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Equipment Authorization measurements on 13.56 MHz Transceiver Unit
FCC ID: 2AHDLNGCR

(9 appendices)
Rev.1, 2017-12-07: FCC id changed by the client. Only this page has been revised.

Test objects

Mifare card reader standard
AR40S-MF
EUT 1: Part-Nr. S54504-F102-A100; Product Rev. 10; PCBA HW Rev.09.
AR40S-MF/VR40S
EUT 2: Part-Nr. V54504-F102-A100; Product Rev. 01; PCBA HW Rev.10.
EUT 3: Part-Nr. S54504-F102-A100; Product Rev. 11; PCBA HW Rev.10. (with dummy load)
AR10S-MF/VR10S
EUT 4: Part-Nr. S54504-F101-A101; Product Rev. 10; PCBA HW Rev.10.
EUT 5: Part-Nr. V54504-F101-A100; Product Rev. 02; PCBA HW Rev.10. (with dummy load)

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 15.225 Operation within the band 13.110-14.010 MHz	**Yes**		
15.225 (c),Operation in the band 13.11-14.01 MHz	Yes	2	
15.209, Radiated emission limit	Yes	3	
15.215 (c), 20 dB bandwidth	Yes	4	
15.207, Conducted emission limits	Yes	5	
2.1049, Occupied bandwidth	Yes	6	
2.1049, Band Edge	Yes	7	
2.1093, RF Exposure	Yes	8	

SP Technical Research Institute of Sweden
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Purpose of test

The tests were performed to verify that NGCR meets the electromagnetic compatibility requirements of FCC 47 CFR part 15 C.

Test facility

The used test sites is compliant with the requirements of section 2.948 of the FCC rules and listed, registration number 96866, as a facility accepted for certification under parts 15 and 18. The site complies with RSS Gen, Issue 4 and is accepted by Industry Canada for the performance of radiated measurements, IC-file number 3482A-1.

Test objects

Transceiver:	NGCR
Antenna type:	Integral, Loop, area= 32 cm^2
Frequency range	Tx:13.56 MHz
Modulation:	-
Channel separation:	Single channel
Supply voltage:	24 V DC
For DC equipment:	External power supply

The highest frequency generated in the EUT is 50 MHz.

Five test samples were used during the tests. Three samples with the standard antenna connected and two sample with a dummy load (47 Ω) instead of the antenna.

The following test samples were used for each test according to the table below.

Test		EUT 1	EUT 2	EUT 3	EUT 4	EUT 5
Operation in the band 13.11-14.01 MHz	Transmitter power		X		X	
	Transmitter frequency tolerance during the temperature variation	X				
Radiated emission limit	Semi anechoic chamber		X		X	
	Asphalt surface		X			
15.215 (c), 20 dB bandwidth			X		X	
Conducted emission limits			X	X	X	X
Occupied bandwidth			X		X	
Band Edge			X		X	
RF Exposure			X			

Justification

According to the client there are different variants of the test object.
The client has provided detailed documentation about the variants. The differences are either different brand or that variant are assembled with/without display and keypad. Otherwise it is the same HW and the same antenna.

Summary of the differences:

Variants of XRX0S-MF reader	Type	Part-No	Hardware Rev.	Features
1	AR40S-MF Card Reader Keypad / Display (Siemens branded)	S54504-F102-A100	10	with Keypad/ Display
2	AR10S-MF Card Reader (Siemens branded)	S54504-F101-A100	10	without Keypad/Display
3	VR40S-MF Card Reader Keypad / Display (Vanderbilt branded)	V54504-F102-A100	10	Same as 1. Only other brand name
4	VR10S-MF Card Reader (Vanderbilt branded)	V54504-F101-A100	10	Same as 2. Only other brand name

The AR40S-MF/ VR40S-MF Mifare card reader standard; version is fully equipped with keypad and display and was deemed to be the worst-case version.
Some justifications measurements were performed on the different variants with/without display and keypad, see the table at previous page.

Operational test mode

The EUT was transmitting with 100% of the time, that is, it gives out a continuous unmodulated carrier wave at 13.56 MHz. Duty cycle = 100%.

Tests were performed with the EUT powered by an external DC power supply, 24 V DC. The external DC power supply was powered by 120 V AC/60 Hz.
The EUT transmitter is always active.
During the test the EUT was connected to a central unit AP. A laptop PC via a router and a functional test NGCR unit were also connected to the central unit AP. All the supporting equipment was placed outside the anechoic chamber during the test.

Cabling during radiated emission test:

EUT port	Cable type	Termination / use
DC+signal	Multiwire, shielded, 20 m length,	Connected to the central unit and the external DC power supply. A ferrite clamp Lüthi FTC 40X15E and clamp on ferrites, type amidon 2X-43-151, were attached at lead-through of the chamber.

Connected equipment during the tests

PC laptop Precision M4700 with s/w: Aliro ver 1.15.0.26	Client equipment
Central unit AP	Client equipment
TP link Wireless Router Model: TL-WR841N	Client equipment
Functional test NGCR transceiver	Client equipment
Transformer 115 V AC/230 V AC, Tufvasons Art. no: 7853-0017	Client equipment
AC/DC-adapter 230 VAC/24 VDC Tufvasons Art. no: 8524-0038	Client equipment

Measurement equipment

Measurement equipment	Calibration Due	SP number
Semi anechoic chamber, Tesla	2017-03	503 881
EMI Test Receiver R&S ESU 40	2018-06	901 385
ETS Lindgren BiConiLog 3142E	2019-03	BX61914
EMC 32 ver. 9.15.0	-	503 899
LISN Rohde & Schwarz NNLK 8121	2017-01	502 112
Limiter Electro-Metrics EM 7600	2019-03	BX42882
EMI Test Receiver R&S ES1 40	2017-07	503 125
LISN Schwarzbeck NNLA 8120	2017-01	504 129
Emco 6502, Active loop antenna	2017-05	502 916
120 V AC/60 Hz AC Power source HP 6813B	2017-94	503 091
DC power supply HP E3632A	-	503 170
True RMS Multimeter Fluke 85III	2018-01	503 418
Multimeter Fluke 83	2017-06	501 522
Attenuator 20 dB Inmet 2100-20dB	2016-12	503 871
Climate Chamber Weiss technik	-	503 360
Temperature and humidity meter Testo 625	2017-06	504 188

Uncertainties

Measurement and test instrument uncertainties are described in the quality assurance documentation ”SP QD 10885”. The measurement uncertainties can be found in the table below. The uncertainties are calculated with a coverage factor k=2 (95% level of confidence). The measurement uncertainties can be found in the table below:

Method	**Uncertainty**
Radiated emission, 9 kHz - 30 MHz	5.3 dB
Radiated emission, 30 – 1000 MHz	4.8/5.6 dB (V/H-pol)
Radiated emission, 1 – 40 GHz	2.6 dB
20 dB bandwidth	2.6 %
Occupied bandwidth	2.6 %
Conducted emission AC	3.5 dB

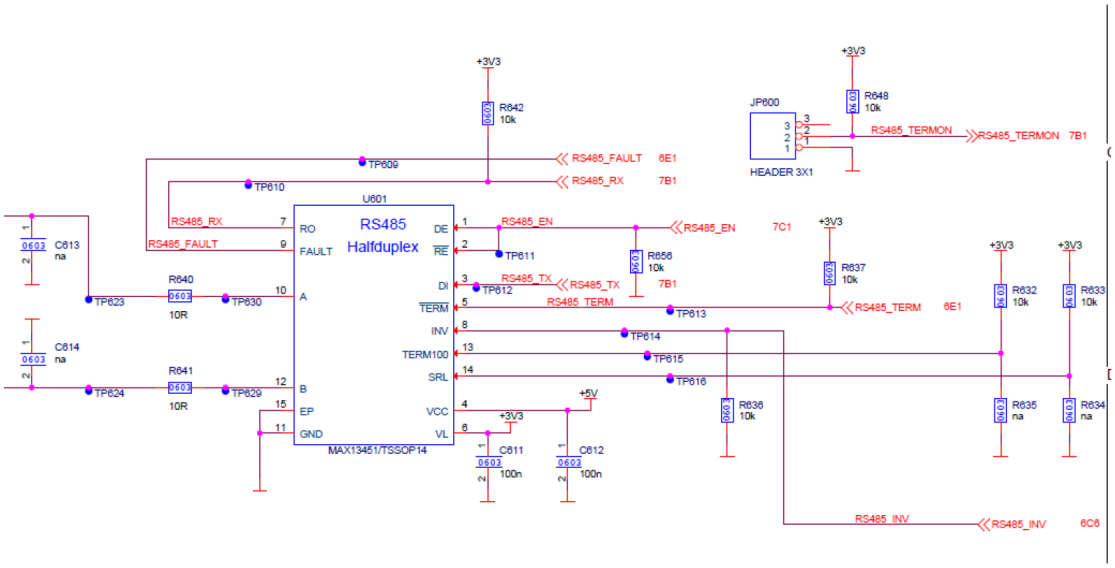
Compliancy evaluation is based on a shared risk principle with respect to the measurement uncertainty.

Reservation

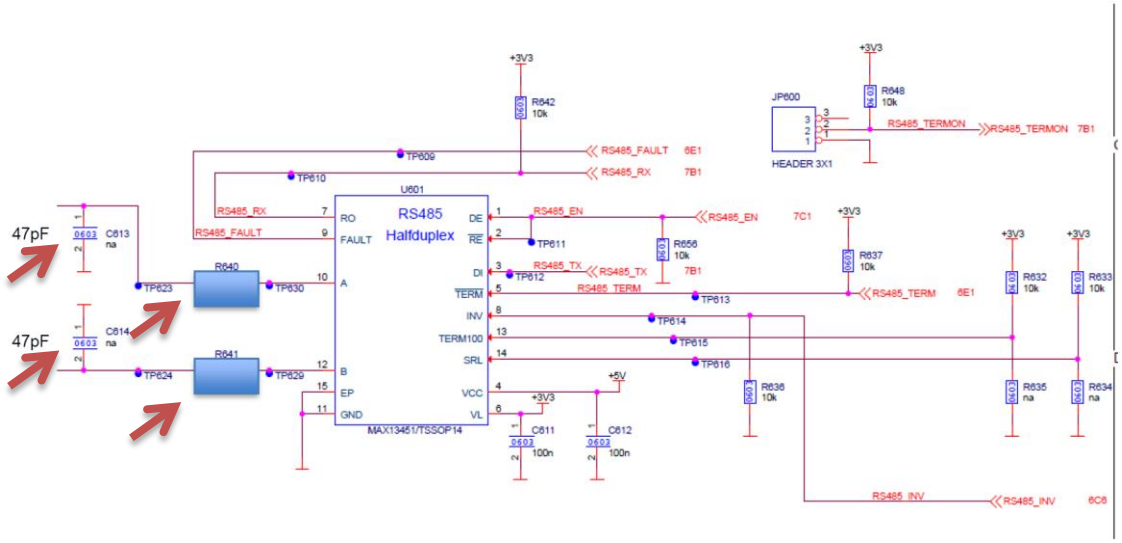
The test results in this report apply only to the particular test object as declared in the report.

To reduce the radiated emission in the frequency range 30-1000 MHz the EUT was modified by adding LC filter
(Ferrite WE (742 792 662) + Capacitor 47 pF).

Before the modification:



After the modification:



The modified readers will result in HW rev 11 after change in PLM system.
It was deemed that the modification does not affect the Transmitter frequency tolerance during the temperature variation test. All other tests were performed with the modified readers.

Delivery of test objects

The test objects were delivered: 2015-12-04 and 2016-10-18

Test participant

Magnus Pihl (was present 2016-10-18), Vanderbilt International AB

Test engineers

Hyder Khalaf, Olof Johansson and Fredrik Isaksson, SP

Transmission in operation band according to FCC 47 CFR 15.225

Date	Temperature	Humidity
Anechoic chamber: 2016-10-18 2016-10-19	 23 °C ± 3 °C 23 °C ± 3 °C (measurement equip.)	 36 % ± 5 % 37 % ± 5 % (measurement equip.)
Climate chamber: 2015-12-14	 23 °C ± 3 °C	 20 % ± 5 %
Asphalt surface: 2016-11-03	 5 °C ± 3 °C (EUT)	 68 % ± 5 % (EUT)

Test set-up and procedure

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

The test of radiated emission was first performed in a semi anechoic chamber and then on an asphalt surface. The measurements were performed with three perpendicular antenna positions below 30 MHz.

The measurement procedure for frequencies below 30 MHz is as the follows:

1. A pre-measurement is performed at 3 m and with peak detector in a semi anechoic chamber. The test object is scanned 360 degrees with max hold peak detector for the three antenna positions A, B and C.
2. Then a final measurement is performed on an asphalt surface at 10 m distance. The test object is scanned 360 degrees for maximum response with peak detector for the three antenna positions A, B and C. Then the emission is measured with the quasipeak detector, according to 15.35(a).

The field strength levels are measured with a resolution bandwidth of 10 kHz for frequencies between 150 kHz and 30 MHz.

During the frequency tolerance test in the climate chamber the frequency was measured with a near field probe and the used test equipment was connected to an external 10 MHz reference standard during measurement.

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

Measurement equipment	SP number
Semi anechoic chamber, Tesla	503 881
EMI Test Receiver R&S ESU 40	901 553
Emco 6502, Active loop antenna	502 916
Multimeter Fluke 83	501 522
True RMS Multimeter Fluke 85III	503 418
Near field probe EMCO 7405	501 673
Attenuator 20 dB Inmet 2100-20dB	503 871
DC power supply HP E3632A	503 170
Climate Chamber Weiss technik	503 360
Temperature and humidity meter Testo 625	504 188

Results

The pre-test emission spectra for the worst case configuration at 3 m in the anechoic chamber with the active loop antenna at 13.56 MHz can be found in the diagrams below:

Diagram 1	13.56 MHz, antenna position A, EUT 2, Note
Diagram 2	13.56 MHz, antenna position A, EUT 4

Note: Final measurement was performed on the EUT with highest output power.

Final measurement at asphalt surface at 10 m, EUT 2:

Test conditions		Transmitter power at 13.56 MHz at asphalt surface measured at 10 m and converted to 30 m (dBµA/m)			
		Measured QP Pos A	Measured Peak Pos A	Measured RMS Pos A	Limit QP @ 30 m
V_{nom}	24.0 V DC	-23.8	-23.6	-24.9	32.5
V_{min}	20.4 V DC	-23.1	-22.9	-24.2	
V_{max}	27.6 V DC	-23.8	-23.6	-24.8	
Measurement uncertainty		5.5 dB			

Note: The transmitter power level at 13.56 MHz was measured at the asphalt surface at 10 m. The 24 V DC voltage to the EUT was adjusted between 85% and 115% of the nominal 24 V DC.

The power measured at 10 m was converted to 30 m according to the formula below:

$$FS_{limit} = FS_{max} - 40\log\left(\frac{d_{limit}}{d_{measure}}\right)$$

where

FS_{limit}	is the calculation of field strength at the limit distance, expressed in dBµV/m
FS_{max}	is the measured field strength, expressed in dBµV/m
$d_{near\ field}$	is the $\lambda/2\pi$ distance
$d_{measure}$	is the distance of the measurement point from the EUT
d_{limit}	is the reference distance or the distance of the $\lambda/2\pi$ point

EUT 1:

Test conditions		Transmitter frequency tolerance during the temperature variation Nominal frequency=13.56 MHz		
		Measured frequency (MHz)	Measured frequency error (kHz)	Frequency tolerance limit
T_{nom} 50°C	V_{nom} 24.0 V DC	13.559757	-0.243	±100 ppm at 13.56 MHz = ±1.356 kHz
T_{nom} 40°C	V_{nom} 24.0 V DC	13.559789	-0.211	
T_{nom} 30°C	V_{nom} 24.0 V DC	13.559823	-0.177	
T_{nom} 20°C	V_{nom} 24.0 V DC	13.559802	-0.198	
T_{nom} 10°C	V_{nom} 24.0 V DC	13.559903	-0.097	
T_{nom} 0°C	V_{nom} 24.0 V DC	13.559924	-0.076	
T_{nom} -10°C	V_{nom} 24.0 V DC	13.559928	-0.072	
T_{nom} -20°C	V_{nom} 24.0 V DC	13.559913	-0.087	
Measurement uncertainty		± 1 x 10-9		

Note: At the transmitter frequency tolerance test the frequency and the output level were measured for relative change with a near field probe placed close to the antenna in the climatic chamber.

Limits

The limits below are given for 30 m measurement distances. Below 30 MHz the field strength is converted to magnetic field units, dBµA/m, by subtracting with 51.5 dB (20xLog(377)) since it is measured with a magnetic loop antenna.

According to 47CFR 15.225, Operation within the band 13.110-14.010 MHz

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(e) The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Complies?	Yes

Diagram 1

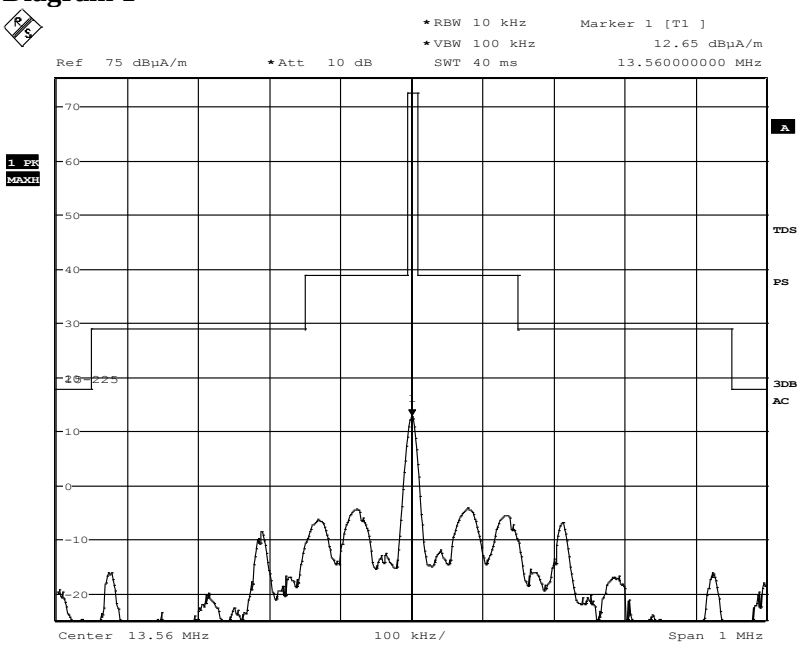


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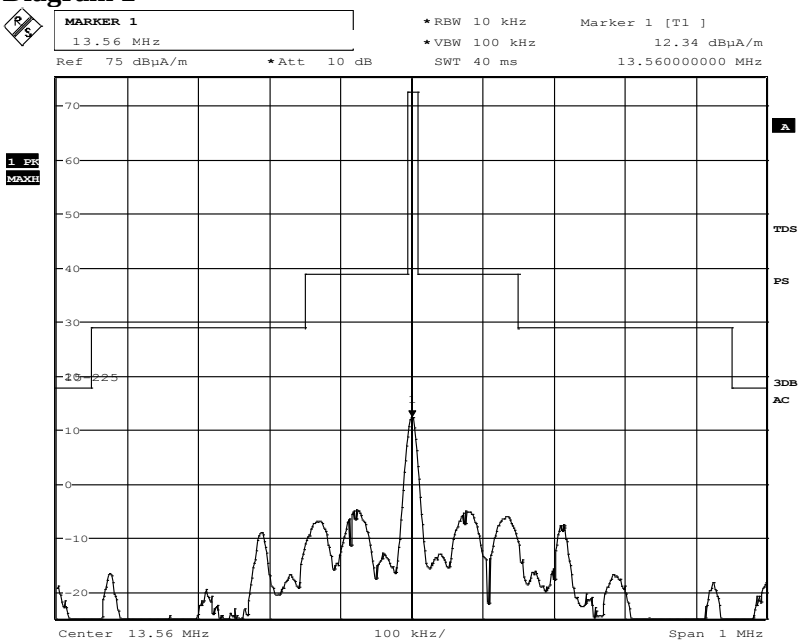
Diagram 2



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Radiated emission measurements according to FCC 47 CFR part 15.209

Date	Temperature	Humidity
Anechoic chamber: 2016-10-18 2016-10-19	 23 °C ± 3 °C 23 °C ± 3 °C	 36 % ± 5 % 37 % ± 5 %
Asphalt surface: 2016-11-03	 5 °C ± 3 °C (EUT)	 68 % ± 5 % (EUT)

Test set-up and procedure

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

The measurement procedure for frequencies below 30 MHz is as the follows:
The measurements were performed with three perpendicular antenna positions.
The pre-measurement of radiated emission was performed in a semi anechoic chamber at 3 m distance.
The final measurement of radiated emission was performed on an asphalt surface at 10 m distance.

1. A pre-measurement is performed with peak detector. The test object is scanned 360 degrees with max hold peak detector.
2. If the emission is close or above the limit during the pre-measurement a final measurement is performed on an asphalt surface at 10 m distance. The test object is scanned 360 degrees for maximum response with peak detector. Then the emission is measured with the quasi-peak detector according to 15.209(d).

The measurement procedure for frequencies above 30 MHz is as the follows:
The test of radiated emission was performed in a semi anechoic chamber. The measurements were performed with vertical and horizontal polarization. The antenna distance was 3 m.

1. A pre-measurement is performed with peak detector. The test object is measured in eight directions 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. Then the emission is measured with the quasi-peak detector on frequencies below 1 GHz and with the average detector above 1 GHz.

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

Measurement equipment	SP number
Semi anechoic chamber, Tesla	503 881
EMI Test Receiver R&S ESU 40	901 553
ETS Lindgren BiConiLog 3142E	BX61914
Emco 6502, Active loop antenna	502 916
120 V AC/60 Hz AC Power source HP 6813B	503 091
DC power supply HP E3632A	503 170
Multimeter Fluke 83	501 522
True RMS Multimeter Fluke 85III	503 418
Temperature and humidity meter Testo 625	504 188

Results

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

Diagram 1:	Ambient, 9 kHz-150 kHz, only EUT power off, connected equipment to the EUT power on, antenna pos A
Diagram 2:	Ambient, 150 kHz-30 MHz, only EUT power off, connected equipment to the EUT power on, antenna pos A
Diagram 3:	9 kHz-150 kHz, antenna pos A, EUT 2
Diagram 4:	150 kHz-30 MHz, antenna pos A, EUT 2
Diagram 5:	9 kHz-150 kHz, antenna pos B, EUT 2
Diagram 6:	150 kHz-30 MHz, antenna pos B, EUT 2
Diagram 7:	9 kHz-150 kHz, antenna pos C, EUT 2
Diagram 8:	150 kHz-30 MHz, antenna pos C, EUT 2
Diagram 9:	9 kHz-150 kHz, antenna pos A, EUT 4
Diagram 10:	150 kHz-30 MHz, antenna pos A, EUT 4
Diagram 11:	9 kHz-150 kHz, antenna pos B, EUT 4
Diagram 12:	150 kHz-30 MHz, antenna pos B, EUT 4
Diagram 13:	9 kHz-150 kHz, antenna pos C, EUT 4
Diagram 14:	150 kHz-30 MHz, antenna pos C, EUT 4

No unwanted emissions were detected in the frequency range 9-150 kHz during the pre-test.

Free field measurements at asphalt surface were performed with EUT 2 (fully equipped with keypad and display) in antenna position A, B and C in the frequency range 1-8 MHz at 10 m measurement distance and no unwanted emission from the EUT that could be detected above the ambient emission level.

The emission spectra in semi anechoic chamber at 3m in the frequency range 30-1000 MHz can be found in the diagrams below:

Diagram 15:	Ambient, 30-1000 MHz, only EUT power off, connected equipment to the EUT power on, vertical and horizontal polarization
Diagram 16:	30-1000 MHz, vertical and horizontal polarization, EUT 2
Diagram 17:	30-1000 MHz, vertical and horizontal polarization, EUT 4

Limits

The limits below 30 MHz are given for different measurement distances. The limits below are converted to 3 m by using the extrapolation factor 40 dB/decade (§15.31). Below 30 MHz the field strength is converted to magnetic field units, dBµA/m, by subtracting with 51.5 dB (20xLOG(377)) since it is measured with a magnetic loop antenna.

Frequency (MHz)	**Field strength (dBµV/m)@3m**	**Field strength (dBµA/m)@3m**	**Field strength (dBµA/m)@10m**
0.009-0.490	128.5-93.8	77.0-42.3	56.1-21.4
0.490-1.705	73.8-63.0	22.3-11.5	1.4- -9.4
1.705-30.0	69.5	18.0	-2.9
30-88	40.0		
88-216	43.5		
216-960	46.0		
960-1000	54.0		

Note: The FCC limit in the limit table above below 30 MHz is calculated with the extrapolation factor 40 dB/decade and converted to magnetic field (dBµA/m).

The field strength limit is given for the quasi-peak value except that the average value is valid in the band 9-90 kHz and 110-490 kHz.

According to 15.35(b) there is 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 47CFR 15.225, Operation within the band 13.110-14.010 MHz
(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

Complies?	Yes

Diagram 1

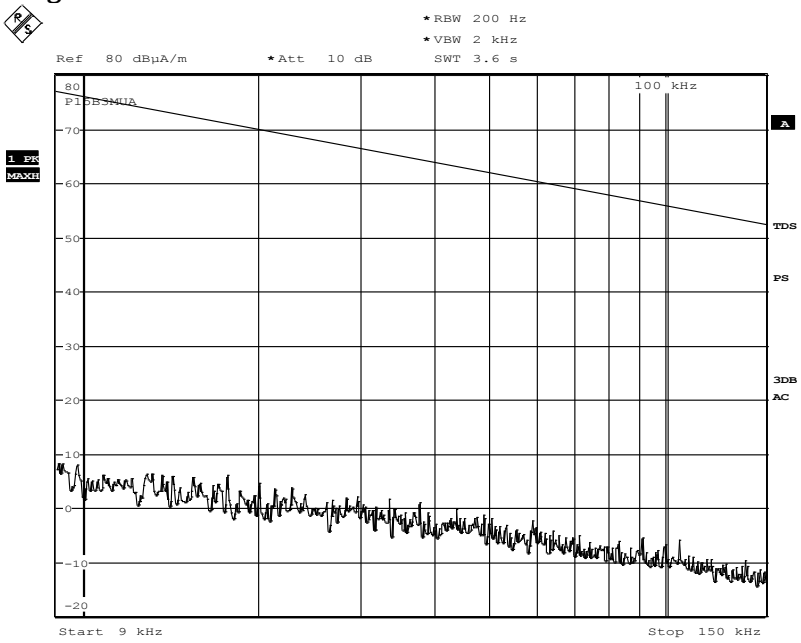

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Diagram 2

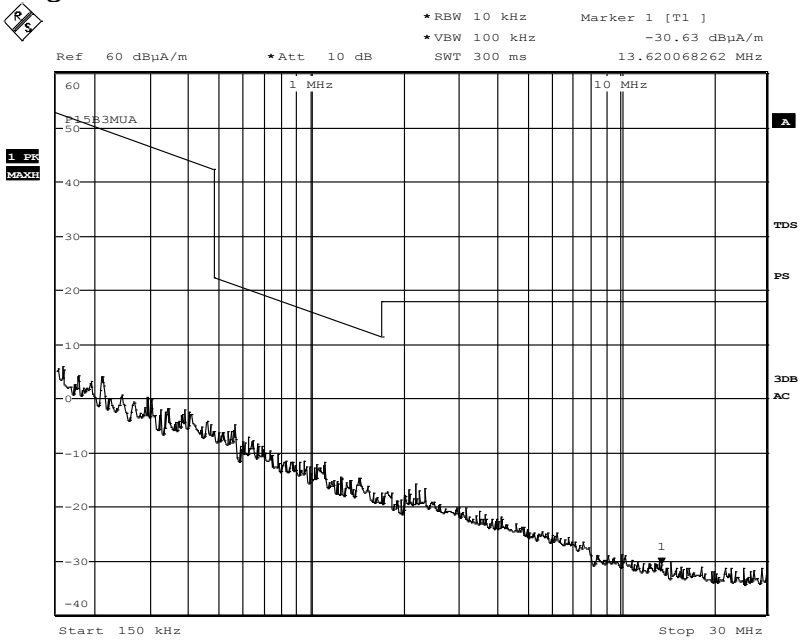

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Diagram 3

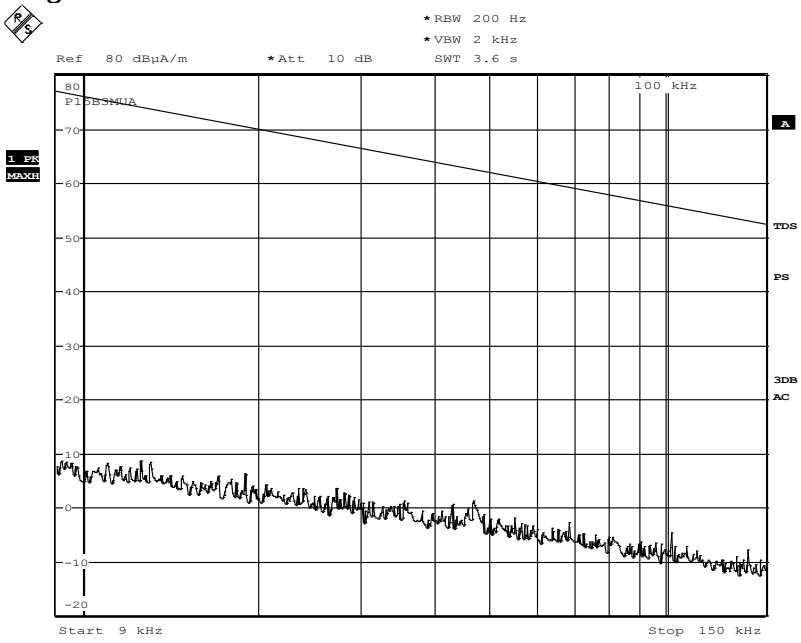

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Diagram 4

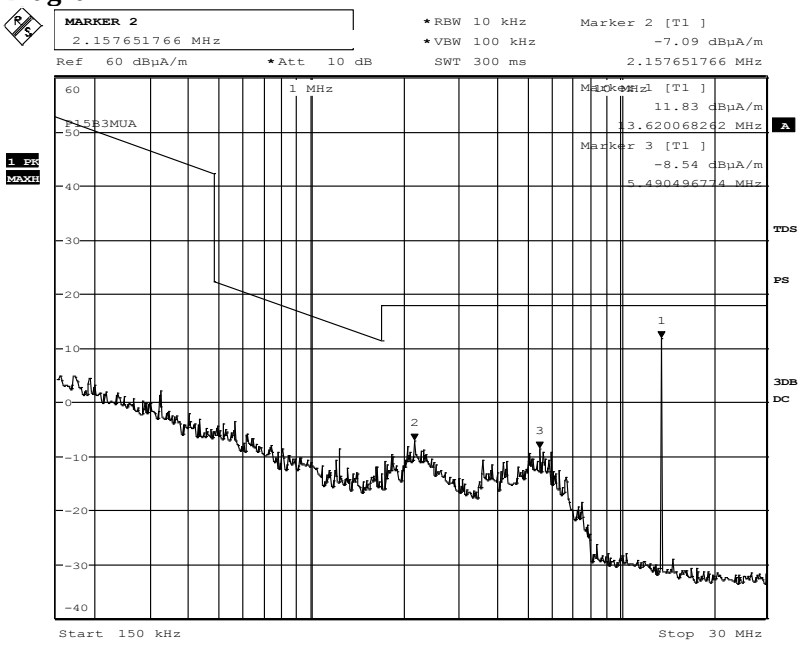

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Diagram 5

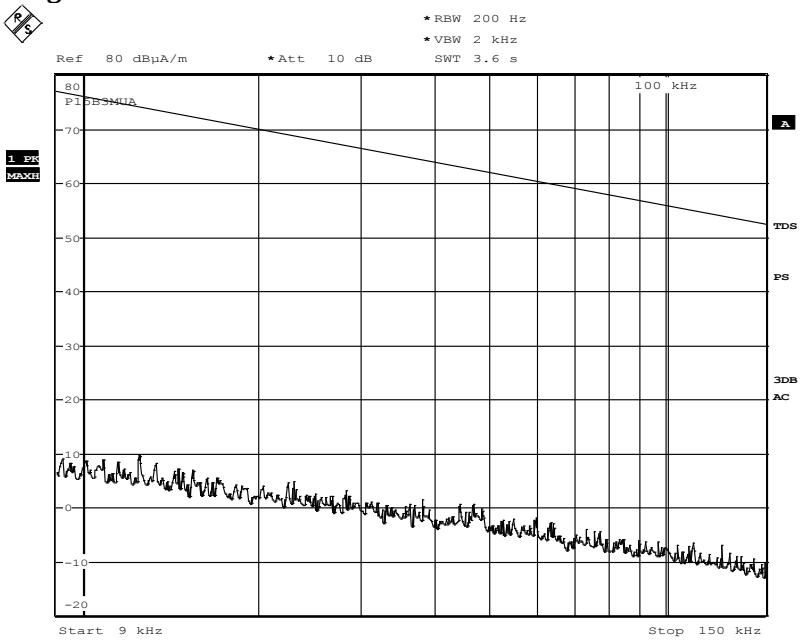

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Diagram 6

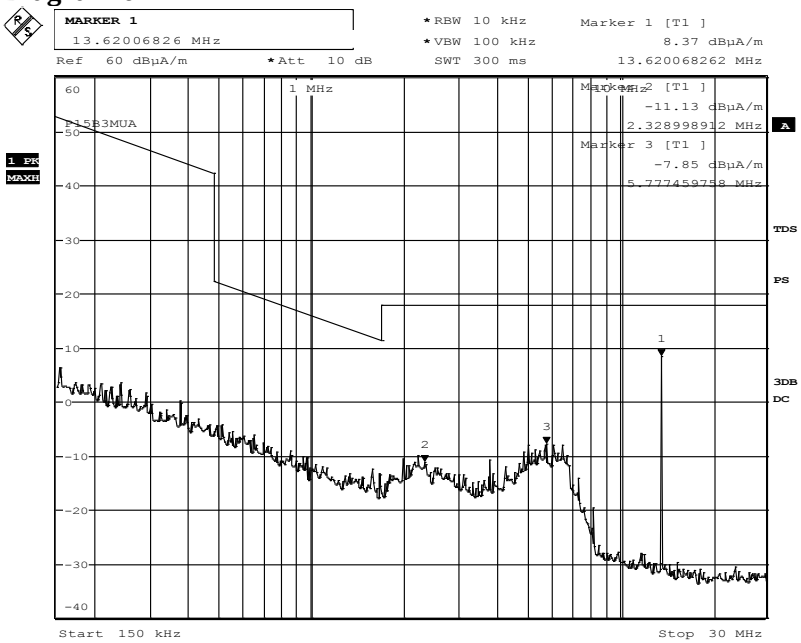

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Diagram 7

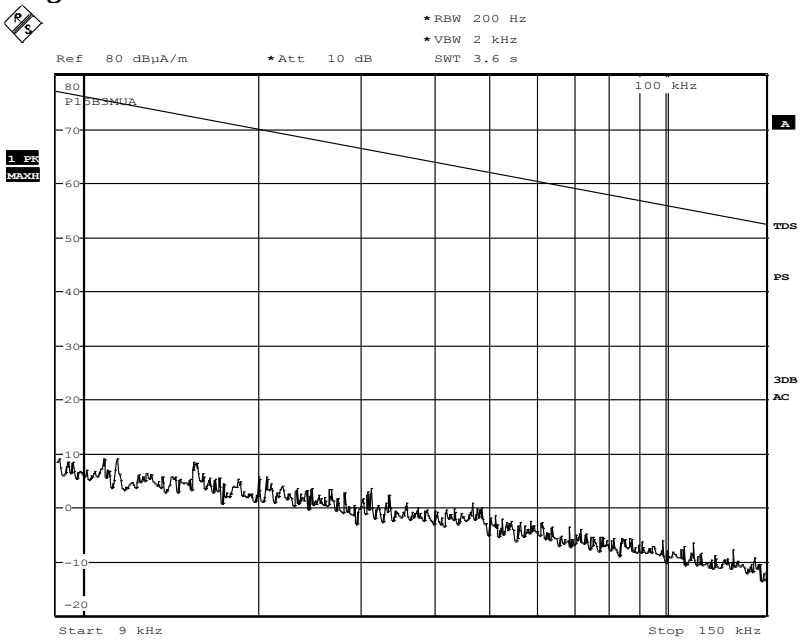

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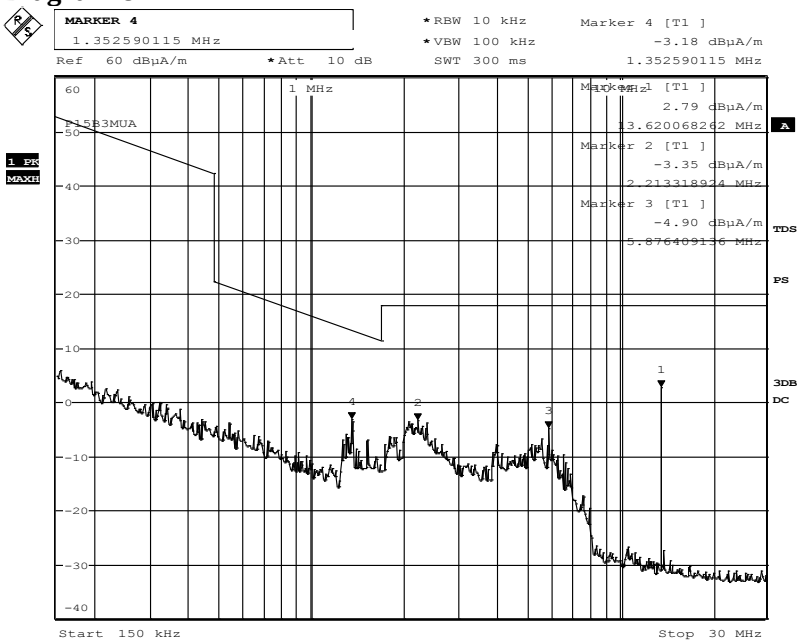
Diagram 8



Date: 19.OCT.2016 08:33:20

Diagram 9

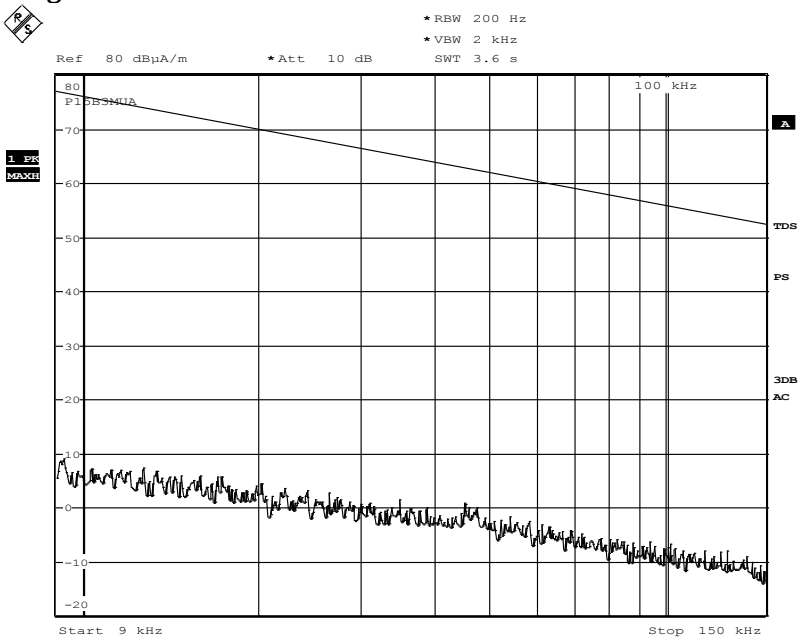


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Diagram 10

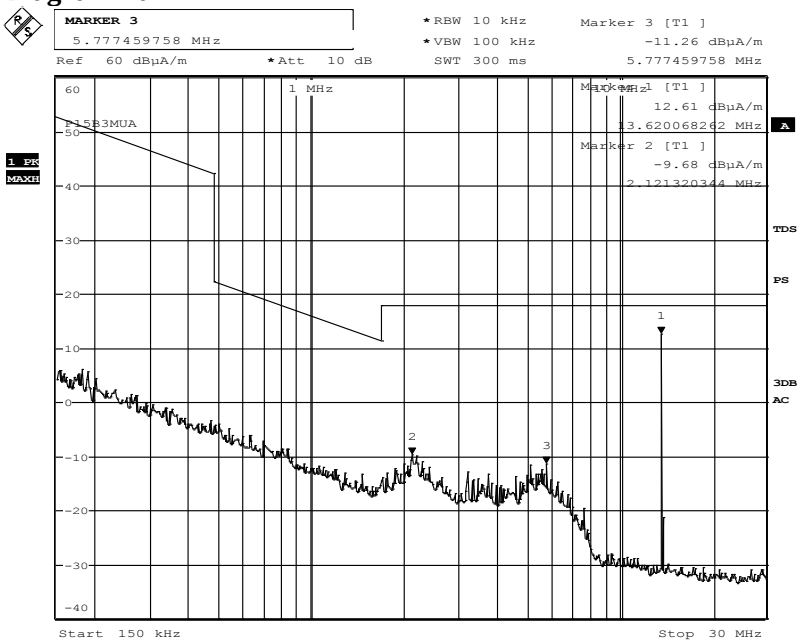

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Diagram 11

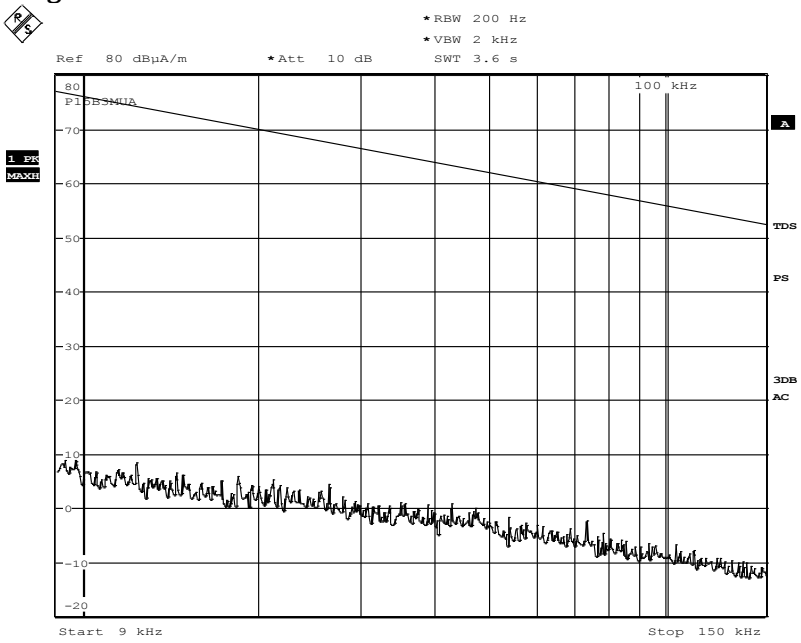

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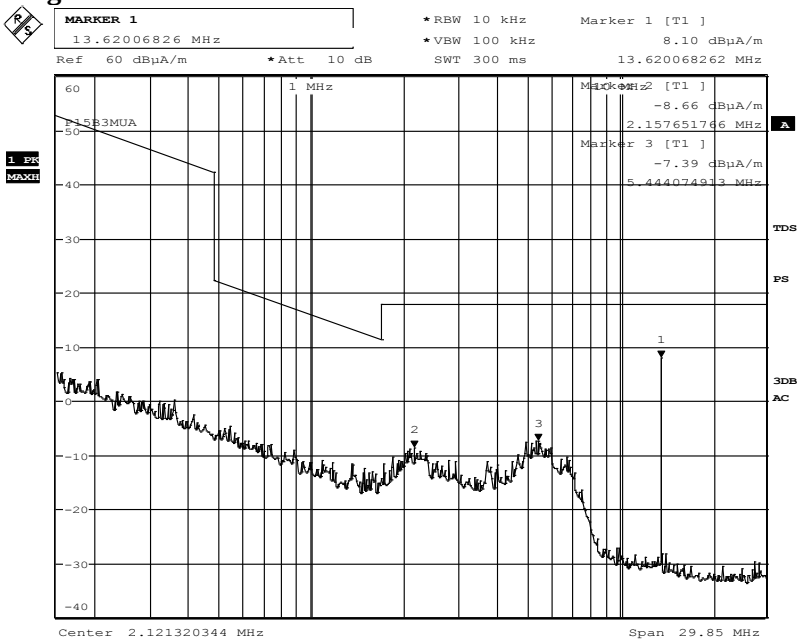
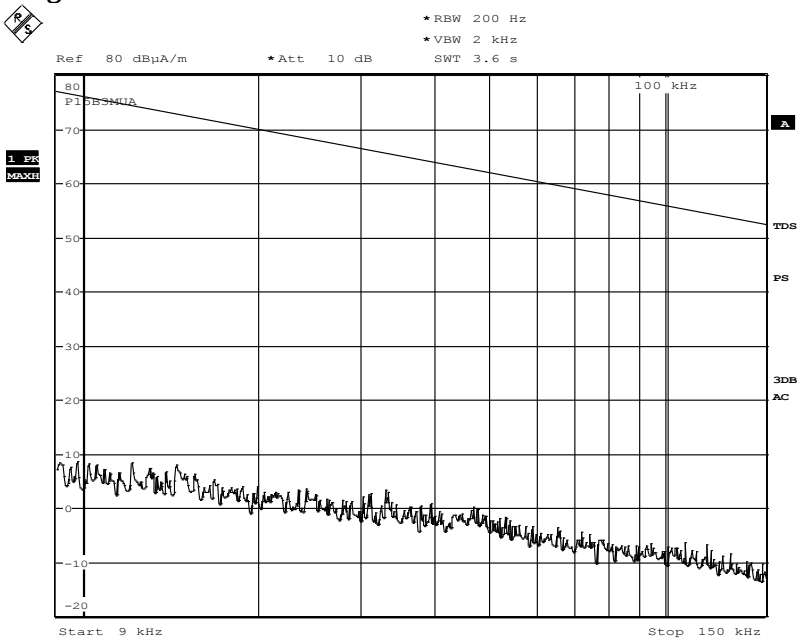
Diagram 12



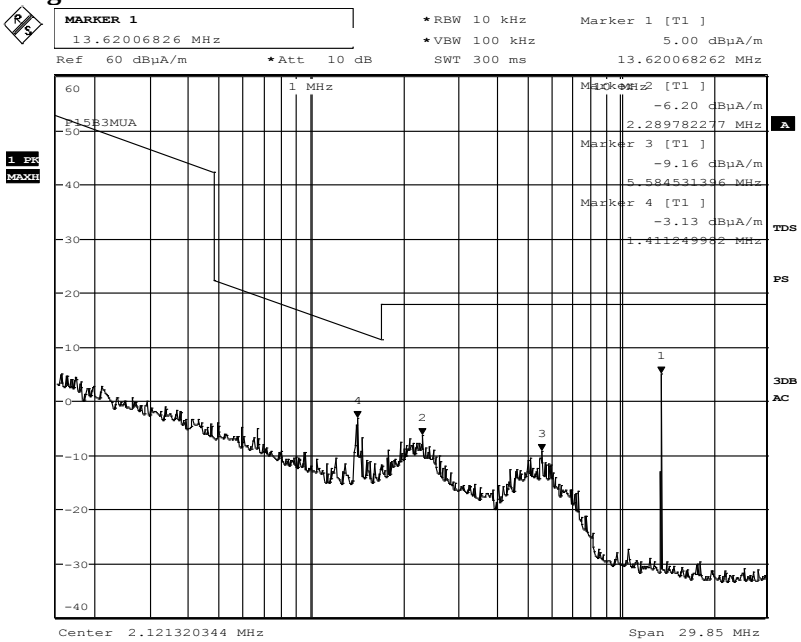
Date: 18.OCT.2016 13:54:27

Diagram 13



Date: 18.OCT.2016 14:27:17

Diagram 14



Date: 18.OCT.2016 14:13:00

Diagram 15

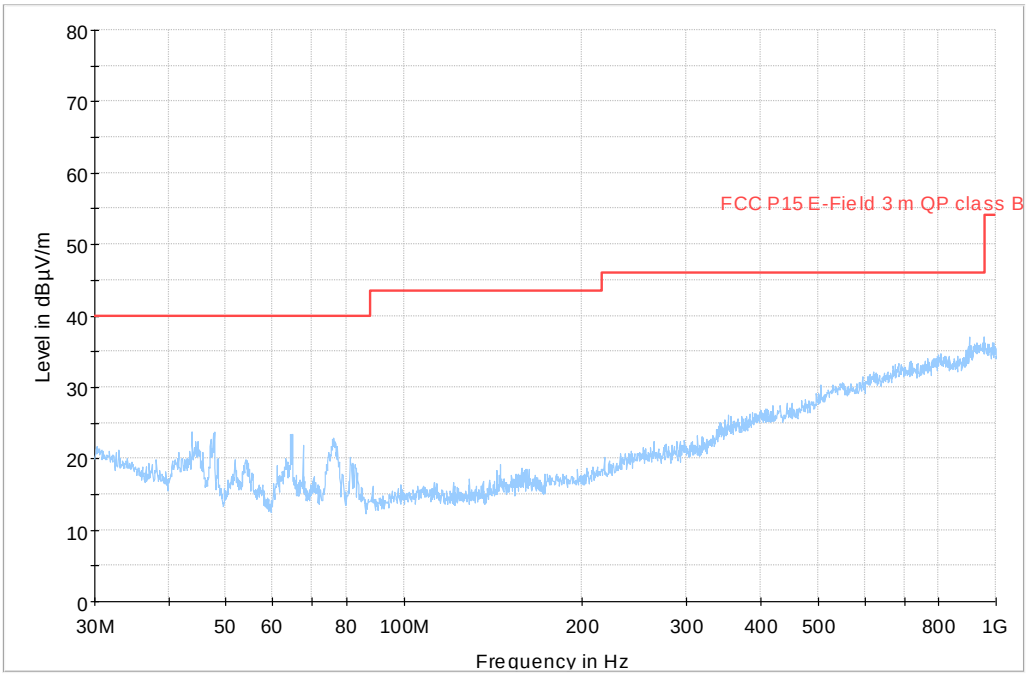
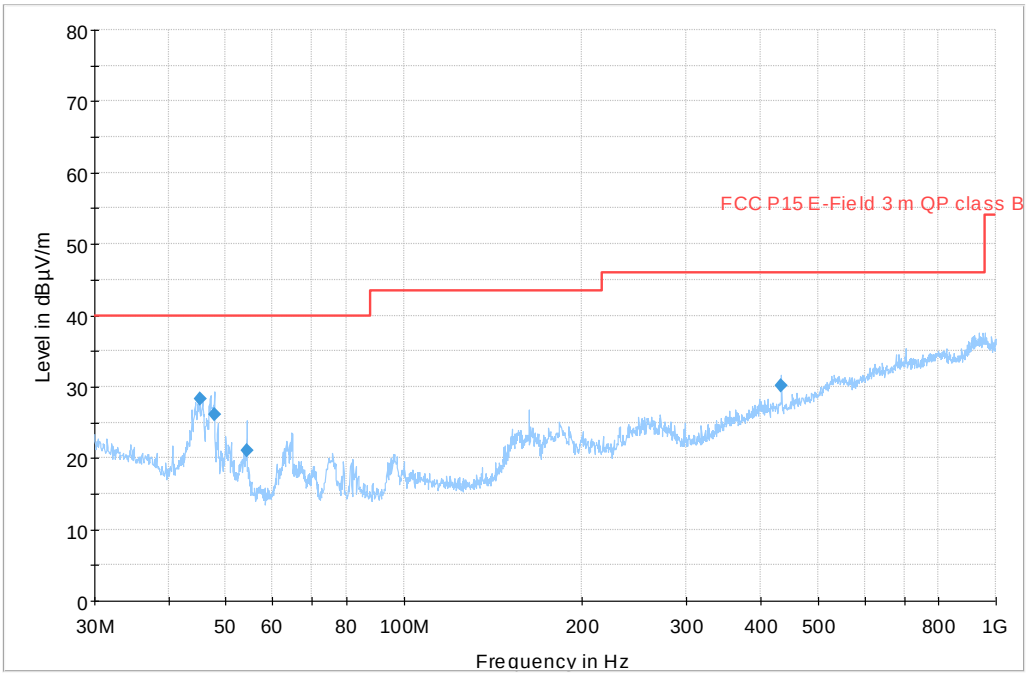

FCC P15 E-Field 3 m QP class B
Level in dBµV/m
Frequency in Hz
80
70
60
50
40
30
20
10
0
30M
50
60
80
100M
200
300
400
500
800
1G

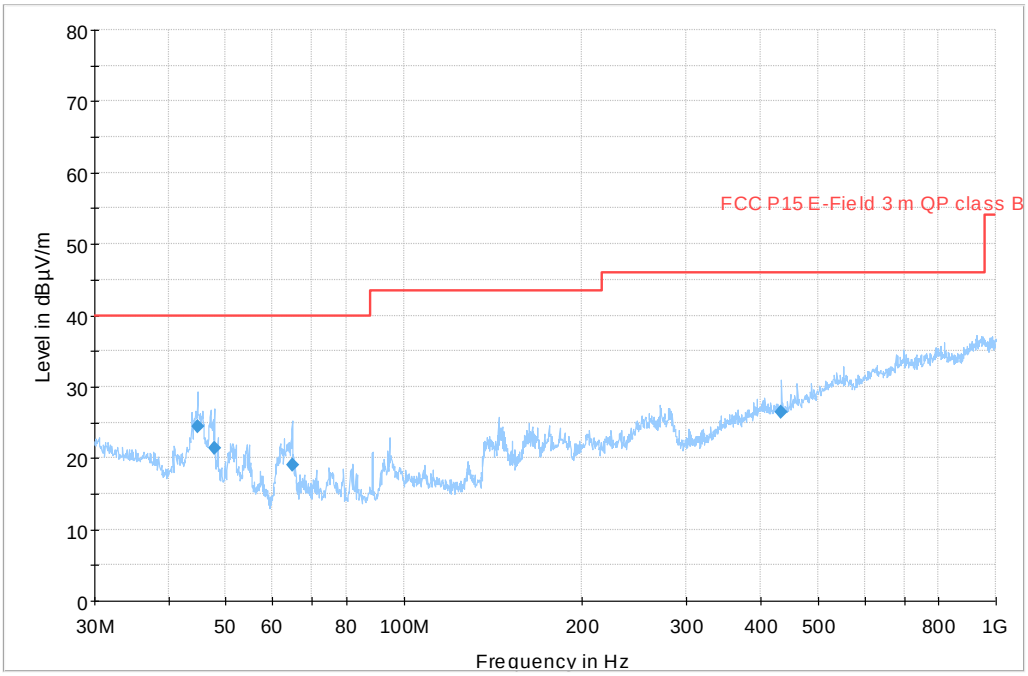
Diagram 16



Final measurements

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
45.273	28.28	40.00	11.72	5000	120	106.0	V	73.0
47.798	26.13	40.00	13.87	5000	120	100.0	V	349.0
54.180	21.01	40.00	18.99	5000	120	135.0	V	341.0
433.907	30.17	46.00	15.83	5000	120	102.0	V	164.0

Diagram 17



Final measurements

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
44.761	24.44	40.00	15.56	5000	120	102.0	V	286.0
47.801	21.32	40.00	18.68	5000	120	102.0	V	98.0
64.674	18.99	40.00	21.01	5000	120	141.0	V	288.0
433.907	26.51	46.00	19.49	5000	120	210.0	H	273.0

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

Date	Temperature	Humidity
2016-10-18	23 °C ± 3 °C	36 % ± 5 %
2016-10-19	23 °C ± 3 °C	37 % ± 5 %

Test set-up and procedure

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

Radiated measurements were performed in a semi anechoic chamber. The measurements were performed with the antenna and the turntable at the position with the highest level of the fundamental, according to Appendix 2. The antenna distance was 3.0 m.
The EUT height above the reference ground plane was 0.8 m.

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

Measurement equipment	SP number
Semi anechoic chamber, Tesla	503 881
EMI Test Receiver R&S ESU 40	901 553
Emco 6502, Active loop antenna	502 916
Multimeter Fluke 83	501 522
Temperature and humidity meter Testo 625	504 188

Results

The 20 dB BW measurements in the semi anechoic chamber at 3m can be found in the diagrams below:

Diagram 1:	13.56 MHz	20 dB BW = **9.47 kHz**	EUT 2
Diagram 2:	13.56 MHz	20 dB BW = **9.47 kHz**	EUT 4

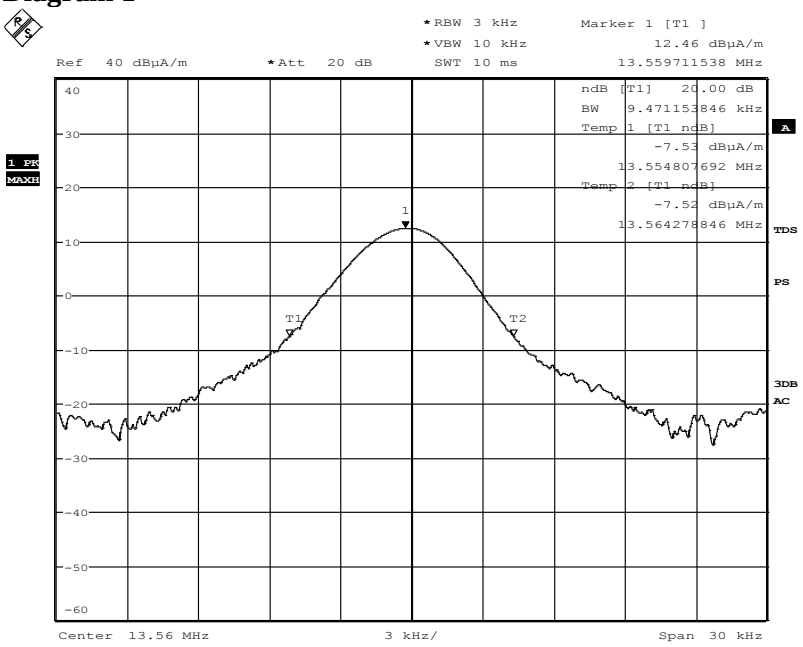
Note: The EUT do not use any modulation, just an unmodulated carrier wave, thus the 20 dB BW value is direct dependent of the RBW setting. With different RBW also the 20 dB BW value will be different.
The measurement was performed with a RBW setting of 3 kHz.

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 a 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.

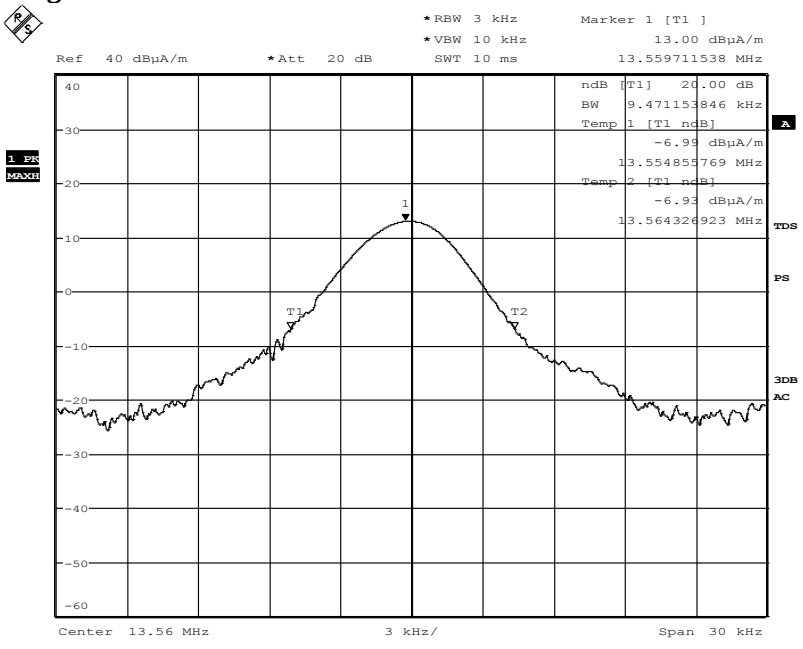
Complies?	Yes

Diagram 1



Date: 19.OCT.2016 13:19:24

Diagram 2



Date: 19.OCT.2016 13:14:22

Conducted AC emission measurements according to according to FCC 47 CFR part 15.207

Date	Temperature	Humidity
2016-10-28	22 °C ± 3 °C	38 % ± 5 %

Test set-up and procedure

The measurements were performed according to ANSI C63.4-2014 and KDB 174176 D01 Line Conducted FAQ v01r01, Q5.

Measurements were performed with continuous transmission (100% duty cycle with the original antenna and varying duty cycle with the dummy load).
Measurements were performed on the 120 V AC/60 Hz, phase and neutral terminals, at the Transformer 115 V AC/230 V AC, Tufvasons.

1. The test was first performed with the antenna attached, to make sure the device complies with the 15.207 limits outside transmitter's fundamental emission band.
2. A retest was made on another unit with a dummy load to make sure the device complies with the 15.207 limits inside the transmitter fundamental emission band. The dummy load was a resistor, 47 Ω.

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

Measurement equipment	SP number
Semi anechoic chamber, Tesla	503 881
EMI Test Receiver R&S ESU 40	901 553
Software: R&S EMC32, ver. 9.15.0	503 899
LISN Schwarzbeck NNLA 8120	504 129
LISN Schwarzbeck NNLK 8121	502 112
Limiter Electro-Metrics EM 7600	BX42882
Multimeter Fluke 83	501 522
Temperature and humidity meter Testo 625	504 188

Result

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

Diagram 1:	120 V AC, phase terminal, ambient
Diagram 2:	120 V AC, neutral terminal, ambient
Diagram 3:	120 V AC, phase terminal, EUT 2 with the internal antenna connected
Diagram 4:	120 V AC, neutral terminal, EUT 2 with the internal antenna connected
Diagram 5:	120 V AC, phase terminal, EUT 4 with the internal antenna connected
Diagram 6:	120 V AC, neutral terminal, EUT 4 with the internal antenna connected
Diagram 7:	120 V AC, phase terminal, EUT 2 with the dummy load resistor connected
Diagram 8:	120 V AC, neutral terminal, EUT 2 with the dummy load resistor connected
Diagram 9:	120 V AC, phase terminal, EUT 4 with the dummy load resistor connected
Diagram 10:	120 V AC, neutral terminal, EUT 4 with the dummy load resistor connected

The limit lines indicated as Voltage on Mains in the diagrams are the same limit lines as of FCC part 15.207.

Limits

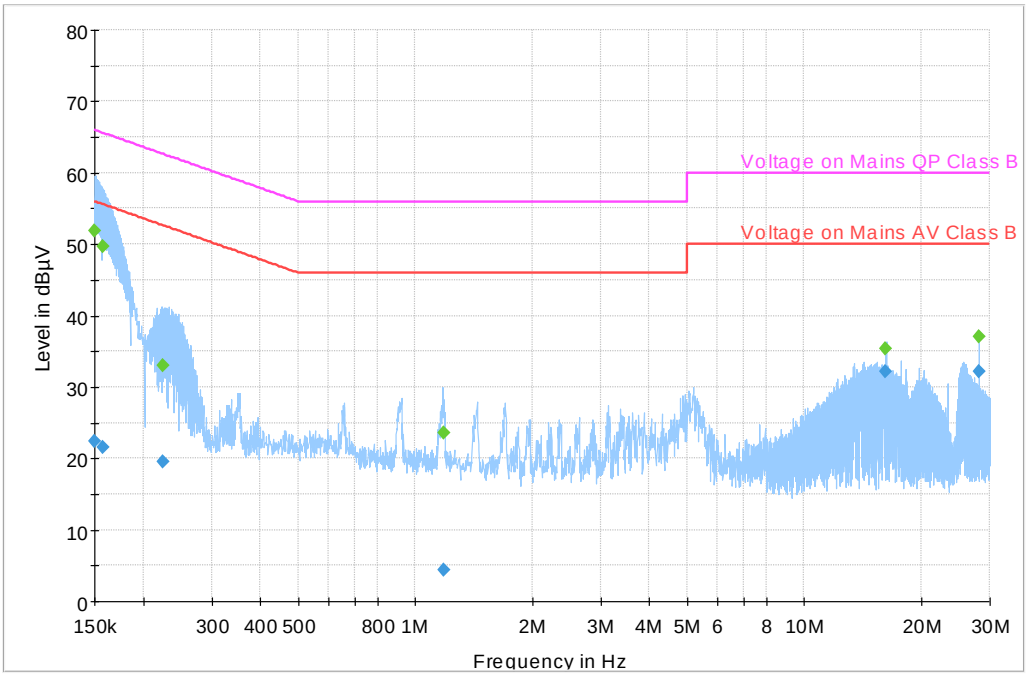
According to 47CFR 15.207

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

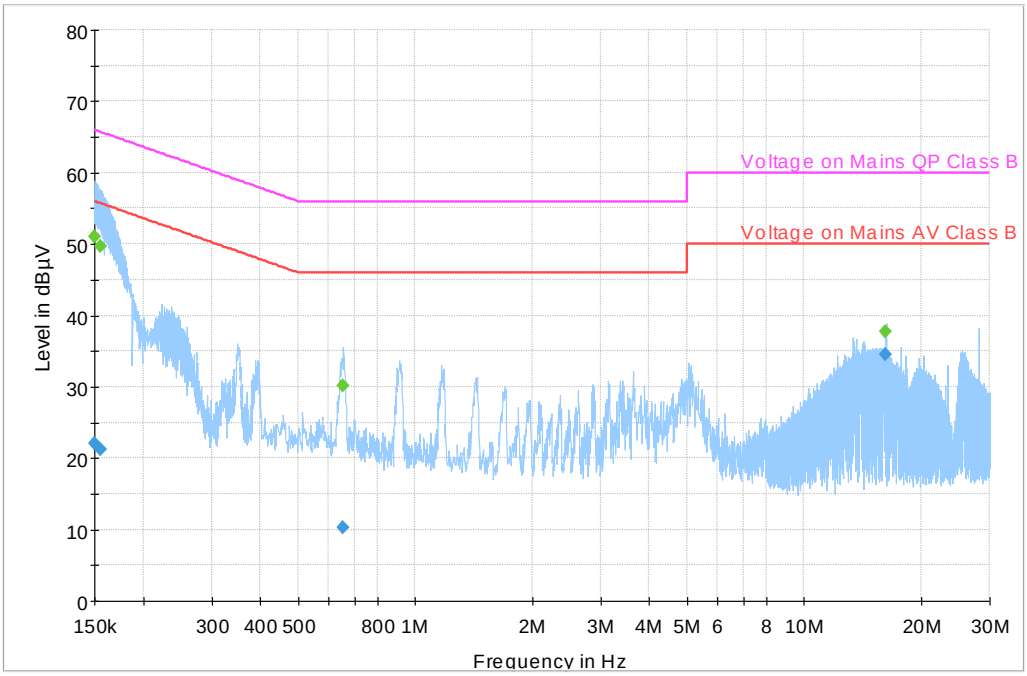
Diagram 1



Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	51.81	65.99	14.18	15000.0	9.000	9.9
0.150	22.40	---	55.99	33.59	15000.0	9.000	9.9
0.157	---	49.65	65.57	15.92	15000.0	9.000	9.9
0.157	21.53	---	55.57	34.04	15000.0	9.000	9.9
0.224	---	33.01	62.63	29.62	15000.0	9.000	9.9
0.224	19.61	---	52.63	33.02	15000.0	9.000	9.9
1.182	---	23.55	56.00	32.45	15000.0	9.000	10.0
1.182	4.30	---	46.00	41.70	15000.0	9.000	10.0
16.229	---	35.37	60.00	24.63	15000.0	9.000	10.9
16.229	32.21	---	50.00	17.79	15000.0	9.000	10.9
28.120	---	37.12	60.00	22.88	15000.0	9.000	11.6
28.120	32.11	---	50.00	17.89	15000.0	9.000	11.6

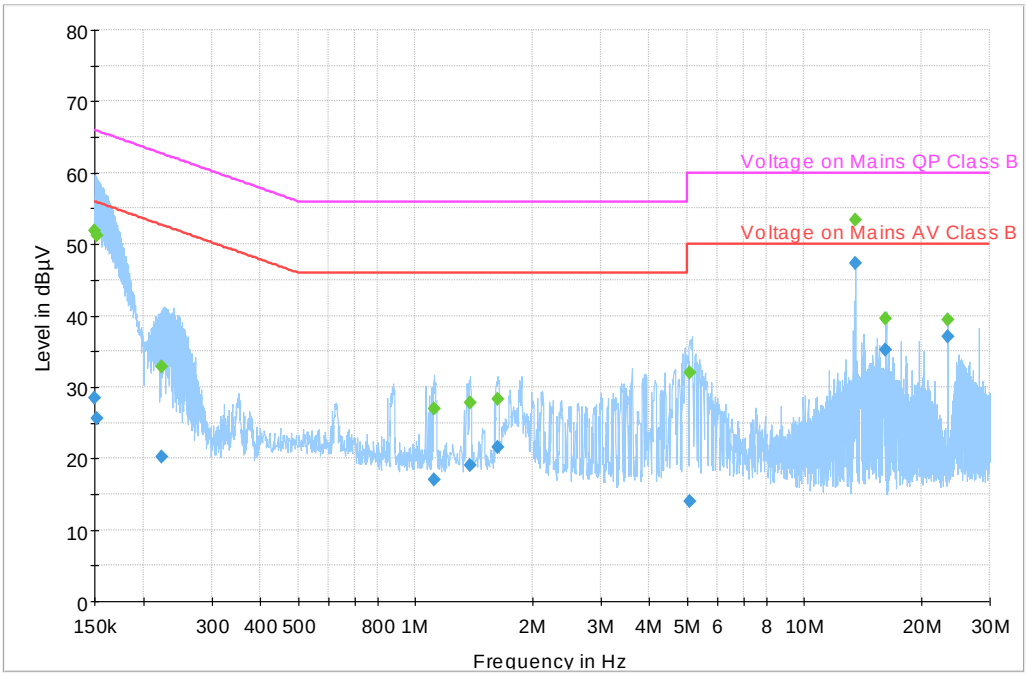
Diagram 2



Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	51.07	65.99	14.92	15000.0	9.000	9.9
0.150	21.98	---	55.99	34.01	15000.0	9.000	9.9
0.155	---	49.74	65.72	15.98	15000.0	9.000	9.9
0.155	21.20	---	55.72	34.52	15000.0	9.000	9.9
0.651	---	30.12	56.00	25.88	15000.0	9.000	9.9
0.651	10.20	---	46.00	35.80	15000.0	9.000	9.9
16.228	---	37.75	60.00	22.25	15000.0	9.000	10.9
16.228	34.61	---	50.00	15.39	15000.0	9.000	10.9

Diagram 3

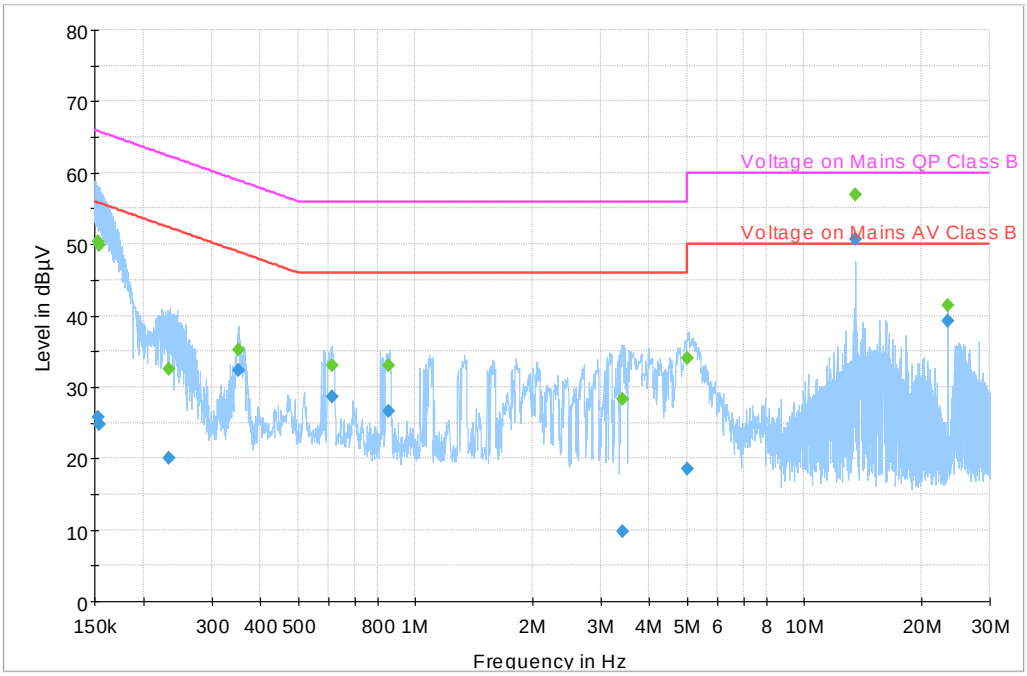


The emission at 13.56M are the Tx carrier signal and shall be disregarded according to KDB 174176 D01 Line Conducted FAQ v01r01, Q5

Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	51.82	65.98	14.16	15000.0	9.000	9.9
0.150	28.47	---	55.98	27.51	15000.0	9.000	9.9
0.152	---	51.27	65.87	14.60	15000.0	9.000	9.9
0.152	25.56	---	55.87	30.31	15000.0	9.000	9.9
0.223	---	32.85	62.67	29.82	15000.0	9.000	9.9
0.223	20.22	---	52.67	32.45	15000.0	9.000	9.9
1.119	---	26.90	56.00	29.10	15000.0	9.000	9.9
1.119	16.99	---	46.00	29.01	15000.0	9.000	9.9
1.389	---	27.81	56.00	28.19	15000.0	9.000	10.0
1.389	18.98	---	46.00	27.02	15000.0	9.000	10.0
1.627	---	28.24	56.00	27.76	15000.0	9.000	10.0
1.627	21.56	---	46.00	24.44	15000.0	9.000	10.0
5.074	---	32.00	60.00	28.00	15000.0	9.000	10.2
5.074	13.94	---	50.00	36.06	15000.0	9.000	10.2
13.558	---	53.38	60.00	6.62	15000.0	9.000	10.8
13.558	47.39	---	50.00	2.61	15000.0	9.000	10.8
16.229	---	39.62	60.00	20.38	15000.0	9.000	10.9
16.229	35.26	---	50.00	14.74	15000.0	9.000	10.9
23.433	---	39.47	60.00	20.53	15000.0	9.000	11.4
23.433	36.99	---	50.00	13.01	15000.0	9.000	11.4

Diagram 4

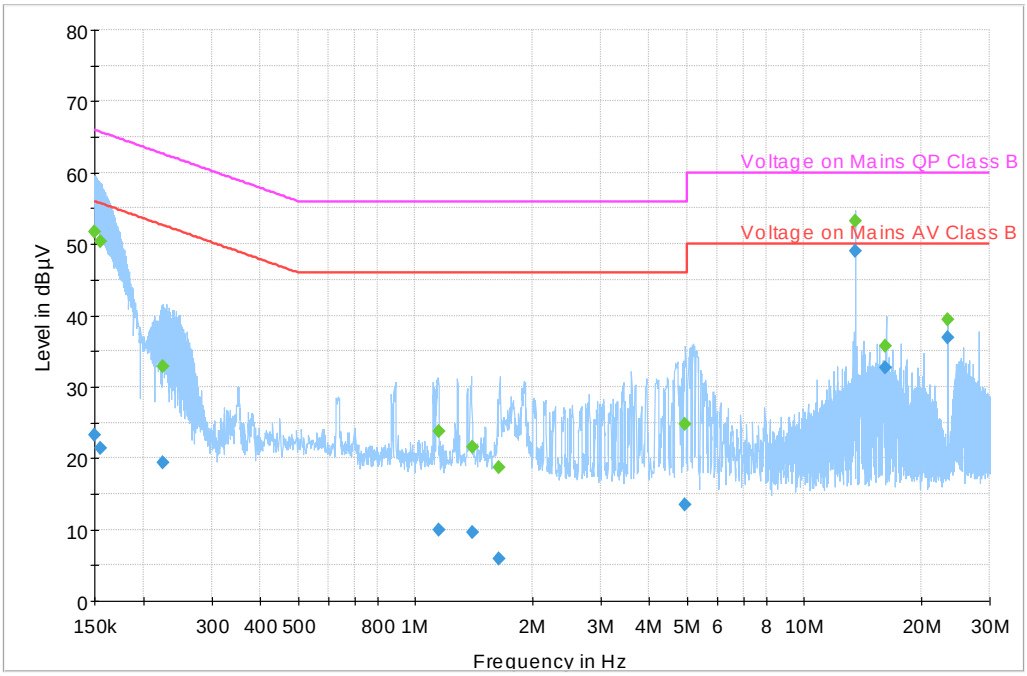


The emission at 13.56M are the Tx carrier signal and shall be disregarded according to KDB 174176 D01 Line Conducted FAQ v01r01, Q5

Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.153	---	50.34	65.83	15.49	15000.0	9.000	9.9
0.153	25.85	---	55.83	29.98	15000.0	9.000	9.9
0.154	---	49.88	65.74	15.86	15000.0	9.000	9.9
0.154	24.68	---	55.74	31.06	15000.0	9.000	9.9
0.233	---	32.58	62.33	29.75	15000.0	9.000	9.9
0.233	20.06	---	52.33	32.27	15000.0	9.000	9.9
0.350	---	35.28	58.95	23.67	15000.0	9.000	9.9
0.350	32.38	---	48.95	16.57	15000.0	9.000	9.9
0.611	---	33.06	56.00	22.94	15000.0	9.000	9.9
0.611	28.64	---	46.00	17.36	15000.0	9.000	9.9
0.854	---	33.03	56.00	22.97	15000.0	9.000	9.9
0.854	26.65	---	46.00	19.35	15000.0	9.000	9.9
3.405	---	28.36	56.00	27.64	15000.0	9.000	10.1
3.405	9.72	---	46.00	36.28	15000.0	9.000	10.1
5.022	---	33.98	60.00	26.02	15000.0	9.000	10.2
5.022	18.61	---	50.00	31.39	15000.0	9.000	10.2
13.559	---	56.88	60.00	3.12	15000.0	9.000	10.8
13.559	50.77	---	50.00	-0.77	15000.0	9.000	10.8
23.434	---	41.51	60.00	18.49	15000.0	9.000	11.4
23.434	39.23	---	50.00	10.77	15000.0	9.000	11.4

Diagram 5

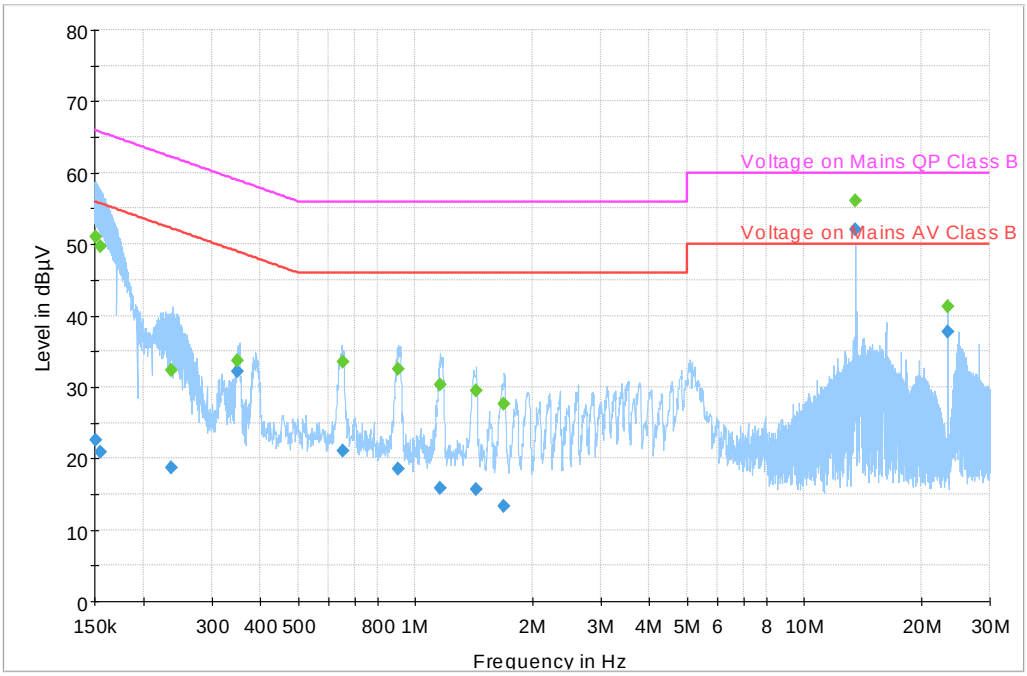


The emission at 13.56M are the Tx carrier signal and shall be disregarded according to KDB 174176 D01 Line Conducted FAQ v01r01, Q5

Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	51.78	65.98	14.20	15000.0	9.000	9.9
0.150	23.26	---	55.98	32.72	15000.0	9.000	9.9
0.155	---	50.34	65.69	15.35	15000.0	9.000	9.9
0.155	21.31	---	55.69	34.38	15000.0	9.000	9.9
0.224	---	32.90	62.65	29.75	15000.0	9.000	9.9
0.224	19.36	---	52.65	33.29	15000.0	9.000	9.9
1.150	---	23.74	56.00	32.26	15000.0	9.000	9.9
1.150	9.99	---	46.00	36.01	15000.0	9.000	9.9
1.400	---	21.59	56.00	34.41	15000.0	9.000	10.0
1.400	9.56	---	46.00	36.44	15000.0	9.000	10.0
1.647	---	18.70	56.00	37.30	15000.0	9.000	10.0
1.647	5.94	---	46.00	40.06	15000.0	9.000	10.0
4.955	---	24.69	56.00	31.31	15000.0	9.000	10.2
4.955	13.49	---	46.00	32.51	15000.0	9.000	10.2
13.559	---	53.22	60.00	6.78	15000.0	9.000	10.8
13.559	49.00	---	50.00	1.00	15000.0	9.000	10.8
16.229	---	35.65	60.00	24.35	15000.0	9.000	10.9
16.229	32.61	---	50.00	17.39	15000.0	9.000	10.9
23.431	---	39.33	60.00	20.67	15000.0	9.000	11.4
23.431	36.94	---	50.00	13.06	15000.0	9.000	11.4

Diagram 6

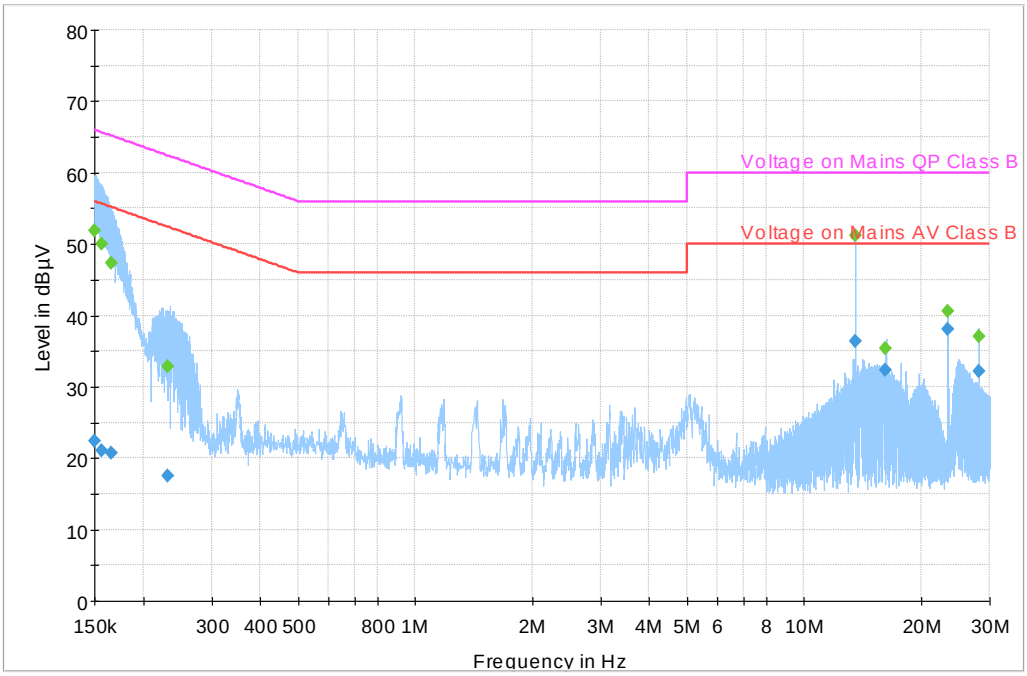


The emission at 13.56M are the Tx carrier signal and shall be disregarded according to KDB 174176 D01 Line Conducted FAQ v01r01, Q5

Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	50.96	65.97	15.01	15000.0	9.000	9.9
0.150	22.50	---	55.97	33.47	15000.0	9.000	9.9
0.155	---	49.64	65.70	16.06	15000.0	9.000	9.9
0.155	20.92	---	55.70	34.78	15000.0	9.000	9.9
0.235	---	32.41	62.24	29.83	15000.0	9.000	9.9
0.235	18.65	---	52.24	33.59	15000.0	9.000	9.9
0.350	---	33.68	58.96	25.28	15000.0	9.000	9.9
0.350	32.12	---	48.96	16.84	15000.0	9.000	9.9
0.650	---	33.46	56.00	22.54	15000.0	9.000	9.9
0.650	21.07	---	46.00	24.93	15000.0	9.000	9.9
0.905	---	32.53	56.00	23.47	15000.0	9.000	9.9
0.905	18.59	---	46.00	27.41	15000.0	9.000	9.9
1.159	---	30.29	56.00	25.71	15000.0	9.000	9.9
1.159	15.87	---	46.00	30.13	15000.0	9.000	9.9
1.436	---	29.44	56.00	26.56	15000.0	9.000	10.0
1.436	15.66	---	46.00	30.34	15000.0	9.000	10.0
1.694	---	27.59	56.00	28.41	15000.0	9.000	10.0
1.694	13.28	---	46.00	32.72	15000.0	9.000	10.0
13.559	---	56.16	60.00	3.84	15000.0	9.000	10.8
13.559	52.02	---	50.00	-2.02	15000.0	9.000	10.8
23.429	---	41.33	60.00	18.67	15000.0	9.000	11.4
23.429	37.69	---	50.00	12.31	15000.0	9.000	11.4

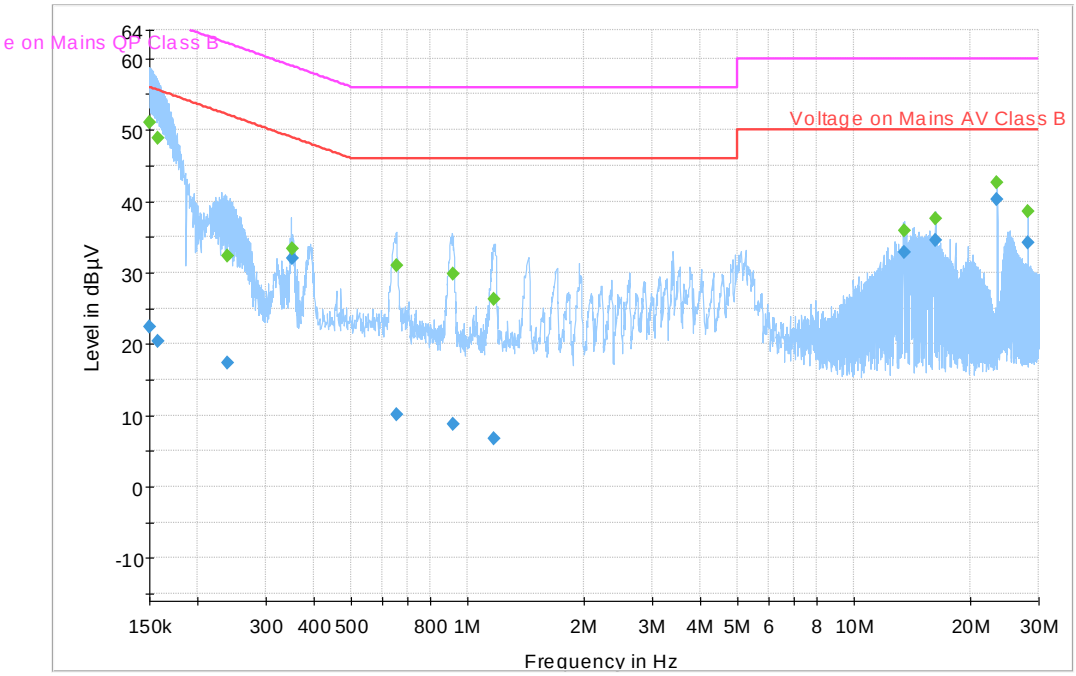
Diagram 7



Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	51.79	65.98	14.19	15000.0	9.000	9.9
0.150	22.37	---	55.98	33.61	15000.0	9.000	9.9
0.156	---	50.09	65.64	15.55	15000.0	9.000	9.9
0.156	21.08	---	55.64	34.56	15000.0	9.000	9.9
0.165	---	47.34	65.20	17.86	15000.0	9.000	9.9
0.165	20.65	---	55.20	34.55	15000.0	9.000	9.9
0.231	---	32.81	62.39	29.58	15000.0	9.000	9.9
0.231	17.56	---	52.39	34.83	15000.0	9.000	9.9
13.559	---	51.13	60.00	8.87	15000.0	9.000	10.8
13.559	36.33	---	50.00	13.67	15000.0	9.000	10.8
16.229	---	35.45	60.00	24.55	15000.0	9.000	10.9
16.229	32.42	---	50.00	17.58	15000.0	9.000	10.9
23.430	---	40.52	60.00	19.48	15000.0	9.000	11.4
23.430	38.14	---	50.00	11.86	15000.0	9.000	11.4
28.121	---	37.00	60.00	23.00	15000.0	9.000	11.6
28.121	32.10	---	50.00	17.90	15000.0	9.000	11.6

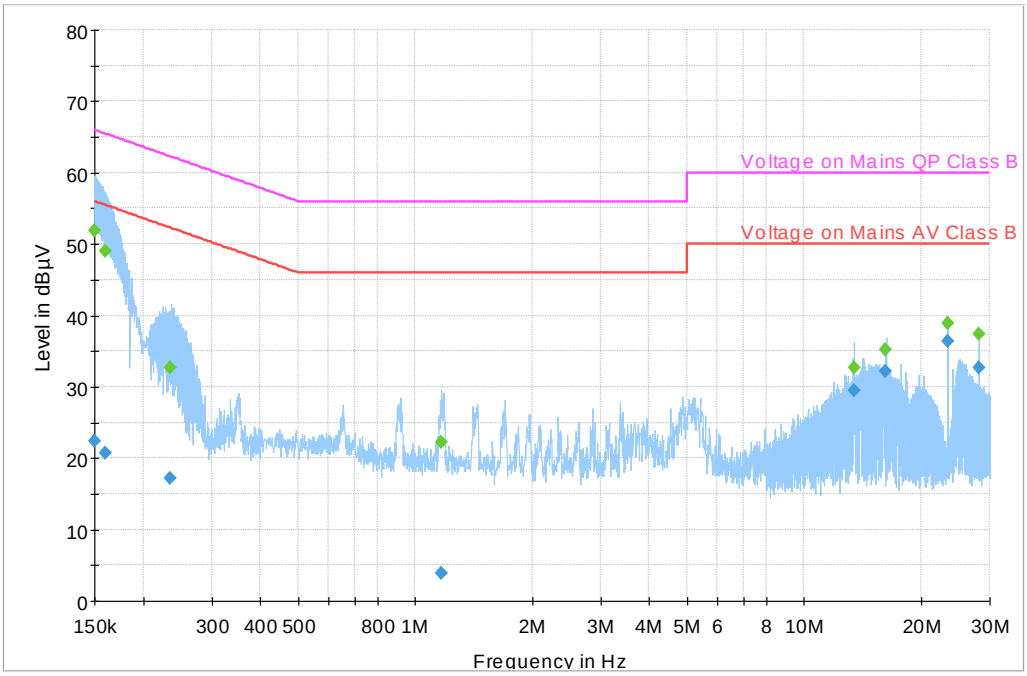
Diagram 8



Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	51.10	66.00	14.90	15000.0	9.000	9.9
0.150	22.36	---	56.00	33.64	15000.0	9.000	9.9
0.158	---	48.87	65.56	16.69	15000.0	9.000	9.9
0.158	20.40	---	55.56	35.16	15000.0	9.000	9.9
0.238	---	32.33	62.15	29.82	15000.0	9.000	9.9
0.238	17.37	---	52.15	34.78	15000.0	9.000	9.9
0.351	---	33.43	58.93	25.50	15000.0	9.000	9.9
0.351	32.01	---	48.93	16.92	15000.0	9.000	9.9
0.656	---	30.91	56.00	25.09	15000.0	9.000	9.9
0.656	10.16	---	46.00	35.84	15000.0	9.000	9.9
0.918	---	29.84	56.00	26.16	15000.0	9.000	9.9
0.918	8.84	---	46.00	37.16	15000.0	9.000	9.9
1.171	---	26.21	56.00	29.79	15000.0	9.000	10.0
1.171	6.77	---	46.00	39.23	15000.0	9.000	10.0
13.479	---	35.82	60.00	24.18	15000.0	9.000	10.8
13.479	32.76	---	50.00	17.24	15000.0	9.000	10.8
16.229	---	37.63	60.00	22.37	15000.0	9.000	10.9
16.229	34.60	---	50.00	15.40	15000.0	9.000	10.9
23.430	---	42.69	60.00	17.31	15000.0	9.000	11.4
23.430	40.17	---	50.00	9.83	15000.0	9.000	11.4
28.120	---	38.65	60.00	21.35	15000.0	9.000	11.6
28.120	34.18	---	50.00	15.82	15000.0	9.000	11.6

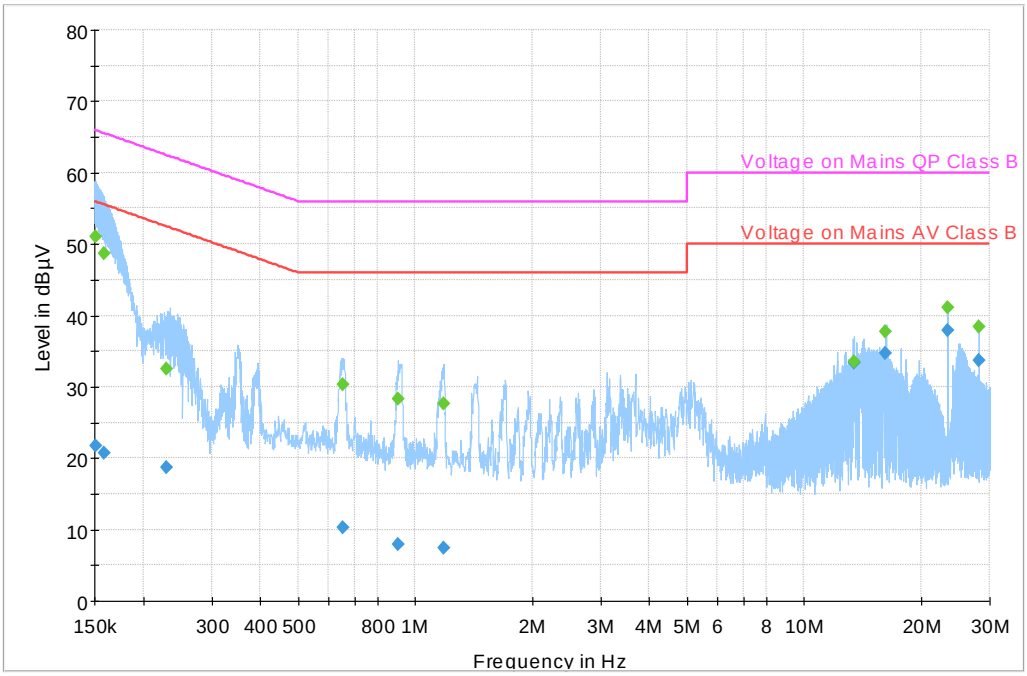
Diagram 9



Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	51.86	66.00	14.14	15000.0	9.000	9.9
0.150	22.45	---	56.00	33.55	15000.0	9.000	9.9
0.160	---	49.05	65.46	16.41	15000.0	9.000	9.9
0.160	20.80	---	55.46	34.66	15000.0	9.000	9.9
0.234	---	32.61	62.30	29.69	15000.0	9.000	9.9
0.234	17.14	---	52.30	35.16	15000.0	9.000	9.9
1.168	---	22.21	56.00	33.79	15000.0	9.000	10.0
1.168	3.81	---	46.00	42.19	15000.0	9.000	10.0
13.480	---	32.59	60.00	27.41	15000.0	9.000	10.8
13.480	29.49	---	50.00	20.51	15000.0	9.000	10.8
16.229	---	35.28	60.00	24.72	15000.0	9.000	10.9
16.229	32.23	---	50.00	17.77	15000.0	9.000	10.9
23.430	---	38.97	60.00	21.03	15000.0	9.000	11.4
23.430	36.30	---	50.00	13.70	15000.0	9.000	11.4
28.120	---	37.41	60.00	22.59	15000.0	9.000	11.6
28.120	32.75	---	50.00	17.25	15000.0	9.000	11.6

Diagram 10



Final measurement

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)
0.150	---	50.95	65.97	15.02	15000.0	9.000	9.9
0.150	21.68	---	55.97	34.29	15000.0	9.000	9.9
0.158	---	48.73	65.54	16.81	15000.0	9.000	9.9
0.158	20.77	---	55.54	34.77	15000.0	9.000	9.9
0.229	---	32.46	62.46	30.00	15000.0	9.000	9.9
0.229	18.70	---	52.46	33.76	15000.0	9.000	9.9
0.651	---	30.24	56.00	25.76	15000.0	9.000	9.9
0.651	10.26	---	46.00	35.74	15000.0	9.000	9.9
0.907	---	28.34	56.00	27.66	15000.0	9.000	9.9
0.907	7.87	---	46.00	38.13	15000.0	9.000	9.9
1.185	---	27.62	56.00	28.38	15000.0	9.000	10.0
1.185	7.36	---	46.00	38.64	15000.0	9.000	10.0
13.464	---	33.58	60.00	26.42	15000.0	9.000	10.8
13.464	33.27	---	50.00	16.73	15000.0	9.000	10.8
16.229	---	37.74	60.00	22.26	15000.0	9.000	10.9
16.229	34.71	---	50.00	15.29	15000.0	9.000	10.9
23.428	---	41.08	60.00	18.92	15000.0	9.000	11.4
23.428	37.84	---	50.00	12.16	15000.0	9.000	11.4
28.120	---	38.38	60.00	21.62	15000.0	9.000	11.6
28.120	33.63	---	50.00	16.37	15000.0	9.000	11.6

Occupied bandwidth measurements according to 47CFR 2.1049

Date	Temperature	Humidity
2016-10-18	23 °C ± 3 °C	36 % ± 5 %
2016-10-19	23 °C ± 3 °C	37 % ± 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 RMS detector.

Radiated measurements were performed in a semi anechoic chamber. The measurements were performed with the antenna and the turntable at the position with the highest level of the fundamental, according to Appendix 2. The antenna distance was 3.0 m.
The EUT height above the reference ground plane was 0.8 m.

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

Measurement equipment	SP number
Semi anechoic chamber, Tesla	503 881
EMI Test Receiver R&S ESU 40	901 553
Emco 6502, Active loop antenna	502 916
Multimeter Fluke 83	501 522
Temperature and humidity meter Testo 625	504 188

Results

The OBW measurements in the semi anechoic chamber at 3m can be found in the diagrams below:

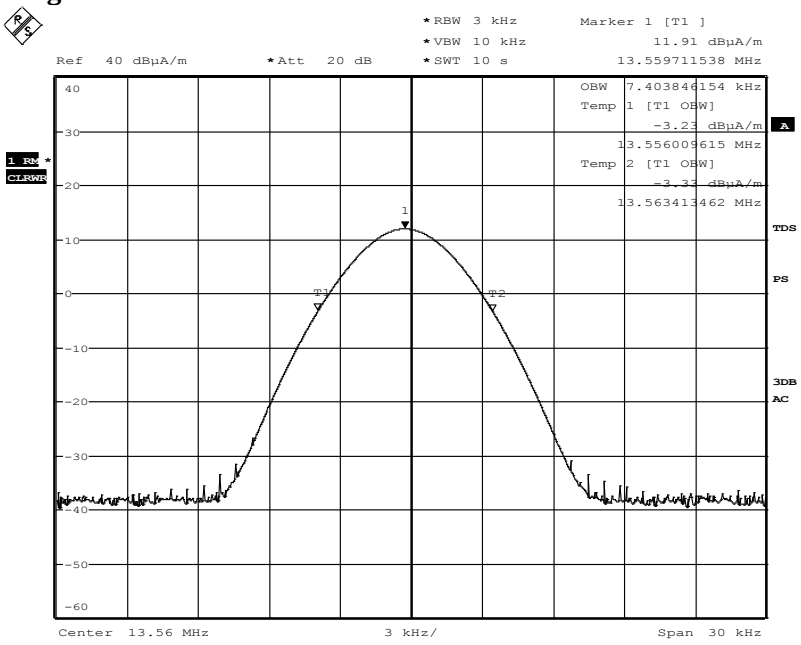
Diagram 1:	13.56 MHz	OBW = **7.40 kHz** (99%)	EUT 2
Diagram 2:	13.56 MHz	OBW = **7.40 kHz** (99%)	EUT 4

Note: The EUT do not use any modulation, just an unmodulated carrier wave, thus the OBW value is direct dependent of the RBW setting. With different RBW also the OBW value will be different.
The measurement was performed with a RBW setting of 3 kHz.

Complies?	Yes

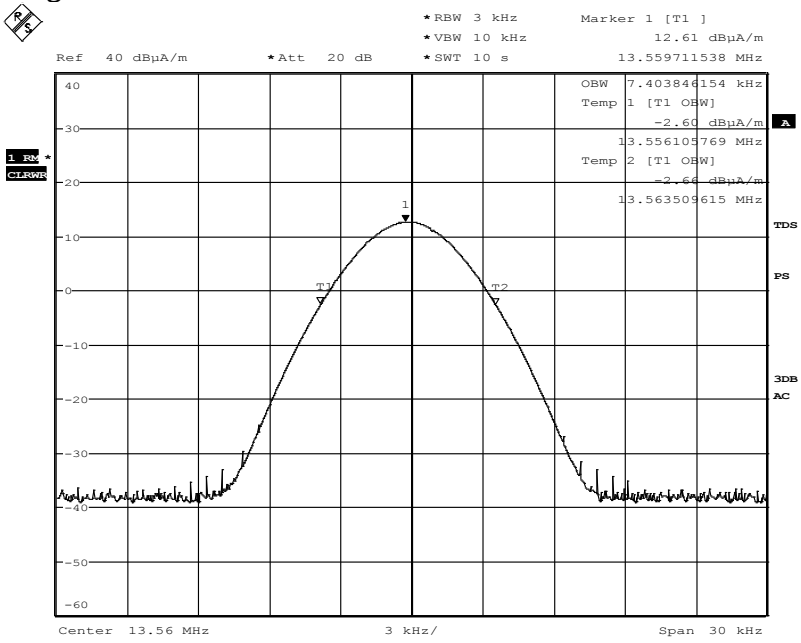
Appendix 6

Diagram 1



Date: 19.OCT.2016 13:01:30

Diagram 2



Date: 19.OCT.2016 13:10:12

Band edge measurements according to 47CFR 2.1049

Date	Temperature	Humidity
2016-10-18	23 °C ± 3 °C	36 % ± 5 %
2016-10-19	23 °C ± 3 °C	37 % ± 5 %

Test set-up and procedure

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

Radiated measurements were performed in a semi anechoic chamber. The measurements were performed with the antenna and the turntable at the position with the highest level of the fundamental, according to Appendix 2. The antenna distance was 3.0 m.
The EUT height above the reference ground plane was 0.8 m.

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

Measurement equipment	SP number
Semi anechoic chamber, Tesla	503 881
EMI Test Receiver R&S ESU 40	901 553
Emco 6502, Active loop antenna	502 916
Multimeter Fluke 83	501 522
Temperature and humidity meter Testo 625	504 188

Results

Operation band within the band 13.110-14.010 MHz.
The pre-measurement diagrams with peak detector can be found in the diagrams below:

Diagram 1	13.56 MHz	Band edge at 13.110 MHz and 14.010 MHz, EUT 2
Diagram 2	13.56 MHz	Band edge restricted bands at 13.36 MHz and 13.41 MHz, EUT 2
Diagram 3	13.56 MHz	Band edge at 13.110 MHz and 14.010 MHz, EUT 4
Diagram 4	13.56 MHz	Band edge restricted bands at 13.36 MHz and 13.41 MHz, EUT 4

Final measurements with QP detector at restricted bands 13.36 and 13.41 MHz.
Levels measured at 3 m and converted to 30 m:

EUT 2

EUT setting	Frequency (MHz)	QP level (dBµA/m)	QP Limit (dBµA/m)	Antenna pos
13.56 MHz	13.36	-76.7	29.5	A
13.56 MHz	13.41	-74.5	29.5	A

EUT 4

EUT setting	Frequency (MHz)	QP level (dBµA/m)	QP Limit (dBµA/m)	Antenna pos
13.56 MHz	13.36	-76.5	29.5	A
13.56 MHz	13.41	-74.4	29.5	A

Limits

According to 47CFR 15.225, Operation within the band 13.110-14.010 MHz:

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

According to 47CFR 15.209, radiated emission limits; general requirements.

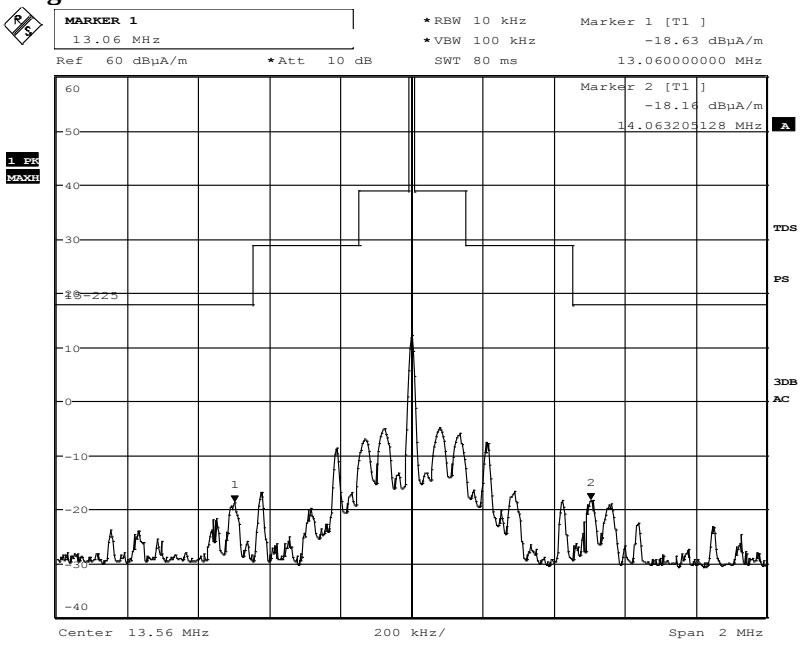
(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurements distance (meters)
0.009-0.490	2400/F(kHz) (128.5-93.8 dBuV/m@3m)	300
0.490-1.705	24000/F(kHz) (73.8-62.9 dBuV/m@3m)	30
1.705-30.0	30 (69.5 dBuV/m@3m)	30
30-88	100 (40 dBuV/m@3m)	3
88-216	150 (43.5 dBuV/m@3m)	3
216-960	200 (46 dBuV/m@3m)	3
Above 960	500 (54 dBuV/m@3m)	3

The limits for 13.56 MHz are given for 30 m measurement distances. The limits below are converted to 3 m by using the extrapolation factor 40 dB/decade (§15.31). Below 30 MHz the field strength is converted to magnetic field units, dBµA/m, by subtracting with 51.5 dB (20xLog(377)) since it is measured with a magnetic loop antenna.

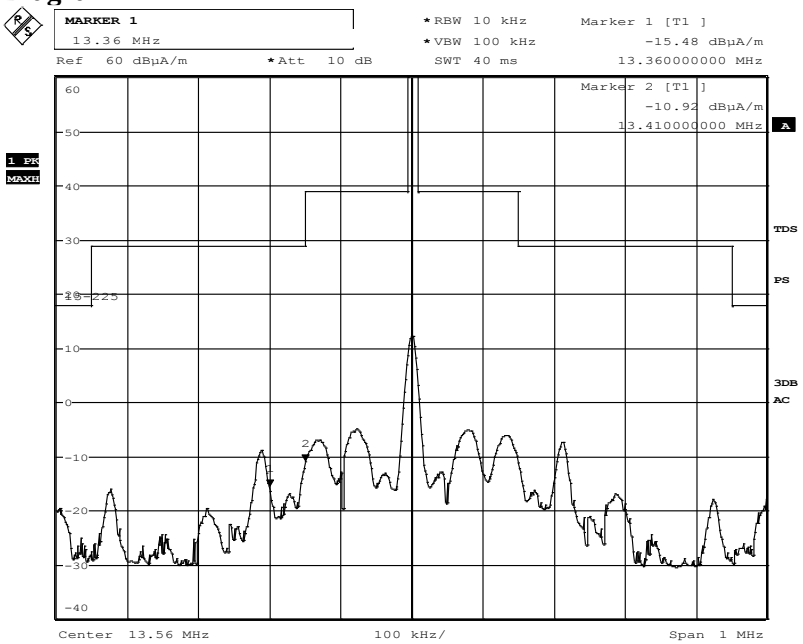
Complies?	Yes

Diagram 1



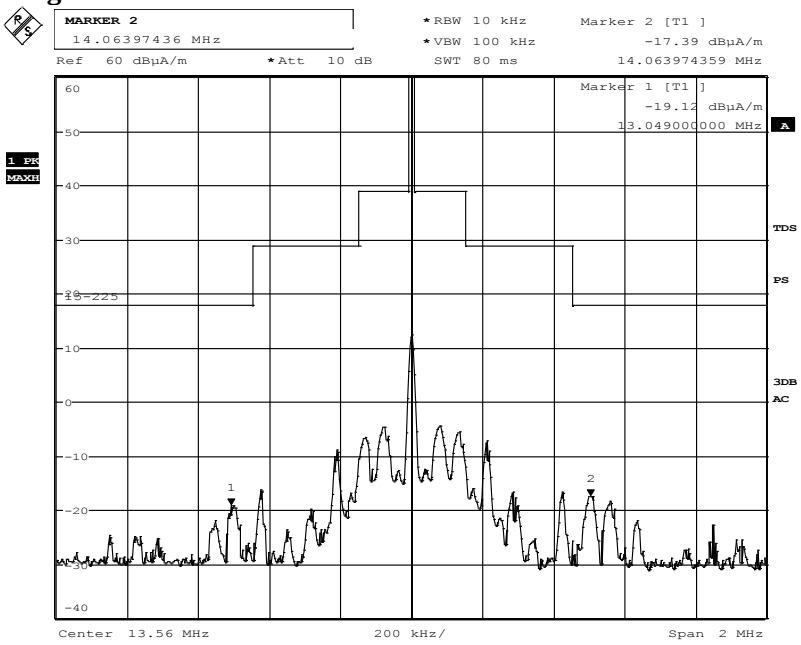
Date: 19.OCT.2016 09:23:38

Diagram 2



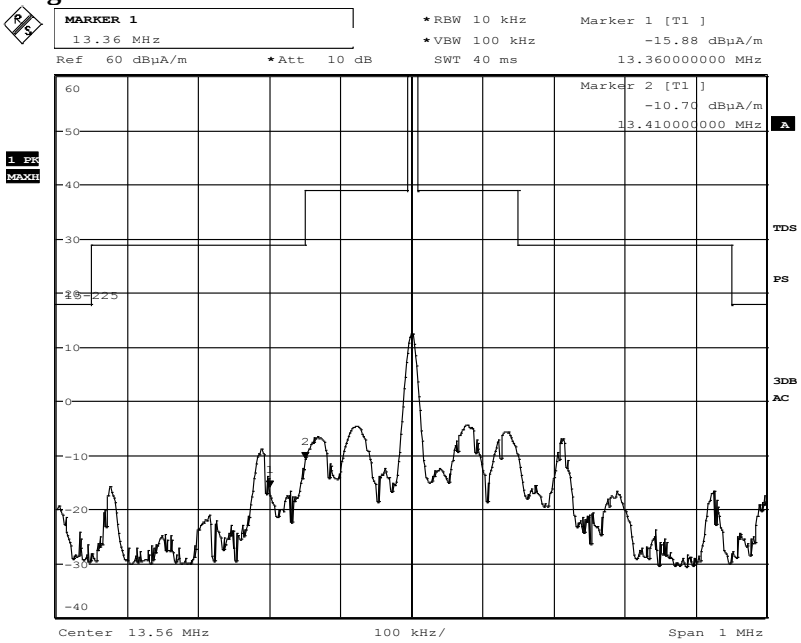
Date: 19.OCT.2016 09:31:10

Diagram 3



Date: 18.OCT.2016 15:05:48

Diagram 4



Date: 18.OCT.2016 15:12:27

RF exposure evaluation: 2.1093 Portable devices / KDB 447498

Date	Temperature	Humidity
2015-12-15	3 °C ± 3 °C (EUT)	68 % ± 5 % (EUT)

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 2.1093 this device has been defined as a portable device to be used within 20 centimetres of the body of the user.
According to KDB 447498.

Results

Standalone SAR exclusion:
Calculations according to KDB 447598 D01 v06, clause 4.3.1:
c) For frequencies below 100 MHz, the following may be considered for SAR test exclusion (also illustrated in Appendix C):
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 .

EUT 2:

Frequency f, (GHz)	Maximum output power Pout with Peak det, (µW)	Distance r, (mm)	Power threshold, for test separation distances ≤ 50 mm (mW)
0.01356	**0.028** Note 1	5	443

Note 1: The maximum measured Peak level was 0.022 µW (-46.6 dBm). According to RSS-102 cl. 2.5.1 the RMS value shall be adjusted for tune-up tolerance. According to the client the tune-up tolerance was ± 1 dB, thus -45.6 dBm (0.028 µW) was used as Maximum output power Pout in the table above.

The maximum radiated peak output power from Appendix 3 was used for calculation.

EUT 2:

Peak output power, Peak det (dBµA/m)	Peak output power, Peak det (dBµV/m)	EIRP Peak output power, Peak det (µW)
-22.9 Note 2	28.6	0.022

Note 2: The measurements were performed in field strength in dBµA/m The field strength is converted to electric field units, dBµV/m, by adding with 51.5 dB (20xLOG(377)) since it is measured in dBµA/m with a magnetic loop antenna.
The EIRP level was then calculated by the formula $P = (Exd)^2/30xG$, with E=field strength, d=antenna dist, G as unity gain of 1.

Limits

FCC 2.1093 / KDB 447498 (ver 6) 4.3.1:

4.3.1 Standalone SAR exclusion:

1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] x [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

• f(GHz) is the RF channel transmit frequency in GHz
• Power and distance are rounded to the nearest mW and mm before calculation
• The result is rounded to one decimal place for comparison

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 is applied to determine SAR test exclusion.

2) At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B.
a) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm) x (f(MHz)/150)] mW, at 100 MHz to 1500 MHz
b) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm) x 10] mW at > 1500 MHz and ≤ 6 GHz

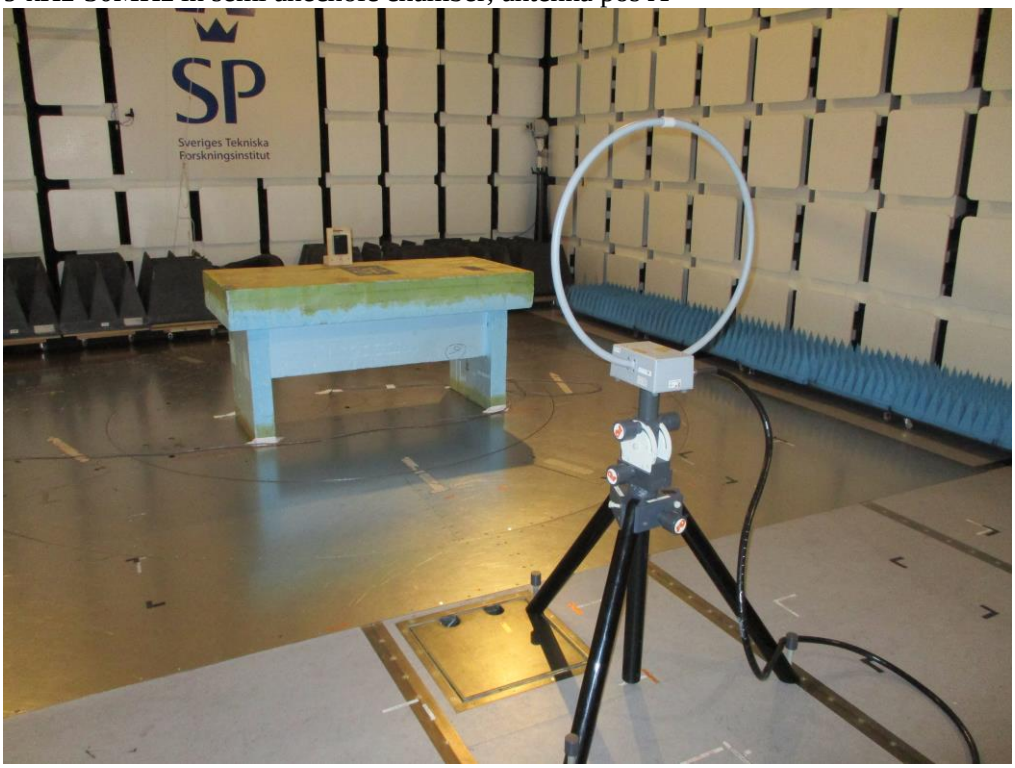
3) At frequencies below 100 MHz, the following may be considered for SAR test exclusion, and as illustrated in Appendix C:
a) The power threshold at the corresponding test separation distance at 100 MHz in step 2) is multiplied by [1 + log(100/$f_{(MHz)}$)] for *test separation distances* > 50 mm and < 200 mm
b) The power threshold determined by the equation in a) for 50 mm and 100 MHz is multiplied by ½ for *test separation distances* ≤ 50 mm
c) SAR measurement procedures are not established below 100 MHz. When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any test results to be acceptable.

Complies?	Yes

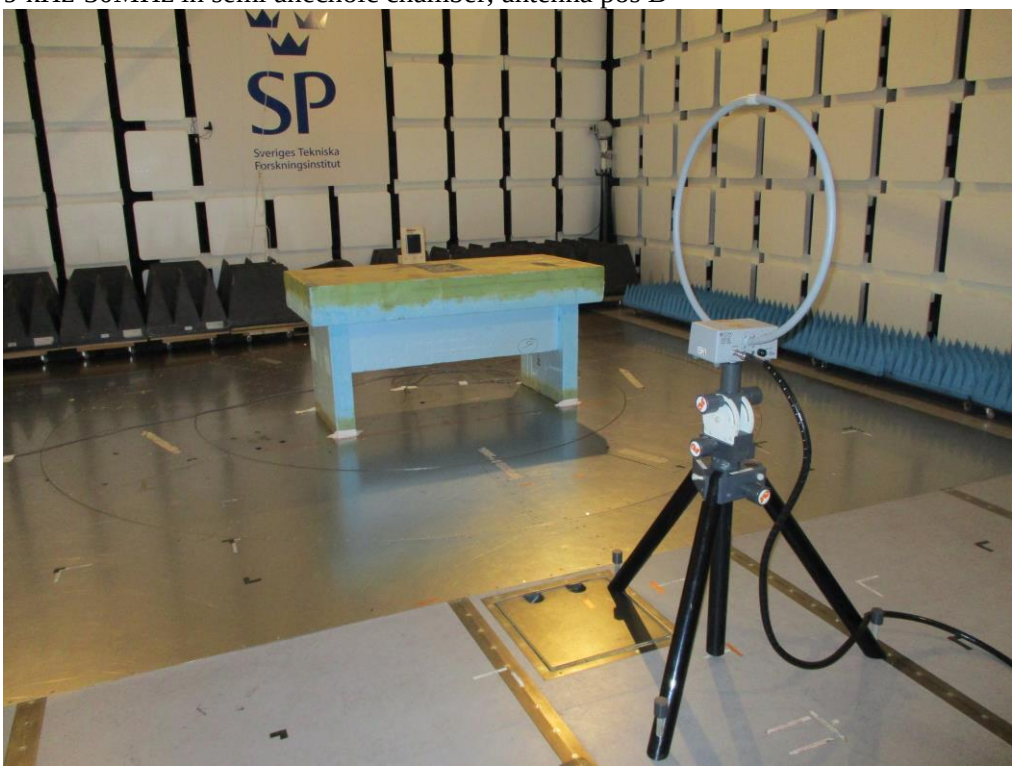
Photos

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

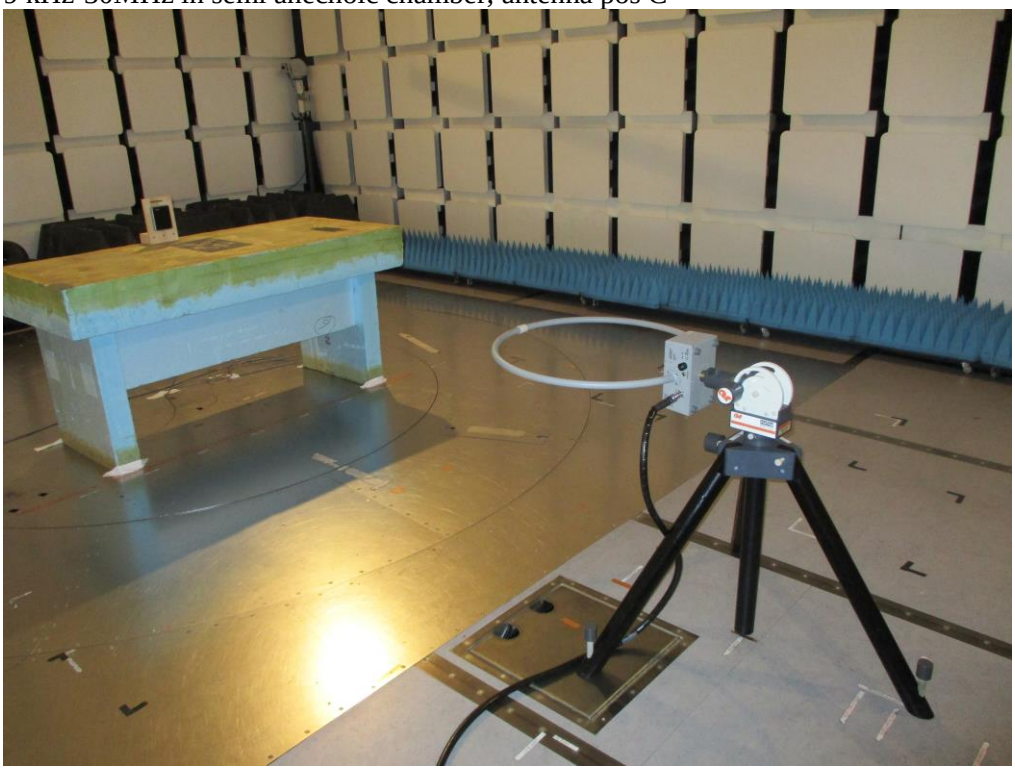
9 kHz-30MHz in semi anechoic chamber, antenna pos A



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



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

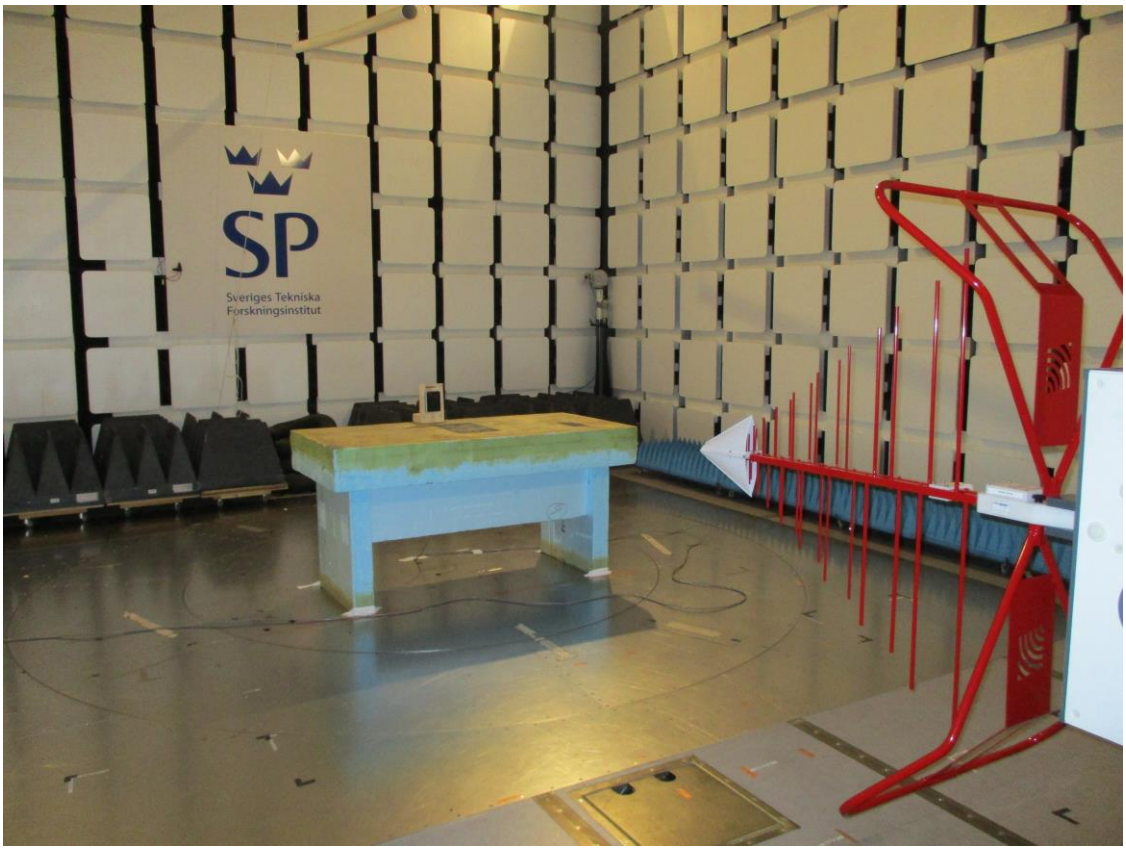


150 kHz-30 MHz at asphalt surface, antenna pos A

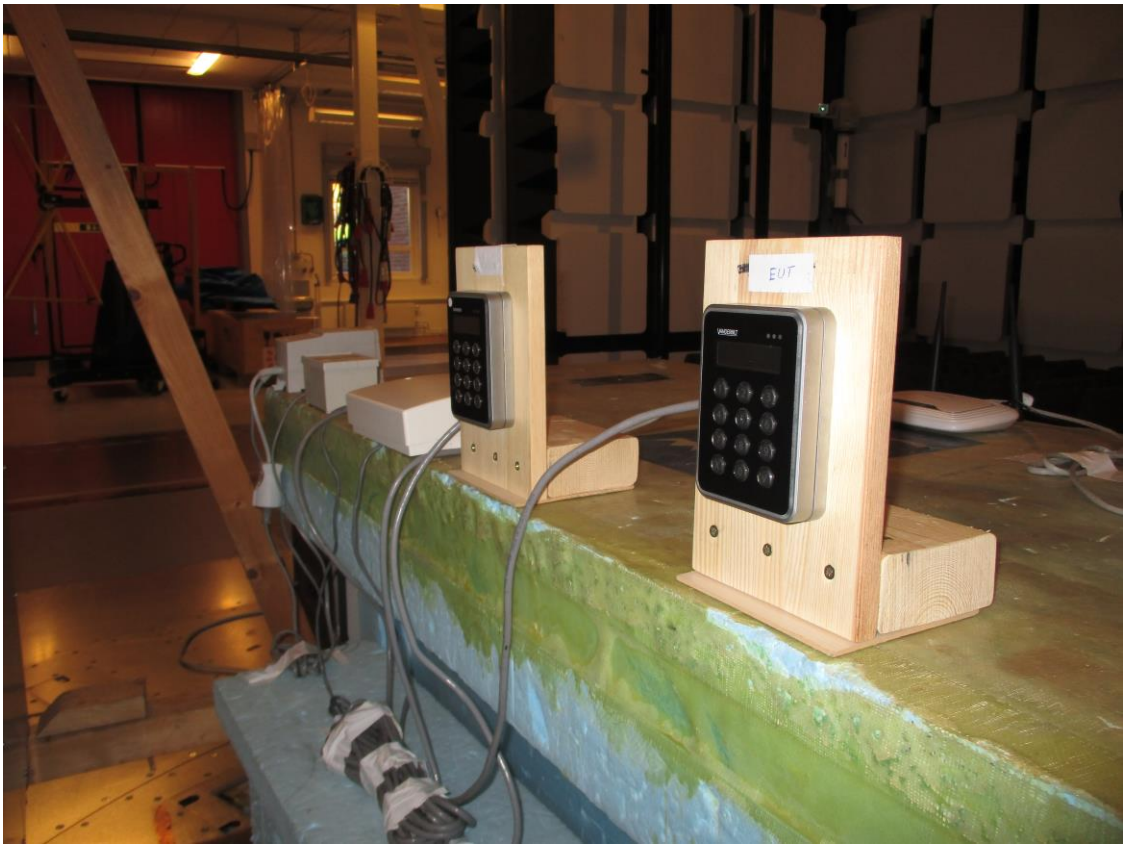
150 kHz-30 MHz at asphalt surface, antenna pos B

150 kHz-30 MHz at asphalt surface, antenna pos C

30-1000 MHz



Conducted emission AC

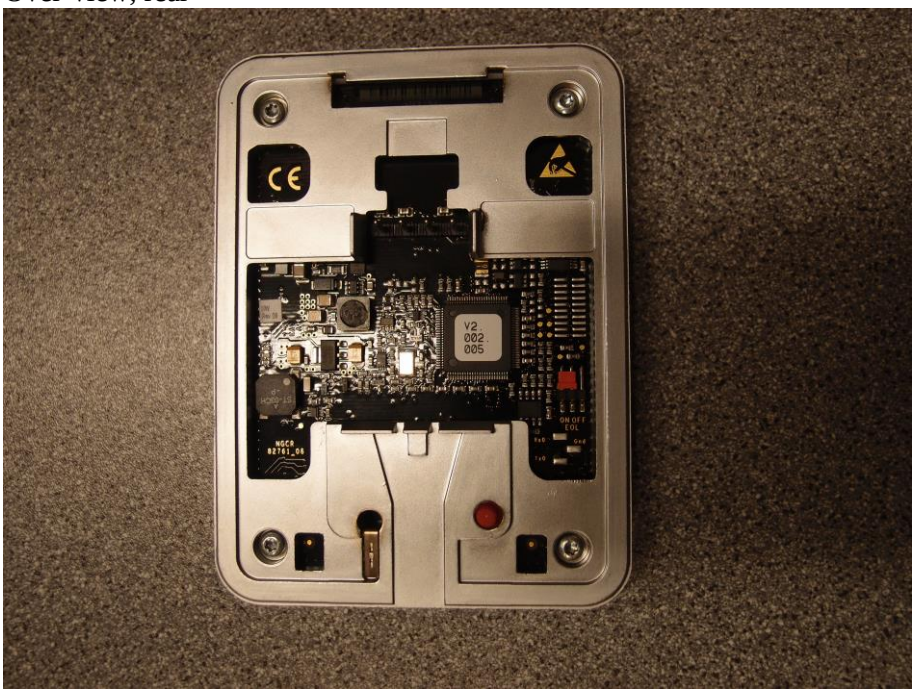


Frequency error in climate chamber

EUT 1:

Over view, front

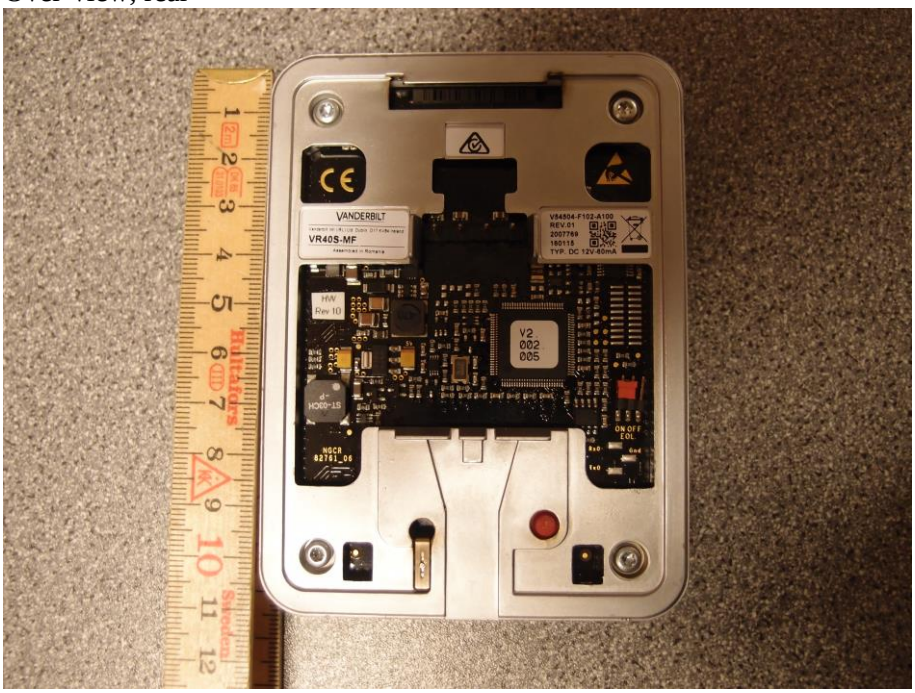
Over-view, rear



EUT 2:

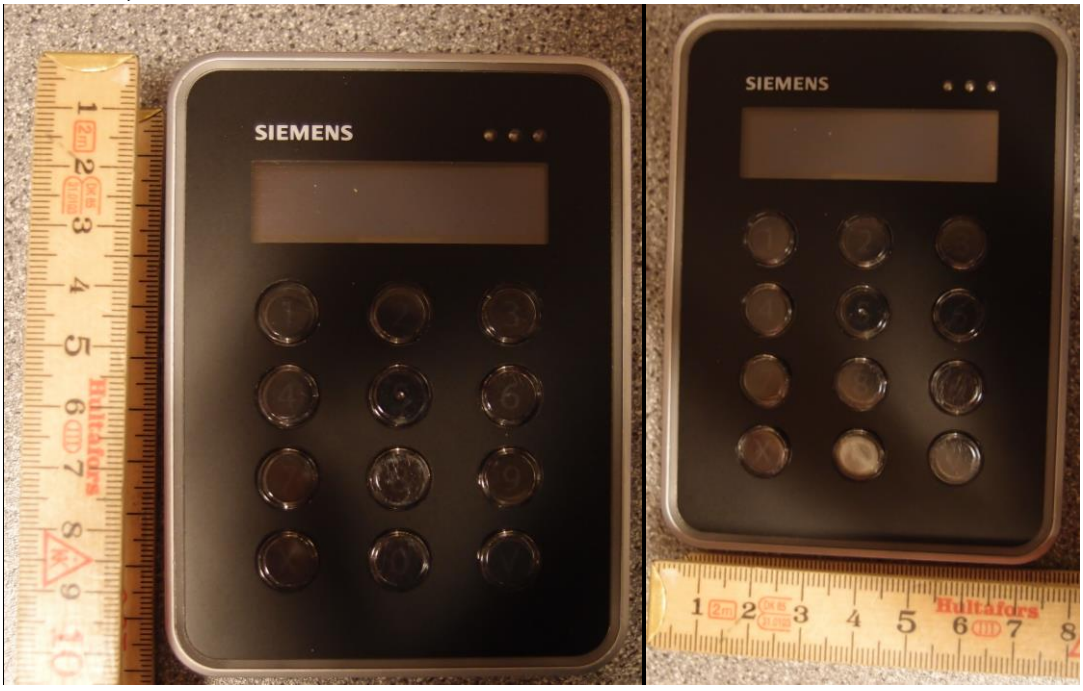
Over view, front

Over-view, rear

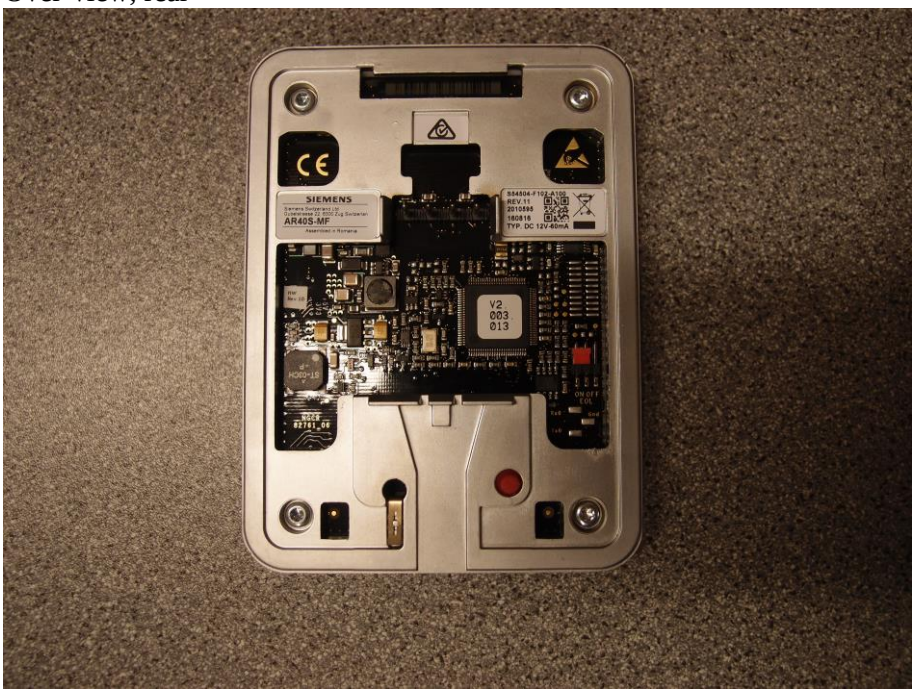


EUT 3:

Over view, front



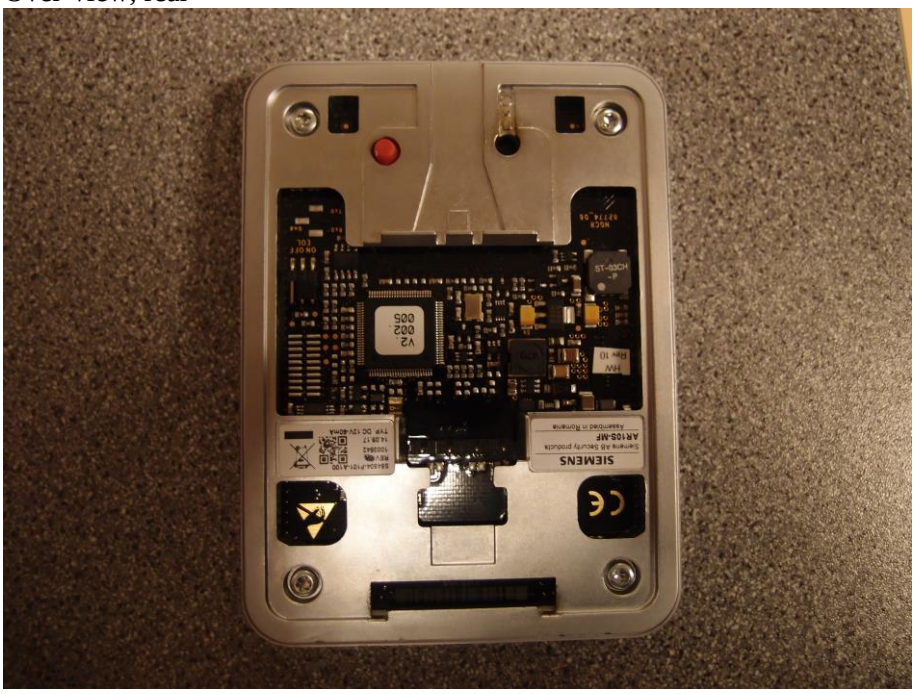
Over-view, rear



EUT 4:

Over view, front

Over-view, rear



EUT 5:

Over view, front

Over-view, rear