DFS Test Report

Applicant	:	Synology Inc.
Product Name	:	Synology 11ax router
Trade Name	:	Synology
Model Number	:	WRX560
Applicable Standard	:	FCC 47 CFR PART 15 SUBPART E ANSI C63.10:2013
Received Date	:	Jan. 19, 2022
Test Period	:	Jun. 16 ~ Jun. 22, 2022
Issued Date	:	Aug. 18, 2022

Issued by

A Test Lab Techno Corp.
No. 140-1, Changan Street, Bade District,
Taoyuan City 334025, Taiwan (R.O.C.)
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Taiwan Accreditation Foundation accreditation number: 1330
Frequency Range : 9 kHz to 40 GHz
Test Firm MRA designation number: TW0010

Note:
1.The test results are valid only for samples provided by customers and under the test conditions described in this report.
2.This report shall not be reproduced except in full, without the written approval of A Test Lab Technology Corporation.
3.The relevant information is provided by customers in this test report. According to the correctness, appropriateness or completeness of the information provided by the customer, if there is any doubt or error in the information which affects the validity of the test results, the laboratory does not take the responsibility.

Revision History

Rev.	Issued Date	Revisions	Revised By
00	Aug. 11, 2022	Initial Issue	Emma Chao
01	Aug. 18, 2022	Update chapter 3.2 (P.12) Added chapter 5.6 (P.18 ~ P.21) Update Appendix A	Emma Chao

Verification of Compliance

Applicant	:	Synology Inc.
Product Name	:	Synology 11ax router
Trade Name	:	Synology
Model Number	:	WRX560
FCC ID	:	YOR-WRX560
Applicable Standard	:	FCC 47 CFR PART 15 SUBPART E ANSI C63.10:2013
Test Result	:	Complied
Performing Lab.	:	A Test Lab Techno Corp. No. 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan (R.O.C.) Tel：+886-3-2710188 / Fax：+886-3-2710190 Taiwan Accreditation Foundation accreditation number: 1330

A Test Lab Techno Corp. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by A Test Lab Techno Corp. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Approved By : Kai Yu Yang

(Kai Yu Yang)

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1 EUT Description

Applicant	Synology Inc. 9F., No.1, Yuandong Rd., Banqiao Dist., New Taipei City 220632				
Product Name	Synology 11ax router				
Trade Name	Synology				
Model Number	WRX560				
FCC ID	YOR-WRX560				
Operate Frequency	Frequency Band		Frequency Range (MHz)	Number of Channels	
	IEEE 802.11a	U-NII Band 2-A	5260 – 5320	4	
		U-NII Band 2-C	5500 – 5700	11	
	IEEE 802.11n 5 GHz 20 MHz / IEEE 802.11ac 20 MHz/ IEEE 802.11ax 20 MHz	U-NII Band 2-A	5260 – 5320	4	
		U-NII Band 2-C	5500 – 5700	11	
	IEEE 802.11n 5 GHz 40 MHz / IEEE 802.11ac 40 MHz/ IEEE 802.11ax 40 MHz	U-NII Band 2-A	5270 – 5310	2	
		U-NII Band 2-C	5510 – 5670	5	
	IEEE 802.11ac 80 MHz/ IEEE 802.11ax 80 MHz	U-NII Band 2-A	5290	1	
		U-NII Band 2-C	5530 – 5610	2	
	IEEE 802.11ac 160 MHz (80 + 80 MHz) / IEEE 802.11ax 160 MHz (80 + 80 MHz)	U-NII Band 2-A	5290	1	
		U-NII Band 2-C	5530 – 5610	2	
Modulation Type	OFDM/OFDMA				
Antenna information	Antenna	Model	Type	Max. Gain (dBi)	
	Ant3 (ANT-0)	MLX22M-121AA0-A	DIPOLE	U-NII Band 2-A	2.0
				U-NII Band 2-C	2.1
	Ant4 (ANT-1)	MLX22M-121AA0-A	DIPOLE	U-NII Band 2-A	2.7
				U-NII Band 2-C	2.4
	Ant5 (ANT-2)	MLX22M-121AA0-A	DIPOLE	U-NII Band 2-A	3.5
				U-NII Band 2-C	3.4
	Ant6 (ANT-3)	MLX22M-121AA0-A	DIPOLE	U-NII Band 2-A	2.4
				U-NII Band 2-C	2.2
Antenna Delivery	IEEE 802.11a : 4TX (CDD) IEEE 802.11n / ac /ax :4TX (CDD/Beamforming on)				
Operate Temp. Range	5 ~ 40 ℃				
EUT Power Rating	DC 12 V, 2.5 A				

Items	Description	
Communication Mode	■IP Based (Load Based)	□Frame Based
TPC Function	■With TPC	□Without TPC
Weather Band (5600 ~ 5650 MHz)	■With 5600 ~ 5650 MHz	□Without 5600 ~ 5650 MHz
Beamforming Function	■With Beamforming	□Without Beamforming
Equipment Type	□Outdoor access point (point-to-point)	
	□Outdoor access point (point-to-multipoint)	
	■Indoor access point	
	□Fixed point-to-point access points	
	□Client devices	
Operating mode	■Master	
	□Client with radar detection	
	□Client without radar detection	
	□Ad-Hoc	
	□Bridge	
	□MESH	

Note：DFS controls (hardware or software) related to radar detection are NOT accessible to the user. Manufacturer statement confirming that information regarding the parameters of the detected Radar Waveforms is not available to the end user.

2 Test Methodology

The tests documented in this report were performed in accordance with ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15.

The tests documented in this report were performed in accordance with FCC KDB request:

- FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02
- FCC KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

3 Dynamic Frequency Selection

3.1. Limits

§15.407 (h) and FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 Compliance measurement procedures for unlicensed-national information infrastructure devcies operating in the 5250-5350 MHZ and 5470-5725 MHZ bands incorporating dynamic frequency selection.

Table 1: Applicability of DFS Requirements Prior to Use of a Channel

Requirement	Operational Mode		
	Master	Client (without Radar Detection)	Client (with Radar Detection)
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client With Radar Detection	Client without Radar Detection
DFS Detection Threshold	Yes	Not required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required

Additional requirements for devices with multiple bandwidth modes	Master Device or Client With Radar Detection	Client without Radar Detection
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note : Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in all 20 MHz channel blocks and a null frequencies between the bonded 20 MHz channel blocks		

Table 3: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection	
Maximum Transmit Power	U-NII Band 2-Aalue (See Notes 1,2 and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and Power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response. Note 3: EIRP is based on the highest antenna gain. For MIMO devices refer to FCC KDB Publication 662911 D01.	

Table 4: DFS Response Requirement U-NII Band 2-Aalues	
Parameter	U-NII Band 2-Aalue
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note 1.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 100 % of the U-NII 99 % transmission power bandwidth. See Note 3.
Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions. Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.	

Table 5: Short Pulse Radar Test Waveforms					
Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	60 %	30
2	1-5	150-230	23-29	60 %	30
3	6-10	200-500	16-18	60 %	30
4	11-20	200-500	12-16	60 %	30
Aggregate (Radar Types 1-4)				80 %	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

Table 5a: Pulse Repetition Intervals U-NII Band 2-Aalues for Test A		
Pulse Repetition Frequency Number	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)
1	1930.5	518
2	1858.7	538
3	1792.1	558
4	1730.1	578
5	1672.2	598
6	1618.1	618
7	1567.4	638
8	1519.8	658
9	1474.9	678
10	1432.7	698
11	1392.8	718
12	1355	738
13	1319.3	758
14	1285.3	778
15	1253.1	798
16	1222.5	818
17	1193.3	838
18	1165.6	858
19	1139	878
20	1113.6	898
21	1089.3	918
22	1066.1	938
23	326.2	3066

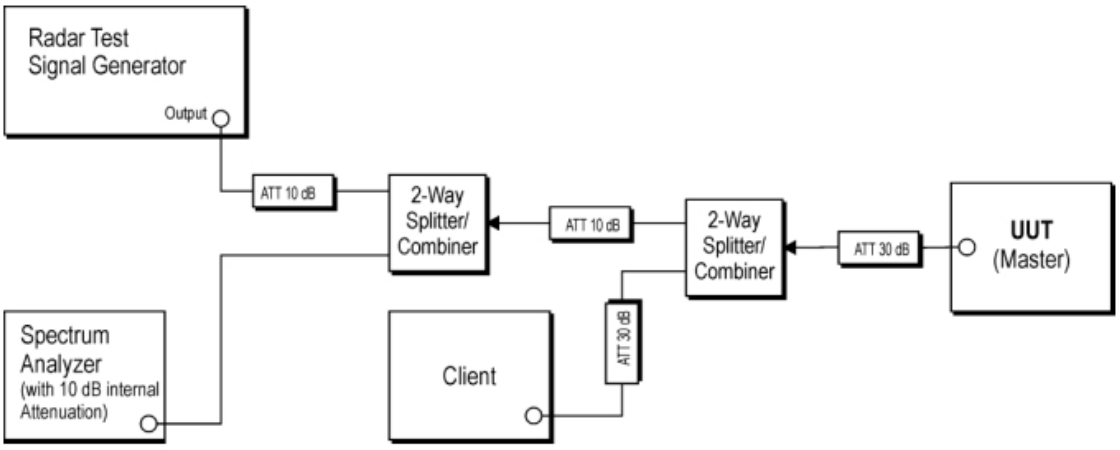
Table 6 – Long Pulse Radar Test Signal							
Radar Waveform	Bursts	Pulses per Burst	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Minimum Percentage of Successful Detection	Minimum Trials
5	8-20	1-3	50-100	5-20	1000-2000	80 %	30

Table 7 – Frequency Hopping Radar Test Signal							
Radar Waveform	Pulse Width (µsec)	PRI (µsec)	Burst Length (ms)	Pulses per Hop	Hopping Rate (kHz)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	300	9	0.333	70 %	30

3.2. Test and Measurement System

3.2.1. Setup for Master with injection at the Master

Example Radiated Setup where UUT is a Master and Radar Test Waveforms are injected into the Master



Tested System Details

The types for all equipments, plus descriptions of all cables used in the tested system (including inserted cards) are:

	Product	Manufacturer	Model No.	ID
1.	Smartphone	SAMSUNG	SM-G960F	FCC：A3LSMG960F

3.2.2. System Calibration

The short pulse types 0,1,2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time. The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the May 2014 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 The frequency of the signal generator is incremented in 1 MHz steps from FL to FH for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.
The signal monitoring equipment consists of a spectrum analyzer. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

3.2.3. System Calibration

The Interference Radar Detection Threshold Level is (-63 dBm), The above equipment setup was used to calibrate the radiated Radar Waveform. A vector signal generator was utilized to establish the test signal level for each radar type. During this process there were replace 50 ohm terminal form Master and Client device and no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) at the frequency of the Radar Waveform generator. Peak detection was used.The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (U-NII Band 2-ABW) were set to at least 3 MHz.
The vector signal generator amplitude was set so that the power level measured at the spectrum analyzer was (-63 dBm). Capture the spectrum analyzer plots on short pulse radar types, long pulse radar type and hopping radar waveform.

3.2.4. Adjustment of Displayed Traffic Level

A link is established between the Master and Slave and the distance between the units is adjusted as needed to provide a suitable received level at the Master and Slave devices. Software to ping the client is permitted to simulate data transfer but must have random ping intervals. The monitoring antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

3.3. Test Instruments

For Conducted
Test Period: Jun.16 ~ 22, 2022
Testing Engineer: Jeremy Lin

Use	Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Cal. Period
☐	Power Sensor	Anritsu	MA2411B	1126022	Sep. 03, 2021	1 year
☐	Power Meter	Anritsu	ML2495A	1135009	Sep. 03, 2021	1 year
☐	Power Sensor	Agilent	N1921A	MY45241957	Dec. 06, 2021	1 year
☐	Power Meter	Agilent	N1911A	MY45101619	Dec. 06, 2021	1 year
☐	Spectrum Analyzer (10 Hz~26.5 GHz)	Keysight	N9010B	MY59071418	Mar. 16, 2022	1 year
☐	Spectrum Analyzer (9 kHz~26.5 GHz)	Agilent	N9010A	MY48030518	Jul. 23, 2021	1 year
☐	Spectrum Analyzer (20 Hz~26.5 GHz)	Agilent	N9020A	US47520902	Sep. 09, 2021	1 year
☐	Spectrum Analyzer (3 Hz~50 GHz)	Agilent	N9030A	MY53120541	Jan. 05, 2022	1 year
☐	Temperature & Humidity Chamber	TAICHY	MHU-225LA	980729	Mar. 30, 2021	1 year
☐	Signal Generator	Keysight	N5182B	MY53052569	Apr. 20, 2021	1 year
☐	Signal Generator	Keysight	N5182BX07	MY59360221	Apr. 20, 2021	1 year
☐	Bluetooth Tester	R&S	CBT	100350	Mar. 17, 2021	2 years
☐	Wireless Connectivity Tester	R&S	CMW270	102208	Jun. 02, 2021	1 year
☐	Power Supply	KEITHLEY	2303	4045290	Jan. 19, 2022	1 year
☐	RF Communication Test Set	HP	8920A	3344A03297	Aug. 10, 2021	1 year
☒	Spectrum Analyzer	R&S	FSV3044	101255	Dec. 20, 2021	1 year
☒	Switch Box	R&S	OSP-B157W8	100850	Dec. 20, 2021	1 year
☒	Signal Generator	R&S	SMM100A	101740	Dec. 20, 2021	1 year
☐	Signal Generator	R&S	SMB100A03	183027	Dec. 20, 2021	1 year

Note: N.C.R. = No Calibration Request.

4 Test Methodology

4.1. Mode of Operation

Decision of Test ATL has verified the construction and function in typical operation. All the test modes were carried out with the EUT in normal operation, which was shown in this test report and defined as:

Test Mode
IEEE 802.11ax 20 MHz Continuous TX mode
IEEE 802.11ax 40 MHz Continuous TX mode
IEEE 802.11ax 80 MHz Continuous TX mode
IEEE 802.11ax 160 MHz Continuous TX mode

4.2. EUT Test Step

1.	Setup the EUT shown on 3.2.
2.	Turn on the power of all equipment.
3.	Turn on Wi-Fi function link to Access Point.
4.	The EUT is operated in the normal mode to the purposes of measurement.

4.3. Test Site Environment

Items	Required (IEC 60068-1)	Actual
Temperature (°C)	15-35	20-30
Humidity (%RH)	25-75	45-75

5 Test Results

5.1. Channel Availability Check Time

5.1.1. Procedure to Determine Initial Power-Up Cycle Time

A link was established on channel then the EUT was rebooted. The time from the cessation of traffic to the re-initialization of traffic was measured as the time required for the EUT to complete the total power-up cycle. The time to complete the initial power-up period is 60 seconds less than this total power-up time.

5.1.2. Procedure for Timing Of Radar Burst

With a link established on channel, the EUT was rebooted. A radar signal was triggered within 0 to 6 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.
The Non-Occupancy list was cleared. With a link established on channel, the EUT was rebooted. A radar signal was triggered within 54 to 60 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

5.1.3. Test Results

See to the Appendix A

5.2. Channel Move Time and Channel Closing Transmission Time

5.2.1. Reporting Notes

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse.
This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:
Aggregate Transmission Time = (Number of analyzer bins showing transmission) * (dwell time per bin)

The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

5.2.2. Test Results

See to the Appendix A

5.3. Non-Occupancy Period

5.3.1. Reporting Notes

Non-Occupancy Period time is 30 minute during which a Channel will not be utilized after a Radar Waveform is detected on that Channel.

5.3.2. Test Results

See to the Appendix A

5.4. U-NII Detection Bandwidth

5.4.1. Test Results

See to the Appendix A

5.5. Statistical Performance check

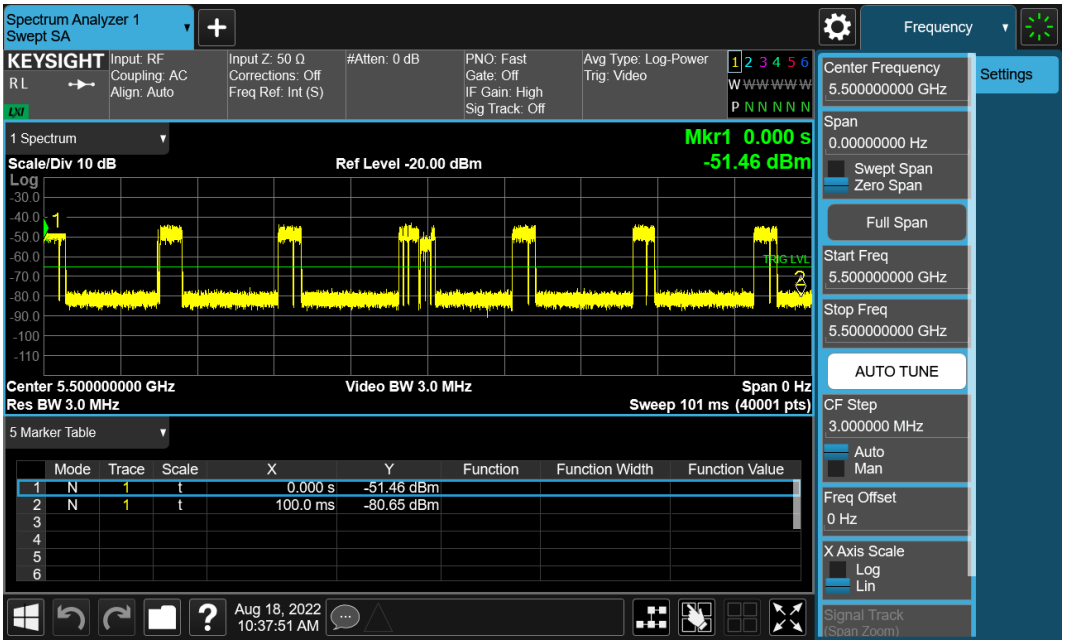
5.5.1. Test Results

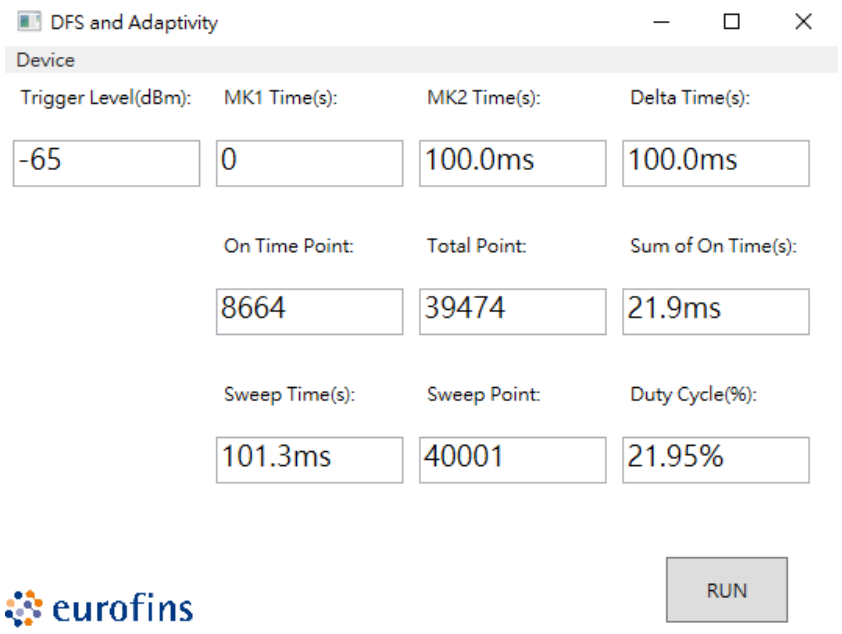
See to the Appendix A

5.6. Channel Loading

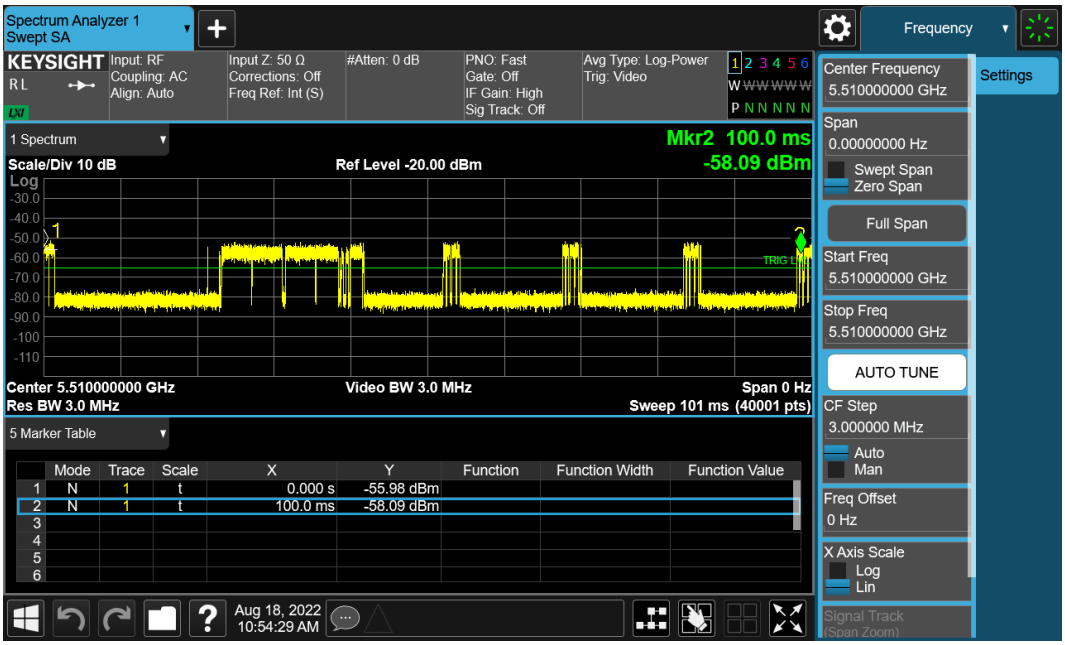
■ **Duty cycle≧17 %**

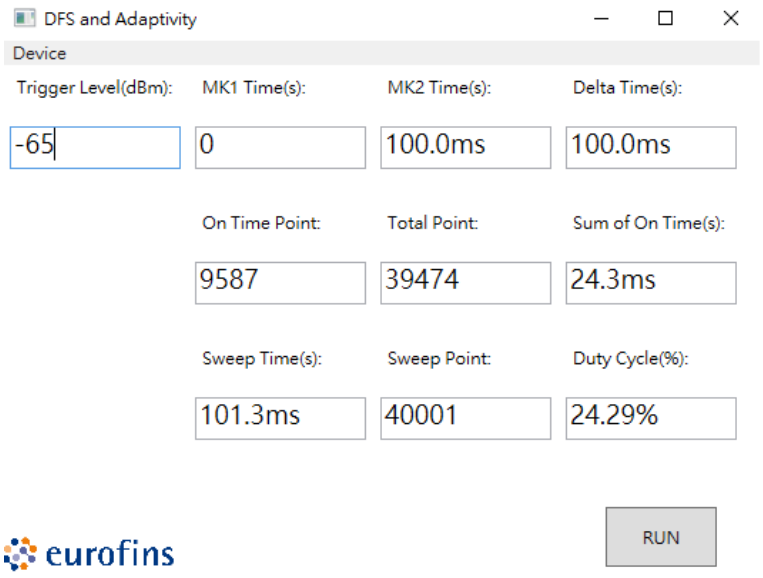
IEEE 802.11ax 20 MHz Continuous TX mode



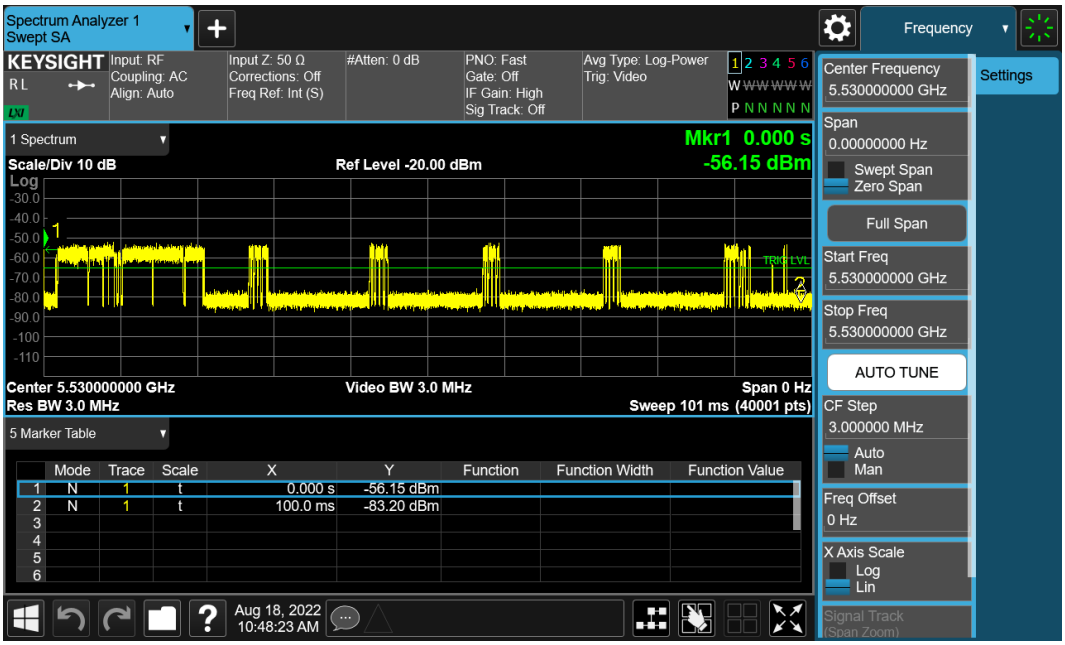


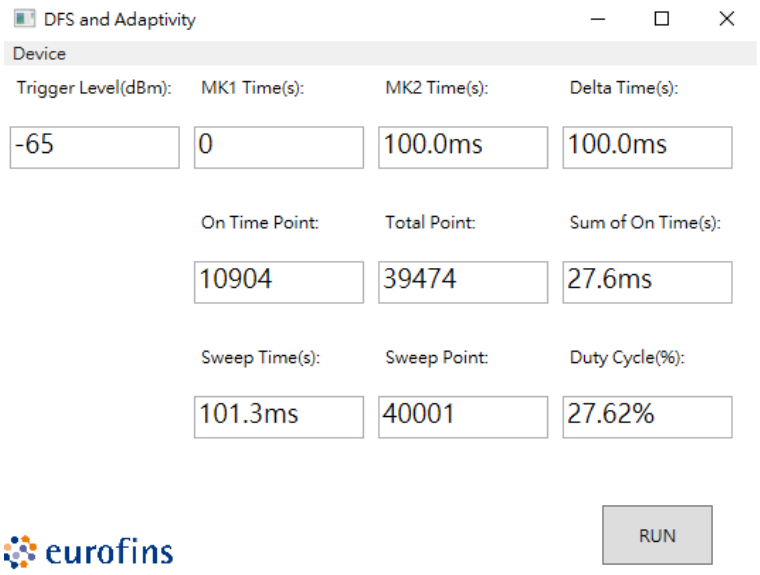
IEEE 802.11ax 40 MHz Continuous TX mode



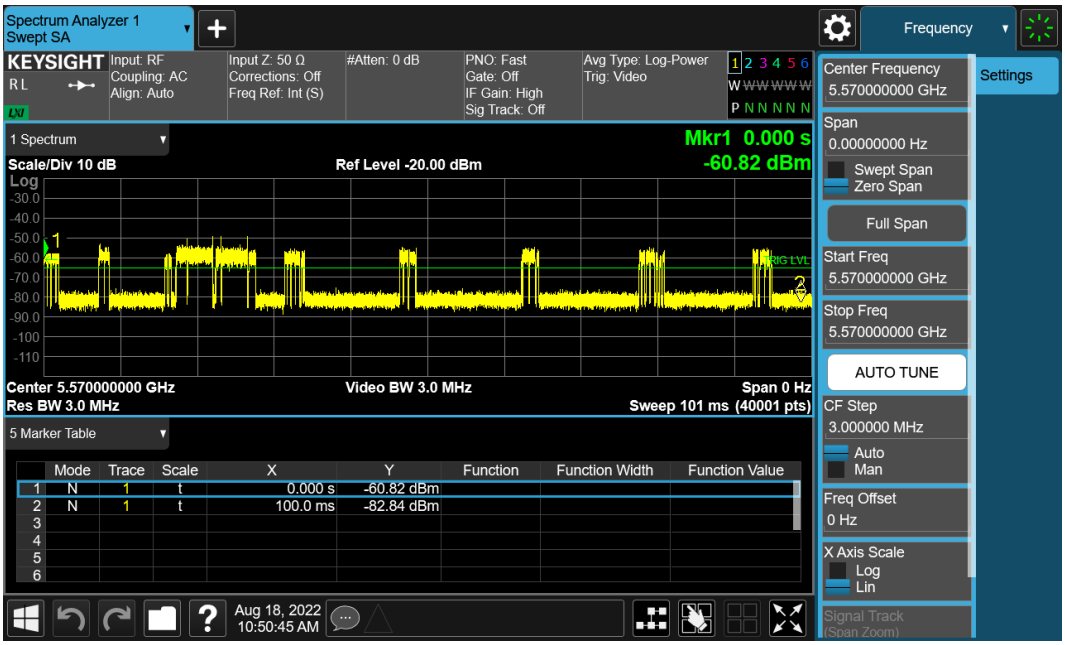


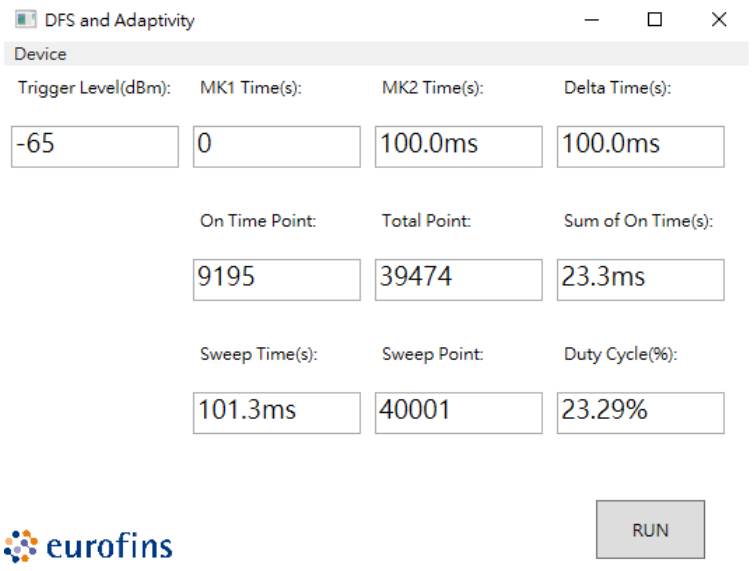
IEEE 802.11ax 80 MHz Continuous TX mode





IEEE 802.11ax 160 MHz Continuous TX mode





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