

Test Report

Report Number:

F210165E1

Equipment under Test (EUT):

**Safety solenoid interlock with RFID reader
AZM40Z-ST-1P2P-PH**

Applicant:

K.A. Schmersal GmbH & Co. KG

Manufacturer:

K.A. Schmersal GmbH & Co. KG



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

- [1] **ANSI C63.10: 2013** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15** Radio Frequency Devices
- [3] **RSS-210 Issue 10 (December 2019)**
Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
- [4] **RSS-Gen Issue 5 (March 2019) Amendment 1**
General Requirements for Compliance of Radio Apparatus

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

Tested and written by:	Michael DINTER	23.03.2021 15:13	23.03.2021
	Name	Signature	Date
Reviewed and approved by:	Manuel BASTERT	23.03.2021 15:12	23.03.2021
	Name	Signature	Date

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1 Identification

1.1 Applicant

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Country:	Germany
Name for contact purposes:	Mr. Bastian ZIMMERMANN
Phone:	+49 (0)202 / 6474-197
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Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	K.A. Schmersal GmbH & Co. KG
Address:	Möddinghofe 30, 42279 Wuppertal
Country:	Germany
Name for contact purposes:	Mr. Bastian ZIMMERMANN
Phone:	+49 (0)202 / 6474-197
eMail address:	BZimmermann@schmersal.com
Manufacturer represented during the test by the following person:	None

1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-06 and D-PL-17186-01-05, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISD# 3469A.

1.4 EUT (Equipment under Test)

Type of equipment: *	Safety solenoid interlock with RFID reader
Model Series: *	AZM40 Series
Model Name: *	AZM40Z-ST-1P2P-PH
HVIN: *	AD
Order number: *	103037333
Serial number: *	-
FCC ID: *	2AFO9-AZ2
IC certification number: *	20745-AZ2
PCB identifier: *	Main PCB: 51512-U17V001 Photo Sensor PCB: 51512-U4V_
Hardware version: *	Main PCB: Index C2 Photo Sensor PCB: Index B
Software version (FVIN): *	-

* Declared by the applicant

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

General:						
Power supply EUT: *	24 VDC					
Supply voltage EUT: *	U _{nom} =	24 V DC	U _{min} =	20.4 V DC	U _{max} =	26.4 V DC
Temperature range: *	-25 °C to +60 °C					
Lowest / highest internal frequency: *	1 Hz / 8 MHz					

* Declared by the applicant

RFID:						
Operating frequency: *	125 kHz					
Power supply: *	Internal DC/DC interface					
Rated output power: *	<250 mW					
Power supply EUT: *	DC					
Supply voltage EUT: *	U _{nom} =	5.0 V DC	U _{min} =	4.9 V DC	U _{max} =	5.1 V DC
Type of modulation: *	ASK 100% to TAG					
Antenna connector: *	Internal					
Number of channels: *	1					
Antenna type: *	Wired coil antenna					
Data rate: *	4 kbit/s					
Temperature range: *	-40 °C to +85°C					

* Declared by the applicant

Ports / Connectors				
Identification			Length during test	Shielding (Yes / No)
	EUT	Ancillary		
24 V DC supply and Test Box	M12 (8 Pin)	M12 (8 Pin)	5 m	No
-	-	-	-	-

Ancillary Equipment	
AC adapter* ¹	QUINT4-PS/3AC/24DC/10 PHOENIX CONTACT Order-No:2904601
Testbox* ²	SCHMERSAL Testbox for standard AZM40 I/O Devices
TAG* ²	AZM40-B1-PH Schmersal 103037328

*¹ Provided by the laboratory

*² Provided by the applicant

1.6 Dates

Date of receipt of test sample:	19.02.2021
Start of test:	22.02.2021
End of test:	02.03.2021

2 Operational States

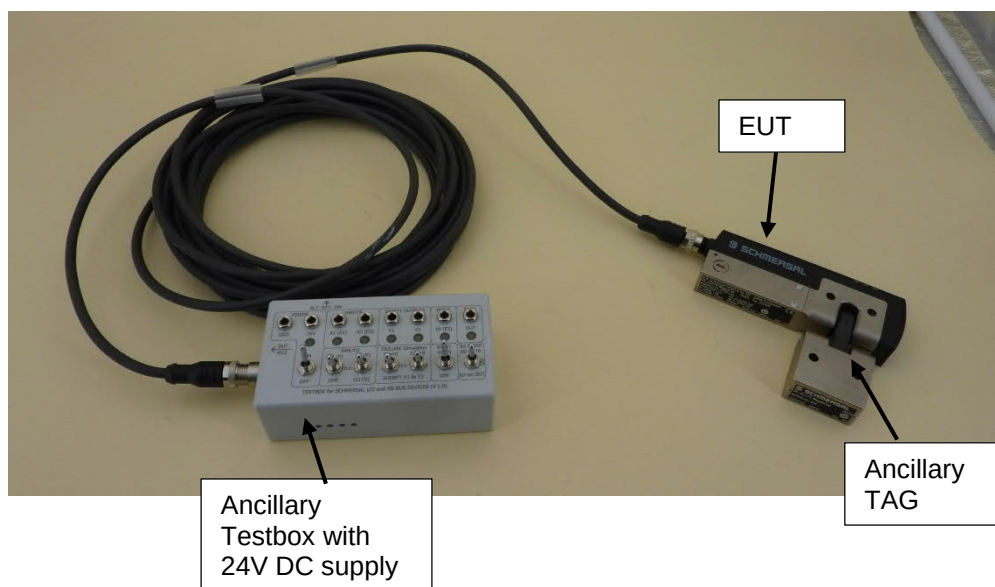
Description of function of the EUT:

The EUT is an RFID reader for door locks in safety applications.
The lock is supplied by 24 V DC.

The following states were defined as the operating conditions:

As pretests has shown, there was no significant difference between measurements with or without reading the TAG. Therefore, the tests were carried out with reading the TAG.
During the conducted emission test the EUT was supplied by an AC adapter (PHOENIX Contact AC/DC adapter type QUINT4-PS/3AC/24DC/10) with 60 Hz 120 V AC mains.
No other peripheral devices except the test box delivered by the applicant were connected during the test.
The radiated measurement was carried out in 3 orthogonal axes of the EUT.

The system was setup as follows:



3 Additional Information

The EUT was not labeled as required by FCC / IC.

The internal photos were delivered by the applicant in order to keep the tested sample operational because the encapsulated housing cannot be opened without destroying.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-Gen, Issue 5 [4] and RSS-210, Issue 10 [3]	Status	Refer page
Conducted emissions on supply line	0.15 – 30	15.207 (a)	8.8 [4]	Passed	10 et seq.
Radiated emissions	0.009 – 1000**	15.205 (a) 15.209 (a)	8.9 and 8.10 [4] 7.1 and 7.3 [3]	Passed	12 et seq.
99 % bandwidth	0.125	-	6.7 [4]	Passed	20 et seq.
Antenna requirement	-	15.203 [2]	6.8 [4]	Passed *	-

*: Integrated antenna only, requirement fulfilled.

**:
As declared by the applicant the highest radio clock frequency is 0.125 MHz.
The radiated emission measurement must be carried out up to 10th of the highest radio clock frequency.
The highest internal frequency of the digital part is below 108 MHz.
Therefore, the test was carried out up to 1 GHz

5 Results

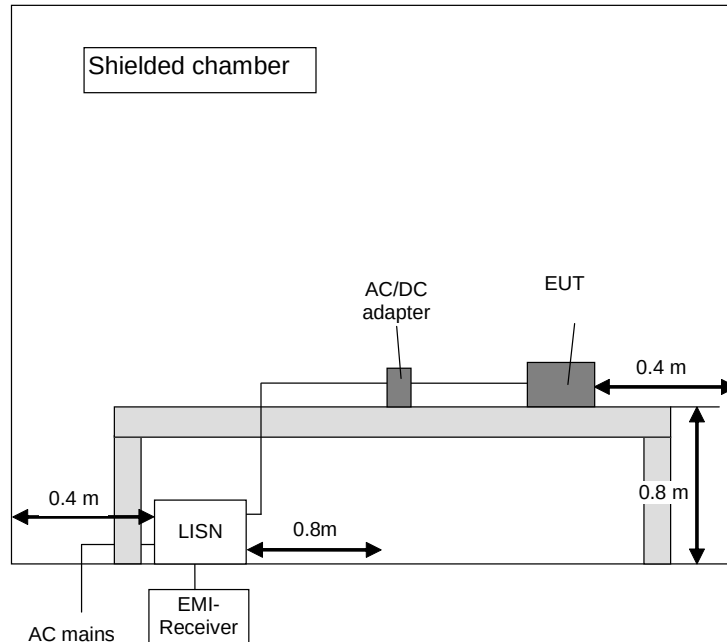
5.1 Conducted emissions on power supply lines

5.1.1 Test method

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. In case of DC powered equipment, which is not exclusively powered by a battery, it will be connected to the LISN via a suitable AC/DC adaptor. The setup of the Equipment under test will be in accordance to [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase and neutral line of the AC mains network. If levels detected 10 dB below the appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz

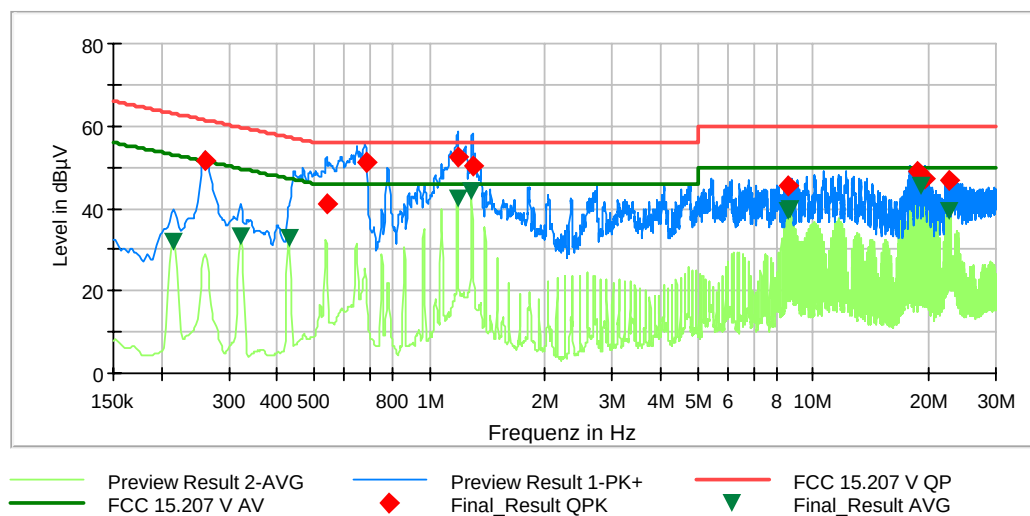


5.1.2 Results conducted emission measurement on AC mains

Ambient temperature:	22 °C
Relative humidity:	38 %

Date:	24.02.2021
Tested by:	Michael DINTER

The curves in the diagrams below only represent for each frequency point the maximum measured value of all preliminary measurements which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by ◆ and the average measured points by ▼.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Transducer (dB)
0.215250	---	32.09	53.00	20.91	5000.0	9.000	L1	GND	9.8
0.260000	51.68	---	61.43	9.75	5000.0	9.000	N	GND	9.8
0.322750	---	33.01	49.64	16.62	5000.0	9.000	L1	GND	9.8
0.430000	---	32.93	47.25	14.32	5000.0	9.000	L1	GND	9.8
0.539750	41.31	---	56.00	14.69	5000.0	9.000	L1	GND	9.8
0.681500	50.93	---	56.00	5.07	5000.0	9.000	L1	GND	9.8
1.182500	52.63	---	56.00	3.37	5000.0	9.000	N	GND	9.8
1.182750	---	42.48	46.00	3.52	5000.0	9.000	N	GND	9.8
1.290250	---	44.13	46.00	1.87	5000.0	9.000	N	GND	9.8
1.295750	50.07	---	56.00	5.93	5000.0	9.000	N	GND	9.8
8.601250	---	39.40	50.00	10.60	5000.0	9.000	N	GND	10.5
8.605000	45.40	---	60.00	14.60	5000.0	9.000	N	GND	10.5
8.709250	---	39.64	50.00	10.36	5000.0	9.000	N	GND	10.5
18.714750	48.99	---	60.00	11.01	5000.0	9.000	N	GND	10.8
19.025750	---	45.48	50.00	4.52	5000.0	9.000	N	GND	10.8
19.472250	47.13	---	60.00	12.87	5000.0	9.000	N	GND	10.8
22.576000	---	39.20	50.00	10.80	5000.0	9.000	N	GND	10.7
22.699750	46.68	---	60.00	13.32	5000.0	9.000	N	GND	10.7

Measurement uncertainty: ± 2.76 dB

Test result Passed

Test equipment (please refer to chapter 6 for details)
1 - 8

5.2 Radiated emissions

5.2.1 Test method

The radiated emission measurement has to be carried out as follows:

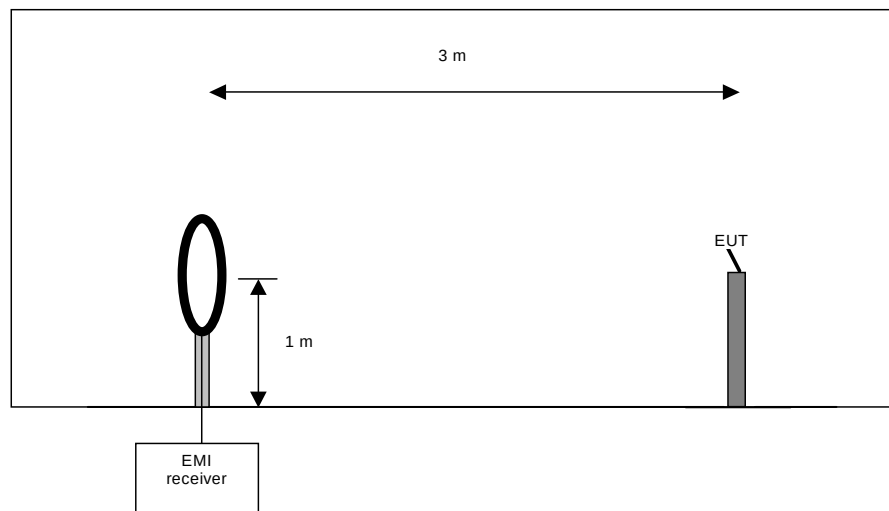
Preliminary measurement (9 kHz to 30 MHz):

The preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Table-top devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to find the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Pre-scans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
- 2) Manipulate the system cables within the range to produce the maximum level of emission.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Make a hardcopy of the spectrum.
- 5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
- 7) Rotate the measuring antenna and repeat steps 1) to 5).

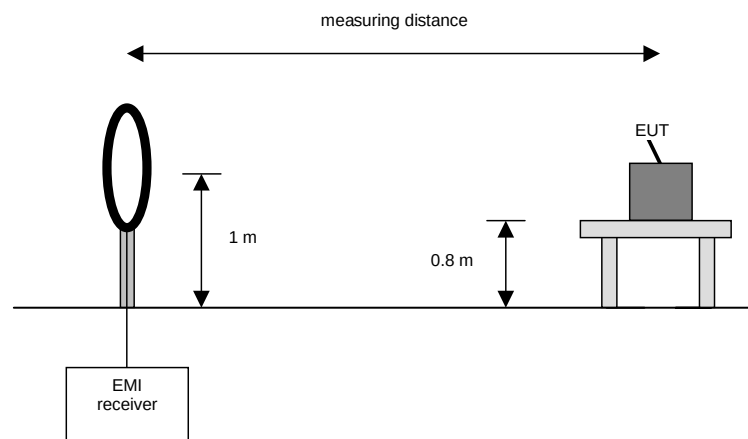
Final measurement (9 kHz to 30 MHz):

The final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the frequencies, which were detected during the preliminary measurements, the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Final measurement procedure:

The following procedure will be used:

- 1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
- 3) Rotate the measuring antenna to find the maximum and note the value.
- 4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
- 5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT (if the EUT is a module and might be used in a handheld equipment application).

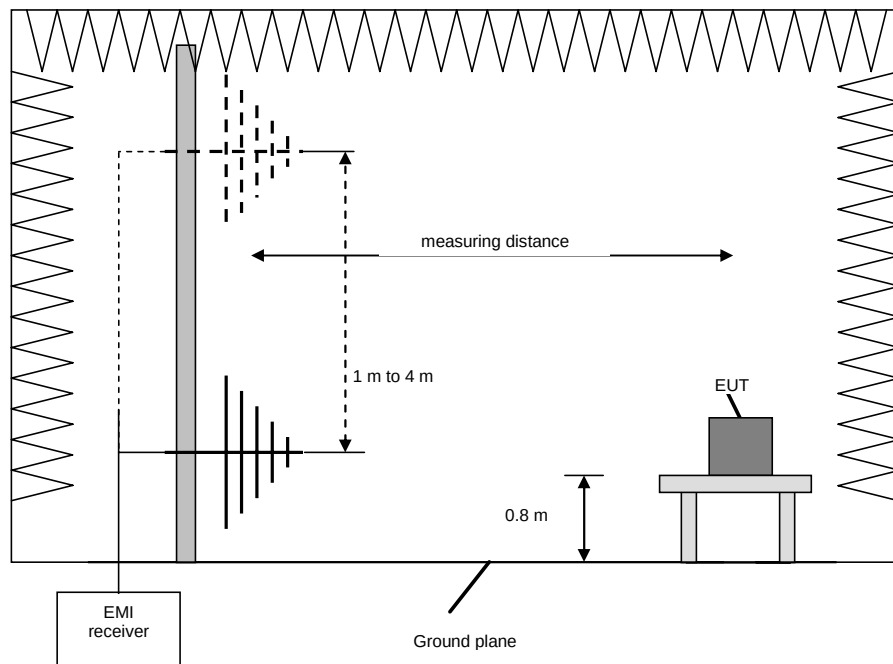
Preliminary and final measurement (30 MHz to 1 GHz)

The preliminary and final measurements were conducted in a semi-anechoic chamber with a metal ground plane in a 3 m distance.

During the test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarization and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Test	Frequency range	Resolution bandwidth
Preliminary measurement	30 MHz to 1 GHz	100 kHz
Frequency peak search	+ / - 1 MHz	10 kHz
Final measurement	30 MHz to 1 GHz	120 kHz



Procedure preliminary measurement:

The following procedure is used:

1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarisation and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for that value.

Procedure final measurement:

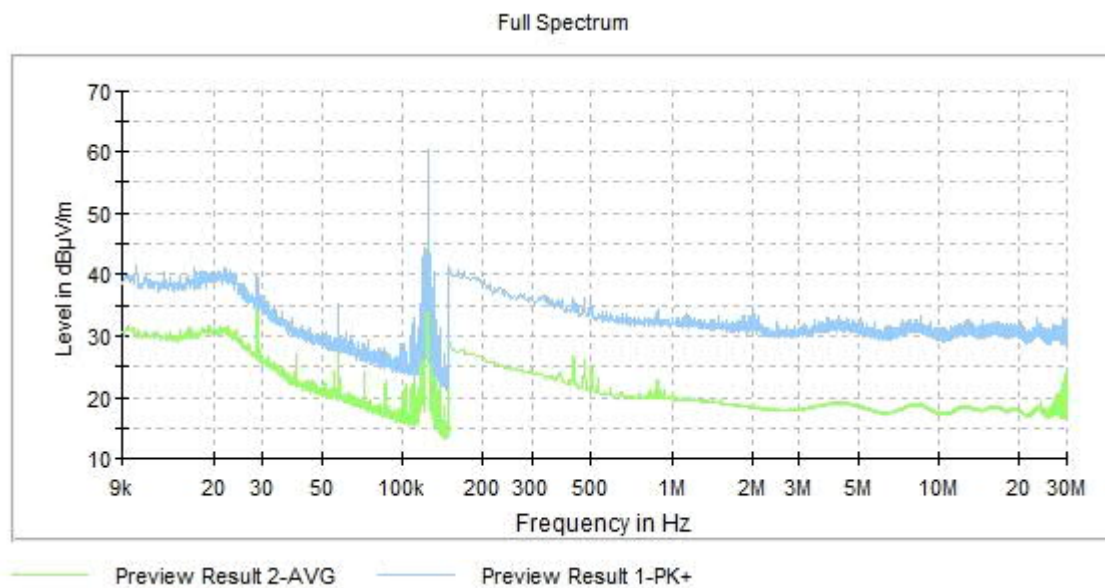
The following procedure is used:

1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the worst case EUT position (x,y,z) for the final test.
4. The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the value obtained in the preliminary measurement, and to monitor the emission level.
5. The worst azimuth turntable position is found by varying the turntable azimuth by +/- 30° from the value obtained in the preliminary measurement, and to monitor the emission level.
6. The final measurement is performed at the worst-case antenna height and the worst case turntable azimuth
7. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

5.2.2 Results preliminary measurement 9 kHz to 30 MHz

Ambient temperature:	22 °C
Relative humidity:	38 %

Date:	24.02.2021
Tested by:	Michael DINTER



The following emission was found according to [2] and [3]. (fundamental of transmitter): 125 kHz.

The following frequencies were found outside and inside the restricted bands according to FCC 47 CFR Part 15 section 15.209.

Frequency (kHz)
28.750
57.450
125.150*
429.000

Remark *: Fundamental

These frequencies have to be measured with in a final measurement.

Test equipment (please refer to chapter 6 for details)
9 - 16

5.2.3 Result final measurement from 9 kHz to 30 MHz

Ambient temperature:	14 °C
Relative humidity:	54 %

Date:	02.03.2021
Tested by:	Michael DINTER

The results of the standard subsequent measurement on the outdoor test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 300 m measuring distance.

Results 9kHz - 30 MHz										
Frequency [MHz]	Reading [dBμV]	Result* [dBμV/m]	Result* [dBμA/m]	Limit acc. 15.209 [dBμV/m]	Limit acc. RSS-Gen Table 6 [dBμA/m]	Margin** [dB]	Detector (acc. to §15.209 (d)	Antenna factor [dB/m]	Measuring Distance [m]	Distance correction factor*** [dB]
0.125000	39.6	-20.1 @ 300 m	-71.6 @ 300 m	25.7	-25.9	45.8	AV	20.3	3	80.0
		No further emission was measured because the noise floor of the outdoor test site was higher than the premeasured signal.								
Measurement uncertainty			+/- 4.69 dB							

Remark: The highest magnetic field strength was measured in the x axis position of the EUT.

* Result @ norm dist = Reading + Antenna factor - Distance correction factor.

Result [dBμA/m] = Result [dBμV/m] - 20*log(377 Ω)

** Margin = Limit [dBμV/m] - Result @ norm dist

*** 40 dB/decade according Part §15.31 (f) (2)

Remark: At 10 m measuring distance the signal of the EUT was below the sensitivity of the measuring system.

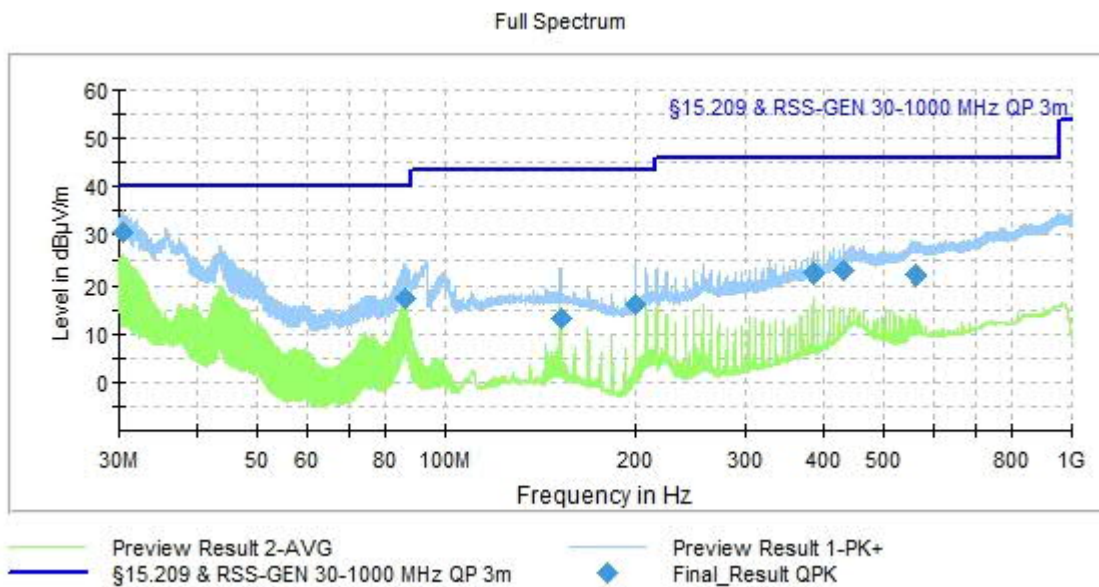
Test: Passed

Test equipment (please refer to chapter 6 for details)
9 - 10, 17

5.2.4 Result final measurement from 30 MHz to 1 GHz

Ambient temperature:	22 °C
Relative humidity:	29 %

Date:	22.02.2021
Tested by:	Michael DINTER



The results of the standard subsequent measurement in a semi anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Orthogonal axis FUT
30.535000	30.53	40.00	9.47	1000.0	120.000	111.0	V	135.0	28.2	X
86.105000	17.26	40.00	22.74	1000.0	120.000	208.0	H	95.0	16.3	X
151.660000	13.20	43.52	30.32	1000.0	120.000	186.0	H	295.0	18.6	X
199.545000	16.30	43.52	27.22	1000.0	120.000	100.0	H	79.0	16.1	X
384.475000	22.38	46.02	23.64	1000.0	120.000	216.0	H	137.0	23.2	Y
432.535000	22.75	46.02	23.27	1000.0	120.000	138.0	H	237.0	24.6	X
562.500000	21.73	46.02	24.29	1000.0	120.000	246.0	V	128.0	28.4	X
Measurement uncertainty: ± 4.8 dB										

Test: Passed

The correction factor was calculated as follows.

Corr. (dB) = cable attenuation (dB) + 6 dB attenuator (dB) + antenna factor (dB)

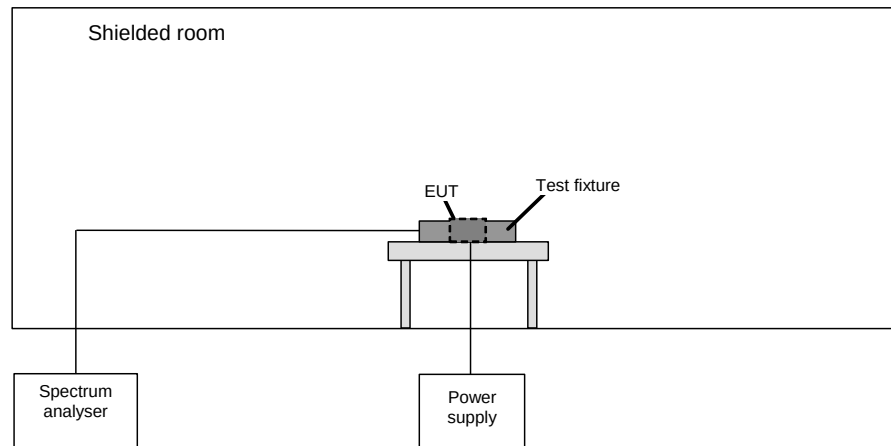
Therefore, the reading can be calculated as follows:

Reading (dBµV/m) = result QuasiPeak (dBµV/m) - Corr. (dB)

Test equipment (please refer to chapter 6 for details)
9, 11 - 16, 18 - 20

5.3 99 % bandwidth

5.3.1 Test method



The following procedure will be used for the occupied bandwidth measurement according to [1]:

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

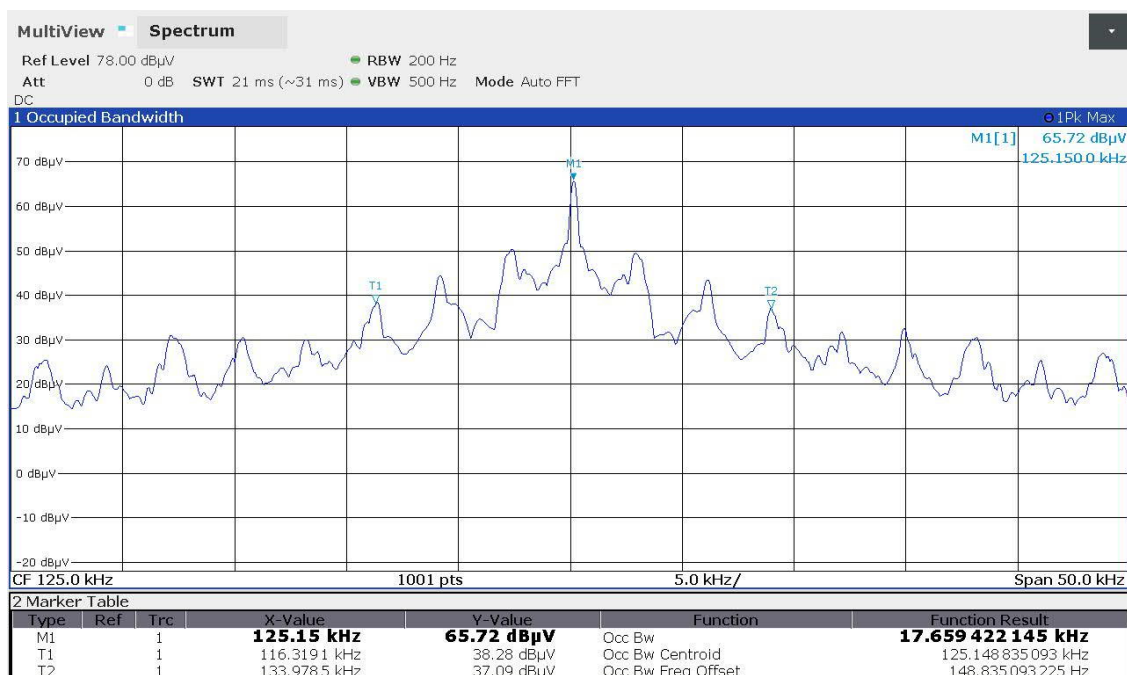
- The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (OBW/RBW)]$ below the reference level. Specific guidance is given in 4.1.5.2.
- Step a) through step c) might require iteration to adjust within the specified range.

5.3.2 Test results

Ambient temperature:	22 °C
Relative humidity:	28 %

Date:	02.03.2021
Tested by:	Michael DINTER

99 % bandwidth:



F_L	F_U	BW ($F_U - F_L$)
116.3191 kHz	133.9785 kHz	17.659 kHz
Measurement uncertainty		$< 1 \cdot 10^{-7}$

Test: Passed

Test equipment (please refer to chapter 6 for details)
9, 21 - 22

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Transient Filter Limiter	CFL 9206A	Teseq	38268	481982	12.02.2020	02.2022
2	EMI Testreceiver	ESR7	Rohde & Schwarz	101939	482558	18.02.2020	02.2022
3	Shielded chamber M155	SK3	Albatross Projects	-	482786	Calibration not necessary	
4	Software	EMC32	Rohde & Schwarz	100619	483182	Calibration not necessary	
5	LISN	NSLK8128	Schwarzbeck	8128161	480138	11.02.2020	02.2022
6	Software	Software	Spitzenberger & Spies	-	480114	Calibration not necessary	
7	EMC test system	EMC D 30000 / PAS	Spitzenberger & Spies	A4507 00/1 1110	481301	Calibration not necessary	
8	Contol unit	SyCore 1k4	Spitzenberger & Spies	A4507 12/0 1110	481302	21.09.2020	09.2022
9	DC Power Supply	TOE8951	Toellner	81995.-	481252	Calibration not necessary	
10	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	14.02.2020	02.2022
11	Software	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
12	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
13	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
14	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
15	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
16	RF Switch Matrix	OSP220	Rohde & Schwarz	-	482976	Calibration not necessary	
17	EMI Receiver	ESCS 30	Rohde & Schwarz	834489/011	580007	17.02.2020	02.2022
18	Attenuator 6 dB	WA2-6	Weinschel	8254	410119	Calibration not necessary	
19	Antenna (Bilog)	CBL6111D	Schaffner / Teseq	25761	480894	09.10.2020	10.2023
20	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
21	Loop antenna	11 cm	PHOENIX TESTLAB	-	410084	Calibration not necessary	
22	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	04.03.2020	03.2022

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
OATS Outdoor	480293	9 kHz – 30 MHz	-	ANSI C63.4-2014	-	-
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA	ANSI C63.4a-2017	19.09.2019	18.09.2021
Shielded chamber M155	482784	9 kHz – 30 MHz	GND-Plane	ANSI C63.4-2014	25.09.2020	24.09.2022

8 Report History

Report Number	Date	Comment
F210165E1	23.03.2021	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A	Test Setup Photos	5 pages
Annex B	EUT External Photos	7 pages
Annex C	EUT Internal Photos	4 pages