

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

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

OF

Product Name:	Vehicle Mount Computer
Brand Name:	Honeywell
Marketing Name:	Thor VM3
Model No.:	VM3WWANUS
Model Difference:	N/A
FCC ID:	HD5-VM3WWANA
Report No.:	ER/2015/20078
Issue Date:	Apr. 07, 2015
FCC Rule Part:	§15.407
Prepared for:	Honeywell International Inc., Honeywell Scanning and Mobility 9680 Old Bailes Road, Fort Mill, SC 29707, USA
Prepared by:	SGS Taiwan Ltd. Electronics & Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803



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VERIFICATION OF COMPLIANCE

Applicant: Honeywell International Inc.,
Honeywell Scanning and Mobility
9680 Old Bailes Road, Fort Mill, SC 29707, USA

Product Name: Vehicle Mount Computer

Brand Name: Honeywell

Marketing Name: Thor VM3

Model No.: VM3WWANUS

Model Difference: N/A

FCC ID: HD5-VM3WWANA

File Number: ER/2015/20078

Date of test: Feb. 04, 2015 ~ Apr. 07, 2015

Date of EUT Received: Feb. 04, 2015

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.

Test By:**Date:**

Apr. 07, 2015

*Marcus Tseng / Engineer***Prepared By:****Date:**

Apr. 07, 2015

*Karen Huang / Clerk***Approved By:****Date:**

Apr. 07, 2015

Jim Chang / Supervisor

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Revision History

Report Number	Revision	Description	Issue Date
ER/2015/20078	Rev.00	Initial creation of document	Apr. 07, 2015

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1. GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	Vehicle Mount Computer	
Brand Name:	Honeywell	
Marketing Name:	Thor VM3	
Model No.:	VM3WWANUS	
Model Difference:	N/A	
Product SW/HW version:	(a)Win7: 99.01.00.0002 (b)Win8: 99.01.00.0004 / ALXH48	
Radio SW/HW version:	10.0.0.27450 / V.1	
Test SW Version:	10.0.0 27450	
Power Supply:	7.3Vdc from Rechargeable Li-ion Battery or 15V from AC/DC Adapter	
	Battery:	Model No.: L3-52301624-R / OVT270L1R00 / 50121692-001, Supplier: TOTEX
	Adapter :	Model No.: GT-81081-6015-T3, Supplier: GlobTek, Inc.

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WLAN 5GHz:

Wi-Fi	Frequency Range	Channels	Rated Power (Avg.)	Modulation Technology
11a	5150~5250	4	15.14dBm	OFDM
	5250~5350	4	14.60dBm	
	5470~5725	8	15.32dBm	
	5725~5850	5	14.04dBm	
11n	HT20 5150~5250	4	(MIMO Chain 0): 10.57dBm (MIMO Chain 1): 10.44dBm (MIMO Chain 0+1): 13.52dBm	OFDM
	HT20 5250~5350	4	(MIMO Chain 0): 13.57dBm (MIMO Chain 1): 13.54dBm (MIMO Chain 0+1): 16.57dBm	
	HT20 5470~5725	11	(MIMO Chain 0): 15.15dBm (MIMO Chain 1): 16.07dBm (MIMO Chain 0+1): 18.64dBm	
	HT20 5725~5850	5	(MIMO Chain 0): 14.27dBm (MIMO Chain 1): 13.74dBm (MIMO Chain 0+1): 17.02dBm	

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Wi-Fi	Frequency Range	Channels	Rated Power (Avg.)	Modulation Technology	
11n	HT40 5150-5250	2	(MIMO Chain 0): 11.03dBm (MIMO Chain 1): 11.30dBm (MIMO Chain 0+1): 14.17dBm	OFDM	
	HT40 5250-5350	2	(MIMO Chain 0): 11.17dBm (MIMO Chain 1): 11.48dBm (MIMO Chain 0+1): 14.34dBm		
	HT40 5470-5725	5	(MIMO Chain 0): 15.24dBm (MIMO Chain 1): 14.41dBm (MIMO Chain 0+1): 17.86dBm		
	HT40 5725-5850	2	(MIMO Chain 0): 14.27dBm (MIMO Chain 1): 13.15dBm (MIMO Chain 0+1): 16.76dBm		
Antenna Designation		<p>Internal, PIFA Antenna: Part No.: FIT-VM3-ANT-21Y, FIT-VM3-ANT-028 5GHz Gain: 5.5dBi</p> <p>External, Dipole Antenna: 1. Model No.: WTS 2450 5GHz Gain: 2.6dBi</p> <p>2. Model No.: R380500314 5GHz Gain: 5.0dBi</p>			
Modulation type		CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM			
Transition Rate:		802.11 a: 6/9/12/18/24/36/48/54 Mbps 802.11 n_20MHz: 6.5 – 144Mbps 802.11 n_40MHz: 13.5 – 300Mbps			

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1.2 Product Feature of Equipment Under Test

The equipment under Test (Hereafter Called: EUT) is Vehicle Mount Computer supporting, GSM / WCDMA / CDMA / LTE, Wi-Fi 802.11abgn, Bluetooth with GPS features, and below is details of information.

Product Feature	
Product Name:	Vehicle Mount Computer
Brand Name:	Honeywell
Marketing Name:	Thor VM3
Model No.:	VM3WWANUS
Model Difference:	N/A
FCC ID:	HD5-VM3WWANA
GSM Operating Band(s)	GSM 850/1900MHz
GPRS / EGPRS Multi Slot Class	GPRS Class 10 / Class 12
CDMA / EVDO	BC0 / BC1 / BC10
WCDMA Operating Band(s)	FDD Band II / IV / V
WCDMA Rel. Version	Rel.8
LTE Operating Band(s)	FCC Band 2 / 4 / 5 / 13 / 17 / 25
LTE Rel. Version	Rel.9
Wi-Fi Specification	802.11a/b/g/n
Bluetooth Version	V4.0 dual mode

Note: The above EUT information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

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1.3 Test Methodology of Applied Standards

FCC Part 15, Subpart E §15.407

FCC KDB 905462

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

1.4 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan. (TAF code 0513)

FCC Registration Numbers are: 990257

Canada Registration Number: 4620A-4.

1.5 Special Accessories

There are no special accessories used while test was conducted.

1.6 Equipment Modifications

There was no modification incorporated into the EUT.

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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.

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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).

U-NII devices operating in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection. According to RSS 210 A9.3), 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.

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(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.

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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 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

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.

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

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP \geq 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.</p> <p>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.</p> <p>Note 3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.</p>	

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 move</i> (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 $\left(\left(\frac{1}{360} \right) \cdot \left(\frac{19 \cdot 10^6}{\text{PRI}_{\mu\text{sec}}} \right) \right)$	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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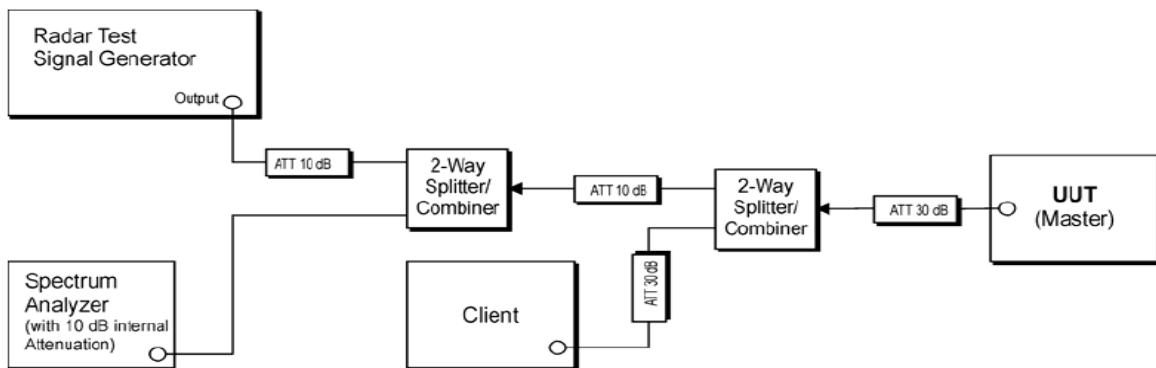
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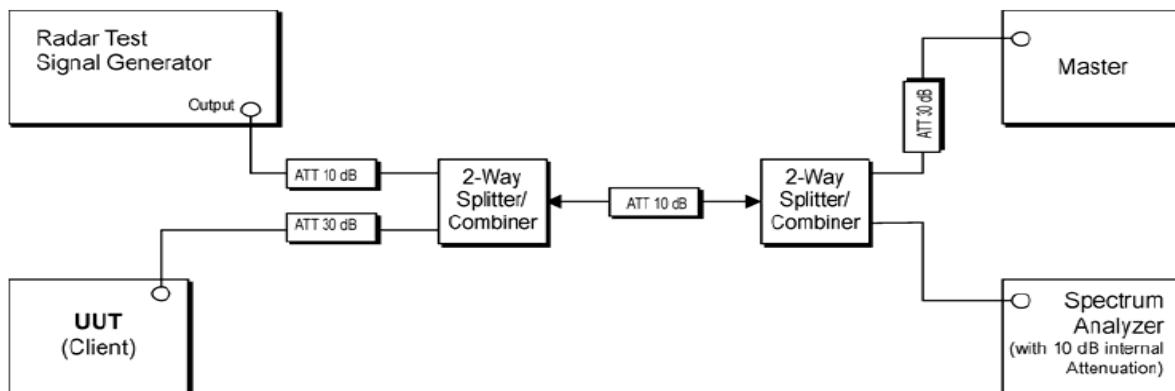
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4.2.2. Test Setup

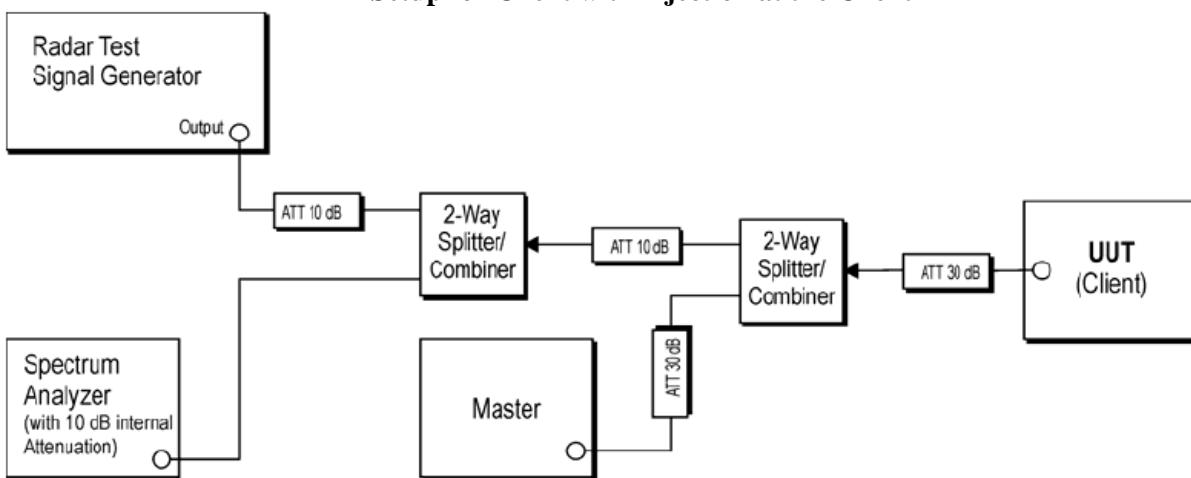
Setup for Master with injection at the Master



Setup for Client with injection at the Master



Setup for Client with injection at the Client



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4.2.3. Test Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Signal Generator	Agilent	E4438C	MY45093613	08/06/2014	08/05/2015
Spectrum Analyzer	Agilent	E4446A	MY51100003	05/19/2014	05/18/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Power Splitter	Mini-Circuits	ZN2PD-9G-S+	N/A	01/02/2015	01/01/2016
Power Splitter	Mini-Circuits	ZN2PD-9G-S+	N/A	01/02/2015	01/01/2016
Attenuator	Agilent	8495B	3308A22470	01/02/2015	01/01/2016
Attenuator	HP	8494B	2812A170605	01/02/2015	01/01/2016

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 a gain of -0.34dBi in the 5GHz Band.

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 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= LDK102061

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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).

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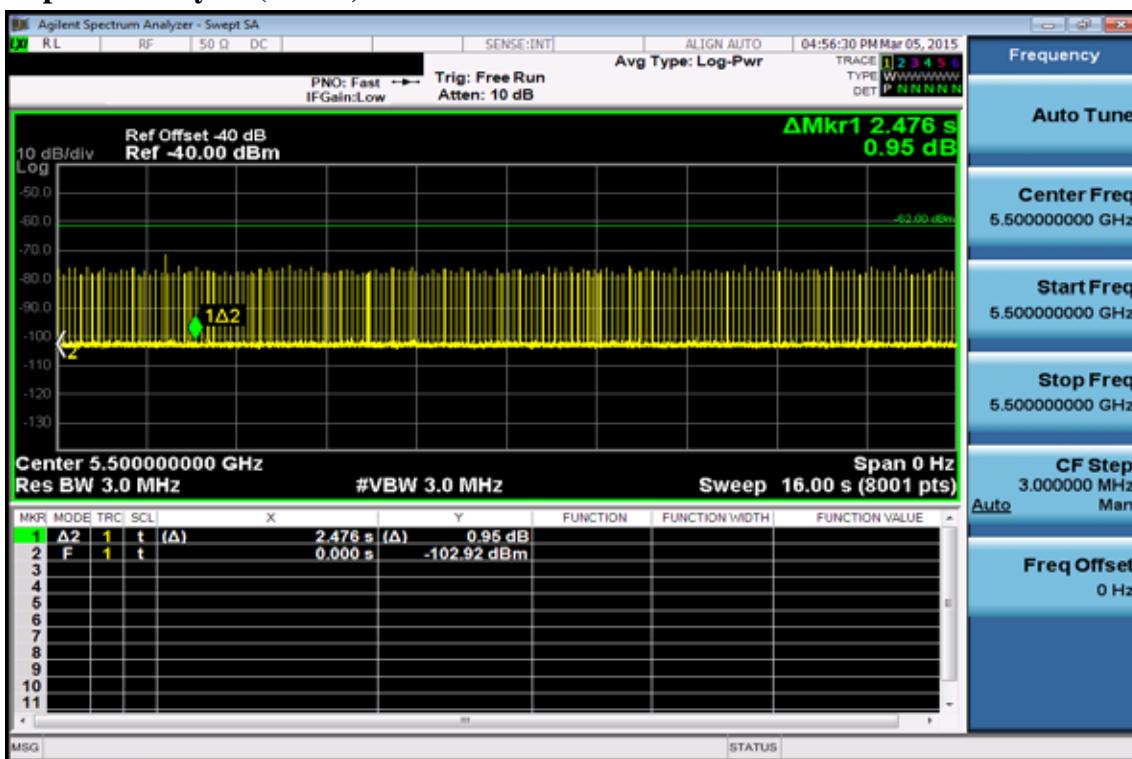
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4.2.5. Test results

The time of power-on cycle (2.476s):



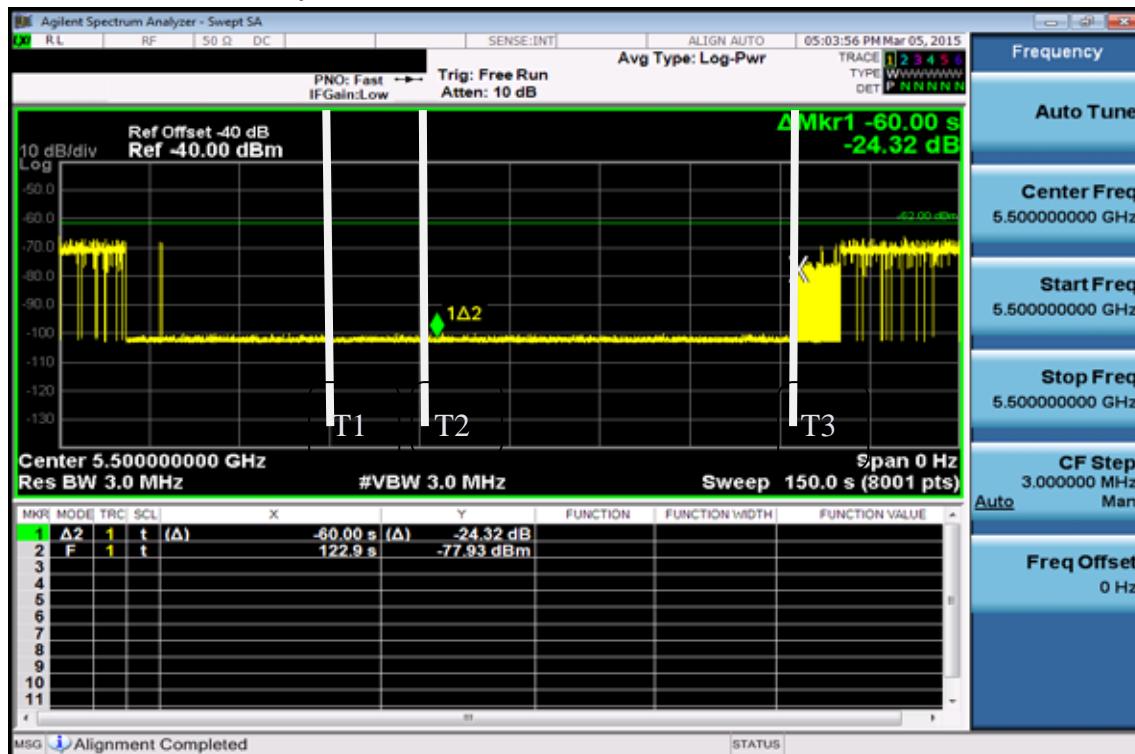
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The time of channel availability check (60s)



Where T1~T2 indicates the time to power up, where T2~T3 represents the channel availability time.

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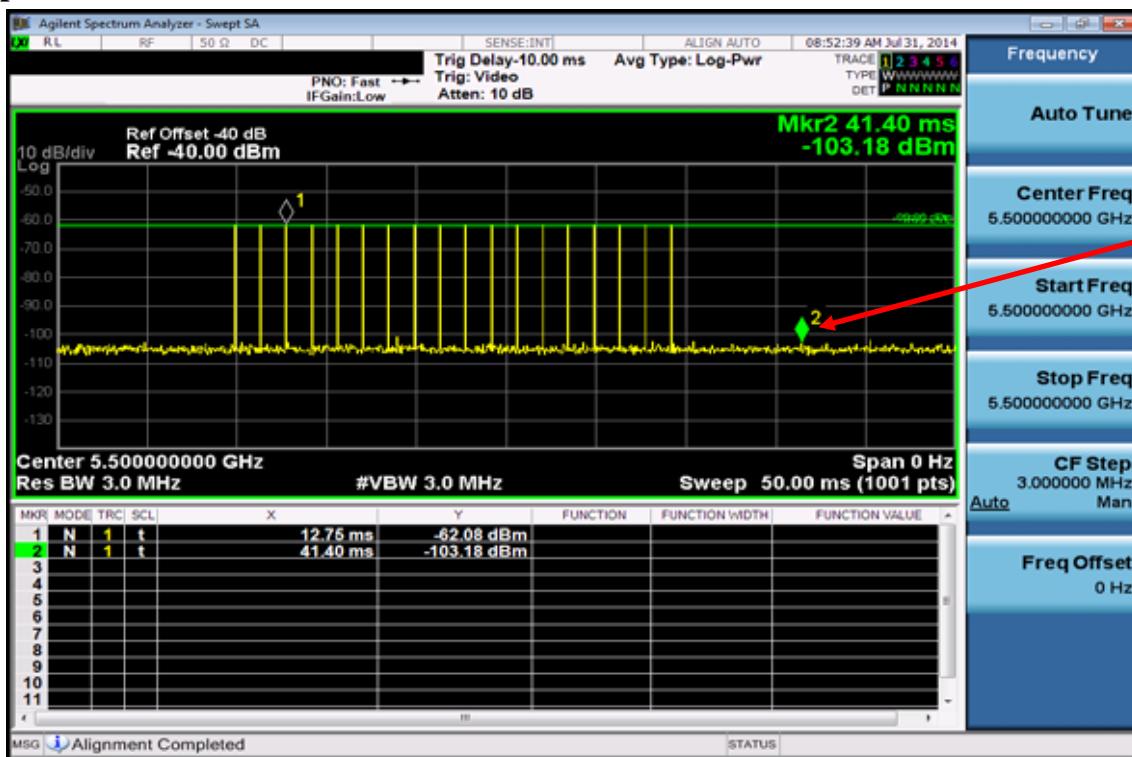
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Calibration plots for each of the required radar waveforms

Radar type 1



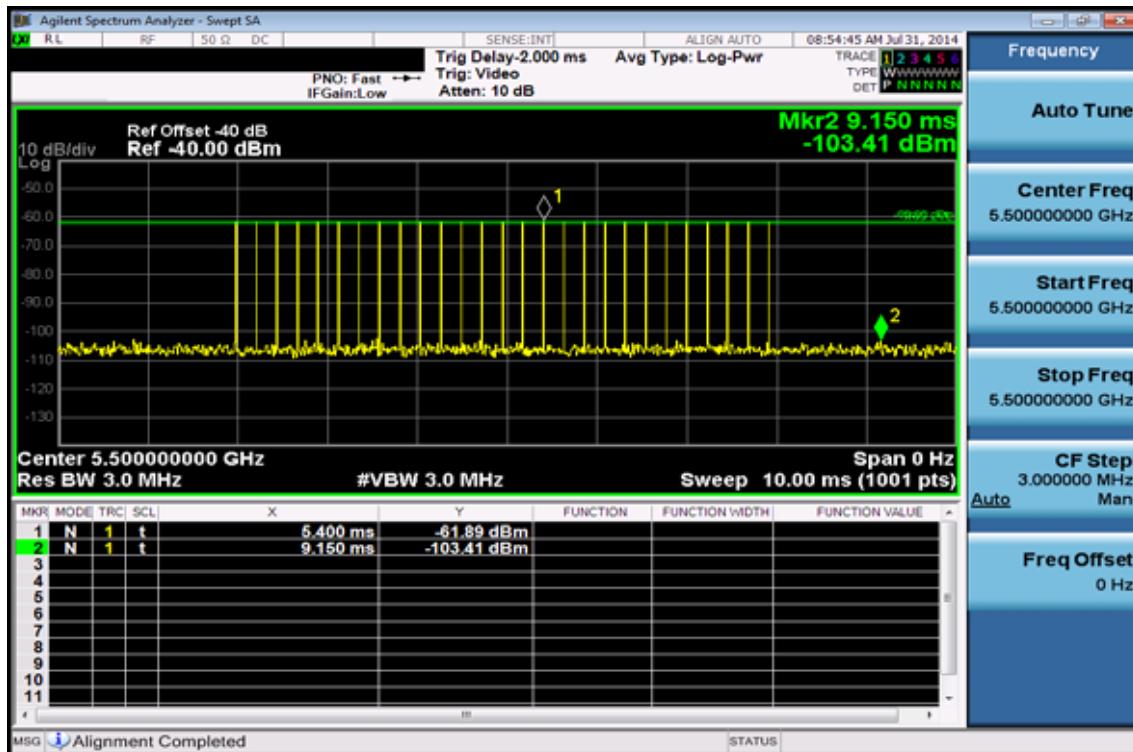
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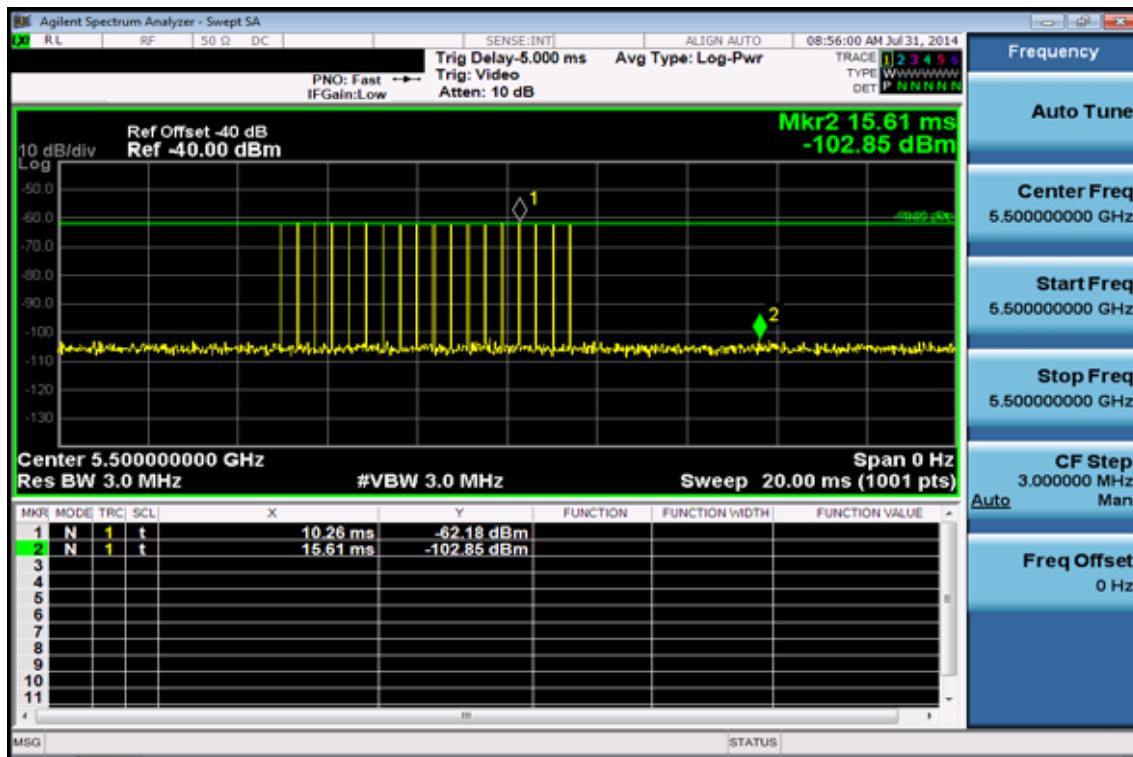
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Radar type 2



Radar type 3



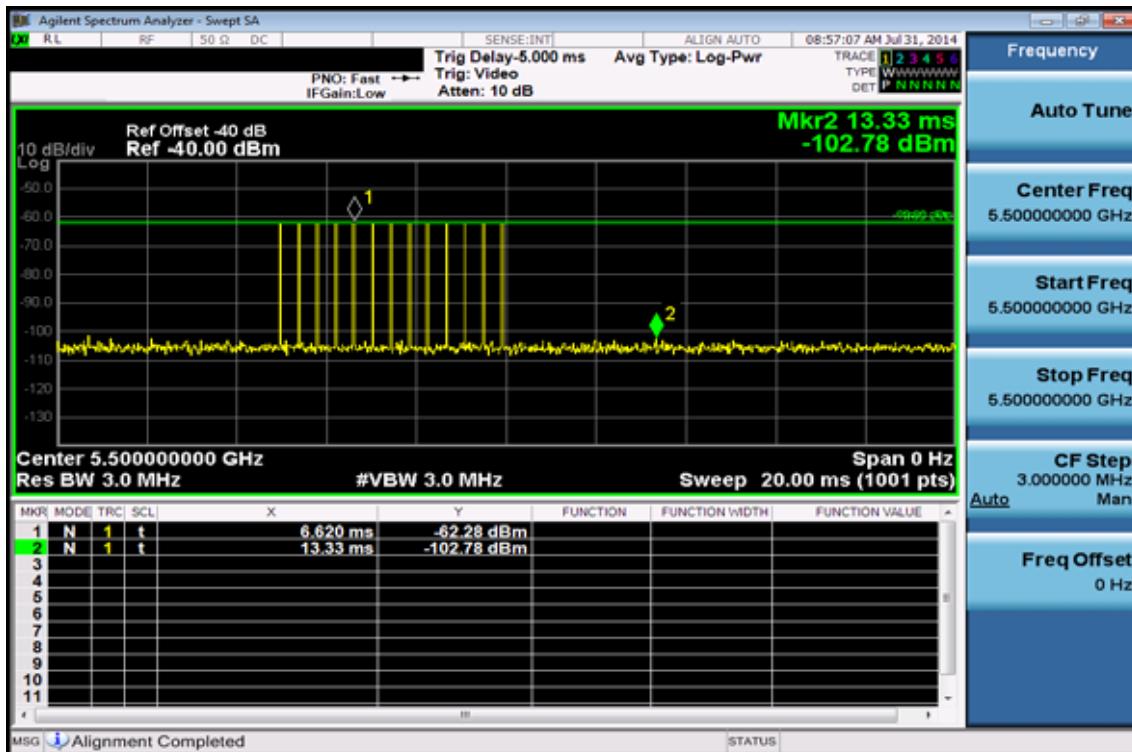
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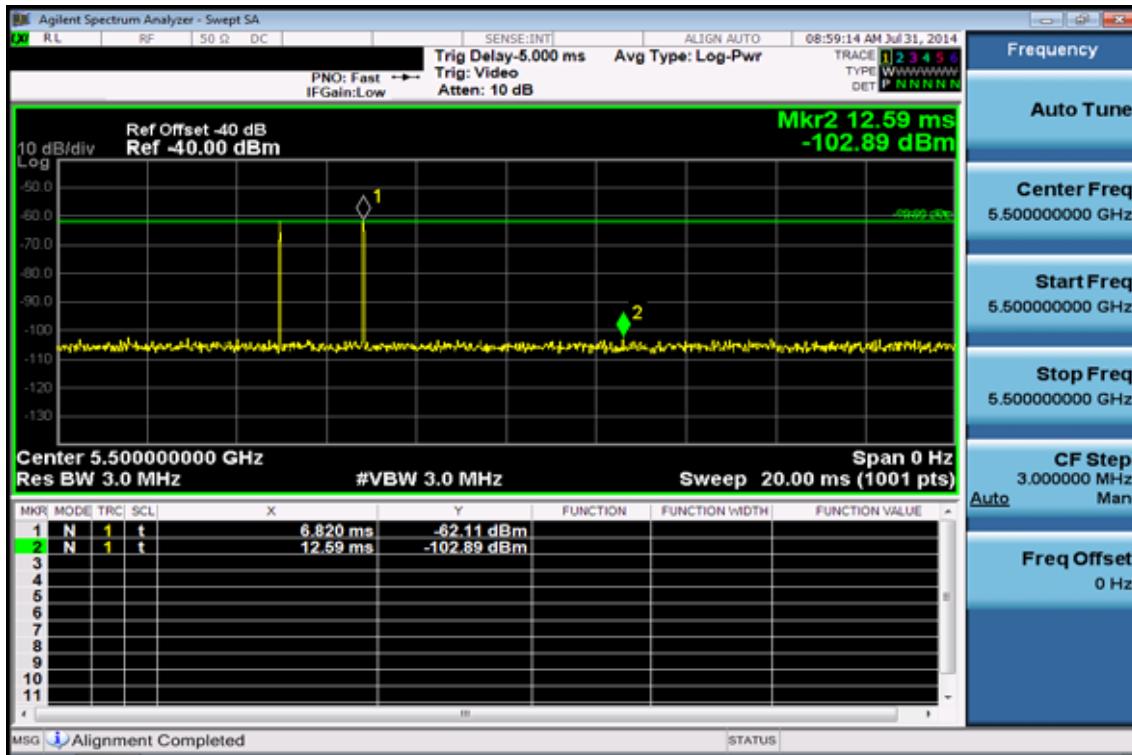
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Radar type 4



Radar type 5



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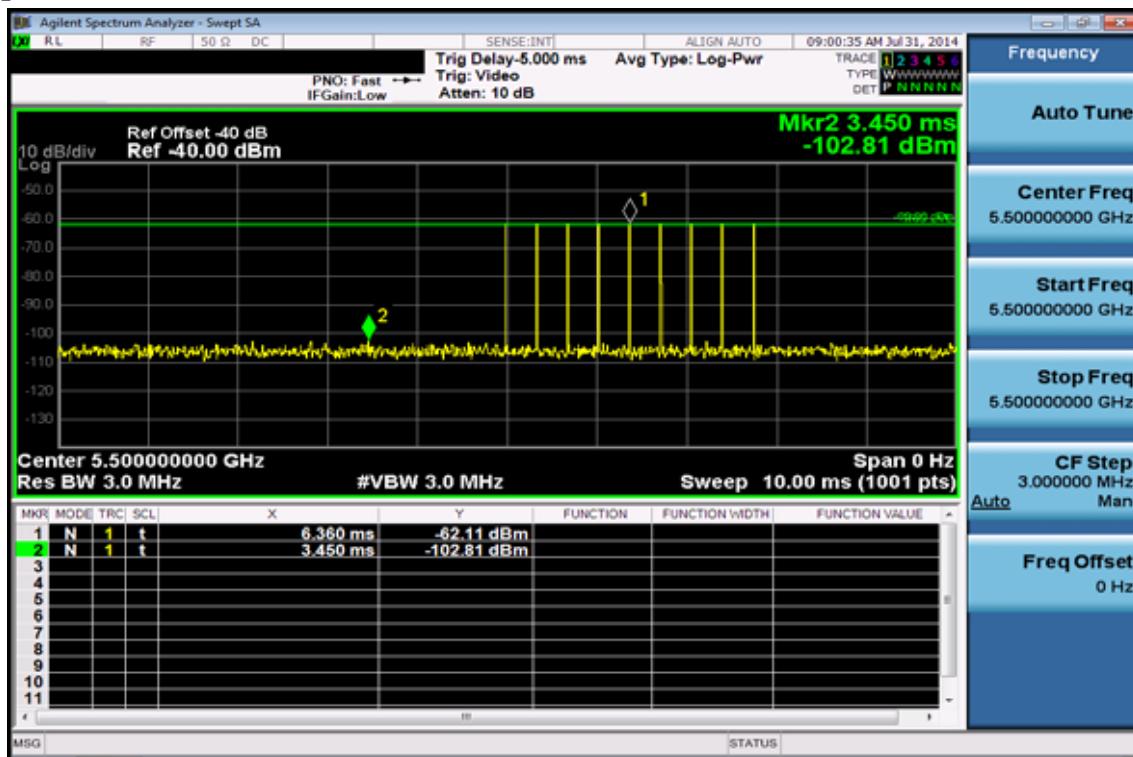
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Radar type 6



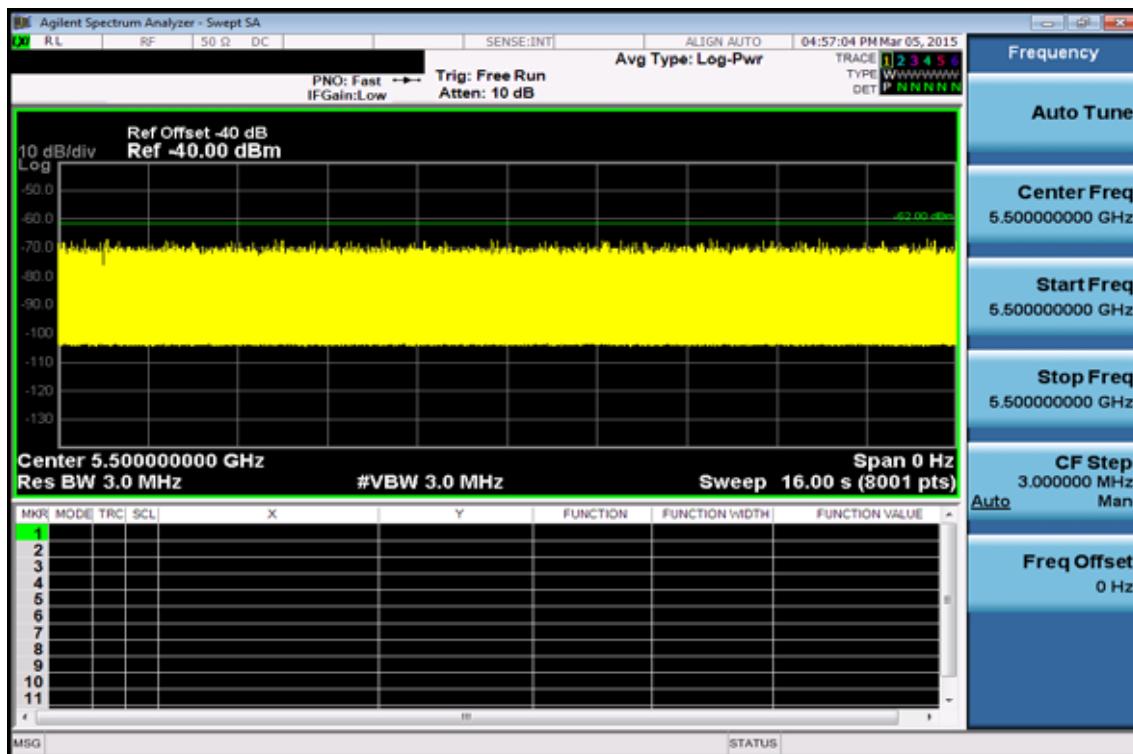
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WLAN traffic



Radar Type 1 Channel Move Time



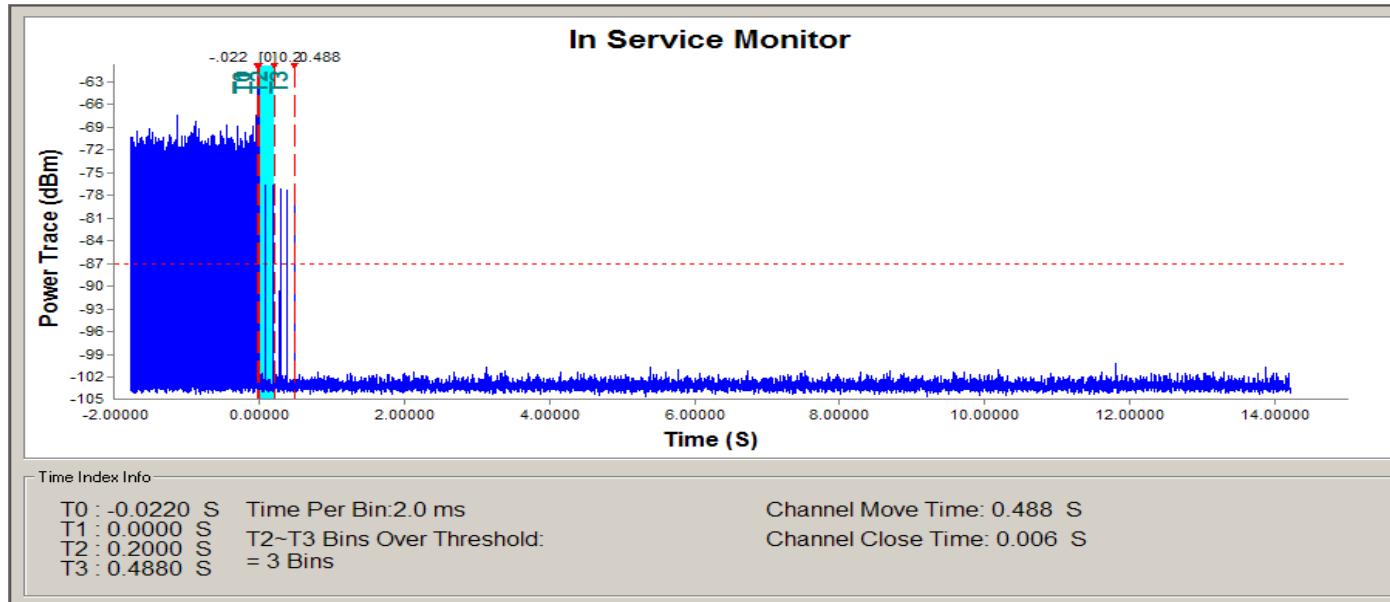
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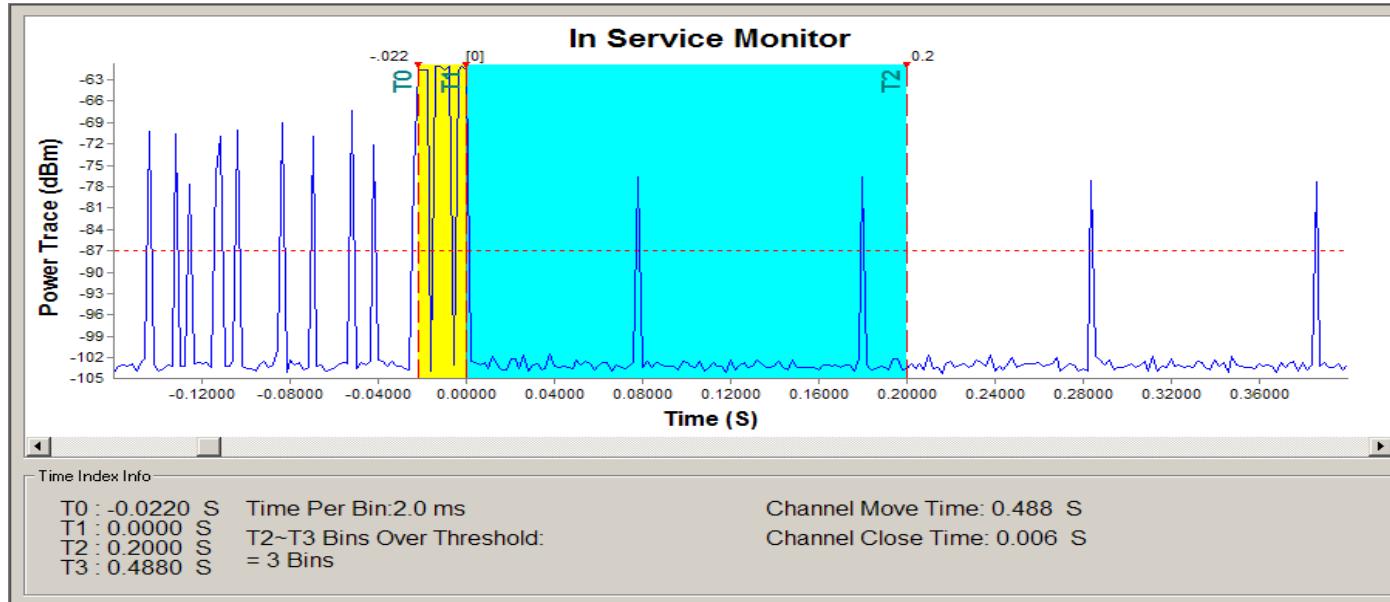
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Radar Type 1 Channel Closing Transmission Time - 1



Radar Type 1 Channel Closing Transmission Time - 2



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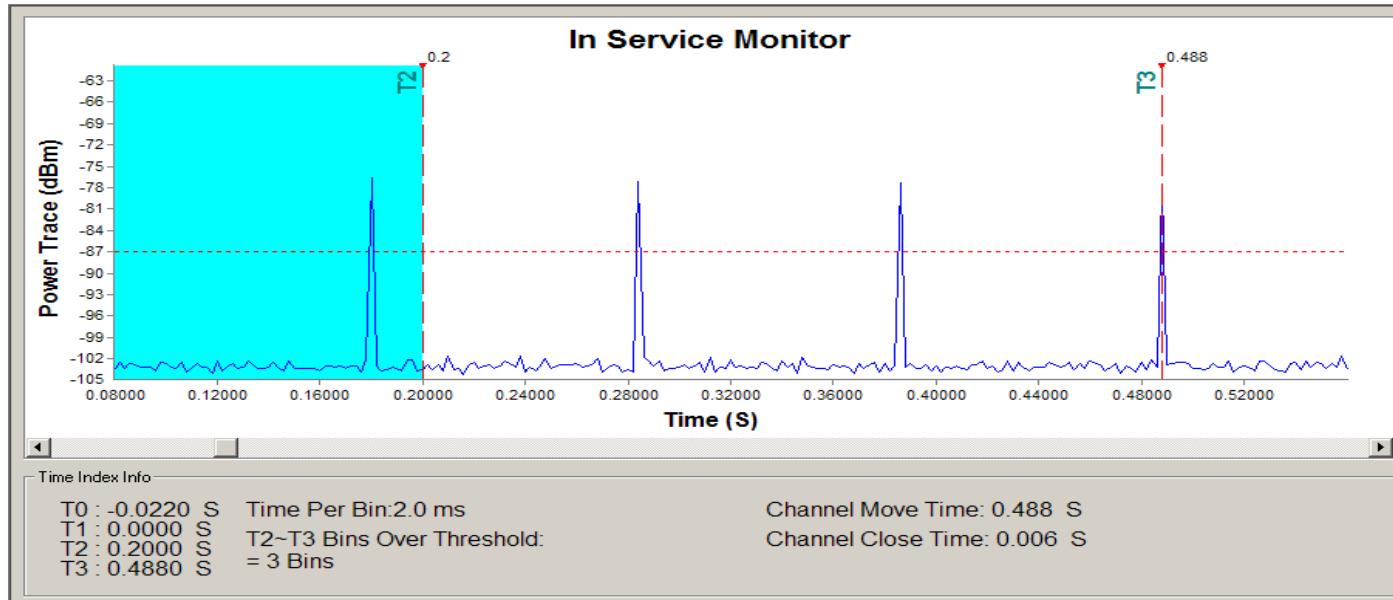
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Radar Type 1 Channel Closing Transmission Time - 3

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Radar Type 1 Channel Closing Transmission Time - 4



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.

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

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