

Test Report

Electromagnetic Compatibility (EMC)



TESTS ACCORDING TO FCC PART 15 B AND ISED CANADA REQUIREMENTS

Equipment Under Test:	Laser light source
Trademark:	CAVILUX OEM
Model:	Sapotech System
Manufacturer:	Cavitar Ltd. Kuokkamaantie 4 A FI-33800 Tampere Finland
Customer:	Cavitar Ltd. Kuokkamaantie 4 A FI-33800 Tampere Finland
FCC Rule Part:	FCC CFR 47 Part 15 Subpart B, Class A
IC Rule Part:	ICES-003 Issue 7, Class A

Date: 12 November 2021

Issued by:

A blue ink signature of Pekka Kälviäinen.

Pekka Kälviäinen
Testing Engineer

Date: 16 November 2021

Checked by:

A blue ink signature of Rauno Repo.

Rauno Repo
Senior EMC Specialist

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GENERAL REMARKS

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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	16 November 2021

PRODUCT DESCRIPTION
Equipment Under Test (EUT)

EUT information	
General Product Description	Laser light source
Trademark	CAVILUX OEM
Model	Sapotech System
Serial numbers	Laser Control Unit: 20211109LCU1 Laser Units: 20211109LU1, 20211109LU2, 20211109LU3, 20211109LU4
Power input port type	DC (Tested with AC/DC Power supply, input 120V 60Hz)
Rated voltage	24 V
Rated current	2.75 A
Rated frequency	DC
Rated power	66 W
EUT Highest operation freq.	1 MHz
Hardware Version (if any)	v3.0
Software Version (if any)	-
Mechanical size of the EUT	Laser Control Unit: Height:200 mm Length 36 mm Width:200 mm Laser Unit: Height 62 mm Length:72 mm Width 150 mm

The EUT was tested as a tabletop unit.

General description

Pulsed high power diode laser light source for the visualization of challenging processes in industrial production lines.

Samples and modifications

No.	Name	Description
1	Sample 1	Normal sample

Ports and cables

Port name and purpose	Connected from-to	Length	Type (e.g. two-wire, cat5, coax, etc.)	Shielded
AC power (120 V 60 Hz)	AC mains to AC/DC power supply	2 m	L/N/PE	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
DC Power in (24 VDC)	AC/DC power to LCU	1 m	M12-A, 4-pin (2 pin in use)	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Control and power (LU1...4)	LCU to LU	30 m	M12-A, 8-pin	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Control in (CAM1..4)	LCU to FET switch	10 m	M12-A, 4-pin	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Power out (WLS)	WLS to LCU	2 m	M16, 10-pin (4 pin in use)	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Control in (RIL)	RIL to LCU	0 m	2-pin short circuit plug	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Control in (SWITCHES)	Key Switch (ON/OFF) and Push Button (START) to LCU	1 m	M16, 10-pin (4 pin in use)	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Pulses	signal generator to FET switch	10 m	coaxial	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Peripherals

Peripheral	Description / Usage
AC/DC power supply	Phoenix Contact QUINT4-PS/1AC/24DC/40, 24 VDC to the EUT
Warning Light System (WLS)	show the operation mode of the lasers
FET switch	simulate camera interface
Key Switch (ON/OFF) Push Button (START)	control in
Remote Interlock (RIL)	control in
signal generator	Siglent SDG6032X, s/n: SDG6XBAQR0215 (located outside of the test area)

The peripherals were supplied by the customer.

TEST CONDITIONS

EUT Test Conditions During EMC-Testing

Configuration of the EUT was made to correspond to the actual assembling conditions as far as possible.

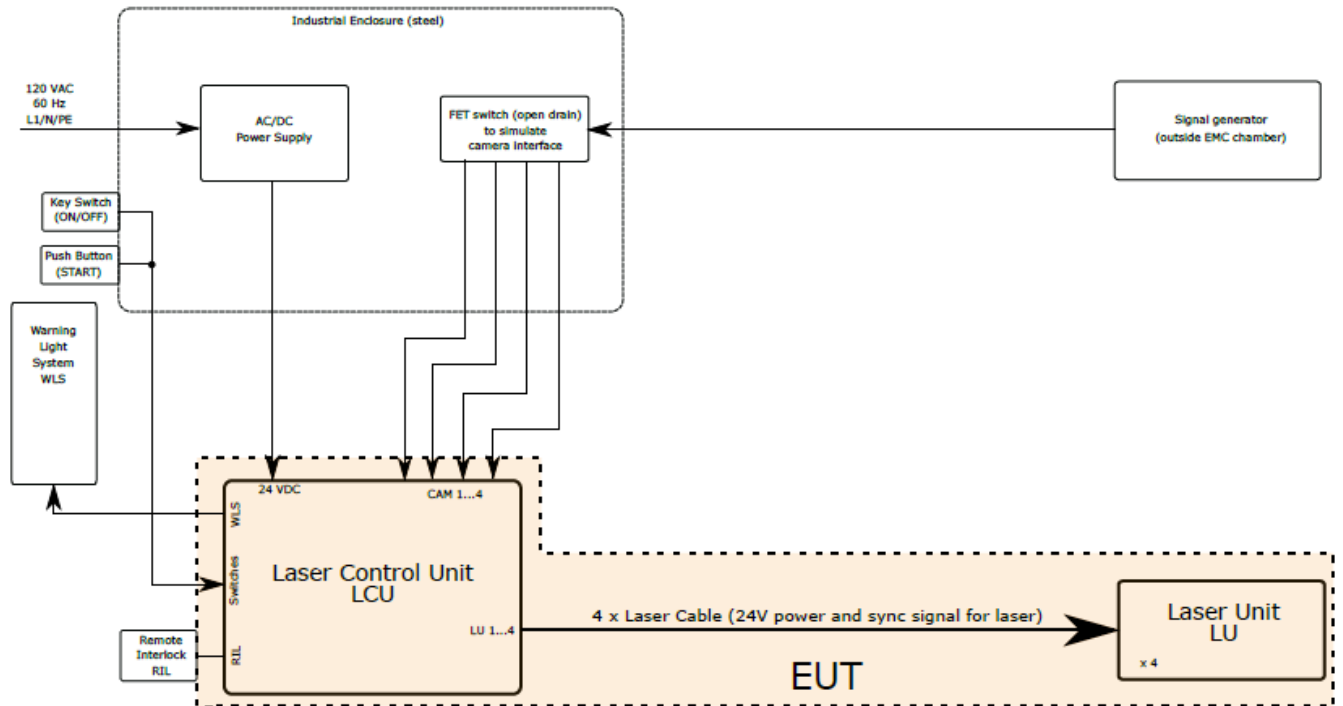


Figure 1: Test setup block diagram

Operation modes

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

Mode	Description
1	Power on, lasers operate
2	Power on, lasers stand-by

Emission Measurement Uncertainty

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

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

EMISSION TEST RESULTS

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

Standard: ANSI C63.4 (2014)
Tested by: PKA
Date: 11 November 2021
Humidity: 30 – 60 %
Temperature: 22 ± 3 °C
Barometric pressure: 860 – 1 060 mbar
Measurement uncertainty: ± 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”.

Class A limits:

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

Test results

Lasers stand-by

Full Spectrum

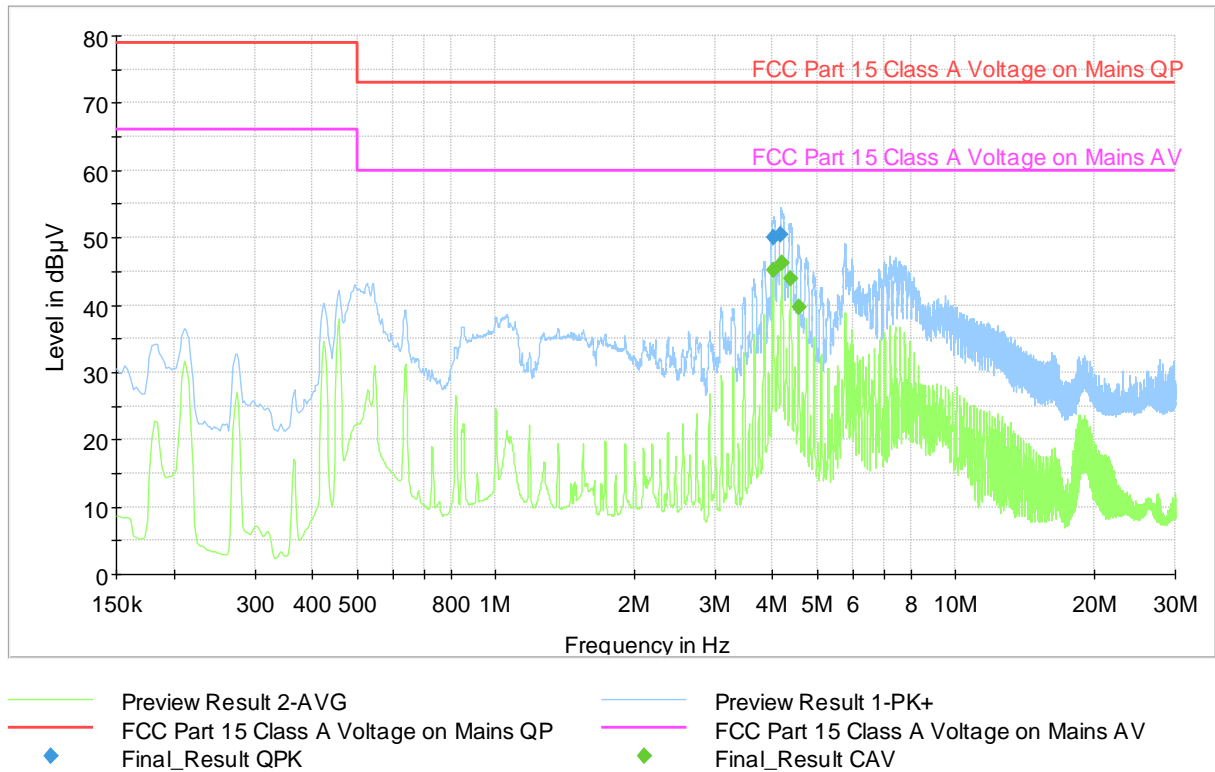


Figure 2: The measured curves with peak-detector and average detector

Final measurements from the worst frequencies

Table 1: Final quasi-peak and average measurements from the worst frequencies

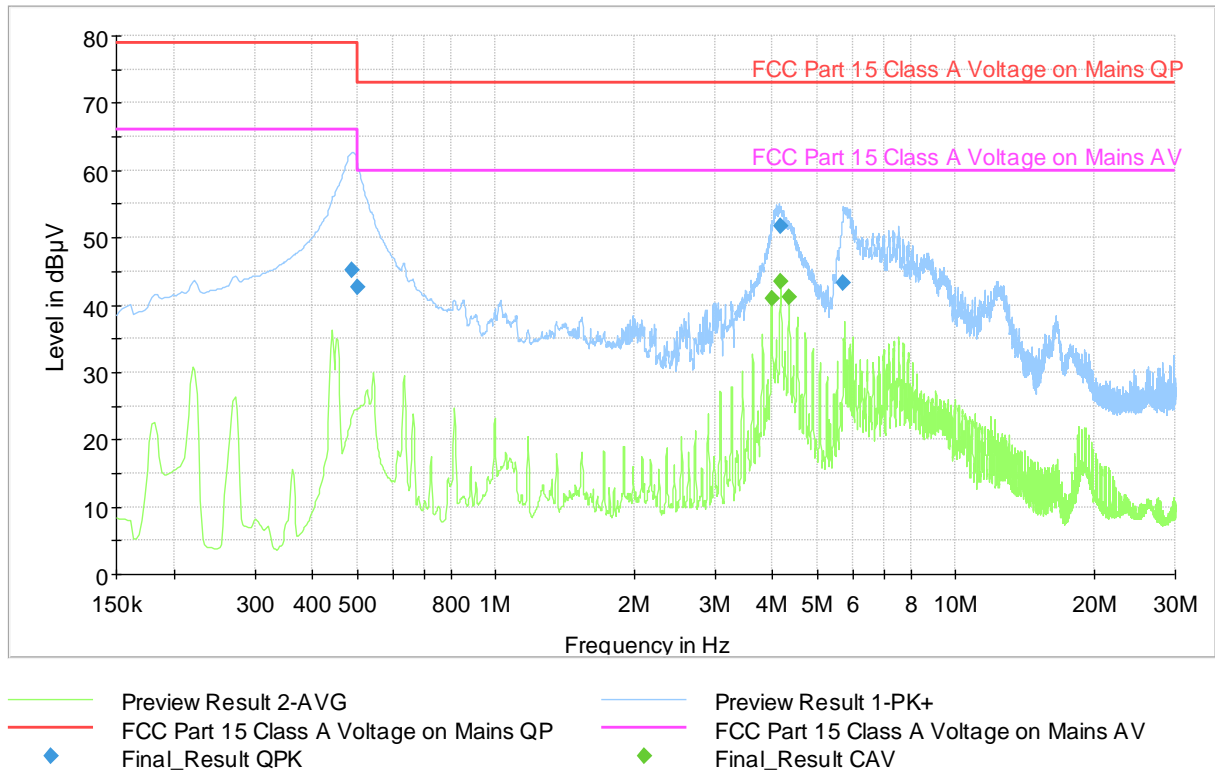
Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
4.009500	---	45.13	60.00	14.87	15x1000.0	9.000	N	ON	10.0
4.020750	49.95	---	73.00	23.05	15x1000.0	9.000	N	ON	10.0
4.178250	50.51	---	73.00	22.49	15x1000.0	9.000	N	ON	10.0
4.191750	---	46.23	60.00	13.77	15x1000.0	9.000	N	ON	10.0
4.378000	---	43.83	60.00	16.17	15x1000.0	9.000	L1	ON	10.0
4.560250	---	39.75	60.00	20.25	15x1000.0	9.000	L1	ON	10.0

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.

Lasers operate

Full Spectrum


Figure 3: The measured curves with peak-detector and average detector

Final measurements from the worst frequencies
Table 2: Final quasi-peak and average measurements from the worst frequencies

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.488000	45.17	---	79.00	33.83	15x1000.0	9.000	N	ON	9.7
0.503250	42.56	---	73.00	30.44	15x1000.0	9.000	N	ON	9.7
3.984750	---	40.99	60.00	19.01	15x1000.0	9.000	N	ON	10.0
4.160750	---	43.52	60.00	16.48	15x1000.0	9.000	N	ON	10.0
4.165250	51.65	---	73.00	21.35	15x1000.0	9.000	N	ON	10.0
4.347000	---	41.12	60.00	18.88	15x1000.0	9.000	L1	ON	10.0
5.703750	43.18	---	73.00	29.82	15x1000.0	9.000	N	ON	10.1

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 - 1000 MHz.

Standard:	ANSI C63.4 (2014)
Tested by:	PKA
Date:	11 November 2021
Humidity:	30 – 60 %
Temperature:	22 ± 3 °C
Barometric pressure:	860 – 1 060 mbar
Measurement uncertainty:	± 4.9 dB (30 – 200 MHz) Level of confidence 95 % (k = 2). ± 4.1 dB (200 – 1 000 MHz)

FCC Rule: 15.109(a)**ICES-003: 3.2.2****Test plan**

The radiated emission measurements were done within a semi anechoic screened chamber. The EUT was placed on a table 0.8 m above the reflecting ground plane. The measurement distance was 3 meters. 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”.

Radiated measurement settings**Preliminary testing:**

Turntable movement:	20 ° step
Turntable position:	10 ° to 350°
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

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

Lasers stand-by

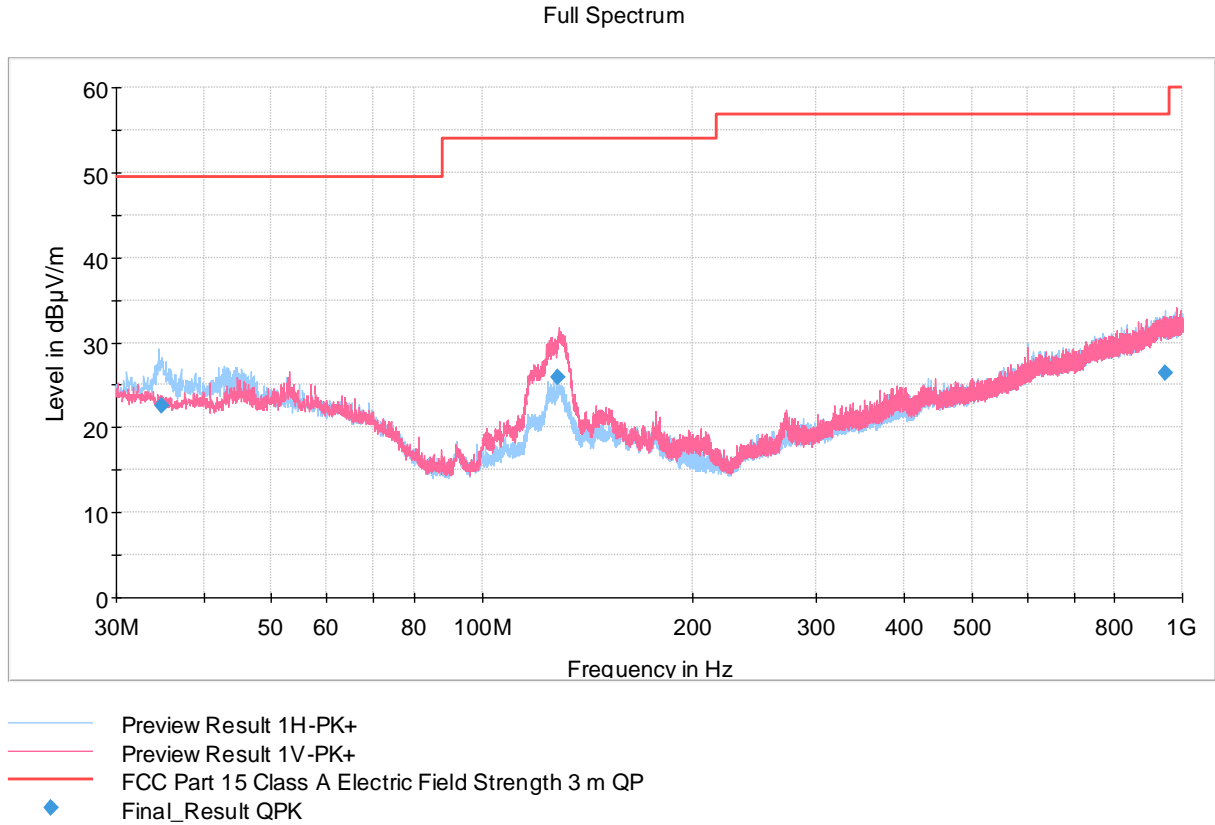


Figure 4: Measured curve with peak-detector.

Final measurements from the worst frequencies

Table 3: Final quasi-peak measurement from the worst frequencies

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
34.810000	22.55	49.49	26.94	15x1000.0	120.000	100.0	H	68.0	16.6
128.340000	25.84	53.96	28.12	15x1000.0	120.000	183.0	V	184.0	16.7
943.820000	26.40	56.86	30.46	15x1000.0	120.000	325.0	H	288.0	31.9

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.

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

Lasers operate

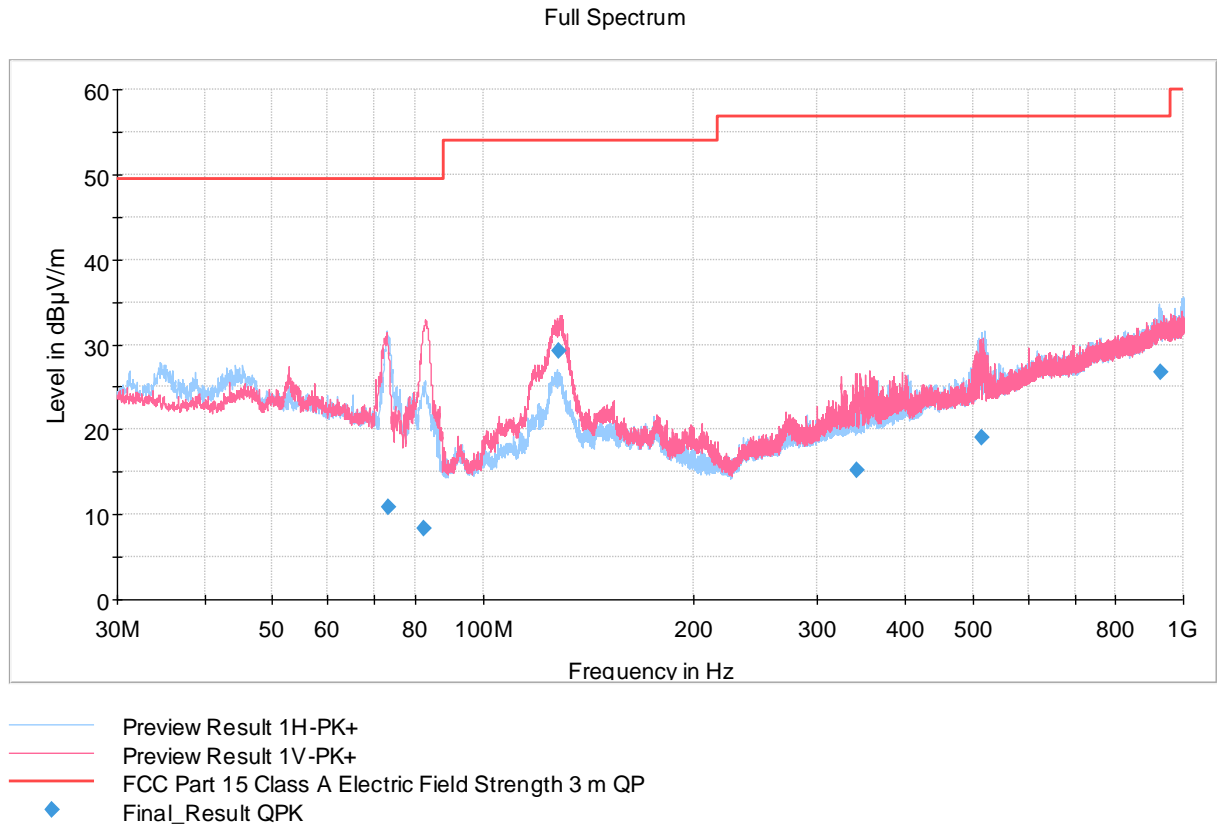


Figure 5: Measured curve with peak-detector.

Final measurements from the worst frequencies

Table 4: Final quasi-peak measurement from the worst frequencies

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
73.090000	10.85	49.47	38.62	15x1000.0	120.000	190.0	H	72.0	15.4
82.430000	8.32	49.46	41.14	15x1000.0	120.000	400.0	V	299.0	12.6
128.340000	29.26	53.96	24.70	15x1000.0	120.000	190.0	V	28.0	16.7
341.070000	15.29	56.86	41.57	15x1000.0	120.000	115.0	V	56.0	20.5
515.790000	19.12	56.86	37.74	15x1000.0	120.000	115.0	H	317.0	24.7
925.940000	26.72	56.86	30.14	15x1000.0	120.000	144.0	H	98.0	31.9

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.

TEST EQUIPMENT

Radiated Emissions

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
POWER SUPPLY TEMPERATURE/ HUMIDITY SENSOR	CALIFORNIA INSTR.	5001 iX Series II	inv:7826	NCR	NCR
TURNTABLE	EDS	OW-ENV-TH, K5 SAC	inv:10517	2021-10-22	2022-10-22
MAST & TURNTABLE CONTROLLER	MATURO	DS430 UPGRADED	inv:10182	NCR	NCR
ANTENNA MAST	MATURO	NCD	inv:10183	NCR	NCR
ATTENUATOR	MATURO	TAM 4.0E	inv:10181	NCR	NCR
TEST SOFTWARE	PASTERNAK ROHDE & SCHWARZ	PE 7004-4 (4dB) EMC-32	inv:10126 -	2021-03-26 NCR	2022-03-26 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

Conducted Emissions

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
POWER SUPPLY TEMPERATURE/ HUMIDITY SENSOR	CALIFORNIA INSTR.	5001 iX Series II	inv:7826	NCR	NCR
TEST SOFTWARE	EDS ROHDE & SCHWARZ	OW-ENV-TH, K5 SAC EMC-32	inv:10517 -	2021-10-22 NCR	2022-10-22 NCR
LISN	ROHDE & SCHWARZ	ENV216	inv:9611	2021-02-26	2022-02-26
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2021-06-21	2022-06-21

NCR = No calibration required

END OF REPORT