

Test Report

47 CFR FCC Part 15 subpart C Par. 15.225 Intentional Radiators

Report reference no. : 28112204-008

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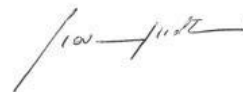
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Applicant's name : AEB INDUSTRIALE Srl

Address : VIA G.Brodolini, 8 Loc. Crespellano – 40053 – VALSAMOGGIA (BO)

Test item description : NFC module for active speaker

Trade Mark : **dB**Technologies

Manufacturer : AEB INDUSTRIALE Srl

Model/Type reference : NFC-VIO, Nfc MASTER1

Ratings : 3,3Vdc 100mA powered by external module

FCC ID : 2ADDV-NFCVIO

Sample :

Samples received on : 09/10/2018

TUV reference samples : 180658 (sampled by the applicant)

Samples tested n. : 1

Testing :

Start Date : 06/11/2018

End Date : 03/01/2019

*The results in this Test Report are exclusively referred to the tested samples.
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RELEASE CONTROL RECORD		
Test report Number	Reason of change	Date of Issue
28112204-003	Original release	04/02/2019
28112204-008	Added conducted emission measurement. This version cancel and replaces full test report nr. 28112204-003 issue date 04/02/2019 and its previous versions	19/07/2019

1. Reference Standards	
Standard	Description
FCC Part 15 (Subpart C)	§15.225 Operation within the band 13.110 – 14.010 MHz.
FCC Part 15 (Subpart C)	§15.207 Conducted Limits
FCC Part 15 (Subpart C)	§15.209 Radiated emission limits; general requirements
FCC Part 15 (Subpart C)	§15.203 Antenna Requirement
ANSI C63.4:2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2013	American National Standard for Testing Unlicensed Wireless Devices

2. Summary of testing

§ 15.203	Antenna Requirements	PASS
§ 15.207 (a)	Power Line Conducted Emission	PASS
§ 15.215 (a) (b) (c)	Additional provisions to the general radiated emission limitations	PASS
§ 15.215 (c)	20 dB Bandwidth	PASS
§ 15.225 (a)	Field strength in band 13,553-13,567MHz	PASS
§ 15.225 (b)	Field strength in band 13,410-13,553 MHz and 13,567-13,710 MHz	PASS
§ 15.225 (c)	Field strength in band 13,110-13,410 MHz and 13,710-14,010 MHz	PASS
§ 15.225 (d) § 15.209 (a) (f)	Field strength outside of the 13,110-14,010 MHz band	PASS
§ 15.225 (e)	Frequency tolerance of the carrier signal	PASS
§ 15.225 (f)	Radio frequency powered tags	N.A. ¹
§ 47CFR 1.1307(b)(1)	RF humane exposure	PASS

N.A. ¹	No powered tag.
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Possible test case verdicts:

- test case does not apply to the test object: N/A
- test object does meet the requirement: PASS
- test object does not meet the requirement: FAIL

General remarks:

The test results presented in this report relate only to the object tested.

The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.

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"(see Enclosure #)" refers to additional information appended to the report.

"(see appended table)" refers to a table appended to the report.

Throughout this report a comma is used as the decimal separator.

3. General product information

NFC tag for active speaker

4. General Chipset information

PST523 (pcb) with the 2 loops antenna path.

5. General Antennas information

PCB antenna

6. Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	NFC tag for active speaker	AEB INDUSTRIALE	NFC-VIO, Nfc MASTER1	
AE	Pre-amplifier board	AEB INDUSTRIALE	Prototype	Used for data exchange with dedicated software
AE	PC laptop	Lenovo	T430	Used for data exchange with pre-amplifier board

Note:

* Use :

EUT - Equipment Under Test,
AE - Auxiliary/Associated Equipment, or
SIM - Simulator (Not Subjected to Test)

No other Auxiliary/Associated Equipment was connected/installed on the EUT

7. Input/Output Ports

CONNECTIONS

Port	Description	Connection	Cable lenght
1	Enclosure	Port not present (printed board)	---
2	AC Power Port	Port not present	---
3	DC Power Port	3,3Vdc powered by internal board	Internal connector
4	Signal port	Data connection to internal board	Internal connector
5	Antenna	Integrated	---

*Note: AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
WN = Wired Network

8. Power Interface

Mode #	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
Rated	3,3	0,1	---	DC	---	Powered by external board

9. EUT Operation Modes

Operation mode	Description
#1	Continuous Modulated RF Transmission at 13,56MHz at max power.

10. EUT Configuration Modes

Description		
Par.	test	EUT Operation Modes
§ 15.203	Antenna Requirements	#1
§ 15.207 (a)	Power Line Conducted Emission	NA
§ 15.215 (a) (b) (c)	Additional provisions to the general radiated emission limitations	#1
§ 15.215 (c)	20 dB Bandwidth	#1
§ 15.225 (a)	Field strength in band 13,553-13,567MHz	#1
§ 15.225 (b)	Field strength in band 13,410-13,553 MHz and 13,567-13,710 MHz	#1
§ 15.225 (c)	Field strength in band 13,110-13,410 MHz and 13,710-14,010 MHz	#1
§ 15.225 (d) § 15.209 (a) (f)	Field strength outside of the 13,110-14,010 MHz band	#1
§ 15.225 (e)	Frequency tolerance of the carrier signal	#1
§ 47CFR 1.1307(b)(1)	RF humane exposure	#1

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{RAW} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V/m} - 20}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

$$25 \text{ dBuV/m} + 17.5 \text{ dB} - 20 \text{ dB} + 1.0 \text{ dB} = 23.5 \text{ dBuV/m}$$

11. Test Conditions and Results

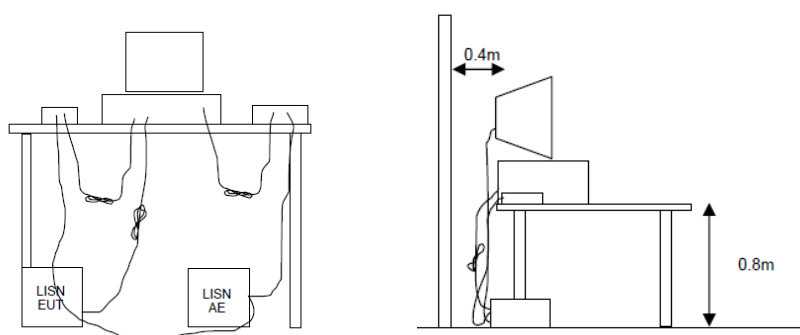
11.1 TEST: Antenna requirements		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	21°C
	Relative Humidity (%)	56%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	12 Vdc	Enclosure
Equipment mode:	Operation mode	#1
FCC Standard	§15.203	
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.		
Antenna specifications		
N° of authorized antenna types	1	
Antenna type	PCB antenna designed according AN1445.	
Maximum total gain	/	
External power amplifiers	Not present	

11.2 TEST: AC Power Conducted Emission			PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C	
	Relative Humidity (%)	30 to 60 %	
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	21°C	
	Relative Humidity (%)	56%	
	Air pressure (hPa)	1020	
—	Power Supply / Frequency	Application Point	
Fully configured sample tested at the power line frequency	115V ~ 60Hz (via AC/DC adapter)	AC Mains	
Equipment mode:	Operation mode	#1	
FCC Standard	§15.207		
Frequency (MHz)	Quasi-peak (dBuV)	Average (dBuV)	Result
0.15-0.5	66 to 56	56 to 46	PASS
0.5-5	56	46	PASS
5-30	60	50	PASS

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

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

Further information to test setup



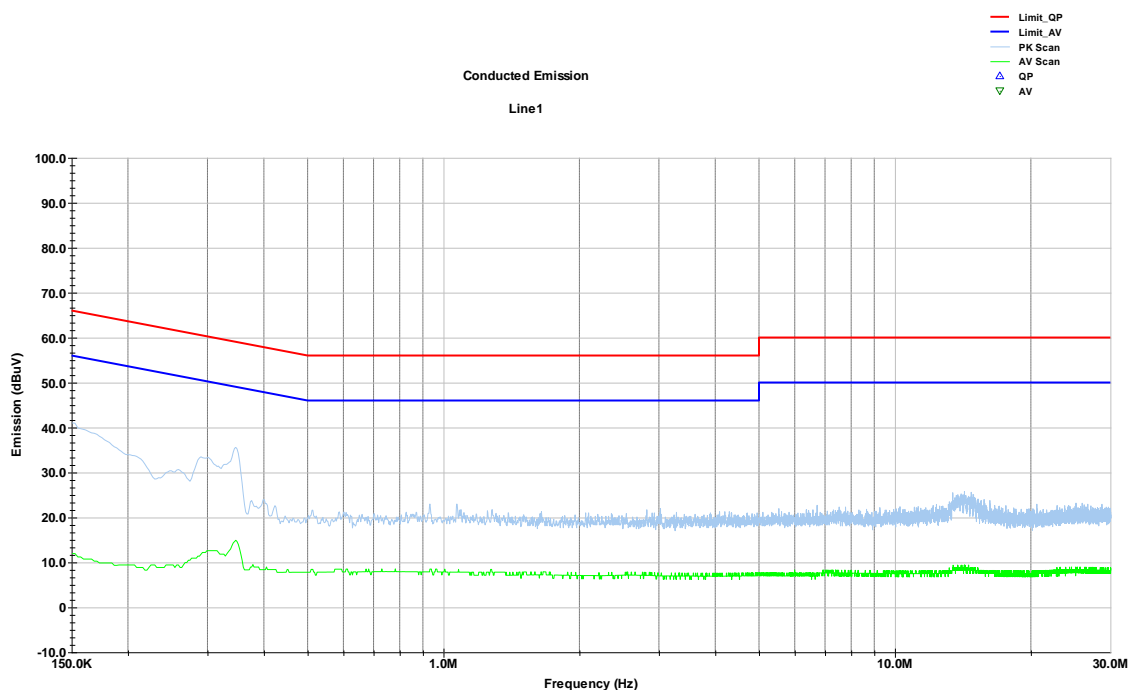
Test Equipment Used					
Description	Manufacturer	Model	TUV Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESR	87020864	12/2018	12/2019
Two line V-Network	R&S	ENV216	87020993	01/2018	01/2020
Stabilized Power Supply	Elettrotest	TPS T 30K60S	87020490	09/2018	09/2020

Test Results

AC mains

Operating mode #1, 110Vac, 60Hz*

Phase



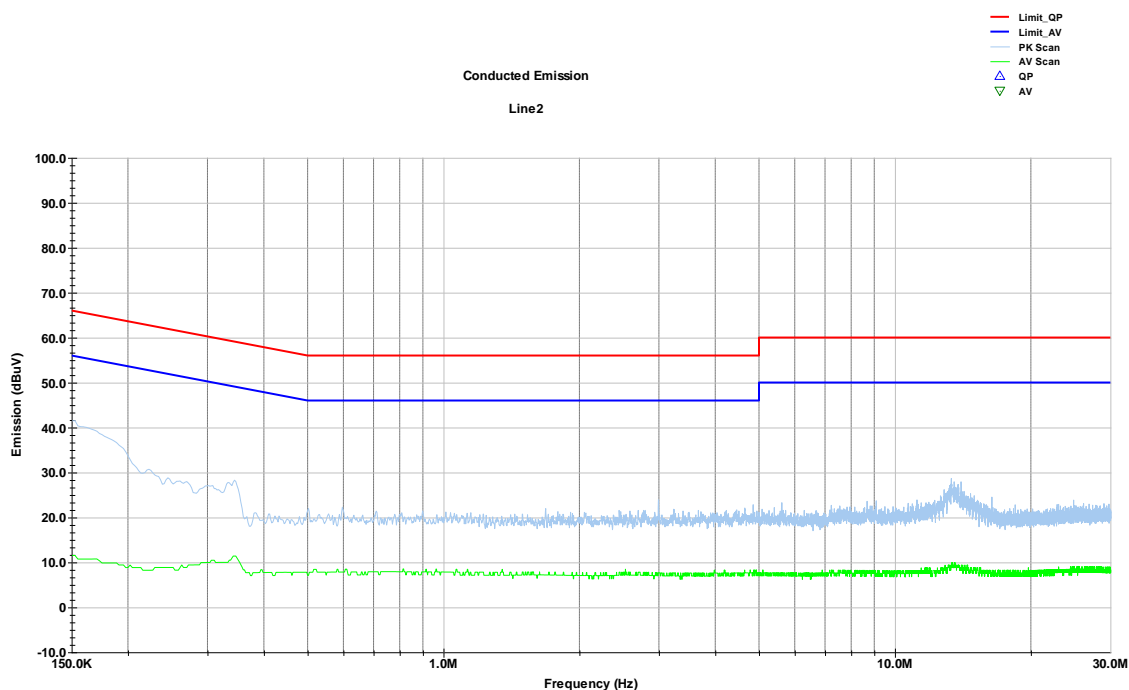
*Test has been executed on AC/DC adapter of auxiliary equipment LENOVO T430 laptop PC.

Test Results

AC mains

Operating mode #1, 110Vac, 60Hz

Neutral



*Test has been executed on AC/DC adapter of auxiliary equipment LENOVO T430 laptop PC.

11.3 TEST: Radiated Emission

PASS

Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22°C
	Relative Humidity (%)	54%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	12 Vdc	Enclosure
Equipment mode:	Operation mode	#1
FCC Standard	§15.205; §15.209; §15.225	

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 :

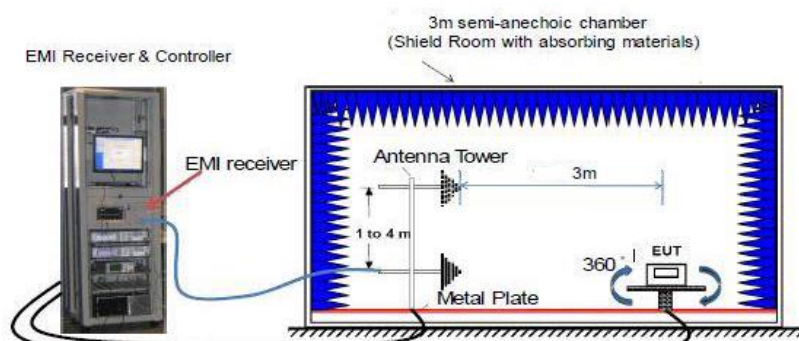
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**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.

Remark: In accordance with part 15.31 (f) (2), where the measurement distance was specified to be 30 or 300 meters, a correction factor was applied in order to permit measurement to be performed at a separation distance. The applied formula for limits at 3 meter is: $\text{Extrapolation (dB)} = 40 \log (300 \text{ meter} / 3 \text{ meter}) = +80 \text{ db}$ $\text{Extrapolation (dB)} = 40 \log (30 \text{ meter} / 3 \text{ meter}) = +40 \text{ db}$

Further information to test setup.

For frequencies above 1GHz, the anechoic material is also placed on the metallic floor between EUT and Antenna



Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	87020484	10/2018	10/2020
EMI Test Receiver	R&S	ESW44	87020967	06/2018	06/2019
Loop Antenna	EMCO	6512	87020465	02/2017	02/2020
Antenna BiConiLog	ETS Lindgren	3124E-PA	87020457	04/2017	04/2020

Graphical representation of Radiated Emission Measurement

Operation Mode: #1

Frequency: 9kHz – 30MHz



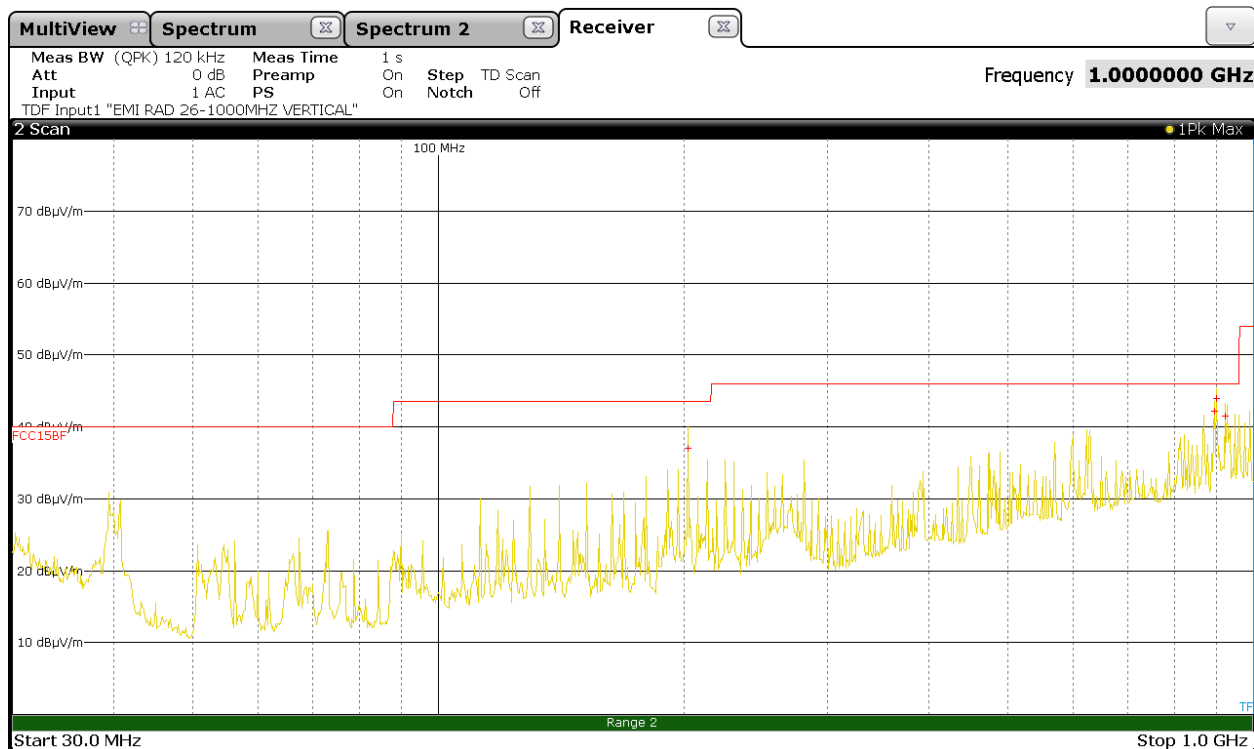
level measured at 3m distance.

Graphical representation of Radiated Emission Measurement

Operation Mode: (#1)

Frequency: 30MHz – 1GHz

Antenna Polarization: Vertical



QUASI-PEAK RESULT (RBW=120kHz)

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dB)	(dBμV/m)
202,50	24,67	10,68	1,72	Not present	37,07
895,02	14,96	23,66	3,61	Not present	42,23
900,00	16,68	23,66	3,61	Not present	43,95
922,14	12,98	24,92	3,61	Not present	41,51

Graphical representation of Radiated Emission Measurement

Operation Mode: (#1)

Frequency: 30MHz – 1GHz

Antenna Polarization: Horizontal



QUASI-PEAK RESULT (RBW=120kHz)

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dB)	(dBμV/m)
253,11	18,69	12,74	1,88	Not present	33,31
600,00	15,51	21,36	2,94	Not present	39,81
623,79	15,86	22,40	3,06	Not present	41,32
630,00	14,83	22,59	3,06	Not present	40,48
697,50	15,65	23,22	3,17	Not present	42,04
720,00	12,98	23,02	3,30	Not present	39,30

11.4 TEST: Field strength in band 13,110-14,010 MHz

PASS

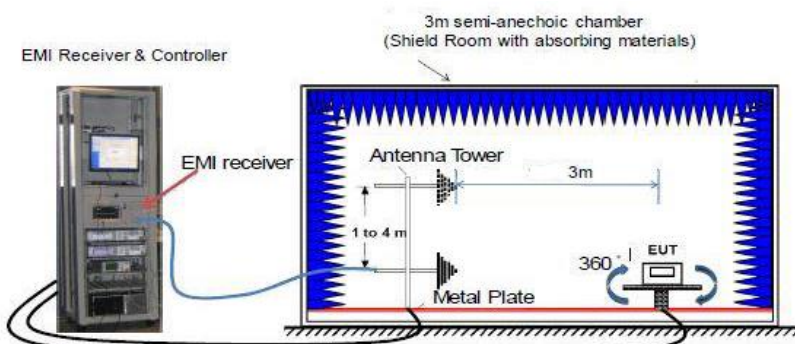
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22°C
	Relative Humidity (%)	54%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	5 Vdc	Enclosure
Equipment mode:	Operation mode	#1
FCC Standard	§15.225 (A); §15.225 (B); §15.225 (C)	

- (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.

Remark: In accordance with ANSI C63.10 (2013) If both the single point and the limit distance are equal to or closer to the EUT than $\lambda/2\pi$, then extrapolation to the limit distance shall be calculated using Equation:

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

Further information to test setup.

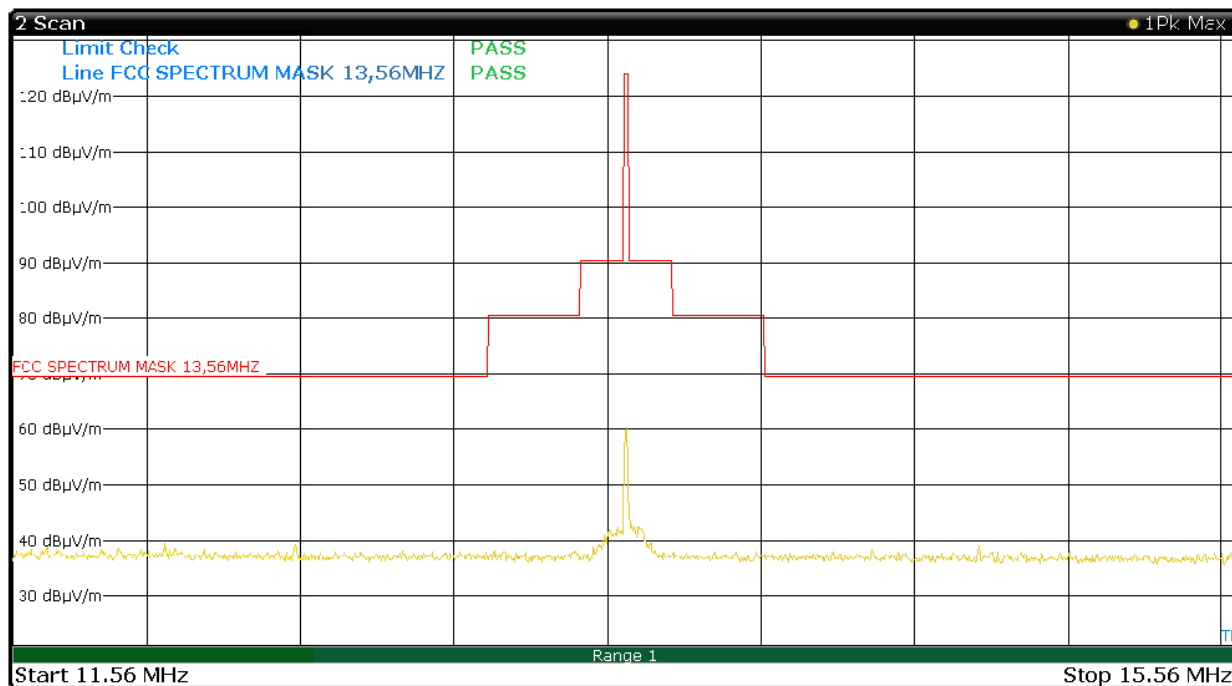


Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	87020484	10/2018	10/2020
EMI Test Receiver	R&S	ESW44	87020967	06/2018	06/2019
Loop Antenna	EMCO	6512	87020465	02/2017	02/2020

Graphical representation of Radiated Emission Measurement

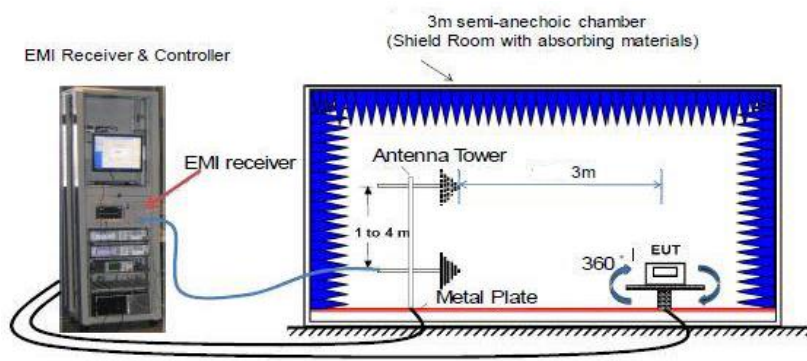
Operation Mode: #1

Frequency: 13,110-14,010 MHz



Field strength emission level

Frequency	13,560MHz	Max level measured	60dBμV/m*
*level measured at 3m distance.			

11.5 TEST: 20dB Bandwidth		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	24°C
	Relative Humidity (%)	48%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	5 Vdc	Enclosure
Equipment mode:	Operation mode	#1
FCC Standard	§ 15.215 (C)	
<p>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.</p>		
Further information to test setup.		

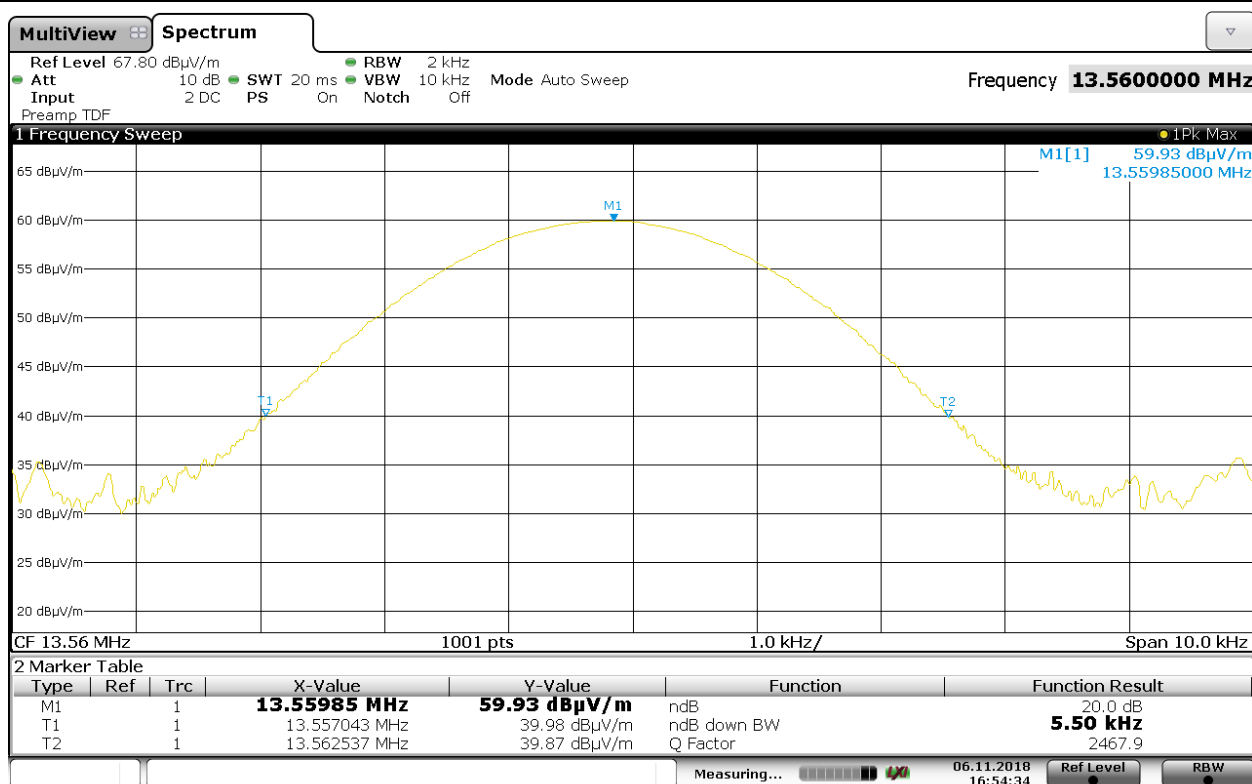
Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESW44	87020967	06/2018	06/2019

Graphical representation of 20dB Bandwidth

Operation Mode: #1

Plot n°1



16:54:34 06.11.2018

Channel (No.)	Frequency (MHz)	Channel Bandwidth at -20dB (kHz)	Plot (No.)
1	13,56	5,50	1

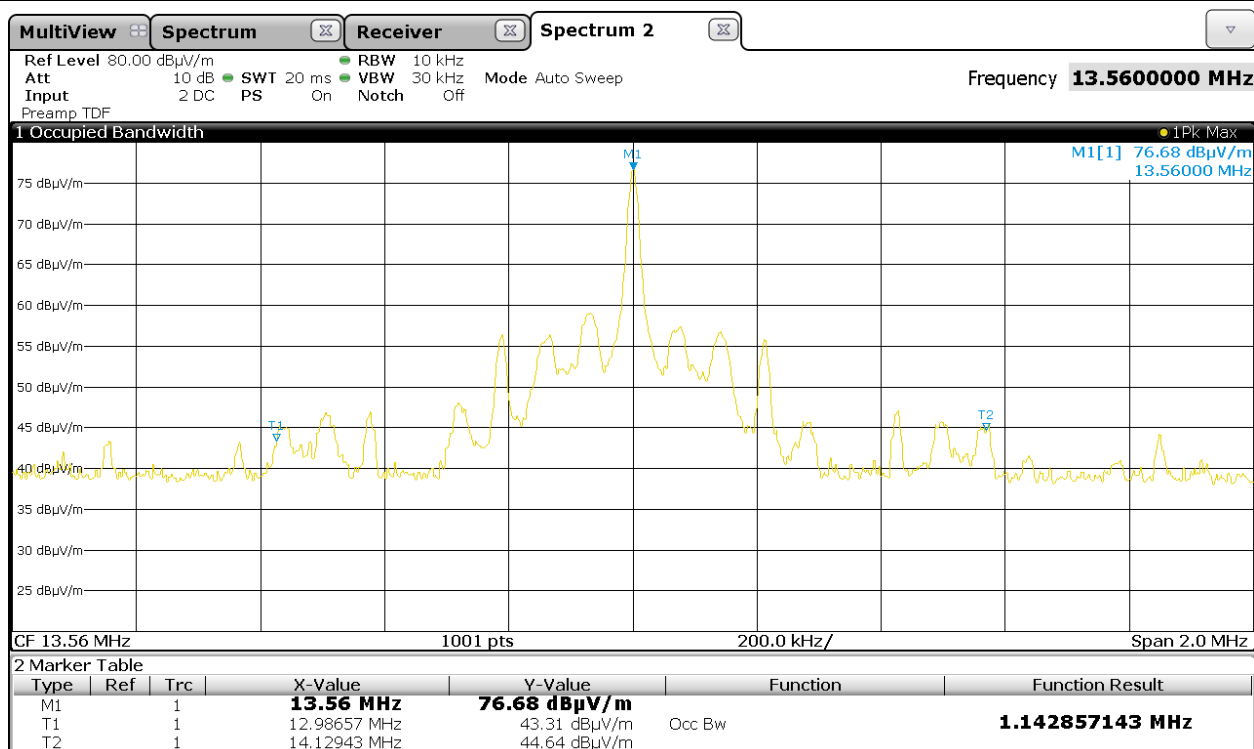
Bandwidth at -20dB (Fmin and Fmax)

Fmin	Fmax
13.556	13.557

Graphical representation of 99% Bandwidth

Operation Mode: #1

Plot n°2



Channel (No.)	Frequency (MHz)	Channel Bandwidth at 99% (kHz)	Plot (No.)
1	13,56	1142,85	2

Bandwidth at 99% (Fmin and Fmax)			
Fmin	12,98657 MHz	Fmax	14,12943 MHz

11.6 TEST: Frequency tolerance of the carrier signal		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22,5°C
	Relative Humidity (%)	51%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	12Vdc	Enclosure
Equipment mode:	Operation mode	#1
FCC Standard	§ 15.225 (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.		

Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
Climatic chamber	WEISS	SB22/300/40	87020044	10/2018	10/2019
EMI Test Receiver	R&S	ESU40	87020455	05/2018	05/2019

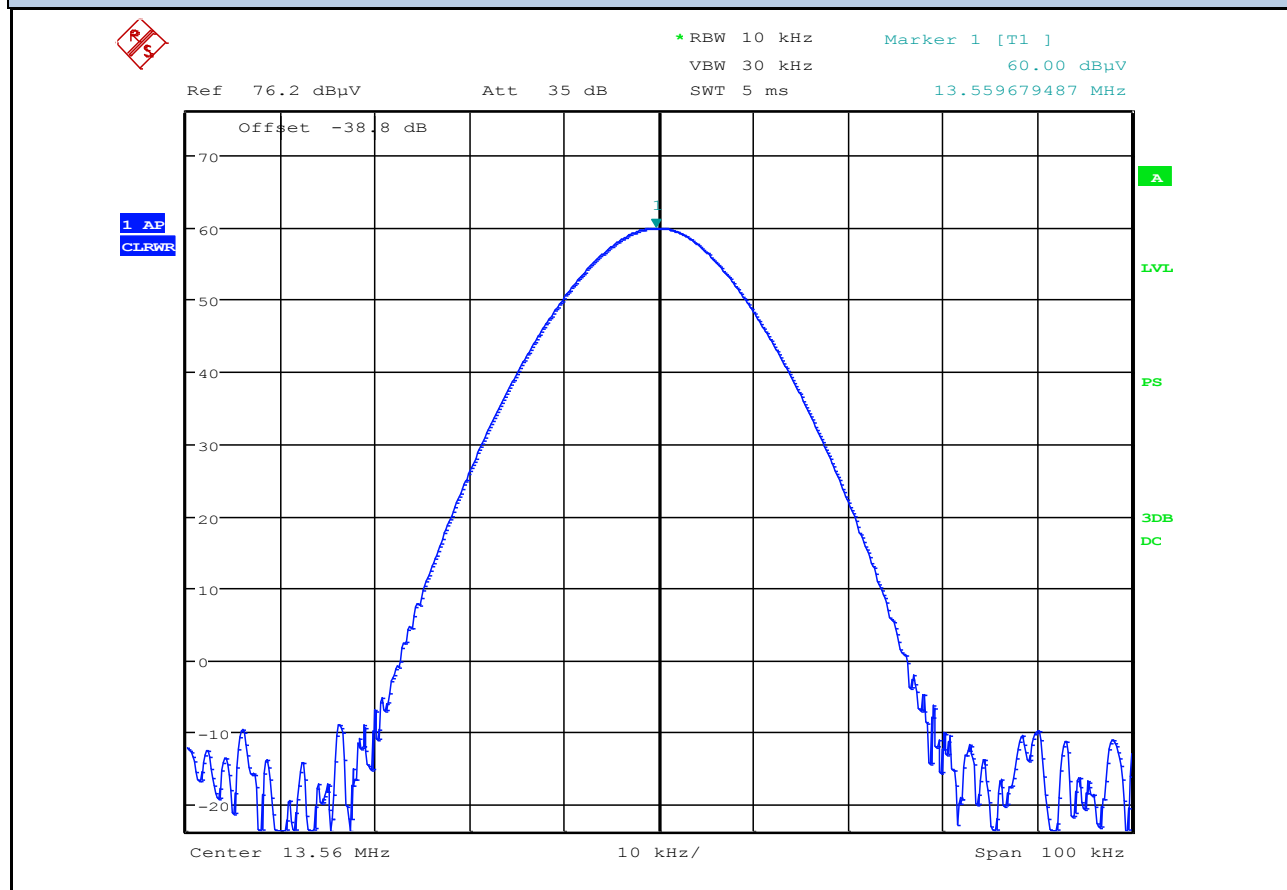
Frequency stability

Operation Mode: #1

Temperature (°C)	Voltage (V)	Measured Frequency (MHz)
25	3,3Vdc	13,55967949

Temperature (°C)	Voltage (V)	Measured Frequency (MHz)	Frequency Delta (ppm)	Frequency Tolerance
-20	3,3Vdc	13,55983974	11,82	0,001%
-10	3,3Vdc	13,55983977	11,82	0,001%
0	3,3Vdc	13,55983944	11,80	0,001%
+10	3,3Vdc	13,55983974	11,82	0,001%
+20	3,3Vdc	13,55983974	11,82	0,001%
+30	3,3Vdc	13,55967949	0,00	0.000%
+40	3,3Vdc	13,55967949	0,00	0.000%
+50	3,3Vdc	13,55967949	0,00	0.000%

Start graphic (at 5Vdc +25°C)



11.7 TEST: Additional provisions to the general radiated emission limitations.		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	24°C
	Relative Humidity (%)	37%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	12V dc	-----
Equipment mode:	Operation mode	#1
FCC Standard	§15.215 (A) (B) (C)	
(A) The regulations in §§ 15.217-15.257 provide alternatives to the general radiated emission limits for intentional radiators operating in specified frequency bands. Unless otherwise stated, there are no restrictions as to the types of operation permitted under these sections.		
(B) In most cases, unwanted emissions outside of the frequency bands shown in these alternative provisions must be attenuated to the emission limits shown in Section 15.209. In no case shall the level of the unwanted emissions from an intentional radiator operating under these additional provisions exceed the field strength of the fundamental emission.		VERDICT
		PASS
(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		VERDICT
		PASS

11.8 TEST: RF Exposure Requirements		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	---
	Relative Humidity (%)	---
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	12V dc	---
Equipment mode:	Operation mode	#1
FCC Standard	§ 1.1310 (1) (B)	
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 of the Commission's guidelines § 1.1310, table (1) (b)		
EUT classification (fixed, mobile or portable devices)	Fixed equipment used in Uncontrolled Exposure environment	
Limits Freq. 13,56 MHz	0.97 (Power Density (mW/cm²))	
Power Density (mW/cm²)	$S = P * G / 4\pi r^2$	

Note:
P = Conducted Power (mW); G = Numeric Gain (10 ^(dBi/10)); r = distance (cm)

Operation Mode: #1							
CH	Frequency	Radiated Output Power	Radiated Output Power ERP	Radiated Output Power ERP	Distance (r)	Power Density (S)	Limit
	(MHz)	(dBuV/m)	(dBm)	(mW)	(cm)		
1	13,56	60	-35,23	0,003	20	0,0002	0,97
VERDICT							
The EUT Radiated Power density at evaluation distance is WHITIN THE LIMIT at the distance of 20cm.							

END OF TEST REPORT