DFS PORTION of FCC 47 CFR PART 15 SUBPART E
DFS PORTION of INDUSTRY CANADA RSS-247 ISSUE 2

CERTIFICATION TEST REPORT

FOR

5 GHz FIXED OUTDOOR WIRELESS TRANSCEIVER

MODEL NUMBER: PTP 450b (MID-GAIN)

FCC ID: Z8H89FT0032
IC: 109W-0032

REPORT NUMBER: 12338572-E2V1

ISSUE DATE: JULY 5, 2018

Prepared for
CAMBIUM NETWORKS
3800 GOLF ROAD
ROLLING MEADOWS, IL 60008-4023, U.S.A.

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	07/05/18	Initial Issue	Henry Lau

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: CAMBIUM NETWORKS
3800 GOLF ROAD
ROLLING MEADOWS, IL 60008-4023, U.S.A.

EUT DESCRIPTION: 5 GHz FIXED OUTDOOR WIRELESS TRANSCEIVER

MODEL: PTP 450b (MID-GAIN)

SERIAL NUMBER: 0a-00-3e-70-2a-9d

DATE TESTED: JUNE 19 to 20, 2018

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
DFS Portion of CFR 47 Part 15 Subpart E	Complies
DFS Portion of INDUSTRY CANADA RSS-247 Issue 2	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with the DFS portion of FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 06-96, FCC KDB 789033, KDB 905462 D02 and D03 and RSS-247 Issue 2.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty level has been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Time	± 0.02 %

The Uncertainty figure is valid to a confidence level of 95%.

5. DYNAMIC FREQUENCY SELECTION

5.1. OVERVIEW

5.1.1. LIMITS

INDUSTRY CANADA

IC RSS-247 is closely harmonized with FCC Part 15 DFS rules. The deviations are as follows:

RSS-247 Issue 2

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.

FCC

§15.407 (h), FCC KDB 905462 D02 “COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5250-5350 MHz AND 5470-5725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION” and KDB 905462 D03 “U-NII CLIENT DEVICES WITHOUT RADAR DETECTION CAPABILITY”.

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	Client **(without DFS)**	Client **(with DFS)**
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required	Yes

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar DFS	Client (without DFS)
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 all 20 MHz channel blocks and a null frequency between the bonded 20 MHz channel blocks.		

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

Maximum Transmit Power	Value (see notes)
E.I.R.P. ≥ 200 mill watt	-64 dBm
E.I.R.P. < 200 mill watt and power spectral density < 10 dBm/MHz	-62 dBm
E.I.R.P. < 200 mill watt that do not meet 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.
Note 3: E.I.R.P. 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	30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds (See Note 1)
Channel Closing Transmission Time	200 milliseconds + approx. 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 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (usec)	PRI (usec)	Pulses	Minimum Percentage of Successful Detection	Minimum 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: {(1/360) x (19 x 10^6 PRI_{usec})}	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 usec. With a minimum increment of 1 usec, 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.

Table 6 – Long Pulse Radar Test Signal

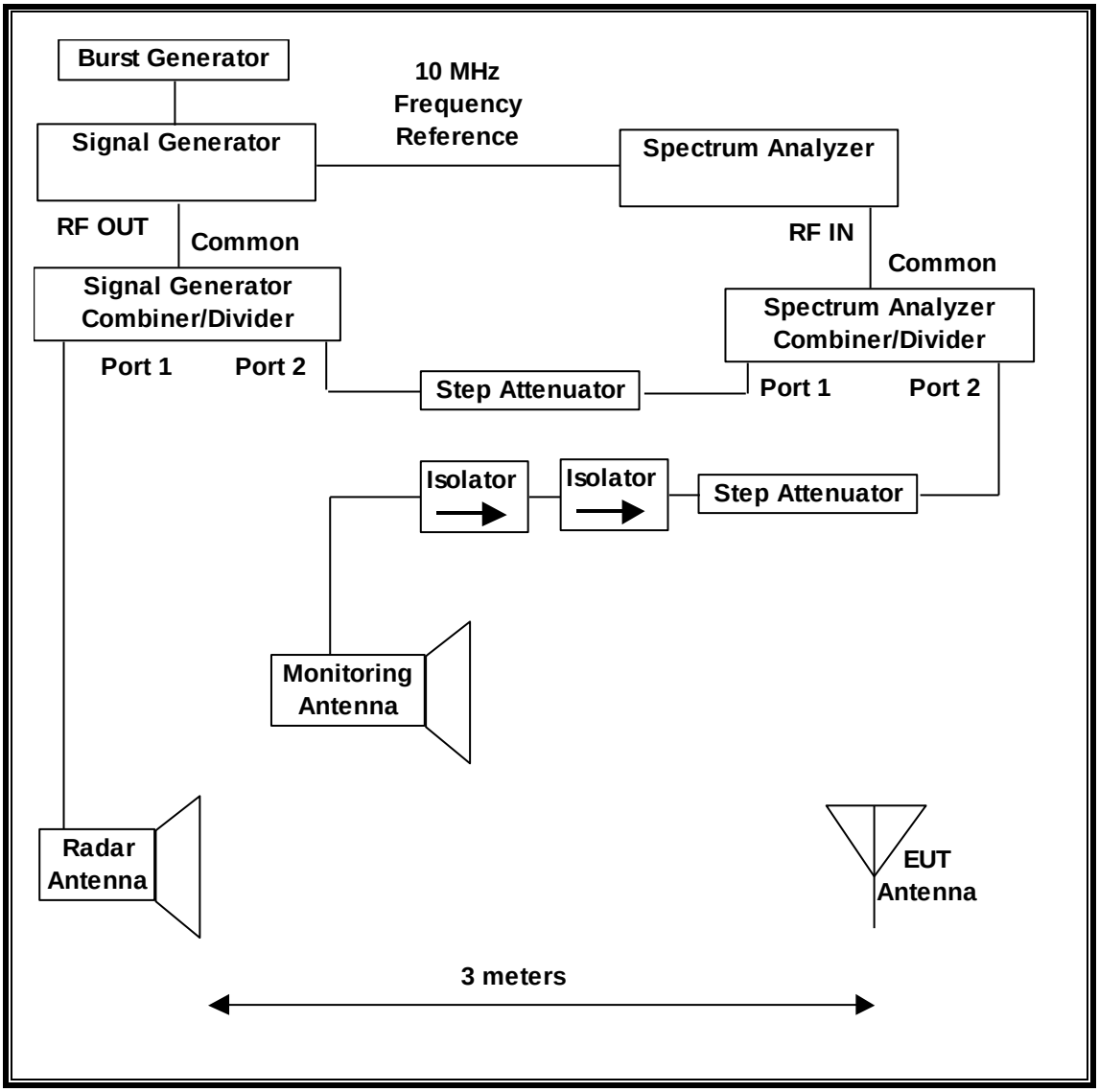
Radar Waveform Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 7 – Frequency Hopping Radar Test Signal

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

5.1.2. TEST AND MEASUREMENT SYSTEM

RADIATED METHOD SYSTEM BLOCK DIAGRAM



SYSTEM OVERVIEW

The short pulse and long pulse signal generating system utilizes the NTIA software. The Vector Signal Generator has been validated by the NTIA. The hopping signal generating system utilizes the CCS simulated hopping method and system, which has been validated by the DoD, FCC and NTIA. The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution.

The short pulse types 1, 2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time.

The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of KDB 905462 D02. The frequency of the signal generator is incremented in 1 MHz steps from F_L to F_H for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

The signal monitoring equipment consists of a spectrum analyzer. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

SYSTEM CALIBRATION

A 50-ohm load is connected in place of the spectrum analyzer, and the spectrum analyzer is connected to a horn antenna via a coaxial cable, with the reference level offset set to (horn antenna gain – coaxial cable loss). The signal generator is set to CW mode. The amplitude of the signal generator is adjusted to yield a level of –64 dBm as measured on the spectrum analyzer.

Without changing any of the instrument settings, the spectrum analyzer is reconnected to the Common port of the Spectrum Analyzer Combiner/Divider. The Reference Level Offset of the spectrum analyzer is adjusted so that the displayed amplitude of the signal is –64 dBm.

The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of –64 dBm and the spectrum analyzer will still indicate the level as received by the Master Device.

ADJUSTMENT OF DISPLAYED TRAFFIC LEVEL

A link is established between the Master and Slave and the distance between the units is adjusted as needed to provide a suitable received level at the Master and Slave devices. Traffic that meets or exceeds the minimum requirement is generated using iPerf traffic generator software and streamed from the Master to the Slave radio devices. The monitoring antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the DFS tests documented in this report:

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**T No.**	**Cal Due**
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	T459	06/30/18
Signal Generator, MXG X-Series RF Vector	Agilent	N5182B	T1134	04/23/19
Arbitrary Waveform Generator	Agilent / HP	33220A	T190	04/23/19

5.1.3. TEST AND MEASUREMENT SOFTWARE

The following test and measurement software was utilized for the tests documented in this report:

TEST SOFTWARE LIST		
Name	**Version**	**Test / Function**
Aggregate Time-PXA	3.1	Channel Loading and Aggregate Closing Time
FCC 2014 Detection Bandwidth-PXA	3.1.1	Detection Bandwidth in 5 MHz Steps
In Service Monitoring-PXA	3.3.4	In-Service Monitoring (Probability of Detection)
PXA Read	3.1	Signal Generator Screen Capture
SGXProject.exe	1.7	Radar Waveform Generation and Download

5.1.4. TEST ROOM ENVIRONMENT

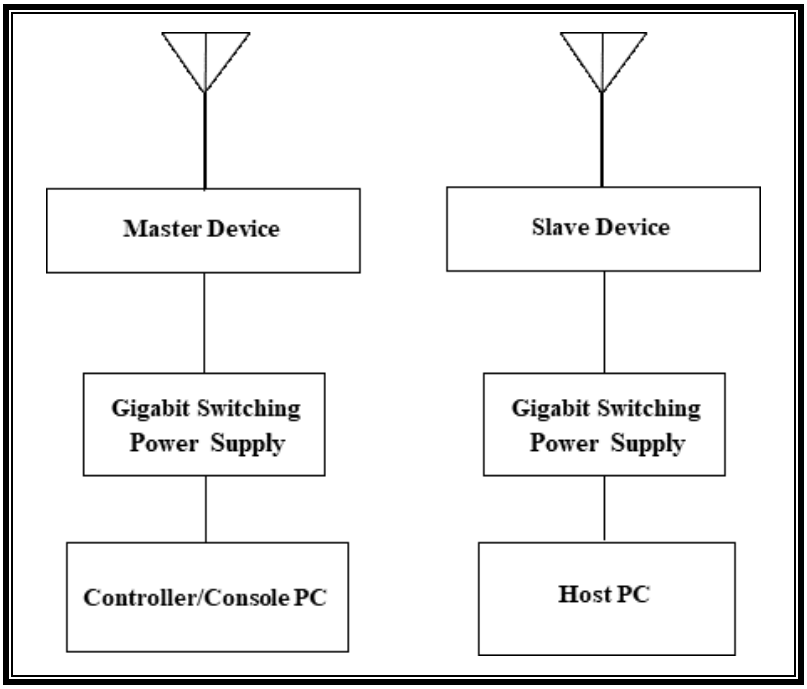
The test room temperature and humidity shall be maintained within normal temperature of 15~35 °C and normal humidity 20~75% (relative humidity).

ENVIRONMENT CONDITION

Parameter	Value
Temperature	26.9 and 27.2 °C
Humidity	36 and 33 %

5.1.5. SETUP OF EUT

RADIATED METHOD EUT TEST SETUP



SUPPORT EQUIPMENT

The following support equipment was utilized for the DFS tests documented in this report:

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Gigabit Switching Power Supply (EUT)	Phihong	PSA15A-300 (AP)	000868116P0401	DoC
Notebook PC (EUT Controller/Console)	Lenovo	Type 4236-B92	PB-HEXC4 12/05	DoC
AC Adapter (Controller/Console PC)	Lenovo	42T4418	11S42T4418Z1ZGWG 08R90M	DoC
5 GHz Fixed Outdoor Transceiver (Slave Device)	Cambium Networks	PTP 450b (Mid-Gain)	0a-00-3e-70-51-8f	Z8H89FT0032
Gigabit Switching Power Supply (Slave)	Phihong	PSA15A-300 (AP)	0167552117P0401	DoC
Notebook PC (Slave Host)	Lenovo	Type 20B7-S0A200	PF-02JN9J 14/06	DoC
AC Adapter (Host PC)	Lenovo	ADLX65NCC2A	11S45N0263Z1ZSHD 41A5JY	DoC

5.1.6. DESCRIPTION OF EUT

For FCC the EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges.

For IC the EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges, excluding the 5600-5650 MHz range.

The EUT is a Master Device.

The manufacturer has declared that the highest power level within these bands is 30 dBm EIRP in the 5250-5350 MHz band and 30 dBm EIRP in the 5470-5725 MHz band.

The EUT utilizes a proprietary protocol. Two nominal channel bandwidths are implemented: 10 MHz and 40 MHz.

The manufacturer has declared that the lowest gain antenna assembly utilized with the EUT has a gain of 2 dBi and the highest gain antenna assembly utilized with the EUT has a gain of 16 dBi.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is –64 dBm. After correction for procedural adjustments, the required radiated threshold at the antenna port is –64 + 1 = -63 dBm.

The calibrated radiated DFS Detection Threshold level is set to –64 dBm. The tested level is lower than the required level hence it provides a margin to the limit.

One integrated antenna array is utilized to meet the diversity and MIMO operational requirements.

The EUT uses one vertically polarized and one horizontally polarized transmitter/receiver chain. During testing the vertical chain is connected to a dipole antenna.

The Slave device associated with the EUT during these tests does not have radar detection capability.

WLAN traffic that meets or exceeds the minimum required loading was generated by transferring a data stream from the Master Device to the Slave Device using iPerf version 2.0.5 software package.

TPC is required since the maximum EIRP is greater than 500 mW (27 dBm).

The software installed in the EUT is Canopy version 15.1.4.

UNIFORM CHANNEL SPREADING

This function is not required per KDB 905462.

5.2. RESULTS FOR 10 MHz BANDWIDTH

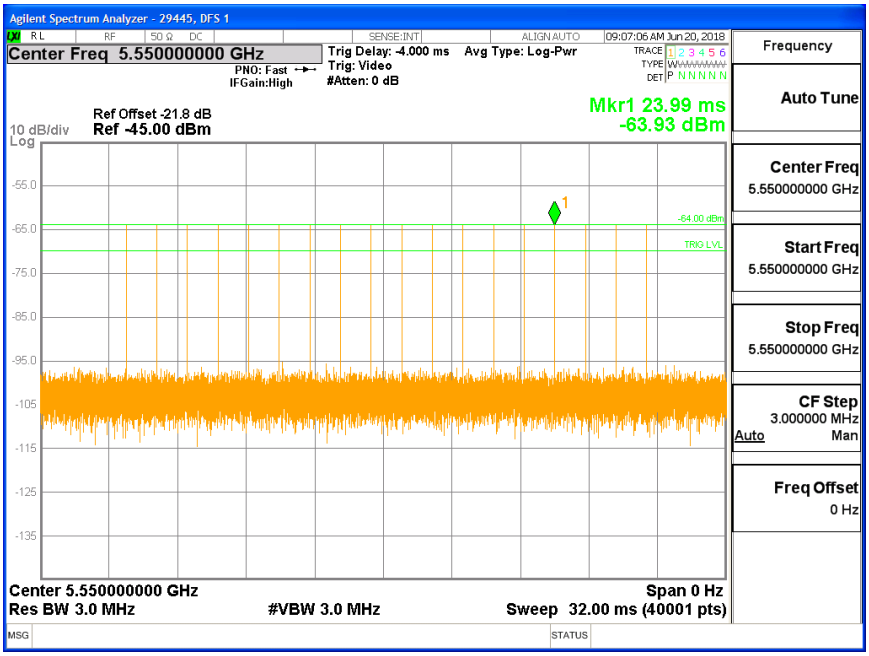
5.2.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5550 MHz.

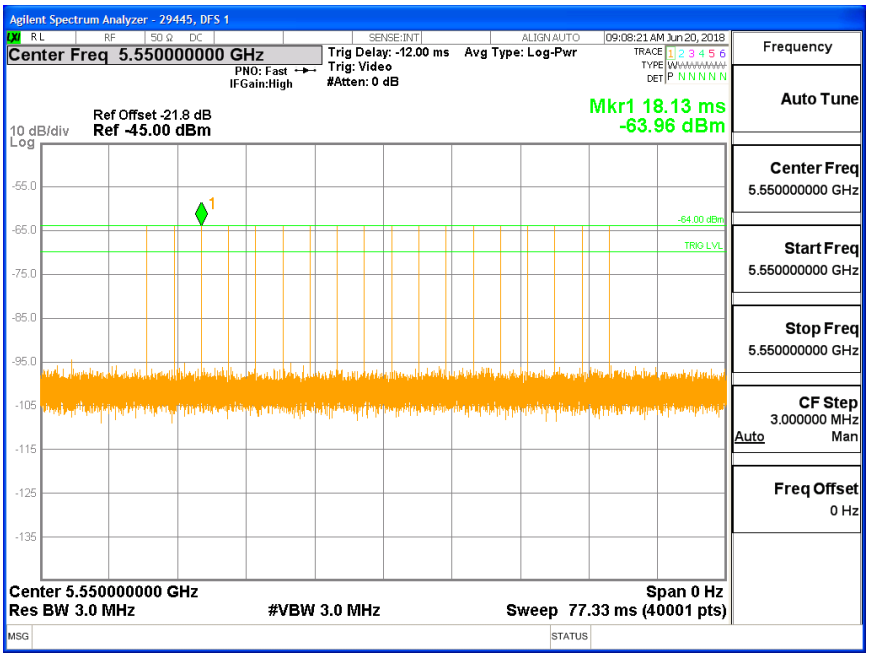
5.2.2. RADAR WAVEFORMS AND TRAFFIC

RADAR WAVEFORMS

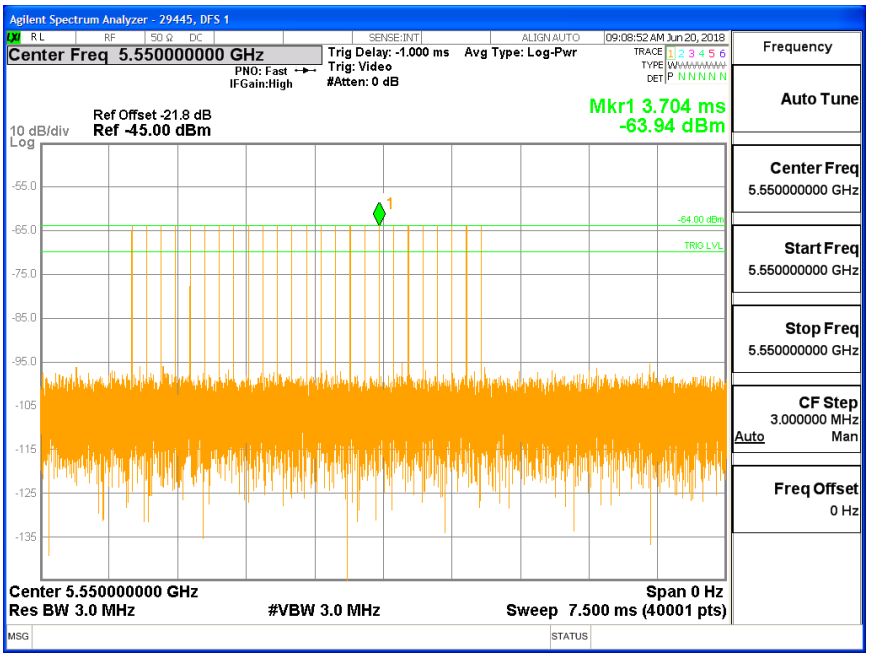
SHORT PULSE RADAR TYPE 0



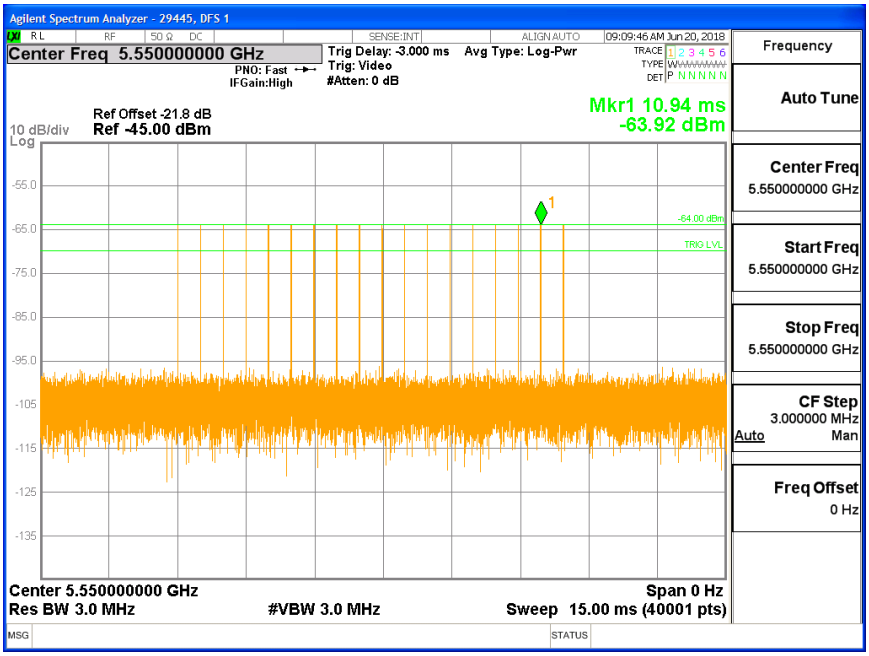
SAMPLE OF RADAR TYPE 1



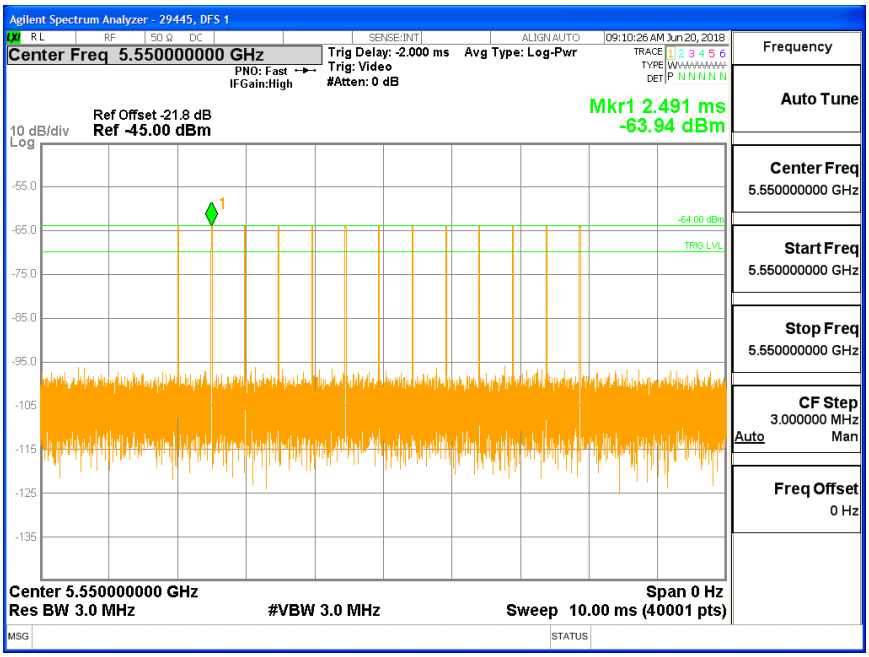
SAMPLE OF RADAR TYPE 2



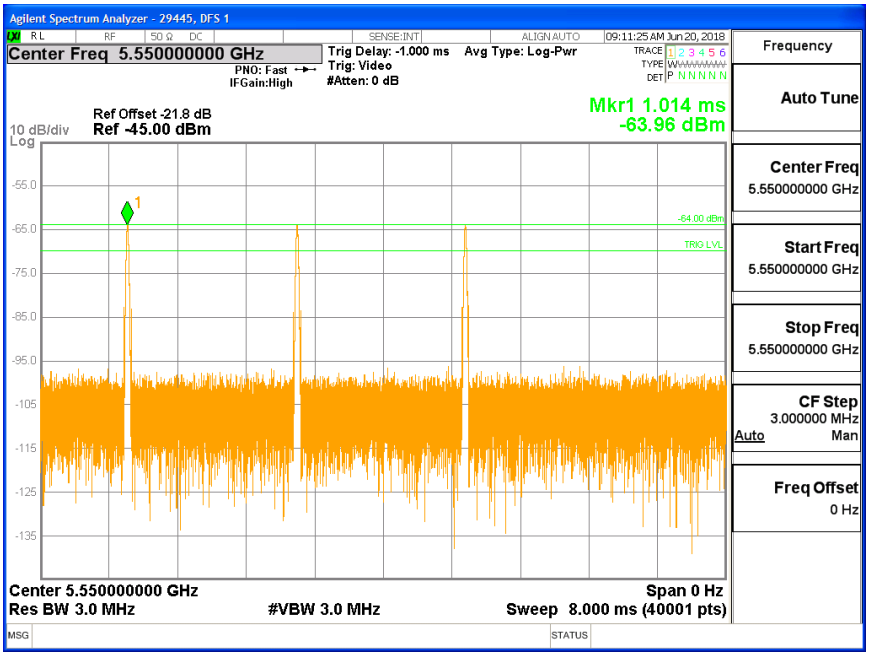
SAMPLE OF RADAR TYPE 3



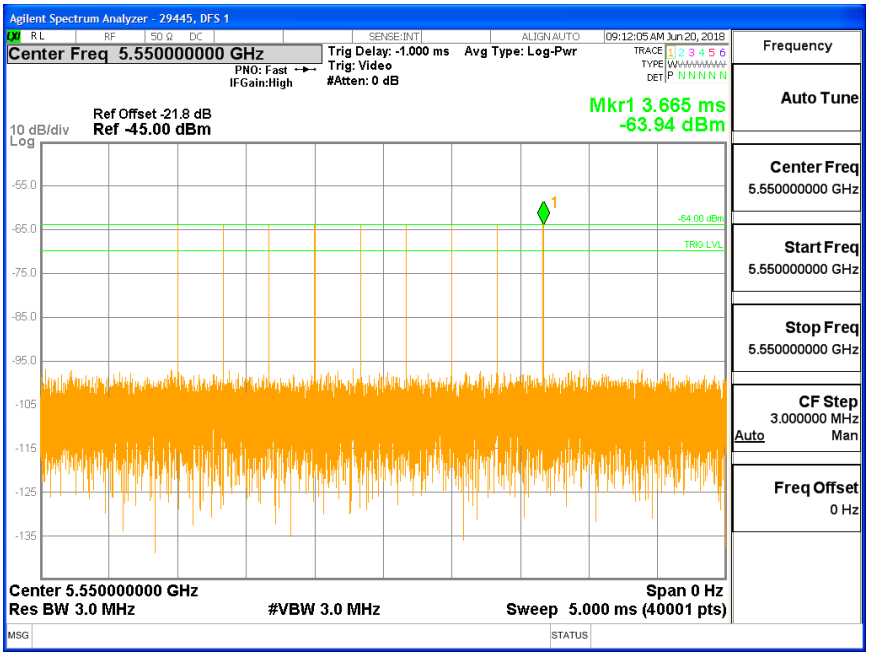
SAMPLE OF RADAR TYPE 4



SAMPLE OF SINGLE BURST OF RADAR TYPE 5

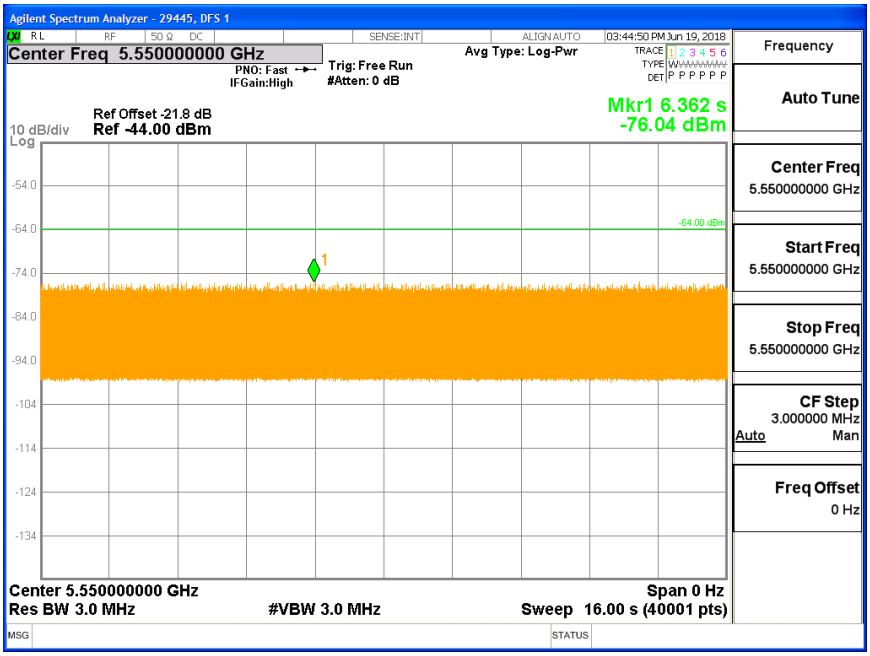


SINGLE BURST OF RADAR TYPE 6

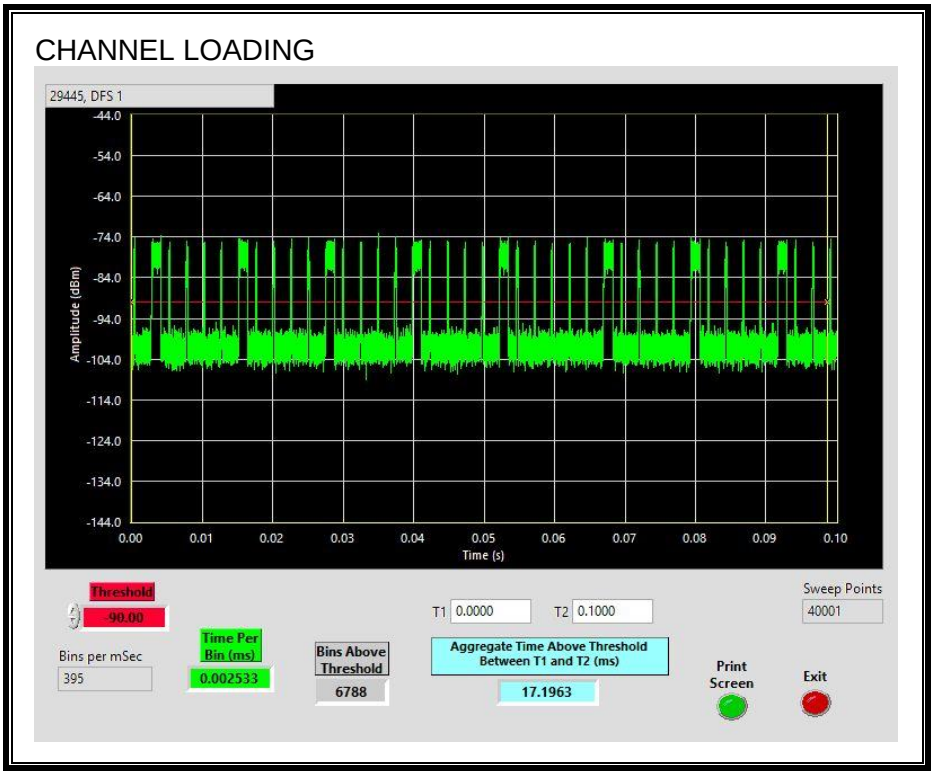


TRAFFIC

TRAFFIC



CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 17.19%.

5.2.3. CHANNEL AVAILABILITY CHECK TIME

Note: Per table 2 of KDB 905462 D02, this test is only required to be performed at the highest supported channel bandwidth. Therefore the manufacturer has chosen not to perform this test for 10 MHz channel bandwidth.

5.2.4. OVERLAPPING CHANNEL TESTS

RESULTS

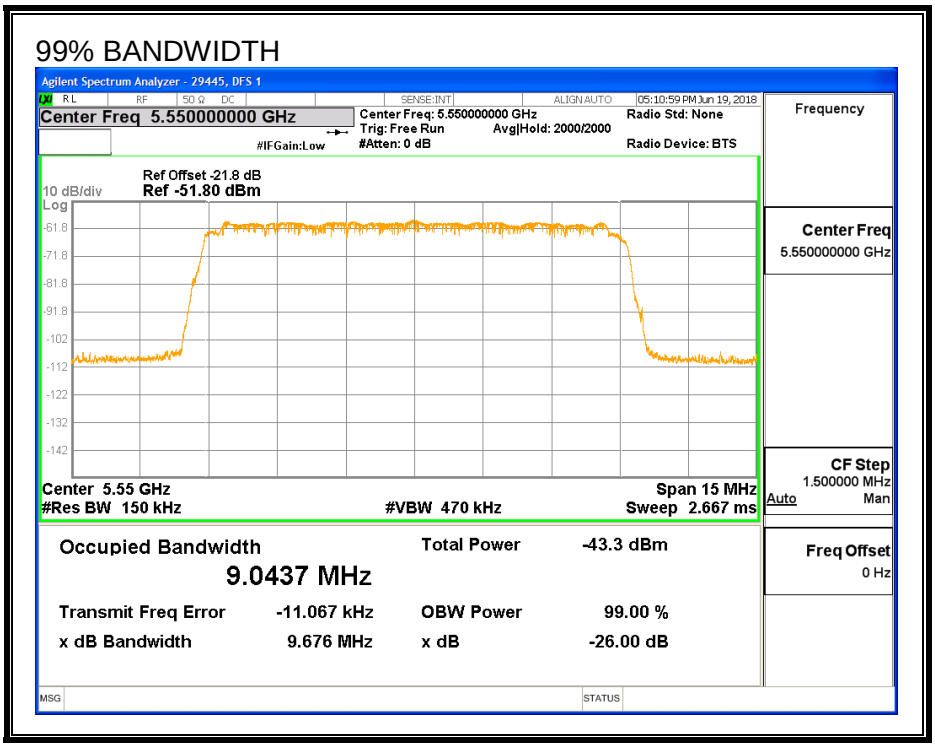
These tests are not applicable. The manufacturer's channel mapping plan prohibits overlapping channel from occurring.

5.2.5. MOVE AND CLOSING TIME

Note: Per table 2 of KDB 905462 D02, this test is only required to be performed at the highest supported channel bandwidth. Therefore the manufacturer has chosen not to perform this test for 10 MHz channel bandwidth.

5.2.6. DETECTION BANDWIDTH

REFERENCE PLOT OF 99% POWER BANDWIDTH



RESULTS

FL (MHz)	FH (MHz)	Detection Bandwidth (MHz)	99% Power Bandwidth (MHz)	Ratio of Detection BW to 99% Power BW (%)	Minimum Limit (%)
5545.4	5554.5	9.1	9.044	100.6	100

DETECTION BANDWIDTH PROBABILITY

DETECTION BANDWIDTH PROBABILITY RESULTS

Detection Bandwidth Test Results		29445	DFS 1	
FCC Type 0 Waveform: 1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst				
Frequency (MHz)	Number of Trials	Number Detected	Detection (%)	Mark
5545.4	10	9	90	FL
5545.5	10	10	100	
5545.6	10	9	100	
5545.7	10	10	100	
5545.8	10	9	90	
5545.9	10	10	100	
5546	10	9	90	
5547	10	9	90	
5548	10	10	100	
5549	10	10	100	
5550	10	10	100	
5551	10	9	90	
5552	40	36	90	
5553	10	10	100	
5554	10	10	100	
5554.1	10	10	100	
5554.2	10	9	90	
5554.3	10	9	90	
5554.4	10	9	90	
5554.5	10	9	90	FH

5.2.7. IN-SERVICE MONITORING

RESULTS

FCC Radar Test Summary

Signal Type	Number of Trials	Detection (%)	Limit (%)	Pass/Fail	Detection Bandwidth FL	Detection Bandwidth FH	OBW	Test Location	Employee Number	In-Service Monitoring Version
FCC Short Pulse Type 1	30	83.33	60	Pass	5545	5554	9.04	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 2	30	100.00	60	Pass	5545	5554	9.04	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 3	30	96.67	60	Pass	5545	5554	9.04	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 4	30	70.00	60	Pass	5545	5554	9.04	DFS 1	29445	Version 3.3.4
Aggregate		87.50	80	Pass						
FCC Long Pulse Type 5	30	100.00	80	Pass	5545	5554	9.04	DFS 1	29445	Version 3.3.4
FCC Hopping Type 6	30	73.33	70	Pass	5545	5554		DFS 1	29445	Version 3.3.4

TYPE 1 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 1

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Test (A/B)	Frequency (MHz)	Successful Detection (Yes/No)
1001	1	3066	18	A	5553	Yes
1002	1	558	95	A	5546	Yes
1003	1	538	99	A	5545	Yes
1004	1	818	65	A	5549	Yes
1005	1	898	59	A	5547	Yes
1006	1	718	74	A	5546	Yes
1007	1	598	89	A	5551	Yes
1008	1	878	61	A	5553	Yes
1009	1	578	92	A	5547	No
1010	1	678	78	A	5547	Yes
1011	1	938	57	A	5549	Yes
1012	1	918	58	A	5546	Yes
1013	1	618	86	A	5546	Yes
1014	1	798	67	A	5554	Yes
1015	1	838	63	A	5554	Yes
1016	1	1257	42	B	5549	Yes
1017	1	2955	18	B	5550	Yes
1018	1	1910	28	B	5552	Yes
1019	1	2543	21	B	5546	No
1020	1	1628	33	B	5547	Yes
1021	1	2390	23	B	5551	Yes
1022	1	1604	33	B	5554	Yes
1023	1	1301	41	B	5553	Yes
1024	1	1998	27	B	5550	No
1025	1	3019	18	B	5553	Yes
1026	1	2652	20	B	5545	No
1027	1	2608	21	B	5551	Yes
1028	1	1016	52	B	5552	Yes
1029	1	2454	22	B	5547	No
1030	1	2346	23	B	5549	Yes

TYPE 2 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 2

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
2001	1.4	159	25	5547	Yes
2002	2.5	200	24	5552	Yes
2003	3.3	213	23	5549	Yes
2004	2.6	177	27	5550	Yes
2005	3.6	195	27	5553	Yes
2006	3.2	163	27	5550	Yes
2007	2.5	227	27	5547	Yes
2008	2.2	199	28	5552	Yes
2009	1.7	187	25	5550	Yes
2010	3.9	168	27	5550	Yes
2011	1.7	160	28	5551	Yes
2012	4	183	23	5549	Yes
2013	2	222	24	5552	Yes
2014	4.6	212	23	5554	Yes
2015	2.8	174	24	5546	Yes
2016	1.7	168	24	5551	Yes
2017	4.2	215	23	5546	Yes
2018	1.2	174	29	5549	Yes
2019	2	188	28	5553	Yes
2020	1.3	152	25	5554	Yes
2021	2.3	169	24	5550	Yes
2022	1.9	218	25	5546	Yes
2023	1.2	202	25	5552	Yes
2024	3.1	217	26	5554	Yes
2025	2.6	161	23	5552	Yes
2026	2.6	224	25	5549	Yes
2027	4.5	215	26	5552	Yes
2028	2.7	158	27	5552	Yes
2029	4.8	197	29	5551	Yes
2030	3.3	186	28	5554	Yes

TYPE 3 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 3

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
3001	8.7	496	18	5547	Yes
3002	9.5	477	18	5552	Yes
3003	7.9	372	18	5554	Yes
3004	7.1	499	17	5547	Yes
3005	9.8	288	17	5551	Yes
3006	9.1	428	16	5552	Yes
3007	6	481	17	5547	No
3008	7.8	383	16	5554	Yes
3009	9	331	17	5546	Yes
3010	6.8	379	16	5553	Yes
3011	6.3	340	18	5546	Yes
3012	8.5	400	18	5548	Yes
3013	8.2	374	16	5547	Yes
3014	6.4	329	17	5551	Yes
3015	8.5	316	17	5549	Yes
3016	9.2	284	17	5549	Yes
3017	7.4	417	17	5548	Yes
3018	8.2	398	17	5554	Yes
3019	6.6	426	17	5548	Yes
3020	9.9	419	16	5546	Yes
3021	8.5	460	16	5552	Yes
3022	7.8	348	18	5549	Yes
3023	6.9	402	16	5549	Yes
3024	6.5	436	18	5553	Yes
3025	7.7	252	16	5548	Yes
3026	9.6	299	18	5548	Yes
3027	9.1	261	17	5546	Yes
3028	7.2	321	16	5548	Yes
3029	6.9	295	18	5552	Yes
3030	9.2	250	16	5548	Yes

TYPE 4 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 4					
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
4001	13.8	488	13	5547	Yes
4002	15.2	456	12	5548	Yes
4003	11.2	338	13	5549	Yes
4004	13.1	318	13	5554	Yes
4005	18.7	346	12	5548	Yes
4006	16.8	340	14	5553	Yes
4007	18.5	381	14	5547	Yes
4008	12.3	269	14	5553	Yes
4009	19.3	323	16	5551	Yes
4010	18.3	357	14	5552	No
4011	11.9	423	16	5547	Yes
4012	16.2	471	14	5548	No
4013	15.1	432	15	5552	Yes
4014	19.9	492	16	5547	No
4015	19.2	466	14	5549	Yes
4016	15.4	421	13	5546	Yes
4017	20	408	16	5548	Yes
4018	12.4	376	15	5548	Yes
4019	17.4	258	12	5551	Yes
4020	19.4	372	14	5552	Yes
4021	15.8	267	15	5549	Yes
4022	13.9	394	13	5553	Yes
4023	15.6	301	12	5552	No
4024	14.2	441	15	5548	Yes
4025	16.4	494	14	5552	No
4026	15.5	278	12	5549	No
4027	13.8	344	15	5545	No
4028	13.4	391	15	5552	No
4029	12.2	353	13	5550	Yes
4030	17	413	14	5546	No

TYPE 5 DETECTION PROBABILITY

Data Sheet for FCC Long Pulse Radar Type 5		
Trial	Frequency (MHz)	Successful Detection (Yes/No)
1	5550	Yes
2	5550	Yes
3	5550	Yes
4	5550	Yes
5	5550	Yes
6	5550	Yes
7	5550	Yes
8	5550	Yes
9	5550	Yes
10	5550	Yes
11	5552	Yes
12	5552	Yes
13	5554	Yes
14	5549	Yes
15	5551	Yes
16	5548	Yes
17	5549	Yes
18	5554	Yes
19	5549	Yes
20	5554	Yes
21	5551	Yes
22	5547	Yes
23	5551	Yes
24	5547	Yes
25	5551	Yes
26	5547	Yes
27	5551	Yes
28	5547	Yes
29	5551	Yes
30	5547	Yes

Note: The Type 5 randomized parameters tested are shown in a separate document.

TYPE 6 DETECTION PROBABILITY

Data Sheet for FCC Hopping Radar Type 6				
1 us Pulse Width, 333 us PRI, 9 Pulses per Burst, 1 Burst per Hop				
NTIA August 2005 Hopping Sequence				
Trial	Starting Index Within Sequence	Signal Generator Frequency (MHz)	Hops within Detection BW	Successful Detection (Yes/No)
1	137	5545	2	Yes
2	1087	5546	1	Yes
3	1562	5547	3	Yes
4	2037	5548	1	Yes
5	3462	5549	4	Yes
6	3937	5550	1	No
7	4412	5551	1	Yes
8	4887	5552	2	Yes
9	5837	5553	1	No
10	6312	5554	3	Yes
11	6787	5545	2	No
12	7262	5546	1	Yes
13	7737	5547	2	Yes
14	8687	5548	3	Yes
15	9162	5549	4	Yes
16	9637	5550	2	Yes
17	10112	5551	1	No
18	10587	5552	3	Yes
19	11062	5553	1	No
20	11537	5554	3	Yes
21	12012	5545	1	Yes
22	12487	5546	4	Yes
23	12962	5547	3	No
24	13437	5548	2	Yes
25	13912	5549	1	No
26	14387	5550	1	Yes
27	14862	5551	4	No
28	15337	5552	3	Yes
29	15812	5553	3	Yes
30	16287	5554	3	Yes

5.3. RESULTS FOR 40 MHz BANDWIDTH

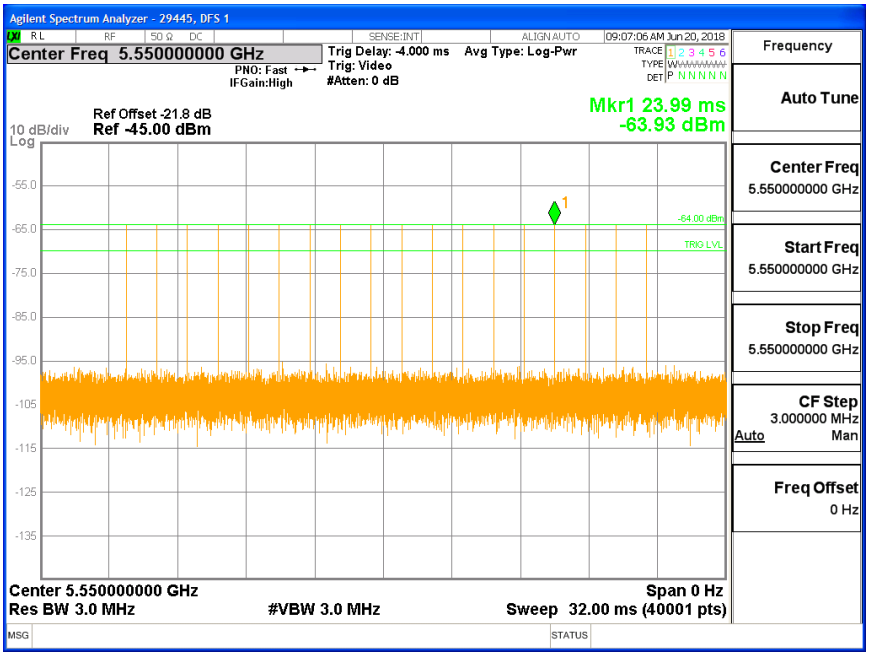
5.3.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5550 MHz.

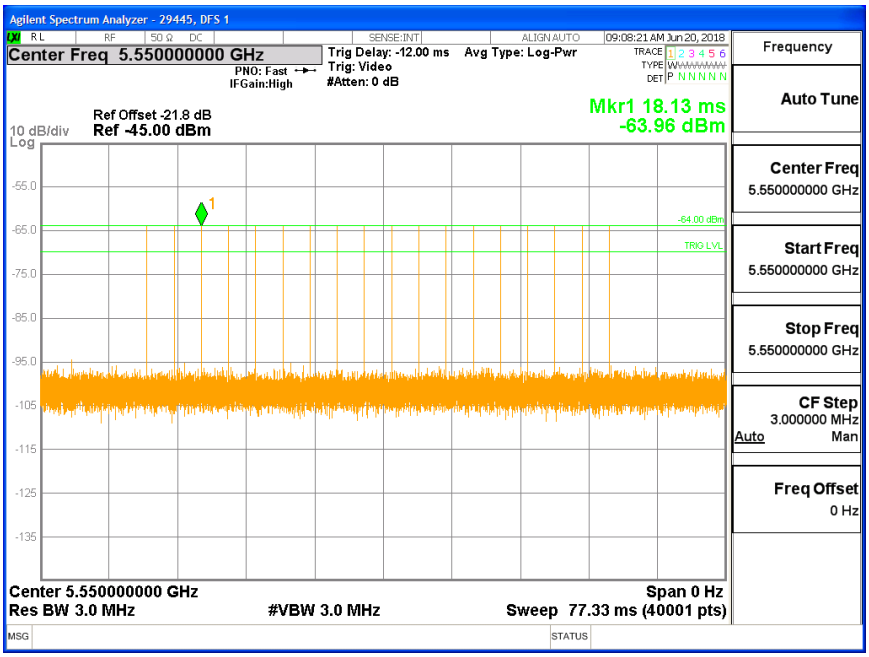
5.3.2. RADAR WAVEFORMS AND TRAFFIC

RADAR WAVEFORMS

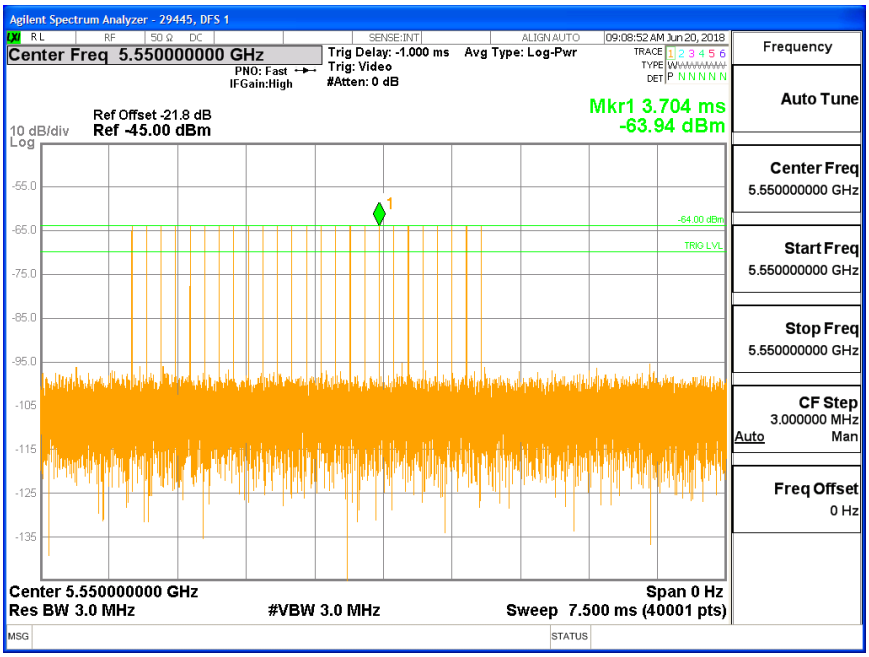
SHORT PULSE RADAR TYPE 0



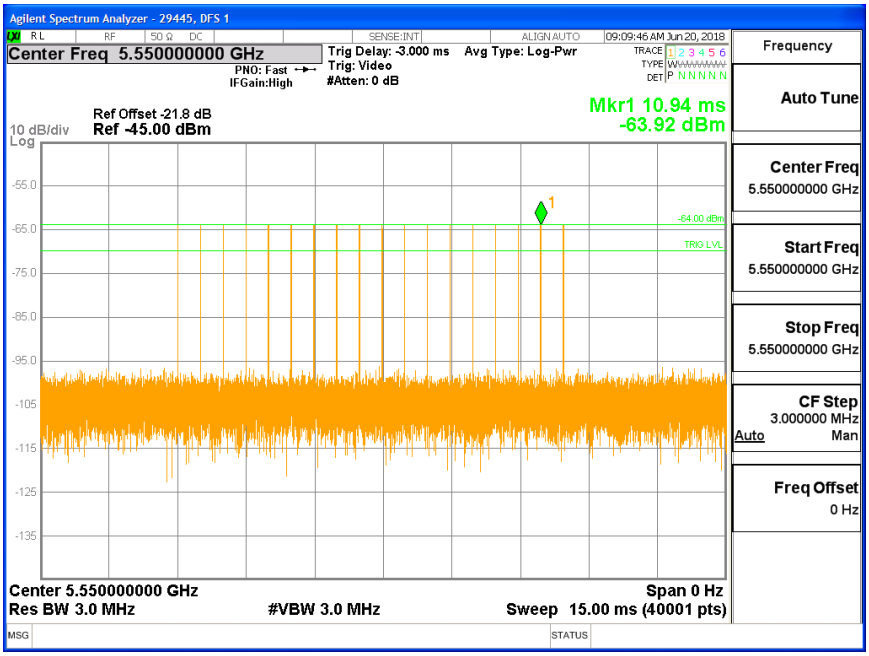
SAMPLE OF RADAR TYPE 1



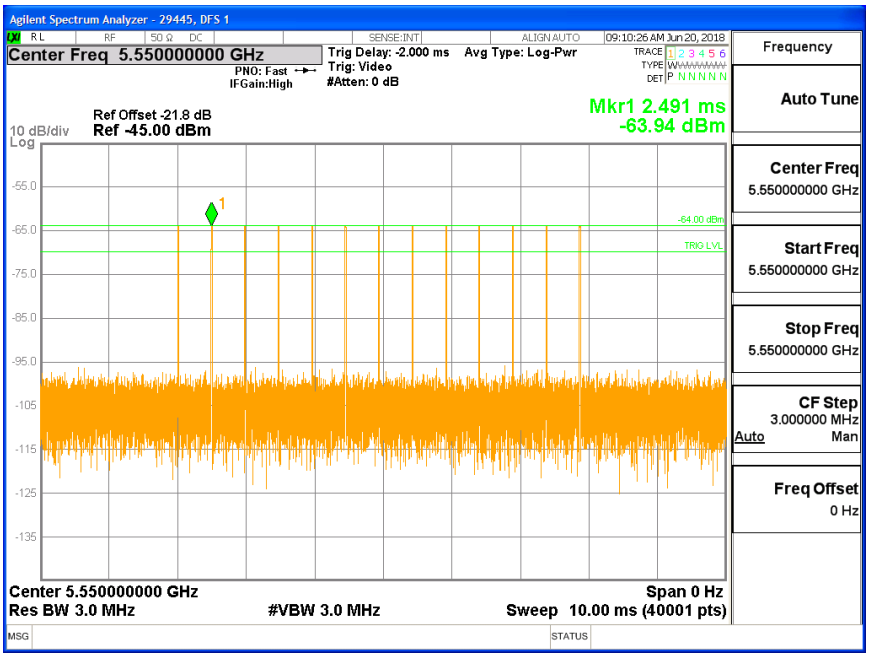
SAMPLE OF RADAR TYPE 2



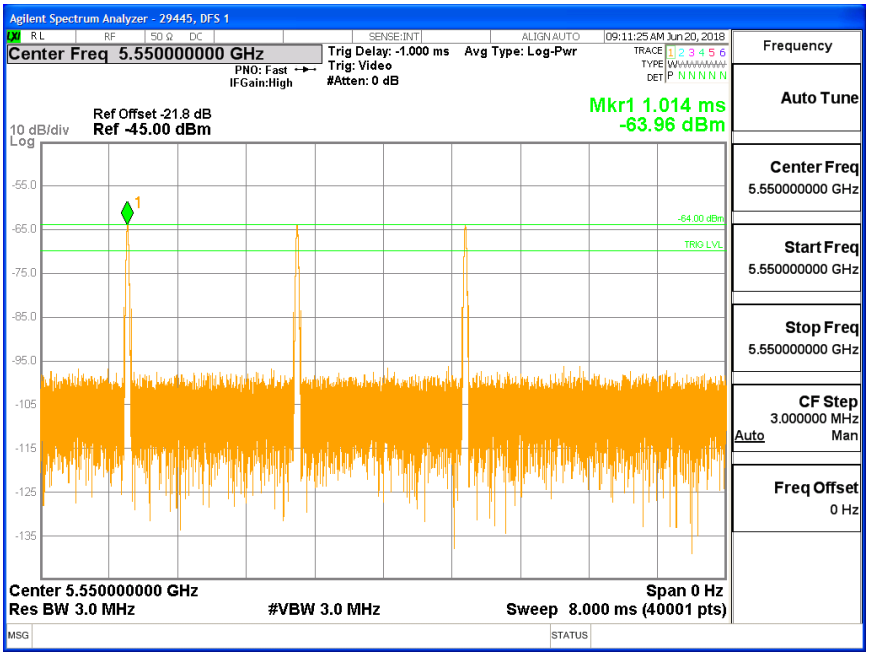
SAMPLE OF RADAR TYPE 3



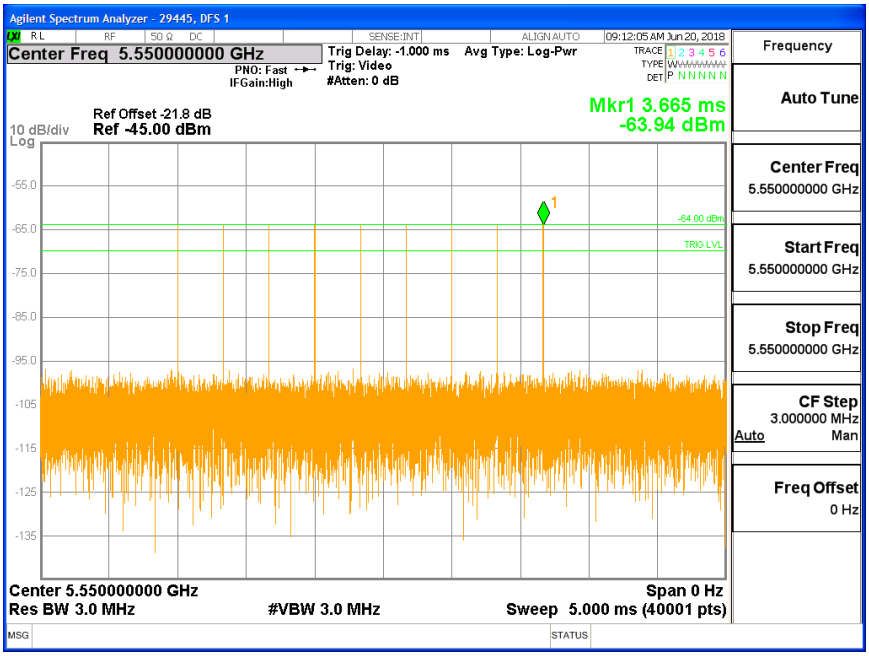
SAMPLE OF RADAR TYPE 4



SAMPLE OF SINGLE BURST OF RADAR TYPE 5

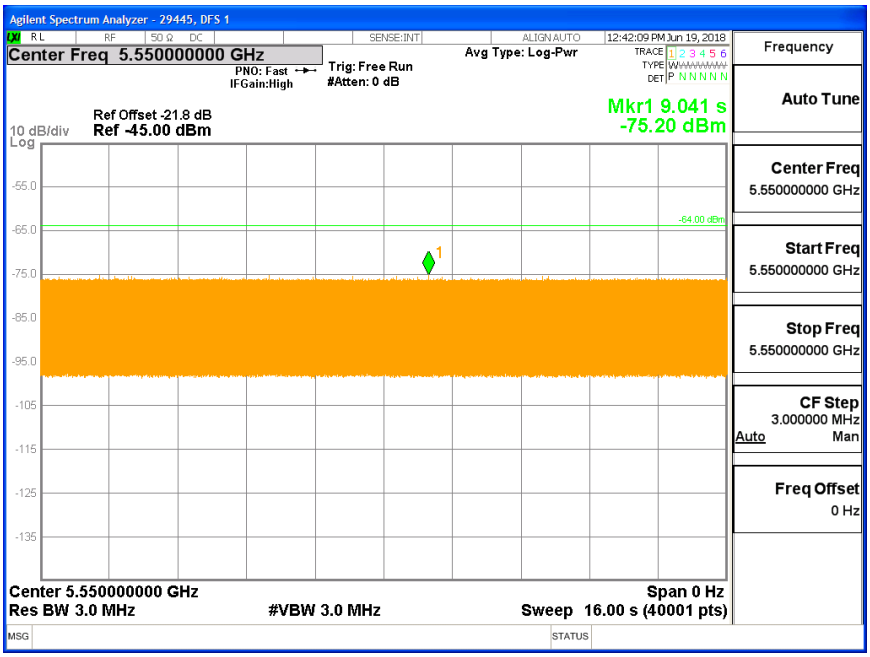


SINGLE BURST OF RADAR TYPE 6

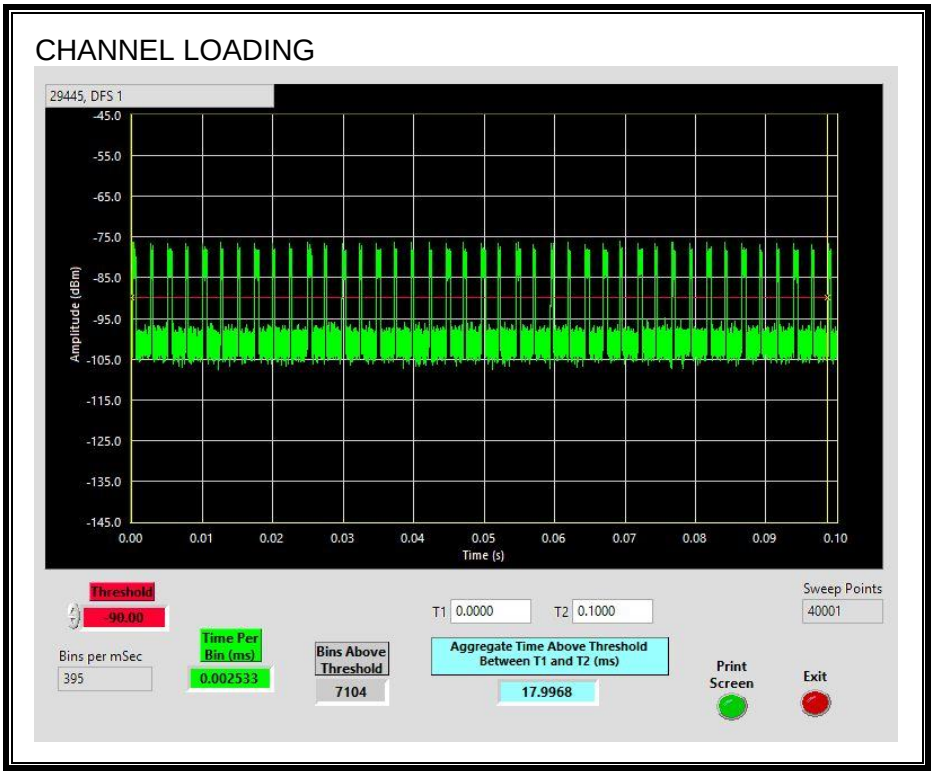


TRAFFIC

TRAFFIC



CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 17.99%.

5.3.3. CHANNEL AVAILABILITY CHECK TIME

PROCEDURE TO DETERMINE INITIAL POWER-UP CYCLE TIME

A link was established on channel then a software reset command was issued to the EUT. The time from the cessation of traffic to the re-initialization of traffic was measured as the time required for the EUT to complete the total power-up cycle. The time to complete the initial power-up period is 60 seconds less than this total power-up time.

PROCEDURE FOR TIMING OF RADAR BURST

With a link established on channel, the EUT was reset. A radar signal was triggered within 0 to 6 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

The Non-Occupancy list was cleared. With a link established on channel, the EUT was reset. A radar signal was triggered within 54 to 60 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

QUANTITATIVE RESULTS

No Radar Triggered

Timing of Reset (sec)	Timing of Start of Traffic (sec)	Total Reset and CAC Cycle Time (sec)	Initial Reset Cycle Time (sec)
30.11	124.5	94.4	34.4

Radar Near Beginning of CAC

Timing of Reset (sec)	Timing of Radar Burst (sec)	Radar Relative to Reset (sec)	Radar Relative to Start of CAC (sec)
32.85	71.2	38.3	3.9

Radar Near End of CAC

Timing of Reset (sec)	Timing of Radar Burst (sec)	Radar Relative to Reset (sec)	Radar Relative to Start of CAC (sec)
32.4	122.2	89.8	55.4

QUALITATIVE RESULTS

Timing of Radar Burst	Display on Control Computer	Spectrum Analyzer Display
No Radar Triggered	EUT marks Channel as active	Transmissions begin on channel after completion of the initial reset and the CAC
Within 0 to 6 second window	EUT indicates radar detected	No transmissions on channel
Within 54 to 60 second window	EUT indicates radar detected	No transmissions on channel

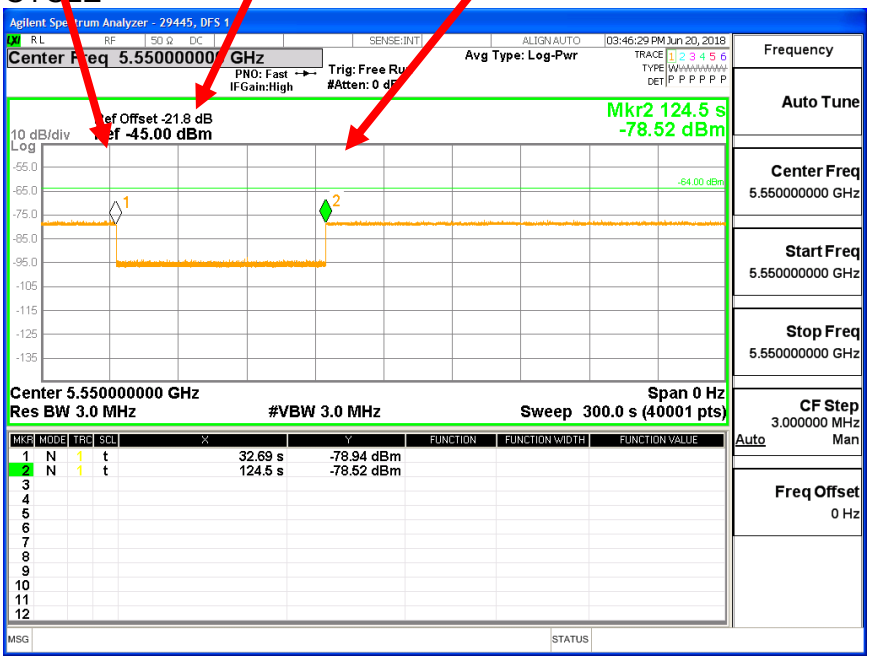
TIMING WITHOUT RADAR DURING CAC

Software Reset Command Issued
Traffic ceases
Start of Initial Reset cycle

End of Initial Reset cycle
Start of CAC

End of CAC
Traffic is Initiated

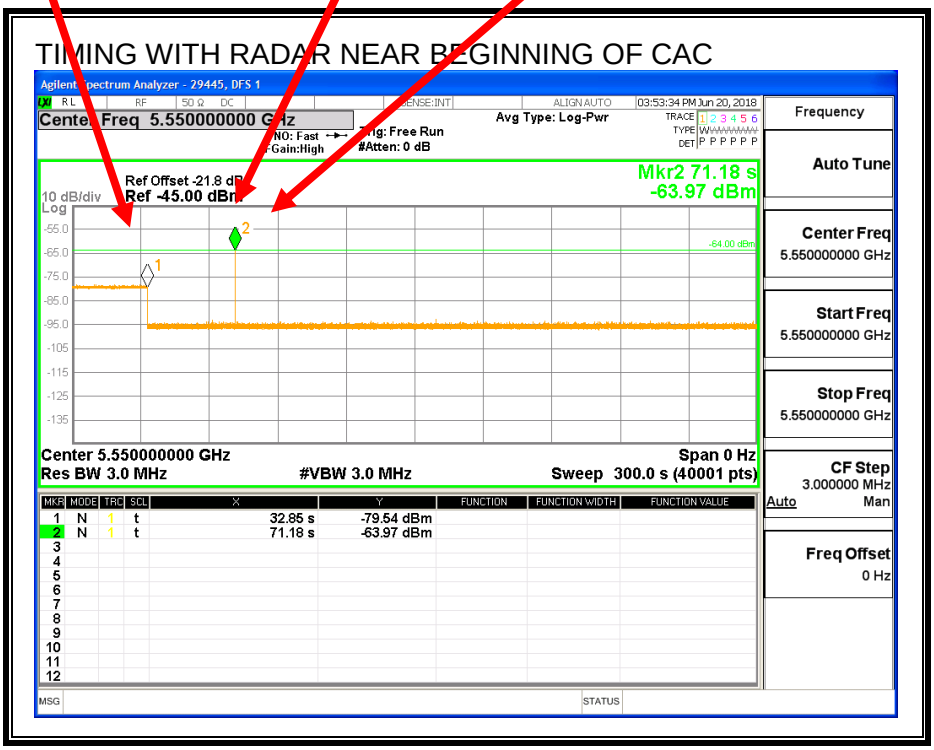
TIMING WITHOUT RADAR – NORMAL RESET AND CAC CYCLE



Transmissions begin on channel after completion of the initial reset cycle and the CAC.

TIMING WITH RADAR NEAR BEGINNING OF CAC

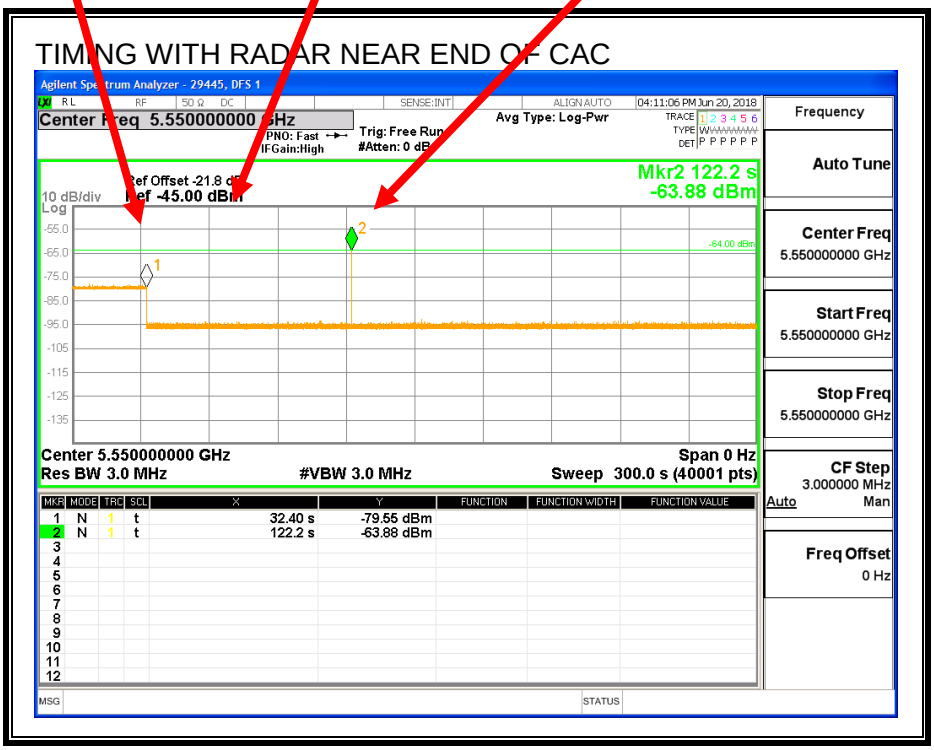
Software Reset Command Issued
Traffic ceases
Start of Initial Reset cycle
End of Initial Reset cycle
Start of CAC
Radar Signal Applied



No EUT transmissions were observed after the radar signal.

TIMING WITH RADAR NEAR END OF CAC

Software Reset Command Issued
Traffic ceases
Start of Initial Reset cycle
End of Initial Reset cycle
Start of CAC
Radar Signal Applied



No EUT transmissions were observed after the radar signal.

5.3.4. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable. The manufacturer's channel mapping plan prohibits overlapping channel from occurring.

5.3.5. MOVE AND CLOSING TIME

REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =
(Number of analyzer bins showing transmission) * (dwell time per bin)

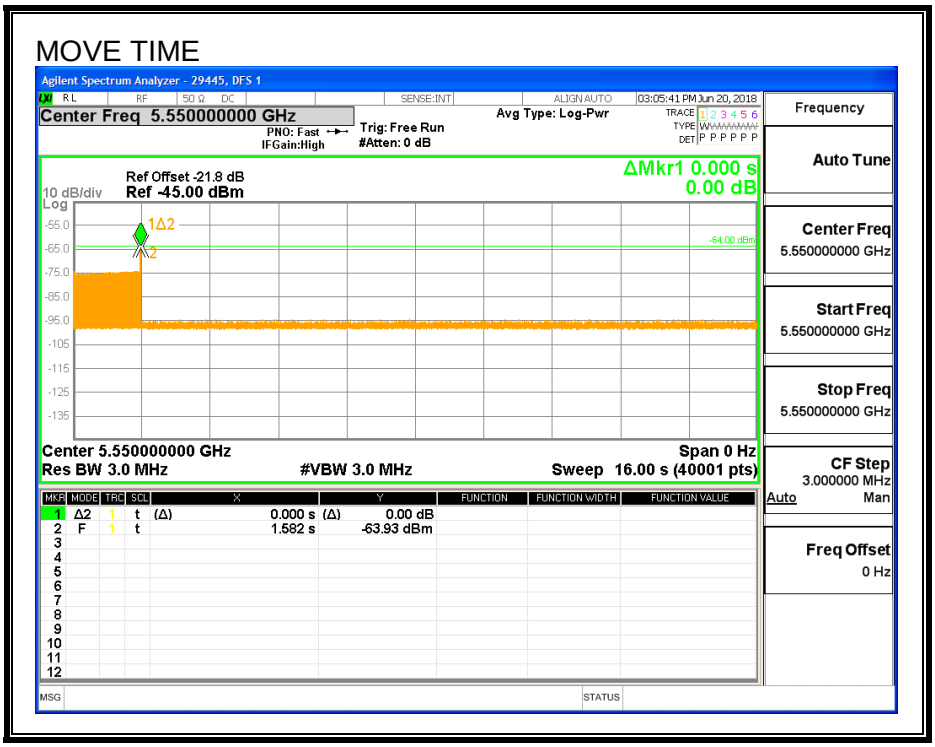
The observation period over which the aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

RESULTS

Channel Move Time (sec)	Limit (sec)
0.000	10

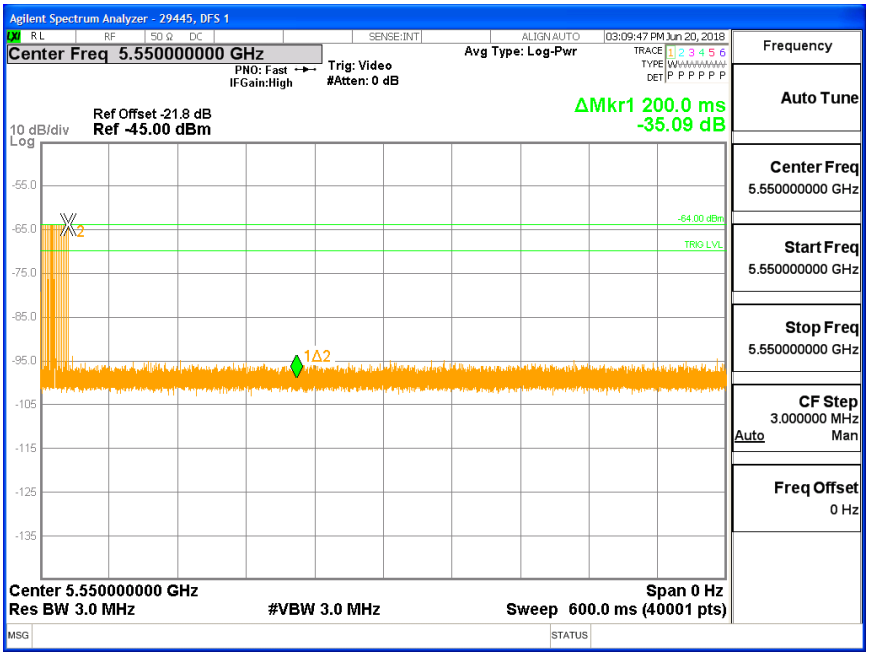
Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
0.0	60

MOVE TIME



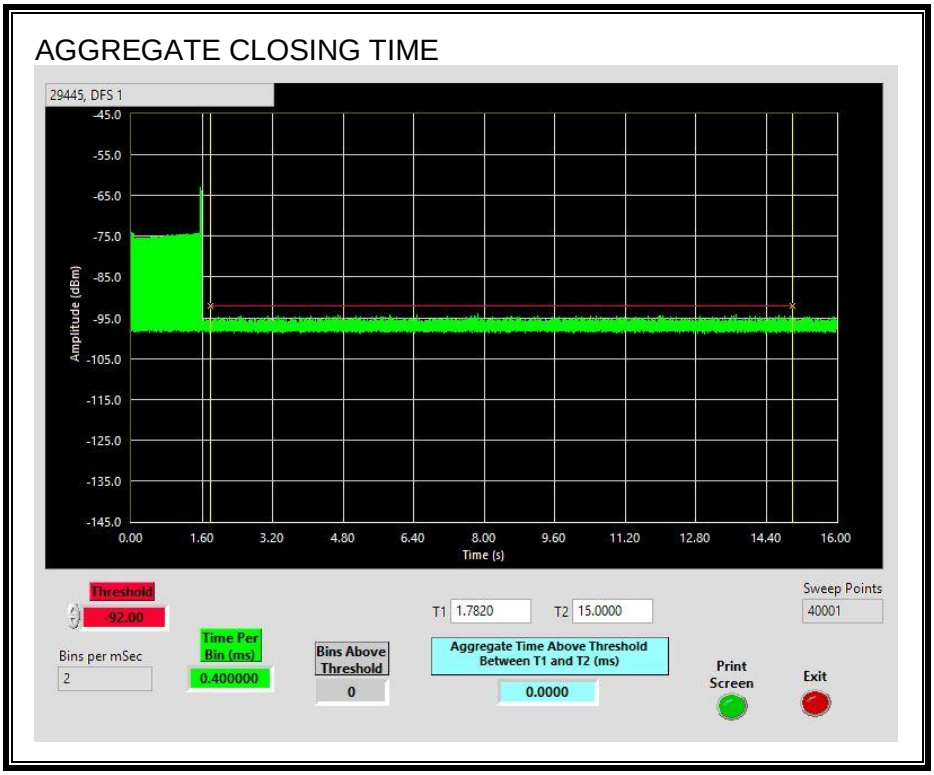
CHANNEL CLOSING TIME

CLOSING TIME



AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

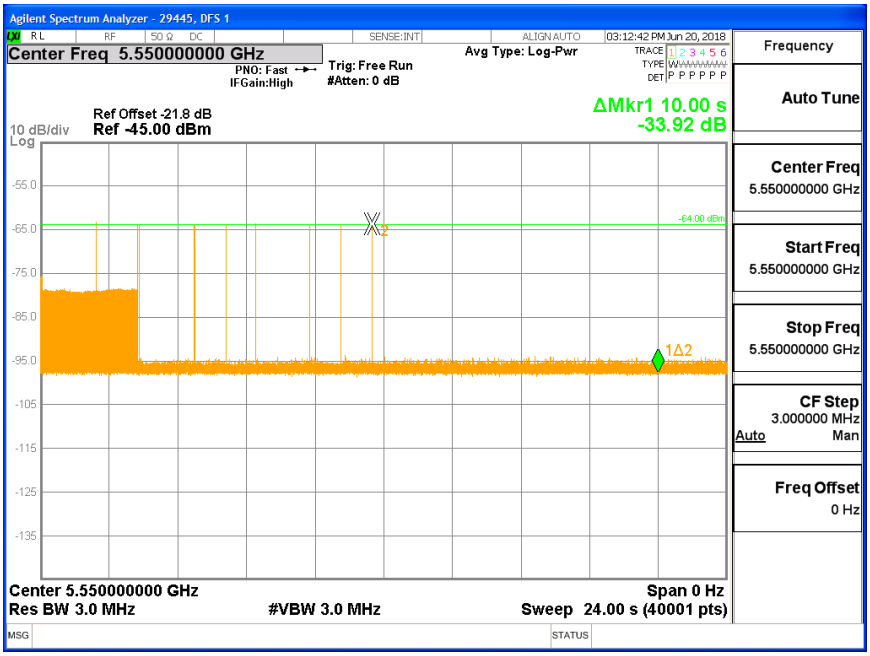
No transmissions are observed during the aggregate monitoring period.



LONG PULSE CHANNEL MOVE TIME

The traffic ceases prior to 10 seconds after the end of the radar waveform.

MOVE TIME FOR LONG PULSE RADAR

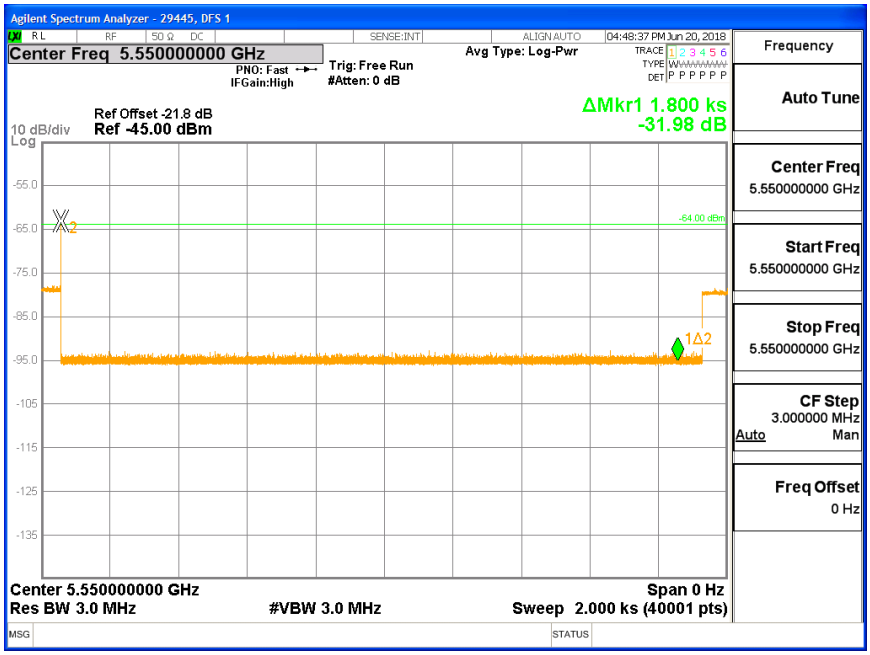


5.3.6. NON-OCCUPANCY PERIOD

RESULTS

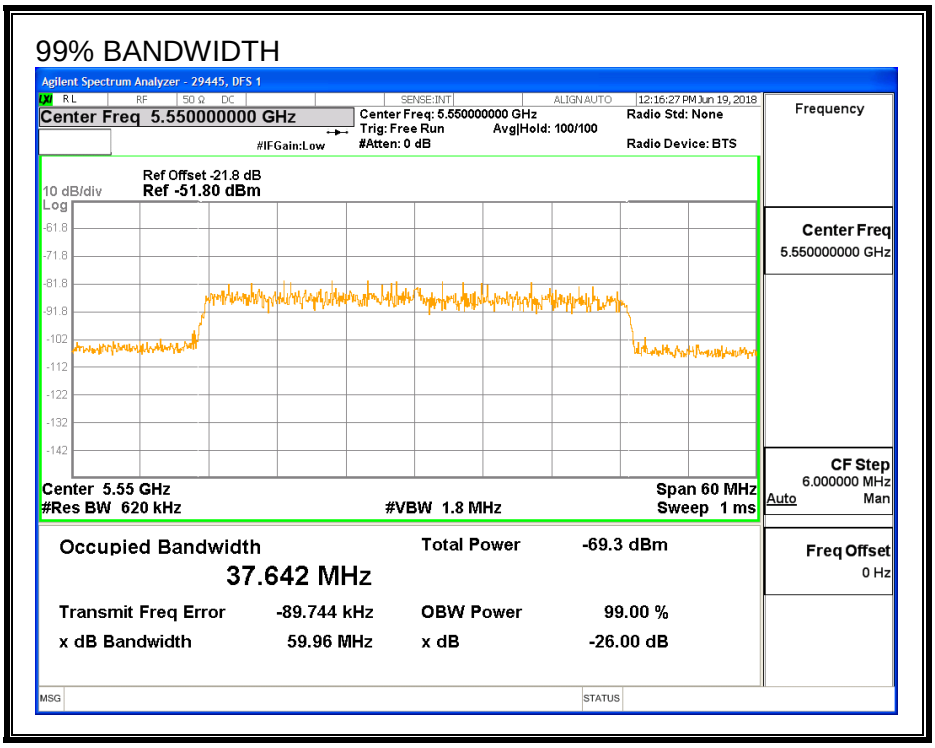
No EUT transmissions were observed on the test channel during the 30-minute observation time. After the 30-minute non-occupancy period the EUT performed a new CAC, then resumed transmissions upon detecting no radar during this CAC period.

NON-OCCUPANCY PERIOD



5.3.7. DETECTION BANDWIDTH

REFERENCE PLOT OF 99% POWER BANDWIDTH



RESULTS

FL (MHz)	FH (MHz)	Detection Bandwidth (MHz)	99% Power Bandwidth (MHz)	Ratio of Detection BW to 99% Power BW (%)	Minimum Limit (%)
5530	5570	40	37.642	106.3	100

DETECTION BANDWIDTH PROBABILITY

DETECTION BANDWIDTH PROBABILITY RESULTS

Detection Bandwidth Test Results		29445	DFS 1	
FCC Type 0 Waveform: 1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst				
Frequency (MHz)	Number of Trials	Number Detected	Detection (%)	Mark
5529	1	0	0	
5530	10	9	90	FL
5535	10	10	100	
5540	10	10	100	
5545	10	10	100	
5550	10	10	100	
5555	10	10	100	
5560	10	10	100	
5565	10	10	100	
5570	10	10	100	FH
5571	1	0	0	

5.3.8. IN-SERVICE MONITORING

RESULTS

FCC Radar Test Summary

Signal Type	Number of Trials	Detection (%)	Limit (%)	Pass/Fail	Detection Bandwidth FL	Detection Bandwidth FH	OBW	Test Location	Employee Number	In-Service Monitoring Version
FCC Short Pulse Type 1	30	100.00	60	Pass	5530	5570	37.64	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 2	30	100.00	60	Pass	5530	5570	37.64	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 3	30	96.67	60	Pass	5530	5570	37.64	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 4	30	96.67	60	Pass	5530	5570	37.64	DFS 1	29445	Version 3.3.4
Aggregate		98.33	80	Pass						
FCC Long Pulse Type 5	30	100.00	80	Pass	5530	5570	37.64	DFS 1	29445	Version 3.3.4
FCC Hopping Type 6	41	100.00	70	Pass	5530	5570		DFS 1	29445	Version 3.3.4

TYPE 1 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 1

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Test (A/B)	Frequency (MHz)	Successful Detection (Yes/No)
1001	1	3066	18	A	5551	Yes
1002	1	558	95	A	5557	Yes
1003	1	538	99	A	5543	Yes
1004	1	818	65	A	5532	Yes
1005	1	898	59	A	5533	Yes
1006	1	718	74	A	5556	Yes
1007	1	598	89	A	5546	Yes
1008	1	878	61	A	5558	Yes
1009	1	578	92	A	5548	Yes
1010	1	678	78	A	5551	Yes
1011	1	938	57	A	5556	Yes
1012	1	918	58	A	5537	Yes
1013	1	618	86	A	5533	Yes
1014	1	798	67	A	5550	Yes
1015	1	838	63	A	5544	Yes
1016	1	1257	42	B	5534	Yes
1017	1	2955	18	B	5555	Yes
1018	1	1910	28	B	5554	Yes
1019	1	2543	21	B	5568	Yes
1020	1	1628	33	B	5535	Yes
1021	1	2390	23	B	5550	Yes
1022	1	1604	33	B	5564	Yes
1023	1	1301	41	B	5531	Yes
1024	1	1998	27	B	5562	Yes
1025	1	3019	18	B	5568	Yes
1026	1	2652	20	B	5552	Yes
1027	1	2608	21	B	5537	Yes
1028	1	1016	52	B	5539	Yes
1029	1	2454	22	B	5560	Yes
1030	1	2346	23	B	5533	Yes

TYPE 2 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 2					
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
2001	1.4	159	25	5543	Yes
2002	2.5	200	24	5541	Yes
2003	3.3	213	23	5565	Yes
2004	2.6	177	27	5565	Yes
2005	3.6	195	27	5535	Yes
2006	3.2	163	27	5567	Yes
2007	2.5	227	27	5567	Yes
2008	2.2	199	28	5535	Yes
2009	1.7	187	25	5559	Yes
2010	3.9	168	27	5531	Yes
2011	1.7	160	28	5550	Yes
2012	4	183	23	5552	Yes
2013	2	222	24	5546	Yes
2014	4.6	212	23	5567	Yes
2015	2.8	174	24	5570	Yes
2016	1.7	168	24	5551	Yes
2017	4.2	215	23	5555	Yes
2018	1.2	174	29	5531	Yes
2019	2	188	28	5558	Yes
2020	1.3	152	25	5541	Yes
2021	2.3	169	24	5568	Yes
2022	1.9	218	25	5547	Yes
2023	1.2	202	25	5538	Yes
2024	3.1	217	26	5569	Yes
2025	2.6	161	23	5546	Yes
2026	2.6	224	25	5559	Yes
2027	4.5	215	26	5542	Yes
2028	2.7	158	27	5563	Yes
2029	4.8	197	29	5564	Yes
2030	3.3	186	28	5561	Yes

TYPE 3 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 3					
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
3001	8.7	496	18	5541	Yes
3002	9.5	477	18	5540	Yes
3003	7.9	372	18	5554	Yes
3004	7.1	499	17	5545	Yes
3005	9.8	288	17	5555	Yes
3006	9.1	428	16	5559	Yes
3007	6	481	17	5557	Yes
3008	7.8	383	16	5553	Yes
3009	9	331	17	5533	Yes
3010	6.8	379	16	5559	Yes
3011	6.3	340	18	5555	Yes
3012	8.5	400	18	5565	Yes
3013	8.2	374	16	5544	Yes
3014	6.4	329	17	5564	Yes
3015	8.5	316	17	5561	Yes
3016	9.2	284	17	5559	No
3017	7.4	417	17	5535	Yes
3018	8.2	398	17	5556	Yes
3019	6.6	426	17	5543	Yes
3020	9.9	419	16	5536	Yes
3021	8.5	460	16	5567	Yes
3022	7.8	348	18	5550	Yes
3023	6.9	402	16	5551	Yes
3024	6.5	436	18	5540	Yes
3025	7.7	252	16	5552	Yes
3026	9.6	299	18	5556	Yes
3027	9.1	261	17	5545	Yes
3028	7.2	321	16	5563	Yes
3029	6.9	295	18	5559	Yes
3030	9.2	250	16	5542	Yes

TYPE 4 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 4					
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
4001	13.8	488	13	5544	Yes
4002	15.2	456	12	5533	Yes
4003	11.2	338	13	5550	Yes
4004	13.1	318	13	5545	Yes
4005	18.7	346	12	5531	Yes
4006	16.8	340	14	5543	Yes
4007	18.5	381	14	5558	Yes
4008	12.3	269	14	5555	Yes
4009	19.3	323	16	5562	Yes
4010	18.3	357	14	5567	No
4011	11.9	423	16	5535	Yes
4012	16.2	471	14	5547	Yes
4013	15.1	432	15	5562	Yes
4014	19.9	492	16	5547	Yes
4015	19.2	466	14	5558	Yes
4016	15.4	421	13	5562	Yes
4017	20	408	16	5556	Yes
4018	12.4	376	15	5561	Yes
4019	17.4	258	12	5547	Yes
4020	19.4	372	14	5538	Yes
4021	15.8	267	15	5539	Yes
4022	13.9	394	13	5558	Yes
4023	15.6	301	12	5569	Yes
4024	14.2	441	15	5569	Yes
4025	16.4	494	14	5553	Yes
4026	15.5	278	12	5543	Yes
4027	13.8	344	15	5563	Yes
4028	13.4	391	15	5560	Yes
4029	12.2	353	13	5534	Yes
4030	17	413	14	5539	Yes

TYPE 5 DETECTION PROBABILITY

Data Sheet for FCC Long Pulse Radar Type 5		
Trial	Frequency (MHz)	Successful Detection (Yes/No)
1	5550	Yes
2	5550	Yes
3	5550	Yes
4	5550	Yes
5	5550	Yes
6	5550	Yes
7	5550	Yes
8	5550	Yes
9	5550	Yes
10	5550	Yes
11	5537	Yes
12	5538	Yes
13	5539	Yes
14	5535	Yes
15	5537	Yes
16	5534	Yes
17	5535	Yes
18	5539	Yes
19	5535	Yes
20	5539	Yes
21	5565	Yes
22	5561	Yes
23	5565	Yes
24	5561	Yes
25	5565	Yes
26	5561	Yes
27	5565	Yes
28	5561	Yes
29	5565	Yes
30	5561	Yes

Note: The Type 5 randomized parameters tested are shown in a separate document.

TYPE 6 DETECTION PROBABILITY

Data Sheet for FCC Hopping Radar Type 6

1 us Pulse Width, 333 us PRI, 9 Pulses per Burst, 1 Burst per Hop

NTIA August 2005 Hopping Sequence

Trial	Starting Index Within Sequence	Signal Generator Frequency (MHz)	Hops within Detection BW	Successful Detection (Yes/No)
1	159	5530	15	Yes
2	634	5531	8	Yes
3	1109	5532	5	Yes
4	1584	5533	7	Yes
5	2059	5534	8	Yes
6	2534	5535	8	Yes
7	3009	5536	12	Yes
8	3484	5537	8	Yes
9	3959	5538	4	Yes
10	4434	5539	12	Yes
11	4909	5540	4	Yes
12	5384	5541	6	Yes
13	5859	5542	5	Yes
14	6334	5543	10	Yes
15	6809	5544	11	Yes
16	7284	5545	8	Yes
17	7759	5546	11	Yes
18	8234	5547	9	Yes
19	8709	5548	9	Yes
20	9184	5549	16	Yes
21	9659	5550	11	Yes
22	10134	5551	4	Yes
23	10609	5552	9	Yes
24	11084	5553	10	Yes
25	11559	5554	9	Yes
26	12034	5555	10	Yes
27	12509	5556	9	Yes
28	12984	5557	11	Yes
29	13459	5558	8	Yes
30	13934	5559	4	Yes
31	14409	5560	13	Yes
32	14884	5561	9	Yes
33	15359	5562	8	Yes
34	15834	5563	8	Yes
35	16309	5564	12	Yes
36	16784	5565	7	Yes
37	17259	5566	11	Yes
38	17734	5567	10	Yes
39	18209	5568	7	Yes
40	18684	5569	6	Yes
41	19159	5570	9	Yes

5.4. BRIDGE MODE RESULTS

Per KDB 905462, Section 5.1 (footnote 1):

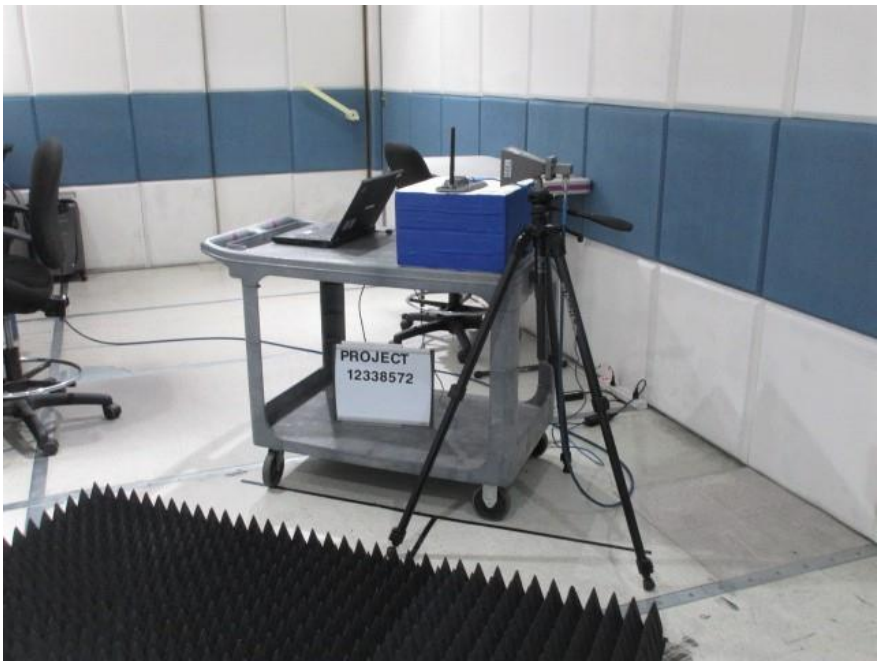
Networks Access Points with Bridge and/or MESH modes of operation are permitted to operate in the DFS bands but must employ a DFS function. The functionality of the Bridge mode as specified in §15.403(a) must be validated in the DFS test report. Devices operating as relays must also employ DFS function. The method used to validate the functionality must be documented and validation data must be documented. Bridge mode can be validated by performing a test statistical performance check (Section 7.8.4) on any one of the radar types. This is an abbreviated test to verify DFS functionality. MESH mode operational methodology must be submitted in the application for certification for evaluation by the FCC.

This device does not support Bridge Mode therefore this test was not performed.

6. SETUP PHOTOS

DYNAMIC FREQUENCY SELECTION MEASUREMENT SETUP

DFS FRONT PHOTO



DFS BACK PHOTO

7. MODEL PMP 450b uPOP DFS EVALUATION

7.1. ATTESTATION OF EVALUATION TEST RESULTS

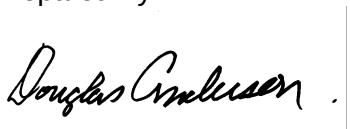
COMPANY NAME:	CAMBIUM NETWORKS 3800 GOLF ROAD ROLLING MEADOWS, IL 60008-4023, U.S.A.
EUT DESCRIPTION:	5 GHz FIXED OUTDOOR WIRELESS TRANSCEIVER
MODEL:	PMP 450b uPop
FCC ID:	Z8H89FT0032
IC:	109W-0032
SERIAL NUMBER:	0a-00-3e-70-80-e2
DATE TESTED:	JUNE 22, 2018

Note: The evaluation test results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Verification Services Inc. By:

HENRY LAU
TEST ENGINEER
UL Verification Services Inc.

Prepared By:



DOUG ANDERSON
EMC ENGINEER
UL Verification Services Inc.

7.2. OVERVIEW

The model PMP 450b uPop is a point to multi-point 5 GHz outdoor fixed access point that incorporates the model PTP 450b (Mid-Gain) assembly as part of its' construction. All aspects of the EUT description, test setup, test software, support peripherals and relevant 5 GHz WLAN RF parameters are identical and can be found on pages 7 through 15 in this report. There is no difference in the implementation of DFS code, thresholds or features between the two models.

7.2.1. PURPOSE

The purpose of this evaluation testing is to demonstrate that the compliance and ability to reliably detect radar of the model PTP450b (Mid-Gain) is maintained when installed in a model PMP 450b uPop unit.

7.2.2. SCOPE

The scope of the evaluation testing encompasses all required tests to demonstrate that the model PMP 450b uPop reliably detects all FCC/IC radar forms. The tests include: traffic/channel loading, detection bandwidth and in-service monitoring.

7.2.3. TEST ROOM ENVIRONMENT

The test room temperature and humidity shall be maintained within normal temperature of 15~35 °C and normal humidity 20~75% (relative humidity).

ENVIRONMENT CONDITION

Parameter	Value
Temperature	26.8 °C
Humidity	33 %

7.3. EVALUATION RESULTS FOR 10 MHz BANDWIDTH

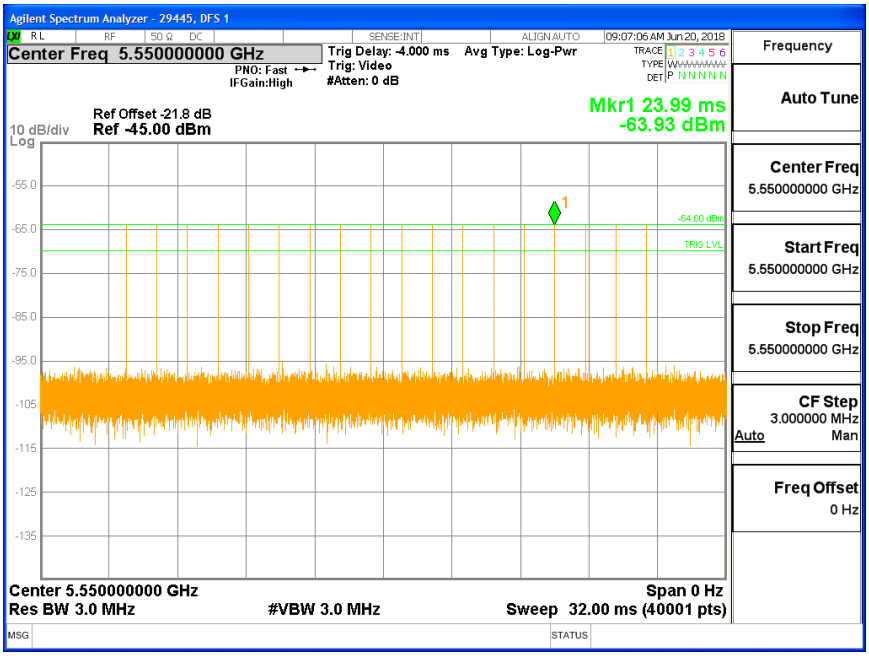
7.3.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5550 MHz.

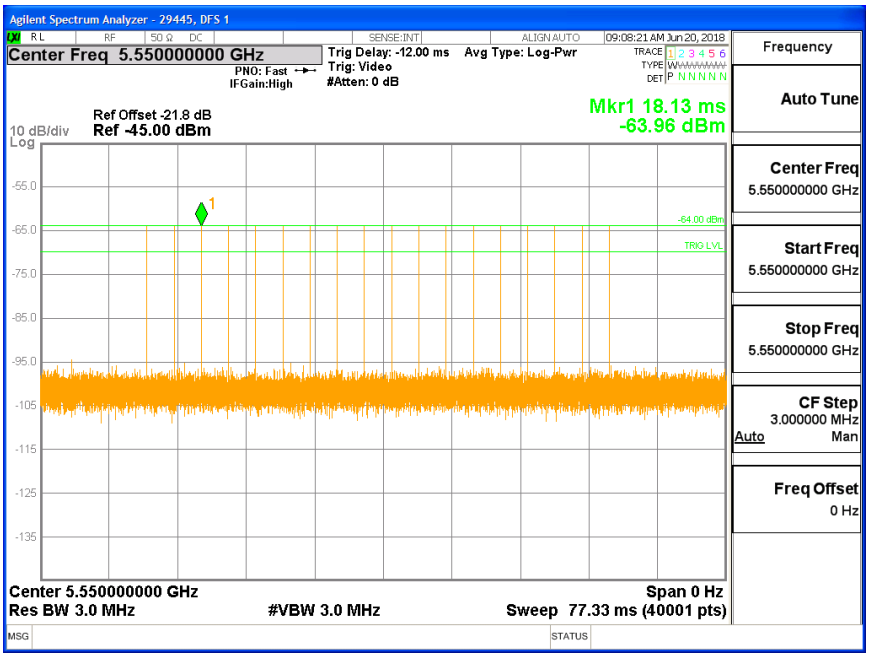
7.3.2. RADAR WAVEFORMS AND TRAFFIC

RADAR WAVEFORMS

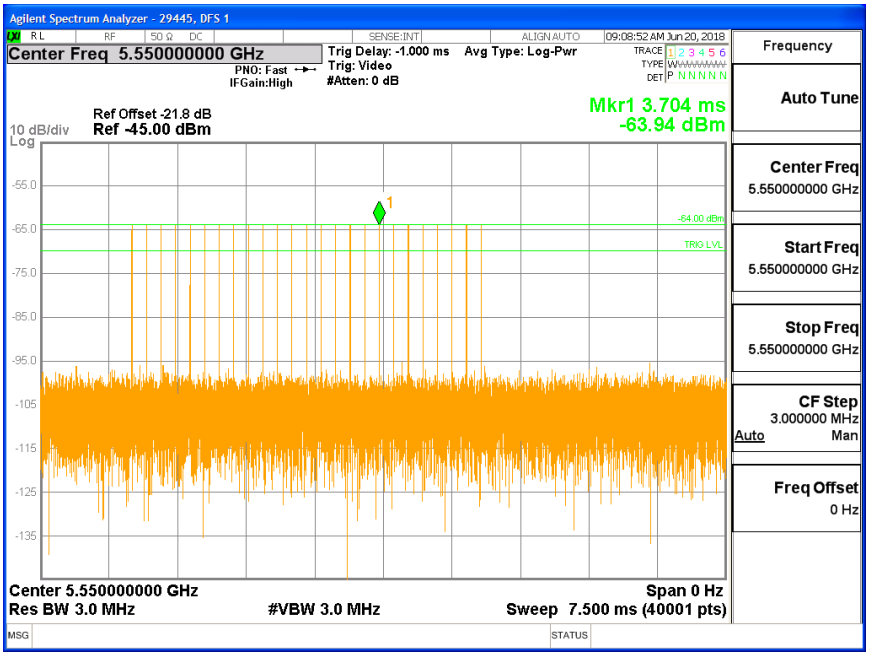
SHORT PULSE RADAR TYPE 0



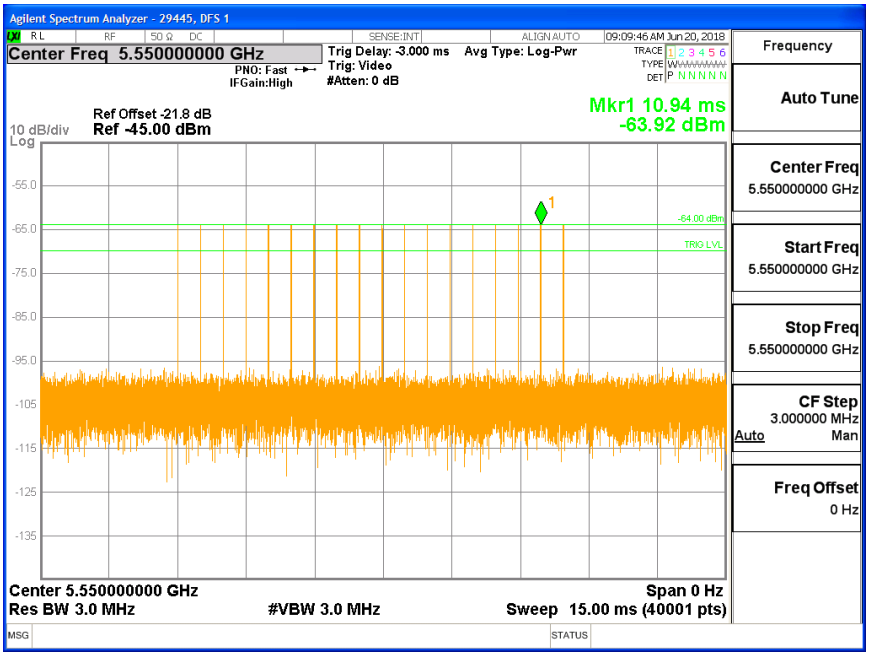
SAMPLE OF RADAR TYPE 1



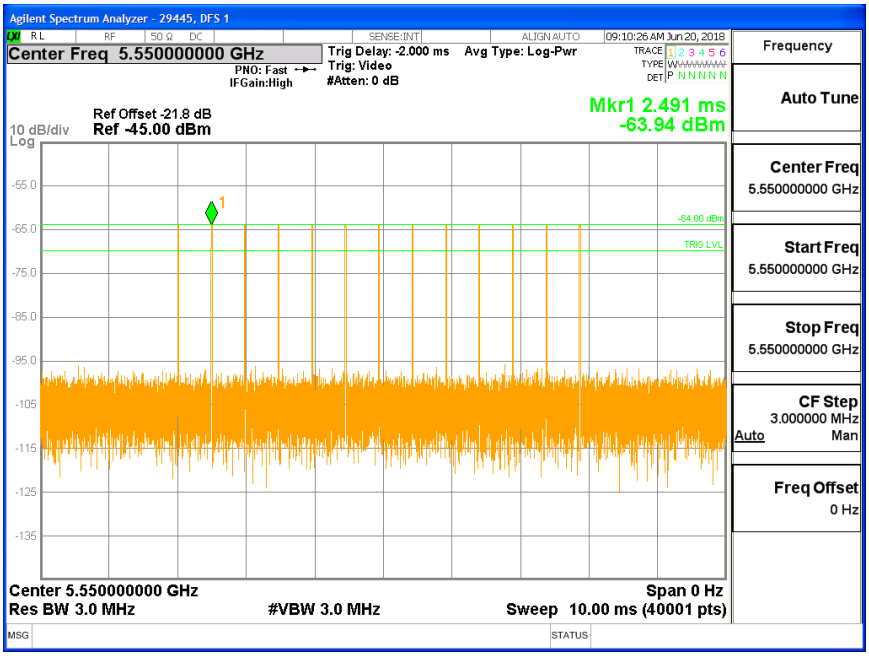
SAMPLE OF RADAR TYPE 2



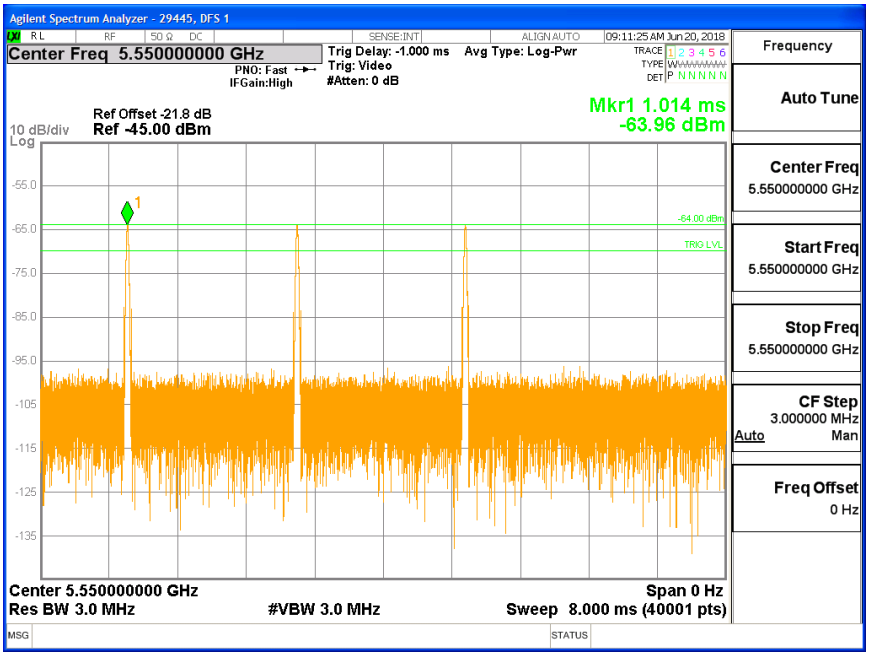
SAMPLE OF RADAR TYPE 3



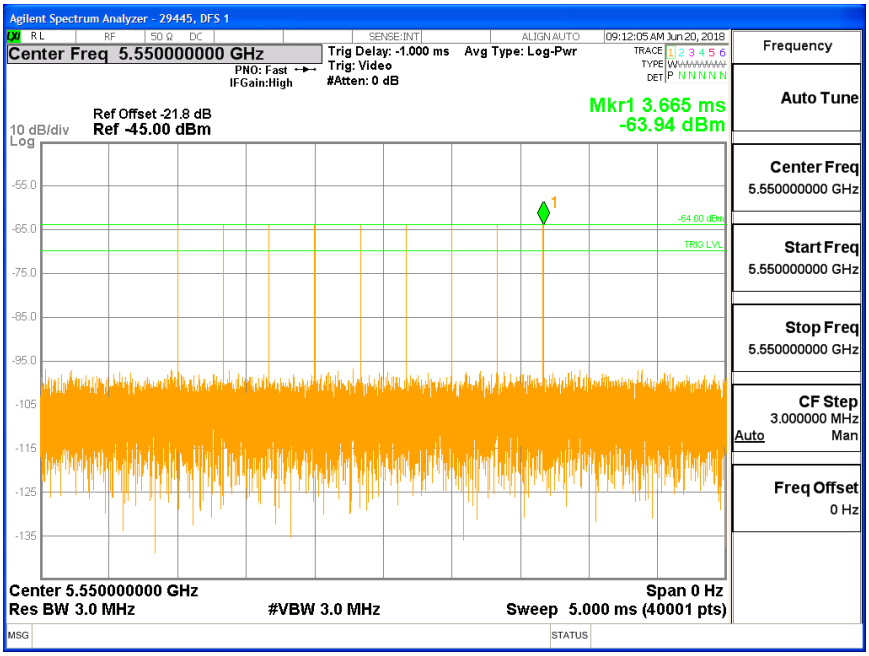
SAMPLE OF RADAR TYPE 4



SAMPLE OF SINGLE BURST OF RADAR TYPE 5

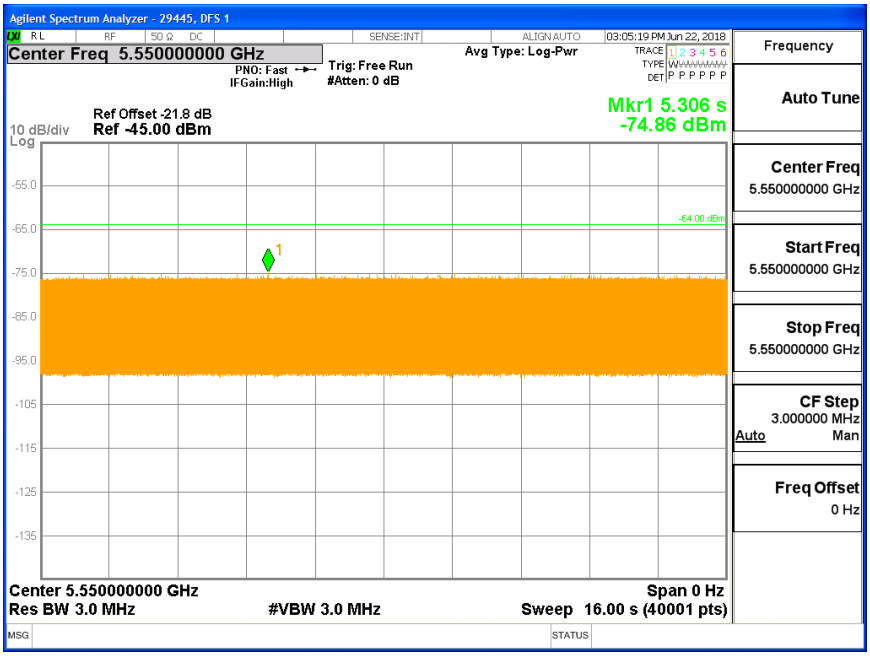


SINGLE BURST OF RADAR TYPE 6

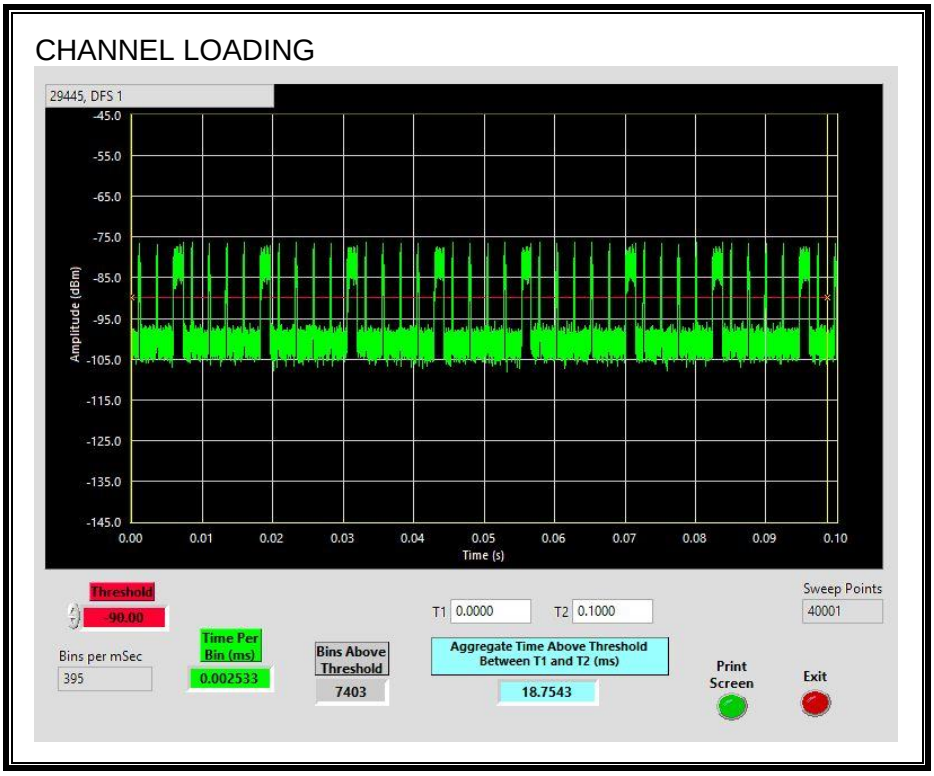


TRAFFIC

TRAFFIC



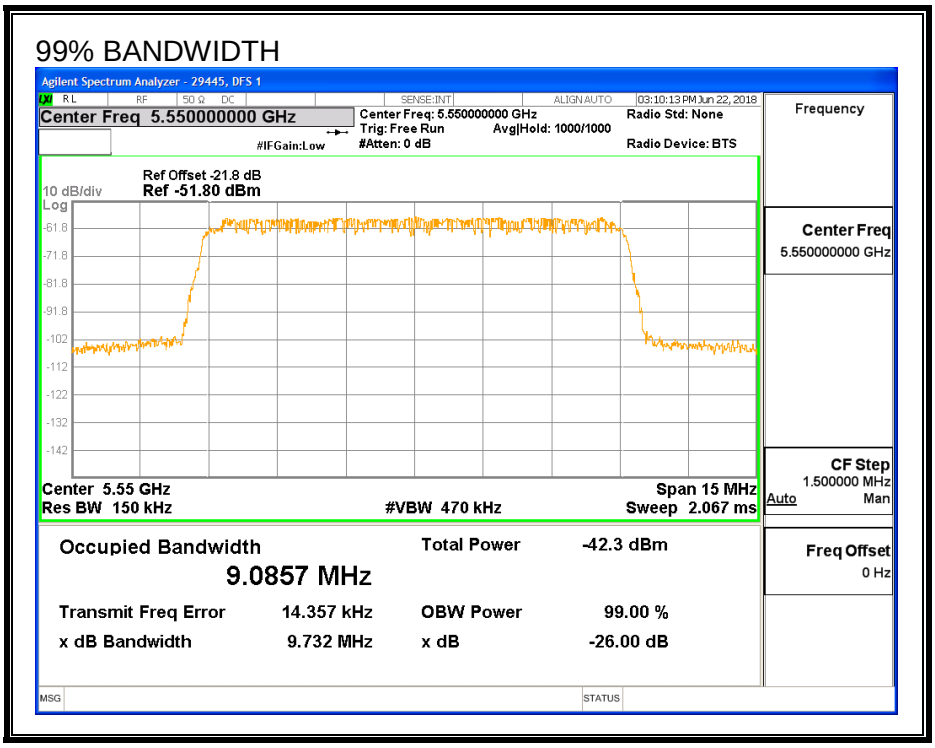
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 18.75%

7.3.3. DETECTION BANDWIDTH

REFERENCE PLOT OF 99% POWER BANDWIDTH



RESULTS

FL (MHz)	FH (MHz)	Detection Bandwidth (MHz)	99% Power Bandwidth (MHz)	Ratio of Detection BW to 99% Power BW (%)	Minimum Limit (%)
5545.0	5555.0	10.0	9.086	110.1	100

DETECTION BANDWIDTH PROBABILITY

DETECTION BANDWIDTH PROBABILITY RESULTS

Detection Bandwidth Test Results		29445	DFS 1	
FCC Type 0 Waveform: 1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst				
Frequency (MHz)	Number of Trials	Number Detected	Detection (%)	Mark
5545	10	10	100	FL
5550	10	10	100	
5555	10	10	100	FH

7.3.4. IN-SERVICE MONITORING

RESULTS

FCC Radar Test Summary

Signal Type	Number of Trials	Detection (%)	Limit (%)	Pass/Fail	Detection Bandwidth FL	Detection Bandwidth FH	OBW	Test Location	Employee Number	In-Service Monitoring Version
FCC Short Pulse Type 1	30	96.67	60	Pass	5545	5555	9.09	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 2	30	86.67	60	Pass	5545	5555	9.09	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 3	30	76.67	60	Pass	5545	5555	9.09	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 4	30	83.33	60	Pass	5545	5555	9.09	DFS 1	29445	Version 3.3.4
Aggregate		85.83	80	Pass						
FCC Long Pulse Type 5	30	100.00	80	Pass	5545	5555	9.09	DFS 1	29445	Version 3.3.4
FCC Hopping Type 6	33	75.76	70	Pass	5545	5555		DFS 1	29445	Version 3.3.4

TYPE 1 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 1

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Test (A/B)	Frequency (MHz)	Successful Detection (Yes/No)
1001	1	3066	18	A	5551	Yes
1002	1	558	95	A	5553	Yes
1003	1	538	99	A	5548	Yes
1004	1	818	65	A	5549	Yes
1005	1	898	59	A	5548	Yes
1006	1	718	74	A	5548	Yes
1007	1	598	89	A	5552	Yes
1008	1	878	61	A	5550	Yes
1009	1	578	92	A	5549	Yes
1010	1	678	78	A	5547	Yes
1011	1	938	57	A	5546	Yes
1012	1	918	58	A	5555	Yes
1013	1	618	86	A	5546	Yes
1014	1	798	67	A	5553	Yes
1015	1	838	63	A	5547	Yes
1016	1	1257	42	B	5549	No
1017	1	2955	18	B	5548	Yes
1018	1	1910	28	B	5548	Yes
1019	1	2543	21	B	5545	Yes
1020	1	1628	33	B	5554	Yes
1021	1	2390	23	B	5551	Yes
1022	1	1604	33	B	5549	Yes
1023	1	1301	41	B	5549	Yes
1024	1	1998	27	B	5552	Yes
1025	1	3019	18	B	5553	Yes
1026	1	2652	20	B	5547	Yes
1027	1	2608	21	B	5551	Yes
1028	1	1016	52	B	5554	Yes
1029	1	2454	22	B	5552	Yes
1030	1	2346	23	B	5553	Yes

TYPE 2 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 2

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
2001	1.4	159	25	5546	No
2002	2.5	200	24	5548	Yes
2003	3.3	213	23	5546	Yes
2004	2.6	177	27	5547	Yes
2005	3.6	195	27	5545	No
2006	3.2	163	27	5546	Yes
2007	2.5	227	27	5546	Yes
2008	2.2	199	28	5548	Yes
2009	1.7	187	25	5554	Yes
2010	3.9	168	27	5552	Yes
2011	1.7	160	28	5547	Yes
2012	4	183	23	5547	Yes
2013	2	222	24	5555	Yes
2014	4.6	212	23	5553	Yes
2015	2.8	174	24	5551	Yes
2016	1.7	168	24	5549	Yes
2017	4.2	215	23	5546	Yes
2018	1.2	174	29	5554	Yes
2019	2	188	28	5553	No
2020	1.3	152	25	5553	No
2021	2.3	169	24	5551	Yes
2022	1.9	218	25	5548	Yes
2023	1.2	202	25	5552	Yes
2024	3.1	217	26	5547	Yes
2025	2.6	161	23	5546	Yes
2026	2.6	224	25	5551	Yes
2027	4.5	215	26	5553	Yes
2028	2.7	158	27	5546	Yes
2029	4.8	197	29	5554	Yes
2030	3.3	186	28	5548	Yes

TYPE 3 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 3					
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
3001	8.7	496	18	5554	No
3002	9.5	477	18	5549	No
3003	7.9	372	18	5550	Yes
3004	7.1	499	17	5550	No
3005	9.8	288	17	5546	Yes
3006	9.1	428	16	5554	No
3007	6	481	17	5552	Yes
3008	7.8	383	16	5546	Yes
3009	9	331	17	5554	Yes
3010	6.8	379	16	5548	Yes
3011	6.3	340	18	5548	Yes
3012	8.5	400	18	5549	Yes
3013	8.2	374	16	5548	Yes
3014	6.4	329	17	5551	Yes
3015	8.5	316	17	5554	Yes
3016	9.2	284	17	5546	Yes
3017	7.4	417	17	5554	Yes
3018	8.2	398	17	5552	Yes
3019	6.6	426	17	5555	No
3020	9.9	419	16	5545	No
3021	8.5	460	16	5550	Yes
3022	7.8	348	18	5548	Yes
3023	6.9	402	16	5553	No
3024	6.5	436	18	5551	Yes
3025	7.7	252	16	5550	Yes
3026	9.6	299	18	5548	Yes
3027	9.1	261	17	5547	Yes
3028	7.2	321	16	5551	Yes
3029	6.9	295	18	5551	Yes
3030	9.2	250	16	5550	Yes

TYPE 4 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 4					
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
4001	13.8	488	13	5545	No
4002	15.2	456	12	5546	Yes
4003	11.2	338	13	5550	Yes
4004	13.1	318	13	5549	Yes
4005	18.7	346	12	5554	Yes
4006	16.8	340	14	5550	Yes
4007	18.5	381	14	5554	Yes
4008	12.3	269	14	5554	No
4009	19.3	323	16	5551	Yes
4010	18.3	357	14	5548	No
4011	11.9	423	16	5553	Yes
4012	16.2	471	14	5546	No
4013	15.1	432	15	5555	No
4014	19.9	492	16	5553	Yes
4015	19.2	466	14	5547	Yes
4016	15.4	421	13	5545	Yes
4017	20	408	16	5554	Yes
4018	12.4	376	15	5548	Yes
4019	17.4	258	12	5550	Yes
4020	19.4	372	14	5547	Yes
4021	15.8	267	15	5554	Yes
4022	13.9	394	13	5549	Yes
4023	15.6	301	12	5548	Yes
4024	14.2	441	15	5550	Yes
4025	16.4	494	14	5552	Yes
4026	15.5	278	12	5553	Yes
4027	13.8	344	15	5546	Yes
4028	13.4	391	15	5549	Yes
4029	12.2	353	13	5549	Yes
4030	17	413	14	5548	Yes

TYPE 5 DETECTION PROBABILITY

Data Sheet for FCC Long Pulse Radar Type 5		
Trial	Frequency (MHz)	Successful Detection (Yes/No)
1	5550	Yes
2	5550	Yes
3	5550	Yes
4	5550	Yes
5	5550	Yes
6	5550	Yes
7	5550	Yes
8	5550	Yes
9	5550	Yes
10	5550	Yes
11	5552	Yes
12	5552	Yes
13	5554	Yes
14	5549	Yes
15	5551	Yes
16	5548	Yes
17	5549	Yes
18	5554	Yes
19	5549	Yes
20	5554	Yes
21	5551	Yes
22	5547	Yes
23	5551	Yes
24	5547	Yes
25	5551	Yes
26	5547	Yes
27	5551	Yes
28	5547	Yes
29	5551	Yes
30	5547	Yes

Note: The Type 5 randomized parameters tested are shown in a separate document.

TYPE 6 DETECTION PROBABILITY

Data Sheet for FCC Hopping Radar Type 6				
1 us Pulse Width, 333 us PRI, 9 Pulses per Burst, 1 Burst per Hop				
NTIA August 2005 Hopping Sequence				
Trial	Starting Index Within Sequence	Signal Generator Frequency (MHz)	Hops within Detection BW	Successful Detection (Yes/No)
1	191	5545	1	Yes
2	666	5546	2	Yes
3	1141	5547	3	Yes
4	1616	5548	1	Yes
5	2091	5549	3	Yes
6	2566	5550	2	Yes
7	3516	5551	3	No
8	3991	5552	2	Yes
9	4941	5553	2	Yes
10	5416	5554	2	No
11	5891	5555	3	Yes
12	6366	5545	4	Yes
13	6841	5546	4	Yes
14	7316	5547	1	Yes
15	7791	5548	1	No
16	8266	5549	2	Yes
17	9216	5550	5	Yes
18	9691	5551	3	Yes
19	10166	5552	3	Yes
20	10641	5553	3	Yes
21	11116	5554	1	No
22	11591	5555	2	No
23	12066	5545	3	Yes
24	12541	5546	2	Yes
25	13016	5547	5	Yes
26	13491	5548	2	Yes
27	13966	5549	1	No
28	14441	5550	1	Yes
29	14916	5551	5	Yes
30	15391	5552	1	Yes
31	15866	5553	2	No
32	16341	5554	2	No
33	16816	5555	3	Yes

7.4. EVALUATION RESULTS FOR 40 MHz BANDWIDTH

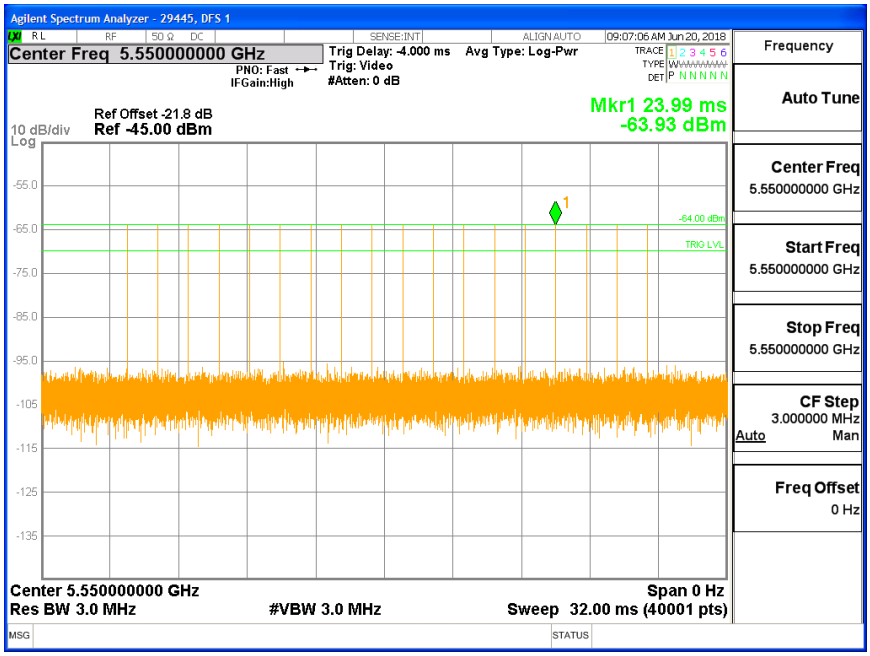
7.4.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5550 MHz.

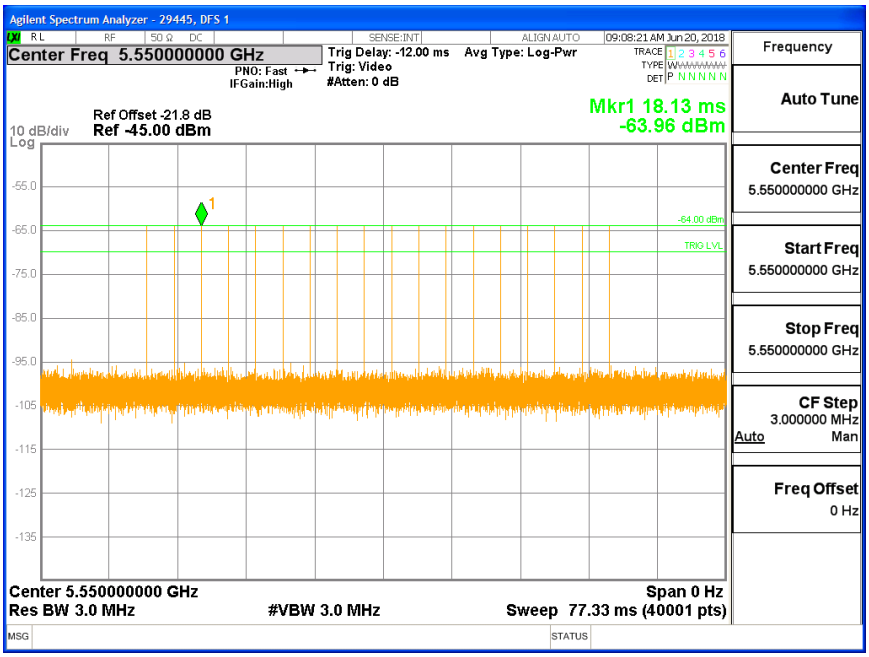
7.4.2. RADAR WAVEFORMS AND TRAFFIC

RADAR WAVEFORMS

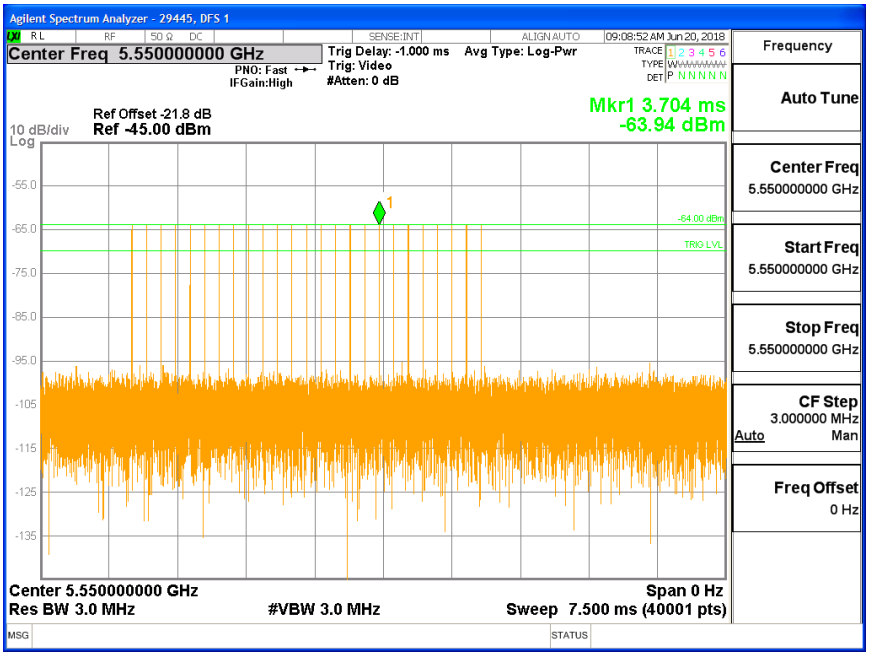
SHORT PULSE RADAR TYPE 0



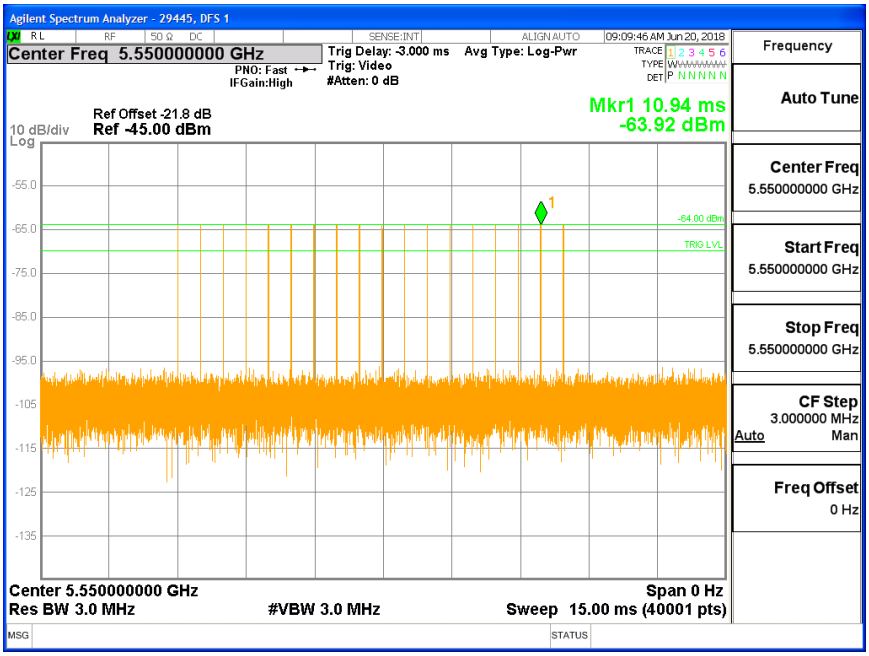
SAMPLE OF RADAR TYPE 1



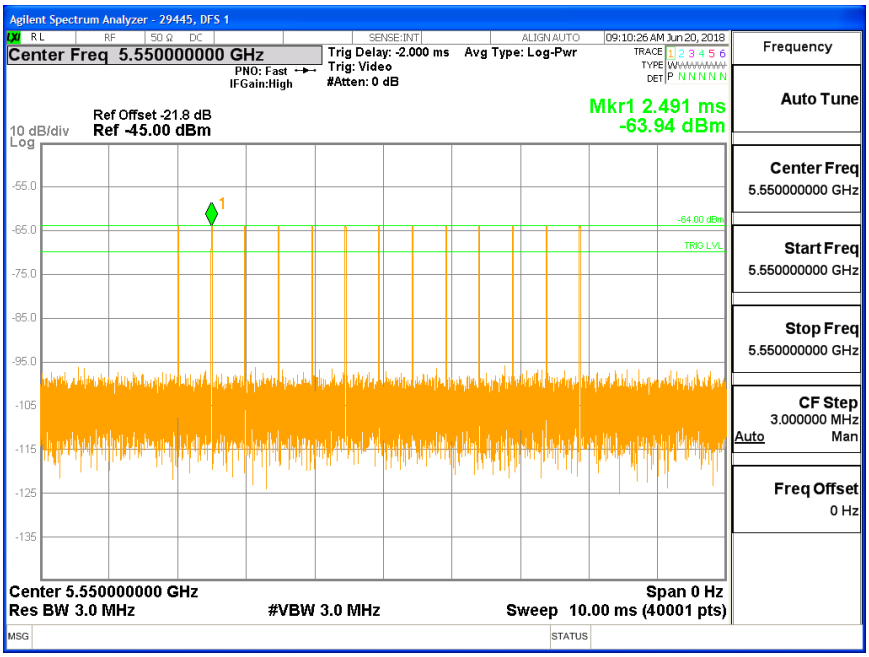
SAMPLE OF RADAR TYPE 2



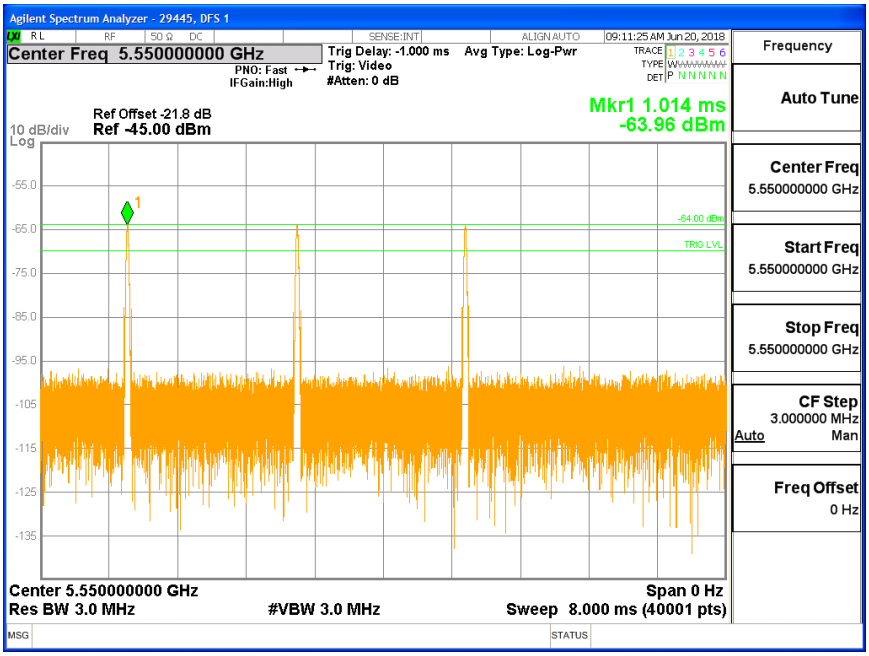
SAMPLE OF RADAR TYPE 3



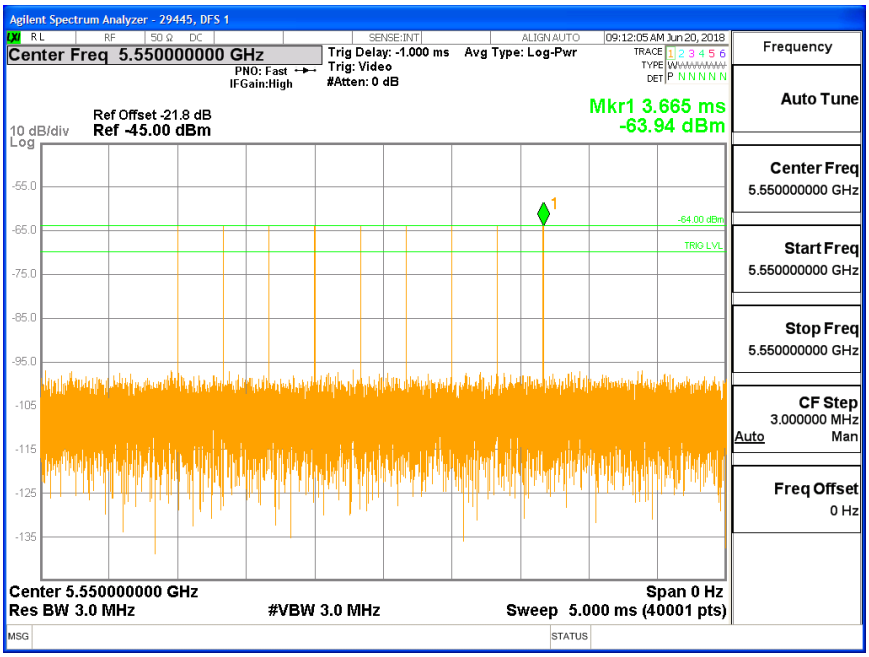
SAMPLE OF RADAR TYPE 4



SAMPLE OF SINGLE BURST OF RADAR TYPE 5

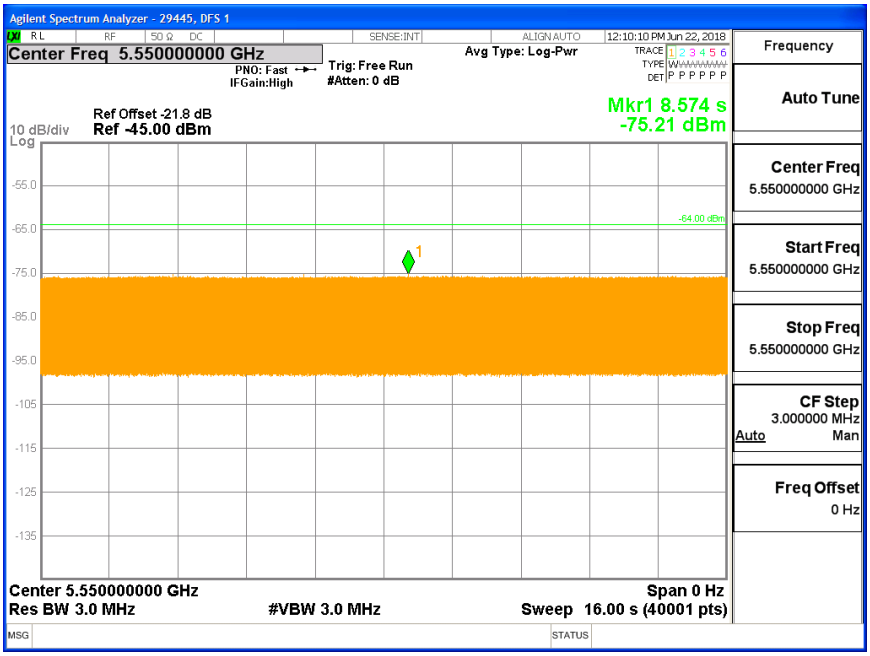


SINGLE BURST OF RADAR TYPE 6

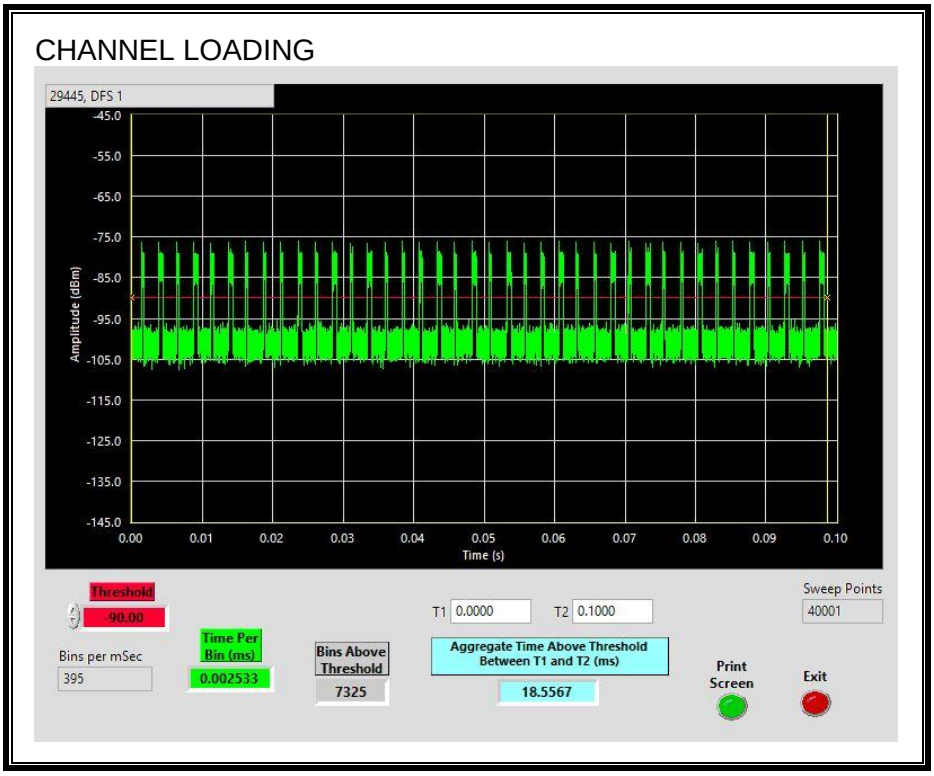


TRAFFIC

TRAFFIC



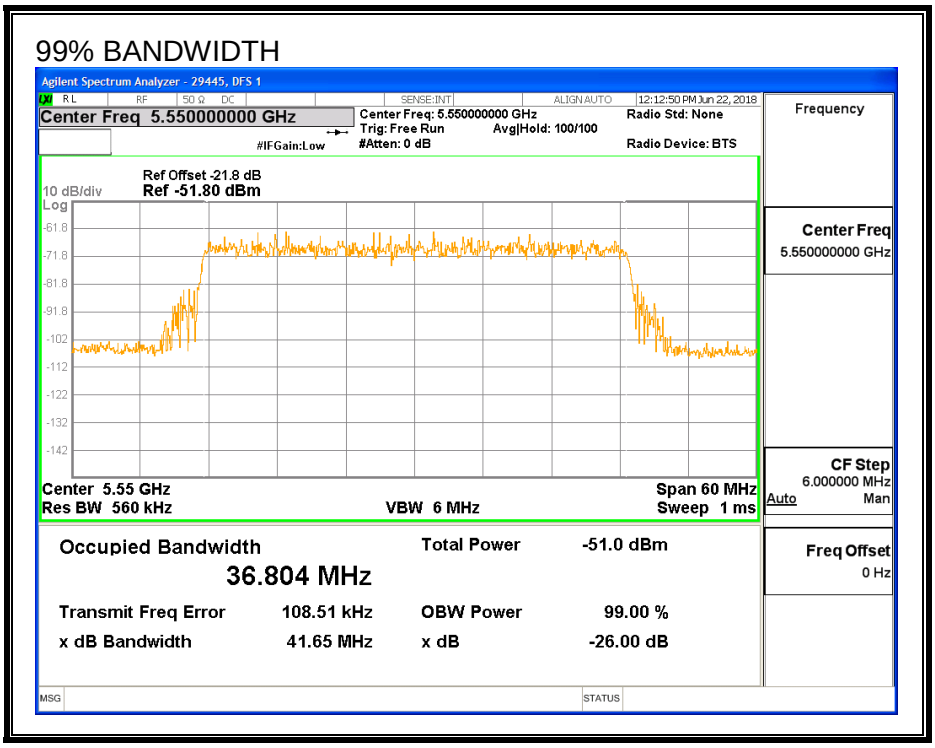
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 18.55%

7.4.3. DETECTION BANDWIDTH

REFERENCE PLOT OF 99% POWER BANDWIDTH



RESULTS

FL (MHz)	FH (MHz)	Detection Bandwidth (MHz)	99% Power Bandwidth (MHz)	Ratio of Detection BW to 99% Power BW (%)	Minimum Limit (%)
5530	5570	40	36.804	108.7	100

DETECTION BANDWIDTH PROBABILITY

DETECTION BANDWIDTH PROBABILITY RESULTS

Detection Bandwidth Test Results		29445	DFS 1	
FCC Type 0 Waveform: 1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst				
Frequency (MHz)	Number of Trials	Number Detected	Detection (%)	Mark
5530	10	10	100	FL
5535	10	10	100	
5540	10	10	100	
5545	10	10	100	
5550	10	10	100	
5555	10	10	100	
5560	10	10	100	
5565	10	10	100	
5570	10	10	100	FH

7.4.4. IN-SERVICE MONITORING

RESULTS

FCC Radar Test Summary

Signal Type	Number of Trials	Detection (%)	Limit (%)	Pass/Fail	Detection Bandwidth FL	Detection Bandwidth FH	OBW	Test Location	Employee Number	In-Service Monitoring Version
FCC Short Pulse Type 1	30	83.33	60	Pass	5530	5570	36.8	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 2	30	90.00	60	Pass	5530	5570	36.8	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 3	30	83.33	60	Pass	5530	5570	36.8	DFS 1	29445	Version 3.3.4
FCC Short Pulse Type 4	30	66.67	60	Pass	5530	5570	36.8	DFS 1	29445	Version 3.3.4
Aggregate		80.83	80	Pass						
FCC Long Pulse Type 5	30	100.00	80	Pass	5530	5570	36.8	DFS 1	29445	Version 3.3.4
FCC Hopping Type 6	41	87.81	70	Pass	5530	5570		DFS 1	29445	Version 3.3.4

TYPE 1 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 1

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Test (A/B)	Frequency (MHz)	Successful Detection (Yes/No)
1001	1	3066	18	A	5542	Yes
1002	1	558	95	A	5546	Yes
1003	1	538	99	A	5565	Yes
1004	1	818	65	A	5550	Yes
1005	1	898	59	A	5563	Yes
1006	1	718	74	A	5568	Yes
1007	1	598	89	A	5564	Yes
1008	1	878	61	A	5556	Yes
1009	1	578	92	A	5557	Yes
1010	1	678	78	A	5535	Yes
1011	1	938	57	A	5568	Yes
1012	1	918	58	A	5533	Yes
1013	1	618	86	A	5568	Yes
1014	1	798	67	A	5552	Yes
1015	1	838	63	A	5561	Yes
1016	1	1257	42	B	5541	No
1017	1	2955	18	B	5559	No
1018	1	1910	28	B	5557	Yes
1019	1	2543	21	B	5545	No
1020	1	1628	33	B	5539	Yes
1021	1	2390	23	B	5536	Yes
1022	1	1604	33	B	5566	Yes
1023	1	1301	41	B	5543	Yes
1024	1	1998	27	B	5567	Yes
1025	1	3019	18	B	5536	No
1026	1	2652	20	B	5570	No
1027	1	2608	21	B	5562	Yes
1028	1	1016	52	B	5537	Yes
1029	1	2454	22	B	5544	Yes
1030	1	2346	23	B	5570	Yes

TYPE 2 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 2

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
2001	1.4	159	25	5567	Yes
2002	2.5	200	24	5553	Yes
2003	3.3	213	23	5552	Yes
2004	2.6	177	27	5542	Yes
2005	3.6	195	27	5533	Yes
2006	3.2	163	27	5545	Yes
2007	2.5	227	27	5531	Yes
2008	2.2	199	28	5566	Yes
2009	1.7	187	25	5536	Yes
2010	3.9	168	27	5561	Yes
2011	1.7	160	28	5531	Yes
2012	4	183	23	5553	Yes
2013	2	222	24	5567	Yes
2014	4.6	212	23	5543	Yes
2015	2.8	174	24	5546	No
2016	1.7	168	24	5532	No
2017	4.2	215	23	5538	Yes
2018	1.2	174	29	5538	Yes
2019	2	188	28	5539	Yes
2020	1.3	152	25	5554	Yes
2021	2.3	169	24	5563	No
2022	1.9	218	25	5559	Yes
2023	1.2	202	25	5559	Yes
2024	3.1	217	26	5557	Yes
2025	2.6	161	23	5548	Yes
2026	2.6	224	25	5555	Yes
2027	4.5	215	26	5537	Yes
2028	2.7	158	27	5539	Yes
2029	4.8	197	29	5558	Yes
2030	3.3	186	28	5540	Yes

TYPE 3 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 3					
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
3001	8.7	496	18	5543	No
3002	9.5	477	18	5535	Yes
3003	7.9	372	18	5551	Yes
3004	7.1	499	17	5566	Yes
3005	9.8	288	17	5549	Yes
3006	9.1	428	16	5551	Yes
3007	6	481	17	5543	No
3008	7.8	383	16	5536	No
3009	9	331	17	5549	Yes
3010	6.8	379	16	5559	Yes
3011	6.3	340	18	5543	Yes
3012	8.5	400	18	5538	Yes
3013	8.2	374	16	5533	Yes
3014	6.4	329	17	5556	Yes
3015	8.5	316	17	5533	Yes
3016	9.2	284	17	5570	Yes
3017	7.4	417	17	5532	No
3018	8.2	398	17	5545	Yes
3019	6.6	426	17	5538	Yes
3020	9.9	419	16	5535	Yes
3021	8.5	460	16	5533	Yes
3022	7.8	348	18	5555	Yes
3023	6.9	402	16	5568	Yes
3024	6.5	436	18	5531	Yes
3025	7.7	252	16	5537	Yes
3026	9.6	299	18	5535	Yes
3027	9.1	261	17	5551	Yes
3028	7.2	321	16	5554	Yes
3029	6.9	295	18	5534	Yes
3030	9.2	250	16	5565	No

TYPE 4 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 4

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
4001	13.8	488	13	5537	No
4002	15.2	456	12	5562	No
4003	11.2	338	13	5556	No
4004	13.1	318	13	5563	Yes
4005	18.7	346	12	5537	No
4006	16.8	340	14	5530	Yes
4007	18.5	381	14	5567	Yes
4008	12.3	269	14	5538	Yes
4009	19.3	323	16	5567	Yes
4010	18.3	357	14	5558	Yes
4011	11.9	423	16	5531	Yes
4012	16.2	471	14	5546	Yes
4013	15.1	432	15	5565	No
4014	19.9	492	16	5531	Yes
4015	19.2	466	14	5559	Yes
4016	15.4	421	13	5545	No
4017	20	408	16	5542	Yes
4018	12.4	376	15	5539	Yes
4019	17.4	258	12	5553	Yes
4020	19.4	372	14	5541	Yes
4021	15.8	267	15	5531	Yes
4022	13.9	394	13	5543	Yes
4023	15.6	301	12	5570	Yes
4024	14.2	441	15	5534	No
4025	16.4	494	14	5551	No
4026	15.5	278	12	5567	Yes
4027	13.8	344	15	5563	Yes
4028	13.4	391	15	5557	Yes
4029	12.2	353	13	5532	No
4030	17	413	14	5547	No

TYPE 5 DETECTION PROBABILITY

Data Sheet for FCC Long Pulse Radar Type 5		
Trial	Frequency (MHz)	Successful Detection (Yes/No)
1	5550	Yes
2	5550	Yes
3	5550	Yes
4	5550	Yes
5	5550	Yes
6	5550	Yes
7	5550	Yes
8	5550	Yes
9	5550	Yes
10	5550	Yes
11	5538	Yes
12	5539	Yes
13	5540	Yes
14	5535	Yes
15	5537	Yes
16	5534	Yes
17	5535	Yes
18	5540	Yes
19	5535	Yes
20	5540	Yes
21	5565	Yes
22	5560	Yes
23	5565	Yes
24	5560	Yes
25	5565	Yes
26	5560	Yes
27	5565	Yes
28	5560	Yes
29	5565	Yes
30	5560	Yes

Note: The Type 5 randomized parameters tested are shown in a separate document.

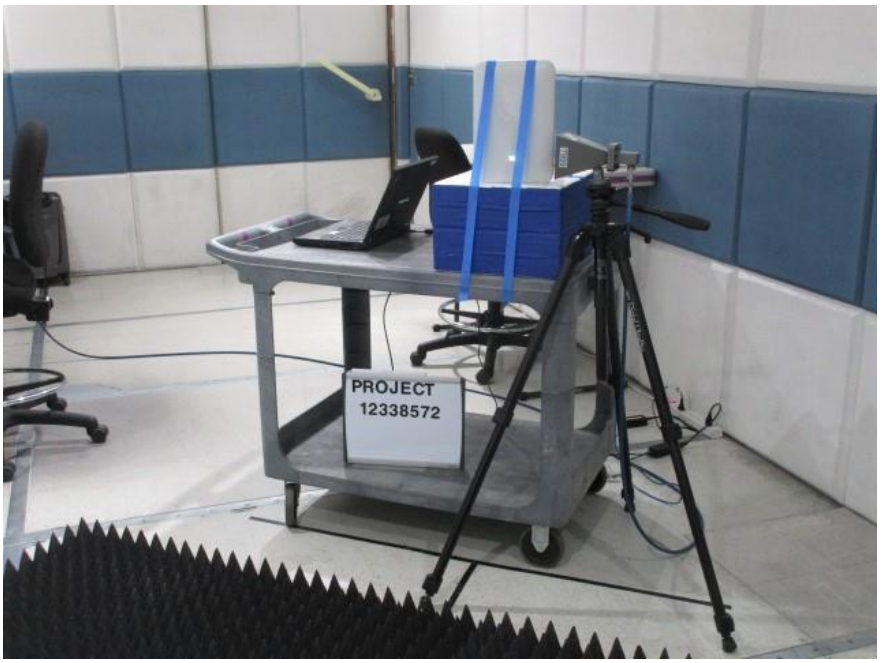
TYPE 6 DETECTION PROBABILITY

Data Sheet for FCC Hopping Radar Type 6				
1 us Pulse Width, 333 us PRI, 9 Pulses per Burst, 1 Burst per Hop				
NTIA August 2005 Hopping Sequence				
Trial	Starting Index Within Sequence	Signal Generator Frequency (MHz)	Hops within Detection BW	Successful Detection (Yes/No)
1	317	5530	5	Yes
2	792	5531	12	Yes
3	1267	5532	10	Yes
4	1742	5533	14	Yes
5	2217	5534	10	Yes
6	2692	5535	7	Yes
7	3167	5536	5	Yes
8	3642	5537	3	No
9	4117	5538	10	Yes
10	4592	5539	8	Yes
11	5067	5540	5	Yes
12	5542	5541	6	Yes
13	6017	5542	6	Yes
14	6492	5543	8	Yes
15	6967	5544	8	No
16	7442	5545	10	Yes
17	7917	5546	13	Yes
18	8392	5547	8	Yes
19	8867	5548	12	Yes
20	9342	5549	6	No
21	9817	5550	11	Yes
22	10292	5551	12	Yes
23	10767	5552	9	Yes
24	11242	5553	9	Yes
25	11717	5554	6	No
26	12192	5555	5	Yes
27	12667	5556	11	Yes
28	13142	5557	8	Yes
29	13617	5558	7	No
30	14092	5559	10	Yes
31	14567	5560	5	Yes
32	15042	5561	6	Yes
33	15517	5562	5	Yes
34	15992	5563	9	Yes
35	16467	5564	6	Yes
36	16942	5565	6	Yes
37	17417	5566	4	Yes
38	17892	5567	7	Yes
39	18367	5568	10	Yes
40	18842	5569	11	Yes
41	19317	5570	10	Yes

7.5. EVALUATION SETUP PHOTOS

DYNAMIC FREQUENCY SELECTION MEASUREMENT SETUP

DFS FRONT PHOTO



DFS BACK PHOTO

END OF REPORT