



FCC RADIO TEST REPORT

FCC ID : UZ7WS5002
Equipment : WS50 Wearable Computer
Brand Name : Zebra
Model Name : WS5002
Applicant : Zebra Technologies Corporation
1 Zebra Plaza, Holtsville, NY 11742
Manufacturer : Zebra Technologies Corporation
1 Zebra Plaza, Holtsville, NY 11742
Standard : FCC Part 15 Subpart C §15.247

The product was received on Mar. 19, 2024 and testing was performed from Mar. 29, 2024 to Apr. 04, 2024. We, Sporton International Inc. Wensan Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this variant report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. Wensan Laboratory, the test report shall not be reproduced except in full.

Approved by: Louis Wu

Sporton International Inc. Wensan Laboratory

No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)



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History of this test report

Report No.	Version	Description	Issue Date
FR431802C	01	Initial issue of report	May 03, 2024



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
-	15.247(a)(2)	6dB Bandwidth	Not Required	-
-	2.1049	99% Occupied Bandwidth	Not Required	-
3.1	15.247(b)	Power Output Measurement	Pass	-
-	15.247(e)	Power Spectral Density	Not Required	-
-	15.247(d)	Conducted Band Edges	Not Required	-
		Conducted Spurious Emission	Not Required	-
3.2	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	1.69 dB under the limit at 2483.52 MHz
-	15.207	AC Conducted Emission	Not Required	-
3.3	15.203	Antenna Requirement	Pass	-

Note:

1. Not required means after assessing, test items are not necessary to carry out.
2. This is a variant report by removing NFC function and changing model name. All the test cases were performed on original report which can be referred to Sporton Report Number FR100707-02C. Based on the original report, the test cases were verified.

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section "Measurement Uncertainty".

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Wei Chen

Report Producer: Wilda Wei



1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	WS50 Wearable Computer
Brand Name	Zebra
Model Name	WS5002
FCC ID	UZ7WS5002
EUT supports Radios application	WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
HW Version	MV
SW Version	11-38-19.00-RN-U00-PRD-WTX-04
MFD	25DEC23
EUT Stage	Identical Prototype

Remark: The EUT's information above is declared by manufacturer.

SKU List				
Helix SKU	Scanner	Battery	Camera	Mounting
SKU 3-1	N/A	Standard Battery	Yes	Wrist Strap
SKU 3-2	N/A	Standard Battery	N/A	Wrist Strap

Specification of Accessories				
Adaptor	Brand Name	Zebra	Model Number	PWR-WUA5V12W0US
Standard Battery	Brand Name	Zebra	Model Number	BT-000446
USB charging cable with cup	Brand Name	Zebra	Model Number	CBL-WS5X-USB1-01
USB C CABLE	Brand Name	Zebra	Model Number	CBL-TC2X-USBC-01



Supported Unit used in test configuration and system				
Converged Scanner Shell	Brand Name	Zebra	Part Number	SG-WS5X-SHLCS-01
Replacement Finger Trigger for Converged	Brand Name	Zebra	Part Number	SG-WS5X-TRGA-01
Wrist Shell	Brand Name	Zebra	Part Number	SG-WS5X-SHLWR-01
Wrist Strap	Brand Name	Zebra	Part Number	SG-WS5X-WSTRP-01
Wrist Mount (without strap)	Brand Name	Zebra	Part Number	SG-WS5X-WSTMT-01
Wrist Mount with strap	Brand Name	Zebra	Part Number	SG-WS5X-WPLTS-01
Back of Hand Mount for Converged	Brand Name	Zebra	Part Number	SG-WS5X-BHMT-01
Thin Mount	Brand Name	Zebra	Part Number	SG-WS5X-TNMNT-01
Black Strap	Brand Name	Zebra	Part Number	SG-WS5X-BNDBK-01
Blur Strap	Brand Name	Zebra	Part Number	SG-WS5X-BNDBL-01
Clip Mount	Brand Name	Zebra	Part Number	SG-WS5X-CPMNT-01
Clip for Clip Mount	Brand Name	Zebra	Part Number	SG-WS5X-MCLIP-01
Shell for Clip Mount	Brand Name	Zebra	Part Number	SG-WS5X-SHELL-01
Headphone 1	Brand Name	Zebra	Part Number	HS2100
Headphone 2	Brand Name	Zebra	Part Number	HDST-35MM-PTT1-01
Generic Lanyard	Brand Name	Zebra	Part Number	N/A

1.2 Product Specification of Equipment Under Test

Product Specification is subject to this standard	
Tx/Rx Channel Frequency Range	2412 MHz ~ 2462 MHz
Maximum Output Power to Antenna	802.11b : 21.60 dBm / 0.1445 W 802.11g : 20.40 dBm / 0.1096 W 802.11n HT20 : 19.80 dBm / 0.0955 W 802.11n HT40 : 20.10 dBm / 0.1023 W 802.11ac VHT20: 19.60 dBm / 0.0912 W 802.11ac VHT40: 19.80 dBm / 0.0955 W
Antenna Type / Gain	PIFA Antenna with gain 2.50 dBi
Type of Modulation	802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ac : OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM)

Remark:

1. For other wireless features of this EUT, test report will be issued separately.
2. The above EUT's information was declared by manufacturer. Please refer to Disclaimer in report summary.

1.3 Modification of EUT

No modifications made to the EUT during the testing.



1.4 Testing Location

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No. TH05-HY, 03CH11-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW3786

1.5 Applicable Standards

According to the specifications declared by the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- ♦ ANSI C63.10-2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: Radiation emission (1 GHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst case emissions were reported in this report.

- b. AC power line Conducted Emission was tested under maximum output power.

2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437		



2.2 Test Mode

The final test modes include the worst data rates for each modulation shown in the table below.

Single Antenna

Modulation	Data Rate
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20	MCS0
802.11n HT40	MCS0
802.11ac VHT20	MCS0
802.11ac VHT40	MCS0

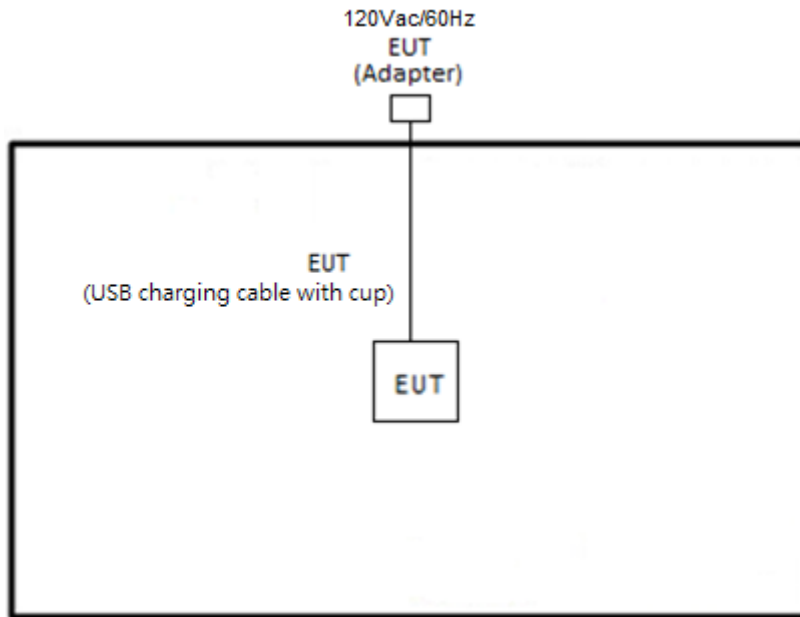
Ch. #	2400-2483.5 MHz	
	802.11b	802.11n HT40
Low	-	-
Middle	06	-
High	-	09

Remark:

1. For radiation spurious emission, the modulation and the data rate picked for testing are determined by the Max. RF conducted power.
2. For Radiated Test Cases, the tests were performed with Standard Battery and SKU3-1.

2.3 Connection Diagram of Test System

<WLAN Tx Mode>



2.4 EUT Operation Test Setup

The RF test items, utility "QRCT Version 4.0.211.0" was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

3 Test Result

3.1 Output Power Measurement

3.1.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5 MHz, the limit for output power is 30 dBm. If transmitting antenna with directional gain greater than 6 dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

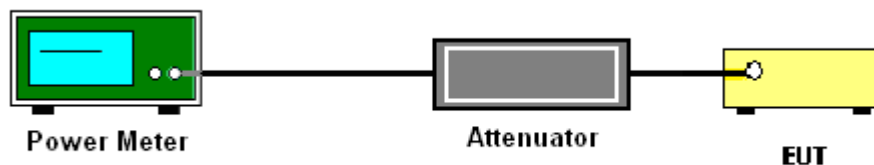
3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.1.3 Test Procedures

1. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.2 Method AVGPM-G
2. The RF output of EUT is connected to the power meter by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of Average Output Power

Please refer to Appendix A.



3.2 Radiated Band Edges and Spurious Emission Measurement

3.2.1 Limit of Radiated band edge and Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device is measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

3.2.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

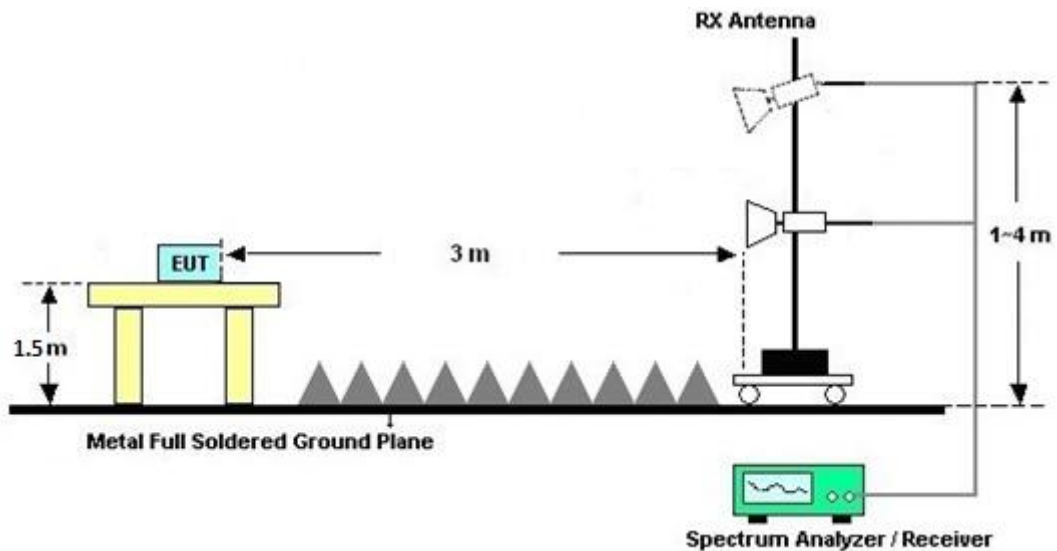
3.2.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT is arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT is placed on a turntable with 1.5 meter for frequency above 1 GHz respectively above ground.
4. The EUT is set 3 meters away from the receiving antenna, which is mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as “-”.

7. Use the following spectrum analyzer settings:
- (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW = 100 kHz for $f < 1$ GHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3 MHz for $f \geq 1$ GHz for peak measurement.
- For average measurement:
- VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW $\geq 1/T$, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.2.4 Test Setup

For radiated test above 1GHz



3.2.5 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B and C.

3.2.6 Duty Cycle

Please refer to Appendix D.

3.2.7 Test Result of Radiated Spurious Emission

Please refer to Appendix B and C.



3.3 Antenna Requirements

3.3.1 Standard Applicable

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.3.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.



4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-01620	1GHz~18GHz	Aug. 17, 2023	Apr. 01, 2024~Apr. 04, 2024	Aug. 16, 2024	Radiation (03CH11-HY)
Preamplifier	E-INSTRUMENT TECH LTD.	ERA-10M-7000-MR	EC1900245	10MHz~7GHz	Jan. 09, 2024	Apr. 01, 2024~Apr. 04, 2024	Jan. 08, 2025	Radiation (03CH11-HY)
Preamplifier	Jet-Power	JPA0118-55-303	1710001800055007	1GHz~18GHz	Jun. 14, 2023	Apr. 01, 2024~Apr. 04, 2024	Jun. 13, 2024	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz~44GHz	Oct. 05, 2023	Apr. 01, 2024~Apr. 04, 2024	Oct. 04, 2024	Radiation (03CH11-HY)
Controller	EMEC	EM 1000	N/A	Control Turn table & Ant Mast	N/A	Apr. 01, 2024~Apr. 04, 2024	N/A	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Apr. 01, 2024~Apr. 04, 2024	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Apr. 01, 2024~Apr. 04, 2024	N/A	Radiation (03CH11-HY)
Software	Audix	E3 6.2009-8-24	RK-001053	N/A	N/A	Apr. 01, 2024~Apr. 04, 2024	N/A	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY1595/2	30MHz~40GHz	Mar. 06, 2024	Apr. 01, 2024~Apr. 04, 2024	Mar. 05, 2025	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30MHz~40GHz	Mar. 06, 2024	Apr. 01, 2024~Apr. 04, 2024	Mar. 05, 2025	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	803951/2	9K~30M	Mar. 06, 2024	Apr. 01, 2024~Apr. 04, 2024	Mar. 05, 2025	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	803951/2	30M~40G	Mar. 06, 2024	Apr. 01, 2024~Apr. 04, 2024	Mar. 05, 2025	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60SS	SN3	3GHz High Pass Filter	Sep. 11, 2023	Apr. 01, 2024~Apr. 04, 2024	Sep. 10, 2024	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303B	TP140325	N/A	Dec. 08, 2023	Apr. 01, 2024~Apr. 04, 2024	Dec. 07, 2024	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303A	TP201996	N/A	Nov. 07, 2023	Mar. 29, 2024	Nov. 06, 2024	Conducted (TH05-HY)
Power Sensor	DARE	RPR3006W	15I00041SNO10 (NO:248)	10MHz~6GHz	Jun. 05, 2023	Mar. 29, 2024	Jun. 04, 2024	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz~40GHz	Aug. 23, 2023	Mar. 29, 2024	Aug. 22, 2024	Conducted (TH05-HY)



5 Measurement Uncertainty

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.30 dB
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Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.30 dB
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Appendix A. Test Result of Conducted Test Items

Test Engineer:	Willy Chang	Temperature:	21~25	°C
Test Date:	2024/3/29	Relative Humidity:	51~54	%

TEST RESULTS DATA
Average Output Power

2.4GHz Band Single Antenna																
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)			Conducted Power Limit (dBm)		DG (dBi)		EIRP Power (dBm)		EIRP Power Limit (dBm)		Pass /Fail
					Ant1	Ant2	SUM	Ant1	Ant2	Ant1	Ant2	Ant1	Ant2	Ant1	Ant2	
11b	1Mbps	1	1	2412	21.60	-		30.00	-	2.50	2.50	24.10	-	36.00	-	Pass
11g	6Mbps	1	6	2437	20.40	-		30.00	-	2.50	2.50	22.90	-	36.00	-	Pass
HT20	MCS0	1	1	2412	19.80	-		30.00	-	2.50	2.50	22.30	-	36.00	-	Pass
HT40	MCS0	1	6	2437	20.10	-		30.00	-	2.50	2.50	22.60	-	36.00	-	Pass
VHT20	MCS0	1	1	2412	19.60	-		30.00	-	2.50	2.50	22.10	-	36.00	-	Pass
VHT40	MCS0	1	6	2437	19.80	-		30.00	-	2.50	2.50	22.30	-	36.00	-	Pass

Note: Measured power (dBm) has offset with cable loss.



Appendix B. Radiated Spurious Emission

Test Engineer :	Fu Chen, Sam Chou and Troye Hsieh	Temperature :	20.0~20.8°C
		Relative Humidity :	53.2~64.8%

2.4GHz 2400~2483.5MHz

WIFI 802.11b (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 06 2437MHz		2388.56	51.48	-22.52	74	42.08	27.49	16.71	34.8	136	170	P	H
		2390	41.36	-12.64	54	31.95	27.5	16.71	34.8	136	170	A	H
	*	2437	110.79	-	-	101.22	27.6	16.77	34.8	136	170	P	H
	*	2437	107.65	-	-	98.08	27.6	16.77	34.8	136	170	A	H
		2489.28	52.72	-21.28	74	42.97	27.7	16.85	34.8	136	170	P	H
		2484.08	41.06	-12.94	54	31.32	27.7	16.84	34.8	136	170	A	H
		2335.28	51.57	-22.43	74	42.44	27.25	16.67	34.79	100	194	P	V
		2390	40.93	-13.07	54	31.52	27.5	16.71	34.8	100	194	A	V
	*	2437	109.84	-	-	100.27	27.6	16.77	34.8	100	194	P	V
	*	2437	106.72	-	-	97.15	27.6	16.77	34.8	100	194	A	V
		2488.88	52.34	-21.66	74	42.59	27.7	16.85	34.8	100	194	P	V
		2483.68	40.95	-13.05	54	31.21	27.7	16.84	34.8	100	194	A	V

Remark

- No other spurious found.
- All results are PASS against Peak and Average limit line.



2.4GHz 2400~2483.5MHz
WIFI 802.11b (Harmonic @ 3m)

WIFI Ant.	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
802.11b CH 06 2437MHz		4874	41.45	-32.55	74	54.76	32.7	11.81	57.82	-	-	P	H	
		7311	54.2	-19.8	74	61.02	36.86	14.77	58.45	148	292	P	H	
		7311	49.48	-4.52	54	56.3	36.86	14.77	58.45	148	292	A	H	
													H	
													H	
													H	
													H	
													H	
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													H	
													H	
			4874	41.61	-32.39	74	54.92	32.7	11.81	57.82	-	-	P	V
			7311	54.29	-19.71	74	61.11	36.86	14.77	58.45	200	238	P	V
			7311	50.27	-3.73	54	57.09	36.86	14.77	58.45	200	238	A	V
														V
														V
														V
														V
														V
													V	
													V	
Remark	<ol style="list-style-type: none"> No other spurious found. All results are PASS against Peak and Average limit line. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only. 													



**2.4GHz 2400~2483.5MHz
WIFI 802.11n HT40 (Band Edge @ 3m)**

WIFI Ant.	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT40 CH 09 2452MHz		2389.52	56.49	-17.51	74	47.08	27.5	16.71	34.8	100	167	P	H
		2390	43.15	-10.85	54	33.74	27.5	16.71	34.8	100	167	A	H
	*	2452	107.09	-	-	97.59	27.5	16.8	34.8	100	167	P	H
	*	2452	98.38	-	-	88.88	27.5	16.8	34.8	100	167	A	H
		2484.4	70.28	-3.72	74	60.54	27.7	16.84	34.8	100	167	P	H
		2483.52	52.31	-1.69	54	42.57	27.7	16.84	34.8	100	167	A	H
		2389.52	51.89	-22.11	74	42.48	27.5	16.71	34.8	100	316	P	V
		2390	40.85	-13.15	54	31.44	27.5	16.71	34.8	100	316	A	V
	*	2452	104.21	-	-	94.71	27.5	16.8	34.8	100	316	P	V
	*	2452	96.25	-	-	86.75	27.5	16.8	34.8	100	316	A	V
		2483.68	69.4	-4.6	74	59.66	27.7	16.84	34.8	100	316	P	V
		2483.52	50.81	-3.19	54	41.07	27.7	16.84	34.8	100	316	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



**2.4GHz 2400~2483.5MHz
WIFI 802.11n HT40 (Harmonic @ 3m)**

WIFI Ant.	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
802.11n HT40 CH 09 2452MHz		4904	41.59	-32.41	74	54.9	32.72	11.8	57.83	-	-	P	H	
		7356	44.48	-29.52	74	51.45	36.66	14.8	58.43	-	-	P	H	
													H	
													H	
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			4904	40.84	-33.16	74	54.15	32.72	11.8	57.83	-	-	P	V
			7356	45.62	-28.38	74	52.59	36.66	14.8	58.43	-	-	P	V
													V	
													V	
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													V	
													V	
													V	
													V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.													



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is Margin line.
P/A	Peak or Average
H/V	Horizontal or Vertical



A calculation example for radiated spurious emission is shown as below:

WIFI	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 01		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H
2412MHz													

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =
Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
3. Margin(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)
= 55.45 (dBμV/m)
2. Margin (dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 55.45(dBμV/m) – 74(dBμV/m)
= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)
= 43.54 (dBμV/m)
2. Margin (dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 43.54(dBμV/m) – 54(dBμV/m)
= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.



Appendix C. Radiated Spurious Emission Plots

Test Engineer :	Fu Chen, Sam Chou and Troye Hsieh	Temperature :	20.0~20.8°C
		Relative Humidity :	53.2~64.8%

Note symbol

-L	Low channel location
-R	High channel location

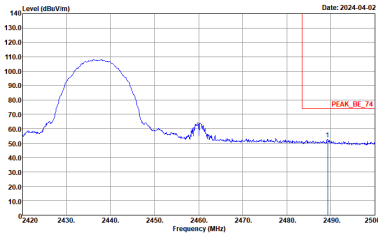
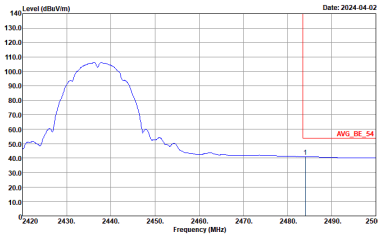


2.4GHz 2400~2483.5MHz

WIFI 802.11b (Band Edge @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11b CH06 2437MHz - L	
	Horizontal	Fundamental
Peak	<p>Site : 03CH11-1HY Condition : PEAK_BE_74 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	<p>Site : 03CH11-1HY Condition : PEAK_74 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	<p>Site : 03CH11-1HY Condition : AVG_BE_54 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto</p>	<p>Site : 03CH11-1HY Condition : AVG_54 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto</p>

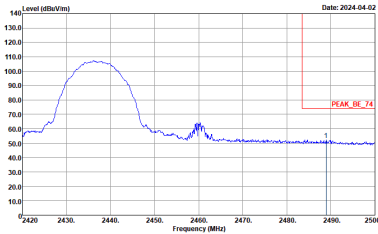
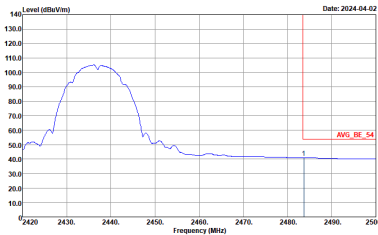


WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11b CH06 2437MHz - R	
	Horizontal	Fundamental
<p>Peak</p>	 <p>Site : 03CHI1-HY Condition : PEAK_BE_74 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	<p>Left blank</p>
<p>Avg.</p>	 <p>Site : 03CHI1-HY Condition : AVG_BE_54 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000kHz VBW:0.010kHz SWT:Auto</p>	<p>Left blank</p>



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11b CH06 2437MHz - L	
	Vertical	Fundamental
Peak	<p>Site : 03CHI1-HY Condition : PEAK_BE_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	<p>Site : 03CHI1-HY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	<p>Site : 03CHI1-HY Condition : AV6_BE_54 3m 91200_01620_230817 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto</p>	<p>Site : 03CHI1-HY Condition : AV6_54 3m 91200_01620_230817 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto</p>

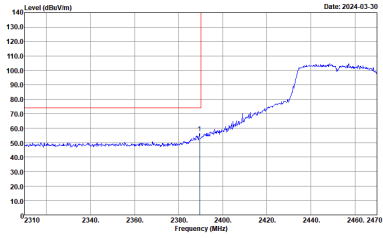
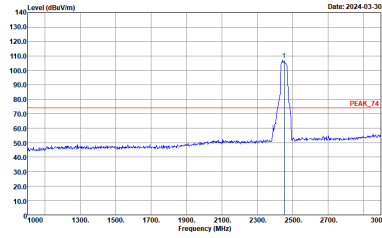
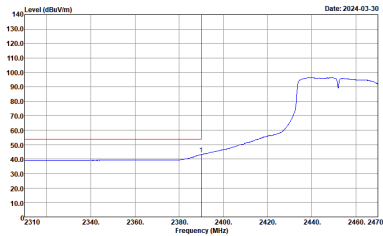
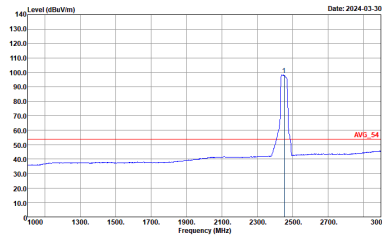


WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11b CH06 2437MHz - R	
	Vertical	Fundamental
<p>Peak</p>	 <p>Site : 03CHI1-HY Condition : PEAK_BE_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWF:Auto</p>	<p>Left blank</p>
<p>Avg.</p>	 <p>Site : 03CHI1-HY Condition : AVG_BE_54 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:0.010kHz SWF:Auto</p>	<p>Left blank</p>



2.4GHz 2400~2483.5MHz

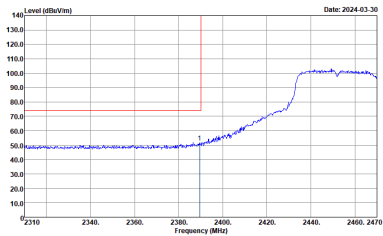
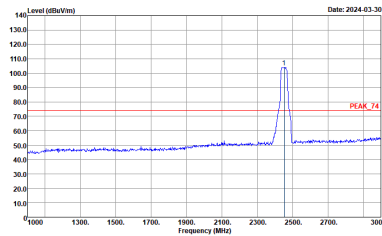
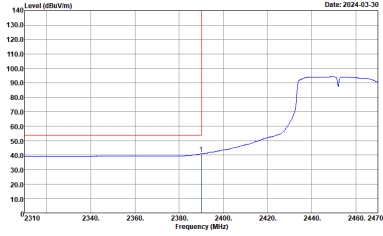
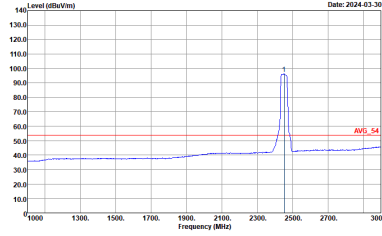
WIFI 802.11n HT40 (Band Edge @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - L	
	Horizontal	Fundamental
Peak	 <p>Level (dBm/100MHz) vs Frequency (MHz) plot showing a rising signal level from 2310 to 2470 MHz. A red vertical line is at 2452 MHz. Site: 03CH11-1Y, Condition: PEAK_BE_74 3m 91200_01620_230817 HORIZONTAL, RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	 <p>Level (dBm/100MHz) vs Frequency (MHz) plot showing a sharp peak at 2452 MHz. A red horizontal line is labeled 'PEAK_74'. Site: 03CH11-1Y, Condition: PEAK_74 3m 91200_01620_230817 HORIZONTAL, RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	 <p>Level (dBm/100MHz) vs Frequency (MHz) plot showing a rising signal level. A red vertical line is at 2452 MHz. Site: 03CH11-1Y, Condition: AVG_BE_54 3m 91200_01620_230817 HORIZONTAL, RBW:1000.000KHz VBW:0.010KHz SWT:Auto</p>	 <p>Level (dBm/100MHz) vs Frequency (MHz) plot showing a sharp peak at 2452 MHz. A red horizontal line is labeled 'AVG_54'. Site: 03CH11-1Y, Condition: AVG_54 3m 91200_01620_230817 HORIZONTAL, RBW:1000.000KHz VBW:0.010KHz SWT:Auto</p>



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - R	
	Horizontal	Fundamental
Peak	<p>Site : 03CHI1-HY Condition : PEAK_BE_74 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	Left blank
Avg.	<p>Site : 03CHI1-HY Condition : AVG_BE_54 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000kHz VBW:0.010kHz SWT:Auto</p>	Left blank



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - L	
	Vertical	Fundamental
Peak	 <p>Site : 03CHI1-HY Condition : PEAK_BE_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	 <p>Site : 03CHI1-HY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>
Avg.	 <p>Site : 03CHI1-HY Condition : AV6_BE_54 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:0.010kHz SWT:Auto</p>	 <p>Site : 03CHI1-HY Condition : AV6_54 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:0.010kHz SWT:Auto</p>



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11n HT40 CH09 2452MHz - R	
	Vertical	Fundamental
<p>Peak</p>	<p>Site : 03CHI1-HY Condition : PEAK_BE_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	<p>Left blank</p>
<p>Avg.</p>	<p>Site : 03CHI1-HY Condition : AVG_BE_54 3m 91200_01620_230817 VERTICAL : RBW:1000.000kHz VBW:0.010kHz SWT:Auto</p>	<p>Left blank</p>

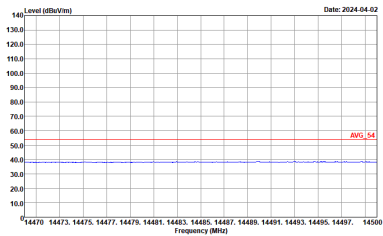
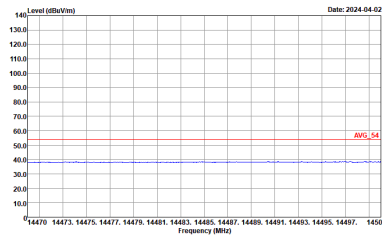
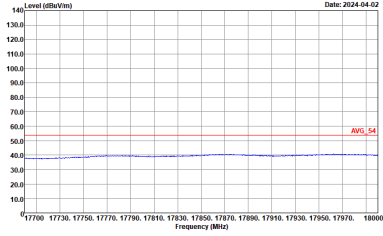
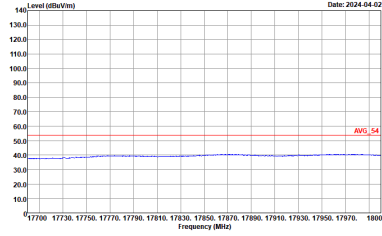


2.4GHz 2400~2483.5MHz

WIFI 802.11b (Harmonic @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	802.11b CH06 2437MHz	
	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH11-FY Condition : PEAK_74 3m 91200_01620_230817 HORIZONTAL</p>	<p>Site : 03CH11-FY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL</p>

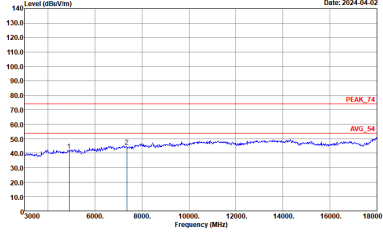
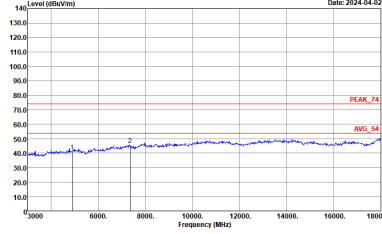


WIFI	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	802.11b CH06 2437MHz	
	Horizontal	Vertical
<p>14.47G ~14.5G Avg.</p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 VERTICAL</p>
<p>17.7G ~18G Avg</p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 VERTICAL</p>

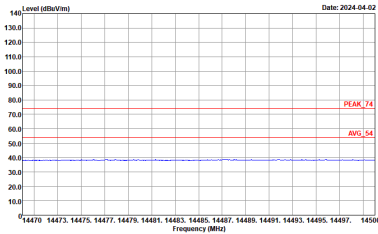
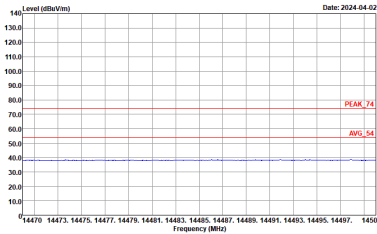
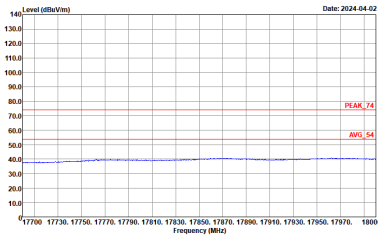
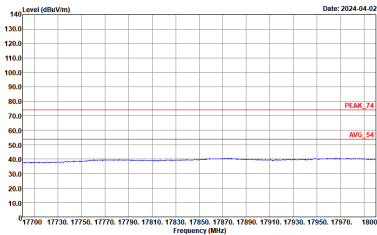


2.4GHz 2400~2483.5MHz

WIFI 802.11n HT40 (Harmonic @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	802.11n HT40 CH09 2452MHz	
	Horizontal	Vertical
<p>Peak</p> <p>Avg.</p>	 <p>Site : 03CH11-FY Condition : PEAK_74 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-FY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL</p>



WIFI	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
ANT	802.11n HT40 CH09 2452MHz	
	Horizontal	Vertical
<p>14.47G ~14.5G Avg.</p>	 <p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL</p>
<p>17.7G ~18G Avg</p>	 <p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL</p>



Appendix D. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
802.11b	100.00	-	-	10Hz
2.4GHz 802.11n HT40	98.19	-	-	10Hz

