

# Test Report

## *Electromagnetic Compatibility (EMC)*



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

Equipment Under Test: Control Unit for Parking Heater

Model: TCon 2  
TCon 2 Pro

Manufacturer: Embelin Oy  
Yrtipellontie 10  
FI-90230, Oulu  
Finland

Customer: Embelin Oy  
Yrtipellontie 10  
FI-90230, Oulu  
Finland

FCC Rule Part: CFR 47 Part 15 Subpart B, Class B  
IC Rule Part: ICES-003, Issue 7 (2020), Class B

Date: 28 April 2021

Issued by: 

Henri Mäki  
Testing Engineer

Date: 28 April 2021

Checked by: 

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Development 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	28 April 2021

**PRODUCT DESCRIPTION****Equipment Under Test (EUT)**

<b>EUT information</b>	
General Product Description	Control Unit for Parking Heater
Trademark	-
Model	TCon 2, TCon 2 Pro
Serial number	9354679095549930
Power input port type	DC
Rated voltage	12 / 24 V
Rated current	-
Rated frequency	-
Rated power	-
EUT Highest operation freq.	2155 MHz (LTE band 4)
Hardware Version (if any)	-
Software Version (if any)	-
Mechanical size of the EUT	Height: 19 mm      Width: 71 mm      Length: 112 mm
Parallel models	-

The EUT was tested as a tabletop unit.

**General description**

The equipment under test is a control unit for parking heater. The control unit can be operated remotely with a smart phone application, or with a push button. The equipment includes an LTE Cat-M1 / NB-IoT and 2G module (u-blox AG SARA-R412M).

**Samples and modifications**

No.	Name	Description
1	TCon 2	Normal sample
2	TCon 2 Pro	Normal sample

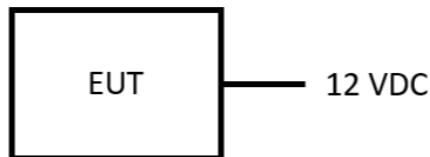
**Ports and cables**

Cable / Port	Description
DC input	Power input port

## 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. The EUT was powered on and continuously sent messages to the CAN-bus. The radio was in stand-by mode during testing. The input voltage was 12 VDC.



**Figure 1:** Test setup block diagram

### Operation modes

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

Mode	Description
1	Power on, continuous messages to the CAN-bus, radio in stand-by mode

### 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
§15.107 / ICES-003 3.2.1	Conducted Emissions, Class B	N/A
§15.109 / ICES-003 3.2.2	Radiated Emissions, Class B	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

## EMISSION TEST RESULTS

### Radiated Emissions In The Frequency Range 30 MHz – 22 GHz

<b>Standard:</b>	ANSI C63.4-2014		
<b>Tested by:</b>	HEM		
<b>Date:</b>	18 February 2021	27 April 2021	28 April 2021
<b>Temperature:</b>	22.9 °C	23.2 °C	23.0 °C
<b>Humidity:</b>	12.0 %RH	24.8 %RH	21.8 %RH
<b>Barometric pressure:</b>	1020.5 mbar	1005.6 hPa	1006.7 hPa
<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 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”.

The pre-measurements were performed with the EUT being in three orthogonal positions (X, Y, Z). Final measurements were done in worst position.

#### Radiated measurement settings

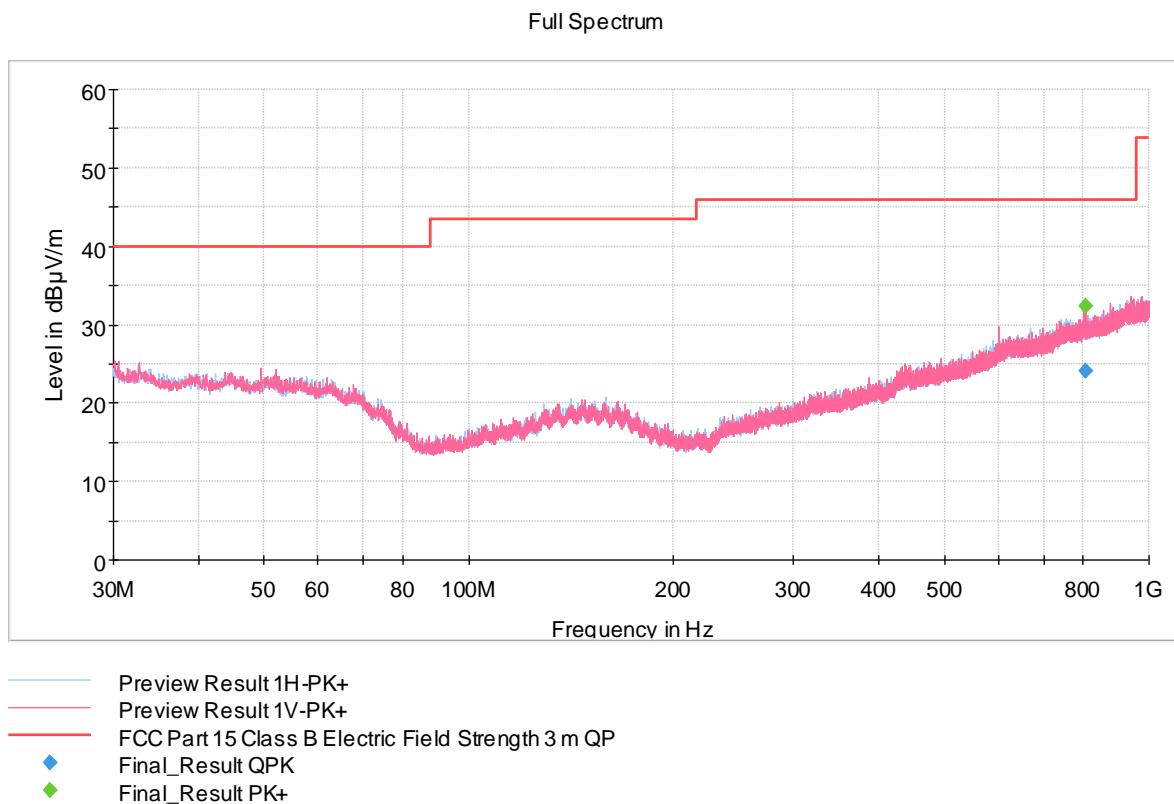
##### Preliminary testing:

Turtable movement:	30° step (30-1000 MHz), 15° step (1-18 GHz), 8° step (18-22 GHz)
Turtable position:	15° to 345° (30 MHz – 18 GHz), 0° to 352° (18-22 GHz)
Antenna movement:	1.5 m step (30 MHz – 18 GHz), 1.0 m step (18-22 GHz)
Antenna height:	1.0 m to 4.0 m (30 MHz – 18 GHz), 1.0 m to 2.0 m (18-22 GHz)
Antenna polarization:	Vertical and horizontal

##### Final testing:

Turtable movement:	Continuous
Turtable position:	± 30° (30-1000 MHz), ± 7.5° (1-18 GHz), ± 15° (18-22 GHz)
Antenna movement:	Continuous
Antenna height:	± 0.75 m (30 MHz – 18 GHz), ± 0.50 m (18-22 GHz)
Antenna polarization:	Vertical and horizontal

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

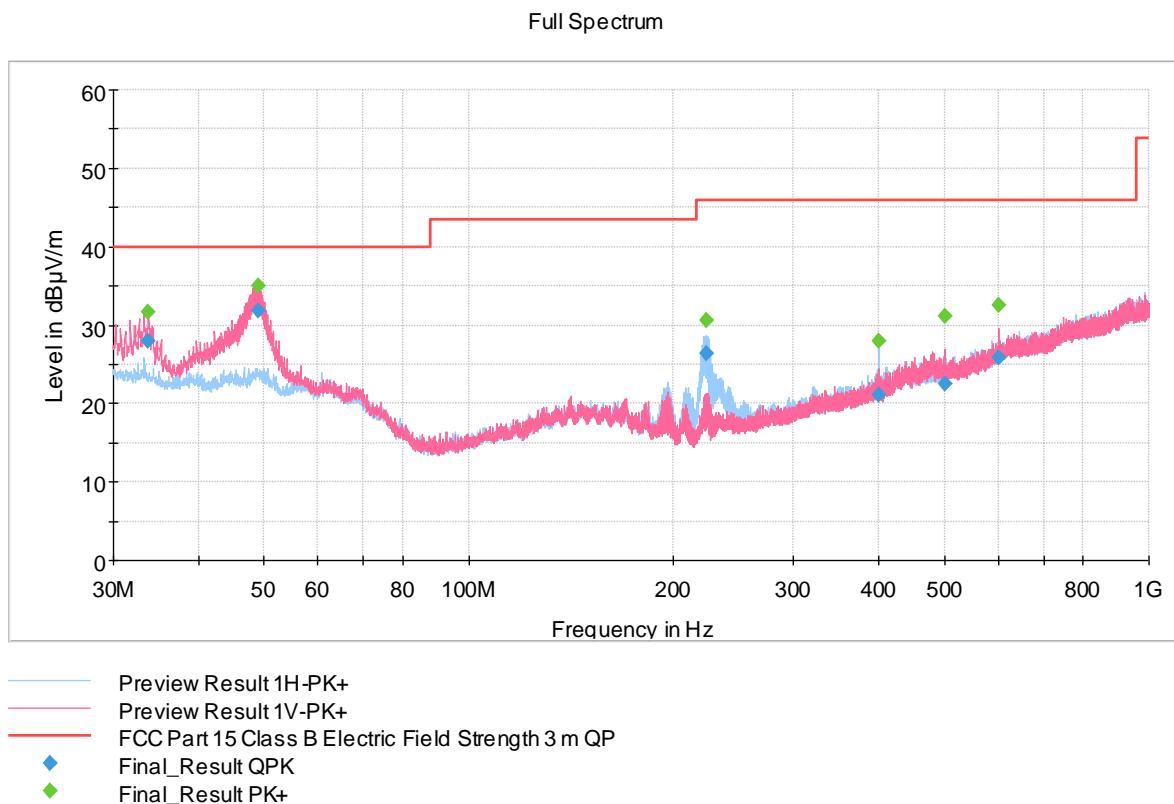


**Figure 2:** Measured curve with peak-detector, Sample 1

**Table 1:** Final quasi-peak measurement from the worst frequencies, Sample 1

Frequency (MHz)	QuasiPeak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
805.970000	24.12	46.00	21.88	1000.0	120.000	250.0	V	135.0	29.9

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



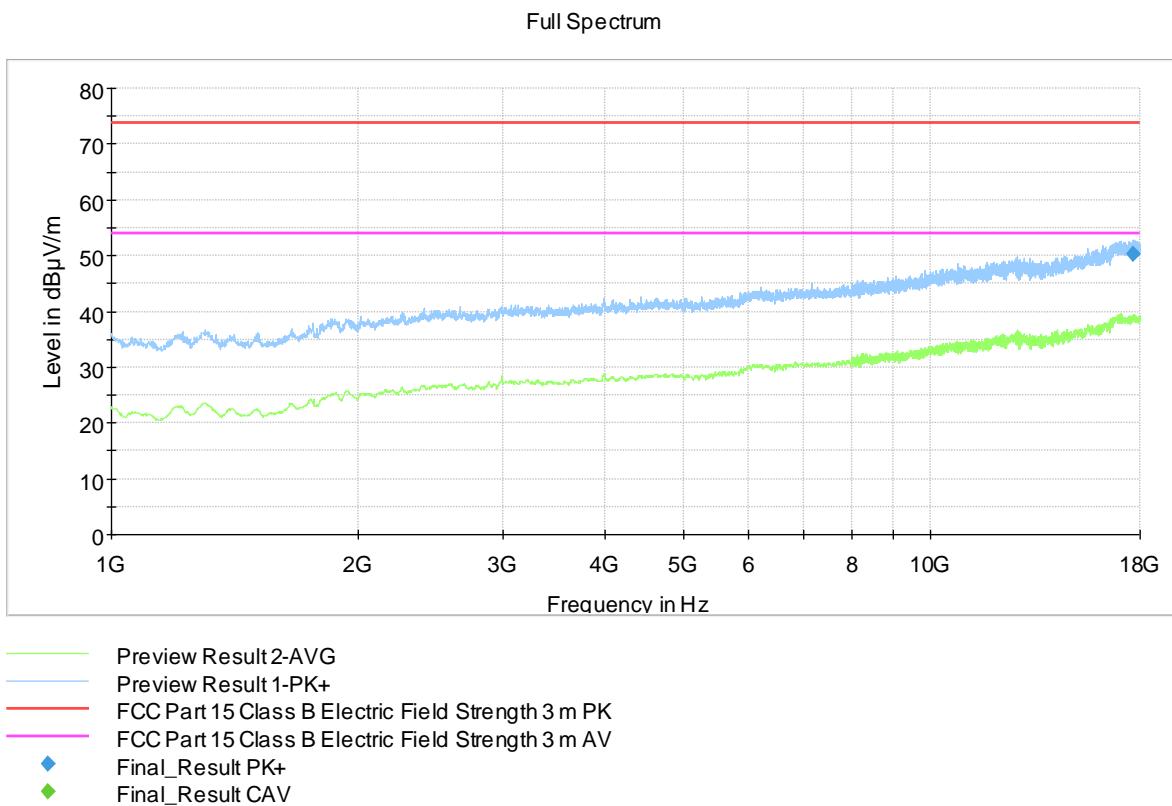
**Figure 3:** Measured curve with peak-detector, Sample 2

**Table 2:** Final quasi-peak measurement from the worst frequencies, Sample 2

Frequency (MHz)	QuasiPeak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.770000	27.97	40.00	12.03	1000.0	120.000	100.0	V	55.0	16.5
49.040000	31.79	40.00	8.21	1000.0	120.000	100.0	V	149.0	17.8
223.270000	26.38	46.00	19.62	1000.0	120.000	144.0	H	95.0	15.3
399.980000	21.04	46.00	24.96	1000.0	120.000	281.0	H	64.0	21.8
499.990000	22.49	46.00	23.51	1000.0	120.000	175.0	V	105.0	24.6
600.000000	25.82	46.00	20.18	1000.0	120.000	144.0	V	149.0	26.8

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

## Measured Peak and Average Values In The Frequency Range 1 – 18 GHz

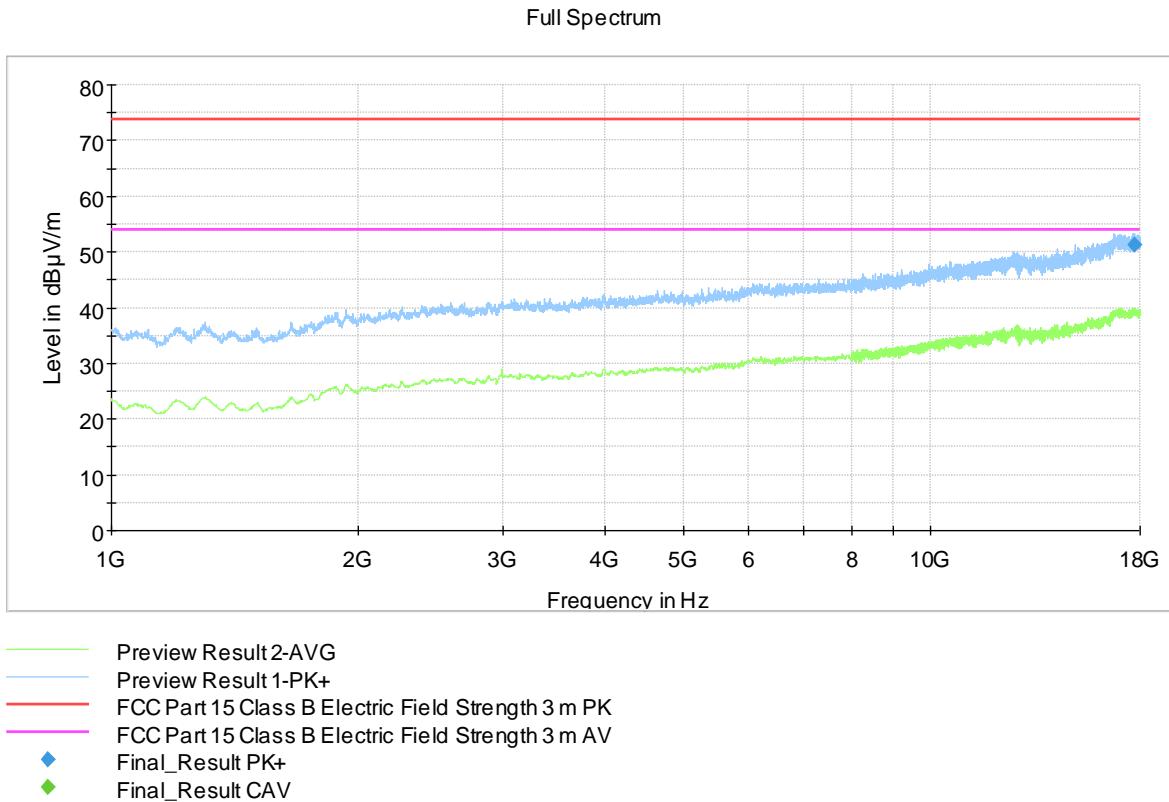


**Figure 4:** Measured curve with peak and average detectors, Sample 1

**Table 3:** Final peak and average measurement from the worst frequencies, Sample 1

Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	CAverage (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17666.875000	50.32	---	73.90	23.58	1000.0	1000.000	244.0	V	186.0	23.6

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



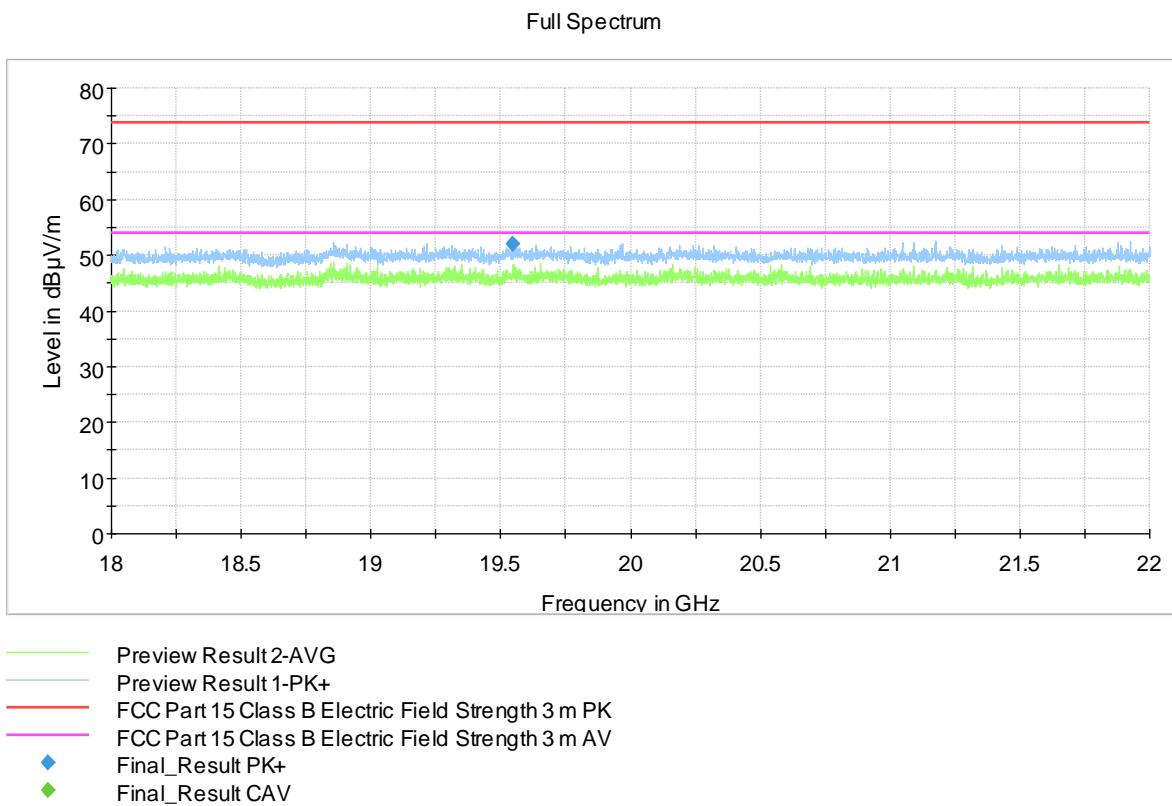
**Figure 5:** Measured curve with peak and average detectors, Sample 2

**Table 4:** Final peak and average measurement from the worst frequencies, Sample 2

Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	CAverage (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17705.825000	51.34	---	73.90	22.56	1000.0	1000.000	231.0	H	142.0	24.0

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

## Measured Peak and Average Values In The Frequency Range 18 – 22 GHz



**Figure 6:** Measured curve with peak and average detectors, Sample 1

**Table 5:** Final peak and average measurement from the worst frequencies, Sample 1

Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	CAverage (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19548.150000	52.02	---	73.90	21.88	1000.0	1000.000	231.0	V	308.0	7.1

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

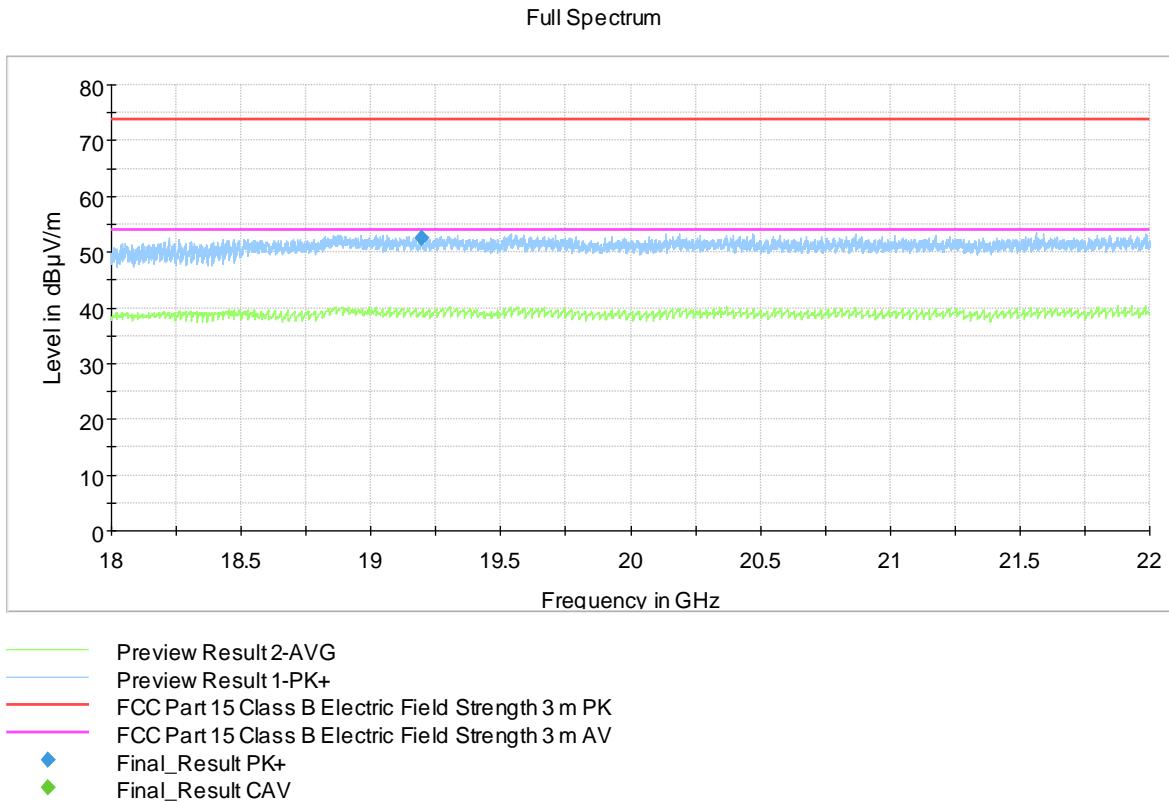


Figure 7: Measured curve with peak and average detectors, Sample 2

Table 6: Final peak and average measurement from the worst frequencies, Sample 2

Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	CAverage (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19193.100000	52.52	---	73.90	21.38	1000.0	1000.000	139.0	H	133.0	7.1

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

**TEST EQUIPMENT**

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
ANTENNA	EMCO	3160-09	inv. 7294	2020-02-20	2021-02-20
				2021-02-19	2022-02-19
ANTENNA	EMCO	3117	inv. 7293	2020-03-11	2022-03-11
ANTENNA	SCHWARZBECK	VULB 9168	inv. 8911	2020-11-04	2022-11-04
ANTENNA MAST	MATURO	TAM 4.0E	inv. 10181	NCR	NCR
ATTENUATOR	PASTERNACK	PE 7004-4 (4dB)	inv. 10126	2019-04-01	2021-04-01
				2021-03-26	2023-03-26
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv. 10679	2020-07-20	2021-07-20
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv. 10183	NCR	NCR
POWER SUPPLY	DELTA	SM 130-25D	inv. 10406	NCR	NCR
RF PREAMPLIFIER	CIAO	CA1840-5019	inv. 10593	2020-10-09	2021-10-09
RF PREAMPLIFIER	CIAO	CA118-3123	inv. 10278	2020-10-09	2021-10-09
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-
TURNTABLE	MATURO	DS430 UPGRADED	inv. 10182	NCR	NCR

NCR = No Calibration Required

**END OF REPORT**