Test Report

Verified code: 559788

Report No.: E20211217696105-6

Customer:	BYD Auto Industry Company Limited
Address:	No. 3001, 3007, Hengping Road, Pingshan, Shenzhen, P. R. China
Sample Name:	DiLink
Sample Model:	DiLink 3.0F
Receive Sample Date:	Feb.10,2022
Test Date:	Apr.03,2022 ~ Apr.14,2022
Reference Document:	CFR 47, FCC Parts 15 Subpart E Unlicensed National Information Infrastructure Devices
Test Result:	Pass

Prepared by: Yang Zhaoyun Reviewed by: Zhao Zetian Approved by: Xiao Liang

GUANGZHOU GRG METROLOGY & TEST CO., LTD

Issued Date: 2022-06-08

Statement

1. The report is invalid without "special seal for inspection and testing"; some copies are invalid; The report is invalid if it is altered or missing; The report is invalid without the signature of the person who prepared, reviewed and approved it.

2. The sample information is provided by the client and responsible for its authenticity; The content of the report is only valid for the samples sent this time.

3. When there are reports in both Chinese and English, the Chinese version will prevail when the language problems are inconsistent.

4. If there is any objection concerning the report, please inform us within 15 days from the date of receiving the report.

5. Without the agreement of the laboratory, the client is not authorized to use the test results for unapproved propaganda.

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REPORT ISSUED HISTORY

Report Version	Report No.	Description	Compile Date
1.0	E20211217696105-6	Original Issue	2022-05-11

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1. TEST RESULT SUMMARY

CFR 47, FCC Parts 15 Subpart E(§15.407)			
Item	**Test Mode**	**FCC Standard Section**	**Result**
Channel Closing Transmission Time	IEEE 802.11a 5320MHz/5700MHz IEEE 802.11ac VHT80 5290MHz/5530MHz	15.407(h)	PASS
Channel Move Time	IEEE 802.11a 5320MHz/5700MHz IEEE 802.11ac VHT80 5290MHz/5530MHz	15.407(h)	PASS

Note:Recorded the worst case results in this report

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2. GENERAL DESCRIPTION OF EUT

2.1 APPLICANT

Name:	BYD Auto Industry Company Limited
Address:	No. 3001, 3007, Hengping Road, Pingshan, Shenzhen, P. R. China

2.2 MANUFACTURER

Name:	BYD Auto Industry Company Limited
Address:	No. 3001, 3007, Hengping Road, Pingshan, Shenzhen, P. R. China

2.3 FACTORY

Name:	Huizhou BYD Electronics Co., Ltd.
Address:	Xiangshui River, Economic Development Zone, Daya Bay, Huizhou, Guangdong, P. R. China

2.4 BASIC DESCRIPTION OF EQUIPMENT UNDER TEST

Equipment:	DiLink
Model No.:	DiLink 3.0F
Adding Model:	/
Trade Name:	BYD
FCC ID:	SD4-DILINK6125F
Power Supply:	DC 12V
Operation Frequency:	U-NII-1: 5180 MHz-5240 MHz U-NII-2A: 5260 MHz-5320 MHz U-NII-2C: 5500 MHz-5700 MHz U-NII-3: 5745 MHz-5825 MHz
Modulation type:	OFDM
Number Of Channel	U-NII-1: IEEE 802.11a / n HT20 / ac VHT20: 4 Channels IEEE 802.11n HT40 / ac VHT40: 2 Channels IEEE 802.11ac VHT80: 1 Channel U-NII-2A: IEEE 802.11a / n HT20 / ac VHT20: 4 Channels IEEE 802.11n HT40 / ac VHT40: 2 Channels IEEE 802.11ac VHT80: 1 Channel U-NII-2C: IEEE 802.11a / n HT20 / ac VHT20: 11 Channels IEEE 802.11n HT40 / ac VHT40: 5 Channels IEEE 802.11ac VHT80: 2 Channel

	U-NII-3: IEEE 802.11a / n HT20 / ac VHT20: 5 Channels IEEE 802.11n HT40 / ac VHT40: 2 Channels IEEE 802.11ac VHT80: 1 Channel
Channels Spacing:	IEEE 802.11a: 20MHz IEEE 802.11n HT20: 20MHz IEEE 802.11n HT40: 40MHz IEEE 802.11ac VHT20: 20MHz IEEE 802.11ac VHT40: 40MHz IEEE 802.11ac VHT80: 80MHz
Antenna Specification:	U-NII-1: External antenna with -3.81dBi gain (Max.) U-NII-2A: External antenna with -4.34dBi gain (Max.) U-NII-2C: External antenna with -4.34dBi gain (Max.) U-NII-3: External antenna with -4.39dBi gain (Max.)
Temperature Range:	-30℃~70℃
Hardware Version:	DiLink HW 6125F
Software Version:	DiLink SW 4.0F
Sample No:	E20211217696105-0001
Note:	/

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2.5 TEST OPERATION MODE

Mode No.	Description of the modes
1	IEEE 802.11a mode (5320MHz, 5700MHz)
2	IEEE 802.11ac VHT80 mode (5290MHz, 5530MHz)

DFS Operation Mode Information

□	Master
□	Slave with radar detection
■	Slave without radar detection
■	With TPC
□	Without TPC

Description of EUT

Overview of EUT with respect to §15.407 (H) requirements

EUT is a vehicle terminal device. It only has one BT and Wi-Fi antenna. It is a slave device that does not have radar detection capabilities. EUT is tested by running data stream with AP equipment and connecting to the test system through Wi-Fi antenna.

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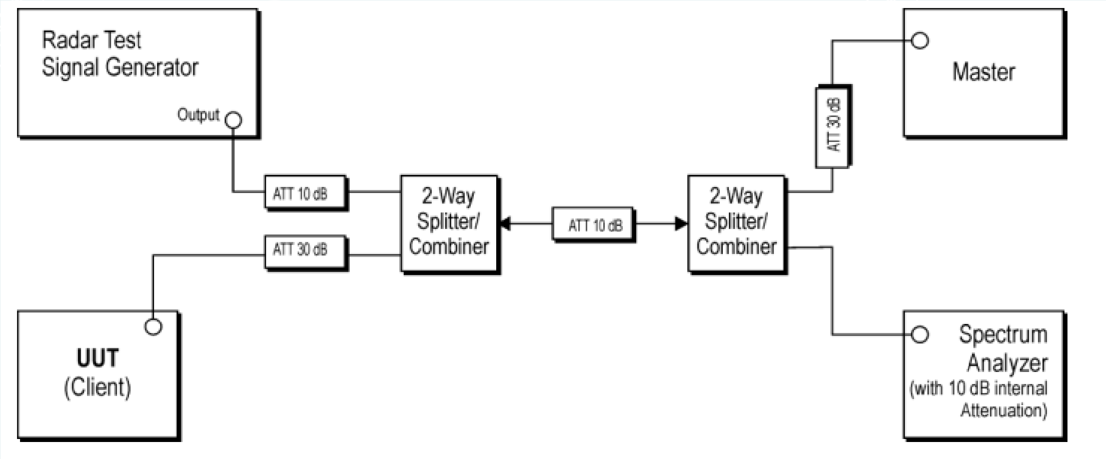
2.6 LOCAL SUPPORTIVE INSTRUMENTS

Name of Equipment	Manufacturer	Model	Serial Number	Note
Router	FiberHome	SR1041D	/	/
Laptop	LENOVO	TianYi 310-14ISK	MP18DLC6	/

Test set-up



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3. LABORATORY AND ACCREDITATIONS AND MEASUREMENT UNCERTAINTY

3.1 LABORATORY

The tests & measurements refer to this report were performed by Shenzhen EMC Laboratory of Guangzhou GRG Metrology & Test Co,.Ltd.

Add.:	No.1301 Guanguang Road Xinlan Community, Guanlan Street, Longhua District Shenzhen, 518110, People's Republic of China
P.C.:	518110
Tel :	0755-61180008
Fax:	0755-61180008

3.2 ACCREDITATIONS

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

USA	A2LA(Certificate #2861.01)

The measuring facility of laboratories has been authorized or registered by the following approval agencies.

Canada	ISED (Company Number: 24897, CAB identifier:CN0069)
USA	FCC (Registration Number: 759402, Designation Number:CN1198)

Copies of granted accreditation certificates are available for downloading from our web site, http://www.grgtest.com

3.3 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Uncertainty
RF frequency	6.0×10^{-6}
RF power conducted	0.8dB
Occupied channel bandwidth	0.4dB
Unwanted emission, conducted	0.7dB
Humidity	6%
Temperature	2℃

This uncertainty represents an expanded uncertainty factor of *k*=2.

4. LIST OF USED TEST EQUIPMENT AT GRGT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY50510140	2022-11-08
Vector signal generator	Agilent	N5182A	MY50142870	2022-09-04
Simultaneous sampling DAQ	Tonscend	JS0806-2	186060020	2022-09-04
Adjustable Attenuator	SHX	GKTS2-2-99-18-A7-B	20113001	2022-11-08
Adjustable Attenuator	SHX	GKTS2-2-99-18-A7-B	20113002	2022-11-08
BT/Wi-Fi System	Tonscend	Js1120-3		

Note: The calibration interval of the above test instruments is 12 months.

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5. EIRP POWER

Band	Test Mode	Maximum Conducted Power(dBm)	Antenna Gain	Total EIRP Power (dBm)
UNII-2A (5260MHz-5320 MHz)	IEEE 802.11a	15.88	-4.34	11.54
	IEEE 802.11n HT20	15.74		11.40
	IEEE 802.11ac VHT20	15.75		11.41
	IEEE 802.11n HT40	14.68		10.34
	IEEE 802.11ac VHT40	14.71		10.37
	IEEE 802.11ac VHT80	13.17		8.83
UNII-2C (5500 MHz-5700 MHz)	IEEE 802.11a	16.14	-4.34	11.80
	IEEE 802.11n HT20	16.02		11.68
	IEEE 802.11ac VHT20	15.97		11.63
	IEEE 802.11n HT40	15.18		10.84
	IEEE 802.11ac VHT40	15.15		10.81
	IEEE 802.11ac VHT80	13.67		9.33

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6. DYNAMIC FREQUENCY SELECTION REQUIREMENTS

6.1 DFS OVERVIEW

The manufacturer shall state whether the UUT is capable of operating as a Master and/or a Client. If the UUT is capable of operating in more than one operating mode then each operating mode shall be tested separately. See tables 1 and 2 for the applicability of DFS requirements for each of the operational modes.

Table 5: Applicability of DFS requirements prior to use 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
Uniform Spreading	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 6: Applicability of DFS requirements during normal operation.

Requirement	Operational Mode		
	Master	Client without radar detection	Client with radar detection
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required	Yes

6.2 TEST LIMITS AND RADAR SIGNAL PARAMETERS

DETECTION THRESHOLD VALUES

Table 7: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection.

Maximum Transmit Power	Value (See Notes 1 and 2)
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: Through out 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.
Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911D01

Table 8: DFS Response Requirement Values

Parameter	Value
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 UNII 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.

PARAMETERS OF DFS TEST SIGNALS

Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

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Table 9: 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	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^{6}}{\text{PRI}_{\mu sec}}\right)\right\}$	60%	30
		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			
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.					

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B.
For example if in Short Pulse Radar Type 1 Test B a PRI of 3066 µsec is selected, the number of pulses would be Round up $\{(1/360)(19\times10^{6}/3066)\}$ = Round up {17.2} = 18.

Table 10: Long Pulse Radar Test Waveform

Radar Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Number of Pulsesper Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Number ofTrials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

The parameters for this waveform are randomly chosen（The center frequency for each of the 30 trials of the Bin 5 radar shall be randomly selected within 80% of the Occupied Bandwidth.） Thirty unique waveforms are required for the Long Pulse Radar Type waveforms. If more than 30 waveforms are used for the Long Pulse Radar Type waveforms, then each additional waveform must also be unique and not repeated from the previous waveforms.

Table 11: Frequency Hopping Radar Test Waveform

Radar Type	Pulse Width (μsec)	Chirp Width (MHz)	PRI (μsec)	Number of Pulsesper Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

DESCRIPTION OF EUT

Overview Of EUT With Respect To §15.407 (H) Requirements

The firmware installed in the EUT during testing was:
Firmware Rev: DiLink SW 4.0F

The EUT is a Slaver Device.

The EUT operates over the 5260-5320 MHz ,5500-5700 MHz range as a Client Device that does not have radar detection capability.

The antenna assembly utilized with the EUT has a gain of -4.34 dBi.

The EUT uses one transmitter connected to two 50-ohm coaxial antenna ports via a diversity switch. Only one antenna port is connected to the test system since the EUT has one antenna only.

The Slave device associated with the EUT during these tests does not have radar detection capability.

WLAN traffic is generated by using the iperf software to send packets from the Master IP address to the Slave IP address.

The EUT utilizes the IEEE 802.11a architecture, with a nominal channel bandwidth of 20 MHz.

The Master Device is a Fiber Home 802.11a/b/g/n/ac Access Point, FCC ID: 2AV2N-SR1041D.

The rated output power of the Master unit is < 23dBm (EIRP). Therefore the required interference threshold level is -62dBm.

The calibrated conducted DFS Detection Threshold level is set to -62dBm. The tested level is lower than the required level hence it provides margin to the limit.

Manufacturer’s Statement Regarding Uniform Channel Spreading

The end product implements an automatic channel selection feature at startup such that operation commences on channels distributed across the entire set of allowed 5GHz channels. This feature will ensure uniform spreading is achieved while avoiding non-allowed channels due to prior radar events.

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TEST AND MEASUREMENT SYSTEM

System Overview

The measurement system is based on a conducted test method.

The short pulse and long pulse signal generating system utilizes the NTIA software and the same manufacturer/ model Vector Signal Generator as the NTIA. The hopping signal generating system utilizes the simulated hopping method.

The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution. The short pulse types 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 August 2005 NTIA Hopping Frequency List, with the initial starting point randomized at run-time.

The signal monitoring equipment consists of a spectrum analyzer with the capacity to display 8192 bins on the horizontal axis. A time-domain resolution of 2 msec / bin is achievable with a 16 second sweep time, meeting the 10 second short pulse reporting criteria. 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 maxhold. A time-domain resolution of 3 msec / bin is achievable with a 24 second sweep time, meeting the 22 second long pulse reporting criteria and allowing a minimum of 10 seconds after the end of the long pulse waveform.

Frequency Hopping Signal Generation

The hopping burst generator is a High Speed Digital I/O card plugged into the control computer. This card utilizes an independent hardware clock reference therefore the output pulse timing is unaffected by host computer operating system latency times.

The software selects the hopping sequence as a 100-length segment of the August 2005 NTIA hopping frequency list. This list contains 274 unique pseudo random sequences. Each such sequence contains 475 frequencies ordered on a random without replacement basis. Each successive trial uses a contiguous 100-length segment from within each successive 475-length sequence in the list. The initial starting point within the list is randomized at run-time such that the first 100-length segment is entirely contained within the first 475-length sequence. The starting point of each successive trial 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 06-96 APPENDIX. 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.

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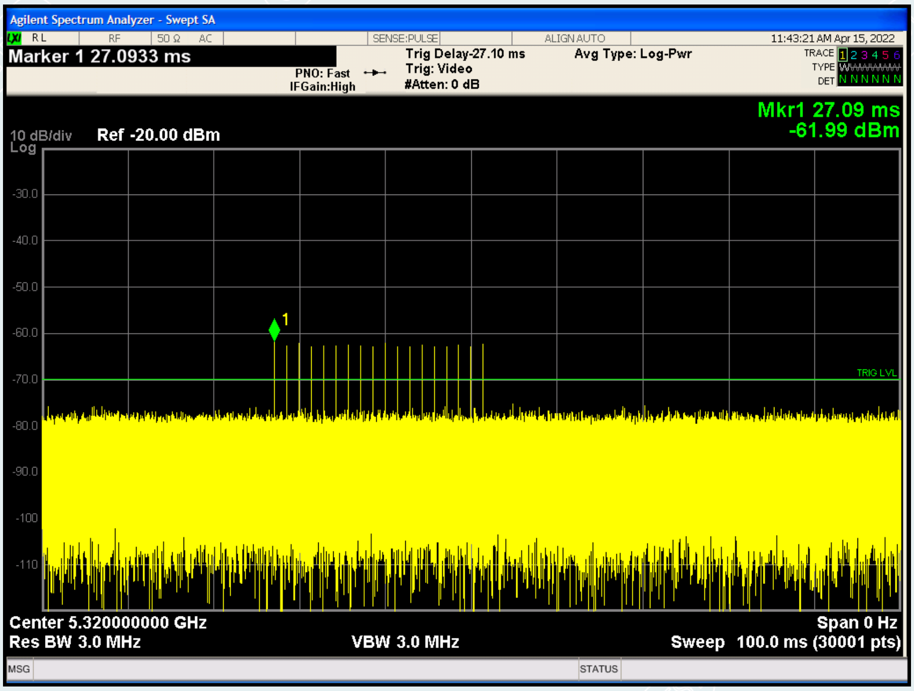
TEST PLOTS

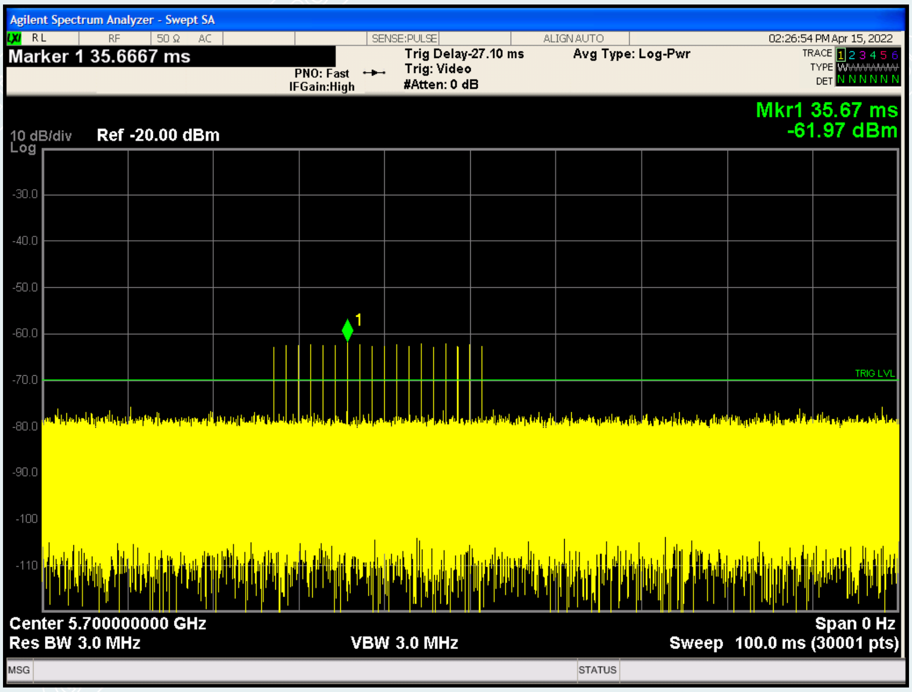
IEEE 802.11a 5320MHz

Type 0

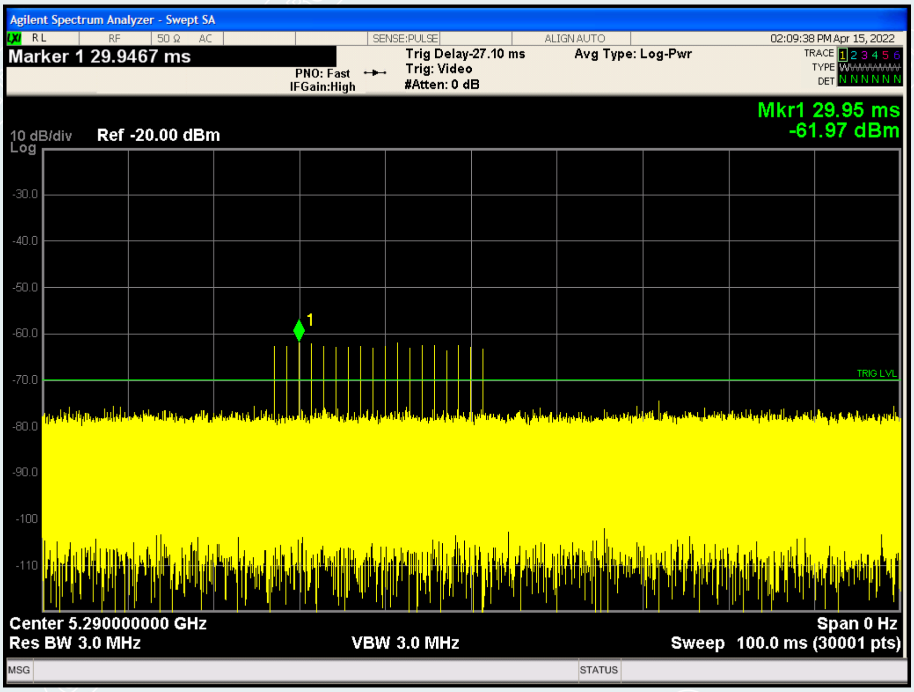


IEEE 802.11a 5700MHz

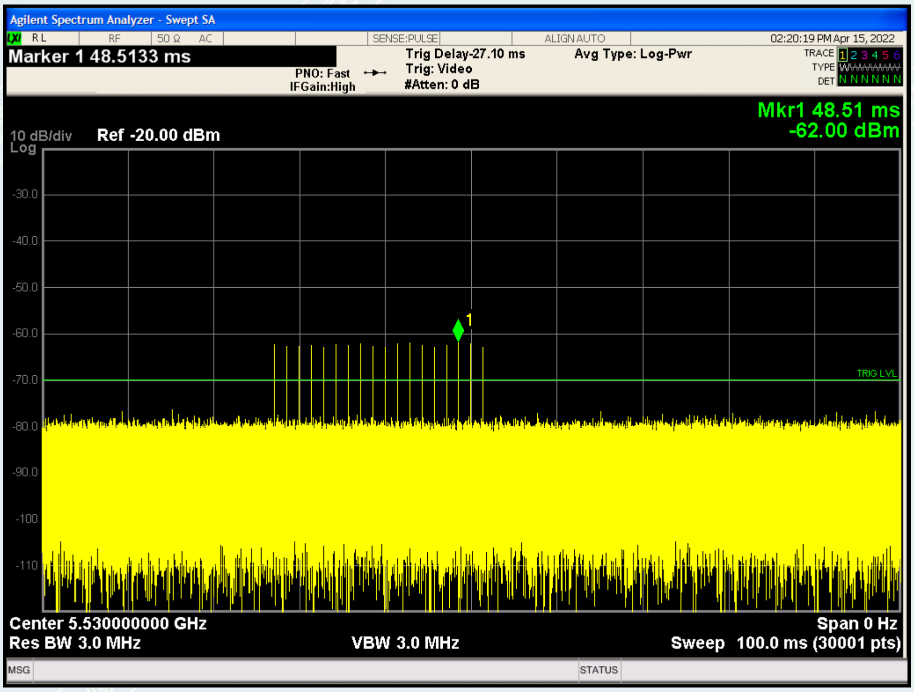
Type 0



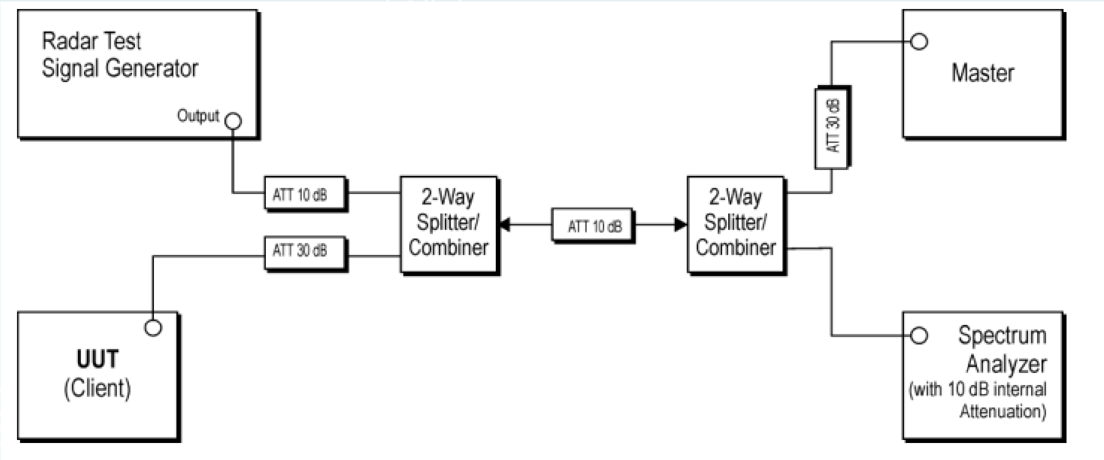
IEEE 802.11ac VHT80 5290MHz
Type 0



IEEE 802.11ac VHT80 5530MHz
Type 0



6.3 CONDUCTED METHOD SYSTEM BLOCK DIAGRAM



6.4 CALIBRATION OF DFS DETECTION THRESHOLD LEVEL

A 50 ohm load is connected in place of the spectrum analyzer, and the spectrum analyzer is connected in place of the master device and the signal generator is set to CW mode. The amplitude of the signal generator is adjusted to yield a level of –62dBm as measured on the spectrum analyzer.

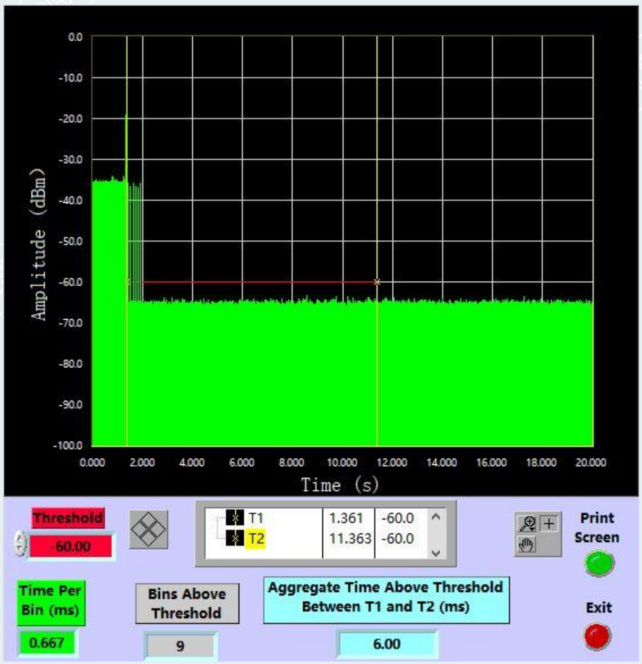
Without changing any of the instrument settings, the spectrum analyer is reconnected to the Common port of the Spectrum Analyzer Combiner/Divider. Measure the amplitude and calculate the difference from –62dBm. Adjust the Reference Level Offset of the spectrum analyzer to this difference.
The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of –62dBm and the spectrum analyzer will still indicate the level as received by the Master Device.
Set the signal generator to produce a radar waveform, trigger a burst manually and measure the level on the spectrum analyzer. Readjust the amplitude of the signal generator as required so that the peak level of the waveform is at a displayed level equal to the required or desired interference detection threshold. Separate signal generator amplitude settings are determined as required for each radar type.

6.5 DEVIATION FROM TEST STANDARD

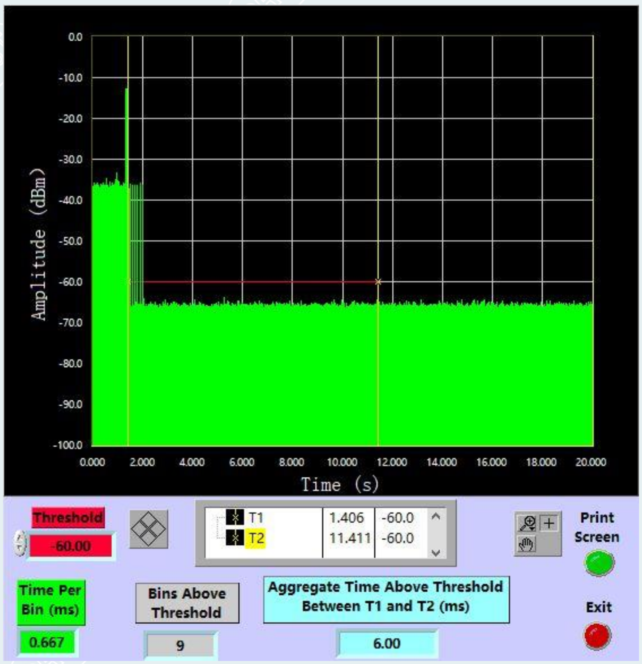
No deviation.

6.6 TEST RESULTS

Test Mode	Test frequency (MHz)	Channel Move Time (s)	Limit (s)	Result
IEEE 802.11a	5320	0.00600	10	Pass
	5700	0.00600	10	Pass



5320MHz



5700MHz

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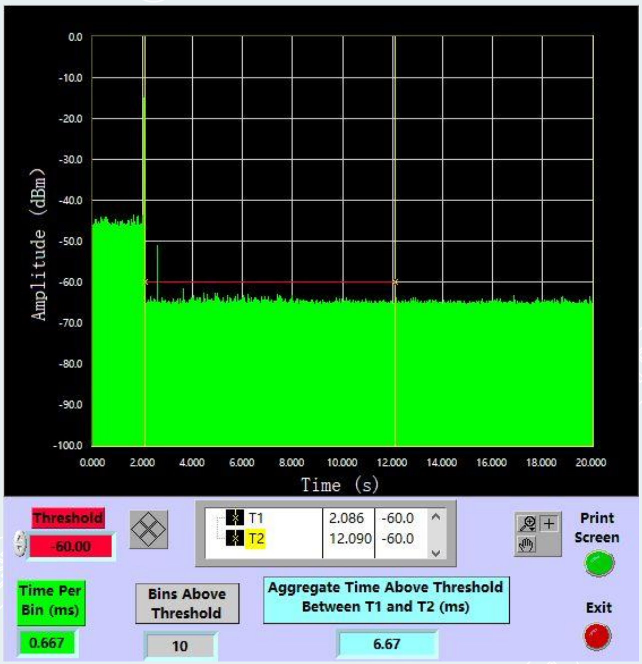
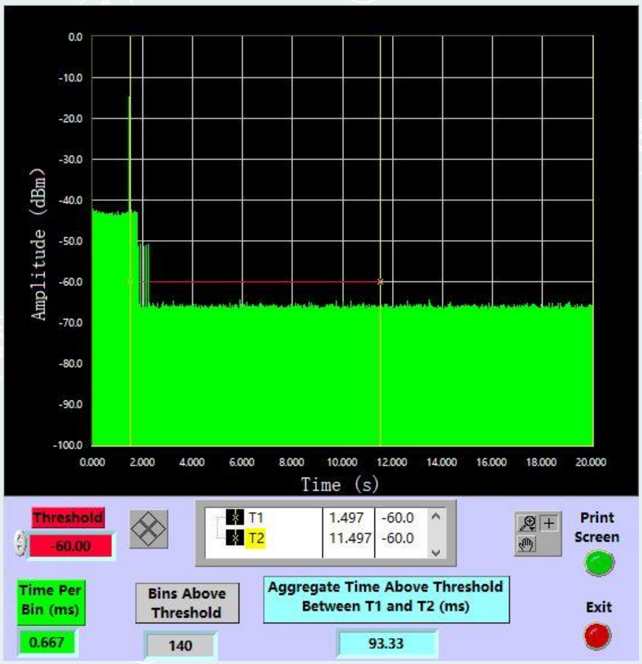
Test Mode	Test frequency (MHz)	Channel Move Time (s)	Limit (s)	Result
IEEE 802.11ac VHT80	5290	0.00667	10	Pass
	5530	0.09333	10	Pass



5290MHz



5530MHz

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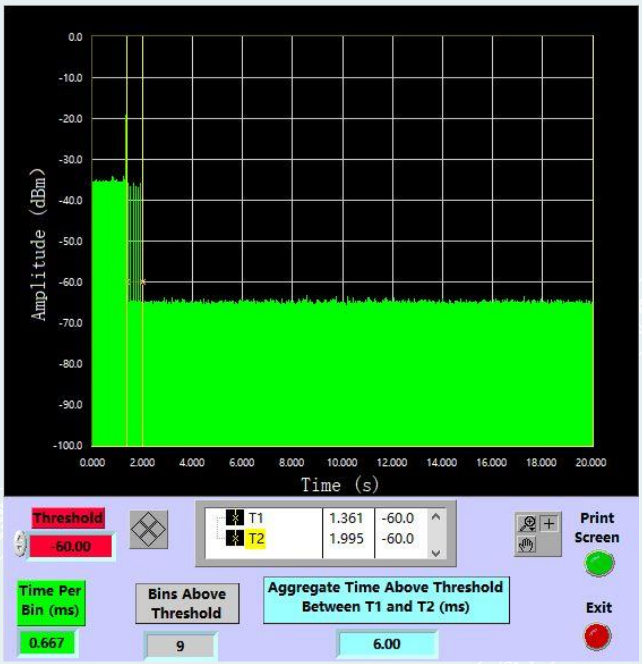
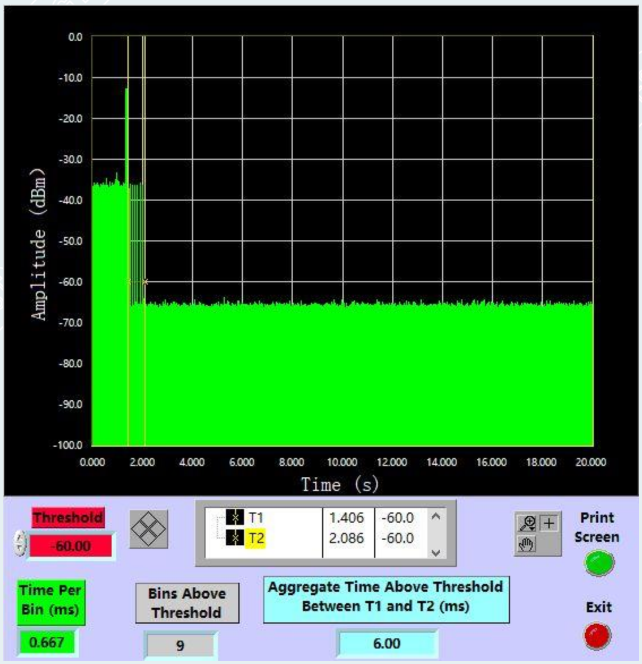
Reference Channel Closing Time

Test Mode	Test frequency (MHz)	Channel Closing Transmission Time(s)	Limit (s)	Result
IEEE 802.11a	5320	0.00600	0.26	Pass
	5700	0.00600	0.26	Pass



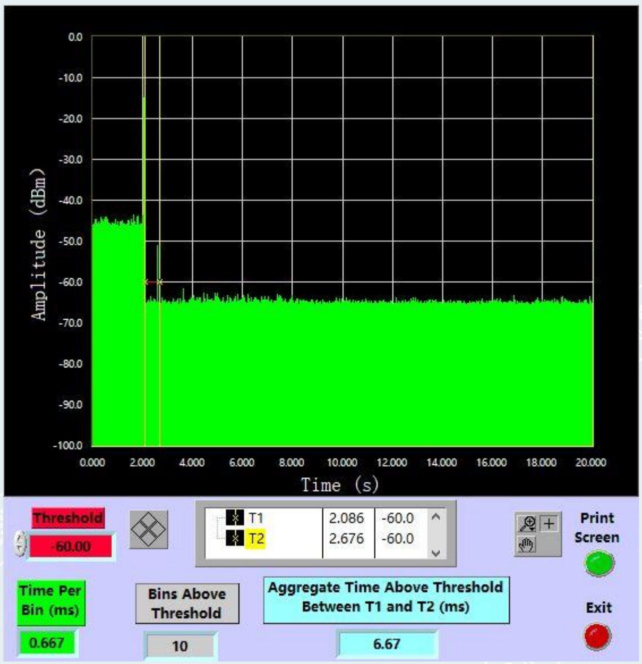
5320MHz



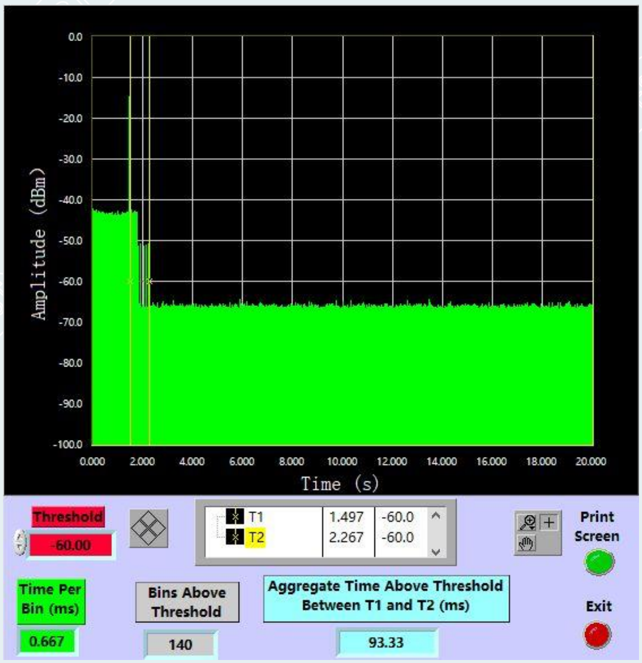
5700MHz

------------ The following blanks ------------

Test Mode	Test frequency (MHz)	Channel Closing Transmission Time (s)	Limit (s)	Result
IEEE 802.11ac VHT80	5290	0.00667	0.26	Pass
	5530	0.09333	0.26	Pass



5290MHz



5530MHz

APPENDIX A. PHOTOGRAPH OF THE TEST CONNECTION DIAGRAM

Please refer to the attached document E20211217696105-10 Test photo.

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