

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



FCC Applicant: Murata Manufacturing Co., Ltd.
1-10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan

FCC Manufacturer: Murata Manufacturing Co., Ltd.
1-10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan

ISED Applicant: Murata Manufacturing Co., Ltd.
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ISED Manufacturer: Murata Manufacturing Co., Ltd.
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Product Name: Communication Module

Brand Name: muRata

Model No.: LBEE5ZZ1XL, LBEE5ZZ2XS

Model Difference: Refer to section 1.8

Report Number: E2/2022/10040

FCC ID VPYLBEE5ZZ1XL

IC: 772C-LBEE5ZZ1XL

Issue Date: June 30, 2022

Date of Test: April 8, 2022~June 30, 2022

Date of EUT Received: January 11, 2022

Approved By _____

Jay Lin

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.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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Revision History					
Report Number	Revision	Description	Issue Date	Revised By	Remark
E2/2022/10040	00	Original.	June 22, 2022	Yami Kuo	*
E2/2022/10040	01	Added the results of 20MHz BW.	June 30, 2022	Yami Kuo	*

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, please refer to section 1.8 of this report for details.
Test results of this report are applicable to the sample EUT(s) received and variant models are assessed as electrically identical, no further tests are required for the variant.

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Communication Module
Brand Name:	muRata
Model No.:	LBEE5ZZ1XL, LBEE5ZZ2XS
Model Difference:	Refer to section 1.8
Hardware Version:	1
Firmware Version:	17.80.200.204
EUT Series No.:	1XL: Sample. No7
Power Supply:	3.3Vdc, 1.8Vdc

1.2 DFS Firmware version:

```

COM22 - Tera Term VT
File Edit Setup Control Window Help
tds_link_status
tds_powemode
tds_setinfo
tds_setup
tds_stop_channel_switch
tds_teardown
thermal
ts_status
tsf
txaggrctrl
txbufcfg
txcontrol
txpowercfg
opermodecfg
uakeupreason
uarmreset
ummcfg
ummparancfg
min_ba_threshold
upsession
uuscfg
mc_cfg
mc_policy
mc_cfg_ext
get_sensor_temp
tlk_enable
neighbor_report
channel_switch
indrstcfg
dfs_offload
cumode
txrxhistogram
per_pkt_cfg
dot11_txrx
robustcoex
ctrldeauth
dnscs
range_ext
tut_setup
tut_teardown
rx_abort_cfg
rx_abort_cfg_ext
tx_anpdu_prot_mode
rate_adapt_cfg
cck_desense_cfg
get_chmrgpur
comparemgpur
comparetrpc
getcfgchanlist
lpm
arb
dot11ac_umacsec_ftx_cfg
hal_phy_cfg
root@imx8mqek:/?script/NXP# nlanut1 nland version
version string received: PCIE9098--17.68.1.p81-MXMSX17277-GPL-(FP68)
root@imx8mqek:/?script/NXP#

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1.3 RF specification

FCC

Wi-Fi	Frequency Range	Channels	Modulation Technology
a/ n_HT/ ac_VHT/ ax_HE 20M	5180~5240	4	OFDM
	5260~5320	4	OFDM
	5500~5720	12	OFDMA
	5745-5825	5	OFDM
n_HT ac_VHT/ ax_HE 40M	5190~5230	2	OFDMA
	5270~5310	2	OFDM
	5510~5710	6	OFDM
	5755-5795	2	OFDMA
ac_VHT/ ax_HE 80M	5210	1	OFDMA
	5290	1	OFDMA
	5530~5690	3	OFDM
	5775	1	OFDMA

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ISED

Wi-Fi	Frequency Range	Channels	Modulation Technology
a/ n_HT/ ac_VHT/ ax_HE 20M	5180~5240	4	OFDM
	5260~5320	4	OFDM
	5500~5700	8	OFDMA
	5720 (U-NII 2C)	1	OFDM
	5720 (U-NII 3)	1	OFDMA
	5745-5825	5	OFDM
n_HT ac_VHT/ ax_HE 40M	5190~5230	2	OFDMA
	5270~5310	2	OFDMA
	5510~5670	3	OFDM
	5710 (U-NII 2C)	1	OFDMA
	5710 (U-NII 3)	1	OFDM
	5755-5795	2	OFDMA
ac_VHT/ ax_HE 80M	5210	1	OFDMA
	5290	1	OFDMA
	5530	1	OFDM
	5690 (U-NII 2C)	1	OFDMA
	5690 (U-NII 3)	1	OFDM
	5775	1	OFDMA

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 2 Feb. 2017

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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 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				
<p>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.</p>				

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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1.8 Model difference

LBEE5ZZ1XL has a dedicated antenna port for BT.

LBEE5ZZ2XS BT shares same antenna port with WLAN.

Some passive components are different between models as below

LBEE5ZZ1XL	LBEE5ZZ2XS
C 336 No mounted	C336 mounted
C337 mounted	C337 No mounted
L310 mounted	L310 Nomounted

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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	+/- 0.88 Hz
Temperature	+/- 0.4 °C
Humidity	+/- 3.5 %
DC / AC Power Source	+/- 1 %

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=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

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 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.

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- (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.

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 $200 \text{ mW} \leq \text{e.i.r.p.} \leq 1 \text{ W}$	-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.
- (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.

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- (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.

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4.3 Limit

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

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Additional requirements for devices with multiple bandwidth mode	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
<p>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.</p>		

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
<p>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 KDB Publication 662911 D01.</p>	

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Table 4: DFS Response requirement values

Parameter	Value
<i>Non-occupancy period</i>	Minimum 30 minutes
<i>Channel Availability Check Time</i>	60 seconds
<i>Channel Move Time</i>	10 seconds See Note 1.
<i>Channel Closing Transmission Time</i>	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
<i>U-NII Detection Bandwidth</i>	Minimum 100% of the U-NII 99% transmission power bandwidth. See Note 3.
<p>Note 1: <i>Channel Move Time</i> and the <i>Channel Closing Transmission Time</i> should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.</p> <p>Note 2: The <i>Channel Closing Transmission Time</i> is comprised of 200 milliseconds starting at the beginning of the <i>Channel Move Time</i> plus any additional intermittent control signals required to facilitate a <i>Channel</i> 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.</p> <p>Note 3: During the <i>U-NII Detection Bandwidth</i> 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.</p>	

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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 $\left\{ \left(\frac{1}{360} \right) \cdot \left(\frac{19 \cdot 10^6}{PRI_{\mu sec}} \right) \right\}$	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.

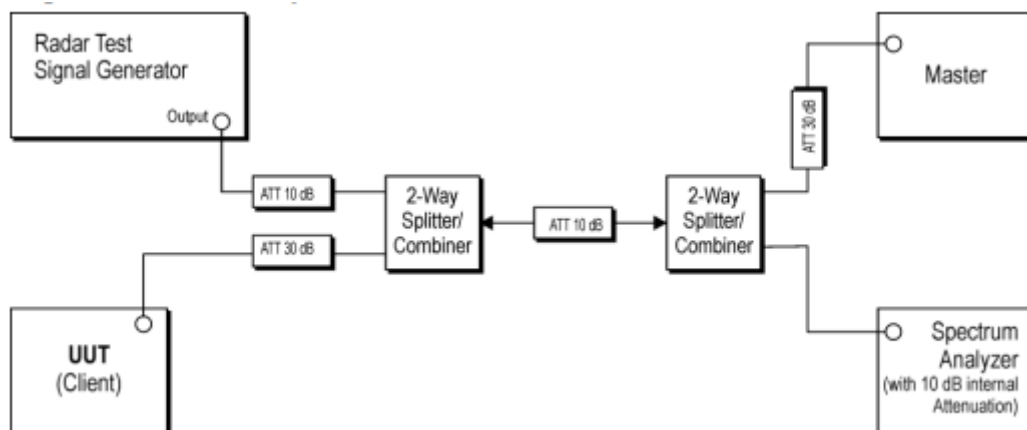
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5 TEST SETUP

Setup for Client with injection at the Master



5.1 Test Equipment Used:

Conducted Emission Test Site: Conducted A					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	Anritsu	N9038A	MY52260216	11/29/2021	11/28/2022
DC Power Supply	Agilent	E3640A	MY53130054	09/30/2021	09/29/2022
DC Power Supply	HOLA	DP-3003	D7070035	05/28/2021	05/27/2022
Signal Generator	KEYSIGHT	N5182B	MY59100873	03/01/2022	02/28/2023
Test Software	SGS Taiwan	Dynamic Frequency Selection Test	Ver. 21	N.C.R	N.C.R
Test Software	Keysight	N7607C Signal Studio for DFS Radar profiles	Ver. 2.2.0.0	N.C.R	N.C.R
Attenuator	KEYSIGHT	8496B	TH60075263	05/07/2021	05/06/2022
Attenuator	KEYSIGHT	8494B	TH60075458	05/07/2021	05/06/2022
DC Block	PASTERNAK	PE8210	RF152	11/18/2021	11/17/2022
Splitter	RF-Lambda	RFLT4W1G18G	18090300130	04/28/2021	04/27/2022
Splitter	RF-Lambda	RFLT2W1G18G	18112200217	04/28/2021	04/27/2022
Splitter	RF-Lambda	RFLT2W1G18G	21032900016	04/28/2021	04/27/2022
Power Divider Splitter	Titan	T0510E2W118Q	22015160	03/30/2022	03/29/2023

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5.2 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.

EUT has no TPC mechanism implemented, the level of output power stays at fixed and not adjustable.

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 $\geq 23\text{dBm}$ (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 $<23\text{ dBm}$ (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.

5.3 Test results

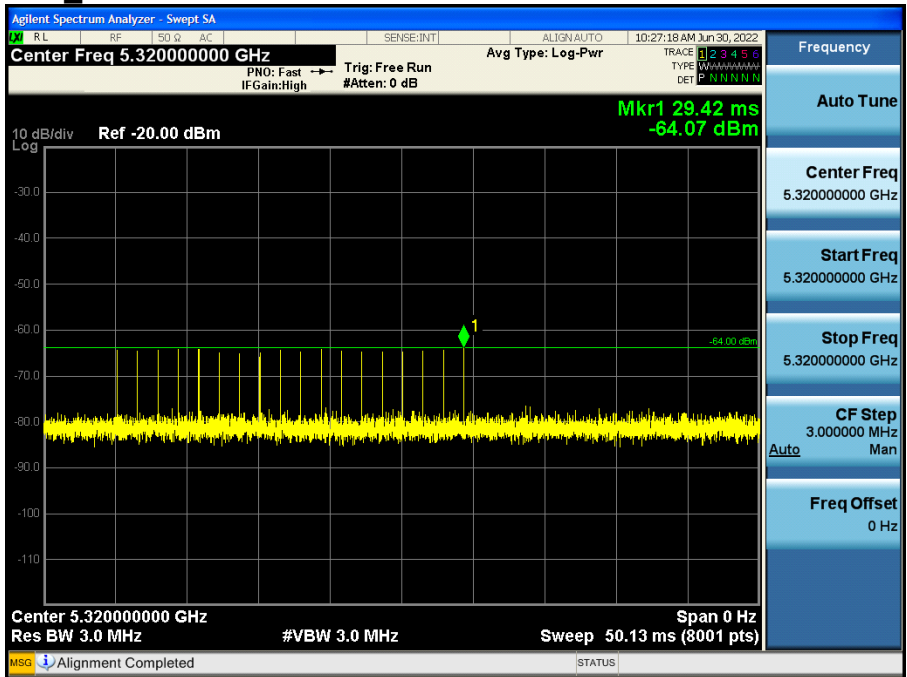
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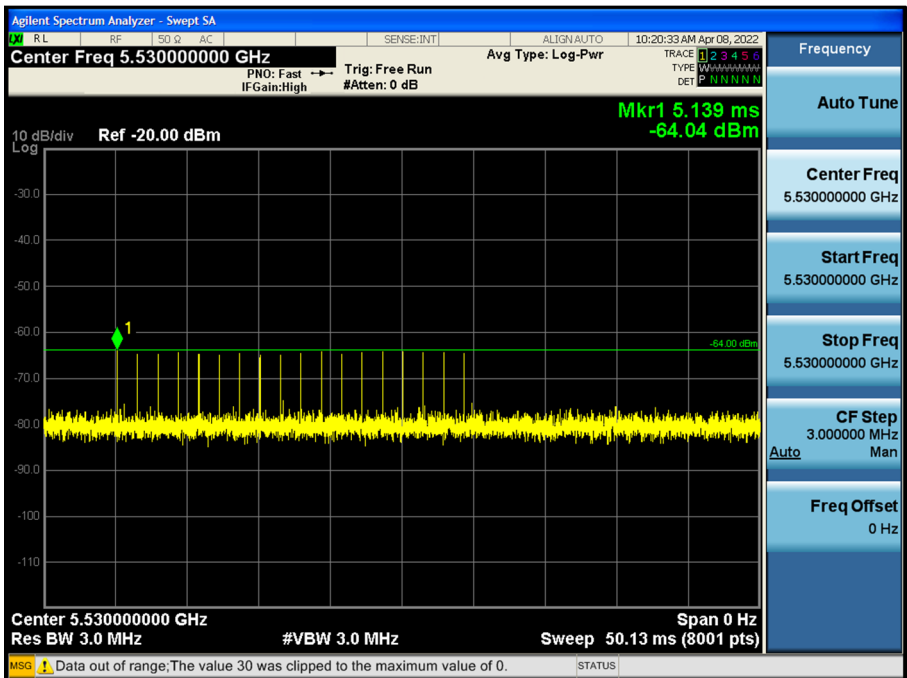
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5.3.1 Radar waveforms

Radar type 0_HE20_5320MHz



Radar type 0_HE80_5530MHz



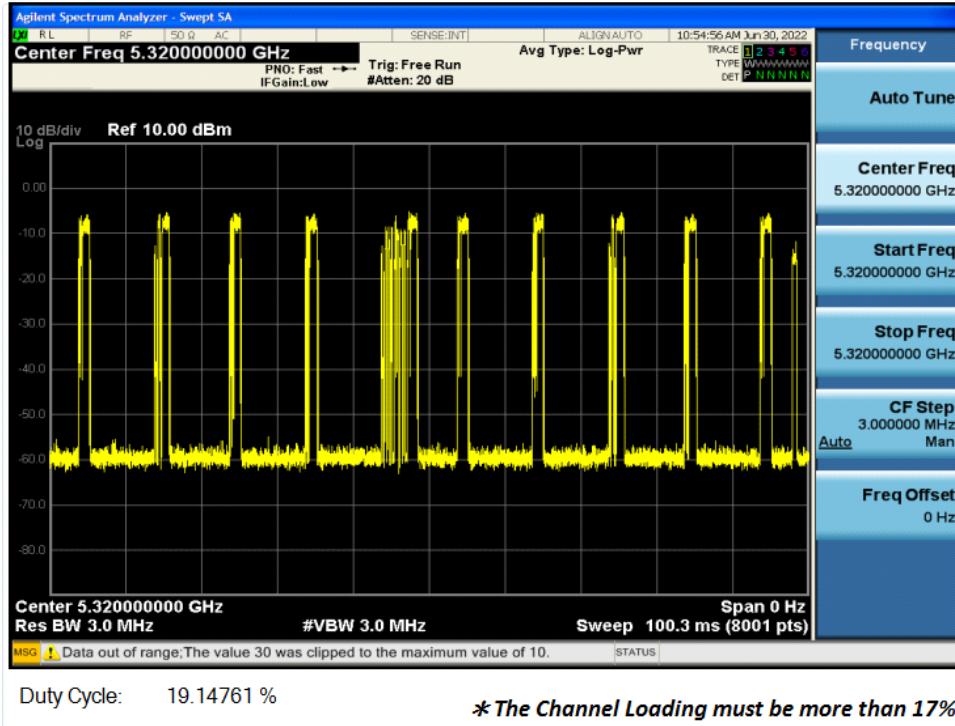
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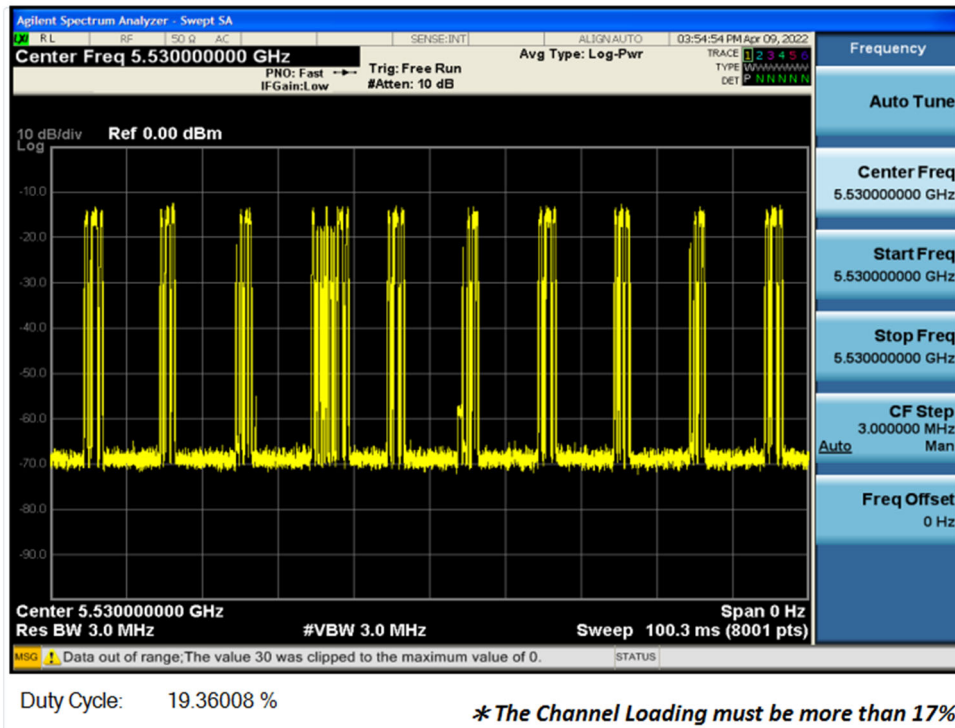
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5.3.2 WLAN traffic

HE20_5320MHz



HE80_5530MHz



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5.3.3 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	5320	Type 0	18	0.846
HE80	5530	Type 0	22	1.204
Limit			60	10
Result			Complied	

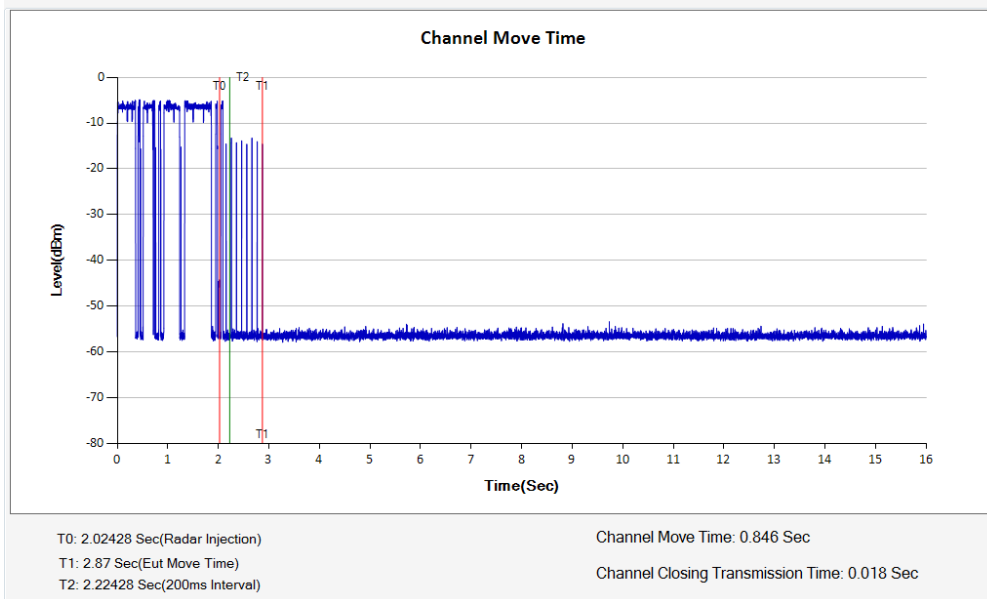
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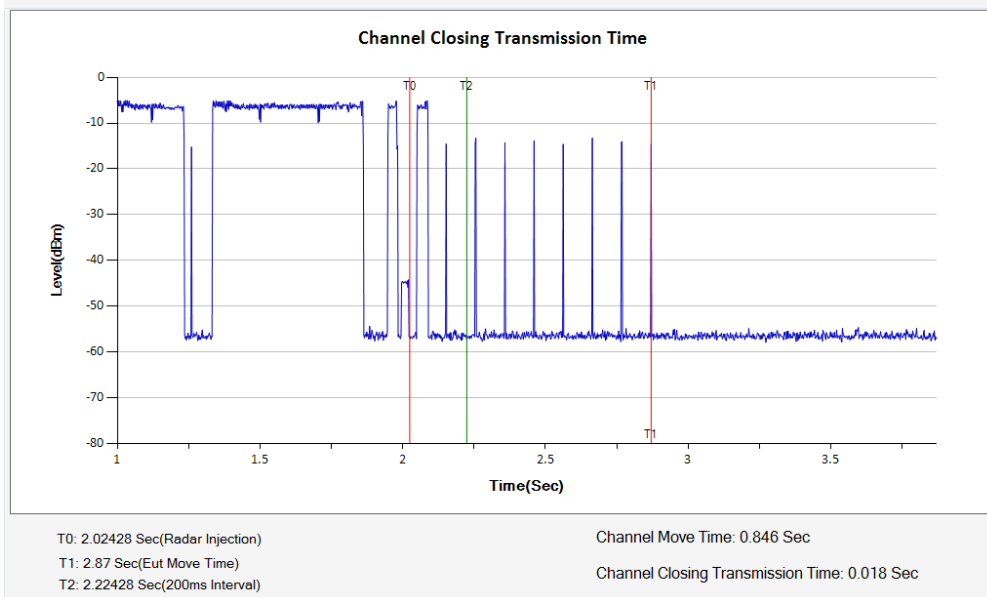
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HE20_5320MHz

Channel Move and Closing Transmission Time - 1



Channel Move and Closing Transmission Time - 2



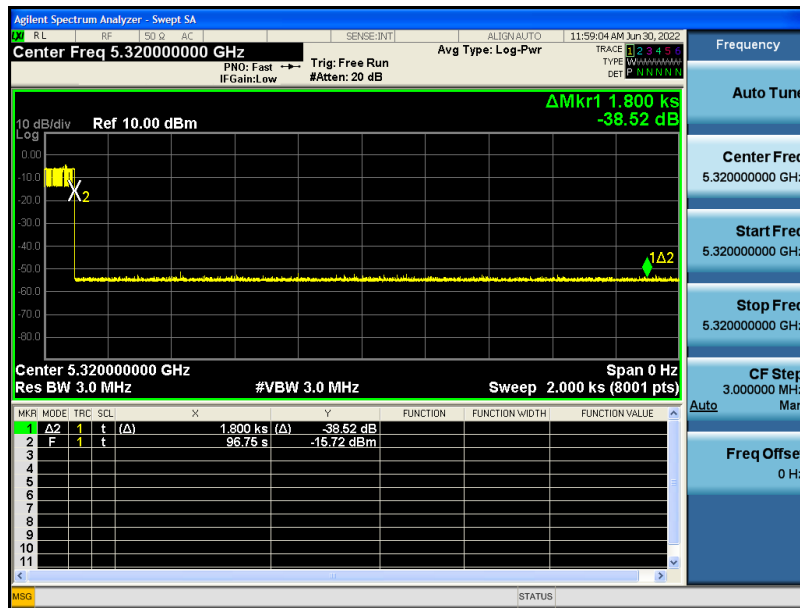
Verdict: Note: narrowing the sweep time as the good engineering process for the verification of transmission closing in 200ms

Non-occupancy Period (without radar detection)

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Verdict: To verify whether channel is unavailable to be operated in 30 minutes.
 $1.8ks = 1800s = 1800 \text{ s/min} / 60 = 30\text{minute}$

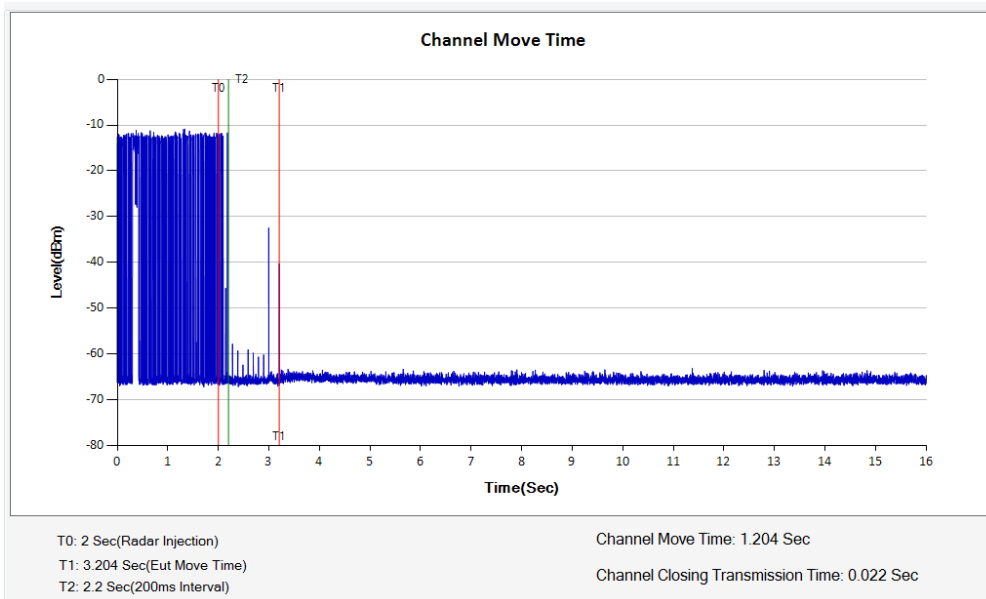
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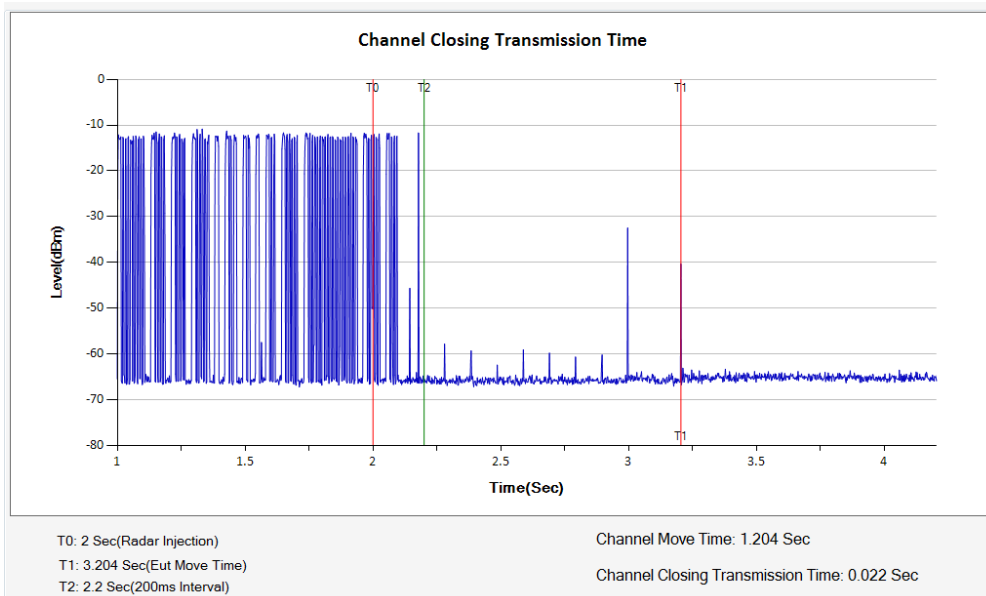
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HE80_5530MHz

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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Non-occupancy Period (without radar detection)



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

$$1.8\text{ks} = 1800\text{s} = 1800 \text{ s/min} / 60 = 30\text{minute}$$

~ End of Report ~

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