



Test Report No. 9812323302

For Maytronics Ltd.

Equipment Under Test:

**Communication Printed Circuit Assembly with
IoT capability. BLE module.**

**Model of Printed Circuit Assembly: ComBii
FCC ID: WCH99956085B**

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



Certificate Number: AT-1359



Test report No: 9812323302	Page 2 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

Table of Contents

1. Applicant information.....	3
2. Test performance.....	3
3. Summary of test:	5
4. Equipment under test description.....	6
4.1 General description	6
5. Test results.....	7
5.1 Transmitter characteristics.....	7
5.1.1 Transmitter 6 dB occupied bandwidth.....	7
5.1.2 Maximum conducted output power test.....	9
5.1.3 Power spectral density test	11
5.1.4 Radiated emissions according to §§ 15.247(d), 15.205(a).....	13
5.2 Radiated emissions test according to § 15.209	18
5.3 Conducted emissions test according to § 15.207.....	20
APPENDIX A Test equipment used.	23
APPENDIX B Photo of the test setups.	28
APPENDIX C Abbreviations and acronyms.....	30

**Test report No:** 9812323302**Page 3 of 30 Pages****Title:** Communication Printed Circuit Assembly with IoT capability. BLE module**Model:** ComBii**FCC ID:** WCH99956085B

1. Applicant information

Applicant:	Maytronics Ltd.
Address:	Kibbutz Yizreel, Yizreel, Israel
Sample for test selected by:	The customer
The date of tests:	28 Aug, 6 Sep 2018

Equipment under test information

Description of Equipment Under Test (EUT):	Communication Printed Circuit Assembly with IOT capability. BLE module.
Communication PCA model:	ComBii
Software version of BLE unit:	SDK6.1
Hardware version:	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 30 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.



Test report No: 9812323302

Page 4 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B

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



Test report No: 9812323302	Page 5 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

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

October 2018

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

Name: Alexander Karlinas.
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
Substitution measurements	
In a FAR at 3 m distance 1.0 GHz – 18 GHz	± 3.41 dB

Test report No: 9812323302	Page 6 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

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:	2402 MHz – 2480 MHz	-
Maximum declare EIRP:	2 dBm	-
Bluetooth standard:	BLE 4.1	-
Types of modulation:	GFSK	-
Antenna information		
Type	Manufacturer	Antenna gain, dBi
Internal on PCB. Inverted F	Maytronics Ltd.	0.0

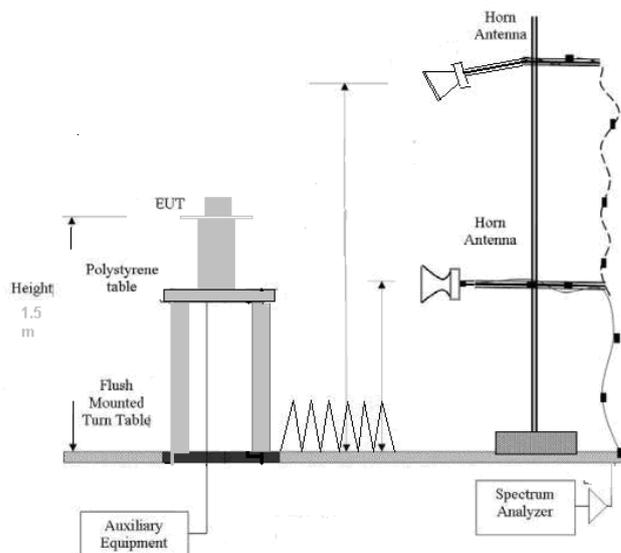


Fig.1. RE test setup above 1 GHz.



Test report No: 9812323302	Page 7 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

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	2402– 2480 MHz		
Detector used	Peak		
Resolution bandwidth	100 kHz		
Video bandwidth	> 3 x RBW.		
Trace mode	Max Hold.		
Sweep time:	Auto couple.		
Ambient Temperature 23° C	Relative Humidity 56%	Air Pressure 1010 hPa	

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

Carrier frequency, MHz	Measured 6 dB occupied bandwidth, kHz	6 dB occupied bandwidth limit, kHz	Reference to plot #
2402	669.4	500	1
2440	671.2	500	2
2480	670.3	500	3

TEST EQUIPMENT USED:

1	3	13				
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Test report No: 9812323302

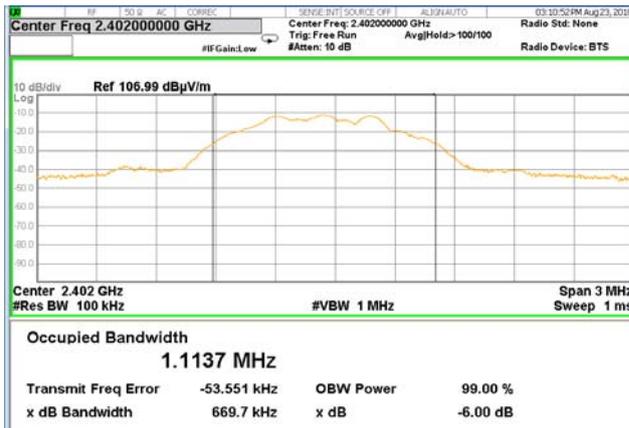
Page 8 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

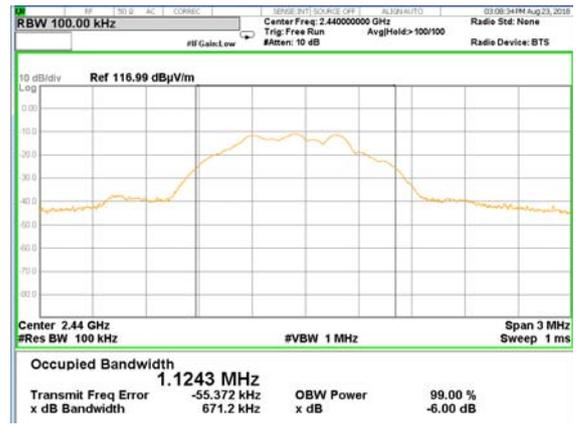
Model: ComBii

FCC ID: WCH99956085B

OBW test result.



Plot # 1.



Plot # 2.



Plot # 3.



Test report No: 9812323302

Page 9 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B

5.1.2 Maximum conducted output power test.

Method of measurement	ANSI C63.10 subclause 11.9.1.1		
Operating Frequency Range	2402– 2480 MHz		
Detector used	RMS		
Resolution bandwidth	1 MHz		
Video bandwidth	3 x RBW.		
Trace mode	Max Hold.		
Ambient Temperature 23° C	Relative Humidity 56%	Air Pressure	1010 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.

Carrier frequency, MHz	Field strength, dBµV/m	**EIR power, dBm	*Conducted output power, dBm	Conducted power limit, dBm	Reference to plot #
2402	96.3	1.1	1.1	30	4
2440	96.7	1.5	1.5	30	5
2480	96.6	1.4	1.4	30	6

*The maximum conducted output power = EIR power – Antenna gain. Antenna gain = 0.0 dBi.

**EIR power = E Field strength (dBµV/m@3m) - 95.2

Measured field straight level was converted to EIR power level. The measurement of EIRP provided after verification according to ANSI/TIA-603-D 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	3	14				
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Test report No: 9812323302

Page 10 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

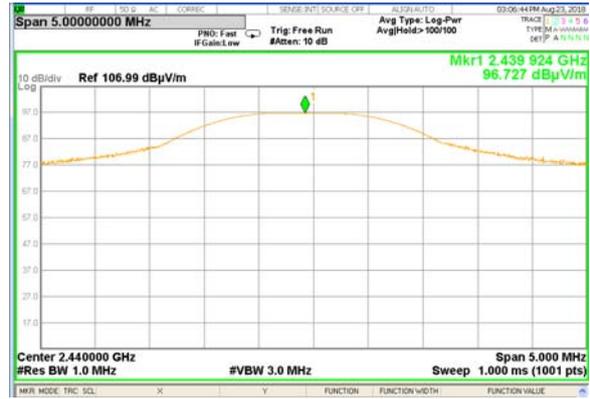
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FCC ID: WCH99956085B

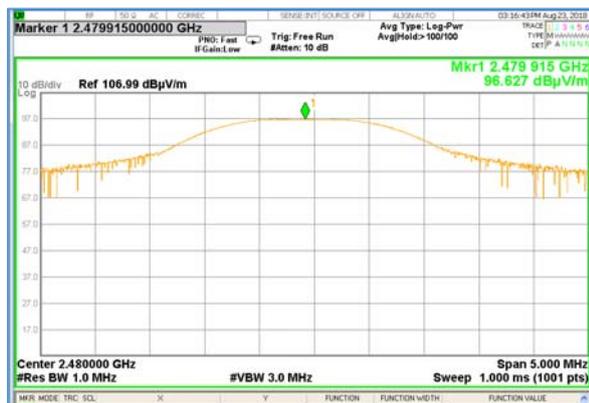
EIRP test result.



Plot # 4. Carrier frequency – 2402 MHz



Plot # 5. Carrier frequency – 2440 MHz



Plot # 6. Carrier frequency – 2480 MHz



Test report No: 9812323302	Page 11 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

5.1.3 Power spectral density test

Method of measurement	ANSI C63.10 subclause 11.10.2		
Operating Frequency Range	2402– 2480 MHz		
Detector used	Peak		
Resolution bandwidth	10 kHz		
Video bandwidth	3 x RBW.		
Trace mode	Max Hold.		
Ambient Temperature 23° C	Relative Humidity 56%	Air Pressure 1010 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.

Carrier frequency, MHz	Field strength, dBµV/m	**EIR power, dBm	*Conducted PSD dBm	Conducted PSD limit, dBm/3 kHz	Reference to plot #
2402	84.2	-16.2	-16.2	8	7
2440	84.7	-15.7	-15.7	8	8
2480	85.0	-15.4	-15.4	8	9

*The conducted to antenna PSD: EIR power – Antenna gain. Where antenna gain = 0.0 dBi.

**EIRP = E Field strength (dBµV/m@3m) - 95.2 + 10 Log (3 kHz RBW/ 10 kHz RBW).

Calculation of EIRP performed after verification by substitution method.

TEST SUMMARY

The Power Spectral Density result is below PSD limit per 47 CFR 15.247(e).
The EUT was found complies with standard requirement.

TEST EQUIPMENT USED:

1	3	14				
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Test report No: 9812323302

Page 12 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B



Plot # 7. Carrier frequency – 2402 MHz



Plot # 8. Carrier frequency – 2440 MHz



Plot # 9. Carrier frequency – 2480 MHz

**Test report No: 9812323302****Page 13 of 30 Pages****Title: Communication Printed Circuit Assembly with IoT capability. BLE module****Model: ComBii****FCC ID: WCH99956085B****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	2402– 2480 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° 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).

Carrier frequency 2402 MHz

Frequency, MHz	Radiated emissions, dBμV/m	Peak limit, dBμV/m	Avg limit, dBμV/m	Margin, dB	Note	Note	Reference to plot#
2390.4	63.7	74	-	10.3	*RB	Detector peak	10
2378.9	38.3	-	54	15.7	RB	Detector average	10
2400.0	62.3	75.3	-	13	Band edge	Detector peak.	11
2488.0	51.2	74.0	-	22.8	RB	Detector peak	12
2488.0	38.1	-	54	15.9	RB	Detector average	12
4803	53.2	74.0	-	20.8	RB	Detector peak	13
4806	42.1	-	54	11.9	RB	Detector average	13
7206	56	74		18	RB	Detector peak	14
7215	47.4		54	6.6	RB	Detector average	14
12012	61.2	74		12.8	RB	Detector peak	14
12021	52.9		54	1.1	RB	Detector average	14

*RB – restricted band



Test report No: 9812323302	Page 14 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

Carrier frequency 2440 MHz

Frequency, MHz	Radiated emissions, dB μ V/m	Peak limit, dB μ V/m	Avg limit, dB μ V/m	Margin, dB	Note	Note	Reference to plot#
2309	62.6	74	-	11.4	RB	Detector peak	16
2310.7	50.8	-	54	3.2	RB	Detector average	16
2400	58.7	75.3	-	16.6	Band edge	Detector peak.	17
5519	55.0	74	-	19	RB	Detector peak	18
5526	42.8	-	54	11.2	RB	Detector average	18
7323	56.9	74	-	17.1	RB	Detector peak	19
7332	47	-	54	7.0	RB	Detector average	19
12201	60.4	74		13.6	RB	Detector peak	19
12210	52.2	-	54	1.8	RB	Detector average	19

Carrier frequency 2480 MHz

Frequency, MHz	Radiated emissions, dB μ V/m	Peak limit, dB μ V/m	Avg limit, dB μ V/m	Margin, dB	Note	Note	Reference to plot#
2387.2	60.8	74	-	13.2	*RB	Detector peak	21
2381.6	49.2	-	54	4.8	RB	Detector average.	21
2483.6	73.5	74	-	0.5	RB	Detector peak	23
2483.6	51.7	-	54	2.3	RB	Detector average	23
2500	59.0	74	-	15	RB	Detector peak	22
5566.0	42.6	-	54	11.4	RB	Detector average	22
7440	56.0	74		18	RB	Detector peak	25
7449	46.8		54	7.2	RB	Detector average	25

*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	10	13	14	
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Test report No: 9812323302

Page 15 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

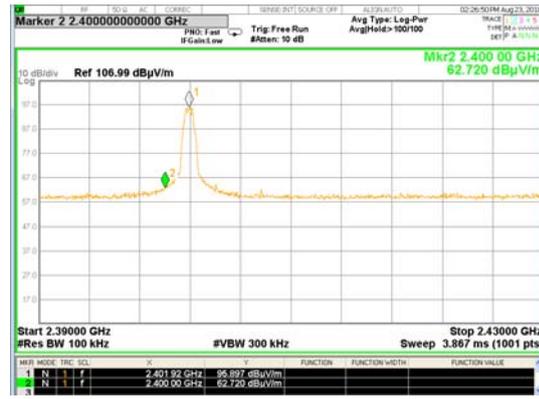
Model: ComBii

FCC ID: WCH99956085B

Carrier frequency – 2402 MHz.



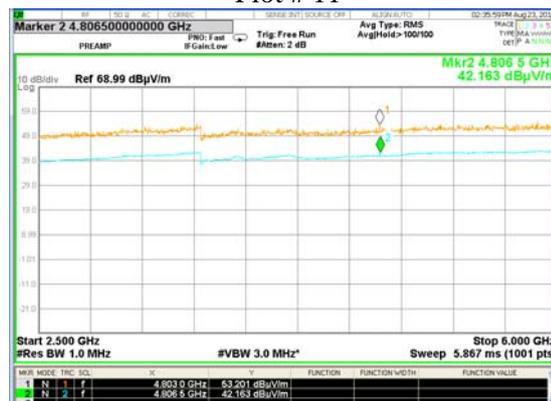
Plot # 10



Plot # 11



Plot # 12



Plot # 13



Plot # 14.



Plot # 15.



Test report No: 9812323302

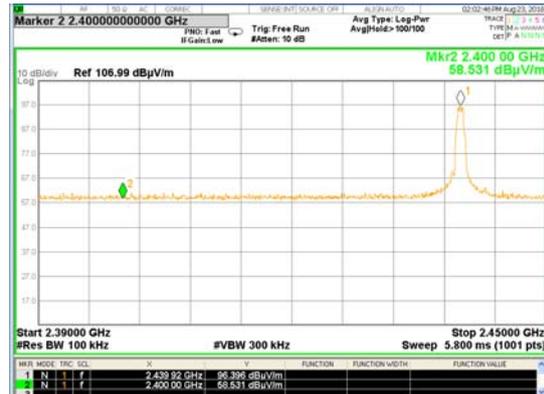
Page 16 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B

Carrier frequency - 2440 MHz.



Plot # 16

Plot # 17



Plot # 18

Plot # 19



Plot # 20.



Test report No: 9812323302

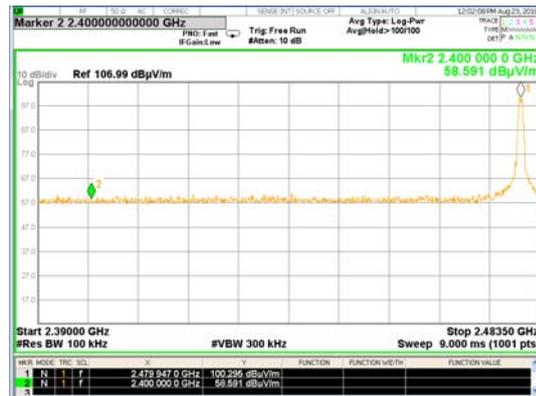
Page 17 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

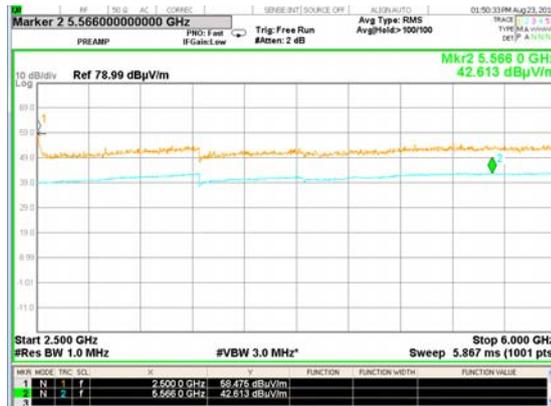
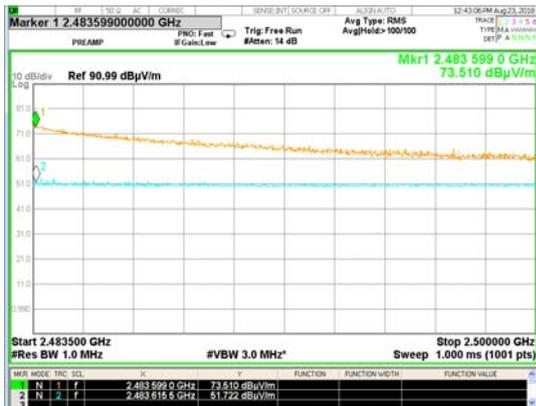
FCC ID: WCH99956085B

Carrier frequency 2480 MHz.



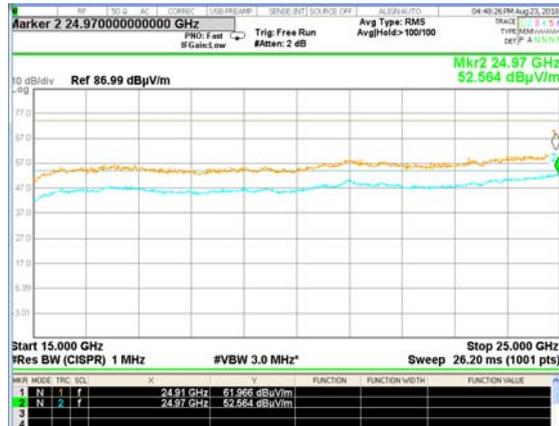
Plot # 21

Plot # 22



Plot # 23

Plot # 24



Plot # 25

Plot # 26



Test report No: 9812323302	Page 18 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

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° 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 0.15 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:

The maximum peak emissions value is at least 10 dB below the limits
 Test results present in plots ## 27, 28

TEST EQUIPMENT USED:

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Test report No: 9812323302

Page 19 of 30 Pages

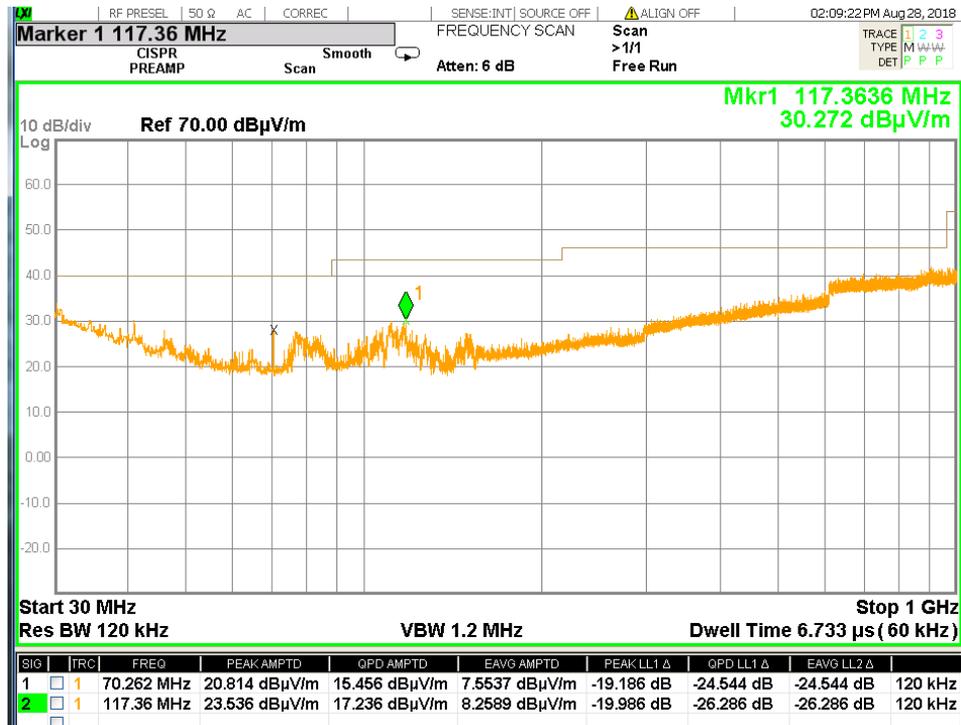
Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B



Plot # 27. Investigation result in 0.15 – 30 MHz frequency range.



Plot # 28. Investigation result in 30 - 1000 MHz frequency range.



Test report No: 9812323302	Page 20 of 30 Pages
Title: Communication Printed Circuit Assembly with IoT capability. BLE module	
Model: ComBii	FCC ID: WCH99956085B

5.3 Conducted emissions test according to § 15.207.

Method of measurement	ANSI C63.10 §6.2	
Ambient Temperature 23 ⁰ C	Relative Humidity 56%	Air Pressure 1010 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 transmittion mode present in plots # 29, 30.

TEST EQUIPMENT USED:

1	12	13			
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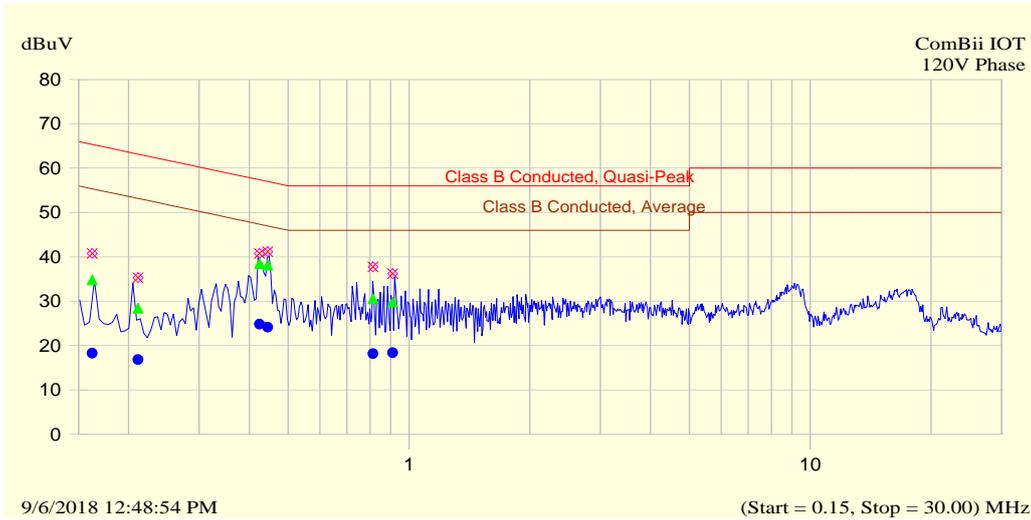
Test report No: 9812323302

Page 21 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B



Plot # 29. AC line conducted emissions test. Line Phase

Frequency MHz	Peak dBuV	QP dBuV	Limit QP dB	QP-QP Limit dB	Avg dBuV	Limit Avg. dB	Avg-Avg Limit dB
0.162	40.8	34.8	65.3	-30.5	18.3	55.3	-37.1
0.211	35.3	28.4	63.2	-34.7	16.9	53.2	-36.3
0.424	40.8	38.5	57.4	-18.9	24.8	47.4	-22.5
0.444	41.1	38.1	57.0	-18.8	24.1	47.0	-22.8
0.814	37.7	30.5	56.0	-25.5	18.2	46.0	-27.8
0.910	36.2	29.8	56.0	-26.2	18.4	46.0	-27.6

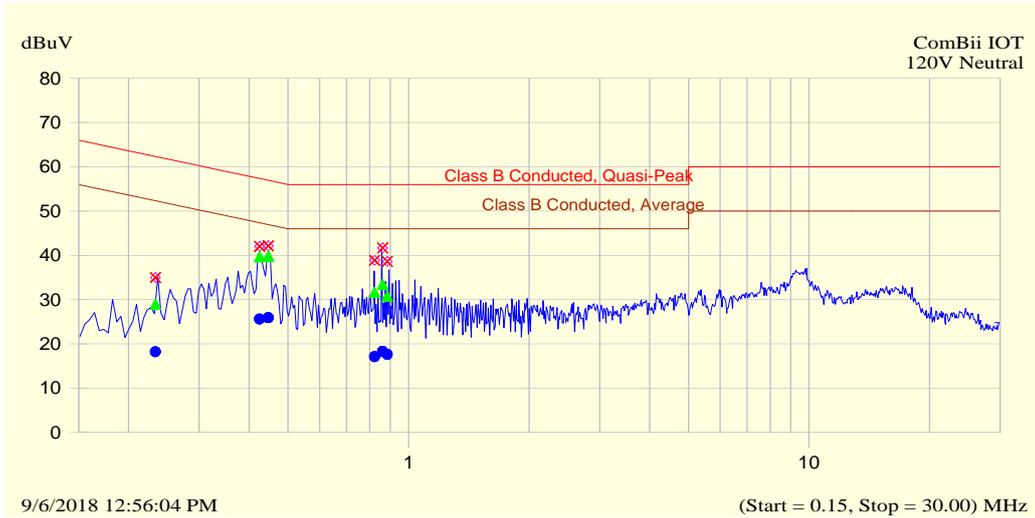
Test report No: 9812323302

Page 22 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B



Plot # 30. AC line conducted emissions test. Line Neutral

Frequency MHz	Peak dBuV	QP dBuV	Limit QP dB	QP-QP Limit dB	Avg dBuV	Limit Avg. dB	Avg-Avg Limit dB
0.234	35.0	28.9	62.3	-33.4	18.2	52.3	-34.1
0.425	42.0	39.7	57.4	-17.7	25.6	47.4	-21.7
0.446	42.1	39.8	56.9	-17.1	25.9	46.9	-21.0
0.823	38.9	31.7	56.0	-24.3	17.1	46.0	-28.9
0.862	41.7	33.4	56.0	-22.6	18.3	46.0	-27.7
0.885	38.6	30.8	56.0	-25.2	17.6	46.0	-28.4

**Test report No: 9812323302****Page 23 of 30 Pages****Title: Communication Printed Circuit Assembly with IoT capability. BLE module****Model: ComBii****FCC ID: WCH99956085B****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	April 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	January 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	Cable RF 5m	Harbour Industries	Neoflex LLEF142	1802	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	00143074	February 2019

**Test report No: 9812323302****Page 24 of 30 Pages****Title: Communication Printed Circuit Assembly with IoT capability. BLE module****Model: ComBii****FCC ID: WCH99956085B****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



Test report No: 9812323302

Page 25 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B

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	-	-

**Test report No: 9812323302****Page 26 of 30 Pages****Title: Communication Printed Circuit Assembly with IoT capability. BLE module****Model: ComBii****FCC ID: WCH99956085B****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; Ser.No.1802; 5 m length**

Point	Frequency (GHz)	Cable Loss (dB)
0	0.0-1.0	1.3
1	1.0 - 3.0	2.4
2	3.0 - 5.0	3.2
3	5.0-7.0	4.0
4	7.0-9.0	4.4
5	9.0-10.0	4.7
6	10.0-12.0	5.2
7	12.0-14.0	5.9
8	14.0-16.0	6.1
9	16.2-18.00	6.6



Test report No: 9812323302

Page 27 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B

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

Test report No: 9812323302

Page 28 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B

APPENDIX B Photo of the test setups.



Photo 1.



Photo 2.



Photo 3.



Photo 4.

Test report No: 9812323302

Page 29 of 30 Pages

Title: Communication Printed Circuit Assembly with IoT capability. BLE module

Model: ComBii

FCC ID: WCH99956085B



Photo 5.



Photo 6.



Photo 7.



Photo 8

**Test report No: 9812323302****Page 30 of 30 Pages****Title: Communication Printed Circuit Assembly with IoT capability. BLE module****Model: ComBii****FCC ID: WCH99956085B**

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(μ V)	decibel referred to one microvolt
dB(μ V/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
NA	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
W	width