SGS

TEST REPORT

Date:	**ESPOO 01.04.2014**	Page:	**1 (18)**
		Appendices	–

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Tested by:

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SORT OF EQUIPMENT:	**Vital Signs Monitor**
MARKETING NAME:	***VC150 Vital Signs Monitor***
TYPE:	***VC150***
MANUFACTURER:	***Innokas Medical***
CLIENT:	**Innokas Medical**
ADDRESS:	**Tarjusojantie 12, FI-90440 Kempele, FINLAND**
TELEPHONE:	**+358 8 562 3100**
TEST LABORATORY:	**SGS Fimko EMC Oy**
FCC REG. NO.	**359859 October 25, 2013**
IC FILE NO.	**2040F-1 November 22, 2012**

SUMMARY:

In regard to the performed tests the equipment under test fulfils the requirements defined in the test specifications, see page 2 for details.

Summary of performed tests and test results

Section in CFR 47		*Result*
15.407 (h)(2)	Dynamic Frequency Selection (DFS)	**PASS** [1)]

1) EUT type Client without radar detection.

Explanations:

PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.

Contents

1. EUT and Accessory Information

1.1 EUT description

The EUT is a Vital Signs Monitor with WLAN unit.

1.2 EUT and accessories

EUT, client:

Type	*S/N*	*SW*
VC150	**SK513370003YP**	**application version release 18.0**

Master unit (Access point):

Type	*S/N*	*SW*
Cisco AIR-AP1131AG-E-K9	**FCZ1613QXS**	**12.4 (10b)JDA3**

FCC ID: LDK102054E

Notebook:

Type	*S/N*
HP Elitebook 8770w	**CNU305B55M**

2. Standards and measurement methods

The test were performed in guidance of the CFR 47 Part 15, 407 h

2.1 Technical requirements for DFS in the 5250-5350 MHz and 5470-5725 MHz bands

2.1.1 DFS Overview

A U-NII network will employ a DFS function to:

- detect signals from radar systems and to avoid co-channel operation with these systems.
- provide on aggregate a *Uniform Spreading* of the Operating Channels across the entire band. This applies to the 5250-5350 MHz and/or 5470-5725 MHz bands.

Within the context of the operation of the DFS function, a U-NII device will operate in either *Master Mode* or *Client Mode*. U-NII devices operating in *Client Mode* can only operate in a network controlled by a U-NII device operating in *Master Mode*.

Tables 1 and 2 shown below summarize the information contained in sections 2.1.1 and 2.1.2.

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
Uniform Spreading	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 Radar Detection**	**Client With Radar Detection**
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

The operational behavior and individual DFS requirements that are associated with these modes are as follows:

2.1.2 Master Devices

a) The *Master Device* will use DFS in order to detect *Radar Waveforms* with received signal strength above the *DFS Detection Threshold* in the 5250 – 5350 MHz and 5470 – 5725 MHz bands. DFS is not required in the 5150 – 5250 MHz or 5725 – 5825 MHz bands.

b) Before initiating a network on a *Channel*, the *Master Device* will perform a C*hannel Availability Check* for a specified time duration (*Channel Availability Check Time*) to ensure that there is no radar system operating on the *Channel*, using DFS described under subsection a) above.

c) The *Master Device* initiates a U-NII network by transmitting control signals that will enable other U-NII devices to *Associate* with the *Master Device*.

d) During normal operation, the *Master Device* will monitor the *Channel (In-Service Monitoring)* to ensure that there is no radar system operating on the *Channel*, using DFS described under a).

e) If the *Master Device* has detected a *Radar Waveform* during *In-Service Monitoring* as described under d), the *Operating Channel* of the U-NII network is no longer an *Available Channel*. The *Master Device* will instruct all associated *Client Device(s)* to stop transmitting on this *Channel* within the *Channel Move Time*. The transmissions during the *Channel Move Time* will be limited to the *Channel Closing Transmission Time*.

f) Once the *Master Device* has detected a *Radar Waveform* it will not utilize the *Channel* for the duration of the *Non-Occupancy Period*. [1]

g) If the *Master Device* delegates the *In-Service Monitoring* to a *Client Device*, then the combination will be tested to the requirements described under d) through f) above.

2.1.3 Client Devices

a) A *Client Device* will not transmit before having received appropriate control signals from a *Master Device*.

b) A *Client Device* will stop all its transmissions whenever instructed by a *Master Device* to which it is associated and will meet the *Channel Move Time* and *Channel Closing Transmission Time* requirements. The *Client Device* will not resume any transmissions until it has again received control signals from a *Master Device*.

c) If a *Client Device* is performing *In-Service Monitoring* and detects a *Radar Waveform* above the *DFS Detection Threshold*, it will inform the *Master Device*. This is equivalent to the *Master Device* detecting the *Radar Waveform* and d) through f) of section 2.1.1 apply.

d) Irrespective of *Client Device* or *Master Device* detection the *Channel Move Time* and *Channel Closing Transmission Time* requirements remain the same.

[1] Applies to detection during the Channel Availability Check or In-Service Monitoring.

2.1.4 DFS Detection Thresholds

Table 3 below provides the *DFS Detection Thresholds* for *Master Devices* as well as *Client Devices* incorporating *In-Service Monitoring*.

Table 3: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection

Maximum Transmit Power	Value (See Notes 1 and 2)
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 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.	

2.1.5 Response Requirements

Table 4 provides the response requirements for *Master* and *Client Devices* incorporating DFS.

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 80% of the U-NII 99% transmission power bandwidth. See Note 3.
Note 1: The instant that the *Channel Move Time* and the *Channel Closing Transmission Time* begins is as follows: • For the Short Pulse Radar Test Signals this instant is the end of the *Burst*. • For the Frequency Hopping radar Test Signal, this instant is the end of the last radar *Burst* generated. • For the Long Pulse Radar Test Signal this instant is the end of the 12 second period defining the *Radar Waveform*. **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 1 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.	

2.1.6 RADAR TEST WAVEFORMS

This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

2.1.7 Short Pulse Radar Test Waveforms

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
1	1	1428	18	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)				80%	120

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. For Short Pulse Radar Type 1, the same waveform is used a minimum of 30 times. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms.

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 Detections	Minimum Percentage 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%			

2.1.8 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 *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

The parameters for this waveform are randomly chosen. Thirty unique waveforms are required for the Long Pulse Radar Type waveforms. If more than 30 waveforms are used for the Long Pulse Radar Type waveforms, then each additional waveform must also be unique and not repeated from the previous waveforms.

Each waveform is defined as follows:

1) The transmission period for the Long Pulse Radar test signal is 12 seconds.
2) There are a total of 8 to 20 *Bursts* in the 12 second period, with the number of *Bursts* being randomly chosen. This number is *Burst_Count*.
3) Each *Burst* consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each *Burst* within the 12 second sequence may have a different number of pulses.
4) The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a *Burst* will have the same pulse width. Pulses in different *Bursts* may have different pulse widths.
5) Each pulse has a linear frequency modulated chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a *Burst* will have the same chirp width. Pulses in different *Bursts* may have different chirp widths. The chirp is centered on the pulse. For example, with a radar frequency of 5300 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and ends at 5310 MHz.
6) If more than one pulse is present in a *Burst*, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a *Burst*, the random time interval between the first and second pulses is chosen independently of the random time interval between the second and third pulses.
7) The 12 second transmission period is divided into even intervals. The number of intervals is equal to *Burst_Count*. Each interval is of length (12,000,000 / *Burst_Count*) microseconds. Each interval contains one *Burst*. The start time for the *Burst*, relative to the beginning of the interval, is between 1 and [(12,000,000 / *Burst_Count*) – (Total *Burst* Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The start time for each *Burst* is chosen randomly.

3. Test results

3.1 DFS

The test was performed as a compliance test. The test parameters concerned were as follows:

Site name	SGS Fimko EMC Oy/ Perkkaa
Date of testing	31.3.2014
Test equipment	42, 566, 567, 525, 542, 434, 564, 2090, 2078
Test conditions	22 °C, 30 % RH
Test result	**PASS**

3.1.1 Test method

The test was performed inside a fully anechoic room. For the duration of the test the EUT was placed on a non-conductive table 0.8 m high (see photograph 1). The radiated test setup was used.
During the channel move tests the system was configured to file transfer (MPEG stream not usable) from the master device (connected to local area network via Ethernet interface) to the client device, channel loading was between 10-30%. The transferred file was data file and the client device was using http.
Master was configured to use 5250 – 5350 MHz and 5470 – 5725 MHz bands with DFS enabled.
Test was done at one channel at 5250 – 5350 MHz band and at one channel at 5470 – 5725 MHz band. 1 burst of radar pulses was transmitted.

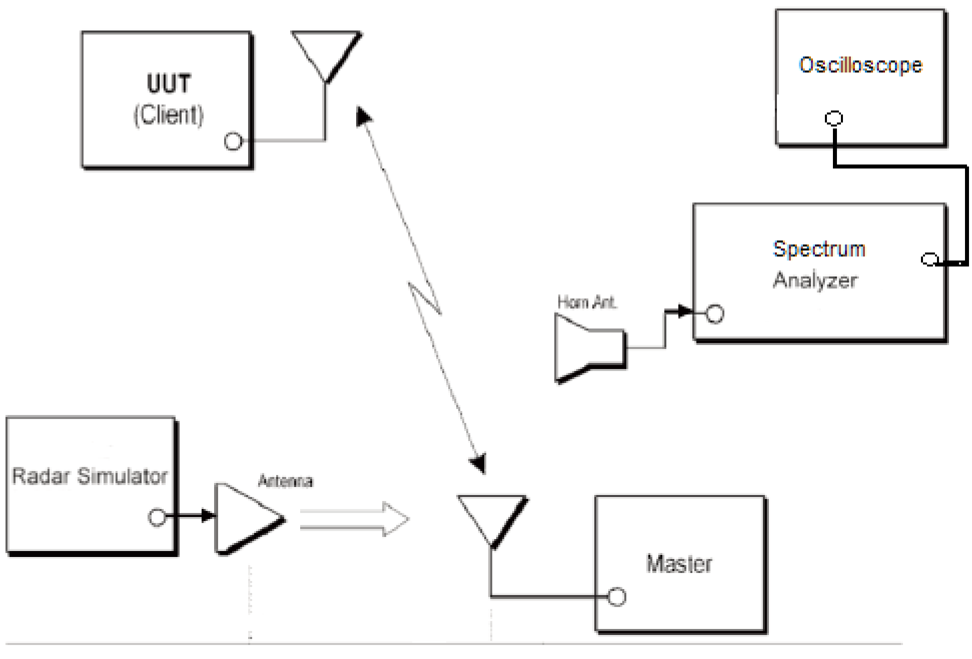


Figure 1: DFS Timing Monitoring Diagram for Method #1

3.1.2 Test data

	Radar type	*Frequency*	*Measured value*	*Requirement*	*Verdict*
Channel closing time	type 1	5280 MHz	12.9ms	aggregate of 60ms after 200ms	**Pass**
Channel move time	type 1	5280 MHz	7.2s	10s	**Pass**
Channel non-occupancy period	type 1	5280 MHz	>30 min	>30 min	**Pass**
Channel closing time	type 1	5580 MHz	12.9 ms	aggregate of 60ms after 200ms	**Pass**
Channel move time	type 1	5580 MHz	7.2s	10s	**Pass**
Channel non-occupancy period	type 1	5580 MHz	>30 min	>30 min	**Pass**

After the final channel closing test the channel was monitored for a 30 minutes. No transmissions occurred on the channel.

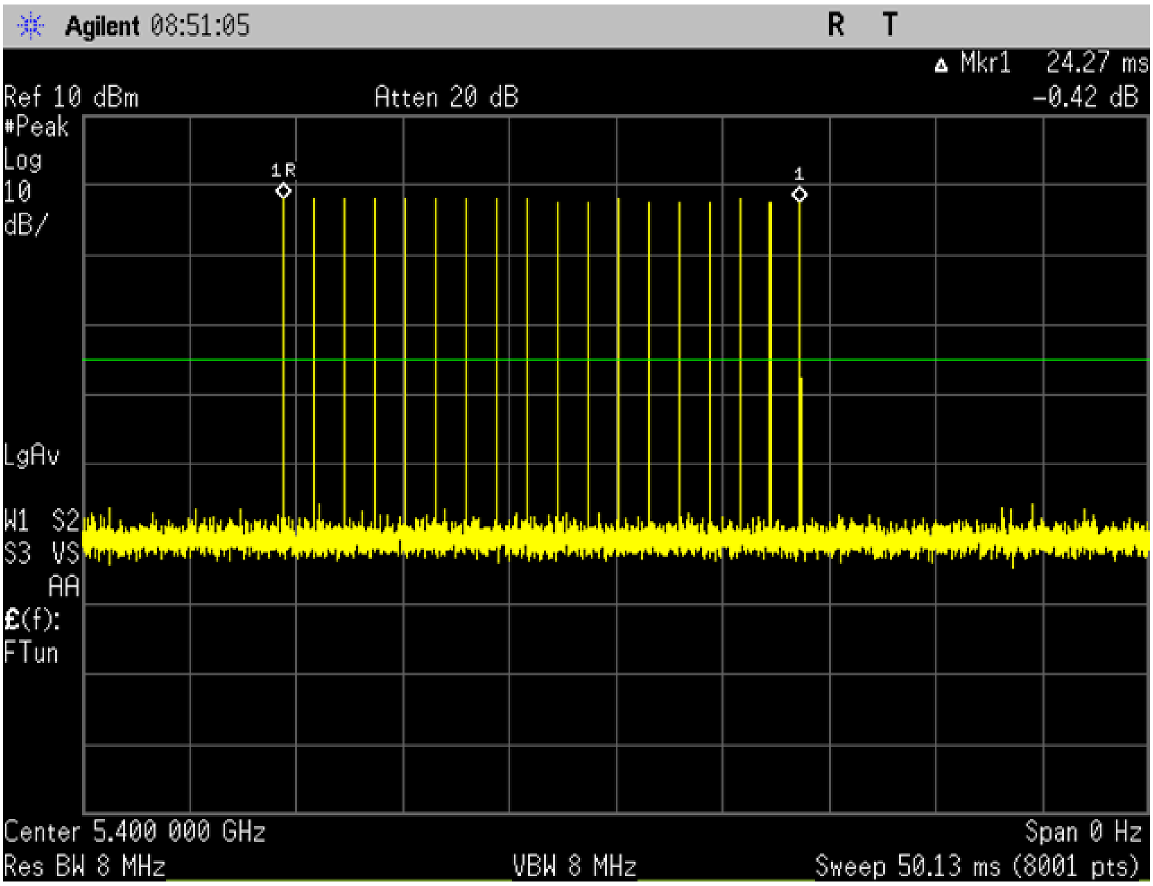


Figure 2: Radar pulse type 1 18x1µs PRF 1428µs

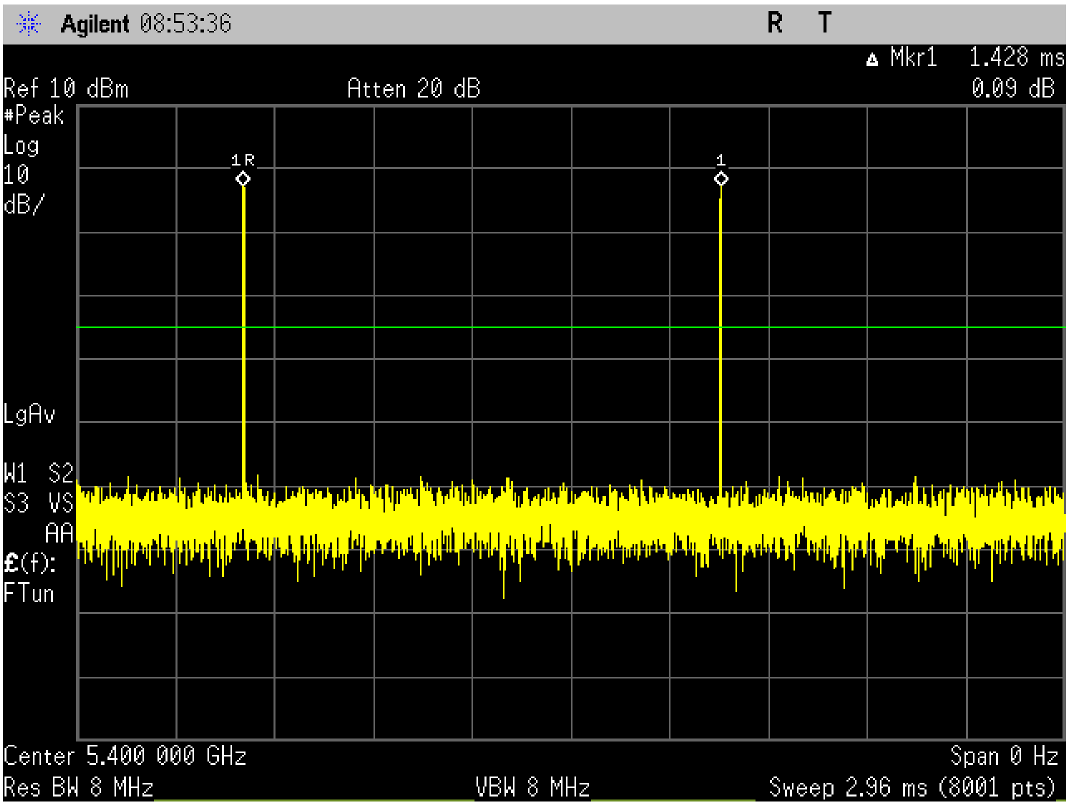


Figure 3: Radar pulse PRF 1428µs

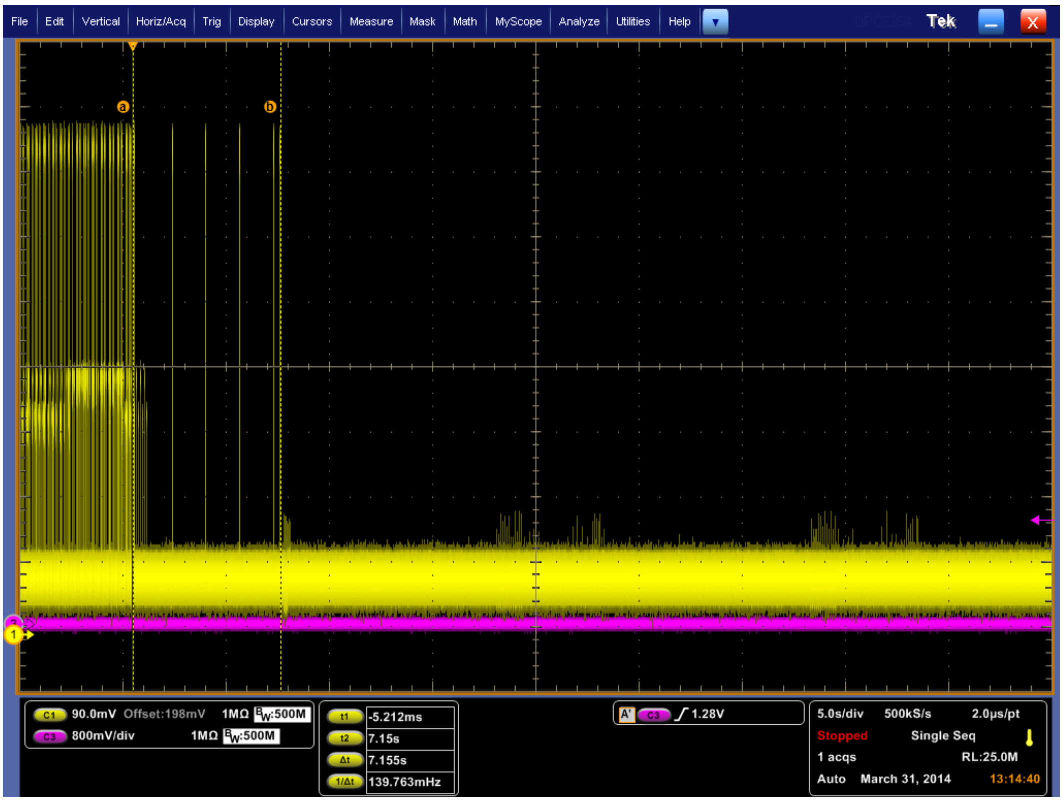


Figure 4: 5280 MHz, master and client, data transmission stops after 7.2s from last radar pulse. (radar pulse purple curve, EUT highest on yellow curve)

Figure 5: 5280MHz, client transmissions after 200ms: (20x0.14ms)x4 + 10x0.07ms =11.2+0.7=11.9ms. (radar pulse purple curve, EUT highest on yellow curve).

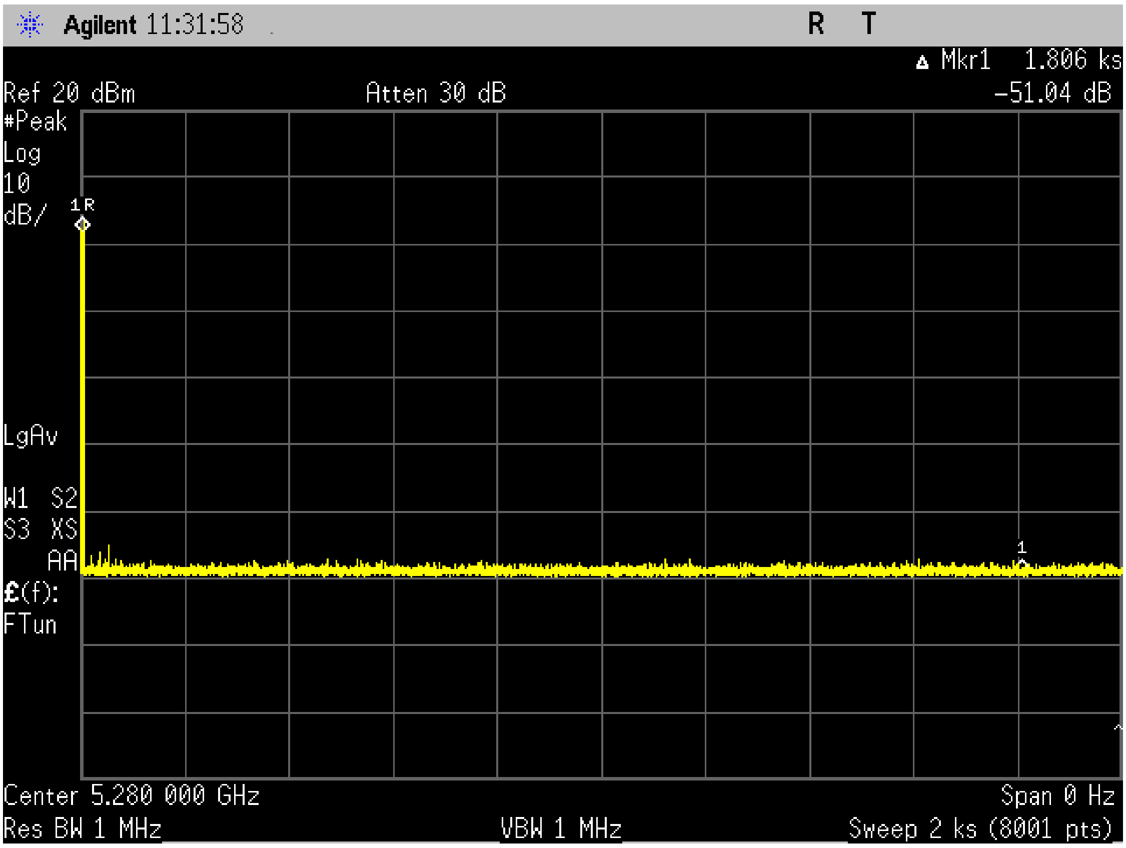


Figure 6: 5280MHz, channel non-occupancy period >30min

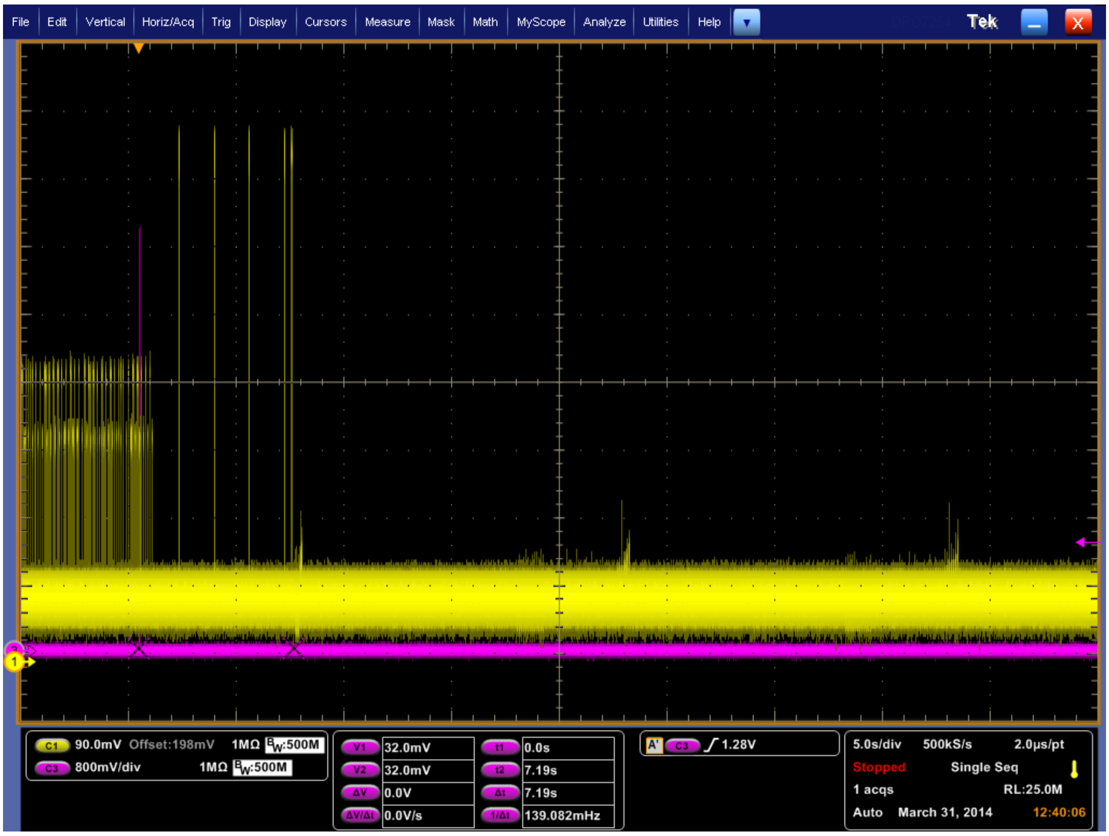


Figure 7: 5580MHz, master and client, data transmission stops after 7.2 s from last radar pulse (radar pulse purple curve, EUT highest on yellow curve).

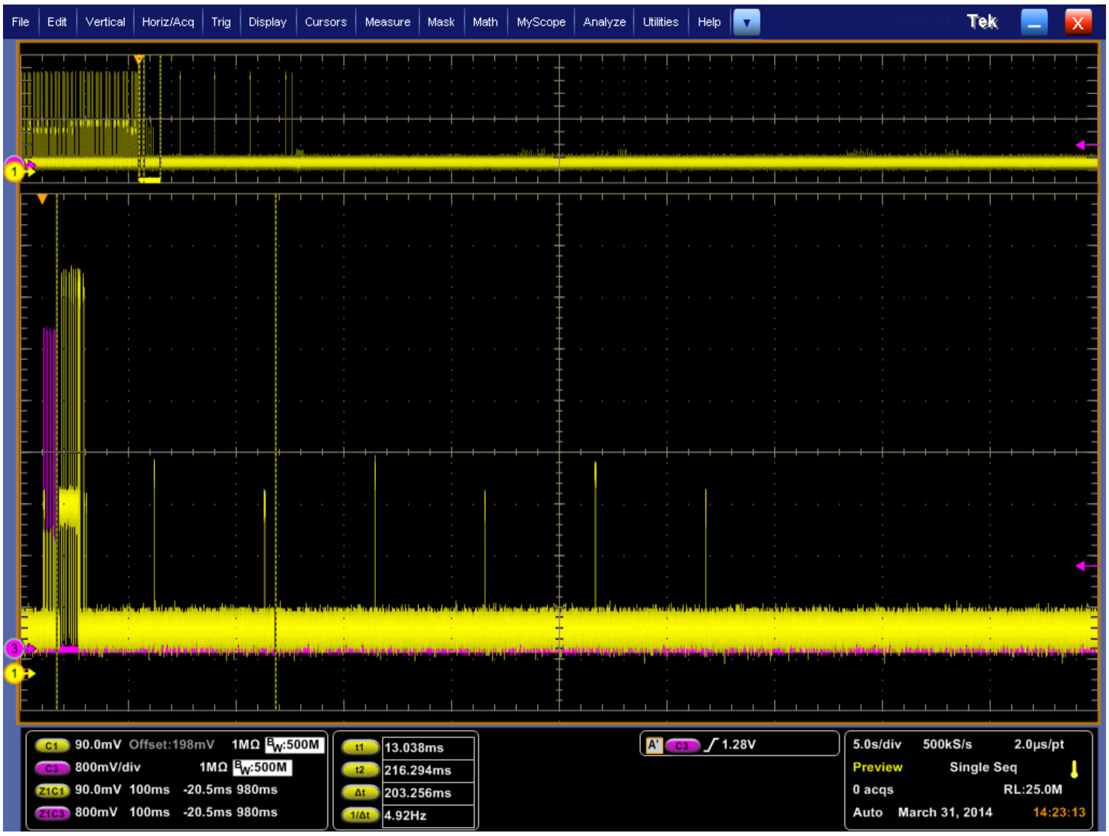


Figure 8: 5580MHz, master transmissions 6x0.27ms, 4 after 200ms = aggregate = 1 ms. (radar pulse purple curve, EUT highest on yellow curve)

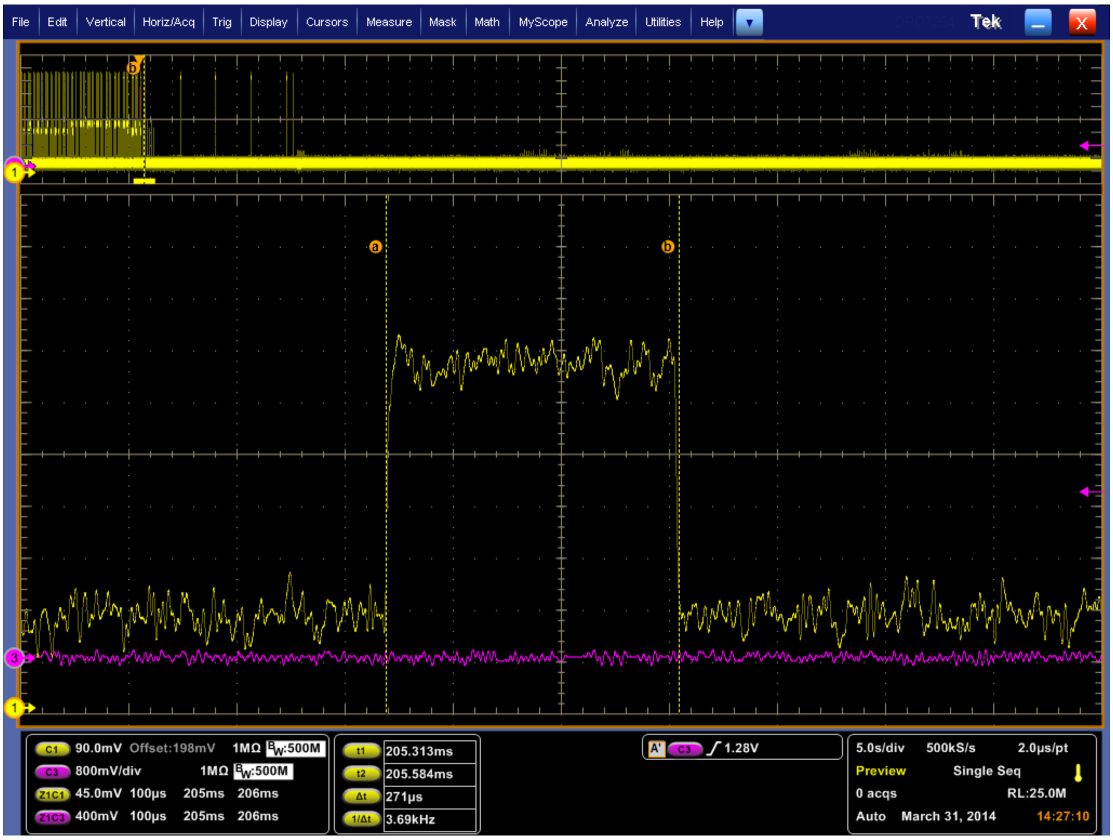


Figure 9: 5580MHz, master 6x0.27ms, 4x0.27 after 200ms, aggregate = 1 ms

Figure 10: 5580MHz, client transmissions after 200ms last burst:10x0.07ms

Figure 11: 5580MHz, client transmissions after 200ms: (20x0.14ms)x4 + 10x0.07ms =11.2+0.7=11.9ms

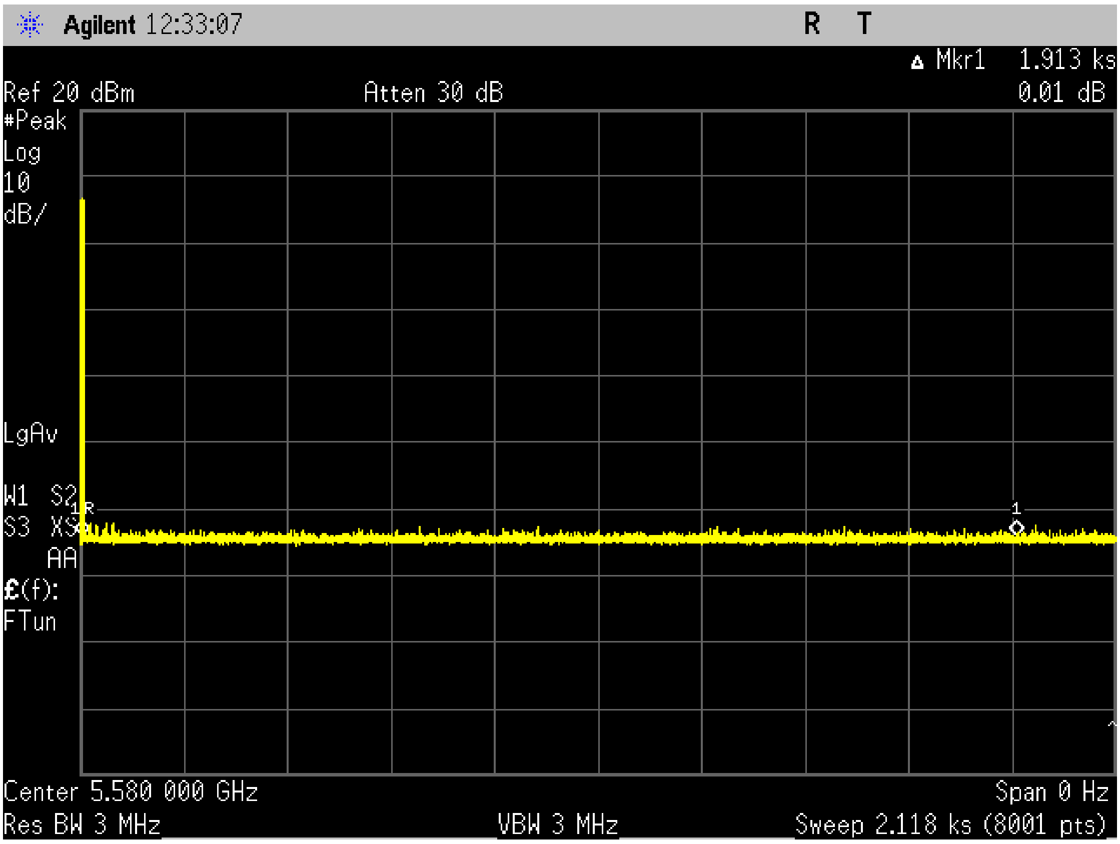
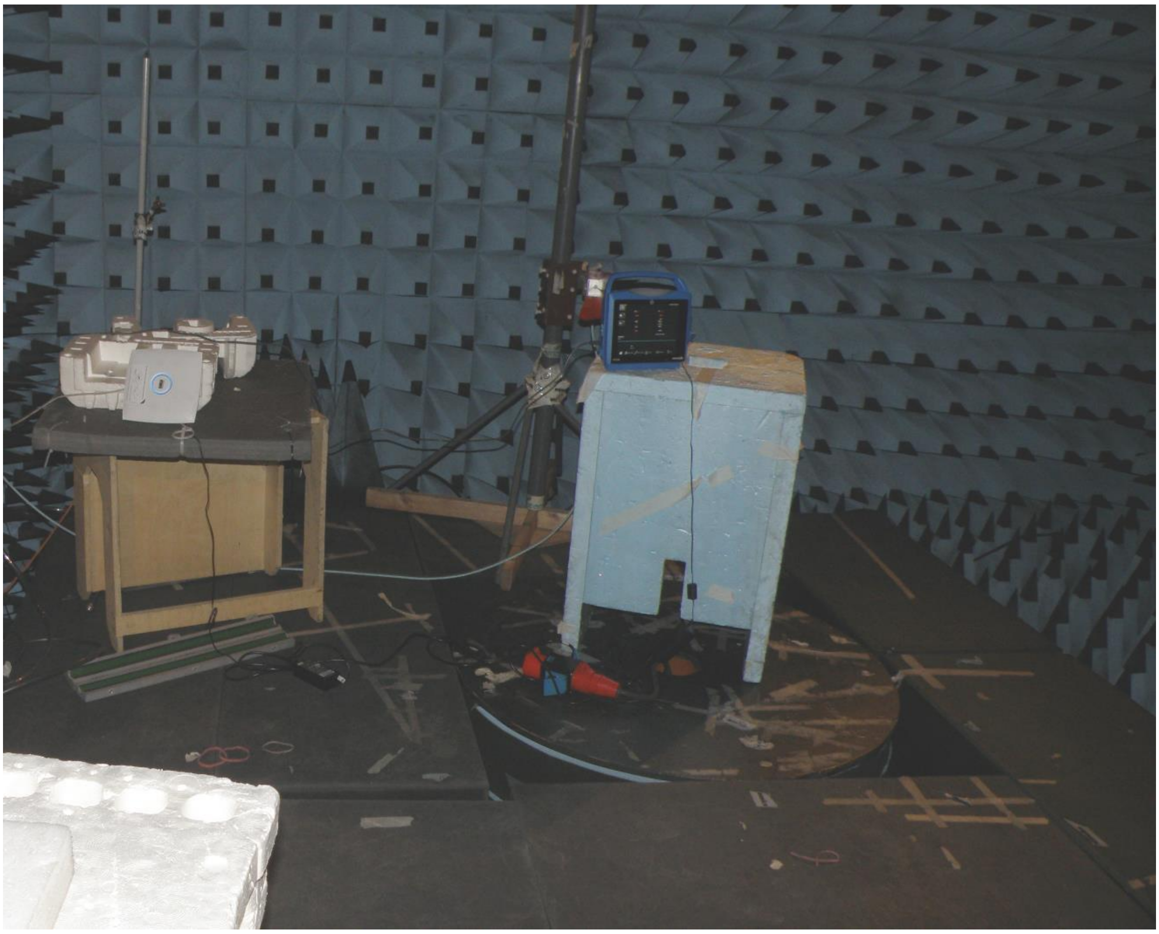


Figure 12: 5580MHz, channel non-occupancy period >30min



Photograph 1.Test setup for DFS tests.

4. List of test equipment

Each active test equipment is calibrated once a year, antennas every 18 months and other passive equipment every 24 months.

Nr.	Equipment	Type	Manufacturer	Serial number	Cal date	Cal due
542	Double-Ridged Horn	3115	Emco	00023905	10.10.2012	4.2014
525	Double-Ridged Horn	3115	Emco	6691	10.10.2012	4.2014
588	Double-Ridged Horn	3117	Emco	00086191	10.10.2012	4.2014
2090	Oscilloscope	DPO7254	Tektronix	B056867	29.10.2013	10.2014
564	RF amplifier	CA018-4010	CIAO Wireless	132	3.2.2014	2.2015
566	Spectrum analyzer	E4448A	Agilent	US42510236	17.04.2013	4.2014
42	Spectrum analyzer	8566B	Hewlett Packard	2637A04102	24.07.2013	7.2014
567	RF generator	E8257C	Agilent	MY43320736	11.3.2014	3.2015
434	Function generator	HP 33120A	Hewlett Packard	US36027944	20.11.2013	11.2014
2078	Power divider	1870A	Weinschel	1798	6.11.2013	11.2014