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TEST REPORT # TX 311362 E
LSR Job #: C-1371

Compliance Testing of:
TiWi5

Test Date(s):
March 12th to 28th, April 25th 2012

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

This Test Report is issued under the Authority of:
Khairul Aidi Zainal, Senior EMC Engineer.

Signature: 

Date: 5-16-12

Test Report Reviewed by:
Adam Alger, EMC Engineer

Signature: 

Date: 5-14-12

Project Engineer:
Khairul Aidi Zainal, Senior EMC Engineer.

Signature: 

Date: 5-16-12

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.407 RSS GEN issue 3 and RSS 210 issue 8 Annex 9 RSS 102 issue 4
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:	OET KDB 789033 D01 General UNII Test Procedure
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 – Normative References

Publication	Year	Title
FCC CFR Parts 0-15	2012	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 9	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 3	2010	General Requirements and Information for the Certification of Radio Apparatus
RSS 102	2010	Radio Frequency (RF) Exposure Compliance of Radiocommunication apparatus.
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 789033 D01	2012	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices- Part 15 Subpart E.
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.

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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

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to the SI standard.

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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:	SN361116, SN041201 : Radiated measurements SN051201 : Conducted measurements

2.3 - Associated Antenna Description

The antennas associated with the EUT are:

1. A dual band sleeve dipole antenna with a 2.0 dBi gain in both the 2.4 GHz and 5.5GHz band.
2. A dual band ceramic chip antenna with a gain of 1.0 dBi in the 2.4 GHz band and -1.5dBi in the 5.4GHz band.

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2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	5180 to 5240 MHz 5280 to 5320 MHz 5500 to 5700 MHz
RF Power in Watts (Conducted measurement)	
Minimum:	0.0166 Watts
Maximum:	0.0501 Watts
Max Conducted Output Power (in dBm)	17.0 dBm
Field Strength at 3 meters (Maximum)	Not Applicable
Occupied Bandwidth (99% BW)	6 MBPS = 30.5 MHz 12 MBPS = 26.8 MHz 24 MBPS = 26.5 MHz MCS7 = 23.4 MHz
Type of Modulation	OFDM
Transmitter Spurious (worst case) at 3 meters	49.1 dBμV/m at 21120MHz
Stepped (Y/N)	N
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 1 PPM
Transceiver Model # (if applicable)	WL1273L
Antenna Information	
Detachable/non-detachable	Both detachable and non-detachable
Type	Dual band Sleeve Dipole and Ceramic Chip antenna
Gain (From data sheet)	Dipole: 2.4GHz and 5.8GHz = 2.0dBi Chip antenna: 2.4GHz = 1.0dBi 5.8GHz = -1.5dBi
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.407
EUT will be operated under RSS Rule Part(s)	RSS 210 A9
Modular Filing	☒ Yes ☐ No
Portable or Mobile?	Mobile

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RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	X	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use

Duty Cycle used in evaluation: 100 %

Standard used for evaluation: OET 65

Measurement Distance: 20 cm

RF Value: 0.1580 ☐ V/m ☐ A/m ☒ W/m²
☐ Measured ☐ Computed ☒ Calculated

2.5 - Product Description

The 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).

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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

3.2.1 Operation in the 5.15 – 5.25 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (a)(1)	210 A9.2 (1)	Power Limits	Pass
15.407 (a)(1)	210 A9.2 (1)	Peak Power Spectral Density	Pass
15.407 (a)(1)	210 A9.2 (1)	26dB Bandwidth	Pass
15.407 (a)(6)	N/A	Peak Excursion Ratio	Pass
15.407 (b)(1)	210 A9.2 (1)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7),	210 A9.2 (1) GEN	Spurious Emissions below 1GHz AC Mains emissions	Pass
15.407 (e)	210 A.9.2 (1)	Indoor Operation	Pass
15.407 (f)	102 (4)	RF Exposure requirements	Pass
15.407 (g)	N/A	Frequency Stability	Pass

3.2.2 Operation in the 5.25 – 5.35 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (a)(2)	210 A9.2 (2)	Power Limits	Pass
15.407 (a)(2)	210 A9.2 (2)	Peak Power Spectral Density	Pass
15.407 (a)(2)	210 A9.2 (2)	26dB Bandwidth	Pass
15.407 (a)(6)	N/A	Peak Excursion Ratio	Pass
15.407 (b)(2)	210 A9.2 (2)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7),	210 A9.2 (2) GEN	Spurious Emissions below 1GHz AC Mains emissions	Pass
15.407 (f)	102 (4)	RF Exposure requirements	Pass
15.407 (g)	N/A	Frequency Stability	Pass
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

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

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3.2.3 Operation in the 5.47 – 5.725 GHz band

FCC Rule Part	RSS Rule Part	Test Description	Test Result
15.407 (a)(2)	210 A9.2 (3)	Power Limits	Pass
15.407 (a)(2)	210 A9.2 (3)	Peak Power Spectral Density	Pass
15.407 (a)(2)	210 A9.2 (3)	26dB Bandwidth	Pass
15.407 (a)(6)	N/A	Peak Excursion Ratio	Pass
15.407 (b)(3)	210 A9.2 (3)	Undesirable emissions Limit	Pass
15.407 (b)(6) & (7),	210 A9.2 (3) GEN	Spurious Emissions below 1GHz AC Mains emissions	Pass
15.407 (f)	1025 (4)	RF Exposure requirements	Pass
15.407 (g)	N/A	Frequency Stability	Pass
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

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

3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☐ None ☒ Yes (explain below)

Channel 52 of the EUT shall not be used and will be disabled.
Statement from manufacturer:

“The permitted channels are activated through firmware control and customers are not allowed to change the settings defined by LSR. Channel 52 is not activated in the firmware settings therefore customers may not activate channel 52.”

3.4 - Deviations & Exclusions From Test Specifications

☒ None ☐ Yes (explain below)

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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, and Industry Canada RSS-210, Issue 8 (2010), Annex 9.

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

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.

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EXHIBIT 5. General Procedures.

5.1 Radiated measurements

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 40000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz while a standard gain horn antenna was used in the 18 GHz to 40 GHz range. The maximum radiated RF emissions between 30MHz to 4 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. Measurements above 4 GHz are performed at 1 meter separation distance.

The EUT was positioned in 3 orthogonal orientations.

5.2 Calculation of Radiated emissions limits and reported data.

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dBµV/m).

As specified in 15.247 (d) and RSS 210 A8.5, radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2 of RSS 210 for IC, must comply with the general emissions limit.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS GEN.

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Frequency (MHz)	3 m Limit $\mu\text{V/m}$	3 m Limit (dB $\mu\text{V/m}$)	1 m Limit (dB $\mu\text{V/m}$)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength ($\mu\text{V/m}$ to dB $\mu\text{V/m}$):
dB $\mu\text{V/m}$ = $20 \log_{10} (100) = 40$ dB $\mu\text{V/m}$ (from 30-88 MHz)

Conversion of field strength measurements to EIRP (KDB 412172).

$$E[\text{dB}\mu\text{V/m}] = \text{EIRP}[\text{dBm}] - 20 \log(d[\text{meters}]) + 104.77$$

E is the field strength
d is the measurements distance

Example:

1. Field strength to EIRP:

$$E = 105.2 \text{ [dB}\mu\text{V/m]}, d = 3 \text{ [meters]}$$

$$\text{EIRP} = 105.2 - 95.2 = \underline{10 \text{ dBm}}$$

2. EIRP to field strength:

$$\text{EIRP} = -30.0 \text{ dBm}, d = 3 \text{ [meters]}$$

$$E = -30.0 + 95.2 = 65.2 \text{ [dB}\mu\text{V/m]}$$

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EXHIBIT 6. EUT Duty Cycle

Test Engineer: Adam Alger

All measurements are to be performed with the EUT transmitting at greater than or equal to 98% percent duty cycle. If greater than or equal to 98 percent duty cycle is not available, the actual duty cycle needs to be measured so that power and peak spectral density measurements can be corrected upwards.

6.1 Test Procedure.

Per KDB 789033 D01 section B, a spectrum analyzer with zero span at the frequency of interest was used to measure the on and off times of the transmitted signal.

6.2 Data.

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

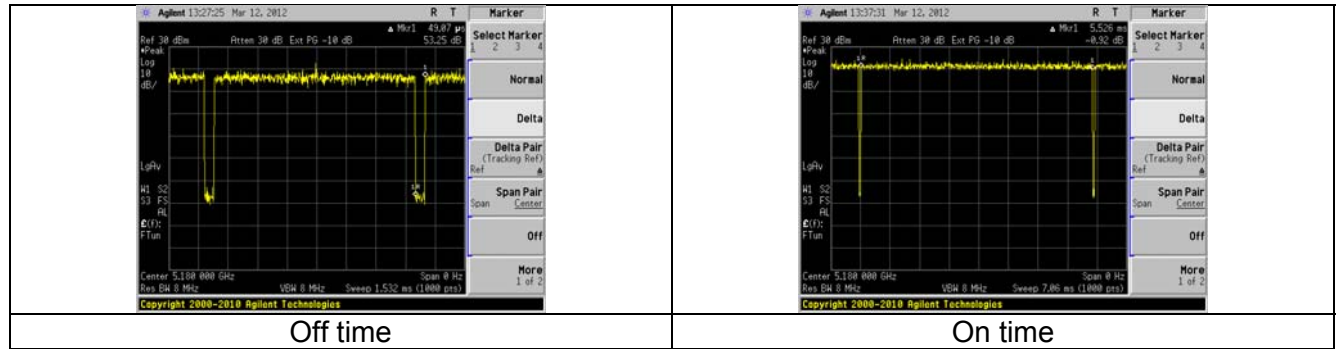
Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

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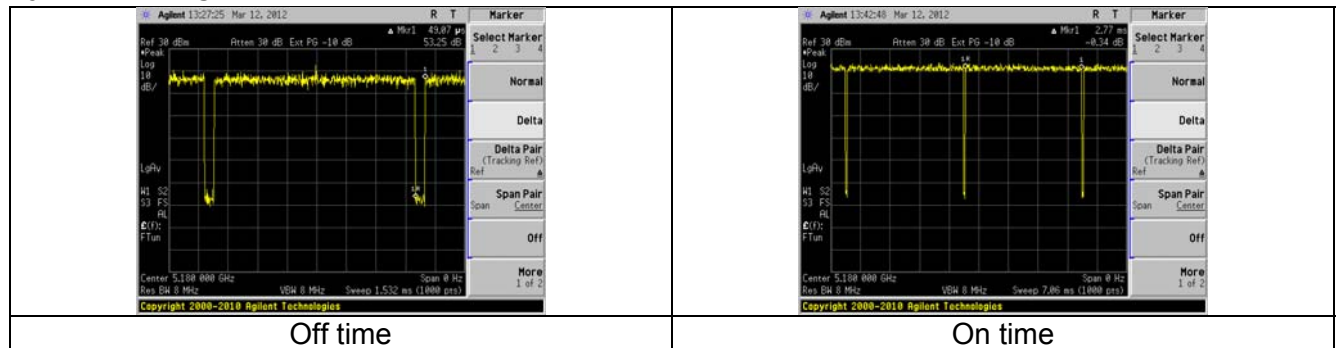
6.2.1 6MBPS.



$$\text{Duty Cycle} = \text{Tx On} / (\text{Tx On} + \text{Tx Off})$$

$$\text{Duty Cycle} = 5.526\text{ms} / 5.575\text{ms} = .99$$

6.2.2 12MBPS

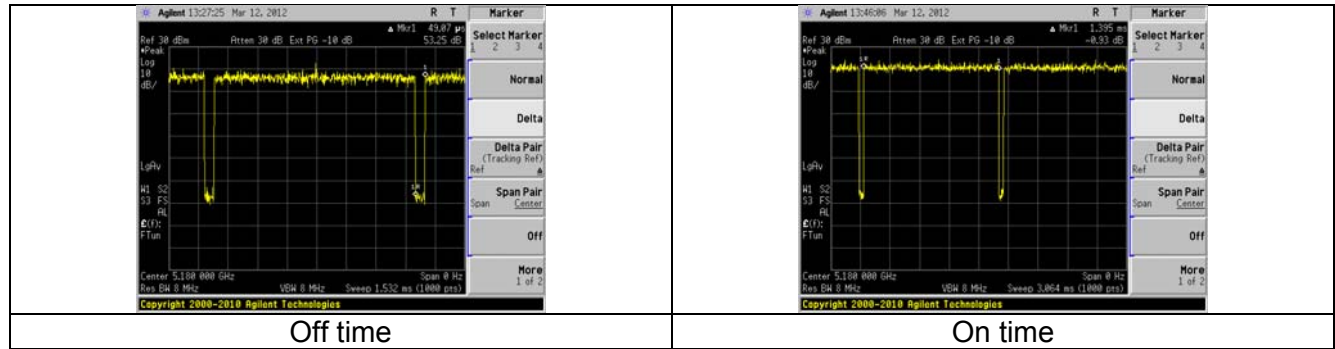


$$\text{Duty Cycle} = \text{Tx On} / (\text{Tx On} + \text{Tx Off})$$

$$\text{Duty Cycle} = 2.77\text{ms} / 2.82\text{ms} = .98$$

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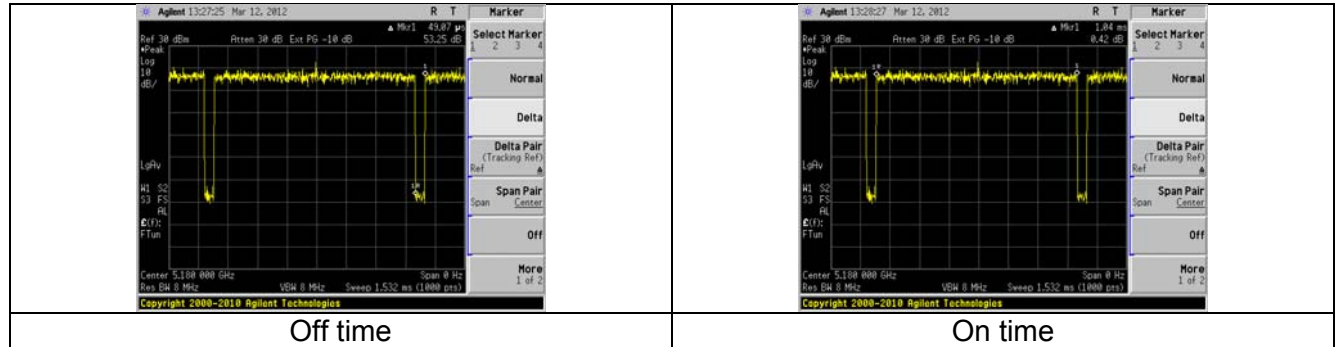
6.2.3 24MBPS



$$\text{Duty Cycle} = \text{Tx On} / (\text{Tx On} + \text{Tx Off})$$

$$\text{Duty Cycle} = 1.395\text{ms} / 1.444\text{ms} = .966$$

6.2.4 MCS7



$$\text{Duty Cycle} = \text{Tx On} / (\text{Tx On} + \text{Tx Off})$$

$$\text{Duty Cycle} = 1.039\text{ms} / 1.088\text{ms} = .95$$

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EXHIBIT 7. Emission Bandwidth (EBW)

Test Engineer: Adam Alger

The emission bandwidth is the 26dB bandwidth in MHz. This bandwidth is used to determine the maximum conducted output power measurement and the appropriate limit.

7.1 Test procedure.

KDB 789033 D01 section D.

7.2 Test Data.

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

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7.2.1 Operation in the 5.15 – 5.25 GHz band

7.2.1.1 6MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
6 Mbps	36	5180	23.0
	40	5200	23.3
	48	5240	23.0

7.2.1.2 12MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
12 Mbps	36	5180	23.3
	40	5200	22.6
	48	5240	22.2

7.2.1.3 24MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
24 Mbps	36	5180	21.5
	40	5200	22.0
	48	5240	21.6

7.2.1.4 MCS7

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
65 Mbps (MCS7)	36	5180	22.8
	40	5200	22.6
	48	5240	22.2

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7.2.2 Operation in the 5.25 – 5.35 GHz band

7.2.2.1 6MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
6 Mbps	56	5280	29.4
	60	5300	30.5
	64	5320	29.2

7.2.2.2 12MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
12 Mbps	56	5280	26.7
	60	5300	26.8
	64	5320	26.0

7.2.2.3 24MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
24 Mbps	56	5280	26.2
	60	5300	25.0
	64	5320	26.5

7.2.2.4 MCS7

Data Rate	Channel	Tx Power Setting	EBW 26dB (MHz)
65 Mbps (MCS7)	56	12.5	23.1
	60	12.5	23.4
	64	12.5	22.3

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7.2.3 Operation in the 5.47 – 5.725 GHz band

7.2.3.1 6MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
6 Mbps	100	5500	24.3
	116	5580	25.1
	140	5700	26.1

7.2.3.2 12MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
12 Mbps	100	5500	22.8
	116	5580	24.1
	140	5700	23.4

7.2.3.3 24MBPS

Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
24 Mbps	100	5500	24.4
	116	5580	22.4
	140	5700	22.8

7.2.3.4 MCS7

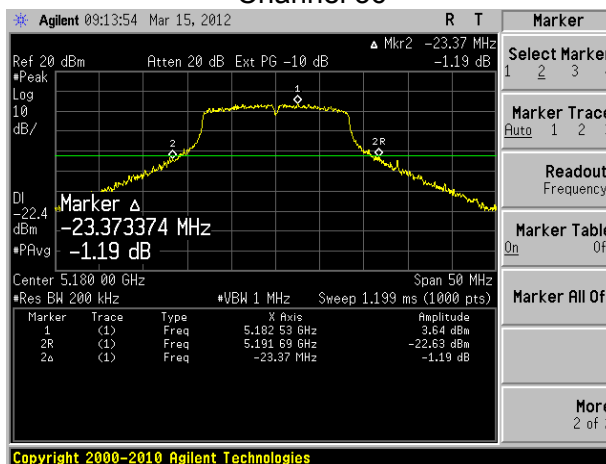
Data Rate	Channel	Frequency (MHz)	EBW 26dB (MHz)
65 Mbps (MCS7)	100	5500	23.0
	116	5580	22.7
	140	5700	22.4

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7.3 Screen Captures

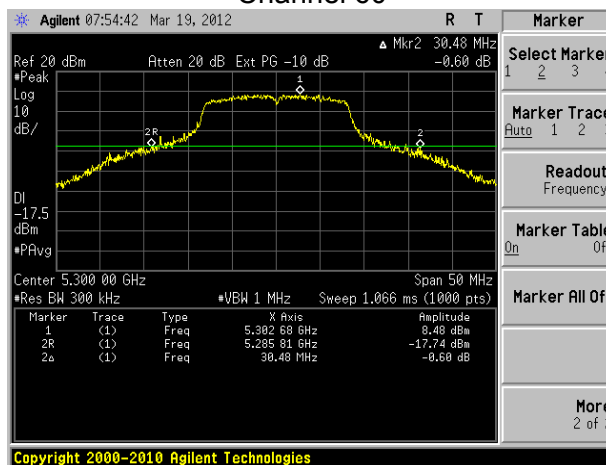
7.3.1 Operation in the 5.15 – 5.25 GHz band

Channel 36



7.3.2 Operation in the 5.25 – 5.35 GHz band

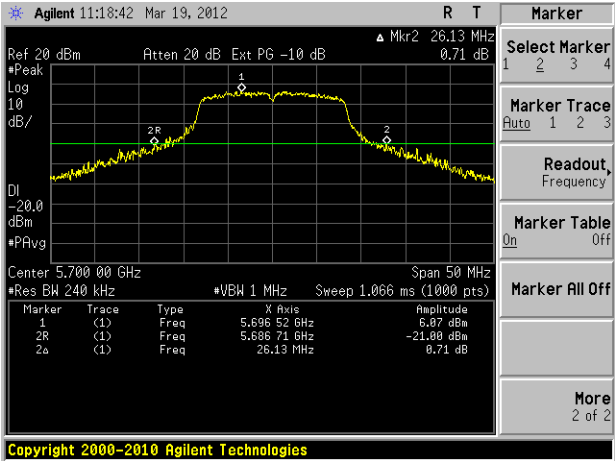
Channel 60



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7.3.1 Operation in the 5.47 – 5.725 GHz band

Channel 140



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EXHIBIT 8 Maximum Conducted Output Power And Peak Power Spectral Density

Test Engineer: Adam Alger

8.1 Test Procedure

KDB 789033 D01 section C (Maximum Conducted Output Power) and E (Peak Power Spectral Density)

8.2 Limits

8.2.1 Operation in the band 5.15 to 5.25 GHz

Maximum conducted output power = Lesser of 50mW or 4dBm + 10 log EBW

Peak Power Spectral Density = 4 dBm/MHz

8.2.2 Operation in the band 5.25 to 5.35 GHz

Maximum conducted output power = Lesser of 250mW or 11dBm + 10 log EBW

Peak Power Spectral Density = 11 dBm/MHz

8.2.3 Operation in the band 5.47 to 5.725 GHz

Maximum conducted output power = Lesser of 250mW or 11dBm + 10 log EBW

Peak Power Spectral Density = 11 dBm/MHz

8.2.4 Operation in the band 5.725 to 5.825 GHz

Maximum conducted output power = Lesser of 1W or 4dBm + 17 log EBW

Peak Power Spectral Density = 17 dBm/MHz

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8.3 Test Data

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

8.3.1 Operation in the band 5.15 to 5.25 GHz

8.3.1.1 6MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6 Mbps	36	5180	13.6	17	3.4	3.4	4	0.7
	40	5200	13.5	17	3.5	3.4	4	0.6
	48	5240	13.4	17	3.6	3.2	4	0.8

8.3.1.2 12MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
12 Mbps	36	5180	13.4	17	3.6	3.2	4	0.9
	40	5200	13.6	17	3.4	3.3	4	0.7
	48	5240	13.7	17	3.4	3.5	4	0.6

8.3.1.3 24 MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
24 Mbps	36	5180	13.6	17	3.4	3.7	4	0.3
	40	5200	13.7	17	3.3	3.4	4	0.7
	48	5240	13.7	17	3.3	3.5	4	0.5

Note: 0.15 dB of duty cycle correction was added to measurements

Sample calculation:

Power (Chan 40) = 13.59dBm + 0.15dB (duty cycle correction) = 13.7dBm

PPSD (Chan 40) = 3.21dBm + 0.15dB (duty cycle correction) = 3.4dBm

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8.3.1.4 MCS7

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
65 Mbps (MCS7)	36	5180	12.9	17	4.1	2.5	4	1.5
	40	5200	13.0	17	4.0	2.5	4	1.5
	48	5240	12.6	17	4.4	2.5	4	1.5

Note: 0.20 dB of duty cycle correction was added to measurements

Sample calculation:

Power (Chan 40) = 12.8dBm + 0.20dB (duty cycle correction) = 13.0dBm

PPSD (Chan 40) = 2.3dBm + 0.20dB (duty cycle correction) = 2.5dBm

8.3.2 Operation in the band 5.25 to 5.35 GHz

8.3.2.1 6MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6 Mbps	56	5280	17.0	24	7.0	6.5	11	4.5
	60	5300	17.0	24	7.0	6.8	11	4.2
	64	5320	17.0	24	7.0	6.7	11	4.3

8.3.2.2 12MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
12 Mbps	56	5280	17.0	24	7.0	6.9	11	4.1
	60	5300	16.8	24	7.3	6.9	11	4.1
	64	5320	16.7	24	7.3	6.5	11	4.5

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8.3.2.3 24 MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
24 Mbps	56	5280	16.8	24	7.2	6.5	11	4.5
	60	5300	16.2	24	7.8	6.2	11	4.8
	64	5320	16.8	24	7.2	6.9	11	4.1

Note: 0.15 dB of duty cycle correction was added to measurements

Sample calculation:

Power (Chan 60) = 16.1dBm + 0.15dB (duty cycle correction) = 16.2dBm

PPSD (Chan 60) = 6.1dBm + 0.15dB (duty cycle correction) = 6.2dBm

8.3.2.4 MCS7

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
65 Mbps (MCS7)	56	5280	12.5	24	11.5	2.0	11	9.0
	60	5300	12.2	24	11.8	1.8	11	9.2
	64	5320	12.7	24	11.3	2.3	11	8.7

Note: 0.20 dB of duty cycle correction was added to measurements

Sample calculation:

Power (Chan 60) = 12.0dBm + 0.20dB (duty cycle correction) = 12.2dBm

PPSD (Chan 60) = 1.6dBm + 0.20dB (duty cycle correction) = 1.8dBm

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8.3.3 Operation in the band 5.47 to 5.725 GHz

8.3.3.1 6MBPS

Data Rate	Channel	EBW 26dB (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6 Mbps	100	24.3	16.0	24	8.1	5.9	11	5.1
	116	25.1	15.6	24	8.4	5.2	11	5.8
	140	26.1	15.7	24	8.3	5.3	11	5.7

8.3.3.2 12MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
12 Mbps	100	5500	15.9	24	8.1	5.4	11	5.6
	116	5580	15.5	24	8.5	5.3	11	5.7
	140	5700	15.6	24	8.4	5.2	11	5.8

8.3.3.3 24 MBPS

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
24 Mbps	100	5500	15.9	24	8.2	5.7	11	5.3
	116	5580	15.5	24	8.5	5.2	11	5.8
	140	5700	15.7	24	8.3	5.2	11	5.8

Note: 0.15 dB of duty cycle correction was added to measurements

Sample calculation:

Power (Chan 116) = 15.4dBm + 0.15dB (duty cycle correction) = 15.5dBm

PPSD (Chan 116) = 5.1dBm + 0.15dB (duty cycle correction) = 5.2dBm

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8.3.3.4 MCS7

Data Rate	Channel	Frequency (MHz)	Power *SA2 (dBm)	Power Limit (dBm)	Power Margin (dB)	*PPSD (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
65 Mbps (MCS7)	100	5500	13.5	24	10.5	3.2	11	7.8
	116	5580	13.3	24	10.7	3.3	11	7.7
	140	5700	13.0	24	11.0	2.6	11	8.4

Note: 0.20 dB of duty cycle correction was added to measurements

Sample calculation:

Power (Chan 116) = 13.1dBm + 0.20dB (duty cycle correction) = 13.3dBm

PPSD (Chan 116) = 3.1dBm + 0.20dB (duty cycle correction) = 3.3dBm

8.3.4 Operation in the band 5.725 to 5.825 GHz

8.3.4.1 6MBPS

Not Applicable

8.3.4.2 12MBPS

Not Applicable

8.3.4.3 24 MBPS

Not Applicable

8.3.4.4 MCS7

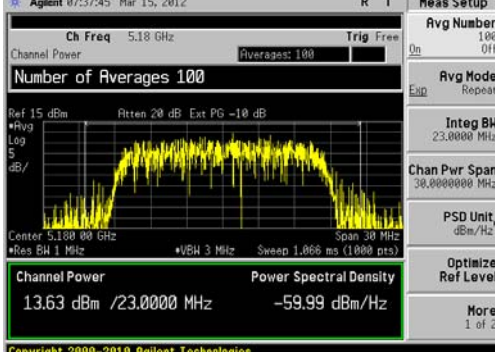
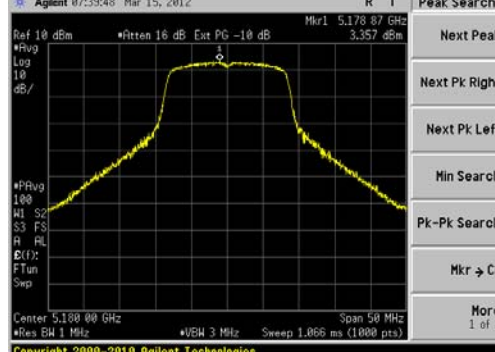
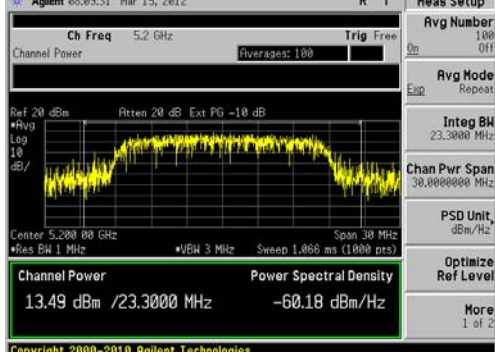
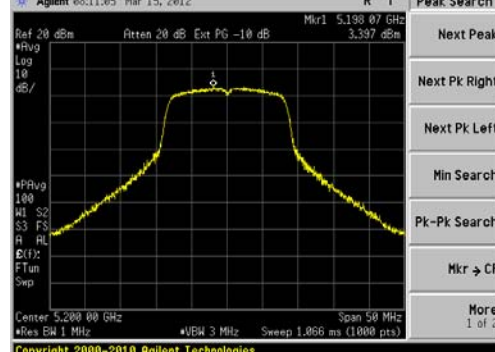
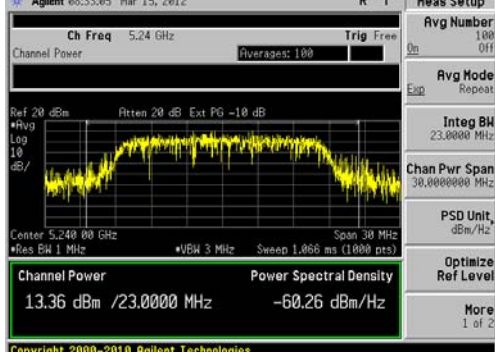
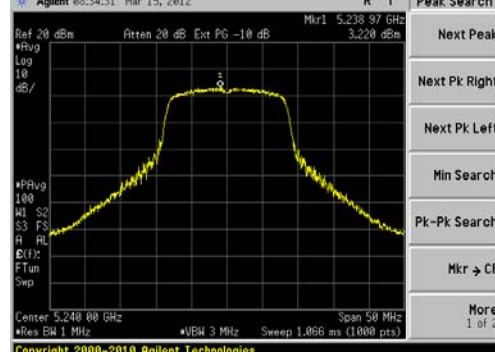
Not Applicable

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Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 28 of 88

8.4 Screen Captures

8.4.1 Operation in the band 5.15 to 5.25 GHz

8.4.1.1 6MBPS

 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
Low channel Output Power	Low channel Peak Power Spectral Density
 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
Middle channel Output Power	Middle channel Peak Power Spectral Density
 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

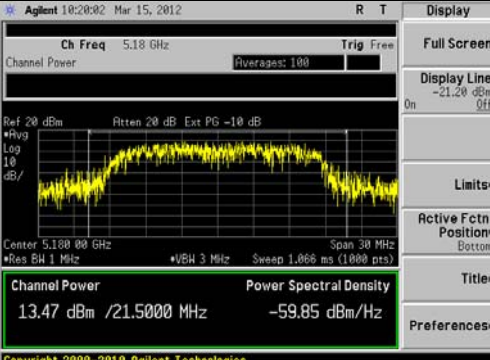
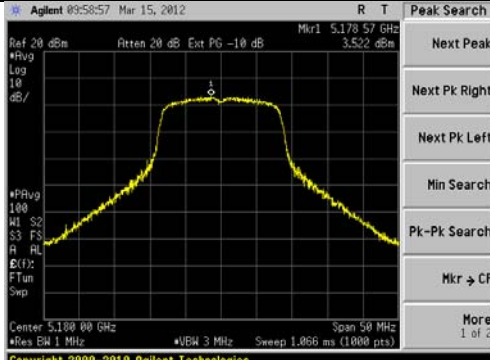
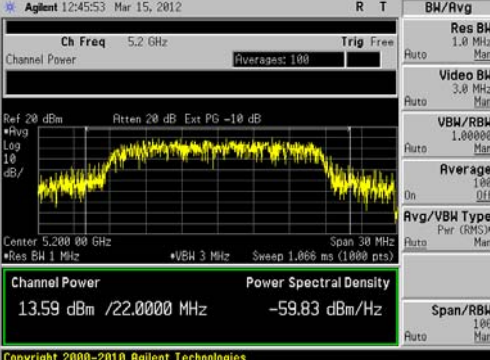
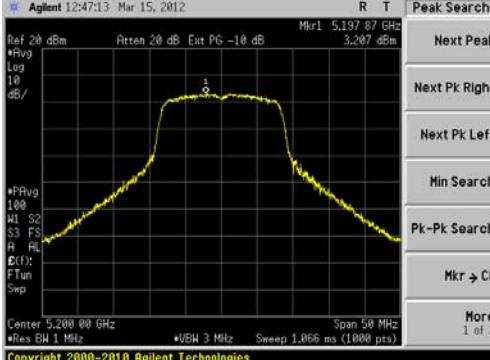
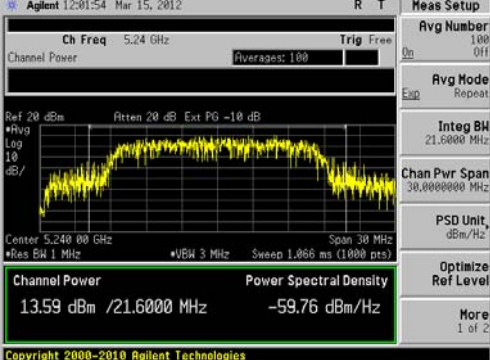
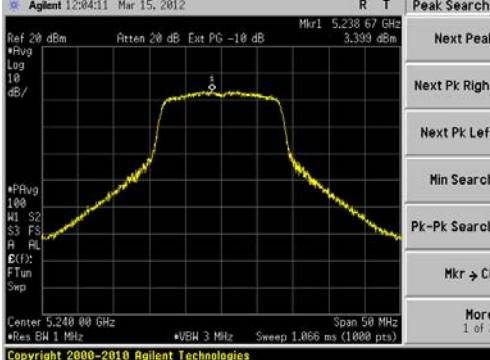
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 29 of 88

8.4.1.2 12MBPS

Agilent 09:15:54 Mar 15, 2012 Ch Freq 5.18 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.180 00 GHz Channel Power 13.43 dBm / 23.3000 MHz Power Spectral Density -60.25 dBm/Hz	Agilent 09:17:26 Mar 15, 2012 Ch Freq 5.178 GHz Peak Search Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.180 00 GHz Peak Search 3.150 dBm
Low channel Output Power Agilent 12:34:14 Mar 15, 2012 Ch Freq 5.2 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.200 00 GHz Channel Power 13.56 dBm / 22.6000 MHz Power Spectral Density -59.99 dBm/Hz	Low channel Peak Power Spectral Density Agilent 12:35:10 Mar 15, 2012 Ch Freq 5.202 GHz Peak Search Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.200 00 GHz Peak Search 3.264 dBm
Middle channel Output Power Agilent 12:19:50 Mar 15, 2012 Ch Freq 5.24 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.240 00 GHz Channel Power 13.65 dBm / 22.2000 MHz Power Spectral Density -59.81 dBm/Hz	Middle channel Peak Power Spectral Density Agilent 12:20:41 Mar 15, 2012 Ch Freq 5.241 GHz Peak Search Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.240 00 GHz Peak Search 3.452 dBm
High channel Output Power	High channel Peak Power Spectral Density

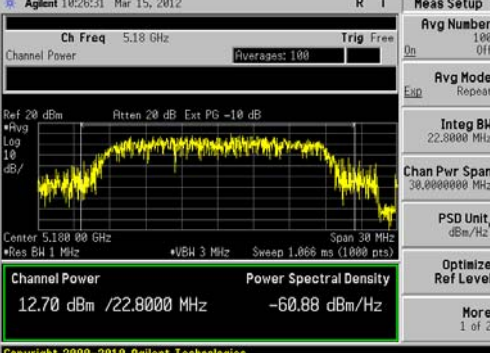
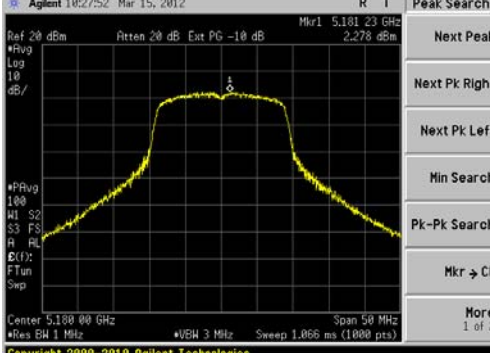
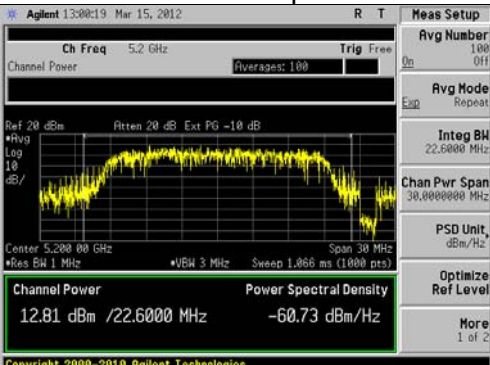
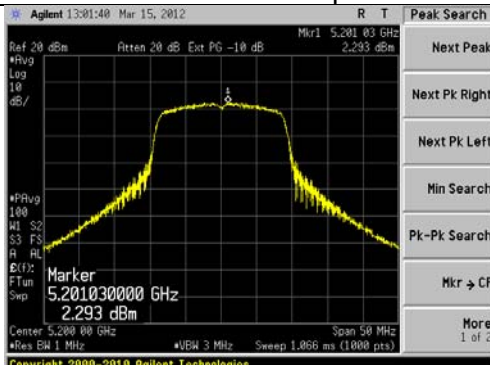
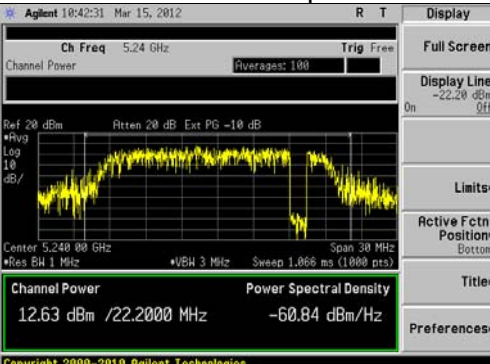
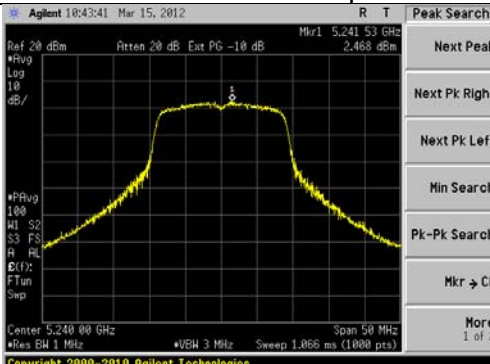
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #:	Serial #:	Page 30 of 88
C-1371	SN051201 Conducted	
	SN041201, SN361116 Radiated	

8.4.1.3 24MBPS

 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
Low channel Output Power	Low channel Peak Power Spectral Density
 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
Middle channel Output Power	Middle channel Peak Power Spectral Density
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High channel Output Power	High channel Peak Power Spectral Density

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8.4.1.3 MCS7

 Agilent 1826031 Mar 15, 2012 Ch Freq 5.18 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.180 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power 12.70 dBm / 22.8000 MHz Power Spectral Density -60.88 dBm/Hz Copyright 2000-2010 Agilent Technologies	 Agilent 182752 Mar 15, 2012 Ref 20 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.181 23 GHz 2.278 dBm Center 5.180 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 50 MHz Peak Power Spectral Density 2.278 dBm Copyright 2000-2010 Agilent Technologies
Low channel Output Power  Agilent 130819 Mar 15, 2012 Ch Freq 5.2 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.200 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power 12.81 dBm / 22.6000 MHz Power Spectral Density -60.73 dBm/Hz Copyright 2000-2010 Agilent Technologies	Low channel Peak Power Spectral Density  Agilent 130140 Mar 15, 2012 Ref 20 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.201 03 GHz 2.293 dBm Center 5.200 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 50 MHz Peak Power Spectral Density 2.293 dBm Copyright 2000-2010 Agilent Technologies
Middle channel Output Power  Agilent 1824231 Mar 15, 2012 Ch Freq 5.24 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Center 5.240 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power 12.63 dBm / 22.2000 MHz Power Spectral Density -60.84 dBm/Hz Copyright 2000-2010 Agilent Technologies	Middle channel Peak Power Spectral Density  Agilent 1824341 Mar 15, 2012 Ref 20 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.241 53 GHz 2.468 dBm Center 5.240 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 50 MHz Peak Power Spectral Density 2.468 dBm Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

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C-1371	SN051201 Conducted	
	SN041201, SN361116 Radiated	

8.4.2 Operation in the band 5.25 to 5.35 GHz

8.4.2.1 6MBPS

Copyright 2000-2010 Agilent Technologies	Copyright 2000-2010 Agilent Technologies
Low channel Output Power Copyright 2000-2010 Agilent Technologies	Low channel Peak Power Spectral Density Copyright 2000-2010 Agilent Technologies
Middle channel Output Power Copyright 2000-2010 Agilent Technologies	Middle channel Peak Power Spectral Density Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

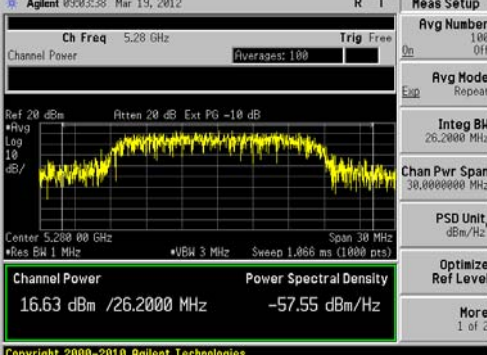
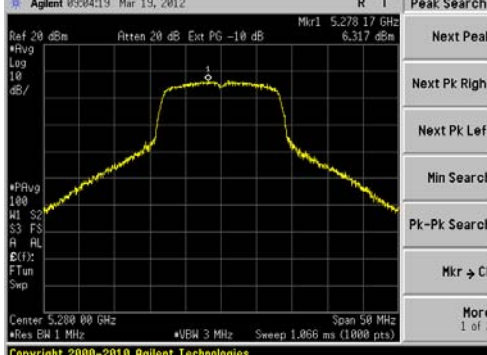
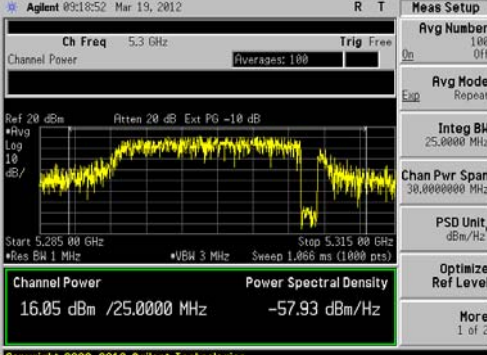
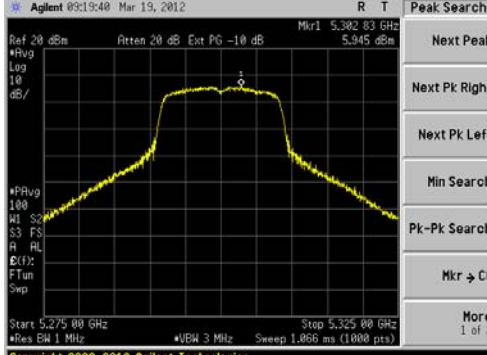
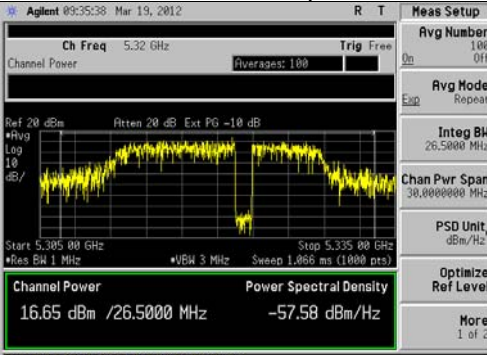
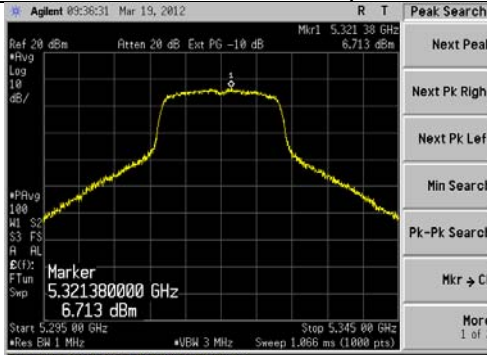
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 33 of 88

8.4.2.2 12MBPS

Agilent 882536 Mar 19, 2012 Ch Freq 5.28 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Power Spectral Density 17.04 dBm /26.7000 MHz -57.23 dBm/Hz Copyright 2000-2010 Agilent Technologies	Agilent 882626 Mar 19, 2012 Peak Search Next Peak Next Pk Right Next Pk Left Min Search Pk-Pk Search Mkr → CF More 1 of 2 Copyright 2000-2010 Agilent Technologies
Low channel Output Power Agilent 883713 Mar 19, 2012 Ch Freq 5.3 GHz Channel Power Ref 20 dBm Atten 20 dB Ext PG -10 dB Power Spectral Density 16.75 dBm /26.8000 MHz -57.53 dBm/Hz Copyright 2000-2010 Agilent Technologies	Low channel Peak Power Spectral Density Agilent 883748 Mar 19, 2012 Peak Search Next Peak Next Pk Right Next Pk Left Min Search Pk-Pk Search Mkr → CF More 1 of 2 Copyright 2000-2010 Agilent Technologies
Middle channel Output Power Agilent 884518 Mar 19, 2012 Ch Freq 5.32 GHz Channel Power Ref 16 dBm Atten 16 dB Ext PG -10 dB Power Spectral Density 16.70 dBm /26.0000 MHz -57.45 dBm/Hz Copyright 2000-2010 Agilent Technologies	Middle channel Peak Power Spectral Density Agilent 884547 Mar 19, 2012 Peak Search Next Peak Next Pk Right Next Pk Left Min Search Pk-Pk Search Mkr → CF More 1 of 2 Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

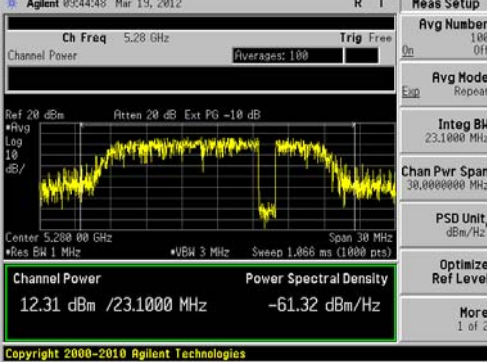
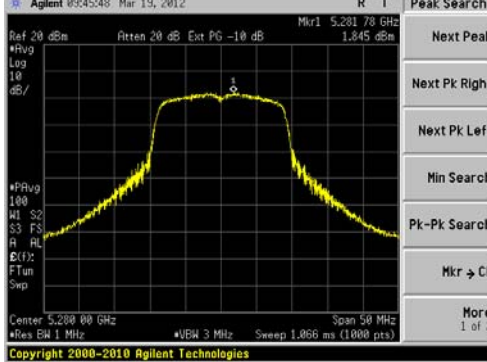
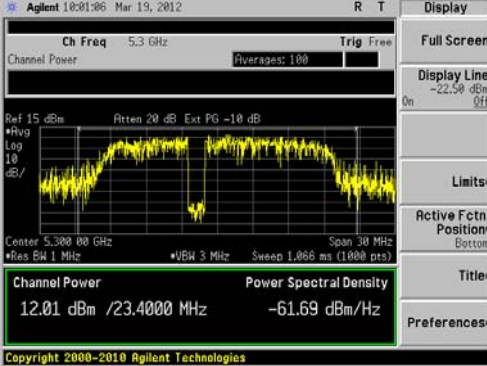
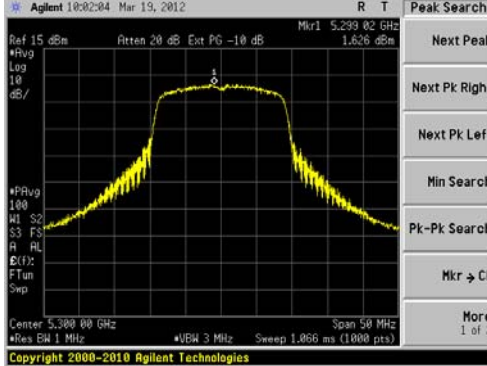
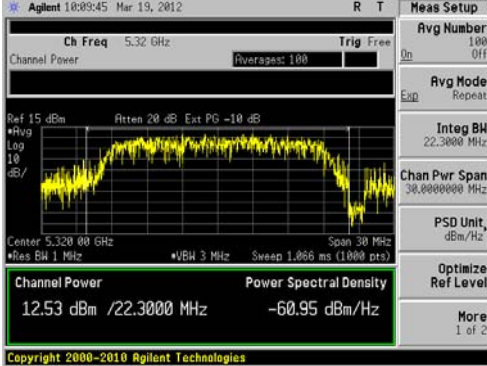
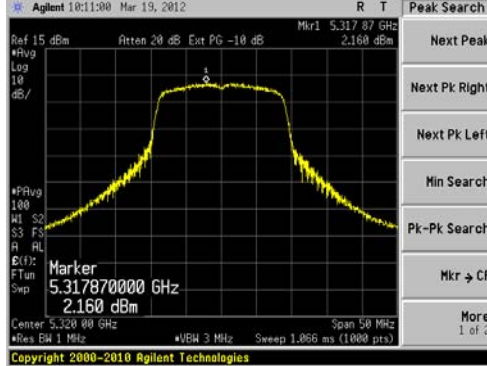
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 34 of 88

8.4.2.3 24MBPS

 Agilent 8903538 Mar 19, 2012 Ch Freq: 5.28 GHz Channel Power: 16.63 dBm / 26.2000 MHz Power Spectral Density: -57.55 dBm/Hz	 Agilent 890419 Mar 19, 2012 Mkr1: 5.27817 GHz Peak: 6.317 dBm
Low channel Output Power	Low channel Peak Power Spectral Density
 Agilent 890352 Mar 19, 2012 Ch Freq: 5.3 GHz Channel Power: 16.05 dBm / 25.0000 MHz Power Spectral Density: -57.93 dBm/Hz	 Agilent 890354 Mar 19, 2012 Mkr1: 5.30283 GHz Peak: 5.945 dBm
Middle channel Output Power	Middle channel Peak Power Spectral Density
 Agilent 8903538 Mar 19, 2012 Ch Freq: 5.32 GHz Channel Power: 16.65 dBm / 26.5000 MHz Power Spectral Density: -57.58 dBm/Hz	 Agilent 8903631 Mar 19, 2012 Mkr1: 5.32138 GHz Peak: 6.713 dBm
High channel Output Power	High channel Peak Power Spectral Density

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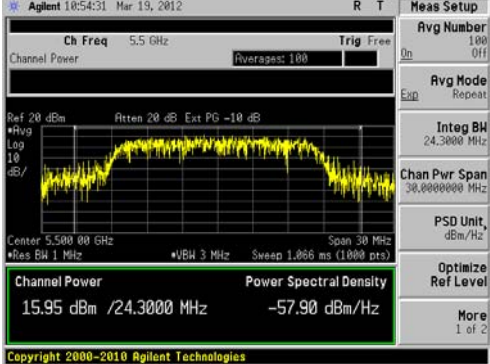
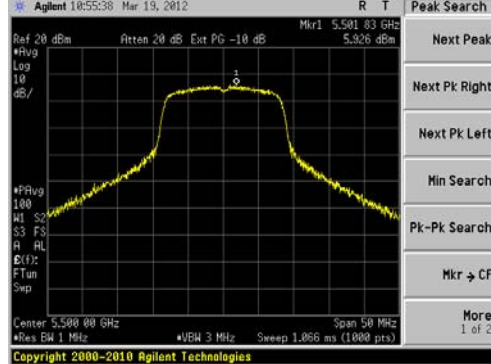
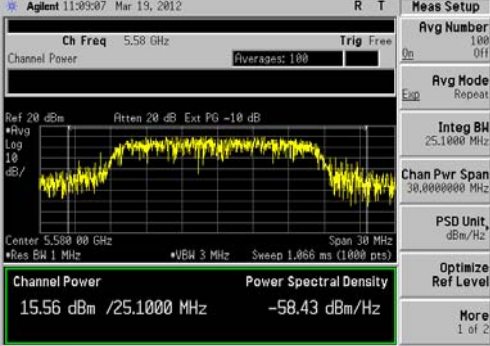
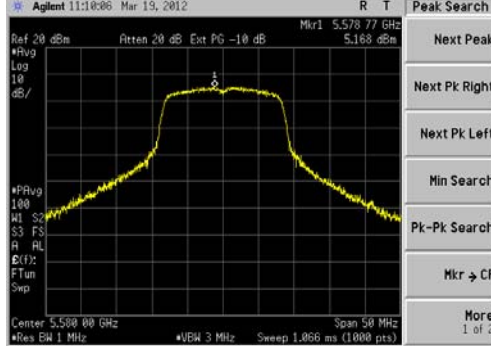
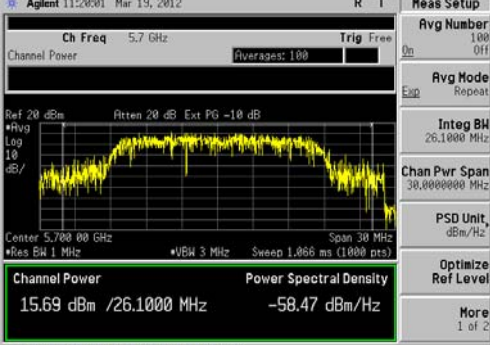
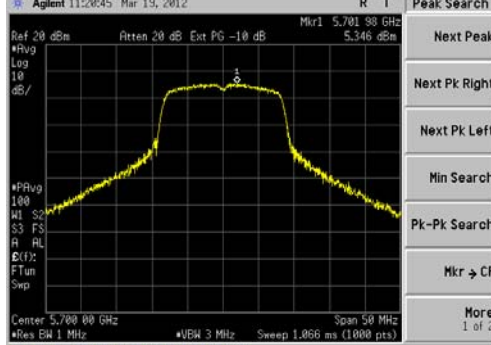
8.4.2.4 MCS7

 Agilent 6944:48 Mar 19, 2012 Ch Freq 5.28 GHz Channel Power Averages: 100 Ref 20 dBm Atten 20 dB Ext PG -10 dB *Avg Log 10 dB/ Center 5.280 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power 12.31 dBm / 23.1000 MHz Power Spectral Density -61.32 dBm/Hz Copyright 2000-2010 Agilent Technologies	 Agilent 6945:48 Mar 19, 2012 Ref 20 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.281 78 GHz 1.845 dBm *Avg Log 10 dB/ *PAvg 100 M1 S2 S3 FS A AL B(F): FTun Swp Center 5.280 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 50 MHz Copyright 2000-2010 Agilent Technologies
Low channel Output Power  Agilent 1801:06 Mar 19, 2012 Ch Freq 5.3 GHz Channel Power Averages: 100 Ref 15 dBm Atten 20 dB Ext PG -10 dB *Avg Log 10 dB/ Center 5.300 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power 12.01 dBm / 23.4000 MHz Power Spectral Density -61.69 dBm/Hz Copyright 2000-2010 Agilent Technologies	Low channel Peak Power Spectral Density  Agilent 1802:04 Mar 19, 2012 Ref 15 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.299 02 GHz 1.626 dBm *Avg Log 10 dB/ *PAvg 100 M1 S2 S3 FS A AL B(F): FTun Swp Center 5.300 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 50 MHz Copyright 2000-2010 Agilent Technologies
Middle channel Output Power  Agilent 1809:45 Mar 19, 2012 Ch Freq 5.32 GHz Channel Power Averages: 100 Ref 15 dBm Atten 20 dB Ext PG -10 dB *Avg Log 10 dB/ Center 5.320 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power 12.53 dBm / 22.3000 MHz Power Spectral Density -60.95 dBm/Hz Copyright 2000-2010 Agilent Technologies	Middle channel Peak Power Spectral Density  Agilent 1811:00 Mar 19, 2012 Ref 15 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.317 87 GHz 2.160 dBm *Avg Log 10 dB/ *PAvg 100 M1 S2 S3 FS A AL B(F): FTun Swp Center 5.320 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 50 MHz Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

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	SN041201, SN361116 Radiated	

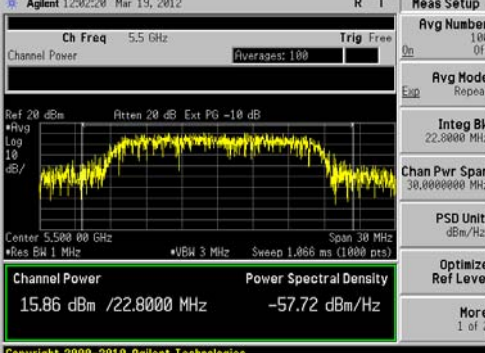
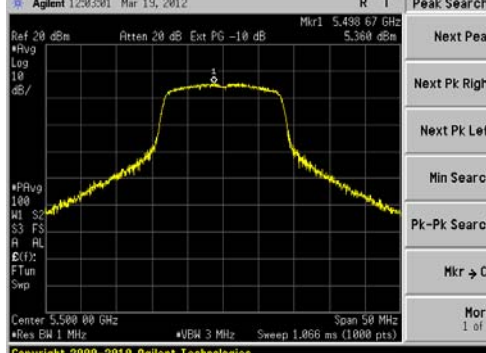
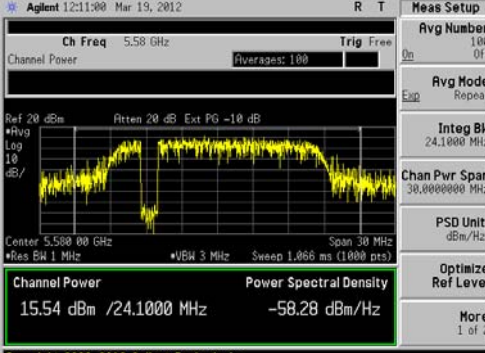
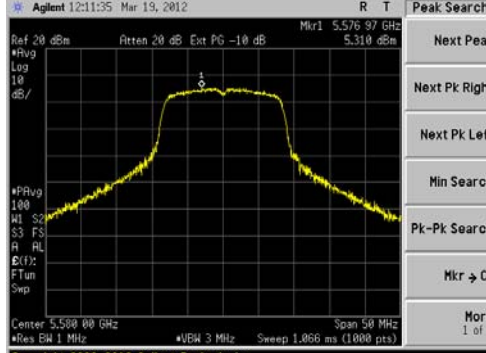
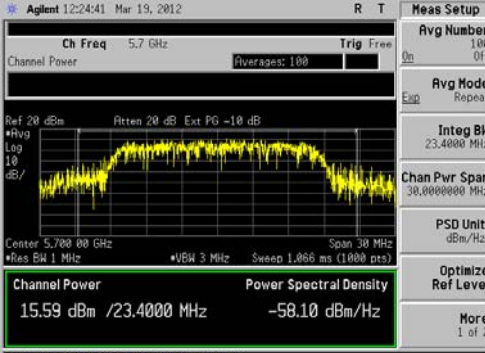
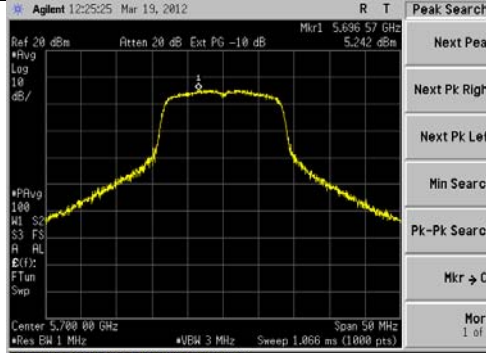
8.4.3 Operation in the band 5.47 to 5.725 GHz

8.4.3.1 6MBPS

 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
Low channel Output Power  Copyright 2000-2010 Agilent Technologies	Low channel Peak Power Spectral Density  Copyright 2000-2010 Agilent Technologies
Middle channel Output Power  Copyright 2000-2010 Agilent Technologies	Middle channel Peak Power Spectral Density  Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

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8.4.3.2 12MBPS

 Agilent 12802:28 Mar 19, 2012 Ch Freq 5.5 GHz Channel Power Averages: 100 Ref 20 dBm Atten 20 dB Ext PG -10 dB *Avg Log 10 dB/ Center 5.500 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power Power Spectral Density 15.86 dBm / 22.8000 MHz -57.72 dBm/Hz Copyright 2000-2010 Agilent Technologies	 Agilent 12803:01 Mar 19, 2012 Ref 20 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.498 67 GHz 5.360 dBm Next Peak Next Pk Right Next Pk Left Min Search Pk-Pk Search Mkr -> CF More 1 of 2 Copyright 2000-2010 Agilent Technologies
Low channel Output Power  Agilent 1211:00 Mar 19, 2012 Ch Freq 5.58 GHz Channel Power Averages: 100 Ref 20 dBm Atten 20 dB Ext PG -10 dB *Avg Log 10 dB/ Center 5.580 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power Power Spectral Density 15.54 dBm / 24.1000 MHz -58.28 dBm/Hz Copyright 2000-2010 Agilent Technologies	Low channel Peak Power Spectral Density  Agilent 1211:35 Mar 19, 2012 Ref 20 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.576 97 GHz 5.310 dBm Next Peak Next Pk Right Next Pk Left Min Search Pk-Pk Search Mkr -> CF More 1 of 2 Copyright 2000-2010 Agilent Technologies
Middle channel Output Power  Agilent 1224:41 Mar 19, 2012 Ch Freq 5.7 GHz Channel Power Averages: 100 Ref 20 dBm Atten 20 dB Ext PG -10 dB *Avg Log 10 dB/ Center 5.700 00 GHz *Res BW 1 MHz *VBW 3 MHz Sweep 1.066 ms (1000 pts) Span 30 MHz Channel Power Power Spectral Density 15.59 dBm / 23.4000 MHz -58.10 dBm/Hz Copyright 2000-2010 Agilent Technologies	Middle channel Peak Power Spectral Density  Agilent 1225:25 Mar 19, 2012 Ref 20 dBm Atten 20 dB Ext PG -10 dB Mkr1 5.696 57 GHz 5.242 dBm Next Peak Next Pk Right Next Pk Left Min Search Pk-Pk Search Mkr -> CF More 1 of 2 Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

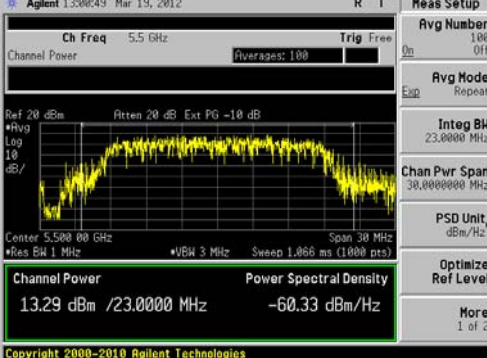
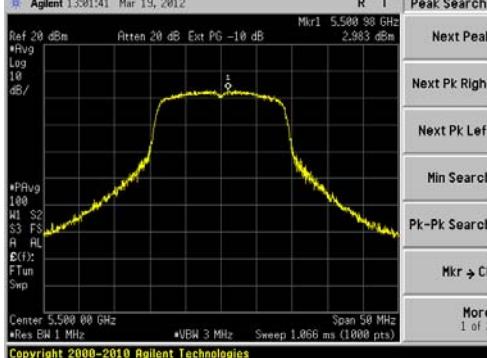
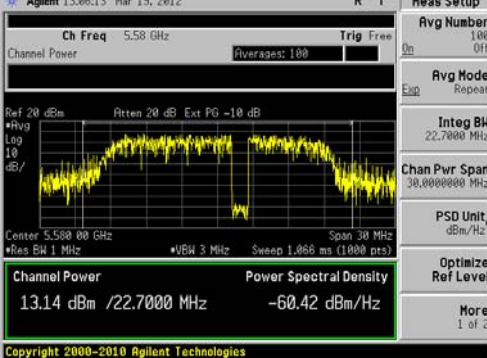
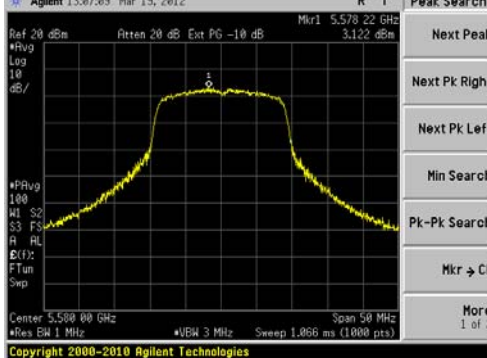
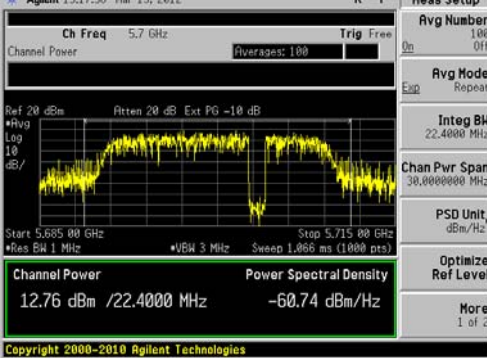
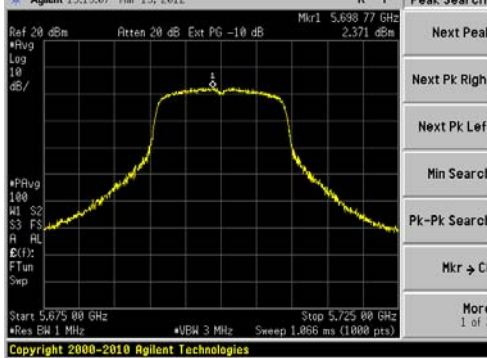
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
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C-1371	SN051201 Conducted	
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8.4.3.3 24MBPS

Low channel Output Power	Low channel Peak Power Spectral Density
Middle channel Output Power	Middle channel Peak Power Spectral Density
High channel Output Power	High channel Peak Power Spectral Density

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8.4.3.4 MCS7

 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
Low channel Output Power	Low channel Peak Power Spectral Density
 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
Middle channel Output Power	Middle channel Peak Power Spectral Density
 Copyright 2000-2010 Agilent Technologies	 Copyright 2000-2010 Agilent Technologies
High channel Output Power	High channel Peak Power Spectral Density

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Report # 311362 E	Model #:TiWi5	Template: 15.407
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EXHIBIT 9. Peak Excursion Ratio

Test Engineer: Adam Alger

9.1 Test Procedure

KDB 789033 D01 section F

9.2 Limit

The ratio of the peak excursion of the modulation envelope to the maximum conducted output power shall not exceed 13dB across any 1 MHz bandwidth or the emission bandwidth, whichever is less.

9.3 Test Data

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

Generic example of reported data at 2440 MHz:

Reported Measurement data = 8.55 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 9.4 (dBm).

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Sample calculation for peak excursion:

Peak Excursion (Channel 48/6MBPS) = 11.3 dBm (Peak Max Hold) – 3.4dBm(PPSD) = 7.9dBm

9.3.1 Operation in the 5.15 – 5.25 GHz band

9.3.1.1 6MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
6 Mbps	36	5180	8	13	5
	40	5200	7.3	13	5.7
	48	5240	7.9	13	5.1

9.3.1.2 12MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
12 Mbps	36	5180	8	13	5
	40	5200	7.7	13	5.3
	48	5240	8.4	13	4.6

9.3.1.3 24MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
24 Mbps	36	5180	7.7	13	5.3
	40	5200	8.1	13	4.9
	48	5240	8	13	5

9.3.1.4 MCS7

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
65 Mbps (MCS7)	36	5180	8.5	13	4.5
	40	5200	8.4	13	4.6
	48	5240	7.8	13	5.2

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9.3.2 Operation in the 5.25 – 5.35 GHz band

9.3.2.1 6MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
6 Mbps	56	5280	7.8	13	5.2
	60	5300	7.3	13	5.7
	64	5320	8.1	13	4.9

9.3.2.2 12MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
12 Mbps	56	5280	7.5	13	5.5
	60	5300	6.8	13	6.2
	64	5320	8.4	13	4.6

9.3.2.3 24MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
24 Mbps	56	5280	8	13	5
	60	5300	8.3	13	4.7
	64	5320	8.5	13	4.5

9.3.2.4 MCS7

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
65 Mbps (MCS7)	56	5280	8.9	13	4.1
	60	5300	8.9	13	4.1
	64	5320	8.8	13	4.2

9.3.3 Operation in the 5.47 – 5.725 GHz band

9.3.3.1 6MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
6 Mbps	100	5500	7	13	6
	116	5580	7.4	13	5.6
	140	5700	7.5	13	5.5

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9.3.3.2 12MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
12 Mbps	100	5500	8.4	13	4.6
	116	5580	8.7	13	4.3
	140	5700	8.9	13	4.1

9.3.3.3 24MBPS

Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
24 Mbps	100	5500	8.4	13	4.6
	116	5580	8.5	13	4.5
	140	5700	8.7	13	4.3

9.3.3.4 MCS7

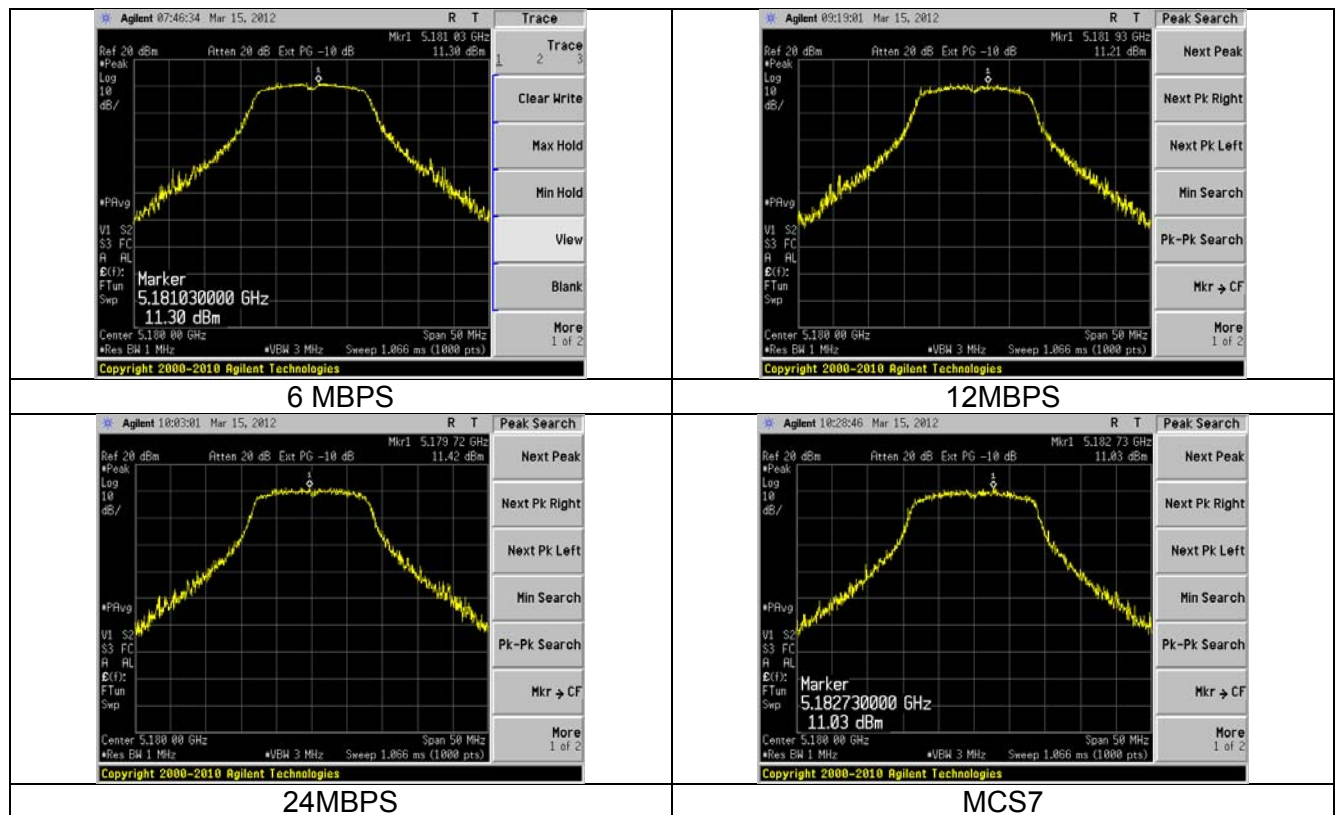
Data Rate	Channel	Frequency (MHz)	Peak Excursion (dB)	Peak Excursion Limit (dB)	Peak Excursion Margin (dB)
65 Mbps (MCS7)	100	5500	8	13	5
	116	5580	8.3	13	4.7
	140	5700	9.36	13	3.64

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9.4 Screen Captures

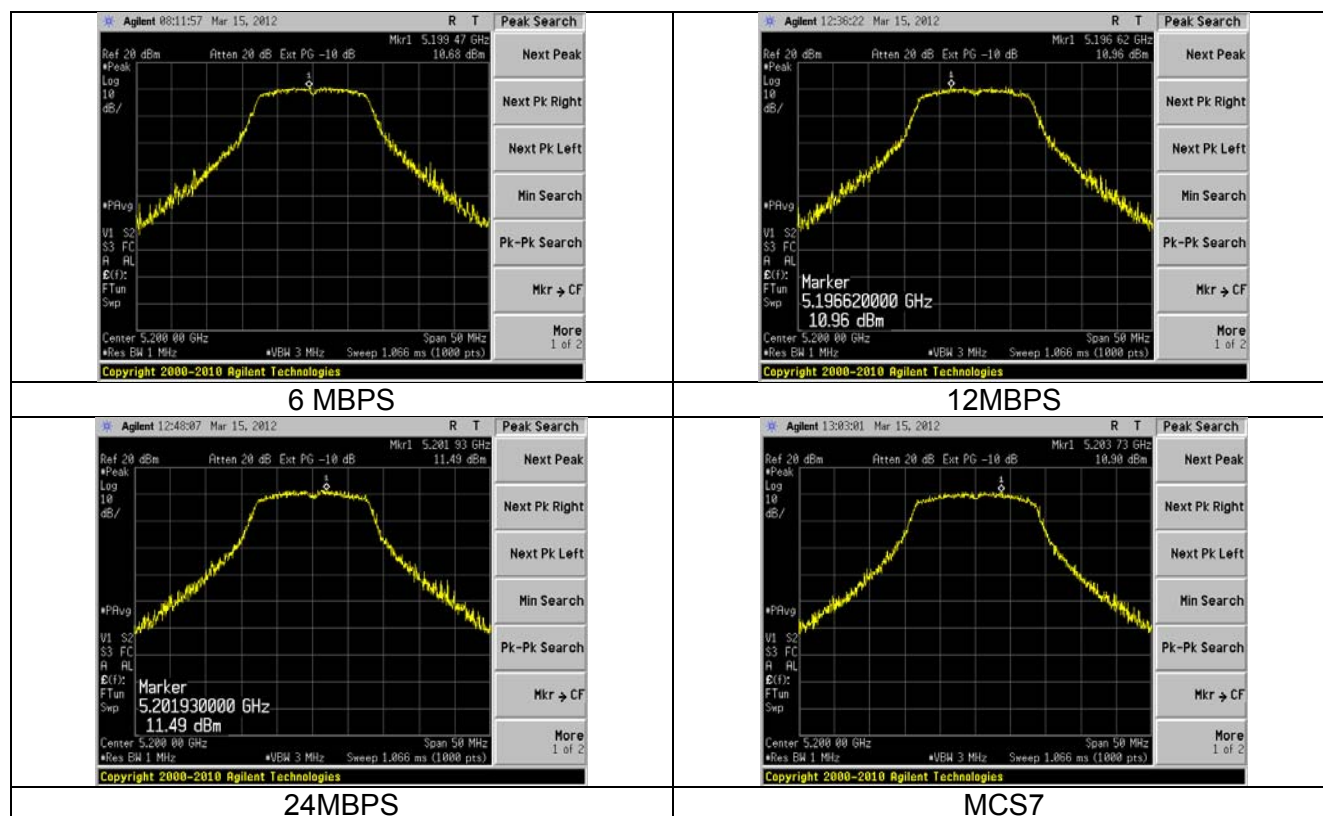
9.4.3.1 Operation in the 5.15 – 5.25 GHz band

9.4.1.1 Channel 36



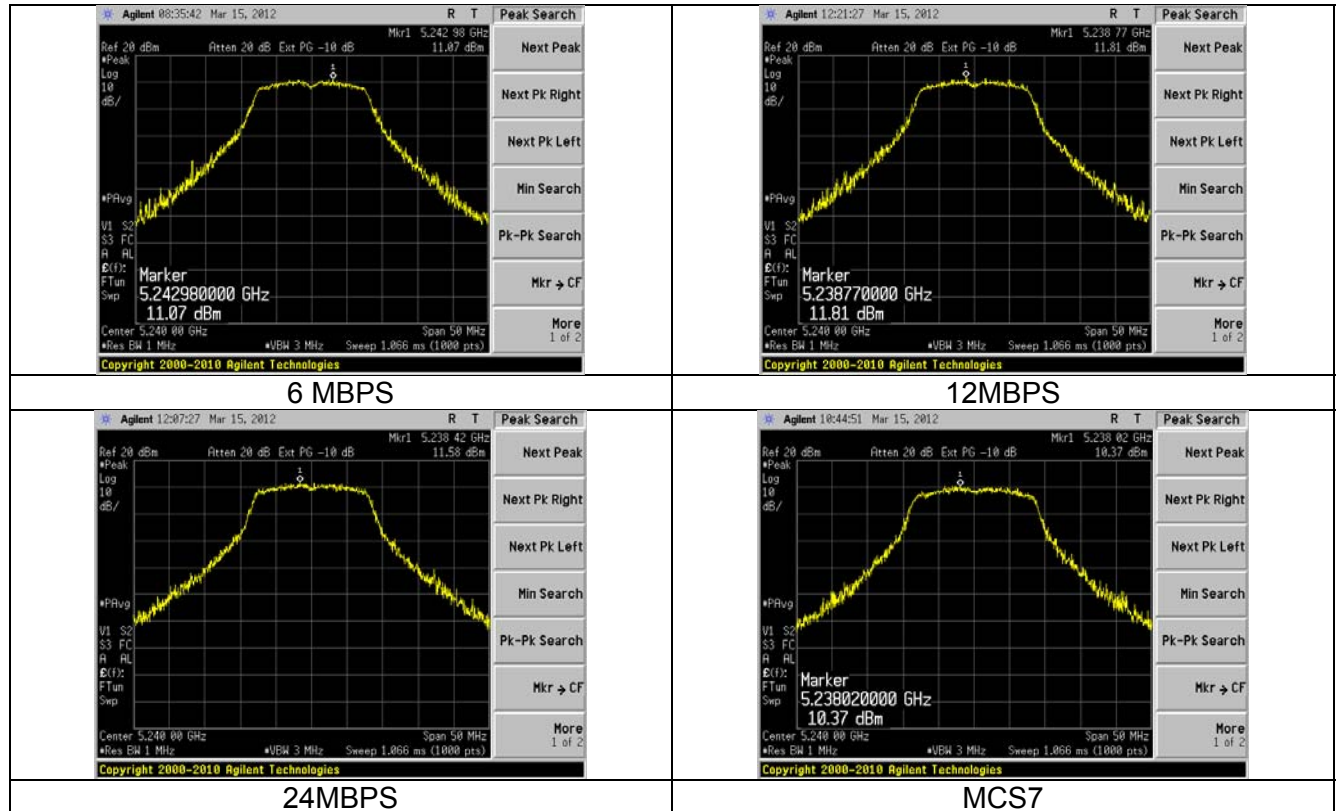
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 45 of 88

9.4.1.2 Channel 40



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Report # 311362 E	Model #:TiWi5	Template: 15.407
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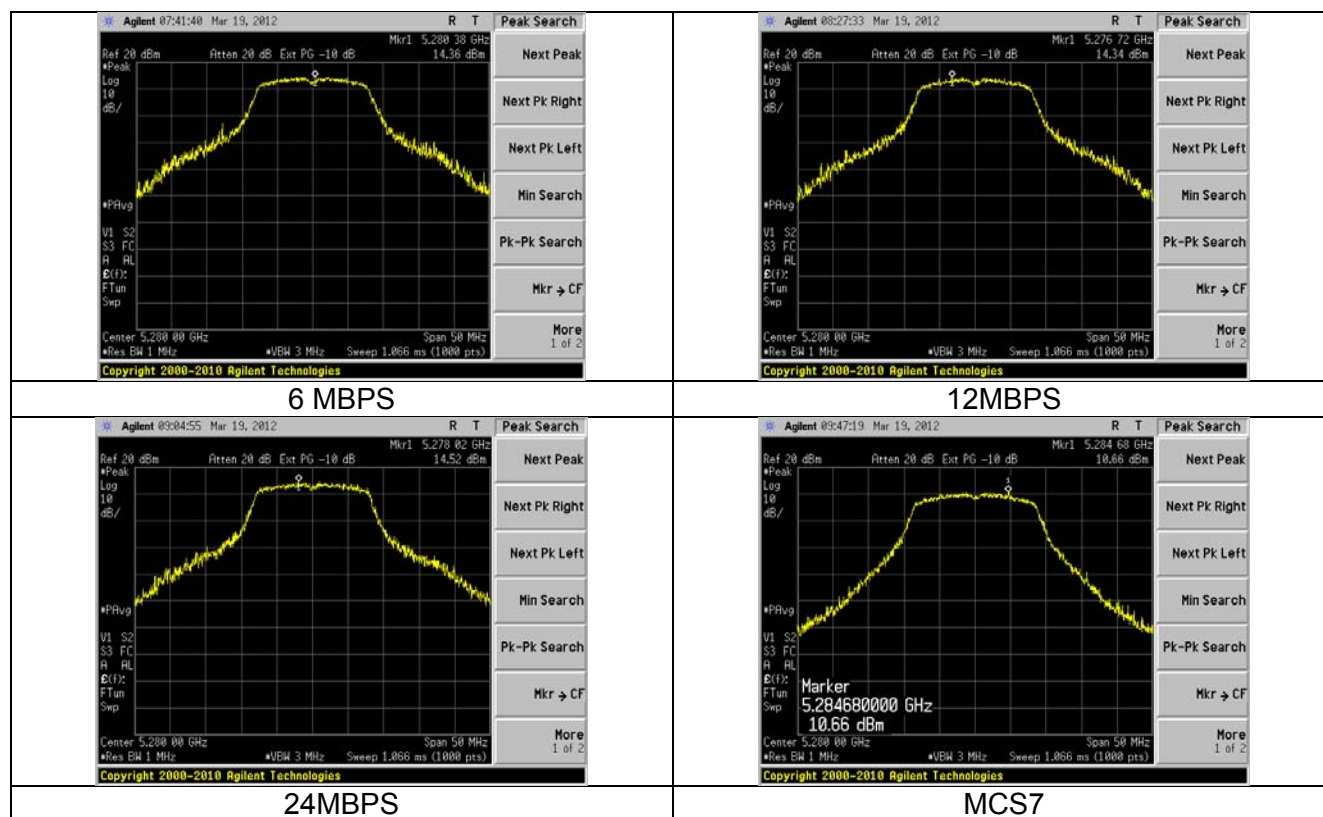
9.4.1.3 Channel 48



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 47 of 88

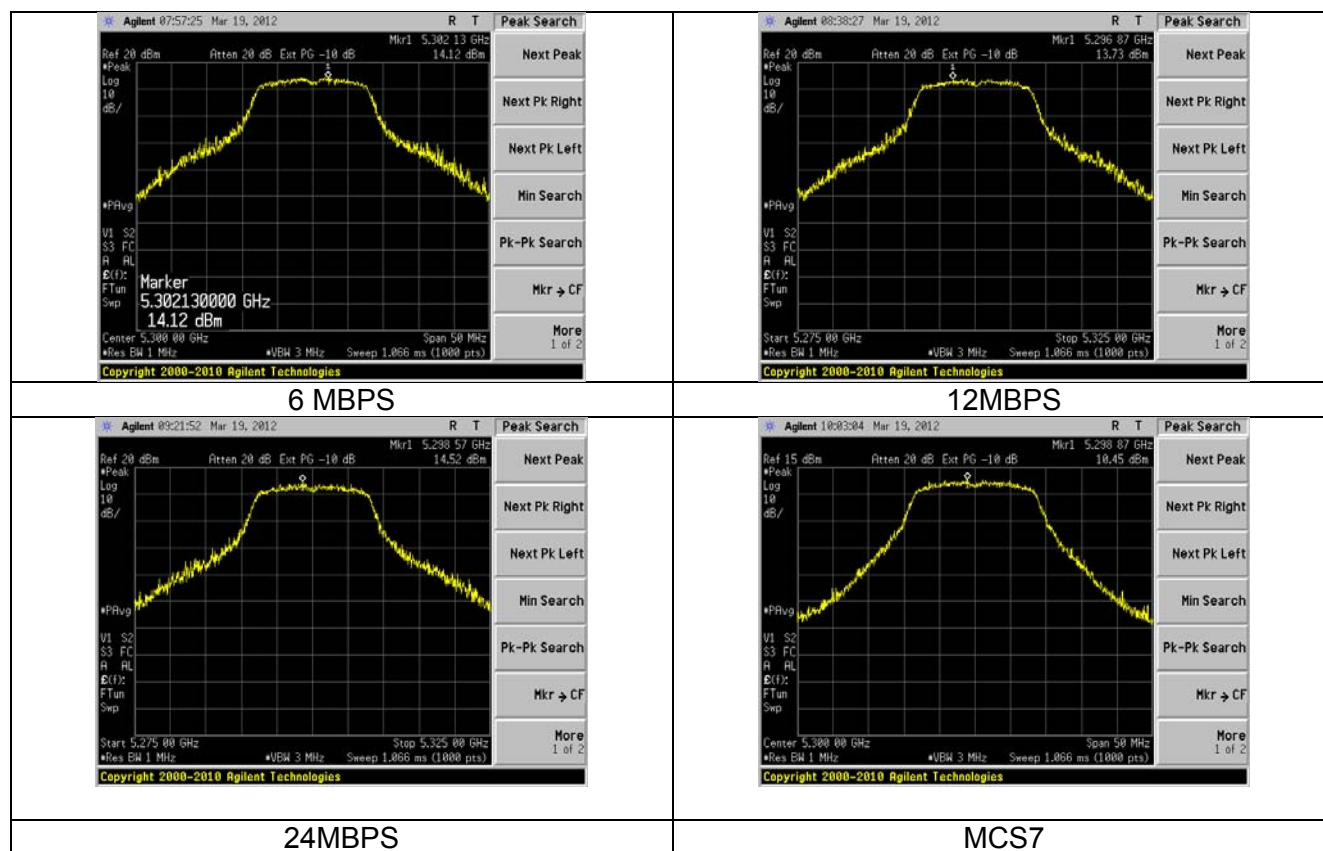
9.4.2 Operation in the 5.25 – 5.35 GHz band

9.4.2.1 Channel 56



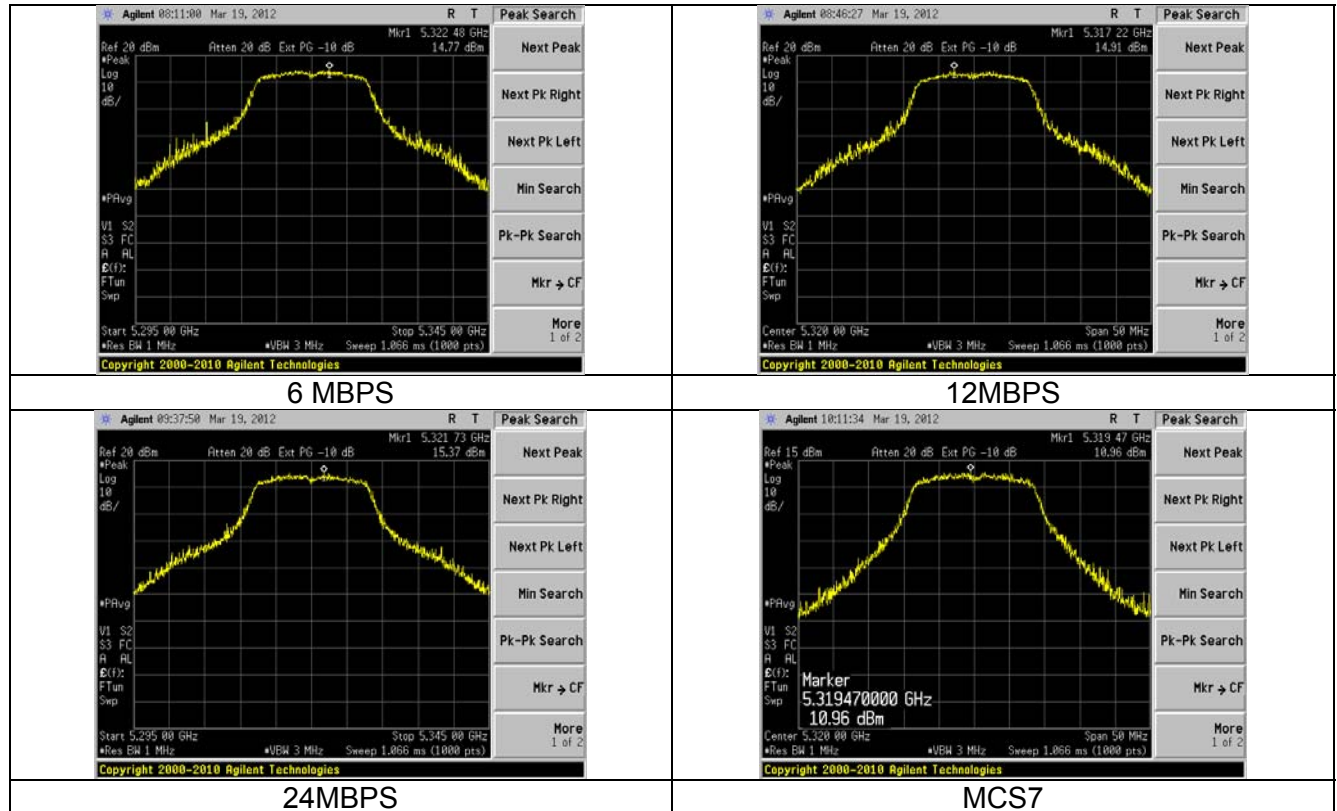
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 48 of 88

9.4.2.2 Channel 60



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Report # 311362 E	Model #:TiWi5	Template: 15.407
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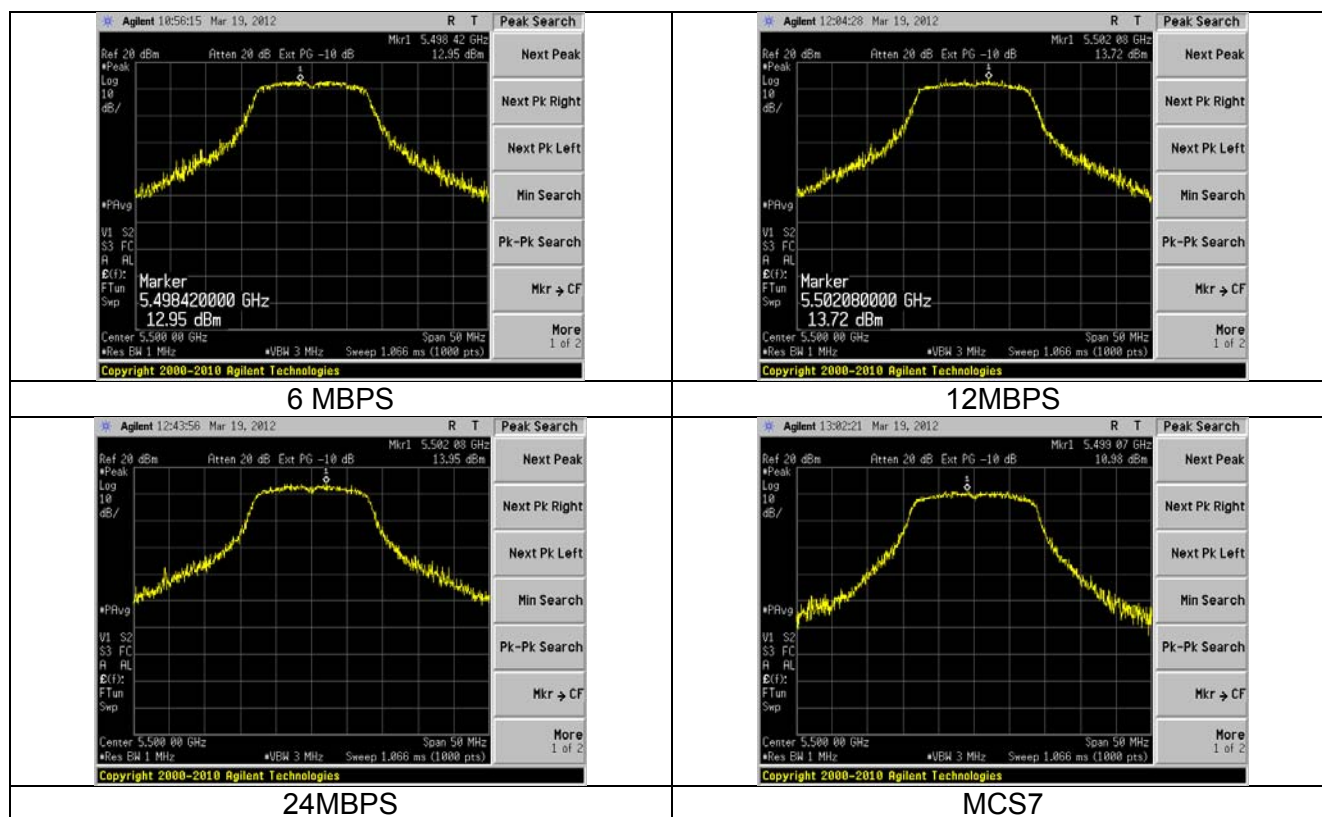
9.4.2.3 Channel 64



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LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 50 of 88

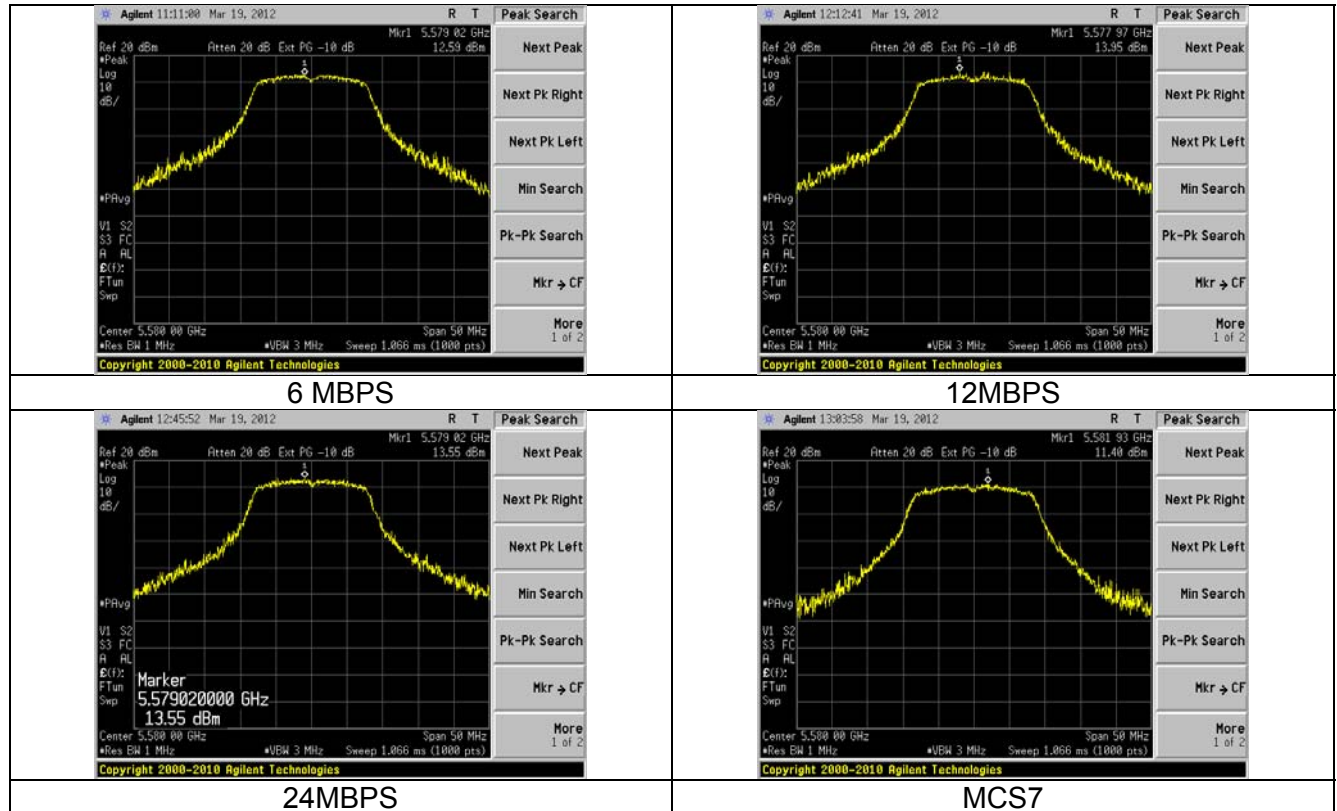
9.4.1 Operation in the 5.47 – 5.725 GHz band

9.4.1.1 Channel 100



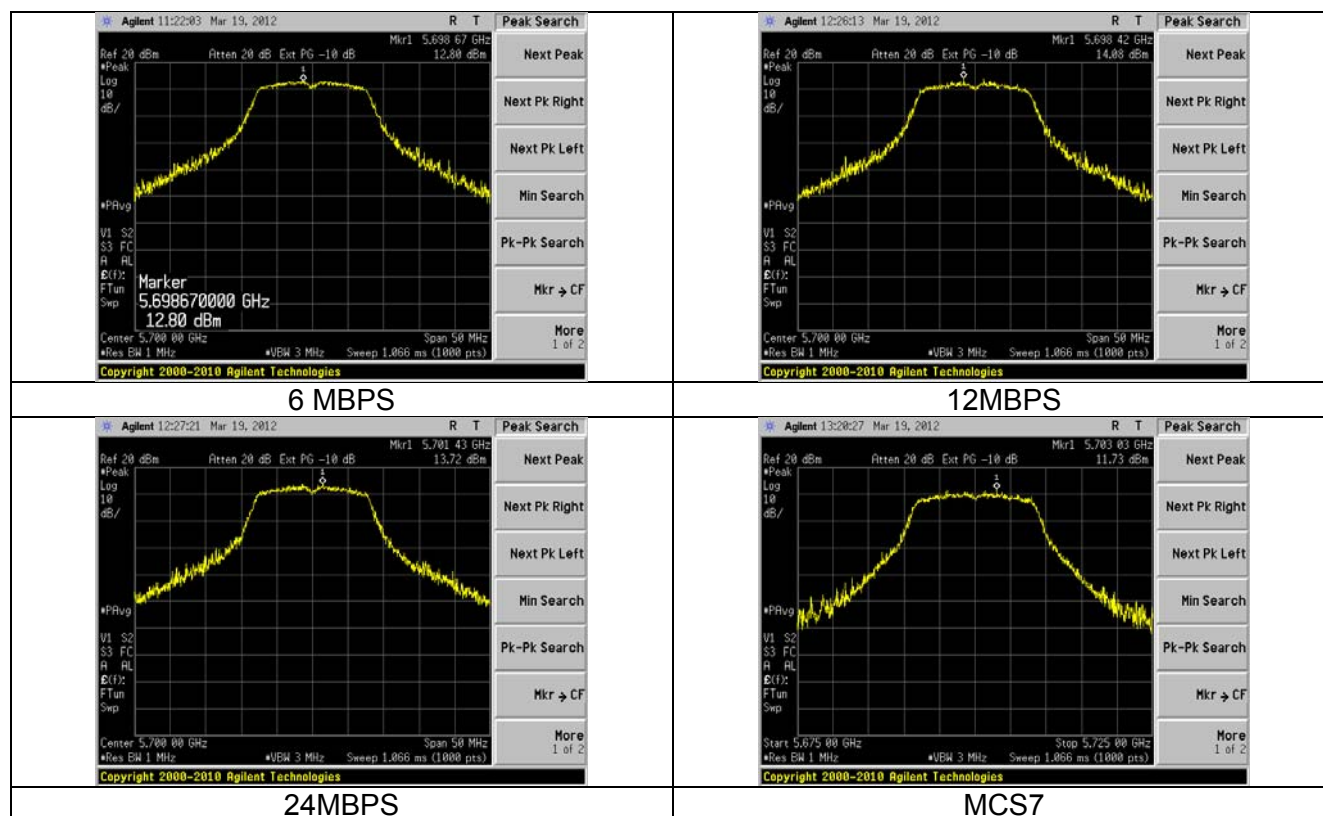
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 51 of 88

9.4.1.2 Channel 116



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Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 52 of 88

9.4.1.3 Channel 140



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 53 of 88

EXHIBIT 10 Spurious Emissions

Test Engineers: Adam Alger, Khairul Aidi Zainal

10.1 Test Procedure

1. KDB 789033 D01 section G.
2. ANSI C63.4-2003

The unwanted emissions measurements both in the restricted and non-restricted bands were performed via antenna-port conducted measurements in conjunction with cabinet emissions test. In the cabinet emissions tests, the EUT antenna was replaced with a termination matching the nominal impedance of the antenna.

10.2 Limits

10.2.1 Operation in the 5150 to 5250 MHz band

All emissions outside of the 5150 to 5350 MHz band shall not exceed an EIRP of -27dBm.

10.2.2 Operation in the 5250 to 5350 MHz band

All emissions outside of the 5150 to 5350 MHz band shall not exceed an EIRP of -27dBm. Devices operating in the 5250 to 5350 MHz band that generate emissions in the 5150 to 5250 MHz band must meet all applicable technical requirements for operation in the 5150 to 5250 MHz band (including indoor use) or alternatively meet an out of band emission EIRP limit of -27dBm/MHz in the 5150 to 5250 MHz band.

10.2.3 Operation in the 5470 to 5725 MHz band

All emissions outside of the 5150 to 5350 MHz band shall not exceed an EIRP of -27dBm

10.2.4 Operation in the 5725 MHz to 5825 MHz band

All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of -17dBm/MHz.

For frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27dBm/MHz.

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Report # 311362 E	Model #:TiWi5	Template: 15.407
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10.3 Test Data

10.3.1 Antenna port conducted measurements.

10.3.1.1 Operation in the 5150 to 5250 MHz band

10.3.1.1.1 Band-edge

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
6 Mbps	36	5180	-42.8	2	0	-40.8	-27.0	13.8
	40	5200	N/A	N/A	0	N/A	-27.0	N/A
	48	5240	-46.8	2	0	-44.8	-27.0	17.8

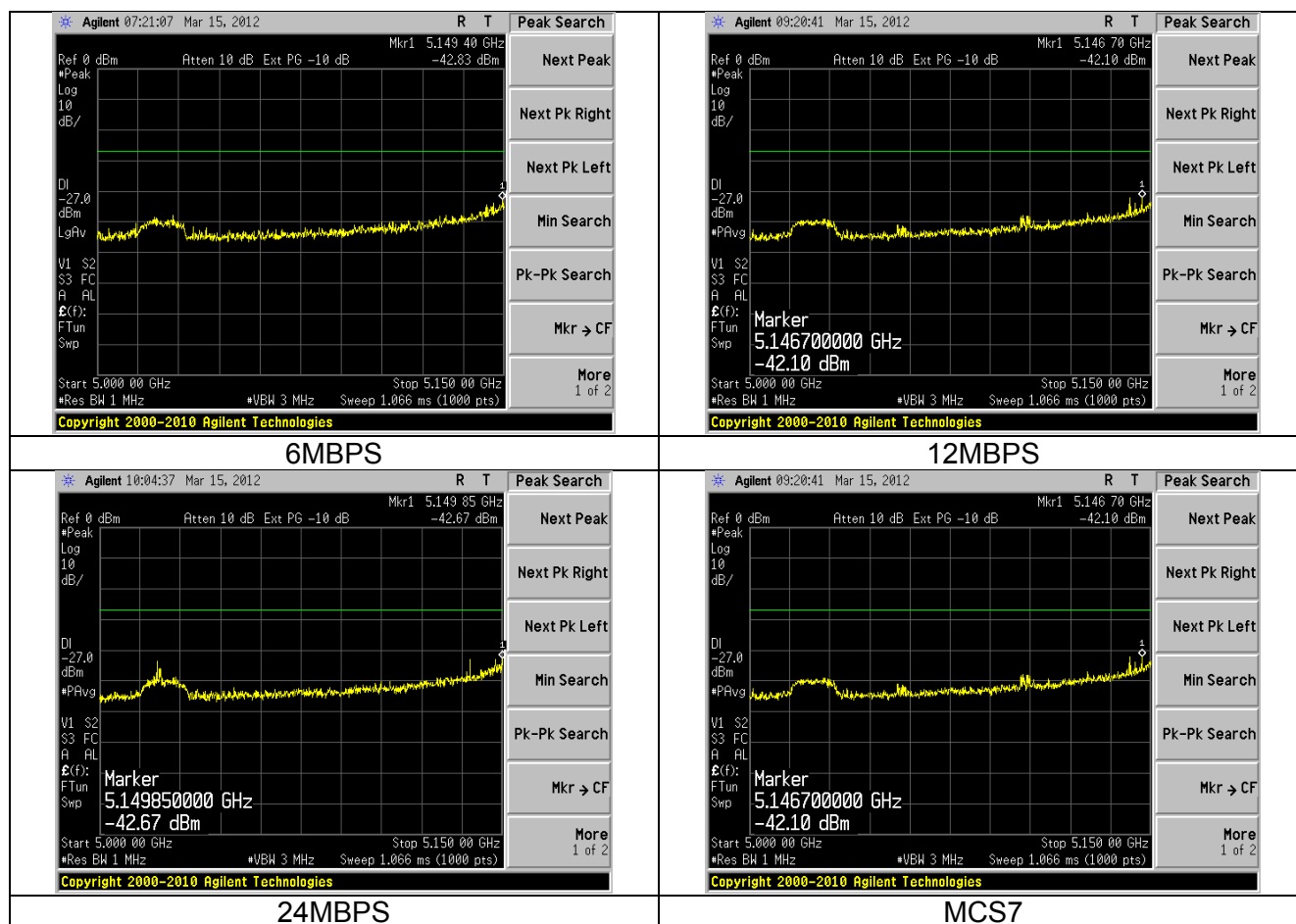
Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
12 Mbps	36	5180	-42.1	2	0	-40.1	-27	13.1
	40	5200	N/A	N/A	N/A	N/A	N/A	N/A
	48	5240	-43.5	2	0	-41.5	-27	14.5

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
24 Mbps	36	5180	-42.7	2	0.15	-40.5	-27	13.5
	40	5200	N/A	N/A	N/A	N/A	N/A	N/A
	48	5240	-46.5	2	0.15	-44.3	-27	17.3

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
65 Mbps (MCS7)	36	5180	-44.5	2	0.2	-42.3	-27	15.3
	40	5200	N/A	N/A	N/A	N/A	N/A	N/A
	48	5240	-42.12	2	0.2	-39.92	-27	12.92

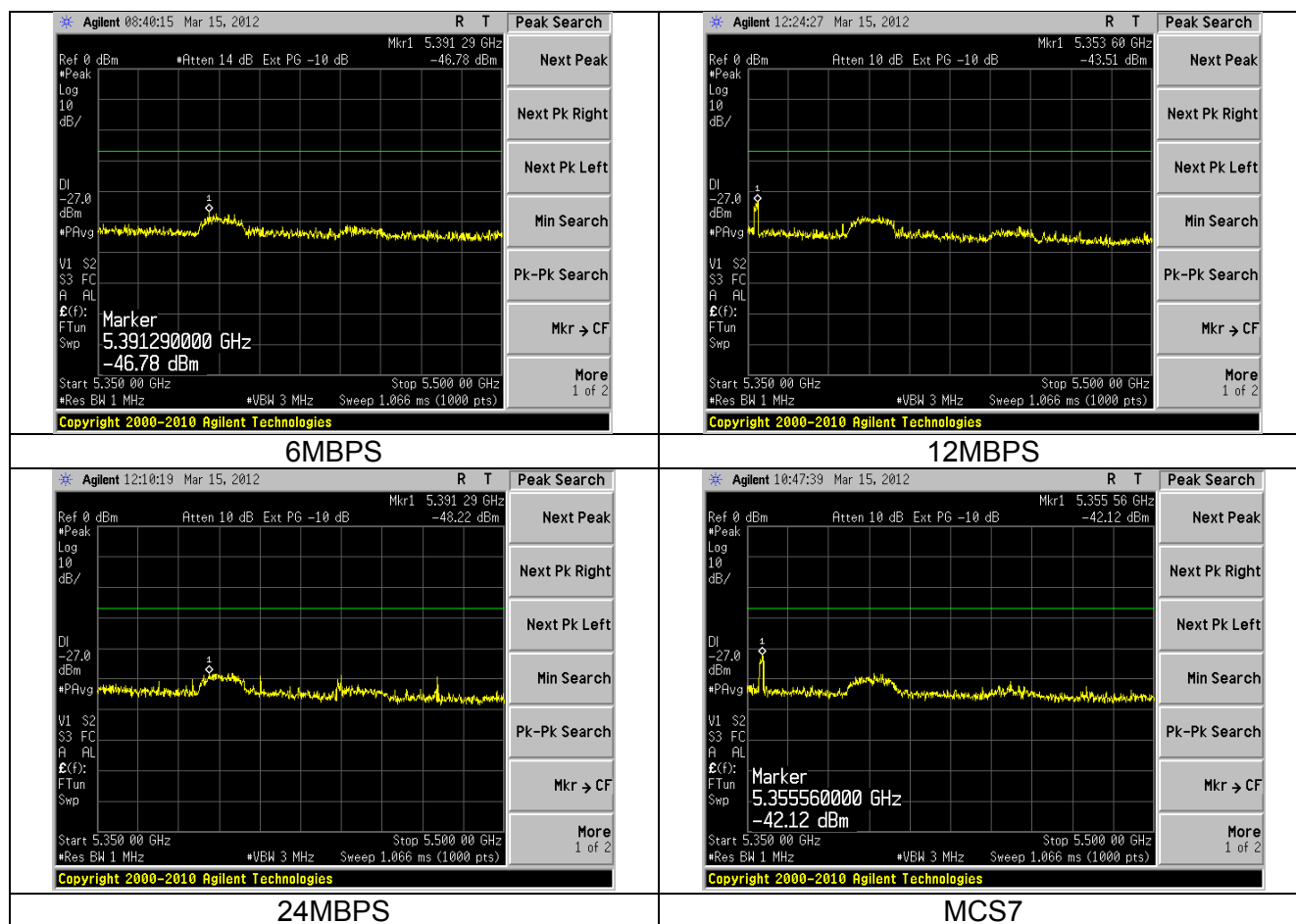
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 55 of 88

10.3.1.1.2 Lower Band edge screen captures



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Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 56 of 88

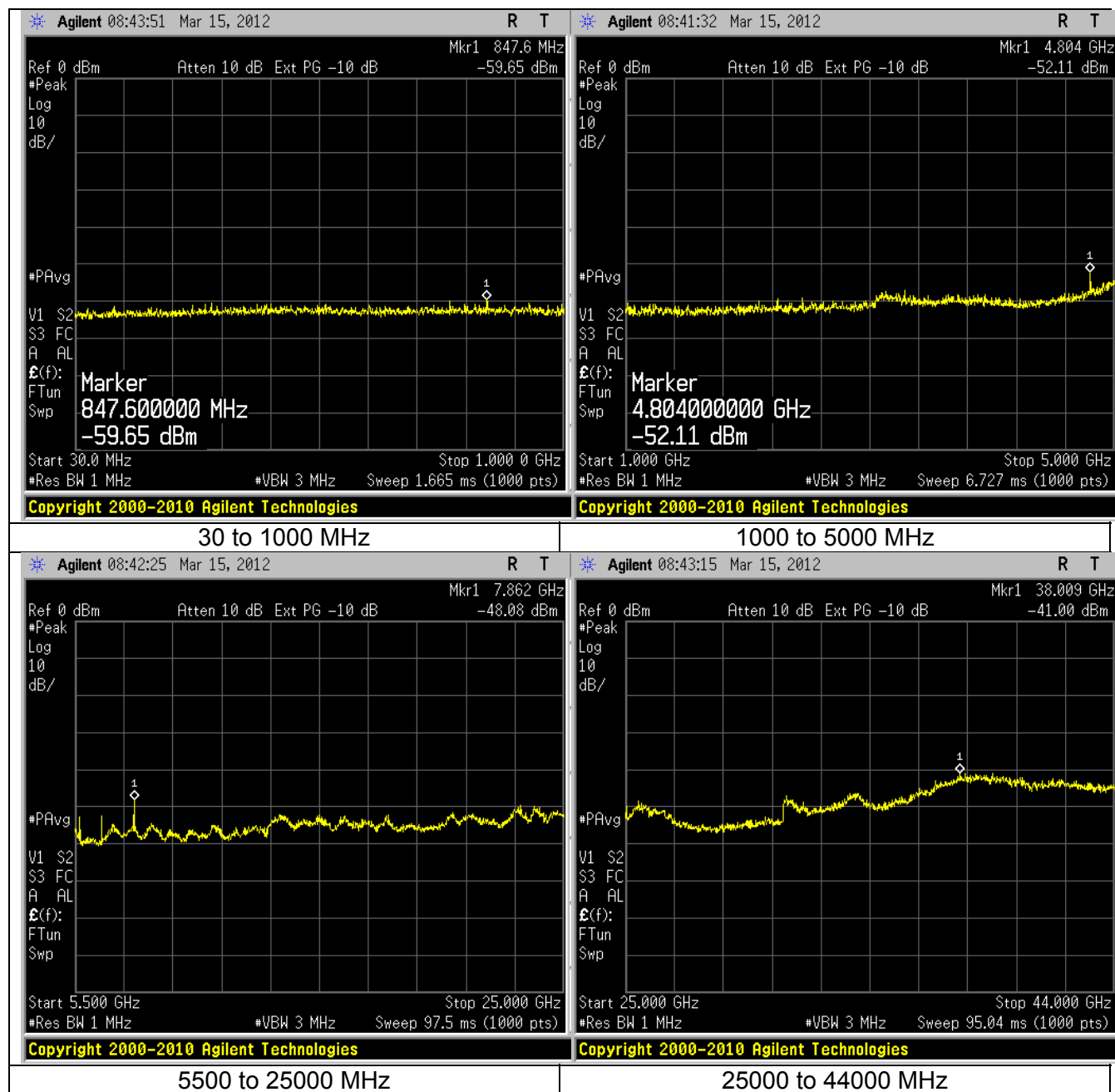
10.3.1.1.3 Upper Band edge screen captures



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 57 of 88

10.3.1.1.2 Unwanted Emissions

The plots shown below are those of 6MBPS which is representative of the other data rates.



Note: The band edges are shown in the preceding section.

Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 58 of 88

10.3.1.2 Operation in the 5250 to 5350 MHz band

10.3.1.2.1 Band-edge

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
6 Mbps	56	5280	-30.24	2	0	-28.24	-27	1.24
	60	5300	N/A	N/A	N/A	N/A	N/A	N/A
	64	5320	-31.88	2	0	-29.88	-27	2.88

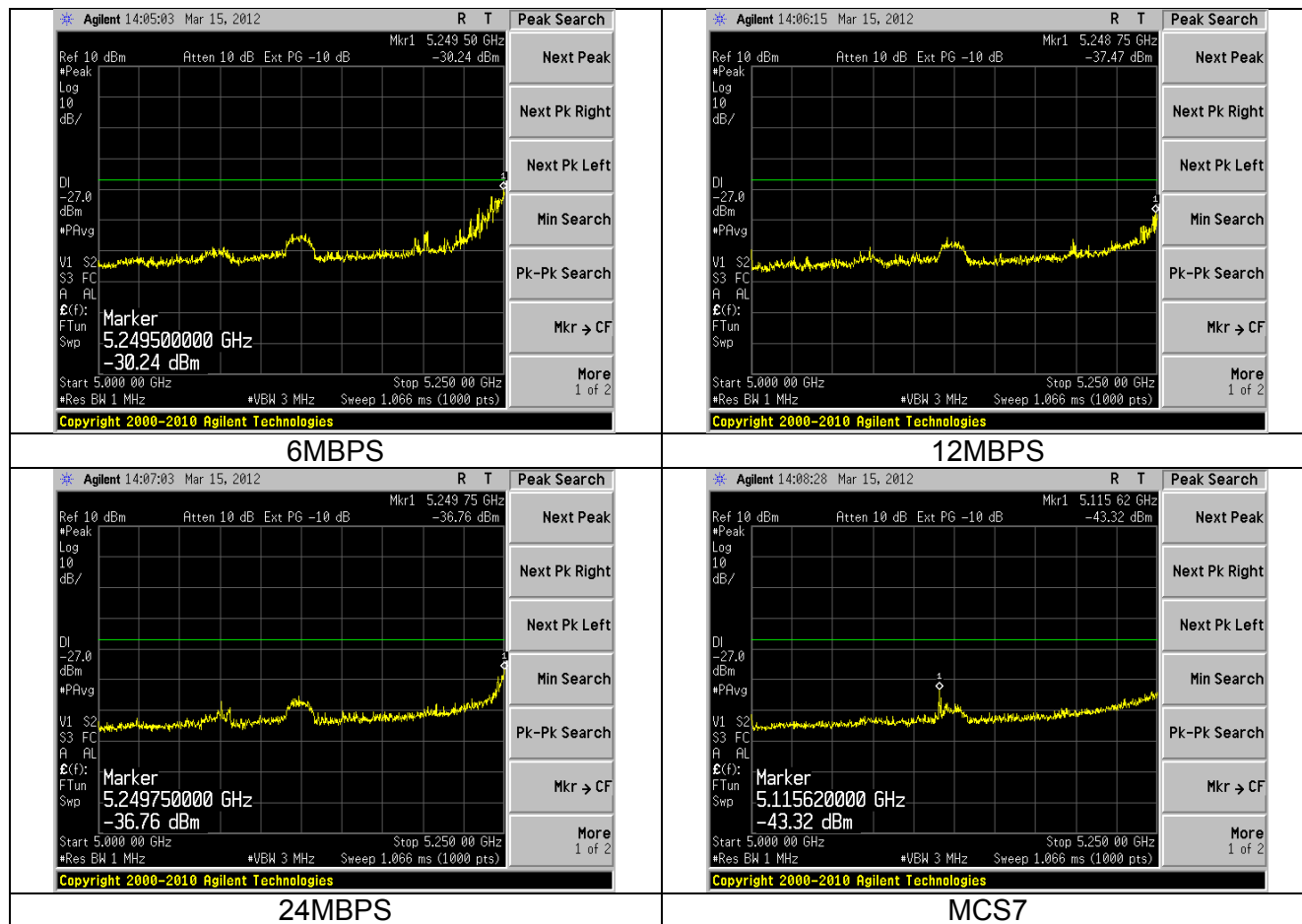
Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
12 Mbps	56	5280	-37.47	2	0	-35.47	-27	8.47
	60	5300	N/A	N/A	N/A	N/A	N/A	N/A
	64	5320	-34.76	2	0	-32.76	-27	5.76

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
24 Mbps	56	5280	-36.76	2	0.15	-34.61	-27	7.61
	60	5300	N/A	N/A	N/A	N/A	N/A	N/A
	64	5320	-33.76	2	0.15	-31.61	-27	4.61

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
65 Mbps (MCS7)	56	5280	-39.87	2	0.2	-37.67	-27	10.67
	60	5300	N/A	N/A	N/A	N/A	N/A	N/A
	64	5320	-42.92	2	0.2	-40.72	-27	13.72

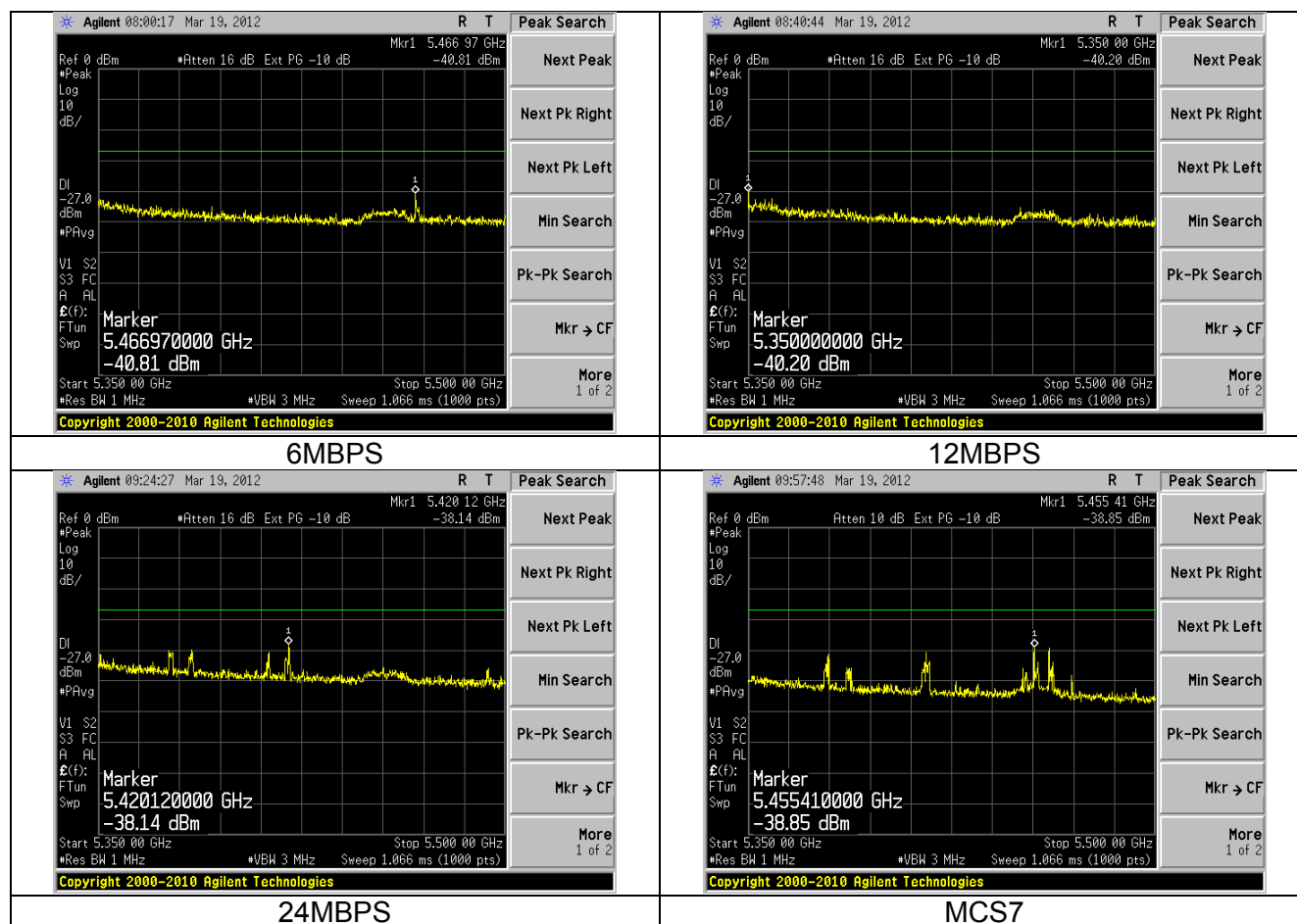
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 59 of 88

10.3.1.2.2 Lower Band edge screen captures



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 60 of 88

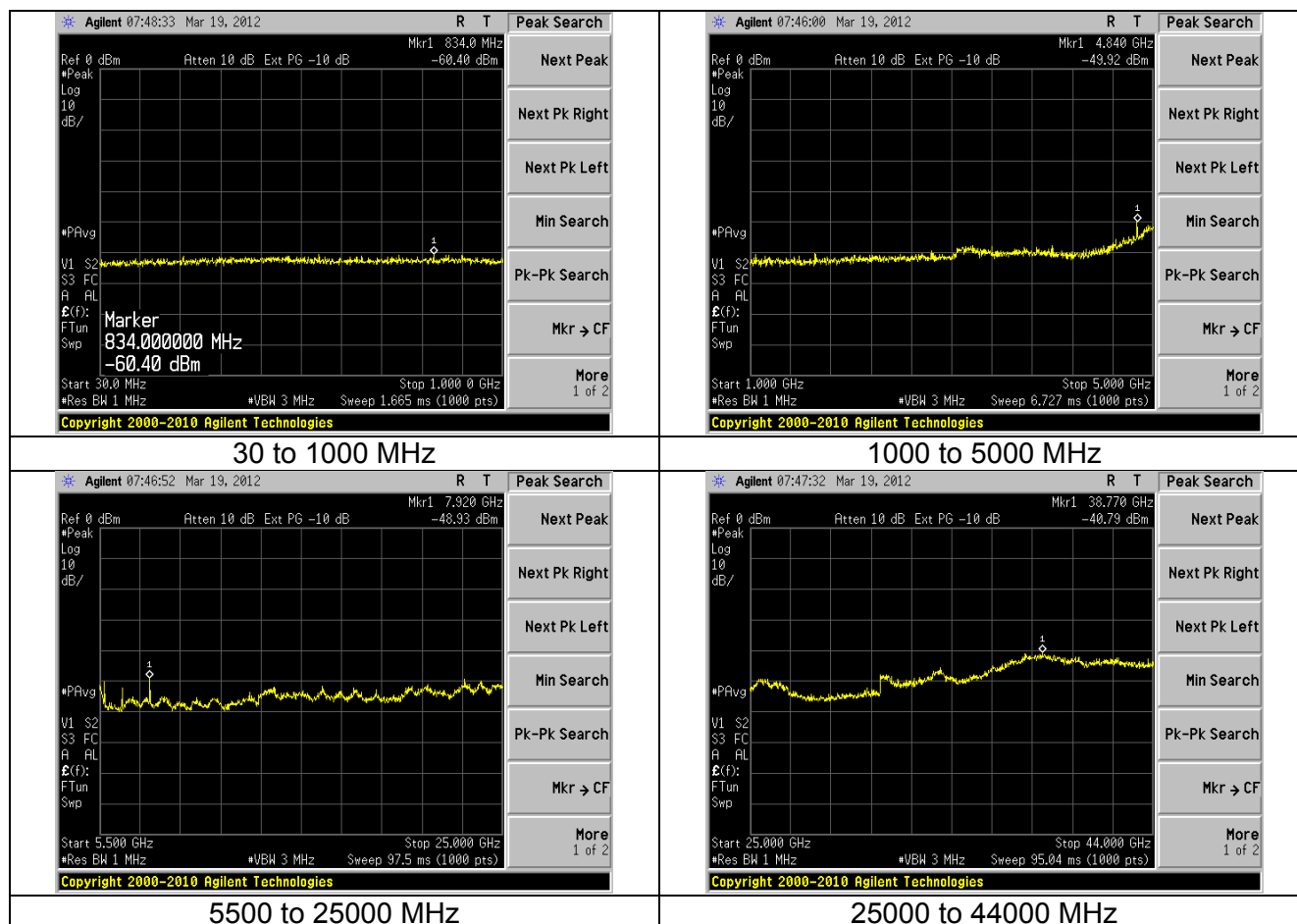
10.3.1.2.3 Upper Band edge screen captures



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 61 of 88

10.3.1.2.4 Unwanted Emissions

The plots shown below are those of 6MBPS which is representative of the other data rates.



Note: The band edges are shown in the preceding section.

Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 62 of 88

10.3.1.3 Operation in the 5470 to 5725 MHz band

10.3.1.3.1 Band-edge

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
6 Mbps	100	5500	-29.59	2	0	-27.59	-27	0.59
	116	5580	N/A	N/A	N/A	N/A	N/A	N/A
	140	5700	-30.38	2	0	-28.38	-27	1.38

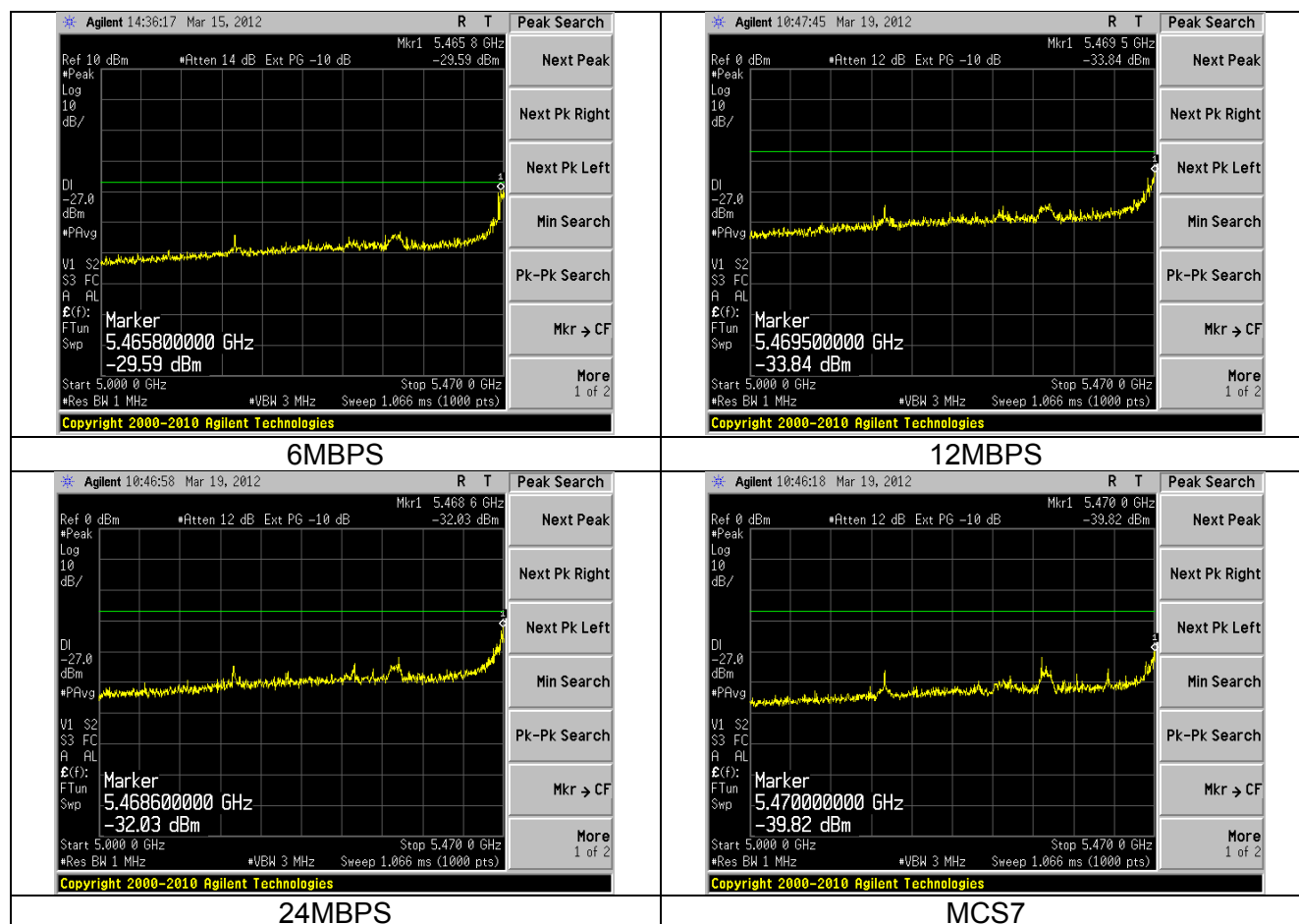
Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
12 Mbps	100	5500	-33.84	2	0	-31.84	-27	4.84
	116	5580	N/A	N/A	N/A	N/A	N/A	N/A
	140	5700	-29.81	2	0	-27.81	-27	0.81

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
24 Mbps	100	5500	-32.03	2	0.15	-29.88	-27	2.88
	116	5580	N/A	N/A	N/A	N/A	N/A	N/A
	140	5700	-29.77	2	0.15	-27.62	-27	0.62

Data Rate	Channel	Frequency (MHz)	Band-edge (dBm)	Antenna Gain(dBi)	Duty Cycle (dB)	Total	Limit (dBm/MHz)	Margin (dB)
65 Mbps (MCS7)	100	5500	-39.82	2	0.2	-37.62	-27	10.62
	116	5580	N/A	N/A	N/A	N/A	N/A	N/A
	140	5700	-32.64	2	0.2	-30.44	-27	3.44

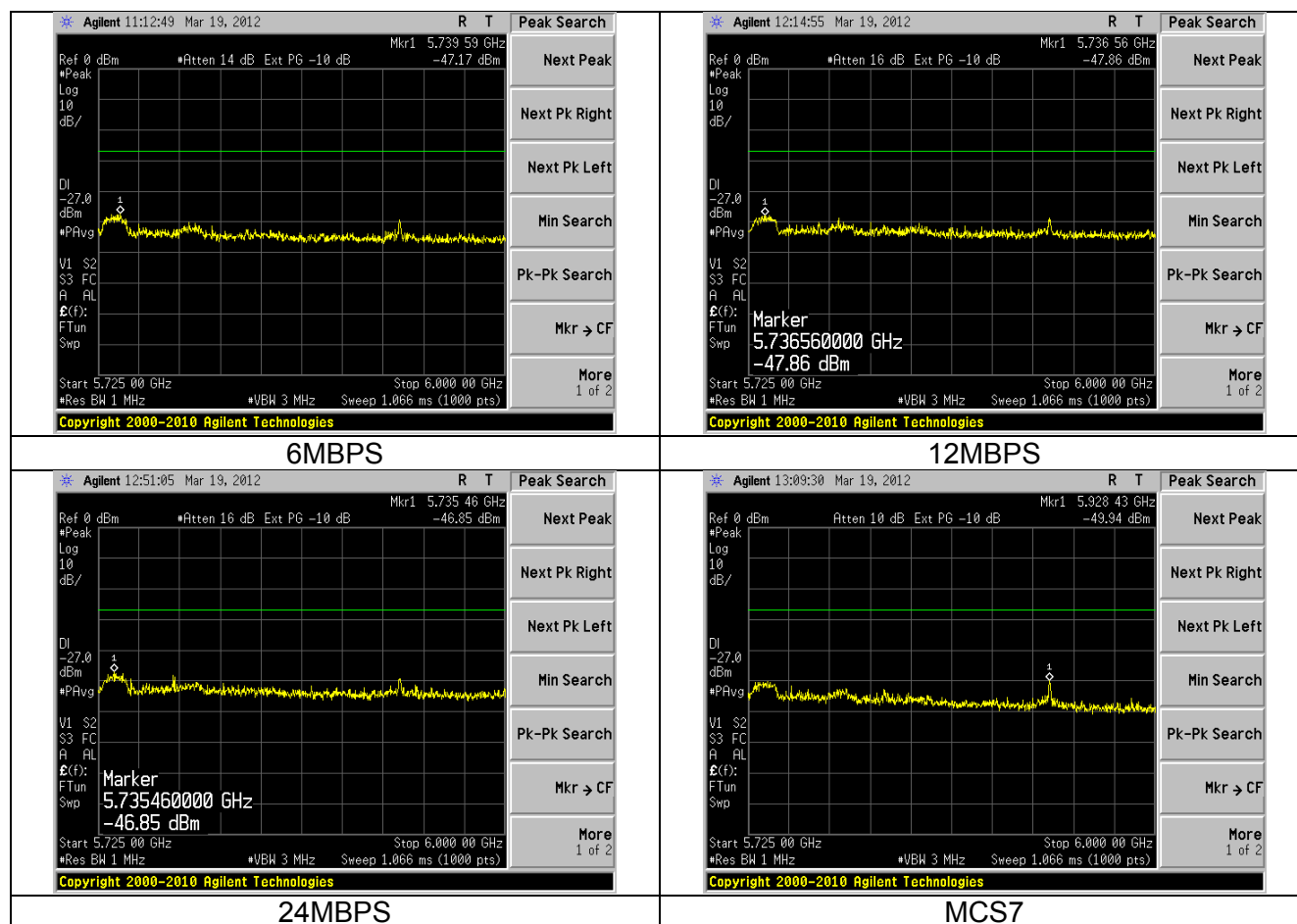
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 63 of 88

10.3.1.3.2 Lower Band edge screen captures



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 64 of 88

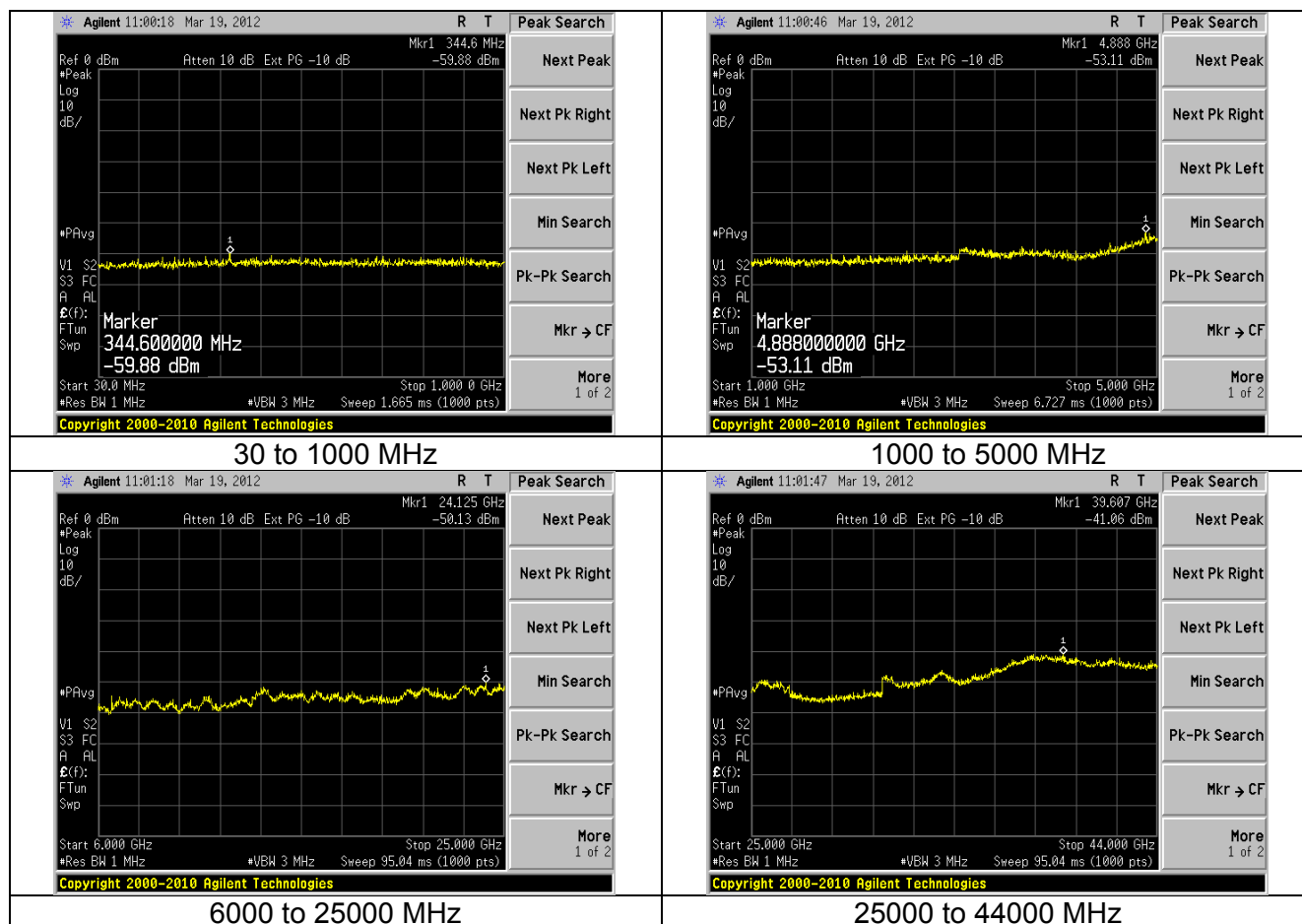
10.3.1.3.3 Upper Band edge screen captures



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 65 of 88

10.3.1.3.4 Unwanted Emissions

The plots shown below are those of 6MBPS which is representative of the other data rates.

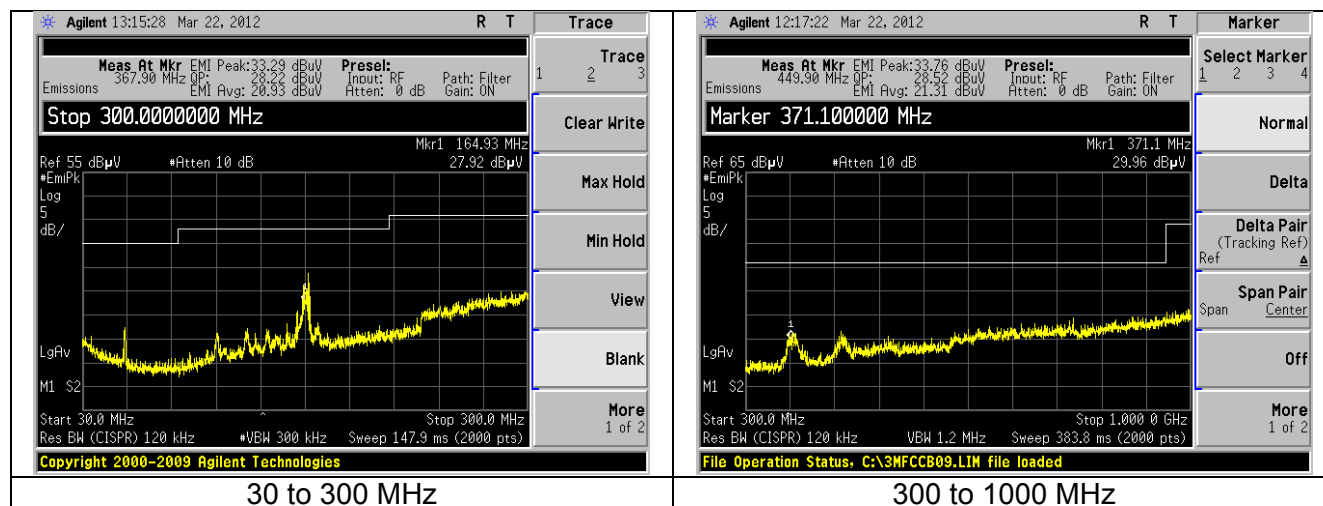


Note: The band edges are shown in the preceding section.

Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
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10.3.2 Cabinet radiation measurements.

10.3.2.1 Emissions below 1000 MHz



Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Quasi Peak Reading (dBμV/m)	Average Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
374.6	1.00	155	29.2	23.3	16.1	46.0	22.7	V	V
166.4	1.37	114	34.6	25.2	15.7	43.0	17.8	H	V
160.0	1.00	132	33.4	31.3	29.4	43.0	11.8	V	V
55.3	1.00	111	36.5	33.3	26.0	40.0	6.7	V	V
67.7	1.00	121	33.3	29.9	22.9	40.0	10.1	V	V

Note:

- The emissions seen were not a function of the EUT.
- H: Horizontal; V: Vertical

10.3.2.2 Emissions above 1000 MHz

For the following data, measurements were performed at a separation distance of 1 meter. The field strength was then converted to EIRP per KDB 789033:

$$EIRP [dBm] = E[dBuV/m] + 20 \log(d[meters]) - 104.77$$

EIRP is the equivalent isotropically radiated power in Watts

E is the field strength

D is the measurement distance

Examples:

Above 960MHz Restricted band limit conversion to EIRP:

$$EIRP = 54[dBuV/m] + 9.54 - 104.77 = \underline{\underline{-41.27dBm}}$$

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10.3.2.2.1 Operation in the 5150 to 5250 MHz band

10.3.2.2.1.1 Significant emissions data table

Channel 36

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
10360	1.02	284	53.6	-51.2	-27.0	N/A	N/A	N/A	24.2	N/A
20720	1.14	296	58.2	-46.6	-21.3	54.6	-50.1	-41.27	25.3	8.9

Channel 40

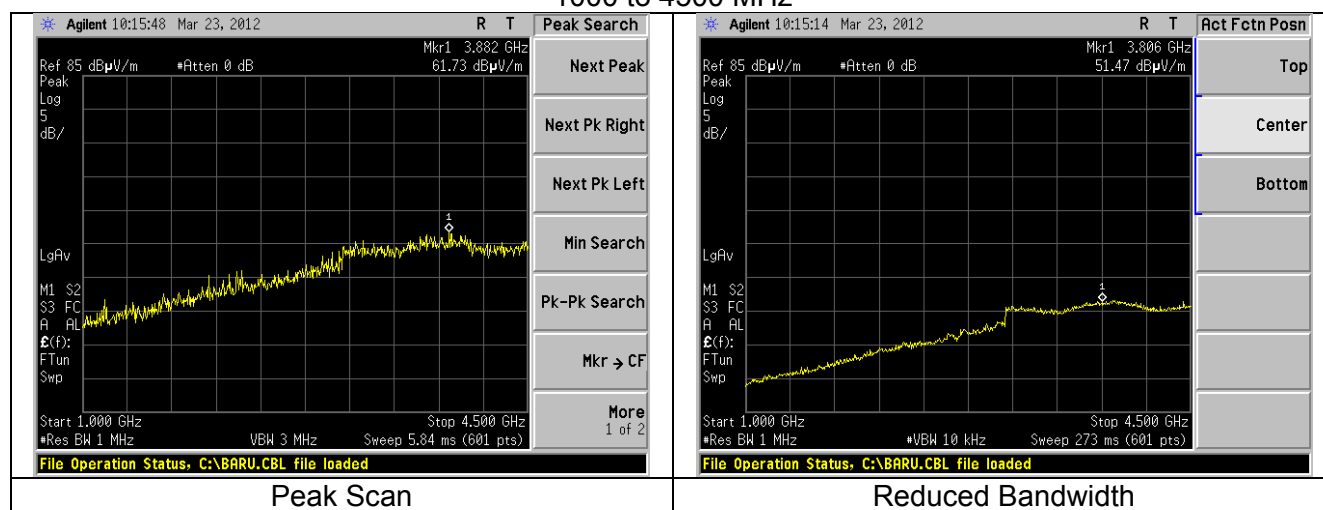
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
10400	1.02	17	52.68	-52.1	-27.0	N/A	N/A	N/A	25.1	N/A
20800	1.07	243	57.58	-47.2	-21.3	53.15	-51.6	-41.27	25.9	10.4

Channel 48

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
10480	1.01	19	54.16	-50.6	-27.0	N/A	N/A	N/A	23.6	N/A
20960	1.12	255	57.16	-47.6	-21.3	52.51	-52.3	-41.27	26.3	11.0

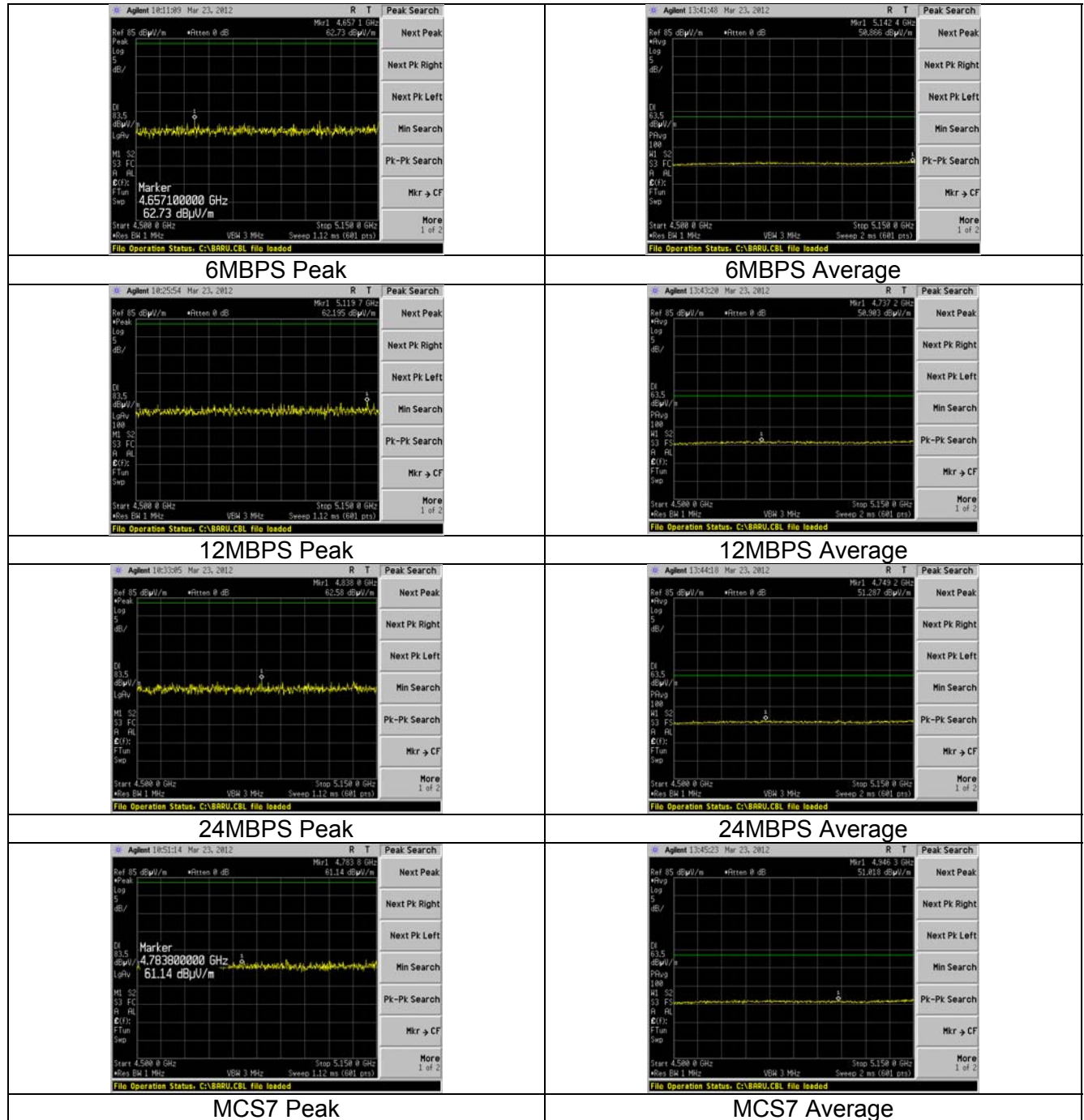
10.3.2.2.1.2 Emissions between 1000 to 8000 MHz

1000 to 4500 MHz



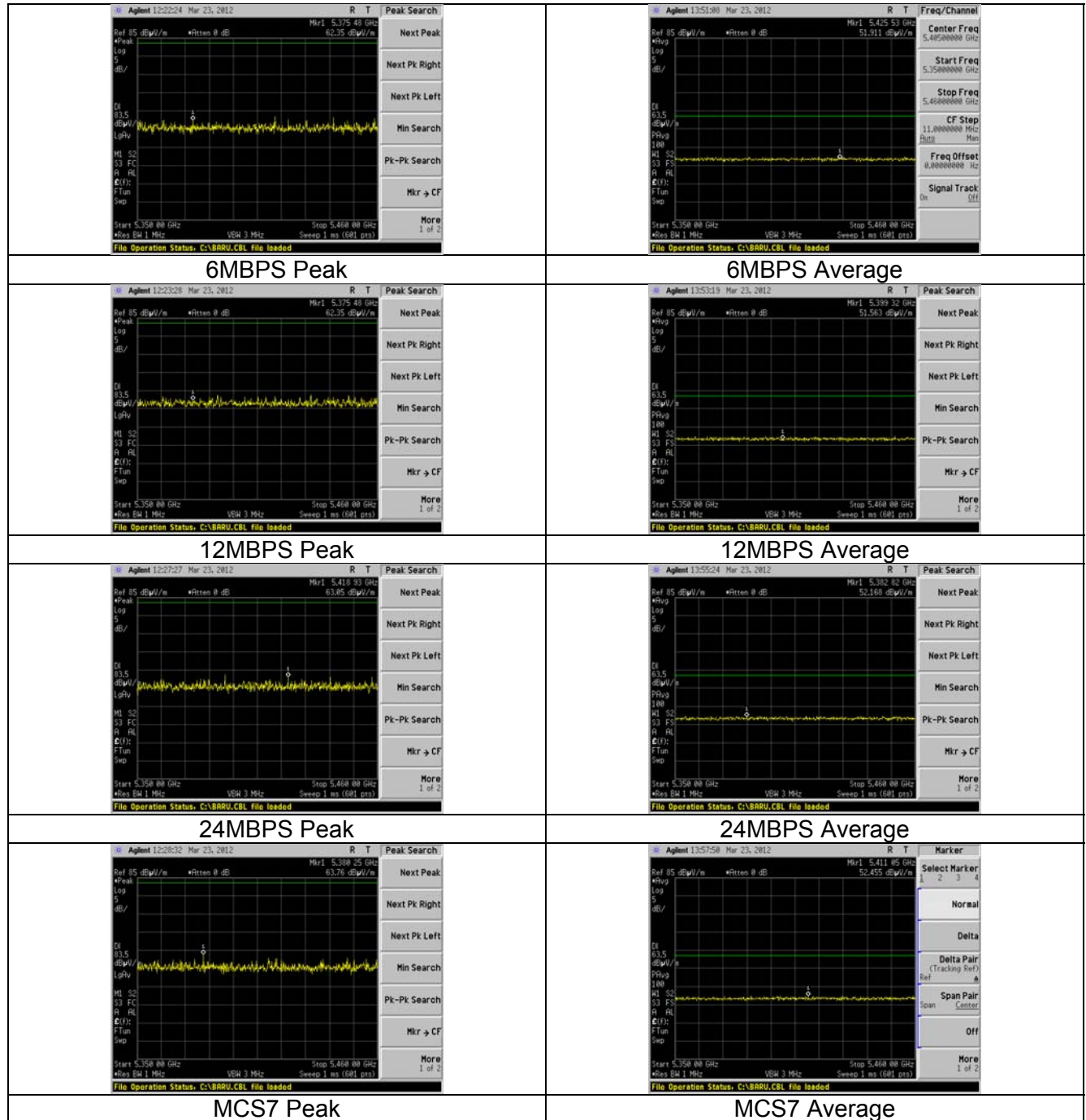
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 68 of 88

4500 to 5150 MHz



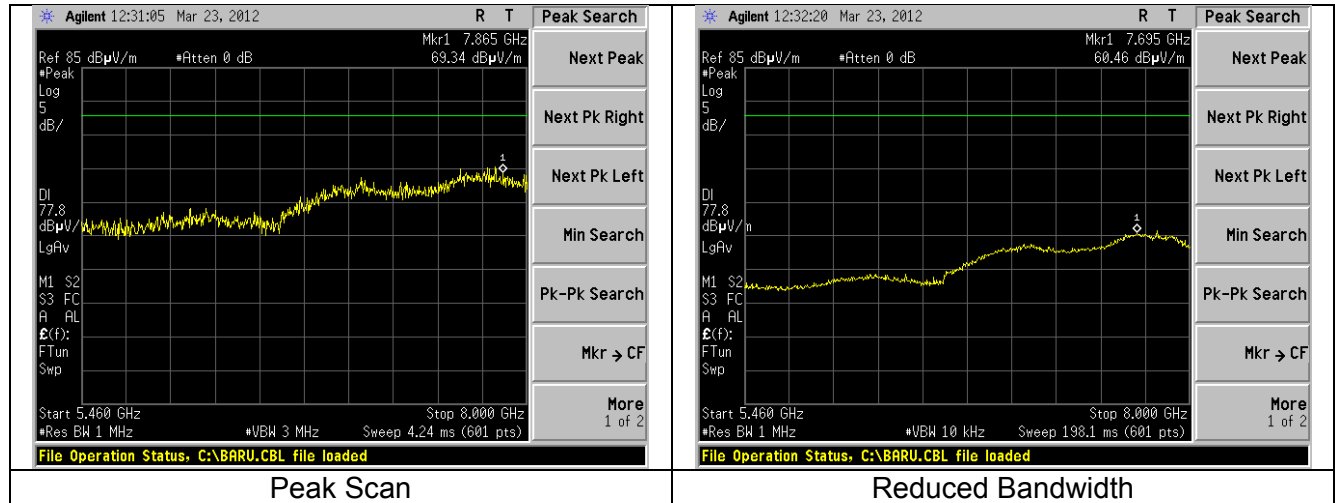
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
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5350 to 5460 MHz



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
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5460 to 8000 MHz



10.3.2.2.2 Operation in the 5250 to 5350 MHz band

10.3.2.2.2.1 Significant emissions data table

Channel 56

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
10560	1.00	321	56.77	-48.0	-27.0	N/A	N/A	N/A	21.0	N/A
21120	1.00	280	58.66	-46.1	-21.3	48.38	-56.4	-41.27	24.8	15.1

Channel 60

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
10600	1.00	321	56.68	-48.1	-27.0	N/A	N/A	N/A	21.1	N/A
21200	1.00	292	57.72	-47.1	-21.3	49.01	-55.8	-41.27	25.8	14.5

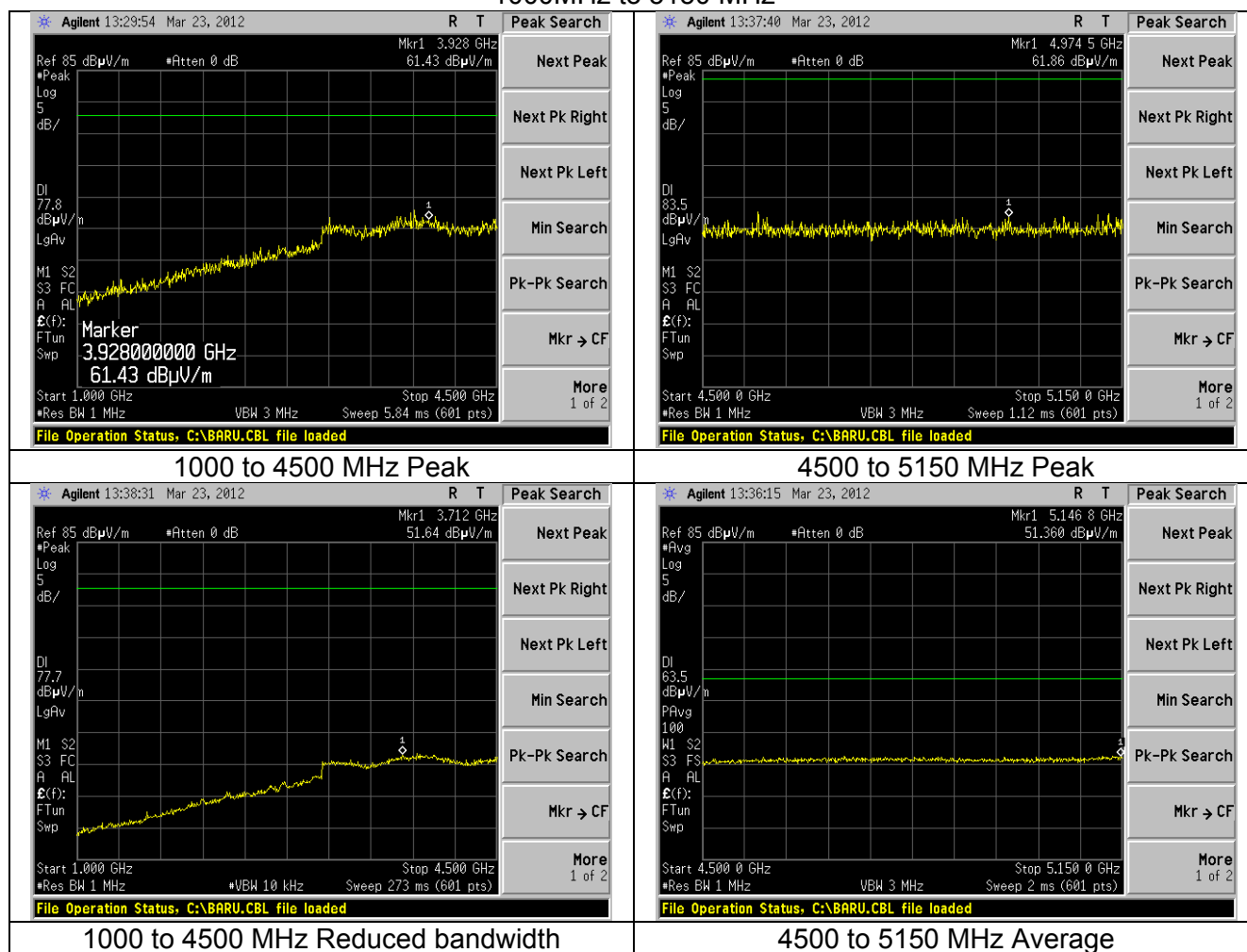
Channel 64

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
10640	1.00	339	56.72	-48.1	-21.3	51.04	-53.7	-41.27	26.8	12.5
21280	1.00	277	57.17	-47.6	-21.3	46.85	-57.9	-41.27	26.3	16.7

Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 71 of 88

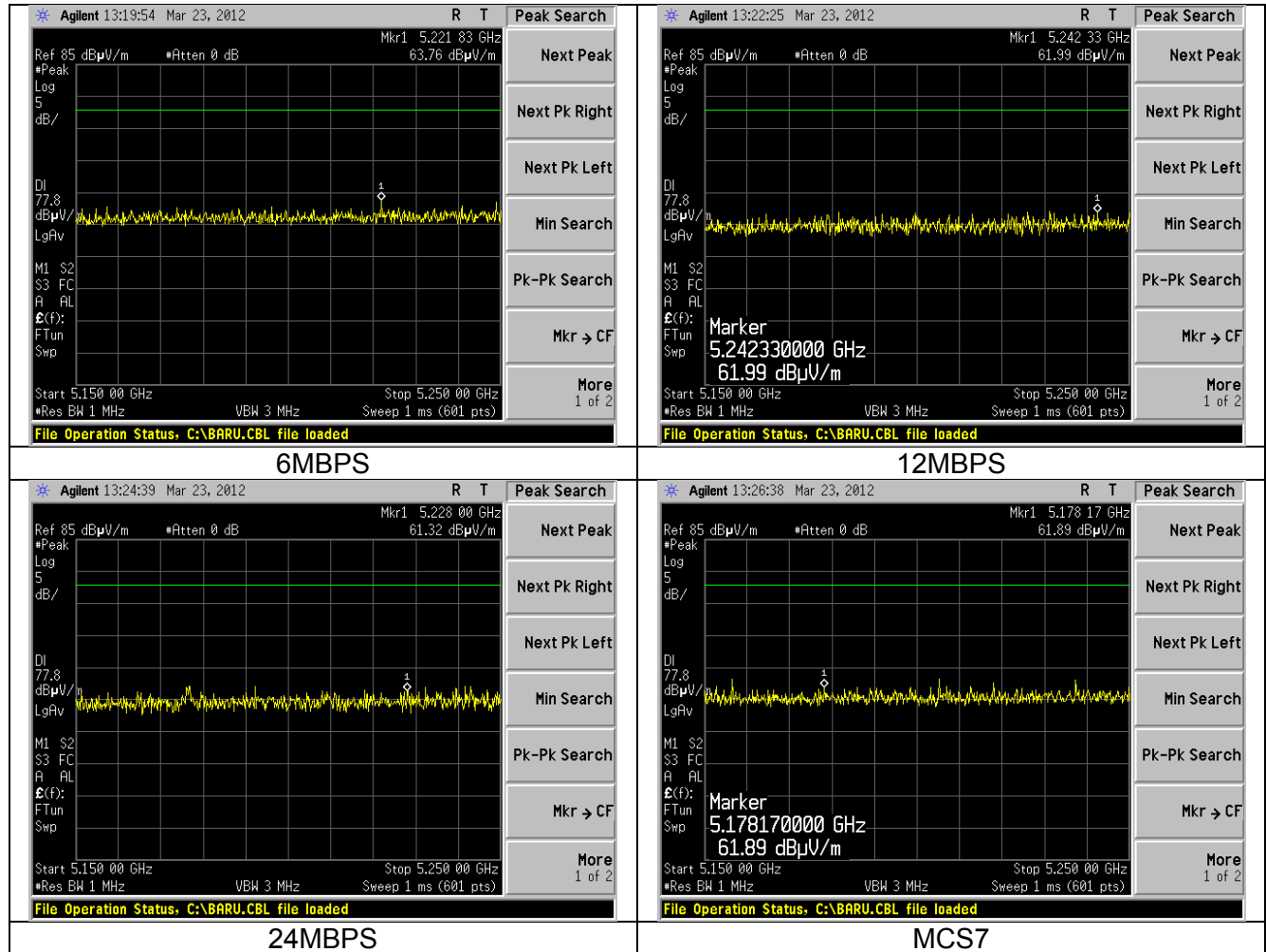
10.3.2.2.2 Emissions between 1000 to 8000 MHz

1000MHz to 5150 MHz



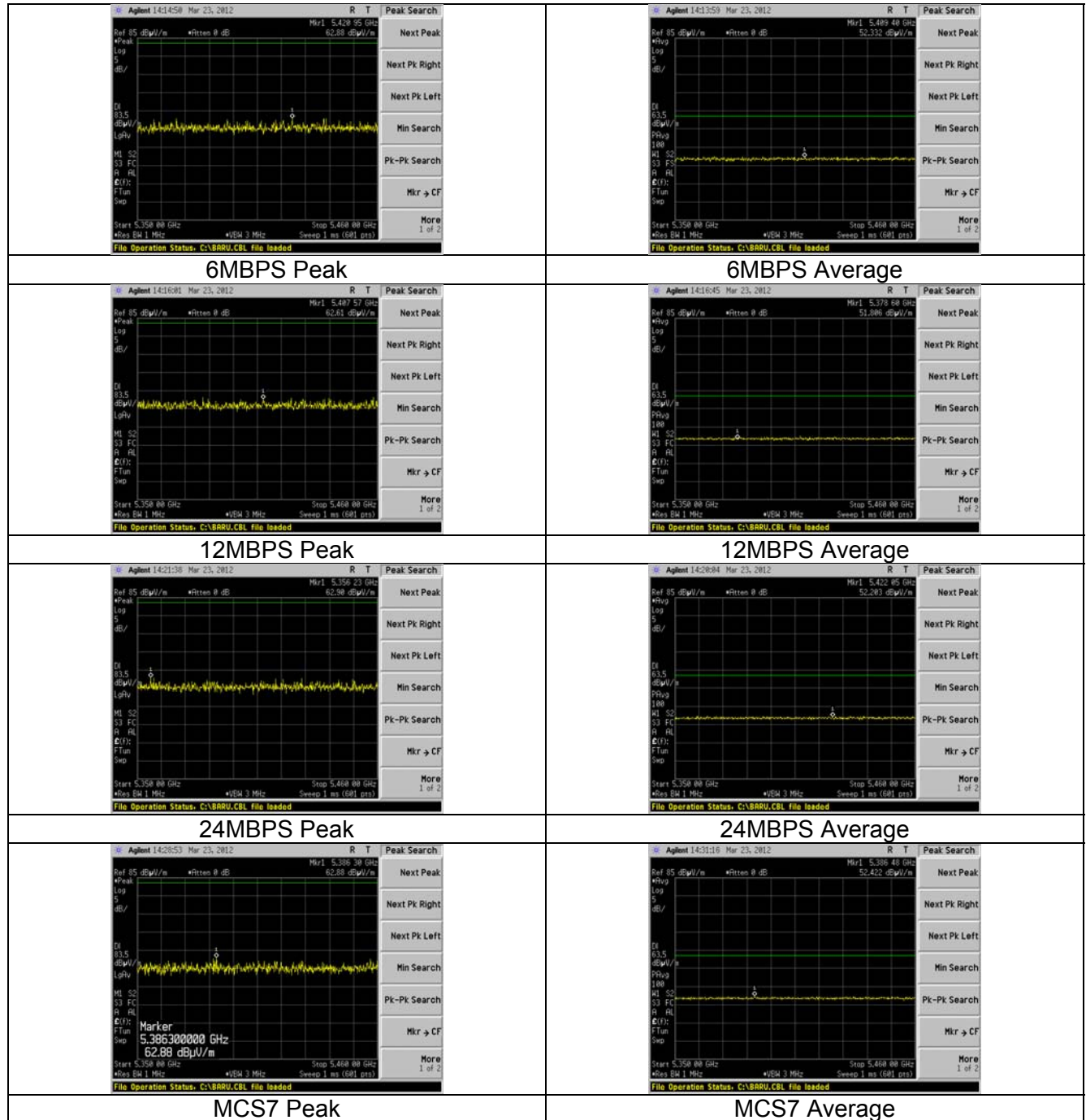
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 72 of 88

5150 MHz to 5250 MHz



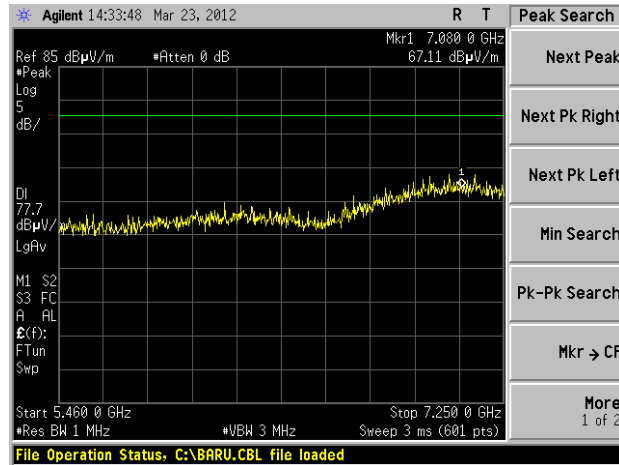
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #: TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201, SN361116 Radiated	Page 73 of 88

5350 to 5460 MHz

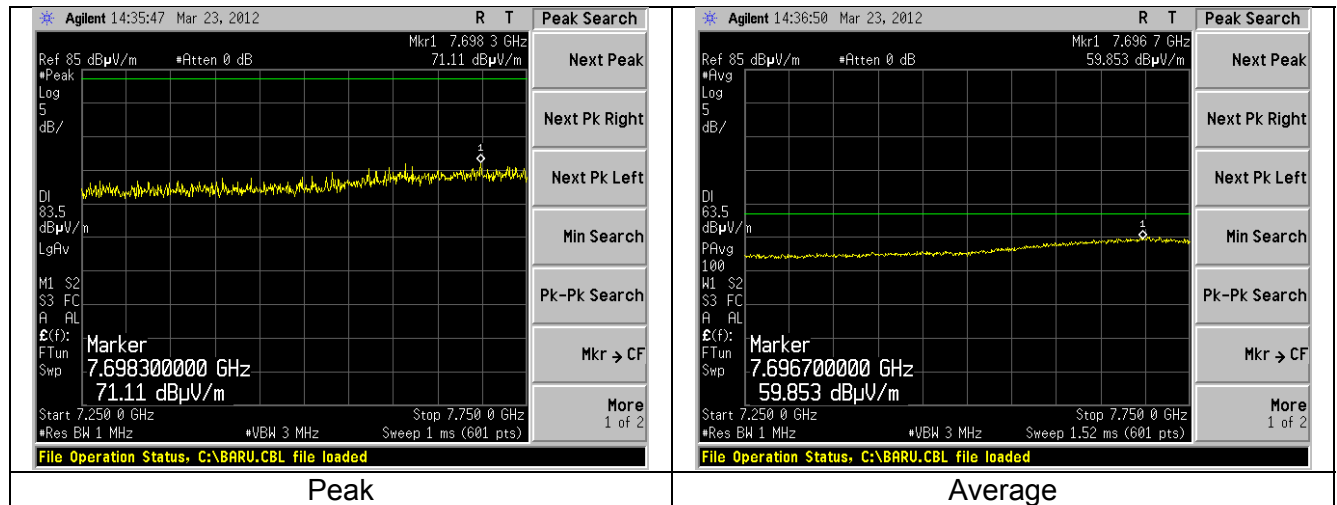


Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 74 of 88

5460MHz to 7250MHz

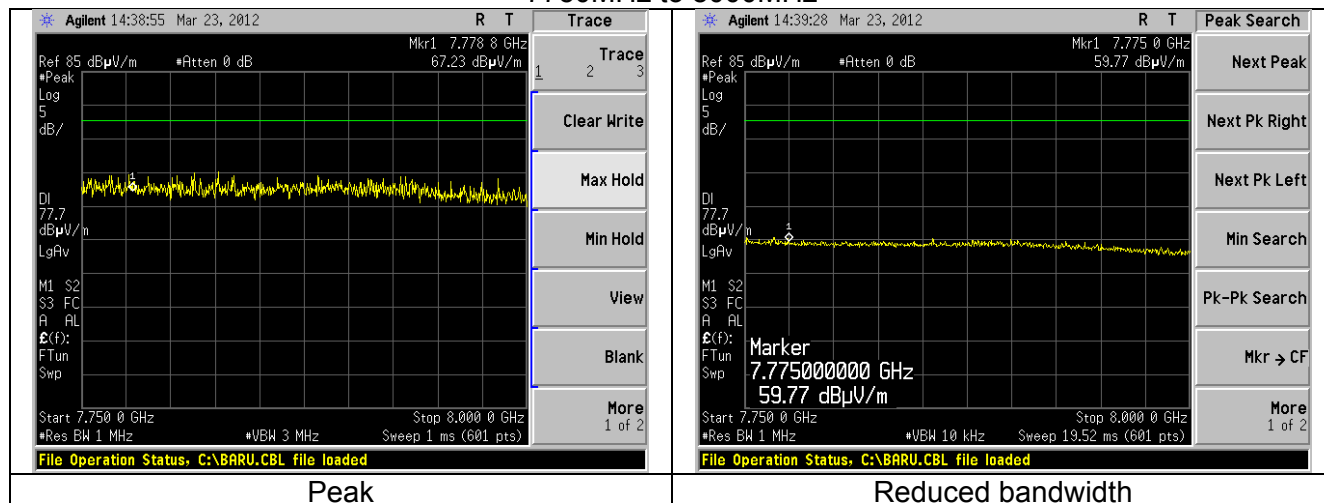


7250MHz to 7750MHz



Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
Report # 311362 E	Model #:TiWi5	Template: 15.407
LSR Job #: C-1371	Serial #: SN051201 Conducted SN041201,SN361116 Radiated	Page 75 of 88

7750MHz to 8000MHz



10.3.2.2.3 Operation in the 5470MHz to 5725MHz band

10.3.2.2.3.1 Significant emissions data table

Channel 100

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
8250	1.03	19	51.61	-53.2	-21.3	42.92	-61.9	-41.27	31.9	20.6
11000	1.00	37	56.33	-48.4	-21.3	50.22	-54.6	-41.27	27.2	13.3
13750	1.00	79	56.21	-48.6	-27.0	N/A	N/A	N/A	21.6	N/A
22000	1.00	84	53.37	-51.4	-27.0	N/A	N/A	N/A	24.4	N/A

Channel 116

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
8370	1.00	27	54.06	-50.7	-21.3	46.21	-58.6	-41.27	29.4	17.3
11160	1.00	58	56.83	-47.9	-21.3	50.67	-54.1	-41.27	26.7	12.8
22320	1.00	279	53.23	-51.5	-21.3	45.32	-59.5	-41.27	30.3	18.2

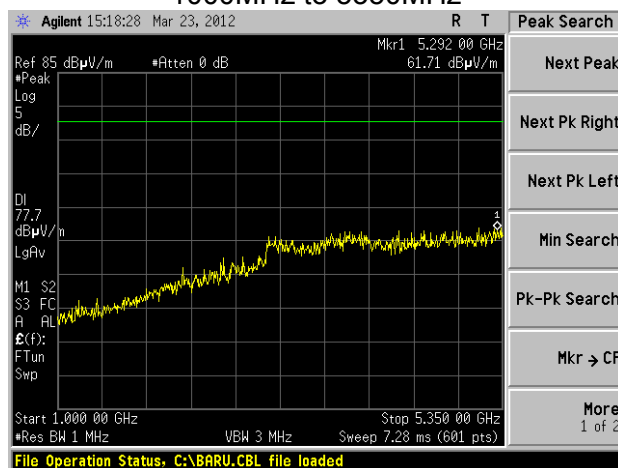
Channel 140

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak EIRP (dBm)	Peak Limit (dBm)	Avg Reading (dBμV/m)	Avg EIRP (dBm)	Avg Limit (dBm)	Peak margin (dB)	Avg margin (dBm)
8550	1.07	24	54.8	-50.0	-27.0	N/A	N/A	N/A	23.0	N/A
11400	1.15	274	53.46	-51.3	-21.3	46.98	-57.8	-41.27	30.0	16.5
14250	1.01	9	55.08	-49.7	-27.0	N/A	N/A	N/A	22.7	N/A
22800	1.06	156	54.62	-50.2	-21.3	48.21	-56.6	-41.27	28.9	15.3

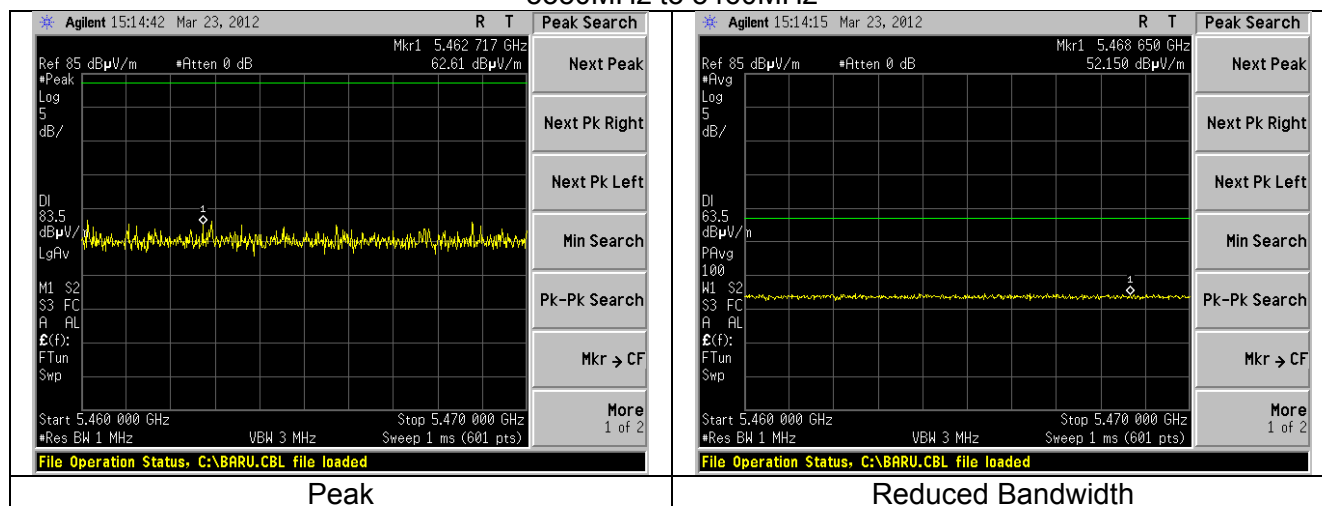
Prepared For: LS Research, LLC	EUT: TiWi5	LS Research, LLC
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10.3.2.2.3.2 Emissions between 1000 to 8000 MHz

1000MHz to 5350MHz

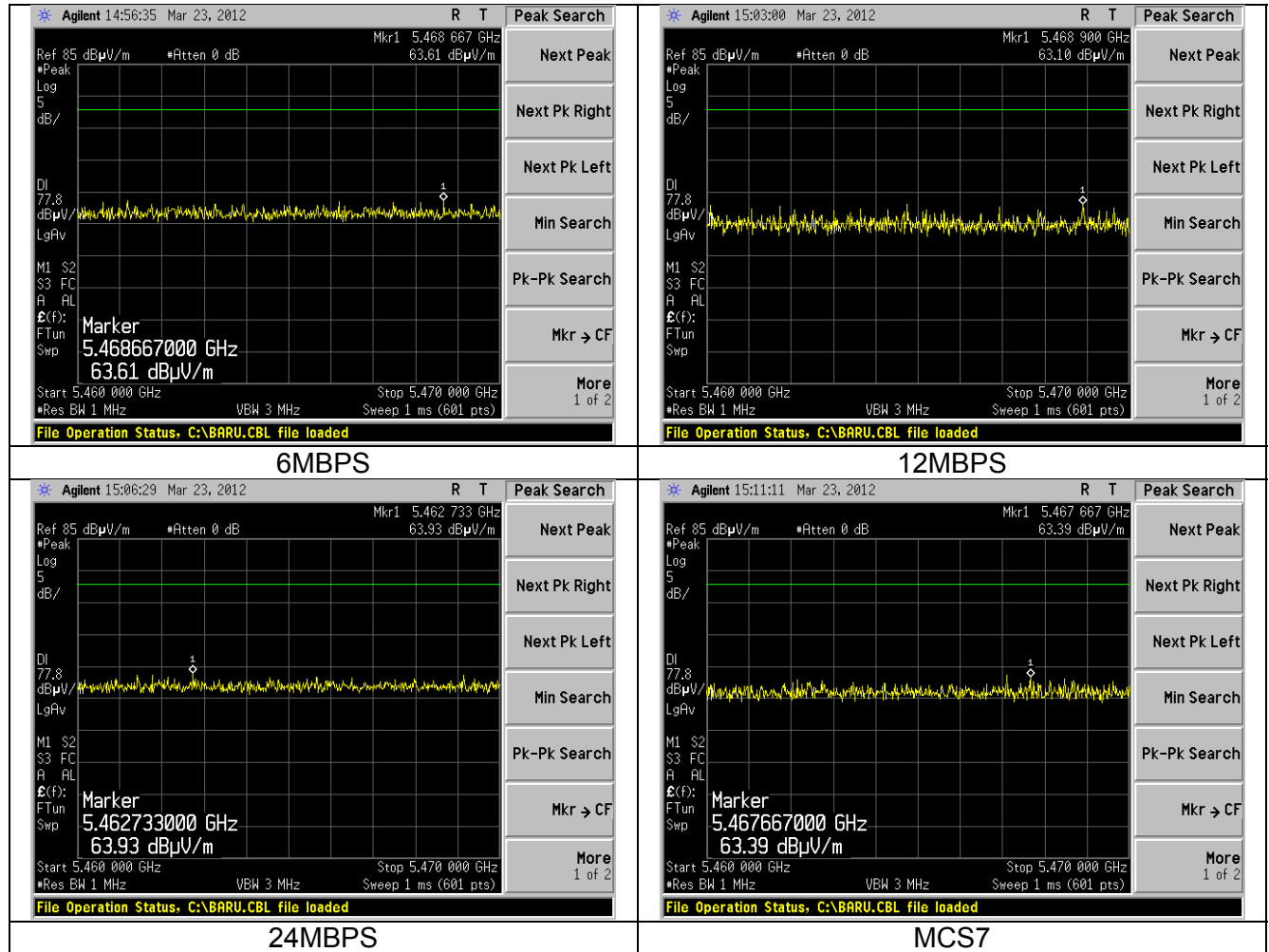


5350MHz to 5460MHz



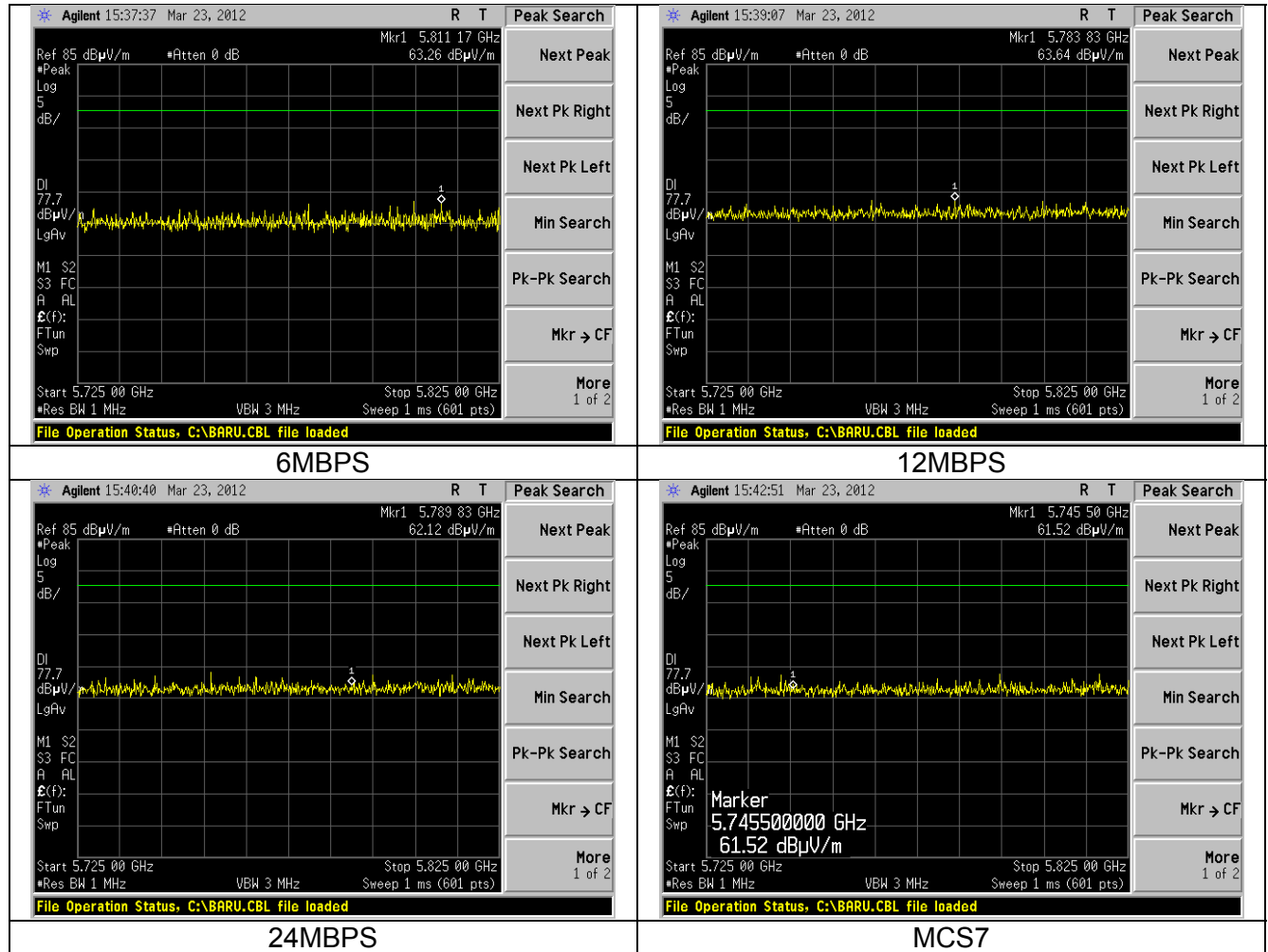
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5460MHz to 5470MHz



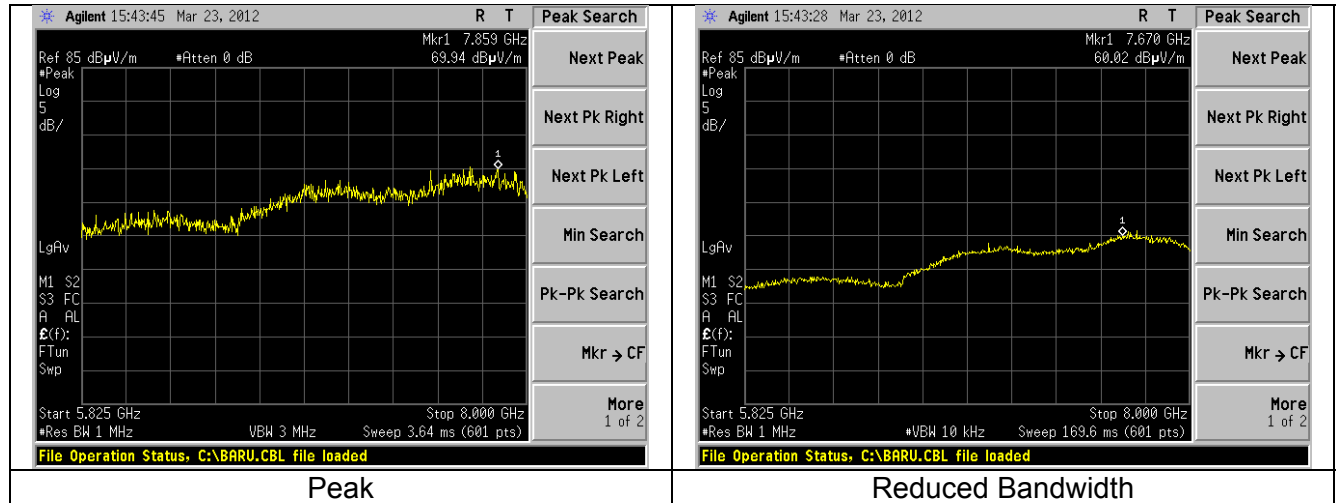
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5725MHz to 5825MHz



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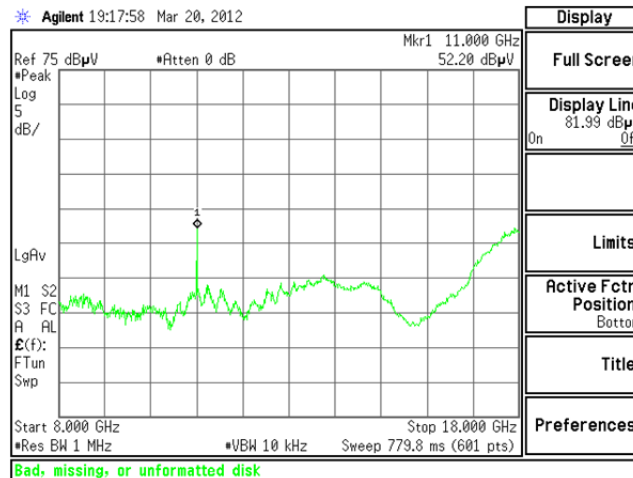
5825MHz to 8000MHz



10.3.2.2.4 Emissions between 8000MHz to 40000MHz

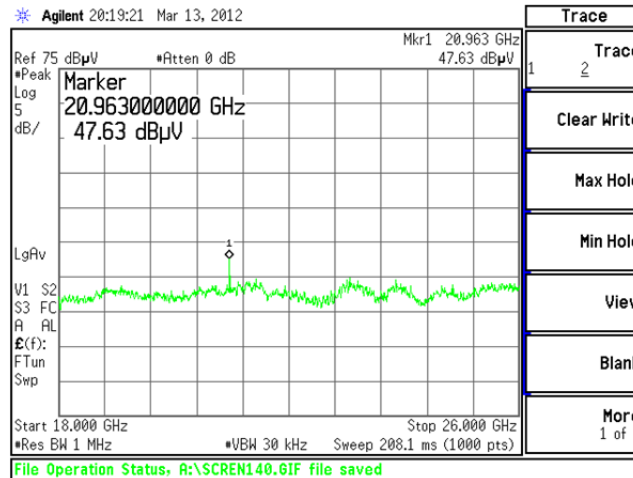
The plots shown below are those of 6MBPS which is representative of the other data rates.

800MHz to 18000MHz

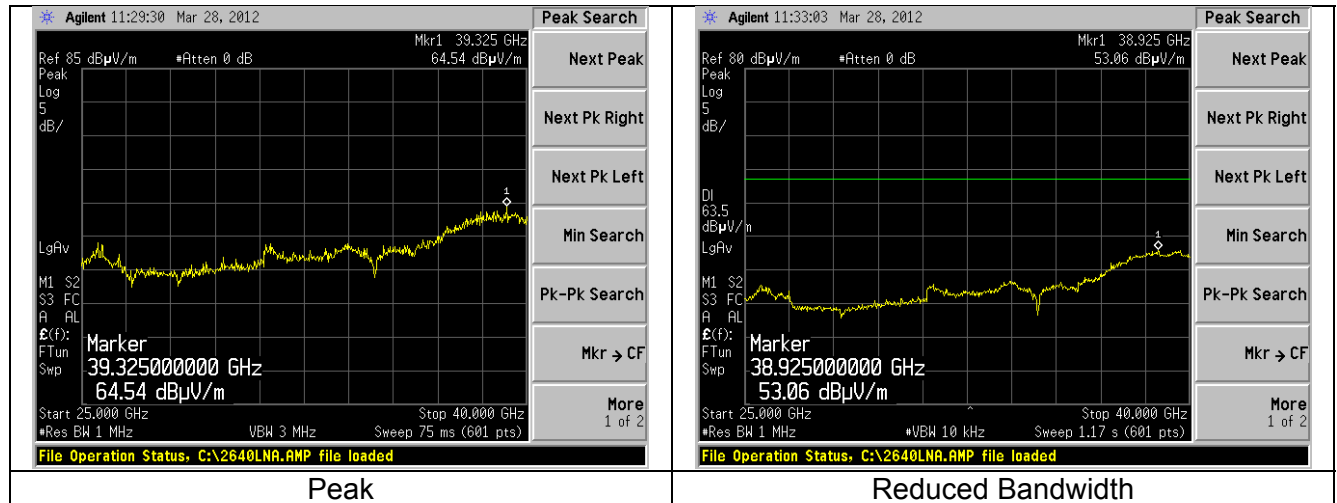


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18000MHz to 26000MHz



26000MHz to 40000MHz



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EXHIBIT 11 Frequency Stability

Test Engineer: Khairul Aidi Zainal

11.1 Test Procedure

For this test, the EUT was placed inside an environmental chamber. Antenna port conducted measurements were performed at the operating temperature ranges specified by the manufacturer owner's manual. In addition, the supply voltage was varied per the operating ranges specified in the owner's manual.

11.2 Limit

Manufacturer of U-NII devices are responsible for insuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

11.3 Test Data

			Supply Voltage (V)		
			3.00	3.60	4.80
Temp	Channel	Nominal Frequency (MHz)	Measured Frequency (Hz)	Measured Frequency (Hz)	Measured Frequency (Hz)
-40°C	36	5180.0	5180013165	5180013365	5180013155
	64	5320.0	5320013625	5320013625	5320013285
	112	5560.0	5560013884	5560014095	5560014135
23°C	36	5180.0	5180009465	5180009890	5180010355
	64	5320.0	5320009720	5320010420	5320010500
	112	5560.0	5560009870	5560010820	5560011020
+85°C	36	5180.0	5180011400	5180014950	5180020650
	64	5320.0	5320016875	5320021625	5320016375
	112	5560.0	5560004500	5560012250	5560018625

The data collected shows that the frequency stability of the EUT is better than 1PPM and hence will result in the EUT will remain within the bands of operation.

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EXHIBIT 12 Conducted Emissions Test, AC Power Line

Test Engineer: Michael Hintzke

12.1 Test Setup

The test area and setup are in accordance with ANSI C63.4-2003 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μ H Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

12.2 Test Procedure

The EUT was investigated in continuous modulated transmit mode and continuous receive mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

An off-the-shelf DC power supply was used during the test to supply the EUT with the appropriate DC voltage.

12.3 Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dB μ V)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW $\geq$ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

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12.4 Test Data

Manufacturer:	LS Research				
Date(s) of Test:	April 25 th 2012				
Project Engineer:	Khairul Aidi Zainal				
Test Engineer:	Mike Hintzke				
Voltage:	120 VAC				
Operation Mode:	Continuous transmit, modulated				
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 40%				
Test Location:	X	AC Mains Test area			Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane			10cm Spacers
	X	80cm above Ground Plane			Other:
Measurements:		Pre-Compliance		Preliminary	X Final
Detectors Used:		Peak	X	Quasi-Peak	X Average

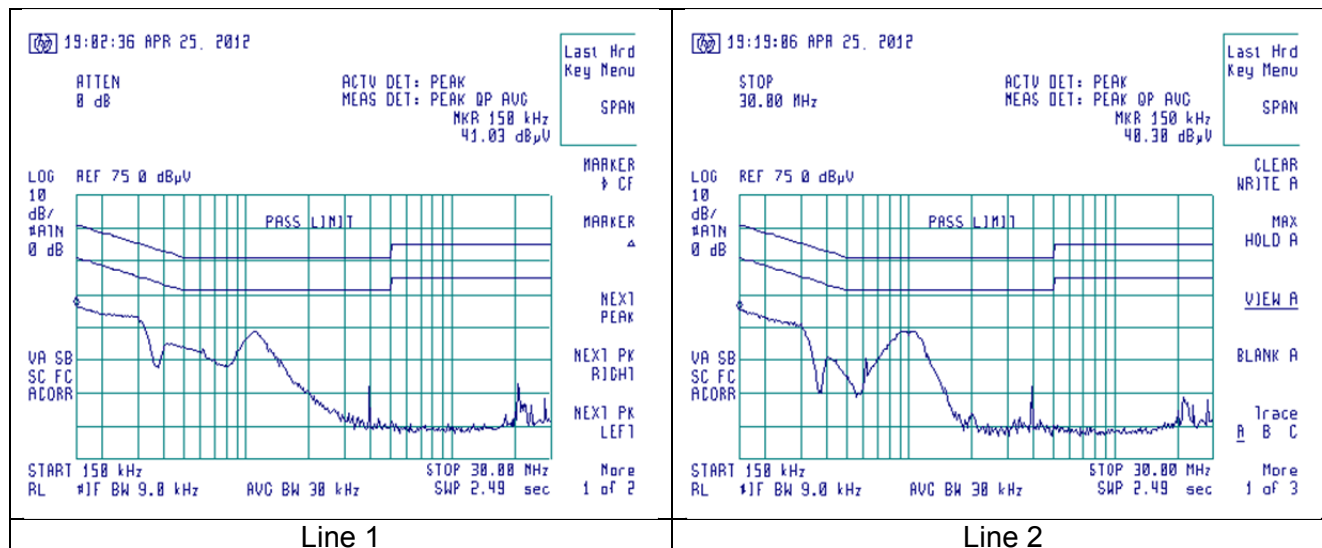
Frequency (MHz)	Line	Quasi-Peak			Average		
		Q-Peak Reading (dBμV)	Q-Peak Limit (dBμV)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
0.150	L1	35.2	66.0	30.8	5.2	56.0	50.8
0.302	L1	32.2	60.2	28.0	10.7	50.2	39.5
1.106	L1	27.2	56.0	28.8	-2.7	46.0	48.7
0.150	L2	34.6	66.0	31.4	4.9	56.0	51.1
0.416	L2	20.0	57.5	37.5	-7.0	47.5	54.5
0.295	L2	30.0	60.4	30.4	0.6	50.4	49.8
1.025	L2	27.6	56.0	28.4	-2.4	46.0	48.4
0.618	L2	22.1	56.0	33.9	17.7	46.0	28.3

Notes:

- 1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

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These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).



6.5 Test Setup Photo(s)



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APPENDIX A – Test Equipment List



Date : 20-Dec-2011

Type Test : Radiated Measurements

Job #: C-1371

Prepared By: Aidi

Customer : LSR

Quote #: 311362

No.	Asset #	Description	Manufacturer	Model#	Serial#	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
2	EE 960147	Pre-Amp	Adv. Micro	WLA 622	123101	1/4/2011	1/4/2012	Active Calibration
3	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro	WLA 622-4	123001	1/13/2011	1/13/2012	Active Calibration
4	EE 960157	3Hz - 13.2GHz SpectrumAnalyzer	Agilent	E4445A	MY 46250225	6/6/2011	6/6/2012	Active Calibration
5	EE 960158	RF Preselector	Agilent	N8039A	MY 46520110	6/11/2011	6/11/2012	Active Calibration
6	EE 960161	26.5-40GHz LNA	Ducommun Techn	ALN-33144030	1103717-01	10/4/2011	10/4/2012	Active Calibration
7	AA 960144	Phaselink	Gore	ERD010010720	5800373	6/1/2011	6/1/2012	Active Calibration
8	AA 960005	Biconical Antenna	EMCO	931108	9601-2280	6/1/2011	6/1/2012	Active Calibration
9	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	1/15/2011	1/15/2012	Active Calibration
10	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6007	1/4/2011	1/4/2012	Active Calibration
11	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	60259	10/4/2011	10/4/2012	Active Calibration
12	AA 960160	UNIFLEX Cable	Micro-Cox	UFC142A-0-0720-20R	218652-001	10/4/2011	10/4/2012	Active Calibration

Project Engineer: Aidi

Quality Assurance: PETER



Date : 20-Dec-2011

Type Test : Conducted measurements

Job #: C-1371

Prepared By: Aidi

Customer : LSR

Quote #: 311362

No.	Asset #	Description	Manufacturer	Model#	Serial#	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaselink	Gore	ERD01001048.0	5546519	6/1/2011	6/1/2012	Active Calibration
2	CC 000221C	SpectrumAnalyzer	HP	E4407B	US39160256	5/4/2011	5/4/2012	Active Calibration
3	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	4/25/2011	4/25/2012	Active Calibration
4	AA 960144	Phaselink	Gore	ERD010010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: Aidi

Quality Assurance: ADAMALGER



Date : 20-Dec-2011

Type Test : AC mains

Job #: C-1371

Prepared By: Aidi

Customer : LSR

Quote #: 311362

No.	Asset #	Description	Manufacturer	Model#	Serial#	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	8546A System	3617A00320,3448A	11/22/2011	11/22/2012	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	11/22/2011	11/22/2012	Active Calibration
3	AA 960072	Transient Limiter	HP	11947A	3107A02515	11/22/2011	11/22/2012	Active Calibration
4	AA 960075	LSN	EMCO	3810/2NM	9612-1710	9/19/2011	9/19/2012	Active Calibration

Project Engineer: Aidi

Quality Assurance: Mike Hintzle

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APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2012		
RSS GEN	2010		
RSS 210	2010		
RSS 102	2010		

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APPENDIX C - 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	$\pm 0.64^{\circ}$ C
7	Humidity	± 2.9 %
8	DC voltage	± 0.03 %
9	Low frequency voltage	± 0.1 %

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