TEST REPORT

Date:	**ESPOO 24.03.2014**	Page:	**1 (18)**
		Appendices	–

Number: No. 1 / 1

275987A

Date of handing in: 19.03.2014

Tested by:

Pekka Kälviäinen, Test Engineer

Reviewed by:

Timo Hietala, Test Specialist

SORT OF EQUIPMENT:	**2.4 GHz Transceiver**
MARKETING NAME:	
TYPE:	***Quha Zono***
MANUFACTURER:	***Quha Oy***
CLIENT:	**Quha Oy**
ADDRESS:	**Pirkkalaistie 1, FI-3700 Nokia, Finland**
TELEPHONE:	**+358 (0)400 339655**
TEST LABORATORY:	**Nemko Oy**
FCC REG. NO.	**359859 October 25, 2013**
IC FILE NO.	**2040F-1 November 22, 2012**

SUMMARY:

In regard to the performed tests the equipment under test fulfils the requirements defined in the test specifications, see page 2 for details

Summary of performed tests and test results

Section in CFR 47	*Section in RSS-GEN or RSS-210, Issue 8*		*Result*
15.249 (a)	A2.9	Field strength of fundamental	PASS
15.249 (d)(e), 15.209	A2.9	Band-edge compliance of RF emissions	PASS
15.249 (d)(e), 15.209	A2.9	Spurious radiated emissions	PASS
15.215	-	20 dB bandwidth	X
-	4.6.1	99% bandwidth	X
15.207	7.2.2	AC power line conducted emissions	N.A.

Explanations:

PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.
N.A. The test not applicable, battery operated equipment
X The measurement was done, but there is no applicable performance criteria.

Contents

1. EUT and Accessory Information

1.1 EUT description

2.4 GHz transceiver, Digital modulated, 16 channels

1.2 EUT and accessories

	unit	*type*	*s/n*
EUT (2405MHz)	**Transceiver**	**Quha Zono**	**838861062**
EUT (2440MHz)	**Transceiver**	**Quha Zono**	**838861061**
EUT (2475MHz)	**Transceiver**	**Quha Zono**	**838861063**

Operating voltages

3.0VDC, integral battery

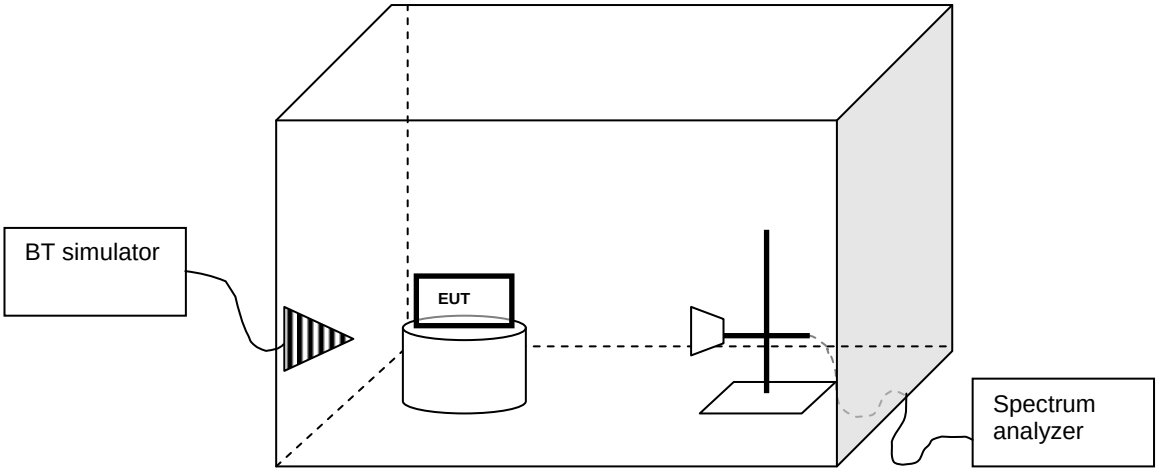
1.3 Additional information related to testing

Tested Technology:	**Digital modulated, 16 channels**	
Antenna:	**Integral**	
Type of Unit	**Transmitter**	
Modulation:	**DSSS**	
Power Supply Requirement:	**Nominal**	**3.0VDC**
Transmit Frequency Range	**2400 MHz to 2483.5 MHz**	
Transmit Channels Tested:	**Channel Frequency (MHz)**	
	2405	
	2440	
	2475	

2. Test setups

Setup (Radiated measurements)

The test was performed inside a semi anechoic shielded room. For the duration of the test the EUT was placed on a non-conductive support 0.8 m high standing on the turntable. The tower and turn table were remotely controlled to turn the EUT and change the antenna polarization. The measured signal was routed from the measuring antenna to the spectrum analyzer. A BT simulator was not used.



3. Standards and measurement methods

The test were performed in guidance of the CFR 47, FCC Rules Part 15 Subpart C, ANSI C63.4 (2003), CISPR 22 Ed. 6.0, ANSI C63.10 (2009), IC standards RSS-GEN (Issue 3, December 2010) and RSS-210 (Issue 8, December 2010).

4. Test results

4.1 Field strength of fundamental

The test was performed as a compliance test. The test parameters concerned were as follows:

EUT	**EUT**
Site name	**Perkkaa**
FCC rule part	**§ 15.249 (a)**
Section in RSS-210	**A2.9**
Date of testing	**19.03.2014**
Test equipment	**566, 525, 350**
Test conditions	**22 °C, 30 % RH**

4.1.1 EUT operation mode

EUT frequency (MHz)	**2405, 2440 and 2475**

4.1.2 Test method and limit

Frequency range (MHz)	Limit Average (dBµV/m)	Limit Peak (dBµV/m)
2400 – 2483.5	**≤ 94**	**≤ 114**

The measurement results were obtained as described below.

$$E\ [\mathrm{dB}(\mu V/m)] = U_{RX} + A_{CABLE} + AF$$

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

Duty Cycle correction factor(dB) -26.83 dB was used. (RFon 36*0.1265ms/100ms)

4.1.3 Test results

frequency (MHz)	*E Average (dBµV/m)*	*E Peak (dBµV/m)*	*Result*
2405	**68.51**	**95.34**	**PASS**
2440	**69.39**	**96.22**	**PASS**
2475	**69.11**	**95.94**	**PASS**

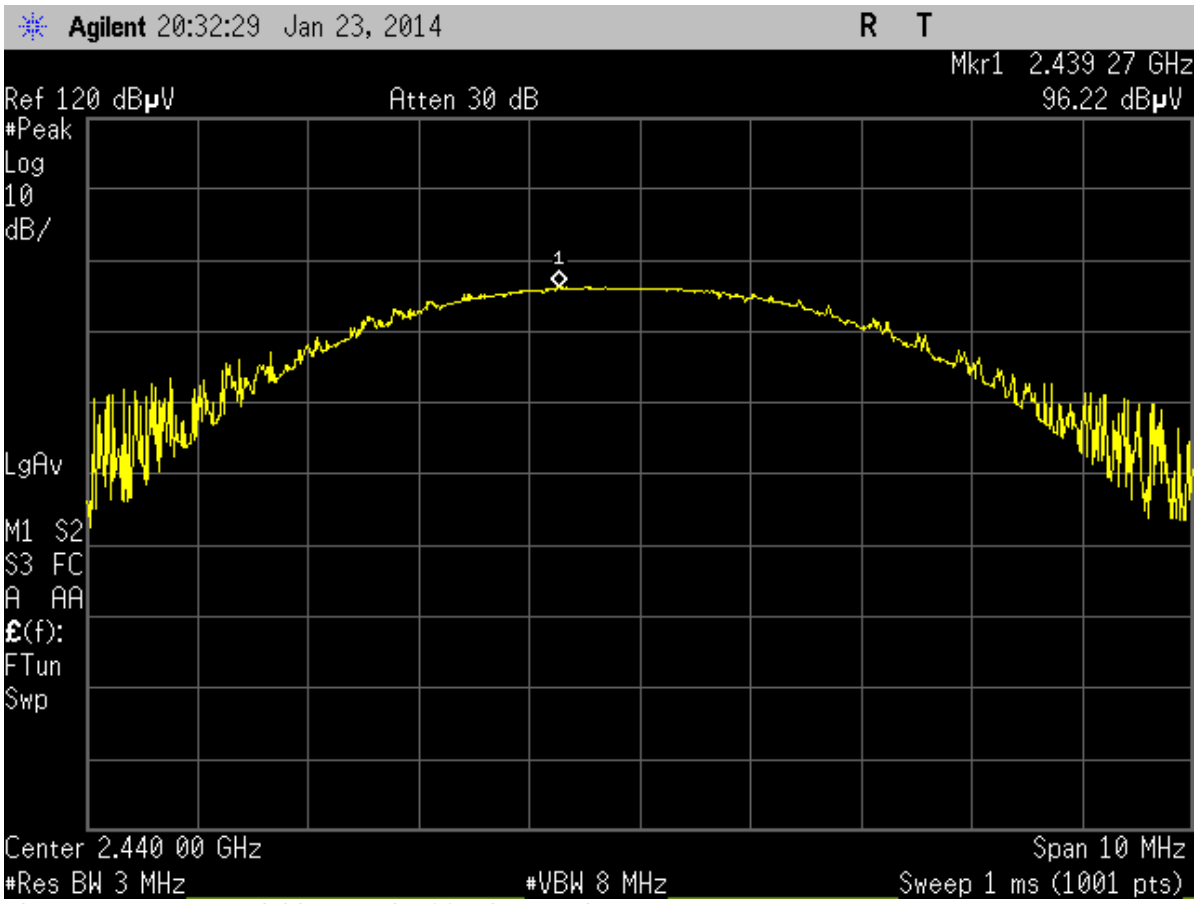


Figure 1. 2440MHz, Field strength of fundamental

4.2 Band-edge compliance of RF emissions

The test was performed as a compliance test. The test parameters concerned were as follows:

EUT	**EUT**
Site name	**Perkkaa**
FCC rule part	**§ 15.249 (d)(e), § 15.209**
Section in RSS-210	**A2.9**
Date of testing	**19.03.2014**
Test equipment	**566, 525, 350**
Test conditions	**22 °C, 35 % RH**
Test result	**PASS**

4.2.1 EUT operation mode

EUT frequency (MHz)	**2405 and 2475**

4.2.2 Test method and limit

The measurement is made according to Public notice ANSI C63.10 (2009) and IC standard RSS-210.

3m measurement distance

Frequency range (MHz)	*Limit Average (dBµV/m)*	*Limit Peak (dBµV/m)*
Below 2400 and above 2483.5	**≤ 54**	**≤ 74**

The measurement results were obtained as described below.

$$E\ [\mathrm{dB}(\mu V/m)] = U_{RX} + A_{CABLE} + AF$$

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

Duty Cycle correction factor(dB) -26.83dB was used. (RFon 36*0.1265ms/100ms)

4.2.3 Test results

2405 MHz:

Below 2400 MHz:

Detector (RBW: 1MHz)	*E (dBµV/m)*	*Result*
Peak	**67.97**	**PASS**
Average	**41.14**	**PASS**

2475 MHz:

Above 2483.5 MHz:

Detector (RBW: 1MHz)	*E (dBµV/m)*	*Result*
Peak	**63.73**	**PASS**
Average	**36.90**	**PASS**

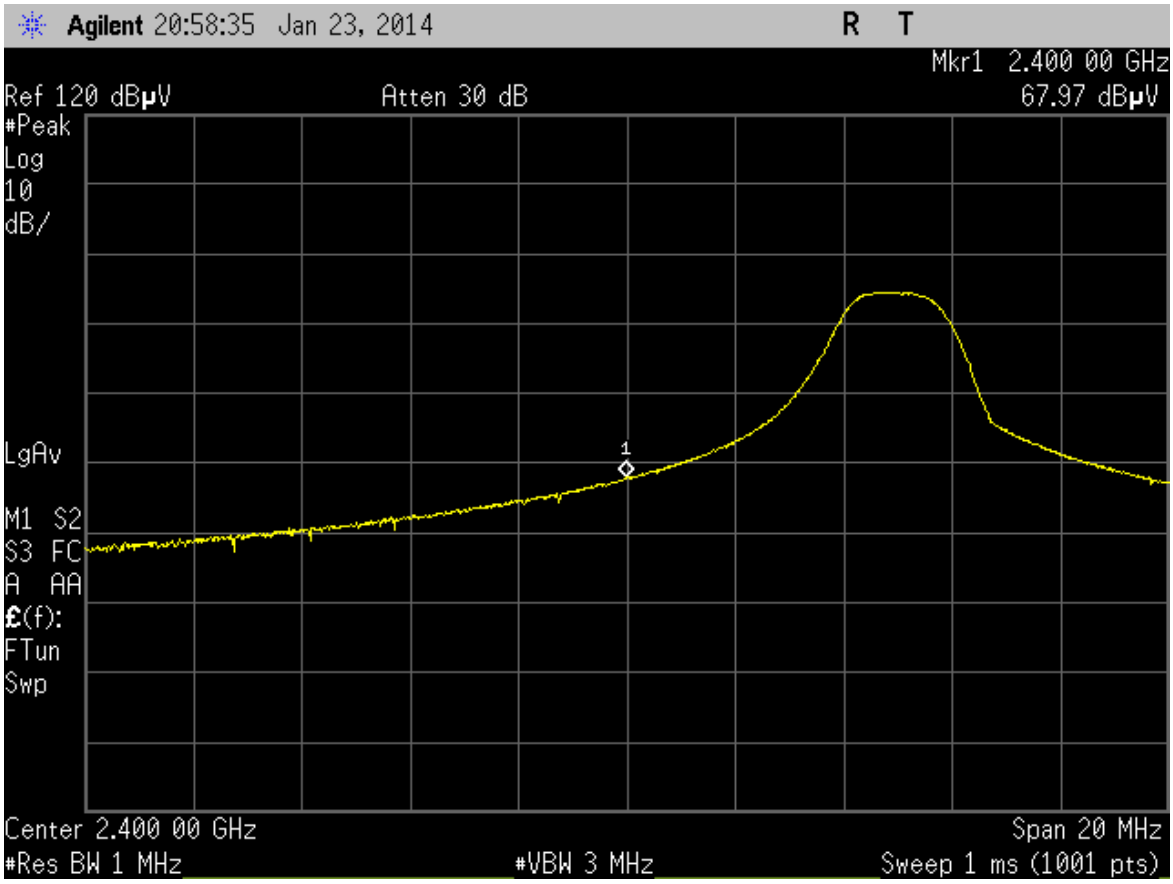


Figure 1. 2405MHz, Band-edge compliance, low end

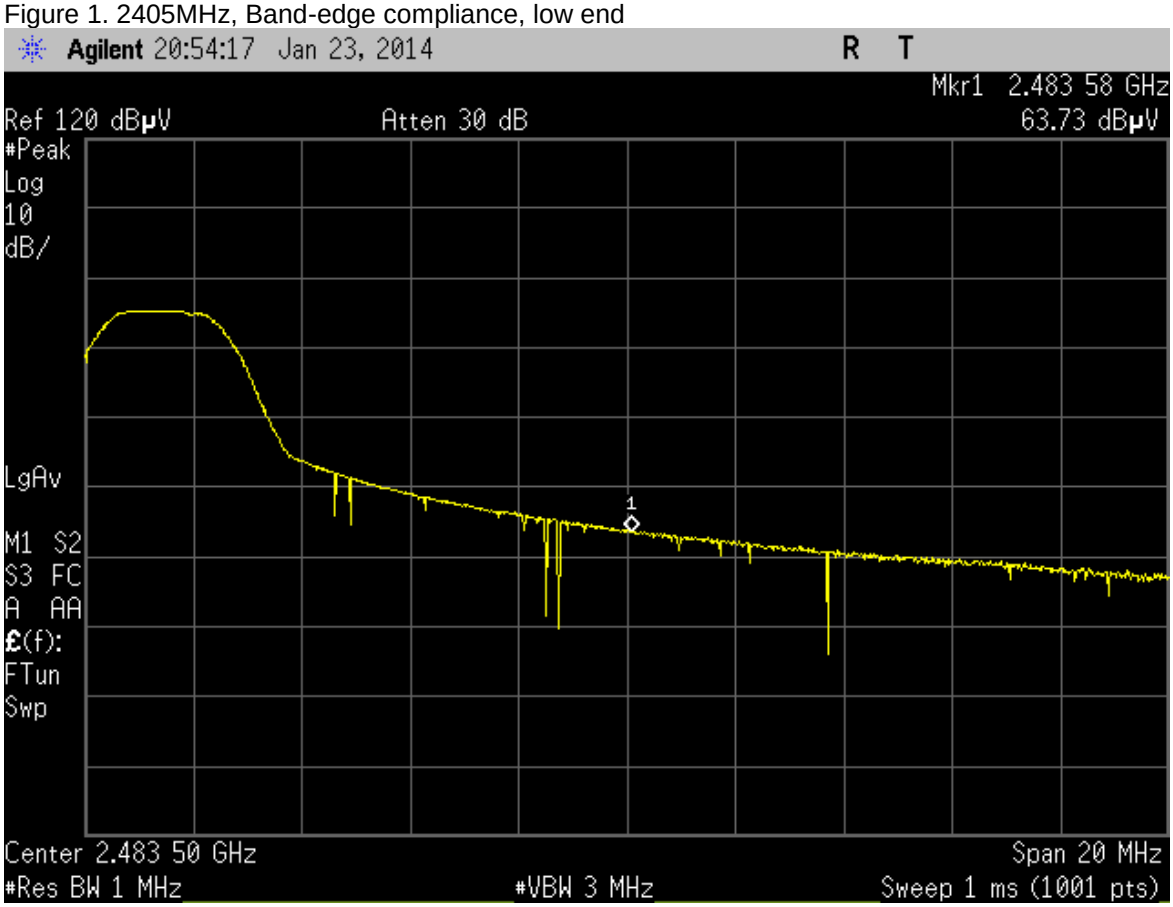


Figure 5. 2475MHz, Band-edge compliance, high end

4.3 Spurious radiated emission

The test was performed as a compliance test. The test parameters concerned were as follows:

EUT	**EUT**
Site name	**Perkkaa**
FCC rule part	**§ 15.249 (d)(e), § 15.209**
Section in RSS-210	**A2.9**
Date of testing	**21.03.2014**
Test equipment	**566, 709, 564, 559, 525, 319, 544, 350, 88**
Test conditions	**22 °C, 35 % RH**

4.3.1 EUT operation mode

EUT frequency (MHz)	**2405, 2440 and 2475**

4.3.2 Test method and limit

The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table standing on the turntable. During the test the distance from the EUT to the measuring antenna was 3 m. The excess length of the cables of the EUT was made into bundles 30-40 cm in length. In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed with the measuring antenna being both in horizontal and vertical polarizations.

Vertical and horizontal polarizations in the frequency range 30 – 1000 MHz was measured by using the peak detector. During the peak detector scan, the turntable was rotated from 0° to 360° with 30° step with the antenna heights 1.0 m and 3.0 m. The highest levels of the radiated interference field strength measured by using the quasi-peak detector were recorded.

Vertical and horizontal polarizations in the frequency range 1000 – 25000 MHz was measured by using the peak detector. During the peak detector scan, the turntable was rotated from 0° to 360° with 15° step with the antenna heights 1.0 m, 1,5m, 2.0m, 2,5m and 3.0 m. The highest levels of the radiated interference field strength measured by using the average and peak detectors were recorded.

Minimum Standard: Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

Emissions falling in the restricted bands of 15.205 shall not exceed the limits shown in §15.209.
At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions.

3m measuring distance, FCC Part 15.209

Frequency band MHz	*limit, Quasi peak detector dB(µV/m)*
30 - 88	**40**
88 - 216	**43.5**
216 - 960	**46**
960 - 1000	**54**

Frequency band MHz	*limit, average detector dB(µV/m)*	*limit, peak detector dB(µV/m)*
1000 - 25000	**54**	**74**

The EUT was tested on three orthogonal axes.
The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency per 15.33.
The device was tested on three channels per 15.31(l).

The CFR 47 Part 15. Subpart B. Class B limit of 500 µV/m has been calculated to correspond 54 dB(µV/m) as follows: [dB(µV/m)]=20log[µV/m].

The measurement results were obtained as described below.

$$E\ [\mathrm{dB}(\mu V/m)] = U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

Where

U_{RX}	receiver reading
A_{CABLE}	attenuation of the cable
AF	antenna factor
G_{PREAMP}	gain of the preamplifier

Duty Cycle correction factor(dB) -26.83 dB was used. (RFon 36*0.1265ms/100ms)

4.3.3 Test results

below 1GHz: RBW 120kHz
above 1GHz: peak, RBW 1MHz, VBW 3MHz

2405MHz

Frequency MHz	*Peak dB(µV/m)*	*Limit dB(µV/m)*	*Margin dB*	*Result*
4810	**55.7**	**74**	**18.3**	**PASS**

Frequency MHz	*Average dB(µV/m)*	*Limit dB(µV/m)*	*Margin dB*	*Result*
4810	**28.9**	**54**	**25.1**	**PASS**

2440MHz

Frequency MHz	*Peak dB(µV/m)*	*Limit dB(µV/m)*	*Margin dB*	*Result*
4880	**54.2**	**74**	**19.8**	**PASS**

Frequency MHz	*Average dB(µV/m)*	*Limit dB(µV/m)*	*Margin dB*	*Result*
4880	**27.4**	**54**	**26.6**	**PASS**

2480MHz

Frequency MHz	*Peak dB(µV/m)*	*Limit dB(µV/m)*	*Margin dB*	*Result*
4960	**53.9**	**74**	**20.1**	**PASS**

Frequency MHz	*Average dB(µV/m)*	*Limit dB(µV/m)*	*Margin dB*	*Result*
4960	**27.1**	**54**	**26.9**	**PASS**

Results more than 20 dB below the limit are not listed.

4.4 20 dB and 99% bandwidths

The test was performed as a compliance test. The test parameters concerned were as follows:

EUT	**EUT**
Site name	**Perkkaa**
FCC rule part	**§ 15.215**
IC rule part	**RSS-GEN: 4.6.1**
Date of testing	**19.03.2014**
Test equipment	**566, 525, 350**
Test conditions	**22 °C, 35 % RH**

4.4.1 EUT operation mode

EUT frequency (MHz)	**2405, 2440 and 2475**

4.4.2 Test method and limit

The measurement is made according to Public notice ANSI C63.10 (2009) and IC standard RSS-210.

Limit (MHz)
N/A

4.4.3 Test results

EUT frequency (MHz)	*20 dB bandwidth (MHz)*	*99% bandwidth (MHz)*
2405	**1.211**	**1.342**
2440	**1.386**	**1.575**
2480	**1.494**	**1.683**

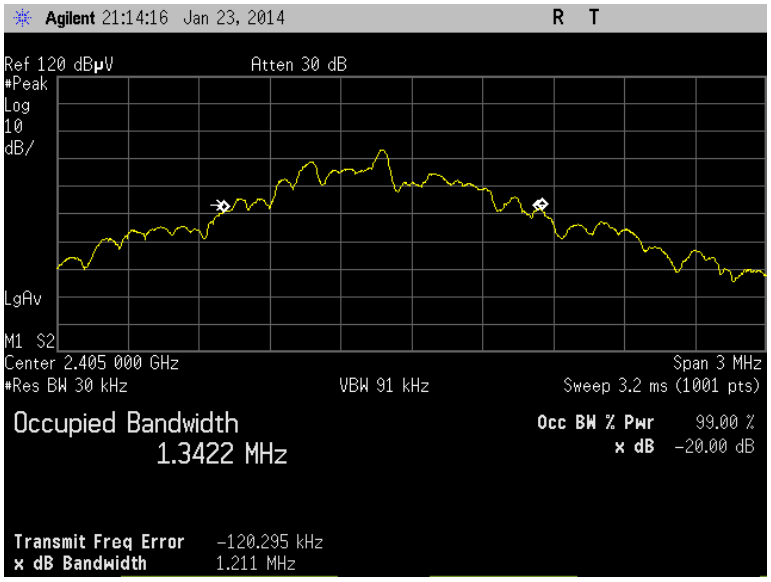


Figure 6. 2405MHz, 20 dB bandwidth

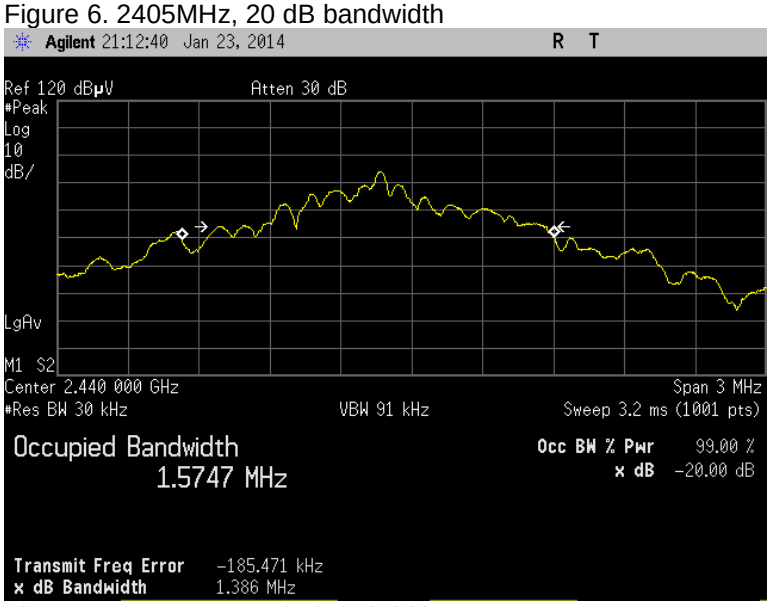


Figure 7.2440MHz, 20 dB bandwidth

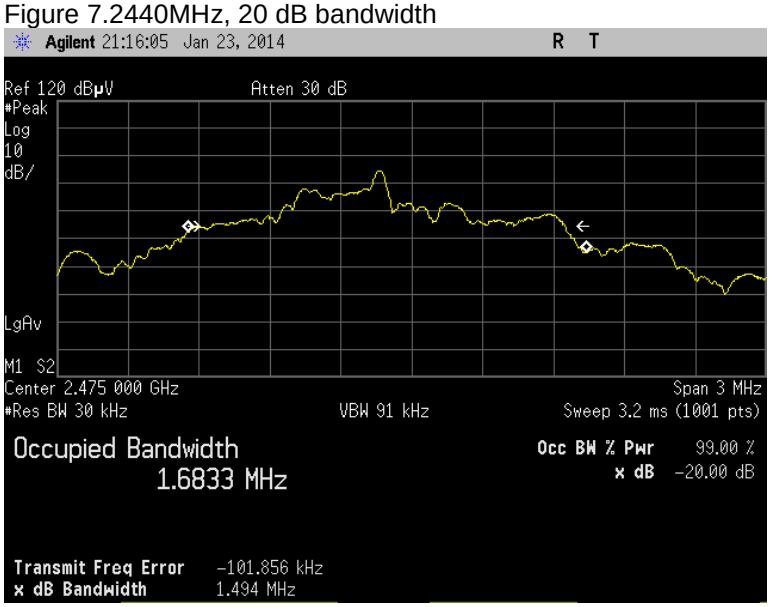


Figure 8. 2475MHz, 20 dB bandwidth

4.5 Duty cycle correction factor, Transmit time in 100 ms

Spectrum analyzer with zero span was used to investigate spectrum.

15.35(c) Unless otherwise specified, e.g.§ 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

4.5.1 Test data

Pulses/100ms=36
Length of one pulse = 0.1265ms

*DutyCycleCorrectionFactor=20*log(Tocc/100)=20*log(9*4*0.1265/100)=-26.83dB*

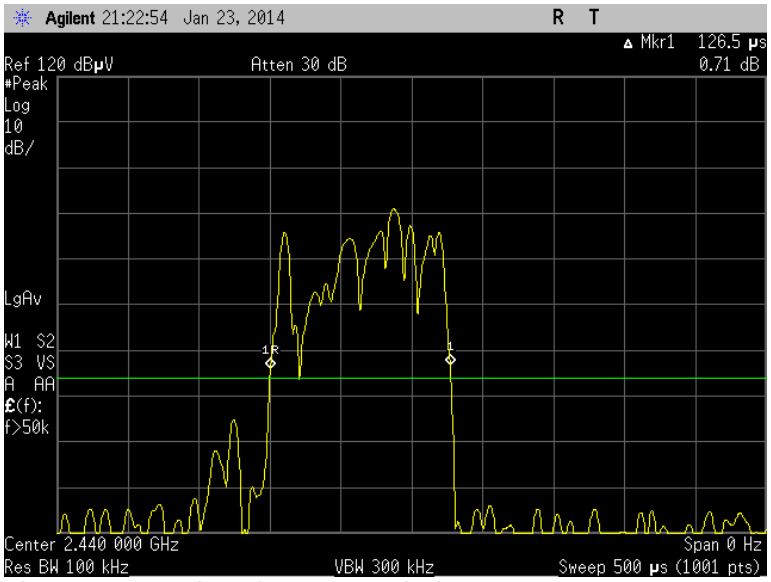
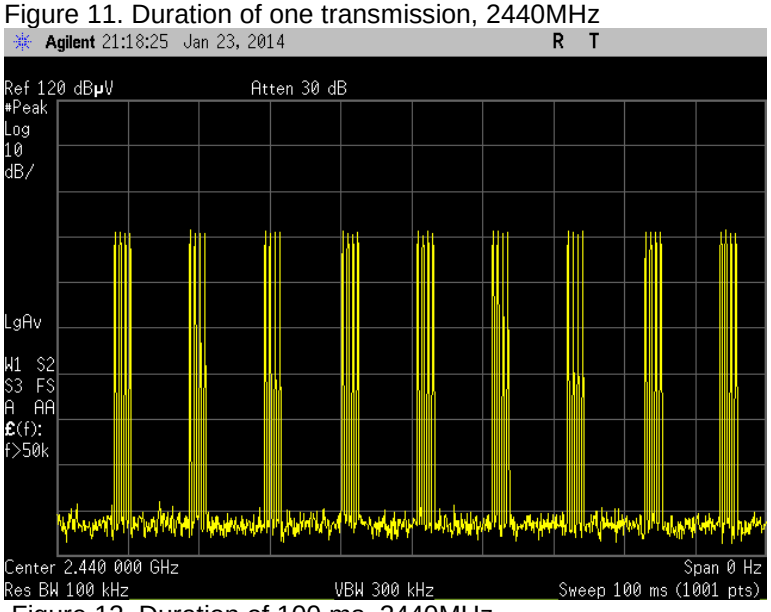


Figure 11. Duration of one transmission, 2440MHz



.Figure 12. Duration of 100 ms, 2440MHz

5. List of test equipment

Each active test equipment is calibrated once a year, antennas every 18 months and other passive equipment every 24 months.

Nr.	Equipment	Type	Manufacturer	Serial number	Cal date	Cal due
338	Test receiver	ESS	Rohde & Schwarz	847151/009	24.11.2013	11.2014
566	Spectrum analyzer	E4448A	Agilent	US42510236	17.4.2013	4.2014
709	EMI test receiver	ESU8	Rohde & Schwarz	100297	24.07.2013	7.2014
567	RF generator	E8257C	Agilent	MY43320736	11.3.2013	3.2015
544	RF-amplifier	ZFL-2000VH2	Mini-Circuits	QA0749010	29.1.2014	1.2015
564	RF amplifier	CA018-4010	CIAO Wireless	132	3.2.2014	2.2015
745	2-Line V-Network	ENV216	Rohde & Schwarz	101466	11.6.2013	6.2014
319	Antenna	CBL6112	Chase	2018	26.11.2013	5.2015
525	Double-Ridged Horn	3115	Emco	6691	10.10.2012	4.2014
542	Double-Ridged Horn	3115	Emco	00023905	10.10.2012	4.2014
559	Highpass Filter	WHKX3.0/18G-10SS	Wainwright Instruments	1	3.2.2014	2.2016
88	Waveguide horn	638	Narda	8003	-	-
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327	26.10.2012	10.2014
348	Shielded room	RFSD-100	Euroshield Oy	1320	-	-

6. Photographs

Please see Appendix to Test report: 275987A.