

FCC, IC and AS/NZS Test Report for Parts
15.247, 15.207 and 15.209 (DTS);
RSS-247, RSS Gen;
AS/NZS 4268

Product name : BG-RC012-01
Applicant : Velux A/S
FCC ID : XSG831641
IC ID : 8642A-831641

Test report No. : 180401552 001 Ver 2.00

Laboratory information

Accreditation

Telefication is designated by the FCC as an Accredited Test Firm for compliance testing of equipment subject to Certification under Parts 15 & 18. The Designation number is: NL0001.

The Industry Canada registration number for the 3 meter test chamber of Telefication is: 4173A-1.

Documentation

Telefication complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2005. The accreditation covers the quality system of the laboratory as well as the specific activities as described in the authorized annex bearing the accreditation number L021 and is granted on 30 November 1990 by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at Telefication Netherlands.

Testing Location

Test Site	Telefication BV
Test Site location	Edisonstraat 12a 6902 PK Zevenaar The Netherlands Tel. +31889983600 Fax. +31316583189
Test Site FCC	NL0001

Revision History

Version	Date	Remarks	By
v0.50	18-10-2018	First draft	PvW
v1.00	25-10-2018	Initial release	PvW
v2.00	08-04-2019	Updated type of modulation in clause 1.4 Product specifications of Equipment under test from GFSK to OQPSK	KR

Table of Contents

Revision History	2
Summary of Test results.....	5
1 General Description.....	6
1.1 Applicant.....	6
1.2 Manufacturer	6
1.3 Tested Equipment Under Test (EUT)	6
1.4 Product specifications of Equipment under test	7
1.5 Modification of the Equipment Under Test (EUT).....	7
1.6 Observations and remarks.....	7
1.7 Environmental conditions.....	7
1.8 Measurement Standards	7
1.9 Applicable Standards	7
1.10 Conclusions.....	8
2 Test configuration of the Equipment Under Test	9
2.1 Test mode	9
2.2 Tested channels and Data rates	9
2.3 Test setups.....	9
2.4 Equipment used in the test configuration.....	10
2.5 Sample calculation.....	11
3 Test results	12
3.1 6dB bandwidth Measurement.....	12
3.1.1 Limit.....	12
3.1.2 Measurement instruments	12
3.1.3 Test setup.....	12
3.1.4 Test procedure	12
3.1.5 Test Results of the 6 dB bandwidth Measurement.....	12
3.2 99% Occupied Bandwidth.....	13
3.2.1 Limit.....	13
3.2.2 Measurement instruments	13
3.2.3 Test setup.....	13
3.2.4 Test procedure	13
3.2.5 Test results of the 99% occupied bandwidth measurement.....	13
3.2.6 Plots of the 99% occupied bandwidth measurement	14
3.3 Output Power Measurement	16
3.3.1 Limit.....	16
3.3.2 Measurement instruments	16
3.3.3 Test setup.....	16

3.3.4	Test procedure	16
3.3.5	Test results of Output Power Measurement.....	16
3.4	Power Spectral Density.....	17
3.4.1	Limit.....	17
3.4.2	Measurement instruments	17
3.4.3	Test setup.....	17
3.4.4	Test procedure	17
3.4.5	Test results of Power Spectral Density Measurement	17
3.5	Band edge Measurement	18
3.5.1	Limit.....	18
3.5.2	Measurement instruments	18
3.5.3	Test setup.....	18
3.5.4	Test procedure	18
3.5.5	Measurement Uncertainty.....	18
3.5.6	Plots of the Band edge Measurements.....	18
3.6	Radiated Spurious Emissions Measurement	20
3.6.1	Limit.....	20
3.6.2	Measurement instruments	20
3.6.3	Test setup.....	20
3.6.4	Test procedure	20
3.6.5	Notes	20
3.6.6	Plots of the Radiated Spurious Emissions	21
3.6.7	Measurement Uncertainty.....	26
4	Additional tests	27
4.1	Operation within permitted operating frequency band.....	27
4.1.1	Limit.....	27
4.1.2	Measurement equipment	27
4.1.3	Test set up	27
4.1.4	Test procedure	27
4.1.5	Measurement uncertainty	27
4.1.6	Results of the operation within permitted operating frequency band measurement	27
4.2	Radiated power level.....	28
4.2.1	Limit.....	28
4.2.2	Measurement equipment	28
4.2.3	Test set up	28
4.2.4	Test procedure	28
4.2.5	Results	28
4.2.6	Measurement uncertainty	28

Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247 (a)	RSS-247 5.2	6dB Bandwidth	3.1	Pass
--	RSS-Gen 6.6	99% Bandwidth	3.2	Pass
15.247 (b)	RSS-247 5.1 (2)	RF output power	3.3	Pass
15.247 (e)	RSS-247 5.2 (2)	Power spectral density	3.4	Pass
15.247 (d)	RSS-247 5.5	Band edge	3.5	Pass
15.209 (a)	RSS-247 5.4	Radiated Spurious emissions	3.6	Pass
15.205 (a)	RSS Gen 8.10	Spurious emissions in the restricted bands	3.6	Pass
15.207 (c)	RSS-Gen 8.8	Conducted spurious emissions on AC mains	3.7	Pass

AS/NZS	Method in EN 300-440-1	Description	Section in report	Verdict
8.4	--	Operation within permitted frequency band	4.1	Pass
8.1	7.1	Radiated power level	4.2	Pass

1 General Description

1.1 Applicant

Client name:	Velux A/S
Address:	Baekgaardsvej 40, SKJERN, Denmark
Zip code:	--
Telephone:	97 353511
E-mail:	Bjarne.andreasen@velux.com
Contact name:	Bjarne Ravndal Andreasen

1.2 Manufacturer

Manufacturer name:	Velux A/S
Address:	Baekgaardsvej 40, SKJERN, Denmark
Zip code:	--
Telephone:	30581588
E-mail:	j.a.m.thomsen@velux.com
Contact name:	Jens Thomsen

1.3 Tested Equipment Under Test (EUT)

Product name:	BG-RC012-01
Brand name:	Velux A/S
Product type:	Battery operated remote control
FCC ID:	XSG831641
IC ID	8642A-831641
Software version:	--
Hardware version:	831679/03
Date of receipt	30-05-2018
Tests started:	11-06-2018
Testing ended:	25-10-2018

1.4 Product specifications of Equipment under test

TX Frequency range (MHz)	802.15.4: 2400 – 2483.5
RX frequency range (MHz)	802.15.4: 2400 – 2483.5
Maximum output power to antenna (dBm)	9.23
Antenna type	PCB antenna
Antenna gain (dBi)	1.33
Type of modulation	OQPSK
Emission designator Zigbee	2M18G1D

1.5 Modification of the Equipment Under Test (EUT)

None.

1.6 Observations and remarks

The manufacturer provided a radiated sample and a conducted sample with a temporary antenna connector for radio testing.

1.7 Environmental conditions

Test date	11-06-2018	14-06-2018	19-10-2018	25-10-2018
Ambient temperature	25.6 °C	23.8 °C	21.6 °C	22.0 °C
Humidity	45.6 %	45.1 %	46.0 %	46.3 %

1.8 Measurement Standards

- FCC KDB Publication No. 558074 D01DTS Meas. Guidance V04
- ANSI C63.10:2013
- AS/NZS 4268:2012
- ETSI EN 300 440-1 V1.4.1 (2008)

1.9 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247, §15.207, §15.209
- RSS-247 Issue 2, RSS-Gen Issue 5
- AS/NZS 4268:2012

1.10 Conclusions

The sample of the product showed NO NON-COMPLIANCES to the specifications stated in paragraph 1.9 of this report.

The results of the test as stated in this report, are exclusively applicable to the product items as identified in this report. Telefication accepts no responsibility for any properties of product items in this test report, which are not supported by the tests as specified in paragraph 1.9 "*Applicable standards*".

All tests are performed by:

Name : P. van Wanrooij, BASC

Review of test methods and report by:

Name : ing. R. van Barneveld

The above conclusions have been verified by the following signatory:

Date : 08-04-2019

Name : ing. K.A. Roes

Function : Coordinator Radio Laboratory

Signature :



2 Test configuration of the Equipment Under Test

2.1 Test mode

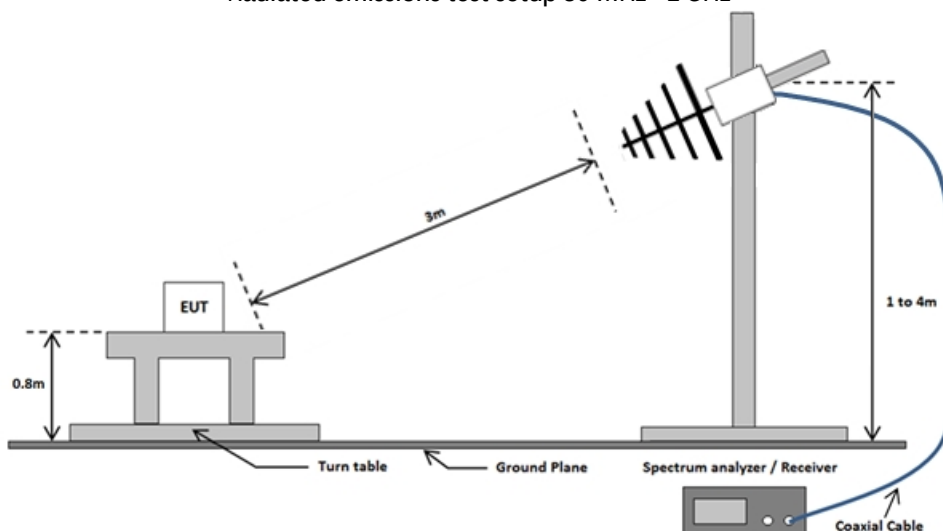
The applicant provided test mode firmware for the EUT, in which it was possible to configure the EUT into different test channels.

2.2 Tested channels and Data rates

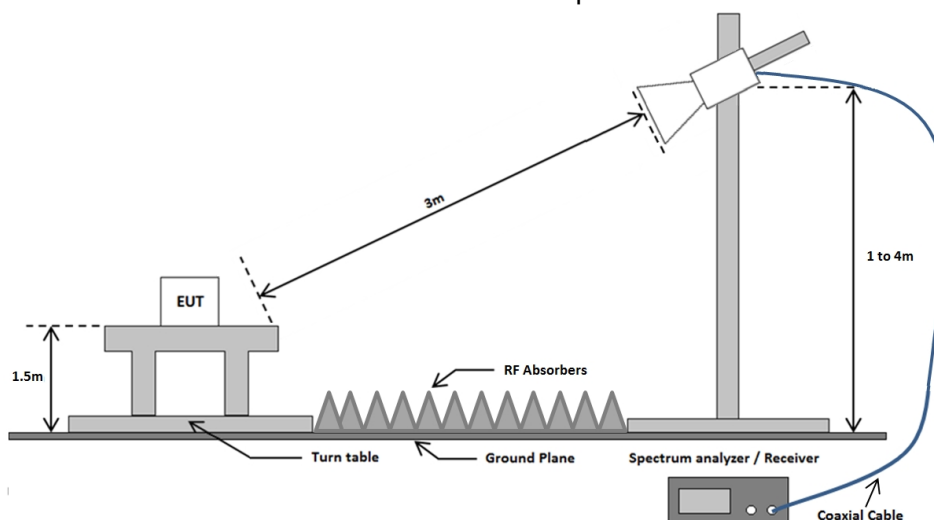
Technology	Channels	Data rate	Frequency (MHz)
IEEE 802.15.4 (Zigbee)	15 (Low)	250 kbps	2425
	20 (Mid)	250 kbps	2450
	25 (High)	250 kbps	2475

2.3 Test setups

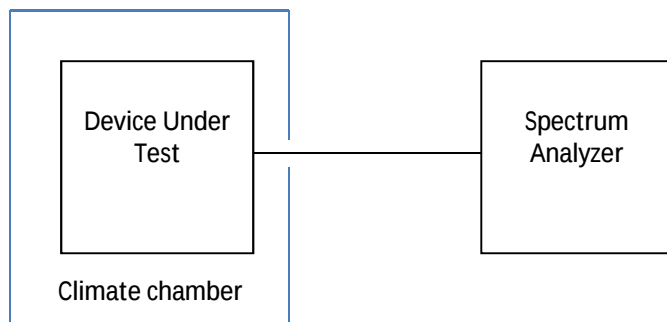
Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



Conducted emissions and climate tests



2.4 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Used at Par.
Spectrum Analyzer	Rohde & Schwarz	FSV40	TE01269	3.1 - 3.5
Spectrum Analyzer	Rohde & Schwarz	FSP40	TE11125	3.6
Spectrum Analyzer	Rohde & Schwarz	ESCI	TE11128	3.6
Spectrum Analyzer	Rohde & Schwarz	FSV40	TE11160	4.1
Biconilog Antenna	Chase	CBL6112A	TE00967	3.6
Horn Antenna	EMCO The Electro – Mechanics Co	3115	TE00531	3.6
SAC	Comtest Engineering BV	-	TE00861	3.6
Pre-amplifier	Miteq	Js4-18004000-30-8P-A1	TE11131	3.6
Software	DARE Instruments	Radimation 2016.2.8	--	3.6
6 dB attenuator	Hewlett Packard	8491A	TE00403	3.1 – 3.5
Climate chamber	CTS	C-40/350	TE00741	4.1
Power sensor	Hewlett Packard	8481A	TE00485	4.2
Power meter	Hewlett Packard	8487A	TE00489	4.2

2.5 Sample calculation

Field Strength Measurement example:

Frequency (GHz)	Polarization	Height(m)	Peak (dB μ V/m)
7,236	Horizontal	2	52.5

The following relation applies:

$$E \text{ (dB}\mu\text{V/m)} = U \text{ (dB}\mu\text{V)} + AF \text{ (dB/m)} - G \text{ (dB)} + CL \text{ (dB)}$$

Where:

E = Electric field strength

U = Measuring receiver voltage

AF = Antenna factor

G = Gain of the pre-amplifier

CL = Cable loss

$$(52.5 = 48.12 + 36.1 - 37.42 + 5.7)$$

3 Test results

3.1 6dB bandwidth Measurement

3.1.1 Limit

The minimum 6 dB Bandwidth shall be at least 500 kHz.

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.1.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.

IRN 017 - Occupied bandwidth (Hz) Method 2.

3.1.5 Test Results of the 6 dB bandwidth Measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	6dB bandwidth (kHz)
Zigbee	15	2425	250 kbps	1595
	20	2450	250 kbps	1596
	25	2475	250 kbps	1590
Uncertainty	± 40 kHz			

3.2 99% Occupied Bandwidth

3.2.1 Limit

According to RSS-Gen 6.6

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.2.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.2.4 Test procedure

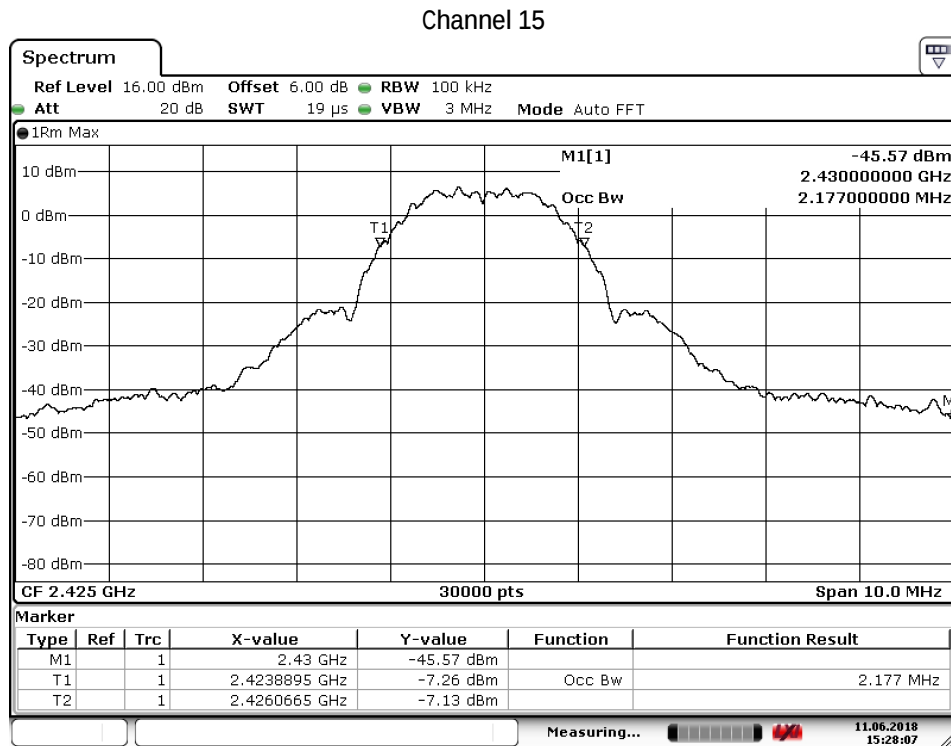
IRN 017 - Occupied bandwidth (Hz) Method 1 – XX % power bandwidth.

1. Set the centre frequency to the nominal EUT channel centre frequency
2. Set span = 1.5 times to 0.5 times the Occupied Bandwidth
3. Set VBW $\geq$ 3x RBW
4. Video averaging is not permitted. Where practical, detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

3.2.5 Test results of the 99% occupied bandwidth measurement

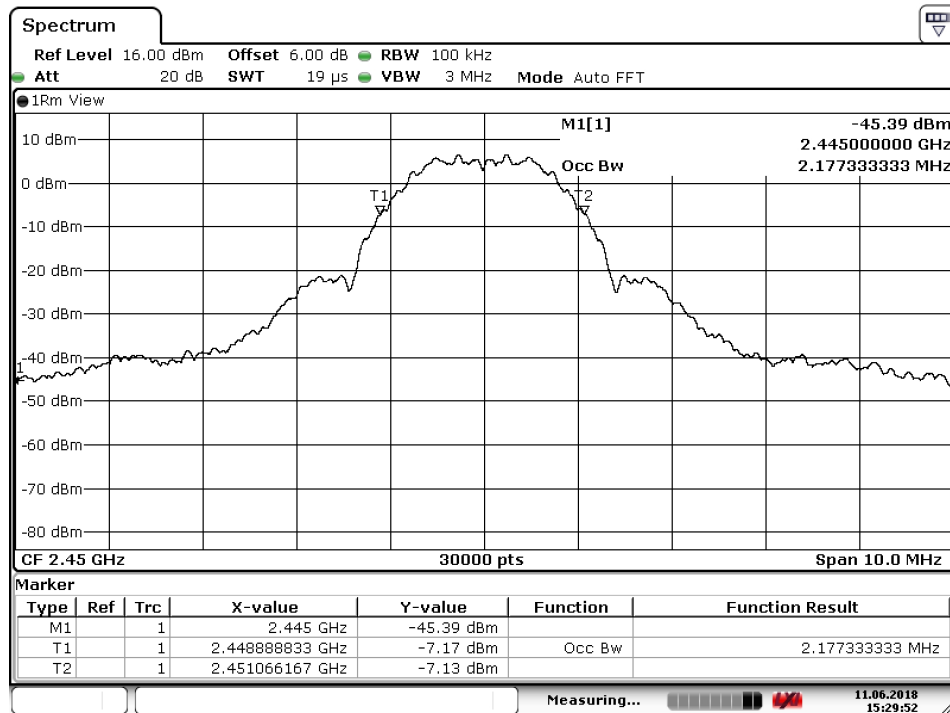
Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Zigbee	15	2425	250 kbps	2177
	20	2450	250 kbps	2177
	25	2475	250 kbps	2180
Uncertainty	± 40 kHz			

3.2.6 Plots of the 99% occupied bandwidth measurement



IEEE802_11b, channel: 13 : Measure RX Spurious Emission 1 -
12.5 GHz
Date: 11.JUN.2018 15:28:07

Channel 20

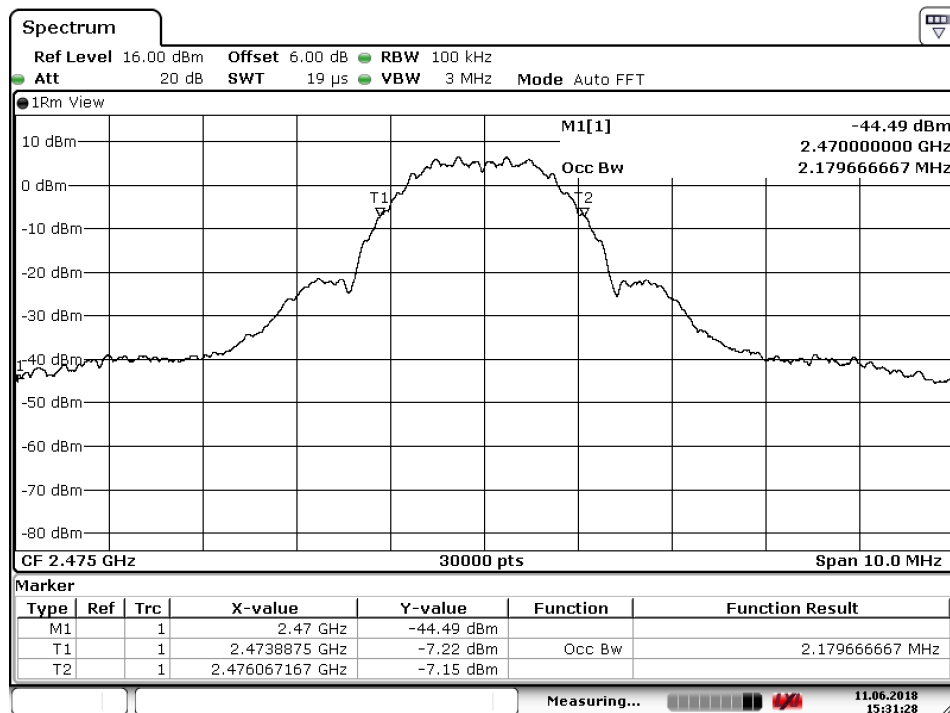


IEEE802_11b, channel: 13 : Measure RX Spurious Emission 1 -

12.5 GHz

Date: 11.JUN.2018 15:29:52

Channel 25



IEEE802_11b, channel: 13 : Measure RX Spurious Emission 1 -

12.5 GHz

Date: 11.JUN.2018 15:31:28

3.3 Output Power Measurement

3.3.1 Limit

For systems using digital modulation in the 2400-2483.5 MHz, the limit for the peak output power is 30 dBm. If transmitting antenna of directional gain greater than 6 dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point to point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.3.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.3.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
IRN 014 - RF power (W) - Method 1 – AVGSA (DTS) according to ANSI C63.10.

3.3.5 Test results of Output Power Measurement

Peak method				
Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power (dBm)
Zigbee	15	2425	250 kbps	10.50
	20	2450	250 kbps	10.56
	25	2475	250 kbps	10.46
Uncertainty	± 0.71 dB			

3.4 Power Spectral Density

3.4.1 Limit

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band at any time interval of continuous transmission.

3.4.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.4.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.4.4 Test procedure

The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.

IRN 030 - Spectral power density (W per n.Hz) - Method 5 – Peak method PKPSD (PSD in 3 kHz band).

3.4.5 Test results of Power Spectral Density Measurement

Peak Power spectral density				
Technology Std.	Channel	Frequency (MHz)	Data rate	PSD/3kHz (dBm)
Zigbee	15	2425	250 kbps	5.89
	20	2450	250 kbps	5.92
	25	2475	250 kbps	5.83
Uncertainty	± 2 dB			

3.5 Band edge Measurement

3.5.1 Limit

Band edge:

At the edge of the authorized band the RF power shall be at least 20 dB down.

3.5.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.5.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.5.4 Test procedure

According to KDB Publication 558074 V04, sections 11.3 and 12.1.

IRN 026 - Radiated electrical disturbance (V per m) Method 6 – Radiated electrical disturbance at the Authorized band edge.

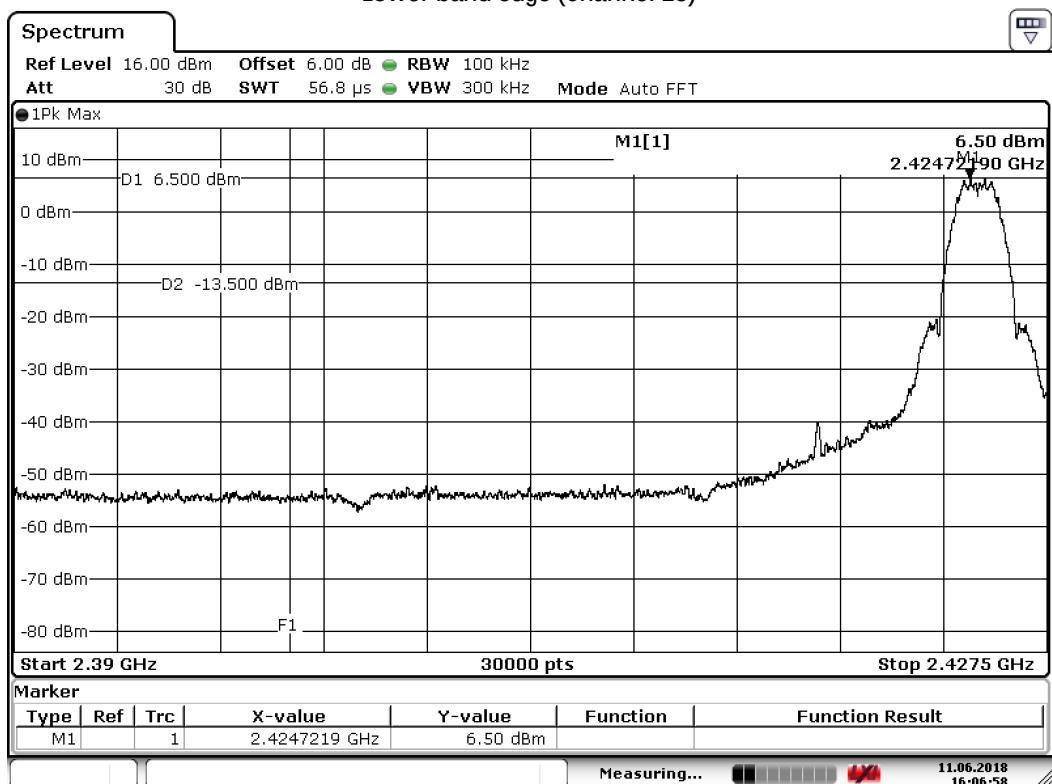
3.5.5 Measurement Uncertainty

± 5.7 dB.

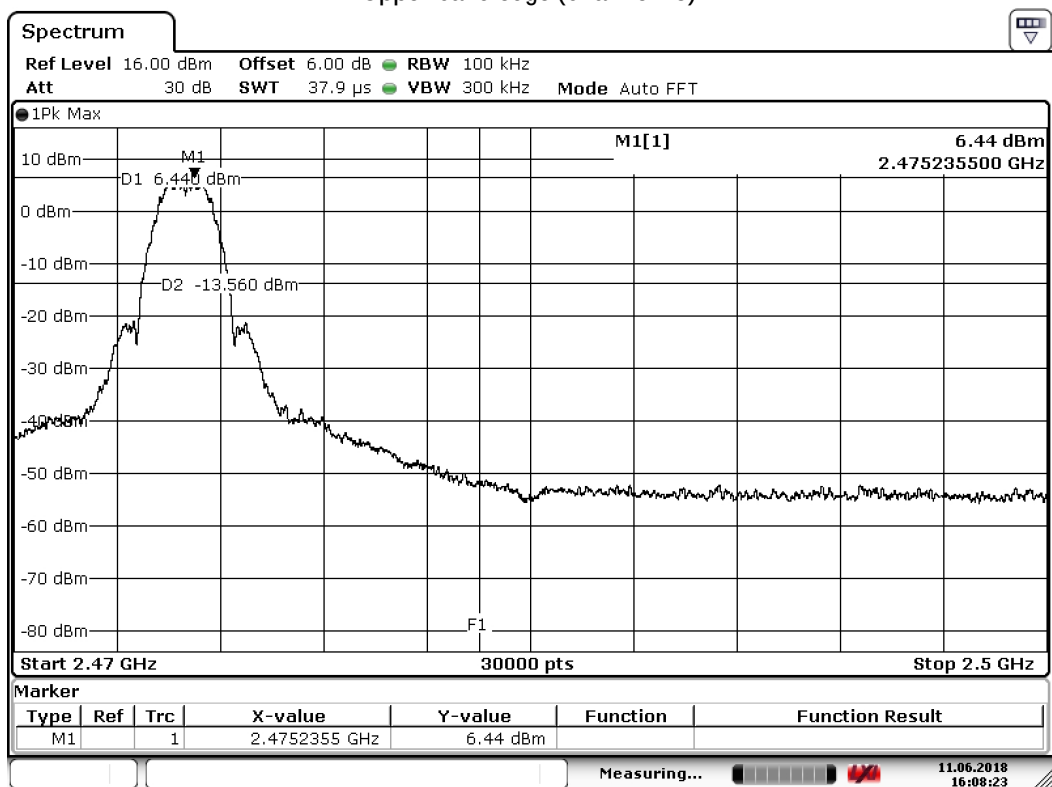
3.5.6 Plots of the Band edge Measurements

See next page.

Lower band edge (Channel 15)



Upper band edge (Channel 25)



3.6 Radiated Spurious Emissions Measurement

3.6.1 Limit

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

15.209

Frequency (MHz)	Field strength ($\mu\text{V/m}$)	Measurement distance(m)
0.009 – 0.490	$2400/F(\text{kHz})$	300
0.490 – 1.705	$24000/F(\text{kHz})$	30
1.705 - 30	30	30
30 -88	100	3
88 - 216	150	3
216-960	200	3
Above 960	500	3

3.6.2 Measurement instruments

The measurement instruments are listed in chapter 2.4 of this report.

3.6.3 Test setup

The test setup is as shown in chapter 2.3 of this report.

3.6.4 Test procedure

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

Other details are according to KDB Publication 558074 V04, sections 11.3 and 12.1.

IRN 026 - Radiated electrical disturbance (V per m) Method 1 – 30 MHz – 1 GHz in SAR.

IRN 026 - Radiated electrical disturbance (V per m) Method 2 – 1 - 18 GHz in SAR.

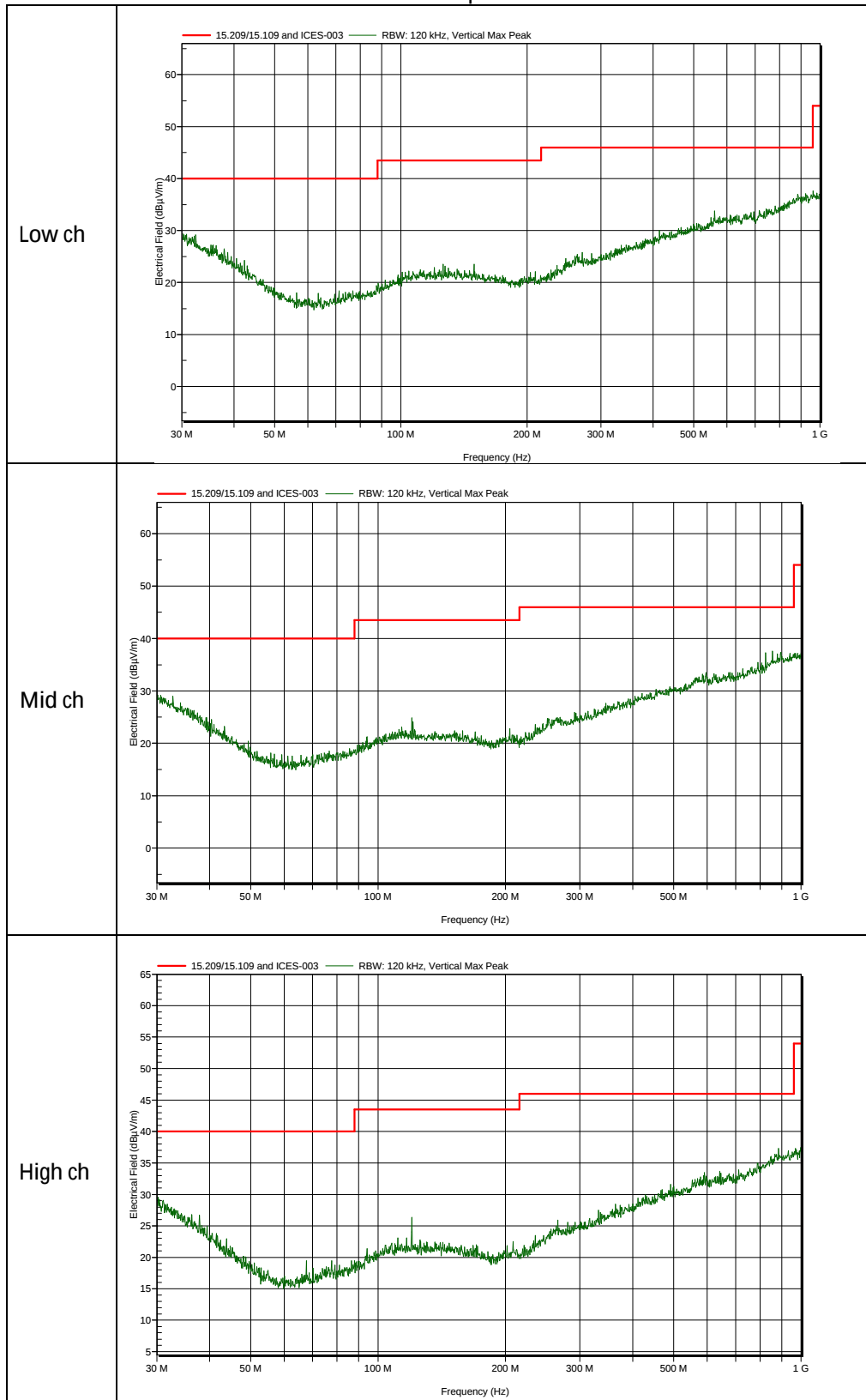
3.6.5 Notes

- In the frequency range of 1 – 26 GHz the green trace is measured using a peak detector and the red trace is measured using an average detector. The top limit line represent the peak limit and the bottom limit represents the average limit
- Emissions in the 18-26.5 GHz range are measured conducted, as any emissions found in this range would be products of the RF generator or harmonics of the carrier.

3.6.6 Plots of the Radiated Spurious Emissions

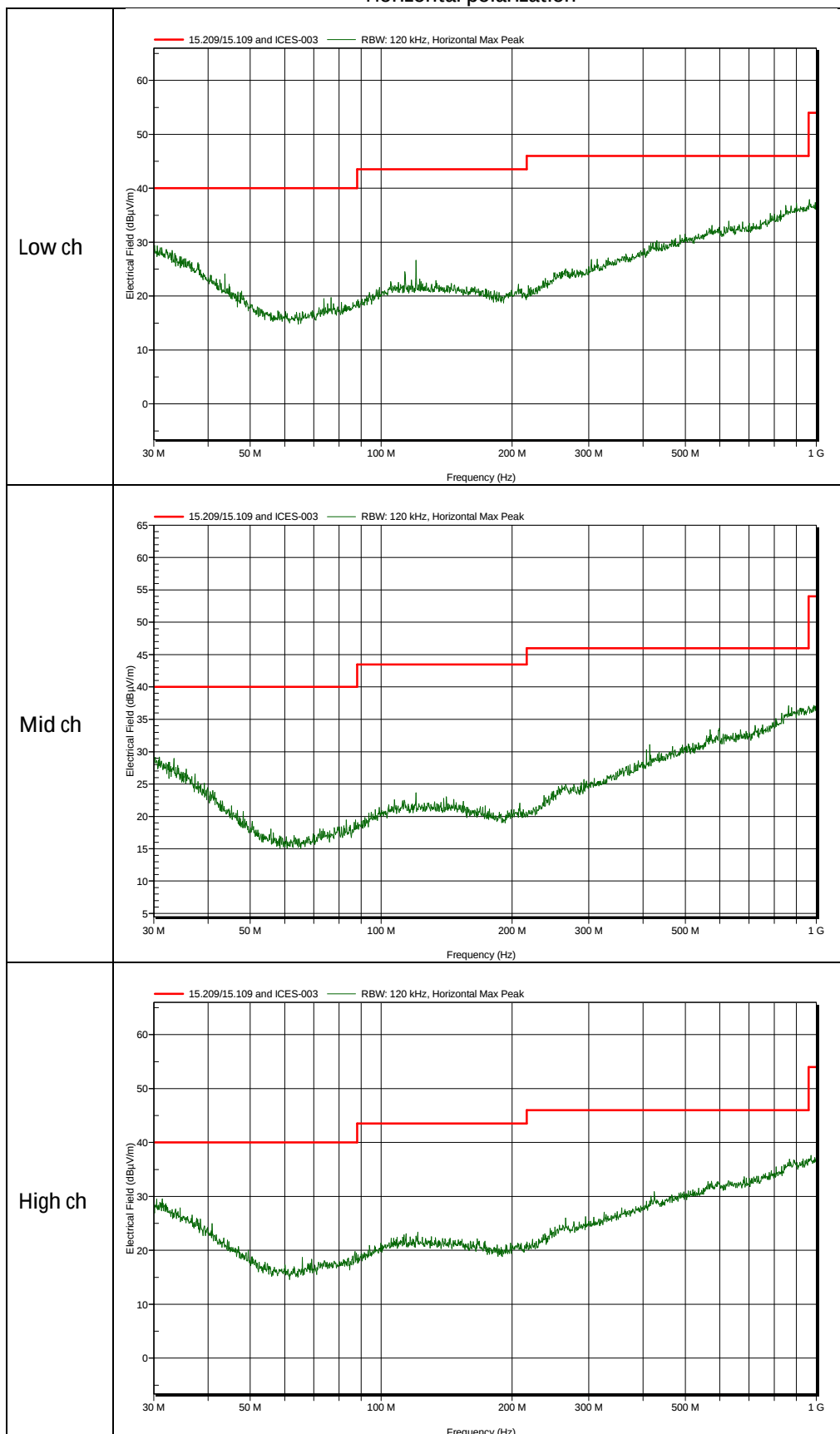
30 MHz to 1 GHz

Vertical polarization



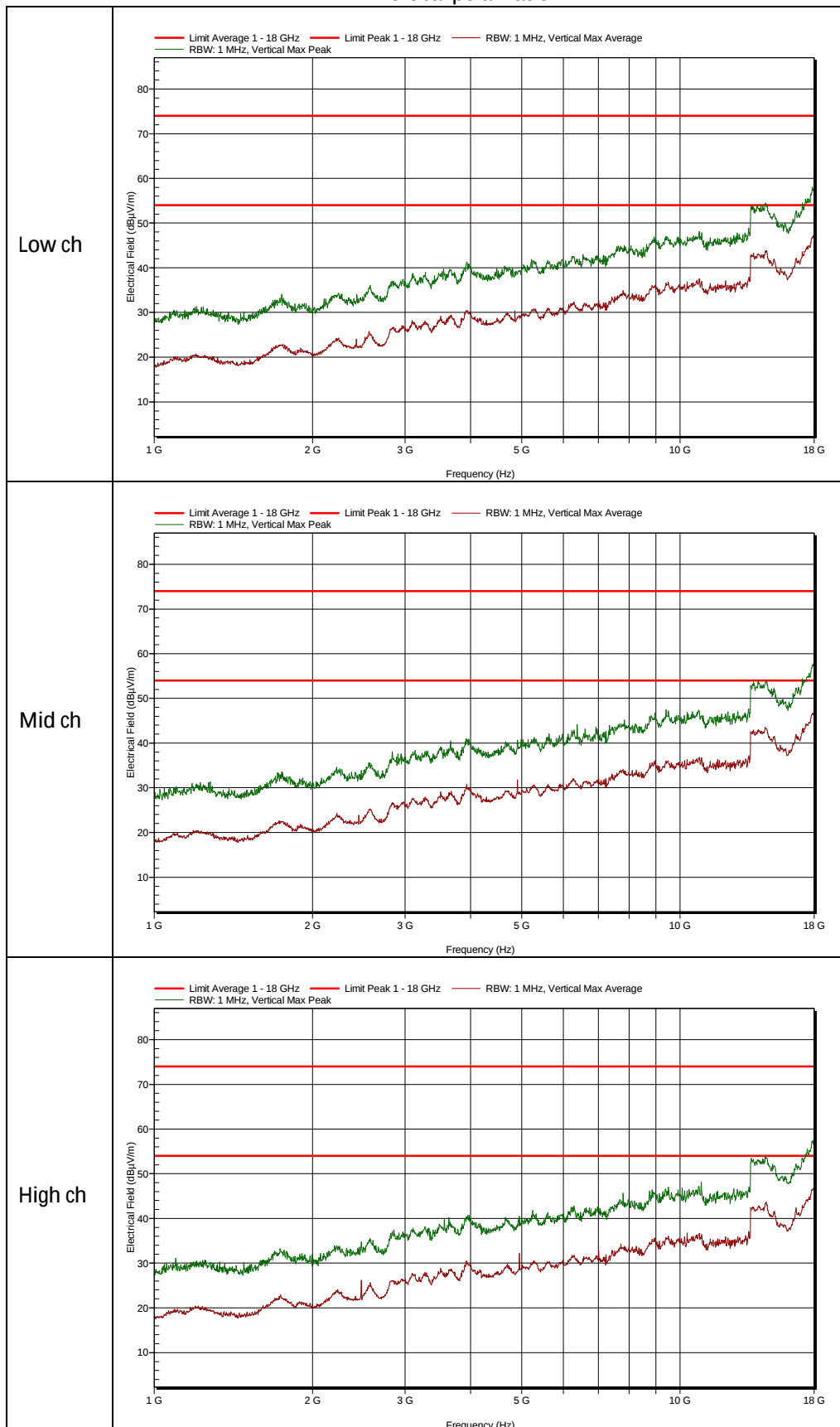
30 MHz to 1 GHz

Horizontal polarization



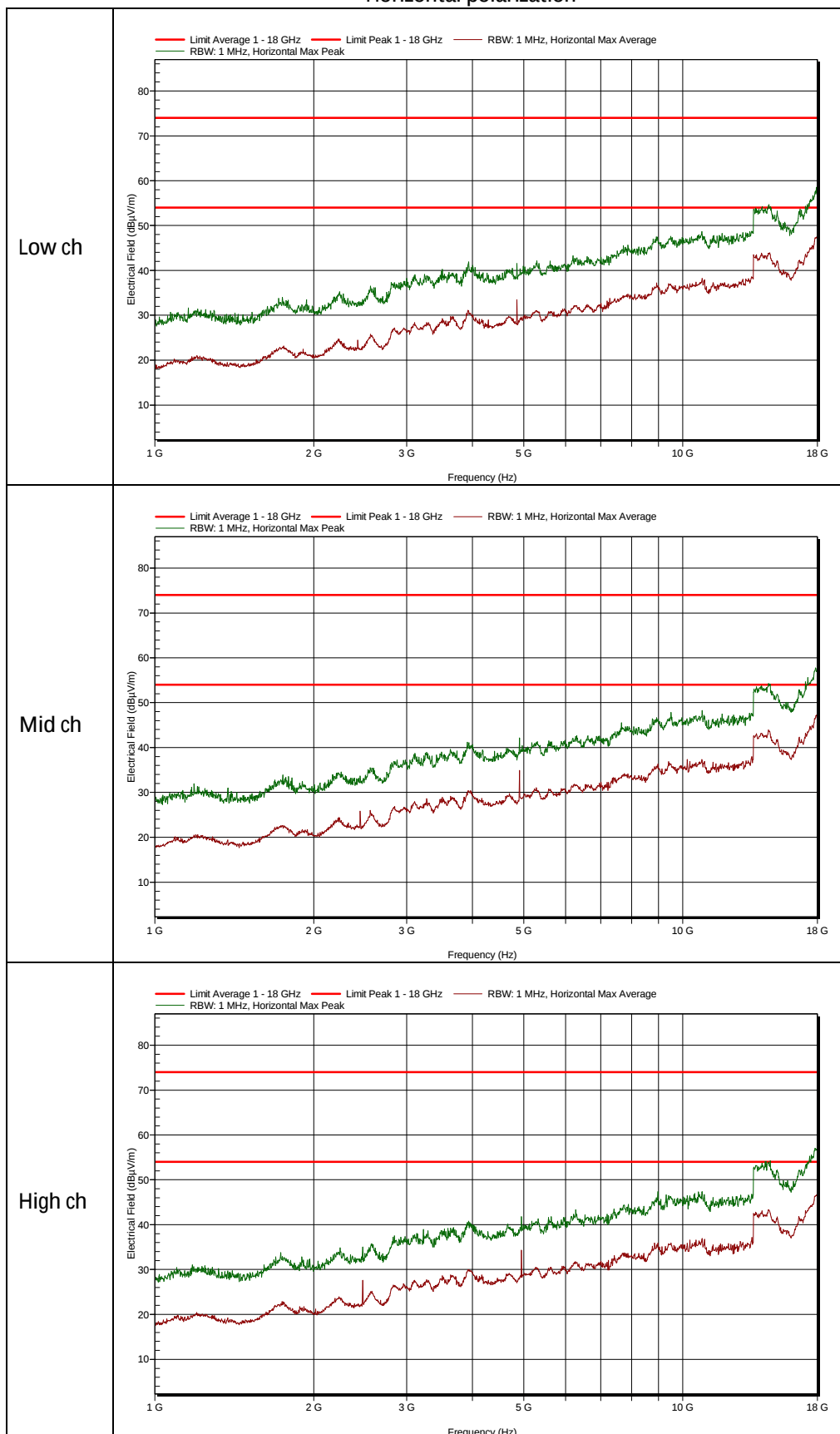
1 GHz to 18 GHz

Vertical polarization



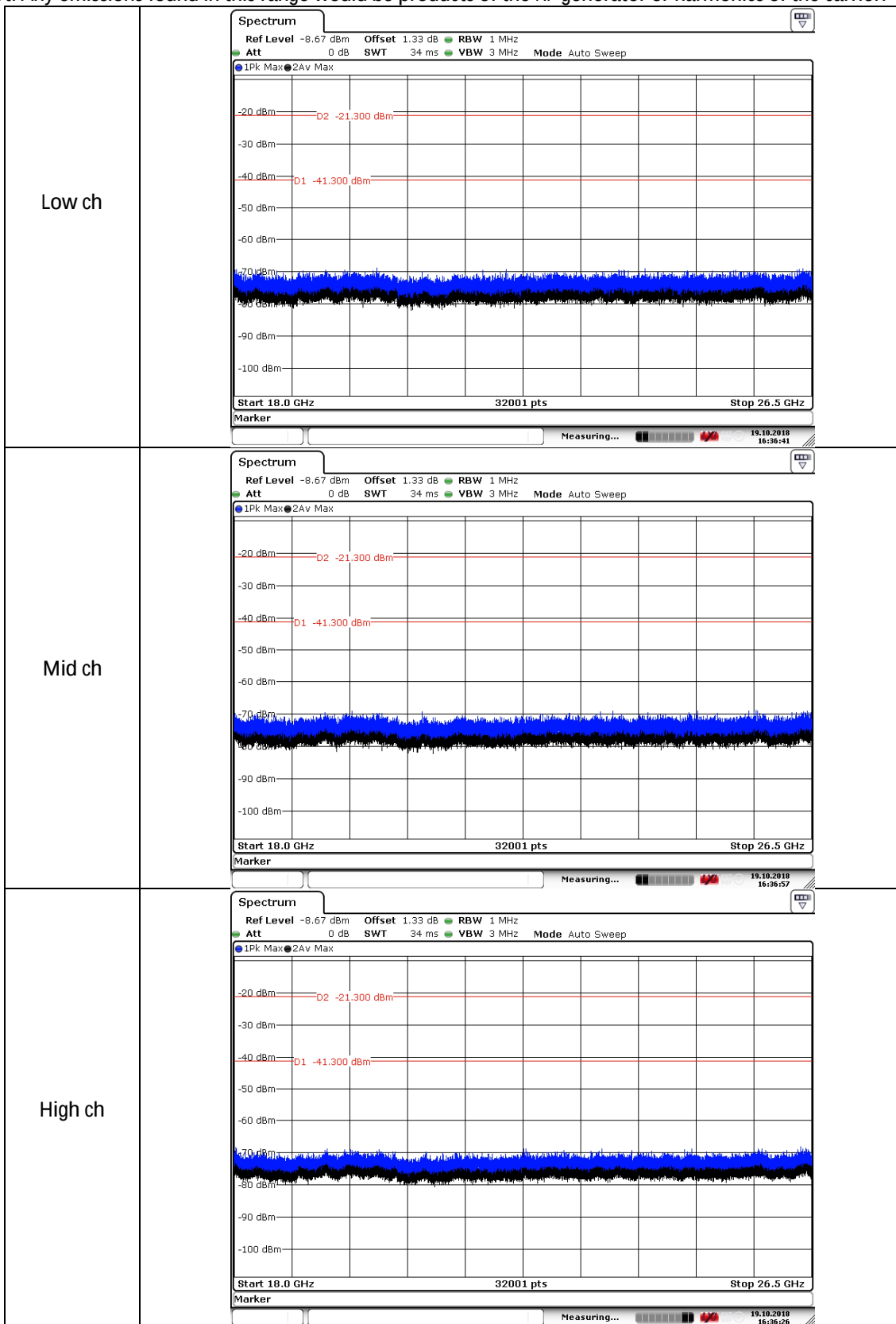
1 GHz to 18 GHz

Horizontal polarization



18 GHz to 26 GHz

Note: Spurious emissions measured in the 18 to 26 GHz range have been measured conducted at the antenna port. Any emissions found in this range would be products of the RF generator or harmonics of the carrier.



3.6.7 Measurement Uncertainty

Measurement uncertainty Radiated emissions below 1 GHz

Horizontal polarization	
30 – 200 MHz	4.5 dB
200 – 1000 MHz	3.6 dB
Vertical polarization	
30 – 200 MHz	5.4 dB
200 – 1000 MHz	4.6 dB

Measurement uncertainty Radiated emissions above 1 GHz

1000- 18000 MHz	5.7 dB
18000 – 26000 MHz	3.9 dB

4 Additional tests

4.1 Operation within permitted operating frequency band

4.1.1 Limit

Permitted operating frequency band: 2400 – 2483.5 MHz.

4.1.2 Measurement equipment

The measurement instruments are listed in chapter 2.4 of this report.

4.1.3 Test set up

The test setup is listed in chapter 2.3 of this report.

4.1.4 Test procedure

According to EN 300 440-1 V1.4.1, section 7.2.2 and AZ/NZS 4268: 2012, sections 4.3 and 4.4.
IRN 017 – Method 1.

4.1.5 Measurement uncertainty

+/- 0.02446 MHz.

4.1.6 Results of the operation within permitted operating frequency band measurement

Temperature (°C)	Lowest frequency (MHz)	Highest frequency (MHz)
-20	2423.90445	2476.08054
20	2423.88950	2476.06717
55	2423.88944	2476.06553

4.2 Radiated power level

4.2.1 Limit

Equivalent isotropically radiated power should be less than 4 W.

4.2.2 Measurement equipment

The measurement instruments are listed in chapter 2.5 of this report.

4.2.3 Test set up

The test setup is as shown in chapter 2.3 of this report.

4.2.4 Test procedure

According to EN 300 440-1 V1.4.1, Annex B.1.

IRN 014 – Method 8.

4.2.5 Results

Test conditions				Transmitter output power (mW eirp)		
				Ch 15	Ch 20	Ch 25
T _{nom.}	22.0 °C	V _{nom.}	3.7 Vdc	14.2	14.0	13.8

4.2.6 Measurement uncertainty

+/- 0.52 dB