COMPLIANCE TESTING REPORT
FCC TITLE 47 PART 15
SUBPARTS A & C

Client:	Circuitlink Pty Ltd
Address:	7/30 Foundry Road Seven Hills NSW 2147
Report Number:	0212CIR_TACHO5_FCC15C *[This report supersedes report 0122CIR_TACHO5_FCC15C]*
Date of Testing:	24 Feb to 29 Aug 2014
File Number:	CIR130403
Equipment Name:	Tacholink 5
Equipment Model Numbers:	TACHO5A, TACHO5B, TACHO5C
Equipment Serial Numbers:	TL500097, TL500014, TL599999
Equipment FCC ID:	2AAARTACHO5B
Equipment Description:	Vehicle Data Recorder with 2.4GHz WiFi Function
Result:	**COMPLIES**
Tested by:	Richard Turner
Approved by:	Colin Gan
Date of Issue:	22 Jan 2015

AUSTEST (NSW) FCC REGISTRATION NUMBER 90455

Results appearing herein relate only to the sample(s) tested.

This report is issued errors and omissions exempt and is subject to withdrawal at Austest Laboratories discretion.

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
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ACCREDITED
TEST LABORATORY
CERT #2765.02

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Report Revision History:

Date	Report Number	Changes
21 Jan 2014	0121CIR_0011103_FCC15C	Original Report.
19 Dec 2014	1219CIR_TACHO5_FCC15C	Report revised to address measurements per latest KDB Publication 558074. Changes to EUT details & configuration.
22 Jan 2015	0122CIR_TACHO5_FCC15C	Report revised to include additional details for TCB Certification review.
12 Feb 2015	0212CIR_TACHO5_FCC15C	Page 6 revised to clarify tested model selection.

1 TEST SUMMARY

Austest makes no claim regarding the consistency of production versions of the EUT.

The results in this report apply only to the tested EUT described in Section 3 of this report.

FCC Section	Test	Result	Notes
FCC Part 15, Subpart C – Intentional Radiators			
15.203	Antenna Requirement	COMPLIES	
15.205	Restricted Bands of Operation	COMPLIES	
15.207	Conducted Limits	NOT APPLICABLE	(iv)
15.209	Radiated Emission Limits, General Requirements	COMPLIES	
15.215	Additional Provisions to the General Radiated Limitations	COMPLIES	
15.247	Operation within the Bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz	COMPLIES	(i)

Notes (applicable only if referenced in "Notes" column of above summary table):
(i) EUT complies (the measurement results were below the applicable limits), but some emissions were within the range of measurement uncertainty of the limits.
(ii) EUT complies (when modified as described in Section 2 of this report).
(iii) There were deviations from the applied standard as described in Section 6.2 of this report.
(iv) EUT is designed to be only powered from a vehicle's battery supply.

2 MODIFICATIONS

No modifications were required to achieve compliance. Testing was performed in accordance with client supplied channel plan.

3 REFERENCES

FCC Title47 Part 15 current as of May 2014
ANSI C63.10: 2009
KDB Publication 558074 D01 DTS Meas Guidance v03r02, 05/06/2014

4 EQUIPMENT UNDER TEST (EUT) DESCRIPTION

EUT Name:	Tacholink 5
EUT Description:	Vehicle data recorder with 2.4GHz WiFi Function
EUT Models:	TACHO5A, TACHO5B, TACHO5C
EUT Serial Number:	TL500097, TL500014, TL500097
EUT FCC ID:	2AAARTACHO5B
Manufacturer:	Circuitlink Pty Ltd
Power Supply & Rating:	12 – 30VDC, <1A
Highest Clock/Operating Frequency:	Clock Frequency: 96MHz Operating Frequency: 2483.5GHz
Lowest Internal Frequency source	Approx 300kHz (switching regulator)
Transmit Frequency Range:	2400 to 2483.5MHz
Maximum Transmit Power:	23.6dBm
Modulation Technique:	BPSK, QPSK, 16-QAM, 64-QAM
Number of Channels:	11
Antenna Specifications:	1. Taoglas MA600 Spartan Combination Antenna (GPS/WiFi/Cellular). Peak gain 2.4 – 2.5GHz: 2.1dBi 2. Taoglas MA206 Stingray Combination Antenna (GPS/WiFi). Peak gain 2.4 – 2.5GHz: 3.4dBi 3. Linx ANT-2.4-CW-RH-SMA stub antenna (WiFi only). Peak gain 2.4 – 2.5GHz: -0.9dBi

The EUT is designed for use in a vehicle and powered by connection to the vehicle's battery supply.

The EUT was also supplied with a dashbox unit, which is used as a driver interface.

Derived Models:

Model variants to be included under the same FCC ID:

Tacholink Model No.	**TACHO5A**	**TACHO5B**	**TACHO5C**
Fitted Modules			
2G Module (Telit GE910)	Yes	-	-
3G Module (Telit HE910)	-	-	Yes
WiFi Module (Qualcomm Atheros AR4100G)	Yes	Yes	Yes
GPS Receiver (µBlox NEO-6Q)	Yes	Yes	Yes
External Antennas			
MA600 Combination Antenna	Yes	Yes	Yes
Taoglas MA.206 Combination Antenna	-	Yes	-
Linx ANT-2.4-CW-RH Antenna	-	Yes	-

All models are housed in identical plastic cases containing the same PBA, (#5060106).

All models use the same Qualcomm Atheros AR4100G module for 2.4GHz WiFi operation.

The Telit GE910 module and Telit HE910 module use the same PCB footprint.

For WiFi, only the external antennas listed are used. There are no internal antennas.

Testing was performed on the TACHO5A model, as the differences with other models were deemed not to affect the performance of the 2.4GHz WiFi transmission. Hence, during the 2.4GHz testing on the TACHO5A model, testing was done with all three antennas (in spite of what is listed in the above table) to obtain the necessary test results.

5 EUT TEST SETUP & CONFIGURATION

Refer to the photographs in
APPENDIX C – EUT TEST SETUP PHOTOGRAPHS for the EUT test setup and physical configuration.

In the test setup, shown in Appendix A, the following cables and auxiliary equipment were used.

Connection / Port	Connecting Cable	Source / Load
USB	Supplied 2.8m shielded USB cable, bundled	-
40 way Samtec	Supplied 1.9m unshielded multicore cable, bundled	Supplied termination unit with LED display
20 way Samtec	Supplied 1.8m unshielded multicore cable, bundled	See below
GPS	Shielded coaxial cable, bundled, permanently fixed to the antenna	MA600 / MA206 antenna
WiFi	Shielded coaxial cable, bundled, permanently fixed to the MA600 / MA206 antenna	MA600 / MA206 antenna / WiFi stub
GSM	Shielded coaxial cable, bundled, permanently fixed to the antenna	MA600 antenna

The 20way Samtec cable connected the EUT to the following units:

- Dashbox unit using a 1.4m unshielded DB15 cable.
- Supplied termination/power unit using a 2m unshielded DB15 cable.

1 metre unshielded power leads connected a DC supply to the termination/power unit.
A single 1 metre unshielded lead connected the LED termination unit to +13.8VDC.

The MA600 and MA206 combination antennas were placed horizontally on the test table.
The WiFi stub antenna was connected directly to the WiFi port without cable and positioned vertically.

Measurements were made after initial boot up was completed. The EUT had been configured to exercise its data logging functions automatically after boot up.

The EUT was tested within the allowed temperature and humidity range.

For testing purposes the EUT was powered from a supplied bench power supply, output set to 13.8VDC.

5.1 EUT Operating Modes

Mode No.	Operating Mode Description
1	802.11b operation, CHs 1 to 11 inclusive. transmit power set in accordance with the supplied channel plan. Duty cycle 100%.
2	802.11g operation, CHs 1 to 11 inclusive, transmit power set in accordance with the supplied channel plan. Duty cycle 100%.
3	802.11n 20MHz operation, CHs 1 to 11 inclusive, transmit power set in accordance with the supplied channel plan. Duty cycle 100%.

Supplied channel plan (reflecting power level settings), as provided by the WiFi module manufacturer (Qualcomm).

When AR4100 is in FCC regulatory domain, the output power (per channel) is shown in the below matrix

	Channel	2412	2417	2422	2427	2432	2437	2442	2447	2452	2457	2462	2467	2472	2484
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Data Rates	1	17	17	17	17	17	17	17	17	17	17	16.5	NA	NA	NA
	2	17	17	17	17	17	17	17	17	17	17	16.5	NA	NA	NA
	5.5	17	17	17	17	17	17	17	17	17	17	16.5	NA	NA	NA
	11	17	17	17	17	17	17	17	17	17	17	16.5	NA	NA	NA
	6	10.5	10.5	17	17	17	17	17	17	17	14.5	10.5	NA	NA	NA
	24	10.5	10.5	17	17	17	17	17	17	17	14.5	10.5	NA	NA	NA
	26	10.5	10.5	17	17	17	17	17	17	17	14.5	10.5	NA	NA	NA
	48	10.5	10.5	15	15	15	15	15	15	15	14.5	10.5	NA	NA	NA
	54	10.5	10.5	15	15	15	15	15	15	15	14.5	10.5	NA	NA	NA
	mcs0	9.5	9.5	17	17	17	17	17	17	17	14	10	NA	NA	NA
	mcs1	9.5	9.5	17	17	17	17	17	17	17	14	10	NA	NA	NA
	mcs2	9.5	9.5	17	17	17	17	17	17	17	14	10	NA	NA	NA
	mcs3	9.5	9.5	17	17	17	17	17	17	17	14	10	NA	NA	NA
	mcs4	9.5	9.5	15	15	15	15	15	15	15	14	10	NA	NA	NA
	mcs5	9.5	9.5	15	15	15	15	15	15	15	14	10	NA	NA	NA
	mcs6	9.5	9.5	15	15	15	15	15	15	15	14	10	NA	NA	NA
	mcs7	8	8	8	8	8	8	8	8	8	8	8	NA	NA	NA

Note:
802.11b mode for rates 1 to 11
802.11g mode for rates 6 to 54
802.11n 20MHz mode for rates mcs0 to mcs7

Various combinations of data rates, transmit power ratings and channels were used to determine worse case scenarios.

6 TEST SPECIFICATIONS

6.1 Accreditations & Listings

Austest Laboratories has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules and Test Site Criteria (ANSI C63.4-2009) by the FCC Laboratory Division for Certification testing under Parts 15 or 18 of the FCC Rules.

Austest Laboratories (NSW)'s Yarramalong test facilities are listed with the FCC under Registration Number 90455.

Austest Laboratories (NSW)'s Yarramalong test facilities are accredited by A2LA. The tests reported herein have been performed in accordance with its terms of accreditation.

6.2 Deviations from Standards and/or Accreditations

None.

6.3 Test Facility

Testing was performed in New South Wales at Austest Laboratories (NSW)'s Yarramalong test facilities located at 46 Glenola Farm Lane in Yarramalong Valley, New South Wales, Australia.

Radiated emission testing is performed at an Open Area Test Site (OATS), where some ambient signals may exceed the continuous disturbance limit. The possibility of missing an emission during testing is removed by use of pre-scans, performed in a shielded enclosure, prior to the final OATS measurements.

6.4 Test Equipment

Test Equipment	Brand & Model	Serial No./ID	Cal. Due Date
EMI Receiver	HP 8574B	MEQ72	23 Jan 2015
Test Software	HP85969PC	-	Verified
Spectrum Analyser	HP 8593E	MEQ738	05 Jun 2014 *
Biconical Array Antenna	Emco EM6912	MEQ297	11 Jun 2014 *
Log-Periodic Array Antenna	Emco EM6950	MEQ298	10 Jun 2014 *
DRG Horn Antenna (1 – 18GHz)	AH Systems SAS-571	MEQ107	31 May 2016
DRG Horn Antenna (18 – 25GHz)	AH Systems SAS-200/574	MEQ600	13 Jan 2015
Loop Antenna	EM-6876	MEQ225	22 Jan 2015
Pre-Amplifier (30MHz-1GHz)	HP 8447E	MEQ74	17 Jan 2015
Pre-Amplifier (1GHz-25GHz)	RE 218A	MEQ651	15 Jan 2015
Pre-Amplifier (4.5GHz–25GHz)	RE 518A	MEQ650	15 Jan 2015
Wideband Power Sensor	Agilent U2021XA	MEQ924	30 Jun 2016
Power Analysis Software	Agilent N1918A	-	Verified
Attenuator	Omni Spectra 10dB	1022627	27 Sep 2016
Coaxial Cables	Suhner	Various	Jan 2015
Multimeter	8060T	MEQ164	19 Sep 2014
Variable DC Power Supply	Austest	-	Verified

* Radiated emissions using these antennas were done prior to the Cal Due Dates.

All test equipment was checked and performance verified prior to testing.

6.5 Measurement Uncertainties

The following uncertainties are for a 95% level of confidence, based on a coverage factor, k=2.

Test	Measurement Uncertainty
Mains Conducted Emissions	±2.6dB
Antenna Port Conducted Emissions	±2.6dB
Radiated Emissions	±4.7dB
Frequency	±5 part in 10^{10}

7 FCC Part 15C, Section 15.203 – ANTENNA REQUIREMENT

The EUT complies with the requirement of this Section since client has stated that it will only be installed by trained professional installers.

8 FCC Part 15C, Section 15.205 – RESTRICTED BANDS OF OPERATION

The EUT complies with the requirements of this Section since it does not operate within the listed Restricted Bands of Operation. The EUT operates in the frequency range 2400 to 2483.5MHz.

9 FCC Part 15C, Section 15.207 - CONDUCTED LIMITS

NOT APPLICABLE.

The EUT is designed to be installed in a vehicle and would not be connected to an AC mains supply.

10 FCC Part 15C, Section 15.209 - RADIATED EMISSION LIMITS, GENERAL REQUIREMENTS

Test Date:	24 Feb, 3 Apr and 22 May 2014	Temperature:	23-32°C
Test Officer:	Richard Turner	Humidity:	54-68%
Test Location:	Austest Laboratories (NSW)		

10.1 EUT Operating Mode

a. DC supply voltage – 13.8VDC.
b. Mode 1 – 802.11b operation.
c. Mode 2 - 802.11g operation.
d. Mode 3 – 802.11n 20MHz operation.
e. Channels, data rate and level settings adjusted to maximise measured levels, in accordance with the supplied channel plan.

10.2 Test Method

a. Measurements are performed in accordance with ANSI C63.10-2009 and KDB 558074 D01 DTS Meas Guidance v03r02.
b. Set the measuring receiver BW settings to:
   i. 9kHz (150kHz to 30MHz) EMI Receiver BW.
   ii. 120kHz (30MHz to 1GHz) EMI Receiver BW.
   iii. 1MHz (above 1GHz) RBW, 1MHz or more VBW, using a Spectrum Analyser for Peak measurements.
   iv. 1MHz (above 1GHz) RBW, 10Hz VBW with linear detection, using a Spectrum Analyser for Average measurements.
c. Set up the EUT on a non-conductive turntable, 0.8m above the OATS conductive ground plane, and at the indicated test distance away from the measuring antenna.
d. To maximise emissions, rotate the EUT through 360° and adjust the measuring antenna height between 1m to 4m in the following antenna orientations:
   i. Loop antenna (150kHz to 30MHz) – Coaxial and coplanar orientations.
   ii. Biconical and Log-Periodic antennas (30MHz to 1GHz) - Both vertical and horizontal polarizations.
   iii. Horn antenna (above 1GHz) - Both vertical and horizontal polarizations.
e. Measure the maximised emission and repeat the above for all measurement frequencies.
f. Average level measurements were not made where the peak level did not exceed the average limit.
g. Check linearity of the measuring system, reducing gain when required.

10.3 Sample Calculation Example

The final radiated emission levels were obtained from the measurement equipment software which automatically applied all the stored calibration factors. The calibration / correction factors were applied as follows:

$$\mathbf{E = V + AF + L_{cbl} - G_{pre}}$$

Where:

E = Radiated Electric Field Strength in dBµV/m at the specified distance.
V = EMI Receiver measured signal input voltage in dBµV.
AF = Antenna Factor of the measuring antenna in dB/m.
L_{cbl} = Total cable insertion loss in dB.
G_{pre} = Preamplifier gain in dB.

Frequency (MHz)	Receiver Level, V (dBµV)	AF (dB/m)	Lcbl (dB)	Gpre (dB)	Corrected Level, E (dBµV/m)
100.0	40.0	12.0	2.9	22.5	32.4

10.4 Test Results

10.4.1 Band edge measurements at 3m distance with MA600 antenna fitted

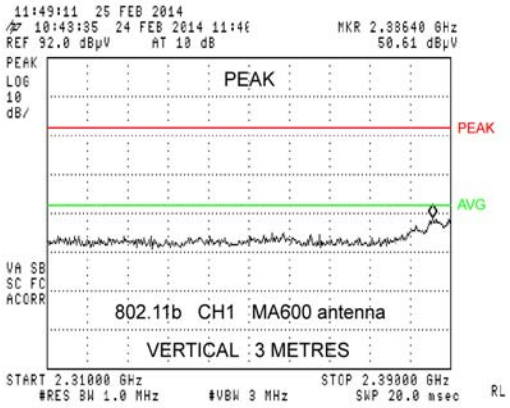
15.209 limit: 500µV/m using average detection. Peak limit set to 20dB above the average limit.

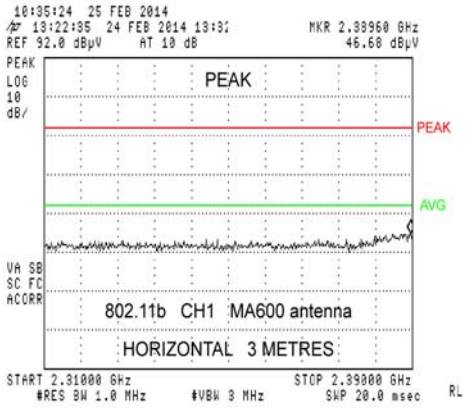
Measurements were performed on the TACHO5A unit only. The TACHO5B and TACHO5C units use the same WiFi module, PCB and enclosure.

Mode 1 – 802.11b operation - Restricted band 2310 to 2390MHz

Channel 1, data rate 1mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2386.4	Vertical	50.6	-	74.0	54.0	-23.4	-
2389.6	Horizontal	46.7	-	74.0	54.0	-27.3	-

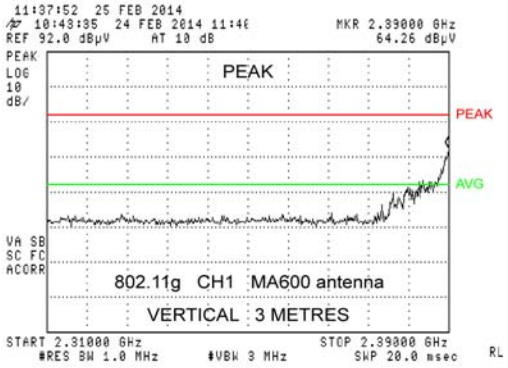


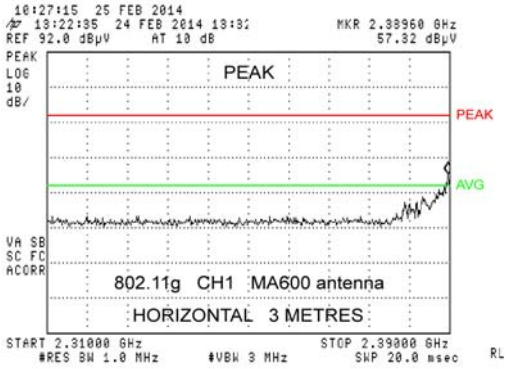


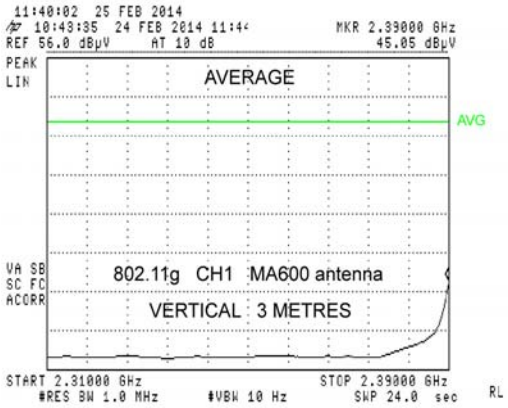
Mode 2 – 802.11g operation - Restricted band 2310 to 2390MHz

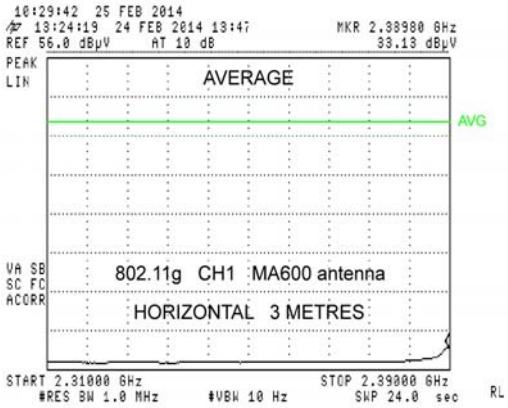
Channel 1, data rate 6mbps, level setting 10.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	64.3	45.1	74.0	54.0	-9.7	-8.9
2389.8	Horizontal	57.3	33.1	74.0	54.0	-16.7	-20.9



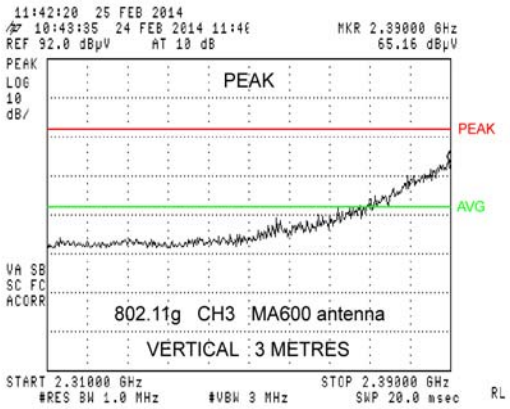


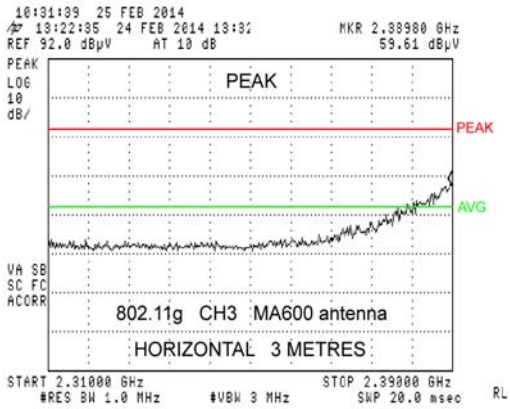


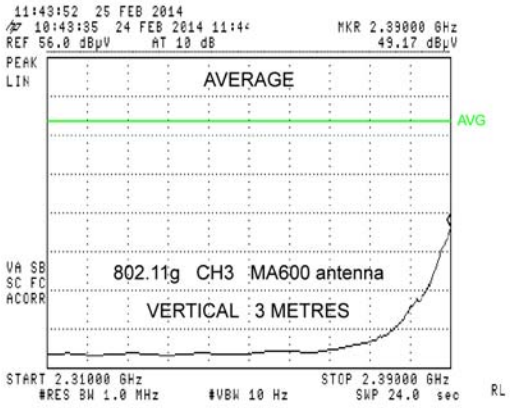


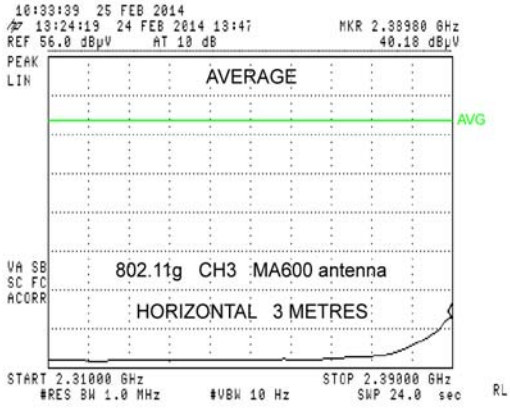
Channel 3, data rate 36mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	65.2	49.2	74.0	54.0	-8.8	-4.8
2389.8	Horizontal	59.6	40.2	74.0	54.0	-14.4	-13.8





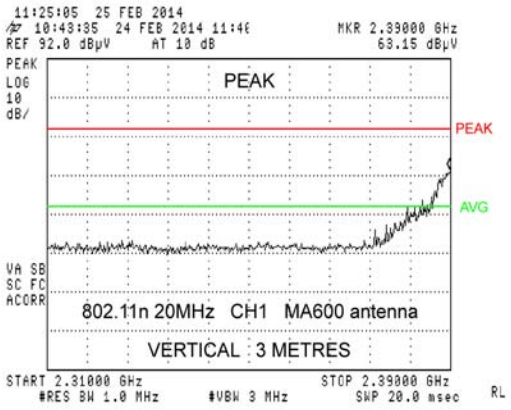


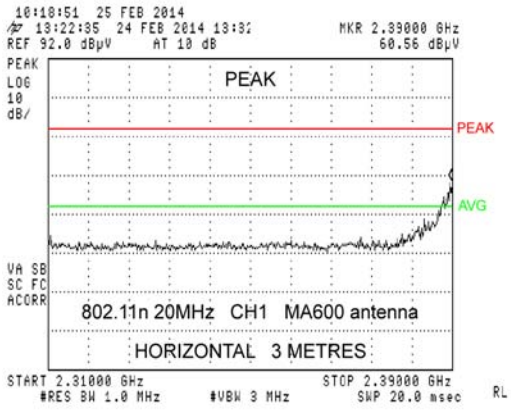


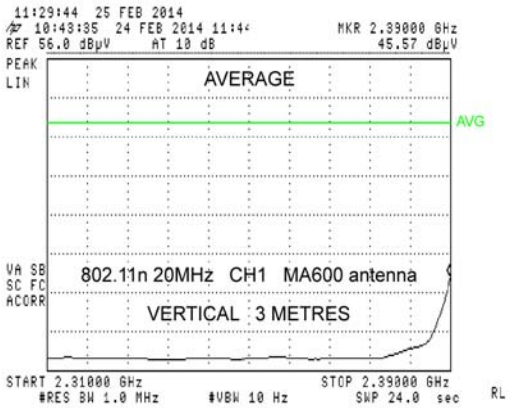
Mode 3 – 802.11n 20MHz operation - Restricted band 2310 to 2390MHz

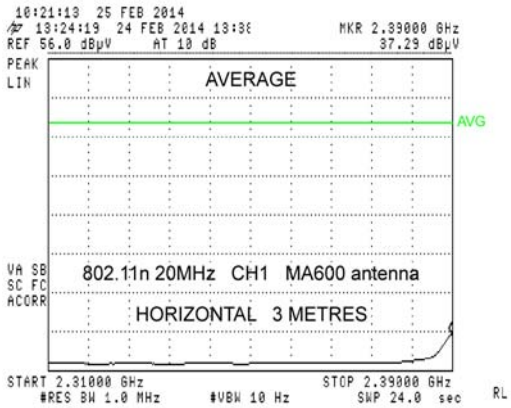
Channel 1, data rate MCS0, level setting 9.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	63.2	45.6	74.0	54.0	-10.8	-8.4
2390.0	Horizontal	60.6	37.3	74.0	54.0	-13.4	-16.7





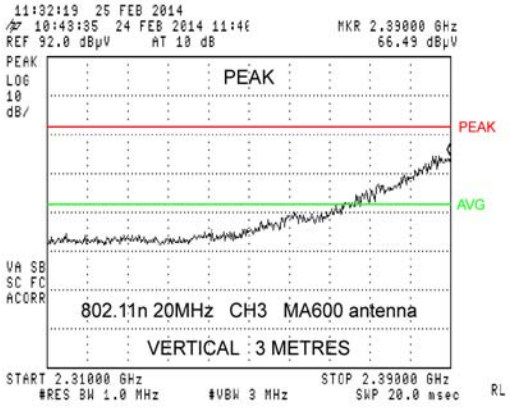


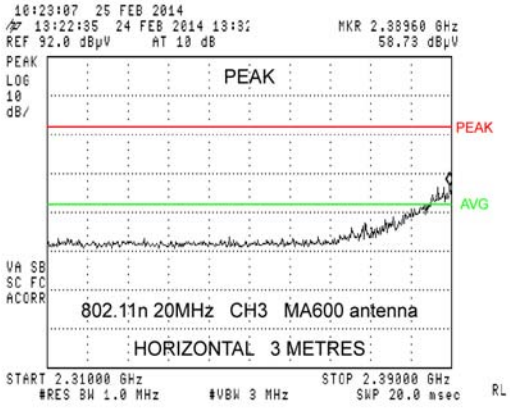


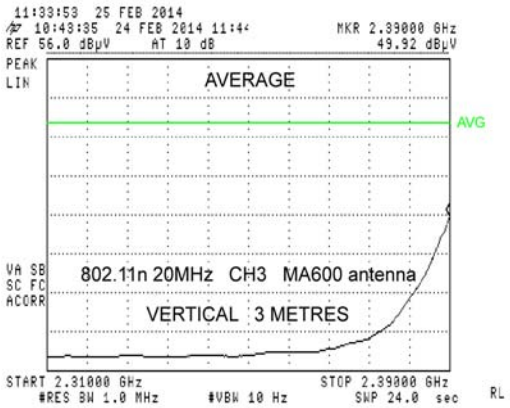
Channel 3, data rate MCS3, level setting 17dBm

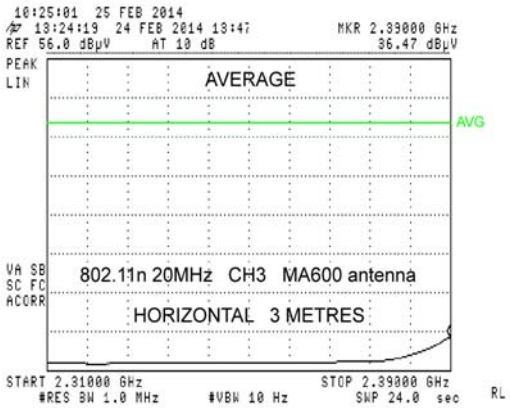
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	66.5	49.9	74.0	54.0	-7.5	-4.1*
2390.0	Horizontal	58.7	36.5	74.0	54.0	-15.3	-17.5

*Result was within the laboratory's measurement uncertainty.





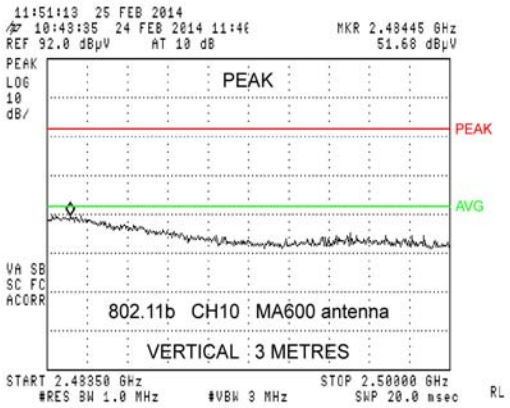


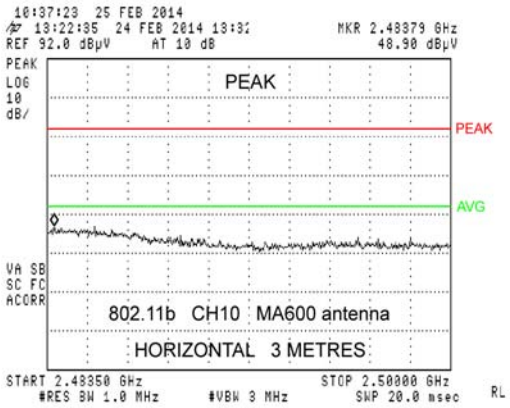


Mode 1 – 802.11b operation - Restricted band 2483.5 to 2500MHz

Channel 10, data rate 1mbps, level setting 17dBm

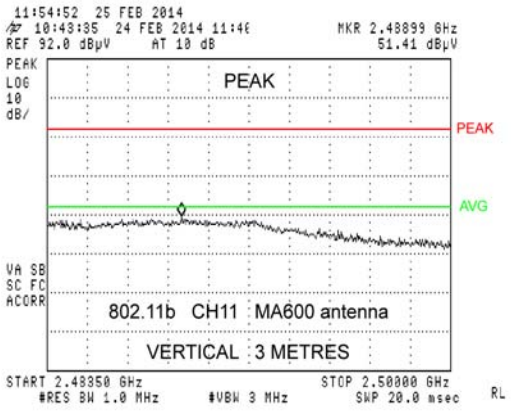
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2484.5	Vertical	51.7	-	74.0	54.0	-22.3	-
2483.8	Horizontal	48.9	-	74.0	54.0	-25.1	-

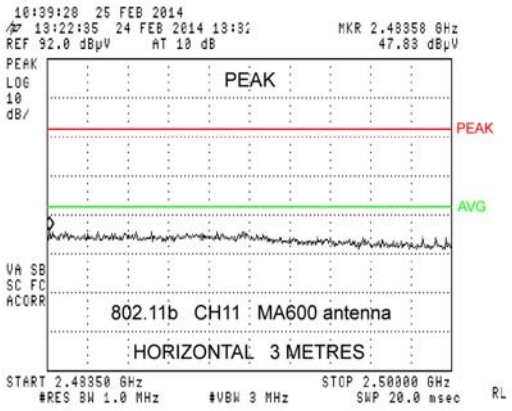




Channel 11, data rate 1mbps, level setting 16.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2489.0	Vertical	51.4	-	74.0	54.0	-22.6	-
2483.6	Horizontal	47.8	-	74.0	54.0	-26.2	-

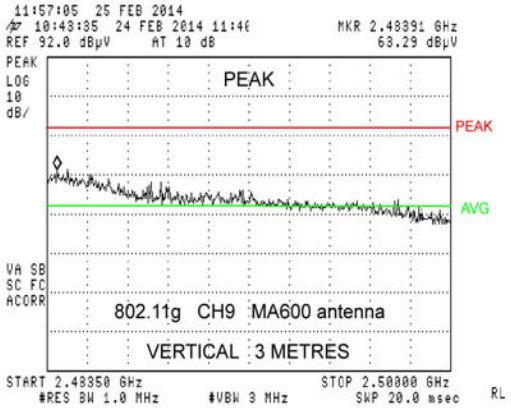


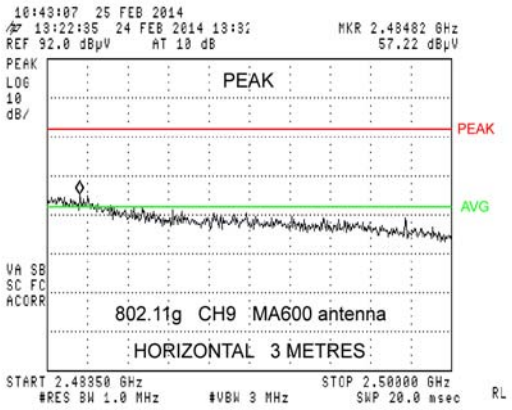


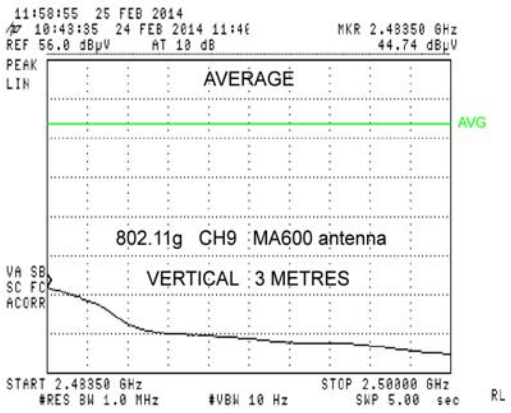
Mode 2 – 802.11g operation - Restricted band 2483.5 to 2500MHz

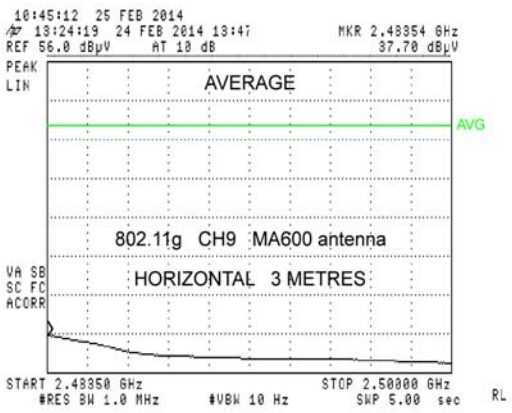
Channel 9, data rate 36mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	63.3	44.7	74.0	54.0	-10.7	-9.3
2483.5	Horizontal	57.2	37.7	74.0	54.0	-16.8	-16.3



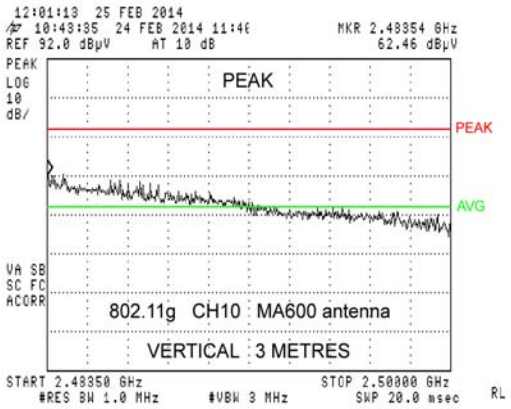


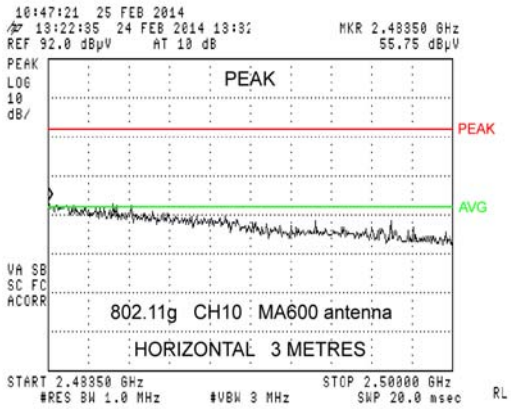


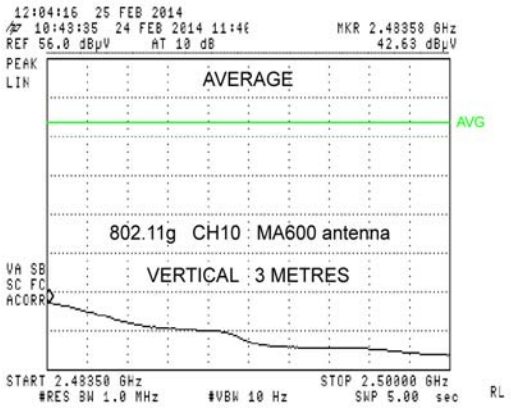


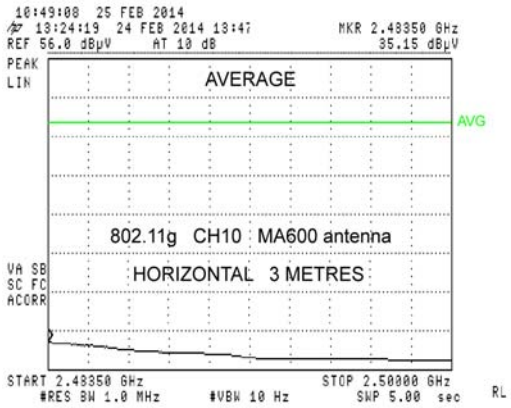
Channel 10, data rate 54mbps, level setting 14.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.6	Vertical	62.5	42.6	74.0	54.0	-11.5	-11.4
2483.5	Horizontal	55.8	35.2	74.0	54.0	-18.2	-18.8



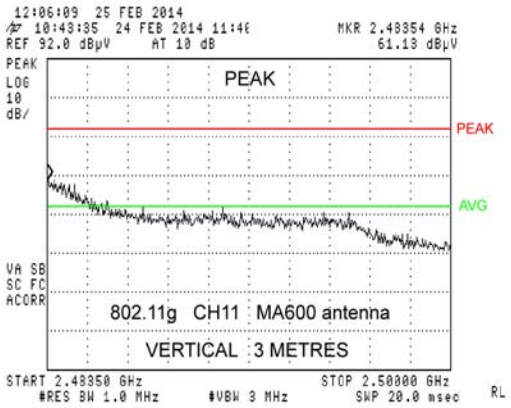


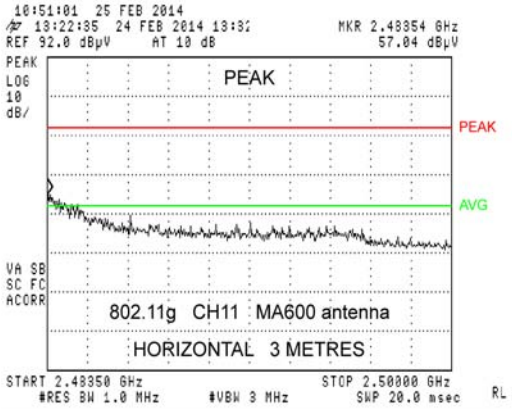


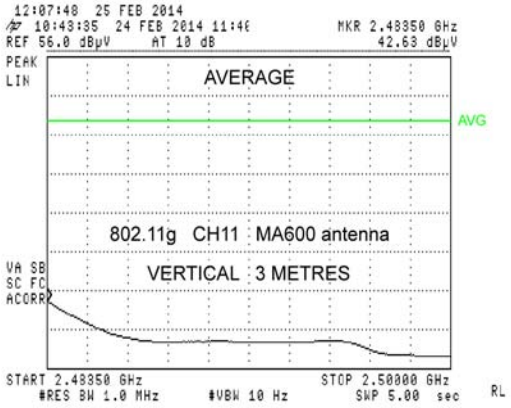


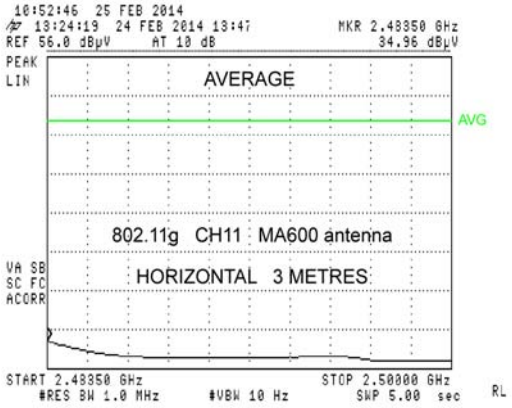
Channel 11, data rate 54mbps, level setting 10.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	61.1	42.6	74.0	54.0	-12.9	-11.4
2483.5	Horizontal	57.0	35.0	74.0	54.0	-17.0	-19.0





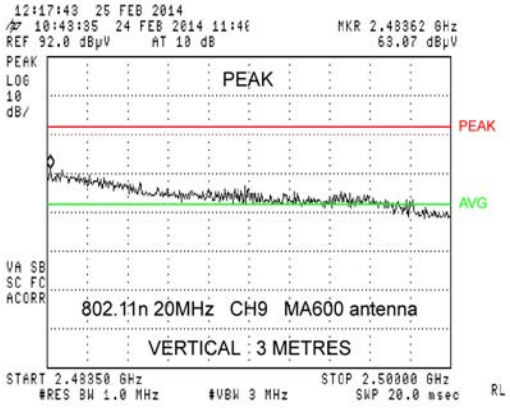


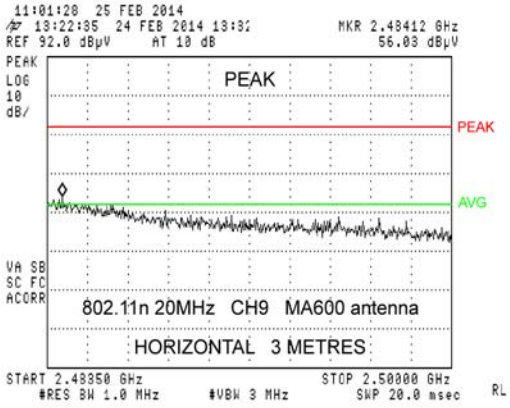


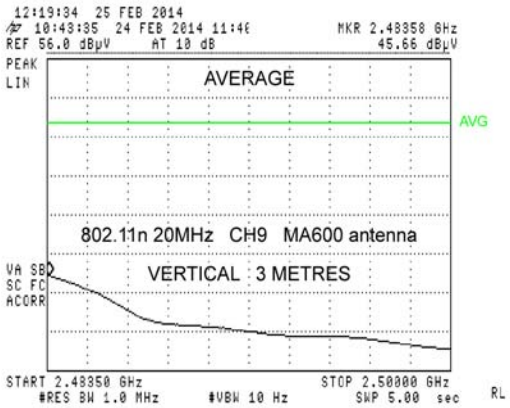
Mode 3 – 802.11n 20MHz operation - Restricted band 2483.5 to 2500MHz

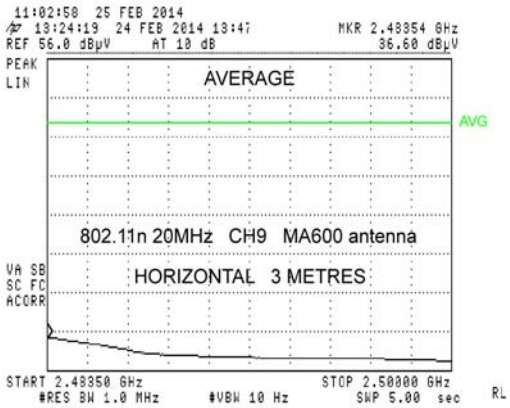
Channel 9, data rate MCS3, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.6	Vertical	63.1	45.7	74.0	54.0	-10.9	-8.3
2483.5	Horizontal	56.0	36.6	74.0	54.0	-18.0	-17.4



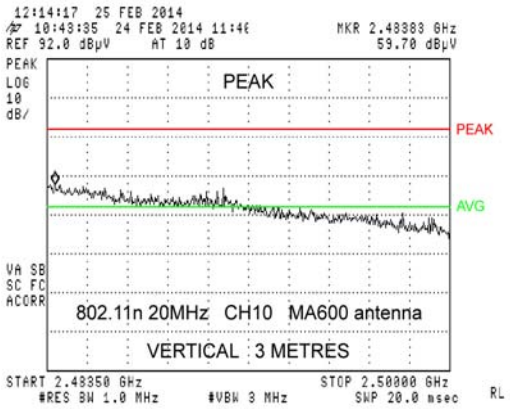


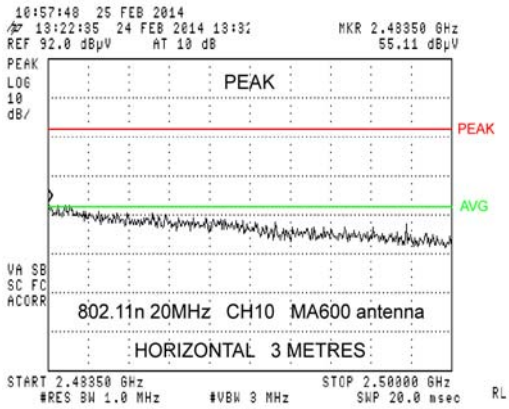


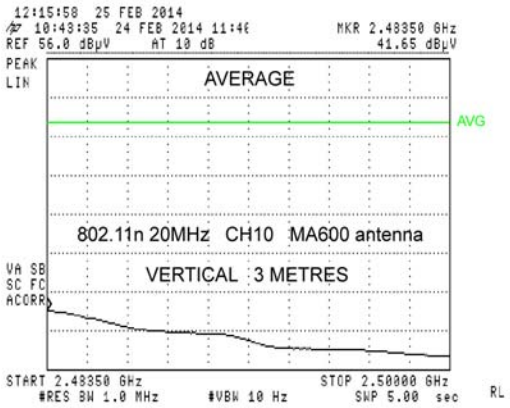


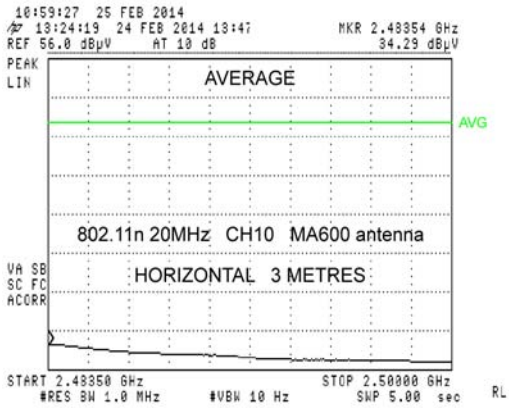
Channel 10, data rate MCS6, level setting 14dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	59.7	41.7	74.0	54.0	-14.3	-12.3
2483.5	Horizontal	55.1	34.3	74.0	54.0	-18.9	-19.7



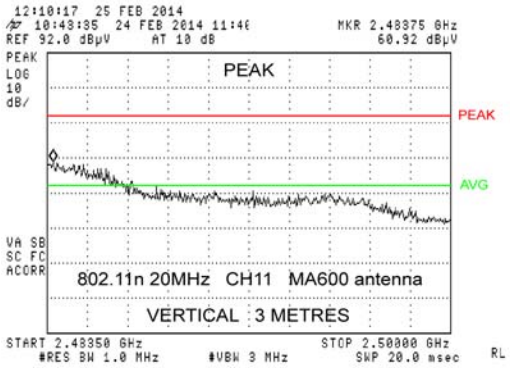


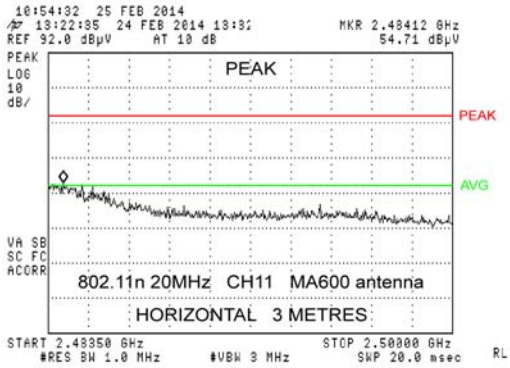


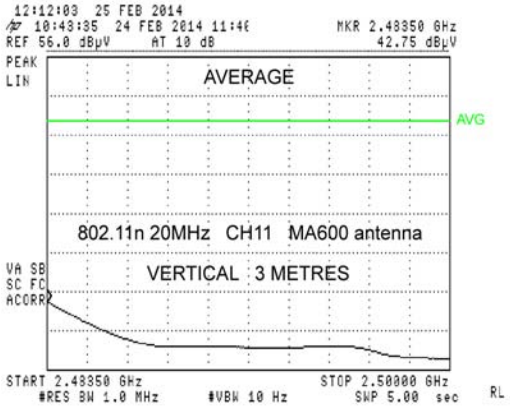


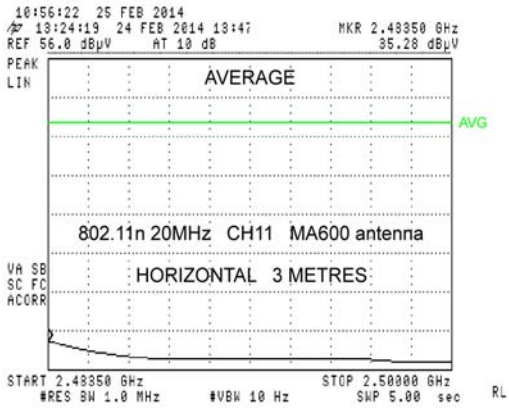
Channel 11, data rate MCS6, level setting 10dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	60.9	42.8	74.0	54.0	-13.1	-11.2
2483.5	Horizontal	54.7	35.3	74.0	54.0	-19.3	-18.7









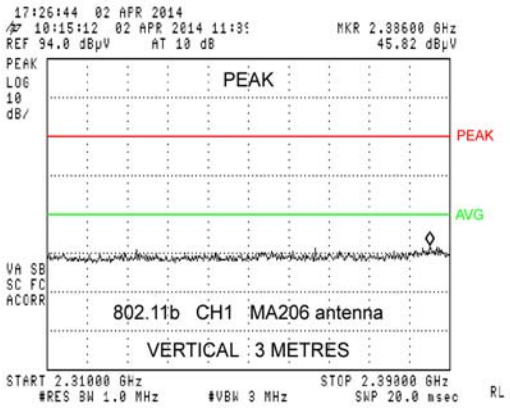
10.4.2 Band edge measurements at 3m distance with MA206 antenna fitted

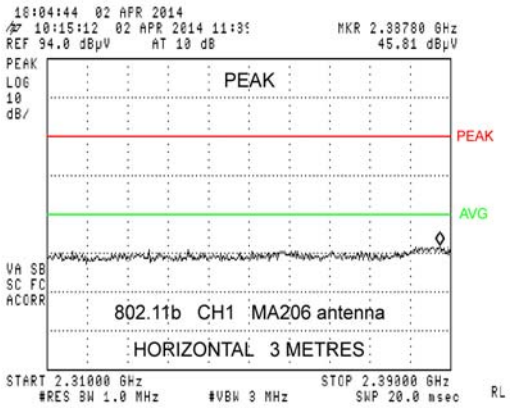
15.209 limit: 500µV/m using average detection. Peak limit set to 20dB above the average limit.
Measurements were performed on the TACHO5A unit only with no GSM antenna connection. The TACHO5C unit uses the same WiFi module, PCB and enclosure.

Mode 1 – 802.11b operation - Restricted band 2310 to 2390MHz

Channel 1, data rate 1mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2386.0	Vertical	45.8	-	74.0	54.0	-28.2	-
2387.8	Horizontal	45.8	-	74.0	54.0	-28.2	-

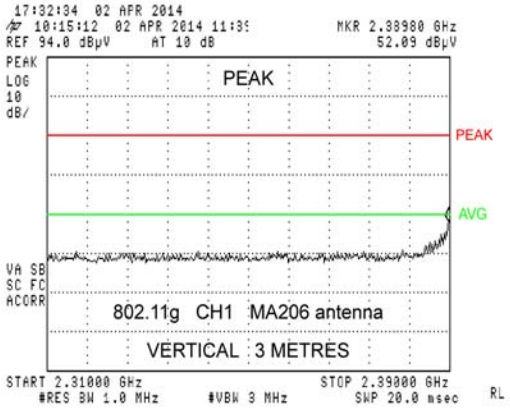


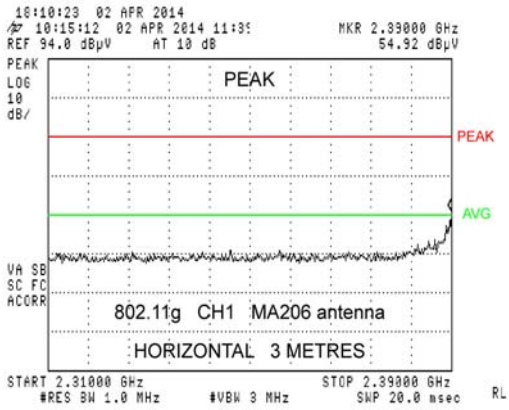


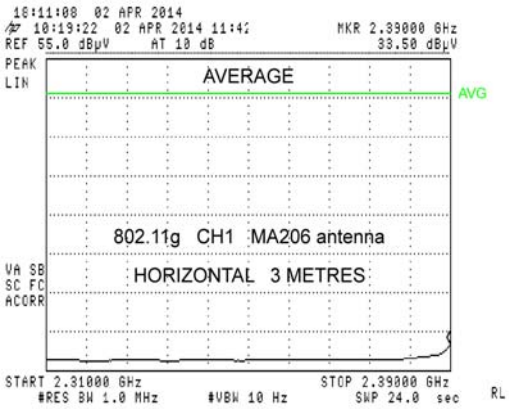
Mode 2 – 802.11g operation - Restricted band 2310 to 2390MHz

Channel 1, data rate 6mbps, level setting 10.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Horizontal	54.9	33.5	74.0	54.0	-19.1	-20.5
2389.8	Vertical	52.1	-	74.0	54.0	-21.9	-

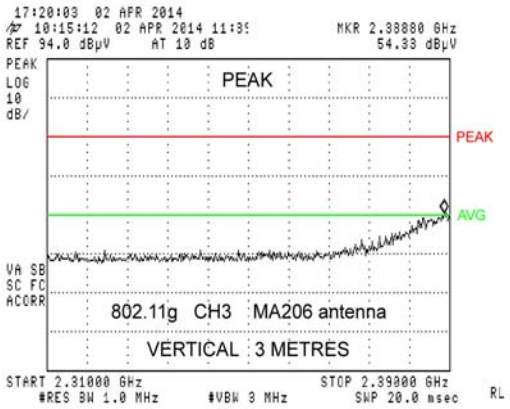


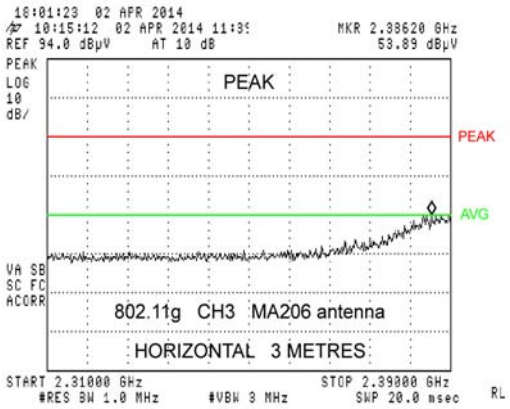


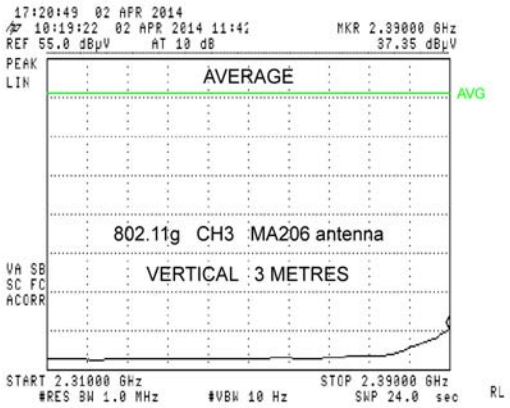


Channel 3, data rate 36mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	54.3	37.4	74.0	54.0	-19.7	-16.6
2386.2	Horizontal	53.9	-	74.0	54.0	-20.1	-



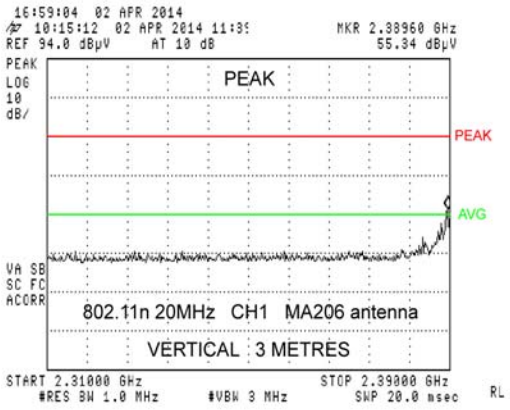


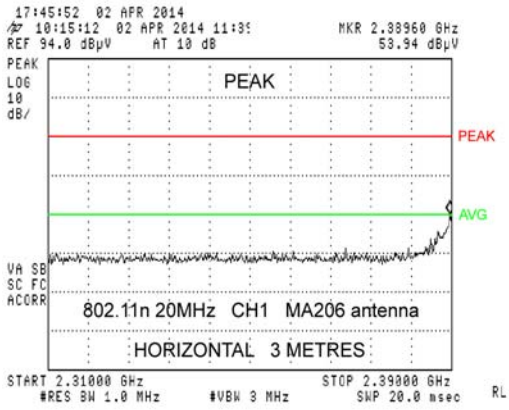


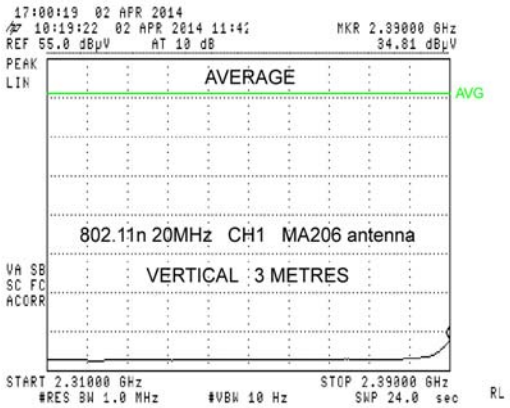
Mode 3 – 802.11n 20MHz operation - Restricted band 2310 to 2390MHz

Channel 1, data rate MCS0, level setting 9.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	55.3	34.8	74.0	54.0	-18.7	-19.2
2389.6	Horizontal	53.9	-	74.0	54.0	-20.1	-

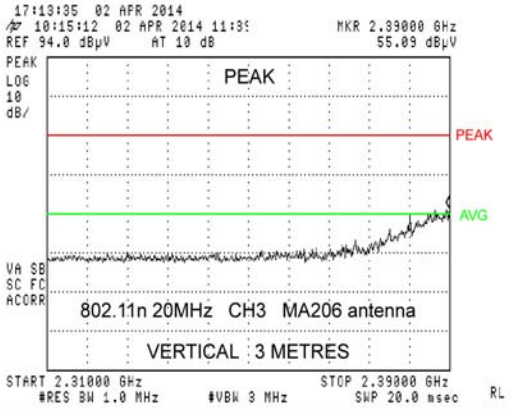


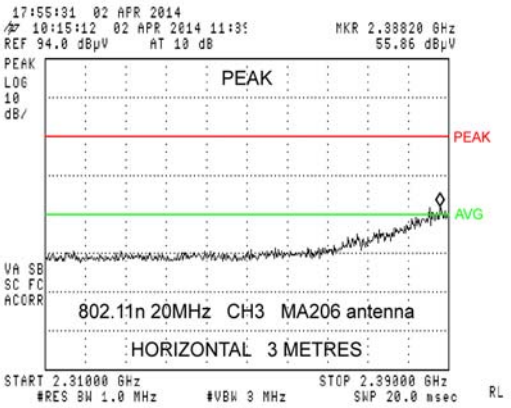


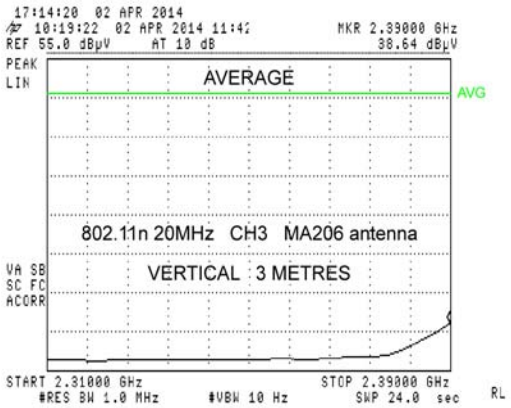


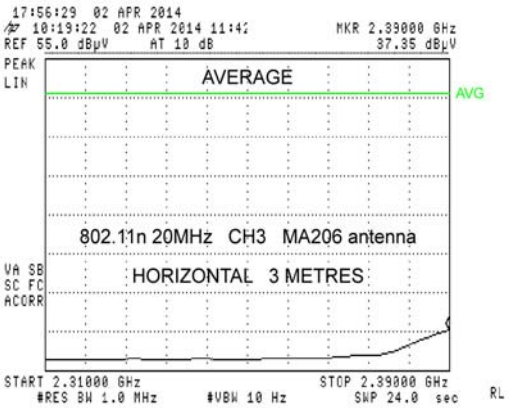
Channel 3, data rate MCS3, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Horizontal	55.9	37.4	74.0	54.0	-18.1	-16.6
2390.0	Vertical	55.1	38.6	74.0	54.0	-18.9	-15.4





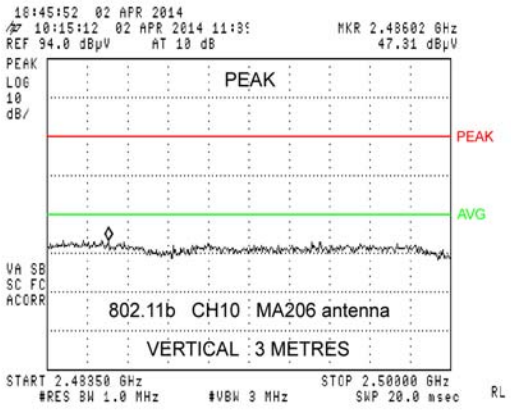


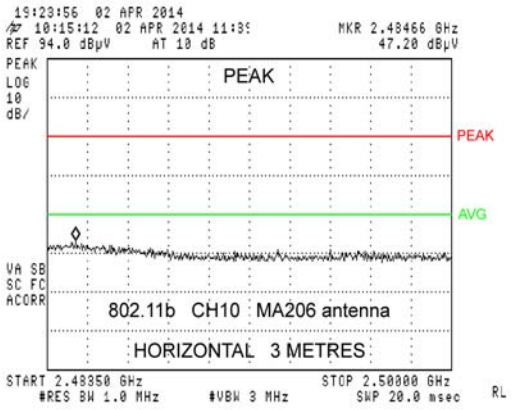


Mode 1 – 802.11b operation - Restricted band 2483.5 to 2500MHz

Channel 10, data rate 1mbps, level setting 17dBm

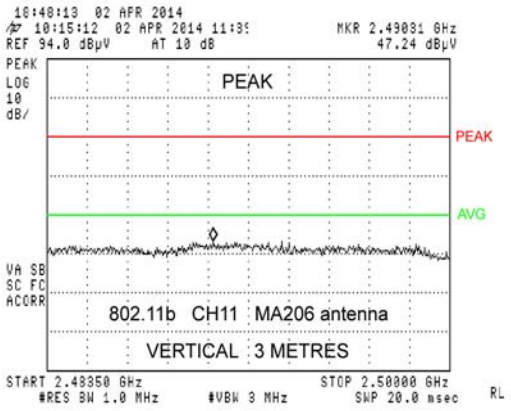
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2486.0	Vertical	47.3	-	74.0	54.0	-26.7	-
2484.7	Horizontal	47.2	-	74.0	54.0	-26.8	-

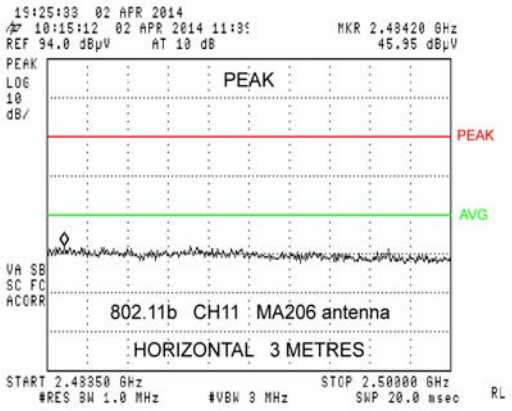




Channel 11, data rate 1mbps, level setting 16.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2490.3	Vertical	47.2	-	74.0	54.0	-26.8	-
2484.2	Horizontal	46.0	-	74.0	54.0	-28.0	-

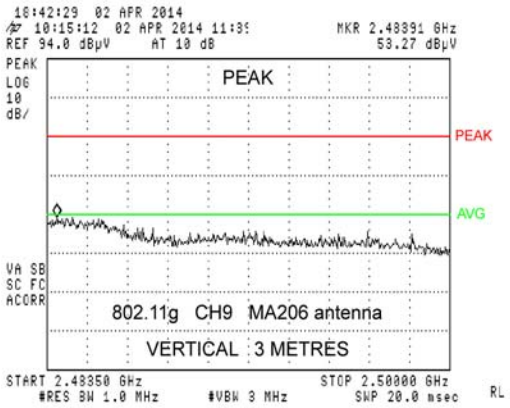


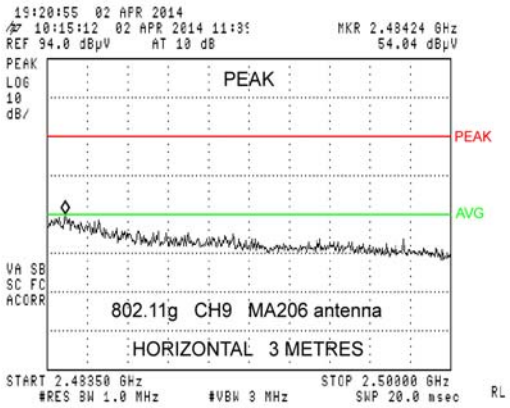


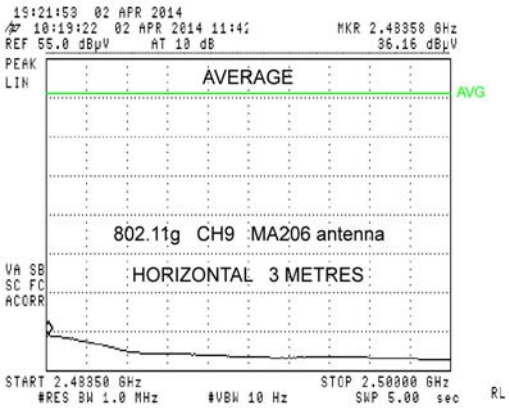
Mode 2 – 802.11g operation - Restricted band 2483.5 to 2500MHz

Channel 9, data rate 36mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.6	Horizontal	54.0	36.2	74.0	54.0	-20.0	-17.8
2483.9	Vertical	53.3	-	74.0	54.0	-20.7	-

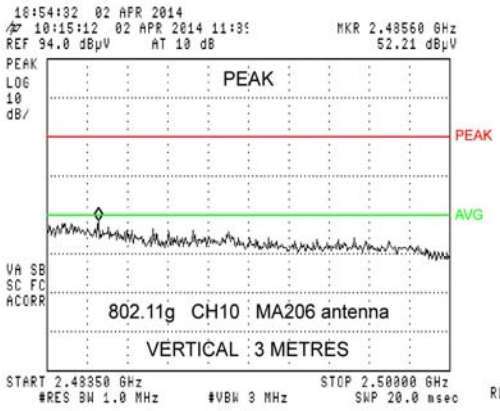


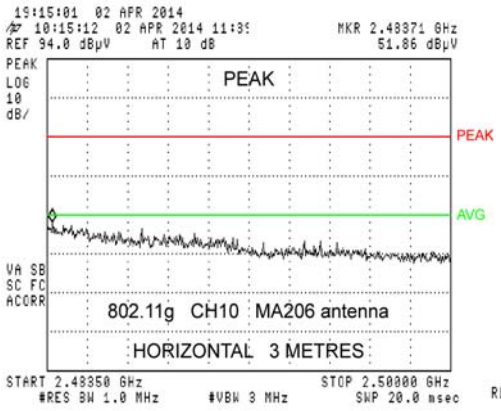




Channel 10, data rate 54mbps, level setting 14.5dBm

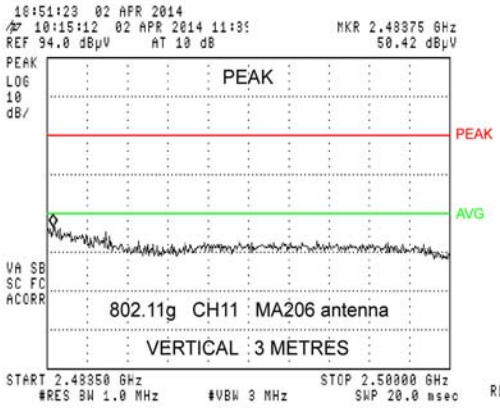
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2485.6	Vertical	52.2	-	74.0	54.0	-21.8	-
2483.7	Horizontal	51.9	-	74.0	54.0	-22.1	-

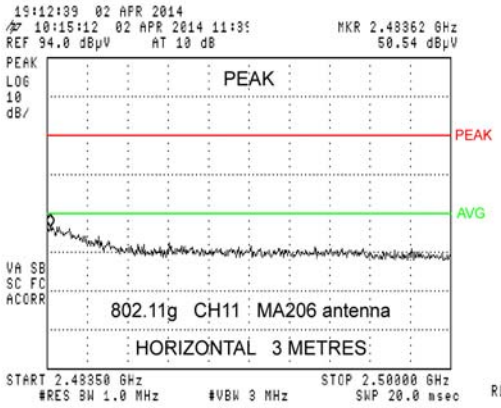




Channel 11, data rate 54mbps, level setting 10.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.6	Horizontal	50.5	-	74.0	54.0	-23.5	-
2483.8	Vertical	50.4	-	74.0	54.0	-23.6	-

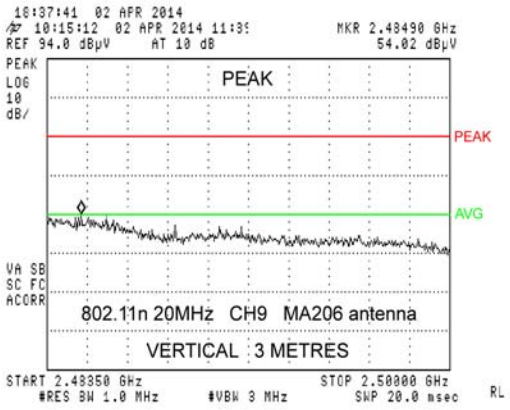


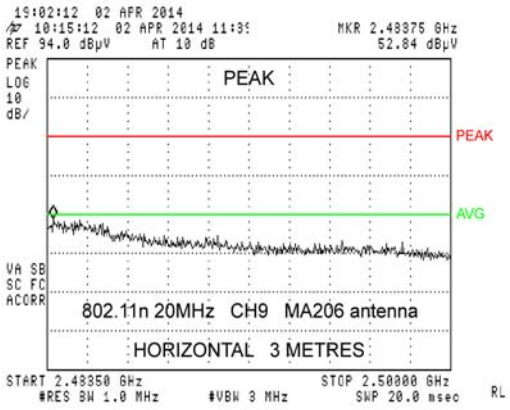


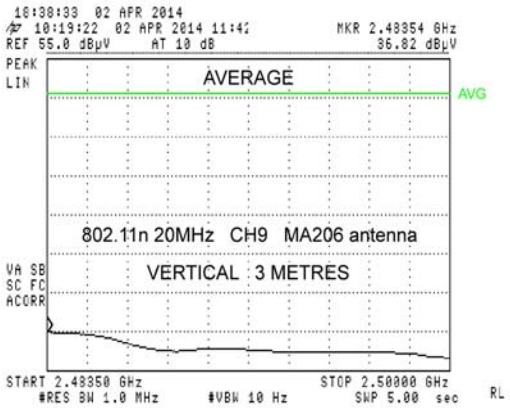
Mode 3 – 802.11n 20MHz operation - Restricted band 2483.5 to 2500MHz

Channel 9, data rate MCS3, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	54.0	36.8	74.0	54.0	-20.0	-17.2
2483.8	Horizontal	52.8	-	74.0	54.0	-21.2	-17.4

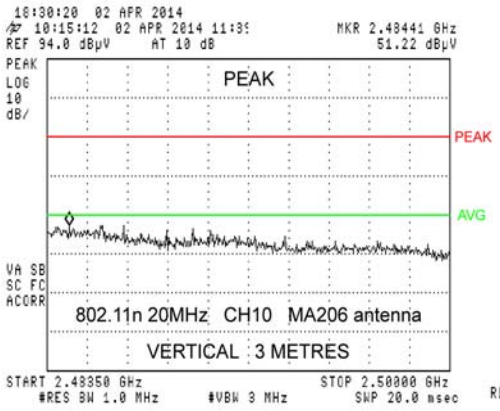


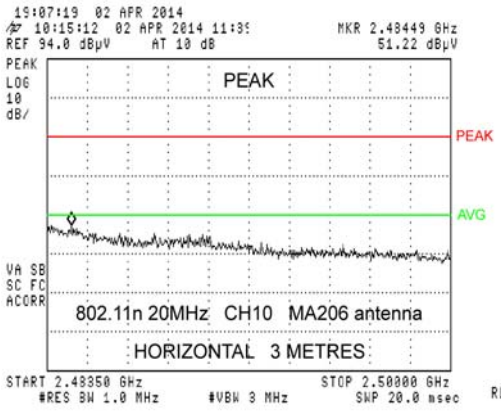




Channel 10, data rate MCS6, level setting 14dBm

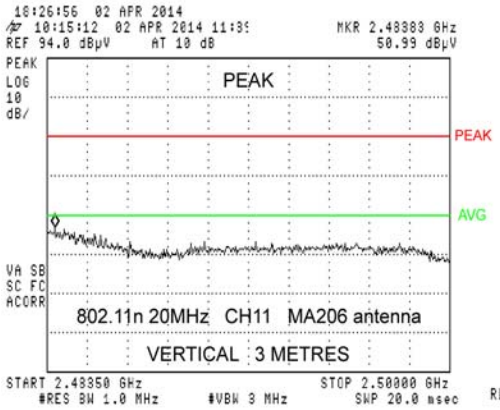
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2484.4	Vertical	51.2	-	74.0	54.0	-22.8	-
2484.5	Horizontal	51.2	-	74.0	54.0	-22.8	-

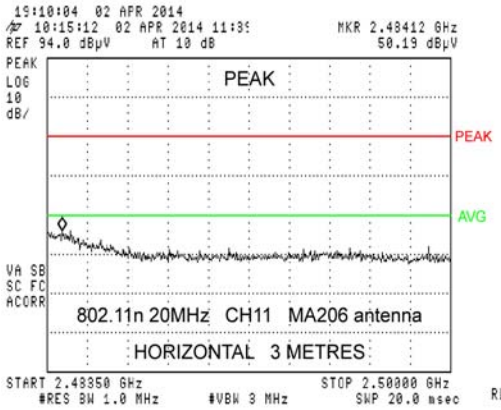




Channel 11, data rate MCS6, level setting 10dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.8	Vertical	51.0	-	74.0	54.0	-23.0	-
2484.1	Horizontal	50.2	-	74.0	54.0	-23.8	-





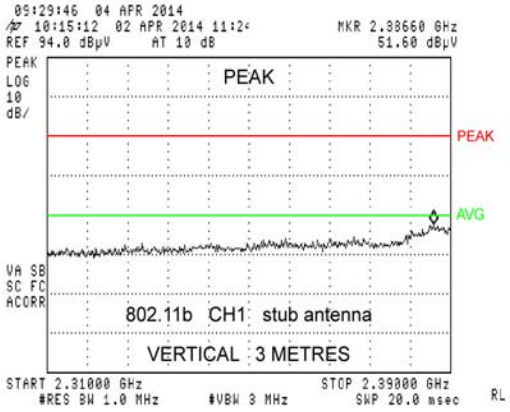
10.4.3 Band edge measurements at 3m distance with WiFi stub antenna fitted

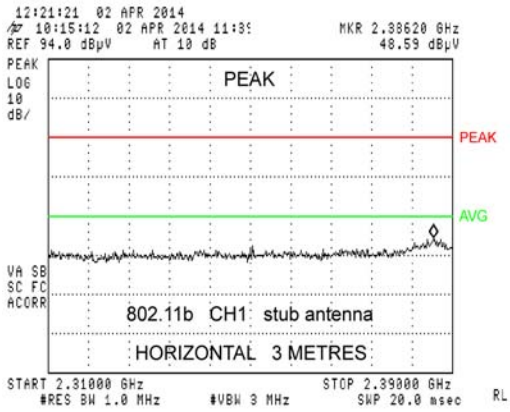
15.209 limit: 500µV/m using average detection. Peak limit set to 20dB above the average limit.
Measurements were performed on the TACHO5A unit only with no GSM and GPS antenna connection.

Mode 1 – 802.11b operation - Restricted band 2310 to 2390MHz

Channel 1, data rate 1mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2386.6	Vertical	51.6	-	74.0	54.0	-22.4	-
2386.2	Horizontal	48.6	-	74.0	54.0	-25.4	-

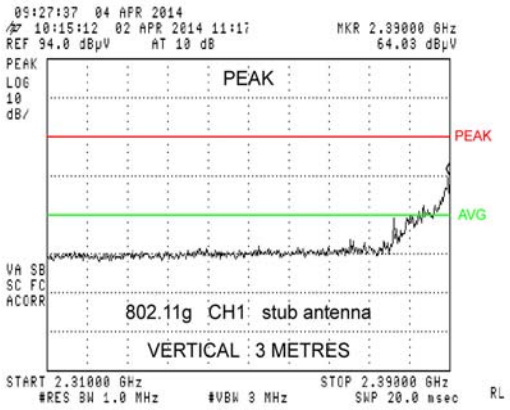


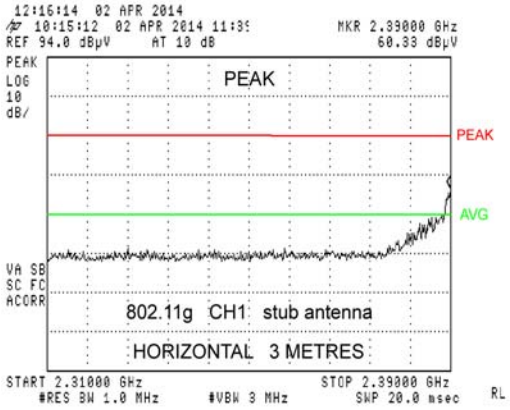


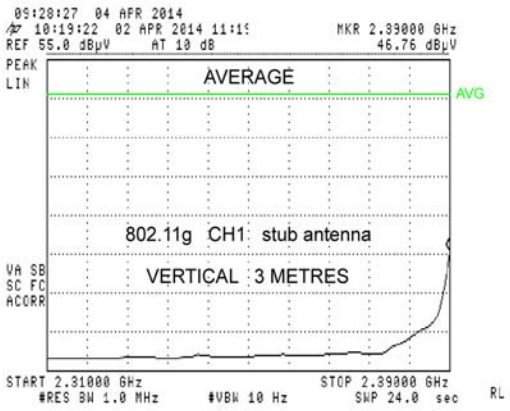
Mode 2 – 802.11g operation - Restricted band 2310 to 2390MHz

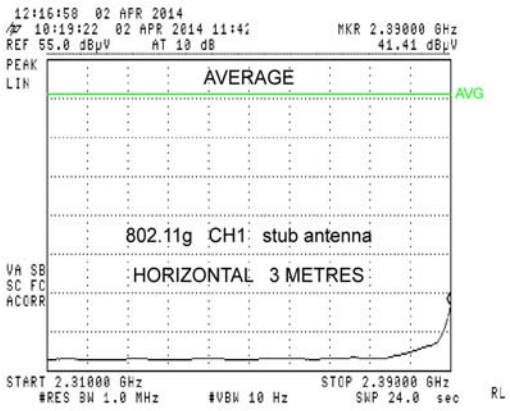
Channel 1, data rate 6mbps, level setting 10.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	64.0	46.8	74.0	54.0	-10.0	-7.2
2390.0	Horizontal	60.3	41.4	74.0	54.0	-13.7	-12.6





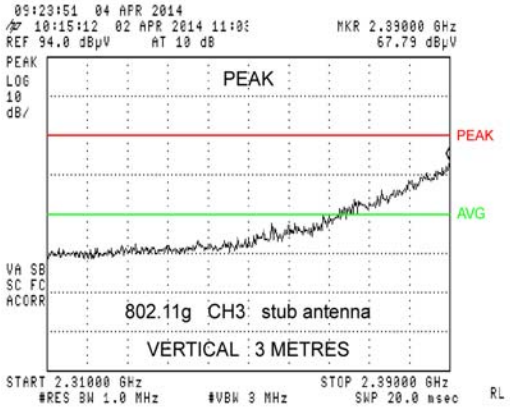


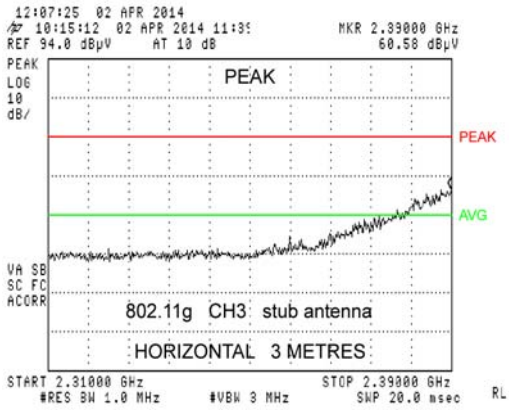


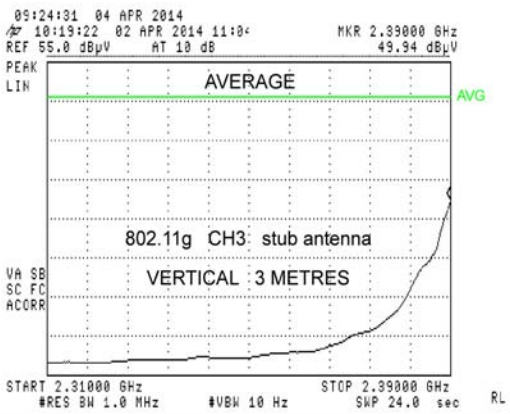
Channel 3, data rate 36mbps, level setting 17dBm

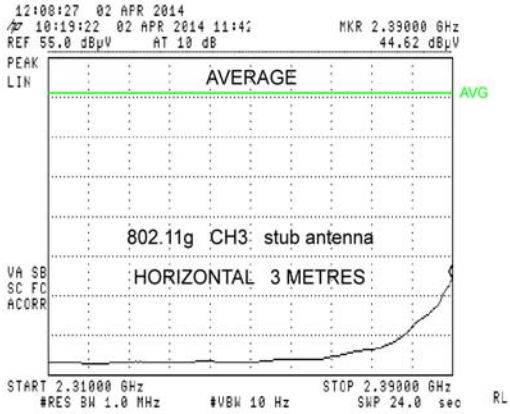
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	67.8	49.9	74.0	54.0	-6.2	-4.1*
2390.0	Horizontal	60.6	44.6	74.0	54.0	-13.4	-9.4

*Result was within the laboratory's measurement uncertainty.







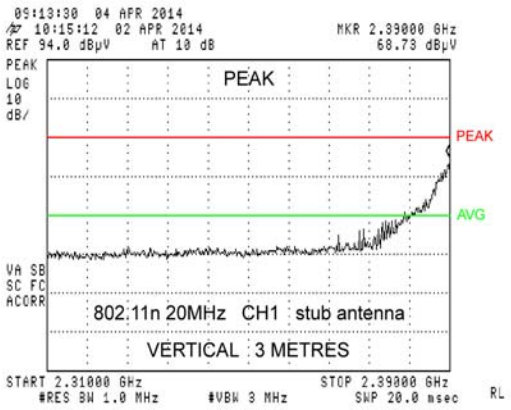


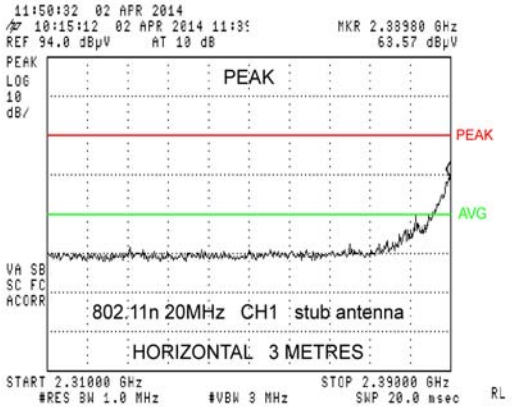
Mode 3 – 802.11n 20MHz operation - Restricted band 2310 to 2390MHz

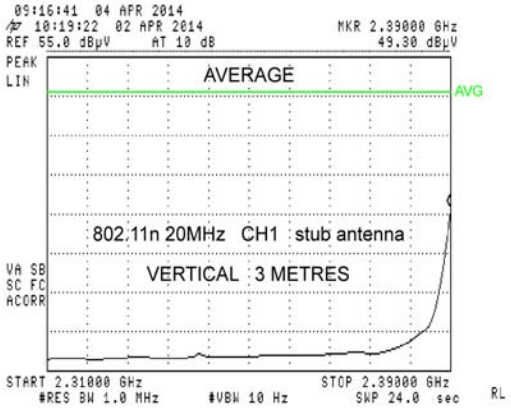
Channel 1, data rate MCS0, level setting 9.5dBm

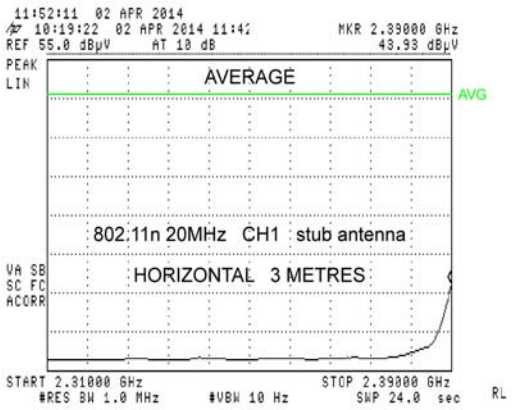
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	68.7	49.3	74.0	54.0	-5.3	-4.7*
2390.0	Horizontal	63.6	43.9	74.0	54.0	-10.4	-10.1

*Results were within the laboratory's measurement uncertainty.





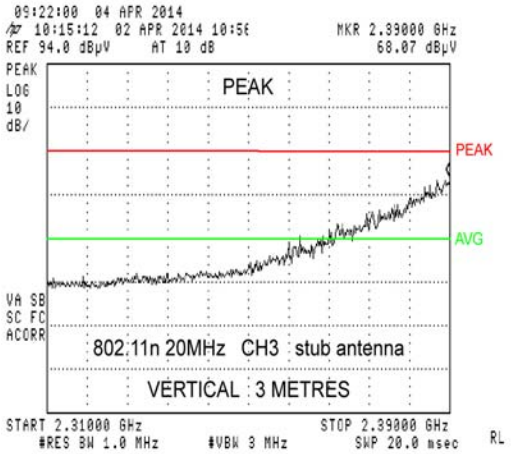


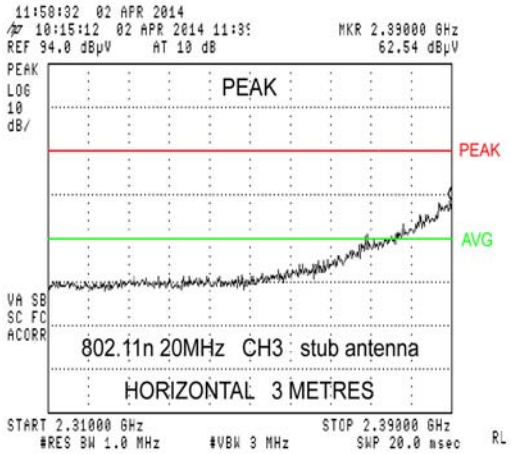


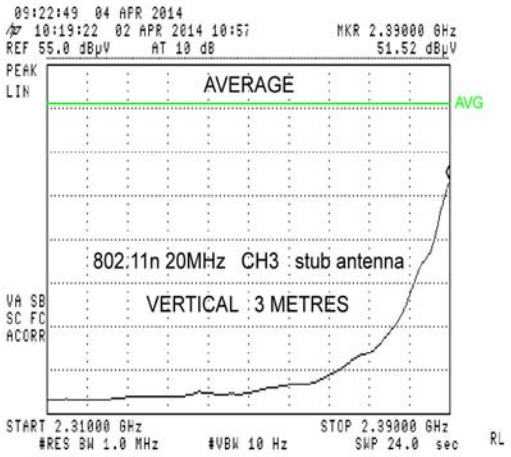
Channel 3, data rate MCS3, level setting 17dBm

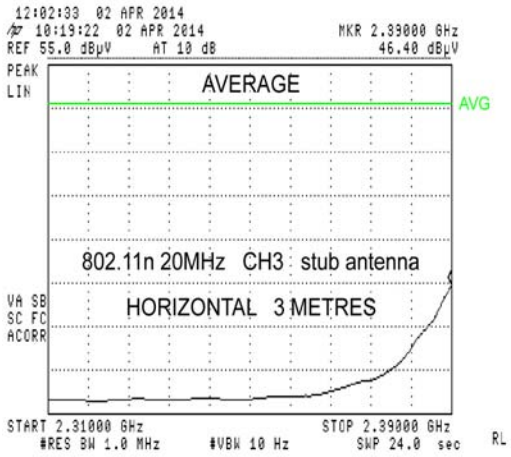
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2390.0	Vertical	68.1	51.5	74.0	54.0	-5.9	-2.5*
2390.0	Horizontal	62.5	46.4	74.0	54.0	-11.5	-7.6

*Results were within the laboratory's measurement uncertainty.





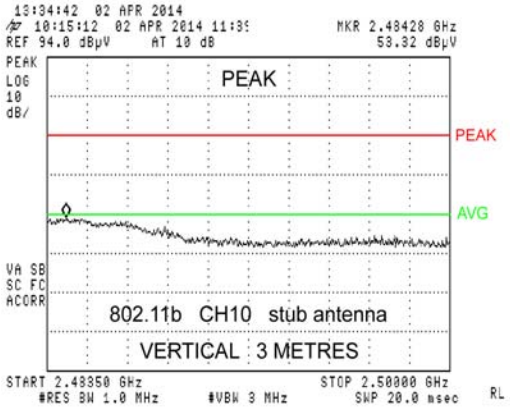


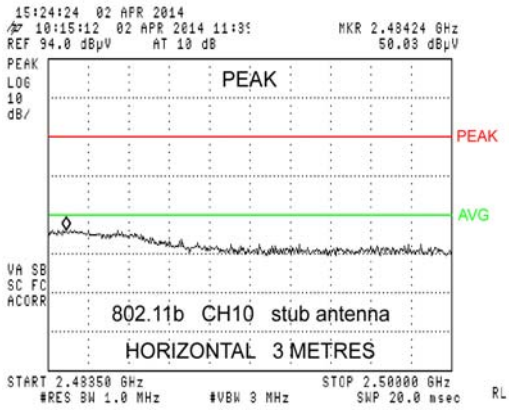


Mode 1 – 802.11b operation - Restricted band 2483.5 to 2500MHz

Channel 10, data rate 1mbps, level setting 17dBm

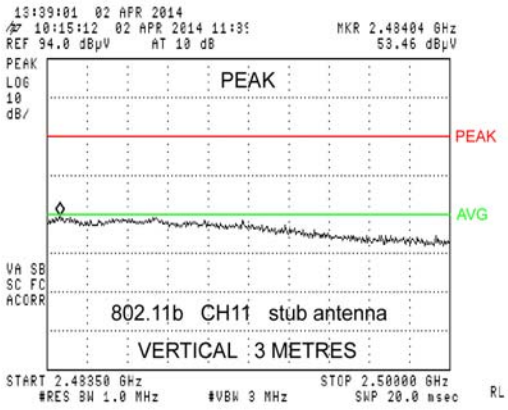
Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2484.3	Vertical	53.3	-	74.0	54.0	-20.7	-
2484.2	Horizontal	50.0	-	74.0	54.0	-24.0	-

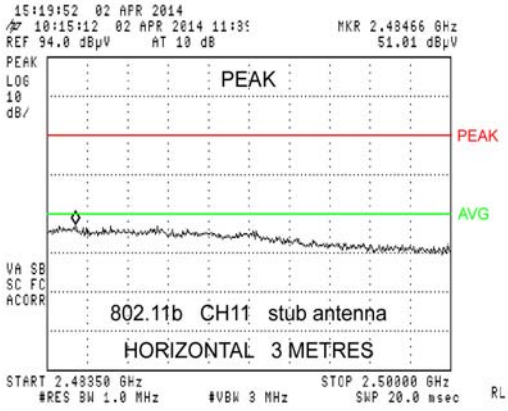




Channel 11, data rate 1mbps, level setting 16.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2484.0	Vertical	53.5	-	74.0	54.0	-20.5	-
2484.7	Horizontal	51.0	-	74.0	54.0	-23.0	-

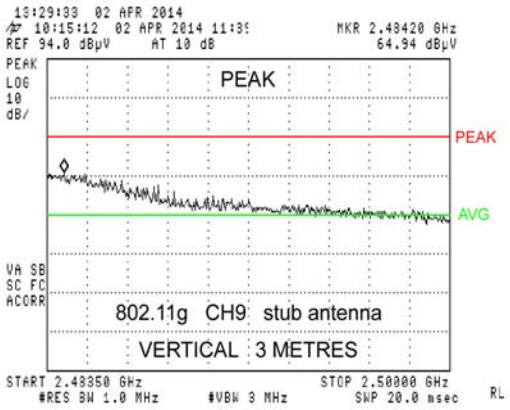


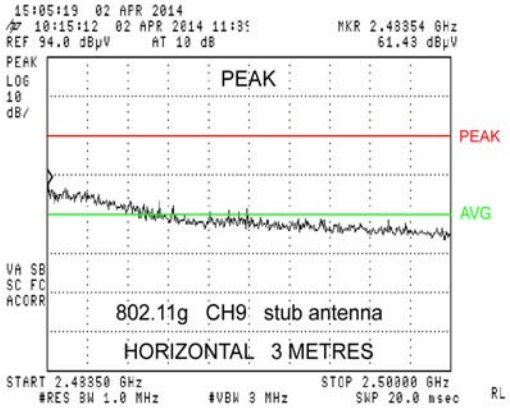


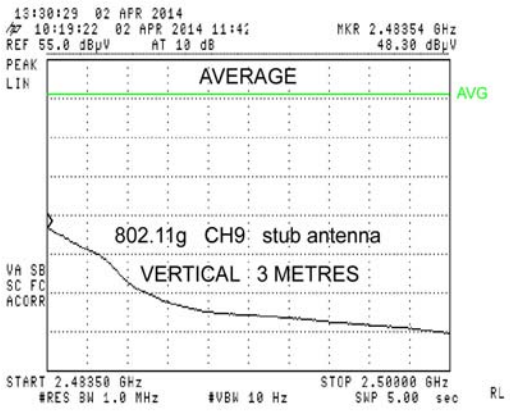
Mode 2 – 802.11g operation - Restricted band 2483.5 to 2500MHz

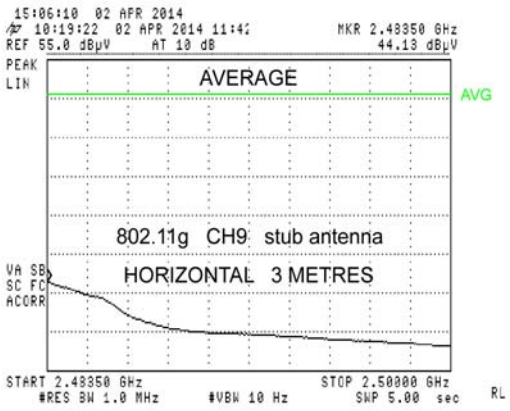
Channel 9, data rate 36mbps, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	64.9	48.3	74.0	54.0	-9.1	-5.7
2483.5	Horizontal	61.4	44.1	74.0	54.0	-12.6	-9.9



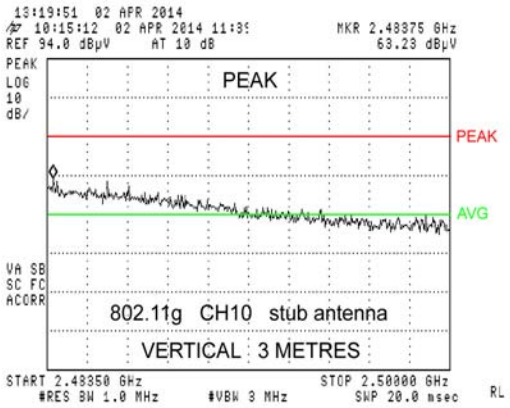


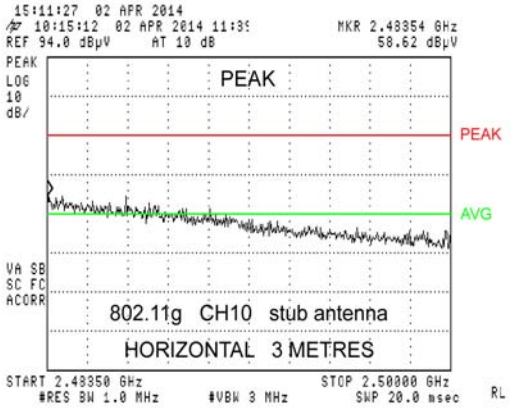


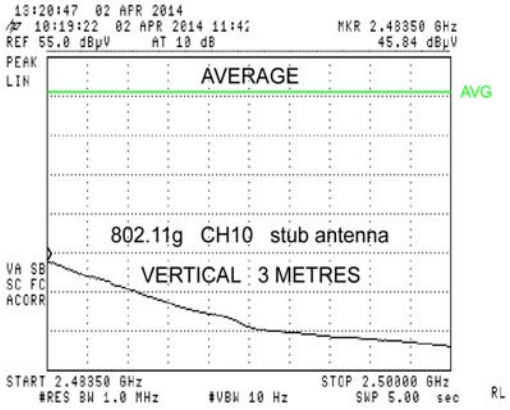


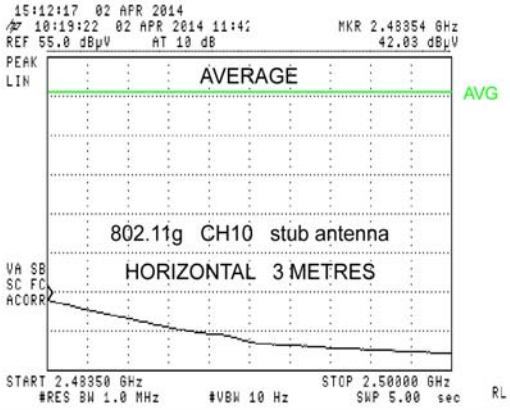
Channel 10, data rate 54mbps, level setting 14.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	63.2	45.8	74.0	54.0	-10.8	-8.2
2483.5	Horizontal	58.6	42.0	74.0	54.0	-15.4	-12.0



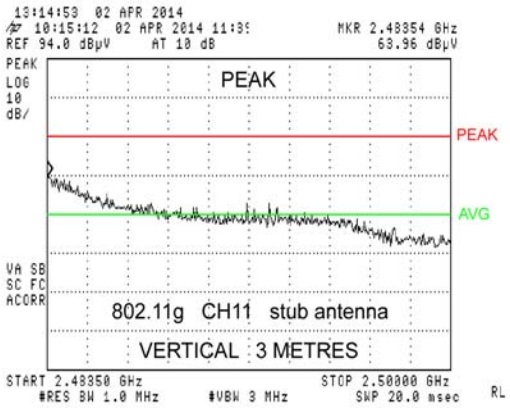


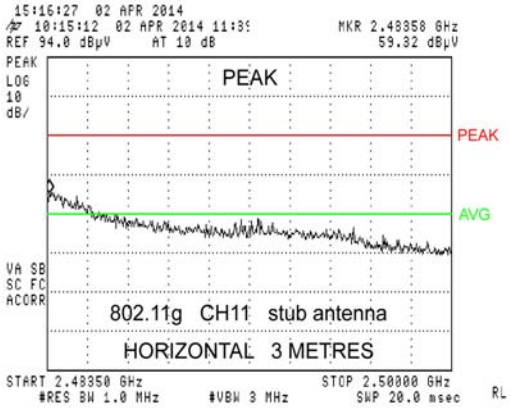


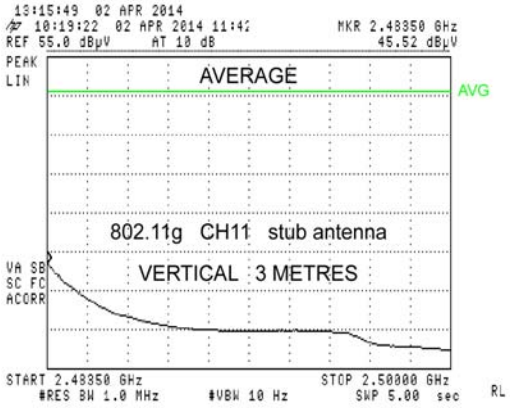


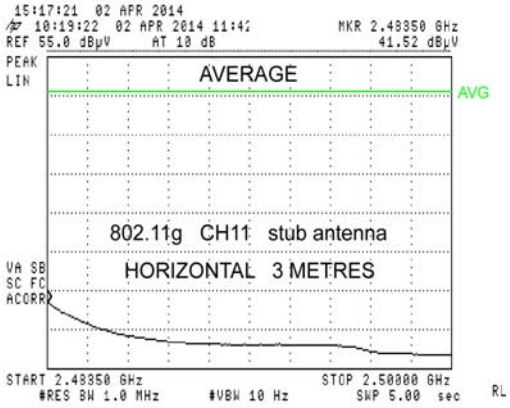
Channel 11, data rate 54mbps, level setting 10.5dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	64.0	45.5	74.0	54.0	-10.0	-8.5
2483.5	Horizontal	59.3	41.5	74.0	54.0	-14.7	-12.5





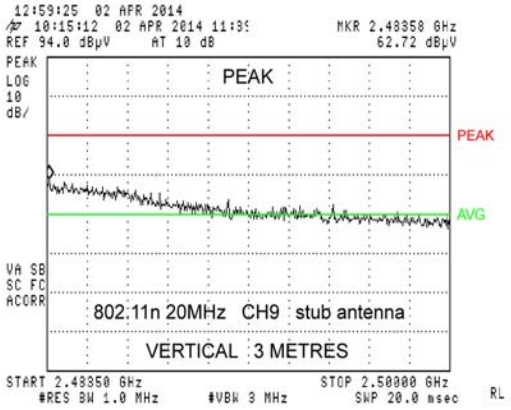


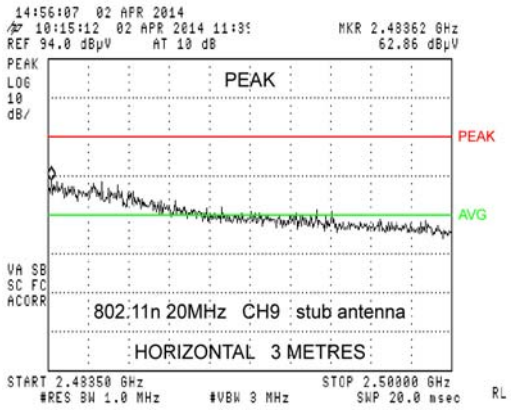


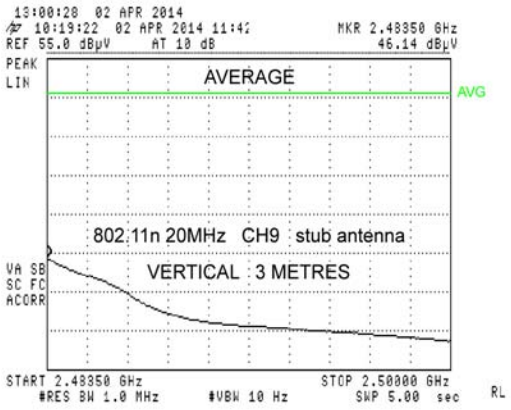
Mode 3 – 802.11n 20MHz operation - Restricted band 2483.5 to 2500MHz

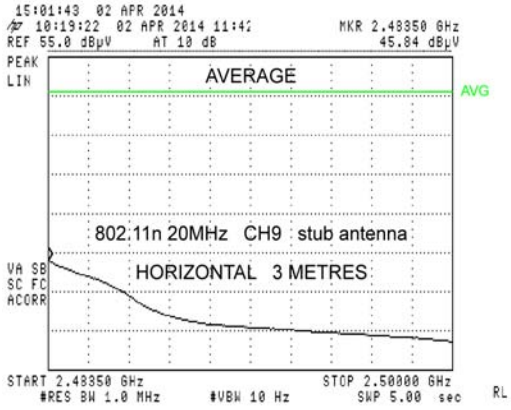
Channel 9, data rate MCS3, level setting 17dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	62.7	46.1	74.0	54.0	-10.3	-7.9
2483.5	Horizontal	62.9		74.0	54.0	-11.1	-8.2



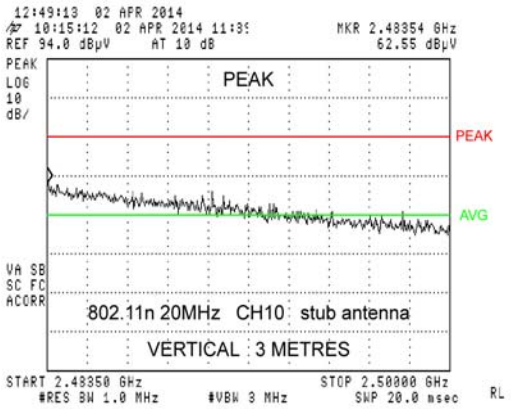


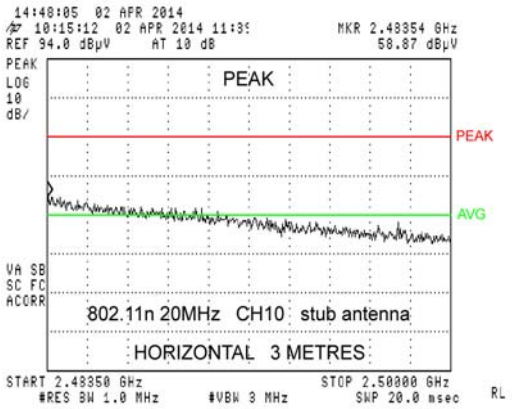


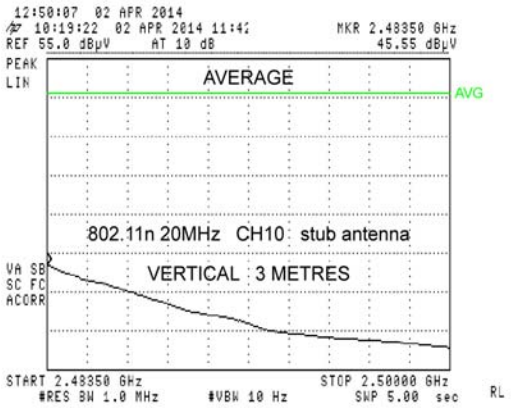


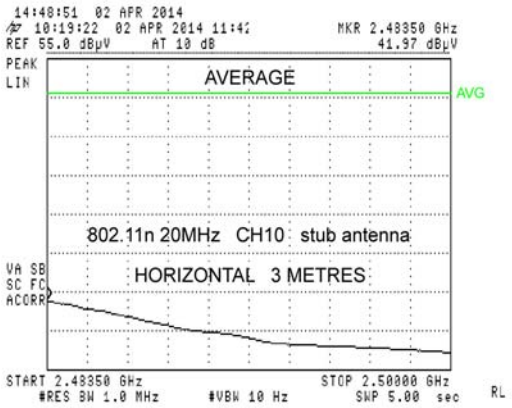
Channel 10, data rate MCS6, level setting 14dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	62.6	45.6	74.0	54.0	-11.4	-8.4
2483.5	Horizontal	58.9	42.0	74.0	54.0	-15.1	-12.0



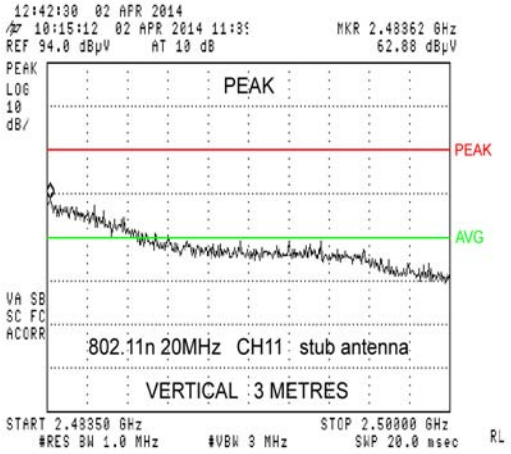


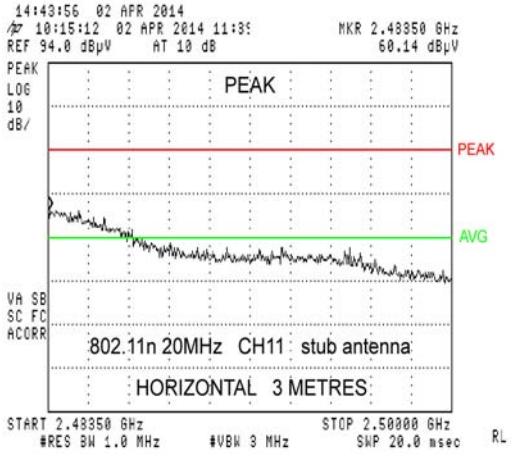


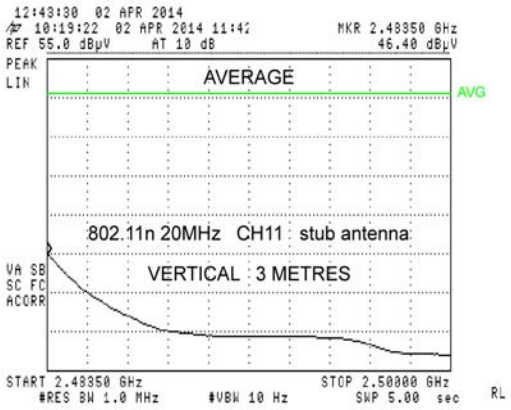


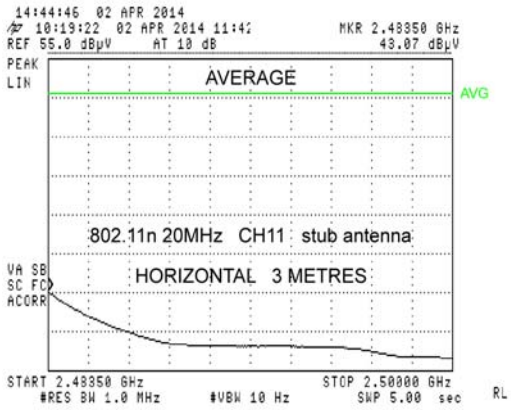
Channel 11, data rate MCS6, level setting 10dBm

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
2483.5	Vertical	62.9	46.4	74.0	54.0	-11.1	-7.6
2483.5	Horizontal	60.1	43.1	74.0	54.0	-13.9	-10.9





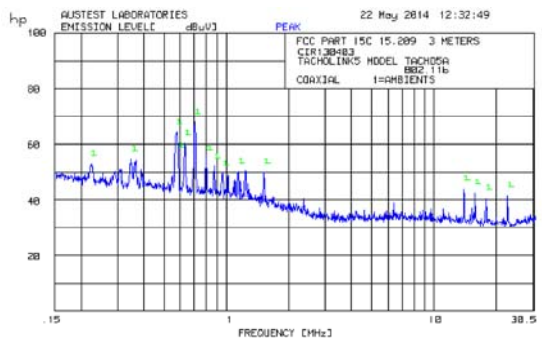


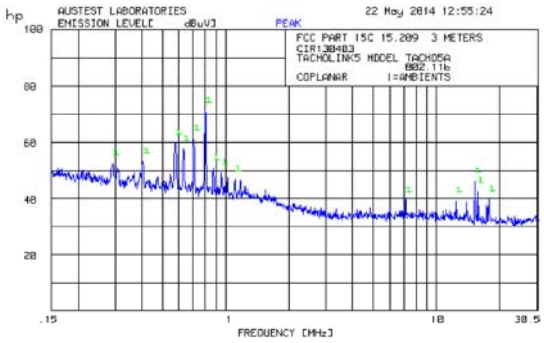


10.4.4 Radiated Disturbances: 150kHz to 30MHz at 3m distance

No significant difference in emission levels were noted between the TACHO5A, TACHO5B and TACHO5C models. Emission levels were not affected by the type of antenna used. Final measurements were made on the TACHO5A unit with MA600 combination antenna fitted.

All intentional radiation was greater than 20dB below the limits specified in section 15.209. Measurement made across all transmitter modes, in accordance with the supplied channel plan. Final measurement was made with the EUT operating in 802.11b mode, channel 6, data rate 1mbps, level setting 17dBm.





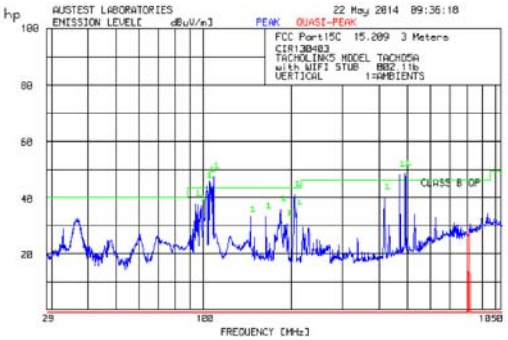
10.4.5 Radiated Disturbances: 30MHz to 1000MHz at 3m distance

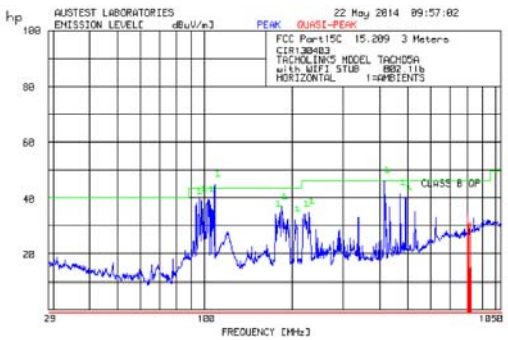
No significant difference in emission levels were noted between the TACHO5A, TACHO5B and TACHO5C models. No significant intentional radiation levels were detected with use of the MA600 and MA206 combination antennas. Radiation levels were detected when the WiFi stub antenna was used.

Therefore final measurement was made on the TACHO5A model with WiFi stub antenna fitted. Low, middle and high channels were assessed using the supplied channel plan.

Mode 1 – 802.11b operation
The highest measured quasi-peak level was 12.0dB below the 15.209 limit at 803.0MHz, when using channel 1.

Frequency MHz	Polarisation	Quasi-Peak		Limit		Below Limit dB
		µV/m	dBµV/m	µV/m	dBµV/m	
803.0 (Ch1)	Horizontal	50	34.0	200	46.0	12.0
819.9 (Ch11)	Horizontal	35	31.0	200	46.0	15.0
810.2 (Ch6)	Horizontal	34	30.7	200	46.0	15.3
803.2 (Ch1)	Vertical	26	28.3	200	46.0	17.7
811.7 (Ch6)	Vertical	23	27.1	200	46.0	18.9

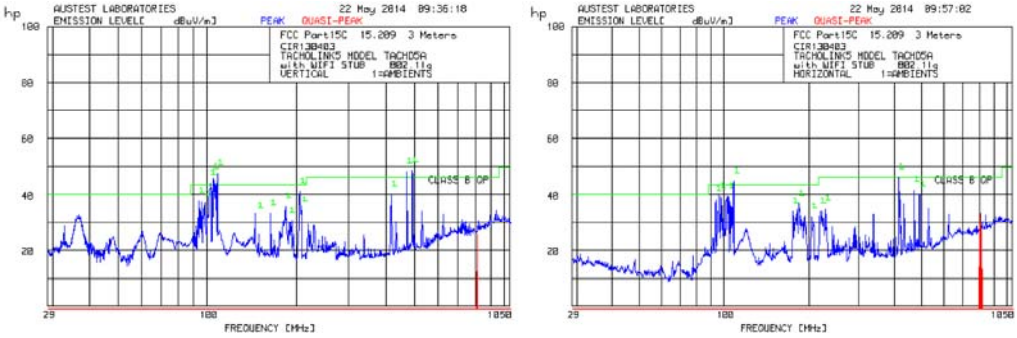




Mode 2 – 802.11g operation

The highest measured quasi-peak level was 12.7dB below the 15.209 limit at 807.0MHz, when using channel 6.

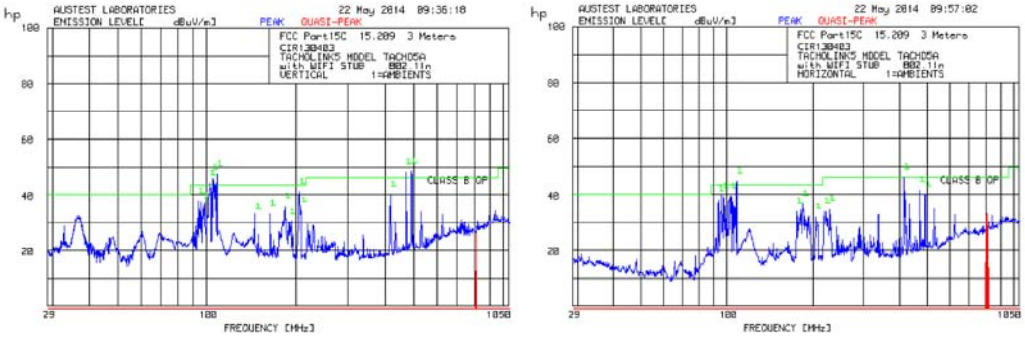
Frequency MHz	Polarisation	Quasi-Peak		Limit		Below Limit dB
		µV/m	dBµV/m	µV/m	dBµV/m	
807.0 (Ch6)	Horizontal	46	33.3	200	46.0	12.7
801.6 (Ch1)	Horizontal	30	29.4	200	46.0	16.6
816.0 (Ch11)	Horizontal	24	27.7	200	46.0	18.3



Mode 3 – 802.11n 20MHz operation

The highest measured quasi-peak level was 12.6dB below the 15.209 limit at 807.9MHz, when using channel 6.

Frequency MHz	Polarisation	Quasi-Peak		Limit		Below Limit dB
		µV/m	dBµV/m	µV/m	dBµV/m	
807.9 (Ch6)	Horizontal	47	33.4	200	46.0	12.6
801.5 (Ch1)	Horizontal	43	32.7	200	46.0	13.3
816.3 (Ch11)	Horizontal	28	28.8	200	46.0	17.2
811.4 (Ch6)	Vertical	21	26.5	200	46.0	19.5



10.4.6 Radiated Disturbances: 1000MHz to 18000MHz at 3m distance

15.209 limit: 500µV/m using average detection. Peak limit set to 20dB above the average limit.

Measurements were performed on the TACHO5A unit only. The TACHO5B and TACHO5C units use the same WiFi module, PCB and enclosure.

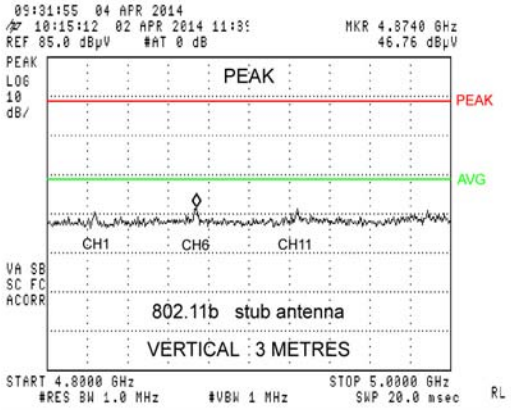
No significant intentional radiation levels were detected with use of the MA600 and MA206 combination antennas. Radiation levels were detected when the WiFi stub antenna was used.

Therefore final measurement was made on the TACHO5A model with WiFi stub antenna fitted. Low, middle and high channels were assessed using the supplied channel plan.

Mode 1 – 802.11b operation
Highest measured intentional radiation as follows:

Frequency MHz	Polarisation	Level dBµV/m		Limit dBµV/m		ΔPk Limit dB	Δ Avg Limit dB
		Peak	Average	Peak	Average		
4874.0 (Ch6)	Vertical	47.1	-	74.0	54.0	-26.9	-
4823.7 (Ch1)	Vertical	46.5	-	74.0	54.0	-27.5	-
4924.0 (Ch11)	Vertical	45.4	-	74.0	54.0	-28.6	

No significant radiation found in horizontal polarisation.



Mode 2 – 802.11g operation
No significant emission levels observed.
All intentional radiation was greater than 20dB below the limits specified in section 15.209.

Mode 3 – 802.11n 20MHz operation
No significant emission levels observed.
All intentional radiation was greater than 20dB below the limits specified in section 15.209.

10.4.7 Radiated Disturbances: 18000MHz to 25000MHz

Preliminary measurements indicated no significant radiation between 18000MHz and 25000MHz. All models assessed with all antennas.

11 FCC Part 15C, Section 15.247 – OPERATION WITHIN THE BANDS 902-928MHz, 2400-2483.5MHz, AND 5725-5850MHz

11.1 6dB Bandwidth - Section 15.247(a)(2)

Test Date:	23 May 2014	Temperature:	26°C
Test Officer:	Richard Turner	Humidity:	67%
Test Location:	Austest Laboratories (NSW)		

11.1.1 EUT Operating Mode

a. Measurements were made on the TACHO5A model.
b. DC supply voltage – 13.8VDC.
c. Mode 1 – 802.11b operation.
d. Mode 2 - 802.11g operation.
e. Mode 3 – 802.11n 20MHz operation.
f. Channels, data rate and level settings adjusted in accordance with the supplied channel plan.

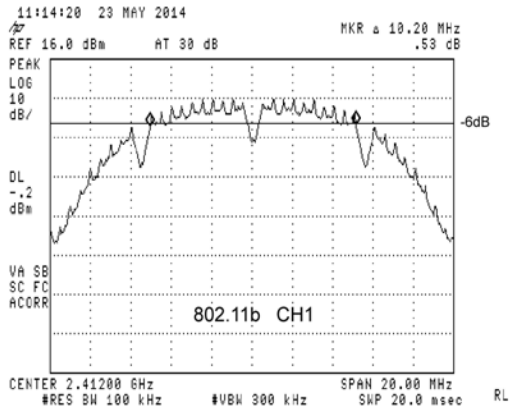
11.1.2 Test Method

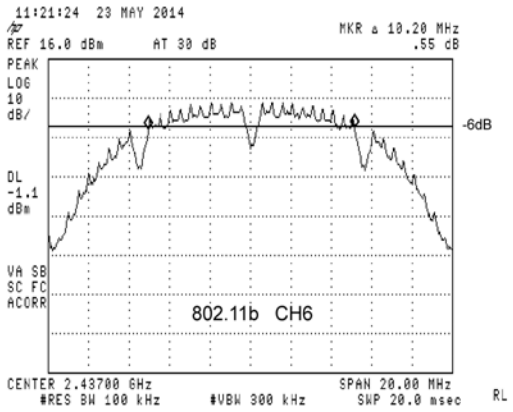
a. Measurements are performed in accordance with ANSI C63.10-2009 and KDB 558074 D01 DTS Meas Guidance v03r02section 8.1.
b. Connect the EUT antenna port directly to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
c. Set the spectrum analyser RBW to 100kHz RBW, and the VBW to 300kHz.
d. Mark the peak frequency level and note the -6dB (lower and upper) frequencies.
e. Repeat the above for the low, middle and high channels across all transmit modes.

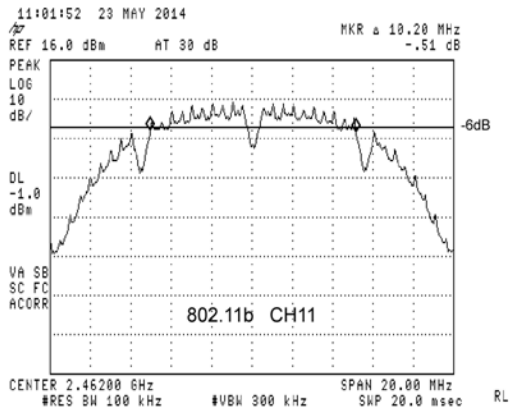
11.1.3 Test Results

Mode 1 – 802.11b operation

Channel	6dB Bandwidth (MHz)	6dB BW Limit (kHz)	Result
CH1	10.20	>500	COMPLIES
CH6	10.20	>500	COMPLIES
CH11	10.20	>500	COMPLIES

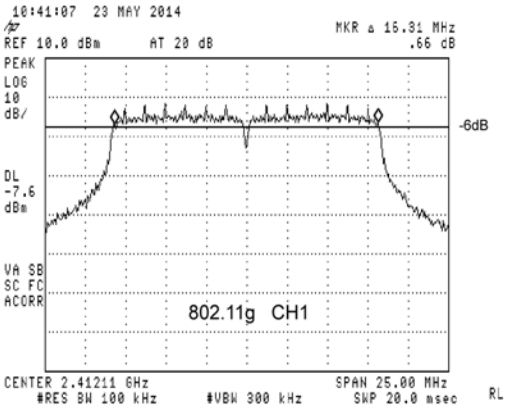


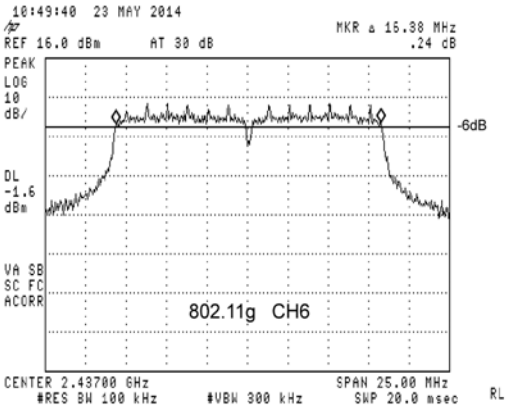


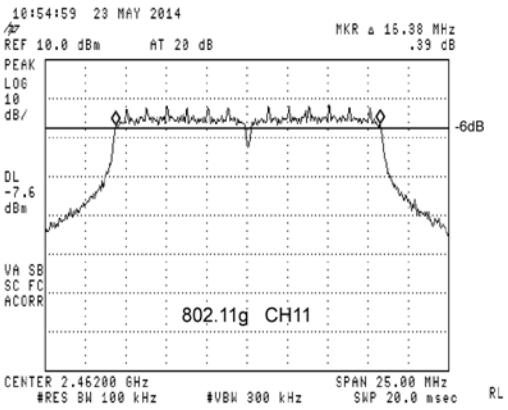


Mode 2 – 802.11g operation

Channel	6dB Bandwidth (MHz)	6dB BW Limit (kHz)	Result
CH1	16.31	>500	COMPLIES
CH6	16.38	>500	COMPLIES
CH11	16.38	>500	COMPLIES

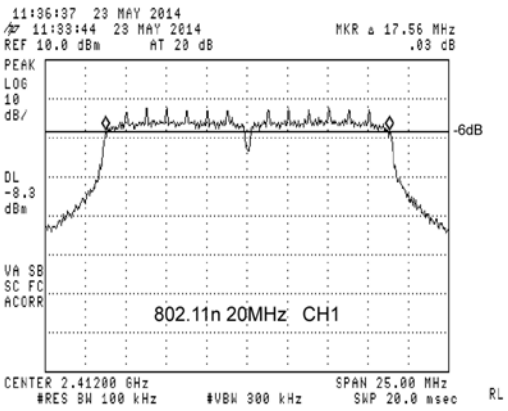


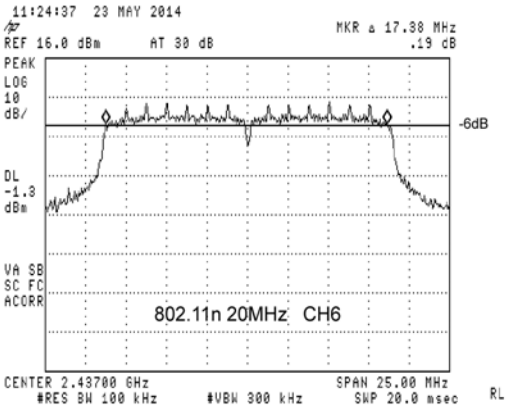


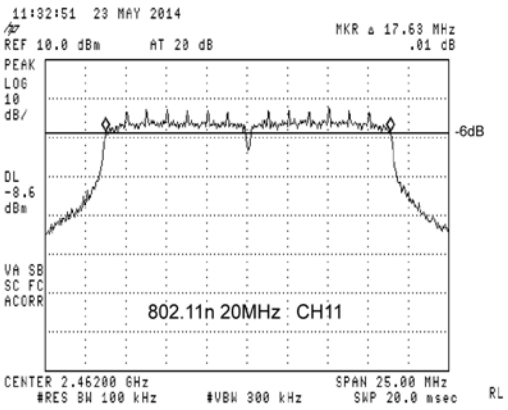


Mode 3 – 802.11n 20MHz operation

Channel	6dB Bandwidth (MHz)	6dB BW Limit (kHz)	Result
CH1	17.56	>500	COMPLIES
CH6	17.38	>500	COMPLIES
CH11	17.63	>500	COMPLIES







11.2 Peak Conducted Output Power – Section 15.247(b)

Test Date:	29 Aug 2014	Temperature:	19°C
Test Officer:	Richard Turner	Humidity:	58%
Test Location:	Austest Laboratories (NSW)		

11.2.1 EUT Operating Mode

a. Measurements were made on the TACHO5A model.
b. DC supply voltage – 13.8VDC.
c. Mode 1 – 802.11b operation.
d. Mode 2 - 802.11g operation.
e. Mode 3 – 802.11n 20MHz operation.
f. Channels, data rate and level settings adjusted in accordance with the supplied channel plan.

11.2.2 Test Method

a. Measurements are performed in accordance with ANSI C63.10-2009 and KDB 558074 D01 DTS Meas Guidance v03r02 section 9.1.2.
b. Connect the EUT antenna port directly to a wideband peak power sensor via an attenuator. The U2021XA power sensor is USB powered and connected to a PC using the Agilent N1918A power analysis manager software.
c. Apply amplitude correction to account for attenuator loss.
d. Set the power sensor to measure peak power and VBW to high (30MHz).
e. Record the maximum reading.
f. Repeat the above for the low, middle and high channels and across all transmit modes.

11.2.3 Directional antenna gain

The gain of the WiFi antenna housed in the supplied MA600 combination antenna was specified as 2.1dBi.

The gain of the WiFi antenna housed in the supplied MA206 combination antenna was specified as 3.4dBi.

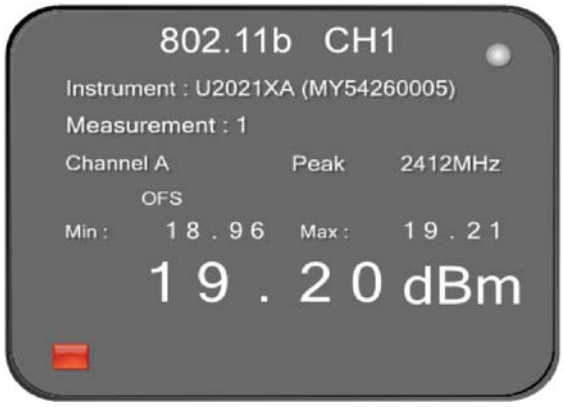
The gain of the WiFi antenna housed in the supplied MA206 combination antenna was specified as -0.9dBi.

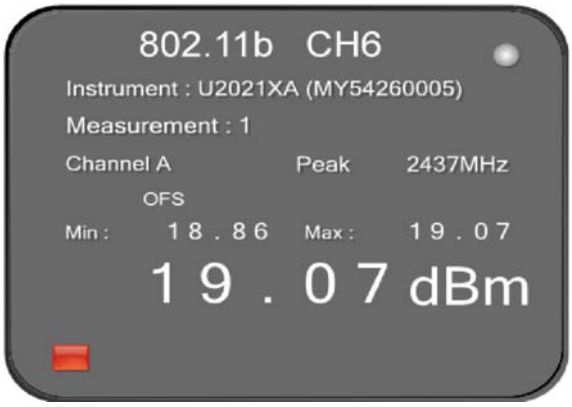
Section 15.247 (b) (4) indicates that the specified limit of 1W for conducted output power is based on the use of an antenna with a directional gain not exceeding 6dBi.

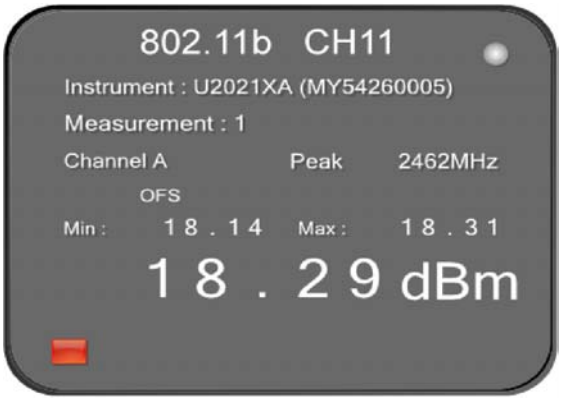
11.2.4 Test Results

Mode 1 – 802.11b operation

Channel	Output Power		Limit		Below Limit
	dBm	mW	dBm	W	dB
CH1	19.2	83	30.0	1.0	10.8
CH6	19.1	81	30.0	1.0	10.9
CH11	18.3	68	30.0	1.0	11.7

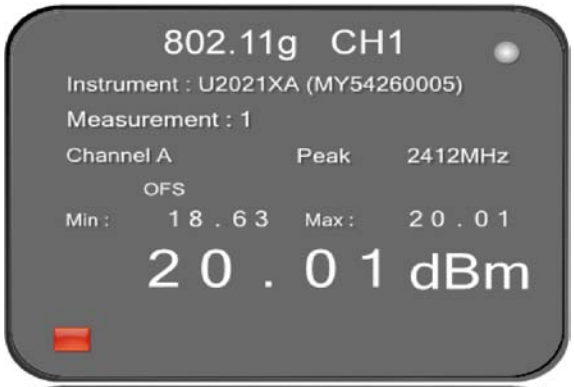


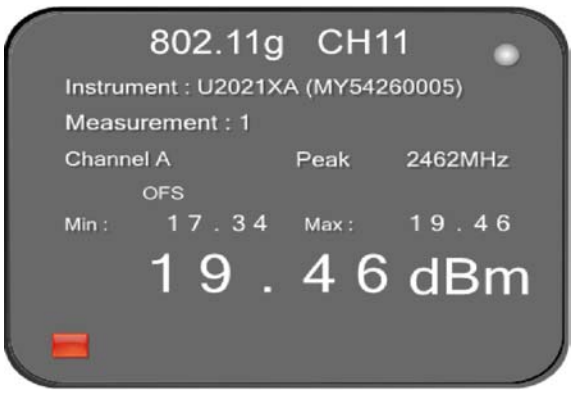




Mode 2 – 802.11g operation

Channel	Output Power		Limit		Below Limit
	dBm	mW	dBm	W	dB
CH1	20.0	100	30.0	1.0	10.0
CH6	23.6	229	30.0	1.0	6.4
CH11	19.5	89	30.0	1.0	10.5





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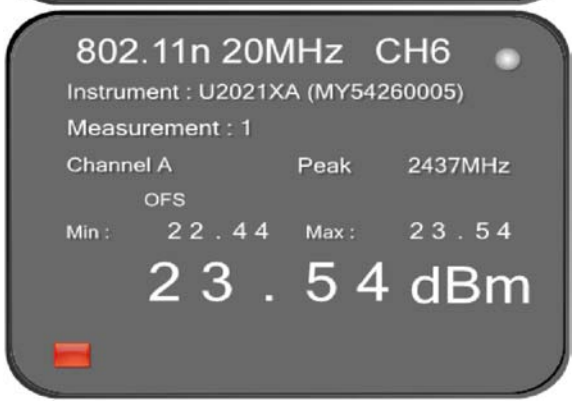
TEST LABORATORY
CERT #2765.02

Mode 3 – 802.11n 20MHz operation

Channel	Output Power		Limit		Below Limit
	dBm	mW	dBm	W	dB
CH1	18.8	76	30.0	1.0	11.2
CH6	23.5	209	30.0	1.0	6.5
CH11	19.0	79	30.0	1.0	11.0



11.2.5 Transmit Power – Supply Voltage Variation

The EUT is powered from a DC supply provided by a vehicle's battery. The client specified a voltage range 12-30VDC.

Section15.31 (e) requires transmitted power at the fundamental to be measured with the supply voltage varied between 85% and 115% of the nominal voltage range.

No change in transmit power at the fundamental was observed when the DC supply voltage was varied.

11.3 Out of band emissions – Section 15.247(d)

Test Date:	23 May 2014	Temperature:	22°C
Test Officer:	Richard Turner	Humidity:	62%
Test Location:	Austest Laboratories (NSW)		

11.3.1 EUT Operating Mode

a. Measurements were made on the TACHO5A model.
b. DC supply voltage – 13.8VDC.
c. Mode 1 – 802.11b operation.
d. Mode 2 - 802.11g operation.
e. Mode 3 – 802.11n 20MHz operation.
f. Channels, data rate and level settings adjusted in accordance with the supplied channel plan.

11.3.2 Test Method

a. Measurements are performed in accordance with ANSI C63.10-2009 and KDB 558074 D01 DTS Meas Guidance v03r02 section 11
b. Connect the EUT antenna port directly to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
c. Set the spectrum analyser RBW to 100kHz, and the VBW to 100kHz or more.
d. Select the channel that recorded the highest spectral density level (section 11.4)
e. Record the highest in band level.
f. Sweep through the frequency range to locate the highest out of band emissions.
g. Ensure that any out of band emissions are greater than 20dB below the recorded in band level.
h. Ensure that any emissions that fall within the restricted bands specified in section 15.205 also meet the radiated emission limits specified in section 15.209.
i. Repeat the above for the low, middle and high channel and across all transmit modes.

11.3.3 Test Results

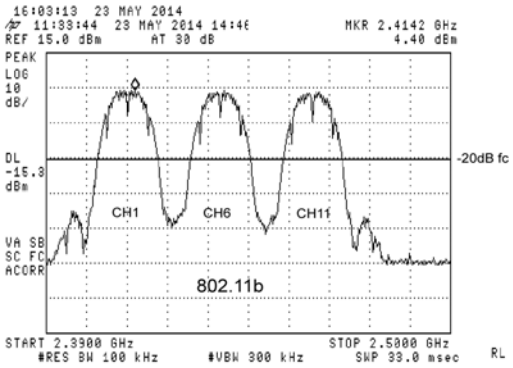
Mode 1 – 802.11b operation

Frequency range: 150kHz to 25000MHz.
Highest in-band level at 2411.0MHz, 4.7dBm (CH1).

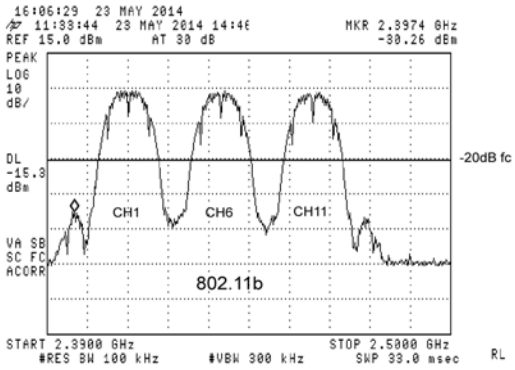
Measurement of peak conducted output power was used to determine compliance with section 15.247 (b) (3). Therefore the out of band emission limit is 20dB below the in-band level, -15.3dBm.

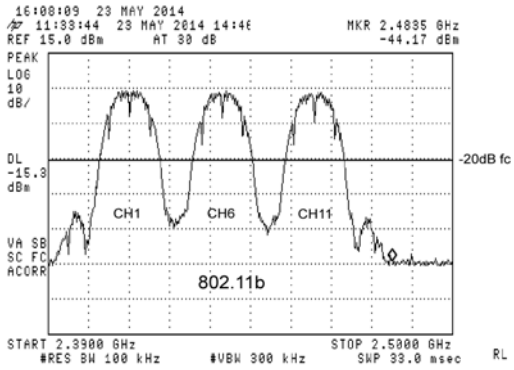
Highest measured out of band emission level was at 2397.4MHz which was 35.0dB below the highest in band level.

Frequency (MHz)	Channel	Peak Level (dBm)	In-Band Peak Level (dBm)	Out of Band Limit (dBm)	Below Limit (dB)
2397.4	1	-30.3	4.7	-15.3	15.0

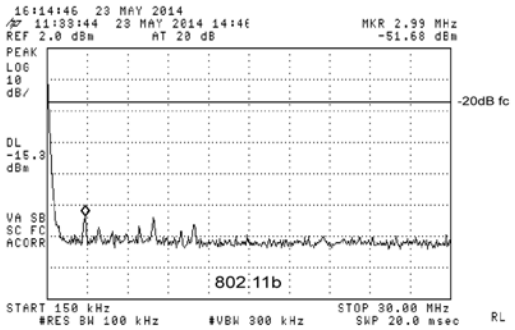


In-band

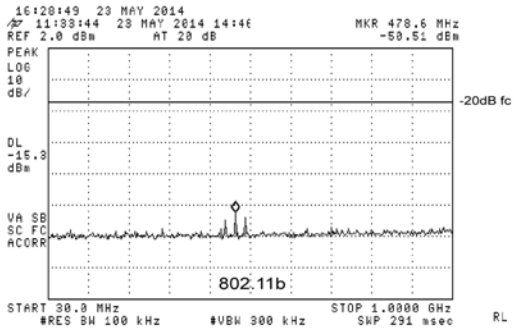




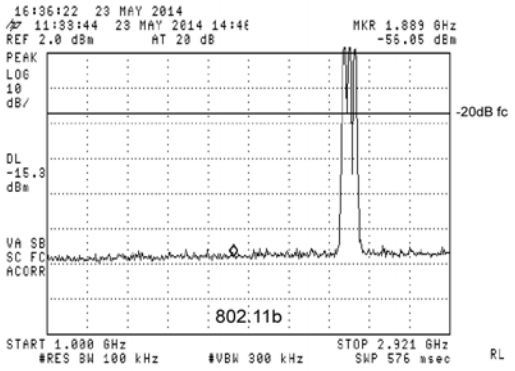
Band-edges



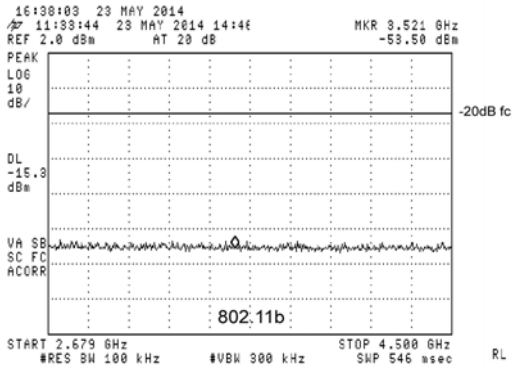
150kHz to 30MHz



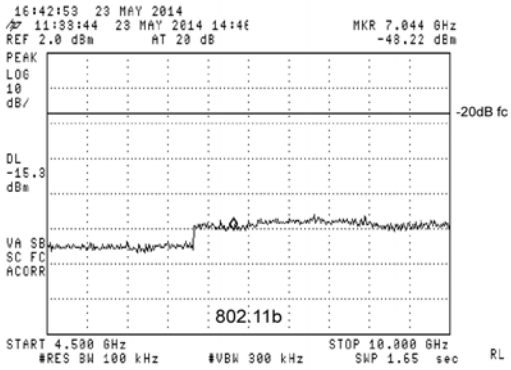
30MHz to 1000MHz



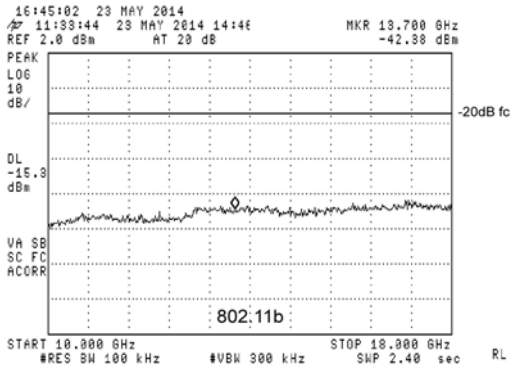
1000MHz to 2900MHz



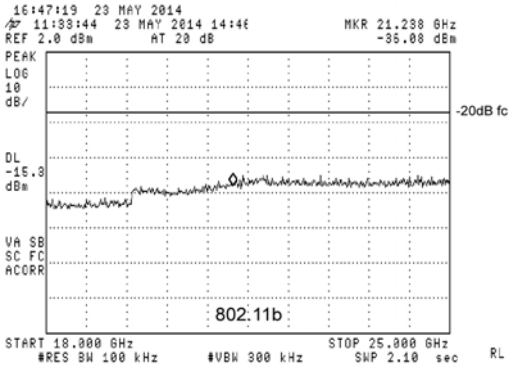
2600MHz to 4500MHz



4500MHz to 10000MHz



10000MHz to 18000MHz



18000MHz to 25000MHz

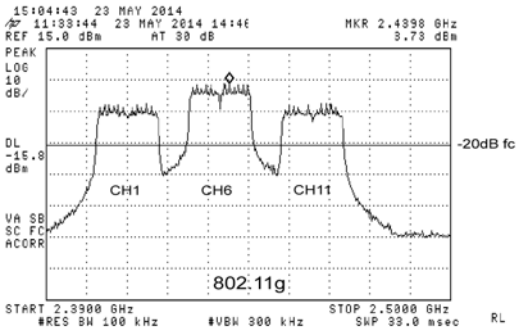
Mode 2 – 802.11g operation

Frequency range: 150kHz to 25000MHz.
Highest in-band level at 2442.9MHz, 4.2dBm (CH6).

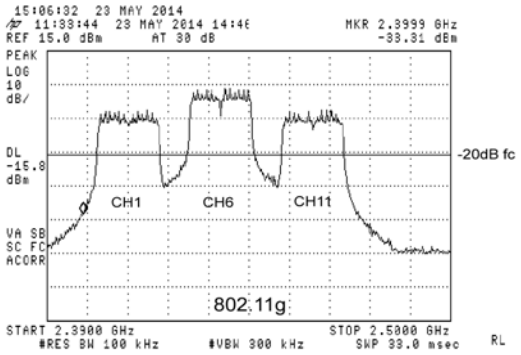
Measurement of peak conducted output power was used to determine compliance with section 15.247 (b) (3). Therefore the out of band emission limit is 20dB below the in-band level, -15.8dBm.

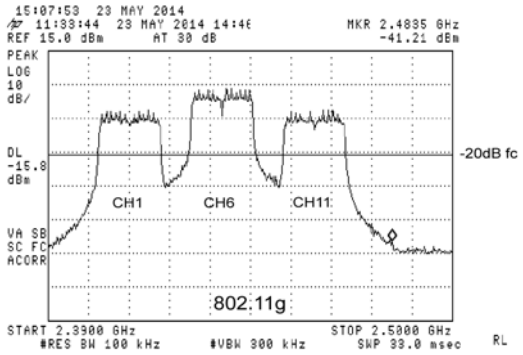
Highest measured out of band emission level was at 2400.0MHz which was 37.5dB below the highest in band level.

Frequency (MHz)	Channel	Peak Level (dBm)	In-Band Peak Level (dBm)	Out of Band Limit (dBm)	BelowLimit (dB)
2400.0	1	-33.3	4.2	-15.8	17.5

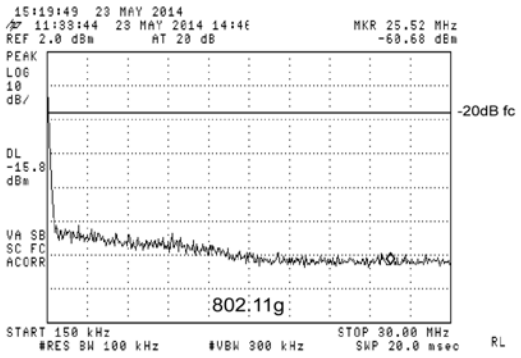


In-band

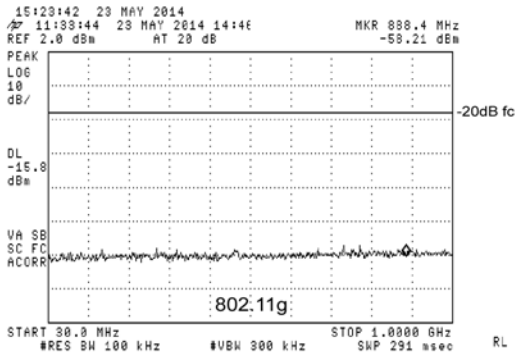




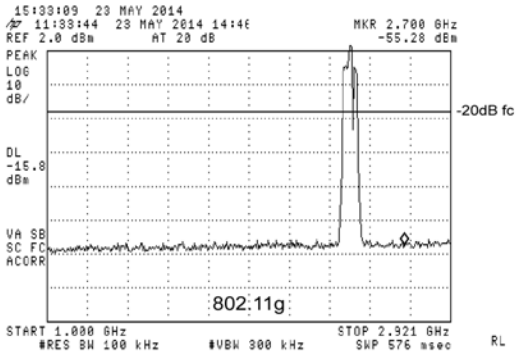
Band-edges



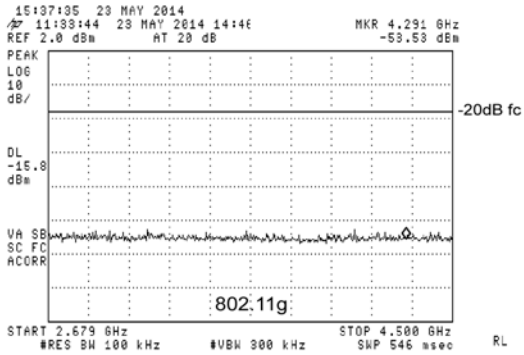
150kHz to 30MHz



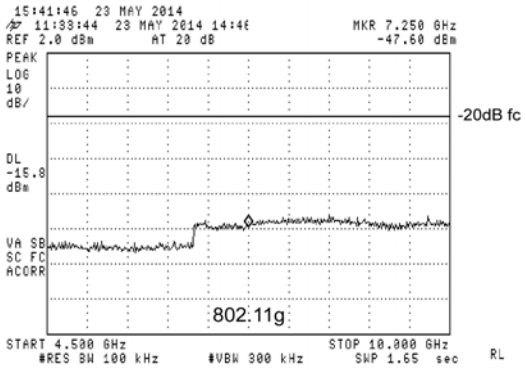
30MHz to 1000MHz



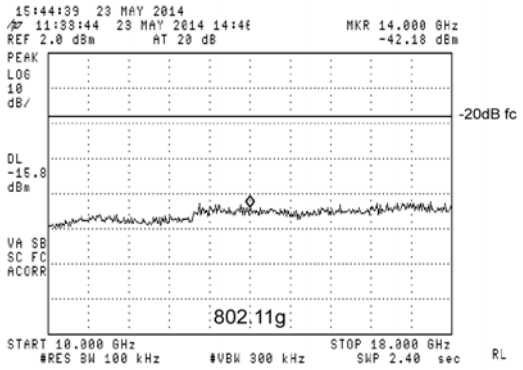
1000MHz to 2900MHz



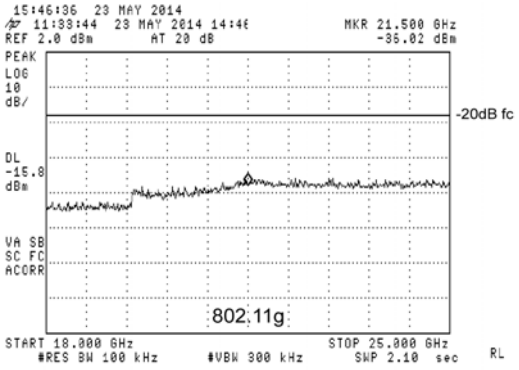
2600MHz to 4500MHz



4500MHz to 10000MHz



10000MHz to 18000MHz

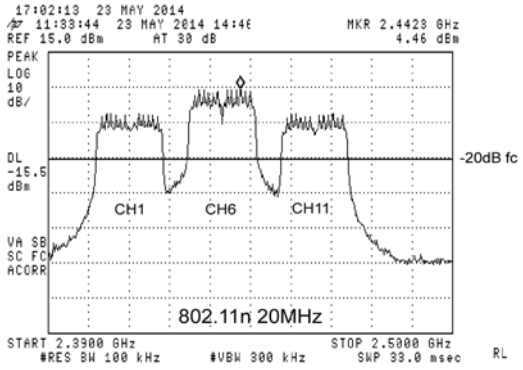


18000MHz to 25000MHz

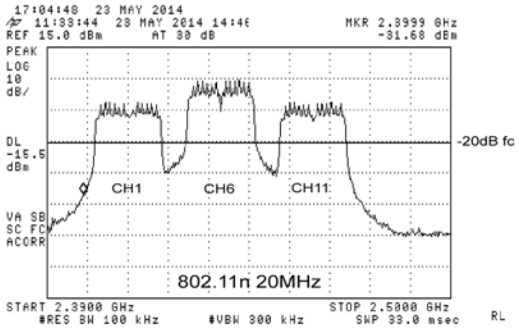
Mode 3 – 802.11n 20MHz operation

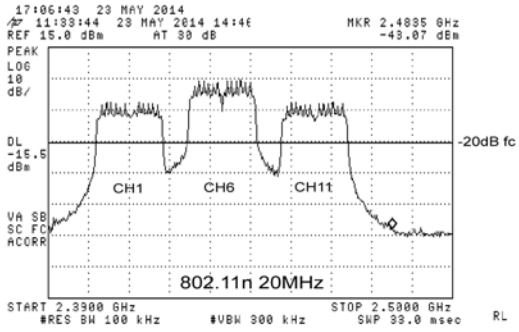
Frequency range: 150kHz to 25000MHz
Highest in-band level at 2442.0MHz, 4.5dBm (CH6)
Measurement of peak conducted output power was used to determine compliance with section 15.247 (b) (3). Therefore the out of band emission limit is 20dB below the in-band level, -15.5dBm
Highest measured out of band emission level was at 2400.0MHz which was 16.2dB below the highest in band level.

Frequency (MHz)	Channel	Peak Level (dBm)	In-Band Peak Level (dBm)	Out of Band Limit (dBm)	Below Limit (dB)
2400.0	1	-31.7	4.5	-15.5	16.2

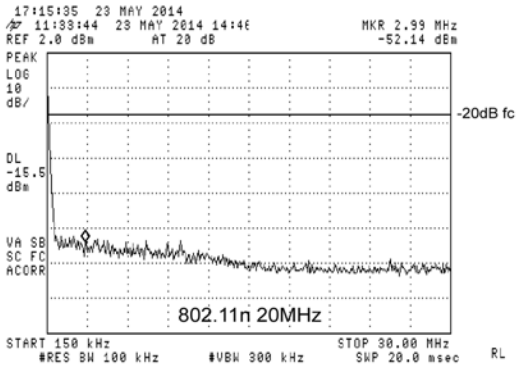


In-band

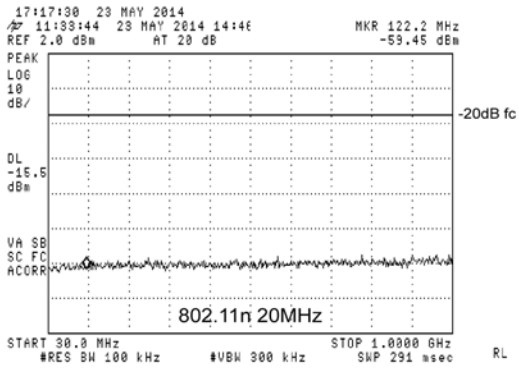




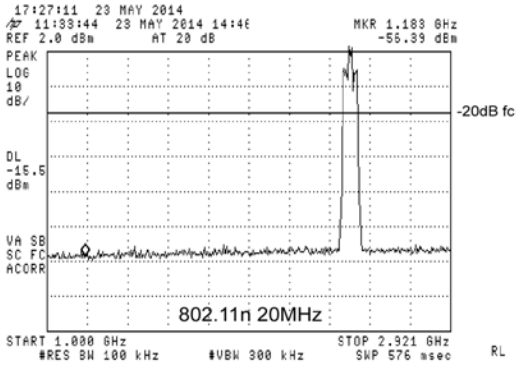
Band-edges



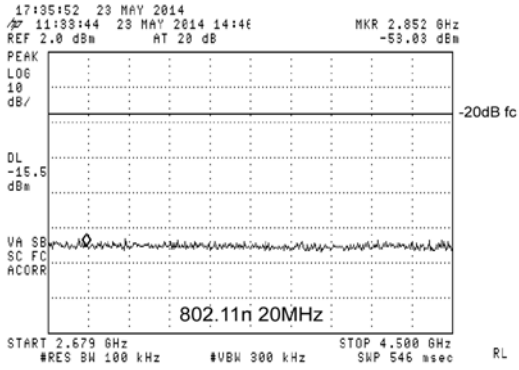
150kHz to 30MHz



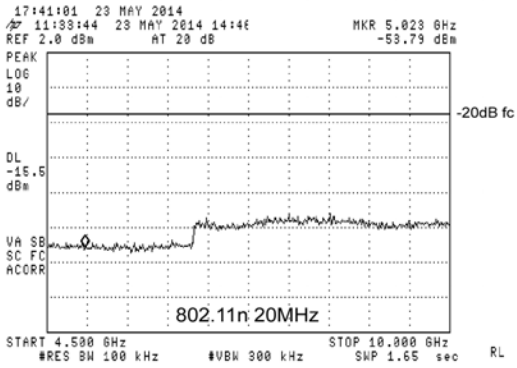
30MHz to 1000MHz



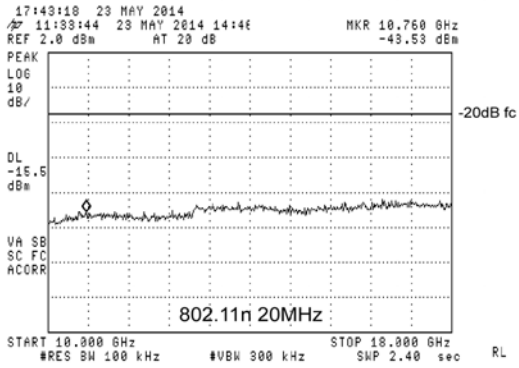
1000MHz to 2900MHz



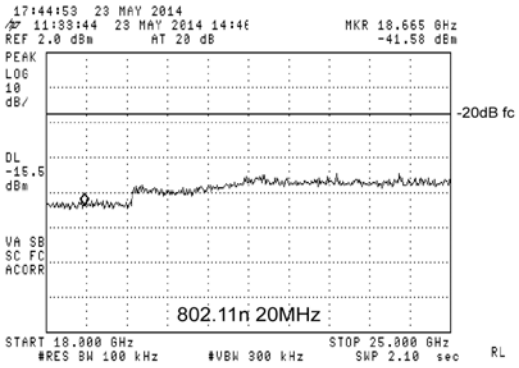
2600MHz to 4500MHz



4500MHz to 10000MHz



10000MHz to 18000MHz



18000MHz to 25000MHz

11.4 Peak Power Spectral Density – Section 15.247(e)

Test Date:	23 May 2014	Temperature:	26°C
Test Officer:	Richard Turner	Humidity:	67%
Test Location:	Austest Laboratories (NSW)		

11.4.1 EUT Operating Mode

a. Measurements were made on the TACHO5A model.
b. DC supply voltage – 13.8VDC.
c. Mode 1 – 802.11b operation.
d. Mode 2 - 802.11g operation.
e. Mode 3 – 802.11n 20MHz operation.
f. Channels, data rate and level settings adjusted in accordance with the supplied channel plan.

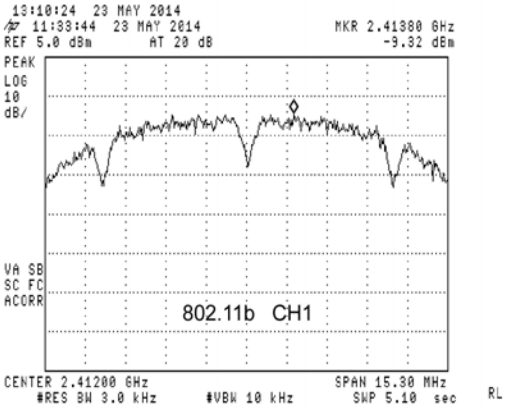
11.4.2 Test Method

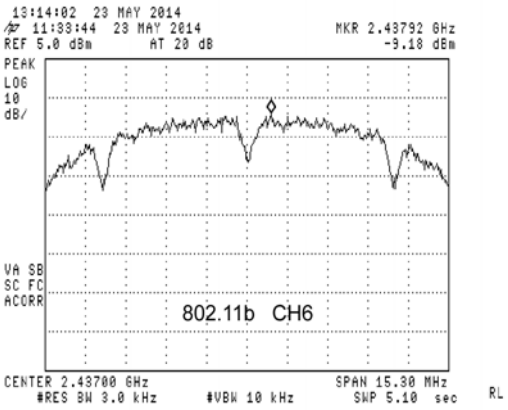
a. Measurements are performed in accordance with ANSI C63.10-2009 and KDB 558074 D01 DTS Meas Guidance v03r02 section 10.2
b. Connect the EUT antenna port directly to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
c. Set the spectrum analyser RBW to 3kHz, VBW to 10kHz, span 1.5 x 6dB bandwidth.
d. Record the maximum reading.
e. Repeat the above for the low, middle and high channel and across all transmit modes. .

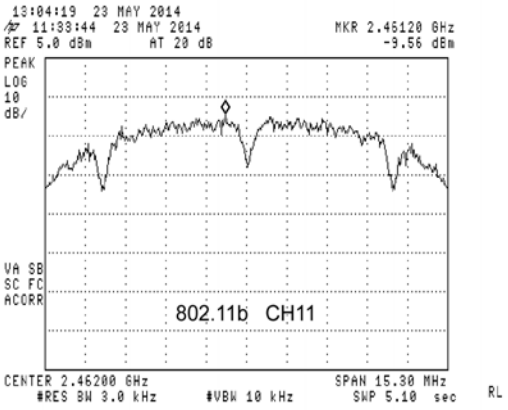
11.4.3 Test Results

Mode 1 – 802.11b operation

Channel	Frequency (MHz)	Power Density Level per 3kHz (dBm)	Power Density Limit (dBm)	Below Limit (dB)
CH1	2413.8	-9.3	8.0	17.3
CH6	2437.9	-9.2	8.0	17.2
CH13	2461.2	-9.6	8.0	17.6

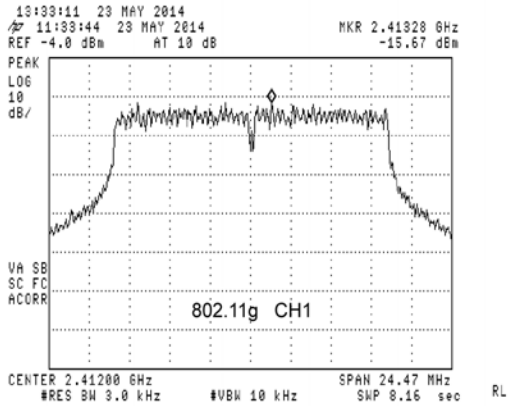


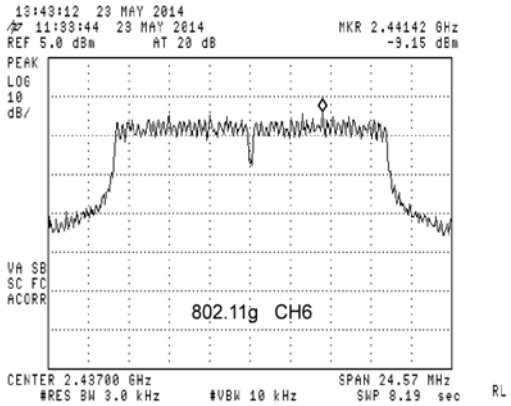


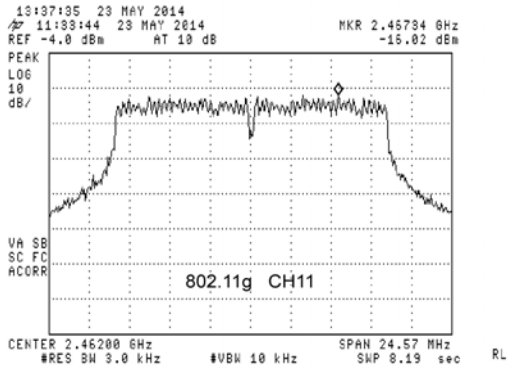


Mode 2 – 802.11g operation

Channel	Frequency (MHz)	Power Density Level per 3kHz (dBm)	Power Density Limit (dBm)	Below Limit (dB)
CH1	2413.3	-15.7	8.0	23.7
CH6	2441.4	-9.2	8.0	17.2
CH11	2467.3	-16.0	8.0	24.0







Mode 3 – 802.11n 20MHz operation

Channel	Frequency (MHz)	Power Density Level per 3kHz (dBm)	Power Density Limit (dBm)	Below Limit (dB)
CH1	2415.2	-16.4	8.0	24.4
CH6	2433.6	-9.7	8.0	17.7
CH11	2462.7	-16.7	8.0	24.7