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Equipment Authorization measurements on D-POS Transceiver Unit
FCC ID: 2AGLF0702901

(9 appendices)
5P07850-5 rev. 1 supersedes 5P07850-5 issued 2016-06-22.
Changes: Information regarding EUT set up was added.

Test object

Product name: D-POS
Product number: NE10 07029-01
Serial number:0702901003400
Manufacturer: NEAT Electronics AB

Summary

See Appendix 1 for general information and Appendix 9 for photos.
Emission measurements as specified below have been performed.

Standard	Compliant	Appendix	Remarks
FCC 47 CFR Part 15 C 15.205+15.207+15.209 Operation at 125 kHz	**Yes**		
IC RSS-Gen Issue 4 November 2014 Operation at 125 kHz	**Yes**		
Duty cycle measurements	**Yes**	2	
15.209 / RSS-Gen 8.9 Field strength of fundamental	**Yes**	3	
15.205+15.209 / RSS-Gen 8.9, 8.10 Radiated emission	**Yes**	4	
15.207 / RSS-Gen 8.8 AC Conducted emission	**Yes**	5	
15.215 (c) 20 dB bandwidth	**Yes**	6	
2.1049 / RSS-Gen 6.6 Occupied bandwidth	**Yes**	7	
2.1093 / RSS-102 2.5.2 RF Exposure	**Yes**	8	

SP Technical Research Institute of Sweden
Electronics - EMC

Performed by

Søren Søltoft

Examined by

Kennet Palm

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Performance test and requirements

The tests were performed to verify that D-POS EUT meets the electromagnetic compatibility requirements of FCC 47 CFR part 15 C and IC RSS-Gen.

Test facility

The used semi anechoic chamber is compliant with the requirements of section 2.948 of the FCC rules and listed, registration number 589866, as a facility accepted for certification under parts 15 and 18. The site complies with RSS Gen and is accepted by Industry Canada for the performance of radiated measurements, IC-file number 0247A-1.

Test object

Transceiver unit:	D-POS
Antenna connector	screw terminals
Antennas:	One Loop and one Ferrite
Antenna gain:	unknown
Frequencies:	125.58 kHz
Frequencies used during test:	125.58 kHz
Modulation:	ASK
Data rate:	2 kbit/s Manchester (4 kbit/s in the air)
Power supply:	12 VDC from HON-KWANG HK-AY-20A160-US
Battery type:	No
Software	Normal

Client states that, the test specimens delivered for test were adjusted to the maximal power level allowed in the clients production.

During the test the EUT was powered by a AC/DC adaptor which was placed next to the EUT on the table. The AC/DC adaptor was powered by 120 VAC/60 Hz delivered by an amplifier model STA-3000, controlled by a oscillator model B&O TG7 to deliver 120 VAC 60 Hz. The voltage and frequency were measured with a calibrated multimeter Hewlett Packard 34401A. The STA 3000, B&O TG7 and the Hewlett Packard 34401A were placed outside the anechoic chamber during the test.

Modification to test specimen during test.

None

Measurement equipment

Description	Model	ID tag	Cal. due
Analyzer 20Hz-26.5GHz	ESI	20763	2016-09-16
Antenna, Broadband, 30MHz-3GHz	HL562	19830	2016-04-25
Antenna Magnetic Loop 9 kHz - 30 MHz	HFH2-Z2	19966	2019-02-17
Multimeter	34401A	14880	2016-02-25
Multimeter	34401A	14885	2016-06-12
Analyzer 20Hz-26.5GHz	ESIB 26	18880	2016-08-26
V-network Two Line	ESH3-Z5	13935	2016-09-11

Operational test mode

The test were performed with the maximal number of antennas. One loop antenna and one ferrite antenna.
The test was performed with normal modulation.
The EUT is transmitting on one antenna after the other.

All measurements were performed using max hold Peak detector.

For duty cycle measurements see appendix 2.
The duty cycle of the tested EUT's was measured to: 36.66%
The duty cycle correction factor was not used in this report.

Cabling during emission test:

EUT port	Cable type	Termination
Power	Two wire unscreened	ACDC adaptor
Loop port	Wire	Loop
Ferrite port	Two wire unscreened	Ferrite antenna

Ancillary and/or support equipment

Description	Supplier	Model	Serial number
AC/DC adaptor	HON-KWANG	HK-AY-120A160-US	-
Ferrite antenna	Neat	NE 10 07030-01	0703001004017

Test support equipment

Description	Supplier	Model	ID tag
Oscillator 10Hz-1MHz	B&O	TG7	11199
Multimeter	Hewlett Packard	34401A	14880
Multimeter	Hewlett Packard	34401A	14885
Audio power amplifier	img Stage Line	STA-3000	50027

Uncertainties

	Frequency [MHz]	Polarization	Expanded Uncertainty [dB] (k=2)
Radiated Emission Mag. Loop Antenna	0.009 - 30		**3.60**
Radiated Emission AEC 30 - 3000 MHz	30 - 200	Vertical	**4.73**
(CISPR 16-4)	200 - 3000	Vertical	**4.97**
HL562 Antenna	30 - 200	Horizontal	**4.72**
	200 - 3000	Horizontal	**5.08**
Radiated Emission AEC 1 - 18 GHz	1000 - 18000	Vertical	**3.76**
(CISPR 16-4)	1000 - 18000	Horizontal	**3.77**
Conducted emission	0.01 - 30		**3.44**
Time measurement using Spectrum Analyser			**8.42%**

Compliancy evaluation is based on a shared risk principle with respect to the measurement uncertainty.

Reservation

The test results in this report apply only to the particular test object as declared in the report.

Delivery of test object

The test object was delivered: 2016-01-20

Test participant(-s)

Michael Jönsson, Neat Electronic AB at AC conducted emission

Test engineers
Ruben Hansen, David Busk, Søren Søltoft

Duty cycle measurements

Date	Temperature	Humidity
2016-01-25	21°C °C ± 3 °C	48% % ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.10-2013.

Radiated measurements at 3 m distance with continuous transmission (normal duty cycle) and with normal modulation.
The test was performed with peak detector.

The EUT was equipped with two antennas. One loop antenna and one ferrite antenna. The EUT is transmitting at each antenna one at a time.

Test set-up photos during the tests can be found in Appendix 9.

Measurement equipment

Description	Supplier	Model	ID tag
Analyzer 20Hz-26.5GHz	Rohde&Schwarz	ESI	20763
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde&Schwarz	HFH2-Z2	19966

Results

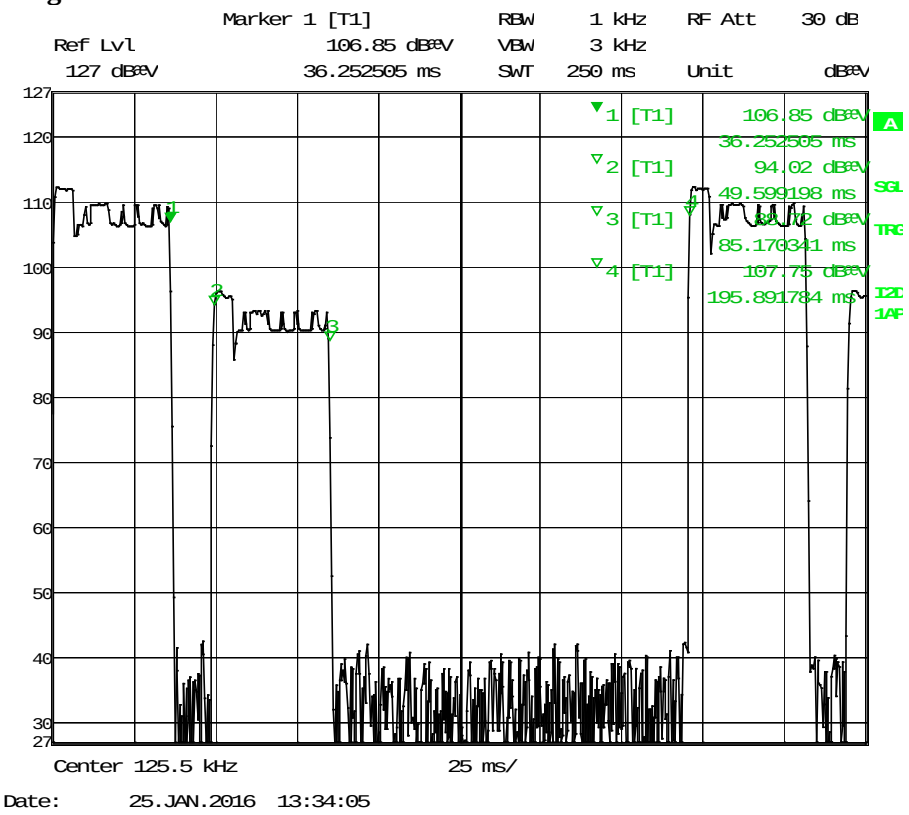
The duty cycle measurements can be found in the diagrams below:

Diagram 1: Duty cycle

Duty cycle antenna 1:	Pulse time: 36.25 ms,	Period time: 195.89 ms,	Duty Cycle: 18.51%.
Duty cycle antenna 2:	Pulse time: 35.57 ms,	Period time: 195.89 ms,	Duty Cycle: 18.16%.
Total duty cycle:	Pulse time: 72.35 ms,	Period time: 195.89 ms,	Duty Cycle: 36.66%

Complies?	N/A

Diagram 1


Marker 1 [T1]
RBW 1 kHz
Ref Lvl
106.85 dBµV
VBW 3 kHz
127 dBµV
36.252505 ms
SWT 250 ms
Unit dBµV
1 [T1] 106.85 dBµV
36.252505 ms
2 [T1] 94.02 dBµV
49.599198 ms
3 [T1] 85.170341 ms
4 [T1] 107.75 dBµV
195.891784 ms
127
120
110
100
90
80
70
60
50
40
30
27
Center 125.5 kHz
25 ms/
Date: 25.JAN.2016 13:34:05

Field strength of fundamental measurements according to FCC 47 CFR part 15.209 / RSS-Gen 8.9

Dates	Temperature	Humidity
2016-03-22	5.5°C to 8°C ± 3 °C	90% to 80% ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.10-2013.

The test was performed with normal transmission (18.5%-18.4% duty cycle) and with normal modulation.
The measurements were performed with a peak detector in max hold mode, and no duty cycle correction were performed.

The EUT was placed 0.8 m above the ground of the grass field. The EUT was equipped with a loop antenna and a ferrite antenna. The two antennas were orientated to have maximal radiation in the same direction.
The measurements were performed at a grass field with three perpendicular antenna positions A, B and C, at 10 m distance. The EUT were rotated 360 degree during measurements. The antenna position and EUT direction giving the highest level at 10 m was used for measurement at 20 m distance.
The EUT was powered with nominal supply voltage.

The measurements at 85% and 115% supply voltage were performed at 20 m at grass field.

Test set-up photos during the tests can be found in Appendix 9.

Measurement equipment

Description	Supplier	Model	ID tag
Analyzer 20Hz-26.5GHz	Rohde&Schwarz	ESIB	18880
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde&Schwarz	HFH2-Z2	19966

Measurements

Frequency: 125.58 kHz, Detector: Peak, BW: 200 Hz, VBW: 1 kHz

Antenna position	Meas. dist.10 m		Meas. dist. 20 m
	dBµV/m	EUT angel	dBµV/m
A	86.1	0	69.6
B	81.8	270	-
C	68.1	0	-

Results

Fundamental frequency: 125.58 kHz

Antenna position	Meas. dist.10 m (dBµV/m)	Limit at 10 m (dBµV/m)	Margin (dBµV/m)
A	86.1	106.59	20.49
B	81.8	106.59	24.79
C	68.1	106.59	38.49

	Supply voltage	Max Peak level
85 % of Nominal supply voltage	102 VAC	69.4 dBµV
Nominal supply voltage	120VAC	69.5 dBµV
115% of Nominal supply voltage	138 VAC	69.5 dBµV

Note 1: According 47CFR 15.31(e), for intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Note 2: The transmitter power level at 125.58 kHz was measured at a grass field at 10 m and 20 m distance.
The limit was converted to 10 m using the DCF calculated at the next page.
The peak level was measured with RBW=200 Hz
As the max peak level meets the average limit no further calculations were performed.

Note 3: The voltage variation test was performed at a grass field at 20 m distance. As no variation in output level occurred with variation of supply voltage, no further calculation were performed.

Pulse desensitization correction factor calculations according to FCC CFR 47 part 15.35(a)

According to ANSI C63.2 the RBW shall be 200 Hz for frequencies below 150 kHz and 9 kHz between 150 kHz – 30 MHz.

To measure and detect the correct levels of the pulsed signal the RBW should be:
RBW > 1/τ (τ=Tx on=71.82 ms)
RBW > 1/71.82 ms = 13.892 Hz,
thus the RBW in the frequency range below 150 kHz was set to 200 Hz.

Duty cycle correction factor calculations

Tx on time = 71.82 ms
Period time = 195.89 ms
Duty cycle correction factor = 20xlog(72.35/195.89) = -8.72 dB

Limits

According to 47CFR 15.209 and according to RSS-Gen 8.9

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009 – 0.490	2400/F(kHz)	300

In the frequency range of 110-490 kHz the limit are referring to an average detector.

Frequency (kHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
125.58	19.11	25.63	300

The roll-of exponent (n) at 125.58 kHz was determined by measuring the transmitter frequency at 10 and 20 m measurement distance and calculating n in the expression:

R_{10}-R_{20}=20 x n x log(20/10),

where R_{10} and R_{20} are the peak reading in dBµV/m at 10 and 20 m respectively.

The DCF (distance correction factor) is 20 x n x log(d_{meas}/d_{limit}) where d is the distance.

Calculation of DCF by measurement of 125.58 kHz at 10 and 20 m:

86.1 – 69.6= 20 x n x log(20/10) gives n = 2.74

DCF=20 x 2.74 x log(10/300) = -80.96 dB (meas. dist. 10 m - limit at 300 m)

With a DCF as calculated above the limit should be increased by 80.96 dB ->
Limit at 300 m = 25.63 dBµV/m,
Limit at 10 m = Limit at 300 m + DCF = 25.63 + 80.96 = 106.59 dBµV/m

According to 15.35(b) there are also a limit on the peak level of the radio frequency emission, the limit on the peak radio frequency emission is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

According to 15.31(e) the radiated field at transmitter frequency shall not exceed the limits when the supply voltage is varied between 85 and 115% of nominal voltage.

Complies?	Yes

Radiated emission measurements according to FCC 47 CFR part 15.205+209 / RSS-Gen 8.9, 8.10

Dates	Temperature	Humidity
2016-01-20	21°C ± 3 °C	37% ± 5 %
2016-03-22	5.5°C to 8°C ± 3 °C	90% to 80% ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.10-2013.

The test was performed with normal transmission (18.5% duty cycle) and with normal modulation.
The measurements were performed with a peak detector, because of the pulse-repetition frequency of 5 Hz. Which is less than the 20 Hz specified in Note in CFR 47 §15.35.
No reduction average duty cycle correction were performed.

The highest frequency generated in the device is stated to be < 20 MHz, thus the highest measurement frequency is 1000 MHz

The measurement in the frequency rang 30 MHz to 1000 MHz was performed in a semi anechoic chamber. The measurements were performed with both horizontal and vertical polarizations of the antenna.
The antenna distance during the measurements was 3.0 m.
The EUT height above the reference ground plane was 0.8 m.

The measurement procedure for frequencies above 30 MHz is as follows:

1. A pre-measurement is performed with peak detector. The test object is measured in eight directions with the antenna in the frequency range 30-1000 MHz, with the antenna at three heights, 1.0 m, 1.5 m and 2.0 m.
2. If the emission is close or above the limit during the pre-measurement, the test object is scanned 360 degrees and the antenna height scanned from 1 to 4 m for maximum response.

The measurement in the frequency range 9 kHz to 30 MHz was performed with a pre-sweep in a semi anechoic chamber at 3 m distance with the antenna in three perpendicular antenna positions A, B and C.
At the frequencies identified during the pre-sweep, measurement were performed at 10 m distance on grass field at three perpendicular antenna positions A, B and C. The EUT were rotated 360 degree for maximal radiation.
With the antenna position giving the highest level at 10 m, a measurement at 20 m was performed.
To ensure sufficient signal to noise ratio at 20 m distance the level for calculating the DCF were performed with RBW of 200 Hz at 10 m and 20 m distance with a peak detector.
The measurement at 10 m distance were also performed with RBW of 9 kHz above 150 kHz.

The following RBW were used:
9-150 kHz: RBW=200 Hz
150 kHz-30 MHz: RBW=9 kHz

Test set-up photos during the tests can be found in Appendix 9.

Measurement equipment

Description	Supplier	Model	ID tag
Analyzer 20Hz-26.5GHz	Rohde&Schwarz	ESIB	18880
Analyzer 20Hz-26.5GHz	Rohde&Schwarz	ESI	20763
Antenna, Ultra Broadband, 30MHz-3GHz	Rohde&Schwarz	HL562	19830
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde&Schwarz	HFH2-Z2	19966

Results

The pre-test emission spectra at 3 m with the loop antenna below 30 MHz can be found in the diagrams below:

Diagram 1:	Pre-sweep. Ambient, 9 kHz – 30 MHz, antenna position A
Diagram 2:	Pre-sweep. 9 kHz – 30 MHz, antenna position A
Diagram 3:	Pre-sweep. 9 kHz – 30 MHz, antenna position B
Diagram 4:	Pre-sweep. 9 kHz – 30 MHz, antenna position C

The highest levels were detected with antenna in position A.
The level of the frequencies found during pre-sweep were measured on a grass field at 10 m and 20 m distance.
The final measurement the frequency range 9 kHz-30 MHz are listed in the tables below.

Frequency (kHz)	Peak level (10 m) (dBµV/m)	Limit (300 m) (dBµV/m)	Limit (30 m) (dBµV/m)	DCF (10 Lim m) (dB)	Limit (10 m) (dBµV/m)	Margin (dB)
251.13	**71.8**	19.61	-	77.53	97.14	26.94
376.73	**63.3**	16.08	-	74.09	90.18	28.68
502.25	**52.8**	-	33.59	22.98	56.57	5.47
753.35	**48.7**	-	30.06	21.40	51.46	4.56
878.91	**48.8**	-	28.73	21.71	50.44	3.24
1004.53	**46.4**	-	27.56	21.87	49.44	5.64
1506.83	**41**	-	24.04	19.97	44.01	5.81

Note 1: The peak level was compared directly to the average and quasi peak limit.
Note 2: The distance correction factor (DCF) calculation is described below.

For calculation of the distance correction factor, the level of radiation at 10 m and 20 m distance were measured using a peak detector with resolution bandwidth of 200 Hz to increase the signal to noise ratio.
The same EUT and antenna position were used at both distances.
The DCF calculation method is described in annex 3.

Frequency (kHz)	Peak level (10 m) (dBµV/m)	Peak level (20 m) (dBµV/m)	n (times)	DCF (10 Lim m) (dB)
251.13	70.2	54.4	2.624	-77.53
376.73	61.5	46.4	2.508	-74.09
502.25	51.1	36.6	2.408	-22.98
753.35	46.9	33.4	2.242	-21.40
878.91	47.2	33.5	2.276	-21.71
1004.53	43.8	30	2.292	-21.87
1506.83	38.2	25.6	2.093	-19.97

The emission spectrum at 3 m in the frequency range 30 MHz -1000 MHz can be found in the diagrams below:

Diagram 5:	Ambient, 30-1000 MHz vertical and horizontal polarization
Diagram 6:	30-1000 MHz, vertical and horizontal polarization

The highest detected levels during the final measurement in the frequency range 30 MHz-1 GHz are listed in the tables below.

Frequency (MHz)	QP level (dBµV/m)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg.)	Margin (dB)	Limit (dBµV/m)
31.0422	29.8	120	100.0	V	85.0	10.2	40.0
35.6508	28.0	120	99.7	V	279.0	12.0	40.0
41.9438	29.5	120	100.1	V	292.0	10.5	40.0
44.9503	34.0	120	100.1	V	256.0	6.0	40.0
96.4331	30.6	120	185.1	H	354.0	12.9	43.5
128.5970	28.1	120	180.0	V	278.0	15.4	43.5

Limits

According to 47CFR 15.205,
(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands in the table in 15.205.

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated

(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.

According to 47CFR 15.209,

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these

frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) 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.

(e) The provisions in §§15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

(f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device.

(g) Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

According to RSS-Gen 8.9,
Transmitter Emission Limits for Licence-Exempt Radio Apparatus,
Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.
Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength (µV/m at 3 meters)
30-88	100
88-216	150
216-960	200
Above 960*	500

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

Table 5 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Below 30 MHz

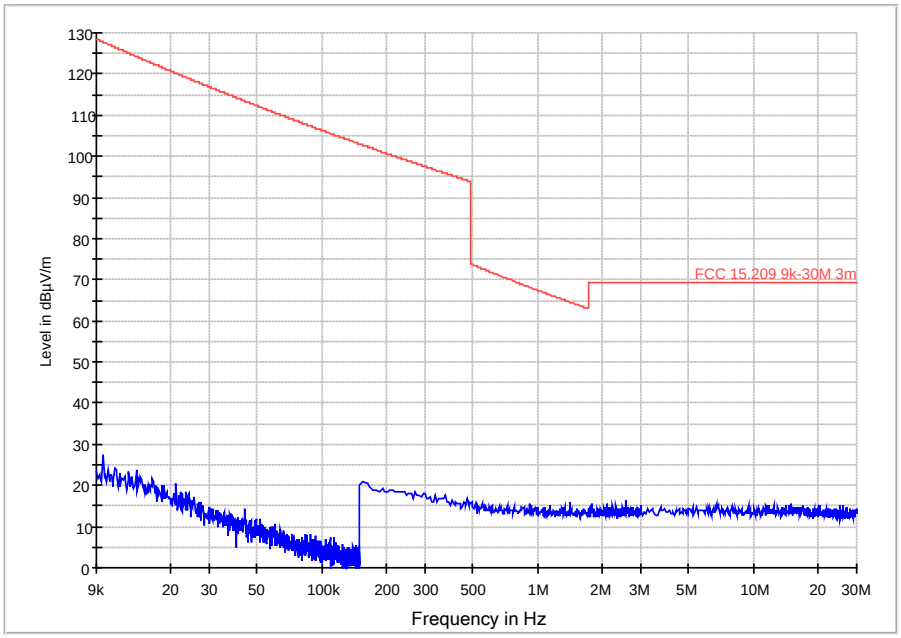
Frequency	Electric Field Strength (µV/m)	Magnetic Field Strength (H-Field) (µA/m)	Meas. Distance (metres)
9-490 kHz	2400/F (F in kHz)	2400/377F (F in kHz)	300
490-1.705 kHz	24000/F (F in kHz)	24000/377F (F in kHz)	30
1.705-30 MHz	30	N/A	30

Note: The emission limits for the bands 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector. Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the relevant RSS.

According to RSS-Gen 8.10, Restricted Frequency Bands,
Restricted bands, identified in Table 6, are designated primarily for safety-of-life services (distress calling and certain aeronautical bands), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following restrictions apply:
(a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 6 except for apparatus complying under RSS-287;
(b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and
(c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

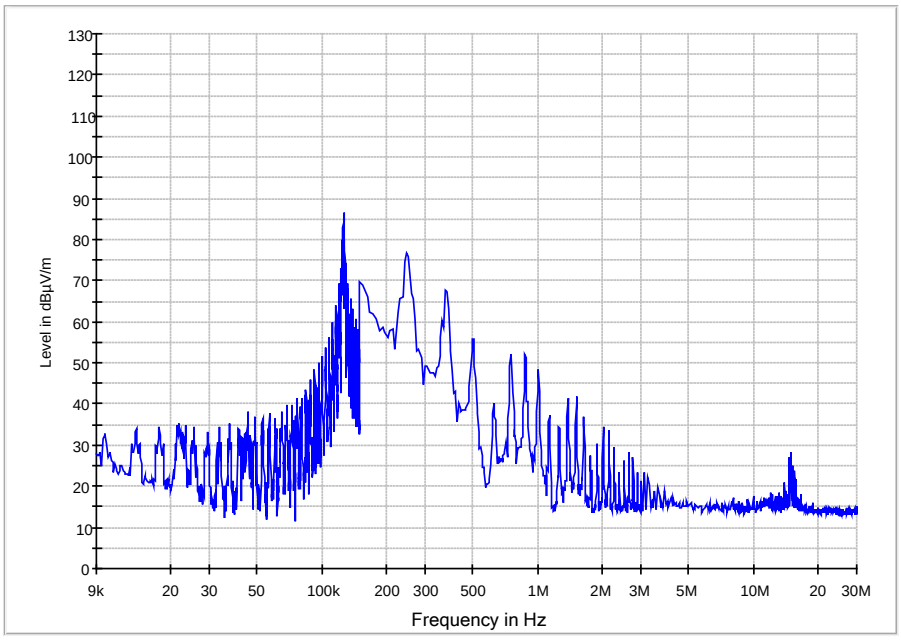
Complies?	Yes

Diagram 1



FCC 15.209 9k-30M 3m Preview Result 1-PK+

Diagram 2



Preview Result 1-PK+

FCC ID: 2AGLF0702901 Appendix 4

Diagram 3

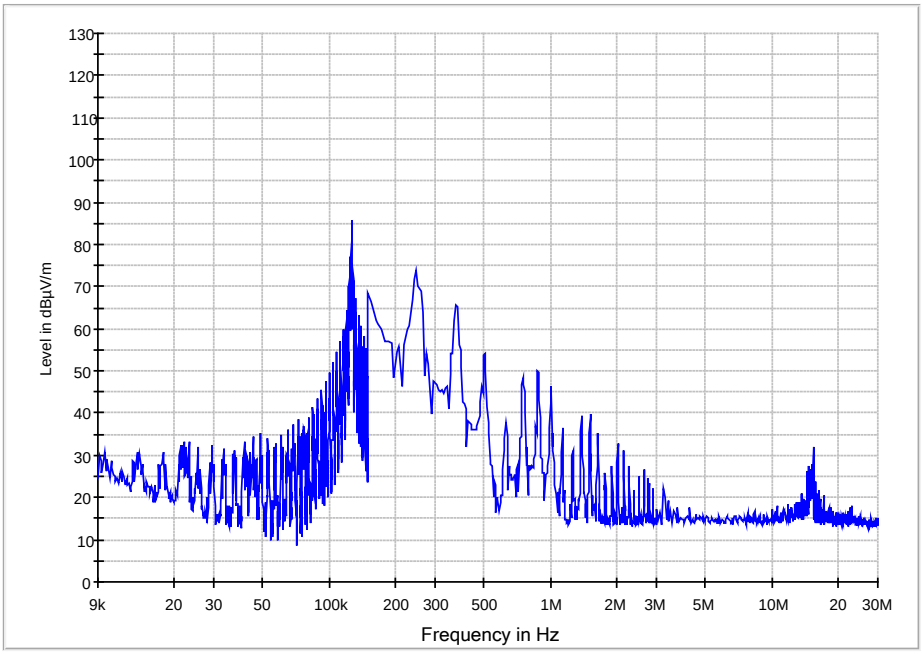


Diagram 4

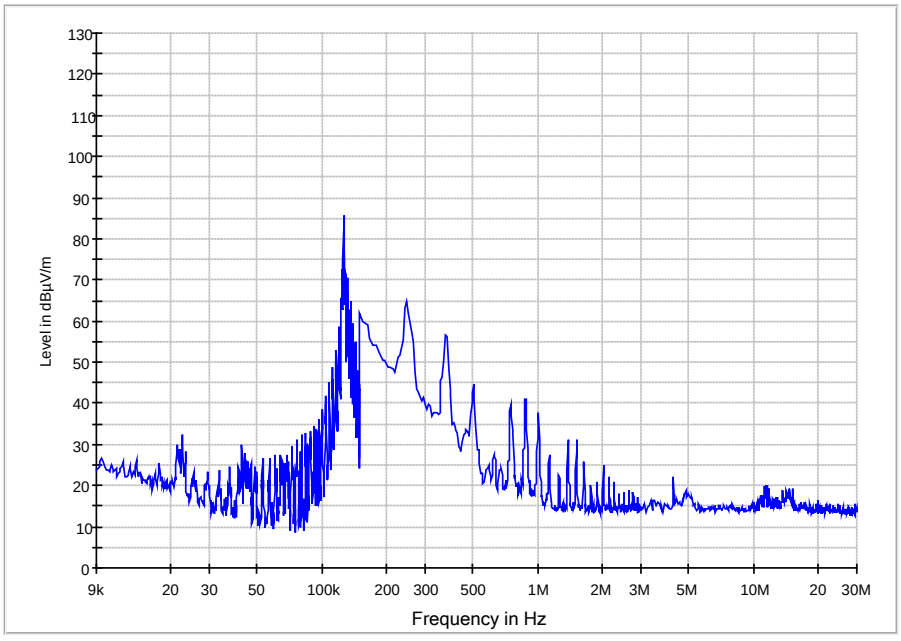


Diagram 5

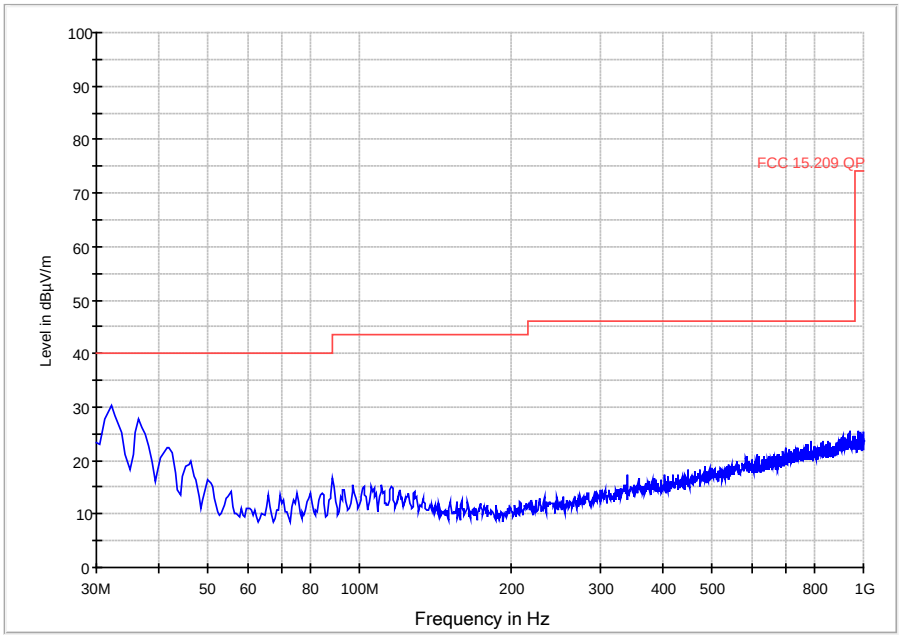
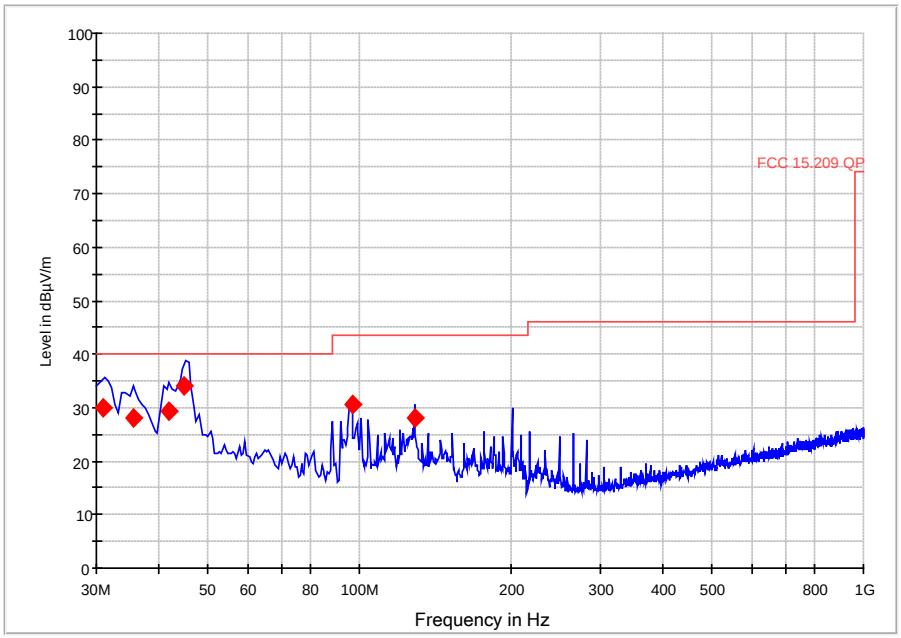


Diagram 6



AC Conducted emission measurements according to FCC 47 CFR part 15.207, class B / RSS-Gen 8.8

Date	Temperature	Humidity
2016-01-20	22°C ± 3 °C	37% ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.4-2014.

Measurements were performed with continuous transmission (normal duty cycle) and with normal modulation.
Measurements were performed on the 120 V AC/60 Hz, phase and neutral terminals, at the AC/DC adapter HON-KWANG, HK-AY-120A160-US.

Test set-up photos during the tests can be found in Appendix 9.

Description	Supplier	Model	ID tag
Analyzer 20Hz-26.5GHz	Rohde&Schwarz	ESIB 26	18880
V-network Two Line	Rohde&Schwarz	ESH3-Z5	13935

Result

The conducted emission spectra can be found in the diagrams below:

Diagram 1:	Ambient phase and neutral with 120 VAC 60 Hz applied,
Diagram 2:	Phase and neutral 120 VAC 60 Hz

Final measurements with quasi peak detector

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Margin (dB)	Limit (dBµV)
0.2512	53.7	9	N	8.10	61.70
0.3770	48.9	9	L1	9.40	58.30
0.7531	46.1	9	L1	9.90	56.00
0.8790	49.6	9	L1	6.40	56.00
1.0041	48.9	9	L1	7.10	56.00
1.3810	46.6	9	L1	9.40	56.00
1.5067	49.1	9	L1	6.90	56.00
1.6323	47.8	9	N	8.20	56.00
2.2595	45.4	9	L1	10.60	56.00
2.6374	46.0	9	N	10.00	56.00
3.2645	45.7	9	N	10.30	56.00
3.3901	44.2	9	N	11.80	56.00
3.6411	44.2	9	N	11.80	56.00
3.7669	45.6	9	L1	10.40	56.00
4.3937	42.5	9	L1	13.50	56.00
14.8175	48.3	9	N	11.70	60.00
14.9407	48.8	9	L1	11.20	60.00
15.0657	48.0	9	L1	12.00	60.00

Final measurements with average detector

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Margin (dB)	Limit (dBµV)
0.2512	37.9	9	N	13.80	51.70
0.3770	33.4	9	L1	14.90	48.30
0.7531	30.4	9	L1	15.60	46.00
0.8790	33.7	9	L1	12.30	46.00
1.0041	32.9	9	L1	13.10	46.00
1.3810	30.8	9	L1	15.20	46.00
1.5067	33.1	9	L1	12.90	46.00
1.6323	31.7	9	N	14.30	46.00
2.2595	29.6	9	L1	16.40	46.00
2.6374	30.2	9	N	15.80	46.00
3.2645	29.7	9	N	16.30	46.00
3.3901	28.3	9	N	17.70	46.00
3.6411	28.1	9	N	17.90	46.00
3.7669	29.4	9	L1	16.60	46.00
4.3937	26.7	9	L1	19.30	46.00
14.8175	34.8	9	N	15.20	50.00
14.9407	35.1	9	L1	14.90	50.00
15.0657	34.4	9	L1	15.60	50.00

Limits

According to 47CFR 15.207 and according to RSS-Gen 8.8,

Frequency (MHz)	Quasi-peak value (dBµV)	Average value (dBµV/m)
0.15-0.5	66-56*	56-46*
0.5-5	56	46
5-30	60	50

*=Decreases with the logarithm of the frequency

Complies?	Yes

Diagram 1

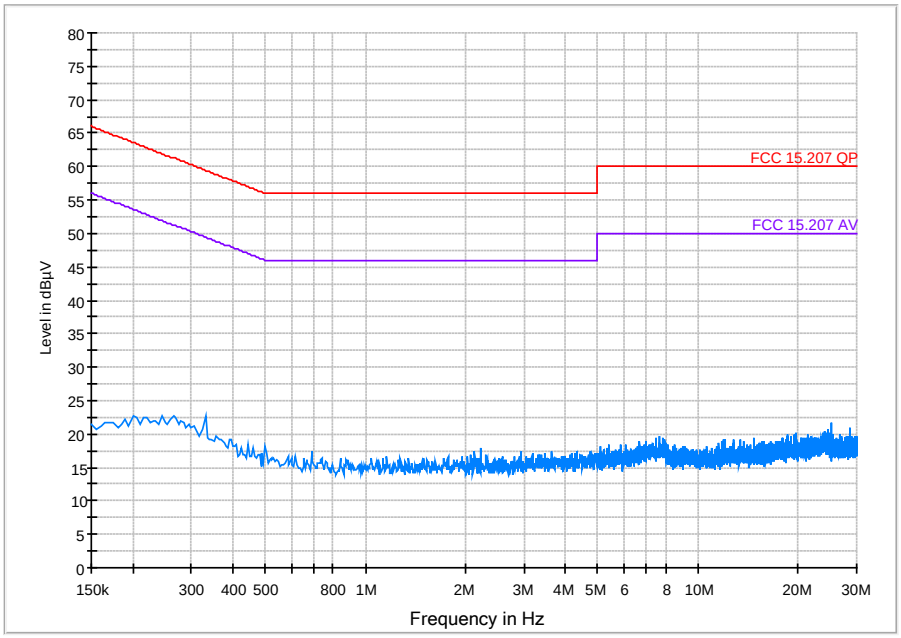
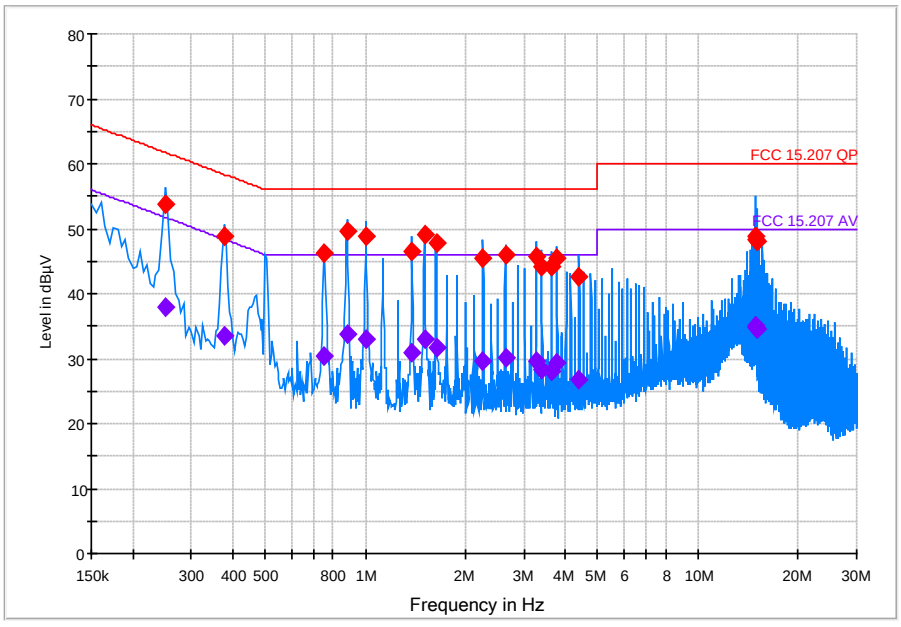


Diagram 2



20 dB bandwidth measurements according to FCC 47 CFR part 15.215 (c)

Date	Temperature	Humidity
2016-01-25	21°C ± 3 °C	48% ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.10-2013 cl. 6.9.2.

The test was performed with continuous transmission (normal duty cycle) and with normal modulation.
The measurement was performed in a semi anechoic chamber at a distance of 3 m.
The EUT height above the reference ground plane was 0.8 m.
The test was performed with peak detector.

Test set-up photos during the tests can be found in Appendix 9.

Description	Supplier	Model	ID tag
Analyzer 20Hz-26.5GHz	Rohde&Schwarz	ESI	20763
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde&Schwarz	HFH2-Z2	19966

Results

The 20 dB BW measurements can be found in the diagram below:

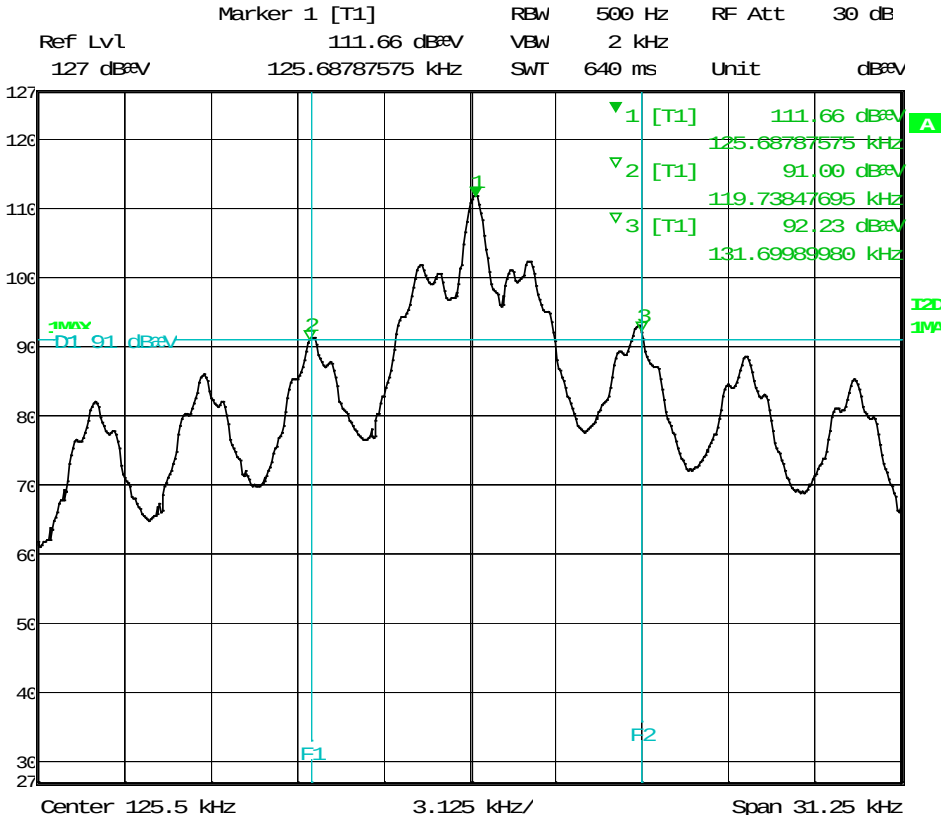
Diagram 1	125.58 kHz	20 dB BW = **11.96 kHz**

Limits

According to 47CFR 15.215(c), intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Complies?	Yes

Diagram 1



Date: 25.JAN.2016 13:21:37

The levels indicated is no adjust for antenna factors and path attenuation.

Occupied bandwidth measurements according to 47CFR 2.1049 / RSS-Gen 6.6

Date	Temperature	Humidity
2016-01-25	21°C ± 3 °C	48% ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.10-2013, cl. 6.9.3.

The test was performed with continuous transmission (normal duty cycle) and with normal modulation.
The measurement was performed in a semi anechoic chamber at a distance of 3 m.
The EUT height above the reference ground plane was 0.8 m.
The test was performed with peak detector.

Test set-up photos during the tests can be found in Appendix 9.

Description	Supplier	Model	ID tag
Analyzer 20Hz-26.5GHz	Rohde&Schwarz	ESI	20763
Antenna Magnetic Loop 9 kHz - 30 MHz	Rohde&Schwarz	HFH2-Z2	19966

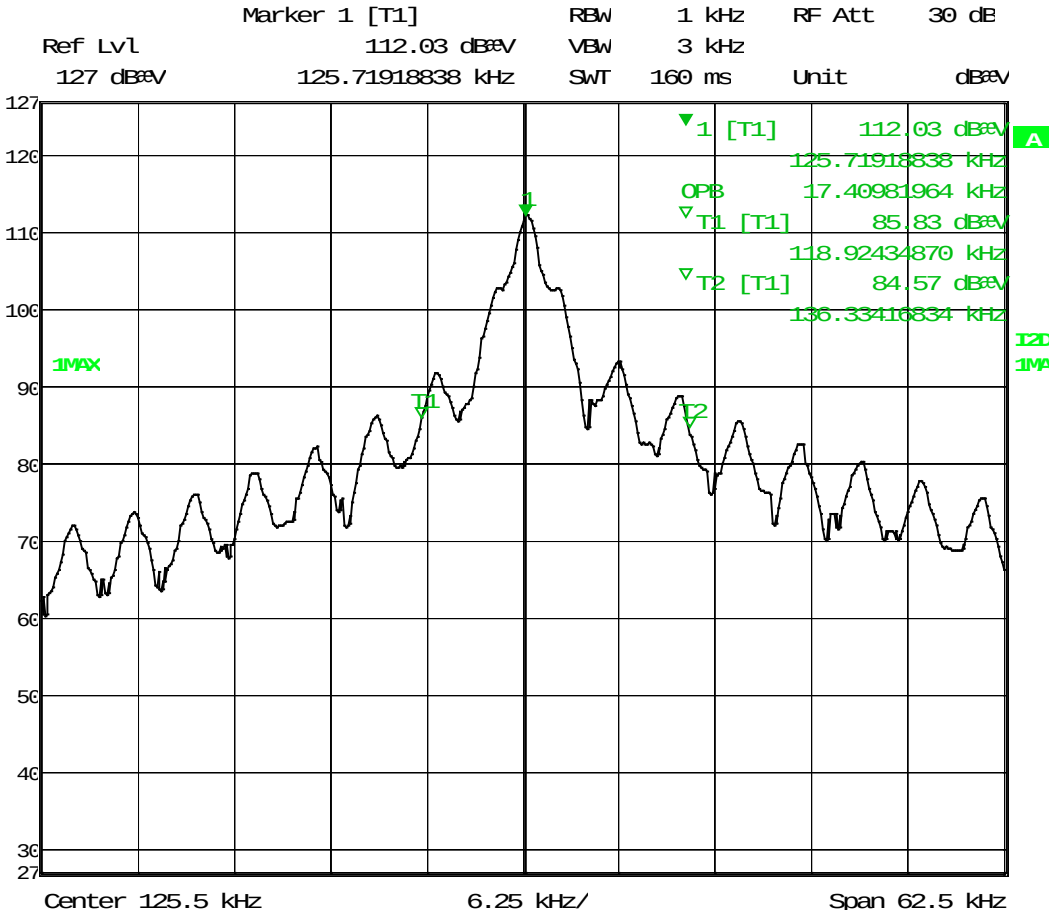
Results

The OBW measurements can be found in the diagram below:

Diagram 1	125.58 kHz	OBW = **17.41 kHz** (99%)

Complies?	Yes

Diagram 1



The levels indicated is no adjust for antenna factors and path attenuation.

RF exposure evaluation: 2.1091 Mobile devices / RSS-102 2.5.2

Date	Temperature	Humidity
2015-03-22	5.5°C to 8°C ± 3 °C	90% to 80% ± 5 %

Procedure

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device. As no separation distance is declared by manufacture a test separation distance <=50 mm is used for exposure evaluation. According to KDB 447498 D01 General RF Exposure Guidance v06.

Results

The following formula was used to calculate the RF exposure,
$P = (E \times d)^2 / 30 \times G$, with G set to unity gain of 1
Where
P: Power
d: Distance between EUT and antenna.
G: the gain of EUT antenna

The maximum radiated peak output power from Appendix 3 was used for calculation of Exclusion threshold

Frequency f, (MHz)	Maximum output power Pout, (mW)	Distance (mm)	Test Exclusion power thresholds for 1-g SAR (mW)
0.125	2.7	<50	925.6

Max. Field strength (dBµV/m) Note 2	Output power Pout (dBm) Note 1	Output power Pout, (mW)
89.1	4.3	2.7

Note 1: The measurements were performed in field strength in dBµV/m. The EIRP level was then calculated by the formula $P = (E \times d)^2 / 30 \times G$, with G as unity gain of 1.

Note 2: According to RSS-102 cl. 2.5.1 the RMS value shall be adjusted for tune-up tolerance. According to the client, the RF power accuracy is declared to ±3 dB, thus the values at Note 2 are increased with 3 dB.

Limits

FCC- 2.1091 / KDB 447498 D01 General RF Exposure Guidance v06

4.3.1 Standalone SAR exclusion:

a) For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:
[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [$\sqrt{f_{(GHz)}}$] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR,[30] where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation31
- The result is rounded to one decimal place for comparison
- The values 3.0 and 7.5 are referred to as numeric thresholds in step b) below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

b) For 100 MHz to 6 GHz and test separation distances > 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following (also illustrated in Appendix B):[32]
1) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW, for 100 MHz to 1500 MHz
2) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·10]} mW, for > 1500 MHz and ≤ 6 GHz

c) For frequencies below 100 MHz, the following may be considered for SAR test exclusion (also illustrated in Appendix C):[33]
1) For test separation distances > 50 mm and < 200 mm, the power threshold at the corresponding test separation distance at 100 MHz in step b) is multiplied by [1 + log(100/f(MHz))]
2) For test separation distances ≤ 50 mm, the power threshold determined by the equation in c) 1) for 50 mm and 100 MHz is multiplied by ½
3) SAR measurement procedures are not established below 100 MHz.

RSS-102 — Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

2.5.1 Exemption Limits for Routine Evaluation — SAR Evaluation

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation — Exemption limits for routine evaluation based on frequency and separation distance

	Exemption Limits (mW)				
Frequency (MHz)	**At separation distance of ≤5 mm**	**At separation distance of 10 mm**	**At separation distance of 15 mm**	**At separation distance of 20 mm**	**At separation distance of 25 mm**
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW
	Exemption Limits (mW)				
Frequency (MHz)	**At separation distance of 30 mm**	**At separation distance of 35 mm**	**At separation distance of 40 mm**	**At separation distance of 45 mm**	**At separation distance of ≥50 mm**
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power.

For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5.

For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5.

If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance.

For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

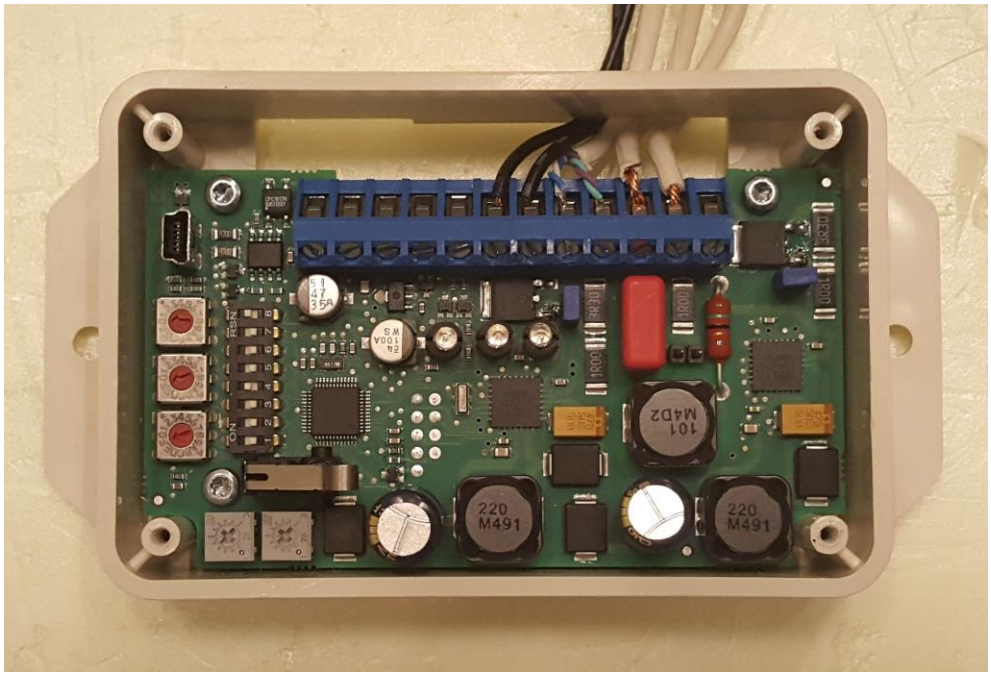
Complies?	Yes

Photos

The test set-up during the radiated tests can be seen in the pictures below.

EUT overview

FCC ID: 2AGLF0702901 Appendix 9

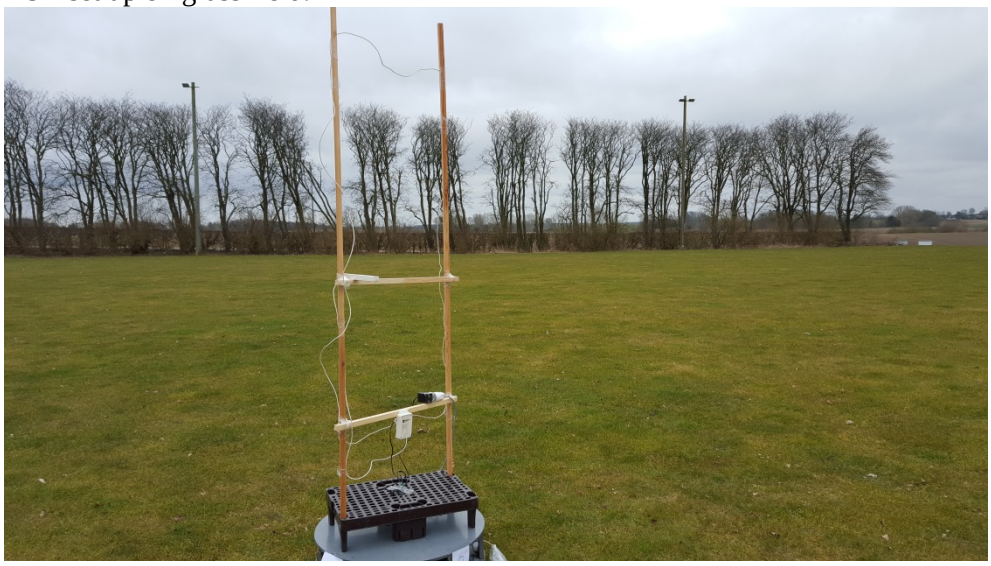


9 kHz-30 MHz, semi anechoic chamber, loop antenna, antenna pos A

9 kHz-30 MHz, semi anechoic chamber, loop antenna, antenna pos B

9 kHz-30 MHz, semi anechoic chamber, loop antenna, antenna pos C

EUT set up on grass field.

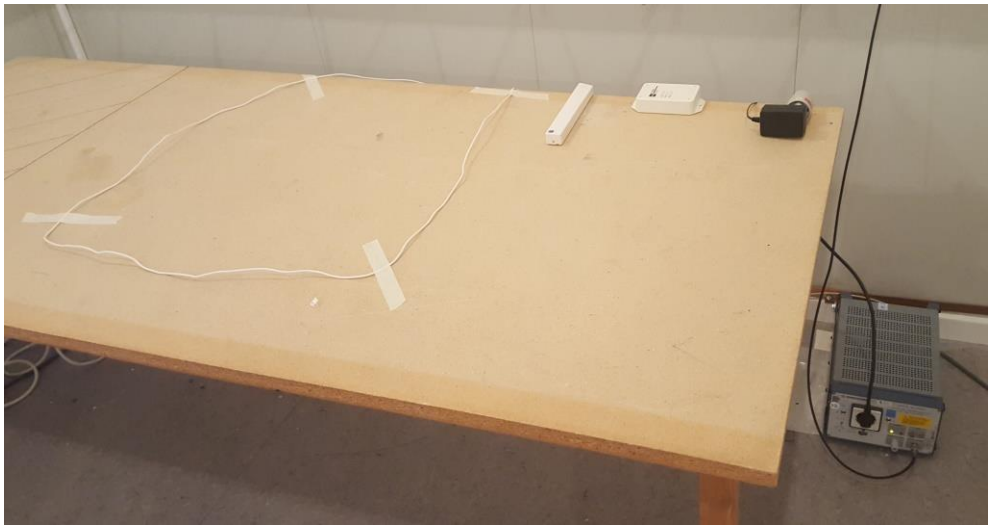


9 kHz-30 MHz, grass field, active loop antenna, antenna pos A at 10 m

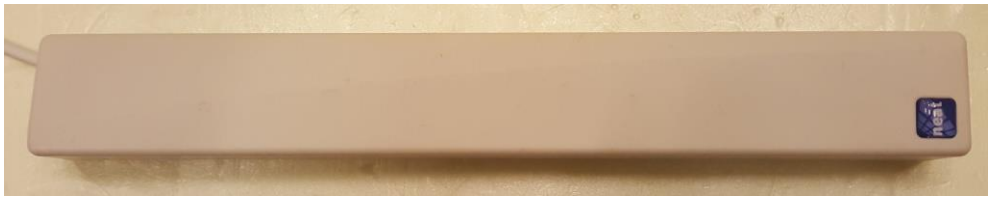
9 kHz-30 MHz, grass field, active loop antenna, antenna pos A at 20 m

Radiated measurements 30-1000 MHz

AC Conducted emission



Ferrite antenna front view



Ferrite antenna back view

ACDC adaptor