Test Report No. 7012300778

Applicant: Ecoppia scientific Ltd.

Equipment Under Test:

Cleaning robot transceiver

Model: T4

From The Standards Institution
Of Israel
Industry Division
Electronics & Telematics Laboratory
EMC Branch

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

Certificate Number: AT-1359

42 Chaim Levanon St. Tel-Aviv 69977 Israel. Management: Tel: 972-3-6467800 Fax: 972-3-6467779 www.sii.org.il
Electronics: Tel: 972-3-6465050 Fax: 972-3-7454026 - Alarms Systems Section: Tel: 972-3-6465370 Fax: 972-3-6467262

Applicant:	Ecoppia scientific Ltd.
Address:	89 Medinat Hayehudim, Herzelia, Israel
Sample for test selected by:	The customer
The date of tests:	19, 22, 23 December 2019

Description of Equipment Under Test (EUT):	Cleaning robot transceiver.
Model:	T4
Software version of the radio unit	rev.2.0
Hardware version of the radio unit	TI CC1310
Manufactured by:	Ecoppia scientific Ltd.

Reference Documents:

❖	CFR 47 FCC:	Rules and Regulations; Part 15. “Radio frequency devices”; Subpart B: “Unintentional Radiators” Section 15.109. “Radiated emission limits” Subpart C: “Intentional radiators” Section 15.209. “Radiated emission limits, general requirements”. “Radiated Emission Limits, Additional Provisions”; Section 15.249. “Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5725 – 5875 MHz and 24.0 - 24.25 GHz”.

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This Test Report contains 27 pages and may be used only in full.	This Test Report applies only to the specimen tested and may not be applied to other specimens of the same product.

Table of Contents

1. EUT Description and operation

1.1. General description:

* Note: the customer supplied all information in clause below.

The EUT is a robot designed to clean solar panels in solar power plants without using water or human intervention.
The robot get energy from lead acid battery 12VDC and is an outdoor appliance.

Assigned frequency band	902 - 928 MHz
Operating frequency range	902.75 – 927.25 MHz
Type of modulation:	FSK
Antenna information:	Internal rod antenna, mfr. Abracon, mod. AEACAC054010-S915

Photo 1. Cleaning robot external view.

2. Test summary

Parameter	FCC Part 15 Reference paragraph	Verdict
Test of field strength emission from unintentional radiator	"Radiated Emission Limits, Section 15.109 class A.	Comply
Test of field strength emission from intentional radiators	"Radiated Emission Limits, Additional Provisions"; Section 15.249.	Comply

Electronics & Telematics Laboratory

December 2019

Name: Eng. Yuri Rozenberg
Position: Head of EMC Branch

Name: Michael Feldman
Position: Test Technician

Measurement uncertainty.

The test equipment has been calibrated according to its recommended procedures and is within the manufacturer's published limit of error.
The laboratory calibrates its standards by a third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements.
In the following table the uncertainty calculation is given.

Type of disturbance Test description	Calculated uncertainty U_{LAB}
Radiated disturbance electric field strength in a SAR at 3 m distance 9kHz – 30MHz 30 MHz – 1.0 GHz	 ±2.54 dB ±4.32 dB
electric field strength in a FAR at 3 m distance 1.0 – 18 GHz. 18 – 40 GHz.	 ±4.47 dB ±2.78 dB

Normative References.

FCC 47 CFR Part 15, Subpart C	Radio Frequency Devices Subpart C – Intentional Radiators
ANSI C63.4: 2009	American National Standard for Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10: 2013	American National Standard for Testing of Unlicensed Wireless Devices.

2.1. Potential emission sources:

The potential emission sources are detailed in Table 1.

Table 1. Potential emission sources

Frequency	Location
32.768KHz	Transmitter real time clock.
8 MHz	Main clock.
24MHz	Transmitter main clock.
902.75 – 927.25 MHz	RF signal.

2.2. EUT setup and operation:

Test was performed in continuous transmission mode in lowest, middle and highest transmit carrier frequencies of 902 – 928 MHz frequency band.

3. Measurements and derived results

3.1. Location of the Test Site:

Radiated test was conducted at the EMC laboratory of the Standards Institution of Israel in Tel-Aviv.

3.2. Test condition:

Temperature: 22 °C. Humidity: 57 %. Atmospheric pressure: 1011 mbar.

3.3. Radiated emission test.

3.3.1. General:

Per FCC Part 15 Subpart C Sections 15.209, 15.249.

- Initial scans were made using a peak detector but still using the appropriate ANSI IF bandwidth.
- A tolerance limit was set 10 dB below the specification limit. Levels above the tolerance limit were retested using the Peak, QP or Average detectors.

3.3.2. Radiated emission measurements:

Preliminary investigation was performed from the lowest radio frequency signal generated in the equipment up to ten harmonic of a carrier frequency.
The final radiated emission measurements were performed in the semi Anechoic chamber at 3 m test distances. The EUT was operated in continue transmition mode. The transmitter was installed on a turn - table. Active Loop, Biconilog and Double Ridged Guide antennas were used. The measurements were performed at frequencies at which the signal level was 10 dB below the limit or less. The levels were maximized by rotating turntable through 360° and changing antenna-to-EUT polarization from vertical to horizontal. The worse case result was noted in a tables.

3.3.3. Radiated emission test results:

Final result measurements presented in tables and plots ## 1 - 26 in section 3.4.5.

3.4. Test of field strength emission from intentional radiator.

3.4.1. General:

Per FCC Part 15 Subpart C clause 15.249.

3.4.2. Requirements:

The field strength limits in paragraph 15.249 (a) based on average value and shall comply with the follow:

Table 2. Section 15.249(a). 902 – 928 MHz band limit.

Specified field strength limit of Fundamental.		Specified field strength limit of Harmonics.	
mV/m	dBμV/m	μV/m	dBμV/m
50.0	94.0	500.0	54.0

Note: the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. The field strength of emissions radiated on any frequency outside of the specified band, except for harmonics shall be attenuated by at least 50 dB below the level of fundamental or to the general radiated emissions limits in section 15.209 whichever is lesser attenuation.

3.4.3. Test procedure:

The test was conducted according to clause 15.249.

3.4.4. Test summary:

The tested unit meets the standard requirement.

3.4.5. Test results:

Table 3. Radiated emission result at carrier frequencies.

Carrier frequency, MHz	Antenna polariz.	Peak Ampl. dBµV/m	Aver. Level* dBµV/m	Specified limit dBµV/m	Margin dB	Reference to plot #
902.75	Vertical	107.6	91.0	94.0	3.0	1
917.25	Vertical	105.1	88.5	94.0	5.5	2
927.25	Vertical	104.6	88.0	94.0	6.0	3

Carrier frequency and spurious emissions average levels calculated as follow:
Peak amplitude – Average factor.
Average factor was calculated according to p.15.35(c) = 20 Log Tx on/100 = 20 Log (14.7ms/100ms) = -16.6 dB. Transmission pulse duration result taken from plots #4, 5

Spurious emissions results.

Table 4. 902.75 MHz carrier frequency.

Freq. MHz	Antenna pol. V/H	Antenna Height (m)	QP Ampl. dBµV/m	Specified @3m limit, dBµV/m	Margin dB	Ref. to plot #
30.3	V	1.0	33.7	40.0	6.3	8
72.0	V	1.0	31.5	40.0	8.5	8

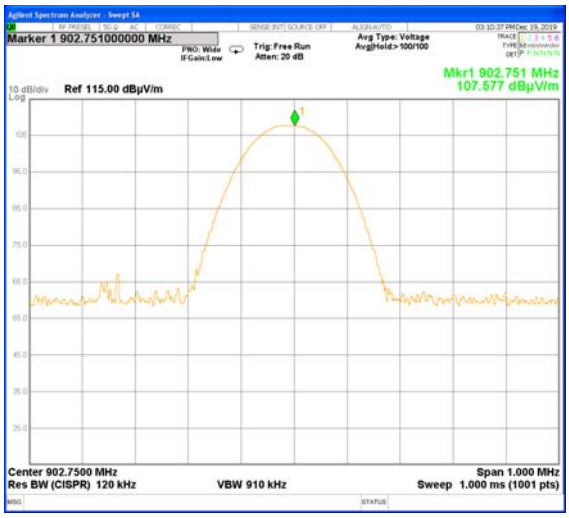
Freq. MHz	Antenna pol. V/H	Peak Ampl dBµV/m	Peak Ampl limit, dBµV/m	Margin dB	Avg Ampl. dBµV/m	Specified @3m limit, dBµV/m	Margin dB	Ref. to plot #
901.8	V	57.4	66.0	8.6	40.8	46.0	5.2	10
1805.4	V	53.2	74.0	>20	40.3	54.0	13.7	12
2708.2	V	58.5	74.0	15.5	46.8	54.0	7.2	13
4513.7	V	60.6	74.0	13.4	48.5	54.0	5.5	14
9475.5	V	56.5	74.0	17.5	46.0	54.0	8.0	15

Table 5. 917.25 MHz carrier frequency.

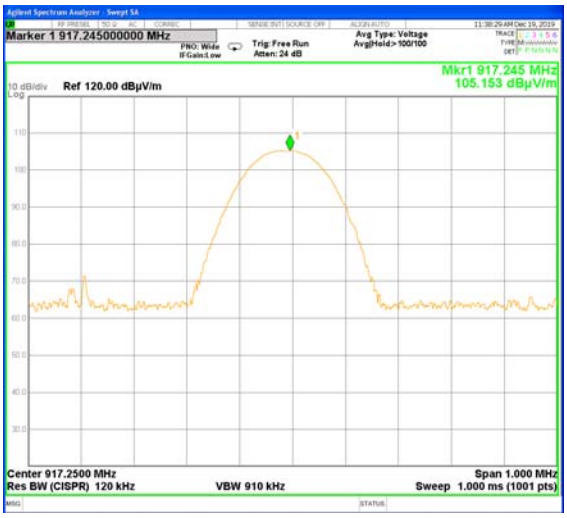
Freq. MHz	Antenna pol. V/H	Peak Ampl dBμV/m	Peak Ampl limit, dBμV/m	Margin dB	Avg Ampl. dBμV/m	Specified @3m limit, dBμV/m	Margin dB	Ref. to plot #
1834.5	V	52.7	74.0	>20	39.9	54.0	14.1	17
2751.7	V	59.0	74.0	15.0	46.0	54.0	8.0	18
4586.1	V	59.6	74.0	14.4	45.8	54.0	8.2	19
9444.0	V	56.1	74.0	17.9	46.9	54.0	7.1	20

Table 6. 927.25 MHz carrier frequency.

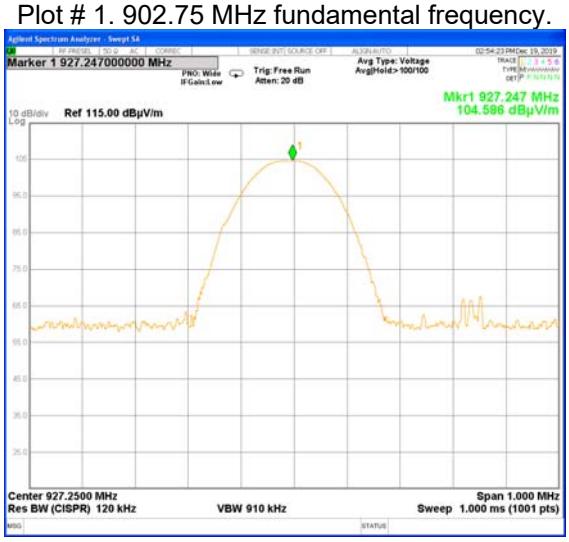
Freq. MHz	Antenna pol. V/H	Peak Ampl dBμV/m	Peak Ampl limit, dBμV/m	Margin dB	Avg Ampl. dBμV/m	Specified @3m limit, dBμV/m	Margin dB	Ref. to plot #
928.0	V	59.3	66.0	6.7	42.7	46.0	3.3	21
1855.5	V	53.1	74.0	>20	40.2	54.0	13.8	23
2783.2	V	58.4	74.0	15.6	45.6	54.0	8.4	24
4638.8	V	61.0	74.0	13.0	48.0	54.0	6.0	25
9444.0	V	60.0	74.0	14.0	50.5	54.0	3.5	26



Plot # 1. 902.75 MHz fundamental frequency.

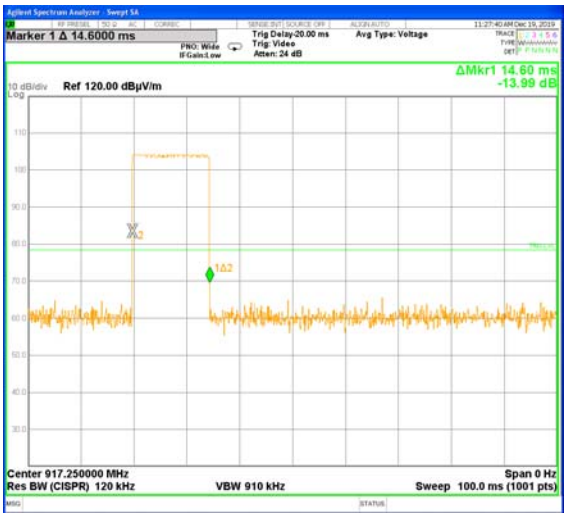


Plot # 2. 917.25 MHz fundamental frequency.



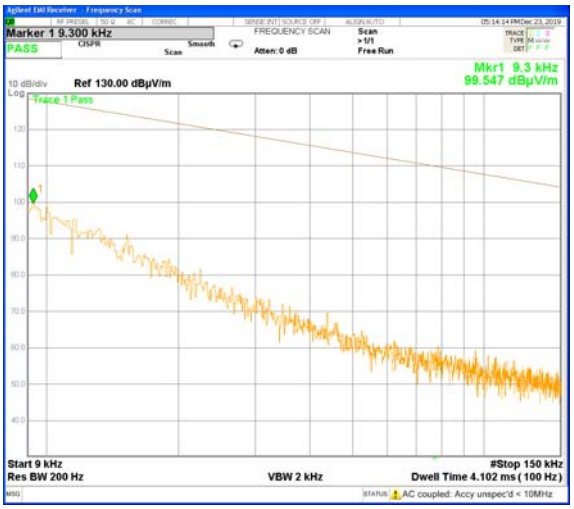
Plot # 3. 927.25 MHz fundamental frequency.

Plot # 4

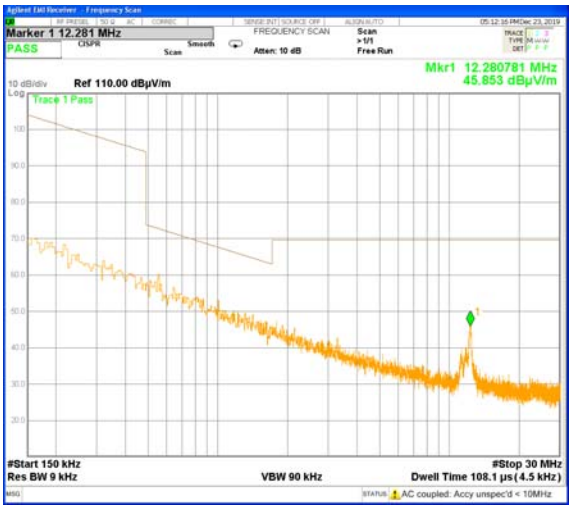


Plot # 5

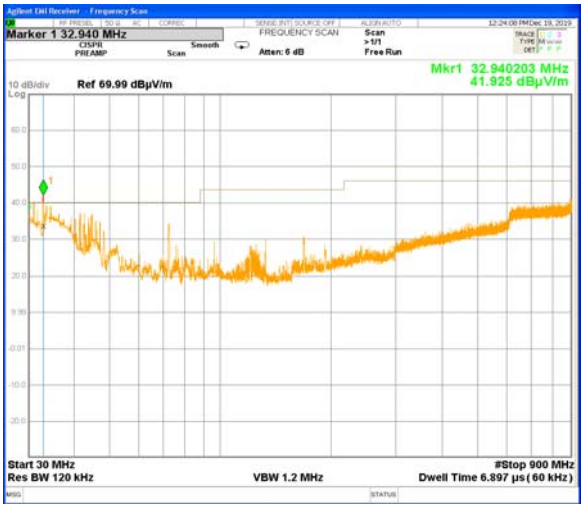
Average factor determination for averaging over one complete pulse train.



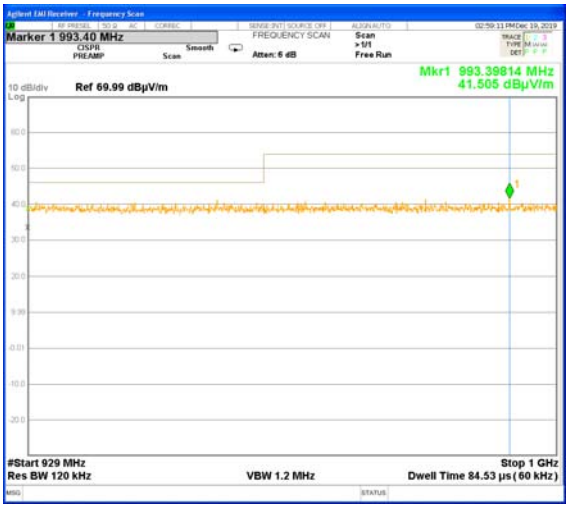
Plot # 6. Emissions scan 0.009 – 0.15 MHz.



Plot # 7. Emissions scan 0.15 MHz – 30 MHz.



Plot # 8. Emissions scan 30 - 900 MHz.

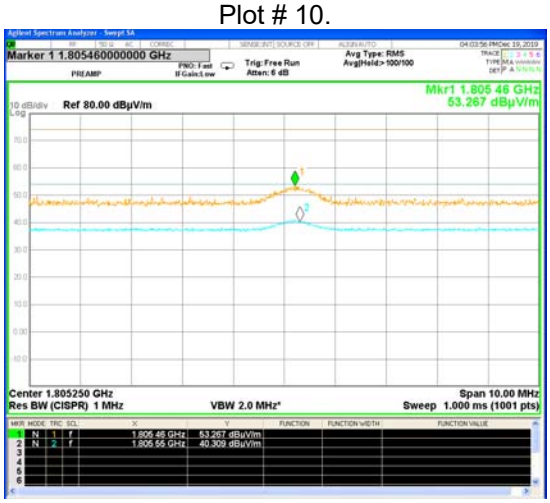


Plot # 9. Emissions scan 929 - 1000 MHz.

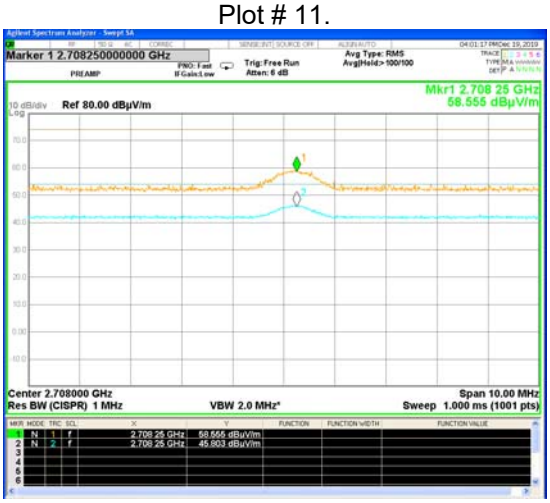
Spurious emissions of 902.25 MHz carrier frequency.

Plot # 10.

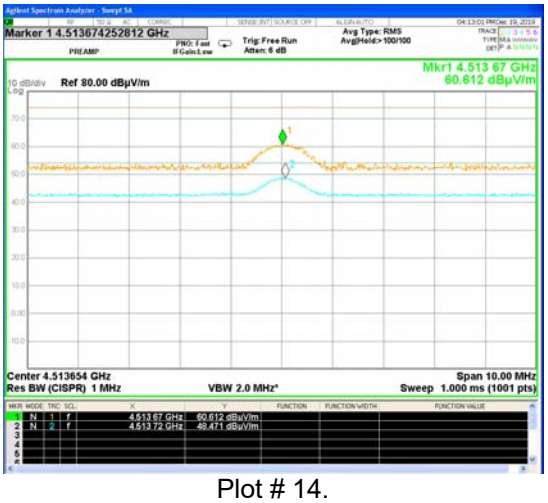
Plot # 11.



Plot # 12.



Plot # 13.

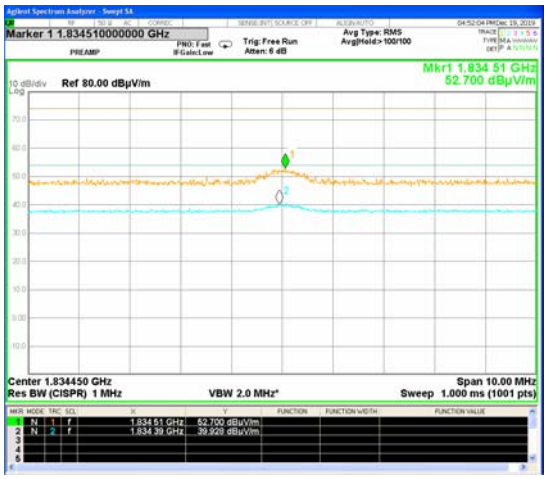


Plot # 14.

Plot # 15

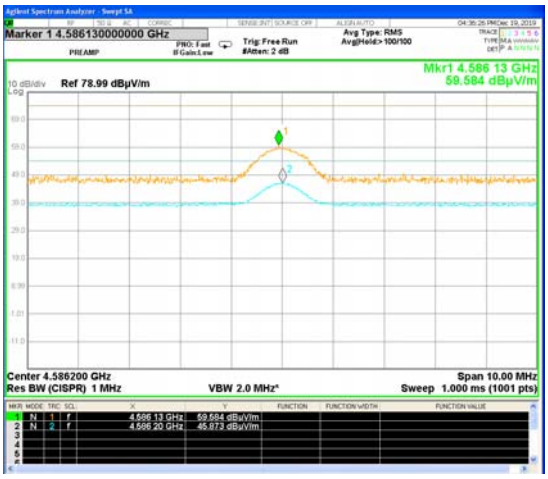
Spurious emissions of 917.25 MHz carrier frequency.

Plot # 16.

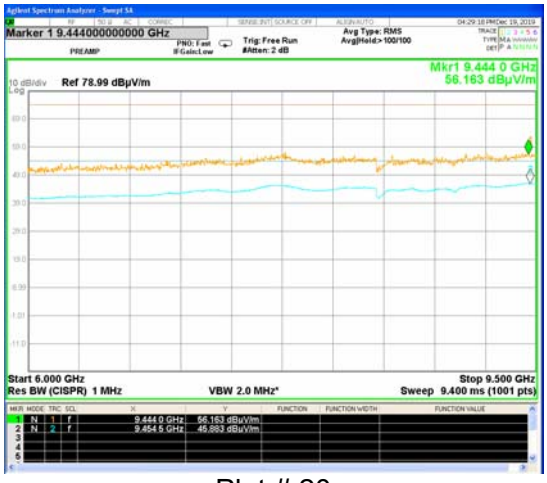


Plot # 17.

Plot # 18.

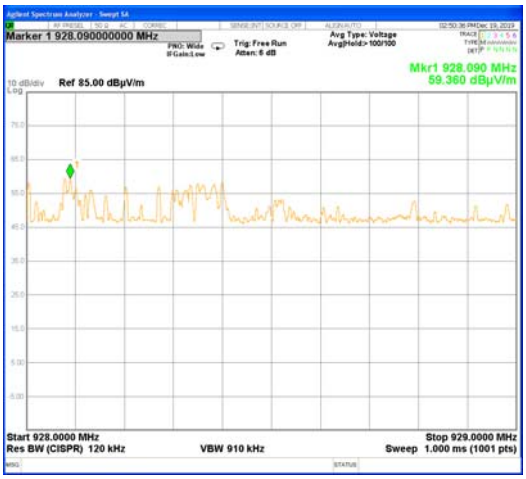


Plot # 19.



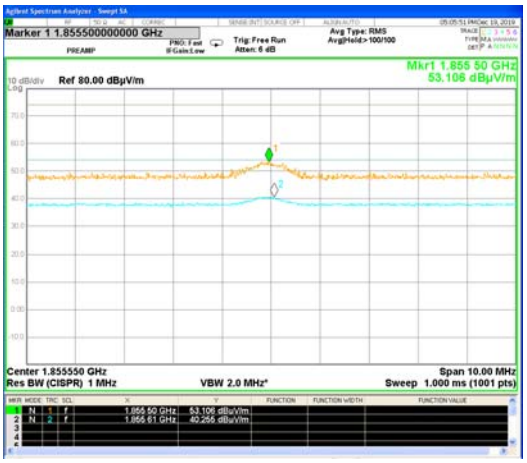
Plot # 20

Spurious emissions of 927.25 MHz carrier frequency.

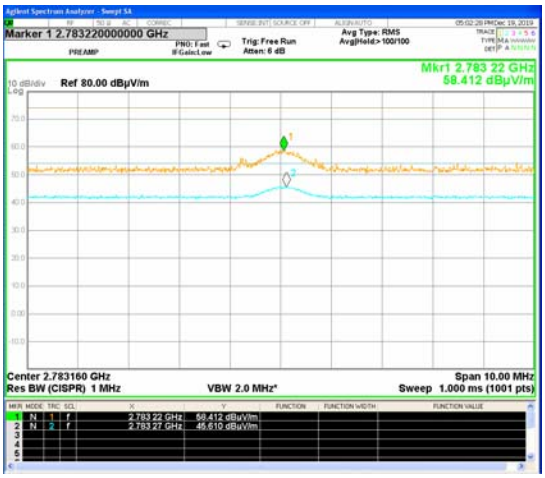


Plot # 21.

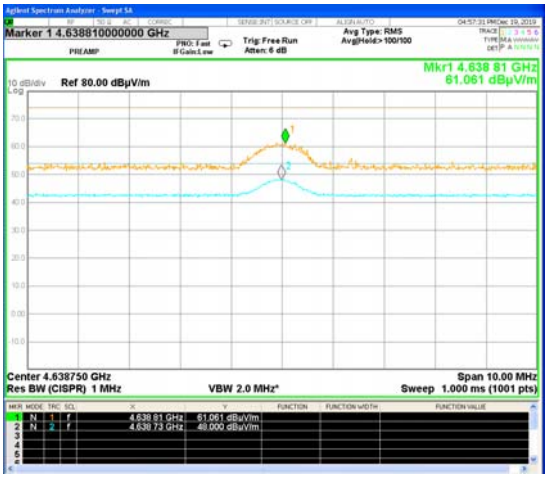
Plot # 22.



Plot # 23.



Plot # 24.



Plot # 25

Plot # 26

3.5. Test of undesired radiated emissions.

Per FCC Part 15 subpart B Section 15.109

3.5.1. Test procedure:

The test performed in robot clean mode as worst case emissions mode.
Final measurements present in table below.

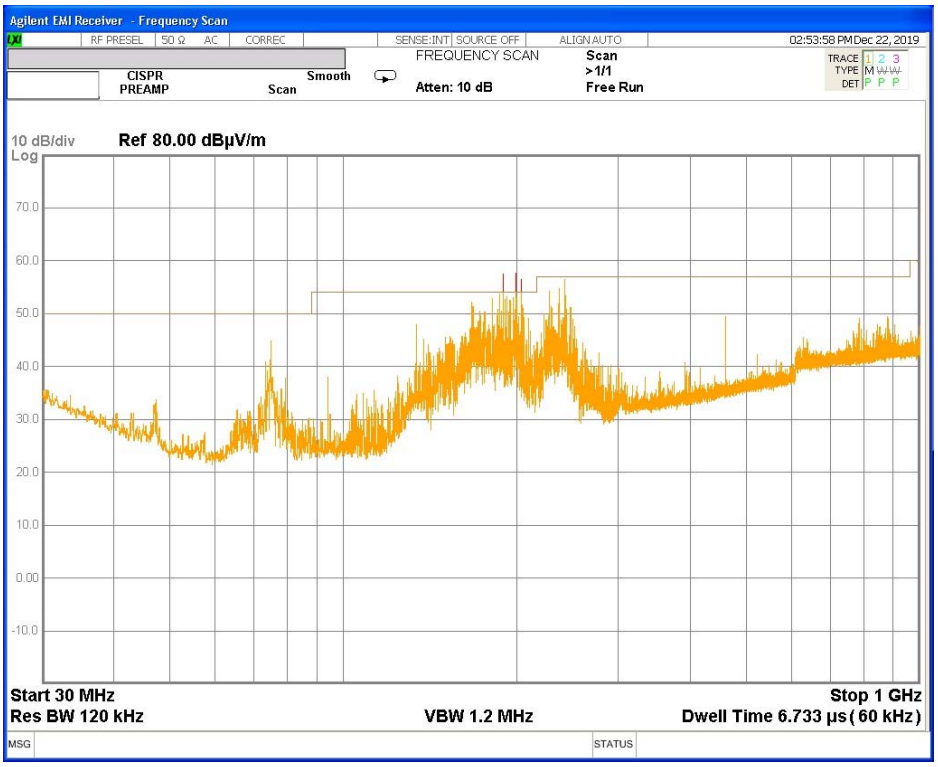
Table 7. Radiated emission test results.

Freq. MHz	Antenna height. m	Antenna pol. V/H	Turn table angle (°)	QP emission level* dBμV/m	Specified @3m limit, dBμV/m	Margin. dB
74.57	1.4	H	30	33.8	50.0	16.2
168.6	1.1	H	185	41.4	54.0	12.6
189.3	1.2	H	122	43.2	54.0	10.8
194.9	1.0	H	101	42.7	54.0	11.3
199.2	1.3	H	115	42.0	54.0	12.0
241.7	1.1	H	56	44.2	57.0	12.8

Note 1: Emission level = E Reading (dBμV) + Cable loss (dB) + Antenna Factor (dB/m)
For Cable Loss and Antenna Factor refer to Appendix 2

3.5.2. Radiated emission test results:

All received emissions found below FCC Parts 15.109 class A limit and presented in table # 7 and plot #27.


Agilent EMI Receiver - Frequency Scan
RF PRESEL
50 Ω
AC
CORREC
SENSE:INT
SOURCE OFF
ALIGN AUTO
02:53:58 PM Dec 22, 2019
FREQUENCY SCAN
Scan
>1/1
Free Run
CISPR
PREAMP
Smooth
Scan
Atten: 10 dB
TRACE 1 2 3
TYPE M
DET P P P
10 dB/div
Log
Ref 80.00 dBµV/m
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.00
-10.0
Start 30 MHz
Res BW 120 kHz
VBW 1.2 MHz
Stop 1 GHz
Dwell Time 6.733 µs (60 kHz)
MSG
STATUS

Plot # 27

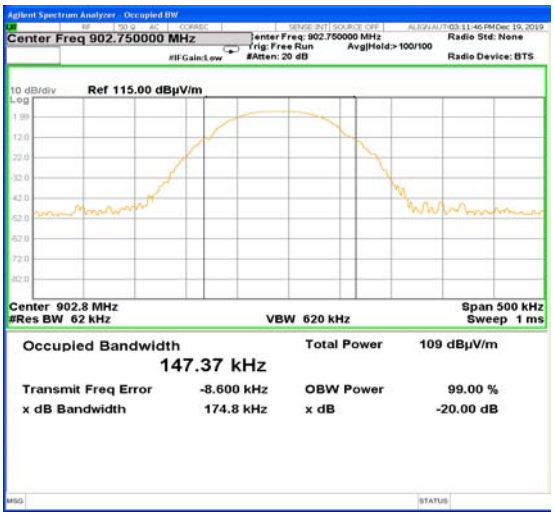
3.6. Test of occupied bandwidth per 15.215(c)

3.6.1. Requirements:

Intentional radiator must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band.

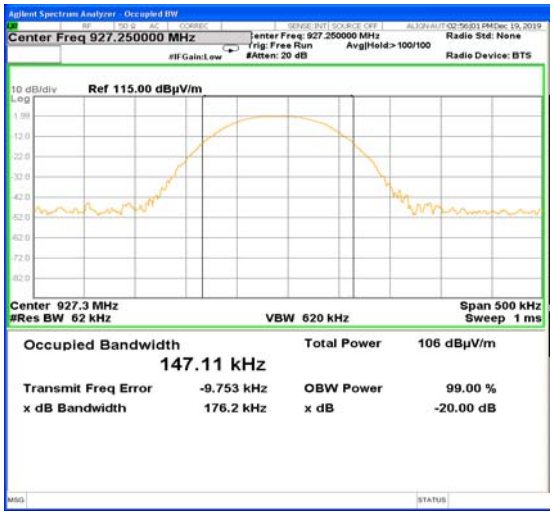
3.6.2. Test results:

Test result presented in plots below.



Plot # 28

Plot # 29



Plot # 30

3.6.3. Test summary:

Maximum 20 dB occupied bandwidth is 147.37 kHz.
The tested unit meets the standard requirement.

4. Appendix 1. Test equipment used

All measurements equipment is on SII calibration schedule with a recalibration interval not exceeding one year.

Test equipment used

No	Description	Manufacturer information			Due Calibration date
		Name	Model	Serial No	
1	MXE EMI Receiver 20 Hz -26.5 GHz	Agilent	N9038A	SII 650114	June 2020
2	Cable RF 1m	Huber-Suhner	Sucoflex 104	21325/4PE	October 2020
3	Double Ridged Guide Antenna 0.75 – 18 GHz	ETS-Lindgren	3115	00143138	March 2020
4	Broadband Horn antenna 15 – 40 GHz	Schwarzbeck Mess-Electronik	BBHA 9170	9170-341	March 2020
5	Double Ridged Waveguide Horn Antenna 1 – 18 GHz	ETS-Lindgren	3117	00139055	December 2020
6	Antenna Biconilog 26 – 6000 MHz	ETS-Lindgren	31142D	0146490	December 2020
7	Spectrum analyzer 20 Hz-40 GHz	Rohde&Schwarz	ESU 40	100168	March 2020
8	MXG Signal Generator 100 KHz - 20 GHz	Agilent	N5183A	6501148	May 2020
9	Attenuator 3 dB DC – 12.4 GHz	HP	8491A	50469	October 2020
10	USB preamplifier 2 GHz – 50 GHz	Keysight	U7227F	MY55380004	January 2020
11	LISN 9 kHz – 30 MHz	FCC	LISN 250-32-4-16	SII5023	October 2020
12	Transient limiter 0.009-200 MHz	HP	11947A	3107105	August 2020
13	Active Loop antenna 1.0 kHz – 30 MHz	ETS-Lindgren	6507	00144641	February 2020
14	Cable RF 4m	Huber-Suhner	Sucoflex 104PE	21329/4PE	October 2020
15	Cable RF 0.5m	Huber-Suhner	Multiflex 141	520201	October 2020

5. Appendix 2: Antenna Factor and Cable Loss

Cable Loss. Antenna Mast 6 m long cable.

Point	Frequency, MHz	Cable Loss, dB	Point	Frequency, MHz	Cable Loss, dB
1	30	0.3	21	1000	2.5
2	50	0.4	22	1100	2.6
3	100	0.6	23	1200	2.8
4	150	0.8	24	1300	2.9
5	200	1.0	25	1400	3.1
6	250	1.1	26	1500	3.2
7	300	1.2	27	1600	3.3
8	350	1.3	28	1700	3.5
9	400	1.5	29	1800	3.6
10	450	1.6	30	1900	3.7
11	500	1.7	31	2000	3.9
12	550	1.8	32	2100	4.0
13	600	1.9	33	2200	4.1
14	650	1.9	34	2300	4.2
15	700	2.0	35	2400	4.4
16	750	2.1	36	2500	4.6
17	800	2.1	37	2600	4.7
18	850	2.2	38	2700	4.8
19	900	2.3	39	2800	4.9
20	950	2.4	40	2900	5.0

Antenna factor
Biconilog Antenna, ETS-Lindgren mod. 31142D, S/N: 0146490 3m calibration.

No.	f / MHz	AF / dB/m	f / MHz	AF / dB/m	f / MHz	AF / dB/m
1	30	18.7	250	12.0	2750	31.0
2	35	15.7	300	13.8	3000	31.2
3	40	12.9	400	16.2	3250	32.7
4	45	10.6	500	18.6	3500	34.5
5	50	9.0	600	20.2	3750	34.3
6	60	7.3	700	21.8	4000	34.5
7	70	7.7	800	22.9	4250	35.3
8	80	8.2	900	24.1	4500	35.5
9	90	9.2	1000	24.8	4750	36.1
10	100	9.4	1250	26.9	5000	37.4
11	120	8.5	1500	30.2	5250	38.4
12	140	8.5	1750	28.5	5000	39.9
13	160	9.1	2000	28.9	5750	38.2
14	180	10.5	2250	29.8	6000	39.1
15	200	10.9	2500	32.5		

Antenna Factor
Double Ridged Guide Antenna mfr ETS-Lindgren model 3115 1m calibration.

Point	Frequency (MHz)	Antenna Factor (dB/m)
1	1000	23.7
2	2000	28.5
3	3000	29.6
4	4000	32.5
5	4500	32.6
6	5000	33.5
7	6000	36.1
8	6500	36.5
9	7000	37.3
10	7500	38.0
11	8000	37.3
12	8500	37.9
13	9000	38.1
14	9500	38.5
15	10000	38.7
16	10500	38.8
17	11000	38.6
18	11500	38.8
19	12000	38.9
20	12500	39.3
21	13000	40.2
22	13500	40.8
23	14000	40.6
24	14500	40.4
25	15000	39.6
26	15500	39.5
27	16000	39.8
28	16500	40.4
29	17000	41.3
30	17500	42.8
31	18000	43.2

Cable Loss
Type: Sucoflex 104PE; Ser.No.21329/4PE; 4 m length

Point	Frequency, GHz	Cable Loss, dB
1	0.0-1.0	1.7
2	1.0– 3.5	3.2
3	3.5– 5.5	4.0
4	5.5 – 7.5	4.7
5	7.5 – 9.5	5.3
6	9.5 – 10.5	5.6
7	10.5 – 12.5	6.2
8	12.5 – 14.5	6.8
9	14.5 – 16.5	7.5
10	16.5 – 18.0	8.1

Active Loop antenna mfr.ETS-Lindgren mod. 6507 S/N 00144641.

Frequency, MHz	Magnetic Antenna factor dBS/m	Electric Antenna factor dB/m
0.009	-21.5	30.0
0.010	-22.0	29.5
0.020	-27.7	23.8
0.075	-32.2	19.4
0.100	-33.0	18.5
0.150	-33.4	18.2
0.250	-33.6	17.9
0.500	-33.7	17.9
0.750	-33.8	17.8
1.000	-33.8	17.7
2.000	-33.8	17.7
3.000	-33.7	17.9
4.000	-33.8	17.8
5.000	-34.0	17.5
10.000	-34.3	17.2
15.000	-35.2	16.4
20.000	-35.8	15.8
25.000	-36.0	15.6
30.000	-36.2	15.3

6. Appendix 3: Test setups photo.

Photo 2.

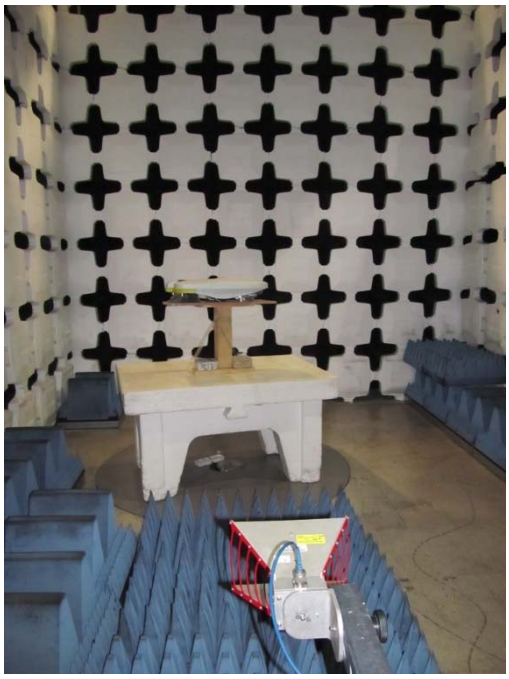


Photo 3.

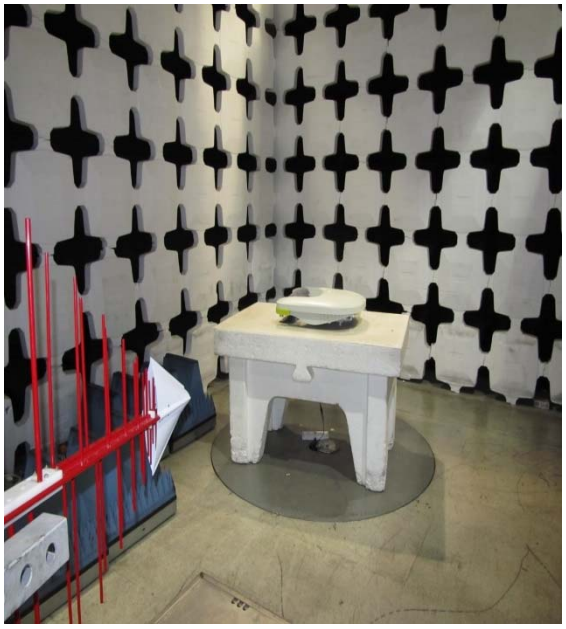


Photo 4.

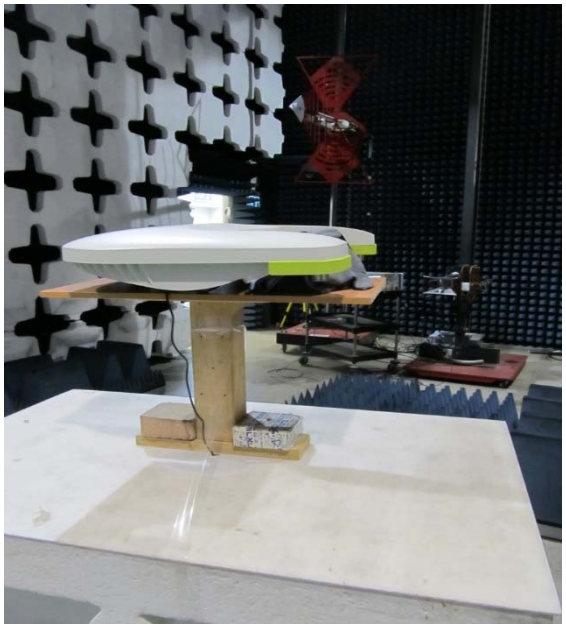


Photo 5.

End of the document.