LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
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TEST REPORT # TR 313033 C
LSR Job #: C-1694

Compliance Testing of:
TiWi5

Test Date(s):
March 19, 2013

Prepared For:
LS Research, LLC
W66 N220 Commerce Ct.
Cedarburg, WI 53012

This Test Report is issued under the Authority of:
Adam Alger, EMC Engineer

Signature: Date: 5-16-13

Test Report Reviewed by:	Project Engineer:
Khairul Aidi Zainal, Senior EMC Engineer	Adam Alger, EMC Engineer
Signature: Date: 5-13-13	Signature: Date: 5-13-13

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart E, Section 15.407 RSS 210 issue 8 Annex 9
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	Appendix B. FCC order, ET Docket No. 03-122 (FCC 06-96)
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 – Normative References

Publication	Year	Title
FCC CFR Parts 0-15	2013	Code of Federal Regulations – Telecommunications
RSS-210 Annex 9	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
Appendix B. FCC order, ET Docket No. 03-122 (FCC 06-96)	2006	Compliance measurement procedures for U-NII devices operating in the 5.25-5.35GHz and 5.47-5.725GHz bands incorporating dynamic Frequency Selection.

1.3 - LS Research, LLC Test Facility

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) as conforming to ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted.

1.4 – Location of Testing

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

List of Facilities Located at LS Research, LLC:

Compact Chamber
Semi-Anechoic Chamber
Open Area Test Site (OATS)

1.5 – Test Equipment Utilized

Description	Manufacturer	Model Number	Serial Number
Arbitrary Waveform Generator	Agilent	33250	US40000583
Signal Generator	Agilent	E4438C	US41460143
Spectrum Analyzer	HP	E4407B	US39160256
Oscilloscope	Agilent	MSO8104A	MY45001068
Access point with DFS (FCC ID: LDK102061 and LDK 102062)	CISCO	AIR-AP 1252AG-AK9	FTX154590DB
Horn antenna	EMCO	3115	6907

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	LS Research, LLC
Address:	W66 N220 Commerce Ct. Cedarburg, WI 53012
Contact Name:	Matthew Meiller

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	TiWi5
Model Number:	TiWi5
Serial Number:	Synapse XBRV4

2.3 - EUT'S Details.

The LS Research, LLC TIWI5 module is a multi-standard module with support for WLAN (802.11 a/b/g/n), Bluetooth 2.1+EDR and Bluetooth 4.0 (LE).
The module was installed on the Synapse XBRV4 host and iperf was used for streaming connection during the test. This method was approved by FCC (Tracking number 678078).

1. EUT operates as client device only with no In-service Monitoring.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70 -71°F
Humidity:	32-42%
Pressure:	728-741mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

3.2.2 Operation in the 5.25 – 5.35 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (h)(1)	210 A9.2 (2)	Transmit Power Control (TPC)	N/A**
15.407 (h)(2)	210 A9.3 (a)	Dynamic Frequency Selection	N/A*
15.407 (h)(2)(ii)	210 A9.3 (b)(ii)	Channel Availability Check Time	N/A*
15.407 (h)(2)(iii)	210 A9.3 (b)(iii)	Channel Move Time	Pass
15.407 (h)(2)(iv)	210 A9.3 (b)(v)	Non-Occupancy period	Pass

* : The EUT is a client device with no in-service monitoring

** : The EUT has an EIRP of less than 500mW.

3.2.3 Operation in the 5.47 – 5.725 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (h)(1)	A9.2 (3)	Transmit Power Control (TPC)	N/A**
15.407 (h)(2)	A9.3 (a)	Dynamic Frequency Selection	N/A*
15.407 (h)(2)(ii)	A9.3 (b)(ii)	Channel Availability Check Time	N/A*
15.407 (h)(2)(iii)	A9.3 (b)(iii)	Channel Move Time	Pass
15.407 (h)(2)(iv)	A9.3 (b)(v)	Non-Occupancy period	Pass

* : The EUT is a client device with no in-service monitoring

** : The EUT has an EIRP of less than 500mW.

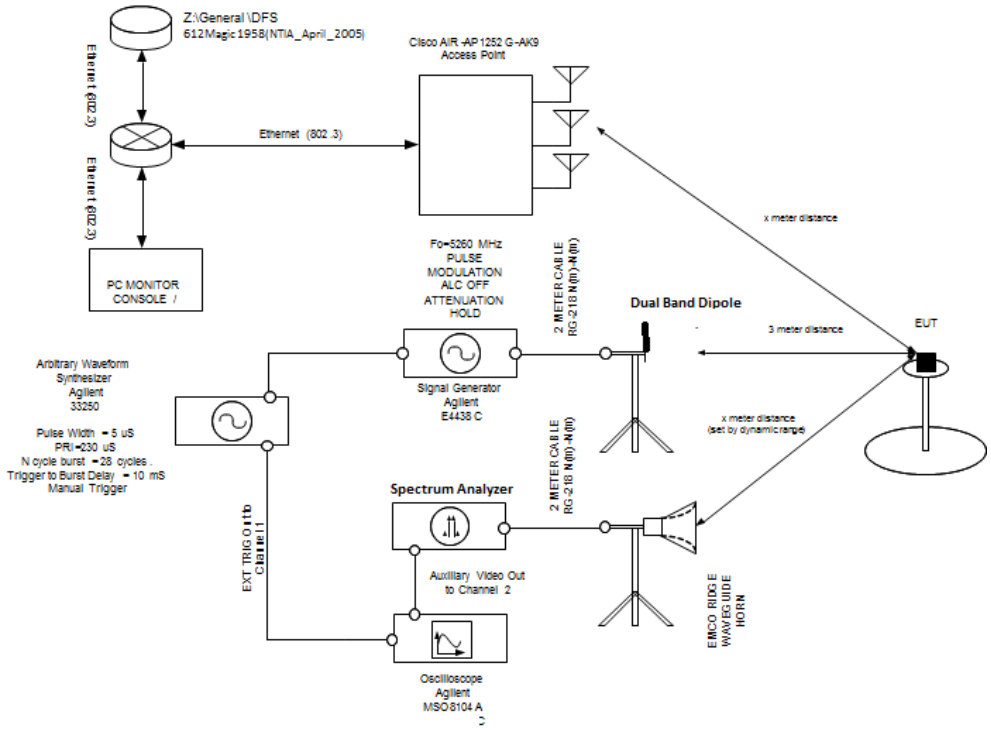
EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.407(h)(2), and Industry Canada RSS-210, Issue 8 (2010), Annex 9.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. SETUP AND PROCEDURE.

5.1 Radiated Setup



The testing was performed in a semi-anechoic chamber. An arbitrary waveform synthesizer coupled with a signal generator was used to generate the interfering radar signal. The EUT was set at a distance of 3 meters away from the radar source and the monitoring system. The monitoring system consisted of a spectrum analyzer (centered at the frequency of interest), an oscilloscope and a receive antenna.

The event log of an approved DFS master, a CISCO AIR-AP1252AG-AK9 (FCC ID: LDK102061 and LDK 102062), was used to determine channel usage and also monitor DFS master commands to the EUT.

5.3 Test Procedure

The procedure referenced was **Appendix B. FCC order, ET Docket No. 03-122 (FCC 06-96)**:

The test was facilitated with the use of an approved DFS master device: A CISCO AIR-AP1252AG. The DFS mechanism of the DFS master device/AP is triggered by presenting it with a recognized radar signal type. The table below lists the approved 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

The radar type used for this test was 28 pulses of **type 2 radar** with a pulse width of 5 microseconds and a pulse repetition interval of 230 microseconds. This waveform originates from the arbitrary waveform generator. This waveform is then fed into a signal generator operating at the desired frequency.

An FCC approved method (KDB Tracking # 678078) of alternate streaming, was utilized for a connection between the DFS master and the EUT. The event log of the DFS master was checked to determine the channel/frequency used for the link. The radar signal described above was then transmitted onto that channel.

The exchange of 802.11(h) traffic and the consequent cessation of test traffic were measured by providing auxiliary video output of a spectrum analyzer (placed into zero-span or tuned receiver mode) to a high-speed, deep memory oscilloscope.

The scope was triggered 2 seconds before the radar pulse was initiated. The radar pulses and traffic were then captured for analysis of the channel closing time and channel move time.

The falling edge of the last pulse of the radar pulse train was used as the t=0 reference for the Channel closing and channel move time.

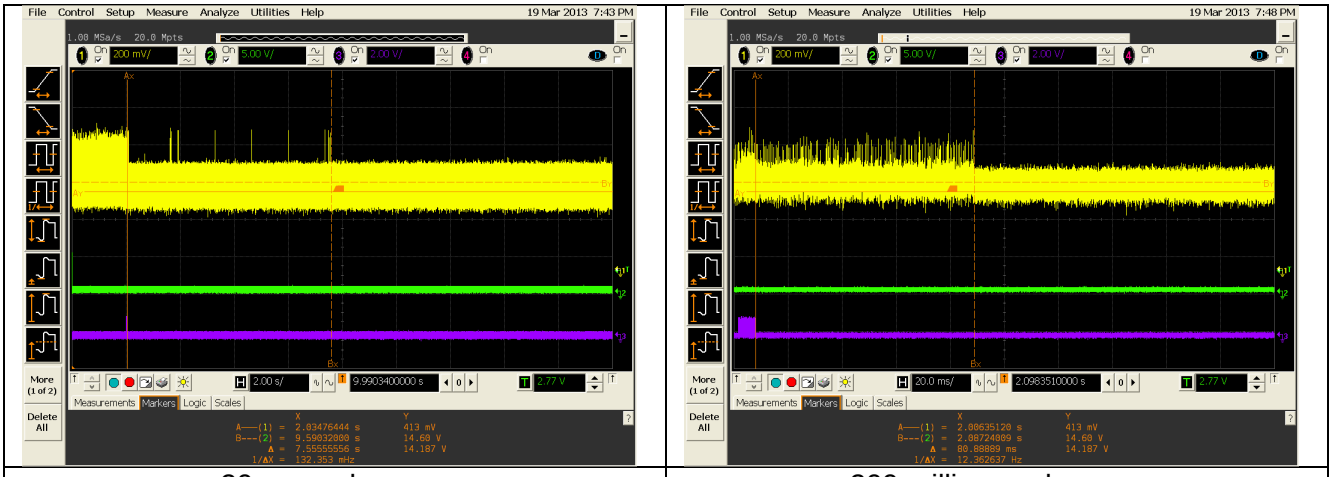
Exhibit 6 Channel Closing Time, Channel Move Time, Channel Non-Occupancy period

Test Engineer: Adam Alger

6.1 Limit

Channel move time: 10 seconds after detection
Channel closing: 200ms after detection + 60 milliseconds (aggregate) over the remaining 10 second period.
Channel non-occupancy period: 30 minutes (1800 seconds)

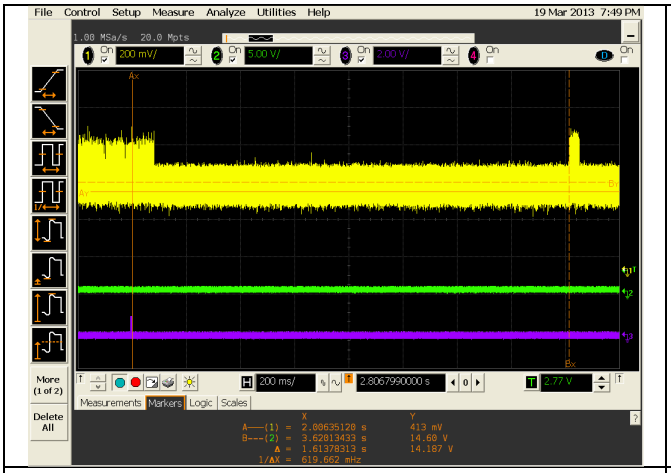
6.2 Test data



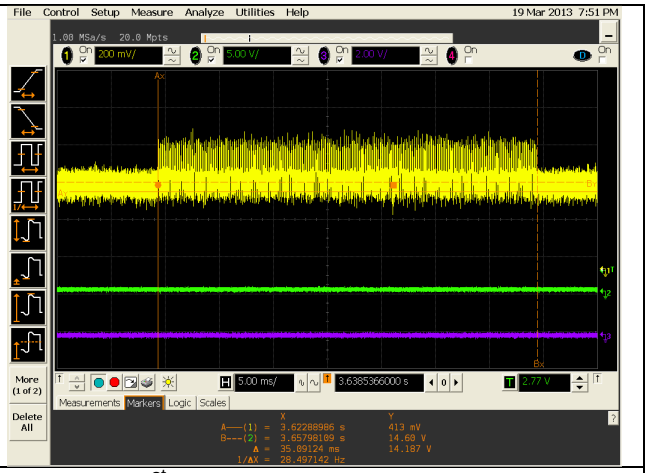
20 second sweep	200 millisecond sweep

Figure 6.2.1 20s and 200ms sweep depicting trigger, video streaming traffic and radar signal

Yellow trace: Traffic on frequency of interest
Purple trace: Type 2 Radar pulse directly from arbitrary wave generator
Green trace: Event trigger (triggers oscilloscope)



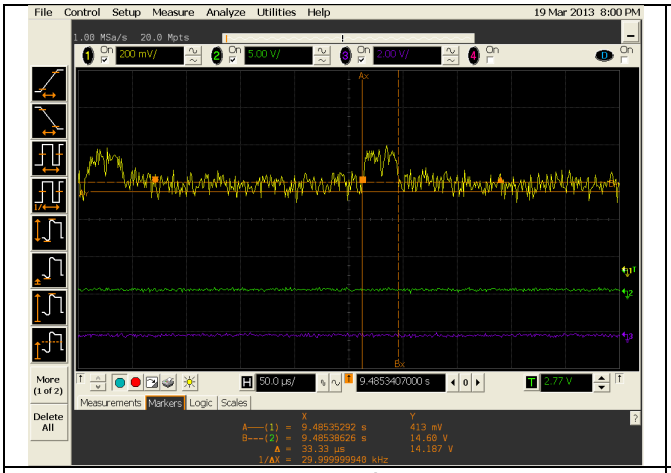
Showing start of first control signal after the 200 ms



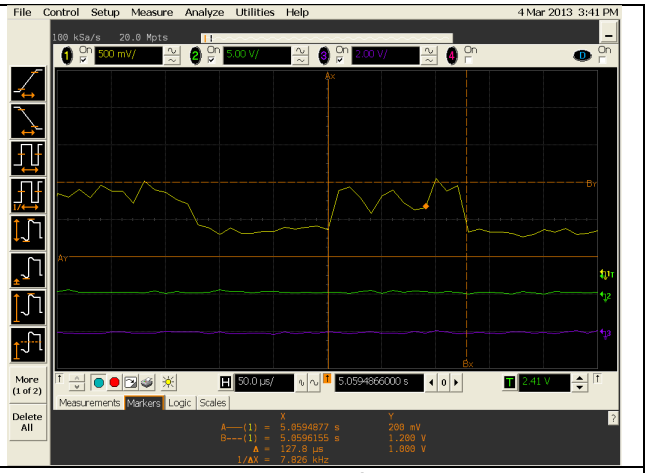
1st control signal pulse train

Figure 6.2.2 Figures depicting remainder traffic and control signals

Yellow trace: Traffic on frequency of interest
Purple trace: Type 2 Radar pulse directly from arbitrary wave generator
Green trace: Event trigger (triggers oscilloscope)

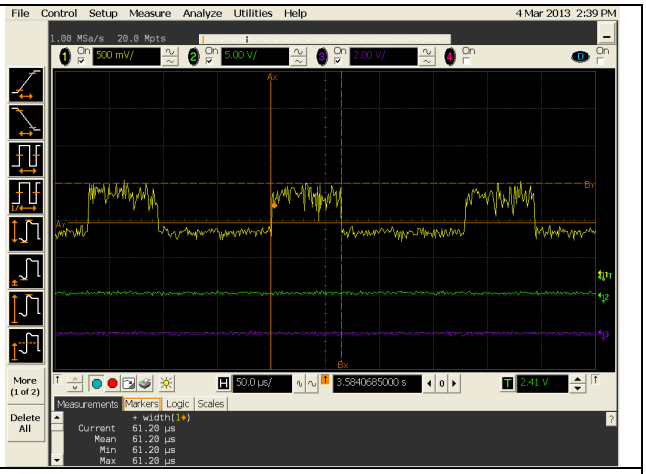


34 us pulse



128 us pulse

Figure 6.2.3 Packet size of control signal



62 us pulse

Figure 6.2.4 Packet size of control signal

Total number of aggregate On-time:

Pulse	Number of pulses	Length of Pulse (µs)	Total Pulse Train On-time (µs)
1	203	62	12586
2	20	128	2560
3	20	128	2560
4	20	128	2560
5	20	128	2560
6	20	128	2560
7	55	34	1870
8	10	62	620
9	10	62	620
	Total On-time (µs)		28496

Table 6.2.5

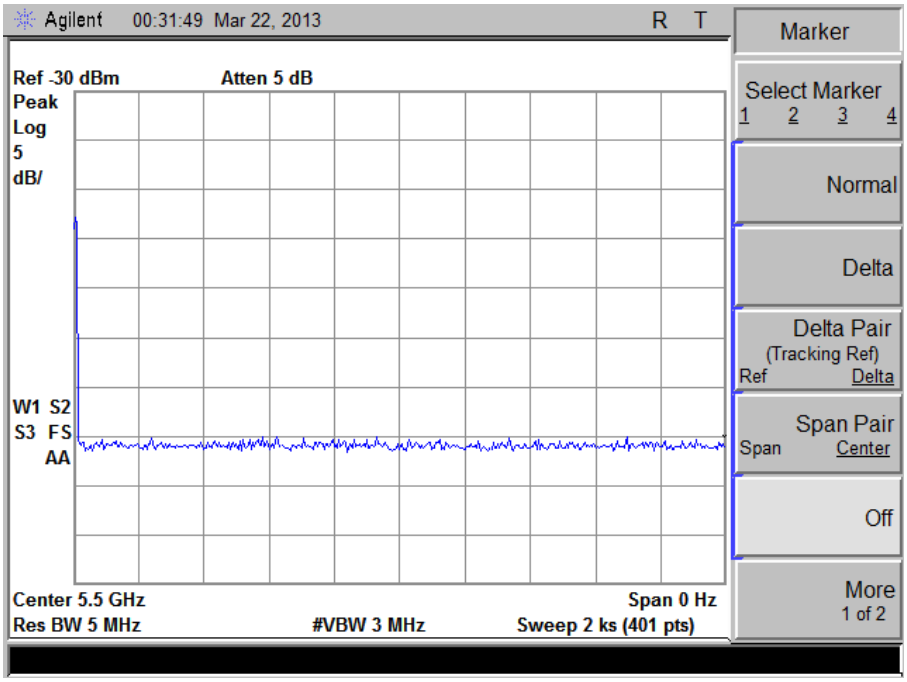


Figure 6.2.6 Non-occupancy scan

6.2.1 Channel move time

The 20 second sweep of the event, in figure 6.2.1, confirms that traffic between the DFS master and the EUT has ceased on the original channel, 5500MHz, within the limit of 10 seconds. The 100 millisecond sweep of the same event shows the occurrence of radar pulse on the channel (yellow trace) and some traffic after.

6.2.2 Channel close time

Figure 6.2.1 confirms cessation of the signal within 200ms. Based on figure 6.2.2, 6.2.3, and 6.2.4 and table 6.2.5, the aggregate of the control signals were within the 60 milliseconds limit.

6.2.3 Channel non occupancy time.

Figure 6.2.6 confirms no other traffic on the channel within the 30 minute limit.

APPENDIX A – Test Standards: CURRENT PUBLICATION DATES

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2013		
RSS GEN	2010		
RSS 210	2010		
RSS 102	2010		

APPENDIX B - Uncertainty Statement

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

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB

	PARAMETER	LSR ± Uncertainty
1	Radio Frequency, from F0	$\pm 1.3 \times 10^{-7}$
2	Total RF conducted Power	±1.38 dB
3	RF conducted power density	±1.38 dB
4	Conducted spurious emissions	±1.38 dB
5	Radiated emissions	±4.87 dB
6	Temperature	±0.64°C
7	Humidity	±2.9 %
8	DC voltage	±0.03 %
9	Low frequency voltage	±0.1 %