

# Test Report

No. 1-0426-25-01-03\_TR1-R01

June 18, 2025

Applicant X2E Gmb

Product Model **Storage Unit  
XORAYA ASU**

Procedure certification FCC ID: 2AU4HASU

Classification JAD (Part 15 Class A Digital Device)

Test Standard(s) **FCC - Title 47 CFR Part 15: 2025-05  
ICES-003, Issue 7: 2020-10  
ANSI C63.4a: 2017**

Verdict ☒ PASS: All applicable Test(s) acc. to the standard(s) are PASS/complies

The test results relate only to devices specified in this document

This test report is electronically signed and valid without handwritten signature.  
Public keys for verification of the electronic signatures can be requested at the testing laboratory.

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authorized by **Uli Kraus**  
Supervisor EMC services  
EMC Labs

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created by **Jan Schöner**  
Testing Manager  
EMC Labs

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## 1 Disclaimer

The test results of this test report relate exclusively to the test item specified in chapter "Test sample information". cetecom advanced does not assume responsibility for any conclusions and generalizations drawn from the test results regarding other specimens or samples of the type of the equipment represented by the test item.

The testing service provided by cetecom advanced has been rendered under the current "General Terms and Conditions for cetecom advanced".

cetecom advanced will not be liable for any loss or damage resulting from false, inaccurate, inappropriate, or incomplete product information provided by the customer.

Under no circumstances does the cetecom advanced test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.

Under no circumstances does the cetecom advanced test report include or imply any product or service warranties from cetecom advanced, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by cetecom advanced.

All rights and remedies regarding vendor's products and services for which cetecom advanced has prepared this test report shall be provided by the party offering such products or services and not by cetecom advanced. In no case this test report can be considered as a Letter of Approval.

The present test report can only be used for the sDOC procedure in the USA if the „Responsible Party“ (located in USA) or an official of the responsible party confirms the report in writing, as designated in FCC§2.938.

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at cetecom advanced.

## 2 Related cetecom advanced documents

Document	Content	Reference
Annex 101	Photographs of the EUT	Annex A101 is separate document.
Annex 103	Test set-up photographs	Annex A103 is separate document.

## 3 Document history

### 3.1 Current release

Release No.: R01  
 Date of release: June 18, 2025  
 Applied changes: Initial release

### 3.2 Previous releases

Release No.	Applied changes	Date of release
-	-	-

## 4 Test laboratory

### 4.1 Contact information

cetecom advanced GmbH  
 Untertuerkheimer Str. 6-10  
 66117 Saarbruecken  
 Germany

### 4.2 Involved test locations

<input checked="" type="checkbox"/> Saarbruecken lab	<input type="checkbox"/> Essen lab
Untertuerkheimer Str. 6-10 66117 Saarbruecken Germany	Im Teelbruch 116 45219 Essen Germany

### 4.3 Subcontracted laboratories

None.

### 4.4 Laboratory listings and recognitions

	Saarbruecken	Essen
FCC	DE0002	DE0003
ISED	DE0001 3462C	DE0001 3462D

### 4.5 Common report information

The period is used as a decimal separator and the comma as a thousand separator.

## 4.6 Abbreviations

DUT	-	Device under Test
EMC	-	Electromagnetic Compatibility
EUT	-	Equipment under Test
FCC	-	Federal Communication Commission
FCC ID	-	Company Identifier at FCC
HW	-	Hardware
IC	-	Industry Canada
Inv. No.	-	Inventory number
NA	-	not applicable
NP		not performed
S/N	-	Serial Number
SW	-	Software

## 5 Client information

### 5.1 Applicant

Name: X2E GmbH

Address: Große Ahlmühle 19  
76865 Rohrbach  
GERMANY

Contact Person: Gerhard Spengler  
Contact Person's Email: [gerhard.spengler@x2e.de](mailto:gerhard.spengler@x2e.de)

### 5.2 Manufacturer

Name: Dr. Karlheinz Weiss

Address: Große Ahlmühle 19  
76865 Rohrbach  
GERMANY

## 6 Test sample information

The data about the test samples is given/supplied by the customer and not under control by cetecom advanced GmbH.

### 6.1 Test Item (declared by applicant)

<b>Product:</b>	Storage Unit
<b>Model:</b>	XORAYA ASU
<b>Equipment mobility:</b>	<input type="checkbox"/> Portable use <input checked="" type="checkbox"/> Fixed Use <input type="checkbox"/> Vehicular Use
<b>Typical Environment:</b>	<input type="checkbox"/> Residential, commercial and light industry <input checked="" type="checkbox"/> Industrial
<b>Mounting position:</b>	<input checked="" type="checkbox"/> Tabletop <input type="checkbox"/> Floor standing <input type="checkbox"/> Wall mounted <input type="checkbox"/> Unknown / Not defined
<b>Additional information:</b>	-Test set-up / cabling / operating modes of EUT during tests acc. to customer requirements -This is a class A digital device: -The instructions furnished the user shall include a statement acc. to §15.105 of the used FCC rules -The following warning shall be included in the instruction of use: This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures

<b>Radio frequency considered in this test report:</b>	<input type="checkbox"/> Integrated radio function(s)
	<input checked="" type="checkbox"/> No radio functionality considered

<b>Highest internal frequency of digital part:</b>	<input type="checkbox"/> < 108 MHz
	<input checked="" type="checkbox"/> < 3000 MHz
	<input type="checkbox"/> > 3000 MHz
	<input type="checkbox"/> unknown

<b>Power Supply:</b>	EUT powered by:	
	<input checked="" type="checkbox"/> AC Mains Defined Input range: 120 V – 230 V / 50 – 60 Hz	
	<b>Testing performed at:</b>	
	<input checked="" type="checkbox"/> 120 V	<input type="checkbox"/> 1 ph. (L1)
	<input type="checkbox"/> 230 V	<input type="checkbox"/> 3 ph. (L1, L2, L3)
	<input type="checkbox"/> 400 V	<input checked="" type="checkbox"/> PE
	<input type="checkbox"/> Various Settings used during test, see test chapter for details	
	<input checked="" type="checkbox"/> DC Mains Defined Input range: 6 V – 32 V	
	<input type="checkbox"/> 12 V	<input type="checkbox"/> Ground
	<input checked="" type="checkbox"/> Via Power Supply	<input type="checkbox"/> Via PoE
<input type="checkbox"/> Various Settings used during test, see test chapter for details		

Additional information:

<b>Wired network port:</b>	Name/number: ETH (Host)	
	<input checked="" type="checkbox"/>	Connected during test
	<input type="checkbox"/>	Not connected during test <sup>1)</sup> <small><sup>1)</sup> only for service and maintenance / not connected during test according to customers declaration this port is not used during tests and should not be connected during normal operation</small>
	Shield:	Shielded
	Possible length:	≥ 3.0m and < 30.0m
	Additional information:	-

<b>Wired network port:</b>	Name/number: ETH SFP+	
	<input checked="" type="checkbox"/>	Connected during test
	<input type="checkbox"/>	Not connected during test <sup>1)</sup> <small><sup>1)</sup> only for service and maintenance / not connected during test according to customers declaration this port is not used during tests and should not be connected during normal operation</small>
	Shield:	Unshielded
	Possible length:	≥ 30.0m
	Additional information:	-

<b>Signal &amp; Control port:</b>	Name/number: USB Type C (front port)	
	<input checked="" type="checkbox"/>	Connected during test
	<input type="checkbox"/>	Not connected during test <sup>1)</sup> <small><sup>1)</sup> only for service and maintenance / not connected during test according to customers declaration this port is not used during tests and should not be connected during normal operation</small>
	Shield:	Shielded
	Possible length:	< 3.0m
	Additional information:	- only USB 2.0 speed



<b>Signal &amp; Control port:</b>	Name/number: USB Type C (rear port)
	<input type="checkbox"/> Connected during test
	<input checked="" type="checkbox"/> Not connected during test <sup>1)</sup>
	<sup>1)</sup> only for service and maintenance / not connected during test according to customers declaration this port is not used during tests and should not be connected during normal operation
	Additional information: -

## 6.2 Equipment under test

EUT no. *)	Product	Model	Serial number	Hardware version	Software version
<b>EUT A</b>	Storage Unit	XORAYA ASU	0284_0020_ 0200_00000b	2.0	5.05.8F0D- ef45f78b5d667df4424dcdd 2aa768f26ab23b448

\*) EUT short description is used to simplify the identification of the EUT in this test report.

### 6.2.1 Auxiliary equipment from customer

AE *)	Auxiliary equipment	Type	Serial number	Hardware version	Software version
<b>AE 1</b>	USB Stick	Transcend 16GB	- / -	- / -	- / -
<b>AE 2</b>	X2E Datacube	Spezal	0000b0	- / -	- / -
<b>AE 3</b>	Powersupply	ETC70H-12	- / -	- / -	- / -
<b>AE 4</b>	Laptop	Thinkpad L440	R9-0FXF2N	- / -	- / -
<b>AE 5</b>	USB Powersupply	ADLX65YLC3D	8SSA10R16919LCZ	Rev.300	- / -

\*) AE short description is used to simplify the identification of the auxiliary equipment in this test report.

### 6.2.2 EUT set-up(s)

EUT set-up no. *)	Combination of EUT and AE	Remarks
<b>set. 1</b>	EUT A + AE 1 + AE 2 + AE 3 + AE 4	Test setup DC powered
<b>set. 2</b>	EUT A + AE 2 + AE 4 + AE 5	Test setup USB powered

\*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

### 6.2.3 EUT operating modes

EUT operating mode no. *)	Description of operating modes	Additional information
<b>op. 1</b>	USB reading and writing with 1600 Kbit/s, Data traffic 2x 1,5 Gbit/s, DC powered	For radiated measurements AE's except the USB stick was placed outside of the measurement area
<b>op. 2</b>	USB powered, Data traffic 2x 2,0 Gbit/s	For radiated measurements AE's were placed outside of the measurement area

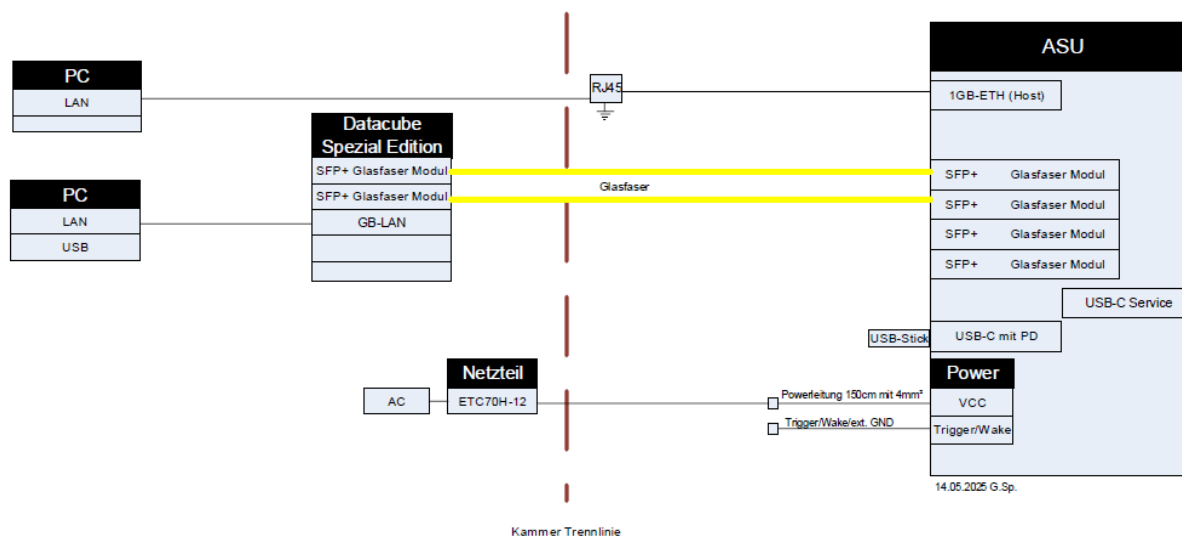
\*) EUT operating mode no. is used to simplify this test report.

### 6.2.4 Performance criteria

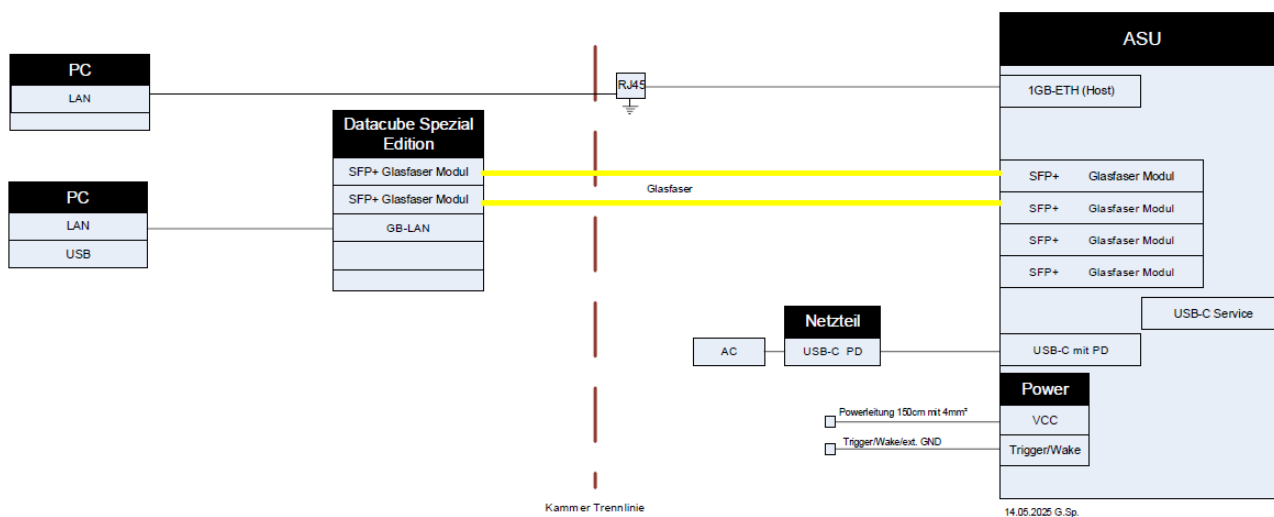
The performance criteria of the used standard(s) were applied.

## 6.2.5 Setup schematics of customer

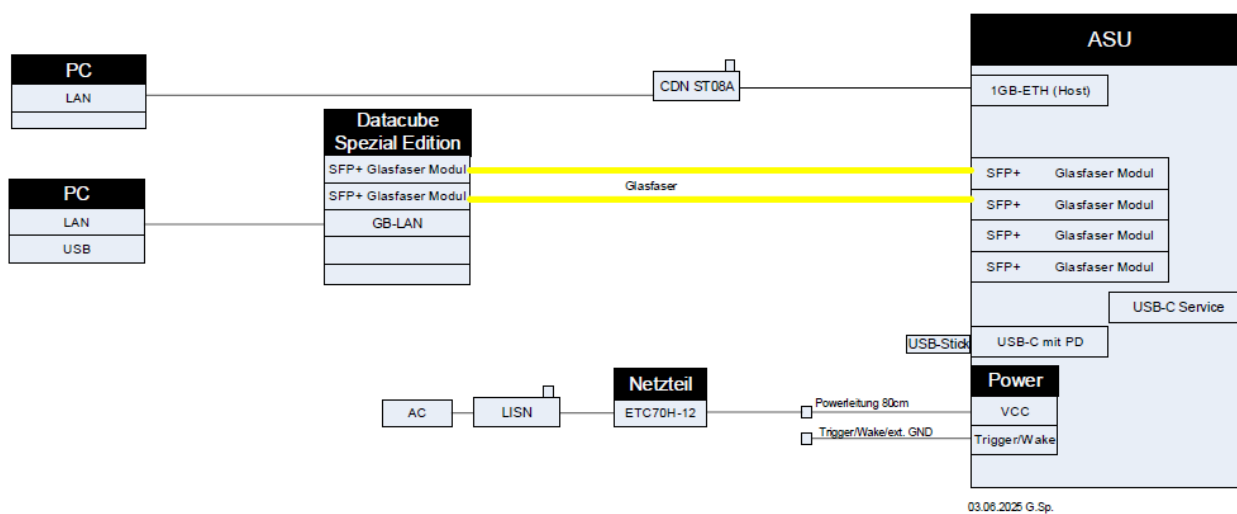
Set 1 radiated emission/



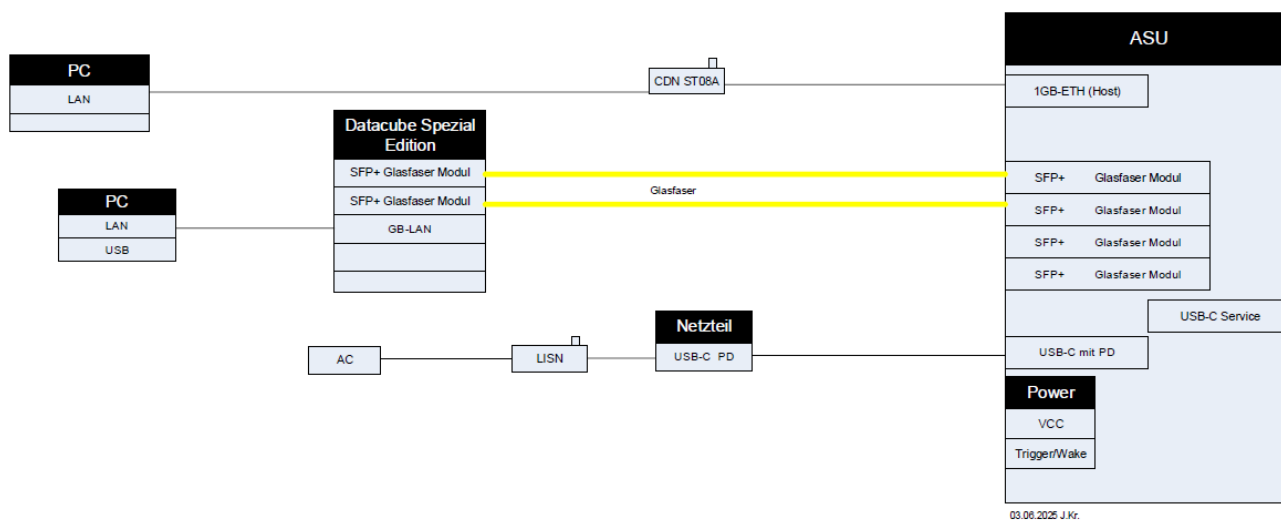
Set 2 radiated emission



## Set.1 conducted emission



## Set 2 conducted emission



## 7 Application details

### 7.1 Scheduling

Date of sample reception: September 15, 2024  
Date(s) of test: May 26, 2025 to May 27, 2025

### 7.2 Climatic data

Temperature: 15°C - 35°C  
Relative humidity: 30%rH - 60%rH  
Barometric pressure: 860hPa - 1060hPa

### 7.3 Opinions and interpretations

None.

### 7.4 Modifications

None.

## 8 Measurement details

### 8.1 Test methodology

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number D-PL-12047-01-00.

Applied test method, standard, rule	Description
FCC - Title 47 CFR Part 15: 2025-05	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
ICES-003, Issue 7: 2020-10	ICES-003 – Information Technology Equipment (including Digital Apparatus)
ANSI C63.4a: 2017	American National Standard for Methods of Measurement of RadioNoise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz Amendment 1: Test Site Validation

### 8.2 Summary of test results

#### 8.2.1 Emission

##### 8.2.1.1 Enclosure

EMI Phenomenon	Frequency range	Limit	Result
Radiated interference field strength	30 – 1000 MHz	FCC Part 15 Class A	<b>passed</b>
Radiated interference field strength	> 1000 MHz	FCC Part 15 Class A	<b>passed</b>

##### 8.2.1.2 AC Mains power Input/Output ports

EMI Phenomenon	Frequency range	Limit	Result
Conducted interference voltage	0.15 – 30 MHz	FCC Part 15 Class A	<b>passed</b>

#### Remarks:

<b>NA1</b>	Not tested because not required by used standard
<b>NA2</b>	Test not applicable because port does not exist
<b>NA3</b>	Test not applicable because port only for services
<b>NA4</b>	Test not applicable because port lengths not longer than 3m
<b>NA5</b>	Not performed, because used frequency < 108 MHz
<b>NA6</b>	Not performed, because the device is for vehicular use
<b>NP1</b>	Not tested because not required by customer

## 8.2.2 Measurement and test set-up

Note: Test set-up / cabling / operating modes of EUT during tests according to customer.

## 8.2.3 Measurement uncertainty

The uncertainty of the measurement equipment fulfils CISPR 16 and the related european and national standards.

The semi anechoic chamber fulfils the requirements of CISPR 16-1 (ANSI C63.4) for a test volume of 4m Ø.

Measurement uncertainty calculations are on file and available from the test laboratory upon request.

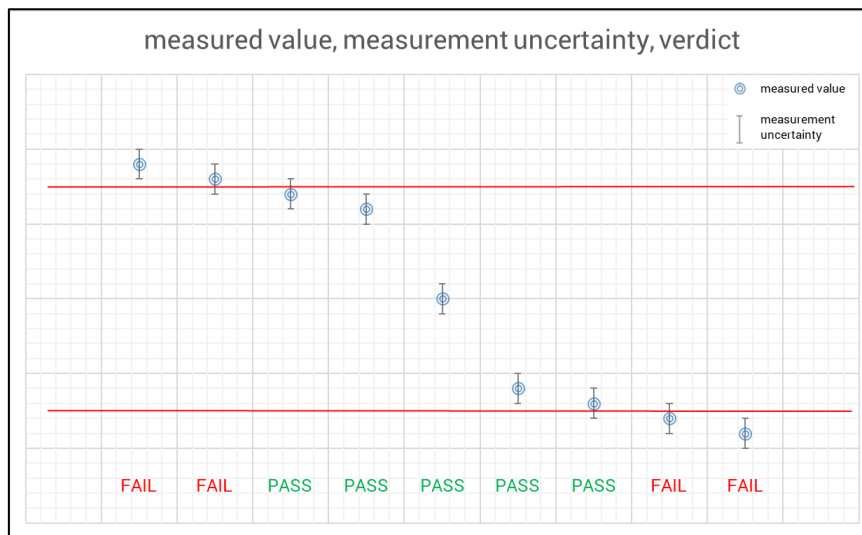
The table below shows the measurement uncertainties for each measurement method.  
The expended uncertainty (k=2 or 95%) was calculated with worst case values.

Measurement Method	Frequency area Impulse duration time	Description	Expanded uncertainty (k=2 or 95%)
<b>Radiated Emission</b> <b>FCC part 15 B, ANSI C63.4</b>	< 1 GHz > 1 GHz	Field strength [dBμV/m]	± 4.75 dB ± 4.60 dB
<b>Conducted Emission</b> <b>FCC part 15 B, ANSI C63.4</b>	9 kHz – 30 MHz	Voltage [dBμV]	± 2.48 dB

## 8.2.4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 8.1.

The measurement uncertainty is mentioned in this test report, see chapter above, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



### Decision Rule for emission testing:

cetecom advanced GmbH follows [ILAC G8:2019 chapter 4.2.1 \(Simple Acceptance Rule\)](#) according to CISPR 16-4-2: ULab < UCISPR. Therefore, the uncertainty is not considered for the statement of conformity in this test report.

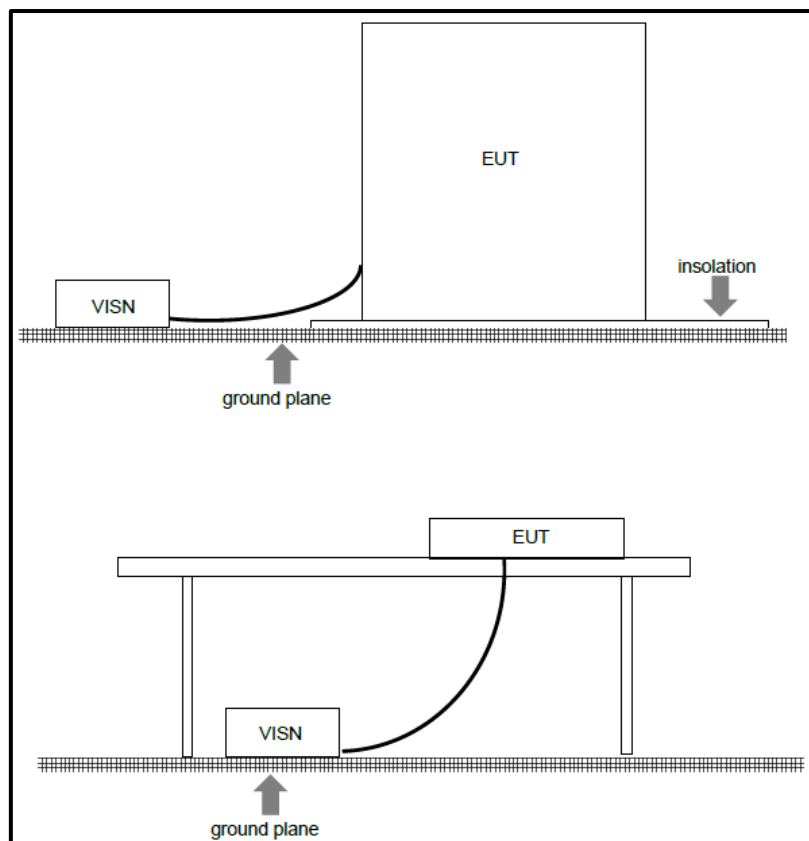
## 8.3 Detailed test results – Emission

### 8.3.1 Conducted Emission

#### 8.3.1.1 Description of the general test setup and methodology

According to EMC basic standard **ANSI C 63.4**

Schematic:



#### 8.3.1.2 Signal strength calculation

Calculation formula:

$$SS = UR + CF + VC$$

List of abbreviations:

- SS ► signal strength
- UR ► voltage at the receiver
- CF ► loss of the cable and filter (passband filter 130 kHz – 30 MHz)
- VC ► correction factor of the ISN (ESH3-Z5)

List with correction factors:

Frequency [MHz]	CL [dB]	VC [dB]
0.15	9.8	1.42
1	9.8	0.41
5	9.9	0.32
10	9.9	0.23
15	10	0.39
20	10	1.19
25	10.2	1.55
30	10.3	1.31

#### Example calculation:

For example, at 10 MHz the measured Voltage (UR) is 37.62 dBμV, the loss of the cable and filter (CF) is 9.90 dB and the correction factor of the ISN (VC) is 0.23 dB the final result will be calculated:

$$V_c [\text{dB}\mu\text{V}] = 37.62 [\text{dB}\mu\text{V}] + 9.90 [\text{dB}] + 0.23 [\text{dB}] = 47.75 [\text{dB}\mu\text{V}] \quad (244.06 \mu\text{V})$$

#### 8.3.1.3 Limits (Power-Line)

Frequency Range [MHz]	FCC part 15 B Class B		FCC part 15 B Class A	
	QUASI-Peak [dBμV]	AVERAGE [dBμV]	QUASI-Peak [dBμV]	AVERAGE [dBμV]
0.15 – 0.5	<b>66 - 56</b>	<b>56 - 46</b>	79	66
0.5 – 5	<b>56</b>	<b>46</b>	73	60
5 – 30	<b>60</b>	<b>50</b>	73	60

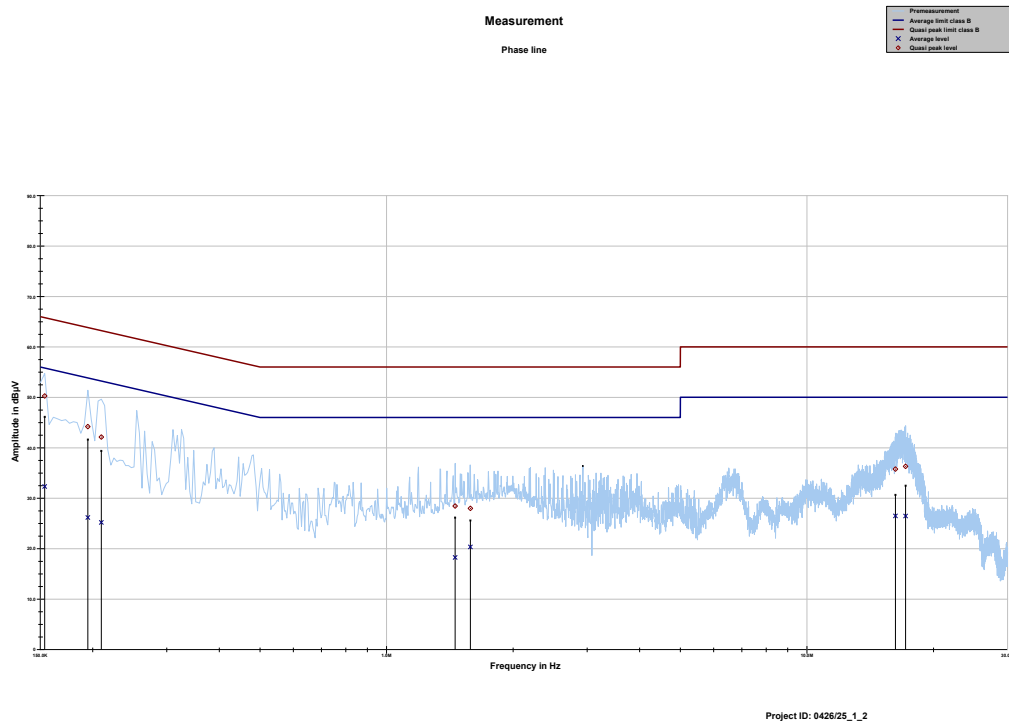
#### 8.3.1.4 Result / Test Plan

<b>EUT set-up</b>	Set.1		
<b>Operating mode</b>	<b>Port / Line</b>	<b>Limit</b>	<b>Result</b>
Op.1	AC power line	FCC part 15 B Class B	passed
<b>Remarks:</b>	Powered by external power supply (120 V / 60 Hz) The stricter limit of Class B was used for the Test class A is also fulfilled.		

<b>EUT set-up</b>	Set.2		
<b>Operating mode</b>	<b>Port / Line</b>	<b>Limit</b>	<b>Result</b>
Op.2	AC power line	FCC part 15 B Class B	passed
<b>Remarks:</b>	Powered by external power supply (120 V / 60 Hz) The stricter limit of Class B was used for the Test class A is also fulfilled.		

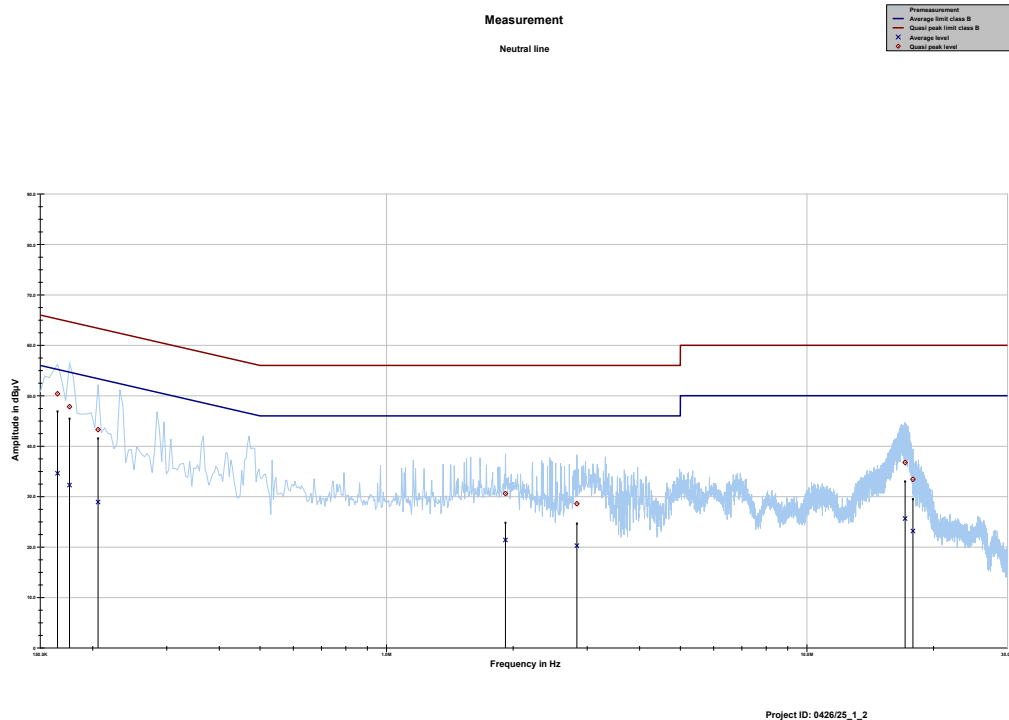


### 8.3.1.5 Measurement Protocol(s) – Test results of Main



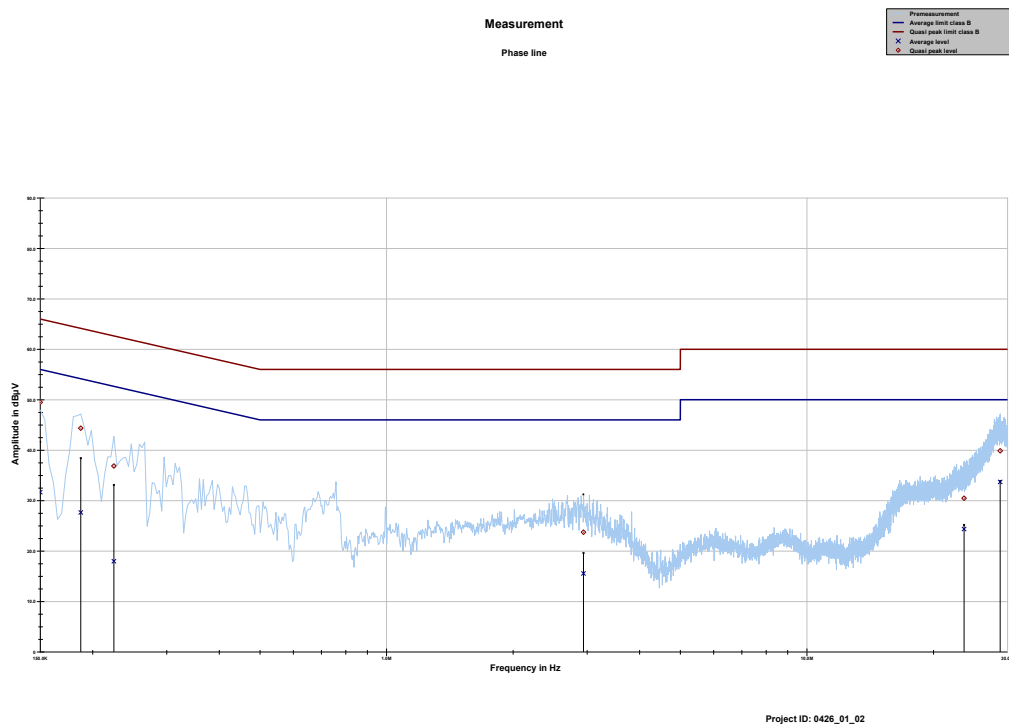
Phase line tbl  
Project ID: 0426/25\_1\_2

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.153731	50.26	15.53	65.796	32.32	23.58	55.893
0.194775	44.19	19.64	63.830	26.17	28.55	54.721
0.209700	42.11	21.11	63.217	25.19	29.11	54.294
1.455938	28.43	27.57	56.000	18.26	27.74	46.000
1.582800	27.97	28.03	56.000	20.33	25.67	46.000
16.242881	35.76	24.24	60.000	26.48	23.52	50.000
17.168231	36.30	23.70	60.000	26.46	23.54	50.000



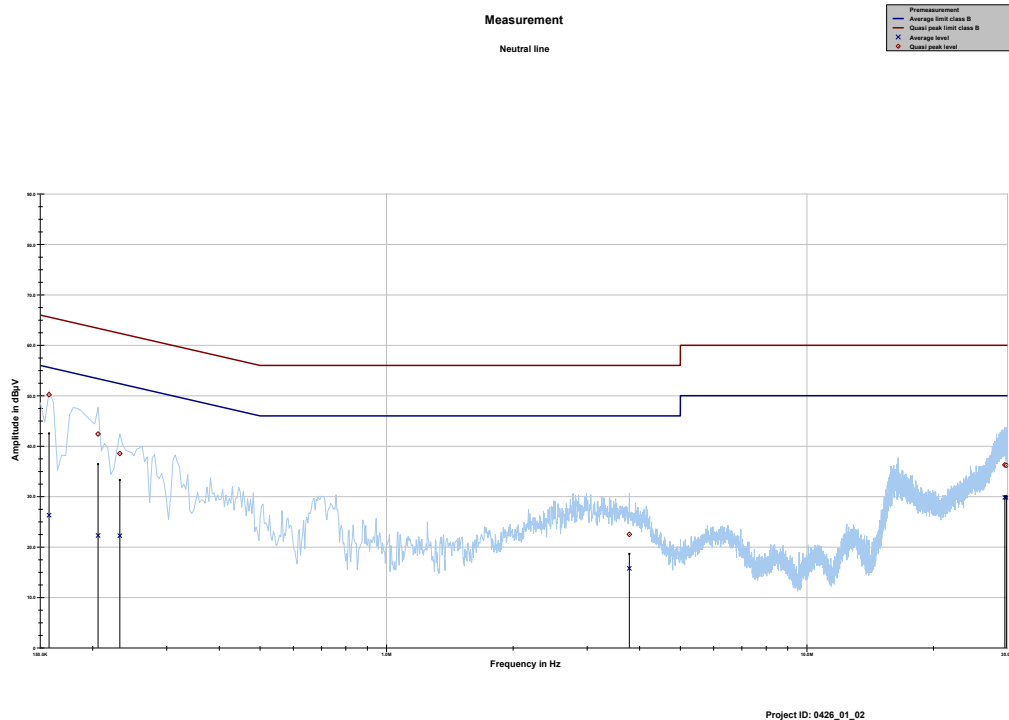
Neutral line tbl  
 Project ID: 0426/25\_1\_2

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.164925	50.38	14.83	65.212	34.62	20.96	55.574
0.176119	47.83	16.83	64.667	32.28	22.97	55.254
0.205969	43.28	20.09	63.366	28.92	25.48	54.401
1.918613	30.60	25.40	56.000	21.41	24.59	46.000
2.836500	28.59	27.41	56.000	20.28	25.72	46.000
17.127188	36.76	23.24	60.000	25.65	24.35	50.000
17.869706	33.43	26.57	60.000	23.17	26.83	50.000



Phase line tbl  
Project ID: 0426\_01\_02

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150000	49.48	16.52	66.000	31.67	24.33	56.000
0.187312	44.35	19.80	64.155	27.65	27.28	54.934
0.224625	36.86	25.78	62.646	17.98	35.89	53.868
2.940975	23.73	32.27	56.000	15.55	30.45	46.000
23.656875	30.47	29.53	60.000	24.36	25.64	50.000
28.817194	39.87	20.13	60.000	33.70	16.30	50.000



Neutral line tbl  
Project ID: 0426\_01\_02

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.157463	50.20	15.39	65.597	26.31	29.47	55.787
0.205969	42.42	20.94	63.366	22.29	32.11	54.401
0.232088	38.54	23.84	62.375	22.26	31.39	53.655
3.780506	22.52	33.48	56.000	15.78	30.22	46.000
29.574638	36.29	23.71	60.000	29.85	20.15	50.000
29.832094	36.20	23.80	60.000	29.77	20.23	50.000

#### 8.3.1.6 Measurement location and Equipment list

G 1	G 2	F 21
-----	-----	------

#### 8.3.1.7 Version of test software

Software version: TILE 7.3.0.15

#### 8.3.1.8 Calibration Information

Device	Serial number	Internal number	Calibration valid until	Calibration interval
ESR3	102981	300006318	12 / 2025	12 months
VISN ESH 3-Z5	893045/004	300000584	12 / 2025	24 months

Remarks: All emission components and the shielded room were checked weekly  
Cable loss: 0.6 to 2.4 dB (150kHz to 30 MHz)

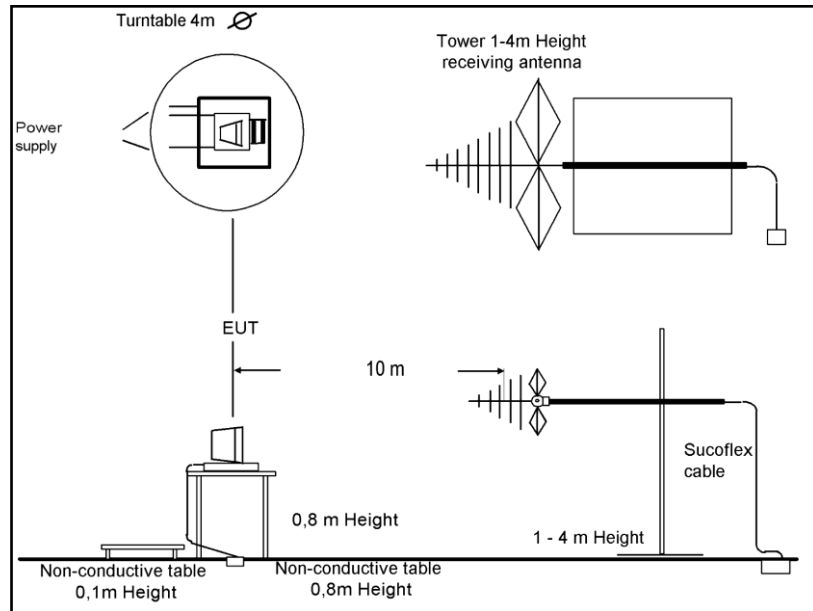
#### 8.3.1.9 Test Set-up Pictures (examples)

See Annex 102

### 8.3.2 Electromagnetic Radiated Emissions (distance 10 m)

#### 8.3.2.1 Description of the general test setup and methodology

Schematic:



#### 8.3.2.2 Sequence of testing:

##### Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a nonconducting table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

##### Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

##### Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position  $\pm 45^\circ$  and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

#### 8.3.2.3 Signal strength calculation:

Calculation formula:

$$SS = U_R + CL + AF$$

#### List of abbreviations:

SS	▶	signal strength
$U_R$	▶	voltage at the receiver
CL	▶	loss of the cable
AF	▶	antenna factor

#### List with correction factors:

Frequency [MHz]	CL [dB]	AF [1/m]
30	0.2	12.3
100	0.6	11.3
200	1.1	10.6
300	1.3	13.2
400	1.6	15.3
500	1.9	16.8
600	2	18.8
700	2.2	20.3
800	2.3	21.5
900	2.4	22.8
1000	2.5	23.3

#### Example calculation:

For example at 500 MHz the measured Voltage ( $U_R$ ) is 12.35 dB $\mu$ V, the loss of the cable (CL) is 1.9 dB and the antenna factor (AF) is 16.8 dB ( $m^{-1}$ ) the final result will be calculated:

$$SS [dB\mu V/m] = 12.35 [dB\mu V] + 1.9 [dB] + 16.8 [dB (m^{-1})] = \underline{31.05 [dB\mu V/m]} \quad (35.69 \mu V/m)$$

### 8.3.2.4 Limits

Frequency Range	FCC part 15 B Class B @ 10 m *	FCC part 15 B Class A @ 10 m
	QP	QP
30 MHz – 88 MHz	<b>30 dB<math>\mu</math>V/m</b>	39.1 dB $\mu$ V/m
88 MHz – 216 MHz	<b>33.5 dB<math>\mu</math>V/m</b>	43.5 dB $\mu$ V/m
216 MHz – 960 MHz	<b>36 dB<math>\mu</math>V/m</b>	46.4 dB $\mu$ V/m
above 960 MHz	<b>44 dB<math>\mu</math>V/m</b>	49.5 dB $\mu$ V/m

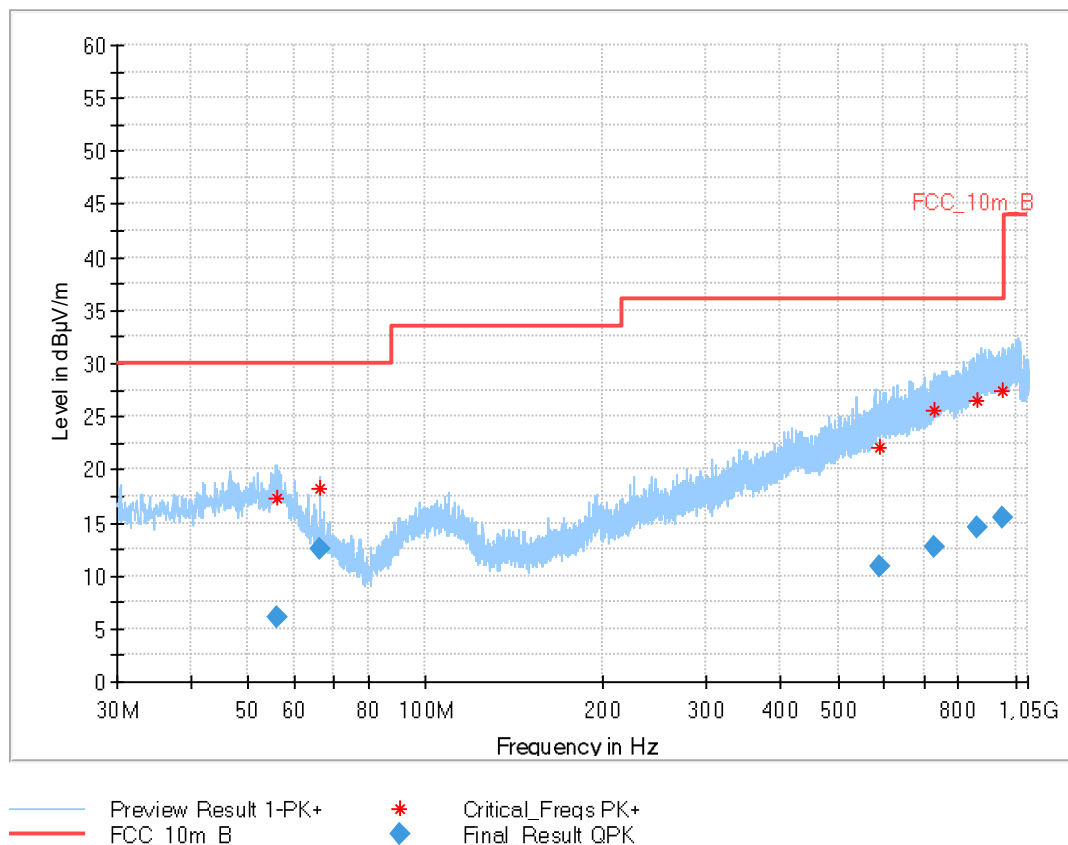
\* These values are recalculated from the class B limits at 3 m antenna distance in §15.109 (g 2) of the FCC rules.

### 8.3.2.5 Result / Test Plan

<b>EUT set-up</b>	set. 1		
Operating mode	Application	Limit	Result
op. 1	Enclosure	FCC part 15 B Class B	passed
<b>Remarks:</b>	Powered by external power supply (120 V / 60 Hz). The stricter limit of Class B was used for the Test class A is also fulfilled.		
<b>EUT set-up</b>	set. 2		
Operating mode	Application	Limit	Result
op. 2	Enclosure	FCC part 15 B Class B	passed
<b>Remarks:</b>	Powered by external power supply (120 V / 60 Hz). The stricter limit of Class B was used for the Test class A is also fulfilled.		

### 8.3.2.6 Measurement Protocol(s)

EUT:	Set.1
Serial number:	0000B
Test description:	FCC Part 15 B Class B
Operating condition:	Op.1
Operator name:	SCR
Comment:	DC 12V

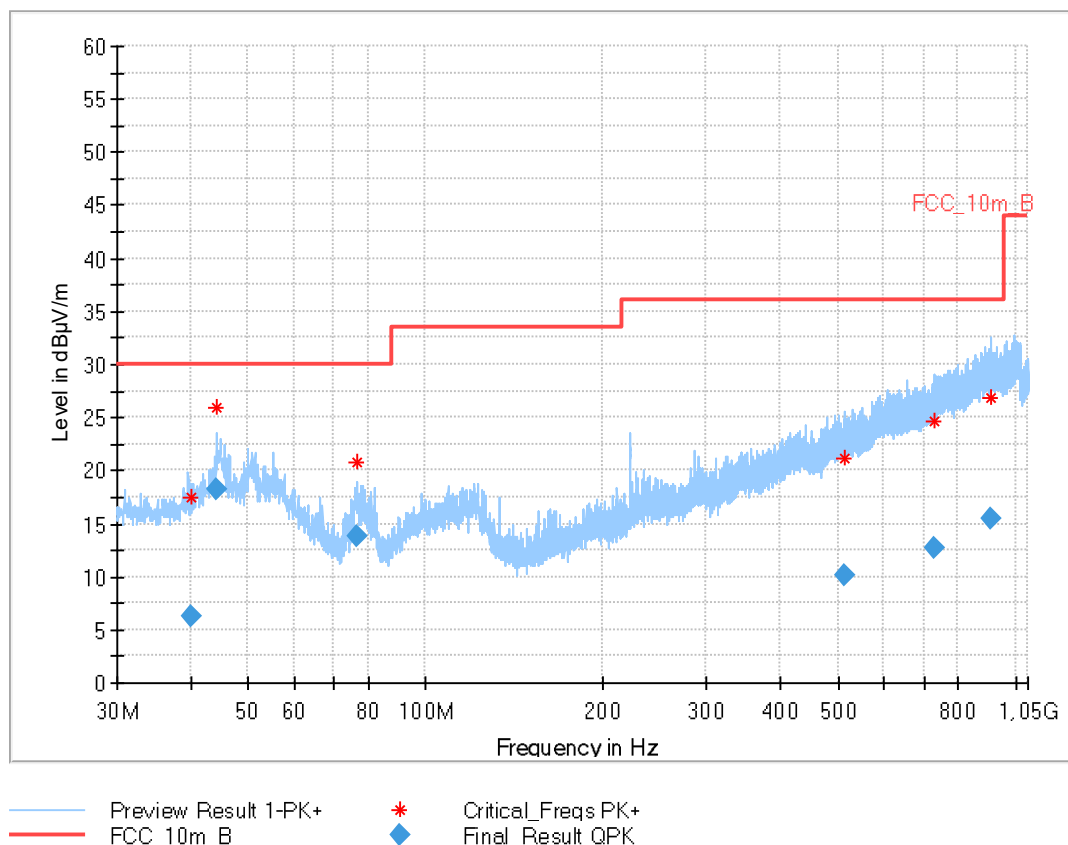


## Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
55.852	6.07	30.0	23.9	1000	120.0	146.0	V	168	16
66.365	12.47	30.0	17.5	1000	120.0	351.0	V	241	12
590.246	10.77	36.0	25.2	1000	120.0	343.0	H	120	21
728.052	12.73	36.0	23.3	1000	120.0	239.0	H	162	23
862.286	14.47	36.0	21.5	1000	120.0	177.0	V	317	25
950.606	15.40	36.0	20.6	1000	120.0	343.0	H	2	25



EUT:	Set.2
Serial number:	0000B
Test description:	FCC Part 15 B Class B
Operating condition:	Op.2
Operator name:	SCR
Comment:	USB powered



## Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
39.987	6.18	30.0	23.8	1000	120.0	171.0	V	188	14
44.254	18.21	30.0	11.8	1000	120.0	110.0	V	90	15
76.562	13.87	30.0	16.1	1000	120.0	313.0	V	111	8
515.121	10.14	36.0	25.9	1000	120.0	206.0	H	225	20
728.355	12.78	36.0	23.2	1000	120.0	290.0	V	180	23
909.812	15.37	36.0	20.6	1000	120.0	338.0	H	215	25

### 8.3.2.7 Measurement location and Equipment list

F 1	F 2	F 4b	F 5	F 6	F 7	F 8	F21
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### 8.3.2.8 Calibration Information

Device	Serial number	Internal Number	Calibration valid until	Calibration interval
ESR 3	1316.3003K03-102587-ct	300005771	12 / 2025	12 months
Trilog Antenna	9163-0216	300003288	09 / 2025	24 months

Remarks: System check of all relevant devices and the chamber (weekly)

### 8.3.2.9 Hardware Set-up:

Frequency Range:	30 MHz - 2 GHz
Receiver:	ESR 3 [ESR 3] @ GPIB0 (ADR 20), SN 1316.3003K03/102587, FW 3.66 SP2
Signal Path:	without Notch
Antenna:	VULB 9163
Antenna Tower:	Tower [EMCO 2090 Antenna Tower]
Turntable:	Turntable [EMCO Turntable]
Software version:	EMC32 V10.59.0

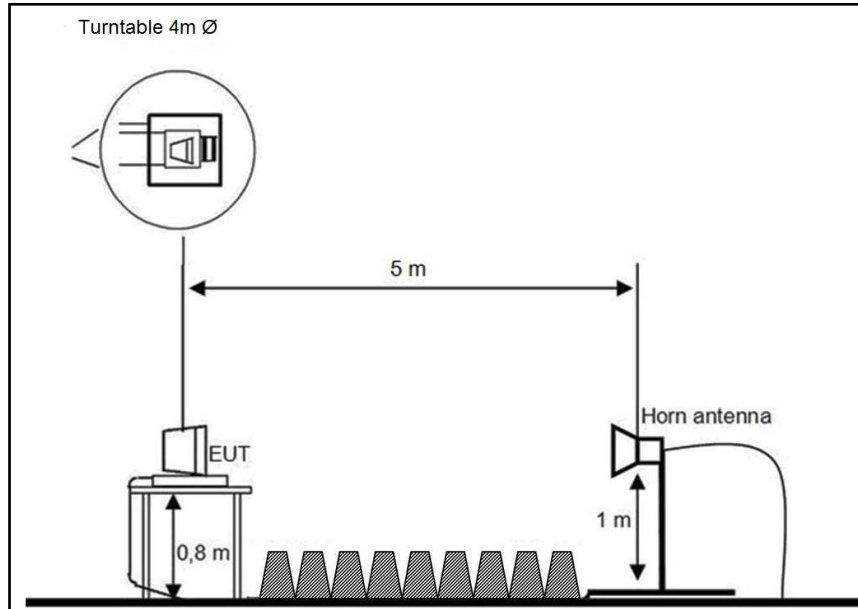
### 8.3.2.10 Test Set-up Pictures (examples)

SEE Annex A 102

### 8.3.3 Electromagnetic Radiated Emissions (distance 5 m)

#### 8.3.3.1 Description of the general test setup and methodology

Schematic:



#### 8.3.3.2 Sequence of testing

##### Setup

- The Equipment was setup to simulate a typical usage like described in the user manual / or described by manufacturer.
- If the EUT is a tabletop system, a nonconducting table with 0,8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is: (see ANSI C 63.4)  
< 18 GHz = 5 m
- The EUT was set into operation.

##### Premeasurement

- The turntable rotates continuous from 0° to 360°
- The antenna is polarized vertical and horizontal.
- In accordance to the antenna beam and the size of the EUT the antenna height changes in 30 cm steps, start at 1 meter. If it is not possible to tilt the emissions will be checked with a manually tilted antenna from top side.
- The analyzer scans quickly to find the maximum emissions of the EUT

##### Final measurement

- The final measurement will be performed with minimum the six highest peaks (depends on emissions and number of measured points below 1 GHz)
- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position ( $\pm 45^\circ$ ).
- The final measurement will be done with AV (Average / see ANSI C 63.4) detector
- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit, and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

### 8.3.3.3 Signal strength calculation

$$SS = U_R + CL + AF + PA + DC$$

#### List of abbreviations:

SS	▶	signal strength
$U_R$	▶	voltage at the receiver
CL	▶	loss of the cable and gain of the preamp
AF	▶	antenna factor
DC	▶	distance correction (results measured on 5 m calculated to 3 m)

List with correction factors: column CL in table contains cable factor and preamplifier correction

Frequency [GHz]	CL [dB]	AF [dB1/m]	DC [dB]
1	-35.5	24.4	4.4
1.5	-35.2	25.1	4.4
2	-35.1	27.4	4.4
2.5	-35	28.5	4.4
3	-34.7	30.2	4.4
3.5	-34.8	31.2	4.4
4	-35	32.6	4.4
4.5	-34.9	32.5	4.4
5	-34.8	33.4	4.4
5.5	-34.35	34.1	4.4
6	-34	34.4	4.4
6.5	-33.5	34.5	4.4
7	-33.1	35.5	4.4
7.5	-33.4	36.5	4.4
8	-33.8	36.9	4.4
8.5	-33.75	37.2	4.4
9	-33.7	37.4	4.4
9.5	-33.5	37.5	4.4
10	-33.4	37.9	4.4
11	-35.9	38.3	4.4
12	-34.4	39.1	4.4
13	-37.3	39.3	4.4
14	-36.2	41.3	4.4
15	-36.9	40.1	4.4
16	-34.9	37.6	4.4
17	-35.6	40.8	4.4
18	-35.7	45.7	4.4

#### Example calculation:

For example at 4 GHz the measured Voltage ( $U_R$ ) is 46.13 dB $\mu$ V, the loss of the cable (CL) is -35 dB, the antenna factor (AF) is 32.6 dB(m-1) and the distance correction (DC) is 4.4 dB the final result will be calculated:

$$SS \text{ [dB}\mu\text{V/m]} = 46.13 \text{ [dB}\mu\text{V]} + (-35) \text{ [dB]} + 32.6 \text{ [dB(m-1)]} + 4.4 \text{ [dB]} = 48.13 \text{ [dB}\mu\text{V/m]} \text{ (202.53 } \mu\text{V/m)}$$

### 8.3.3.4 Limits

Frequency range	47CFR15: (FCC part 15 B) Class B @ 3 m	47CFR15: (FCC part 15 B) Class A @ 3 m*
above 1GHz	54 dB( $\mu$ V/m)	59.5 dB( $\mu$ V/m)

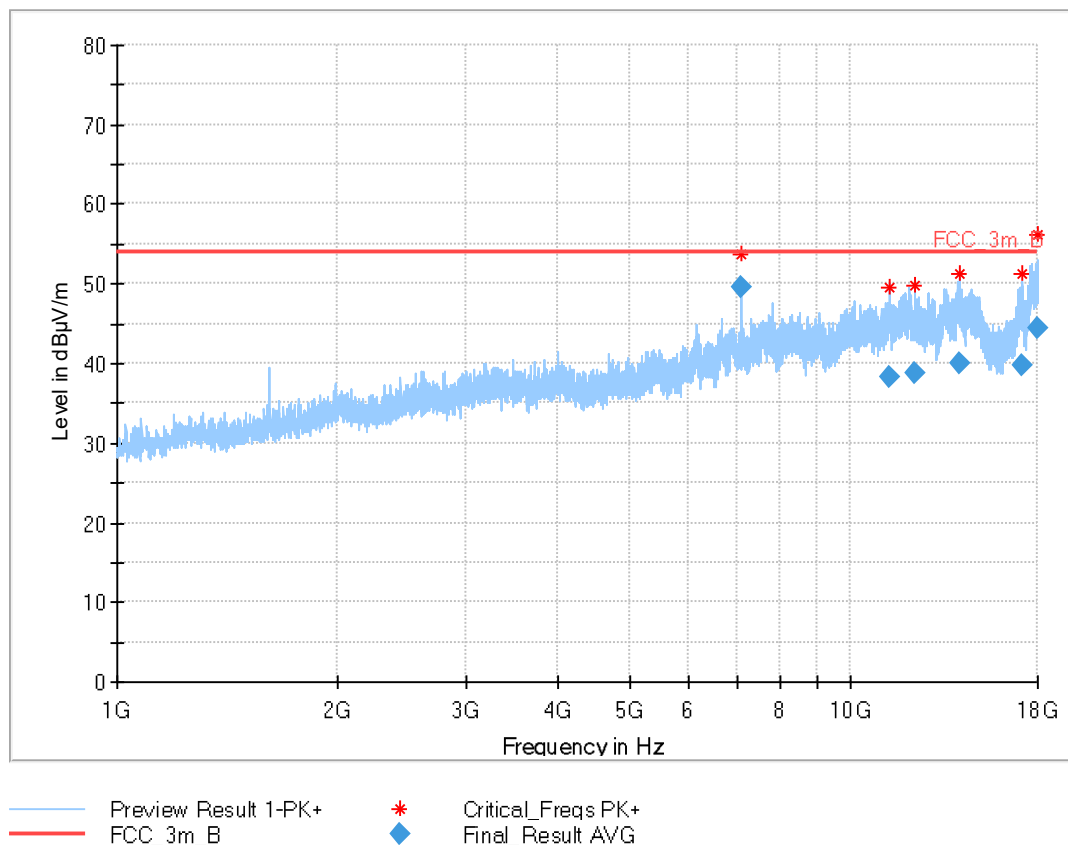
\*These values are recalculated from the class A limits at 10 m antenna distance in §15.109 (g 2) of the FCC rules.

### 8.3.3.5 Result / Test Plan

<b>EUT set-up</b>	set. 1		
<b>Operating mode</b>	<b>Application</b>	<b>Limit</b>	<b>Result</b>
op. 1	Enclosure	FCC part 15 B Class B	passed
<b>Remarks:</b>	The measured values are recalculated from 5m to 3m distance Powered by external power supply AC 120 V / 60 Hz. The stricter limit of Class B was used for the Test class A is also fulfilled.		
<b>EUT set-up</b>	set. 2		
<b>Operating mode</b>	<b>Application</b>	<b>Limit</b>	<b>Result</b>
op. 2	Enclosure	FCC part 15 B Class B	passed
<b>Remarks:</b>	The measured values are recalculated from 5m to 3m distance Powered by external power supply AC 120 V / 60 Hz. The stricter limit of Class B was used for the Test class A is also fulfilled.		

### 8.3.3.6 Measurement Protocol(s)

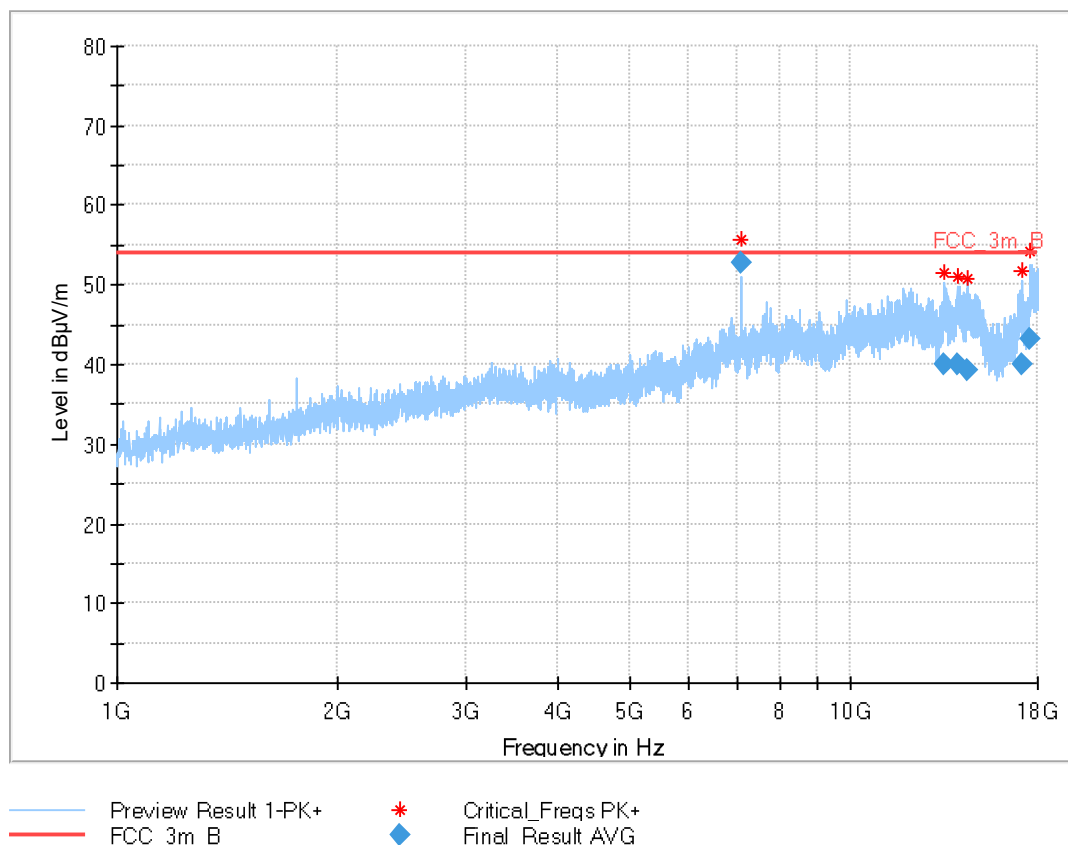
EUT:	Set.1
Serial number:	0000B
Test description:	FCC Part 15 B Class B
Operating condition:	Op.1
Operator name:	SCR
Comment:	DC 12V



## Final Result

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
7089.810	49.47	54.0	4.5	1000	1000.0	V	250	4	
11296.390	38.26	54.0	15.7	1000	1000.0	V	340	9	
12269.449	38.88	54.0	15.1	1000	1000.0	H	105	10	
14095.373	39.89	54.0	14.1	1000	1000.0	V	303	12	
17143.200	39.69	54.0	14.3	1000	1000.0	H	53	14	
17959.560	44.32	54.0	9.7	1000	1000.0	H	198	20	

EUT:	Set.2
Serial number:	0000B
Test description:	FCC Part 15 B Class B
Operating condition:	Op.2
Operator name:	SCR
Comment:	USB powered



## Final Result

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
7089.793	52.71	54.0	1.3	1000	1000.0	V	248	4	
13429.585	40.08	54.0	13.9	1000	1000.0	H	265	11	
14042.673	39.98	54.0	14.0	1000	1000.0	V	255	12	
14462.190	39.32	54.0	14.7	1000	1000.0	H	11	12	
17137.372	40.12	54.0	13.9	1000	1000.0	H	155	14	
17578.685	43.17	54.0	10.8	1000	1000.0	V	196	16	

### 8.3.3.7 Instrumentation for test (see equipment list)

F 1	F 6	F 21	F 30	F 32	F 33	F21
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### 8.3.3.8 Calibration Information

Device	Serial number	Internal Number	Calibration valid until	Calibration interval
FSU 26	200809	300003874	12/2025	12 months
Horn Antenna	9709-5289	300000213	09/2026	24 months

Remarks: System check of all relevant devices and the chamber (weekly)

### 8.3.3.9 Hardware Set-up:

Frequency Range:	1 GHz - 18 GHz
Receiver:	FSU 26 [FSU 26] @ GPIB0 (ADR 17), SN 200809/026, FW 4.71
Signal Path:	1_6_EN
Antenna:	Horn Antenna EMCO 3115
Turntable:	Turntable [EMCO Turntable]
Software version:	EMC32 V10.59.0

### 8.3.3.10 Test Set-up Pictures (examples)

See ANNEX A102



## 8.4 Observations

No observations, exceeding those reported with the single test cases, have been made.

## 8.5 Test equipment and ancillaries used for tests

To simplify the identification of the test equipment and/or ancillaries which were used, the reporting of the relevant test cases only refer to the test item number as specified in the table below.

No.	Instrument / Ancillary	Manufacturer	Type	Serial-No.	Internal-No.
<i>Conducted emission in chamber G</i>					
G 1	EMI Receiver	Rohde & Schwarz	ESR3	102981	300006318
G 2	V-ISO	Rohde & Schwarz	ESH 3-Z5	892475/017	300002209
G 2a	V-ISO	Rohde & Schwarz	ESH 2-Z5	892602/024	300000587
G 3	2-Wire ISO	Schaffner	ISO T200	19075	300003422
G 4	4-Wire ISO	Schaffner	ISO T400	22325	300003423
G 5	Shielded wire ISO	Schaffner	ISO ST08	22583	300003433
G 6	Unshielded 8 wire ISO	Teseq	ISO T800	26113	300003833
G 7	Unshielded 8 wire ISO	Teseq	ISO T8-Cat. 6	26374	300003851
G 8	2-Wire ISO	Teseq	ISO T200A	30506	
G 9	RF Current probe	Solar	9134-1	100254	300004163
<i>Conducted immunity in chamber G</i>					
G 11	Signal generator	Rohde & Schwarz	SMG	8610647025	300000204.01
G 12	RF-Amplifier	BONN	BSA 0125-75	066502-01	300003545
G 13	Power Meter	Rohde & Schwarz	URV 5	837723/025	300002844.01
G 14	Power Sensor	Rohde & Schwarz	URV 5-Z2	839080/005	300002844
G 15	Directional coupler	emv	DC 2000	9401-1677	300000592
G 16	Attenuator 6dB	Alan	50HP6-100 N	121048 0348	300003148
G 17	EM-Injection Clamp	FCC	203i	232	300000626
G 19	CDN	FCC	FCC-801-T2	78	300000629
G 22	CDN	FCC	FCC-801-M1	2027	300002761
G 23	CDN	TESEQ	CDN M016S	38741	300004847
G 23a	Clamp	FCC	F-130A-1	14	300003220
G 24	Transformer for 50Hz Loop Antenna	EM-Test	MC2630	0200-10	300002659.01
G 25	50Hz Loop Antenna	EM-Test	MS 100		300002659
<i>Burst, Surges, Voltage Dips and Interruptions in chamber G</i>					
G 26	Hybrid-Generator	EM-Test	UCS 500N7	P1506148835	300005070
G 27	Motor Variac	EM-Test	MV 2616	039712	300003259
G 28	Capacitive Coupling Clamp	Schaffner	CDN 804	142	300002250
G 29a	Coupling Decoupling Network	EMC-Partner	CDN-2000-06-32	158	300004108
G 29	Coupling Decoupling Network	EMC-Partner	CDN-UTP8 ED3	1503	300004752
<i>ESD in chamber G</i>					
G 30	ESD generator	Schlöder	SESD 30000	511333	300005097
<i>Emission on bench in chamber G</i>					
G 31	Absorbing Clamp	Rohde & Schwarz	MDS-21	832 231/006	300000527
<i>Generic in chamber G</i>					
G 32	power supply	Hewlett Packard	6038A	2848A06673	300001512
G 45	Waveform Generator	Keysight	33500B	MY52500745	300005409
<i>Conducted interference in chamber G</i>					
G 33	Arbitrary Function Generator	Keysight	33521B	MY52702534	300005023
G 35	Shunt	Schwarzbeck	Shunt 9570	9570118	300004107
G 36	Coupling network	EM-Test	CN 200N1	P1322118851	300004742
<i>Magnetic field immunity (50/60 Hz) in chamber G</i>					
M 2	Transformer for Loop Ant.	EM-Test	MC2630	0200-10	300002659.01
M 3	50Hz/60Hz Loop Antenna	EM-Test	MS 100		300002659
<i>Proximity magnetic field rack</i>					
M 4	Voltmeter	Rohde & Schwarz	URE 2	829935/003	300002216
M 5	Multimeter (Voltmeter)	Rohde & Schwarz	URE	871910/050	300000503
M 6	Radiating Loop	Schwarzbeck	FESP 5132	029	300004047

M 7	Amplifier	Crown Macrotech	5002VZ	8001641218	300004094
M 7b	Amplifier	Dynacord	SL900	F 01U076853	4000000200
M 8	Shunt	Schwarzbeck	Shunt 9570	9570118	300004107
M 9	Loop Antenna 0.01-120 MHz with NFC 13.56 MHz compensation network	Schwarzbeck	HFRA 5164 NFCN 1356	00011 00004	300006167

No.	Instrument / Ancillary	Manufacturer	Type	Serial-No.	Internal-No.
<i>Radiated emission in chamber F</i>					
F 1	Control Computer	F+W		2934939v001	300005258
F 2	Trilog-Antenna	Schwarzbeck	VULB 9163	371	300003854
F 4b	Switch	Netgear	GS108P	26V12A3H50336	300000368
F 5	EMI Test receiver	Rohde & Schwarz	ESR	1316.3003K03- 102587-ct	300005771
F 6	Turntable Interface-Box	EMCO / ETS-LINDGREN	Model 105637	44583	300003747
F 7	Tower/Turntable Controller	EMCO / ETS-LINDGREN	Model 2090	64672	300003746
F 8	Tower	EMCO / ETS-LINDGREN	Model 2175	64762	300003745
F 9	Ultra Notch-Filter Rejected band Ch. 62	Wainwright Instruments GmbH	WRCGV10-2363,5 2400- 2483.5-2520-60EE	9	
<i>Radiated immunity in chamber F</i>					
F 10	Control Computer	F+W		2934939v001	300005258
F 11	Signal Generator	Rohde & Schwarz	SMB 100A	1406.6000k02-113856	300005266
F 13	RF-Amplifier	Bonn	BLWA 0860-250/100D	035491	300003210
F 14	Stacked Logper Antenna	Schwarzbeck	STLP 9129	200	300006249
F 14b	Bicon-Antenna	Schwarzbeck	Balun VHBD 9134 elements BBFA 9146	3011	300005385
F 15 F 15a	RF-Amplifier Directional coupler	ar emv	1000LM20 DC 2000	20562 13082	300005334 300005334.0001
F 18	Power Meter	Rohde & Schwarz	NRP2	104973	300005114
F 19	Power sensor	Rohde & Schwarz	NRP-Z22	100227	300003686
F 20	Power sensor	Rohde & Schwarz	NRP-Z22	100234	300003687
F 35	RF- Amplifier	Bonn	BLWA 0860-250/100D	1711608	300005577
<i>Harmonics and flicker in front of chamber F</i>					
F 21	Flicker and Harmonics Test System	Spitzenberger & Spies	EMV E 5000/APS	UO2076 01/0 1023	140607311-000
F 21a	Power Supply	HBS Electronic	ACS-1600-PS	2002-001247-0	300006074
F 28	Power Supply	Hewlett Packard	6032 A	2920 A 04466	300000580
<i>Radiated emission &gt; 1GHz in chamber F</i>					
F 30	Amplifier	ProNova	0518C-138	005	F 024
F 32	Horn antenna	EMCO	3115	9709-5289	300000213
F 33	Spectrum Analyzer	Rohde & Schwarz	FSU26	200809	300003874
F 34	Loop antenna	EMCO	6502	8905-2342	300000256

- END OF TEST REPORT -