

RADIO TEST REPORT

No. 1611873STO-003, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment: Radio Base Station
Product name: RBS 6402 LTE indoor eNodeB with LTE-U module
Product number: KRD 901 060/83
Manufacturer: LM Ericsson AB
Tested by request of: LM Ericsson AB

SUMMARY

All selected test cases specified in this report comply with the requirements according to the following standards:

47 CFR Part 2 (2015)
47 CFR Part 27 (2015): Subpart C
47 CFR Part 15 (2015): Subpart B
RSS-GEN Issue 4 (2014)
RSS-139 Issue 2 (2009)
ICES-003 Issue 6 (2016)

For details, see clause 2 – 4.

Date of issue: 2016-07-05

Tested by:



Matti Virkki

Approved by:



Stefan Andersson

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1	2016-07-05	First release	

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1 CLIENT INFORMATION

The EUT has been tested by request of

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Name of contact Mika Savilakso
Phone +358 442654000

Client observer Esko Korhonen

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment: Radio base station

Product name: RBS 6402

Pproduct number: KRD 901 060/83

Brand name: Ericsson

Serial number: C82A555094

Manufacturer: LM Ericsson AB

Transmitter frequency range: FDD Band 4 2110 – 2155 MHz

Receiver frequency range: FDD Band 4 1710 – 1755 MHz

Antenna: Internal antennas External antenna

Antenna gain: 6 dBi max

Rating RF output power: 13 – 24 dBm to antenna

Type of modulation: LTE (QPSK, 16-QAM, 64-QAM)

Channel BW: 5, 10, 15, 20 MHz

Transmitter standby mode supported: Yes No

2.2 FCC ID, IC and IC model number

Function Designation	Product no.	FCC ID:	IC ID:	IC Model no.
RBS 6402;B2/25 B4 B7	KRD 901 060/83	TA8AKRD90106083	287AB-AS90106083	AS90106083

2.3 EUT description

RBS 6402 is a modular multi-band indoor product for 3GPP LTE.

The main characteristics of the RBS 6402 configuration KRD 901 060/83 product are:

- Full modularity
- Multi-band, FDD
- IBW 20/40 MHz (LTE-U/3GPP)
- FDD LTE carrier aggregation supported
- Ericsson DFE algorithms (CFR, DPD)
- Integrated internal antennas for RBS, external antennas as an option (for RM A module).
- LTE-U with integrated internal antennas as a separate module to be assembled into RF1 slot of RBS 6402.

RBS 6402 eNodeB product's maximum configurable conductive output power is 20 mW...125 mW (+13 ...+21dBm) for Unlicensed spectrum and 20 mW...250 mW for (+13 ...+24 dBm) for Licensed Spectrum complying with 3GPP Local Area requirement specification 3GPP TS 37.104, release 11.

In the tests configuration (KRD 901 060/83) RBS 6402 LTE shall include modules presented in the figure below. One multi-band RF module (RM A) and one dual band RF module (RM F) are included in the configuration.

Single carrier setup is selected according to standard 3GPP TS 37.113, release 11. Configurations with RM F only 20 MHz BW is supported in the RM F module.

Only single carrier setup is tested in this report. Single and dual carrier modes without and with external antenna kits were tested in June and July of 2015, Intertek test reports: 1512825STO-001, ...-002, ...-003 and ...004 (without external antenna kits) and 1512825STO-005, ...-006, ...-007 and ...-008 (with external antenna kits).

Only one RF path out of three at each side of the 3GPP radio module is active at the time to support 2*2 MIMO operations. RM A includes downlink (TX) and uplink (RX). RM F is a downlink only product. RBS 6402 shall always be powered via a specified power supply (AC/DC adapter) or PoE injector. The power input of RBS 6402 is not defined as DC input port in the EMC tests although it is labelled so on the RBS 6402 chassis.

AC/DC power supply adapter is used as a power supply for regulatory approval testing and will be delivered as a site product with RBS 6402. Also PoE power supply (Power over Ethernet) can be used as an alternative power supply.

RBS 6402 is designed to get the clock synchronization from the GPS signal via the separate GRU module of Ericsson. This is connected to the GRU port of RBS 6402.

Additional general information about the RBS with LTE-U module

LTE RBS 6402 product is a synthesized transmitter and receiver designed for use in the 3GPP (Third Generation Partnership Project), LTE (Long Term Evolution) and for LTE-U to extend benefits of LTE on unlicensed spectrum.

RBS 6402 RM A operates in operating frequency bands 2, 25, 4 and 7. LTE-U module (RM F) operates in bands 252 and 255 mentioned in LTE-U forum documentation. Band 252 corresponds to UNII-1 and Band 255 corresponds to UNII-3 band. UNII-2 is not supported by the RBS 6402.

For 3GPP LTE RBS 6402 supports modulations of QPSK, 16QAM and 64QAM. The channel bandwidth is configurable within 5 MHz, 10 MHz, 15 MHz and 20 MHz with possibility to activate 25, 50 and 100 resource blocks (RB) for the licensed bands. It is able to transmit single or dual carrier. On the unlicensed bands, only the 20 MHz channel bandwidth is supported.

This RBS 6402 has two dual-TX radio modules where each of the two RF chains are identical. The first dual-TX radio module operates on the licensed bands, and the other dual-TX radio module operates on the unlicensed bands. The RBS 6402 can be configured to two 2x2 MIMO per radio or CA inter-band CA, or LTE-U operation with two radio cards.

The RBS 6402 supports two radio modules of which the licensed band radio module have two identical down-link and up-link signal paths. The unlicensed band radio module has two identical downlink signal paths and RX observer facility.

This RBS 6402 has following functions:

- Transmitting and Receiving Processing (TRP).
- On licensed band radio module
 - o Downlink (transmitter) and uplink (receiver) signal processing and RF filtering 2-TX (transmitter)
 - o 2-RX (receiver)
 - o Low output power: Max. 250 mW, min. 20 mW total configured conductive power per branch with tolerance ± 1 dB. If two carriers per branch, total power is divided between carriers.
- On unlicensed band radio module
 - o Downlink (transmitter), uplink carrier sensing functionality and RF filtering 2-TX (transmitter)
 - o Carrier sensing receiver (RX observer)
 - o Low output power: Max. 125 mW, min. 4 mW total configured conductive power per branch. If two carriers per branch, total power is divided between carriers.
- Possibility to use integrated wide sector antenna.

Integrated antenna:

- Integrated omni antenna, consisting of two integrated antennas operating on the same frequency band e.g. in dual polarized antenna. In CA configuration, another radio module might have low-band antenna and another radio module might have high-band antenna.
 - o Minimum gain: Gain per antenna port is > -6.0 dBi. ($-180 \text{ deg.} \leq \theta \leq +180 \text{ deg}$ and $0 \text{ deg.} \leq \phi \leq -45 \text{ deg.}$)
 - o Maximum gain: Gain per antenna port is 6 dBi.

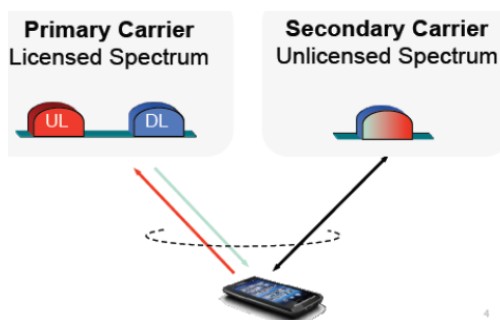


Figure: Licensed and unlicensed spectrum carriers.

Sleeping LTE-U is a fully calibrated and production tested unit, which is then deactivated with specific sleeping LTE-U SW that blocks LTE-U to be used in the field. Sleeping LTE-U can be re-activated afterwards by loading a new activation SW to LTE-U.

Below is a block diagram about RBS 6402 indoor base station for KRD 901 060/83.

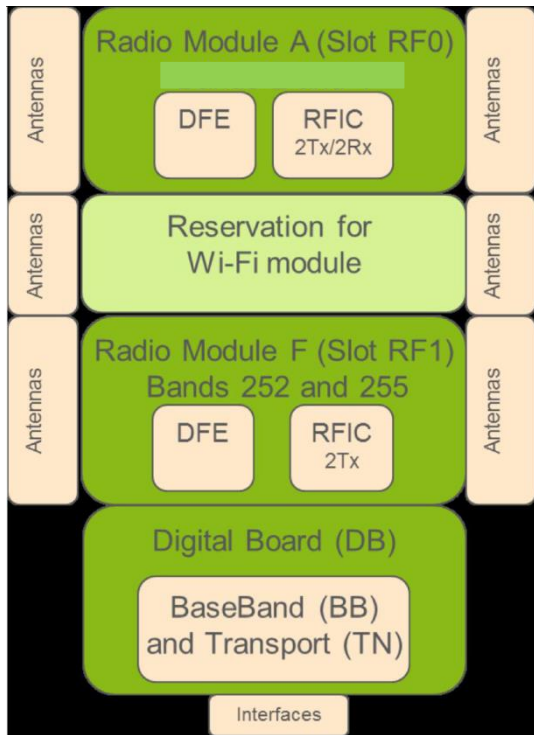


Figure: RBS 6402 high level block diagram (KRD 901 060/83). LTE-U module is assembled to the slot RF1 but in sleeping mode. Wi-Fi module is not assembled.

2.4 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	Serial number	Note
Radio base station	RBS 6402	C82A555094	
AC/DC Power supply adapter	190 09_BML 901 3021_1_A	D880000004	

The EUT was tested with the following cables:

Port:	Type:	Length: [m]	Specifications:
AC port	AC power supply for AC/DC adapter	2	Three-core
DC port	Power	1.2	Coaxial
LAN (WAN A, Telecommunication port)	Signal cable	10	Unshielded, CAT 6, RJ45
GRU signal port	Signal cable	15	Shielded, CAT 6, Mini I/O connector

2.5 Peripheral equipment

Peripheral equipment is equipment needed for correct operation of the EUT, but not included as part of the testing and evaluation of the EUT.

Equipment	Type/Model	Manufacturer	Serial no.
Laptop	Dell Latitude E7450	Dell	CC4N462
GRU line termination	Termination instead of GRU	LM Ericsson AB	-
LAN line termination *	Termination for Ethernet test model PHY *	LM Ericsson AB	-

* In the radiated emission tests below 1 GHz, the PC was disconnected and the LAN line (WAN A) terminated (Ethernet test model TM-1 used).

2.6 Modifications made to improve EMC-characteristics

No modifications have been made during the tests.

3 TEST SPECIFICATIONS

3.1 Standards

Requirements:

- 47 CFR Part 2 (2015)
- 47 CFR Part 27 (2015): Subpart C
- 47 CFR Part 15 (2015): Subpart B
- RSS-GEN Issue 4 (2014)
- RSS-139 Issue 2 (2009)
- ICES-003 Issue 6 (2016)

Test methods:

- ANSI-TIA-603-D-2010
- ANSI C63.26-2015
- ANSI C63.4-2014
- KDB 971168 D01 v02r01

3.2 Additions, deviations and exclusions from standards and accreditation

Only radiated spurious emission and conducted spurious emissions from AC-mains parts of the standards are measured by request from the client.

No other 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 #
BJÖRKHALLEN	Semi-anechoic 3 m	2042G-1

3.4 Mode of operation during the test

Radiated emission tests are made with QPSK modulation on the bottom (B), middle (M) and top (T) channels in band 4 and with the channel bandwidth as stated in the table below.

Conducted emission test is made with EUT transmitting on the top channel in band 7 (2687.5 MHz).

The EUT (RM A module) is activated by software for maximum transmit power 2 x 0.25 W.

Mode	Channel BW [MHz]	TX B, M, T Frequencies [MHz]	TX B, M, T Channels	RX B, M, T Frequencies [MHz]	RX B, M, T Channels
LTE	5	2112.5 2132.5 2152.5	1975 2175 2375	1712.5 1732.5 1752.5	19975 20175 20375

LTE-U module is in sleeping mode.

3.5 Test setup

The tests are carried out with the EUT arranged according to below.

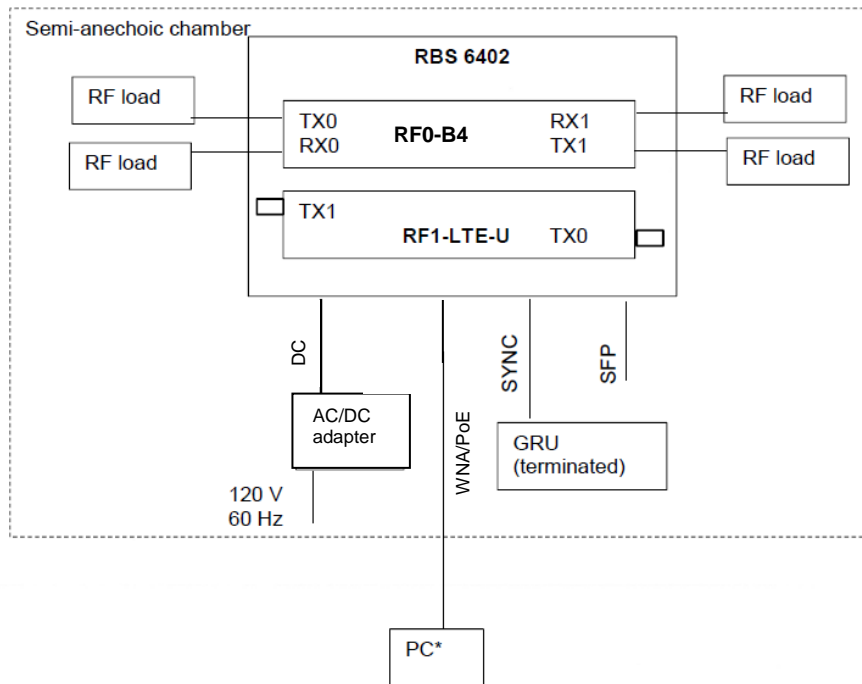
- RM A: Transmitting at full power. Antenna ports are terminated.
- RM F: LTE-U module is in sleeping mode.
- RBS 6402 is powered by AC/DC power supply, supplied with 120 V, 60 Hz.
- The AC/DC power supply adapter is earthed but RBS 6402 itself is not earthed.
- RBS 6402 is mounted in vertical position.
- Fan module is assembled.

Communication:

In the emission tests an external PC is used for start up the RBS and after this communication test model for Ethernet PHY (Test model 1) is started for transmission in WAN A (LAN) port (and Ethernet cable). The WAN A cable is terminated with the termination resistors.

There is a single CPRI lane (8 x mode 4915.2 Mbps) to the both directions between Digital Board SoC and ASIC:s (or FPGA:s) on both RF boards. That makes total of four differential signal lanes at 4915.2 Mbit/s. RM F has also UNII-3 band support (5.875 GHz) which is the highest frequency of the unit. The highest frequency of band 4 is 2152.5 MHz.

Test setup block diagram



* Terminated instead of the PC in the radiated emission measurements below 1 GHz. Ethernet emission test model (TM-1) used.

4 TEST SUMMARY

The results in this report apply only to sample tested:

Standard	Description	Result
	Emission	
CFR 47, Part 2.1046, Part 27.50 RSS-Gen section 4.8 RSS-139 section 6.4	RF output power Not considered to be tested for this report. The EUT complies with the limits. For results see previous report	Not Tested
CFR 47, Part 2.1049 RSS-Gen section 4.6	Occupied bandwidth Not Tested by request of the client. Test is performed by the client in another test house and reported in the corresponding documents.	Not Tested
CFR 47, Part 2.1051, Part 27.53	Intermodulation Not Tested by request of the client. Test is performed by the client in another test house and reported in the corresponding documents.	Not Tested
CFR 47, Part 2.1051, Part 27.53 RSS-Gen section 4.9 RSS-139 section 6.5	Out of band spurious emissions, conducted Not Tested by request of the client. Test is performed by the client in another test house and reported in the corresponding documents.	Not Tested
CFR 47, Part 2.1053, Part 27.53 RSS-Gen section 4.9 RSS-139 section 6.5	Transmitter out of band spurious emissions, radiated The EUT complies with the limits. The margin to the limit was at least 30 dB at 18.0 GHz See clause 6.	PASS
CFR 47, Part 2.1055 RSS-Gen section 4.7 RSS-139 section 6.3	Frequency stability Not Tested by request of the client. Test is performed by the client in another test house and reported in the corresponding documents.	Not Tested
CRF 47, Part 15.109 RSS-Gen section 6.1 ICES-003 section 6.2	Receiver out of band spurious emissions, radiated The EUT complies with the limits. The margin to the limit was at least 11.4 dB at 951.844 MHz See clause 6.	PASS
CRF 47, Part 15.107 ICES-003 section 6.1	Conducted spurious emissions from AC-Mains The EUT complies with the limits. The margin to the limit was at least 15.4 dB at 1.551 MHz See clause 5.	PASS

5 CONDUCTED CONTINUOUS DISTURBANCES IN THE FREQUENCY-RANGE 0.15 - 30 MHz

Date of test:	2016-06-08	Test location:	Björkhallen
EUT Serial:	C82A555094	Ambient temp:	23 °C
Tested by:	Matti Virkki	Relative humidity:	39 %
Test result:	Pass	Margin:	15.4 dB

5.1 Test set-up and test procedure

The test method is in accordance with ANSI C63.4 (2014).

The EUT was connected to the power via Artificial Mains Networks AMN.

The EUT was placed on an insulating support 0.8 m above the reference ground plane and 0.8 m from the AMN/ISN.

Overview sweeps were performed for each lead.

5.2 Conducted emission requirements:

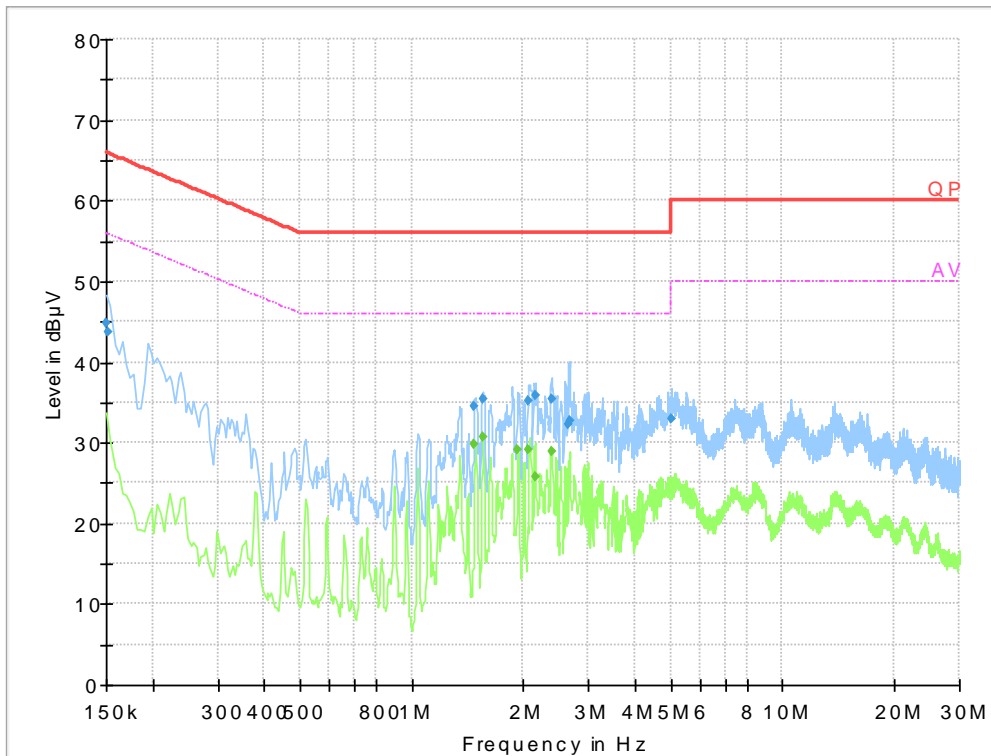
The EUT shall meet the limits for the standards.

Reference: 47 CFR §15.107
ICES-003, section 8.8 table 3

Limits for conducted emission:

Frequency range [MHz]	Limits [dB μ V]	
	Quasi-Peak	Average
0.15 – 0.50	66 – 56	56 – 46
0,50 – 5.00	56	46
5.00 – 30.0	60	50

5.3 Test results: AC Power input port on AC/DC adapter



Diagram, Peak and Average overview sweep, EUT powered by AC/DC adapter

Measurement results, Quasi-peak

Frequency [MHz]	Level [dBµV]	Limit [dBµV]	Line L/N	Margin [dB]
0.150	44.8	66.0	L1	21.2
0.151	43.8	65.9	N	22.2
1.480	34.6	56.0	L1	21.4
1.554	35.3	56.0	L1	20.7
2.067	35.2	56.0	L1	20.9
2.156	35.8	56.0	L1	20.2
2.384	35.3	56.0	L1	20.7
2.639	32.4	56.0	L1	23.7
2.657	32.8	56.0	N	23.2
4.990	32.8	56.0	L1	23.2

Measurement results, Average

Frequency [MHz]	Level [dBµV]	Limit [dBµV]	Line L/N	Margin [dB]
1.480	29.8	46.0	L1	16.2
1.551	30.6	46.0	L1	15.4
1.924	29.2	46.0	L1	16.8
2.066	29.1	46.0	L1	16.9
2.155	25.9	46.0	L1	20.2
2.375	29.0	46.0	L1	17.1

Result [dBµV] = Analyser reading [dBµV] + cable loss [dB] + LISN insertion loss [dB]

6 OUT OF BAND SPURIOUS EMISSIONS THE FREQUENCY-RANGE 30 MHZ TO 26.5 GHZ

Date of test:	2016-06-02 – 2016-06-08	Test location:	Björkhallen
EUT Serial:	C82A555094	Ambient temp:	23 °C
Tested by:	Matti Virkki	Relative humidity:	40 %
Test result:	Pass	Margin:	11.4 dB

6.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.26 and ANSI-TIA-603-D-2010.

Both receiver and transmitter are active during the tests.

The EUT was placed on an insulating support 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. Above 1 GHz both peak and average detector is activated.

6.2 Test conditions**Test set-up:****30 MHz to 1000 MHz**

Test receiver set-up:

Preview test:

Final test:

Peak, RBW 120 kHz, VBW 1 MHz
Quasi-Peak, RBW 120 kHz, VBW 1 MHz

Measuring distance:

EUT height above ground plane:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

3 m
0.8 m
0 – 359°
1 – 4 m
Vertical and Horizontal
Bilog

Test set-up:**1 GHz – 26.5 GHz**

Test receiver set-up:

Preview test:

Final test:

Peak, RBW 1 MHz, VBW 3 MHz
Average, RBW 1 MHz, VBW 3 MHz
Average, RBW 1 MHz, VBW 3 MHz
Peak, RBW 1 MHz, VBW 3 MHz

Measuring distance:

EUT height above ground plane:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

Antenna tilt:

3 m
1.5 m
0 – 359°
1 – 4 m
Vertical and Horizontal
Horn
Activated

6.3 Radiated Emission requirements

The EUT shall meet the limits for the standards.

Receiver

Reference: 47 CFR §15.109
 IC RSS-GEN Table 2
 ICES-003 Table 5, Table 7

Limits for general radiated emission:

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

The values for each measurement distance are given using an extrapolation factor of 20 dB/decade above 30 MHz and 40 dB/decade below 30 MHz according to §15.31(f)(1), §15.31(f)(2) and RSS-GEN sections 6.4 and 6.5.

The frequency range to be inspected is up to the fifth harmonics of the highest fundamental frequency according to 47 CFR §15.33 and ICES-003 Table 3.

Transmitter

Reference: 47 CFR §27.53
 RSS-139 Section 6.5

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB. This gives a limit at -13 dBm.

The frequency range to be inspected is up to the tenth harmonics of the highest fundamental frequency according to 47 CFR 2.1057 and RSS-Gen Section 6.13.

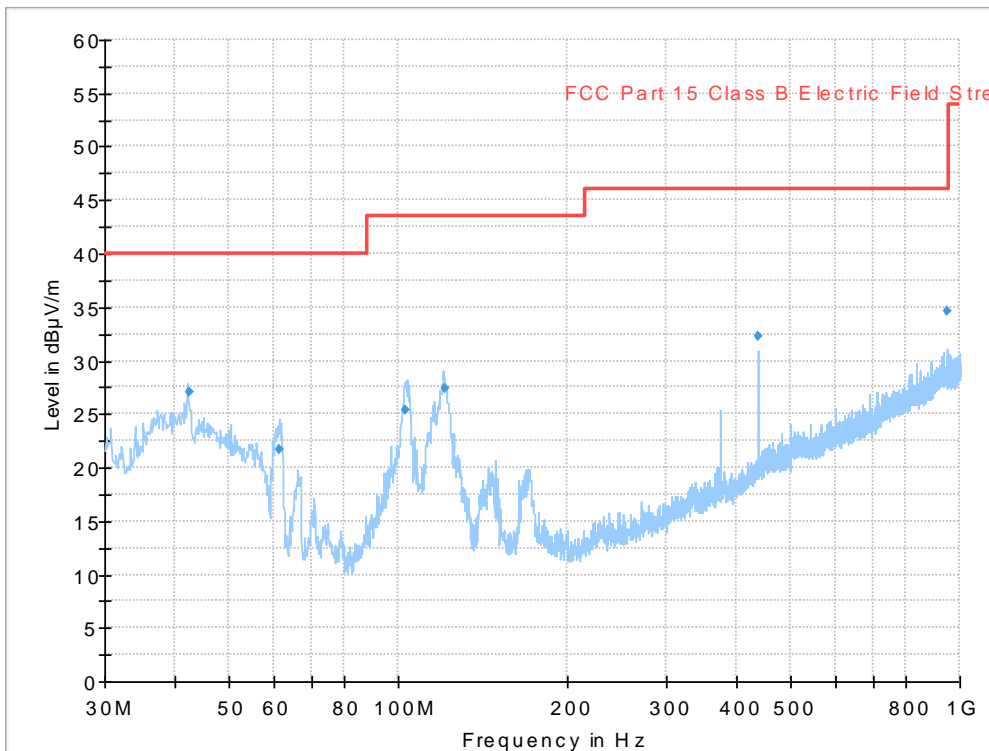
The field strength limit is calculated using the plane wave relation.

$$GP/4\pi R^2 = E^2 / 120\pi$$

G: antenna gain
 P: power (W)
 R: measurement distance (m)

-13 dBm EIRP gives a field strength limit of 82.2 dBµV/m at a 3m measurement distance in an anechoic chamber.

6.4 Test results 30 MHz – 1000 MHz



Diagram, Peak overview sweep, 30 – 1000 MHz at 3 m distance. Middle channel.

Measurement results, Quasi Peak

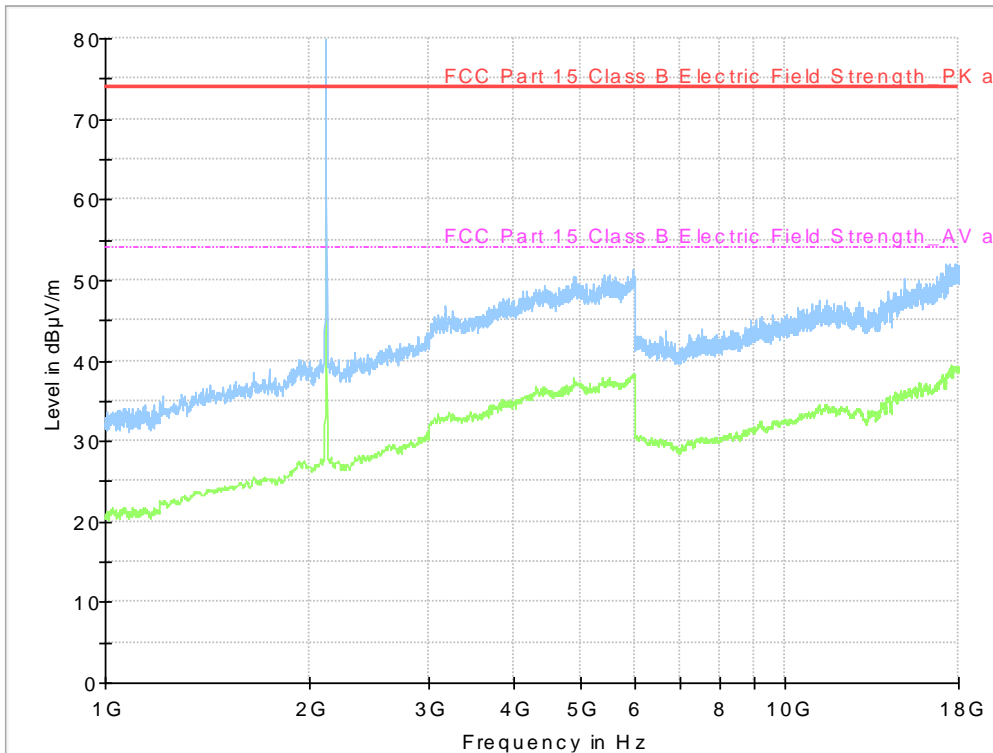
Frequency [MHz]	Level [dBµV/m]	RX limit [dBµV/m]	Polarization H/V	Margin [dB]
42.344	27.0	40.0	V	13.0
61.603	21.6	40.0	V	18.4
103.107	25.4	43.5	V	18.2
120.661	27.3	43.5	V	16.2
437.495	32.4	46.0	V	13.7
951.844	34.6	46.0	H	11.4

The margin to the TX limit is at least 47.6 dB.

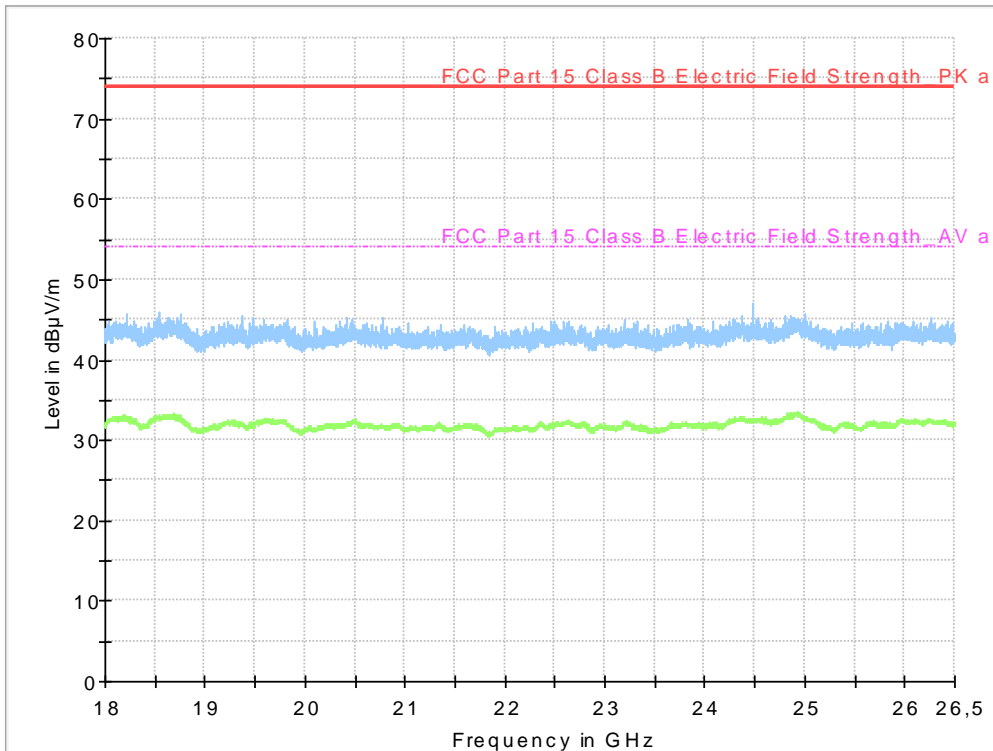
Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

6.5 Test results 1 GHz – 26.5 GHz

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



Diagram, Peak overview sweep, 1 – 18 GHz at 3 m distance. Bottom channel.

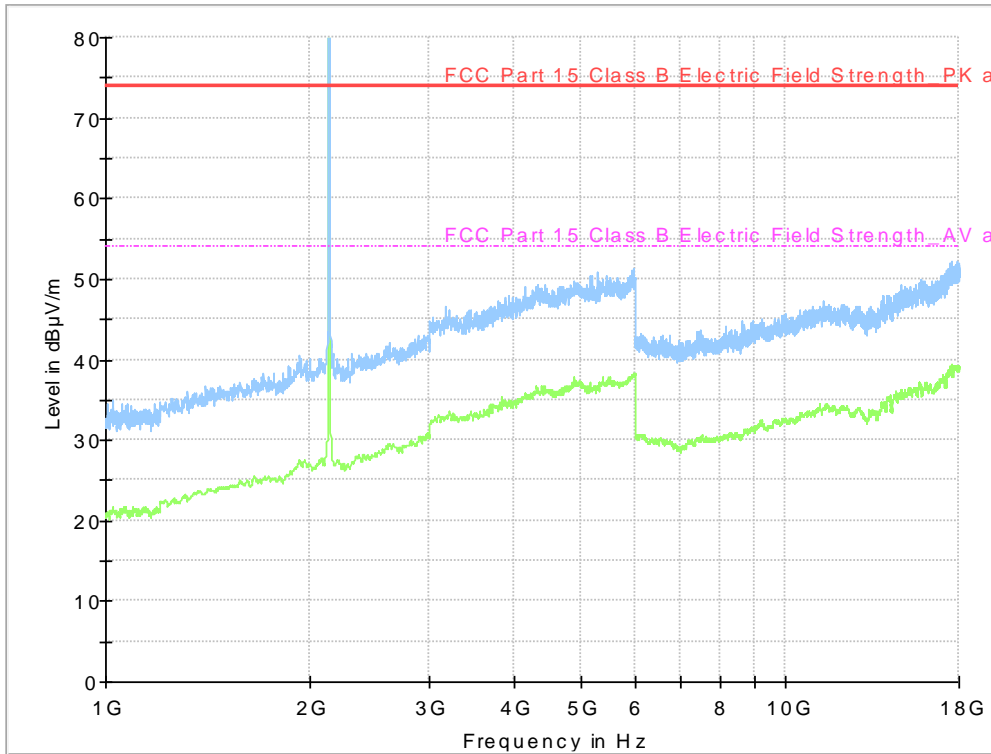


Diagram, Peak overview sweep, 18 – 26.5 GHz at 3 m distance. Bottom channel.

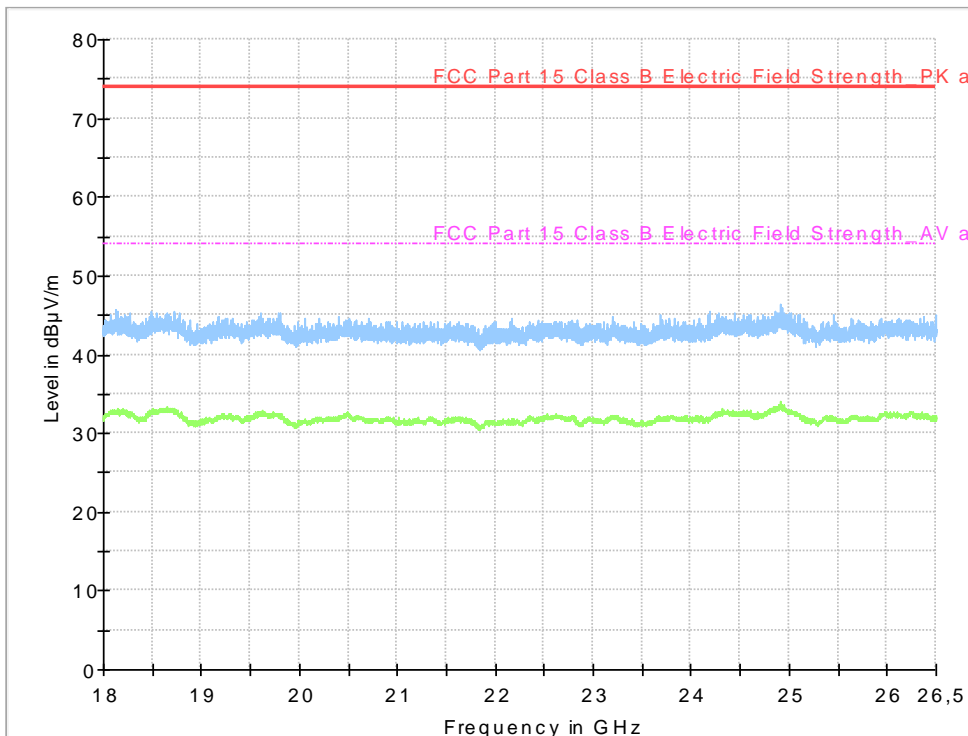
Measurement results, bottom channel

No emissions except carrier are found above noise floor for any frequency above 1 GHz. Noise floor margin to RX mode limit is at least 14 dB.

All measured emissions in TX mode have a margin of more than 30 dB to the limit.



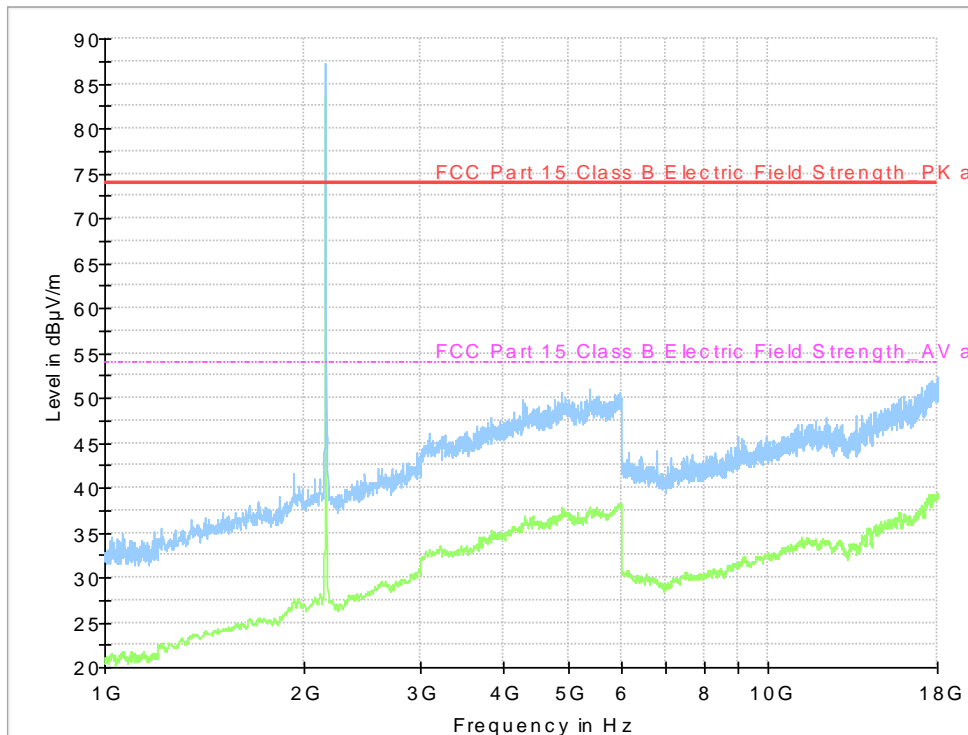
Diagram, Peak overview sweep, 1 – 18 GHz at 3 m distance. Middle channel.



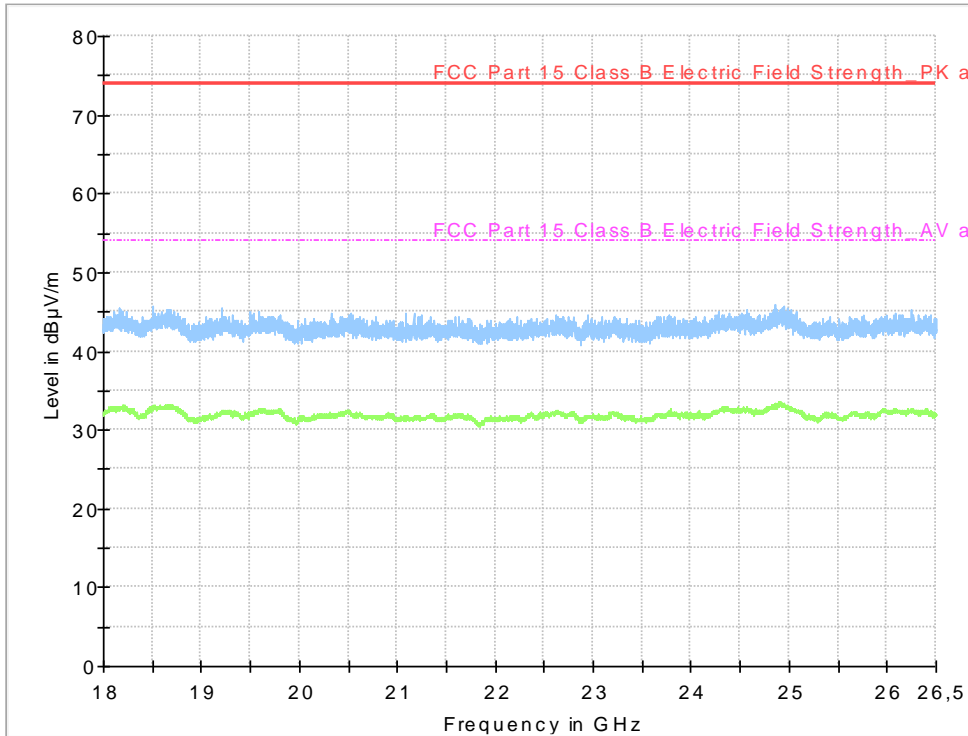
Diagram, Peak overview sweep, 18 – 26.5 GHz at 3 m distance. Middle channel.

Measurement results, middle channel

No emissions except carrier are found above noise floor for any frequency above 1 GHz. Noise floor margin to RX mode limit is at least 14 dB. All measured emissions in TX mode have a margin of more than 30 dB to the limit.



Diagram, Peak overview sweep, 1 – 18 GHz at 3 m distance. Top channel.



Diagram, Peak overview sweep, 18 – 26.5 GHz at 3 m distance. Top channel.

Measurement results, top channel

No emissions except carrier are found above noise floor for any frequency above 1 GHz. Noise floor margin to RX mode limit is at least 14 dB.

All measured emissions in TX mode have a margin of more than 30 dB to the limit.

7 TEST EQUIPMENT

Conducted emission, test site Björkhallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32	--	--	--
Receiver	Rohde & Schwarz	ESIB26	32291	07-2015	1 year
AMN / LISN	Rohde & Schwarz	ESH3-Z5	32711	06-2015	3 years
Pulse limiter	Rohde & Schwarz	ESH3-Z2	32454	06-2015	1 year

Radiated emission, test site Björkhallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32	--	--	--
Receiver	Rohde & Schwarz	ESIB26	32291	07-2015	1 year
Receiver	Rohde & Schwarz	ESU 40	13178	07-2015	1 year
Bilog antenna	Chase	HL562	30711	12-2014	3 years
Preamplifier + antenna	BONN Elektronik	BLMA 1826-5A	31247	01-2014	3 years
OSP Shielded Filter Unit	Rohde & Schwarz	OSP-F7-B	32301	08-2015	1 year
Horn antenna	Rohde & Schwarz	HF907	32307	07-2015	3 years
Open switch and control platform	Rohde & Schwarz	OSP130	32300	07-2014	1 year
Control unit	Maturo GMBH	NCD	32391	--	--

8 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 %.

9 TEST SET UP AND EUT PHOTOS

EUT photos are in separate document 1611873STO, Annex 1, Ed 1.

Test setup photos are in separate document 1611873STO, Annex 2, Ed 1.