ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART E REQUIREMENT DFS TEST REPORT

OF

Applicant:	Robotelf Technologies Co., Ltd 3390 East Harmony Road Fort Collins, Colorado 80528 United States
Product Name:	Robelf Smart Robot
Brand Name:	Robotelf Technologies Co., Ltd
Model No.:	RBE001
Model Difference:	N/A
FCC ID:	2APLA-RBE001
Report Number:	E2/2018/50037
FCC Rule Part:	§15.407, Cat: NII
Issue Date:	Jun. 08, 2018
Date of Test:	Jun. 06, 2018
Date of EUT Received:	Apr. 12, 2018

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory
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 tested as described in this report is in compliance with conducted and radiated emission limits.
The test results of this report relate only to the tested sample identified in this report.

Tested By: Aken Huang

Aken Huang / Engineer

Approved By: Jim Chang

Jim Chang / Manager

Testing Laboratory
0513

Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
E2/2018/50037	Rev.00	Initial creation of document	All	Jun. 08, 2018	Elle Chang

Contents

1 GENERAL INFORMATION 4
1.1 Product Description 4
1.2 Test Methodology of Applied Standards 6
1.3 Test Facility 6
1.4 Special Accessories 6
1.5 Equipment Modifications 6
2 SUMMARY OF TEST RESULT 7
3 MEASUREMENT UNCERTAINTY 7
4 TPC and DFS MEASUREMENT 8
4.1. TPC: Standard Applicable 8
4.2. DFS: Standard Applicable 8

1 GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	Robelf Smart Robot	
Brand Name:	Robotelf Technologies Co., Ltd	
Model No.:	RBE001	
Model Difference:	N/A	
Hardware Version:	N/A	
Software Version:	N/A	
Power Supply:	20V from AC/DC Adapter	
	Adapter:	Model No.: ADPC2045, Supplier: TPV ELECTRONICS(FUJIAN) CO., LTD

WLAN 5GHz:

Wi-Fi 802.11	Frequency Range	Channels	Rated Power (Avg.) (dBm)	Modulation Technology
a	5150~5250	4	16.94	OFDM
	5250~5350	4	16.60	
	5470~5725	12	16.78	
	5725-5850	5	15.94	
n_HT ac_VHT 20M	5150~5250	4	HT: 15.76 (Worst Case)	OFDM
	5250~5350	4	HT: 15.69 (Worst Case)	
	5470~5725	12	HT: 15.89 (Worst Case)	
	5725-5850	5	HT: 15.55 (Worst Case)	
n_HT ac_VHT 40M	5150~5250	2	HT: 15.66 (Worst Case)	OFDM
	5250~5350	2	HT: 15.77(Worst Case)	
	5470~5725	6	HT: 15.36 (Worst Case)	
	5725-5850	2	HT: 15.52 (Worst Case)	
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 – 144.4Mbps 802.11 n_40MHz: 13.5 – 300Mbps 802.11 ac_20MHz: 6.5 –144.4Mbps 802.11 ac_40MHz: 13.5 –300Mbps		

Antenna Designation:

PCB	N/A	N/A	5150~5250	4.61 dBi
			5250~5350	4.73 dBi
			5470~5725	5.08 dBi
			5725~5850	4.5 dBi

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

1.3 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333 (TAF code 0513)
FCC Registration Number and Designation are: 735305 / TW0002.

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 Rules	Description Of Test	Result
§15.407(h)	TPC and DFS Measurement	Compliant

3 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
TPC and DFS Measurement	+/- 123.36 Hz
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC=+/- 0.2%

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

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.

4.2.1. 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	Yes	Yes
DFS Detection Thresh-old	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
Cannel Closing Transmis-sion time	Yes	Yes
Channel Move time	Yes	Yes
U-NII Detection Bandwidth	Yes	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.	

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.	

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

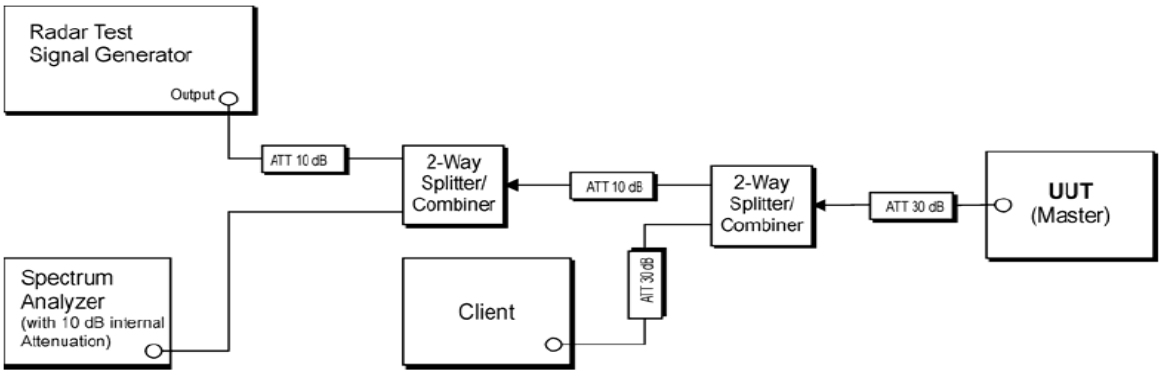
Frequency Hopping Radar

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

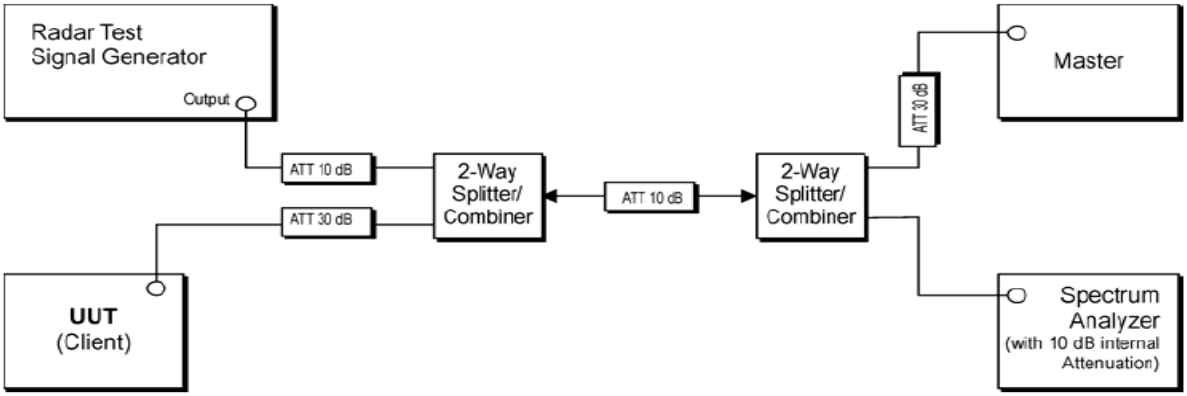
The applicant of this given application confirms that information regarding the parameters of the detected Radar Waveforms is not available to the end user.

4.2.2. Test Setup

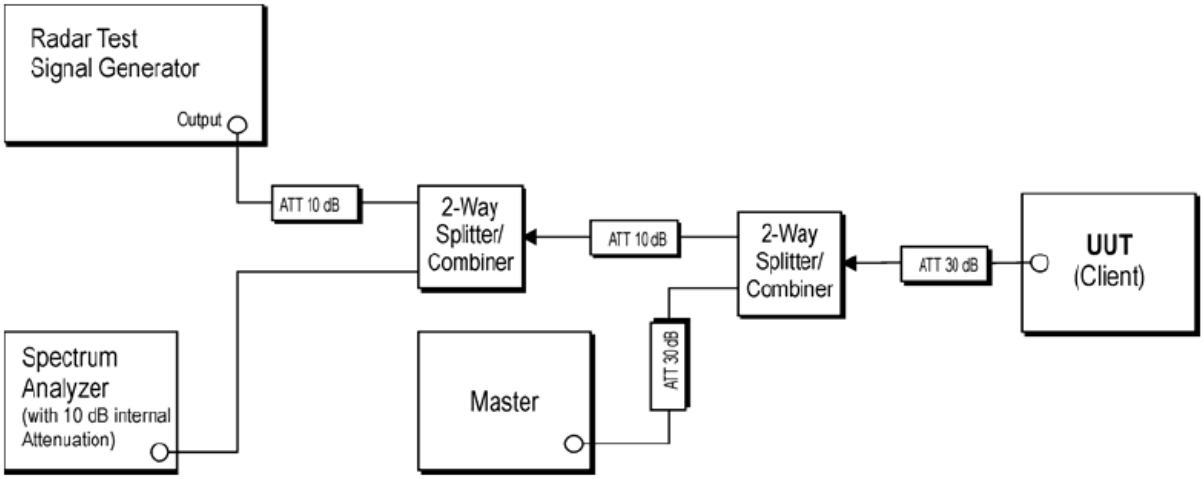
Setup for Master with injection at the Master



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.
Spectrum Analyzer	Agilent	N9010A	MY51440113	06/21/2017	06/20/2018
Attenuator	Marvelous	MVE2213-10	RF31	12/26/2017	12/25/2018
DC Block	PASTERNACK	PE8210	RF81	12/26/2017	12/25/2018
Coaxial Cables	Woken	00100A1F1A185C	RF229	12/26/2017	12/25/2018

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.

The EUT utilizes the 802.11a/n 40M architecture, with a nominal channel bandwidth of 40MHz 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 -62dBm.after correction for antenna gain and procedural adjustments, the required conducted threshold at the antenna port is -62dBm, and the master device as employed for the applicable DFS test is CISCO router whose FCC ID= 2APLAGC317271

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 -62dBm

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

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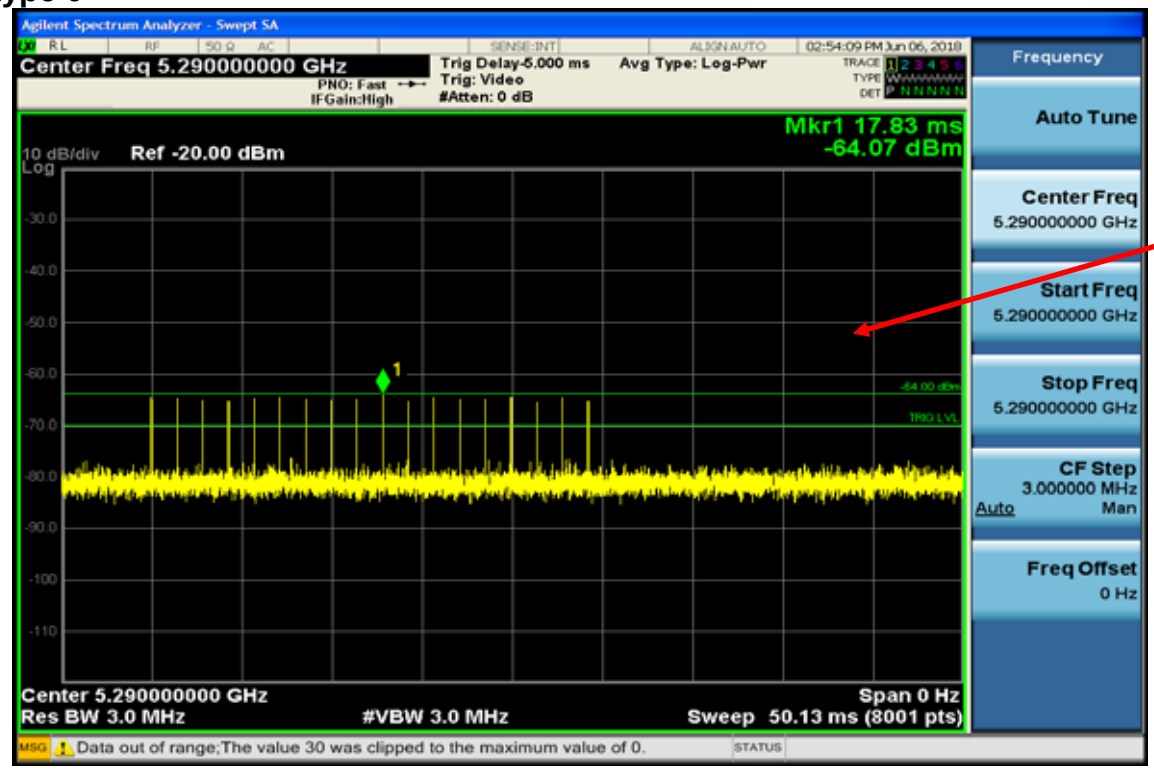
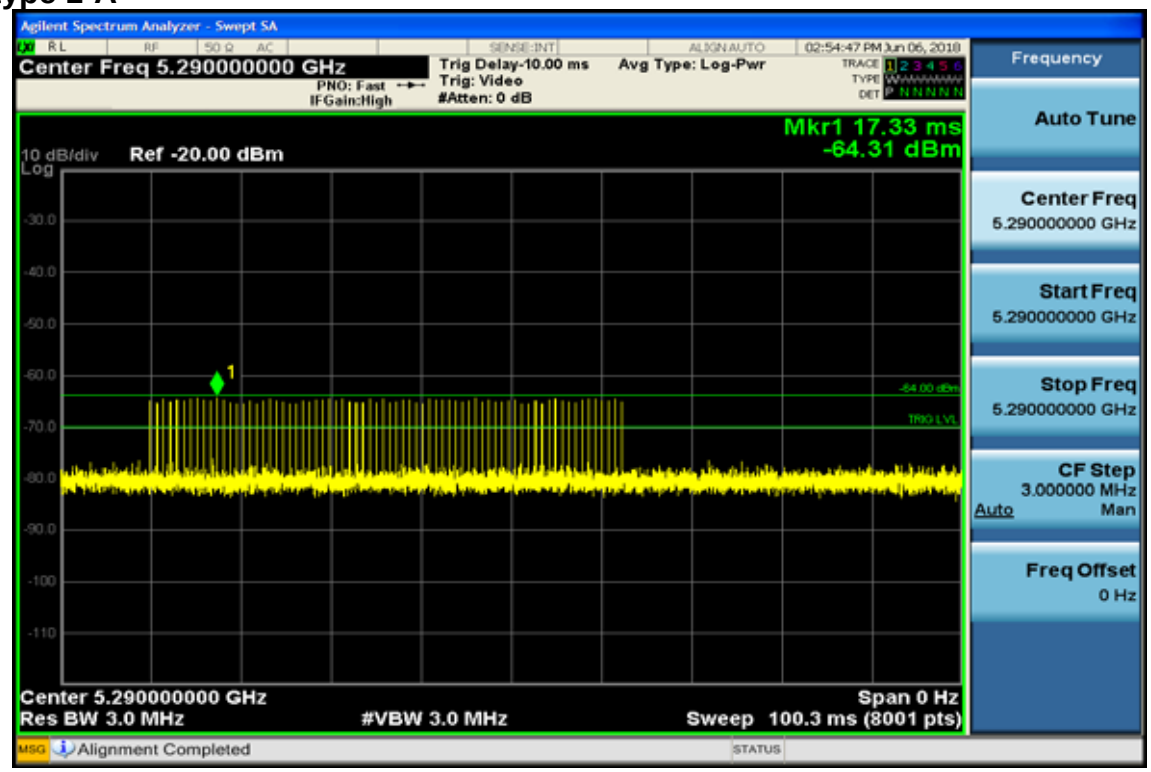
Calibration plots for each of the required radar waveforms

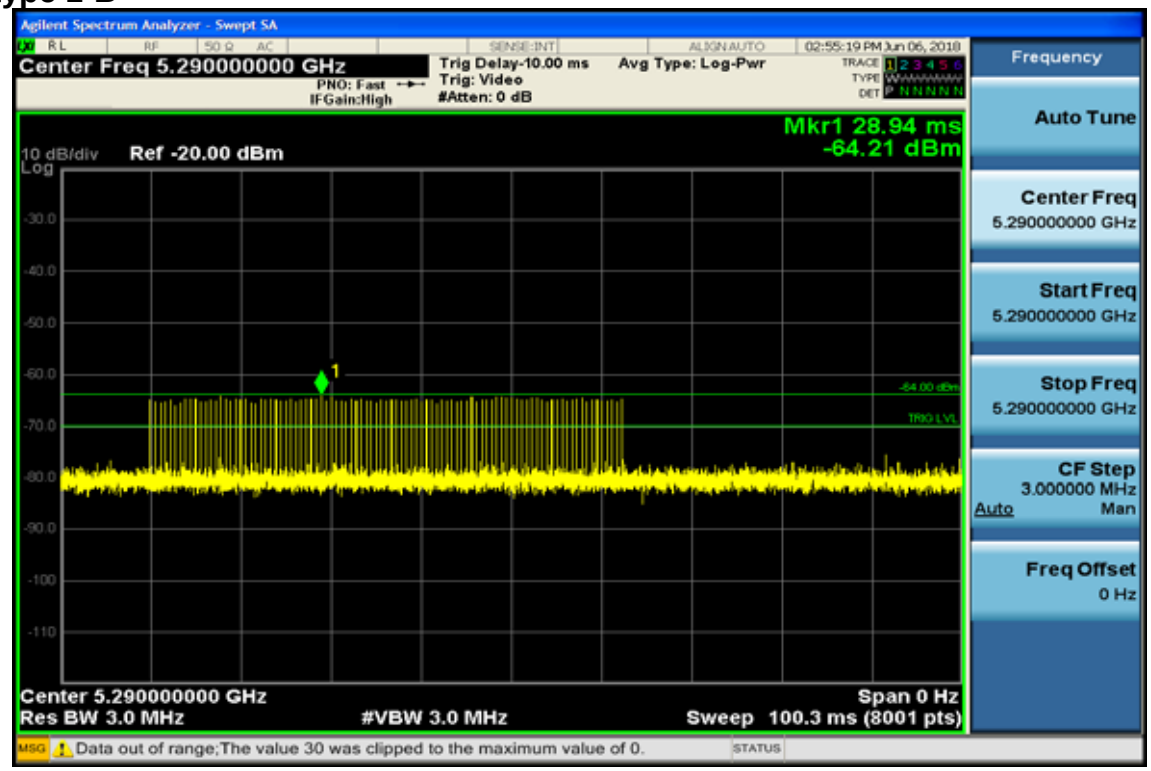
Radar type 0



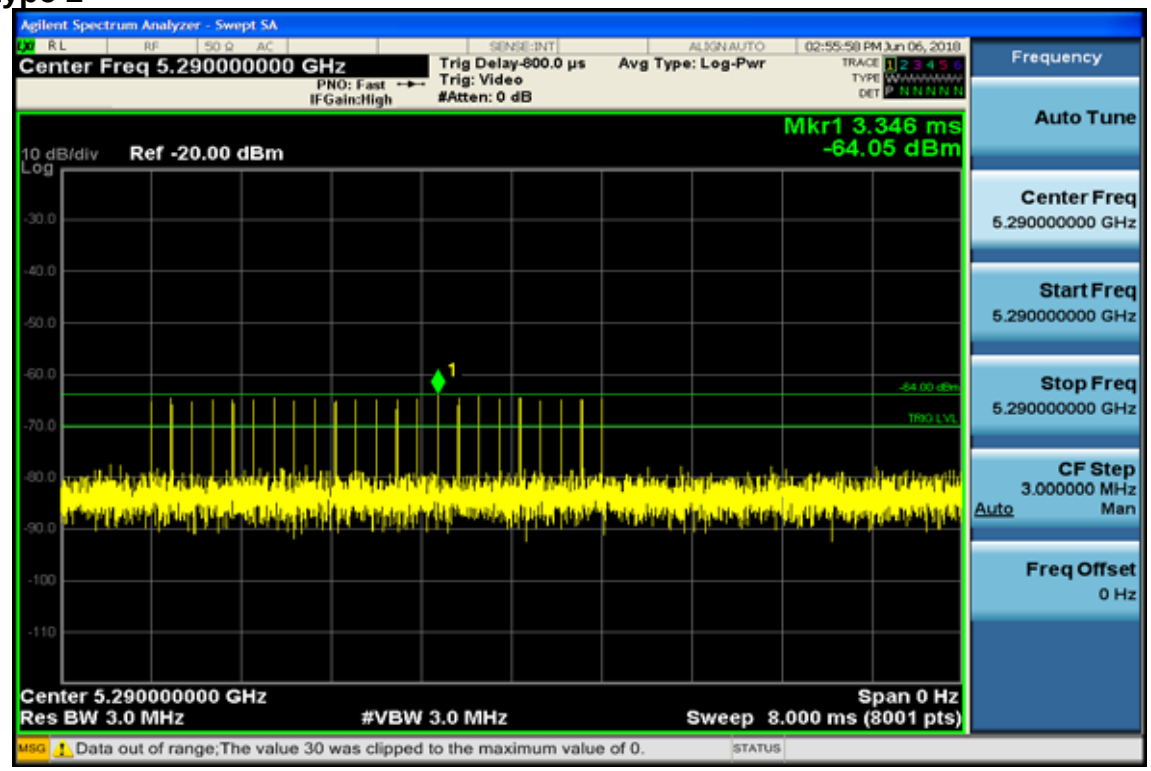
Radar type 1-A



Radar type 1-B

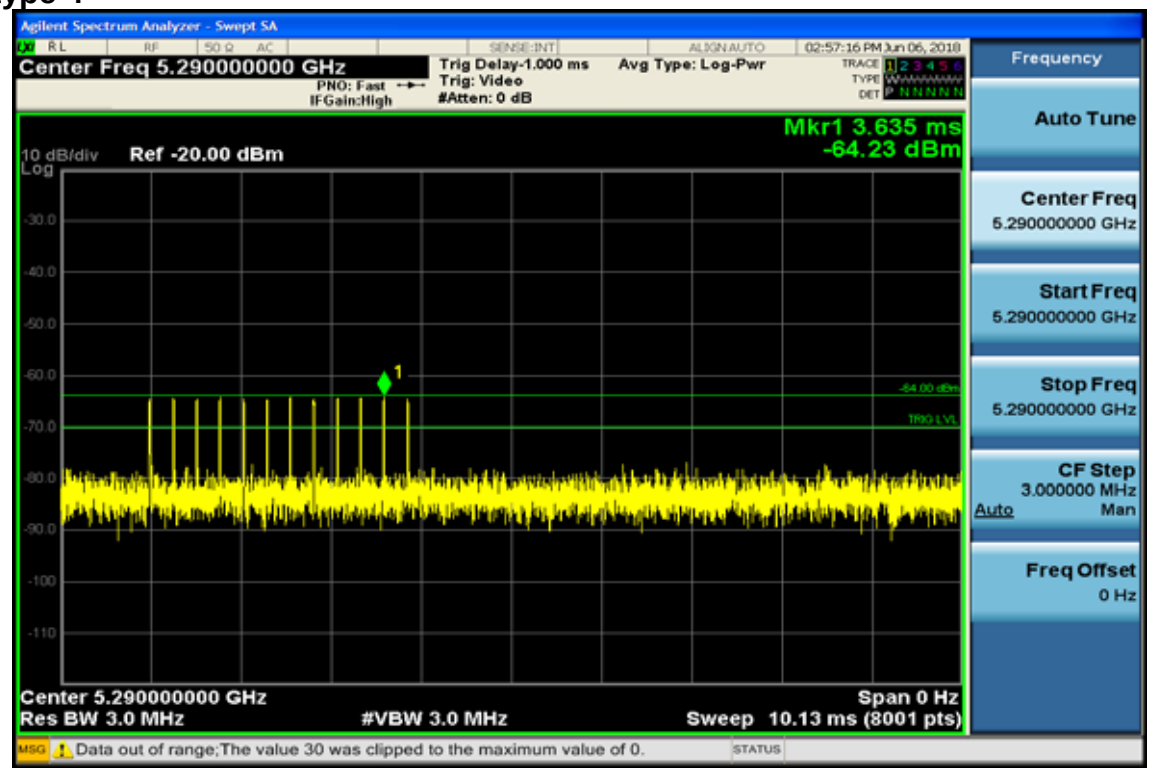


Radar type 2



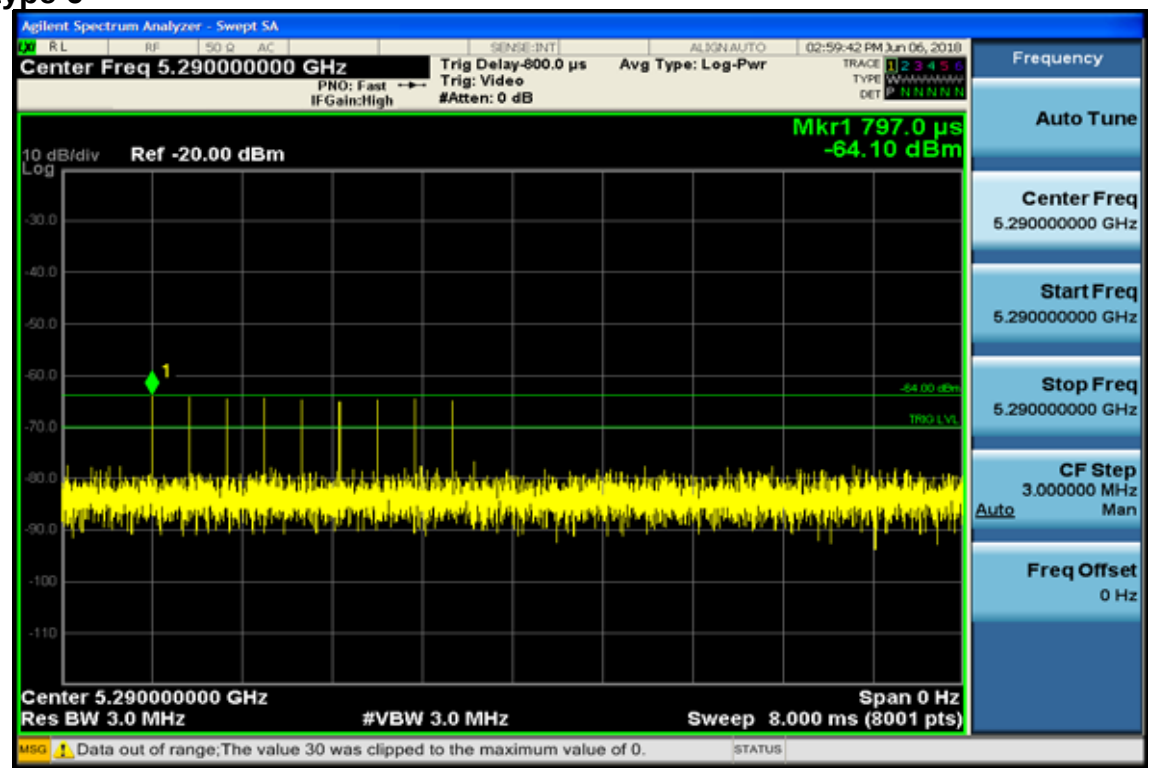
Radar type 3

Radar type 4

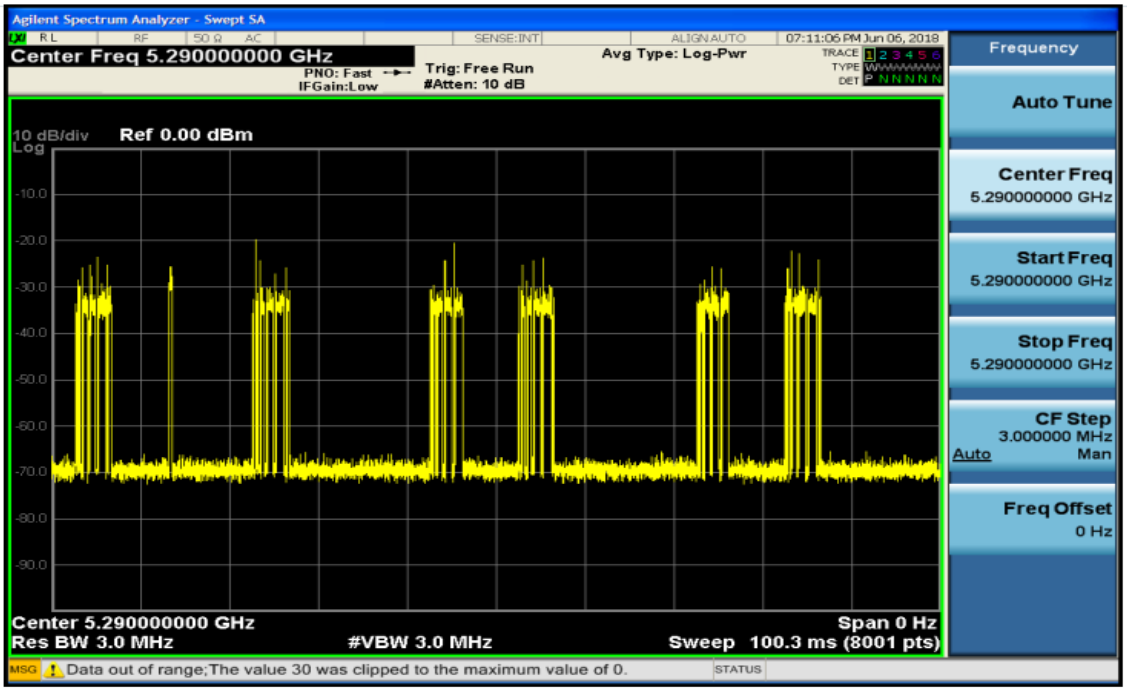


Radar type 5

Radar type 6



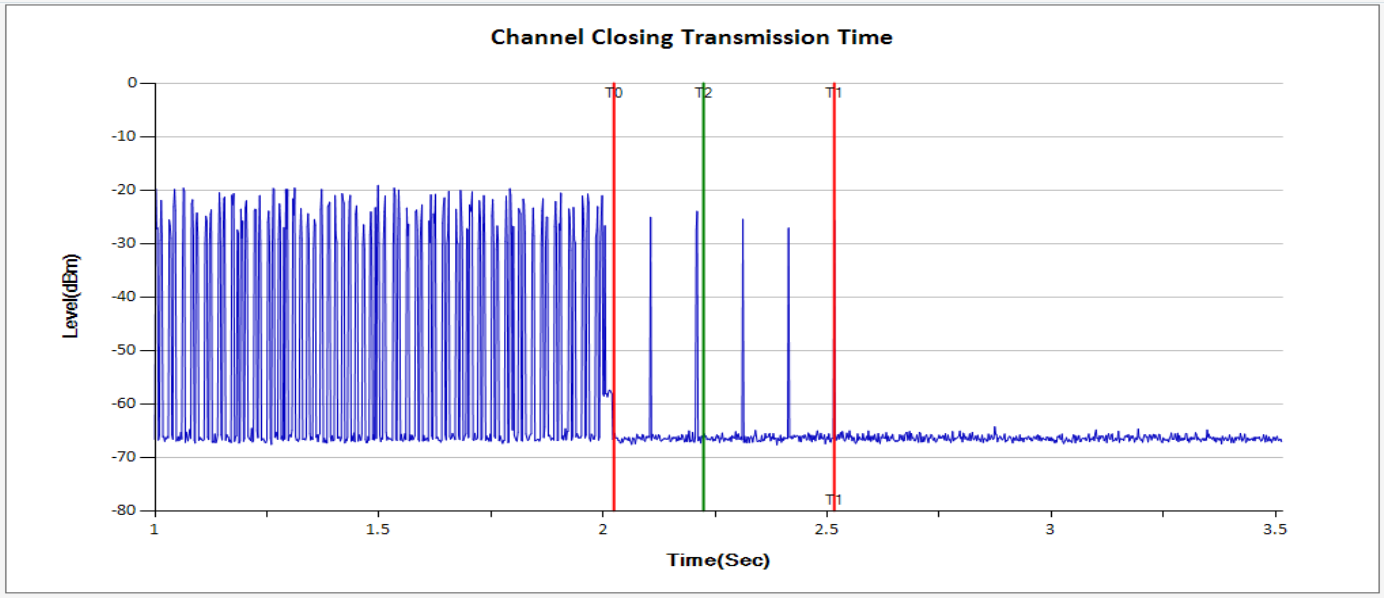
WLAN Payload



Duty Cycle: 17.12286 %

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

Radar Type 1 Channel Move and Closing Transmission Time - 1

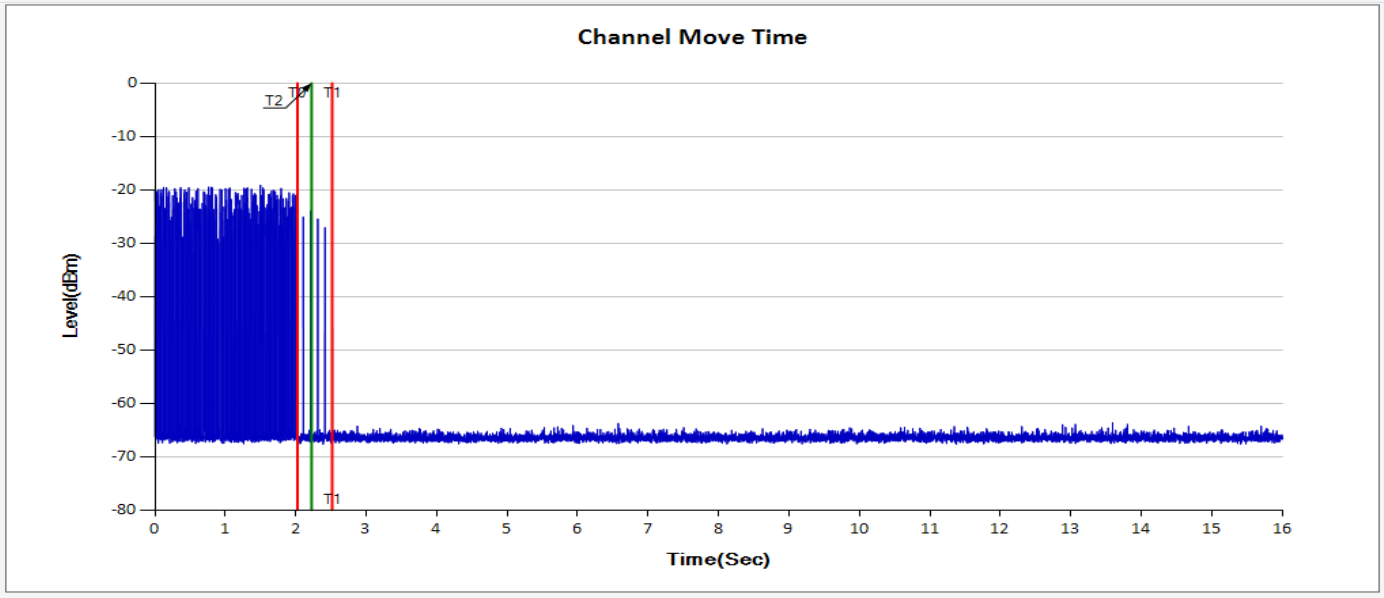


T0: 2.02428 Sec(Radar Injection)
T1: 2.516 Sec(Eut Move Time)
T2: 2.22428 Sec(200ms Interval)

Channel Move Time: 0.492 Sec

Channel Closing Transmission Time: 0.004 Sec

Radar Type 1 Channel Move and Closing Transmission Time - 2



T0: 2.02428 Sec(Radar Injection)
T1: 2.516 Sec(Eut Move Time)
T2: 2.22428 Sec(200ms Interval)

Channel Move Time: 0.492 Sec

Channel Closing Transmission Time: 0.004 Sec

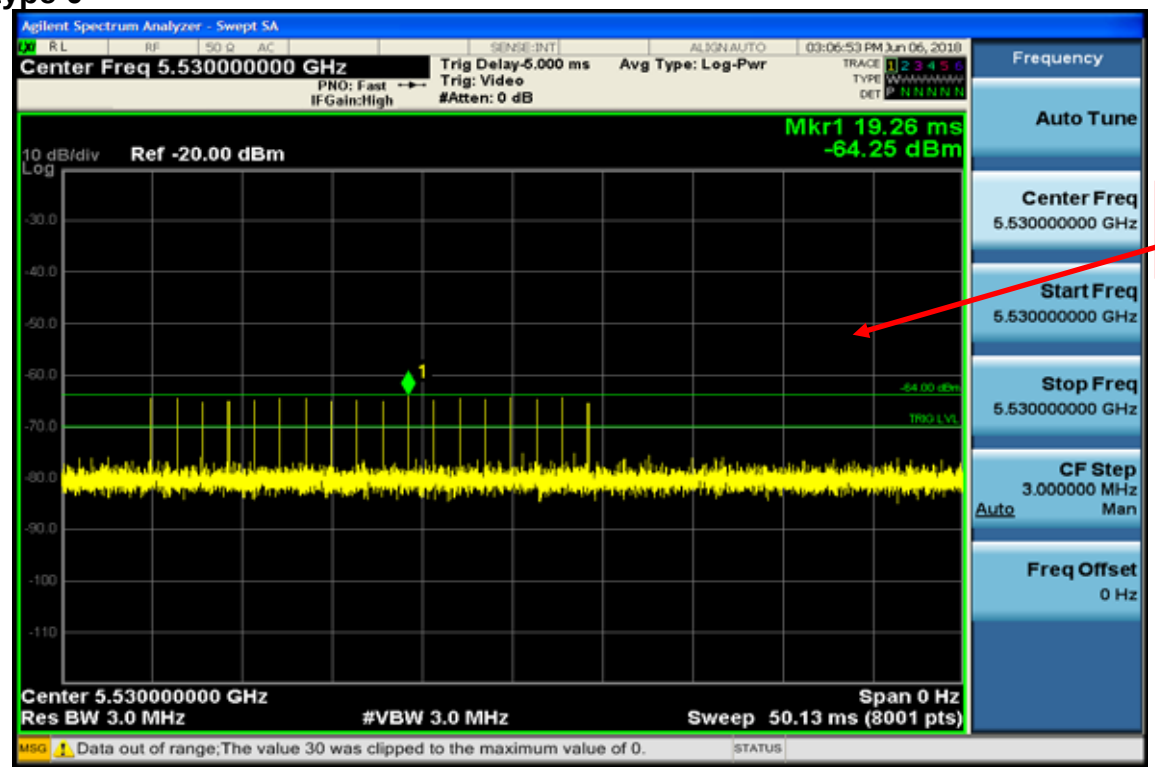
Verdict: *Note: narrowing the sweep time as the good engineering process for the verification of transmission closing in 200ms*

Non-occupancy Period (without radar detection)

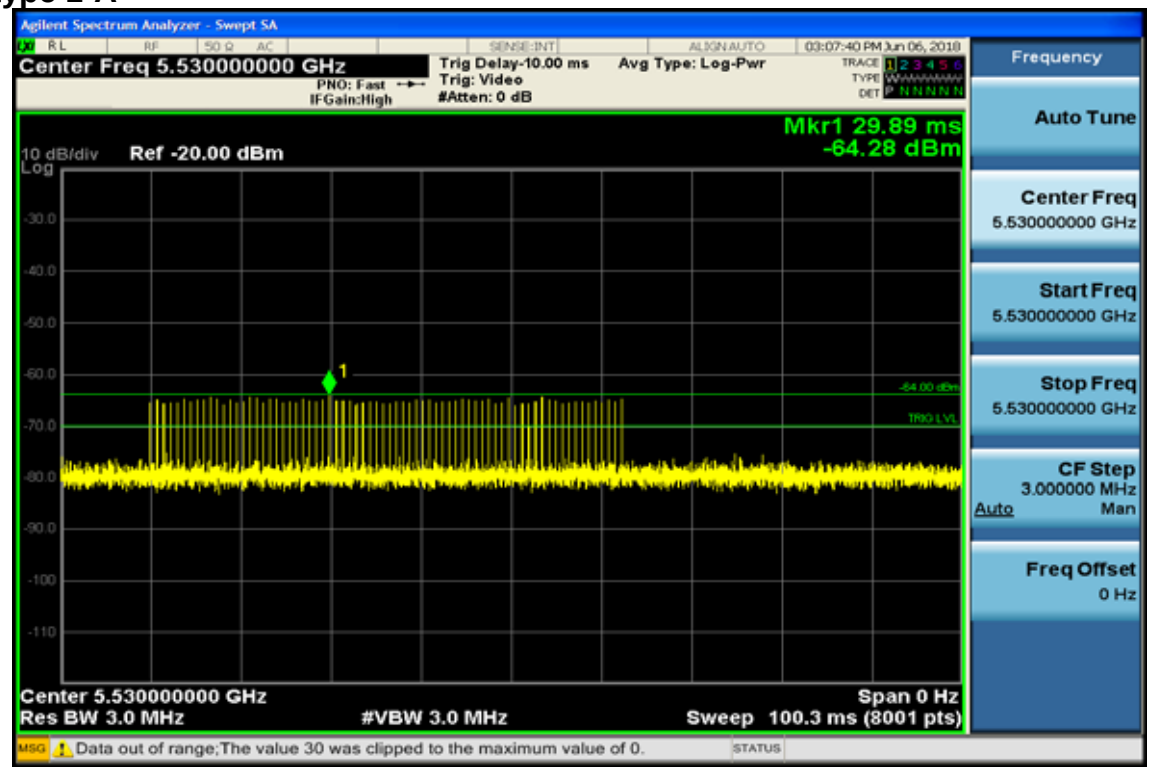
Verdict:

To verify whether channel is unavailable to be operated in 30 minutes.
1.8ks = 1800s = 1800 s/min /60 = 30minute

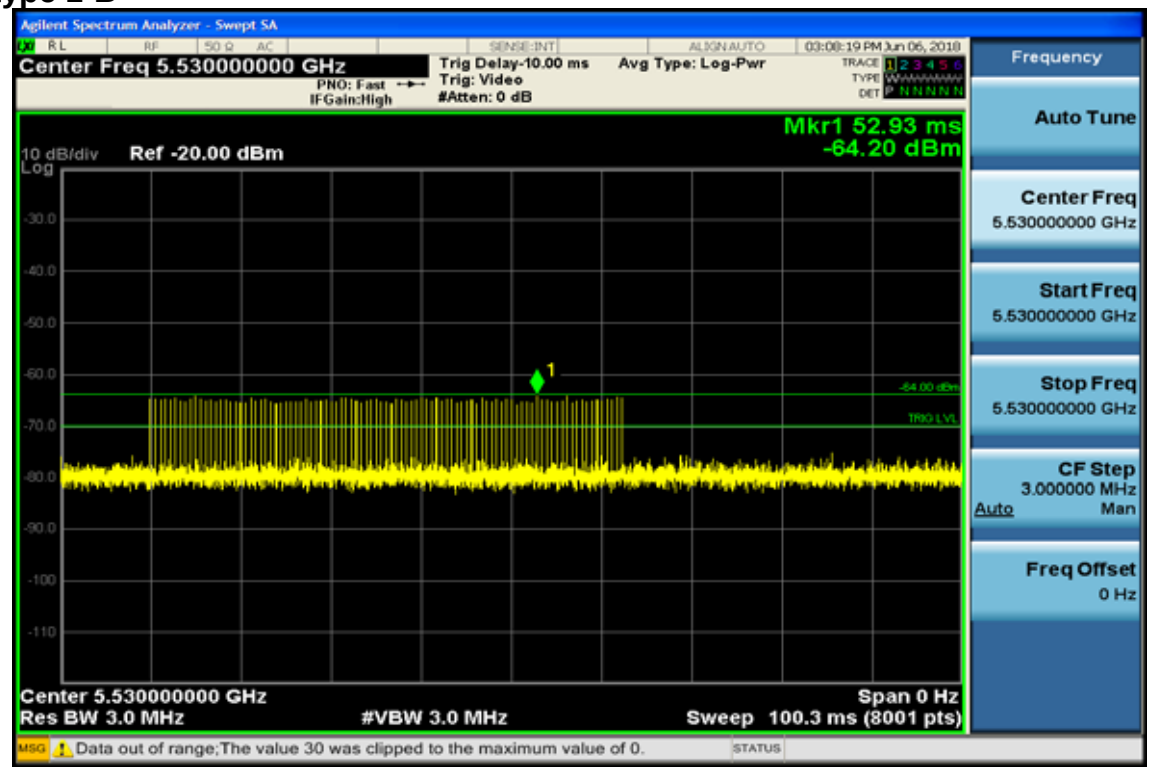
5530
Calibration plots for each of the required radar waveforms
Radar type 0



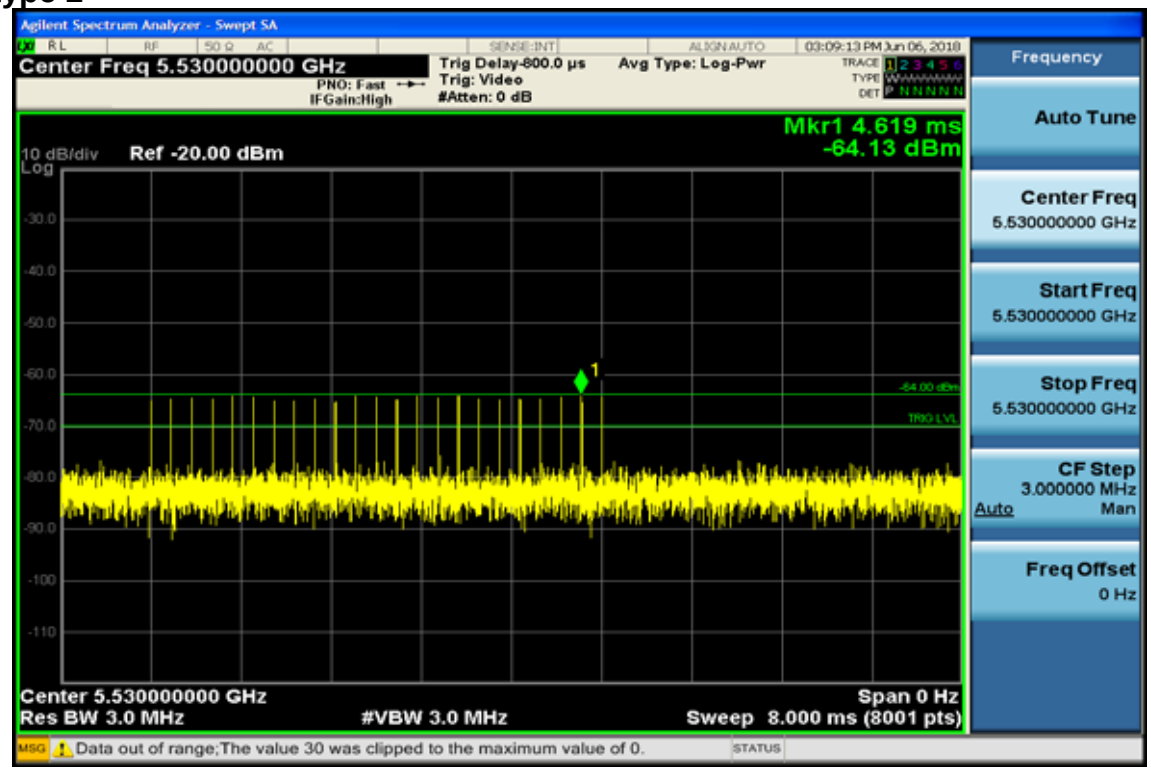
Radar type 1-A



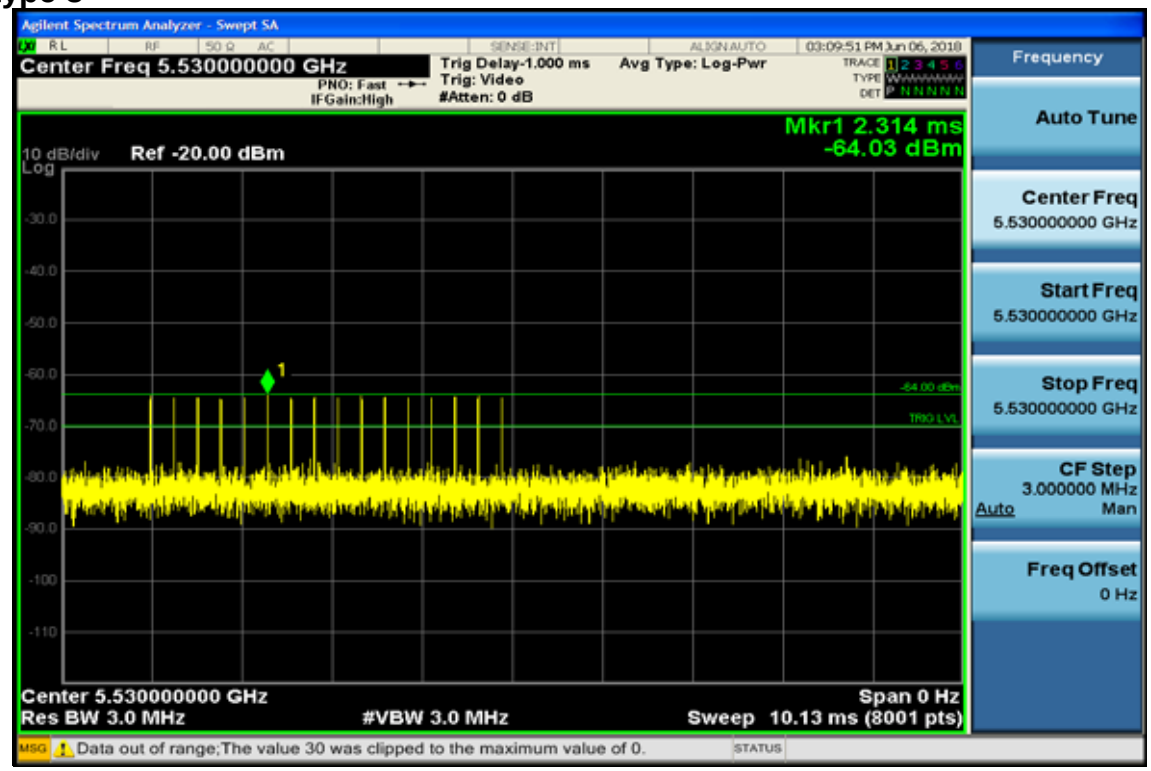
Radar type 1-B



Radar type 2



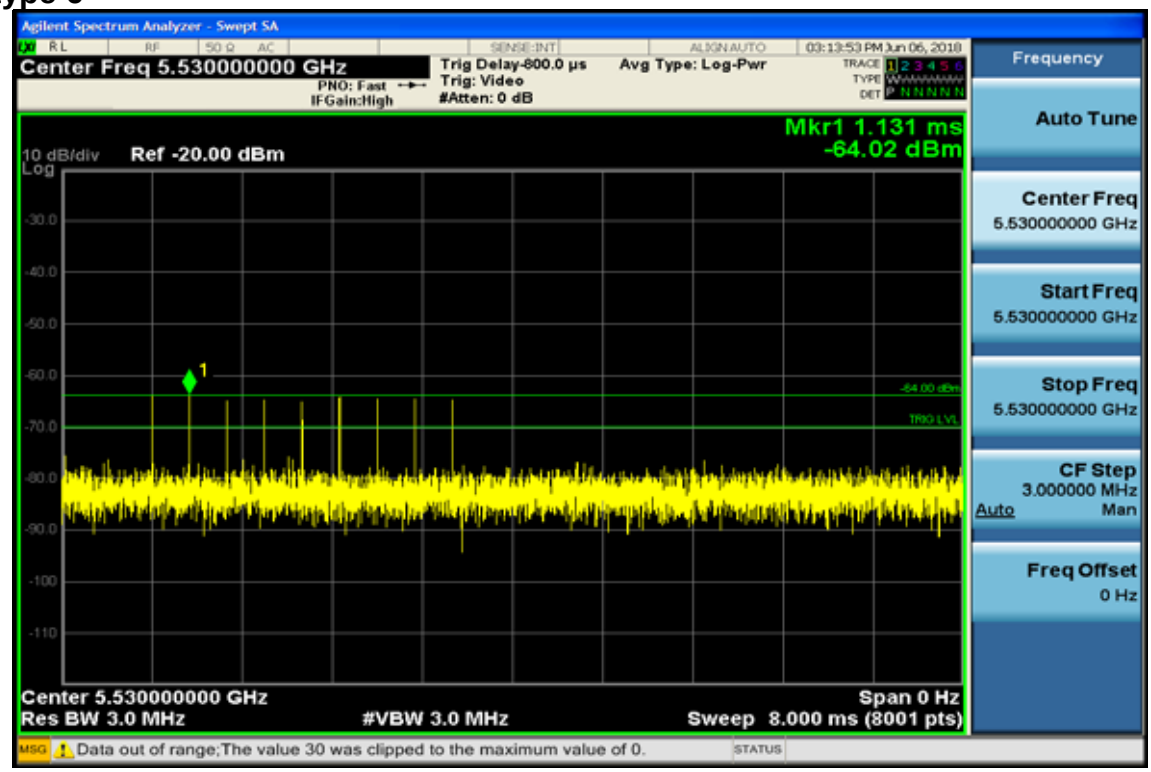
Radar type 3



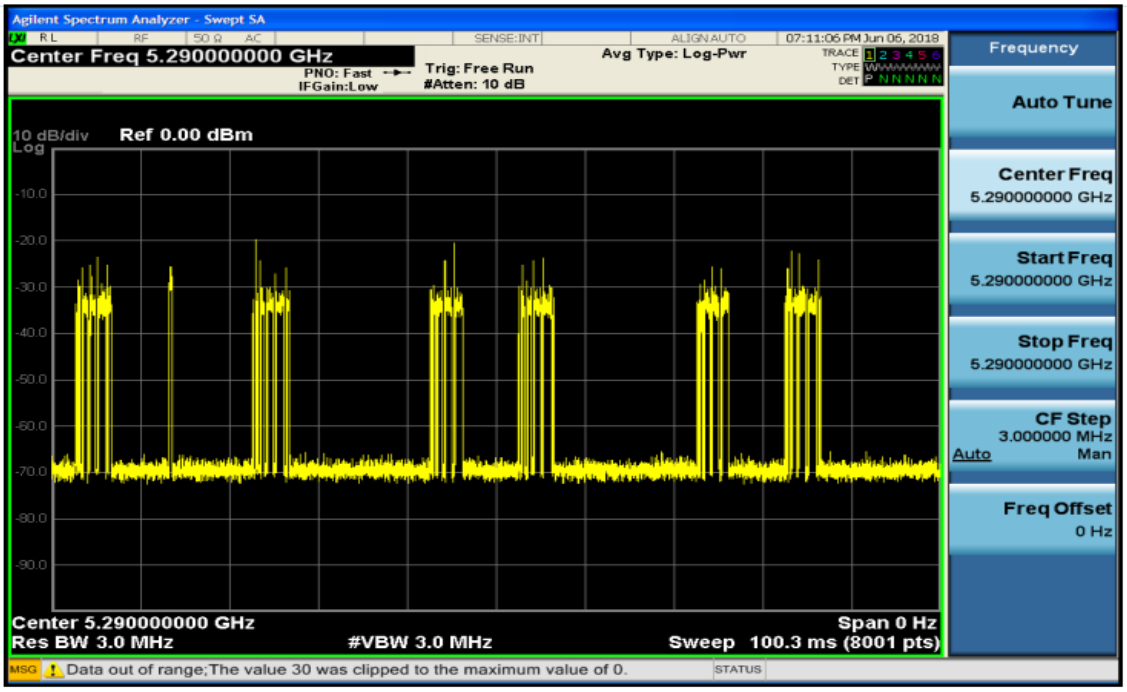
Radar type 4

Radar type 5

Radar type 6



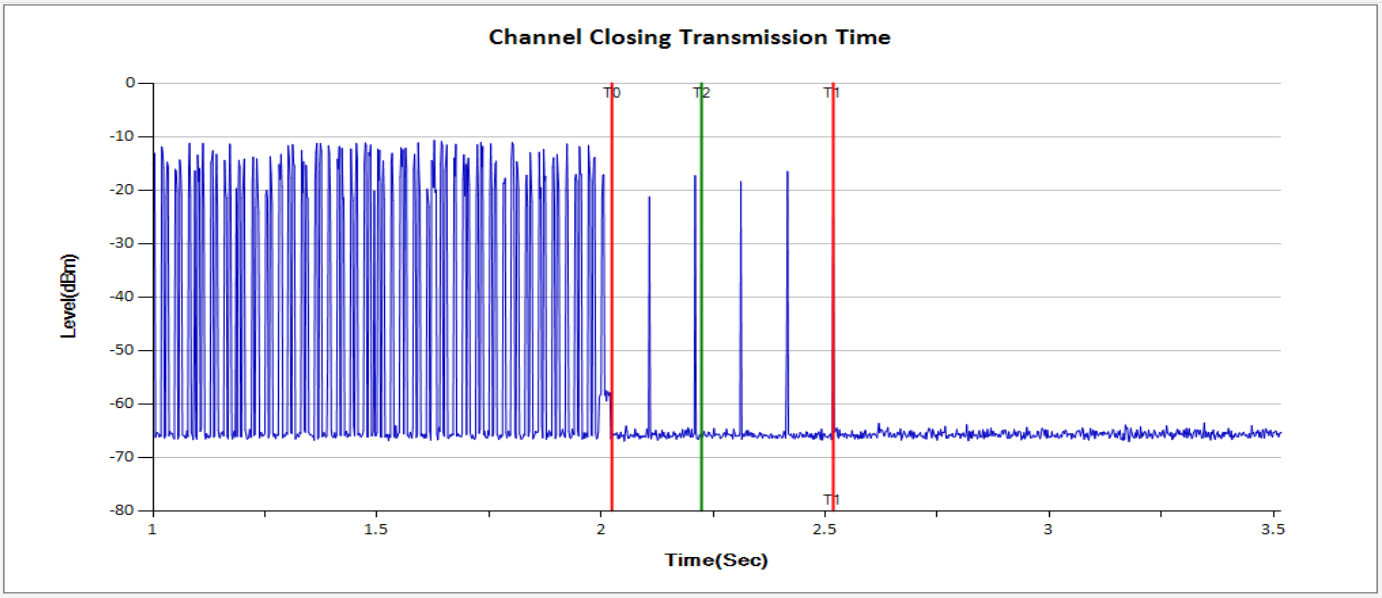
WLAN Payload



Duty Cycle: 17.12286 %

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

Radar Type 1 Channel Move and Closing Transmission Time - 1

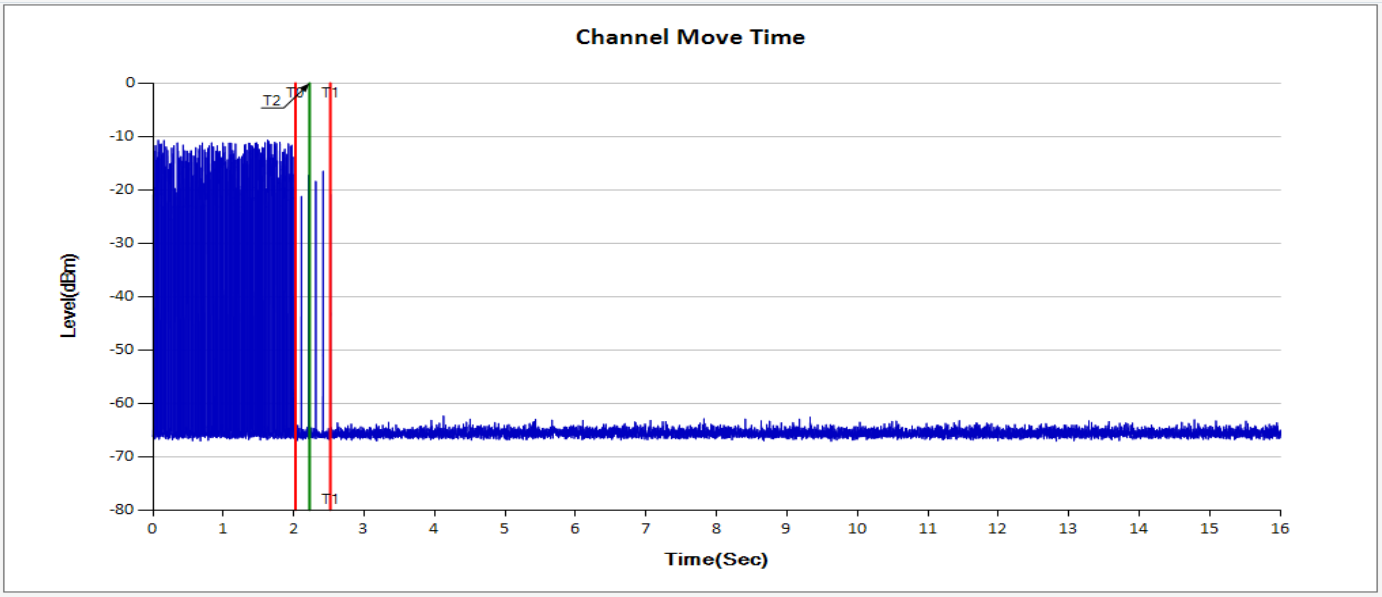


T0: 2.02428 Sec(Radar Injection)
T1: 2.518 Sec(Eut Move Time)
T2: 2.22428 Sec(200ms Interval)

Channel Move Time: 0.494 Sec

Channel Closing Transmission Time: 0.004 Sec

Radar Type 1 Channel Move and Closing Transmission Time - 2



T0: 2.02428 Sec(Radar Injection)
T1: 2.518 Sec(Eut Move Time)
T2: 2.22428 Sec(200ms Interval)

Channel Move Time: 0.494 Sec

Channel Closing Transmission Time: 0.004 Sec

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