

RADIO DFS TEST REPORT

Report No.: STS2012039W05

Issued for

NEUROMOTION INC.

200 Portland Street 5F, Boston MA 02114

A B

Product Name:	MT004-20
Brand Name:	Mightier
Model Name:	MT004-20
Series Model:	N/A
FCC ID:	2AX89-MT004-20
Test Standard:	FCC Part 15.407

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APPROVAL

Shenzhen STS Test Services Co., Ltd.
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TEST REPORT CERTIFICATION

Applicant's Name.....: NEUROMOTION INC.

Address: 200 Portland Street 5F, Boston MA 02114

Manufacture's Name.....: Shenzhen Pretech Industrial Co., Ltd

Nanshan District, Shenzhen 518057, China

Product Description

Product Name.....: MT004-20

Brand Name: Mightier

Model Name: MT004-20

Series Model.....: N/A

Test Standards FCC Part 15.407

905462 D02 UNII DFS Compliance Procedures New Rules v02

Test Procedure 905462 D03 UNII Clients Without Radar Detection New Rules

v01r02

This device described above has been tested by STS, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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Date of Test

Date of receipt of test item 07 Dec. 2020

Test Result..... Pass

Testing Engineer :

(Chris Chen)

Technical Manager :

(Sean she)

Authorized Signatory:

(Vita Li)







Table of Contents

1. SUMMARY OF TEST RESULTS	5
1.1 TEST FACTORY	5
1.2 MEASUREMENT UNCERTAINTY	5
2. GENERAL INFORMATION	6
2.1 GENERAL DESCRIPTION OF THE EUT	6
2.2 TEST CONDITIONS AND CHANNEL	8
2.3 DFS MEASUREMENT INSTRUMENTATION	10
2.4 EQUIPMENTS LIST FOR ALL TEST ITEMS	11
3. DFS PARAMETERS	12
3.1 DFS PARAMETERS	12
3.2 DFS -TEST RESULTS	16
Non-Occupancy	20





Revision History

Rev.	Issue Date	Report NO.	Effect Page	Contents
00	23 Dec. 2020	STS2012039W05	ALL	Initial Issue



Report No.: STS2012039W05



1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards: KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 and 905462 D03 UNII Clients Without Radar Detection New Rules v01r02

Part 15.407						
Requirement	Operation	onal Mode	RESULTS			
Requirement	Master	Client	RESOLIS			
Non-Occupancy Period	Yes	Yes	Pass			
DFS Detection Threshold	Yes	Not required	Not required			
Channel Availability Check Time	Yes	Not required	Not required			
Channel Closing Transmission Time	Yes	Yes	Pass			
Channel Move Time	Yes	Yes	Pass			
U-NII Detection Bandwidth	Yes	Not required	Not required			

1.1 TEST FACTORY

SHENZHEN STS TEST SERVICES CO., LTD

Add.: A 1/F, Building B, Zhuoke Science Park, No.190 Chongqing Road, HepingShequ,

Fuyong Sub-District, Bao'an District, Shenzhen, Guang Dong, China

FCC test Firm Registration Number: 625569

IC test Firm Registration Number: 12108A

A2LA Certificate No.: 4338.01

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement $\mathbf{y} \pm \mathbf{U}$, where expended uncertainty \mathbf{U} is based on a standard uncertainty multiplied by a coverage factor of $\mathbf{k=2}$, providing a level of confidence of approximately $\mathbf{95}$ %.

No.	Item	Uncertainty
1	DFS Threshold (radiated)	±1.50dB
2	DFS Threshold (conducted)	±1.45dB
7	Temperature	±0.5°C
8	Humidity	±2%

Report No.: STS2012039W05

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF THE EUT

Product Name	MT004-20				
Brand Name	Mightier				
Model Name	MT004-20				
Series Model	N/A				
Model Difference	N/A				
	The EUT is MT00	4-20			
		802.11a/n/ac(20):5260 MHz -5320 MHz			
Product Description		802.11a/n/ac(40):5270 MHz -5310 MHz			
	Operation	802.11ac(80) 5290MHz			
	Frequency:	802.11a/n/ac(20):5500 MHz -5700 MHz			
		802.11a/n/ac(40):5510 MHz -5670 MHz			
		802.11ac(80): 5530MHz-5610MHz			
	Modulation Type:	802.11a(OFDM): BPSK,QPSK,16-QAM,64-QAM 802.11n(OFDM): BPSK,QPSK,16-QAM,64-QAM 802.11ac(OFDM): BPSK,QPSK,16-QAM,64-QAM,256-QAM			
	Number Of Channel	Please see Note 2.			
	Antenna Gain(Peak)	0dBi			
	Based on the application, features, or specification exhibited in User's Manual, the EUT is considered as an ITE/Computing Device. More details of EUT technical specification, please refer to the User's Manual.				
Channel List	Refer to below				
Sub-class	H01				
Adapter	Input: AC100-240 Output: 5V 2.5A	V,50/60Hz, 0.45A			
Battery	Rated Voltage: 3.7V Charge Limit Voltage: 4.2V Capacity: 2800mAh				
Hardware version number	BND-MT8168-P86	63-V1.1			
Software version number	sys_mssi_t_32_a	go-user.2020122517 release-keys			

Note:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User Manual, the antenna information refer the manufacturer provide report, applicable only to the tested sample identified in the report.



2

Channel List for 802.11a/n/ac (20MHz)							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Cha nnel	Frequency (MHz)	Channel	Frequency (MHz)
52	5260	56	5280	60	5300	64	5320

Channel List for 802.11n/ac (40 MHz)							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Chan nel	Frequency (MHz)	Channel	Frequency (MHz)
54	5270	62	5310				

	Channel List for 802.11a/n/ac (20 MHz)							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Chan nel	Frequency (MHz)	Channel	Frequency (MHz)	
100	5500	104	5520	108	5540	112	5560	
116	5580	120	5600	124	5620	128	5640	
132	5660	136	5680	140	5700			

Channel List for 802.11 n/ac (40 MHz)							
Channel	Frequency (MHz)	Channel	Frequency (MHz)				
102	5510	110	5550				
134	5670						

For 802.11ac (80 MHz)						
Channel Freq.(MHz) Channel Freq.(MHz)						
58	5290	106	5530			
		122	5610			

Remark: The EUT not support TPC function.

Page 8 of 26 Report No.: STS2012039W05

3.EQUIPMENT UNDER TEST (EUT) DETAILS

The manufacturer declared values for the EUT operational characteristics that affect DFS are as follows

Operating Modes (5250 – 5350 MHz, 5470 – 5725 MHz)

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Client Device (no In Service Monitoring, no Ad-Hoc mode)

Client Device with In-Service Monitoring

Antenna Gains / EIRP (5250 - 5350 MHz, 5470 - 5725 MHz)

	5250 – 5	350 MHz	5470 – 5725 MHz	
Lowest Antenna Gain (dBi)	0	0	0	0
Highest Antenna Gain (dBi)	0	0	0	0
DFS Detection Threshold (dBm)	-62			

Channel Protocol

\boxtimes	IΡ	Based

Frame Based

OTHER

The EUT did not require modifications during testing in order to comply with the requirements of the standard(s) referenced in this test report.

2.2 TEST CONDITIONS AND CHANNEL

	Normal Test Conditions
Temperature	15°C – 35°C
Relative Humidity	20% - 75%
Supply Voltage	DC 3.7V

Channel List			
Band Frequency EUT Channel Test Frequency (
Don't II	CH60	5300	
Band II	CH58	5290	

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Page 9 of 26 Report No.: STS2012039W05

Channel List			
Band Frequency	Test Frequency (MHz)		
Don't III	CH116	5580	
Band III	CH106	5530	



Report No.: STS2012039W05



2.3 DFS MEASUREMENT INSTRUMENTATION

a. RADAR GENERATION SYSTEM

An Agilent PSG is used as the radar-generating source. The integral arbitrary waveform generators are programmed using Agilent's "Pulse Building" software and Elliott custom software to produce the required waveforms, with the capability to produce both unmodulated and modulated (FM Chirp) pulses. Where there are multiple values for a specific radar parameter then the software selects a value at random and, for FCC tests, the software verifies that the resulting waveform is truly unique.

With the exception of the hopping waveforms required by the FCC's rules (see below), the radar generator is set to a single frequency within the radar detection bandwidth of the EUT.

Frequency hopping radar waveforms are simulated using a time domain model. A randomly hopping sequence algorithm (which uses each channel in the hopping radar's range once in a hopping sequence) generates a hop sequence. A segment of the first 100 elements of the hop sequence are then examined to determine if it contains one or more frequencies within the radar detection bandwidth of the EUT. If it does not then the first element of the segment is discarded and the next frequency in the sequence is added. The process repeats until a valid segment is produced. The radar system is then programmed to produce bursts at time slots coincident with the frequencies within the segment that fall

in the detection bandwidth. The frequency of the generator is stepped in 1 MHz increments across the EUT's detection range.

The radar signal level is verified during testing using a CW signal with the AGC function switched on. Correction factors to account for the fact that pulses are generated with the AGC functions switched off are measured annually and an offset is used to account for this in the software. The generator output is connected to the coupling port of the conducted set-up or to the radar-generating antenna.

b. CHANNEL MONITORING SYSTEM

Channel monitoring is achieved using a spectrum analyzer and digital storage oscilloscope. The analyzer is configured in a zero-span mode, center frequency set to the radar waveform's frequency or the center frequency of the EUT's operating channel.

The IF output of the analyzer is connected to one input of the oscilloscope and analyzer. A signal generator output is set to send either the modulating signal directly or a pulse gate with an output pulse co-incident with each radar pulse. This output is connected to a second input on the oscilloscope and the oscilloscope displays both the channel traffic (via the if input) and the radar pulses on its display.

For in service monitoring tests the analyzer sweep time is set to > 20 seconds and the oscilloscope is configured with a data record length of 10 seconds for the short duration and frequency hopping waveforms, 20 seconds for the long duration waveforms. Both instruments are set for a single acquisition sequence. The analyzer is triggered 500ms before the start of the waveform and the oscilloscope is triggered directly by the modulating pulse train. Timing measurements for aggregate channel transmission time and channel move time are made from the oscilloscope data, with the end of the waveform clearly identified by the pulse train on one trace. The analyzer trace data is used to confirm that the last transmission occurred within the 10-second record of the oscilloscope. If necessary the record length of the oscilloscope is expanded to capture the last transmission on the channel prior to the channel move.

Channel availability check time timing plots are made using the analyzer. The analyzer is triggered at start of the EUT's channel availability check and used to verify that the EUT does not transmit when radar is applied during the check time.

The analyzer detector and oscilloscope sampling mode is set to peak detect for all plots.



2.4 EQUIPMENTS LIST FOR ALL TEST ITEMS

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Signal Generator	Agilent	N5182A	MY46240556	2020.10.10	2021.10.09
Signal Analyzer	Agilent	N9020A	MY51110105	2020.03.05	2021.03.04
Coupler	Rio tinto in overseas	ZFSC-2-11	15542	2020.04.30	2021.04.29
Coupler	Rio tinto in overseas	ZN2PD-9G	SF078500430	2020.04.30	2021.04.29
Attenuator	HP	8494B	DC-18G	2020.04.30	2021.04.29
Router	TP-LINK (ID:Q87-WRT3200ACM)	TL-WR885N	1125074010735	N.C.R	N.C.R
Temperature & Humidity	HH660	Mieo	N/A	2020.10.13	2021.10.12



3. DFS PARAMETERS

3.1 DFS PARAMETERS

Table 1: Applicability of DFS Requirements Prior to Use of a Channel

Requirement	Operational Mode			
	Master	Client Without Radar Detection	Client With Radar Detection	
Non-Occupancy Period	Yes	Not required	Yes	
DFS Detection Threshold	Yes	Not required	Yes	
Channel Availability Check Time	Yes	Not required	Not required	
U-NII Detection Bandwidth	Yes	Not required	Yes	

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode		
	Master Device or Client with Radar Detection	Client Without Radar Detection	
DFS Detection Threshold	Yes	Not required	
Channel Closing Transmission Time	Yes	Yes	
Channel Move Time	Yes	Yes	
U-NII Detection Bandwidth	Yes	Not required	

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar Detection	Client Without Radar Detection
U-NII Detection Bandwidth and	All BW modes must be	Not required
Statistical Performance Check	tested	
Channel Move Time and Channel	Test using widest BW mode	Test using the widest
Closing Transmission Time	available	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: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection

Maximum Transmit Power	Value
	(See Notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and	-62 dBm
power spectral density < 10 dBm/MHz	
EIRP < 200 milliwatt that do not meet the power spectral	-64 dBm
density requirement	

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.

Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.

Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

Table 4: DFS Response Requirement Values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds
	See Note 1.
Channel Closing Transmission Time	200 milliseconds + an
	aggregate of 60
	milliseconds over
	remaining 10 second
	period.
	See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 100% of the U-
	NII 99% transmission
	power bandwidth. See
	Note 3.

Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.

Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the *U-NII Detection Bandwidth* detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.



Table 5 - Short Pulse Radar Test Waveforms

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 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	Roundup $ \left\{ \frac{1}{360} \right\}. $ $ \left\{ \frac{19 \cdot 10^6}{\text{PRI}_{\mu \text{sec}}} \right\} $	60%	30	
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) Note 1: Short Pulse Padar Type 0 should be used for the detection bandwidth test, shappel mov					

Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.

Table 5a - Pulse Repetition Intervals Values for Test A

Pulse Repetition Frequency Number	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)		
1	1930.5	518		
2	1858.7	538		
3	1792.1	558		
4	1730.1	578		
5	1672.2	598		
6	1618.1	618		
7	1567.4	638		
8	1519.8	658		
9	1474.9	678		
10	1432.7	698		
11	1392.8	718		
12	1355	738		
13	1319.3	758		
14	1285.3	778		
15	1253.1	798		
16	1222.5	818		
17	1193.3	838		
18	1165.6	858		
19	1139	878		
20	1113.6	898		
21	1089.3	918		
22	1066.1	938		
23	326.2	3066		



The aggregate is the average of the percentage of successful detections of Short Pulse Radar Types 1-4. For example, the following table indicates how to compute the aggregate of percentage of successful detections.

Radar Type	Number of Trials	Number of Successful	Minimum Percentage				
		Detections	of Successful				
			Detection				
1	35	29	82.9%				
2	30	18	60%				
3	30	27	90%				
4	50	44	88%				
Aggregate (82.9% + 60% + 90% + 88%)/4 = 80.2%							

Long Pulse Radar Test Waveform

Table 6 - Long Pulse Radar Test Waveform

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

Figure 1 provides a graphical representation of the Long Pulse Radar Test Waveform.

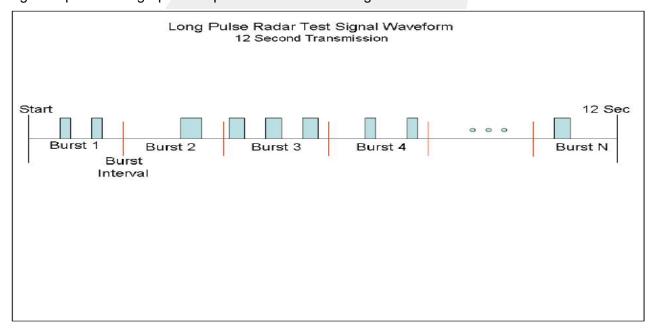


Table 7 – Frequency Hopping Radar Test Waveform

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

Report No.: STS2012039W05



3.2 DFS -TEST RESULTS

3.2.1 TEST RESULTS- FCC Part 15.407 CLIENT DEVICE

Shutdown Time

Chalacter Time							
Mode Frequency (MHz)	Fraguency	Channel	Limit Channel	Close	Limit Close		
	Move Time	Move Time	Transmission	Transmission	Verdict		
	(IVITZ)	(s)	(s)	Time (s)	Time (s)		
ac80	5290	1.3977	10	0.0219	0.26	Pass	
ac80	5530	1.3184	10	0.0246	0.26	Pass	
а	5300	1.2765	10	0.0477	0.26	Pass	
а	5580	1.2517	10	0.0456	0.26	Pass	

Notes:

- 1) Tests were performed using the conduction test method.
- 2) Channel availability check, detection threshold and non-occupancy period are not applicable to client devices.

3.2.2 DFS MEASUREMENT METHODS

a. DFS - CHANNEL CLOSING TRANSMISSION TIME AND CHANNEL MOVE TIME

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. 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.

b. DFS - CHANNEL NON-OCCUPANCY AND VERIFICATION OF PASSIVE SCANNING

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.

c. CHANNEL AVAILABILITY CHECK TIME

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.

d. CONTROL (TPC)

Compliance with the transmit power control requirements for devices is demonstrated through measurements showing multiple power levels and manufacturer statements explaining how the power control is implemented.

e. DETECTION PROBABILITY / SUCCESS RATE

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. Minimum 100% of the U-NII 99% transmission power bandwidth.

f. NON- OCCUPANCY PERIOD

During the 30 minutes observation time, UUT did not make any transmissions on a channel after a radar signal was detected on that channel by either the Channel Availability Check or the In-Service Monitoring



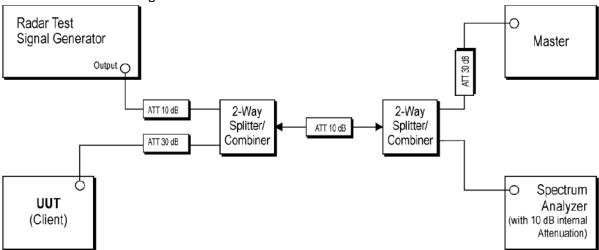
3.2.3 DFS CONDUCTION TEST METHOD

a. The signal level of the simulated waveform is set to a reference level equal to the threshold level (plus 1dB if testing against FCC requirements). Lower levels may also be applied on request of the manufacturer.

The signal level is verified by measuring the CW signal level at the coupling point to the RDD antenna port. The radar signal level is calculated from the measured level, R (dBm) and the lowest gain antenna assembly intended for use with the RDD

If both master and client devices have radar detection capability then the radar level at the non RDD is verified to be at least 20dB below the threshold level to ensure that any responses are due to the RDD detecting radar.

The antenna connected to the channel monitoring subsystem is positioned to allow both master and client transmissions to be observed, with the level of the EUT's transmissions between 6 and 10dB higher than those from the other device.



b. Set-up B is a set-up whereby the UUT is an RLAN device operating in slave mode, with or without Radar Interference Detection function. This set-up also contains an RLAN device operating in master mode. The radar test signals are injected into the master device. The UUT (slave device) is associated with the master device. Figure 5 shows an example for Set-up B. The set-up used shall be documented in the test report.

Channel loading mode:

EUT connects to the router through DFS setup, then controls and switches the EUT channel on the router background page.

Trace

Radar End

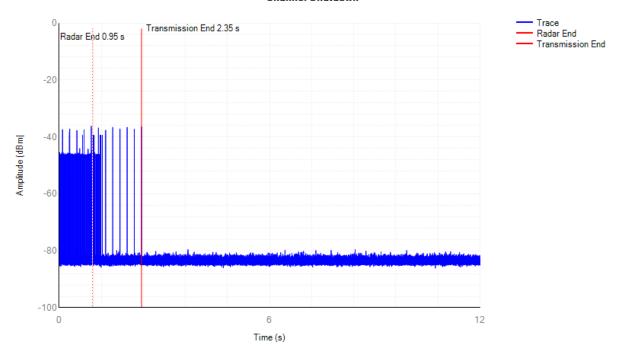


3.2.4 DFS Test Data

Shutdown Time

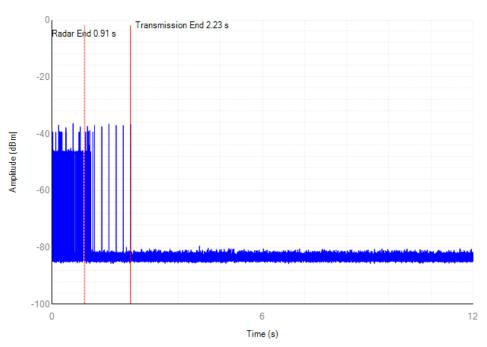
5290MHz ac80 Shutdown

Channel Shutdown



5530MHz ac80 Shutdown

Channel Shutdown



Trace

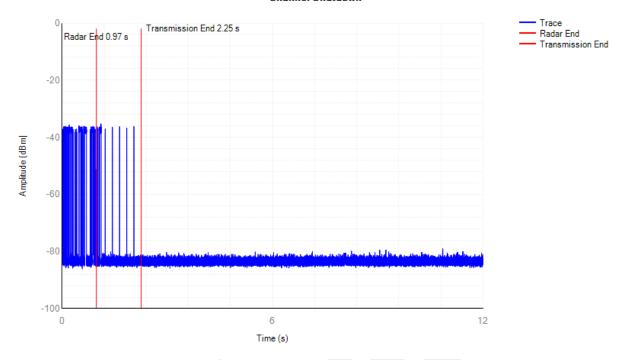
Radar End

Transmission End



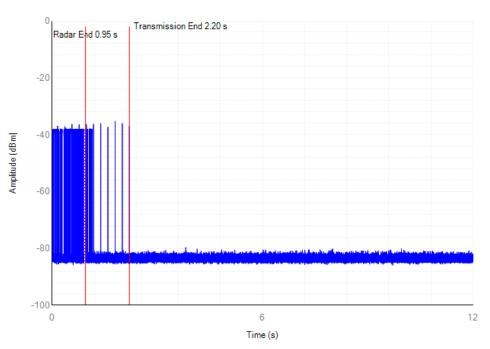
5300MHz a Shutdown

Channel Shutdown



5580MHz a Shutdown

Channel Shutdown

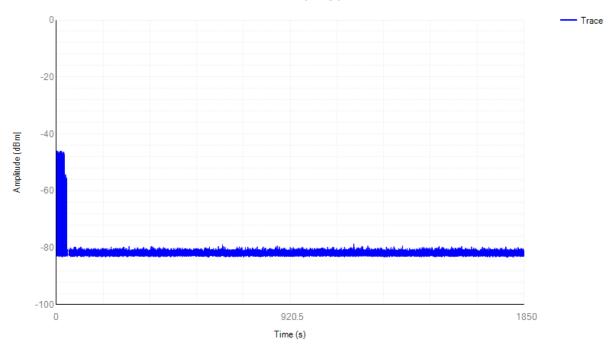




Non-Occupancy

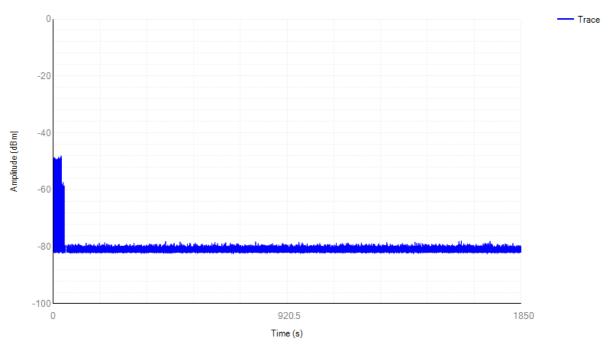
5290MHz ac80 Non-Occupancy

Non-Occupancy period



5530MHz ac80 Non-Occupancy

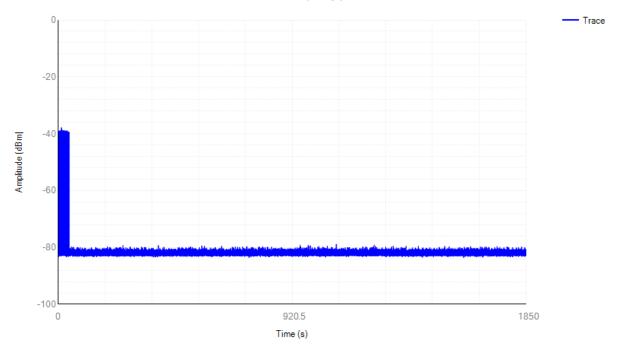
Non-Occupancy period





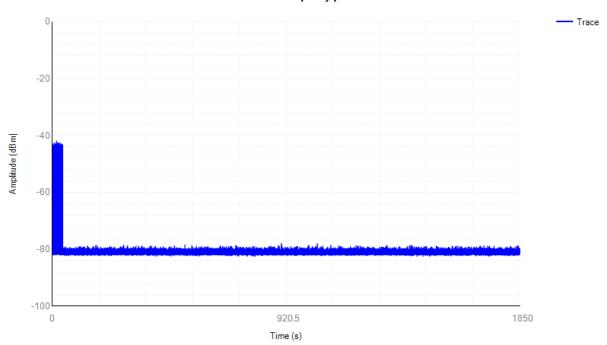
5300MHz a Non-Occupancy

Non-Occupancy period



5580MHz a Non-Occupancy

Non-Occupancy period





Radar Waveform Calibration

Type 0



Type 1





Type 2



Type 3





Type 4

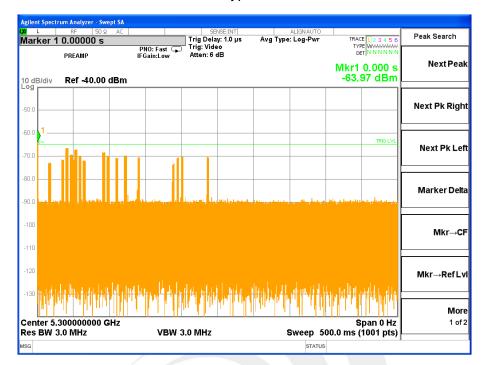


Type 5





Type 6





3.2.5 DFS Test photo



* * * * * END OF THE REPORT * * * *