

# Test Report

*Electromagnetic Compatibility (EMC)*

HELEM2203000134-1



## TESTS ACCORDING TO FCC PART 15 B AND ISED CANADA REQUIREMENTS

Equipment Under Test:	Zenniz smart court for tennis 2.0
Model:	Indoor version
Type:	A100
Trademark:	Zenniz
Customer:	Zenniz Oy Kutomokuja 4 FI-00380 Helsinki Finland
FCC Rule Part:	FCC CFR 47 Part 15 Subpart B, Class A
IC Rule Part:	ICES-003 Issue 7, Class A

Date: 11 April 2022

Issued by:

A handwritten signature in blue ink, appearing to read 'R. Repo'.

Rauno Repo  
Senior EMC Specialist

Date: 11 April 2022

Checked by:

A handwritten signature in blue ink, appearing to read 'P. Kälviäinen'.

Pekka Kälviäinen  
Testing Engineer

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## GENERAL REMARKS

### Disclaimer

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*Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.*

**RELEASE HISTORY**

Version	Changes	Issued
1.0	Initial release	11 April 2022

## PRODUCT DESCRIPTION

### Equipment Under Test (EUT)

EUT information	
General Product Description	Zenniz smart court for tennis 2.0
Trademark	Zenniz
Model	Indoor version
Type	A100
Serial number	Main units: Z01A100J214605 Baseline cameras: Axis P3245-V: B8A44F3A05C7 and B8A44F39FCA1
Power input port type	L, N, PE
Test voltage	Tested with 120 VAC / 60 Hz)
Power Requirements	Internal power supplies by MeanWell: -LRS-350-5: 90 ~ 264 VAC or 180 ~264 VAC by switch -LRS-75-12: 85 ~ 264 VAC -LRS-75-48: 85 ~ 264 VAC Max power consumption: 500 W (230 VAC) Typical power consumption: Less than 150 W
Hardware Version (if any)	Jetson: Nov 21, 2021, Raspberry Pi: Jan 2022
Software Version (if any)	Zenniz 2.0 A100
Mechanical size of the EUT	Height: 1088 mm Width: 250 mm Length: 500 mm
Radio module or chip	AzureWave AW-CB375NF

The EUT was tested as a floor standing unit, microphones as table top units.

### General description

The EUT is a smart court for tennis and it uses sound sensors and cameras around the court to provide game tracking. It has two LED panels and a touchscreen for informing and communicating with the players. There is also a WiFi and LAN communication possibilities.

There are 2 chains of microphones. In each line there are 15 microphones in 3 groups. In each group the middle microphone is an active unit (AMU) and 4 passive units (PMU) are connected to it.

### Samples and modifications

No.	Name	Description
1	Sample 1	Test sample supplied by the customer

A ferrite core (Würth 74271112S) was added around the LAN cables near the baseline cameras. See photographs. Ferrites cores were used with radiated emission measurements 30 to 1000 MHz and with conducted emission measurements from the AC-power line.

**Product Description****Ports and cables**

Cable / Port	Description
Power supply cable	5 to 10 m long cable (L, N, PE), type F, CEE - C13
Microphone chain 1	Max 60 m long 8-wire cable containing chain of 15 microphones
Microphone chain 2	Max 60 m long 8-wire cable containing chain of 15 microphones
LAN cable	Max 20 m Cat 6
LAN cable for baseline camera 1	Max 50 m Cat 6
LAN cable for baseline camera 2	Max 50 m Cat 6

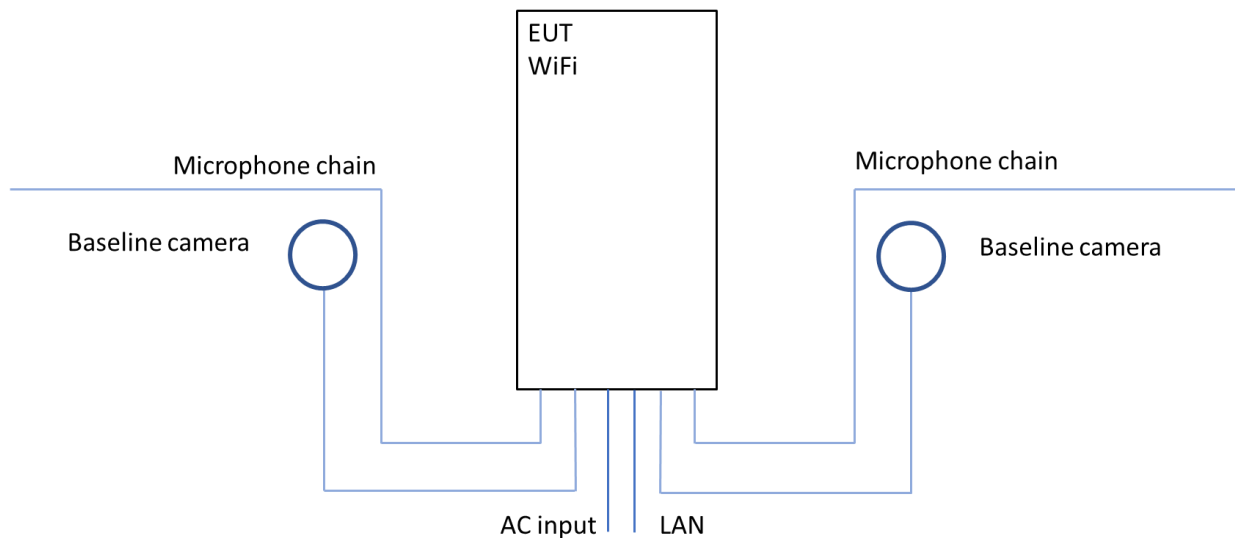
**Peripherals**

Peripheral	Description / Usage
Test PC	EUT configuration and test monitoring (supplied by the customer)
WiFi router	WiFi connection (supplied by the LAB)

## TEST CONDITION

### EUT Test Conditions During EMC-Testing

Configuration of the EUT was made to correspond to the actual assembling conditions as far as possible. The EUT was monitored with peripheral PC provided by the manufacturer and the displays were monitored visually. The WiFi was transmitting during the tests.



**Figure 1:** Test setup block diagram

### Operation modes

During the tests the EUT was in the following operation modes:

Mode	Description
1	The whole Zenniz system was inside the test chamber. Configuration test PC was outside the test chamber. WiFi TX was transmitting (2.4 GHz). The system was operational and monitored with the test PC.

### Emission Measurement Uncertainty

The uncertainties comply with CISPR 16-4-2 ed.2 requirements ( $U_{lab} < U_{CISPR}$ ).

## Summary of Testing

### SUMMARY OF TESTING

Test Specification	Description of Test	Result
FCC CFR 47 15/B §15.107, ICES-003 3.2.1	Conducted emissions, Class A	PASS
FCC CFR 47 15/B §15.109, ICES 003 3.2.2	Radiated Emissions, Class A	PASS

Decision rule used for the emission tests are defined in standard CISPR 16-4-2 / EN 55016-4-2 clause 4.2

### Test Facility

Testing Laboratory / address: FCC designation number: <b>FI0002</b> ISED CAB identifier: <b>T004</b>	SGS Fimko Ltd Takomotie 8 FI-00380, HELSINKI FINLAND
Test Site:	<input type="checkbox"/> K10LAB, ISED Canada registration number: <b>8708A-1</b> <input checked="" type="checkbox"/> K5LAB, ISED Canada registration number: <b>8708A-2</b> <input type="checkbox"/> T10LAB



## Conducted Emissions In The Frequency Range 150 kHz - 30 MHz.

### EMISSION TESTS

#### Conducted Emissions In The Frequency Range 150 kHz - 30 MHz.

<b>Standard:</b>	ANSI C63.4	(2014)
<b>Tested by:</b>	RRE	
<b>Date:</b>	30 March 2022	
<b>Humidity:</b>	30 – 60 %	
<b>Temperature:</b>	22 ± 3 °C	
<b>Barometric pressure:</b>	860 – 1 060 mbar	
<b>Measurement uncertainty:</b>	± 2.9 dB	Level of confidence 95 % (k = 2)

**FCC Rule: 15.107(a)**

**ICES-003: 3.2.1**

#### Test Plan

Conducted disturbance voltage was measured with an artificial main network from 150 kHz to 30 MHz with a resolution bandwidth of 9 kHz. Measurements were carried out with peak and average detectors from the phase(s) and neutral lines of the power supply cable.

The EUT was working as described in the section “EUT Test Conditions”. The test will pass also the B-limit. B-limit results are presented in the figure 2 and table 1.

Class B limits:

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

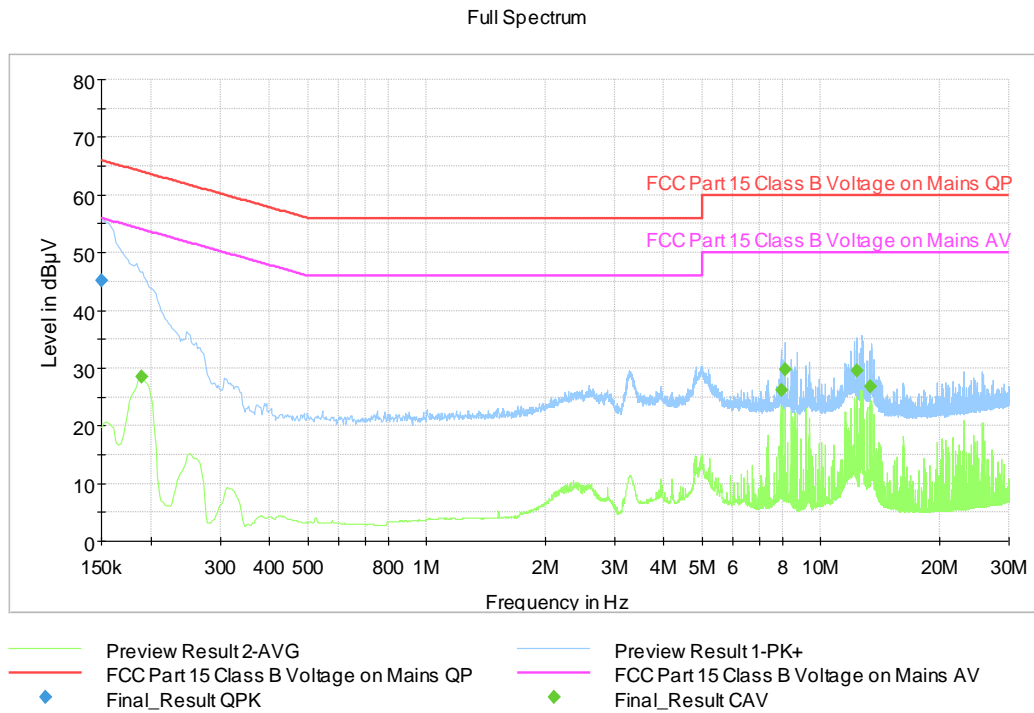
\*Decreases with the logarithm of the frequency.

Class A limits:

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	79	66
0.5-30	73	60

## Conducted Emissions In The Frequency Range 150 kHz - 30 MHz.

### Test results



**Figure 2:** The measured curves with peak-detector and average detector

### Final measurements from the worst frequencies

**Table 1:** Final results

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	CAverage (dB $\mu$ V)	B-Limit (dB $\mu$ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	45.20	---	66.00	20.80	15x1000.0	9.000	N	9.7
0.190000	---	28.57	54.04	25.47	15x1000.0	9.000	L1	9.7
7.922250	---	26.13	50.00	23.87	15x1000.0	9.000	N	10.2
8.131500	---	29.72	50.00	20.28	15x1000.0	9.000	N	10.2
12.331750	---	29.59	50.00	20.41	15x1000.0	9.000	N	10.3
13.378500	---	26.83	50.00	23.17	15x1000.0	9.000	L1	10.4

Correction factor (dB) in the final result tables contains the sum of the transducers (cables + transient limiter + LISN).

QuasiPeak and Average values are the measured values corrected with the correction factor.

## Radiated Emissions In The Frequency Range 30 MHz - 26500 MHz.

### Radiated Emissions In The Frequency Range 30 MHz - 26500 MHz.

<b>Standard:</b>	ANSI C63.4 (2014)	
<b>Tested by:</b>	RRE	
<b>Date:</b>	29 March 2022	
<b>Humidity:</b>	30 – 60 %	
<b>Temperature:</b>	22 ± 3 °C	
<b>Barometric pressure:</b>	860 – 1 060 mbar	
<b>Measurement uncertainty:</b>	± 4.9 dB (30 – 200 MHz)	Level of confidence 95 % (k = 2).
	± 4.1 dB (200 – 1 000 MHz)	
	± 4.3 dB (1 – 18 GHz)	

**FCC Rule: 15.109(a)**

**ICES-003: 3.2.2**

#### Test plan

The radiated emission measurements were done within a semi anechoic screened chamber. Additional floor absorbers were used on the floor between the EUT and receiving antenna in radiated emission test above 1 GHz. The EUT was placed on an insulated support plate above the reflecting ground plane. The microphones and the baseline cameras were on a table 80 cm above the ground plane. The measurement distance was 3 m. The worst interferences were determined during measurements by rotating the turntable and adjusting the antenna height. The measurements were done in horizontal and vertical antenna polarizations. The supply voltage to the turntable was fed through the filter.

The EUT was working as described in the section “EUT Test Conditions”. Test results 30-1000 MHz are presented with A-limits and 1 - 26.5 GHz are presented with B-limits.

#### Radiated measurement settings

##### Preliminary testing:

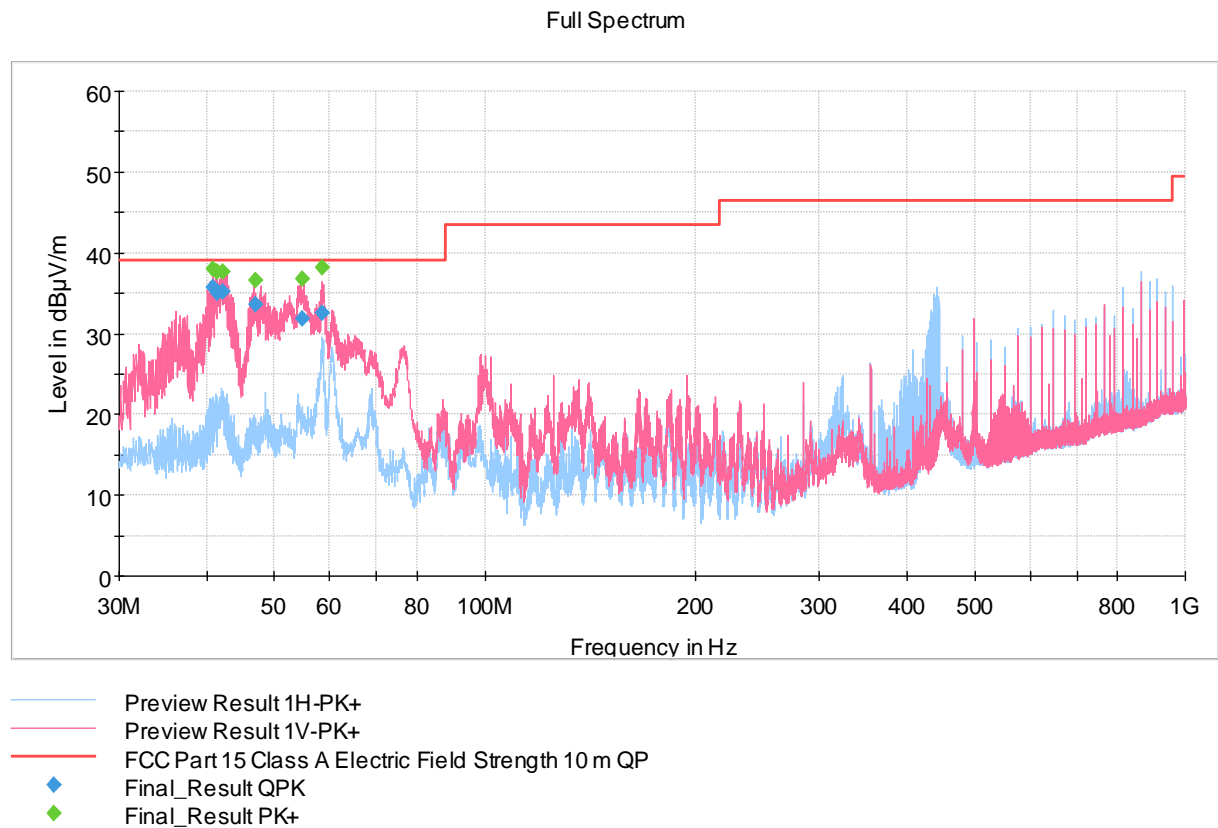
Turntable movement:	30 ° step
Turntable position:	0 ° to 330°
Antenna movement:	1.5 m step
Antenna height:	1.0 m to 4.0 m
Antenna polarization:	Vertical and horizontal

##### Final testing:

Turntable movement:	Continuous
Turntable position:	± 15 °
Antenna movement:	Continuous
Antenna height:	± 0.75 m
Antenna polarization:	Vertical and horizontal

## Radiated Emissions In The Frequency Range 30 MHz - 26500 MHz.

### Measured Quasi-Peak Values In The Frequency Range 30 MHz - 1000 MHz.



**Figure 3:** Measured result

Peak results (green tags) are only for informative purpose.

### Final measurements

**Table 2:** Final results

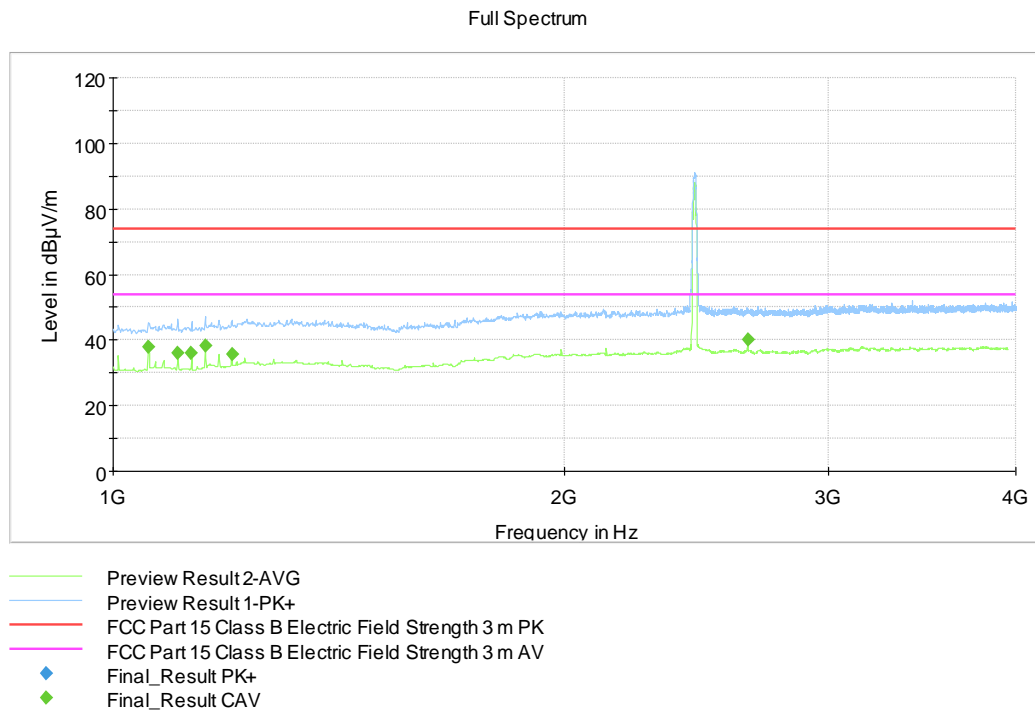
Frequency (MHz)	QuasiPeak (dBµV/m)	A-Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
40.920000	35.70	39.00	3.30	15x1000.0	120.000	100.0	V	24.0	6.8
41.440000	35.06	39.00	3.94	15x1000.0	120.000	100.0	V	345.0	6.8
42.210000	35.18	39.00	3.82	15x1000.0	120.000	122.0	V	18.0	6.9
46.970000	33.61	39.00	5.39	15x1000.0	120.000	100.0	V	40.0	7.3
54.830000	31.79	39.00	7.21	15x1000.0	120.000	116.0	V	13.0	7.4
58.520000	32.49	39.00	6.51	15x1000.0	120.000	129.0	V	0.0	7.4

Correction factor (dB) in the final result tables contains the sum of the transducers (antenna + amplifier + cables).

QuasiPeak values are measured values corrected with the correction factor.

## Radiated Emissions In The Frequency Range 30 MHz - 26500 MHz.

### Measured Peak and Average Values In The Frequency Range 1 GHz - 4 GHz.



**Figure 4:** Measured results with peak and average detector.

### Final measurements

**Table 3:** Final results

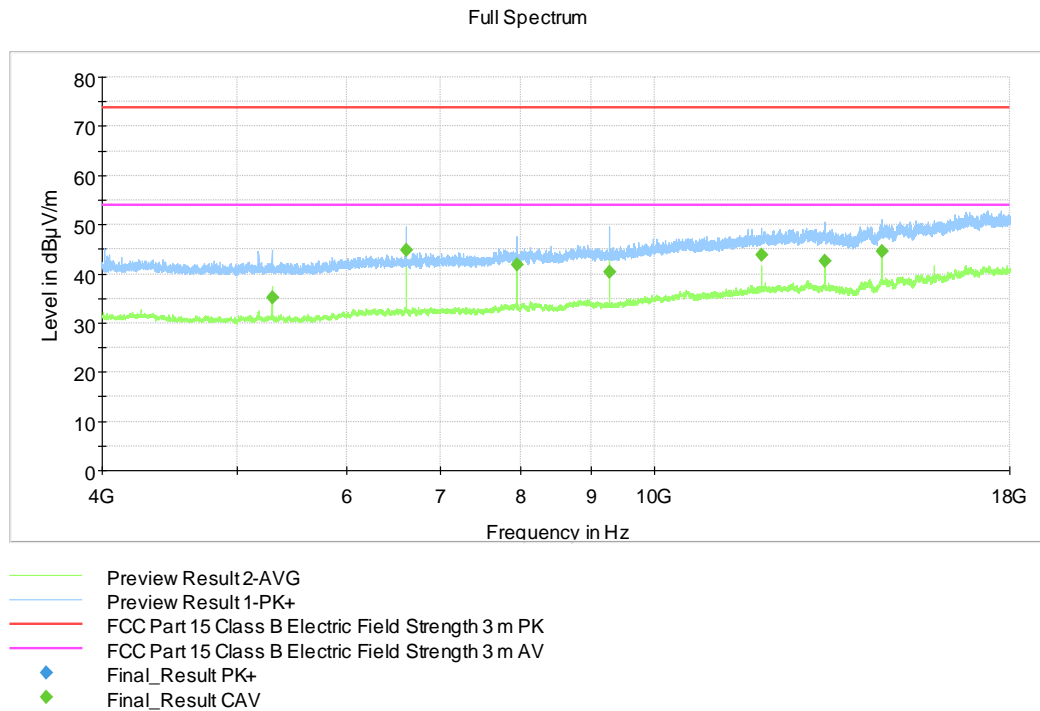
Frequency (MHz)	CAverage (dBµV/m)	B-Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1056.025000	37.89	53.90	16.01	15x1000.0	1000.000	112.0	H	215.0	7.9
1103.975000	36.15	53.90	17.75	15x1000.0	1000.000	107.0	H	144.0	7.9
1127.925000	36.09	53.90	17.81	15x1000.0	1000.000	116.0	H	86.0	7.6
1152.075000	38.23	53.90	15.67	15x1000.0	1000.000	100.0	H	287.0	8.4
1200.025000	35.76	53.90	18.14	15x1000.0	1000.000	167.0	H	119.0	9.0
2440.0 *)	Not Applicable								
2649.950000	40.18	53.90	13.72	15x1000.0	1000.000	176.0	V	158.0	14.1

Correction factor (dB) in the final result tables contains the sum of the transducers (antenna + amplifier + cables).

\*) transmitter of the EUT

## Radiated Emissions In The Frequency Range 30 MHz - 26500 MHz.

### Measured Peak and Average Values In The Frequency Range 4 GHz – 18 GHz.



**Figure 5:** Measured results with peak and average detector.

### Final measurements

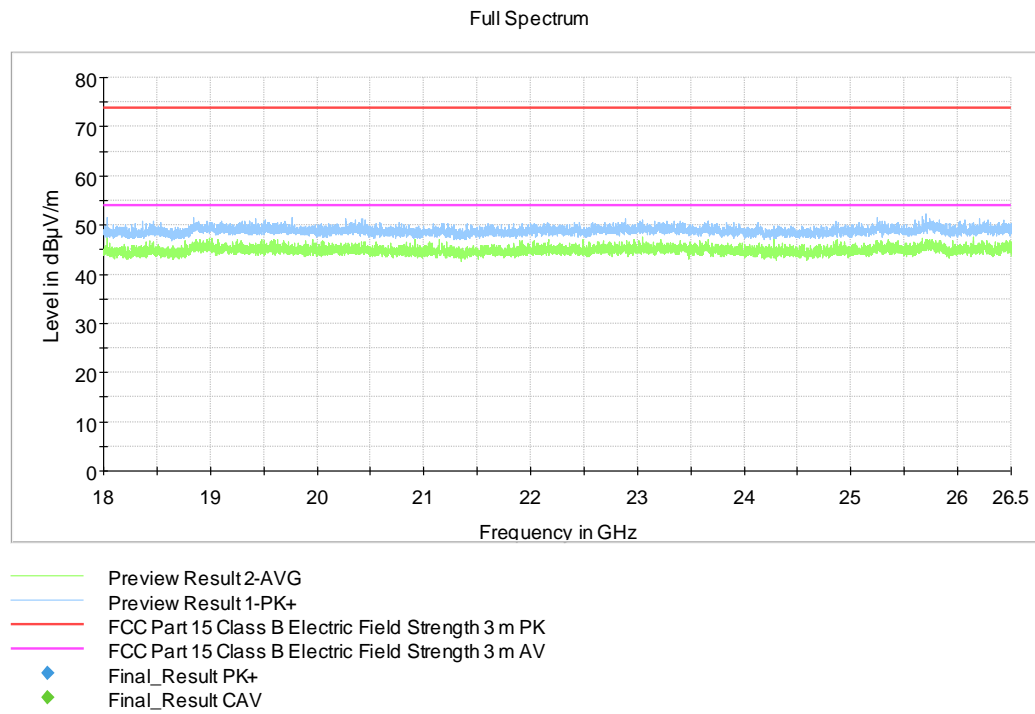
**Table 4:** Final results

Frequency (MHz)	CAverage (dBμV/m)	B-Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
5299.800000	35.07	53.90	18.83	15x1000.0	1000.000	100.0	V	157.0	8.0
6624.700000	44.85	53.90	9.05	15x1000.0	1000.000	174.0	V	163.0	10.3
7949.600000	41.89	53.90	12.01	15x1000.0	1000.000	154.0	V	131.0	11.5
9274.500000	40.34	53.90	13.56	15x1000.0	1000.000	170.0	V	221.0	13.6
11924.300000	43.83	53.90	10.07	15x1000.0	1000.000	146.0	V	131.0	17.5
13249.400000	42.72	53.90	11.18	15x1000.0	1000.000	107.0	V	144.0	17.6
14574.200000	44.59	53.90	9.31	15x1000.0	1000.000	115.0	V	67.0	19.2

Correction factor (dB) in the final result tables contains the sum of the transducers (antenna + amplifier + cables).

**Radiated Emissions In The Frequency Range 30 MHz - 26500 MHz.**

**Measured Peak and Average Values In The Frequency Range 18 – 26.5 GHz.**



**Figure 6:** Measured results with peak and average detector

## TEST EQUIPMENT

## Conducted Emissions

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	NCR
LISN	ROHDE & SCHWARZ	ENV216	inv:9611	2022-02-02	2023-02-02
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2021-06-21	2022-06-21
POWER SUPPLY	CALIFORNIA INSTR.	5001 iX Series II	inv:7826	NCR	NCR
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv:10517	2021-10-22	2022-10-22

## Radiated Emissions

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
POWER SUPPLY	CALIFORNIA INSTR.	5001 iX Series II	inv:7826	NCR	NCR
RF PREAMPLIFIER	CIAO	CA118-3123	inv:10278	2021-10-05	2022-10-05
RF PREAMPLIFIER	CIAO	CA1840-5019	inv:10593	2021-10-05	2022-10-05
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv:10517	2021-10-22	2022-10-22
ANTENNA	EMCO	3117, emi 1-18GHz	inv:9569	2021-04-09	2023-04-09
ANTENNA	EMCO	3160-09, emi 18-26.5GHz	inv:7294	2022-02-22	2023-02-22
TURNTABLE	MATURO	DS430 UPGRADED	inv:10182	NCR	NCR
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv:10183	NCR	NCR
ANTENNA MAST	MATURO	TAM 4.0E	inv:10181	NCR	NCR
ATTENUATOR	PASTERNAK	PE 7004-4 (4dB)	inv:10126	2022-02-23	2024-02-23
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	NCR
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2021-06-21	2022-06-21
ANTENNA	SCHWARZBECK	VULB 9168	inv:8911	2020-11-04	2022-11-04
FILTER	WAINWRIGHT	HP, WHKX4.0/18G-10SS	inv:10403	2021-01-29	2023-01-29
ATTENUATOR	PASTERNAK	10 dB, DC-40 GHz	sn:A1	2021-04-20	2023-04-20

NCR = No calibration required

END OF REPORT