Test Report No. 9812329035

For Maytronics Ltd.

Equipment Under Test:

Communication Printed Circuit Assembly with IoT capability. WiFi module.

Model of Printed Circuit Assembly: ComBii
FCC ID: WCH99956085W

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

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

Certificate Number: AT-1359

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1. Applicant information

Applicant:	Maytronics Ltd..
Address:	Kibbutz Yizreel, Yizreel, Israel
Sample for test selected by:	The applicant.
The date of tests:	16 - 20 August 2018, 13, 26 June 2019

Equipment under test information

Description of Equipment Under Test (EUT):	Communication Printed Circuit Assembly with IoT capability. WiFi module.
Communication PCA model:	ComBii
Firmware version of WiFi module:	19.54
Hardware version of fully assembled PCA:	99951186LF-01
Manufactured by:	Maytronics Ltd.

2. Test performance

Location:	SII EMC Section
Purpose of test:	Apparatus compliance verification in accordance with emission requirements
Test specifications:	47CFR part 15.247, 15.205, 15.207, 15.209 and part 1 §1.1310

This Test Report contains 42 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.

Normative References.

FCC 47 CFR Part 15, Subpart C: 2018	Radio Frequency Devices Subpart C – Intentional Radiators
ANSI C63.4: 2014	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.
FCC OET KDB 558074: August 2018	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

3. Summary of test:

The EUT was found to comply with requirements of: 47CFR Part 15, §§ 15.247, 15.205, 15.207 and 15.209**.**

Transmitter characteristics	Subclasses
Minimum 6 dB bandwidth	15.247(a)(2)
Maximum output power	15.247(b)(3)
Peak power spectral density	15.247(e)
Out of band spurious emissions radiated	15.205, 15.247(d)
Unwanted radiated emissions below 1 GHz	15.209
Conducted emissions on AC power line	15.207

Electronics and
Telematics Laboratory

June 2019

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

Name: Michael Feldman.
Position: Test engineer.

Measurement uncertainty.

The test equipment was 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.

Test description	Calculated uncertainty U_{LAB}
Conducted measurements	
Frequency error	37.6 Hz
Spurious emission	± 2.98 dB
Radiated emissions	
Electric field strength in a SAR at 3 m distance 30 MHz – 1.0 GHz	±4.32 dB
Electric field strength in a FAR at 3 m distance 1.0 GHz – 18 GHz	± 4.47 dB
Substitution measurements	
In a FAR at 3 m distance 1.0 GHz – 18 GHz	± 3.41 dB

4. Equipment under test description.

*The applicant provided description.

4.1 General description

The Unit Under test is a communication Printed Circuit Assembly with IoT capability and is part of the Power supply powering a robotic pool cleaner. On the ComBii PCA, there are two modules for bidirectional communication: the BLE module and the WiFi module. WiFi or BLE communication option separated and used severally in accordance with the monitoring and control purposes.

EUT technical characteristics

Transmitter technical characteristics:		Note
Assigned frequency band:	2400 MHz – 2483.5 MHz	
Operating frequency range:	2412 MHz – 2462 MHz	WiFi transmitter
WiFi transmitter:	IEEE 802.11b (11 Mbit/s data bit rate) IEEE 802.11g (54 Mbit/s data bit) IEEE 802.11n (64-QAM data bit rate)	

Antenna information		
Type	**Manufacturer**	**Antenna gain, dBi**
Integrated on PCB	Maytronics Ltd.	0

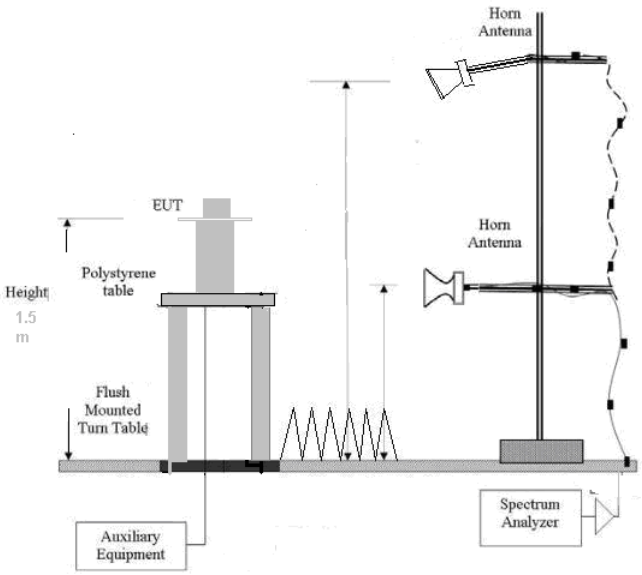


Fig.2. RE test setup above 1 GHz.

5. Test results

5.1 Transmitter characteristics

5.1.1 Transmitter 6 dB occupied bandwidth.

Method of measurement	**ANSI C63.10 subclause 11.8.2**		
Operating Frequency Range	**2412– 2462 MHz**		
Detector used	**Peak**		
Resolution bandwidth	**100 kHz**		
Video bandwidth	**> 3 x RBW.**		
Trace mode	**Max Hold.**		
Sweep time:	**Auto couple.**		
Ambient Temperature 22^0 C	**Relative Humidity 53%**	**Air Pressure**	**1009 hPa**

The minimum 6 dB occupied bandwidth shall be at least 500 kHz.

WLAN transmitter.

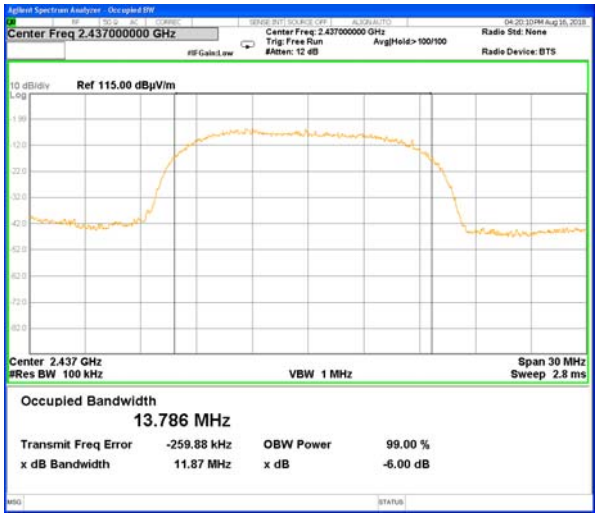
Wi-Fi standard options	Carrier frequency, MHz	Measured 6 dB occupied bandwidth, MHz	Measured 99% power occupied bandwidth, MHz	6 dB occupied bandwidth limit, kHz	Reference to plot #
802.11b	2412	12.1	13.7	500	1
	2437	11.8	13.7	500	2
	2462	12.1	13.7	500	3
802.11g	2412	16.1	16.4	500	4
	2437	16.1	16.4	500	5
	2462	16.4	16.4	500	6
802.11n	2412	17.6	17.6	500	7
	2437	16.4	17.6	500	8
	2462	17.3	17.5	500	9

TEST EQUIPMENT USED:

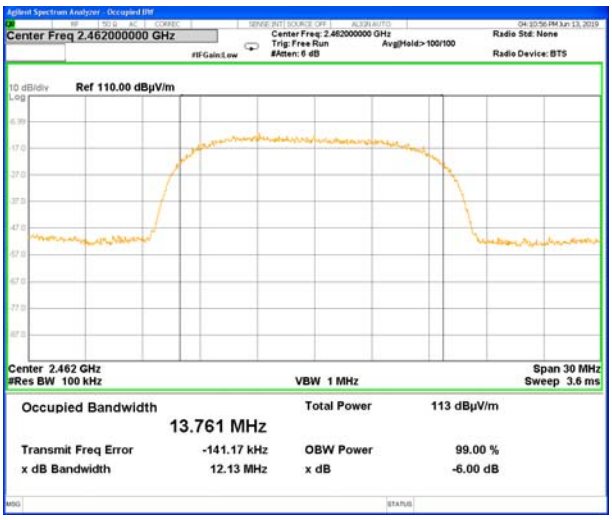
1	3	13				

WLAN transmitter test result.
802.11b

Plot # 1.



Plot # 2.

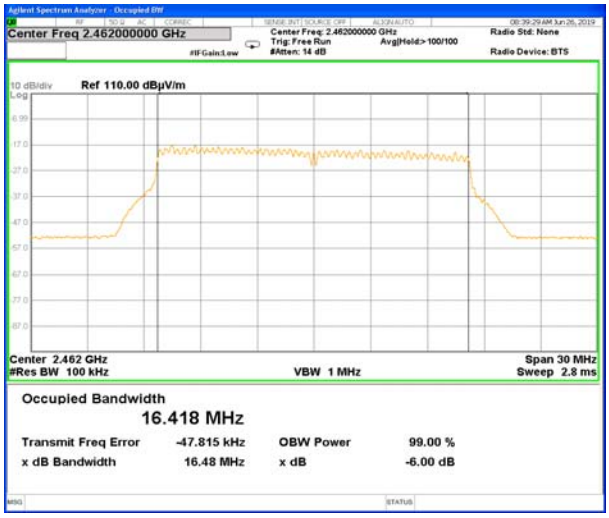


Plot # 3.

802.11g

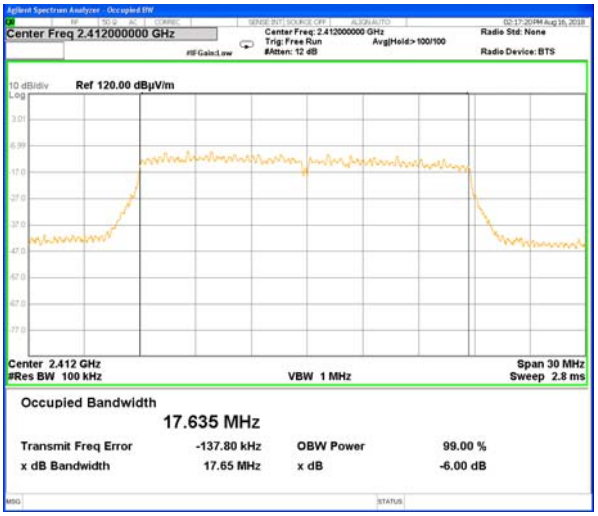
Plot # 4.

Plot # 5.



Plot # 6.

802.11n



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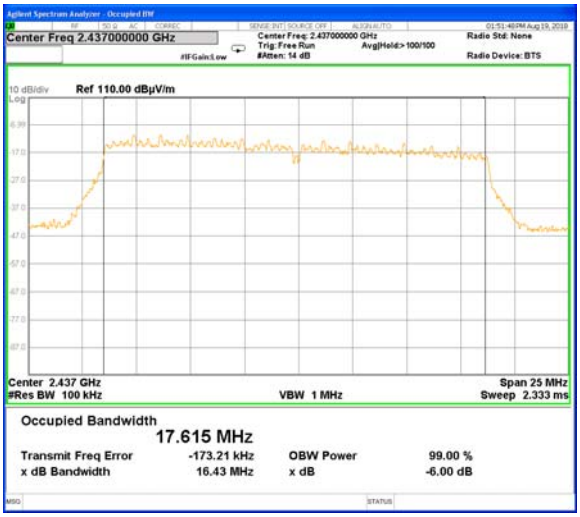
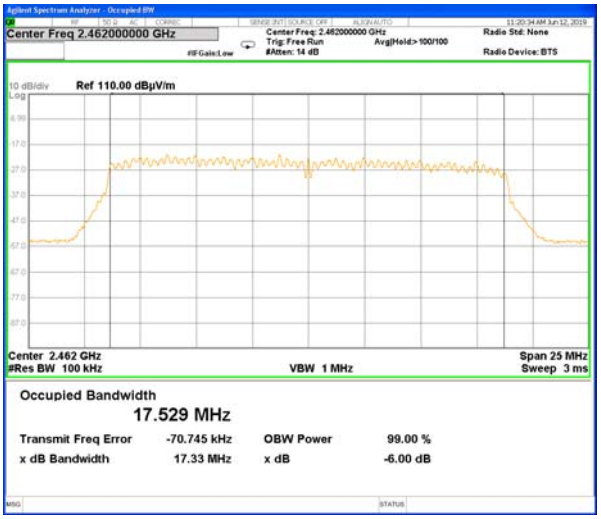


Plot # 8.



Plot # 9.

5.1.2 Maximum conducted output power test.

Method of measurement	**ANSI C63.10 subclause 11.9.2.2**		
Operating Frequency Range	**2412– 2462 MHz**		
Detector used	**RMS**		
Resolution bandwidth	**2 % of OBW**		
Video bandwidth	**3 x RBW.**		
Trace mode	**Max Hold.**		
Ambient Temperature 23^0 C	**Relative Humidity 52%**	**Air Pressure**	**1009 hPa**

For Digital Transmit System the peak conducted output power in the 2400 – 2483.5 MHz band shall not exceed 1W (30 dBm) with antennas gain that do not exceed 6 dBi.

WLAN transmitter.

Wi-Fi standard options	Carrier frequency, MHz	Field strength, dBµV/m	99% OBW, MHz	**EIR power, dBm	*Conducted output power, dBm	Conducted power limit, dBm	Reference to plot #
802.11b	2412	110.7	13.7	15.7	15.7	30	13
	2437	109.8	13.7	14.6	14.6	30	14
	2462	104.6	13.7	9.6	9.6	30	15
802.11g	2412	106.9	16.4	11.7	11.7	30	16
	2437	105.2	16.4	10.0	10.0	30	17
	2462	100.2	16.4	5.8	5.8	30	18
802.11n	2412	106.7	17.6	11.5	11.5	30	19
	2437	104.6	17.6	9.4	9.4	30	20
	2462	104.8	17.5	10.8	10.8	30	21

*The maximum conducted output power = EIR power – Antenna gain. Antenna gain = 0 dBi.
**EIR power = E Field strength (dBµV/m@3m) - 95.2 + 10 Log (1/ Duty cycle).
Measured duty cycle for 802.11b = 0.96, 802.11g = 0.83, 802.11n = 0.75

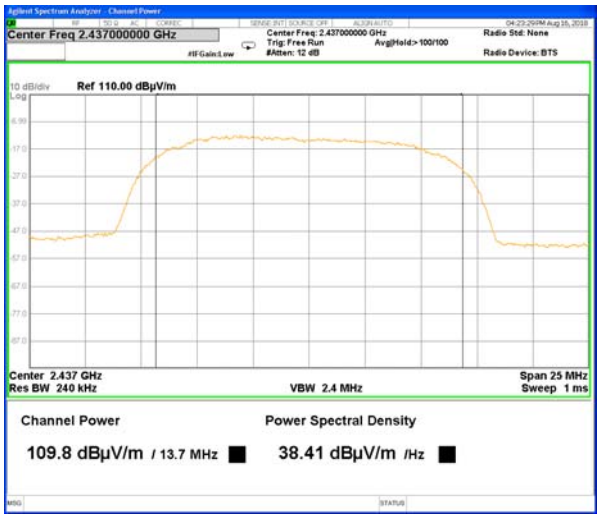
Measured field straight level was converted to EIRP level and compute by integrating across the 99% occupied bandwidth. The measurement of EIRP provided after verification according to substitution test method. EUT was replaced by generator and substitution antenna. Result calculated from generator output level, substitution antenna gain and loss of connected cable was used for EIRP calculation.
Transmitter was operated at continuous transmit mode at bottom, middle and top of the 2400 – 2483.5 MHz frequency band and at maximum output power and maximum data bit rate.

TEST EQUIPMENT USED:

1	2	3	5	8	9	13

WLAN transmitter.
802.11b (11 Mbit/s bit rate).

Plot # 10. Carrier frequency – 2412 MHz

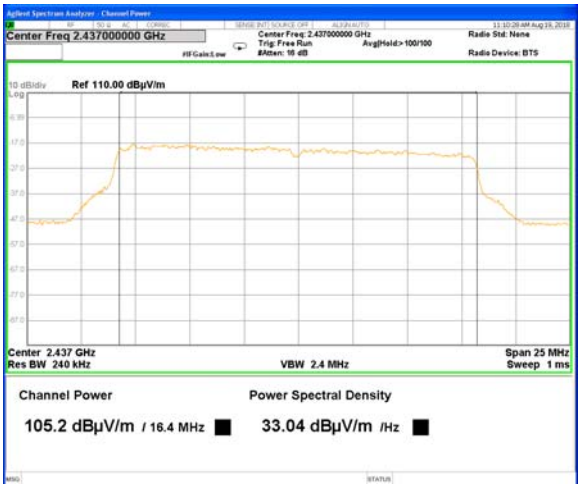


Plot # 11. Carrier frequency – 2437 MHz

Plot # 12. Carrier frequency – 2462 MHz

802.11g (54 Mbit/s bit rate).

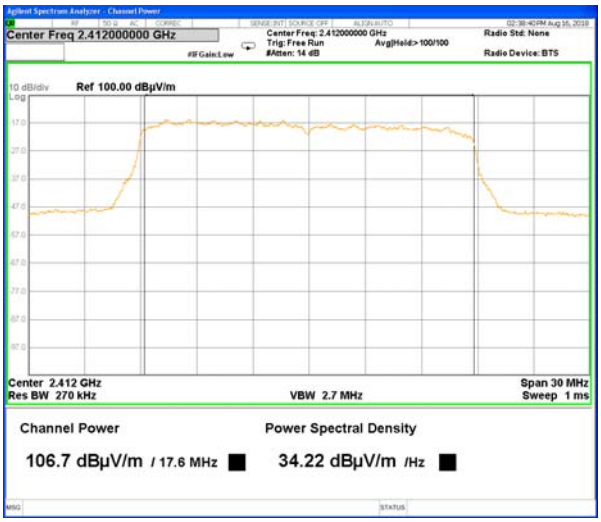
Plot # 13. Carrier frequency – 2412 MHz



Plot # 14. Carrier frequency – 2437 MHz

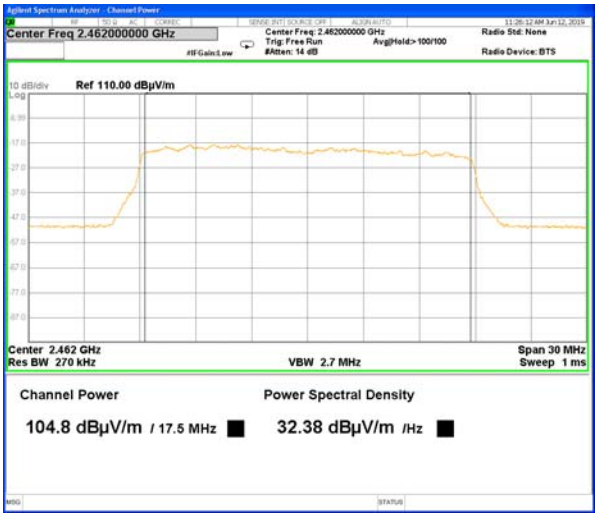
Plot # 15. Carrier frequency – 2462 MHz

802.11n (64-QAM bit rate).



Plot # 16. Carrier frequency – 2412 MHz

Plot # 17. Carrier frequency – 2437 MHz



Plot # 18. Carrier frequency – 2462 MHz

5.1.3 Power spectral density test

Method of measurement	**ANSI C63.10 subclause 11.10.5**		
Operating Frequency Range	**2412– 2462 MHz**		
Detector used	**RMS**		
Resolution bandwidth	**30 kHz**		
Video bandwidth	**3 x RBW.**		
Trace mode	**Max Hold.**		
Ambient Temperature 23^0 C	**Relative Humidity 52%**	**Air Pressure 1009 hPa**	

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

WLAN transmitter.

Wi-Fi protocol options	Carrier frequency, MHz	Field strength, dBµV/m	EIR power, dBm	Conducted PSD dBm	Conducted PSD limit, dBm/3 kHz	Reference to plot #
802.11b	2412	94.3	0.9	-10.9	8	19
	2437	93.5	-1.7	-11.7	8	20
	2462	90.6	-4.6	-14.6	8	21
802.11g	2412	91.4	-3.8	-13.8	8	22
	2437	89.6	-5.6	-15.6	8	23
	2462	87.5	-7.7	-17.7	8	24
802.11n	2412	90.7	-4.5	-14.5	8	25
	2437	90.9	-4.3	-14.3	8	26
	2462	90.8	-4.4	-14.4	8	27

The conducted to antenna PSD: EIR power – Antenna gain. Antenna gain = 0 dBi
EIR power = E Field strength (dBµV/m@3m) - 95.2 + 10 Log (3 kHz/30 kHz RBW).

Calculation of EIRP performed after verification by substitution method.

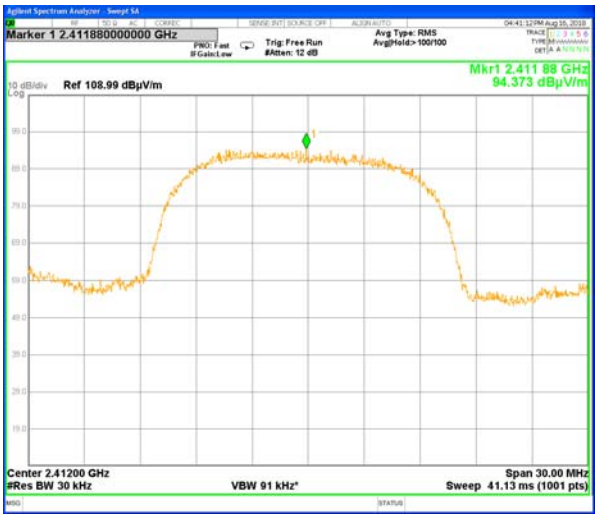
TEST SUMMARY

EUT maximum output power result is below PSD limit per 47 CFR 15.247 (e).
The EUT was found complies with standard requirement.

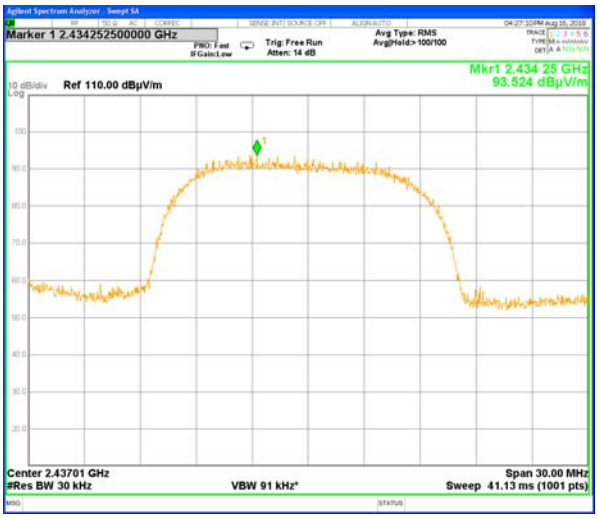
TEST EQUIPMENT USED:

1	3	13				

WLAN transmitter.
802.11b (11 Mbit/s bit rate).



Plot # 19. Carrier frequency – 2412 MHz



Plot # 20. Carrier frequency – 2437 MHz

Plot # 21. Carrier frequency – 2472 MHz

802.11g (54 Mbit/s bit rate).

Plot # 22. Carrier frequency – 2412 MHz

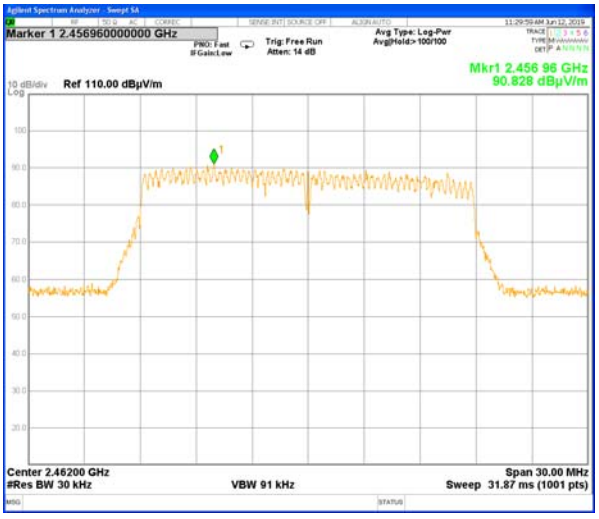
Plot # 23. Carrier frequency – 2437 MHz

Plot # 24. Carrier frequency – 2462 MHz

802.11n (64-QAM bit rate).

Plot # 25. Carrier frequency – 2412 MHz

Plot # 26. Carrier frequency – 2437 MHz



Plot # 27. Carrier frequency – 2462 MHz

5.1.4 Radiated emissions according to §§ 15.247(d), 15.205(a)

Method of measurement	**ANSI C63.10 subclauses 11.11/ 11.12**	
Operating Frequency Range	**2412– 2462 MHz**	
Detector used:	**Trace 1 – Peak; Trace 2 - RMS**	
Resolution bandwidth	**1 MHz/100 kHz**	
Video bandwidth	**3x RBW.**	
Trace mode:	**Trace 1 – Max hold; Trace 2 – Power averaging.**	
Ambient Temperature 23^0 C	**Relative Humidity 52%**	**Air Pressure 1009 hPa**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.
In addition, radiated emissions, which fall in the restricted bands, as defined in Section 15.205(a) must also comply with the radiated emission limits specified in Section 15.209(a).

The test was performed for 802.11b in maximum output power and for 802.11n in maximum output power and maximum occupied bandwidth and data bit rate that is a worst cases for all IEEE 802.11b/g/n standard options.

WLAN transmitter results.
802.11b

Carrier frequency 2412 MHz

Frequency, MHz	Radiated emissions, dBµV/m	Peak limit, dBµV/m	Avg limit, dBµV/m	Margin, dB	Note	Note	Reference to plot#
2381.6	51.4	74	-	>20	*RB	Detector peak	28
2385.8	43.3	-	54	10.7	RB	Detector average	28
2396.8	71.1	82.1	-	11.0	Band edge	Detector peak.	29
4823.6	61.6	74.0	-	12.4	RB	Detector peak	31
4823.8	51.8	-	54	2.2	RB	Detector average	31
23930.0	49.0	74.0	-	>20	RB	Detector peak	33
23920.0	39.0	-	54	15.0	RB	Detector average	33

*RB – restricted band

Carrier frequency 2437 MHz

Frequency, MHz	Radiated emissions, dBμV/m	Peak limit, dBμV/m	Avg limit, dBμV/m	Margin, dB	Note	Note	Reference to plot#
2356.6	51.7	74	-	>20	*RB	Detector peak	34
2358.0	41.3	-	54	12.7	RB	Detector average	34
2400.0	62.0	82.0	-	20.0	Band edge	Detector peak.	35
4873.6	60.9	74	-	13.1	RB	Detector peak	37
4873.6	50.5	-	54	3.5	RB	Detector average	37
22830.0	49.3	74	-	>20	RB	Detector peak	39
22850.0	39.0	-	54	15.0	RB	Detector average	39

Carrier frequency 2462 MHz

Frequency, MHz	Radiated emissions, dBμV/m	Peak limit, dBμV/m	Avg limit, dBμV/m	Margin, dB	Note	Note	Reference to plot#
2361.0	50.7	74	-	>20	*RB	Detector peak	40
2361.0	40.3	-	54	13.7	RB	Detector average.	40
2400.0	54.9	76.0	-	>20	Band edge	Detector peak.	41
2484.5	52.8	74	-	>20	RB	Detector peak	42
2484.5	40.6	-	54	13.4	RB	Detector average	42
9847.9	58.3	76.0	-	17.7	Not RB	Detector peak	45

*RB – restricted band

802.11n

Carrier frequency 2412 MHz

Frequency, MHz	Radiated emissions, dBµV/m	Peak limit, dBµV/m	Avg limit, dBµV/m	Margin, dB	Note	Note	Reference to plot#
2384.4	54.8	74	-	19.2	*RB	Detector peak	47
2384.4	43.2	-	54	11.8	RB	Detector average	47
2400.0	67.0	78.0	-	11.0	Band edge	Detector peak.	48
4820.9	58.2	74.0	-	15.8	RB	Detector peak	50
4822.4	46.0	-	54	8.0	RB	Detector average	50
16000.0	47.6	74	-	>20	RB	Detector peak	52
16000.0	38.3	-	54	15.7	RB	Detector average	52

*RB – restricted band

Carrier frequency 2437 MHz

Frequency, MHz	Radiated emissions, dBµV/m	Peak limit, dBµV/m	Avg limit, dBµV/m	Margin, dB	Note	Note	Reference to plot#
2378.8	50.4	74	-	>20	*RB	Detector peak	53
2376.1	40.4	-	54	13.6	RB	Detector average	53
2400.0	63.8	76.4	-	12.6	Band edge	Detector peak.	54
4874.0	53.3	74	-	>20	RB	Detector peak	55
4874.0	44.0	-	54	3.5	RB	Detector average	55
16000.0	47.7	74	-	>20	RB	Detector peak	57
16000.0	38.4	-	54	15.6	RB	Detector average	57

Carrier frequency 2462 MHz

Frequency, MHz	Radiated emissions, dBμV/m	Peak limit, dBμV/m	Avg limit, dBμV/m	Margin, dB	Note	Note	Reference to plot#
2313.5	50.9	74	-	>20	*RB	Detector peak	58
2313.5	40.4	-	54	13.6	RB	Detector average.	58
2400.0	63.0	75.0	-	12.0	Band edge	Detector peak.	59
2483.5	55.1	74	-	8.9	RB	Detector peak	60
2483.5	42.5	-	54	11.5	RB	Detector average	60
9852.0	61.6	75.0	-	13.4	Not RB	Detector peak	62

*RB – restricted band

TEST SUMMARY

All emissions outside of the 2400 – 2483.5 MHz frequency band were found below 15.247(d) limits.

TEST EQUIPMENT USED:

1	3	4	6	10	13	14

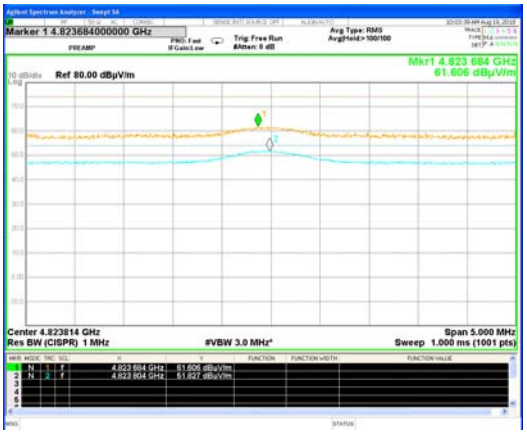
802.11b (11 Mbit/s bit rate).

Carrier frequency – 2412 MHz.

Plot # 28

Plot # 29

Plot # 30



Plot # 31

Plot # 32.

Plot # 33.

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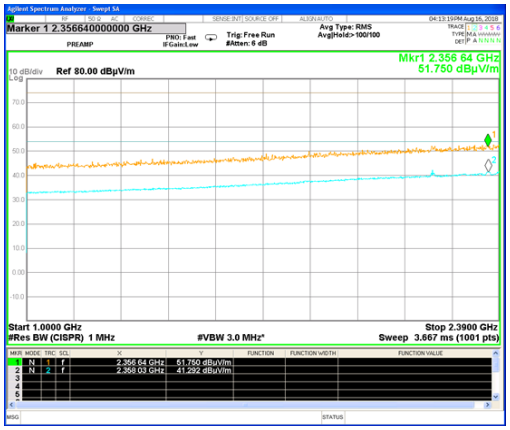
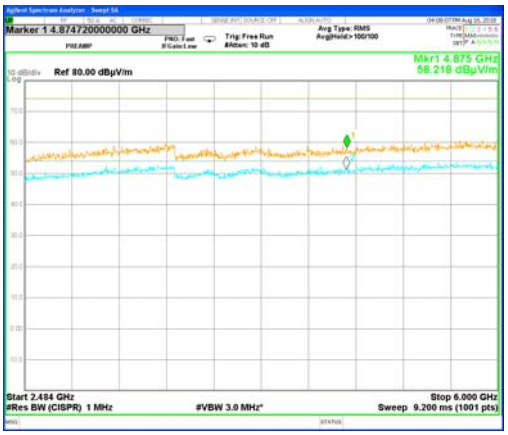
Model: ComBii **FCC ID: WCH99956085W**

Carrier frequency – 2437 MHz.



Plot # 34

Plot # 35



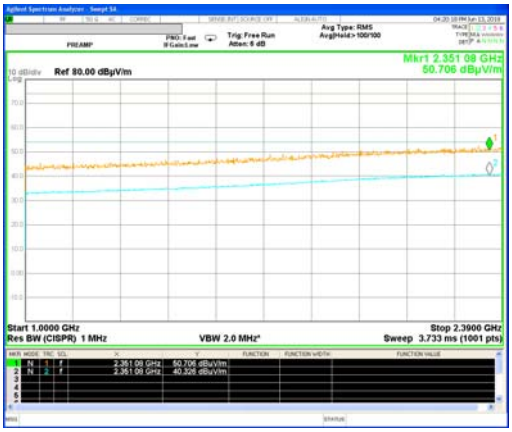
Plot # 36

Plot # 37

Plot # 38

Plot # 39

Carrier frequency – 2462 MHz.



Plot # 40

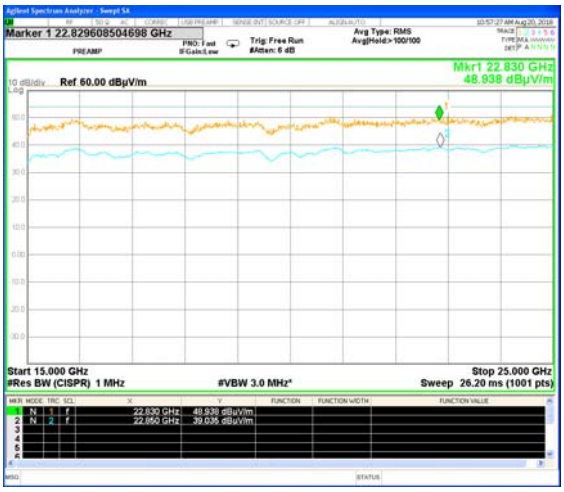
Plot # 41

Plot # 42

Plot # 43

Plot # 44.

Plot # 45.


Marker 1 22.829608504698 GHz
PREAMP
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 6 dB
Avg Type: RMS
Avg|Hold:>100/100
Mkr1 22.830 GHz
48.938 dBµV/m
10 dB/div
Ref 60.00 dBµV/m
Start 15.000 GHz
#Res BW (CISPR) 1 MHz
#VBW 3.0 MHz*
Stop 25.000 GHz
Sweep 26.20 ms (1001 pts)
1 N 1 f 22.830 GHz 48.938 dBµV/m
2 N 2 f 22.850 GHz 39.036 dBµV/m
Plot # 46.

802.11n (64-QAM bit rate).

Carrier frequency – 2412 MHz.

Plot # 47

Plot # 48

Plot # 49

Plot # 50

Plot # 51.

Plot # 52.

Carrier frequency – 2437 MHz.

Plot # 53

Plot # 54

Plot # 55

Plot # 56

Plot # 57

Carrier frequency – 2462 MHz.

Plot # 58

Plot # 59

Plot # 60

Plot # 61

Plot # 62.

Plot # 63.

5.2 Radiated emissions test according to § 15.209

Method of measurement	**ANSI C63.10 §6.5**	
Detectors used	**CISPR Quasi-Peak**	
Resolution bandwidth	**9 kHz/120 kHz**	
Video bandwidth	**>3 x RBW.**	
Trace mode	**Free run**	
Ambient Temperature 24^0 C	**Relative Humidity 55%**	**Air Pressure 1009 hPa**

TEST DESCRIPTION:

The measurements were performed at 3 m test distance in Anechoic chamber. The EUT was arranged on a polystyrene table 0.8 m height placed on the turn - table.
The Active Loop antenna in 9 kHz to 30 MHz frequency band and Biconilog antenna in 30 MHz – 1.0 GHz frequency band were used. The emission level was maximized by initially rotating turntable through 360°, varying the antenna height between 1 m and 4 m, rerouting EUT cables and changing antenna polarization from vertical to horizontal.

REQUIREMENTS:

EUT radiated emission shall not exceed value required in section 15.209

TEST RESULT:

Test results are presented in a table below and in plots ## 64 - 66

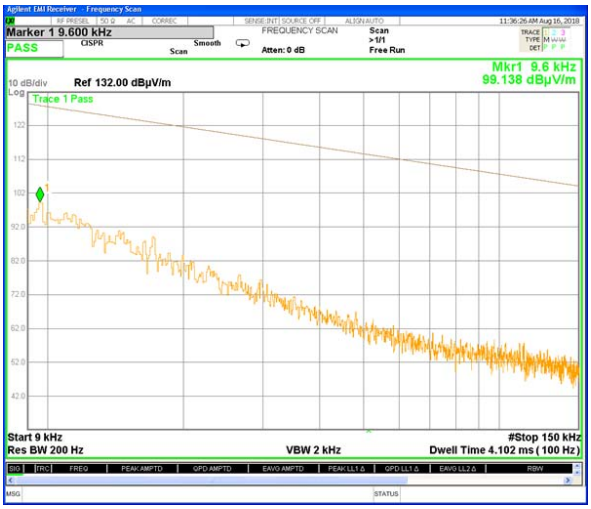
TEST EQUIPMENT USED:

1	6	13	15			

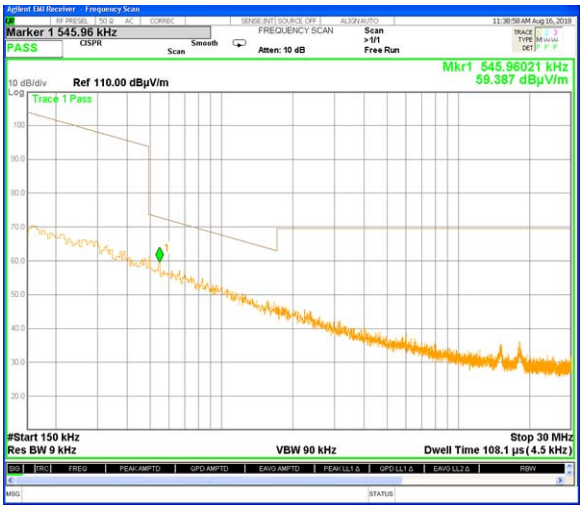
Radiated emission test results.

Frequency (MHz)	Antenna polariz. V/H	Antenna Height m	Turn-table Angle (°)	Emission Level Note 1 dBµV/m	Limit @ 3m dBµV/m	Margin Note 2 dB	Results
34.8	V	1.0	18	27.8	40.0	12.2	Pass
447.4	H	1.2	93	31.2	46.0	14.8	Pass

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

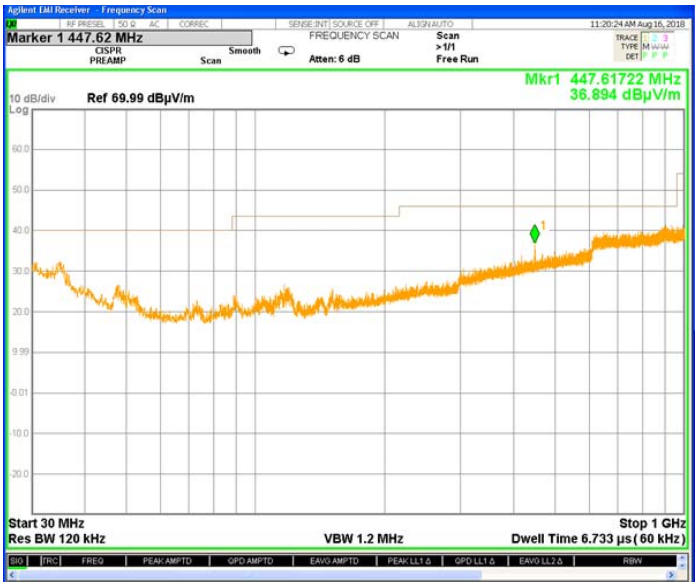


Plot # 64



Plot # 65

Investigation result in 0.009 – 30 MHz frequency range.



Plot # 66. Investigation result in 30 - 1000 MHz frequency range.

5.3 Conducted emissions test according to § 15.207.

Method of measurement	ANSI C63.10 §6.2	
Ambient Temperature 23^0 C	Relative Humidity 54%	Air Pressure 1008 hPa

Frequency, MHz	Conducted limit, dBμV	
	QP	AVRG
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

EUT was placed on a wooden table in a shielded chamber at a height of 80 cm from the floor and 40 cm from the vertical reference plane. The measurements were performed at mains terminals by means of LISN, connected to spectrum analyzer. The measurements were made with quasi-peak and average (CISPR) detectors.

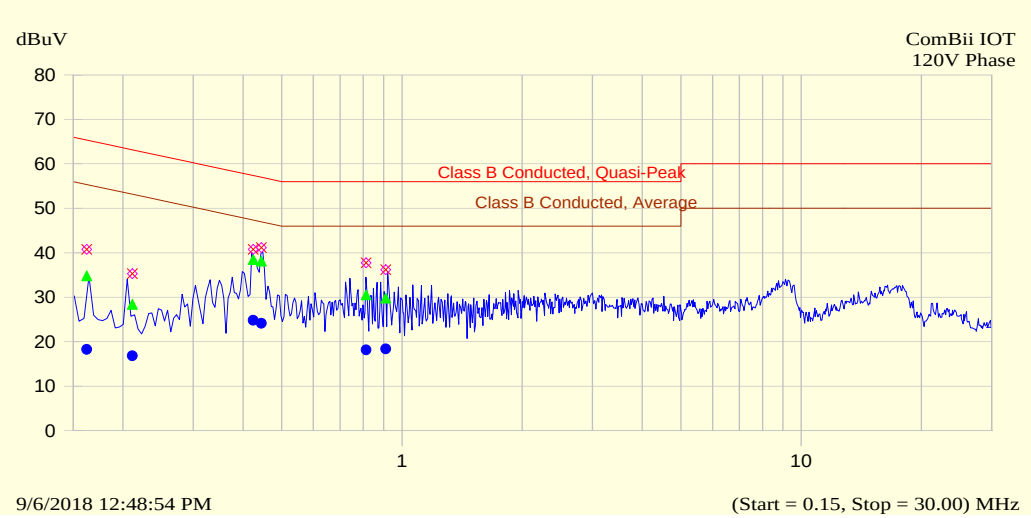
TEST RESULTS:

Test result in transmition mode present in plots # 67, 68.

TEST EQUIPMENT USED:

1	12	13			

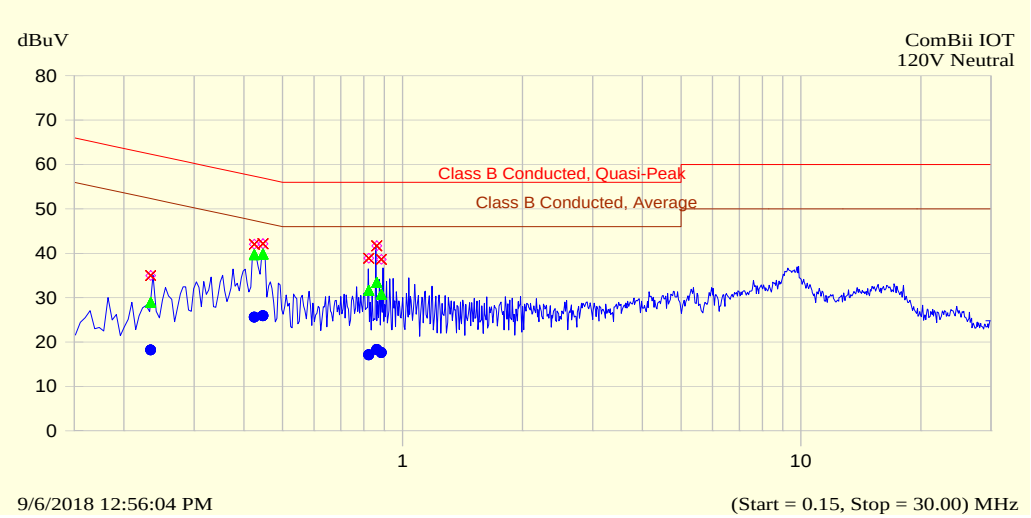
Test report No: 9812329035 **Page 34 of 42 Pages**
Title: Communication Printed Circuit Assembly with IoT capability. WiFi module
Model: ComBii **FCC ID: WCH99956085W**



Plot # 67. AC line conducted emissions test. Line Phase

Frequency MHz	QP dBµV	Limit QP dB	Margin dB	Avg dBµV	Limit Avg dB	Margin dB
0.162	34.8	65.3	-30.5	18.3	55.3	-37.1
0.211	28.4	63.2	-34.7	16.9	53.2	-36.3
0.424	38.5	57.4	-18.9	24.8	47.4	-22.5
0.444	38.1	57.0	-18.8	24.1	47.0	-22.8
0.814	30.5	56.0	-25.5	18.2	46.0	-27.8
0.910	29.8	56.0	-26.2	18.4	46.0	-27.6

Test report No: 9812329035 **Page 35 of 42 Pages**
Title: Communication Printed Circuit Assembly with IoT capability. WiFi module
Model: ComBii **FCC ID: WCH99956085W**



Plot # 68. AC line conducted emissions test. Line Neutral

Frequency MHz	QP dBµV	Limit QP dB	Margin dB	Avg dBµV	Limit Avg dB	Margin dB
0.234	28.9	62.3	-33.4	18.2	52.3	-34.1
0.425	39.7	57.4	-17.7	25.6	47.4	-21.7
0.446	39.8	56.9	-17.1	25.9	46.9	-21.0
0.823	31.7	56.0	-24.3	17.1	46.0	-28.9
0.862	33.4	56.0	-22.6	18.3	46.0	-27.7
0.885	30.8	56.0	-25.2	17.6	46.0	-28.4

APPENDIX A Test equipment used.

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	May 2019
2	Cable RF 1m	Huber-Suhner	Sucoflex 104	21325/4PE	October 2018
3	Double Ridged Guide Antenna 0.75 – 18 GHz	ETS-Lindgren	3115	00143138	December 2018
4	Broadband Horn antenna 15 – 40 GHz	Schwarzbeck Mess-Electronik	BBHA 9170	9170-341	December 2018
5	Double Ridged Waveguide Horn Antenna 1 – 18 GHz	ETS-Lindgren	3117	00139055	December 2018
6	Antenna Biconilog 26 – 6000 MHz	ETS-Lindgren	31142D	0146490	December 2018
7	Spectrum analyzer 20 Hz-40 GHz	Rohde&Schwarz	ESU 40	100168	November 2018
8	MXG Signal Generator 100 KHz - 20 GHz	Agilent	N5183A	6501148	May 2019
9	Attenuator 3 dB DC – 12.4 GHz	HP	8491A	50469	October 2018
10	USB preamplifier 2 GHz – 50 GHz	Keysight	U7227F	MY55380004	October 2019
11	LISN 9 kHz – 30 MHz	FCC	LISN 250-32-4-16	SII5023	October 2018
12	Transient limiter 0.009-200 MHz	HP	11947A	3107105	August 2019
13	Neoflex RF cable 5m	Harbour Industries	LLEF142-26	SII1802	July 2019
14	Cable RF 0.5m	Huber-Suhner	Multiflex 141	520201	October 2018
15	Active Loop antenna 1.0 kHz – 30 MHz	ETS-Lindgren	6507	00144641	December 2018

Cable Loss (Mast 6 m set 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 3 m calibration.

f / MHz	AF / dB/m	f / MHz	AF / dB/m	f / MHz	AF / dB/m
30	18.7	250	12.0	2750	31.0
35	15.7	300	13.8	3000	31.2
40	12.9	400	16.2	3250	32.7
45	10.6	500	18.6	3500	34.5
50	9.0	600	20.2	3750	34.3
60	7.3	700	21.8	4000	34.5
70	7.7	800	22.9	4250	35.3
80	8.2	900	24.1	4500	35.5
90	9.2	1000	24.8	4750	36.1
100	9.4	1250	26.9	5000	37.4
120	8.5	1500	30.2	5250	38.4
140	8.5	1750	28.5	5000	39.9
160	9.1	2000	28.9	5750	38.2
180	10.5	2250	29.8	6000	39.1
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	1500	25.5
3	2000	28.5
4	2500	28.1
5	3000	29.6
6	3500	31.1
7	4000	32.5
8	4500	32.5
9	5000	33.5
10	5500	34.7
11	6000	36.1
12	6500	36.5
13	7000	37.3
14	7500	38.0
15	8000	37.3
16	8500	37.9
17	9000	38.1
18	9500	38.5
19	10000	38.7
20	10500	38.8
21	11000	38.6
22	11500	38.8
23	12000	38.9
24	12500	39.3
25	13000	40.2
26	13500	40.6
27	14000	40.6
28	14500	40.4
29	15000	39.6
30	15500	39.5
31	16000	39.8
32	16500	40.4
33	17000	41.3
34	17500	42.6
35	18000	43.2

Cable Loss
Type: Neoflex LLEF142-26; Ser.No.1802; 5 m length

Point	Frequency (GHz)	Cable Loss (dB)
0	0.5	0.92
1	1.0	1.32
2	2.0	1.92
3	3.0	2.35
4	4.0	2.73
5	6.0	3.41
6	8.0	3.99
7	10.0	4.54
8	12.0	5.01
9	14.0	5.44
10	16.0	5.84
11	18.0	6.34

Antenna Factor
Broadband Horn Antenna model BBHA 9170 1m calibration

Point	Frequency (GHz)	Antenna Factor (dB/m)
1	15.0	38.5
2	16.0	37.7
3	17.0	38.1
4	18.0	37.9
5	19.0	38.0
6	20.0	38.0
7	21.0	37.9
8	22.0	38.2
9	23.0	39.6
10	24.0	39.6
11	25.0	39.3
12	26.0	39.5
13	27.0	39.6
14	28.0	39.6
15	30.0	40.1
16	32.0	41.2
17	34.0	41.5
18	35.0	41.9
19	36.0	42.2
20	38.0	43.8
21	40.0	43.2

Antenna Factor
For Antenna Loop MFR ETS Lindgren, Type/Model 6507, S/N: 00144641

No.	Frequency MHz	Magnetic antenna factor, dBS/m	Electric antenna factor, dB/m
1	9	-21.5	30.0
2	10	-22.0	29.5
3	20	-27.7	23.8
4	50	-32.2	19.4
5	75	-33.0	18.5
6	100	-33.4	18.2
7	150	-33.6	17.9
8	250	-33.7	17.9
9	500	-33.8	17.8
10	750	-33.8	17.7
11	1000	-33.8	17.7
12	2000	-33.7	17.9
13	3000	-33.8	17.8
14	4000	-34.0	17.5
15	5000	-34.3	17.2
16	10000	-35.2	16.4
17	15000	-35.8	15.8
18	20000	-36.0	15.6
19	25000	-36.2	15.3
20	30000	-36.4	15.2

APPENDIX B Photo of the test setups.

Photo 1.

Photo 2.

Photo 3.

Photo 4.

APPENDIX C Abbreviations and acronyms.

The following abbreviations and acronyms are applicable to this test report:

AC	alternating current
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
EBW	emission bandwidth.
EMC	electromagnetic compatibility
EUT	equipment under test
GHz	gigahertz
H	height
Hz	hertz
kHz	kilohertz
L	length
LNA	low noise amplifier
m	meter
Mbps	megabit per second
MHz	megahertz
N/A	not applicable
OFDM	Orthogonal Frequency Division Multiple Access
PRBS	pseudo random binary sequence
QP	quasi-peak
RF	radio frequency
RE	radiated emission
SA	spectrum analyzer
rms	root mean square
WLAN	Wireless Local Area Network