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FCC Test Report for Parts 15.247 (DSS), 15.209, 15.109 and 15.207

Product name	: RF Module 915 MHz
Applicant	: Tyro Products B.V.
FCC ID	: SQLRXTX-02

Test report No. : 191001881 001 v1.00

Laboratory information

Accreditation

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).

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.

Telefication is a Wireless Device Testing laboratory recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements.
The Industry Canada registration number for the 3 meter test chamber of Telefication is: 4173A-1.

Telefication is a registered Conformity Assessment body (CAB) under the Japan-EC MRA (Agreement on Mutual Recognition between Japan and the European Community). The registration number is: 201.

Documentation

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	29-03-2020	First draft	RvB
v1.00	07-04-2020	Initial release	RvB

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Summary of Test results

FCC	Description	Section in report	Verdict
15.247 (a)	20dB Bandwidth	3.1	Pass
15.247 (b)	RF output power	3.2	Pass
15.247 (a)	Dwell time	3.3	Pass
15.247 (a)	Channel separation	3.4	Pass
15.247 (a)	Number of hopping channels	3.5	Pass
15.247 (d)	Band edge	3.6	Pass
15.209 (a)	Radiated Spurious emissions	3.7	Pass
15.205 (a)	Spurious emissions in the restricted bands	3.7	Pass
15.109(a)	Rx Radiated Spurious emissions	3.8	Pass
15.207 (c)	Conducted emission	3.9	Pass

1 General Description

1.1 Applicant

Client name:	Tyro Products B.V.
Address	Bedrijvenpark Twente 299, 7602 KK Almelo
Contact name:	Marcel Krisman
E-mail:	m.krisman@tyroremotes.eu
Telephone:	0546 588790

1.2 Manufacturer

Client name:	Tyro Products B.V.
Address	Bedrijvenpark Twente 299, 7602 KK Almelo
Contact name:	Marcel Krisman
E-mail:	m.krisman@tyroremotes.eu
Telephone:	0546 588790

1.3 Tested Equipment Under Test (EUT)

Product name:	RF module 915 MHz
Brand name:	--
Product type:	Wireless transceiver
FCC id	SQLRXTX-02
Software version:	--
Hardware version:	--
Date of receipt	08-11-2019
Tests started:	08-11-2019
Testing ended:	30-03-2020

1.4 Product specifications of Equipment under test

TX Frequency range (MHz)	910 – 918.855
RX frequency range (MHz)	910 – 918.855
Maximum output power to antenna (dBm)	14.87
Antenna type	½ wave dipole
Antenna gain (dBi)	1.2
Type of modulation	GFSK
Emission designator	61K4G1D

1.5 Modification of the Equipment Under Test (EUT)

None.

1.6 Observations and remarks

Pseudo random channel usage:
Every device has a unique identification number (UID). This UID is used as a seed to generate a pseudo random sequence of 50 channels where each channel from 1-50 will be used only once. Using unique identification numbers as a seed to generate the sequence results in different pseudo random sequences for every device.

Devices communicating with each other use the UID of one device in the group to determine the pseudo random sequence.

1.7 Environmental conditions

Test date	08-11-2019	18-03-2020	30-03-2020
Ambient temperature	20.2°C	20.5°C	21.4°C
Humidity	44.1	37.0%	29.2%

1.8 Measurement Standard

- ANSI C63.10:2013
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05

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, §15.209 and §15.207
- FCC Part 15 Subpart B §15.109

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 : ing. R. van Barneveld

Review of test methods and report by:

Name : ing P.A. Suringa

The above conclusions have been verified by the following signatory:

Date : 07-04-2020

Name : ing P.A. Suringa

Function : Senior test engineer

Signature :

2 Test configuration of the Equipment Under Test

2.1 Test mode

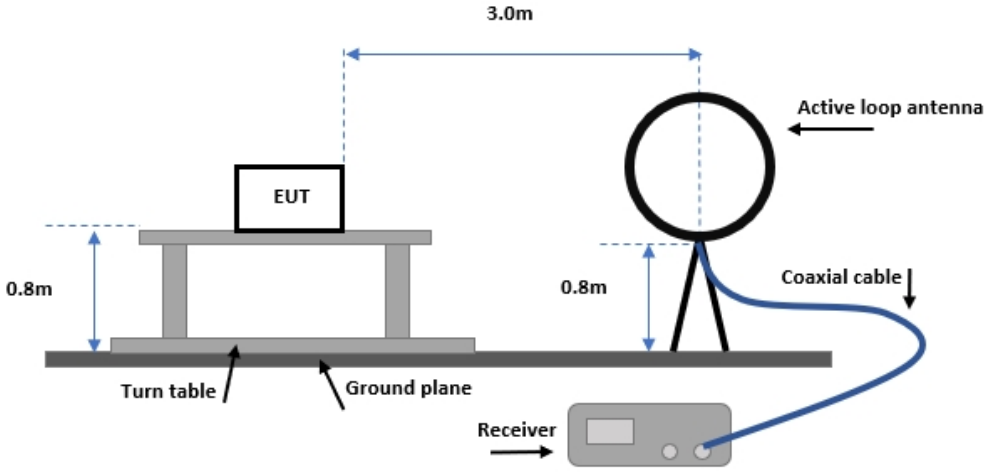
The applicant provided test mode firmware for the EUT, in which it was possible to configure the EUT into different test channels.

2.2 Tested channels and Data rates

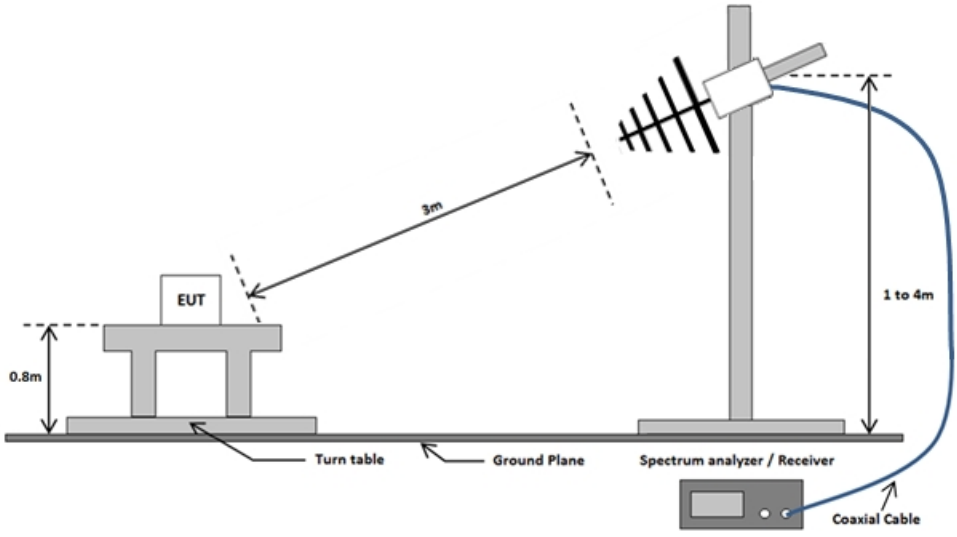
Technology	Channels	Data rate	Frequency (MHz)
GFSK	1 (Low)	50 kbps	910
	25 (Mid)	50 kbps	914.264
	50 (High)	50 kbps	918.855

2.3 Test setups

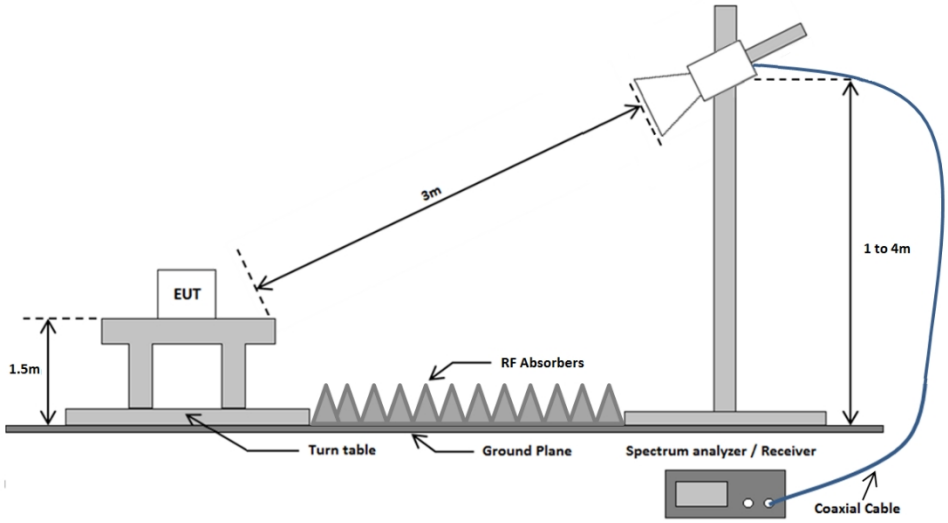
Radiated emissions test setup 9 kHz – 30 MHz



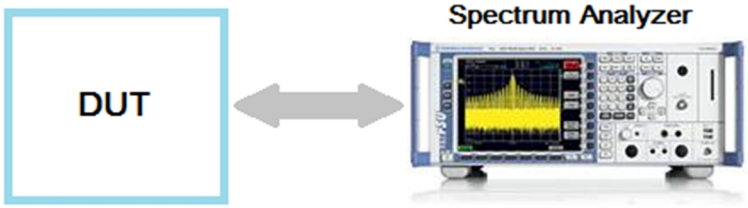
Radiated emissions test setup 30 MHz - 1 GHz



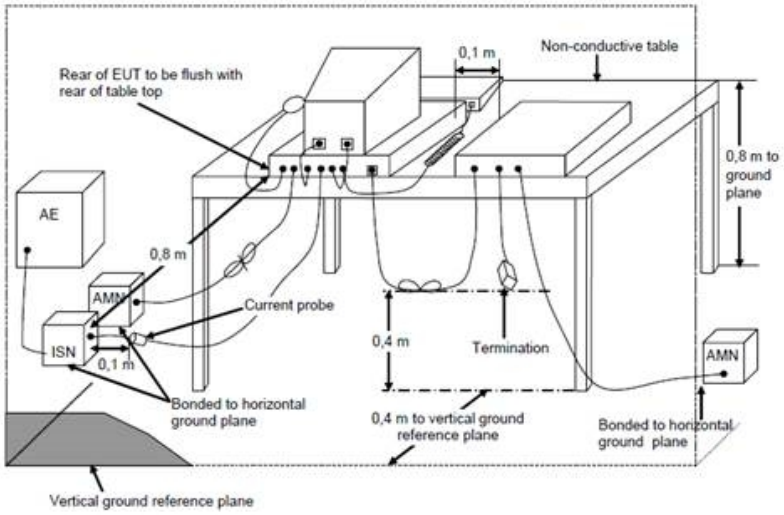
Radiated emissions test setup above 1 GHz



Conducted test setup



Conducted emission



2.4 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Used at Par.
Spectrum Analyzer	Rohde & Schwarz	FSV40	TE01269	3.1 – 3.6
Spectrum Analyzer	Rohde & Schwarz	FSP40	TE11125	3.7/3.8
Spectrum Analyzer	Rohde & Schwarz	ESR7	TE01220	3.7/3.8
Biconilog Antenna	Chase	CBL6112A	TE00967	3.7/3.8
Horn Antenna	EMCO The Electro – Mechanics Co	3115	TE00531	3.7/3.8
SAC Chamber	Comtest Engineering BV	-	TE00861	3.7/3.8
Pre-amplifier	Miteq	AFS42-041001800-29-OP-42	TE00092	3.7/3.8
Software	DARE Instruments	Radimation 2018.3.8	--	3.7/3.8
Active loop antenna	Rohde & Schwarz	HFH2-z2	TE00747	3.7/3.8

Test Setup	Test setup number	Used at paragraphs:
Conducted emission	TS00005	3.9

2.5 Sample calculation

Field Strength Measurement example:

Frequency (GHz)	Polarization	Height(m)	Peak (dBµV/m)
7,236	Horizontal	2	52.5

The following relation applies:

E (dBµV/m) = U(dBµV) + AF (dB/m) – G (dB) + CL (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 20dB bandwidth Measurement

3.1.1 Limit

The maximum 20 dB Bandwidth shall be 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

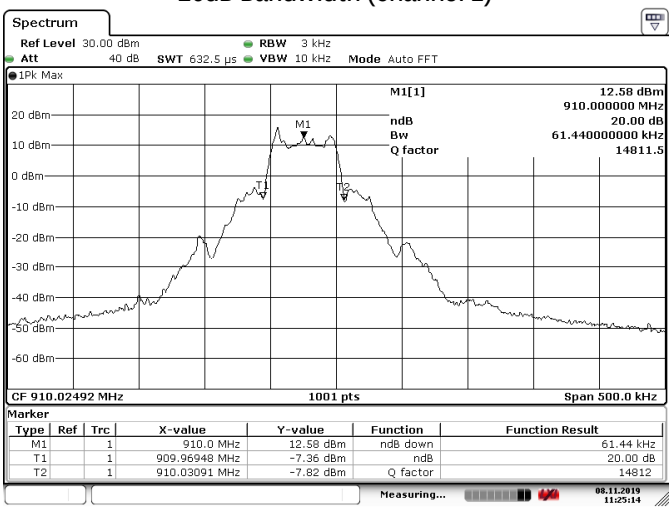
Tests according to ANSI C63.10
IRN 017 - Occupied bandwidth (Hz) Method 4 – DTS Bandwidth.

3.1.5 Test Results of the 6 dB bandwidth Measurement

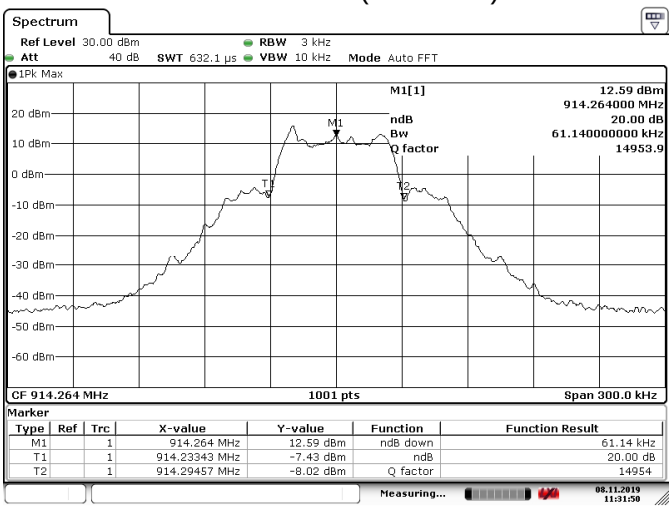
Technology Std.	Channel	Frequency (MHz)	Data rate	20dB bandwidth (kHz)
GFSK	1	910	50 kbps	61.44
	25	914.264	50 kbps	61.14
	50	918.855	50 kbps	60.84
Uncertainty	± 4.4 kHz			

3.1.6 Plots of the 20 dB bandwidth Measurement

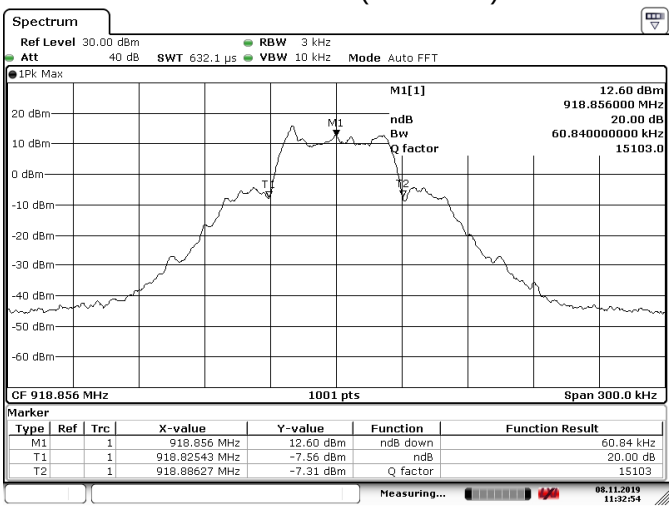
20dB Bandwidth (Channel 1)



20dB Bandwidth (Channel 25)



20dB Bandwidth (Channel 50)



3.2 Output Power Measurement

3.2.1 Limit

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels. 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.

3.2.2 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

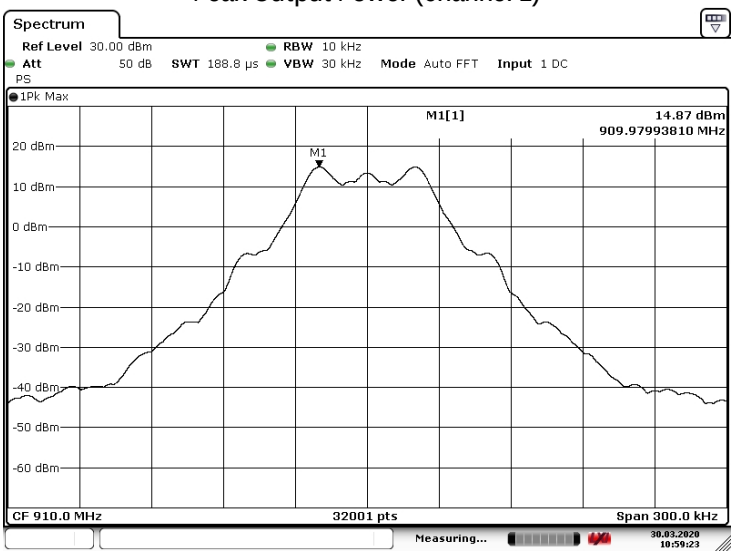
The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05.
IRN 014 - RF power (W) - Method 1 – AVGSA (DTS) according to ANSI C63.10.

3.2.5 Test results of Output Power Measurement

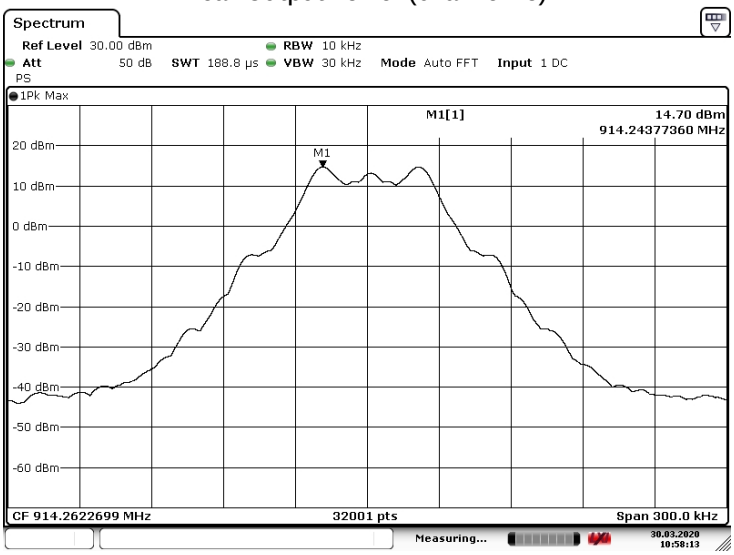
Technology Std.	Channel	Frequency (MHz)	Data rate	Peak output power (dBm)
GFSK	1	910	50 kbps	14.87
	25	914.264	50 kbps	14.70
	50	918.855	50 kbps	14.48
Uncertainty	±0.71 dB			

3.2.6 Plots of the output power measurement

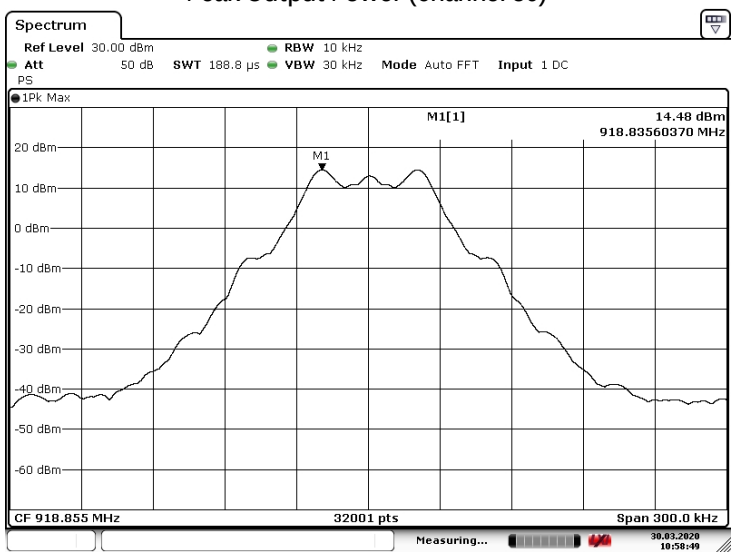
Peak Output Power (Channel 1)



Peak Output Power (Channel 25)



Peak Output Power (Channel 50)



3.3 Dwell time

3.3.1 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period;

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

According to KDB Publication 558074 V05
IRN 013 - Method 2.

3.3.5 Measurement uncertainty

+/- 2.85%

3.3.6 Test results for Dwell time

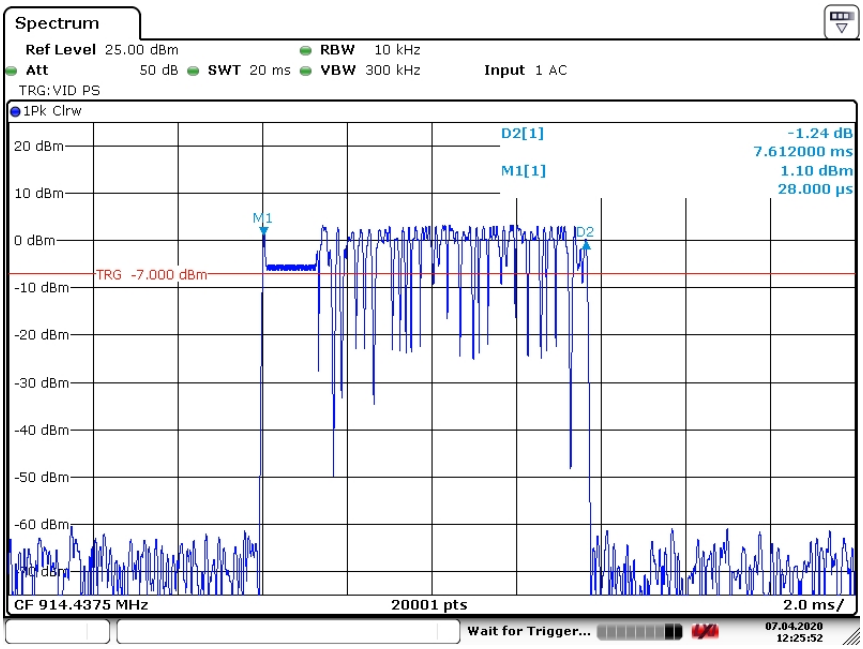
Ton =7.612 ms
Toff = 5.391 s

In 20 seconds the Ton time = 7.612 x 4 = 30.45ms.

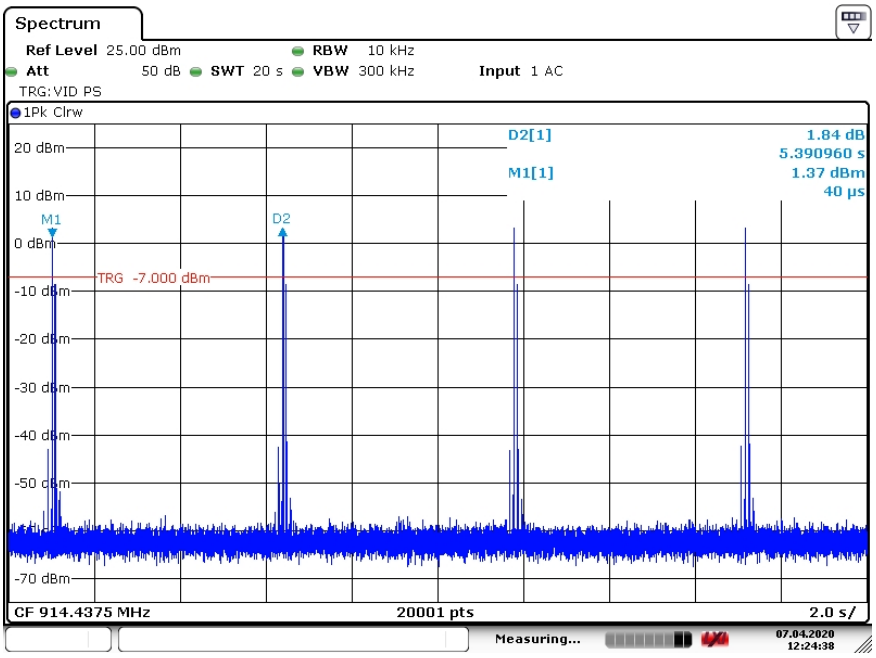
3.3.7 Plots for Dwell time

See next page.

Packet time



Packets in 20 seconds



3.4 Channel separation

3.4.1 Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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.

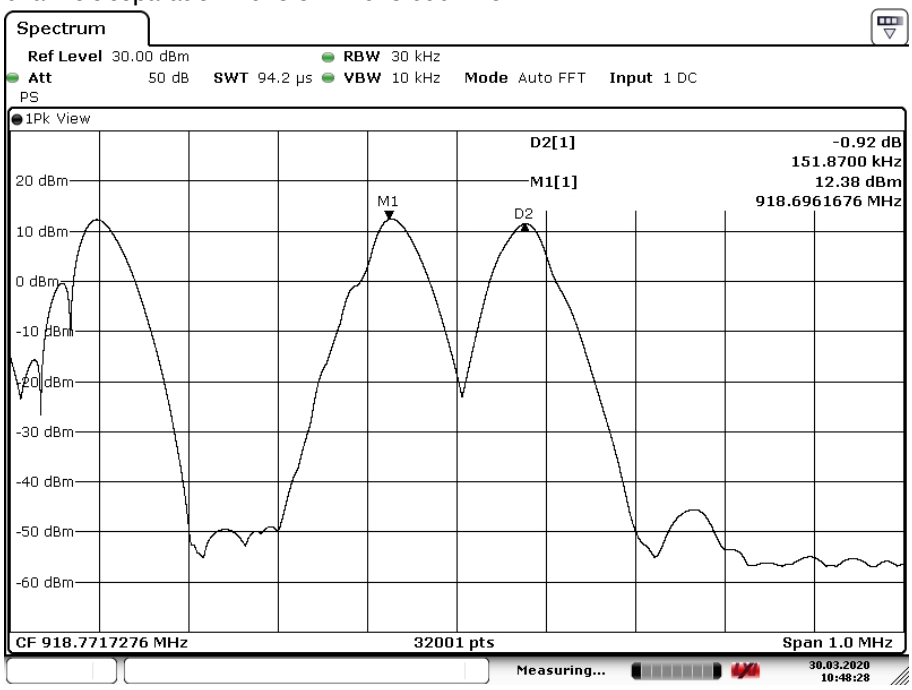
3.4.4 Test procedure

According to KDB Publication 558074 V05
IRN 005, Method 2.

3.4.5 Test results for channel separation

F1= 918.696 MHz
F2= 918.847 MHz

Channels separation = 918.847 – 918.696 = 151 kHz



3.4.6 Measurement uncertainty

+/- 6.81kHz

3.5 Number of hopping channels

3.5.1 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

3.5.2 Measurement instruments

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

3.5.3 Test setup

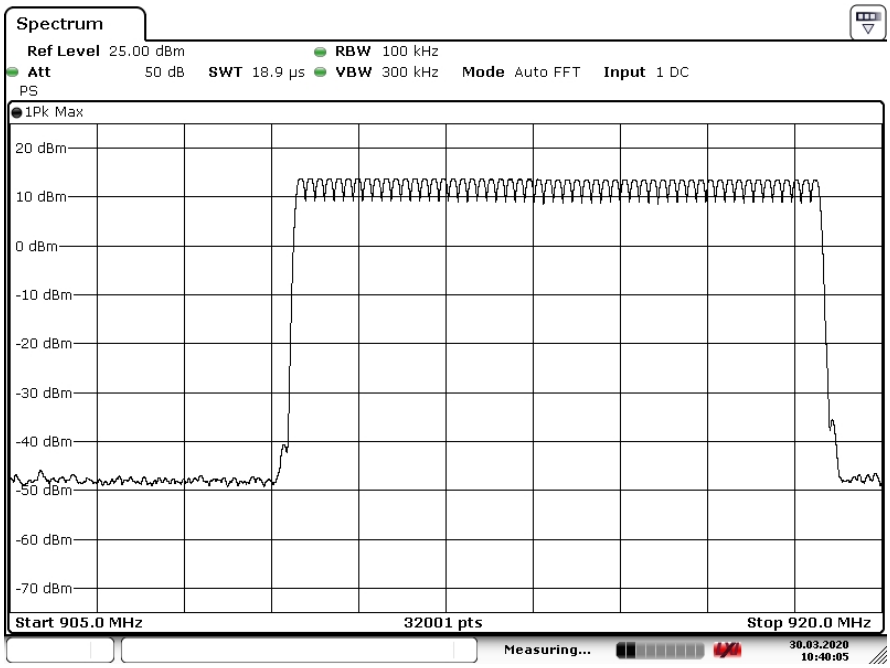
The test setup is as shown in chapter 2.3 of this report.

3.5.4 Test procedure

According to KDB Publication 558074 V05
IRN 005, Method 2.

3.5.5 Test results for number of hopping channels

The EUT uses 50 hopping channels.



3.6 Band edge Measurement

3.6.1 Limit

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

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

According to KDB Publication 558074 V05
IRN 026 - Radiated electrical disturbance (V per m) Method 6 – Radiated electrical disturbance at the Authorized band edge.

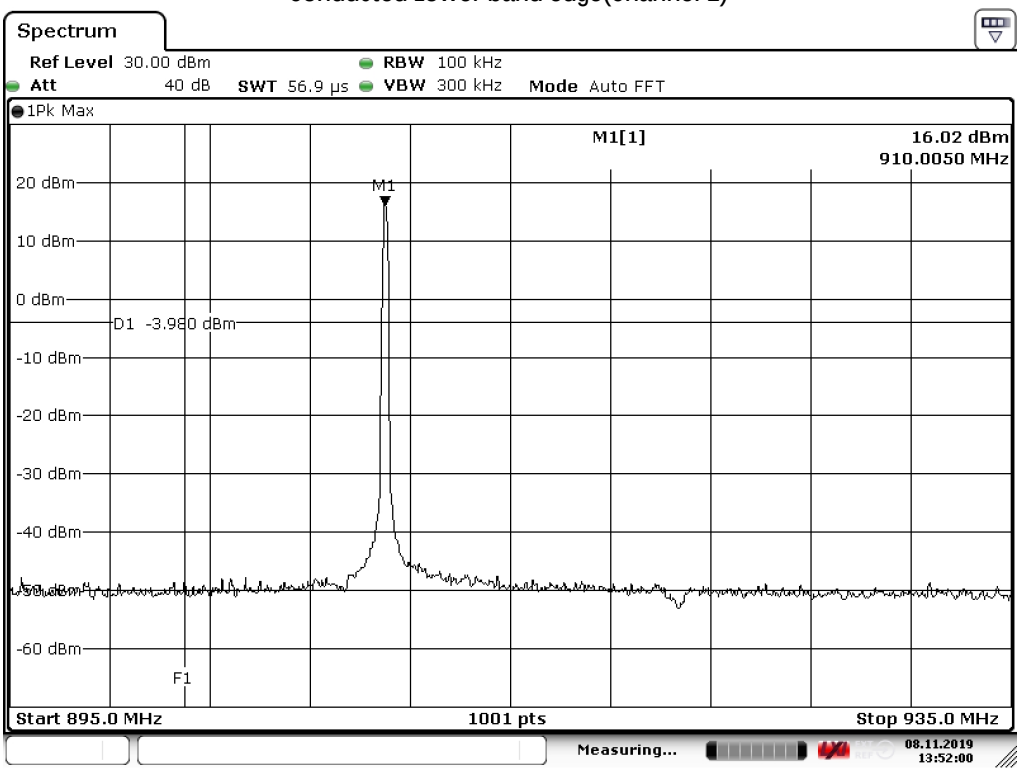
3.6.5 Test results the Band edge Measurements

Band edge

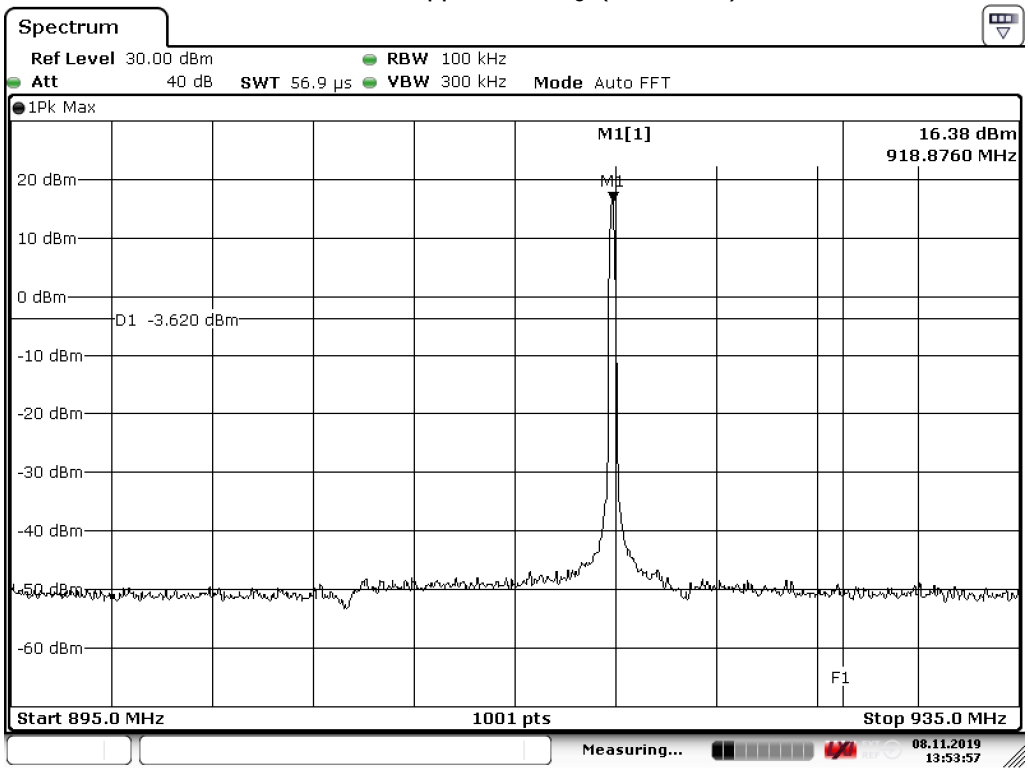
Technology Std.	Channels	Frequency (MHz)	Data rate	Band edge (dBm)	Limit (dBm)
GFSK	1	910	50 kbps	<-40	-5.04
	50	918.855	50 kbps	<-40	-5.80
Uncertainty	±2 dB				

3.6.6 Plots of the Conducted Spurious an Band edge Measurements

Conducted Lower band edge(Channel 1)



Conducted upper band edge(Channel 50)



3.7 Radiated Spurious Emissions Measurement

3.7.1 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 (µV/m)	Measurement distance(m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 - 30	30	30
30 -88	100	3
88 - 216	150	3
216-960	200	3
Above 960	500	3

3.7.2 Measurement instruments

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

3.7.3 Test setup

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

3.7.4 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 V05

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 - 10 GHz in SAR.
IRN 027 - Radiated magnetic disturbance Method 1 – Loop antenna

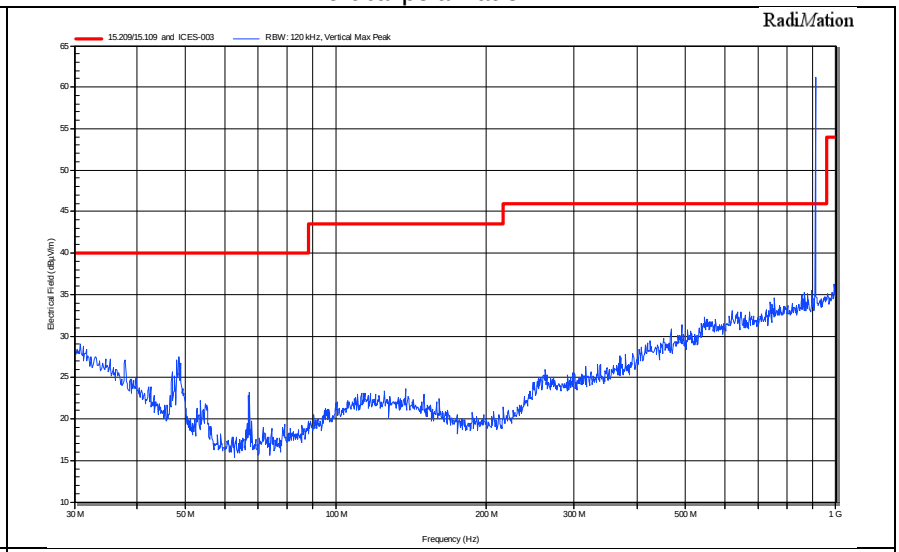
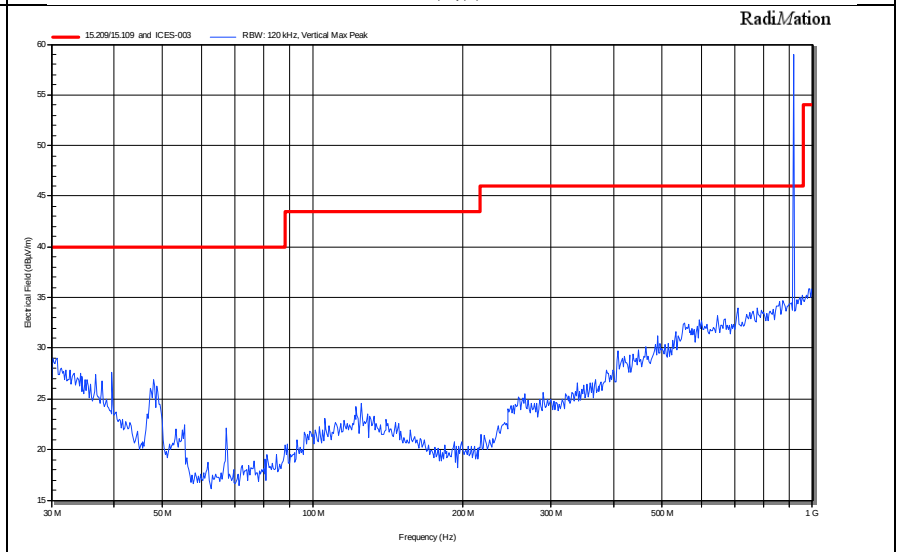
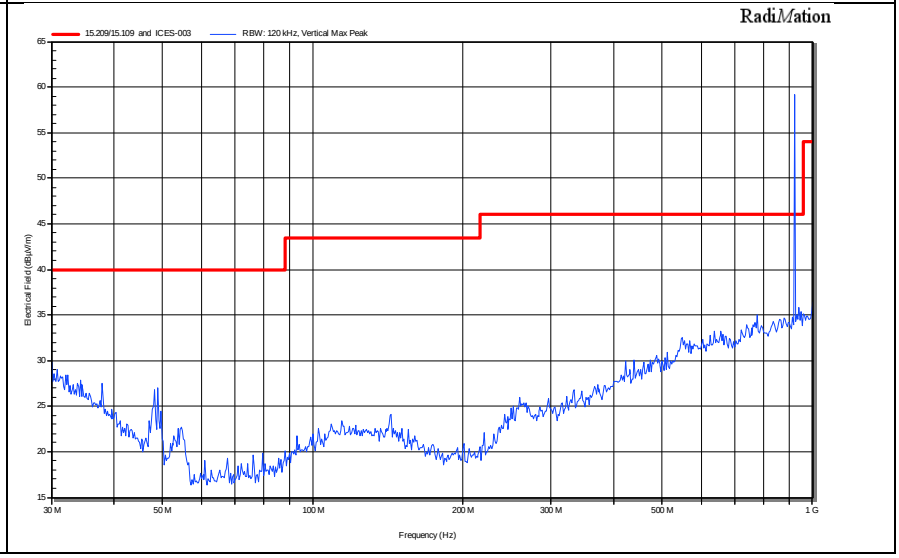
3.7.5 Notes

- In the frequency range of 1 – 10 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
- in the frequency range of 9 kHz to 30 MHz all emissions are 20 dB below the limit and are therefore not reported.

3.7.6 Plots of the Radiated Spurious Emissions

30 MHz to 1 GHz

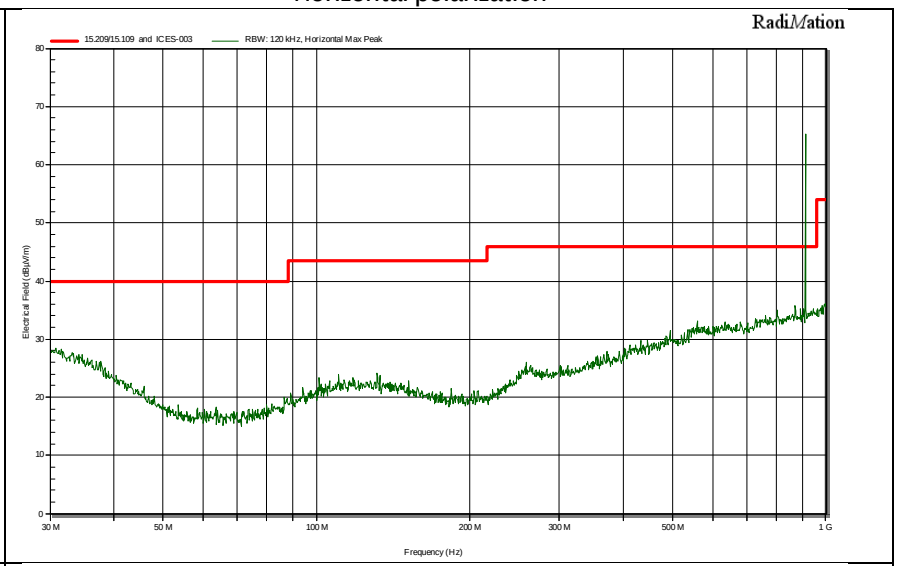
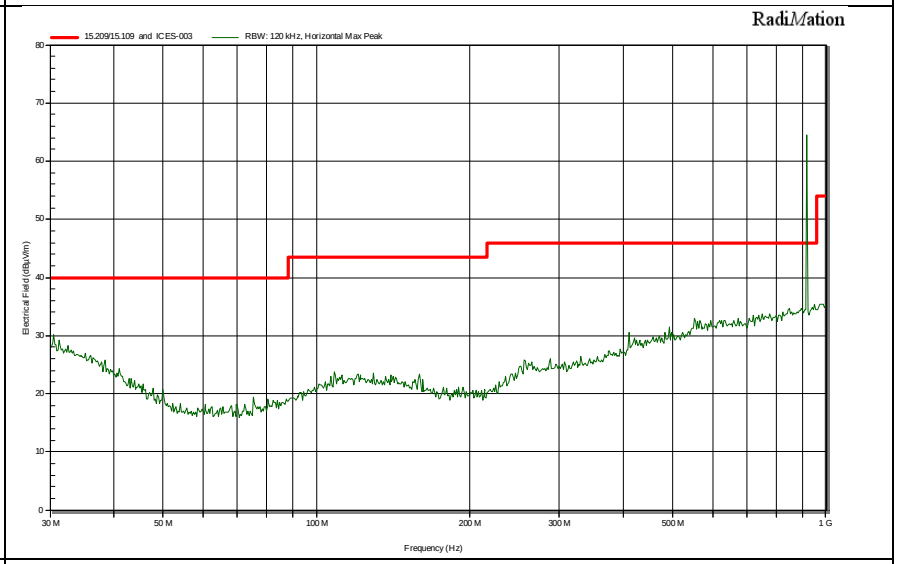
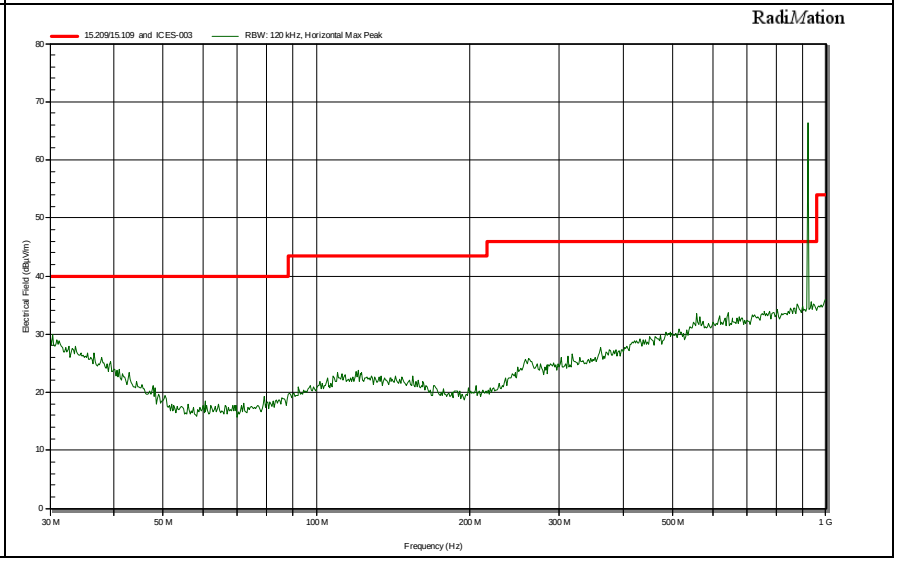
Vertical polarization

Low ch	
Mid ch	
High ch	

Note: the peak seen in the plots is the fundamental frequency and is not subject to the limit.

30 MHz to 1 GHz

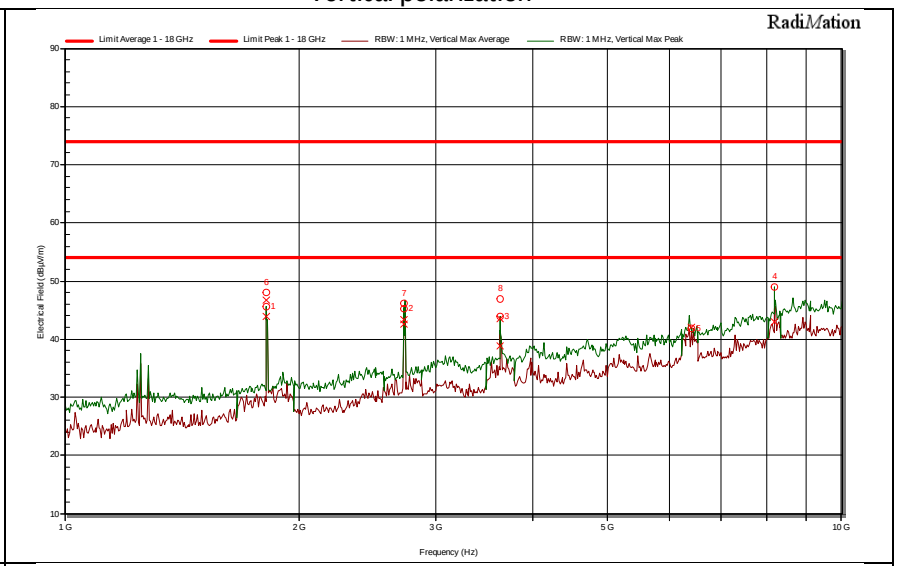
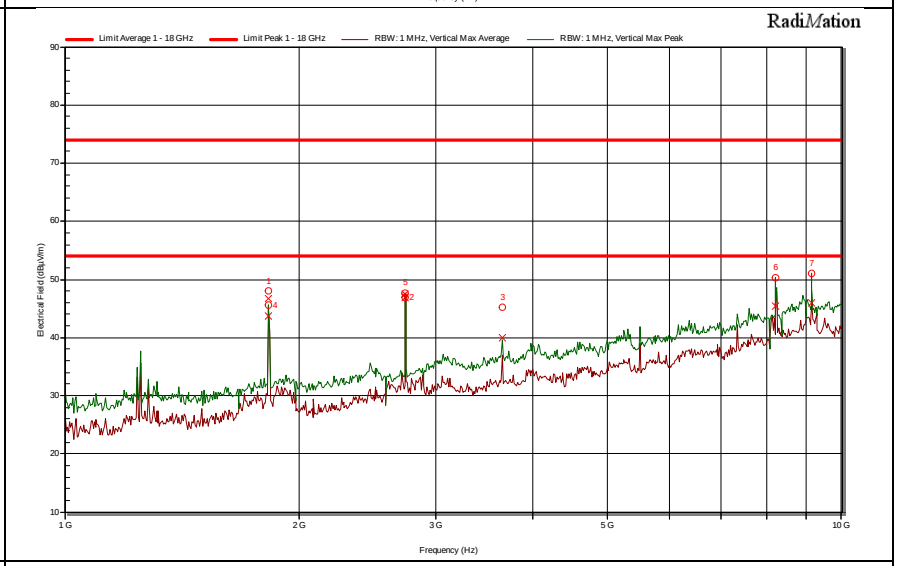
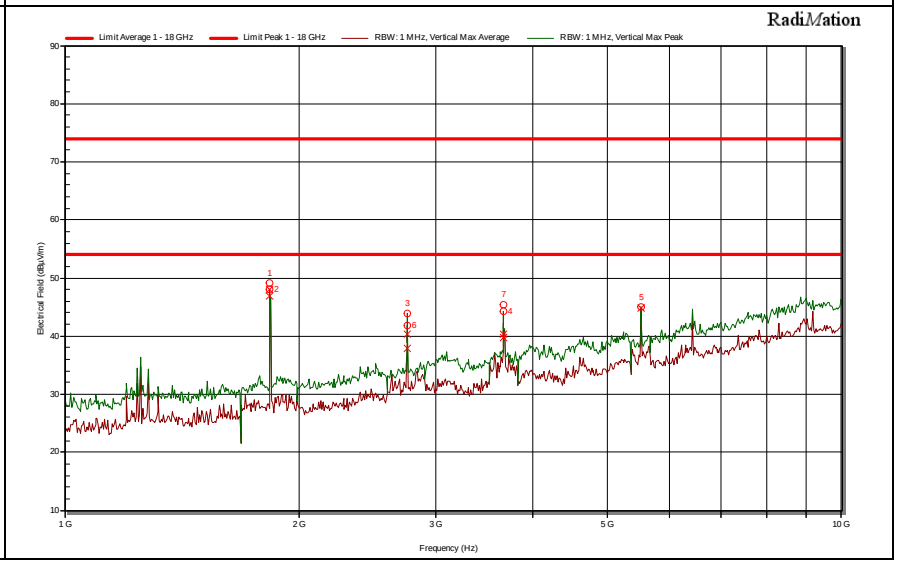
Horizontal polarization

Low ch	
Mid ch	
High ch	

Note: the peak seen in the plots is the fundamental frequency and is not subject to the limit

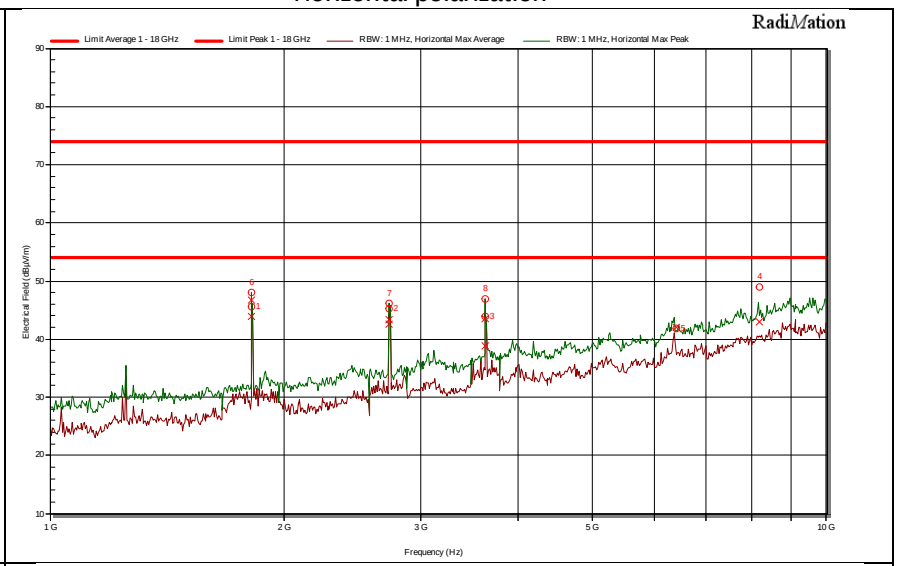
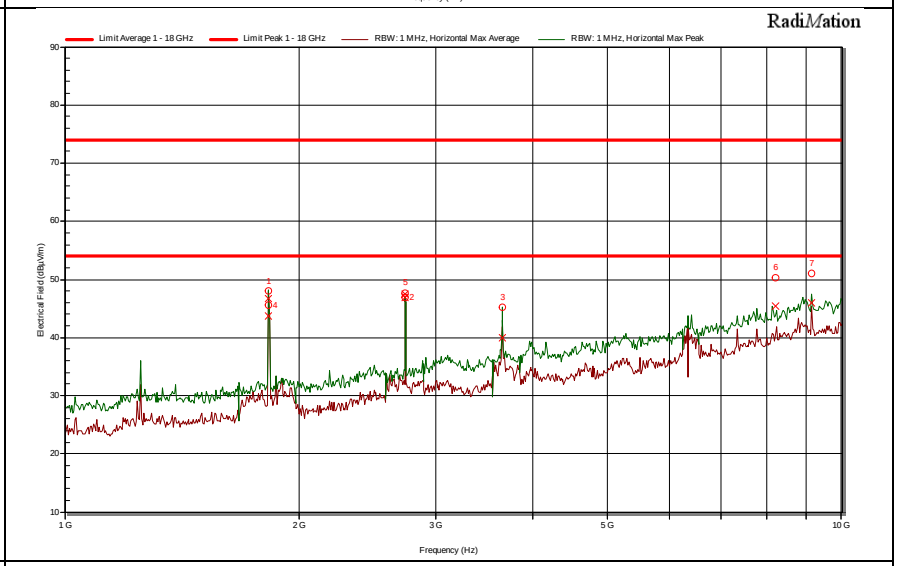
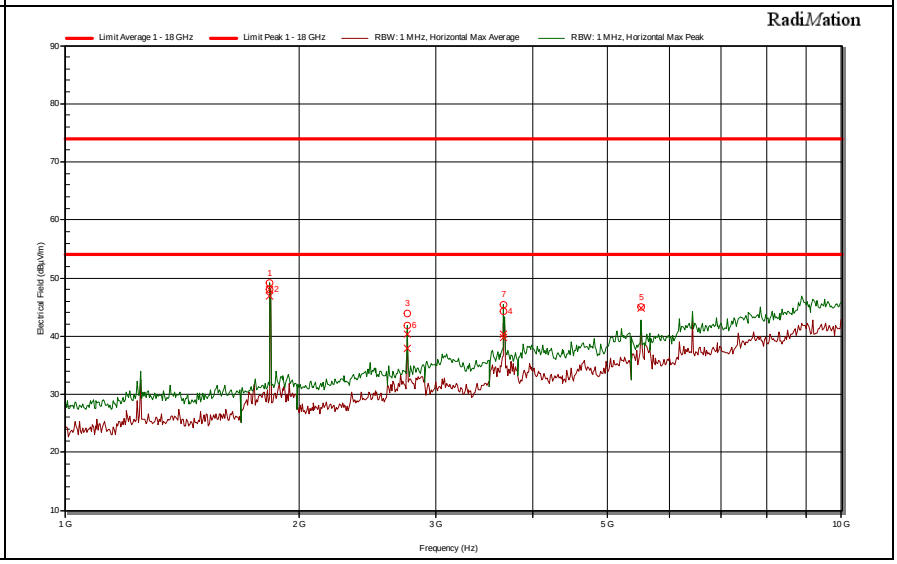
1 GHz to 10 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

1 GHz to 10 GHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

Measured peaks 1 – 10 GHz Low channel

Frequency	Polarization	Height	Peak	Average	Peak Limit	Average Limit	Peak Difference	Average Difference
1,82 GHz	Horizontal	2,5 m	48 dBµV/m	46,7 dBµV/m	74 dBµV/m	54 dBµV/m	-26,0 dB	-7,3 dB
1,82 GHz	Vertical	4 m	45,6 dBµV/m	43,9 dBµV/m	74 dBµV/m	54 dBµV/m	-28,4 dB	-10,1 dB
3,64 GHz	Horizontal	1 m	46,8 dBµV/m	43,6 dBµV/m	74 dBµV/m	54 dBµV/m	-27,2 dB	-10,4 dB
2,73 GHz	Horizontal	2,5 m	46,1 dBµV/m	43,3 dBµV/m	74 dBµV/m	54 dBµV/m	-27,9 dB	-10,7 dB
8,19 GHz	Vertical	1,25 m	49 dBµV/m	42,9 dBµV/m	74 dBµV/m	54 dBµV/m	-25,0 dB	-11,1 dB
2,73 GHz	Vertical	1,25 m	45,2 dBµV/m	42,6 dBµV/m	74 dBµV/m	54 dBµV/m	-28,8 dB	-11,4 dB
6,4 GHz	Vertical	1,75 m	41,7 dBµV/m	42 dBµV/m	74 dBµV/m	54 dBµV/m	-32,3 dB	-12,0 dB

Measured peaks 1 – 10 GHz Middle channel

Frequency	Polarization	Height	Peak	Average	Peak Limit	Average Limit	Peak Difference	Average Difference
2,743 GHz	Vertical	1 m	47,6 dBµV/m	47,4 dBµV/m	74 dBµV/m	54 dBµV/m	-26,4 dB	-6,6 dB
2,743 GHz	Horizontal	1,5 m	46,9 dBµV/m	47 dBµV/m	74 dBµV/m	54 dBµV/m	-27,1 dB	-7,0 dB
1,828 GHz	Horizontal	2,5 m	48 dBµV/m	46,6 dBµV/m	74 dBµV/m	54 dBµV/m	-26,0 dB	-7,4 dB
9,143 GHz	Vertical	3,25 m	51,1 dBµV/m	45,9 dBµV/m	74 dBµV/m	54 dBµV/m	-22,9 dB	-8,1 dB
8,228 GHz	Vertical	2,25 m	50,2 dBµV/m	45,4 dBµV/m	74 dBµV/m	54 dBµV/m	-23,8 dB	-8,6 dB
1,828 GHz	Vertical	1,5 m	45,7 dBµV/m	43,8 dBµV/m	74 dBµV/m	54 dBµV/m	-28,3 dB	-10,2 dB
3,657 GHz	Horizontal	2,5 m	45,1 dBµV/m	40 dBµV/m	74 dBµV/m	54 dBµV/m	-28,9 dB	-14,0 dB

Measured peaks 1 – 10 GHz High channel

Frequency	Polarization	Height	Peak	Average	Peak Limit	Average Limit	Peak Difference	Average Difference
1,838 GHz	Horizontal	2,5 m	49,2 dBµV/m	48,1 dBµV/m	74 dBµV/m	54 dBµV/m	-24,8 dB	-5,9 dB
1,838 GHz	Vertical	1 m	48,1 dBµV/m	46,9 dBµV/m	74 dBµV/m	54 dBµV/m	-25,9 dB	-7,1 dB
5,513 GHz	Vertical	2,25 m	45 dBµV/m	44,8 dBµV/m	74 dBµV/m	54 dBµV/m	-29,0 dB	-9,2 dB
3,676 GHz	Horizontal	2,75 m	45,5 dBµV/m	40,4 dBµV/m	74 dBµV/m	54 dBµV/m	-28,5 dB	-13,6 dB
2,757 GHz	Vertical	2,25 m	43,8 dBµV/m	40,4 dBµV/m	74 dBµV/m	54 dBµV/m	-30,2 dB	-13,6 dB
3,675 GHz	Vertical	3,5 m	44,3 dBµV/m	39,8 dBµV/m	74 dBµV/m	54 dBµV/m	-29,7 dB	-14,2 dB
2,757 GHz	Horizontal	2,25 m	41,9 dBµV/m	37,8 dBµV/m	74 dBµV/m	54 dBµV/m	-32,1 dB	-16,2 dB

3.7.7 Measurement uncertainty

Measurement uncertainty Radiated emissions below 1 GHz

Horizontal polarization	
9 kHz – 30 MHz	+1.5 dB/-1.6dB
30 – 200 MHz	4.5 dB
200 – 1000 MHz	3.6 dB
Vertical polarization	
9 kHz – 30 MHz	+1.5 dB/-1.6dB
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

3.8 Rx Radiated Emissions Measurement

3.8.1 Limit

According to FCC part 15.109(a)

Frequency (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance(m)
30 -88	100	40	3
88 - 216	150	43,5	3
216-960	200	46	3
Above 960	500	54	3

3.8.2 Measurement instruments

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

3.8.3 Test setup

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

3.8.4 Test procedure

According to KDB Publication 558074 V05

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 - 10 GHz in SAR.

3.8.5 Notes

- In the frequency range of 1 – 10 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

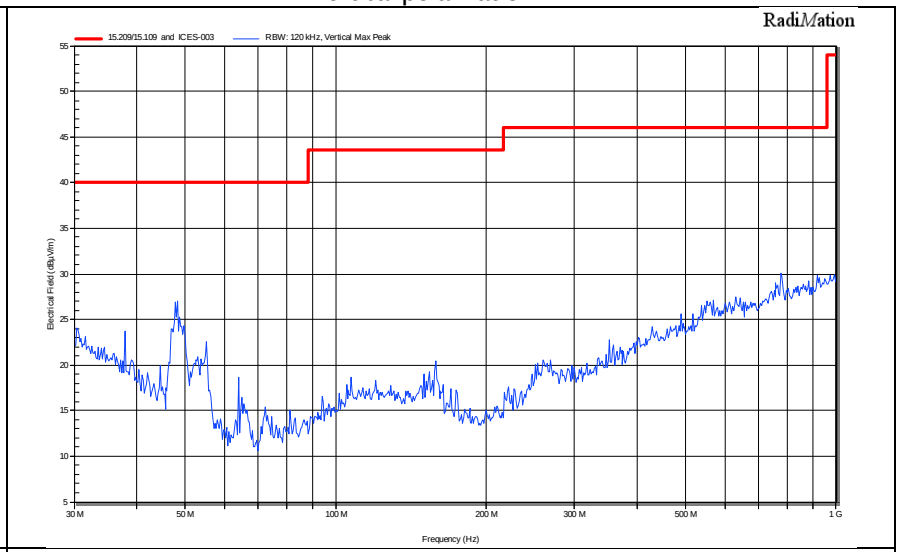
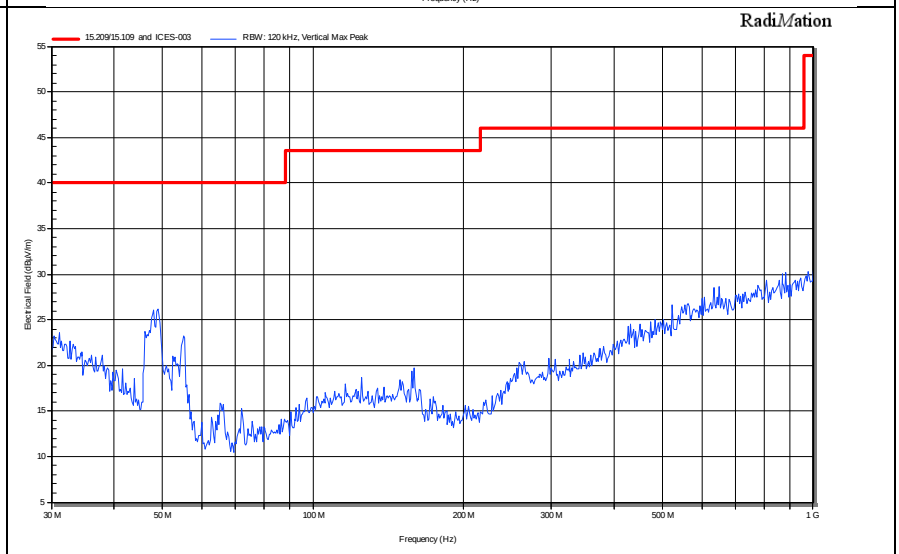
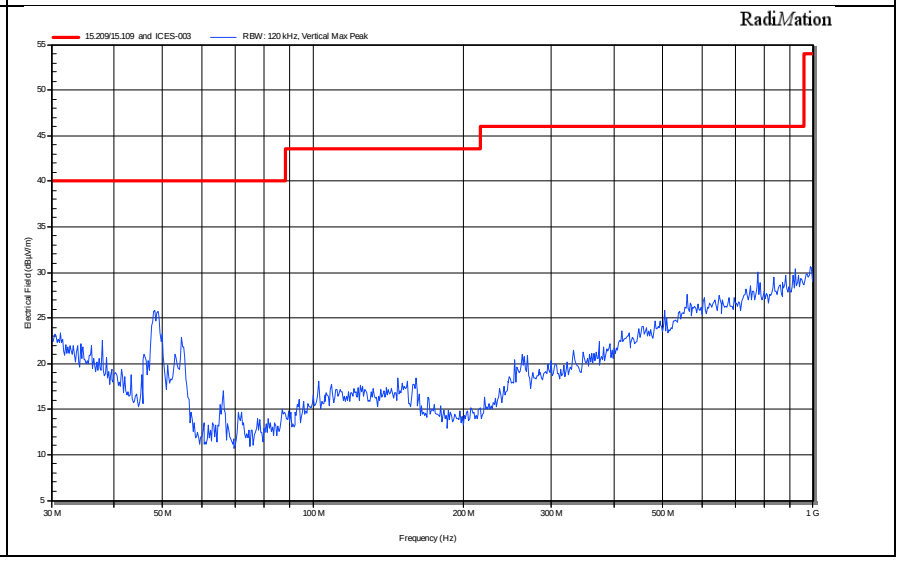
3.8.6 Plots of the Rx Radiated Emissions Measurement

See next pages.

3.8.7 Plots of the RX Spurious Emissions

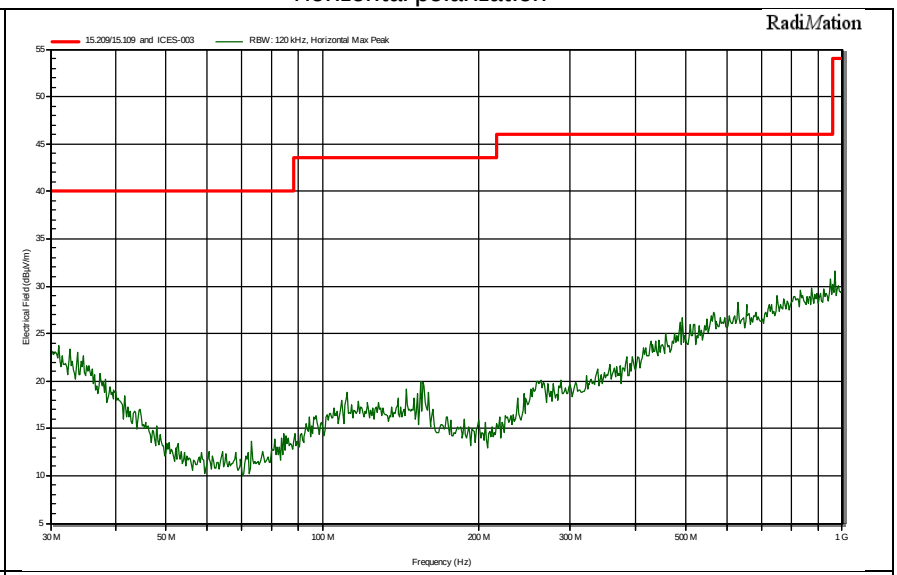
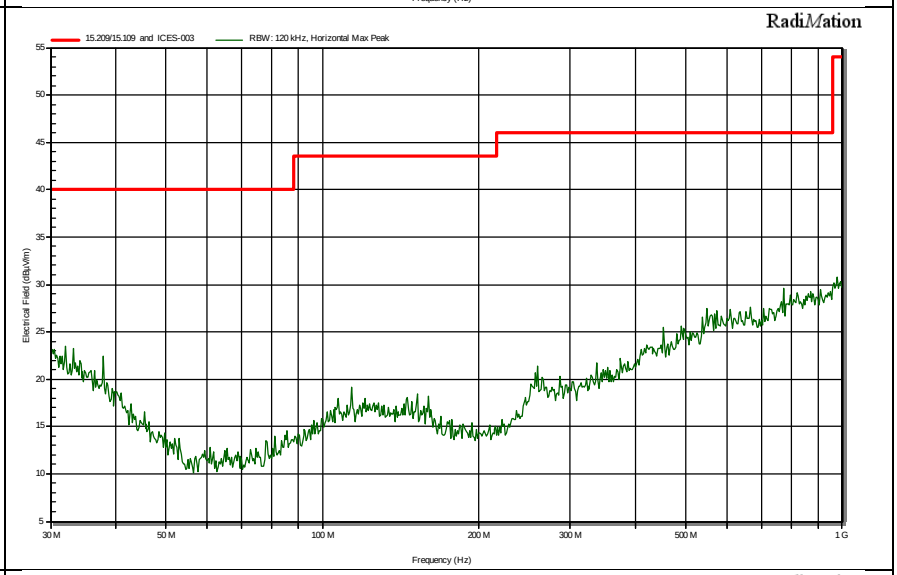
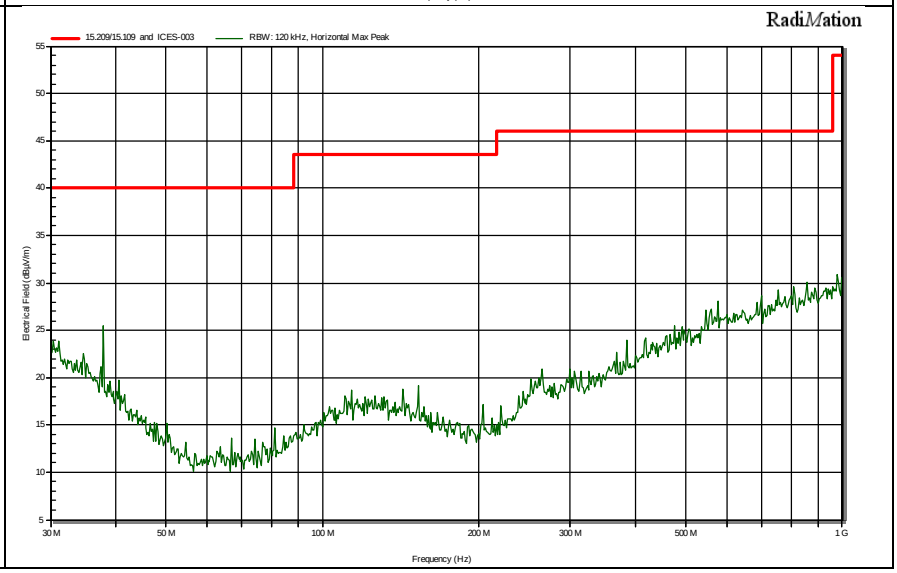
30 MHz to 1 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

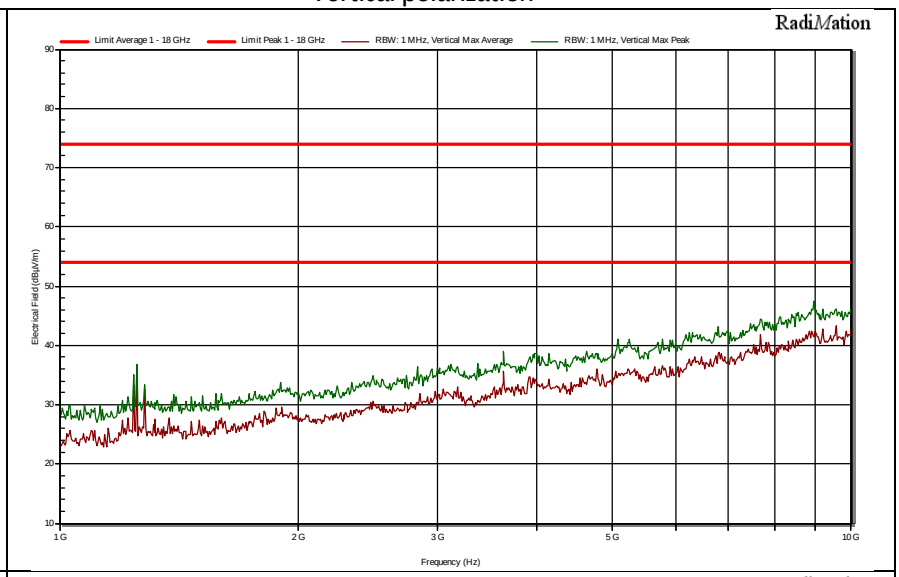
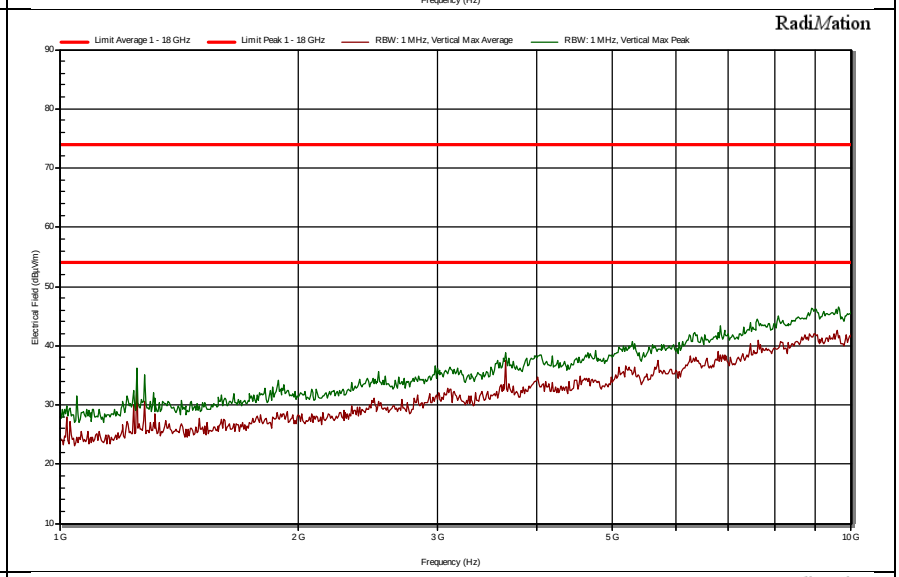
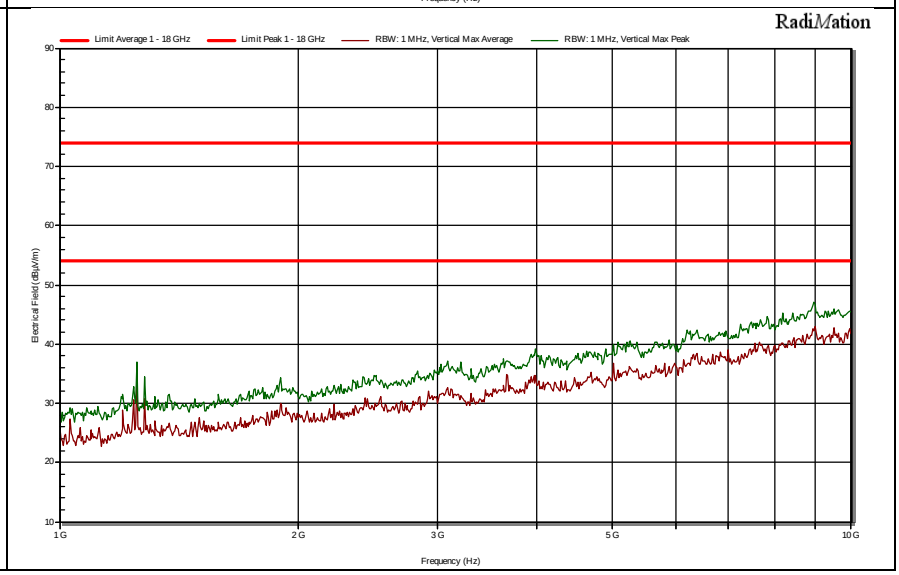
30 MHz to 1 GHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

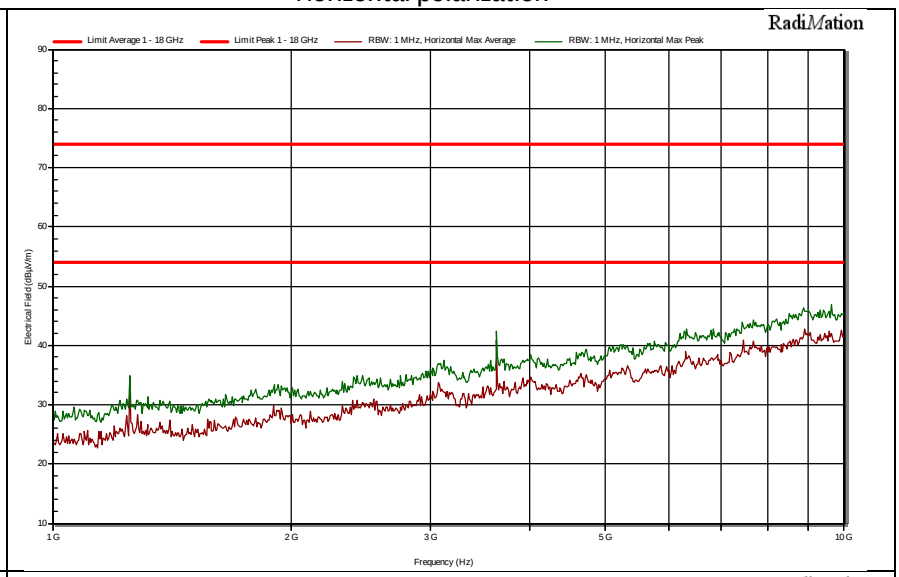
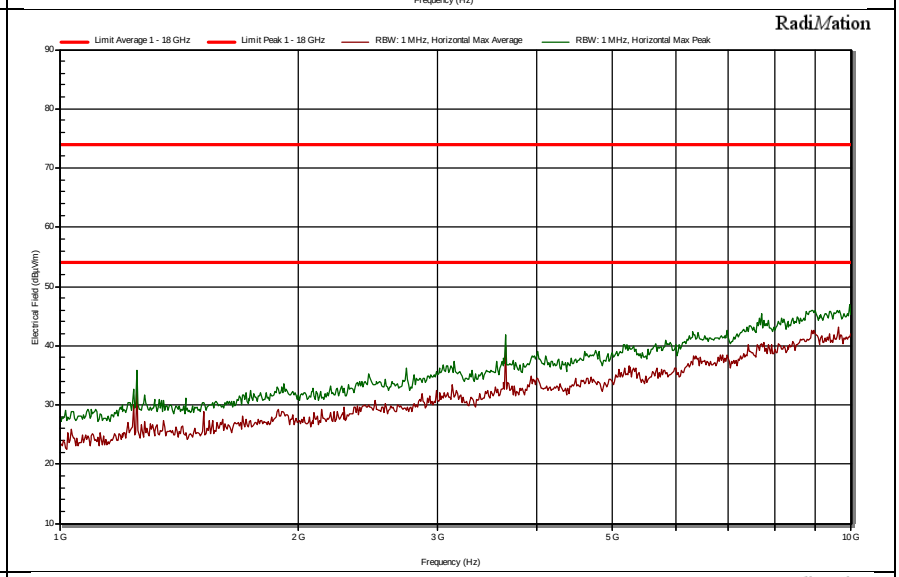
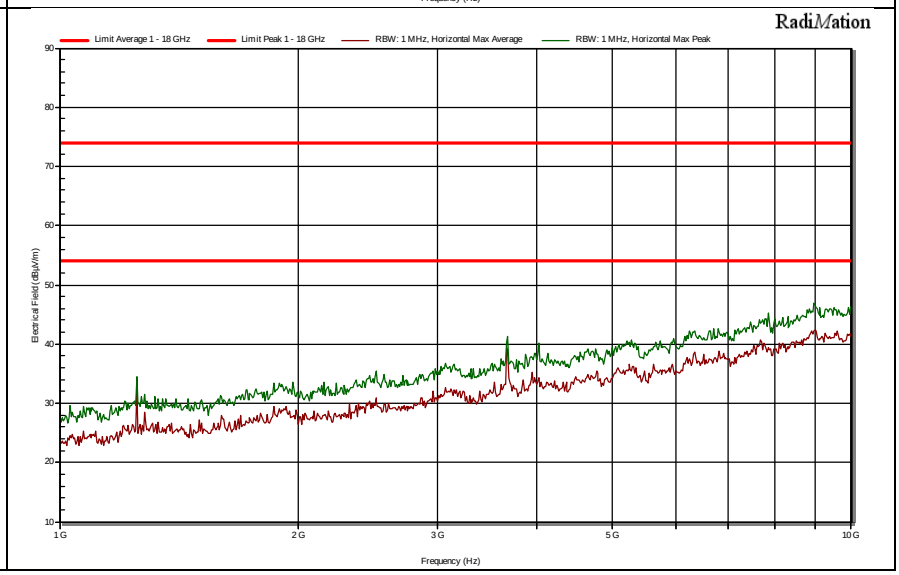
1 GHz to 10 GHz

Vertical polarization

Low ch	
Mid ch	
High ch	

1 GHz to 10 GHz

Horizontal polarization

Low ch	
Mid ch	
High ch	

3.8.8 Measurement uncertainty

Measurement uncertainty Radiated emissions below 1 GHz

Horizontal polarization	
9 kHz – 30 MHz	+1.5 dB/-1.6dB
30 – 200 MHz	4.5 dB
200 – 1000 MHz	3.6 dB
Vertical polarization	
9 kHz – 30 MHz	+1.5 dB/-1.6dB
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

3.9 AC conducted mains measurement

3.9.1 Limit

According to 15.207 (c)

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

3.9.2 Measurement instruments

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

3.9.3 Test setup

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

3.9.4 Test procedure

According to ANSI C63.4: 2014, section 13.3.
IRN 02- Conducted disturbance, method 1.

3.9.5 Test results and plots of the AC conducted mains measurement

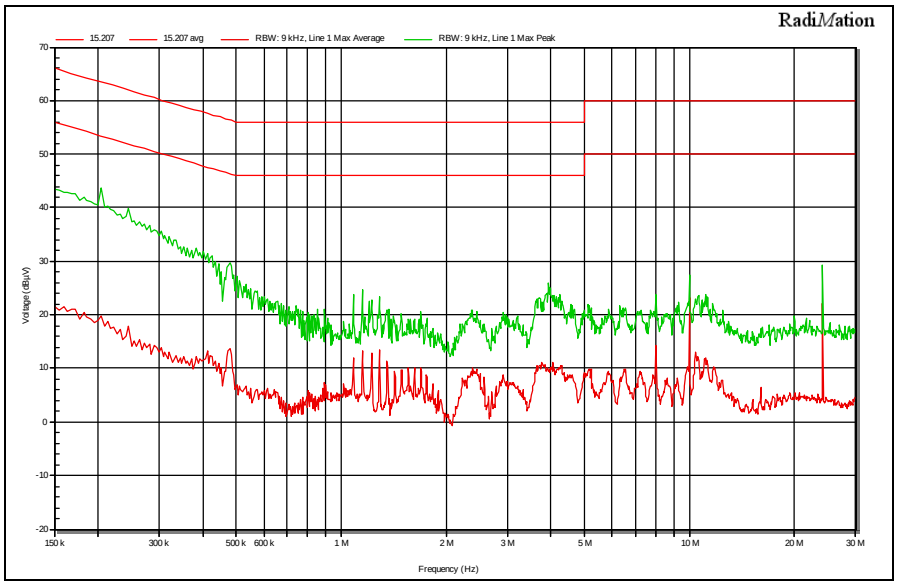
See next page

3.9.6 Measurement uncertainty

+/- 3.6 dB

3.9.7 Plots of the AC conducted spurious measurement

Phase



Neutral