ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Testing Laboratory 3702

Applicant:	Murata Manufacturing Co., Ltd. 1-10-1 Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan
Manufacturer:	Murata Manufacturing Co., Ltd. 1-10-1 Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan
Product Name:	Communication Module
Brand Name:	Murata Manufacturing Co., Ltd.
Model No.: **/ISED HVIN:**	LBES0ZZ2LL
Family Model No.: **/ Family ISED HVIN:**	LBEE0ZZ2KL
Model Difference:	Different functions: LBES0ZZ2LL includes IEEE802.15.4. functionality.
ISED PMN:	LBES0ZZ2LL, LBEE0ZZ2KL
Report Number:	TERF2410002920E2
FCC ID	VPYLBES0ZZ2LL
IC:	772C-LBES0ZZ2LL
Date of EUT Received:	September 24, 2024
Date of Test:	October 4, 2024～October 14, 2024
Issue Date:	December 18, 2024

Approved By Aken Hung

Aken Hung

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.407, ISED RSS-247.

The results of this report relate only to the sample identified in this report.

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2410002920E2	00	Original	Dec. 6, 2024	Candice Li	
TERF2410002920E2	01	Modify FVIN of section 1.1	Dec. 18, 2024	Candice Li	*

Note:

1、 The remark "*" indicates modification of the report upon requests from certification body.

2、 Variant information of model numbers is provided by the applicant, test results of this report are applicable to the sample EUT(s) received.
Only the main model LBES0ZZ2LL has IEEE802.15.4. functionality and has been independently tested for this feature. The variants are assessed as electrically identical in RF characteristics, therefore, no further assessment required for the variant(s).

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Communication Module
Brand Name:	Murata Manufacturing Co., Ltd.
Model No.: /ISED HVIN:	LBES0ZZ2LL
Family Model No.: / Family ISED HVIN:	LBEE0ZZ2KL
Model Difference:	Different functions: LBES0ZZ2LL includes IEEE802.15.4. functionality.
Hardware Version:	1.0
Firmware Version:	1.1.1.1
EUT Series No.:	2LL#135
Power Supply:	3.3 Vdc, 1.8 Vdc
Modulation type	64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11a,11n 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11ac 1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDMA in 802.11ax

1.2 DFS Firmware version:

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1.3 RF Specification

Wi-Fi	Frequency Range	Channels	Modulation Technology
802.11a/ 802.11n_HT20/ 802.11ac_VHT20/ 802.11ax_HE20	5180~5240	4	OFDM
	5260~5320	4	OFDM
	5500~5720	12	OFDM
	5745-5825	5	OFDM

WLAN 5 GHz for ISED (Slave)

Wi-Fi	Frequency Range	Channels	Modulation Technology
802.11a/ 802.11n_HT20/ 802.11ac_VHT20/ 802.11ax_HE20	5180~5240	4	OFDM
	5260~5320	4	OFDM
	5500~5700	11	OFDM
	5720 (U-NII 2C)	1	OFDM
	5720 (U-NII 3)	1	OFDM
	5745-5825	5	OFDM

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1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart E §15.407

FCC KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02

FCC KDB 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

RSS-247 issue 3 Aug. 2023

1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
		Conducted G		

Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

1.6 Special Accessories

There are no special accessories used while test was conducted.

1.7 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SUMMARY OF TEST RESULT

FCC Rules	ISED Rules	Description Of Test	Result
§15.407(h)	IC RSS-247 issue 1 §6.3	TPC and DFS Measurement	Compliant

3 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty		
TPC and DFS Measurement	+/-	1.49	Hz
Temperature	+/-	0.6	°C
Humidity	+/-	3	%
DC / AC Power Source	+/-	1	%

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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4 TPC AND DFS MEASUREMENT

4.1 TPC Requirements

According to Part 15.407 (h)(1) Transmit power control (TPC). U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW.

Result: N/A, TPC is not required.

4.2 DFS: Standard Applicable

4.2.1 FCC

According to §15.407(h)(2) and FCC KDB 905462 D02 , Radar Detection Function of Dynamic Frequency Selection (DFS).

Radar Detection Function of Dynamic Frequency Selection (DFS). U-NII devices operating with any part of its 26 dB emission bandwidth in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. Operators shall only use equipment with a DFS mechanism that is turned on when operating in these bands. The device must sense for radar signals at 100 percent of its emission bandwidth. The minimum DFS detection threshold for devices with a maximum e.i.r.p. of 200 mW to 1 W is −64 dBm. For devices that operate with less than 200 mW e.i.r.p. and a power spectral density of less than 10 dBm in a 1 MHz band, the minimum detection threshold is −62 dBm. The detection threshold is the received power averaged over 1 microsecond referenced to a 0 dBi antenna. For the initial channel setting, the manufacturers shall be permitted to provide for either random channel selection or manual channel selection.

(i) Operational Modes. The DFS requirement applies to the following operational modes:

(a) The requirement for channel availability check time applies in the master operational mode.

(b) The requirement for channel move time applies in both the master and slave operational modes.

(ii) Channel Availability Check Time. A U-NII device shall check if there is a radar system already operating on the channel before it can initiate a transmission on a

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channel and when it has to move to a new channel. The U-NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of this section, is detected within 60 seconds.

(iii) Channel Move Time. After a radar's presence is detected, all transmissions shall cease on the operating channel within 10 seconds. Transmissions during this period shall consist of normal traffic for a maximum of 200 ms after detection of the radar signal. In addition, intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

(iv) Non-occupancy Period. A channel that has been flagged as containing a radar system, either by a channel availability check or in-service monitoring, is subject to a non-occupancy period of at least 30 minutes. The non-occupancy period starts at the time when the radar system is detected.

4.2.2 ISED

According to RSS 247 §6.2.3, Until further notice, devices subject to this section shall not be capable of transmitting in the band 5600-5650 MHz. This restriction is for the protection of Environment Canada's weather radars operating in this band.

According to RSS 247 §6.3,Devices operating in the bands 5250-5350 MHz, 5470-5600 MHz and 5650-5725 MHz band shall comply with the following:

(a) **DFS radar signal detection threshold**

Devices shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. The device must detect radar signals within its entire emission bandwidth. The minimum DFS radar signal detection threshold is described below.

Devices	**DFS Threshold**
Devices with an e.i.r.p. < 200 mW AND a Power Spectral Density < 10 dBm/MHz	-62 dBm
Devices with 200 mW ≤ e.i.r.p. ≤ 1 W	-64 dBm
Note: The detection threshold power is the received power, averaged over a 1-microsecond reference to a 0 dBi antenna.	

(b) **Operational requirements**

Devices shall comply with the following requirements, however, the requirement for in-service monitoring does not apply to slave devices without radar detection.

(i) In-service monitoring: an LE-LAN device shall be able to monitor the operating channel to check that a co-channel radar has not moved or started operation within range of the LE-LAN device. During in-service monitoring, the LE-LAN radar detection function continuously searches for radar signals between normal LE-LAN transmissions.

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(ii) Channel availability check time: the device shall check whether there is a radar system already operating on the channel before it initiates a transmission on a channel and when it moves to a channel. The device may start using the channel if no radar signal with a power level greater than the interference threshold value specified in Section 6.3.1 above is detected within 60 seconds. This requirement only applies in the master operational mode.

(iii) Channel move time: after a radar signal is detected, the device shall cease all transmissions on the operating channel within 10 seconds.

(iv) Channel closing transmission time: is comprised of 200 ms 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 ms) over the remaining 10-second period of the channel move time.

(v) Non-occupancy period: a channel that has been flagged as containing a radar signal, either by a channel availability check or in-service monitoring, is subject to a 30-minute non-occupancy period where the channel cannot be used by the LE-LAN device. The non-occupancy period starts from the time that the radar signal is detected.

4.3 Limit

Table 1: Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode
	Client(without radar detection)
Non-occupancy Period	Not required
DFS Detection Threshold	Not required
Channel Availability Check Time	Not required
U-NII Detection Bandwidth	Not required

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode
	Client Without Radar Detection
DFS Detection Threshold	Not required
Channel Closing Transmission time	Yes
Channel Move time	Yes
U-NII Detection Bandwidth	Not required

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Additional requirements for devices with multiple bandwidth mode	**Client Without Radar Detection**
U-NII Detection Bandwidth and Statistical Performance Check	Not required
Channel Move Time and Channel Closing Transmission Time	Test using the widest BW mode available for the link
All other tests	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 each of the bonded 20 MHz channels and the channel center frequency.	

Table 3: Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	Value (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. **Note3:** EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.	

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Table 4: 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 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.	

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Table 5: Radar Test Waveforms

Short Pulse Radar

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	Roundup $\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot10^6}{PRI_{\mu sec}}\right)\right\}$	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.					

Long Pulse Radar

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

Frequency Hopping Radar

Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

The applicant of this given application confirms that information regarding the parameters of the detected Radar Waveforms is not available to the end user.

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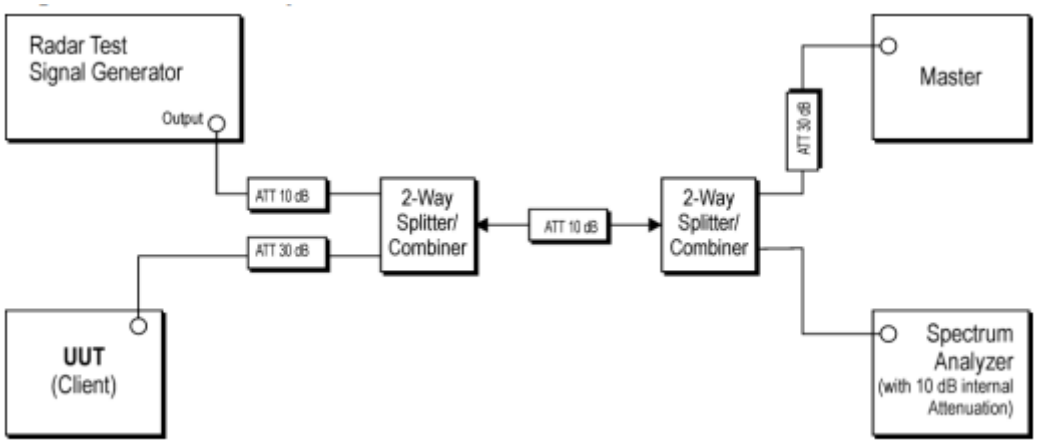
5 TEST SETUP

Setup for Client with injection at the Master



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6 TEST EQUIPMENT USED:

Conducted Emission Test Site: Conducted A					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Attenuator	KEYSIGHT	11716C	8494B TH60075424+8496B TH6075262	11/15/2023	11/14/2024
DC Power Supply	Agilent	E3640A	MY53130054	10/01/2024	09/30/2025
EMI Test Receiver	Anritsu	N9038A	MY52260216	11/30/2023	11/29/2024
Power Divider	Titan	T0510E2W118Q	22015161	11/15/2023	11/14/2024
Signal Generator	Keysight	N5182B	MY59101143	02/17/2024	02/16/2025
Splitter	RF-LAMBDA	RFLT2W1G18G	21032900015	11/15/2023	11/14/2024
Splitter	RF-LAMBDA	RFLT2W1G18G	21032900017	11/15/2023	11/14/2024
Test Software	SGS Taiwan	Dynamic Frequency Selection Test	Ver. 24.01.05	N.C.R	N.C.R

Conducted Emission Test Site: Conducted A					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
AP	ASUS	RT-AX88U	LAITHP000108 (FCC ID : MSQ-RTAXHP00)	N/A	N/A
Notebook	Lenovo	T14	P0003332	N/A	N/A
Notebook	Lenovo	L440	P0000367	N/A	N/A

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7 DESCRIPTION OF EUT:

EUT operates over the 5250-5350MHz and 5470-5725MHz ranges and EUT is a slave device (client equipment) w/o radar detection and DFS capability.

WLAN traffic is generated by streaming the mpeg file from the master to slave in full monitor video mode using the media player.

The rated output power of the master unit is ≧23dBm(EIRP).therefore the required interference threshold level is -64dBm.after correction for antenna gain and procedural adjustments, the required conducted threshold at the antenna port is -64dBm.

The rated output power of the master unit is <23 dBm(EIRP).therefore the required interference threshold level is -62dBm.after correction for antenna gain and procedural adjustments, the required threshold at the antenna port is -62dBm.

While calibrate the path on antenna port of DFS test equipment (master), measurements equipment (spectrum) is ensured to be 50 Ohms, and therefore verification on antenna gain measurement can be ignored.

Message or files that is used for communication between Master and Client:

IP based system:

For the required channel loading, send packets via software to reach a pay load of at least 17%, via the DFS Master device to the UE.

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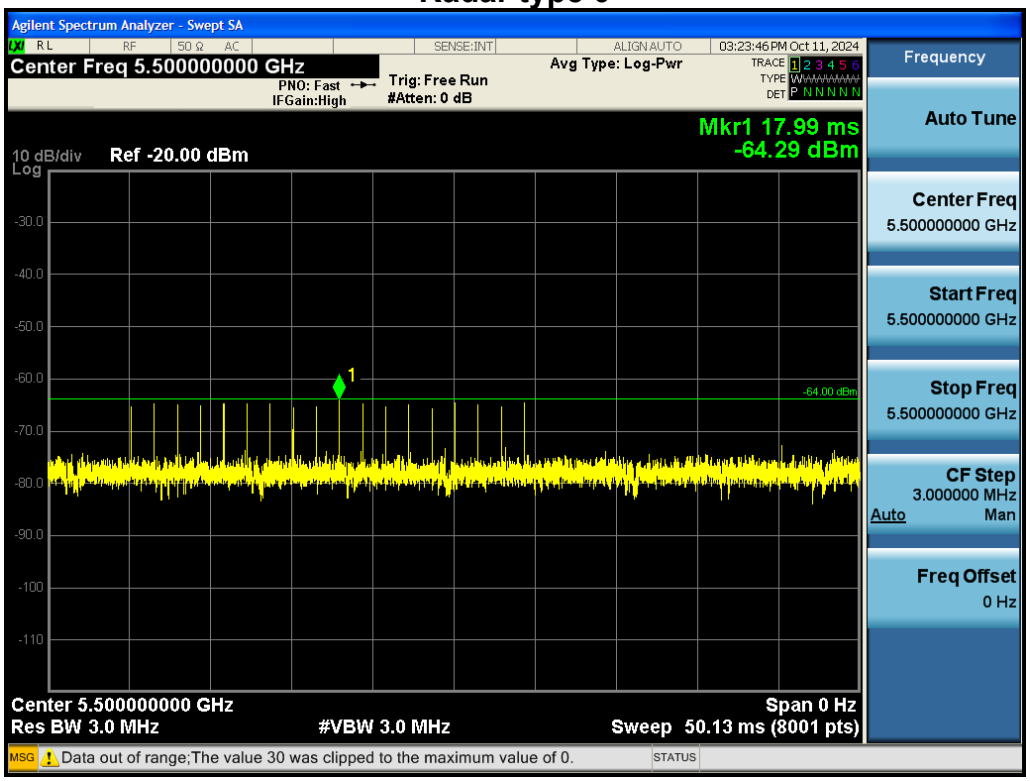
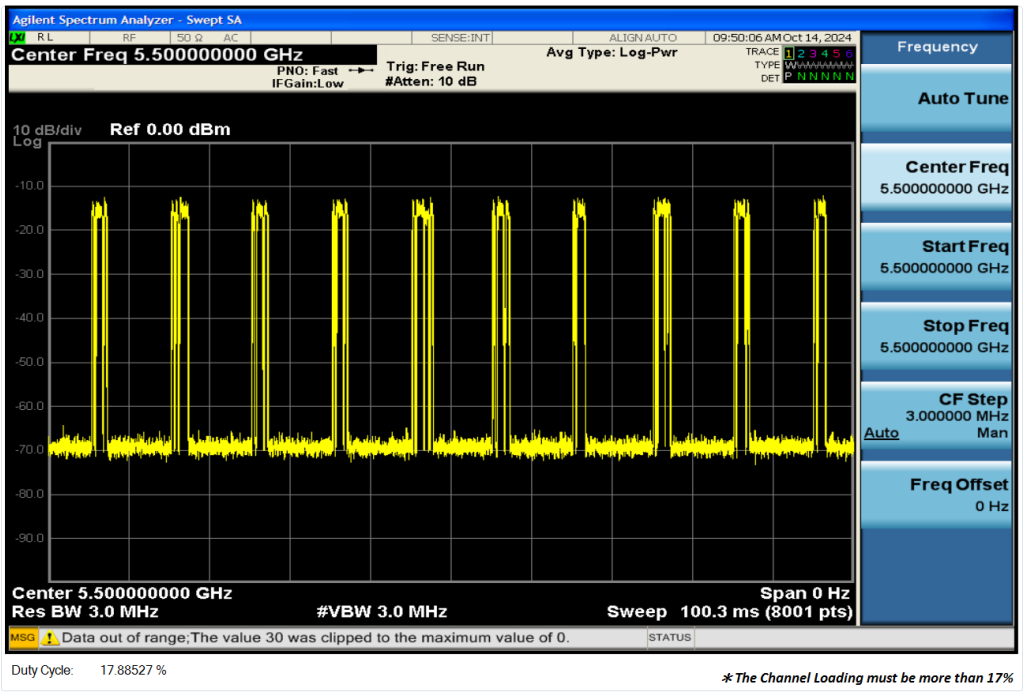
8 TEST RESULTS

8.1 Radar waveforms

Radar type 0



8.2 WLAN traffic



Duty Cycle: 17.88527 %

** The Channel Loading must be more than 17%*

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8.3 Channel closing transmission and Move time

Channel Shutdown Result				
Detection Threshold Level (dBm)			-64	
Modulation Mode	Freq. (MHz)	Radar Test Signal	Channel Closing Transmission Time(ms) 200ms~10sec	Channel Move Time(s)
HE20	5500	Type 0	20	0.894
Limit			60 ms	10 sec
Result			Complied	

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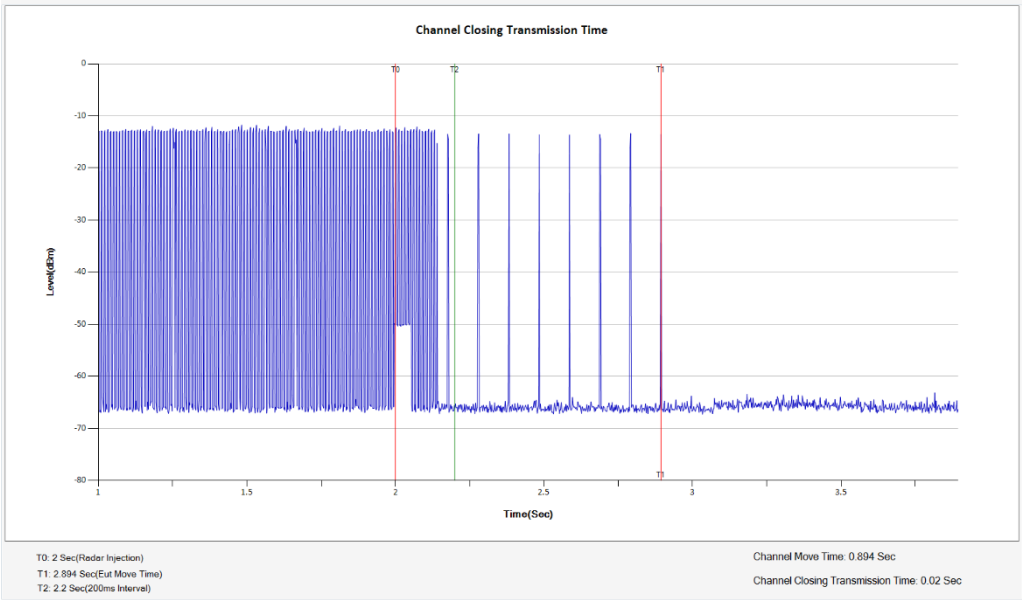
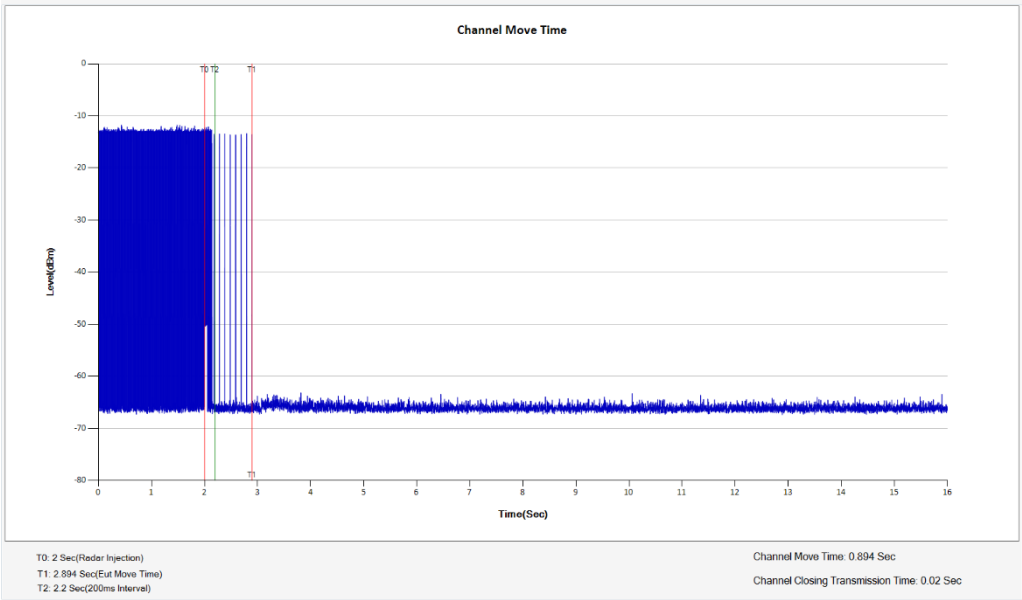
Channel Move and Closing Transmission Time - 1



Channel Move and Closing Transmission Time - 2



Verdict: *Note: narrowing the sweep time as the good engineering process for the verification of transmission closing in 200ms*

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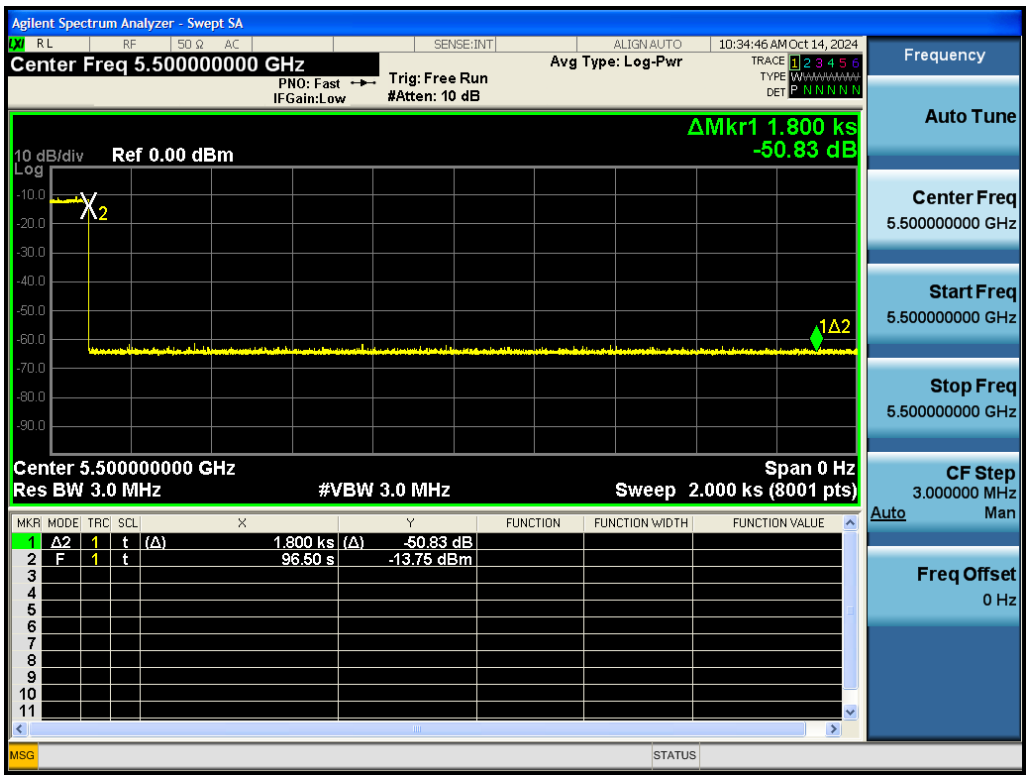
8.4 Non-occupancy Period (without radar detection)



Verdict: *To verify whether channel is unavailable to be operated in 30 minutes.*

1.8ks = 1800s = 1800 s/min /60 = 30minute

~ End of Report ~

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