RADIO TEST REPORT

No. 1510902STO-001, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment:	RFID reader for automatic vehicle identification
Type/Model:	**XT Mini** Reader us
Manufacturer:	TagMaster AB
Tested by request of:	TagMaster AB

SUMMARY

Referring to the emission limits, and the operating mode during the tests specified in this report, the equipment complies with the requirements according to the following standards:

47 CFR Part 15 (2014):, Subpart C: Intentional radiators. Section 15.247
For details, see clause 2 – 4.

Date of issue: 2015-07-08

Tested by: Matti Virkki

Approved by: Stefan Andersson

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S 114 14-05 Strömberg 214248

Revision History

Edition	Date	Description	Changes
1	2015-07-08	First release	

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company	TagMaster AB Kronborgsgränd 11 16446 Kista Sweden
Name of contact	Mattias Gyllenros

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment:	RFID reader for automatic vehicle identification	
Product marketing name/Model:	**XT Mini** reader us	
Brand name:	TagMaster	
Serial number:	R&D Proto 2	
Manufacturer:	TagMaster AB	
Transmitter frequency range:	902.75 – 927.75 MHz	
Receiver frequency range:	902 – 928 MHz	
Frequency agile or hopping:	☒ Yes	☐ No
Antenna:	☒ Internal antenna	☐ External antenna
Antenna connector:	☒ None, internal antenna	☐ Yes,
Antenna gain:	4 dBi	
Rating RF output power:	28 dBm	
Type of modulation:	ASK	
Temperature range:	☐ Category I (General): -20°C to +55°C ☐ Category II (Portable equipment): -10°C to +55°C ☐ Category III (Equipment for normal indoor use): +5°C to +35°C ☒ Other: -40°C to +60°C	
Power rating:	12 – 24 VDC	
Transmitter standby mode supported:	☐ Yes	☒ No

2.2 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Serial number
RFID Reader	XT Mini us	R&D Proto 2

During the tests the EUT supported following software:

Software	Version	Comment
Vigilant FW, 1.1.2-pre,	SVN rev.5790	

2.3 Test signals and operation modes

Continuous signal with ASK modulation on highest, middle and low channels.
Hopping mode with ASK modulation

2.4 Modifications made to improve EMC-characteristics

The following modifications were required to obtain the results presented in this report.

- A piece of dielectric absorber was introduced in the RF shield-box to attenuate box-resonances in the 8 GHz range.
- A 1pF capacitor to gnd was added to the RF_Vout terminal of Q502 inside the shield-box to eliminate conduction in the 7-9 GHz range
- 1 pF capacitors to gnd was added at bias terminals for all semiconductor circuits within the shield-box for the same reason.

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3 TEST SPECIFICATIONS

3.1 Standards

Requirements:
47 CFR Part 15: Radio frequency device, Subpart C: Unintentional radiators (2014).

Test methods:
ANSI C63.10-2009: American National Standard for testing Unlicensed Wireless Devices

3.2 Additions, deviations and exclusions from standards and accreditation

No additions, deviations or exclusions have been made from standards and accreditation.

3.3 Test site

Measurements were performed at:

Intertek Semko AB.
Torshamnsgatan 43,
P.O. Box 1103
SE-164 22 Kista

Intertek Semko AB is a FCC listed test site with site registration number 90913
Intertek Semko AB is a FCC accredited conformity assessment body with designation number SE0002
Intertek Semko AB is an Industry Canada listed test facility with IC assigned code 2042G

Measurement chambers

Measurement Chamber	Type of chamber	IC Site filing #
STORA HALLEN	Semi-anechoic 10 m and 3 m	2042G-2

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4 TEST SUMMARY

The results in this report apply only to sample tested:

Requirement	Description	Result
FCC §15.203	**Antenna requirement** EUT uses internal antenna which is not user removable	PASS
FCC §15.207	**Conducted continuous emission in the frequency range 150 kHz to 30 MHz, AC Power input port**	NA
FCC §15.247(e) 15.209(a)	**Field strength of fundamental and radiated band edge**	PASS
FCC §15.247 (d), 15.209(a)	**Radiated emission of electromagnetic fields in the frequency range 30 – 1000 MHz**	PASS
FCC §15.247(d), 15.209(a)	**Radiated emission of electromagnetic fields in the frequency range above 1 GHz**	PASS
FCC §15.247(a)(2)	**Occupied bandwidth**	PASS
FCC §15.247(b)	**Conducted output power**	PASS
FCC §15.247(e)	**Carrier separatiom**	PASS
FCC §15.247(e)	**Number of hopping frequencies**	PASS
FCC §15.247(e)	**Band edge**	PASS

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5 FIELD STRENGTH OF FUNDAMENTAL AND AT BAND EDGE

5.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-19	21 [°C]	34 [%]	KAF	Pass	46.9 dB

5.2 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10. and ANSI C63.4
The EUT was set up in order to emit maximum disturbances.
The EUT was placed on an insulating support 0.8 m above the turntable which is part of the reference ground plane.
Overview sweeps were performed with the measurement receiver in max-hold mode and the peak detector activated in the frequency-range 30 – 1000 MHz.
Above 1 GHz additionally the average detector was activated.

5.3 Test conditions

Test set-up:	**30 MHz to 1000 MHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 120 kHz. VBW 1 MHz
Final test:	QP,	RBW 120 kHz.
Measuring distance:	3 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Bilog	

Test set-up:	**1 GHz – 10 GHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 1 MHz. VBW 3 MHz
Final test:	Peak,	RBW 1 MHz
	Average	RBW 1 MHz
Measuring distance:	3 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Horn	
Antenna tilt:	Activated	

5.4 Requirement

The EUT shall meet the following limits.

Reference: 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.
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a)

5.5 Test results

Measurement results,

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Detector	Polarization H/V	Margin [dB]
902.75	121.8	--	QP	V	--
902	54.9	101.8	QP	V	46.9
927.25	123.7	--	QP	V	--
928	55.9	103.7	QP	V	47.8

Emissions do not fall on restricted band and are attenuated more than 20 dB from carrier.

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6 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHZ TO 10 GHZ

6.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-19 /2015-06-25	21 / 22[°C]	34 / 46 [%]	KAF / MTV	Pass	0.2 dB

6.2 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10. and ANSI C63.4
The EUT was set up in order to emit maximum disturbances.
The EUT was placed on an insulating support 0.8 m above the turntable which is part of the reference ground plane.
Overview sweeps were performed with the measurement receiver in max-hold mode and the peak detector activated in the frequency-range 30 – 1000 MHz.
Above 1 GHz additionally the average detector was activated.

6.3 Test conditions

Test set-up:	**30 MHz to 1000 MHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 120 kHz. VBW 1 MHz
Final test:	Peak,	RBW 120 kHz. VBW 1 MHz
Measuring distance:	3 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Bilog	

Test set-up:	**1 GHz – 10 GHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 1 MHz. VBW 3 MHz
Final test:	Peak,	RBW 1 MHz
	Average	RBW 1 MHz
Measuring distance:	3 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Horn	
Antenna tilt:	Activated	

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6.4 Radiated Emission requirements

Outside restricted bands

§15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits is not required.

Within restricted bands

§15.209, RSS-Gen section 8.9
Field strength of emissions must comply with limits shown in table below

Frequency range [MHz]	Field strength at 3 m (dBμV/m)	Field strength at 10 m (dBμV/m)	Detector (dBμV/m)
30 – 88	40.0	29.5	Quasi Peak
88 – 216	43.5	33.0	Quasi Peak
216 – 960	46.0	35.5	Quasi Peak
960 – 1000	54.0	43.5	Quasi Peak
Above 1000	54.0 / 74.0	43.5 / 63.5	Average / Peak

The values for 10 m measuring distance are calculated by subtracting 10.5 dB from the 3 m limit. (i.e. an extrapolation factor of 20 dB/decade according to §15.31(f)(1)) and RSS-Gen section 6.5.

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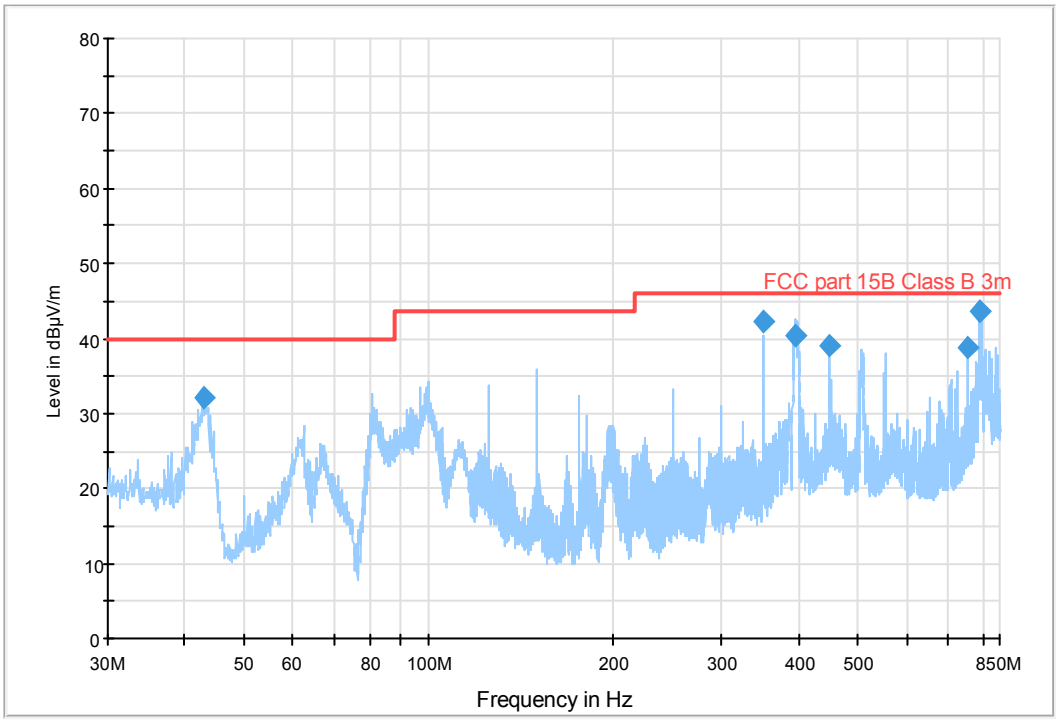
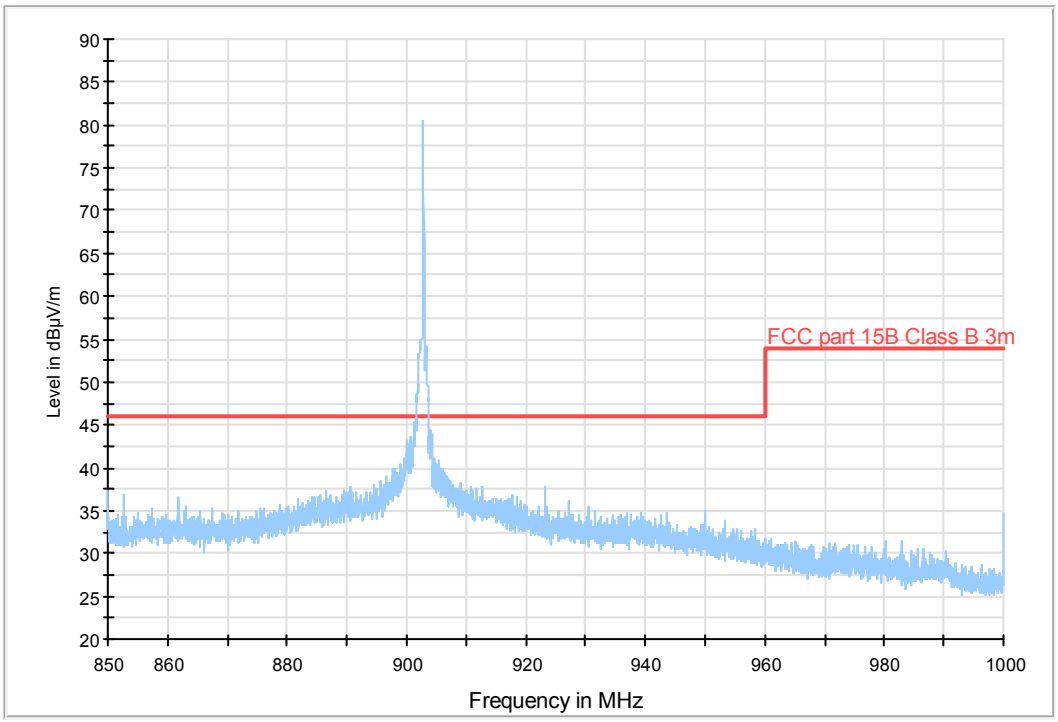
6.5 Test results 30 MHz – 1000 MHz



Diagram, Peak overview sweep, 30 – 800 MHz at 3 m distanceon low channel.



Diagram, Peak overview sweep, 800 – 1000 MHz at 3 m distanceon low channel.
Carrier level is being attenuated with notch filter

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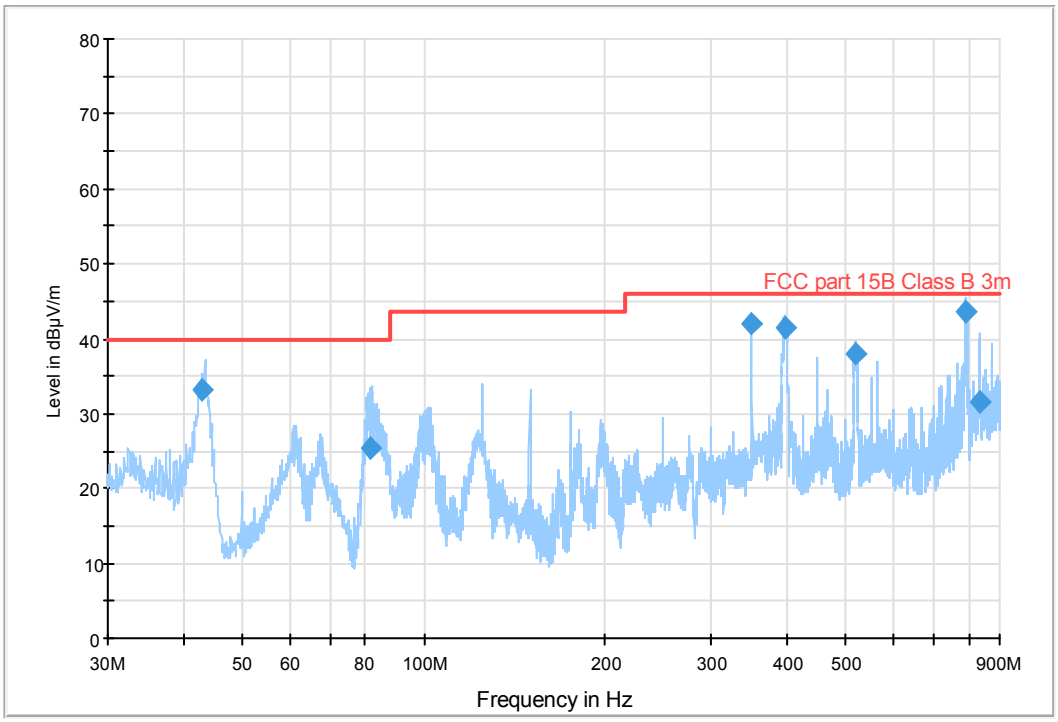
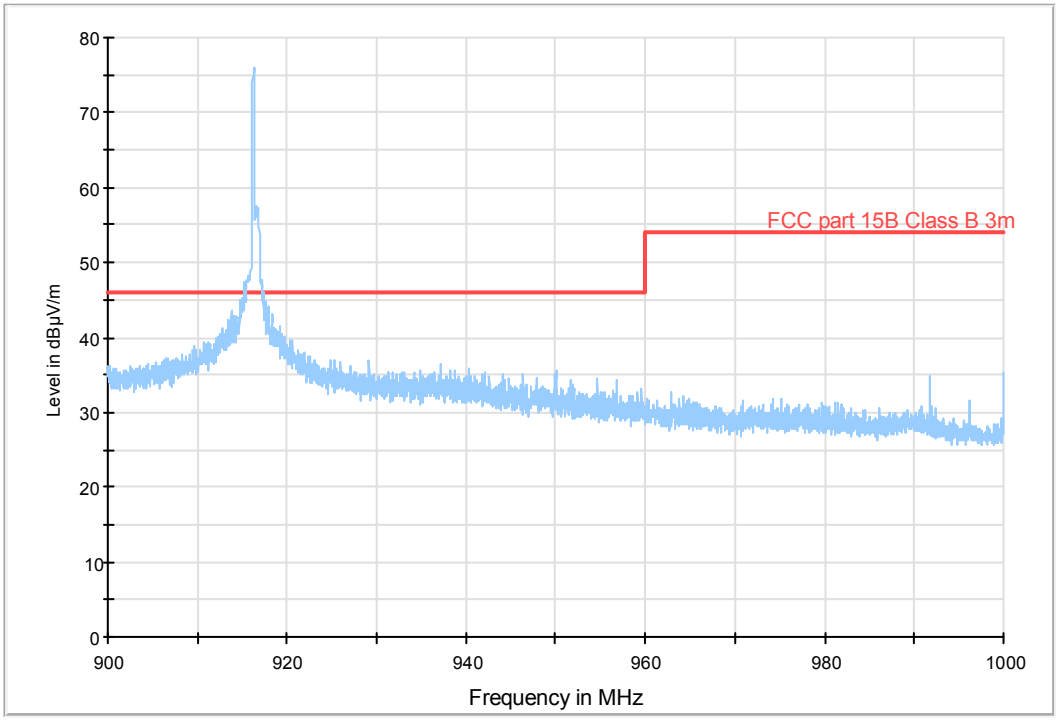
FCC 30 - 1000 MHz FCC class B 3m



Diagram, Peak overview sweep, 30 – 900 MHz at 3 m distanceon middle channel.

FCC 30 - 1000 MHz FCC class B 3m



Diagram, Peak overview sweep, 900 - 1000 MHz at 3 m distanceon middle channel.
Carrier level is being attenuated with notch filter

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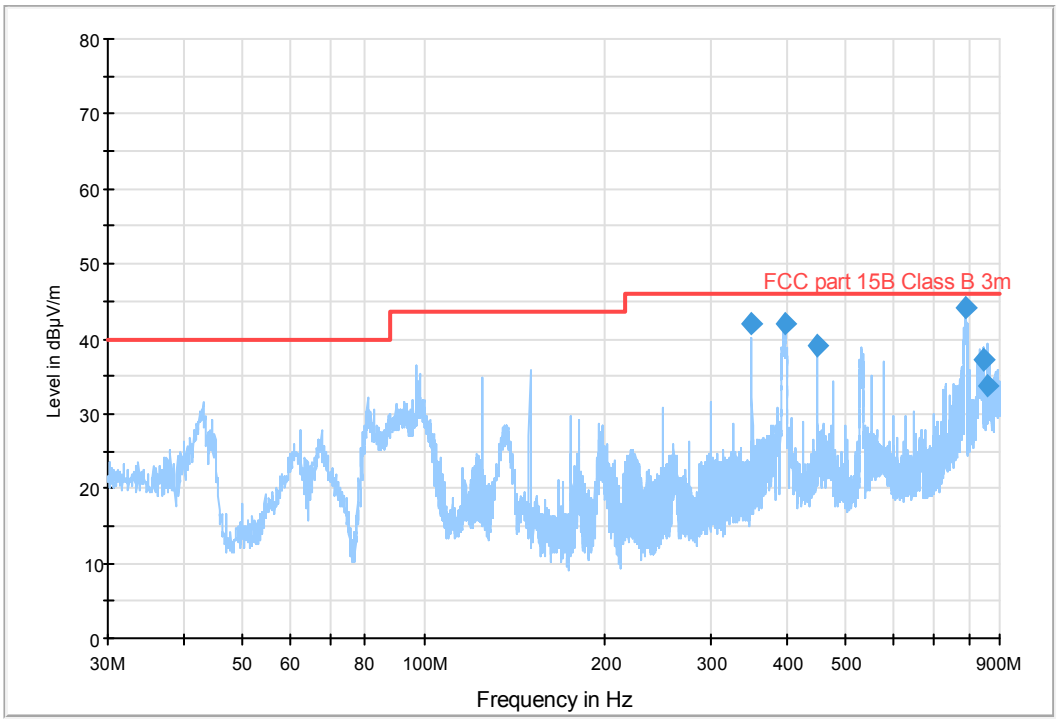
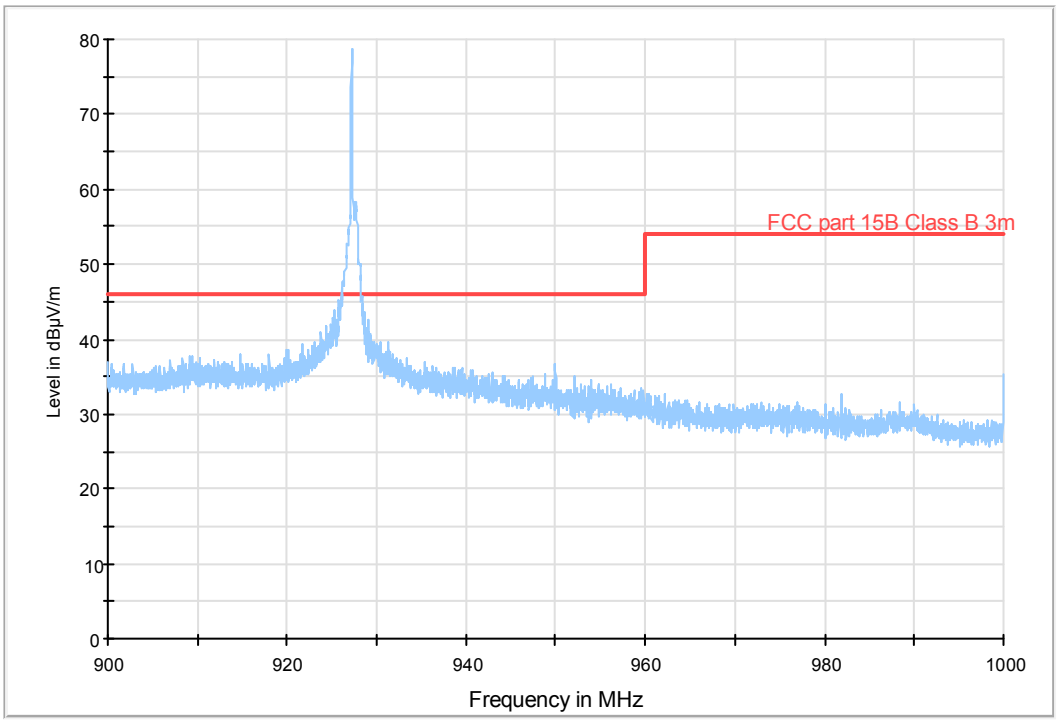
FCC 30 - 1000 MHz FCC class B 3m



Diagram, Peak overview sweep, 30 – 900 MHz at 3 m distance on high channel.

FCC 30 - 1000 MHz FCC class B 3m



Diagram, Peak overview sweep, 900 - 1000 MHz at 3 m distance on high channel.
Carrier level is being attenuated with notch filter

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Measurement results, Quasi Peak

Low channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)
43.129	32.0	1000.0	120	100.0	V	263.0	-21.5	8.0
349.988	42.3	1000.0	120	100.0	H	-3.0	-16.2	3.7
395.781	40.4	1000.0	120	100.0	V	272.0	-14.7	5.6
450.005	39.1	1000.0	120	151.0	H	234.0	-13.0	6.9
752.769	38.8	1000.0	120	133.0	V	93.0	-5.4	7.2
790.534	43.5	1000.0	120	170.0	H	159.0	-5.3	2.5

Middle channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)
43.101	33.2	1000.0	120	100.0	V	-7.0	-21.5	6.8
81.643	25.5	1000.0	120	100.0	V	-1.0	-25.1	14.5
349.988	41.9	1000.0	120	100.0	H	-26.0	-16.2	4.1
396.642	41.4	1000.0	120	122.0	V	237.0	-14.6	4.6
518.991	37.9	1000.0	120	121.0	V	228.0	-11.0	8.1
791.752	43.7	1000.0	120	170.0	H	151.0	-5.3	2.3
835.605	31.5	1000.0	120	121.0	V	225.0	-4.0	14.5

High channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)
349.988	41.9	1000.0	120	100.0	H	-21.0	-16.2	4.1
395.869	42.1	1000.0	120	121.0	V	250.0	-14.7	3.9
450.004	39.0	1000.0	120	151.0	H	228.0	-13.0	7.0
790.665	44.2	1000.0	120	168.0	H	153.0	-5.3	1.8
845.968	37.2	1000.0	120	114.0	V	232.0	-4.0	8.8
859.505	33.7	1000.0	120	115.0	V	234.0	-4.0	12.3

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

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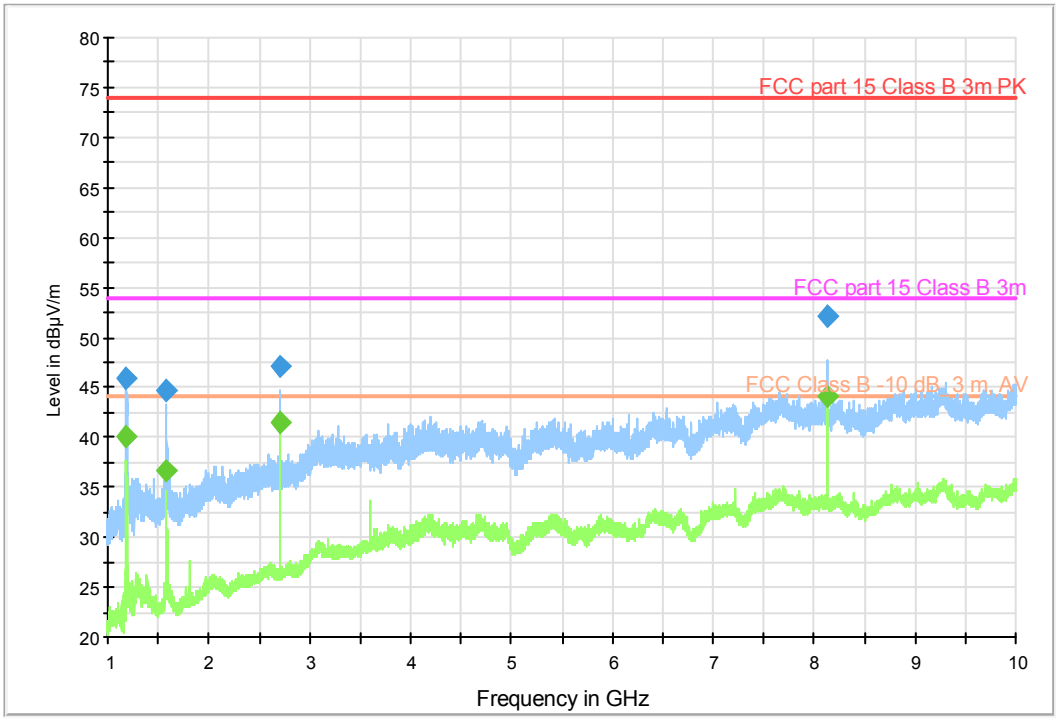
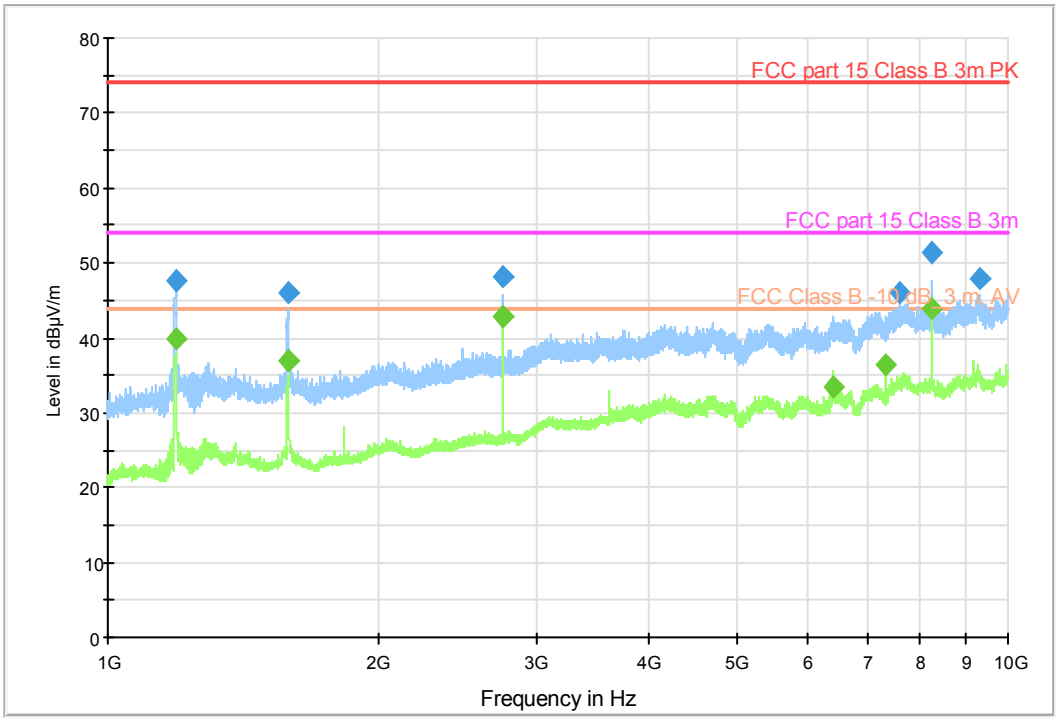
6.6 Test results 1 GHz – 10 GHz

FCC 1 G - 18 G class B 3m ESU40



Diagram, Peak overview sweep, 1 – 10 GHz at 3 m distance. Low channel
An additional 10 dB attenuator was used to eliminate carrier influence to pre-amplifier. Because of this the graph shows 10 dB too low values.

FCC 1 G - 18 G class B 3m ESU40



Diagram, Peak overview sweep, 1 – 10 GHz at 3 m distance. Middle channel
An additional 10 dB attenuator was used to eliminate carrier influence to pre-amplifier. Because of this the graph shows 10 dB too low values.

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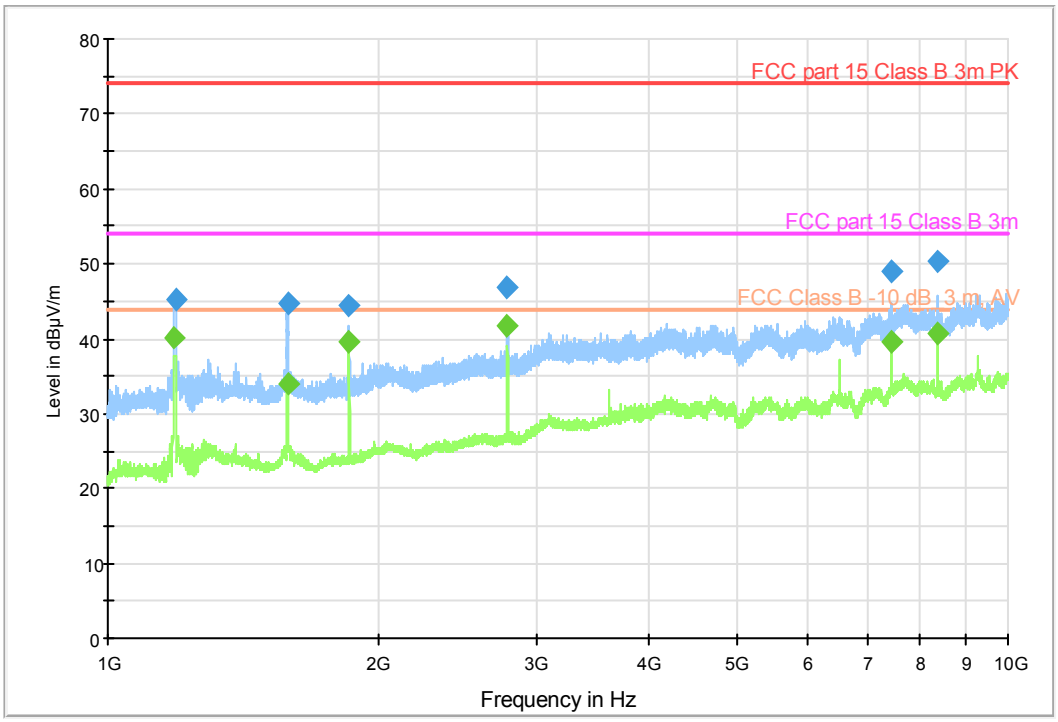
FCC 1 G - 18 G class B 3m ESU40



Diagram, Peak overview sweep, 1 – 10 GHz at 3 m distance high channel
An additional 10 dB attenuator was used to eliminate carrier influence to pre-amplifier. Because of this the graph shows 10 dB too low values.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)
1186.3	55.9	1000.0	1000.000	207.0	V	9.0	18.1	74.0
1581.6	54.7	1000.0	1000.000	205.0	V	35.0	19.3	74.0
2708.2	57.1	1000.0	1000.000	169.0	H	313.0	16.9	74.0
8124.8	62.1	1000.0	1000.000	265.0	V	7.0	11.9	74.0

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB] + attenuator loss [dB] + high pass filter loss[dB]

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)
1186.4	50.0	1000.0	1000.000	169.0	V	11.0	4.0	54.0
1581.7	46.7	1000.0	1000.000	151.0	V	37.0	7.3	54.0
2708.1	51.4	1000.0	1000.000	169.0	H	312.0	2.6	54.0
8124.7	52.6	1000.0	1000.000	134.0	H	308.0	1.4	54.0

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB] + attenuator loss [dB] + high pass filter loss[dB]

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Measurement results, Peak middle channel

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)
1188.3	57.8	1000	1000.000	217.0	V	10.0	16.2	74.0
1583.6	56.1	1000	1000.000	151.0	V	35.0	17.9	74.0
2748.6	58.1	1000	1000.000	115.0	H	313.0	15.9	74.0
7569.6	56.1	1000	1000.000	169.0	V	141.0	17.9	74.0
8246.2	51.4	1000	1000.000	133.0	H	-16.0	12.6	74.0
9308.6	57.8	1000	1000.000	243.0	V	317.0	16.2	74.0

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB] + attenuator loss [dB] + high pass filter loss[dB]

Measurement results, Average middle channel

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)
1187.7	49.9	1000	1000.000	170.0	V	10.0	4.1	54.0
1583.9	46.8	1000	1000.000	151.0	V	37.0	7.2	54.0
2748.7	52.8	1000	1000.000	115.0	H	312.0	1.2	54.0
6413.8	43.4	1000	1000.000	189.0	H	311.0	10.6	54.0
7329.9	46.3	1000	1000.000	168.0	V	332.0	17.7	54.0
8246.2	53.8	1000	1000.000	127.0	H	-16.0	0.2	54.0

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB] + attenuator loss [dB] + high pass filter loss[dB]

Measurement results, Peak high channel

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)
1187.5	55.3	1000	1000.000	193.0	V	10.0	18.7	74.0
1582.5	54.6	1000	1000.000	193.0	V	35.0	19.4	74.0
1854.4	54.5	1000	1000.000	157.0	V	184.0	19.6	74.0
2781.5	56.7	1000	1000.000	100.0	H	315.0	17.3	74.0
7417.8	59.1	1000	1000.000	157.0	V	333.0	14.9	74.0
8345.3	60.3	1000	1000.000	127.0	H	-16.0	13.7	74.0

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB] + attenuator loss [dB] + high pass filter loss[dB]

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Margin (dB)	Limit (dBµV/m)
1187.1	50.0	1000	1000.000	169.0	V	11.0	4.0	54.0
1583.3	44.1	1000	1000.000	100.0	V	35.0	9.9	54.0
1854.5	49.5	1000	1000.000	150.0	V	186.0	4.5	54.0
2781.7	51.8	1000	1000.000	115.0	H	311.0	2.2	54.0
7417.9	49.5	1000	1000.000	157.0	V	338.0	4.5	54.0
8345.1	50.7	1000	1000.000	242.0	V	188.0	3.3	54.0

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB] + attenuator loss [dB] + high pass filter loss[dB]

7 OCCUPIED BANDWIDTH

7.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-20	21 [°C]	31 [%]	KAF	Pass	452.81 kHz

7.2 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10 section 6.9
Marker delta method is used to determine the 20dB bandwidth

7.3 Test conditions

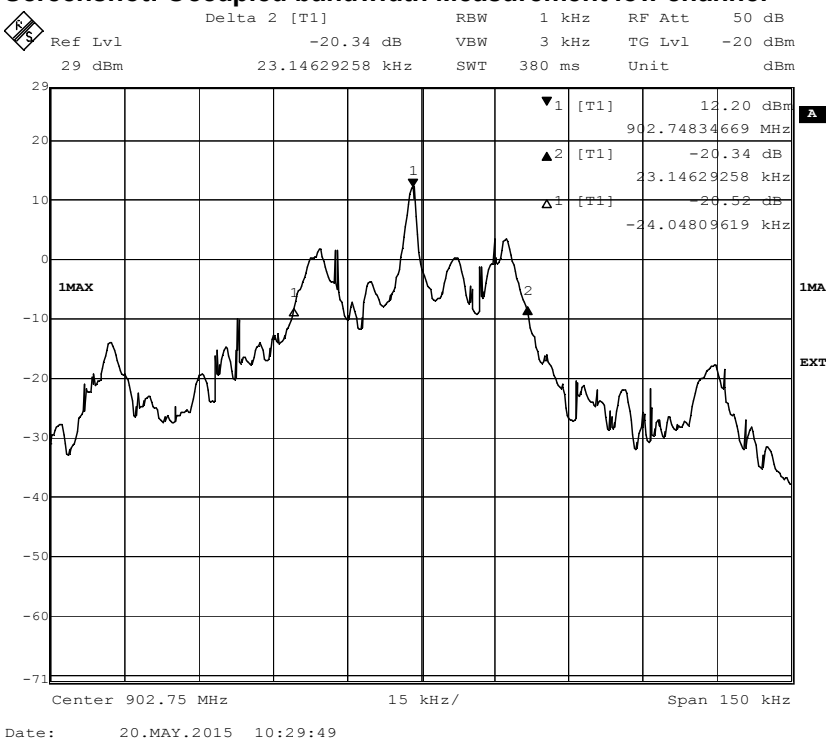
Detector: Peak,
RBW 1 kHz
VBW 3 x RBW
Span 150 kHz

7.4 Requirement

§15.247 (a)(1)
The bandwidth of a frequency hopping channel is the -20 dB emission bandwidth, measured with the hopping stopped.
The bandwidth of a frequency hopping channel is the -20 dB emission bandwidth, measured with the hopping stopped. The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset.
902–928 MHz The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.
5725–5850 MHz maximum allowed -20 dB bandwidth is 1 MHz

7.5 Test results

Screenshot: Occupied bandwidth Measurement low channel



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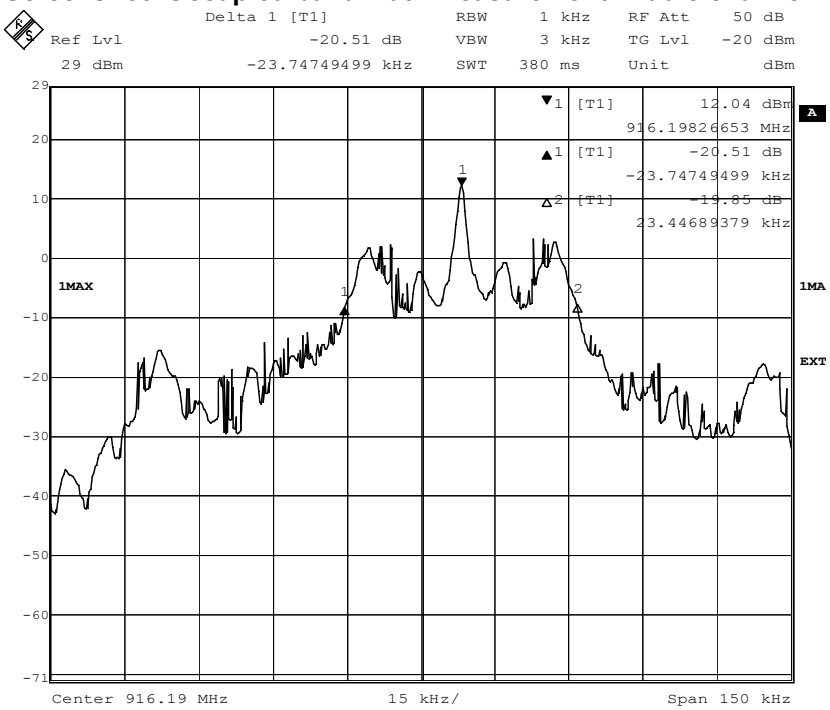
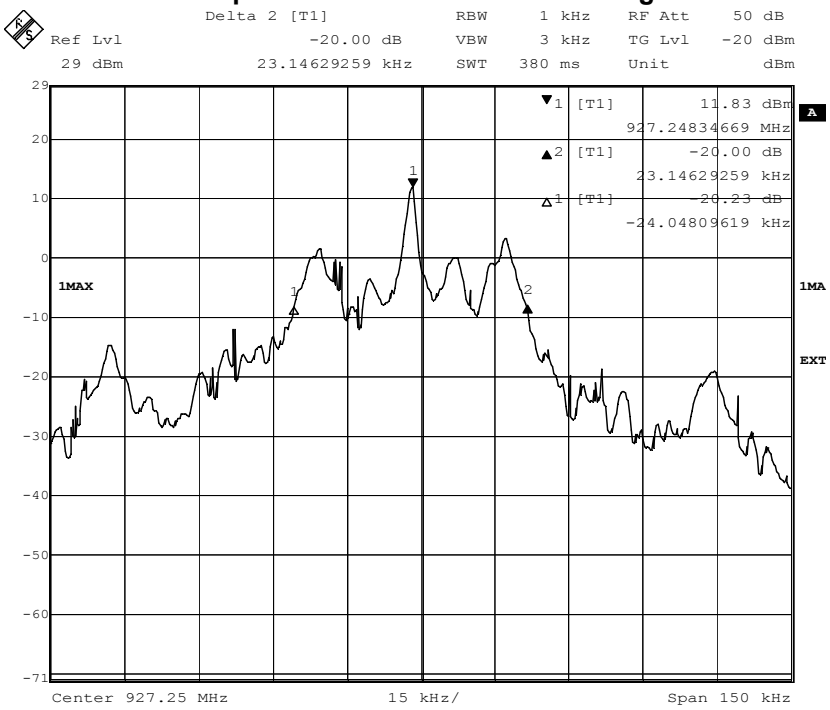
Screenshot: Occupied bandwidth Measurement middle channel



Date: 20.MAY.2015 10:43:04

Screenshot: Occupied bandwidth Measurement high channel



Date: 20.MAY.2015 10:46:03

Test result

20 dB bandwidth (kHz)	Limit (kHz)	Margin (kHz)
47.20	< 500 kHz	452.80
47.19	< 500 kHz	452.81
47.20	< 500 kHz	452.80

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8 NUMBER OF HOPPING FREQUENCIES

8.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-20	21 [°C]	31 [%]	KAF	Pass	0 ch

8.2 Test set-up and test procedure.

Spectrum analyser with occupied bandwidth measurement function is used to determine the occupied bandwidth.

8.3 Test conditions

Detector: Peak
Trace Max hold
RBW 300 kHz
VBW 300 kHz
Span 30 MHz
Sweep Auto

8.4 Requirement

For frequency hopping systems in the band 902–928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.

Frequency hopping systems operating in the band 2400–2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Frequency hopping systems operating in the band 5725–5850 MHz shall use at least 75 hopping channels. The maximum -20 dB bandwidth of the hopping channel shall be 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30-second period.

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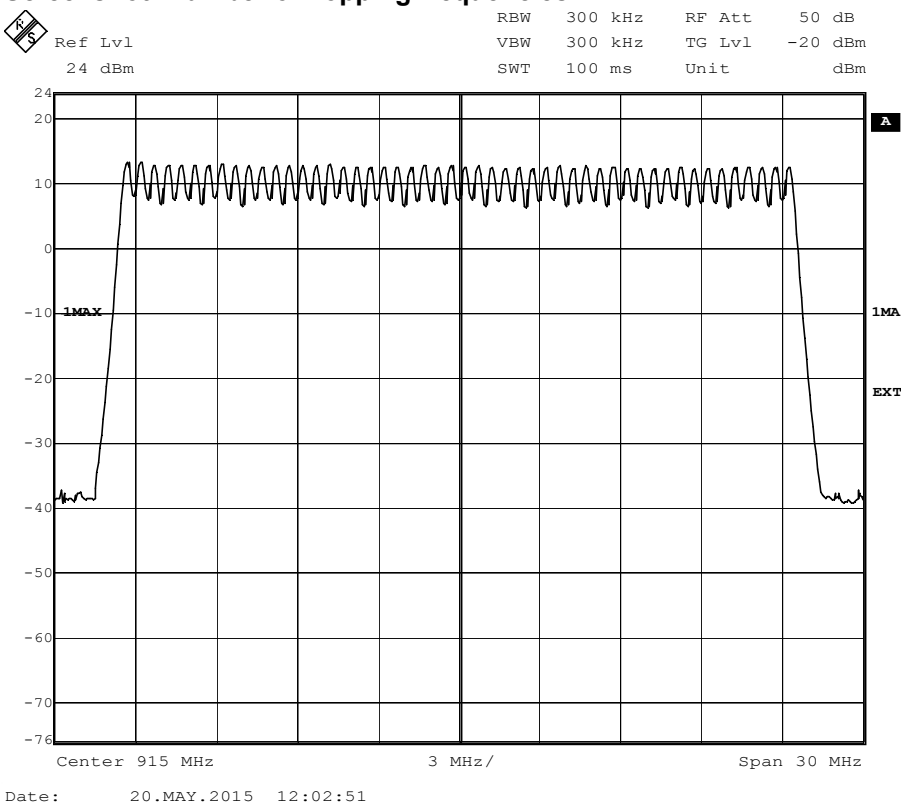
8.5 Test results

Screenshot: Number of hopping frequencies



Test result

number of hopping frequencies	Limit
50	At least 50

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9 CARRIER SEPARATION

9.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-20	21 [°C]	31 [%]	KAF	Pass	453.8 kHz

9.2 Test set-up and test procedure.

The EUT was connected to spectrum analyser via rf-cable and attenuator

9.3 Test conditions

Detector: Peak
Trace Max hold
RBW 20 dB bw / 3
VBW 3 x RBW
Span 5 x 20 dB bw
Sweep Auto

9.4 Requirement

§15.247(a)(1)
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. Alternatively, frequency hopping systems operating in the band 2400–2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

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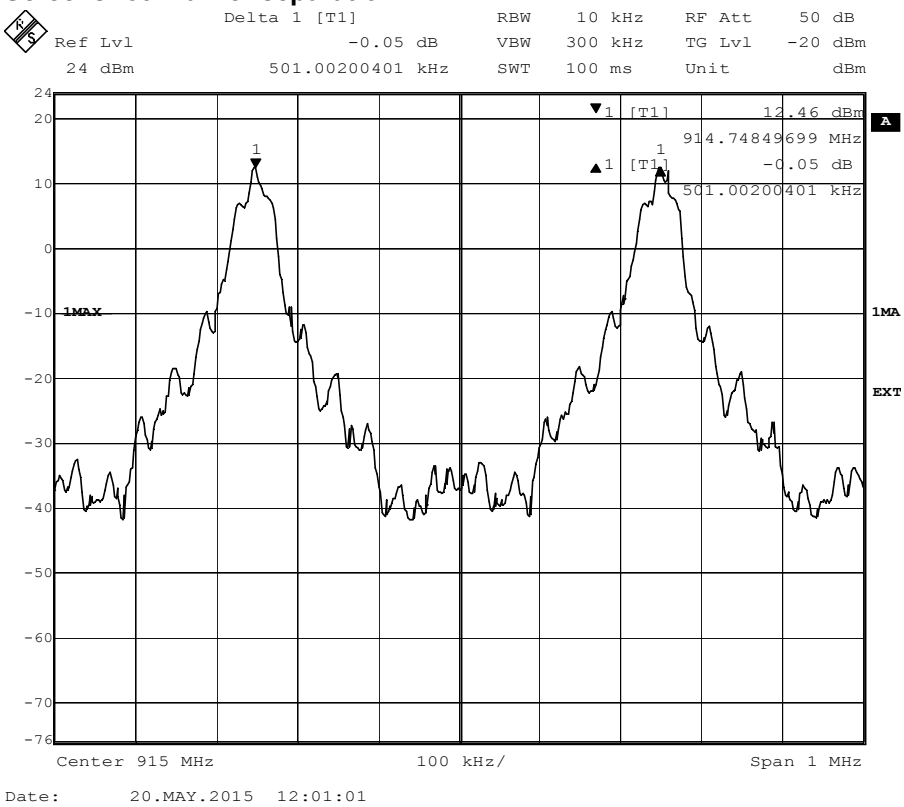
9.5 Test results

Screenshot: Carrier separation



Test result

Carrier separation kHz	Limit kHz
501	47.2

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10 TRANSMITTER TIME OF OCCUPANCY

10.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-20	21 [°C]	31 [%]	KAF	Pass	7 ms

10.2 Test set-up and test procedure.

Spectrum analyser is used to determine the transmitter duty cycle.
The EUT is connected to the anasyr via rf-cable and attenuator.

10.3 Test conditions

Detector:	Peak
RBW	100 kHz
VBW	3 x RBW
Span	0 Hz
Sweep time	500 ms

10.4 Requirement

§15.247(a)(1)

902–928 MHz:
If the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period.
If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period.

2400–2483.5 MHz:
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed.

5725–5850 MHz:
The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30-second period.

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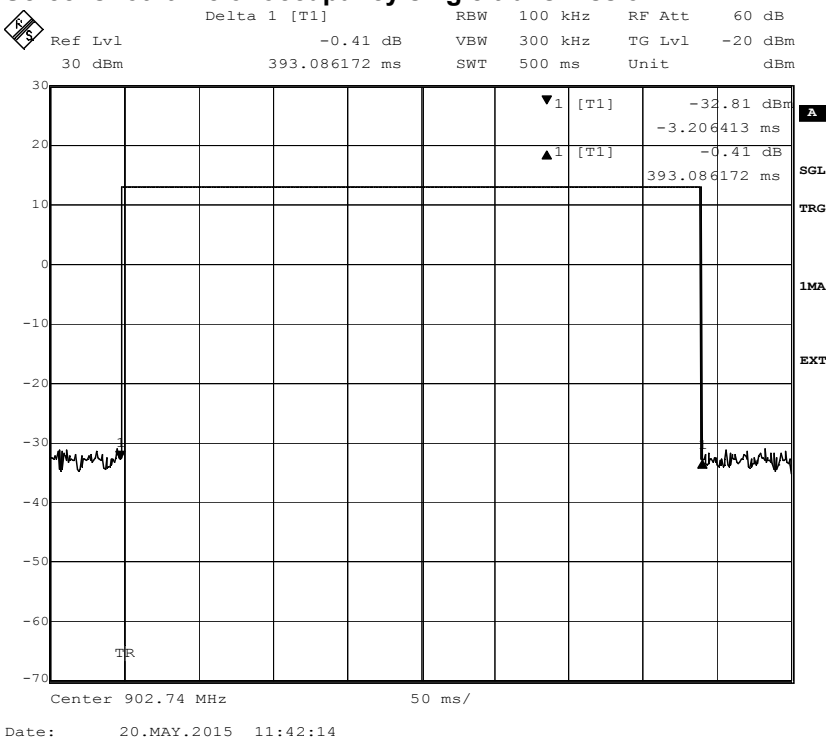
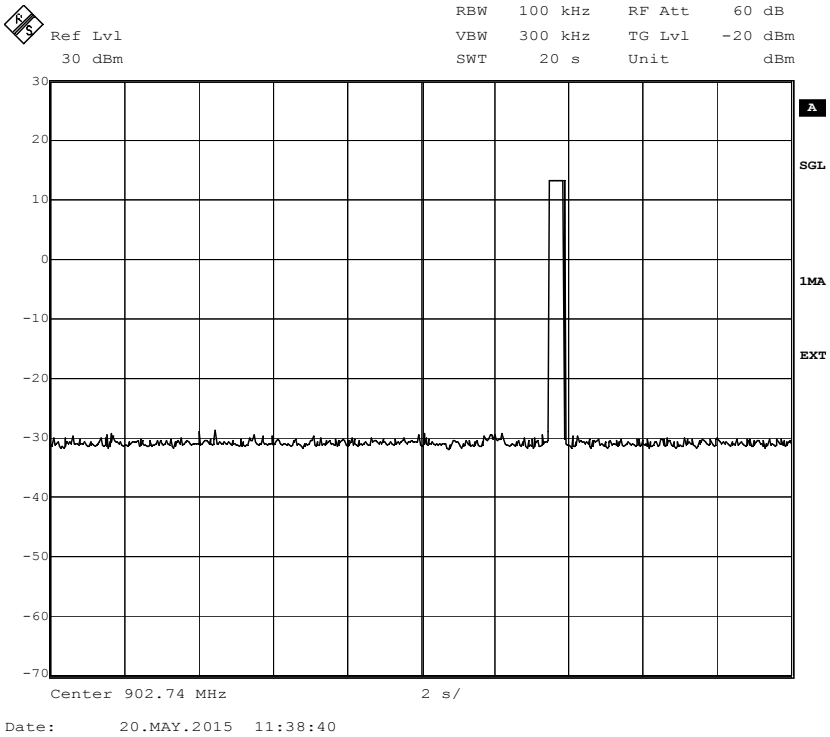
10.5 Test results

Screenshot: time of occupancy single transmission.



Screenshot: number of transmissions / 20 s



Test result

Number of transmissions	Transmission time (ms)	Time of occupancy /20 s (ms)	Limit (ms)	Margin (ms)
1	393	393	400	7

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11 MAXIMUM PEAK CONDUCTED OUTPUT POWER

11.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-20	21 [°C]	31 [%]	KAF	Pass	7.04 dB

11.2 Test set-up and test procedure.

The EUT is connected to the analyser via rf-cable and attenuator.
Spectrum analyser's reference level offset was used to compensate cable and attenuator losses.

11.3 Test conditions

Detector: Peak,
Trace Max hold
RBW 100 kHz
VBW 300 kHz
Span 250 kHz
Marker was used to detect peak power.

The EUT was set up in order to emit maximum disturbances.

11.4 Requirement

§15.247(b)(1)
(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

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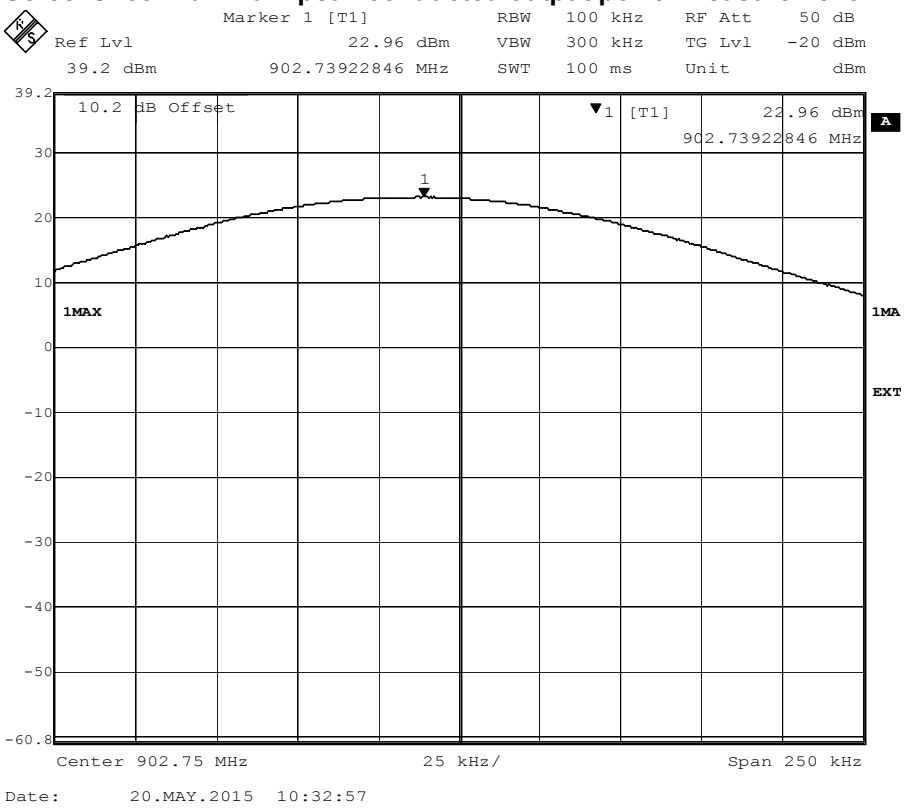
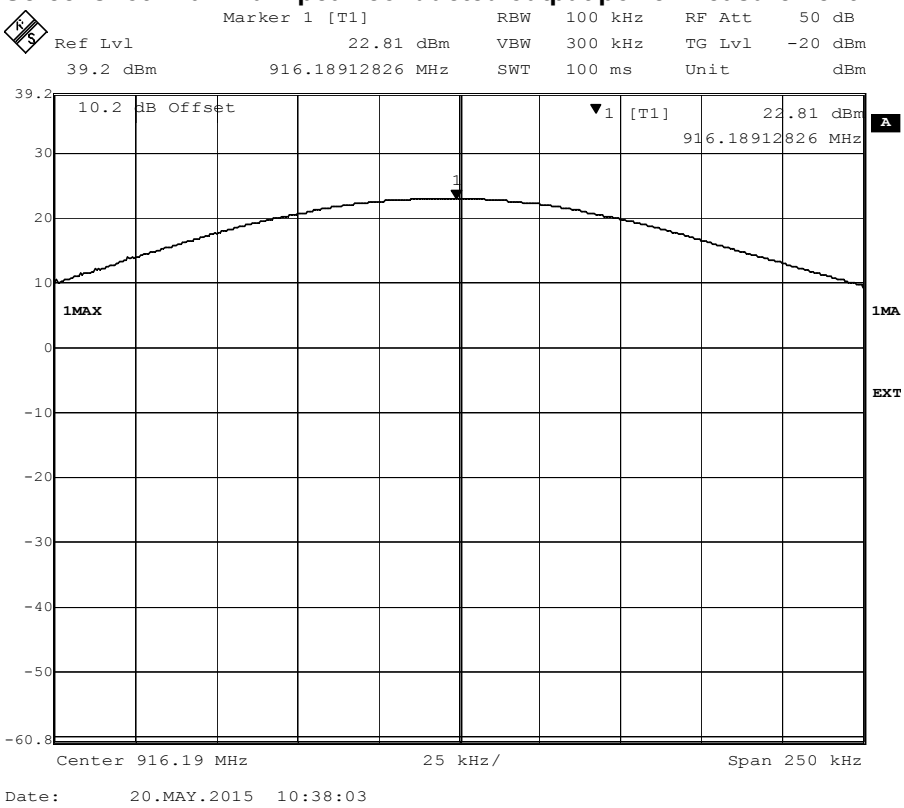
11.5 Test results

Screenshot: maximum peak conducted output power Measurement



Screenshot: maximum peak conducted output power Measurement



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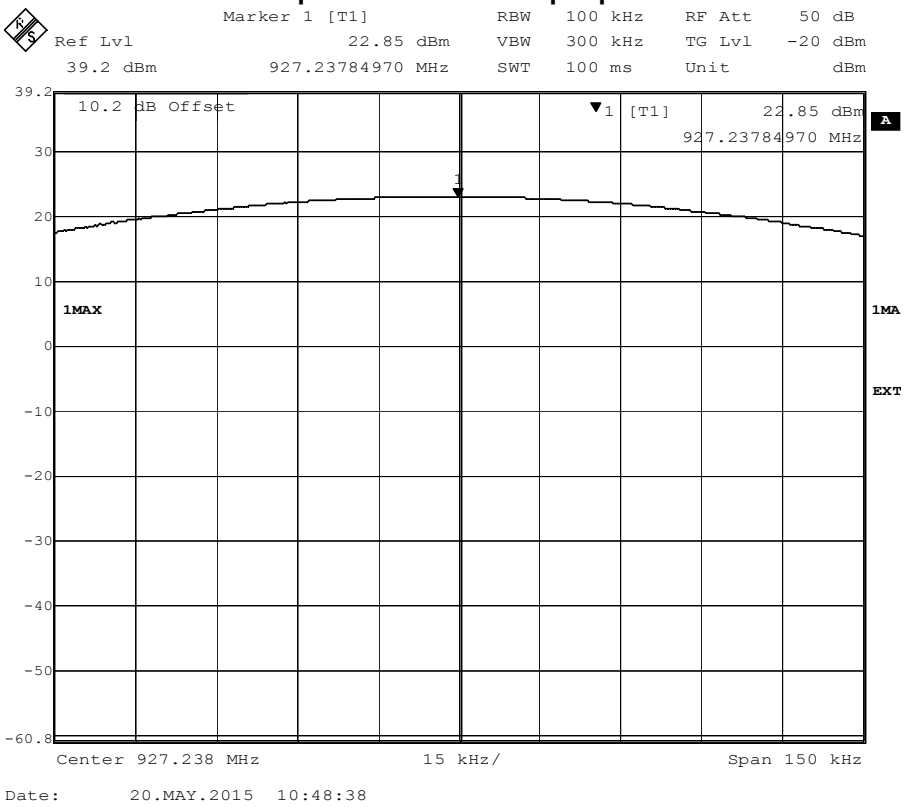
Screenshot: maximum peak conducted output power Measurement



Test result

Low chanel (dBm)	Middle channel (dBm)	High channel (dBm)	Limit (dBm)	Margin (dB)
22.96	22.81	22.85	30	7.04

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12 BAND EDGE CONDUCTED

12.1 Operating environment

Date of test:	Temperature:	Relative Humidity:	Tested by	Result	Margin
2015-05-20	21 [°C]	31 [%]	KAF	Pass	26.96 dB

12.2 Test set-up and test procedure.

The EUT is connected to the analyser via rf-cable and attenuator.

12.3 Test conditions

Detector: Peak
Trace Max hold
RBW 100 kHz
VBW 3 x RBW
Span 50 MHz

The EUT was set up in order to emit maximum disturbances.

12.4 Requirement

§15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits is not required.

12.5 Test results

Test result

902.75 MHz (dBm)	902 MHz Attenuation (dB)	927.75 MHz (dBm)	928 MHz Attenuation (dB)	Limit (dB)	Margin (dB)
23.53	56.96	22.84	58.03	20	26.96

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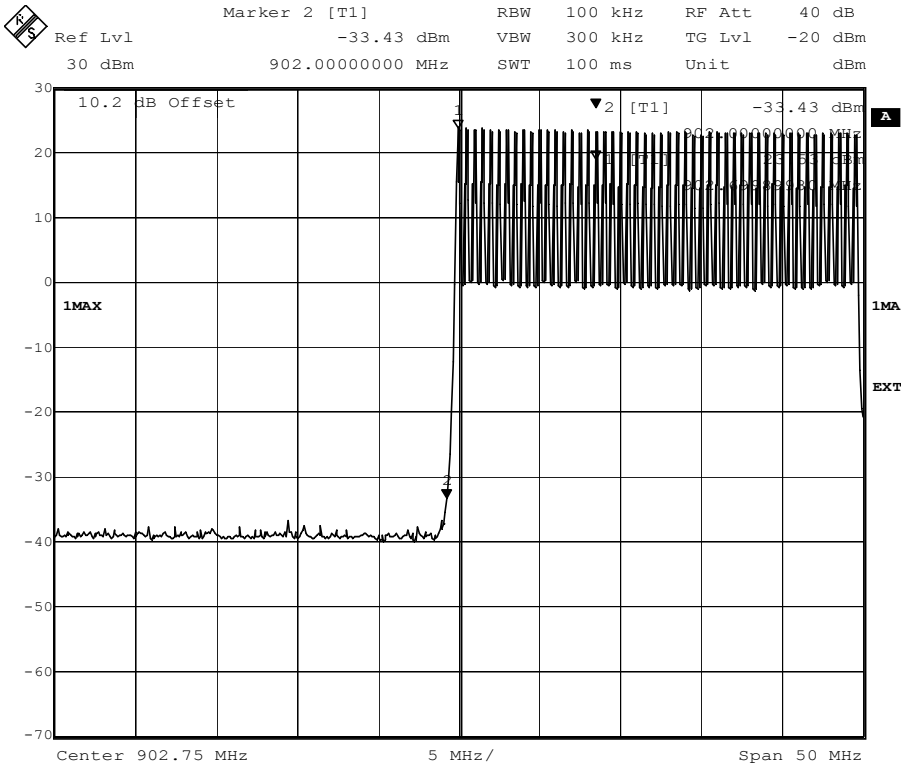
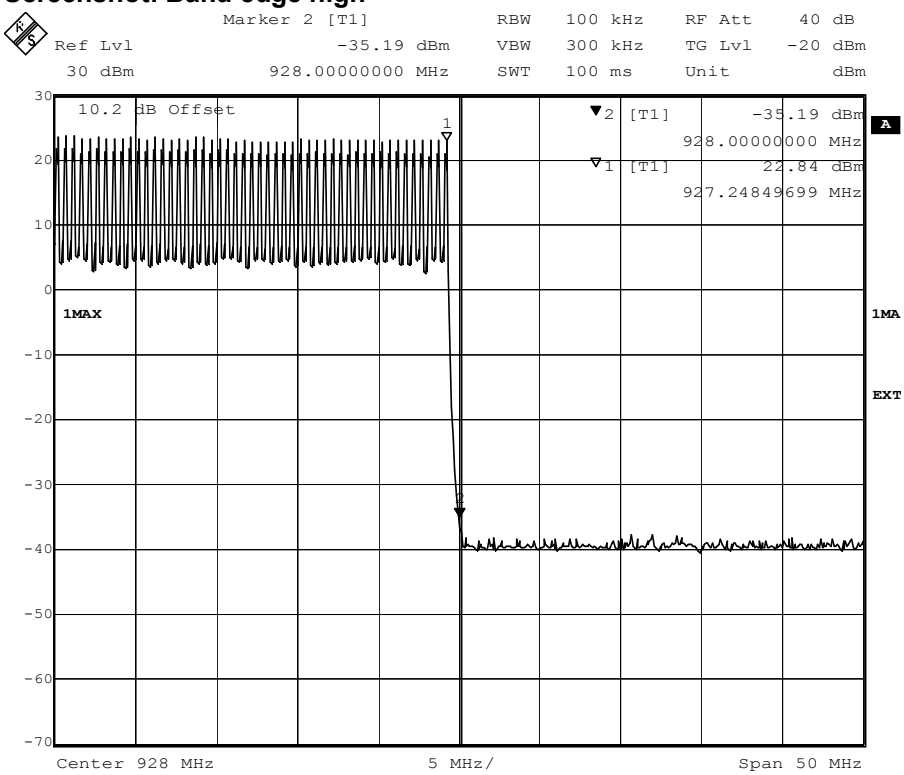
Screenshot: Band edge low



Date: 20.MAY.2015 11:07:17

Screenshot: Band edge high



Date: 20.MAY.2015 11:09:35

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13 TEST EQUIPMENT

Stora hallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - 8.51	--	--	--
Receiver	Rohde & Schwarz	ESU 8	12866	7/2014	1 year
Receiver	Rohde & Schwarz	ESU 40	13178	7/2014	1 year
BiLog antenna	Chase	CBL6110A	971	8/2012	3 years
Preamplifier	SEMKO	AM1331	7992	7/2014	1 year
Horn antenna	Rohde Schwarz	HF907	31245	11/2013	3 years
Preamplifier	Bonn-Elektronik	BLMA 0118-M	31246	7/2014	1 year
1 GHz high pass filter	Microwave Circuits Inc.		13142		
Horn antenna	EMCO	3160-09	30101	10/2013	3 years
10 dB Attenuator:	Huber+Suhner	5910_N-50-010	32696	7/2014	1 year
Tunable Notch filter	K&L	3TNF-500/1000-N	7078	-	-

Wireless centre and 3m FAC

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Signal analyser	Rohde & Schwarz	FSIQ 40	12793	7 / 2014	1 year
10 dB Attenuator:	Huber+Suhner	5910_N-50-010	32696	7 / 2014	1 year

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14 MEASUREMENT UNCERTAINTY

Continuous conducted disturbances with AMN in the frequency range 9 kHz to 30 MHz ± 3.6 dB

Measurement uncertainty for radiated disturbance

Uncertainty for the frequency range 30 to 1000 MHz at 3 m	± 4.9 dB
Uncertainty for the frequency range 30 to 1000 MHz at 10 m	± 4.8 dB
Uncertainty for the frequency range 1.0 to 18 GHz at 3 m	± 5.4 dB
Uncertainty for the frequency range 18 to 26 GHz at 3 m	± 5.5 dB
Uncertainty for the frequency range 26 to 40 GHz at 3 m	± 5.6 dB

Measurement uncertainty is calculated in accordance with CISPR 16-4-2:2011.
The measurement uncertainty is given with a confidence of 95 %.

15 TEST SET UP PHOTOS

Test set up photos are in separate document 1510902STO-001 Annex 1

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