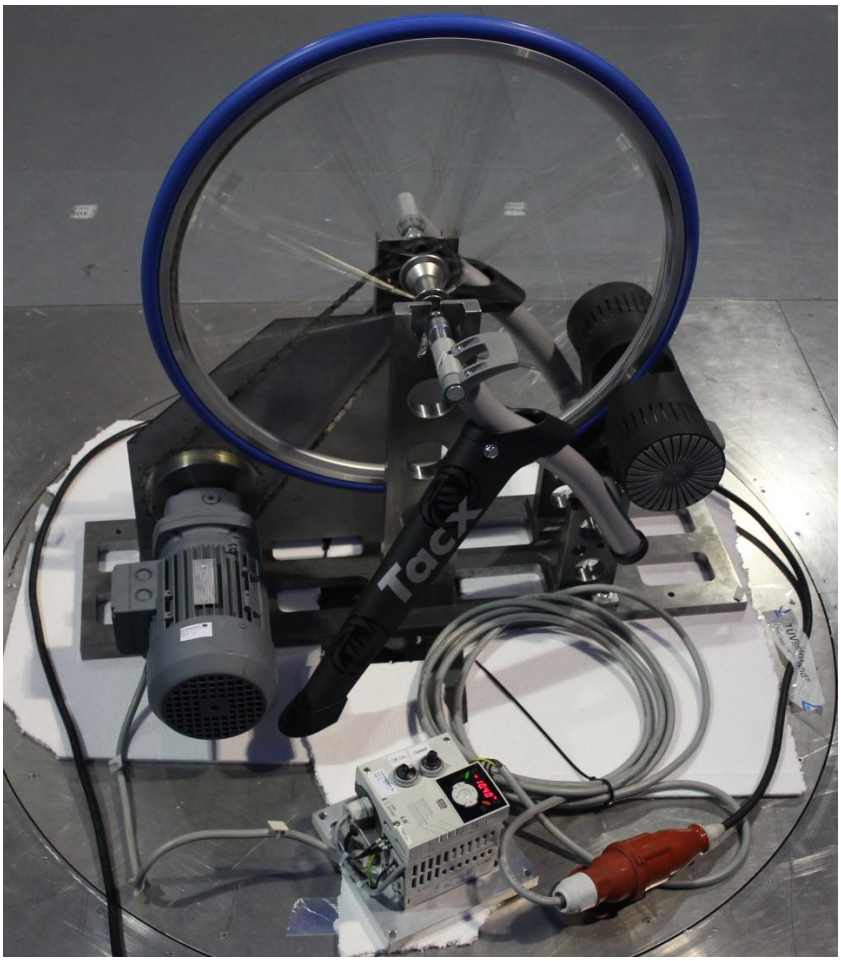
The EUT has been tested in the modes as described in table below

Operation Mode	EUT Status	Frequency (MHz)	TX power
Transmit (Tx)	On	2403	0
Transmit (Tx)	On	2442	0
Transmit (Tx)	On	2480	0

4.3 Physical Configuration for Testing

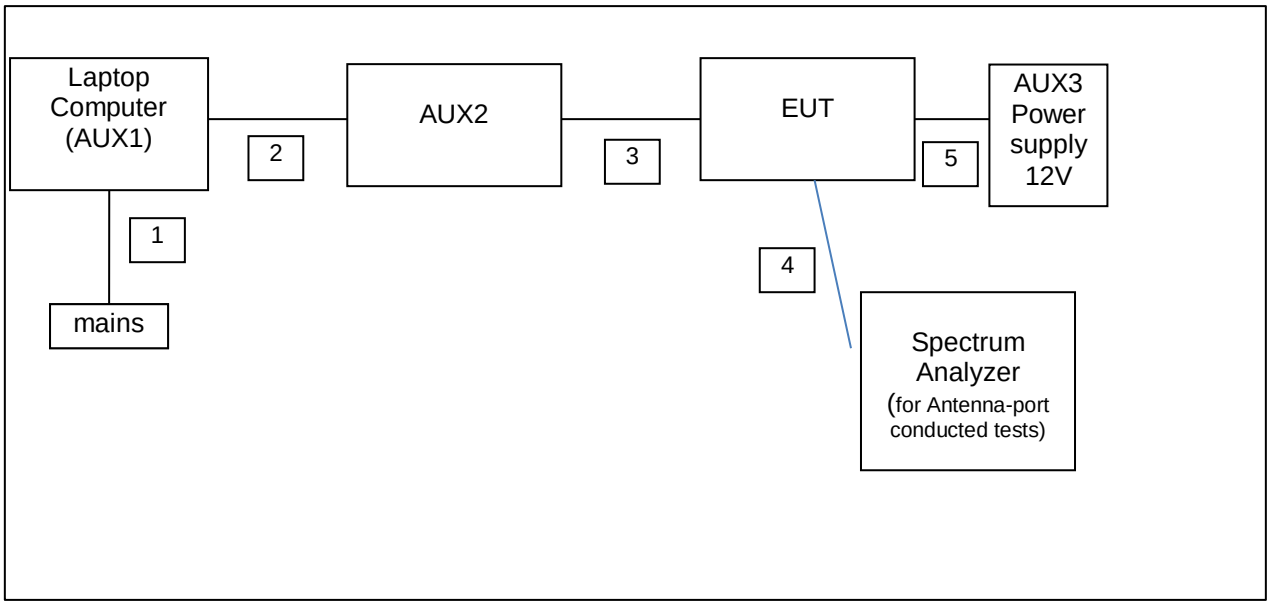
For programming purposes only the EUT was connected to the usb port of a laptop computer. The laptop computer was used to configure the EUT to continuously transmit at a specified output power and channel as specified in the testdata. See section 4.5 for Auxiliary details.

The EUT was tested on a stand-alone basis and the test system was configured in a way that a load condition was emulated by a bicycle wheel that was spun by a controllable speed.



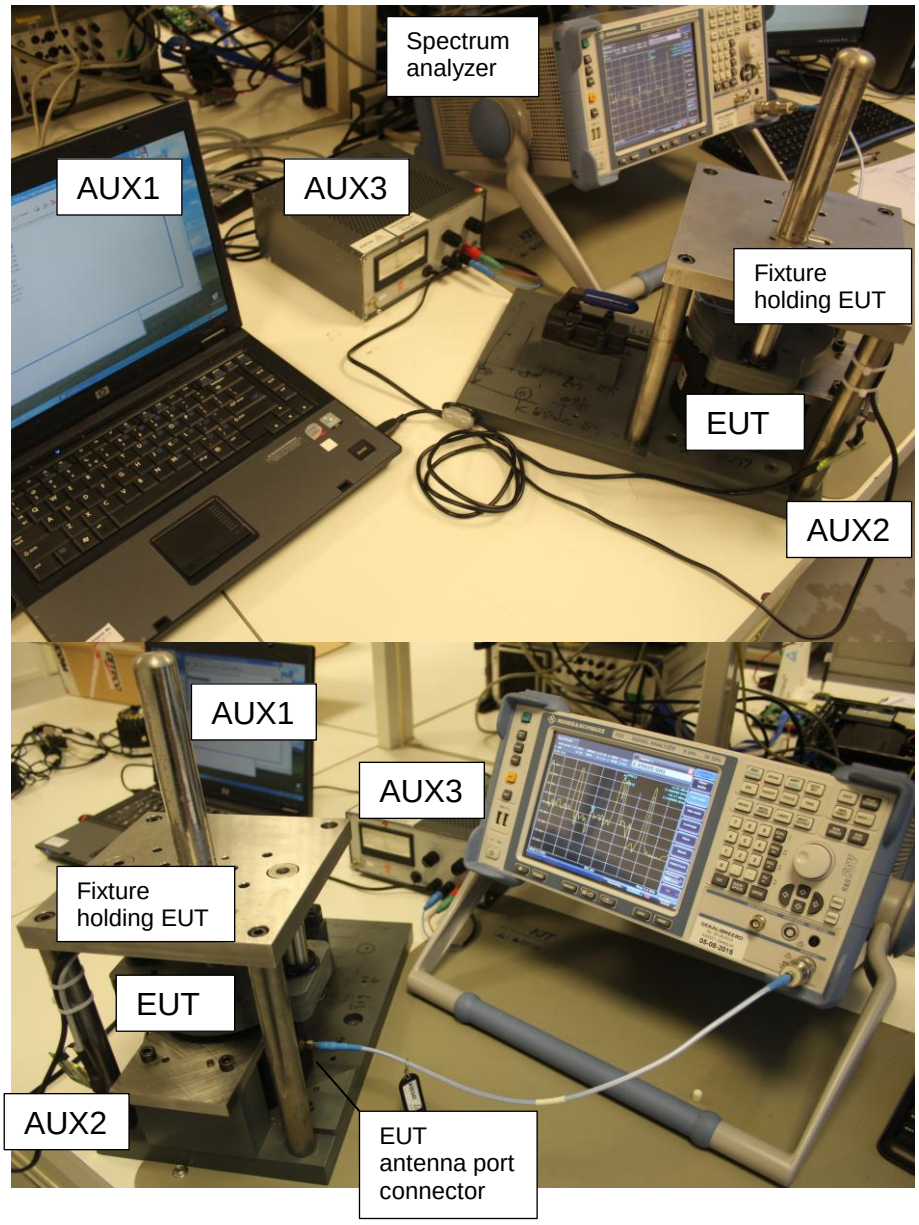
The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.10-2009 and KDB 558074 D01.

Figure 1a: Test Setup Diagram – antenna port conducted tests and programming.



No.	Port	From	To	Remarks
1.	Mains	Mains	Laptop (AUX1)	Through a AC/DC power supply
2.	Data com.	Laptop USB	AUX2	--
3.	Data com.	AUX2	EUT	--
4.	Antenna port	EUT	Spectrum analyzer	Conducted tests
5.	Power supply	AUX3	EUT	12Vdc

Figure 2b: Test Setup Photos – conducted tests and programming.



4.4 Test Software

A continuous transmit mode could be initiated by using test software as supplied by the applicant. The test software was used to define various different operational modes of the EUT for the purpose of compliance testing. The version of the test software, as supplied by the applicant and used during all tests is:

Test software : ANTware2 v 3.1.0

Batch files programmed by the applicant are used to make the required settings.

This software was running on a laptop computer (AUX1). It was used to enable the test operation modes listed in section 4.2 as appropriate.

4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

The auxiliary items were not used during testing, but instead are only used to make the required settings for testing. For setting the transmit frequency, enable hopping etc.

1. AUX1
   Product: Laptop Computer
   Brand: HP
   Model: Compaq 6710b
   Serial Number: CNU8150MD3
   Remark: host for testsoftware, property applicant

2. AUX2
   Product: Programming interface
   Brand: Segger
   Model: J-Link v 9.2
   Serial Number: --
   Remark: property applicant

5. Test Results

5.1 Conducted Measurements at Antenna Port

5.1.1 Conducted Output Power

RESULT: PASS

Date of testing: 2015-02-02

Requirements:

FCC 15.247(b)(3)

For systems using digital modulation in the 2400-2483.5 MHz band, the maximum peak output power is 1W (+30dBm).

Test procedure:

The Peak Conducted Output Power was measured using the method according to section 9.1.1 in KDB 558074 D01.

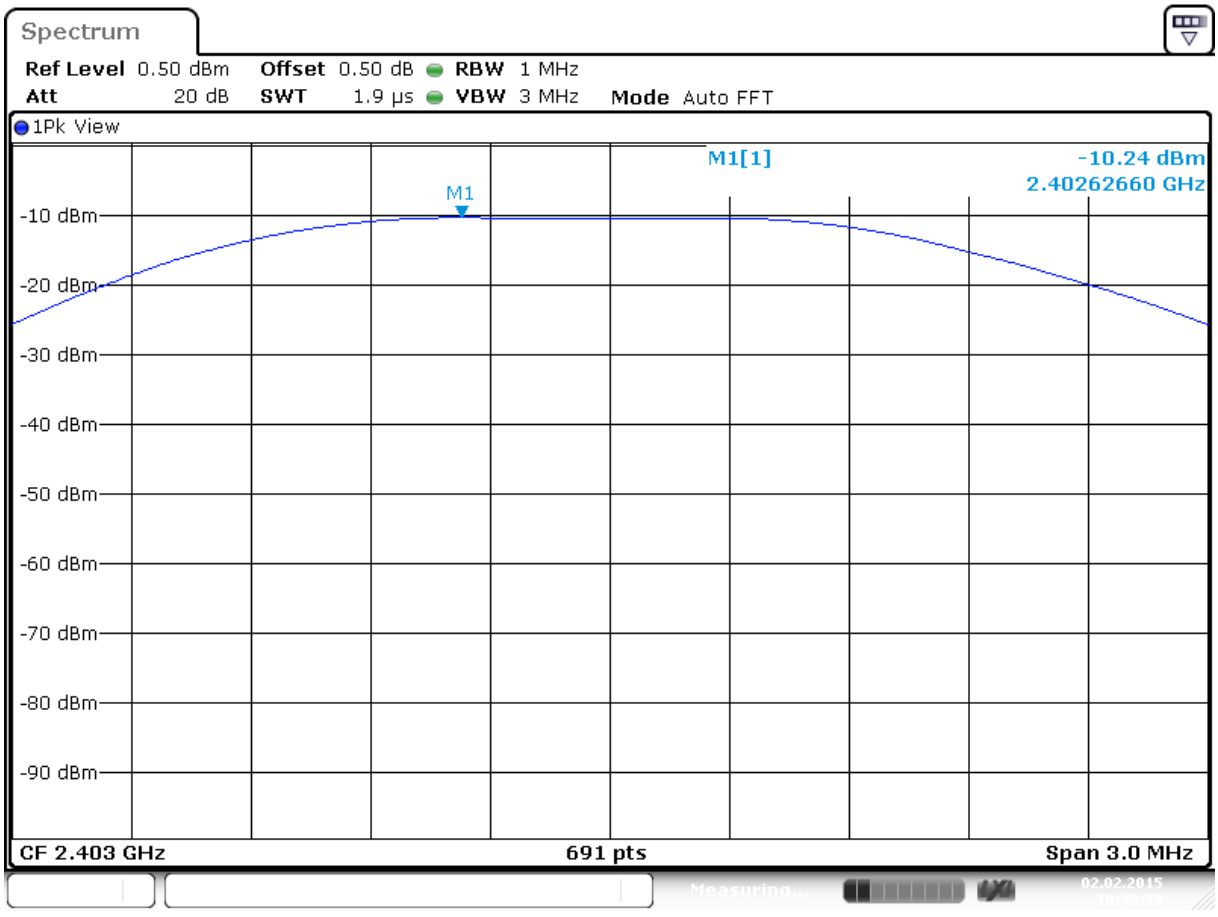
The maximum peak output power (conducted) was measured at the antenna connector with a spectrum analyzer. The final measurement takes into account the loss generated by all the involved cables.

Notes: mW = 10 ^ (dBm/10)
dBm = 10 x log(mW)

plots : Peak power plots,
Figures 1a, 1b and 1c show plots of the Peak Power outputs, correction factors (= 0.5dB Cableloss) included in the reading.

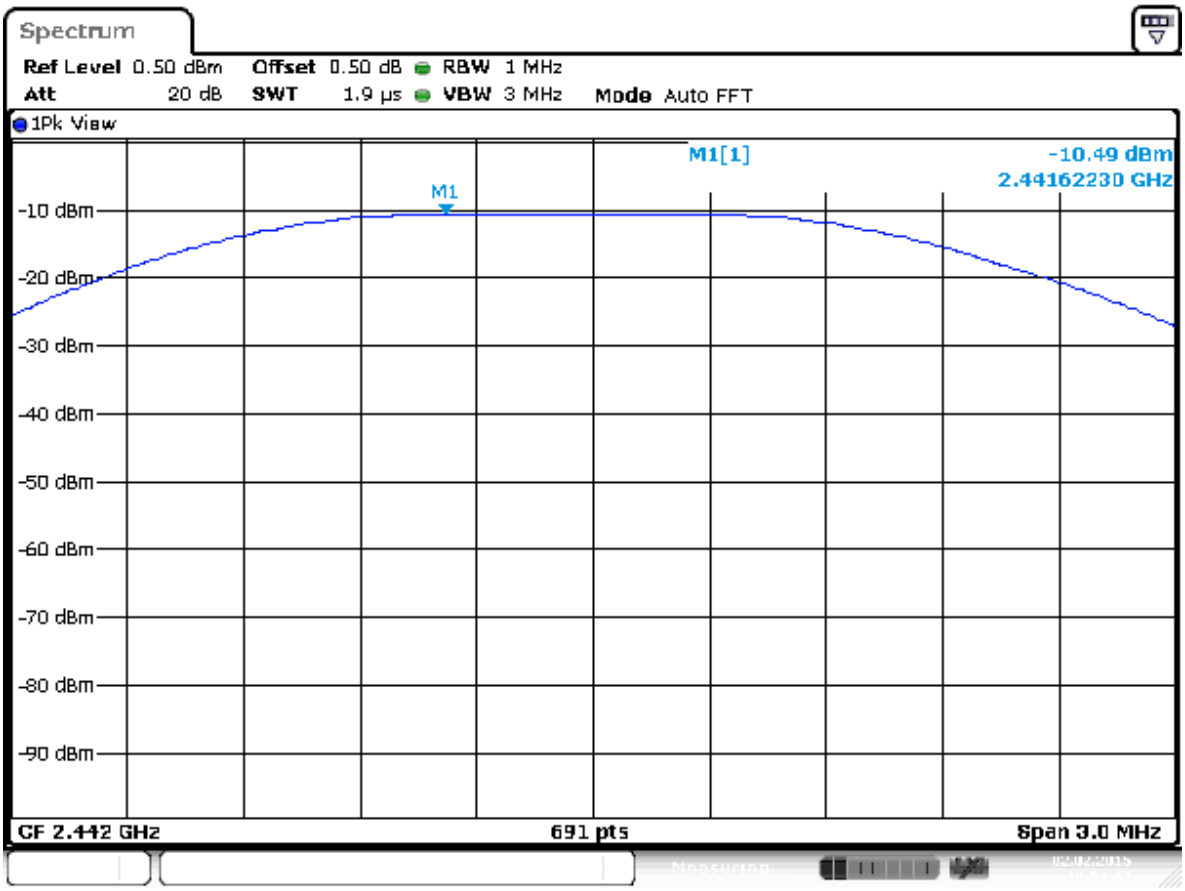
Conducted Output Power

Frequency [MHz]	Output Power [dBm]	Limit [dBm]	Verdict [Pass/Fail]	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	Plot number
2403	-10.24	+30	Pass	+2.0	-8.24	0.150	1A
2442	-10.49	+30	Pass	+2.0	-8.49	0.142	1B
2480	-10.37	+30	Pass	+2.0	-8.37	0.146	1C

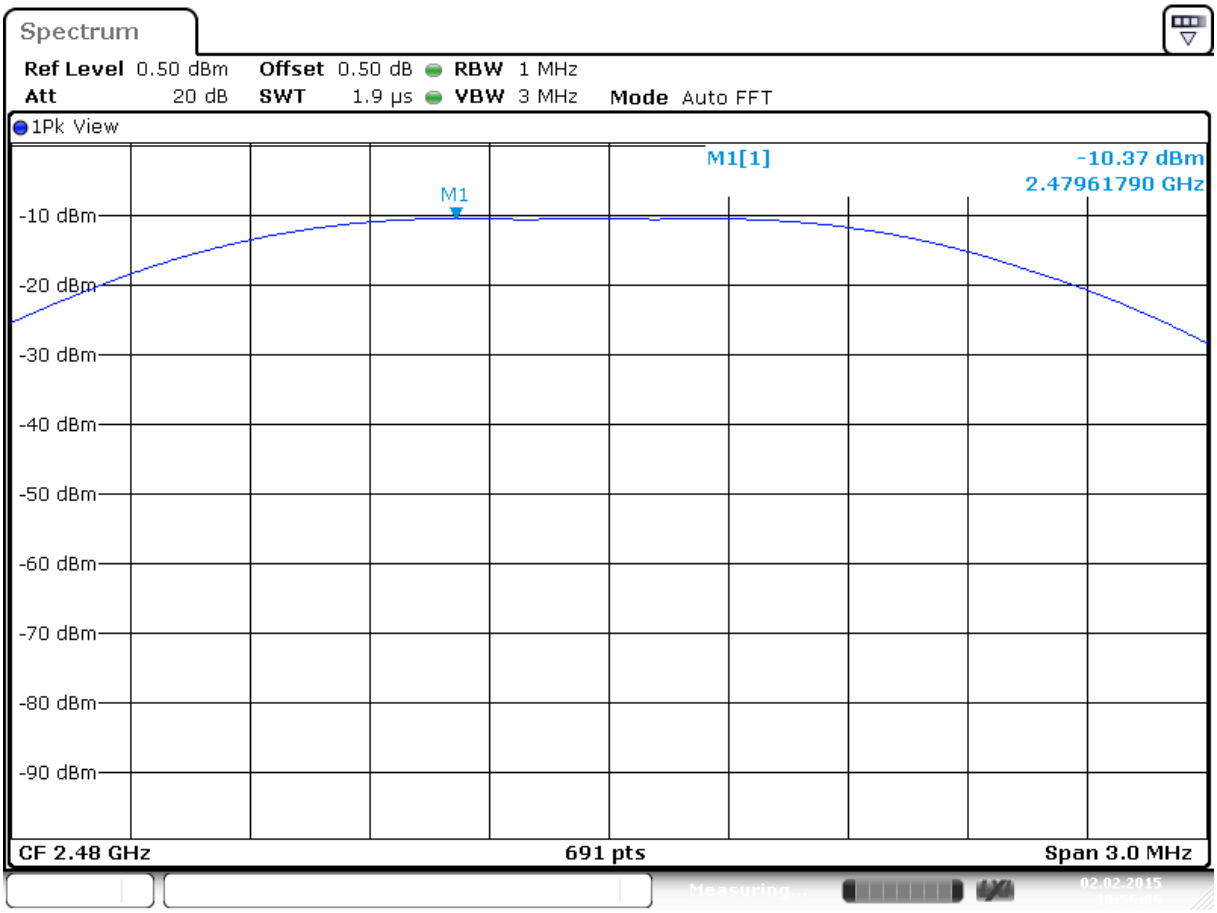


Date: 2.FEB.2015 10:48:59

Plot A


Spectrum
Ref Level 0.50 dBm Offset 0.50 dB RBW 1 MHz
Att 20 dB SWT 1.9 µs VBW 3 MHz Mode Auto FFT
1Pk View
M1[1] -10.49 dBm
2.44162230 GHz
M1
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
CF 2.442 GHz
691 pts
Span 3.0 MHz
Date: 2.FEB.2015 10:54:52

Plot B



Date: 2.FEB.2015 10:56:06

Plot C

5.1.2 6dB Bandwidth

RESULT: PASS

Date of testing: 2015-02-02

Requirements:

FCC 15.247(a)(2).
For systems using digital modulation in the 2400-2483.5MHz band, the 6dB bandwidth shall be at least 500kHz.

Test procedure 6dB bandwidth:

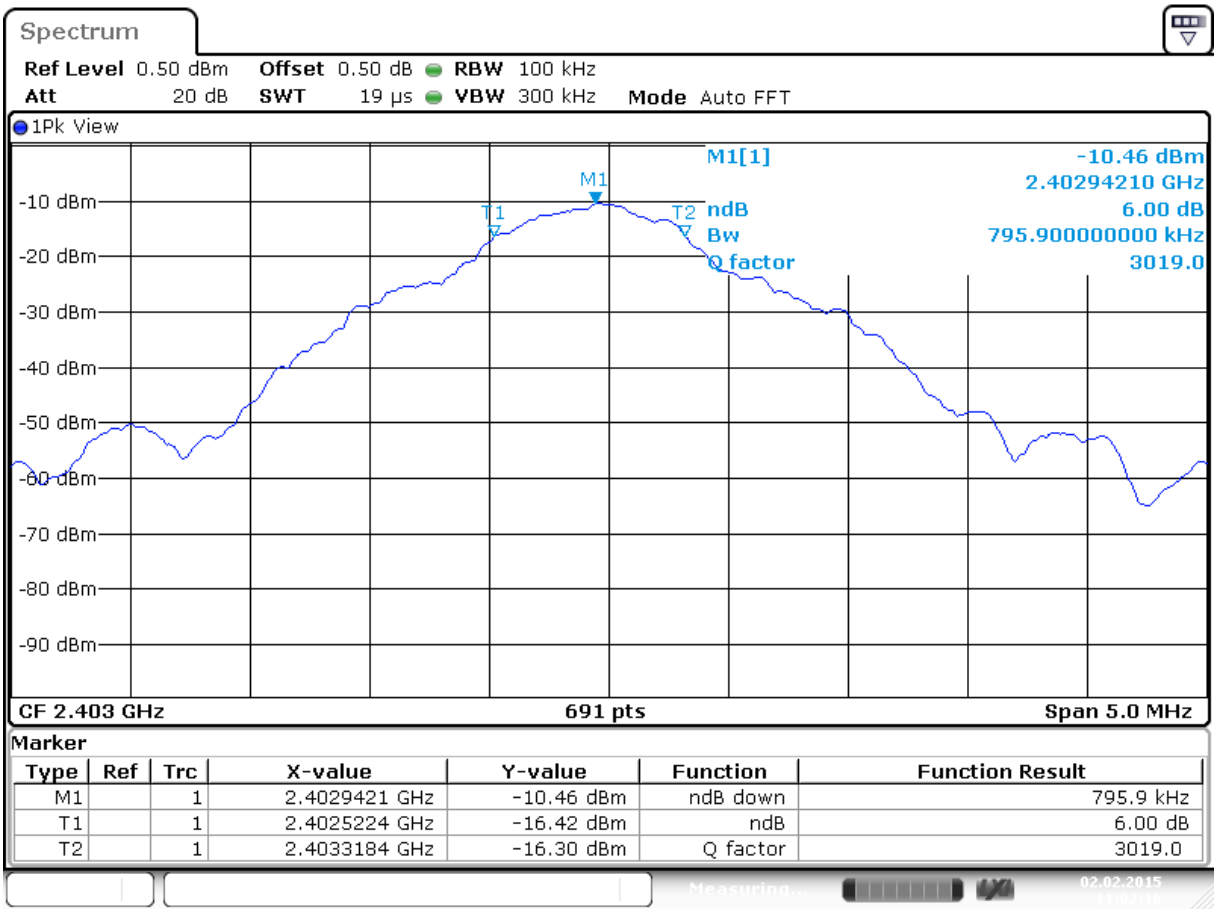
KDB 558074 D01 section 8.1 Option 1

A spectrum analyzer was connected to the antenna port of the EUT. The spectrum analyzer resolution bandwidth was set to 100kHz, video bandwidth to 300kHz and the span wide enough to capture the modulated carrier.

Plots A1,B1 and C1 shown on the next pages are of the 6 dB bandwidth.
Plots A2,B2 and C2 shown on the next pages are of the 99% bandwidth

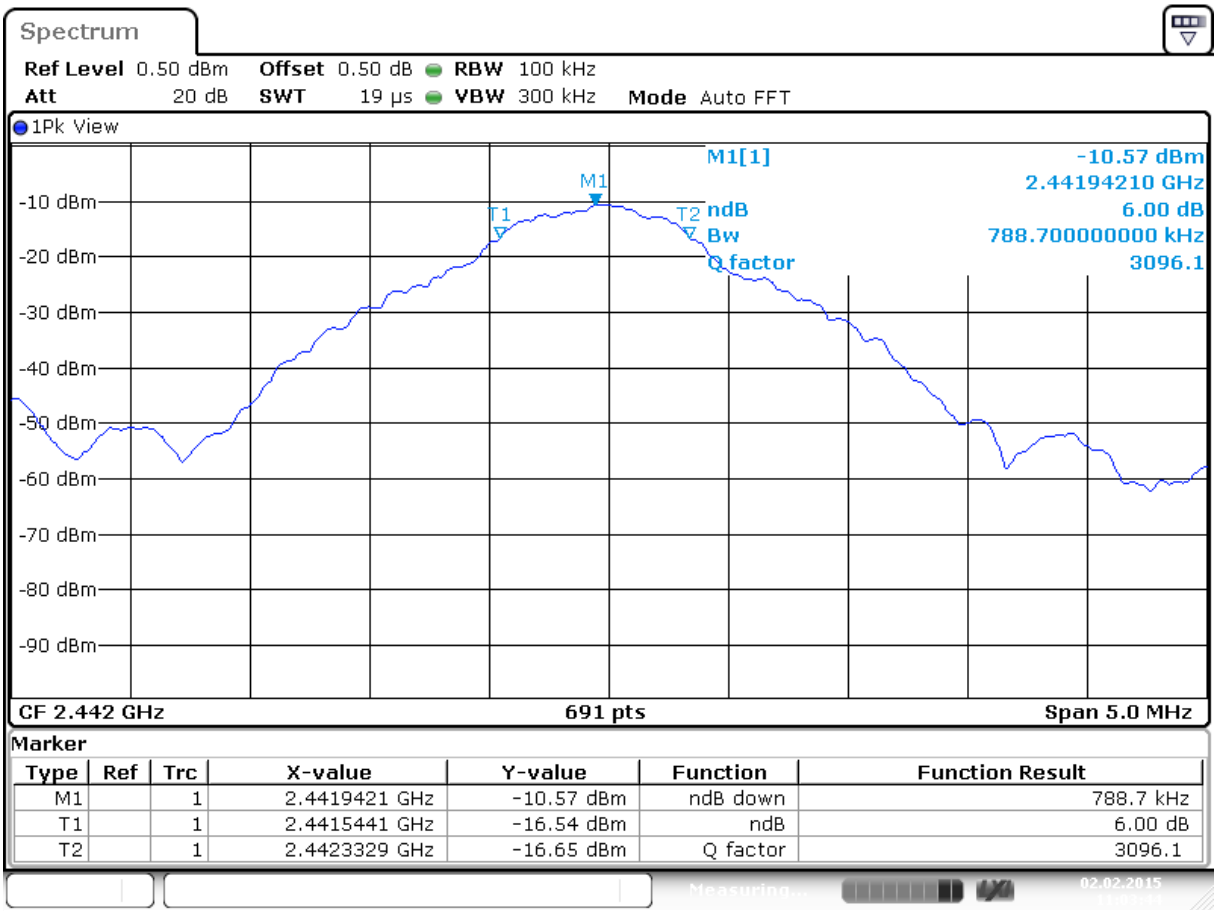
6dB Bandwidth

Operating Frequency [MHz]	6dB Bandwidth [kHz]	Limit [kHz]	Verdict [Pass/Fail]	Plot number
2403	795.9	>500	Pass	A1/A2
2442	788.7	>500	Pass	B1/B2
2480	781.5	>500	Pass	C1/C2



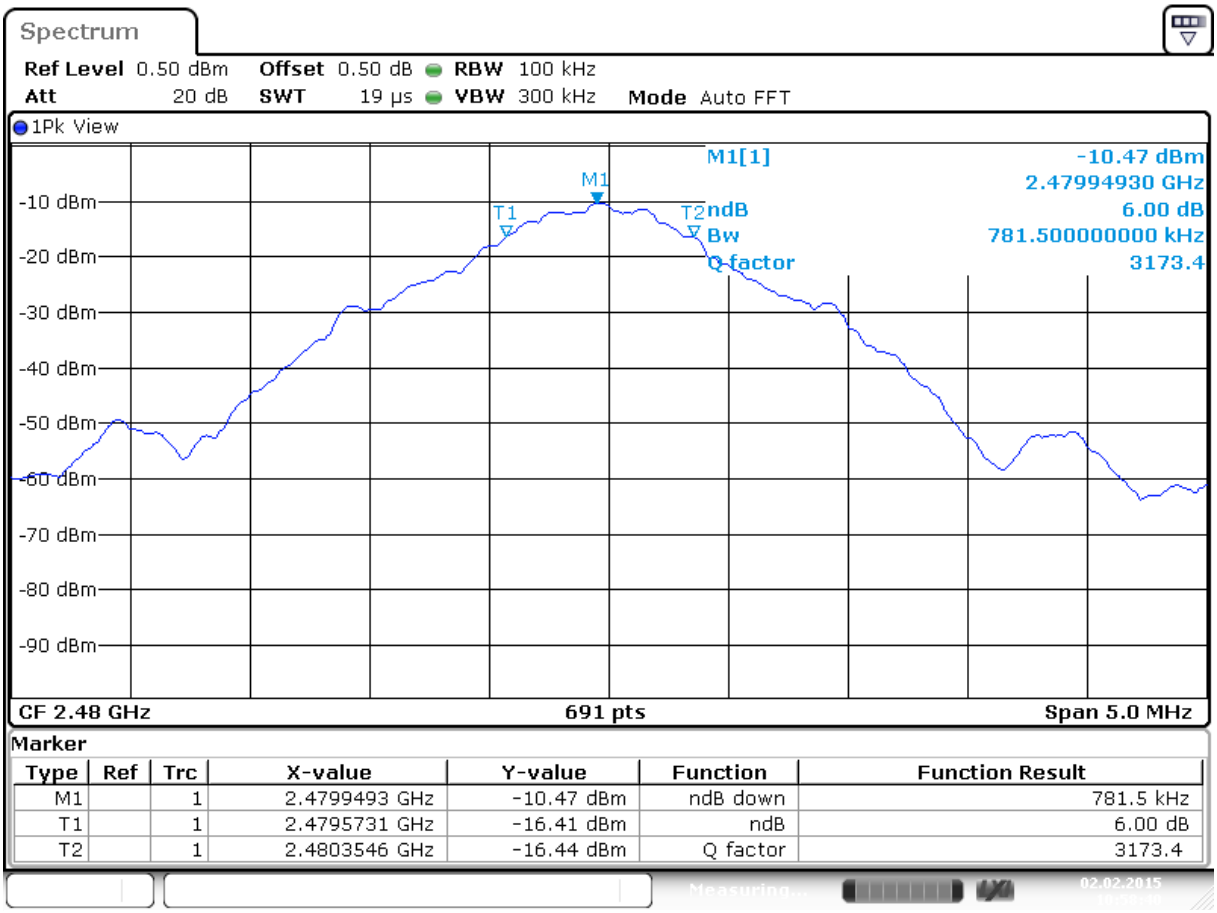
Date: 2.FEB.2015 11:02:16

Plot A1



Date: 2.FEB.2015 11:03:44

Plot B1



Date: 2.FEB.2015 10:58:40

Plot C1

5.1.3 Peak Power Spectral Density

RESULT: PASS

Date of testing: 2015-02-02

Requirements:

FCC 15.247(e)

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

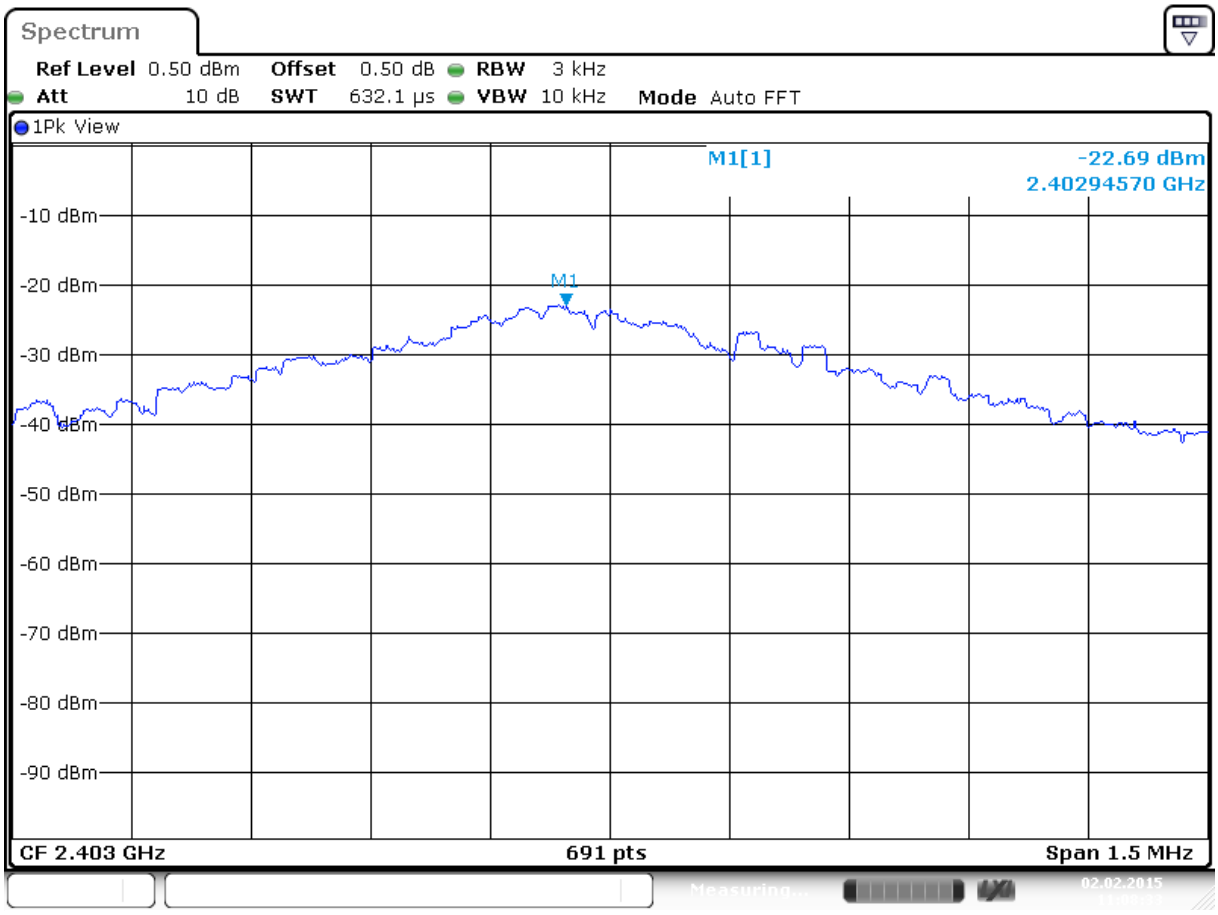
Test procedure:

KDB 558074 D01

The section 10.2 PKPSD peak PSD procedure was used. A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth was set to 3kHz and the video bandwidth was set to 10kHz. The sweep time was set to auto couple and the trace was allowed to stabilize before making the final measurement. By using the Peak marker function the maximum amplitude was determined. The final measurement takes into account the loss generated by all the involved cables (0.5 dB).

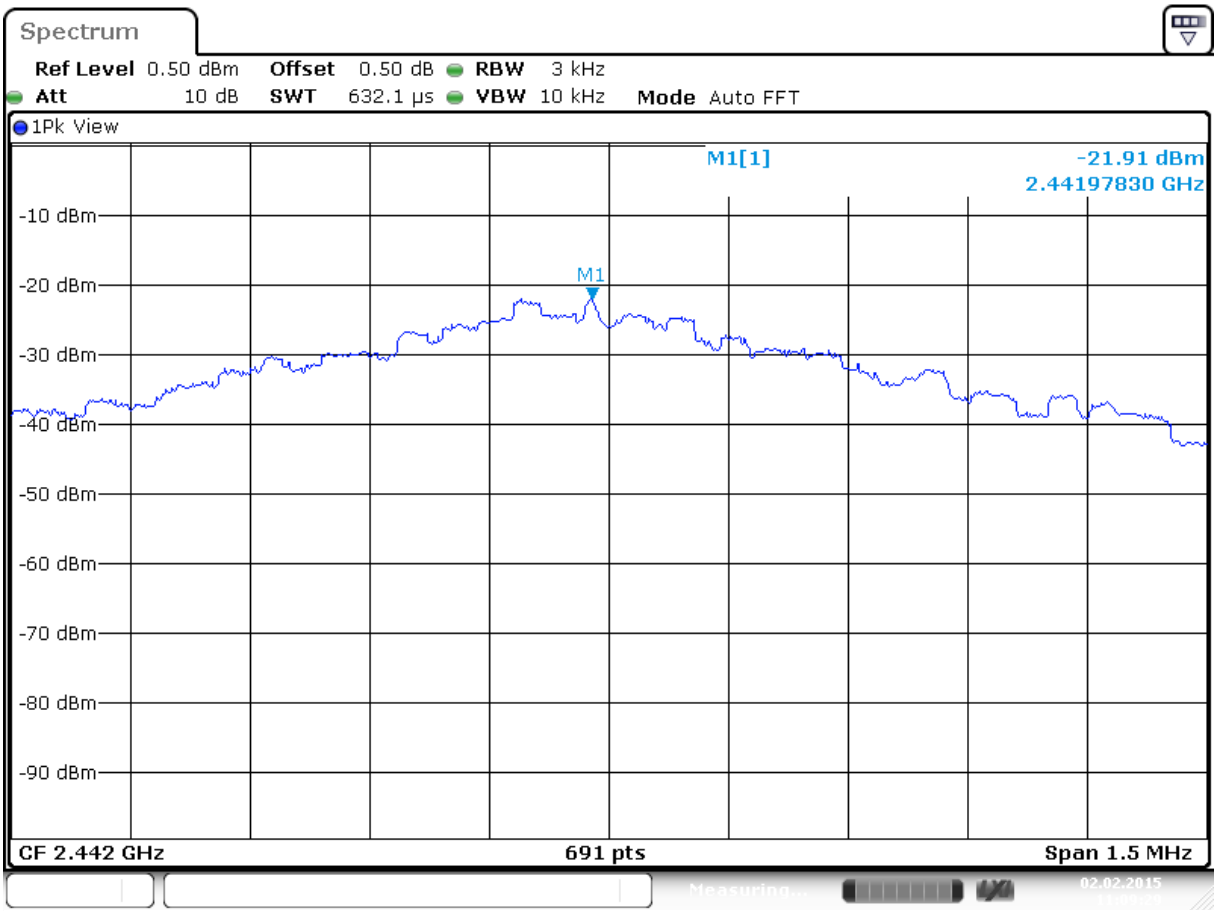
Peak Power Spectral Density

Operating Frequency [MHz]	Max PSD [dBm]	Limit [dBm]	Verdict [Pass/Fail]	Plot
2403	-22.69	8	Pass	A
2442	-21.91	8	Pass	B
2480	-22.19	8	Pass	C



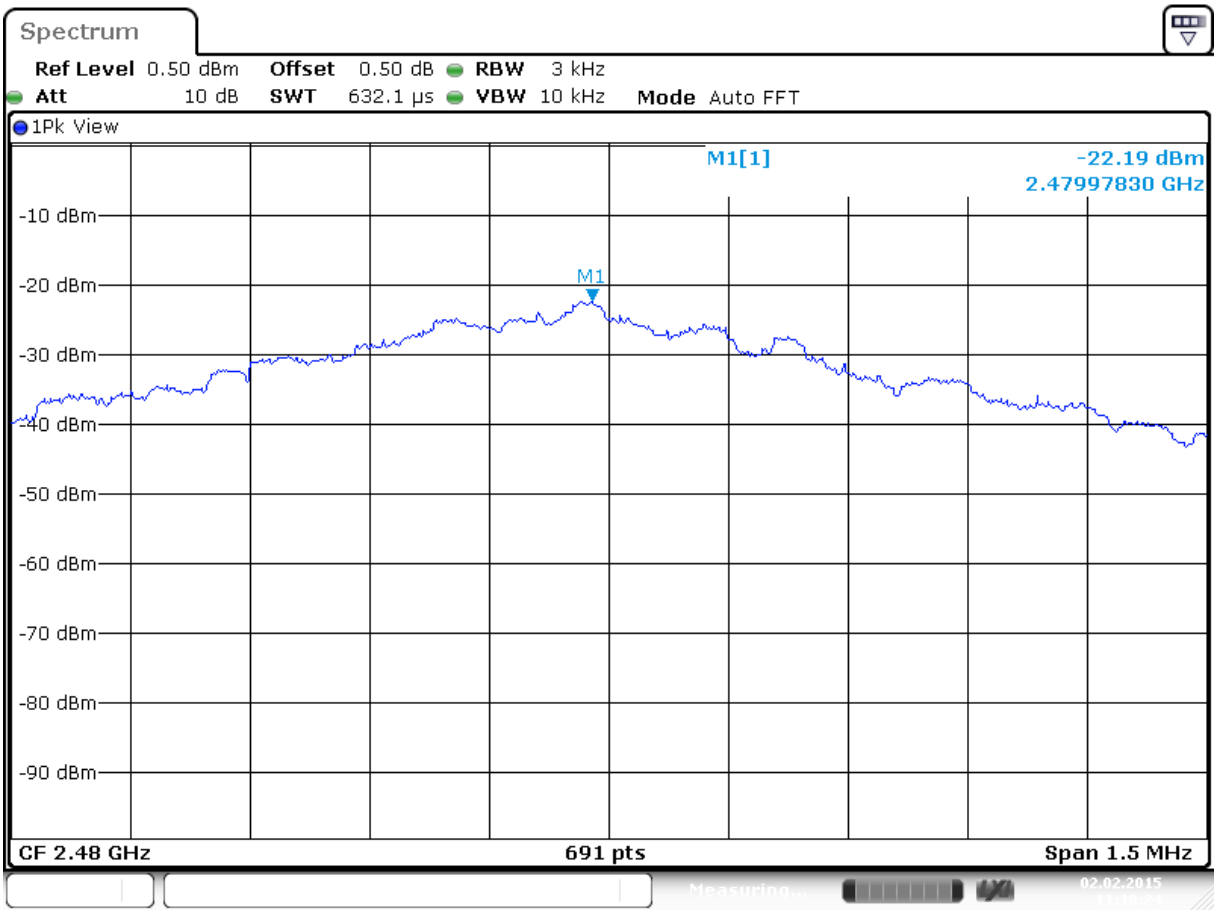
Date: 2.FEB.2015 11:08:33

Plot A



Date: 2.FEB.2015 11:09:30

Plot B



Date: 2.FEB.2015 11:10:25

Plot C

5.1.4 Band Edge Conducted Emissions

RESULT: Pass

Date of testing: 2015-02-02

Requirements:

FCC 15.205, FCC 15.209, FCC 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.

Test procedure:

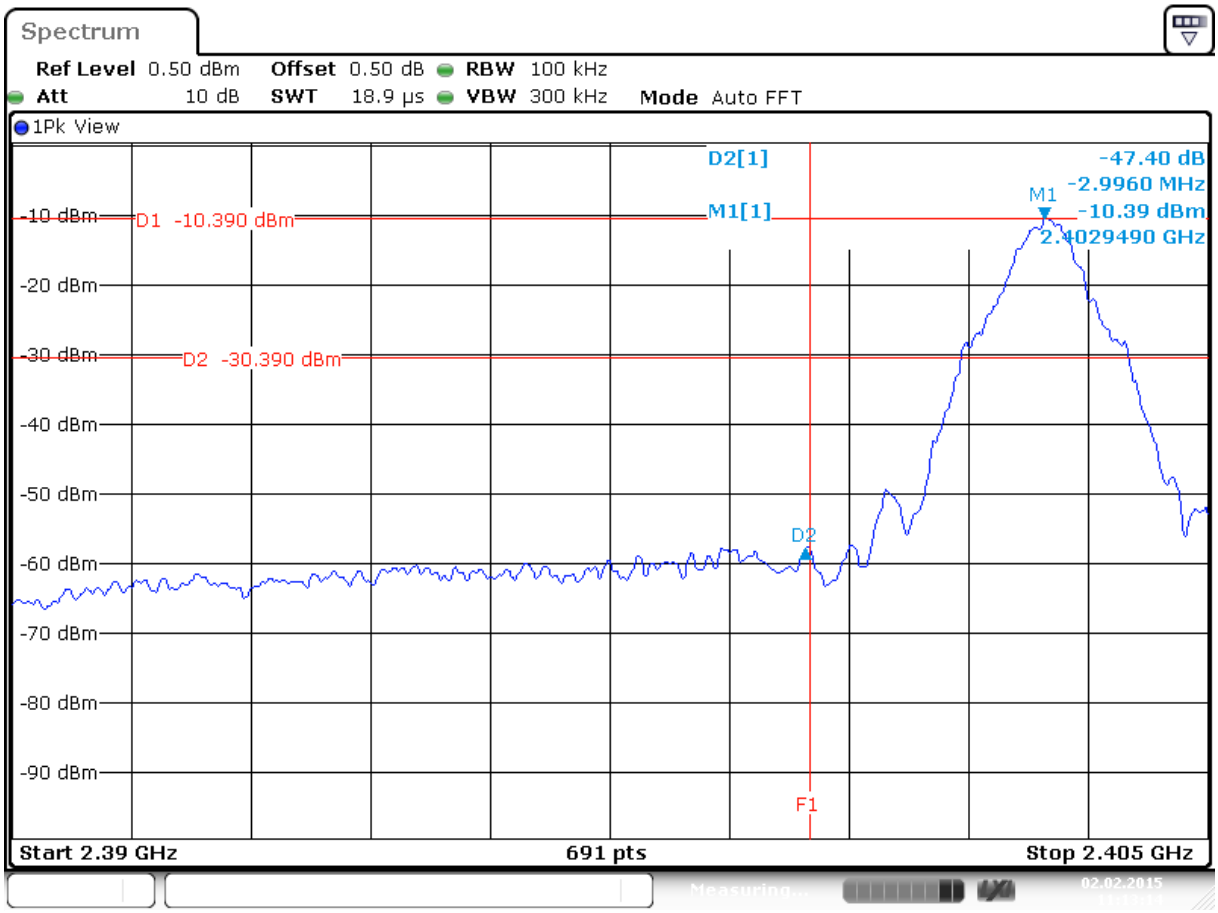
KDB 558074 D01 Section 13.2 and ANSI C63.10-2009

The marker-delta method, as described in ANSI C63.10 was used.

Measurements were performed using a spectrum analyzer with a suitable span to encompass the peak of the fundamental and using the following settings:
RBW = 100kHz, VBW = 300kHz.

The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

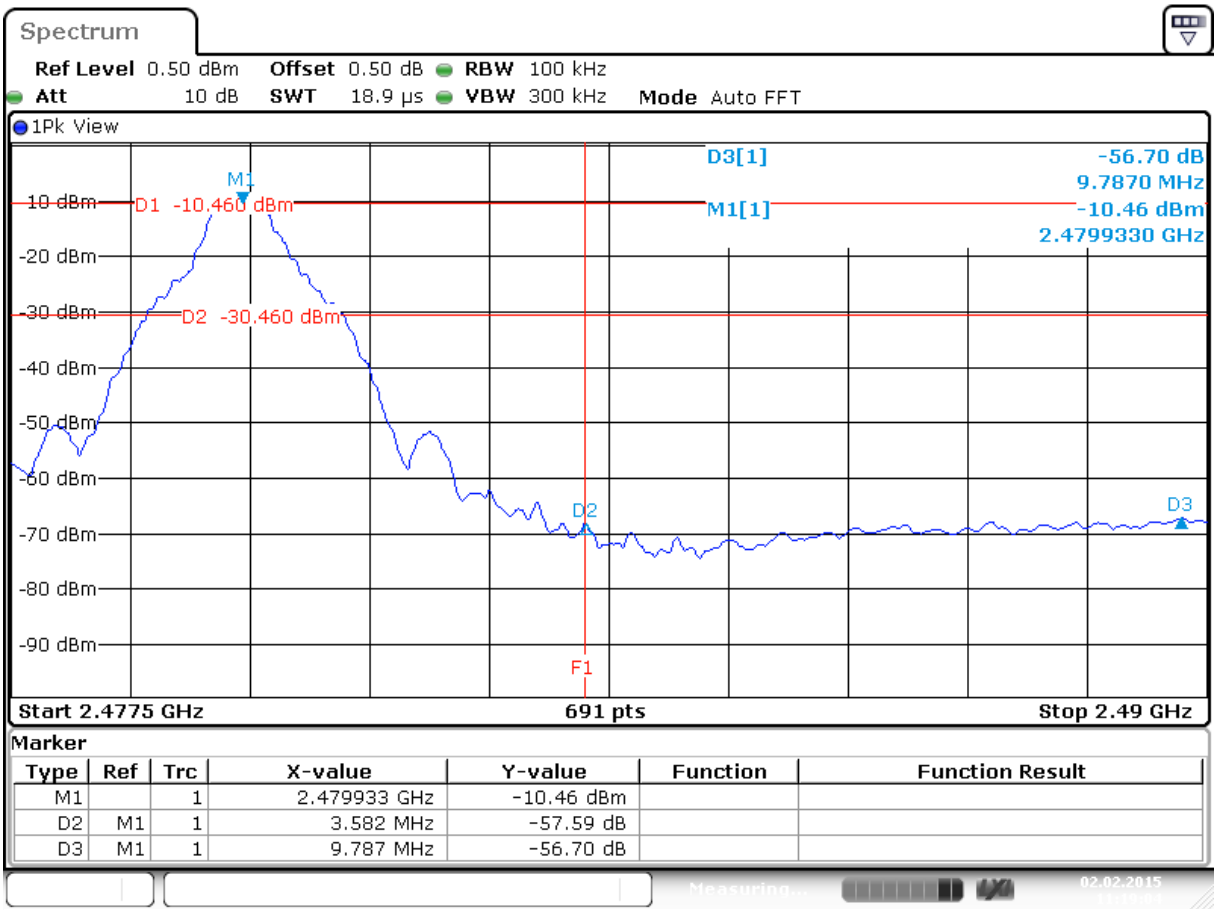
Results: All out of band spurious emissions are more than 20 dB below the fundamental.
See the figures on the following pages.



Date: 2.FEB.2015 11:13:14

Plot: Band Edge Conducted Emission, Spectral Diagram, 2403 MHz

Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2400 MHz.



Date: 2.FEB.2015 11:19:05

Plot: Band Edge Conducted Emission, Spectral Diagram, 2480 MHz.
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2483,5 MHz.

5.1.5 Radiated Spurious Emissions of Transmitter

RESULT: PASS

Date of testing: 2015-01-27

Frequency range: 30MHz - 25GHz

Requirements:

FCC 15.209 and FCC 15.247(d)

Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) or be attenuated at least 20dB below the power level in the 100kHz bandwidth within the band that contains the highest level of the desired power (the less severe limit applies).
Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a), must comply with the radiated emission limits specified in FCC 15.209(a).

Test procedure:

ANSI C63.10-2009

The EUT is considered as floor-standing equipment not typically installed with its base in direct electrical contact with, or connected to, a metal floor or grid. The EUT was placed on the testsite turntable with insulation material in-between of up to 12mm thickness to prevent electric contact.

Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling and the EUT orientation (X, Y, Z) were varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 30MHz to the 10th harmonic of the highest fundamental transmitter frequency (25GHz). Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° and the antenna was raised and lowered from 1 to 4m in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit. The levels are expressed in dBm which are derived from dBm = E(dBµV/m) – 95.2dB. Where Peak (Pk) values where at least 6 dB under the Average (Av) limits, Av value was not tested. Were Average values were tested, Average values were measured using a 10Hz Video Bandwidth.

Radiated Emissions, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations

Frequency [MHz]	Antenna Orientation	Level QP [dBµV/m]	Limit QP [dBµV/m]	Verdict [Pass/Fail]
33.88	Horizontal	34.7	40.0	Pass
61.04	Horizontal	35.9	40.0	Pass
68.80	Horizontal	36.9	40.0	Pass
97.90	Vertical	37.7	43.5	Pass
148.34	Vertical	21.4	43.5	Pass
185.20	Vertical	16.6	43.5	Pass

Note: - Level QP = Reading QP + Factor
- Tested in modes as described in section 4.2, the 6 highest values noted.
Preliminary measurements indicated that the radiated emissions from EUT were not affected by the EUT's operating mode or frequency.
- Quasi Peak detector used with a bandwidth of 120 kHz.
- The EUT was varied in 2 positions (horizontal and vertical) because of it's physical limitations.

Radiated Emissions, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, 2403 MHz.

Frequency [MHz]	Antenna Orientation	Detector	Bandwidth (MHz)	Level [dBm]	Limit [dBm]	Result
1064.9*[R]	Vertical	Pk	1	-62.3	-41.2 (Av) -21.2 (Pk)	Pass
1157.0[*R]	Vertical	Pk	1	-64.6	-41.2 (Av) -21.2 (Pk)	Pass
4806.0*[H*R]	Vertical	Pk	1	-50.0	-41.2 (Av) -21.2 (Pk)	Pass
7210.0*[H]	Vertical	Pk	1	-50.0	-41.2 (Av) -21.2 (Pk)	Pass
9612.0*[H]	Vertical	Pk	1	-46.5	-41.2 (Av) -21.2 (Pk)	Pass
12516.6[*R]	Vertical	Pk	1	-50.7	-41.2 (Av) -21.2 (Pk)	Pass
14730.8	Vertical	Pk	1	-48.5	-41.2 (Av) -21.2 (Pk)	Pass

Radiated Emissions, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, 2442 MHz.

Frequency [MHz]	Antenna Orientation	Detector	Bandwidth (MHz)	Level [dBm]	Limit [dBm]	Result
1080.0*[R]	Horizontal	Pk	1	-62.3	-41.2 (Av) -21.2 (Pk)	Pass
4884.0[*H*R]	Vertical	Pk	1	-50.0	-41.2 (Av) -21.2 (Pk)	Pass
6562	Vertical	Pk	1	-55.6	-41.2 (Av) -21.2 (Pk)	Pass
7344.0[*R]	Vertical	Pk	1	-50.0	-41.2 (Av) -21.2 (Pk)	Pass
9768.0	Vertical	Pk	1	-46.5	-41.2 (Av) -21.2 (Pk)	Pass
11459[*R]	Vertical	Pk	1	-47.9	-41.2 (Av) -21.2 (Pk)	Pass

Radiated Emissions, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, 2480 MHz.

Frequency [MHz]	Antenna Orientation	Detector	Bandwidth (MHz)	Level [dBm]	Limit [dBm]	Result
1080.0^{R}	Horizontal	Pk	1	-62.3	-41.2 (Av) -21.2 (Pk)	Pass
1320.0^{*R}	Horizontal	Pk	1	-63.6	-41.2 (Av) -21.2 (Pk)	Pass
4960^{*H*R}	Vertical	Pk	1	-56.7	-41.2 (Av) -21.2 (Pk)	Pass
7452.0^{*H*R}	Vertical	Pk	1	-48.0	-41.2 (Av) -21.2 (Pk)	Pass
9920.2^{*H}	Vertical	Pk	1	-47.5	-41.2 (Av) -21.2 (Pk)	Pass

Radiated field strength measurements (1 - 25 GHz, E-field), EUT normal operation

Frequency [MHz]	Antenna Orientation	Detector	Resolution Bandwidth (MHz)	Level [dBm]	Limit [dBm]	Result
1064.9^{R}	Vertical	Peak	1	-62.3	-41.2 Av -21.2 Pk	Pass
1080.0^{R}	Horizontal	Peak	1	-62.3	-41.2 Av -21.2 Pk	Pass
1113.8^{R}	Horizontal	Peak	1	-64.7	-41.2 Av -21.2 Pk	Pass
1157.0^{R}	Vertical	Peak	1	-64.6	-41.2 Av -21.2 Pk	Pass
1320.9^{R}	Horizontal	Peak	1	-63.6	-41.2 Av -21.2 Pk	Pass
1441.2^{R}	Horizontal	Peak	1	-63.7	-41.2 Av -21.2 Pk	Pass
4921^{H-R}	Vertical	Peak	1	-54.0	-41.2 Av -21.2 Pk	Pass
4960^{H-R}	Vertical	Peak	1	-56.7	-41.2 Av -21.2 Pk	Pass
6562	Vertical	Peak	1	-55.6	-41.2 Av -21.2 Pk	Pass
11459^{R}	Vertical	Peak	1	-47.9	-41.2 Av -21.2 Pk	Pass
12517^{R}	Vertical	Peak	1	-50.7	-41.2 Av -21.2 Pk	Pass
14731^{H}	Vertical	Peak	1	-48.5	-41.2 Av -21.2 Pk	Pass

Notes:
- *R refers to a frequency in a restricted band,
- *H refers to a frequency which is a harmonic of the fundamental.
- Both transmitters were transmitting at the same time.
- Field strength values of radiated emissions not listed in the tables above are more than 20 dB below the applicable limit.

5.2 AC Power Line Conducted Measurements

RESULT: Not Applicable.

Date of testing: Not Applicable

EUT is not operated by AC mains.

End of report