ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART E AND INDUSTRY CANADA RSS 247 REQUIREMENT DFS TEST REPORT

OF

Applicant:	Murata Manufacturing Co., Ltd. 10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555 Japan
Product Name:	Communication Module
Brand Name:	muRata
Model No.:	LBEE6ZZ1PY
Model Difference:	N/A
Report Number:	T190313W02-RP5
FCC ID:	VPYLB1PY
IC:	772C-LB1PY
FCC Rule Part:	§15.407, Cat: NII
IC Rule Part:	RSS-247 issue 2 Feb. 2017
Issue Date:	Apr. 22, 2019
Date of Test:	Mar. 14, 2019 ~ Apr. 01, 2019
Date of EUT Received:	Mar. 14, 2019
Issued by	Compliance Certification Services Inc.Wugu Lab. No.11, Wugong 6th Rd., Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.) service@ccsrf.com

Note: The test Result was tested by Compliance Certification Services Inc. The test data, data evaluation, test procedures, and equipment configurations shown in this report were given in ANSI C63.10: 2013 and compliance standards.
The test results of this report relate only to the tested sample (EUT) identified in this report.
The test Report of full or partial shall not copy. Without written approval of Compliance Certification Services Inc. (Wugu Laboratory).

Tested By: Peter Weng

Peter Weng / Engineer

Approved By: Kevin Tsai

Kevin Tsai / Deputy Manager

Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
T190313W02-RP5	Rev.00	Initial creation of document	All	Apr. 22, 2019	Violetta Tang

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Communication Module
Brand Name:	muRata
Model No.:	LBEE6ZZ1PY
Model Difference:	N/A
Operation mode	client equipment without radar detection
Product SW/HW version:	1.0 / 1.0
Radio SW/HW version:	1.0 / 1.0
Test SW Version:	N/A
RF power setting in TEST SW:	N/A
Power Supply:	3.3Vdc

FCC WLAN 5GHz:

Wi-Fi	Frequency Range	Channels	Avg. Power (dBm)	Modulation Technology
11a_20	5150~5250	4	10.93	OFDM
	5250~5350	4	10.90	
	5470~5725	12	11.03	
	5725~5850	5	10.93	
11n_HT / ac_VHT 20M	5150~5250	4	HT: 11.08	OFDM
	5250~5350	4	HT: 11.06	
	5470~5725	12	HT: 11.13	
	5725~5850	5	HT: 11.06	
11n_HT / ac_VHT 40M	5150~5250	2	HT: 8.09	OFDM
	5250~5350	2	HT: 8.39	
	5470~5725	6	HT: 8.27	
	5725~5850	2	HT: 8.00	
11ac VHT80M	5150~5250	1	8.55	OFDM
	5250~5350	1	8.74	
	5470~5725	3	8.77	
	5725~5850	1	8.37	
Antenna Designation:		Monopole Antenna, Antenna Gain: 5.2dBi		

IC WLAN 5GHz:

Wi-Fi	Frequency Range	Channels	Avg. or EIRP	Rated Power(dBm)	Modulation Technology
11a	5180~5240	4	EIRP	16.13	OFDM
	5260~5320	4	Avg.	10.90	
	5500~5580	5	Avg.	11.03	
	5660~5720	4	Avg.	10.77	
	5745~5825	5	Avg.	10.93	
11n_HT / ac_VHT 20M	5180~5240	4	EIRP	HT: 16.28	OFDM
	5260~5320	4	Avg.	HT: 11.06	
	5500~5580	5	Avg.	HT: 11.13	
	5660~5720	4	Avg.	HT: 10.88	
	5745~5825	5	Avg.	HT: 11.06	
11n_HT / ac_VHT 40M	5190~5230	2	EIRP	HT: 13.29	OFDM
	5270~5310	2	Avg.	HT: 8.39	
	5510~5550	2	Avg.	HT: 8.27	
	5670~5710	2	Avg.	HT: 7.83	
	5755~5795	2	Avg.	HT: 8.00	
11ac VHT80M	5210~5210	1	EIRP	13.75	OFDM
	5290~5290	1	Avg.	8.74	
	5530~5530	1	Avg.	8.77	
	5690~5690	1	Avg.	8.59	
	5775~5775	1	Avg.	8.37	
Modulation type	64QAM, 16QAM, QPSK, BPSK for OFDM 256QAM for OFDM in 802.11ac only				
Transition Rate:	802.11 a: 6/9/12/18/24/36/48/54 Mbps 802.11 n_20MHz: 6.5 – 72.2Mbps 802.11 n_40MHz: 13.5 - 150.0Mbps 802.11 ac_20MHz: 6.5 –86.7Mbps 802.11 ac_40MHz: 13.5 -200.0Mbps 802.11 ac_80MHz: 29.3 – 433.3Mbps				

1.2 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

All test items have been performed and record as per the above standards.

1.3 Test Facility

Compliance Certification Services Inc. Wugu Lab. No.11, Wugong 6th Rd.,

Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.) (TAF code 1309)

FCC Designation number: TW1309
Canada Company number: 2324G

1.4 Special Accessories

There are no special accessories used while test was conducted.

1.5 Equipment Modifications

There was no modification incorporated into the EUT.

2 SUMMARY OF TEST RESULT

FCC / IC 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	+/- 123.36 Hz

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.

4 TPC AND DFS MEASUREMENT

4.1 TPC: Standard Applicable

According to §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.

4.1.1 Result: N/A, The output power is less than 500mW.

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.

(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 §6.3), Note: For the band 5600-5650 MHz, no operation is permitted. Until further notice, devices subject to this annex shall not be capable of transmitting in the band 5600-5650 MHz. This restriction is for the protection of Environment Canada weather radars operating in this band. Devices operating in the bands 5250-5350 MHz, 5470-5600 MHz and 5650-5725 MHz band shall comply with the following:

(a) Devices shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems (see Note below). The minimum DFS radar signal detection threshold is -62 dBm for devices with a maximum e.i.r.p. less than 200 mW, and -64 dBm for devices with a maximum e.i.r.p. of 200 mW to 1 W. The detection threshold power is the received power, averaged over a 1-microsecond reference to a 0 dBi antenna. The DFS process shall provide a uniform spreading of the loading over all the available channels.

Note: Test procedures for demonstrating compliance with the DFS radar detection requirements set out in this section are being evaluated by Industry Canada. As an interim measure, the Department will, until further notice, accept utilization of the DFS test procedures published by the U.S. Federal Communications Commission (FCC)3 to demonstrate compliance with the requirements of this section.

(b) Operational requirements: the requirement for channel availability check time applies in the master operational mode. The requirement for channel move time applies in both the master and slave operational modes.

(i) In-service monitoring: an LE-LAN device should 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 if 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 A9.3 (a) above is detected within 60 seconds.

(iii) Channel move time: after a radar's signal is detected, the device shall cease all transmissions on the operating channel within 10 seconds. Transmission during this period shall consist of normal traffic for a maximum of 200 ms after detection of the radar signal. Intermittent management and control signals may also be sent during the remaining time to facilitate vacating the operating channel.

(iv)Channel closing time: the maximum channel closing time is 260 ms. (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.

4.2.1 Limit

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

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

Table 2: Applicability of DFS requirements during normal operation

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

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
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.	

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.	

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

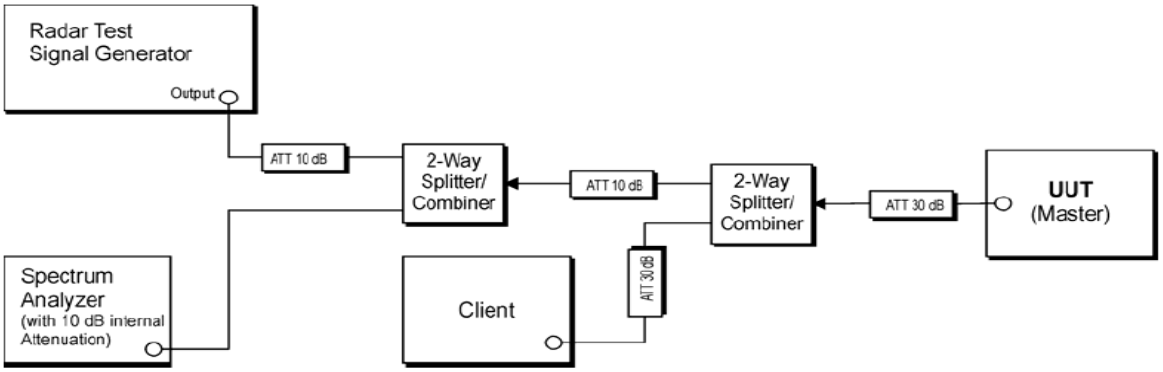
Frequency Hopping Radar

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

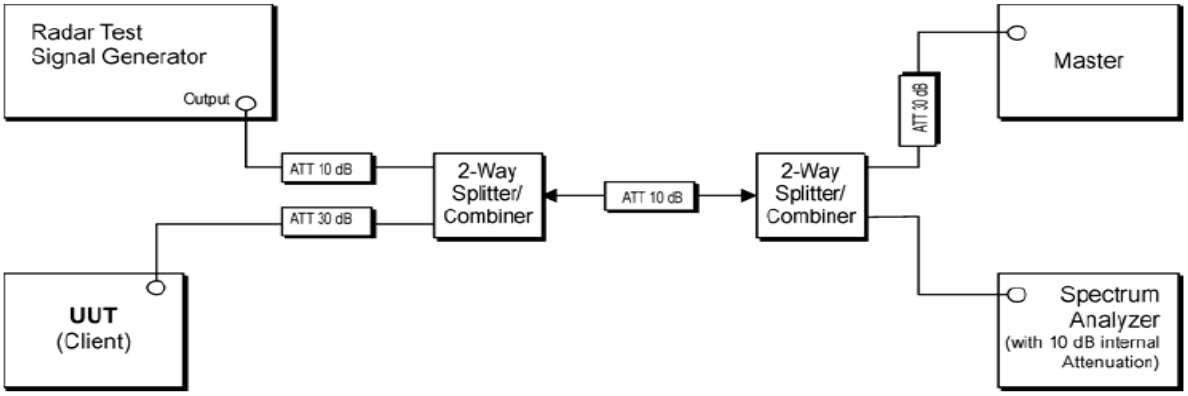
The applicant of this given application confirms that information regarding the parameters of the detected Radar Waveforms is not available to the end user.

4.2.2 Test Setup

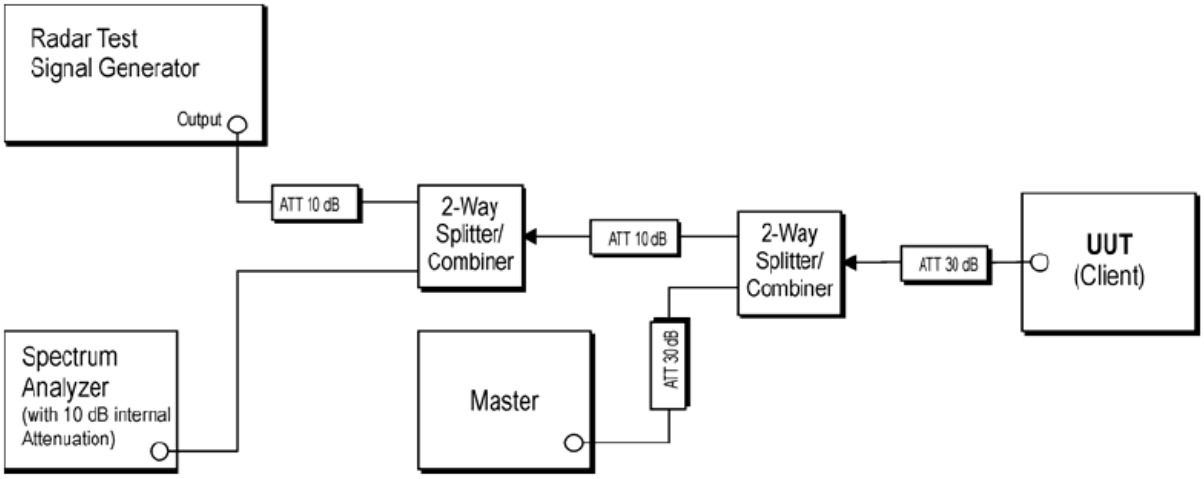
Setup for Master with injection at the Master



Setup for Client with injection at the Master



Setup for Client with injection at the Client



4.2.3 Test Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Signal Generator	Agilent	N5182B	MY56200007	08/13/2018	08/12/2019
EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY57120290	02/13/2019	02/12/2020
Splitter	RF-LAMBAD	RFLT4W1G18G	SPCD10-004	02/26/2019	02/25/2020
Splitter	RF-LAMBAD	RFLT2W1G18G	11-JSPF412-020	02/26/2019	02/25/2020
Splitter	RF-LAMBAD	RFLT2W1G18G	11-JSPF412-017	02/26/2019	02/25/2020
Attenuator	Agilent	8494B	MY42152151	02/26/2019	02/25/2020
Attenuator	Agilent	8496B	MY42147434	02/26/2019	02/25/2020
Splitter	RF-LAMBAD	RFLT2W1G18G	11-JSPD022-013	02/26/2019	02/25/2020
DC Block	Mini-Circuits	BLK-18-S+	31129(1)	02/26/2019	02/25/2020
Accece Ponit	LINKSYS	WRT3200ACM	198106086149 86 FCC ID:Q87-WRT3200ACM IC:3839A-WRT3200ACM	N/A	N/A
Software	e3 V6.11-20180413				

4.2.4 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 with no adjustment of lowest, and highest power, but the level of power emission stays at fixed level.

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, and the master device as employed for the applicable DFS test is LINKSYS router.

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

Conducted test was performed with appropriate adjustment, and calibration to ensure power from DFS simulator injects to antenna port of DFS test equipment (DFS) is -64dBm

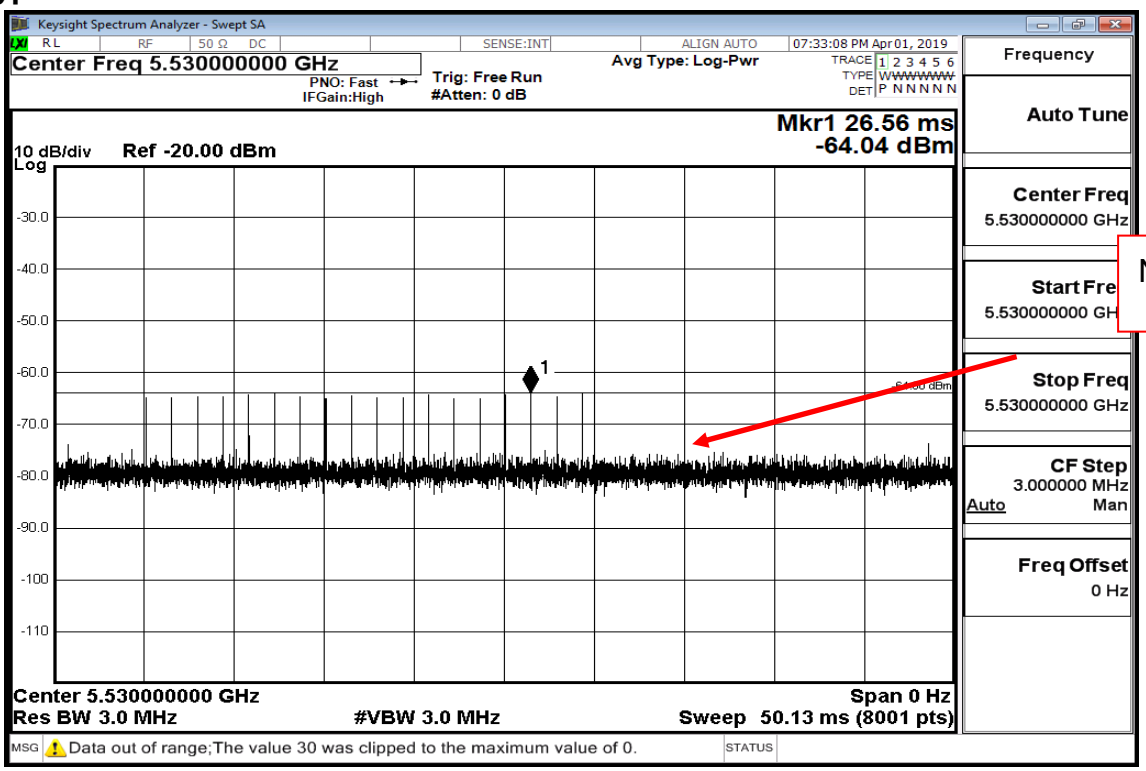
Message or files that is used for communication between Master and Client:

IP based system:

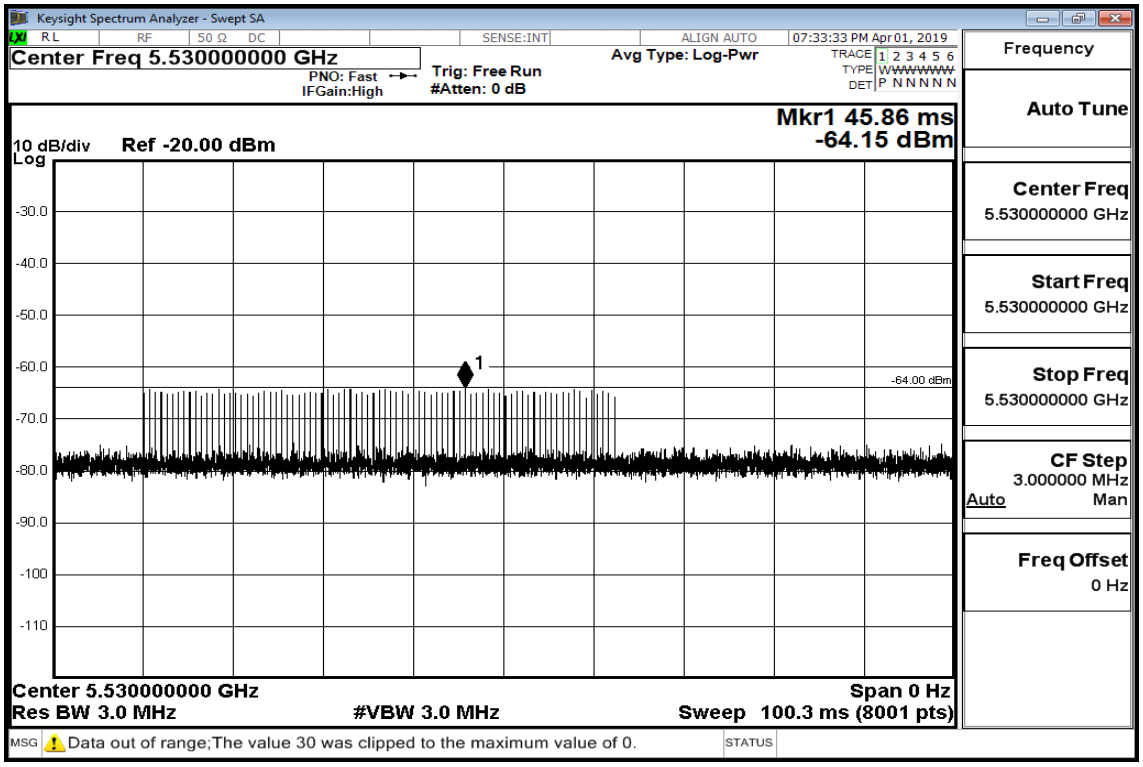
For the required channel loading, the full motion, 30 frames per second MPEG video file from http://ntiacsd.ntia.doc.gov/dfs/ was streamed from a network on a test bench (server of the storage to download the mandatory format of Video file), via the DFS Master device, to the UE (mobile phone).

4.2.5 Test results

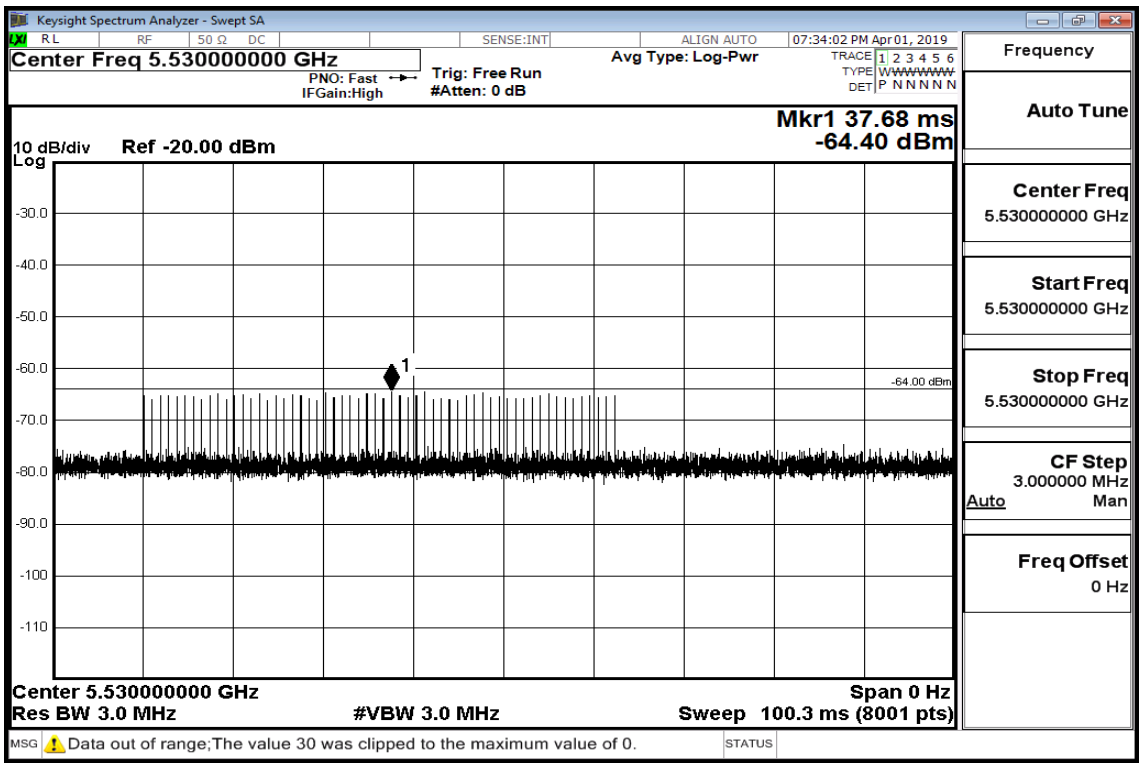
Calibration plots for each of the required radar waveforms
Radar type 0



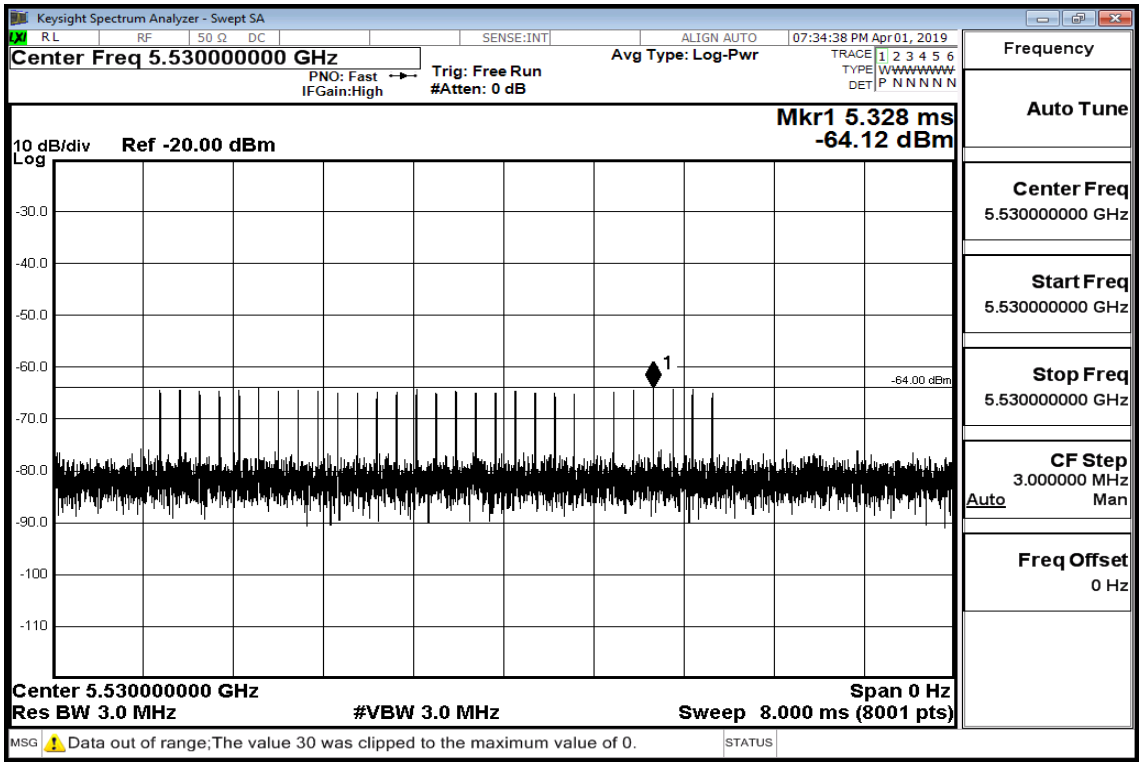
Radar type 1 A



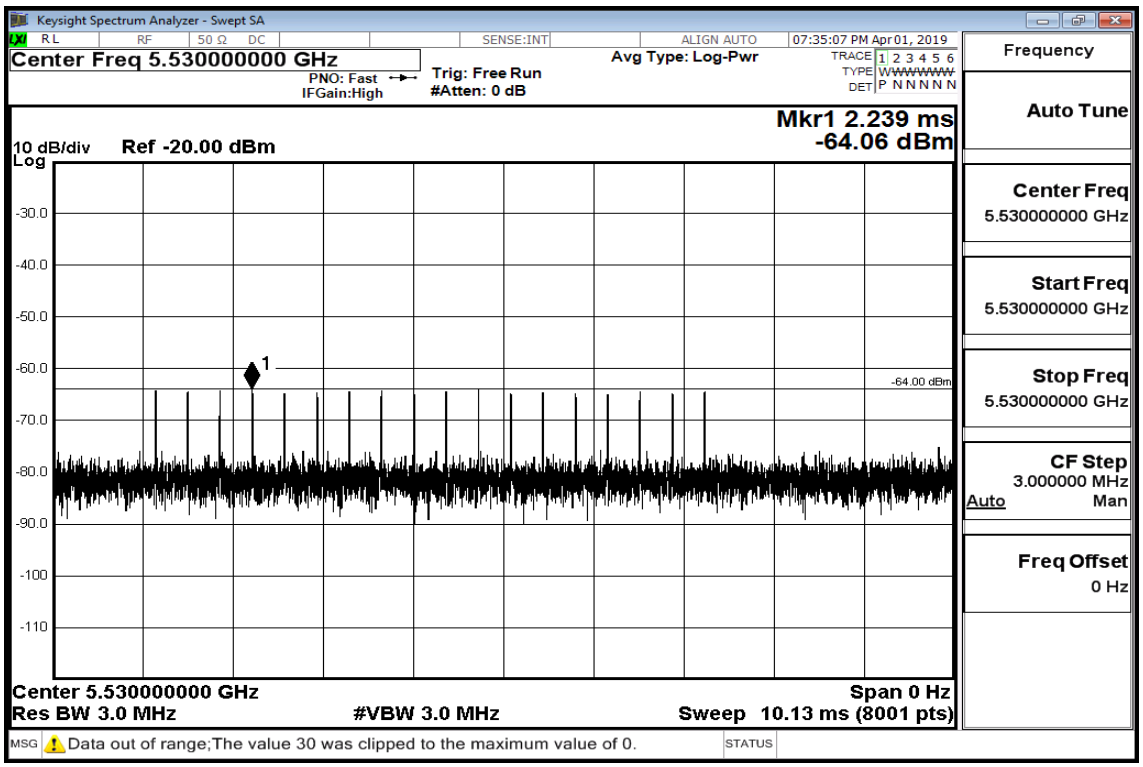
Radar type 1 B



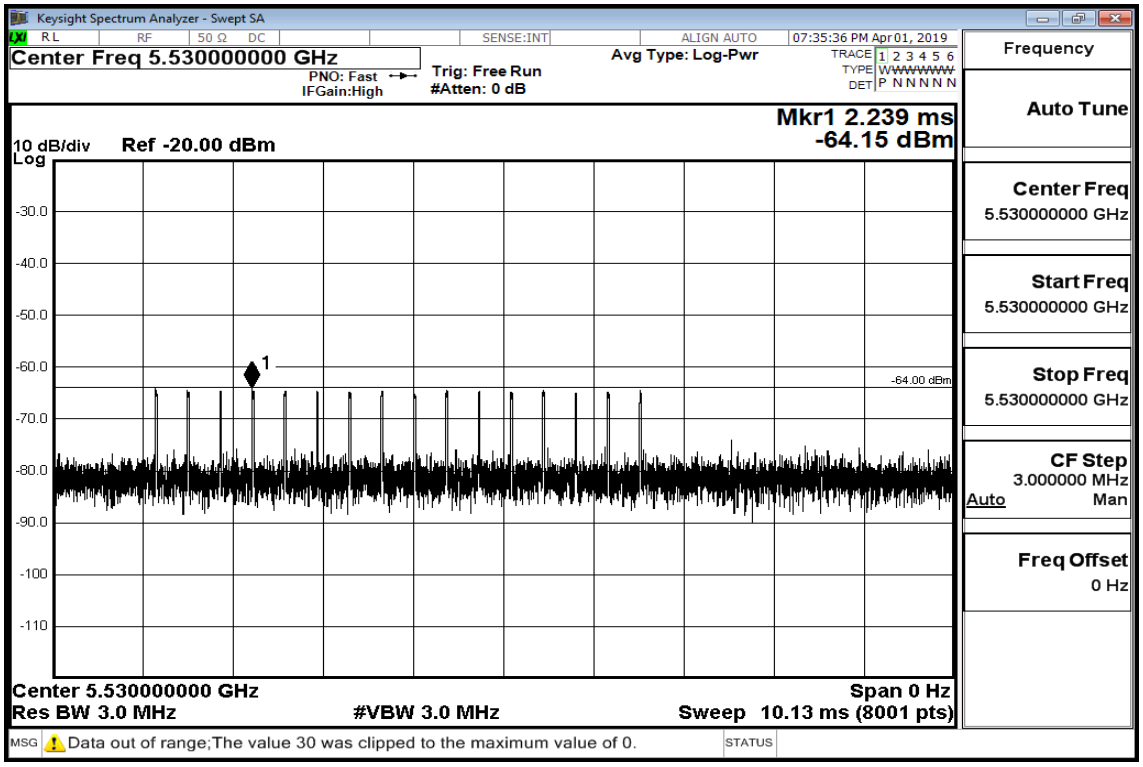
Radar type 2



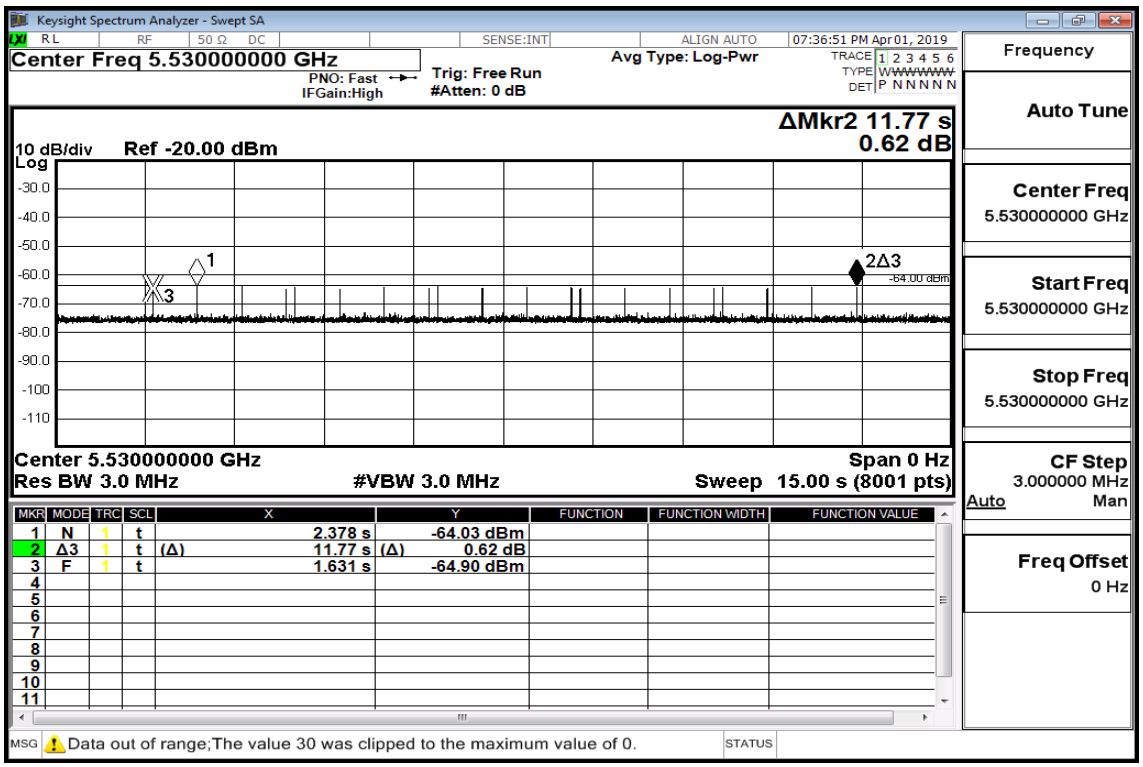
Radar type 3



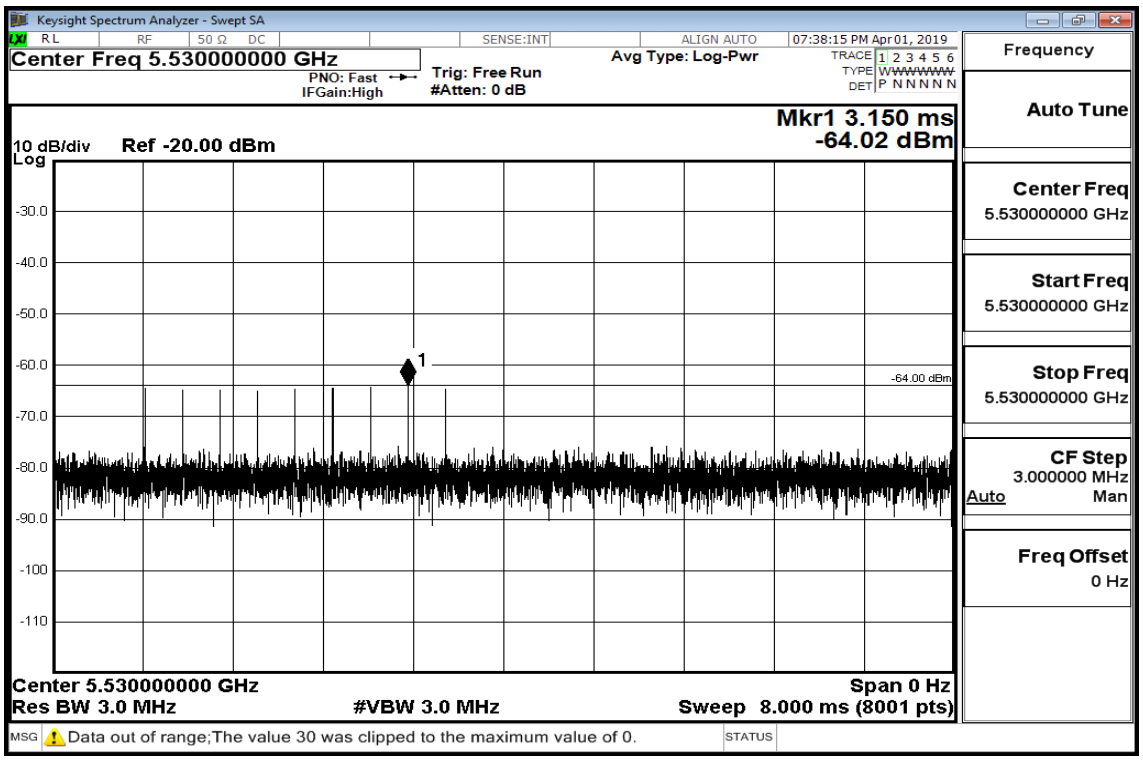
Radar type 4



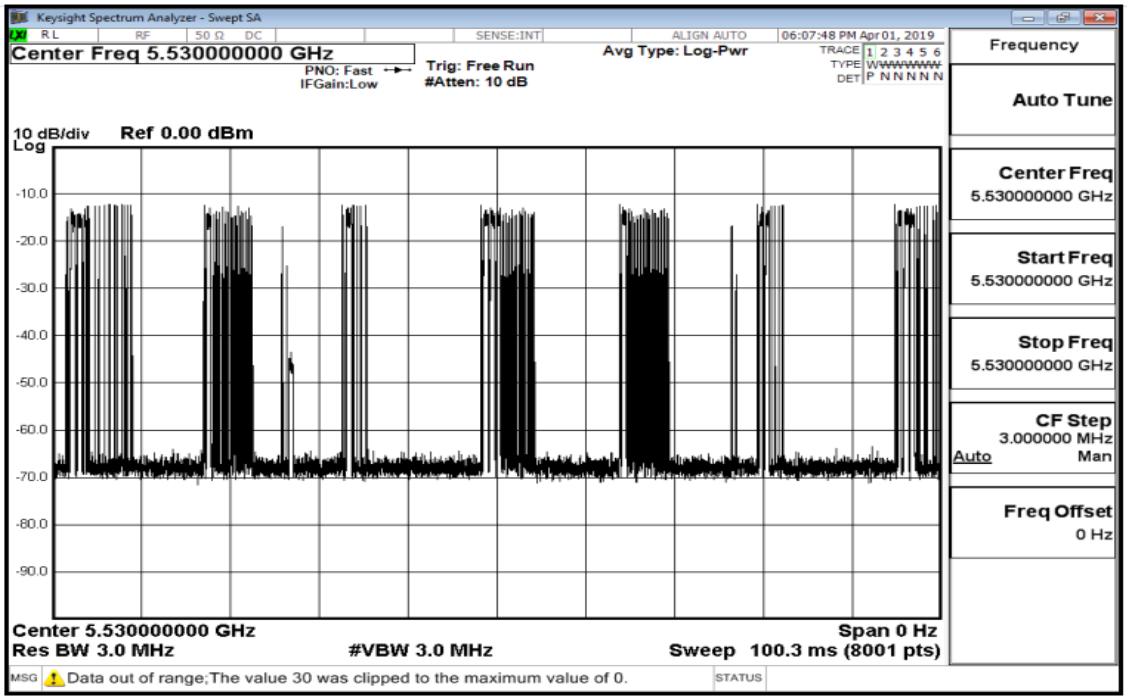
Radar type 5



Radar type 6



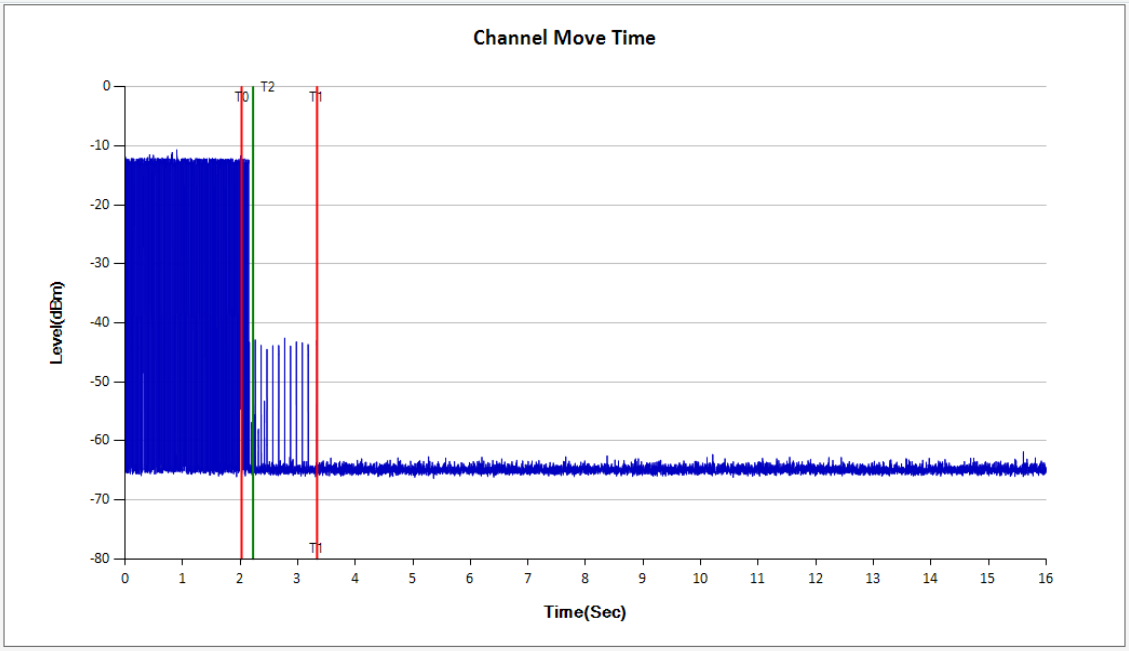
WLAN traffic



Duty Cycle: 17.77278 %

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

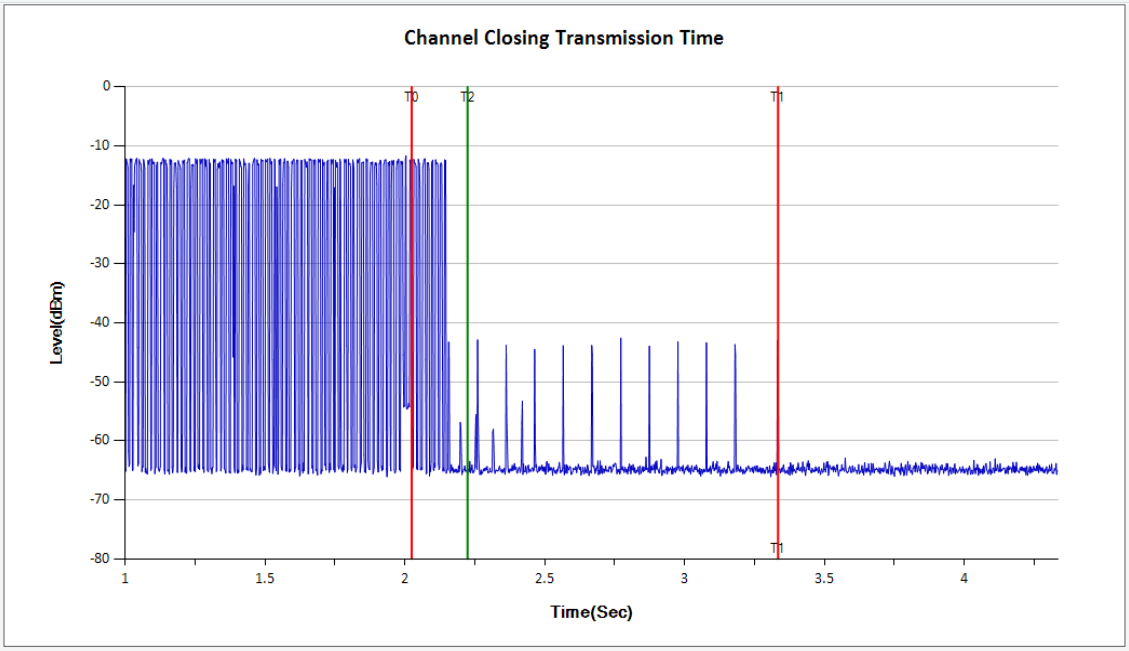
Radar Type 1 Channel Move Transmission Time



T0: 2.02428 Sec(Radar Injection)
T1: 3.334 Sec(Eut Move Time)
T2: 2.22428 Sec(200ms Interval)

Channel Move Time: 1.31 Sec
Channel Closing Transmission Time: 0.026 Sec

Radar Type 1 Channel Move and Closing Transmission Time

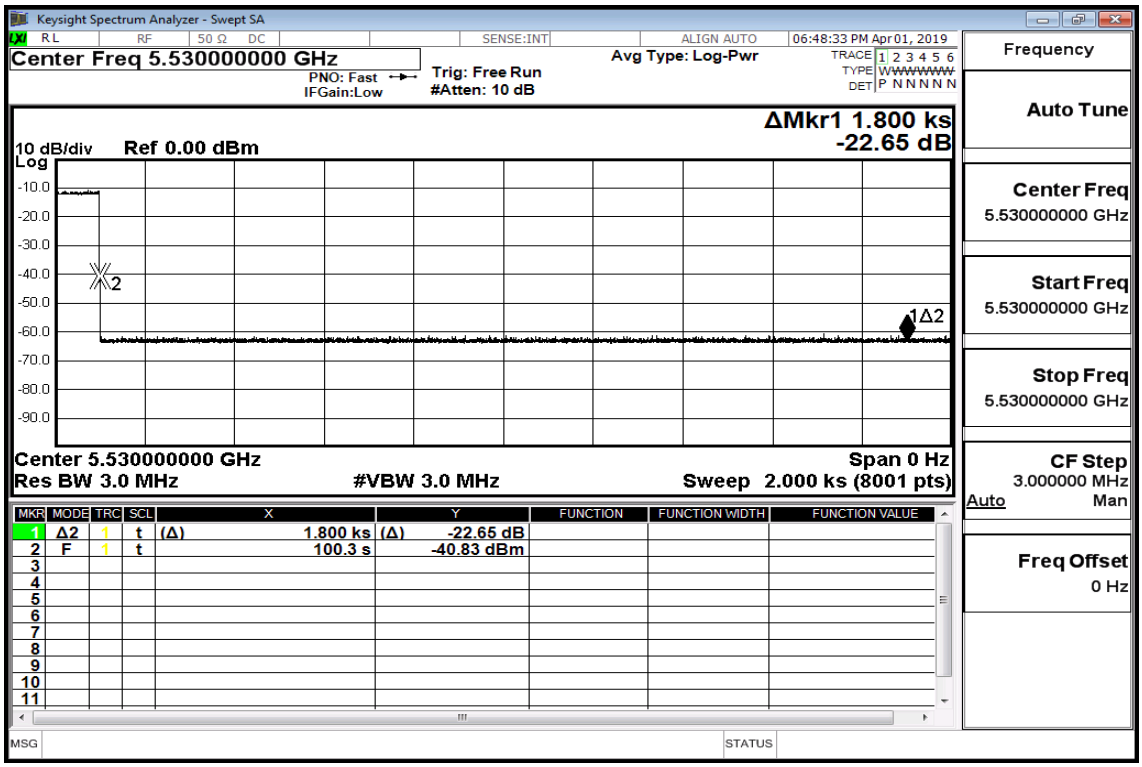


T0: 2.02428 Sec(Radar Injection)
T1: 3.334 Sec(Eut Move Time)
T2: 2.22428 Sec(200ms Interval)

Channel Move Time: 1.31 Sec
Channel Closing Transmission Time: 0.026 Sec

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)



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

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