MET Laboratories, Inc. *Safety Certification - EMI – Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313
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December 28, 2011

Ubiquiti Networks, Inc.
91 E. Tasman
San Jose, CA 95134

Dear Jennifer Sanchez,

Enclosed is the EMC test report for compliance testing of the Ubiquiti Networks, Inc., WispStation5 tested to the requirements of ETSI EN 301 893 (Article 3.2 of R&TTE Directive).

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Ubiquiti Networks, Inc.\EMCS83056-ETS893)

DOC-EMC602 4/30/2004

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Electromagnetic Compatibility Criteria Test Report

For the

Ubiquiti Networks, Inc.
Model WispStation5

Tested under

ETSI EN 301 893

(Article 3.2 of R&TTE Directive)

MET Report: EMCS83056-ETS893

December 28, 2011

Prepared For:

Ubiquiti Networks, Inc.
91 E. Tasman
San Jose, CA 95134

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave.
Baltimore, MD 21230

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MET Report: EMCS83056-ETS893

Anderson Soungpanya, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of ETSI EN 301 893 of the EU Rules under normal use and maintenance.

Shawn McMillen,
Wireless Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	December 28, 2011	Initial Issue.

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List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**Deci*****b***els
dBμA	**Deci*****b***els above one **micro**amp
dBμV	**Deci*****b***els above one **micro**volt
dBμA/m	**Deci*****b***els above one **micro**amp **per m**eter
dBμV/m	**Deci*****b***els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**st**atic **D**ischarge
EUT	**E**quipment **U**nder **T**est
fc	Carrier **F**requency
CISPR	**C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference)
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**H**ert**z**
kPa	**k**ilo**Pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**H**ertz
μH	**micro**H**enry
μF	**micro**F**arad
μs	**micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Requirements Summary

A. Requirements Summary

ETSI EN 301 893 Section Number	Descriptive Name	Comments
Sections 4.2	Carrier Frequencies	Compliant
Sections 4.3	Nominal Channel Bandwidth and Occupied Channel Bandwidth	Compliant
Sections 4.4	RF Output Power	Compliant
	Transmit Power Control (TPC)	Compliant
	Power Density	Compliant
Sections 4.5	Transmitter Unwanted Emissions	
4.5.1	Out of Band Unwanted Emissions – Conducted	Compliant
	Out of Band Unwanted Emissions – Radiated	Compliant
4.5.2	In Band Unwanted Emissions – Conducted	Compliant
Sections 4.6	Receiver Spurious Emissions – Conducted	Compliant
	Receiver Spurious Emissions – Conducted	Compliant
Sections 4.7	Dynamic Frequency Selection (DFS)	
4.7.2.4	Channel Shutdown and Move	Compliant
4.7.2.5	Non-Occupancy Period	Compliant

Table 1. Summary of EMC ETSI EN 301 893 Compliance Testing

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by Ubiquiti Networks, Inc. to perform testing on a WispStation5.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Ubiquiti Networks, Inc. model WispStation5.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	WispStation5
Model(s) Number:	WispStation5
EUT Specifications:	Primary Power: 230VAC 50Hz
	Secondary Power: 24VDC 0.5A
Lab Ambient (Normal) Test Conditions:	Temperature: 15-35º C
	Relative Humidity: 30-60%
	Atmospheric Pressure: 860-1060 mbar
Extreme Test Conditions:	Voltage: 230 VAC +/- 15%
	Temperature: -40 to +60º C
	Relative Humidity: 30-60%
Evaluated by:	Dusmantha Tennakoon
Report Date(s):	December 28, 2011

B. References

ETSI EN 301.893 V1.5.1 (2008-12)	Broadband Radio Access Networks (BRAN); 5GHz high performance RLAN; Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive.

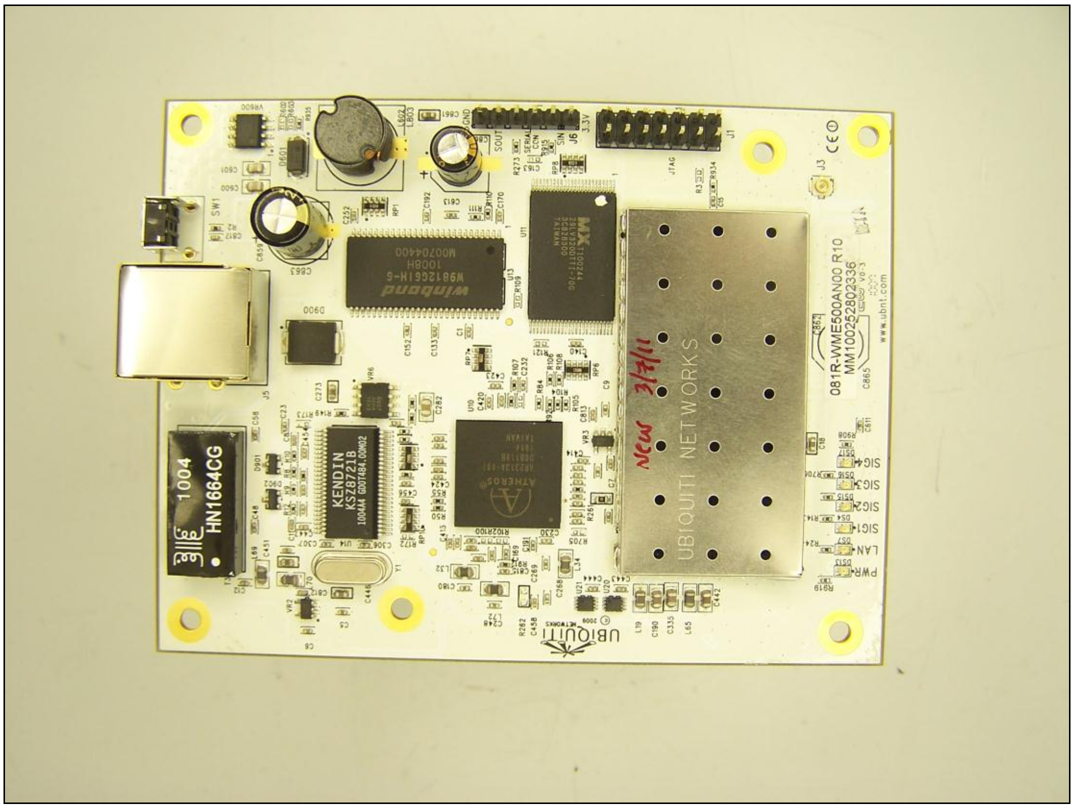
Table 2. Test References

C. Test Site

ETSI EN 893 testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave., Baltimore, MD 21230. DFS testing was performed at MET Laboratories, Inc., 3162 Belick Street, Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

D. Description of Test Sample

The Ubiquiti Networks, Inc. WispStation5, Equipment Under Test (EUT), is a 802.11a Long-Range 5GHz Station.



Photograph 1. Ubiquiti Networks, Inc. WispStation5

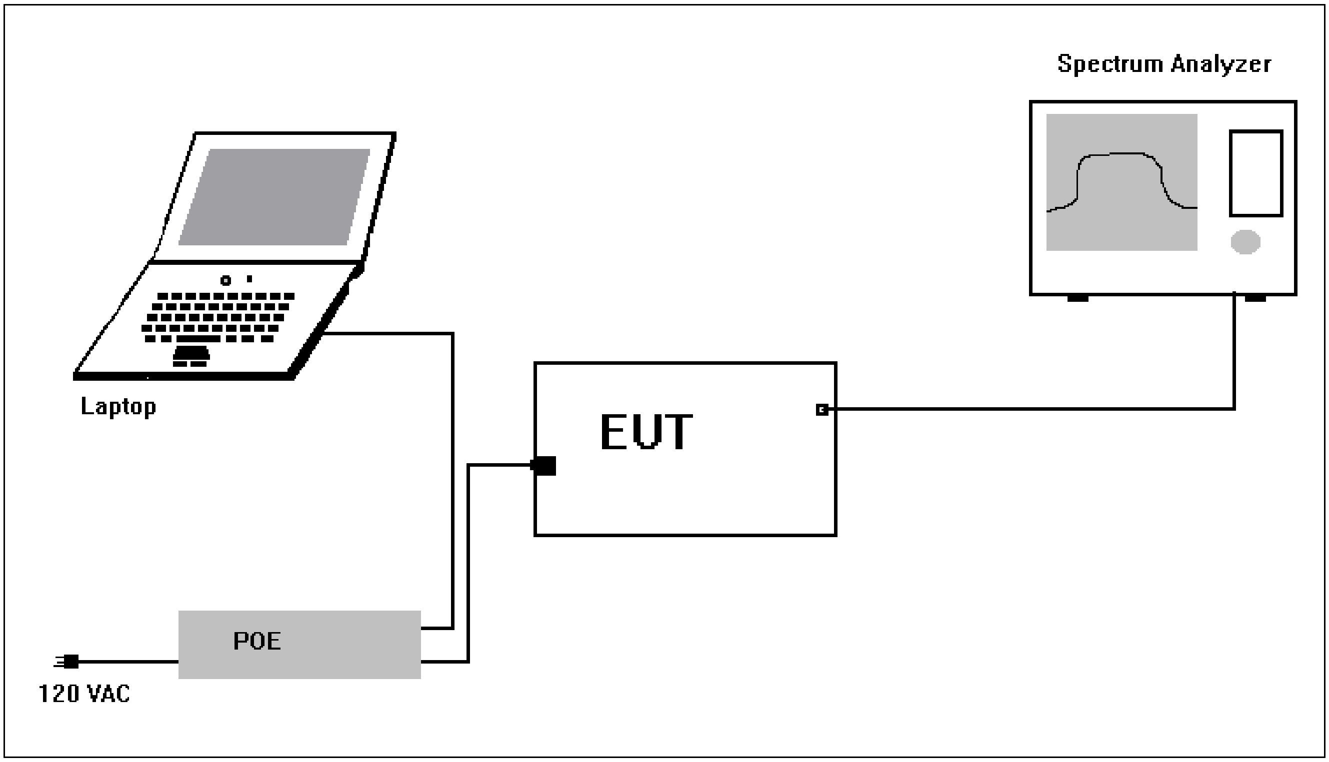


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Name / Description	Model Number	Serial Number
WispStation5	WS5	MM100027314781

Table 3. Equipment Configuration

F. Support Equipment

Ubiquiti Networks, Inc. supplied support equipment necessary for the operation and testing of the WispStation5. All support equipment supplied is listed in the following Support Equipment List.

Name / Description	Manufacturer	Model Number
Laptop	Dell	Inspiron
POE	Ubiquiti Networks	UBI-POE-24-5

Table 4. Support Equipment

G. Ports and Cabling Information

Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Point
1	Ethernet	1	3	Y	POE

Table 5. Ports and Cabling Information

H. Mode of Operation

The EUT operates in OFDM mode with 20 MHz channel bandwidths. EUT was configured to transmit continuously for testing purposes.

I. Modifications

a) Modifications to EUT

No modifications were made to the EUT

b) Modifications to Test Standard

No modifications were made to the test standard.

J. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Ubiquiti Networks, Inc. upon completion of testing.

III. Conformance Requirements

4.2 Centre Frequencies

Test Requirement(s): **ETSI EN 301 893, Clause 5.3.2:**

4.2.1 Definition
The centre frequency is the centre of the channel declared by the manufacturer as part of the declared channel plan(s).

4.2.2 Limits
The actual centre frequency for any given channel declared by the manufacturer shall be maintained within the range $f_c \pm 20$ ppm.

Test Procedure: The EUT was placed in an environmental chamber and the RF port was connected directly to a spectrum analyzer through an attenuator. Depending on which band was being investigated, the EUT was set to transmit at the f_c indicated above at a normal power level. If the EUT was capable of transmitting a CW carrier then the spectrum analyzer's frequency counting function was used to measure the actual frequency. If only a modulated carrier was available then the frequency relative to -10dBc above and below the carrier was measured and the carrier frequency was determined using (f1+f2)/2. The frequency of the carrier was measured at normal and extreme conditions. The resulting carrier frequencies were tabulated below and the frequency error determined.

Test Results: The EUT was found to be compliant with the limits set forth in Clause 5.3.2.

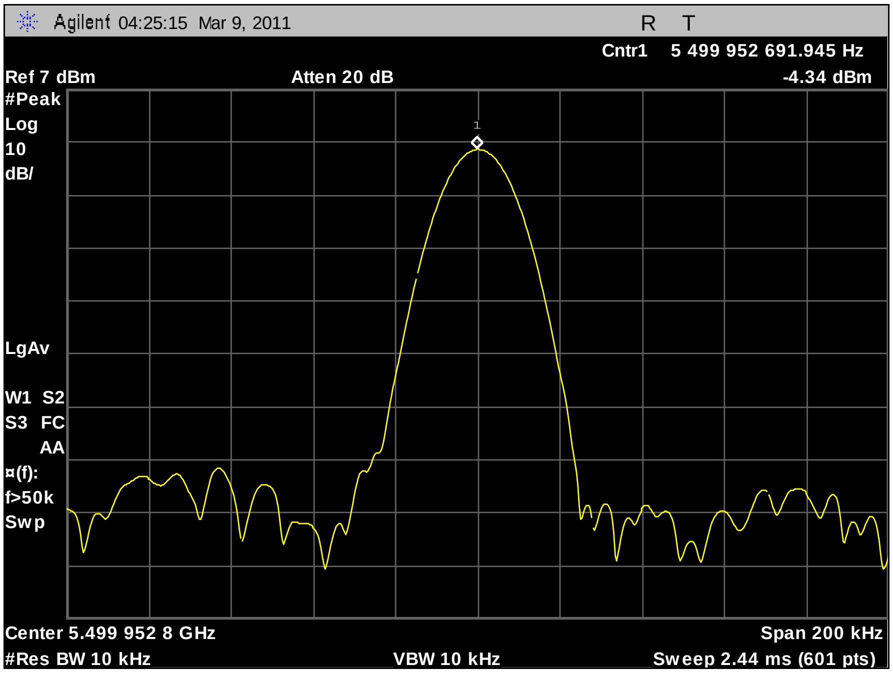
Test Engineer: Dusmantha Tennakoon

Test Date: 03/09/11

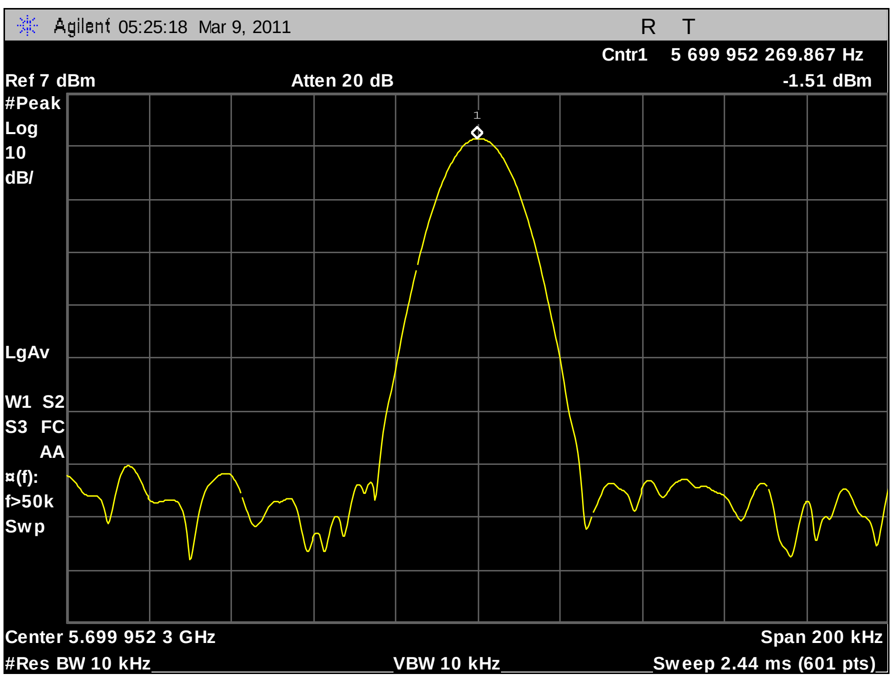
Fundamental	Normal Temp.	-10 C	-10 C	55 C	55 C
	Normal Volts	**207VAC**	**253VAC**	**207VAC**	**253VAC**
5500	5499.952MHz	5499.97733 MHz	5499.97734	5499.95797	5499.95795
5700	5699.952 MHz	5699.97636 MHz	5699.97639	5699.9564	5699.95659

Frequency Error (ppm)				
-10 C	**-10 C**	**55 C**	**55 C**	**20 ppm limits**
207VAC	**253VAC**	**207VAC**	**253VAC**	
4.6	4.6	1	1	
4.3	4.3	0.8	0.8	

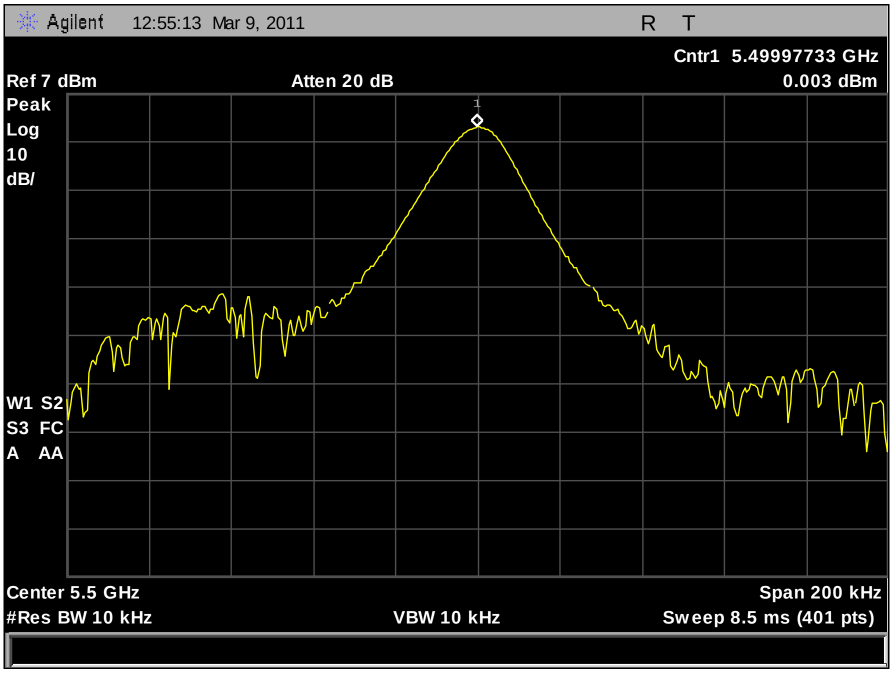
Table 6. Carrier Frequencies, Test Results



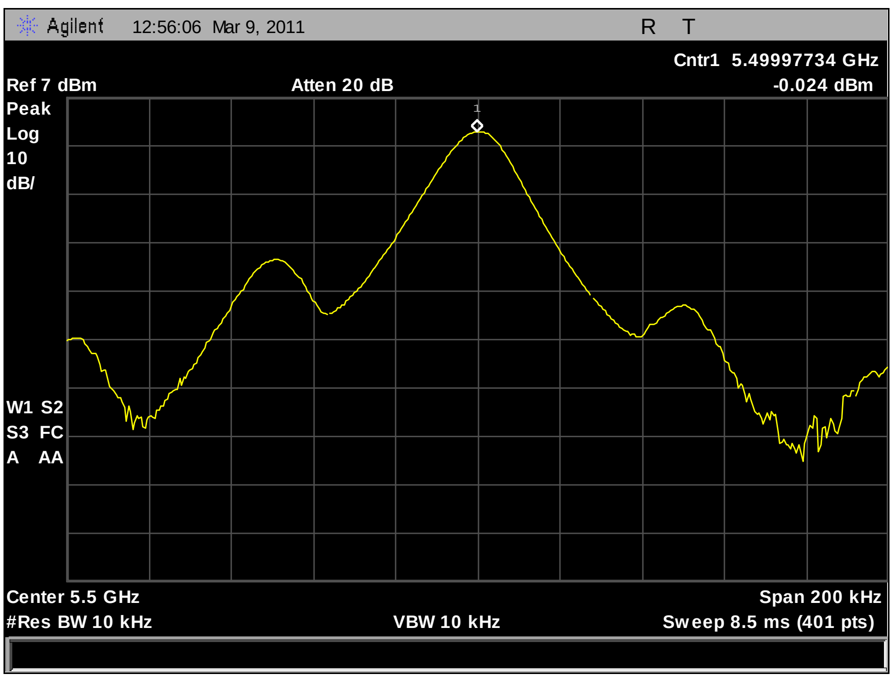
Plot 1. Carrier Frequencies, 5500 MHz, 20°C



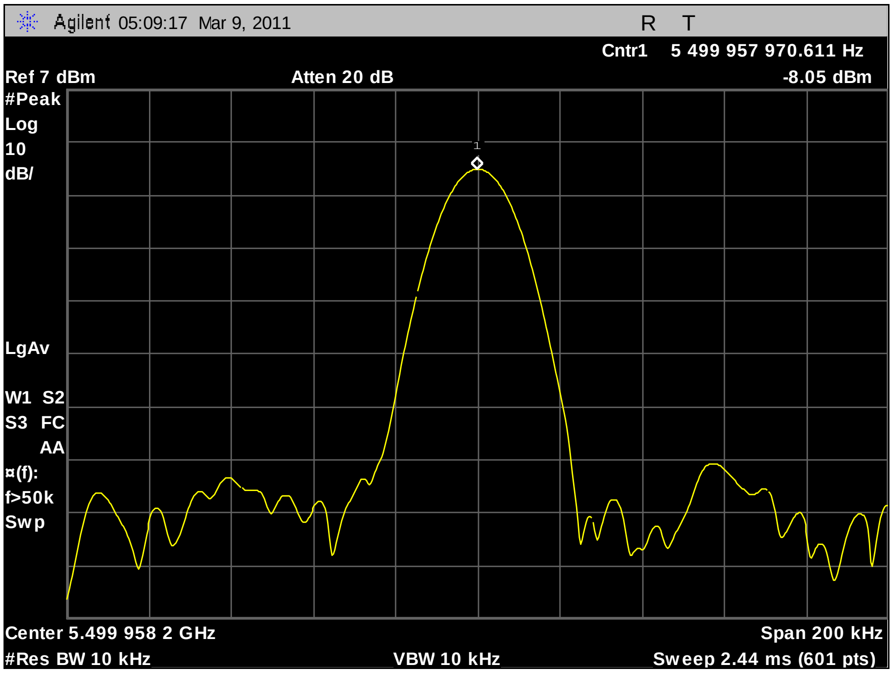
Plot 2. Carrier Frequencies, 5700 MHz, 20°C



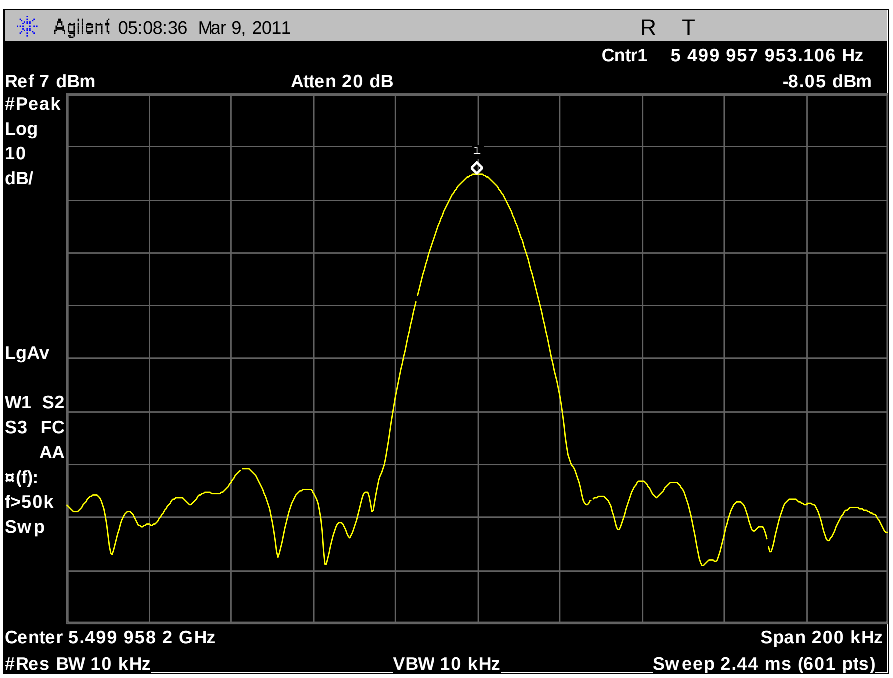
Plot 3. Carrier Frequencies, 5500 MHz, -10°C, 207 VAC



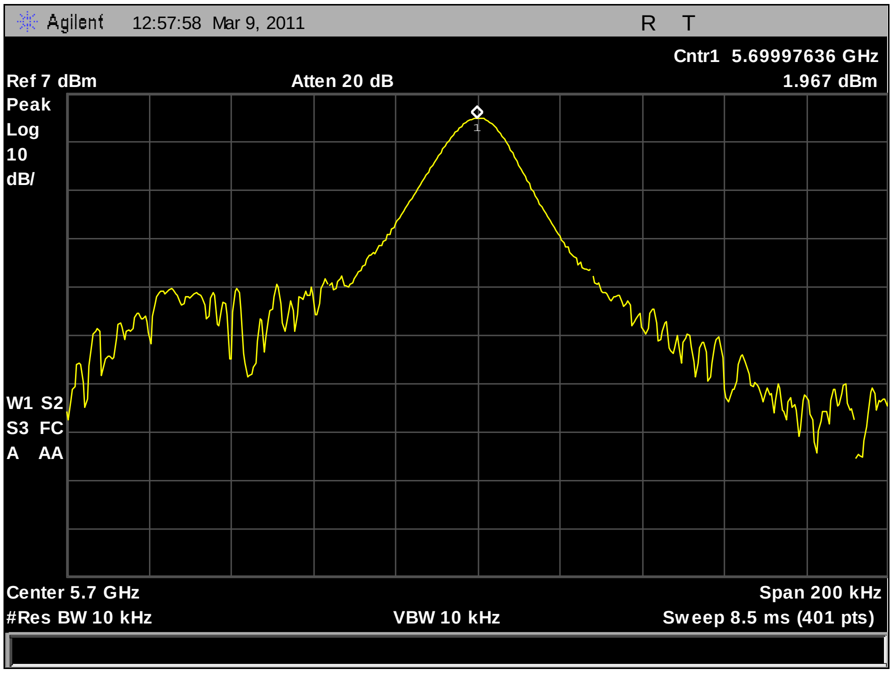
Plot 4. Carrier Frequencies, 5500 MHz, -10°C, 254 VAC



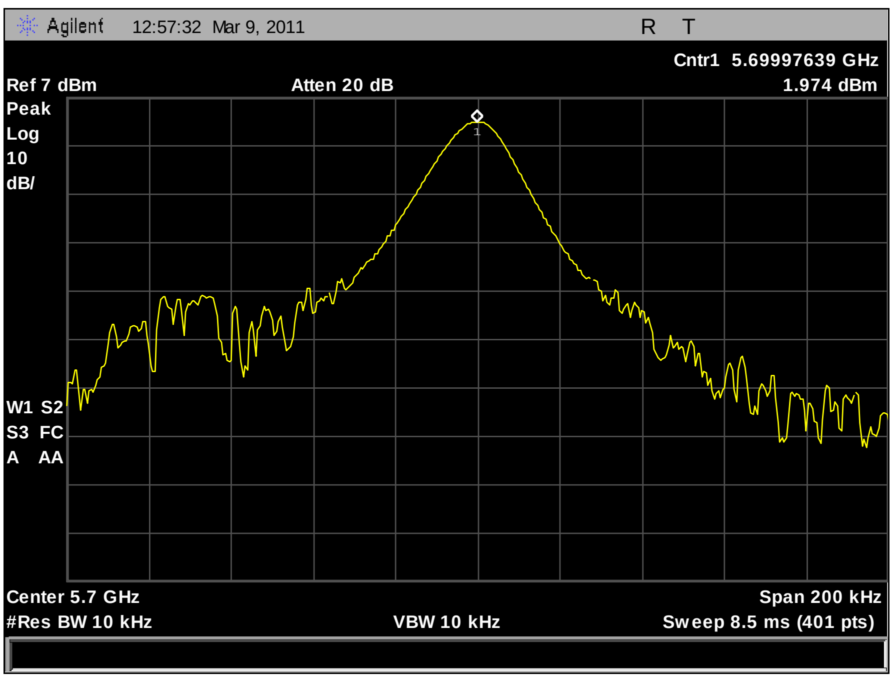
Plot 5. Carrier Frequencies, 5500 MHz, 55°C, 207 VAC



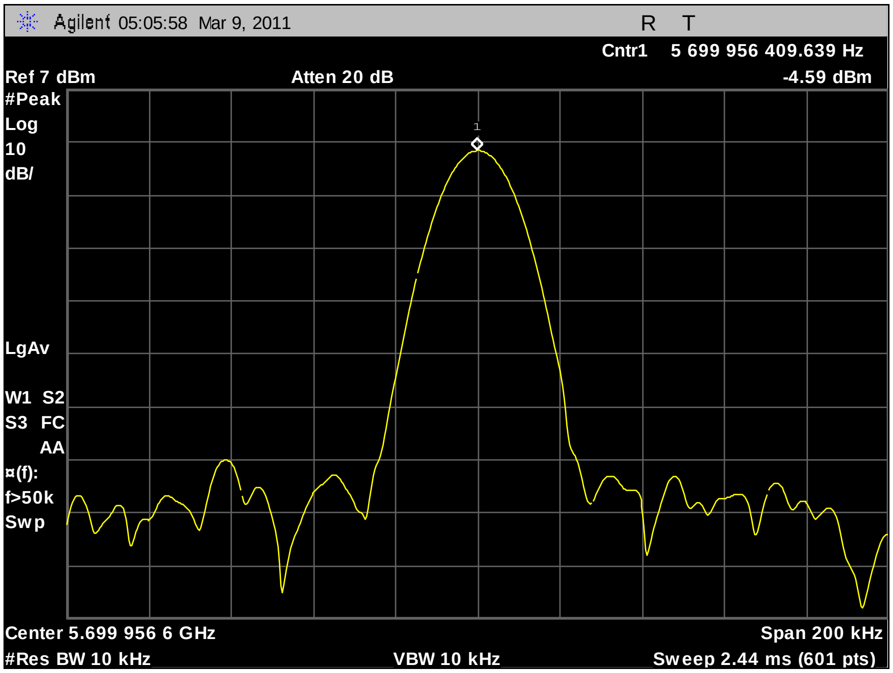
Plot 6. Carrier Frequencies, 5500 MHz, 55°C, 253 VAC



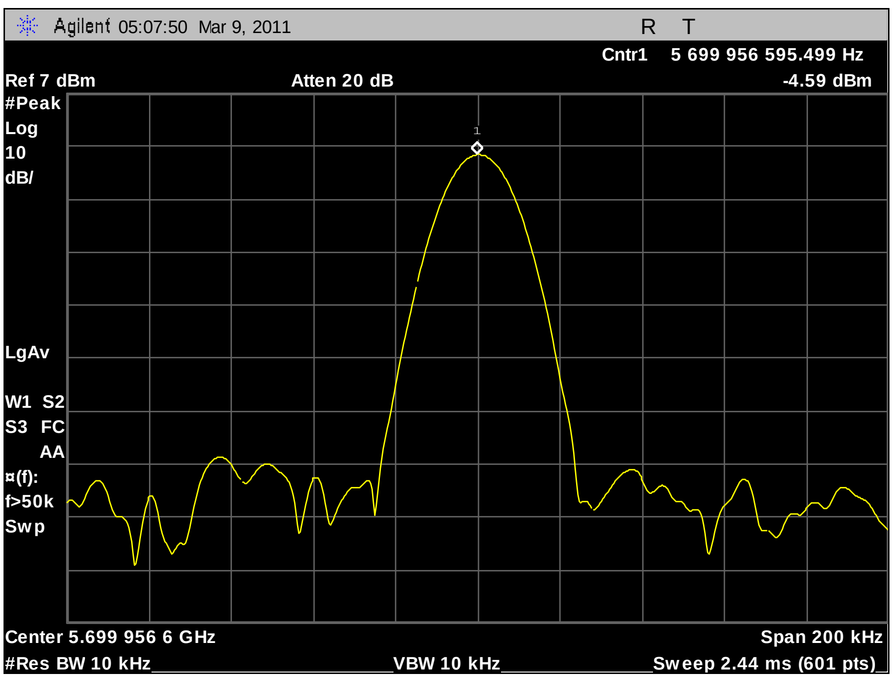
Plot 7. Carrier Frequencies, 5700 MHz, -10°C, 207 VAC



Plot 8. Carrier Frequencies, 5700 MHz, -10°C, 254 VAC



Plot 9. Carrier Frequencies, 5700 MHz, 55°C, 207 VAC



Plot 10. Carrier Frequencies, 5700 MHz, 55°C, 253 VAC

Photograph 2. Temperature Testing, Test Setup

4.3 Nominal Channel Bandwidth and Occupied Channel Bandwidth

Test Requirement(s): **ETSI EN 301 893, Clause 5.3.3:**

4.3.1 Definition
The nominal channel bandwidth is the widest band of frequencies, inclusive of guard bands, assigned to a single channel.

The occupied channel bandwidth is the frequency bandwidth of the signal power at the -6 dBc points when measured with a 100 kHz resolution bandwidth.

NOTE: dBc is the spectral density relative to the maximum spectral power density of the transmitted signal.

4.3.2 Limit
The nominal bandwidth shall be in the range from 5 MHz to 40 MHz.

The occupied channel bandwidth shall be between 80 % and 100 % of the declared nominal channel bandwidth. In case of smart antenna systems (devices with multiple transmit chains) each of the transmit chains shall meet this requirement.

NOTE: The limit for occupied bandwidth is not applicable for devices with a nominal bandwidth of 40 MHz when temporarily operating in a mode in which they transmit only in the upper or lower 20 MHz part of a 40 MHz channel (e.g. to transmit a packet in the upper or lower 20 MHz part of a 40 MHz channel).

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately 1% of the total emission bandwidth, VBW > RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

In case of conducted measurements on smart antenna systems (devices with multiple transmit chains) measurements need only to be performed on one of the active transmit chains (antenna outputs).

Test Results: The EUT as tested was found compliant with the specified limits in clause 5.3.3.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/03/11 – 03/09/11

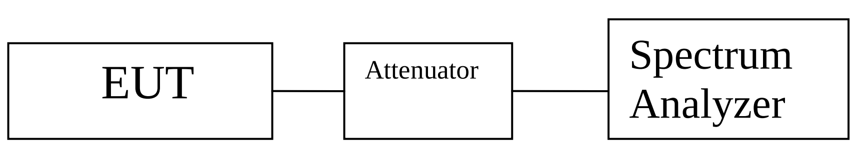
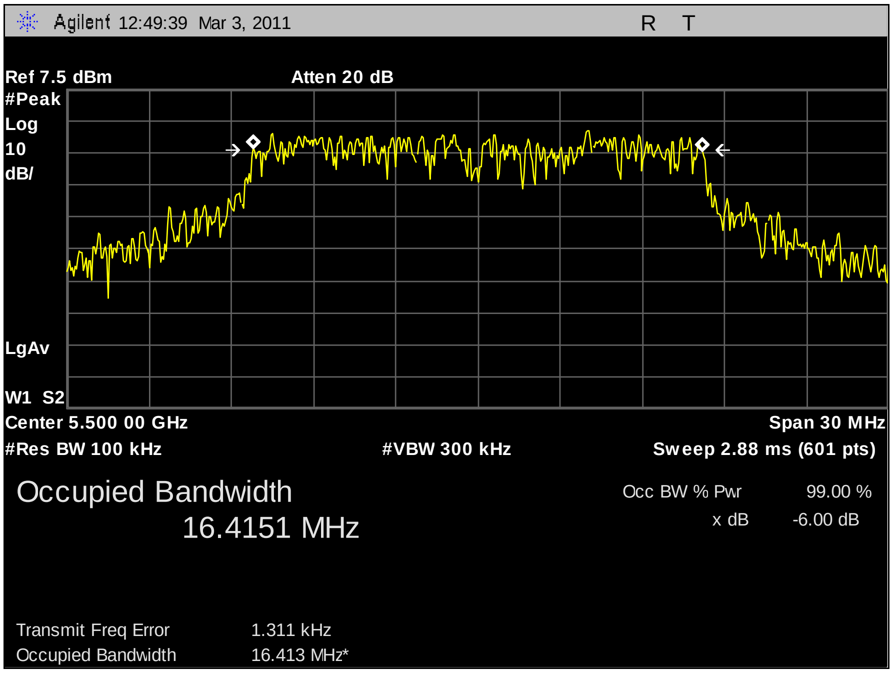
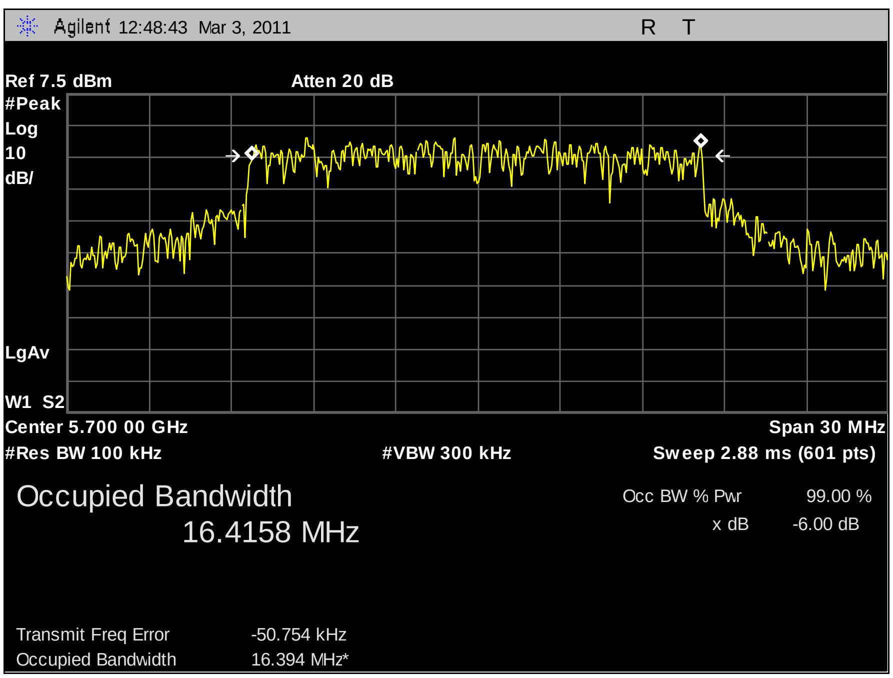


Figure 2. Occupied Bandwidth Test Setup



Plot 11. Occupied Bandwidth, 5500 MHz



Plot 12. Occupied Bandwidth, 5700 MHz

4.4 RF Output Power, Transmit Power Control (TPC), and Power Density

Test Requirement(s): **ETSI EN 301 893, Clause 5.3.4:**

4.4.1 Definitions

4.4.1.1 – RF Power
The RF output power is the mean equivalent isotropically radiated power (EIRP) during a transmission burst.

4.4.1.2 – Transmit Power Control (TPC)
Transmit Power Control (TPC) is a mechanism to be used by the RLAN device to ensure a mitigation factor of at least 3 dB on the aggregate power from a large number of devices. This requires the RLAN device to have a TPC range from which the lowest value is at least 6 dB below the values for mean EIRP given in Table 7.

TPC is not required for channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.

4.4.1.3 – Power Density
The power density is the mean Equivalent Isotropically Radiated Power (EIRP) density during a transmission burst.

4.4.2 Limits
The limits below are applicable to the system as a whole and in any possible configuration. This includes smart antenna systems (devices with multiple transmit chains).

4.4.2.1 Limit: RF Output Power and Power Density at the Highest Power Level
For devices with TPC, the RF output power and the power density when configured to operate at the highest stated power level of the TPC range shall not exceed the levels given in Table 7.

For devices without TPC, the limits in Table 7 shall be reduced by 3 dB, except when operating on channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.

Frequency range	Mean EIRP limit	Mean EIRP Density limit
5 150 MHz to 5 350 MHz	23 dBm	10 dBm/MHz
5 470 MHz to 5 725 MHz	30 dBm (see Note)	17 dBm/MHz (see note)

Table 7. Mean EIRP Limits for RF Output Power and Power Density at the Highest Power Level

Note: For Slave devices without a Radar Interference Detection function the mean EIRP shall be less than 23 dBm and the mean EIRP density shall be less than 10 dBm/MHz.

4.4.2.2 Limit: RF Output Power at the Lowest Power Level of the TPC Range
For devices using TPC, the RF output power during a transmission burst when configured to operate at the lowest stated power level of the TPC range shall not exceed the levels given in Table 8.

Frequency range	Mean EIRP limit
5 250 MHz to 5 350 MHz	17 dBm
5 470 MHz to 5 725 MHz	24 dBm (see Note)

Table 8. Mean EIRP Limits for RF Output Power at the Lowest Power Level of the TPC Range

Note: For Slave devices without a Radar Interference Detection function the mean EIRP shall be less than 17 dBm.

The limits in Table 8 do not apply for devices without TPC or when operating on channels whose nominal bandwidth falls completely within the band 5 150 MHz to 5 250 MHz.

Test Procedures:

RF Output Power
The EUT was connected directly to a spectrum analyzer capable of measuring the average RF power of a modulated carrier. Measurements were carried out in all modulations available. Both normal and extreme test conditions were observed.
The EIRP was determined from the equation P = A + G + 10 log (1/x); where A is the measured power, x is the duty cycle and G is the antenna assembly gain.

Transmit Power Control (TPC)
The EUT was connected directly to a spectrum analyzer capable of measuring the average RF power of a modulated carrier. Measurements were carried out in all modulations available. Both normal and extreme test conditions were observed.

Power Density
The EUT was connected directly to a spectrum analyzer capable of measuring the average RF power of a modulated carrier. Measurements were carried out in all modulations available. The spectrum analyzer was initially set with a RBW and VBW of 1MHz and a span 3 times that of the carrier width. The max hold function was used to determine the frequency which gave the maximum value across the occupied band of the carrier. The spectrum analyzer was reset to use the power density function at the frequency found previously. The power density was then measured over 1MHz resolution.

In case of conducted measurements on smart antenna systems operating in a mode with multiple transmit chains active simultaneously, the output power of each transmit chain shall be measured separately to calculate the total power for the UUT.

Test Results: The EUT as tested was found compliant with the specified limits in clause 5.3.4.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/09/11 – 03/10/11

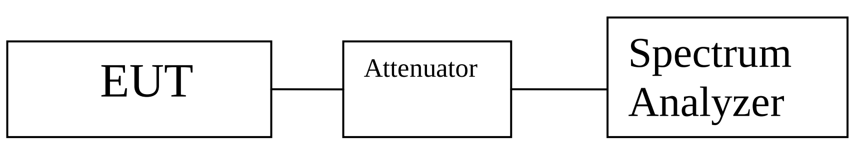
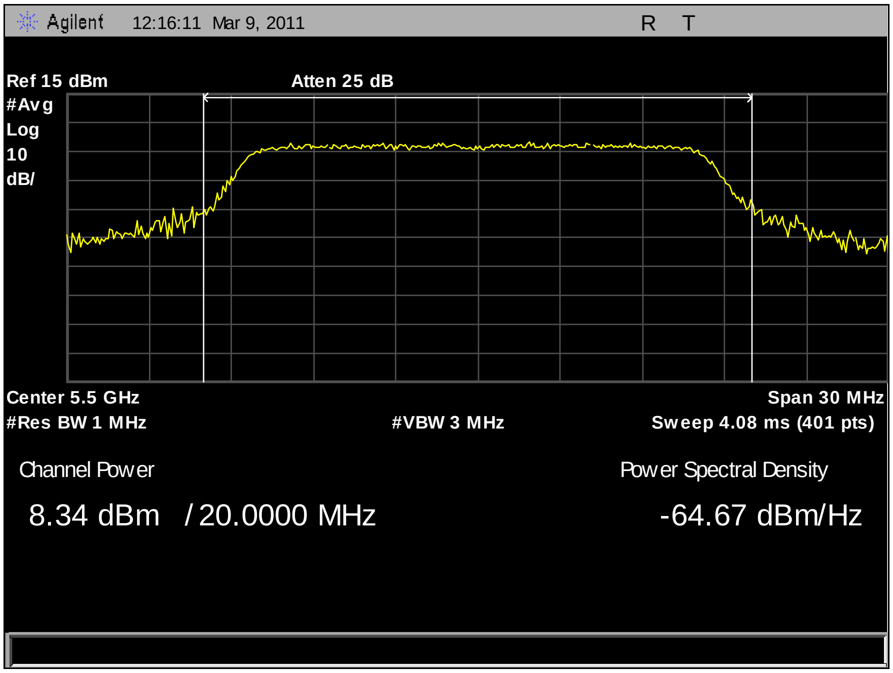


Figure 3. Output Power, TPC, and Power Density Test Setup

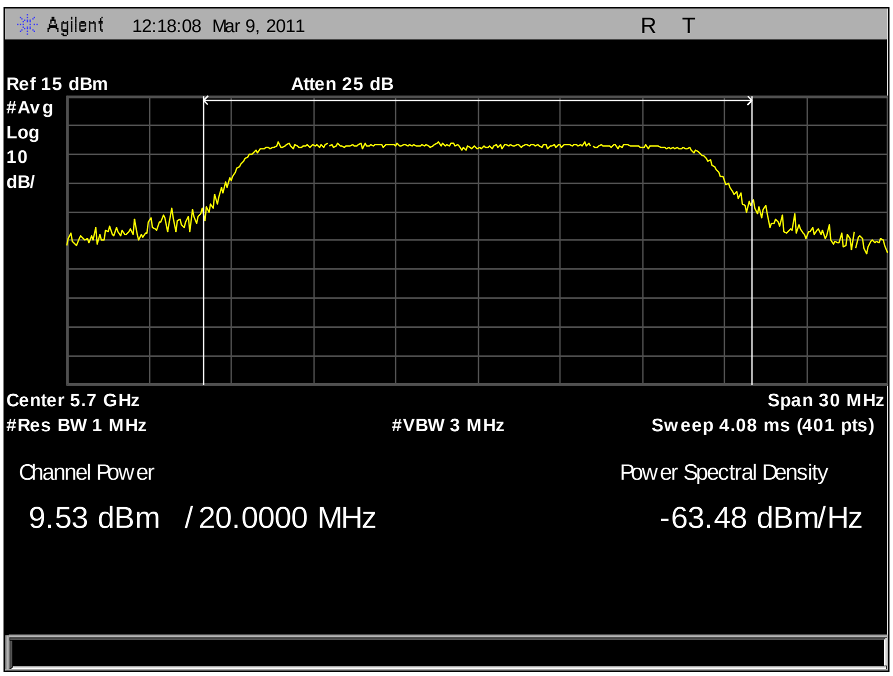
Effective Isotropic Radiated Power Results

Channel	Temperature	Voltage	Mode	Max Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)
Low	Nominal	Nominal	OFDM	8.34	20	28.34	30
High	Nominal	Nominal	OFDM	9.53	20	29.53	30
Low	Maximum	Minimum	OFDM	6.77	20	26.77	30
Low	Maximum	Maximum	OFDM	6.70	20	26.70	30
High	Maximum	Minimum	OFDM	7.70	20	27.70	30
High	Maximum	Maximum	OFDM	7.87	20	27.87	30
Low	Minimum	Minimum	OFDM	8.84	20	28.84	30
Low	Minimum	Maximum	OFDM	8.70	20	28.70	30
High	Minimum	Minimum	OFDM	9.89	20	29.89	30
High	Minimum	Maximum	OFDM	9.94	20	29.94	30

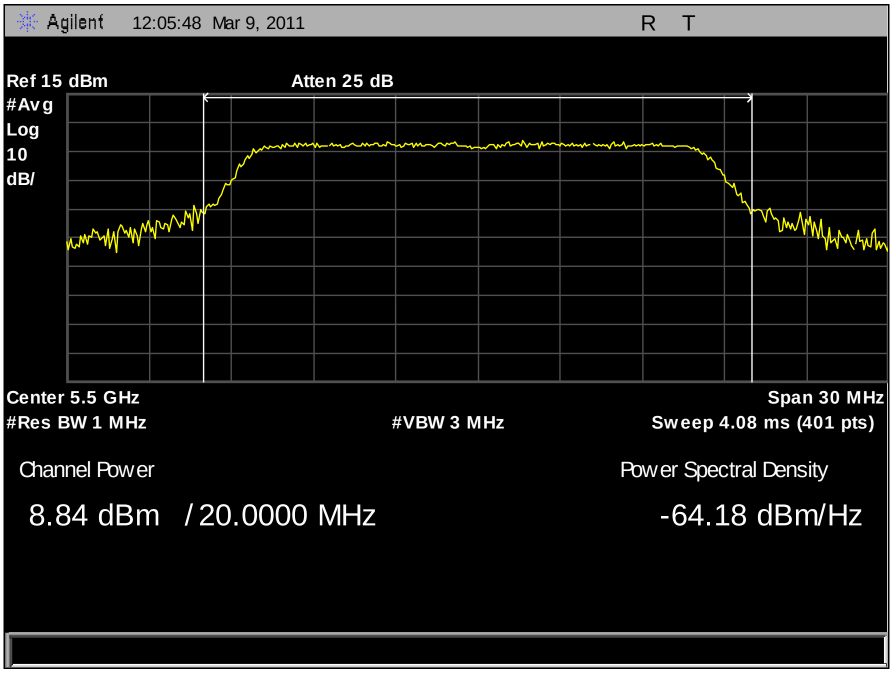
Table 9. RF Output Power, Test Results



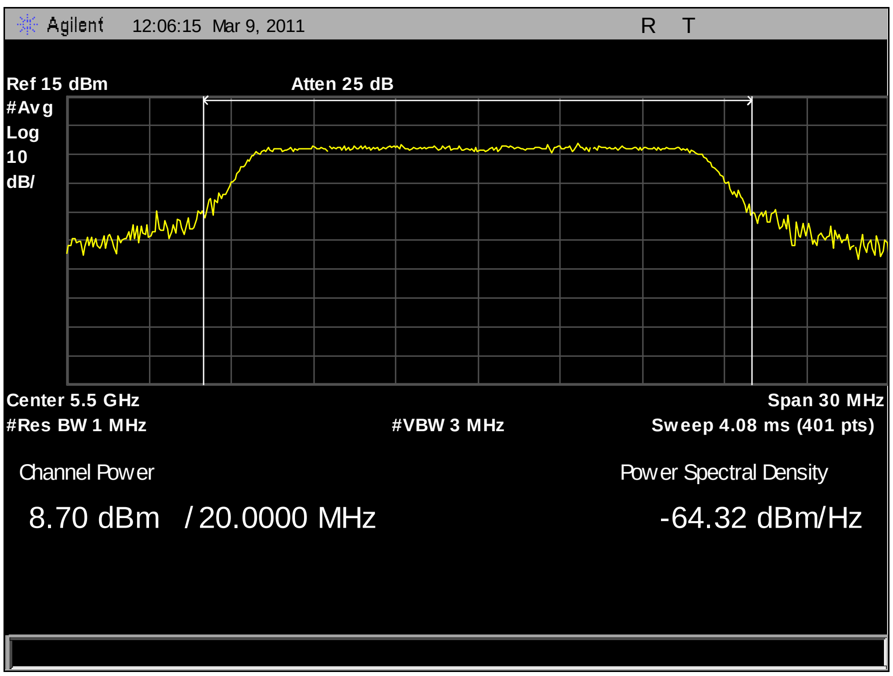
Plot 13. RF Output Power, 5500 MHz, 20°C, 230 VAC



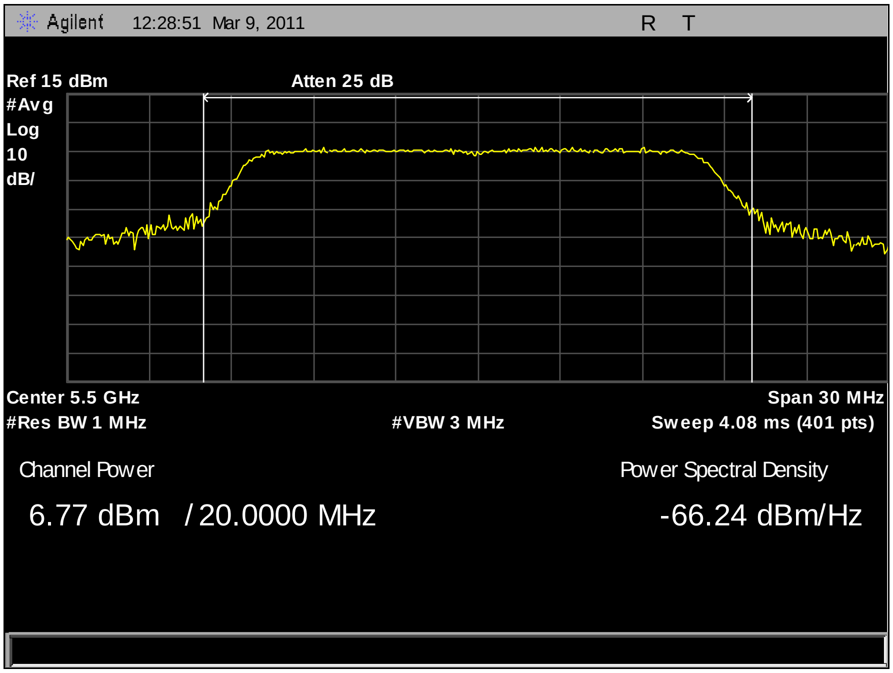
Plot 14. RF Output Power, 5700 MHz, 20°C, 230 VAC



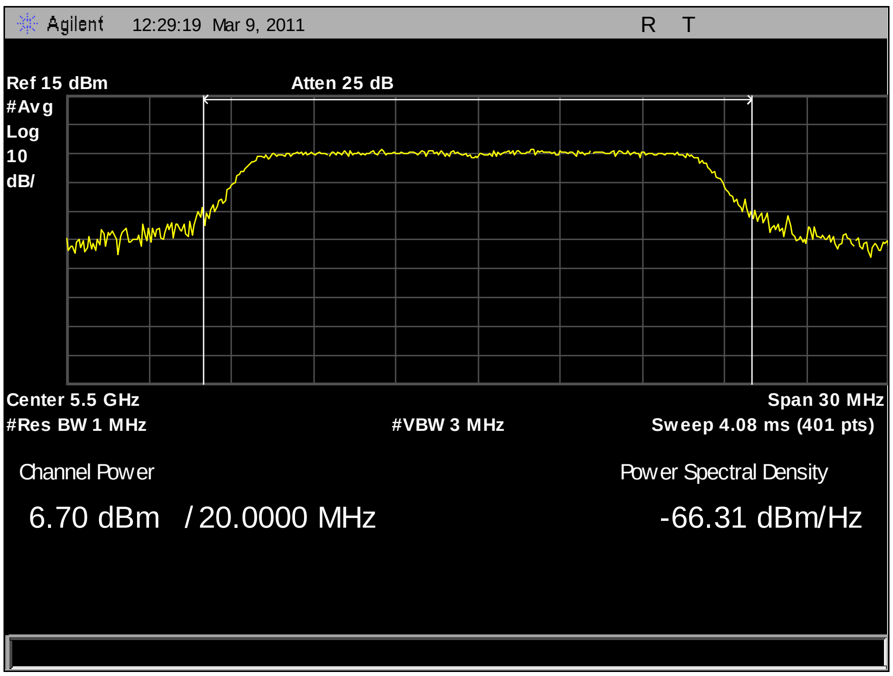
Plot 15. RF Output Power, 5500 MHz, -10°C, 207 VAC



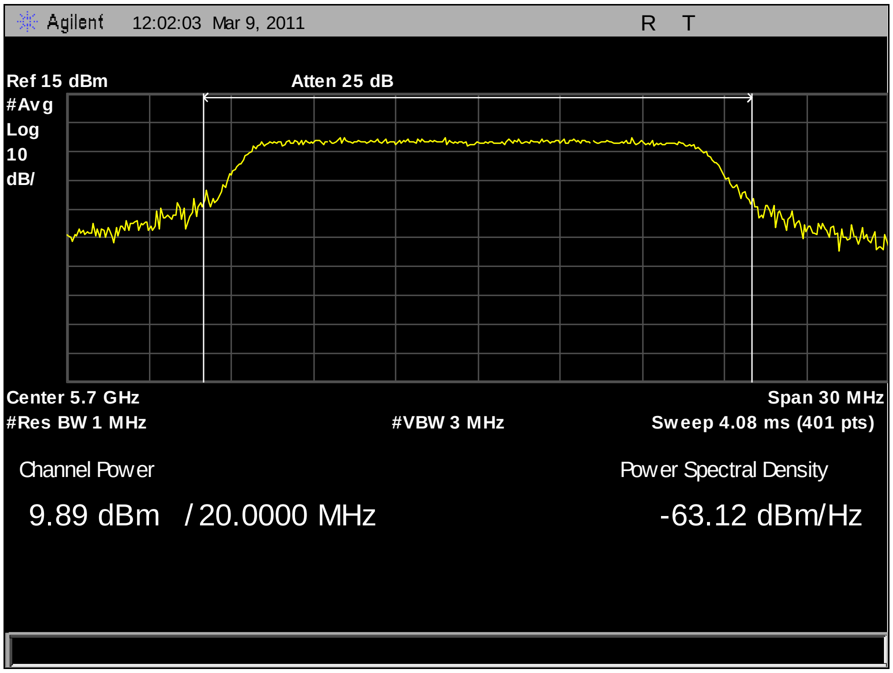
Plot 16. RF Output Power, 5500 MHz, -10°C, 254 VAC



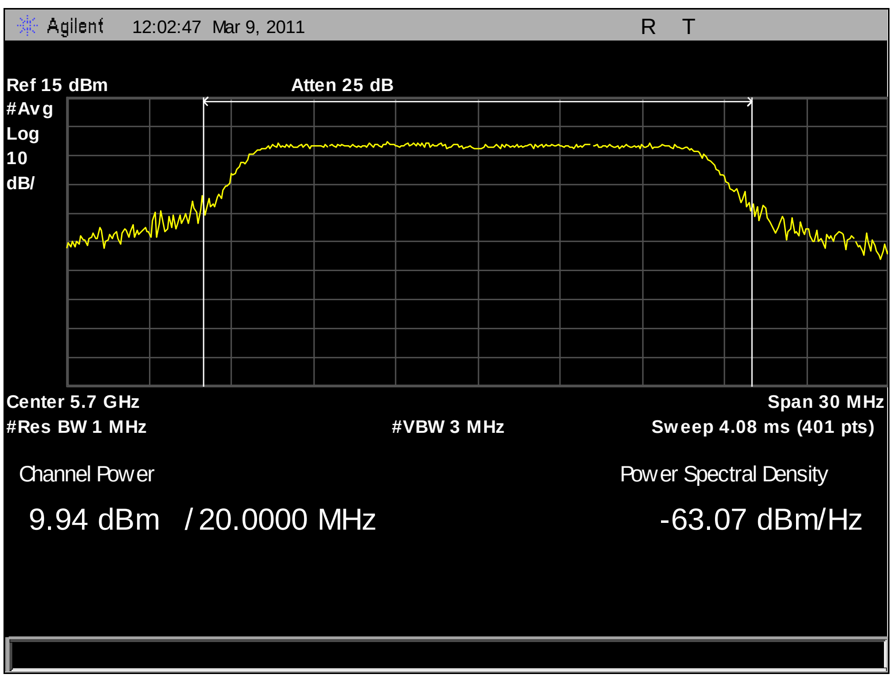
Plot 17. RF Output Power, 5500 MHz, 55°C, 207 VAC



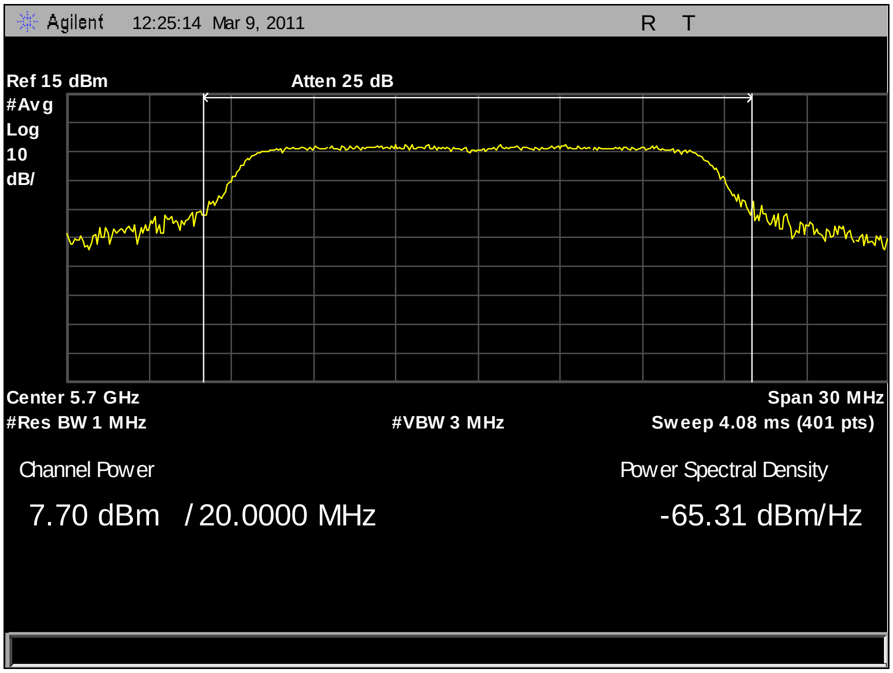
Plot 18. RF Output Power, 5500 MHz, 55°C, 254 VAC



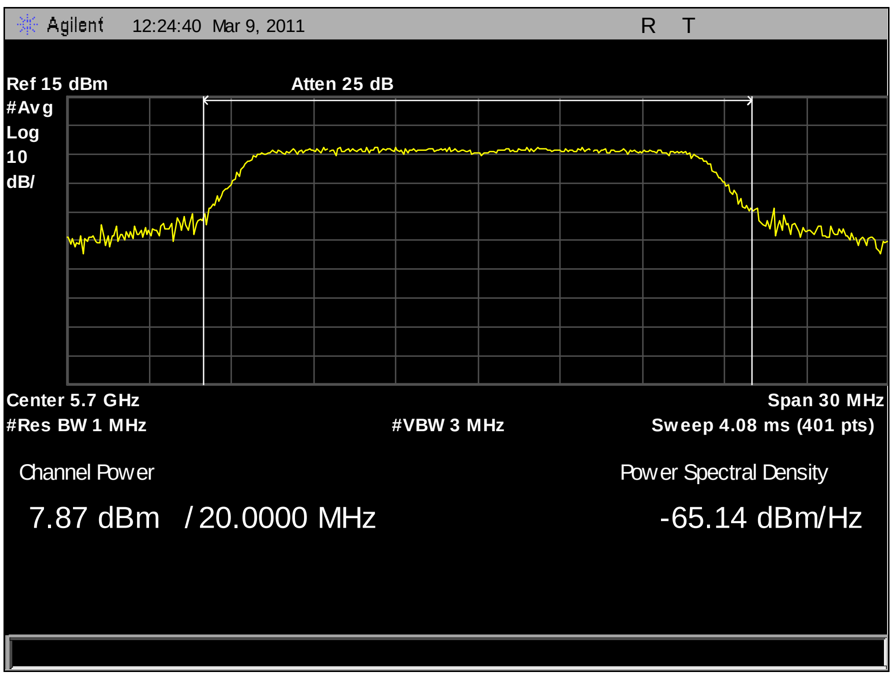
Plot 19. RF Output Power, 5700 MHz, -10°C, 207 VAC



Plot 20. RF Output Power, 5700 MHz, -10°C, 254 VAC



Plot 21. RF Output Power, 5700 MHz, 55°C, 207 VAC

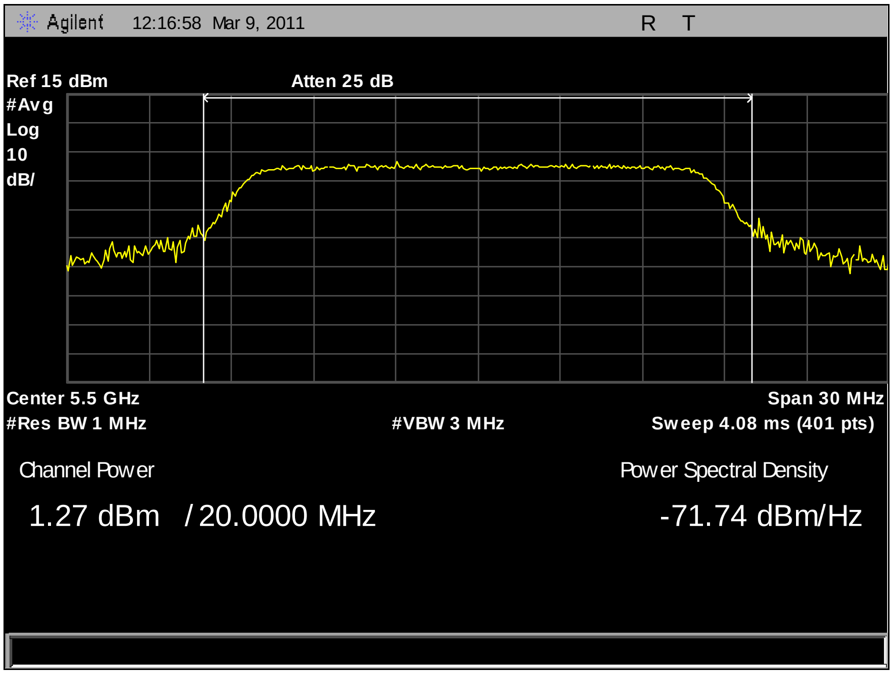


Plot 22. RF Output Power, 5700 MHz, 55°C, 254 VAC

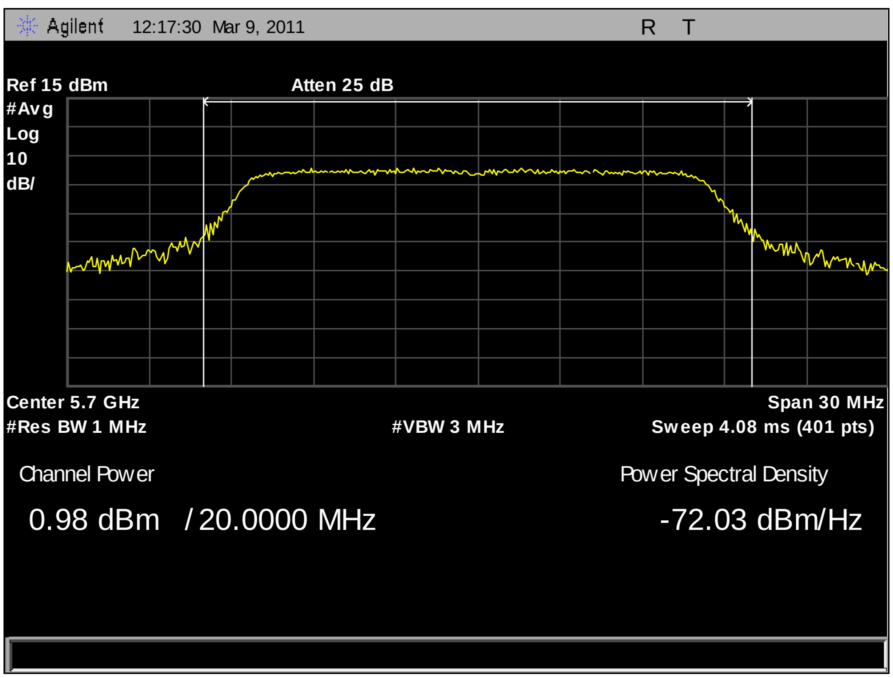
Effective Isotropic Radiated Power Results

Channel	Temperature	Voltage	Mode	Min Conducted TPC Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
Low	Nominal	Nominal	OFDM	1.27	20	21.27
High	Nominal	Nominal	OFDM	0.98	20	20.98
Low	Maximum	Minimum	OFDM	-2.07	20	17.93
Low	Maximum	Maximum	OFDM	-2.17	20	17.83
High	Maximum	Minimum	OFDM	-1.22	20	18.78
High	Maximum	Maximum	OFDM	-1.09	20	18.91
Low	Minimum	Minimum	OFDM	2.48	20	22.48
Low	Minimum	Maximum	OFDM	2.55	20	22.55
High	Minimum	Minimum	OFDM	2.41	20	22.41
High	Minimum	Maximum	OFDM	2.51	20	22.51

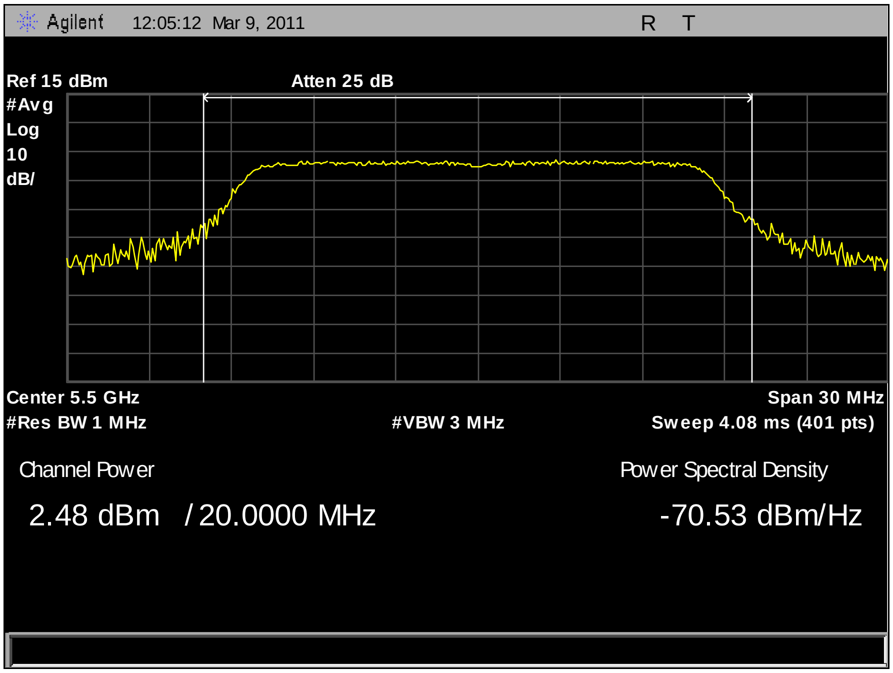
Table 10. Transmit Power Control, Test Results



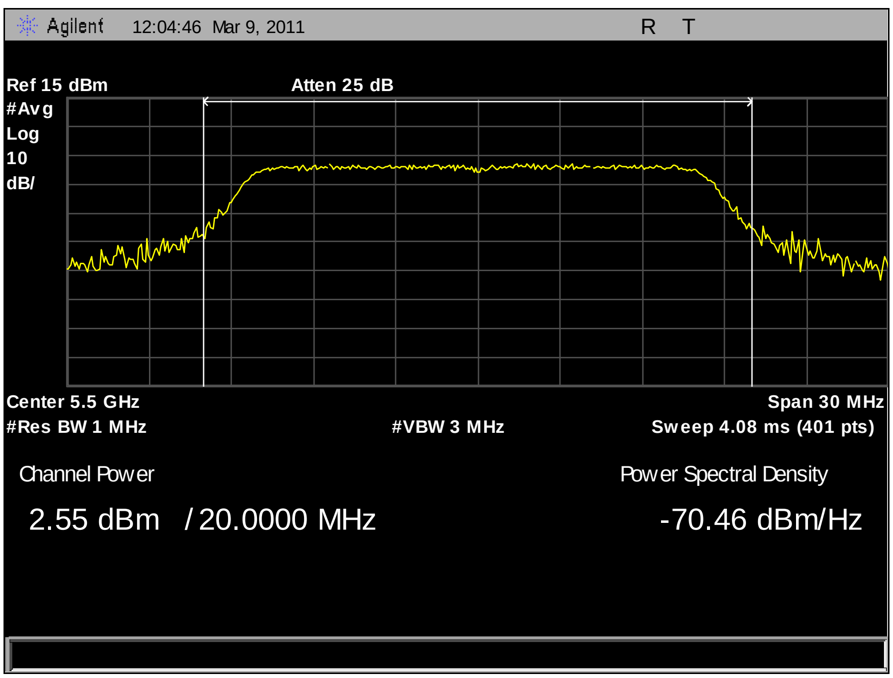
Plot 23. Transmit Power Control, 5500 MHz, 20°C, 230 VAC



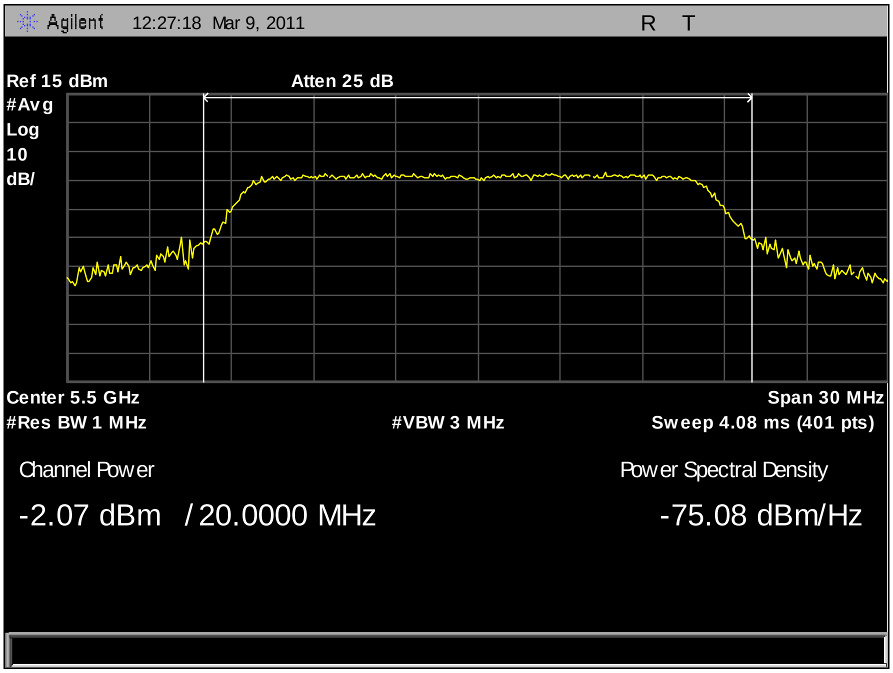
Plot 24. Transmit Power Control, 5700 MHz, 20°C, 230 VAC



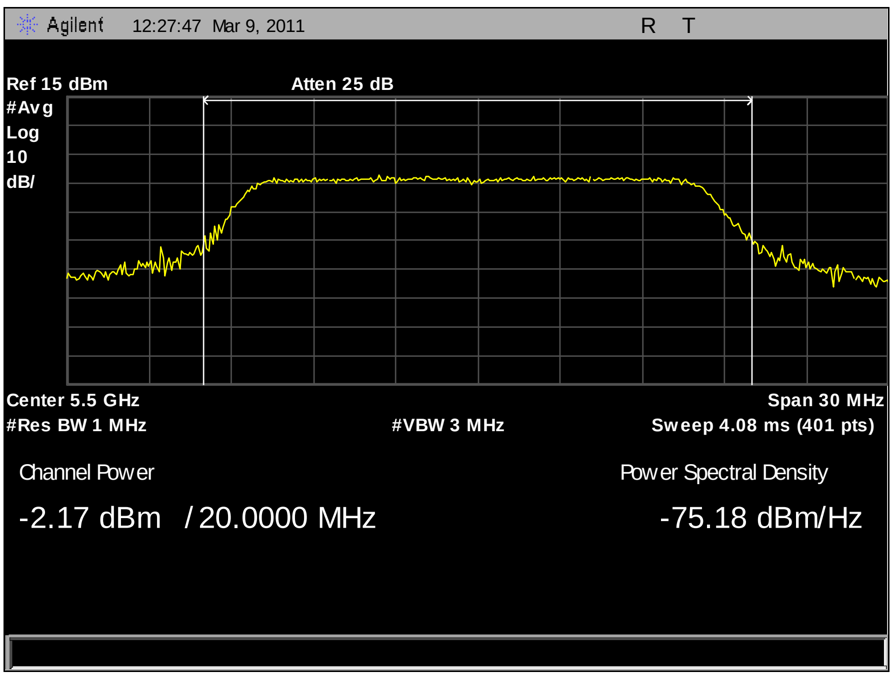
Plot 25. Transmit Power Control, 5500 MHz, -10°C, 207 VAC



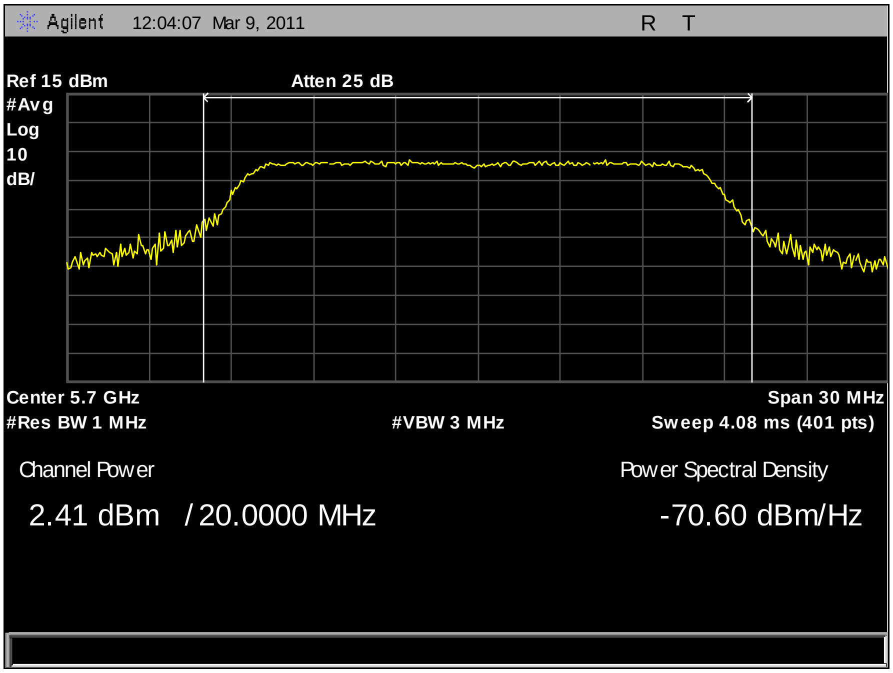
Plot 26. Transmit Power Control, 5500 MHz, -10°C, 254 VAC



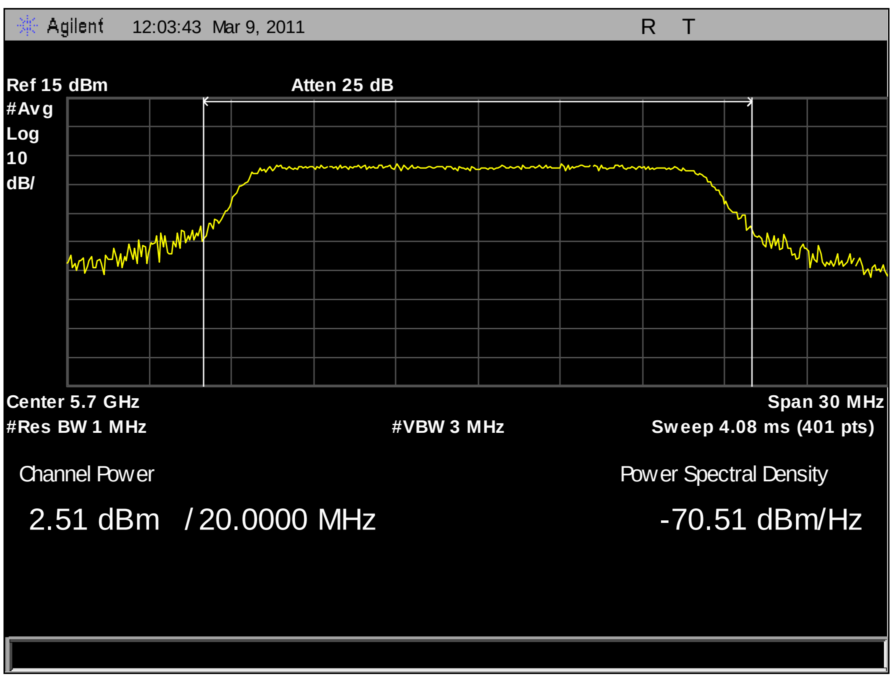
Plot 27. Transmit Power Control, 5500 MHz, 55°C, 207 VAC



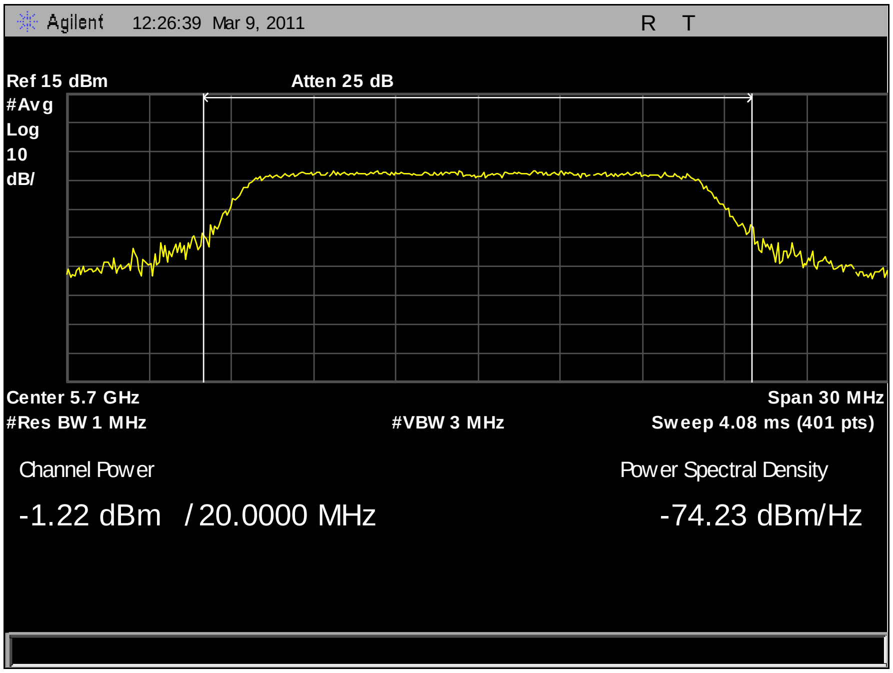
Plot 28. Transmit Power Control, 5500 MHz, 55°C, 254 VAC



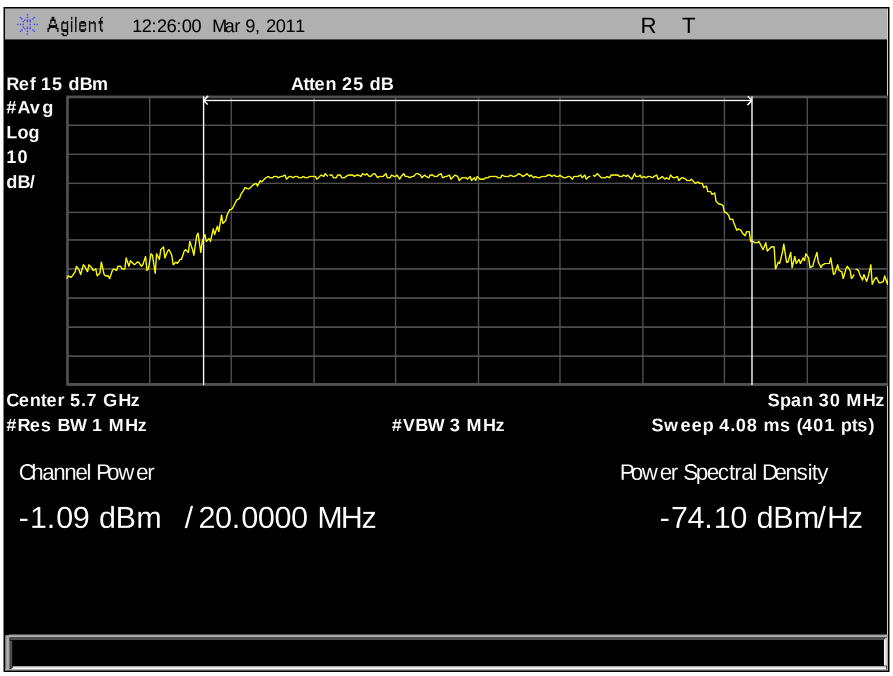
Plot 29. Transmit Power Control, 5700 MHz, -10°C, 207 VAC



Plot 30. Transmit Power Control, 5700 MHz, -10°C, 254 VAC



Plot 31. Transmit Power Control, 5700 MHz, 55°C, 207 VAC



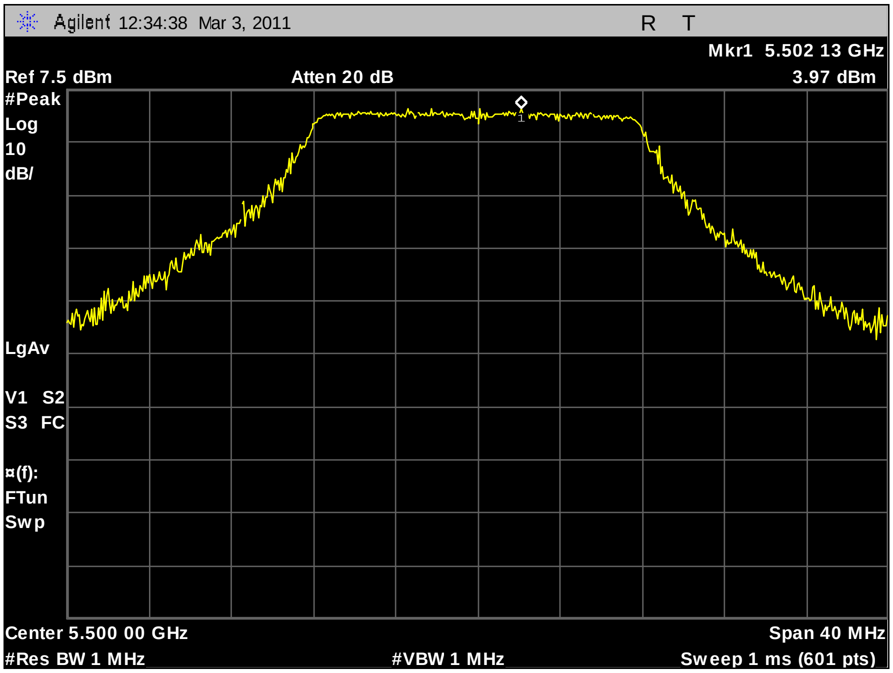
Plot 32. Transmit Power Control, 5700 MHz, 55°C, 254 VAC

Photograph 3. Temperature Testing, Test Setup

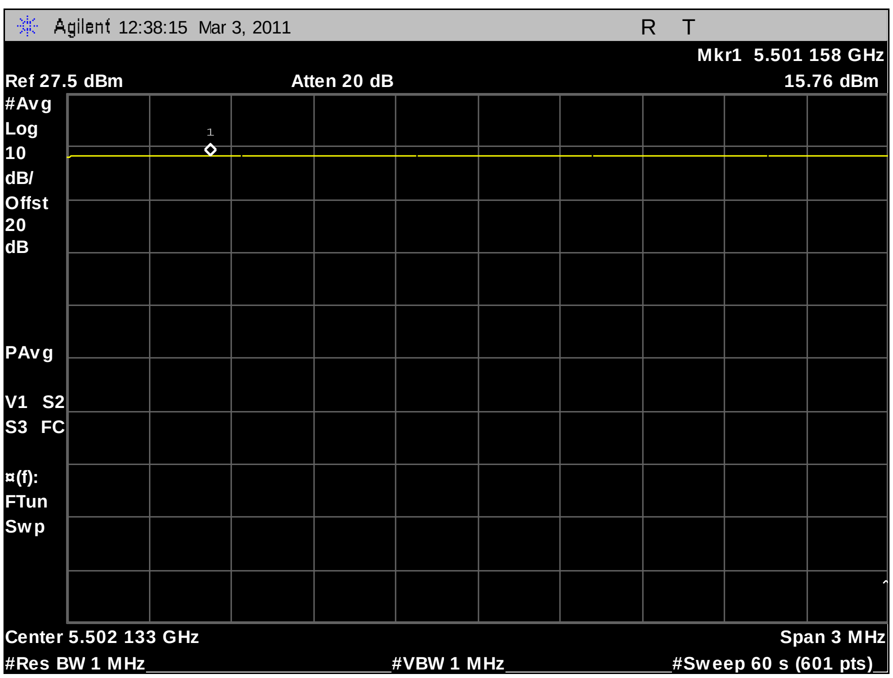
Power Density

Power Spectral Density					
Channel		**Mode**	**Measured Power Density**	**Limit**	**Margin**
(MHz)			**dBm**	**dBm**	**dB**
5500	Low	**OFDM**	15.76	17	-1.24
5700	High	**OFDM**	16.69	17	-0.31

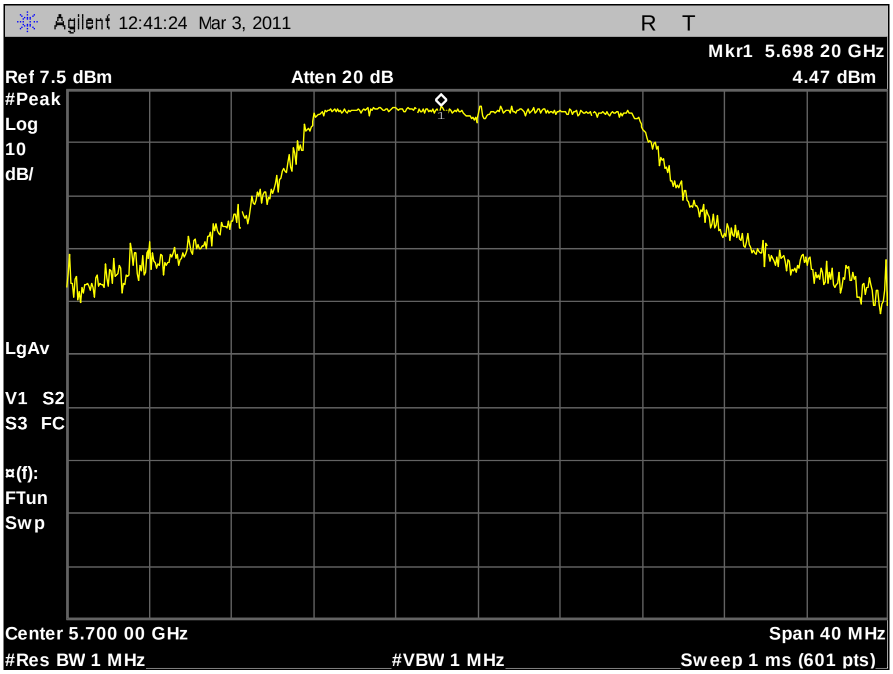
Table 11. Power Spectral Density, Test Results



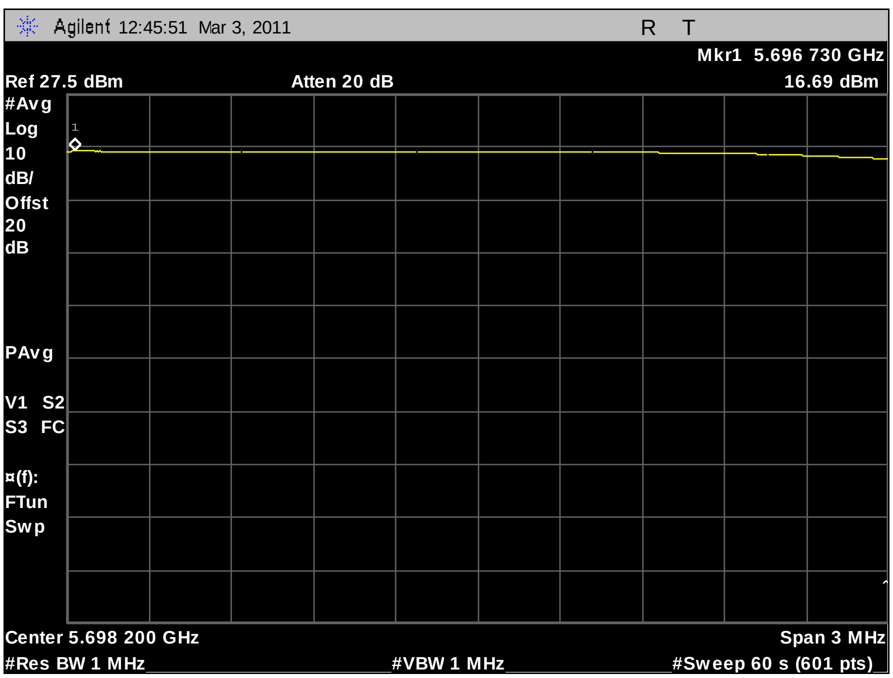
Plot 33. Power Density, PSD Determination, 5500 MHz



Plot 34. Power Density, 5500 MHz



Plot 35. Power Density, PSD Determination, 5700 MHz



Plot 36. Power Density, 5700 MHz

4.5.1 Transmitter Unwanted Emissions Outside the 5GHz RLAN Bands (Conducted)

Test Requirement(s): **EN 301 893, Clause 5.3.5:**

4.5.1.1 Definition
These are conducted radio frequency emissions outside the 5GHz RLAN bands when the RF output port is connected to a spectrum analyzer.

4.5.1.2 Limit
The level of unwanted emissions shall not exceed the limits given below.

Frequency range	Maximum power ERP	Resolution Bandwidth
30 MHz to 47 MHz	-36dBm	100KHz
47 MHz to 74 MHz	-54dBm	100KHz
74 MHz to 87,5 MHz	-36dBm	100KHz
87,5 MHz to 118 MHz	-54dBm	100KHz
118 MHz to 174 MHz	-36dBm	100KHz
174 MHz to 230 MHz	-54dBm	100KHz
230 MHz to 470 MHz	-36dBm	100KHz
470 MHz to 862 MHz	-54dBm	100KHz
862 MHz to 1 GHz	-36dBm	100KHz
1 GHz to 5,15 GHz	-30dBm	1MHz
5,35 GHz to 5,47 GHz	-30dBm	1MHz
5,725 GHz to 26,5 GHz	-30dBm	1MHz

Test Procedure: The EUT was connected directly to a spectrum analyzer through an attenuator. The spectrum analyzer was initially set to the peak hold function or video averaging. Emissions were investigated from 30MHz up to 26.5GHz. If any emission exceeded the limits in the table above then the spectrum analyzer was reset with a resolution of 100KHz, zero span, and the spectrum investigate at 11 frequencies spaced 100KHz in a band ± 0.5MHz centered on the failing frequency. The spectrum also was investigated from 1GHz to 5.15GHz, 5.35GHz to 5.47GHz and 5.725GHz to 26.5GHz using a resolution of 1MHz and a peak hold function or video averaging. Measurements were carried out in all modulations available.

Test Results: The EUT as tested was found compliant with the specified requirements of Clause 5.3.5.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/09/11 – 03/10/11

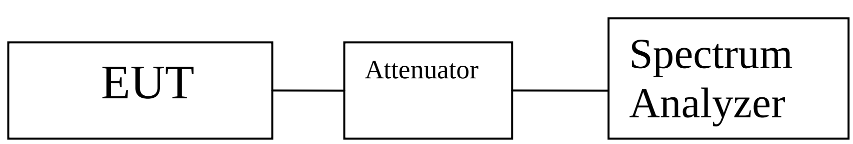
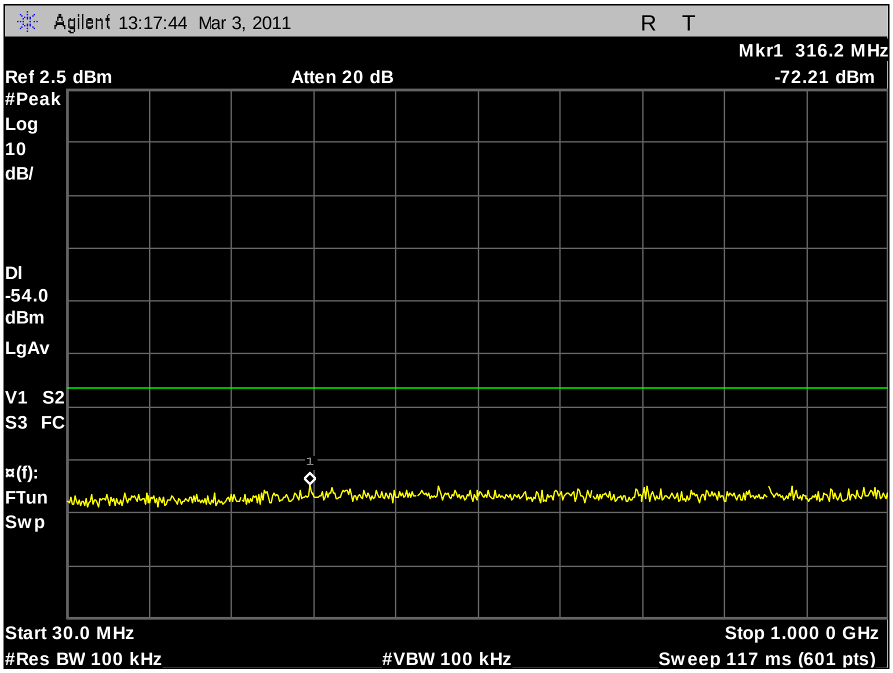
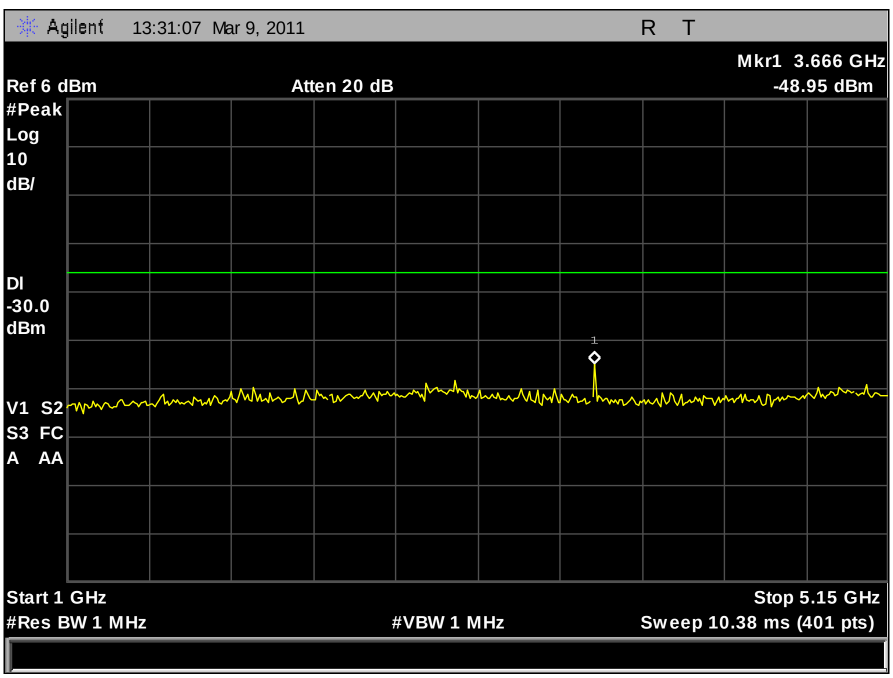


Figure 4. Unwanted Conducted Emissions Outside Test Setup

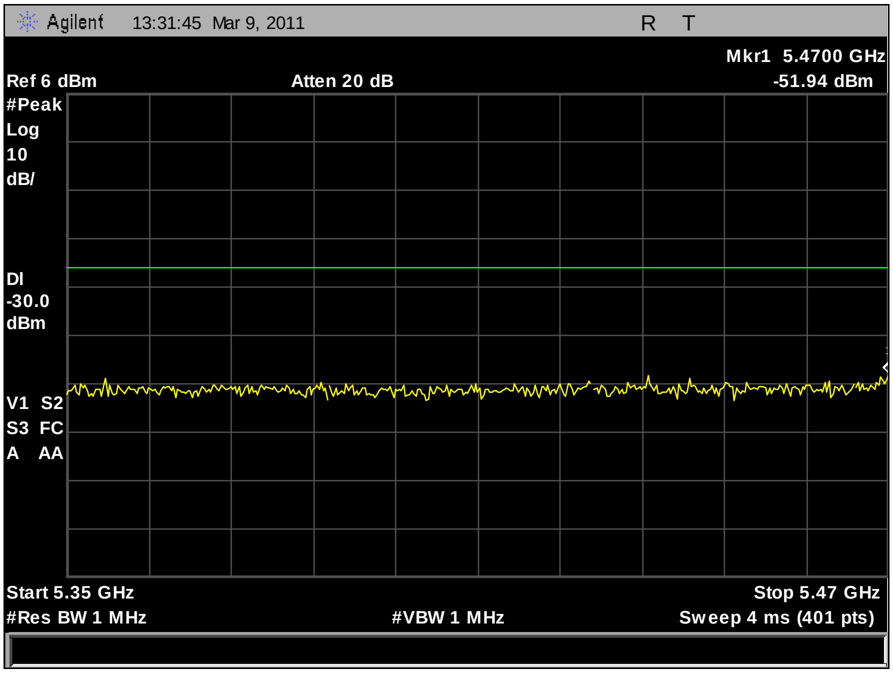
Conducted Spurious Emissions Outside the 5GHz RLAN Bands



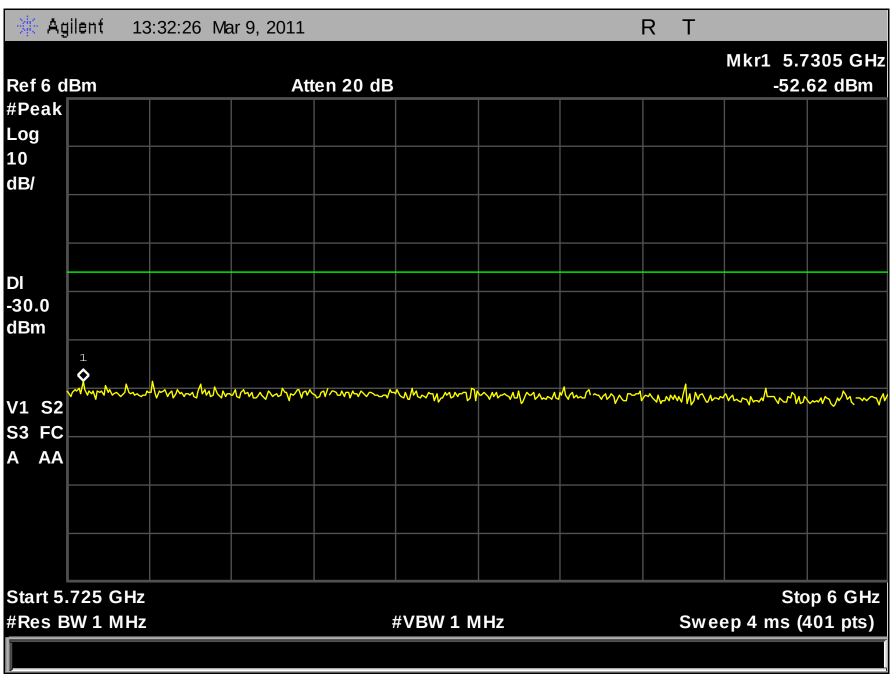
Plot 37. Conducted Spurious Emission, 30 MHz – 1 GHz, 5500 MHz



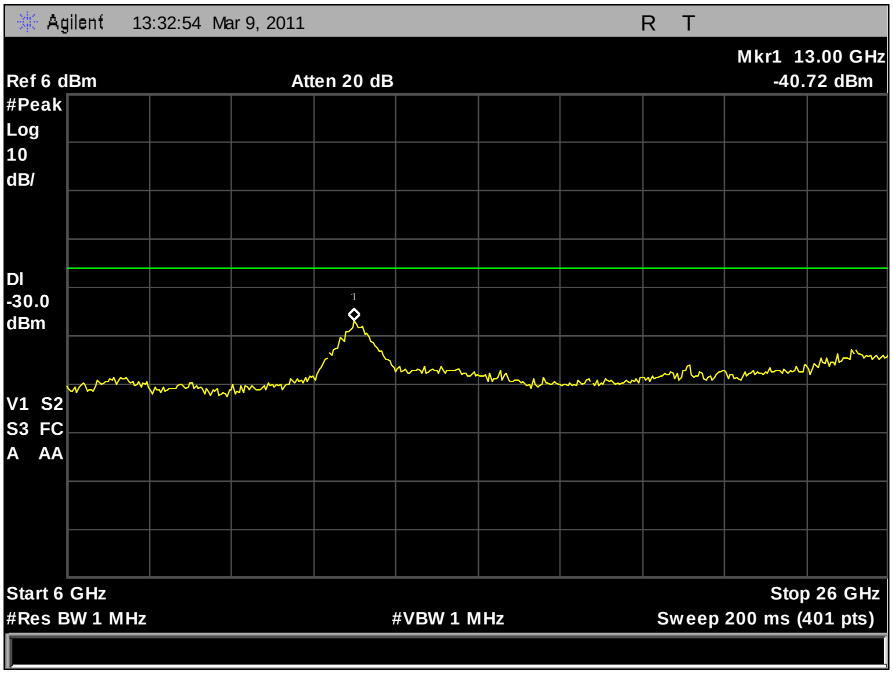
Plot 38. Conducted Spurious Emission, 1 GHz – 5.15 GHz, 5500 MHz



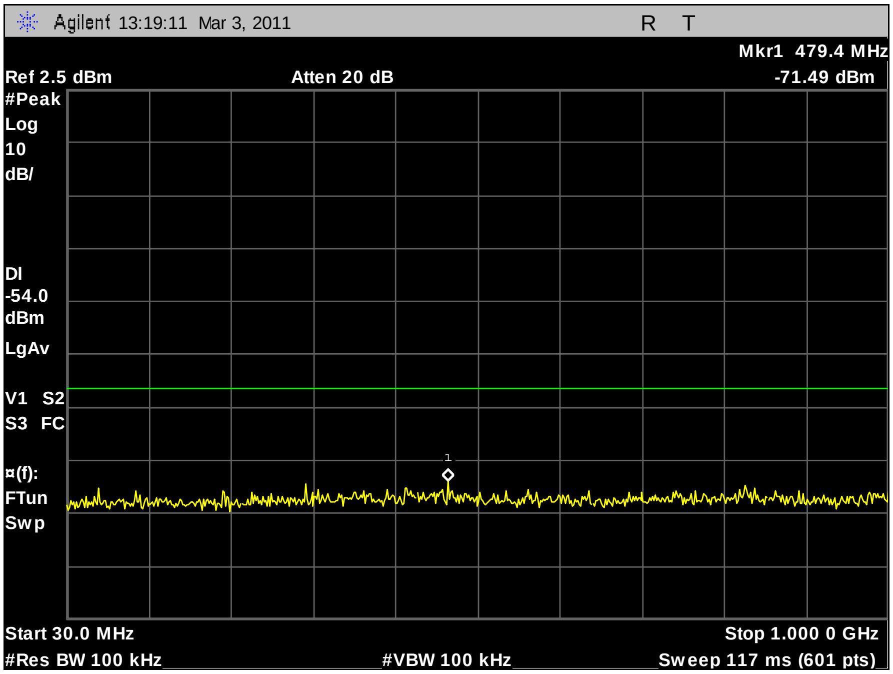
Plot 39. Conducted Spurious Emission, Port 1, 5.35 GHz – 5.47 GHz, 5500 MHz



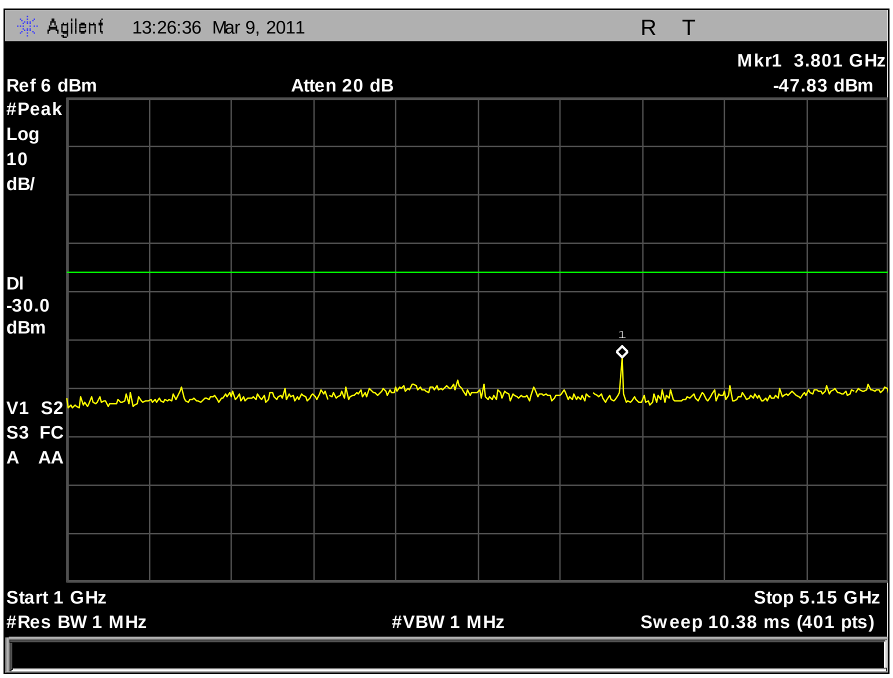
Plot 40. Conducted Spurious Emission, 5.725 GHz – 6 GHz, 5500 MHz



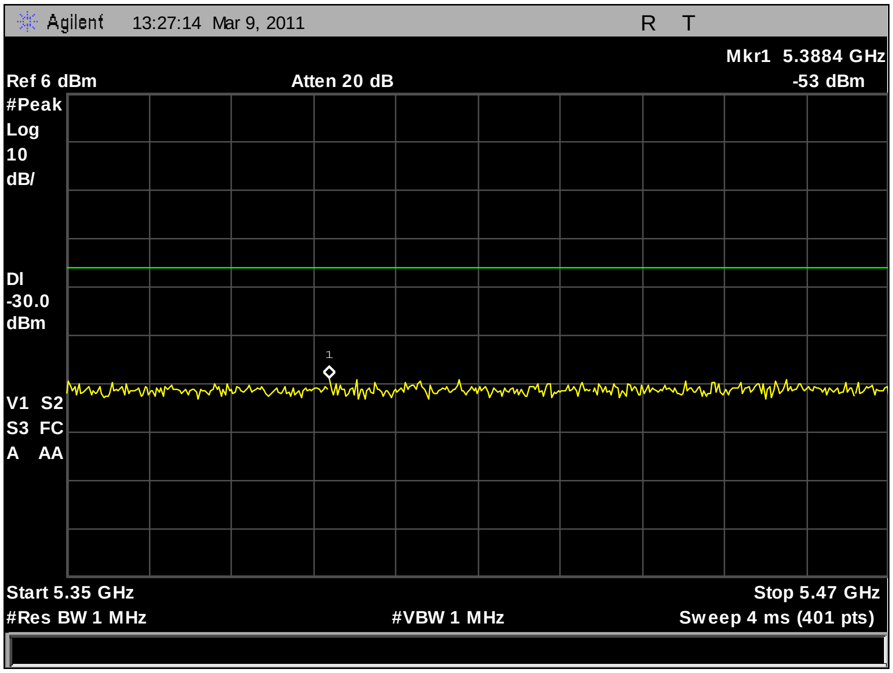
Plot 41. Conducted Spurious Emission, 5.725 GHz – 26 GHz, 5500 MHz



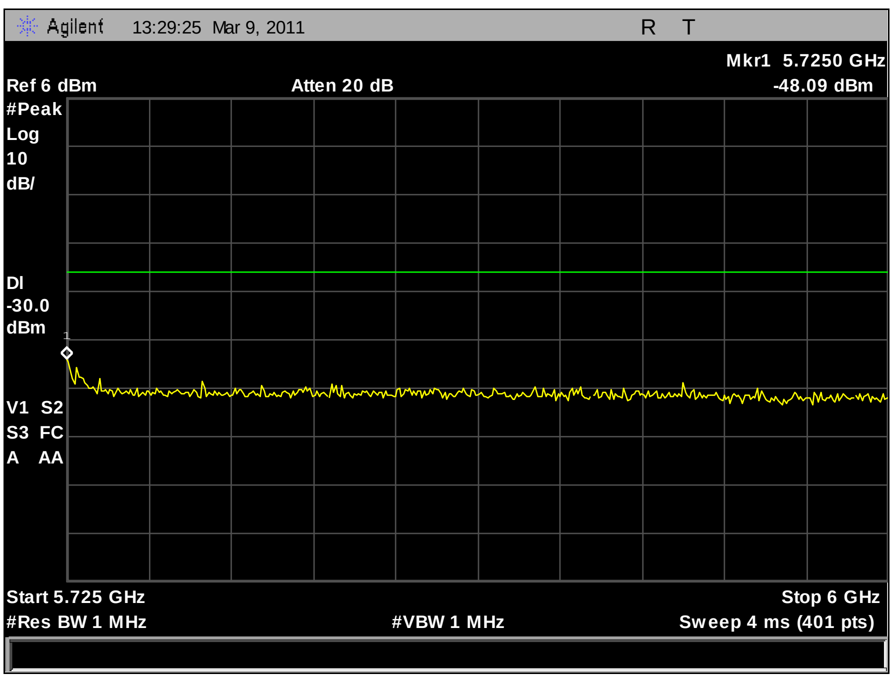
Plot 42. Conducted Spurious Emission, 30 MHz – 1 GHz, 5700 MHz



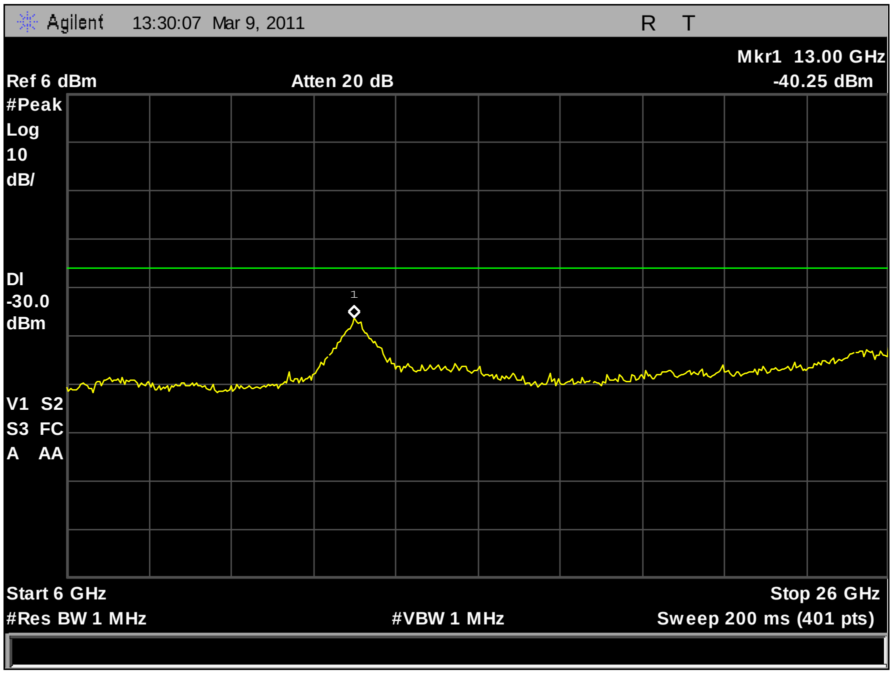
Plot 43. Conducted Spurious Emission, 1 GHz – 5.15 GHz, 5700 MHz



Plot 44. Conducted Spurious Emission, Port 1, 5.35 GHz – 5.47 GHz, 5700 MHz



Plot 45. Conducted Spurious Emission, 5.725 GHz – 6 GHz, 5700 MHz



Plot 46. Conducted Spurious Emission, 5.725 GHz – 26 GHz, 5700 MHz

4.5.1 Transmitter Unwanted Emissions Outside the 5GHz RLAN Bands (Radiated)

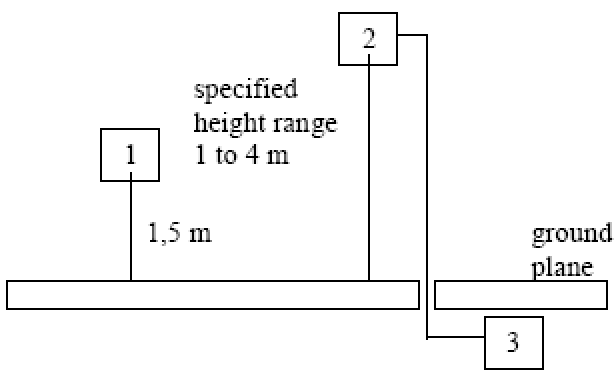
Test Requirement(s): **EN 301 893, Clause 5.3.5**

4.5.1.1 Definition
These are radiated radio frequency emissions outside the 5GHz RLAN bands when the RF output port is connected to a spectrum analyzer.

4.5.1.2 Limit
The level of unwanted emissions shall not exceed the limits given

Frequency range	Maximum power ERP	Bandwidth
30 MHz to 47 MHz	-36dBm	100KHz
47 MHz to 74 MHz	-54dBm	100KHz
74 MHz to 87,5 MHz	-36dBm	100KHz
87,5 MHz to 118 MHz	-54dBm	100KHz
118 MHz to 174 MHz	-36dBm	100KHz
174 MHz to 230 MHz	-54dBm	100KHz
230 MHz to 470 MHz	-36dBm	100KHz
470 MHz to 862 MHz	-54dBm	100KHz
862 MHz to 1 GHz	-36dBm	100KHz
1 GHz to 5,15 GHz	-30dBm	1MHz
5,35 GHz to 5,47 GHz	-30dBm	1MHz
5,725 GHz to 26,5 GHz	-30dBm	1MHz

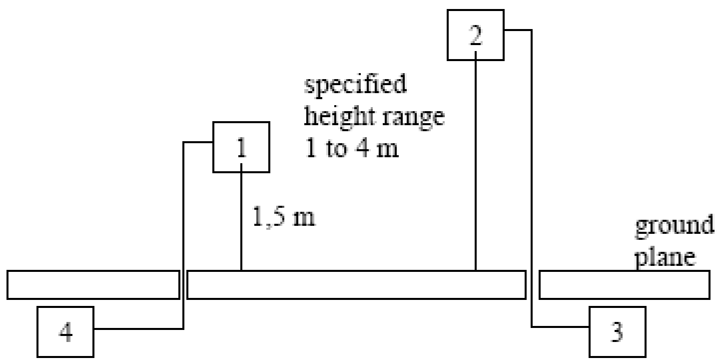
Test Procedure: The EUT was setup as per the specifications set out in Annex B of 301 893 and is shown below.



1. Equipment Under Test
2. Test Antenna
3. Spectrum Analyzer

The antenna ports were terminated into a 50Ω load. The receiving antenna was connected directly to a spectrum analyzer through an RF pre-amplifier. The spectrum analyzer were initially set to the peak hold function or video averaging. Emissions were investigated from. If any emission exceeded the limits in the table above then the spectrum analyzer was reset with a resolution of 100KHz, zero span, and the spectrum investigate at 11 frequencies spaced 100KHz in a band ± 0.5MHz centered on the failing frequency. The spectrum also was investigated from 1GHz to 5.15GHz, 5.35GHz to 5.47GHz and 5.725GHz to 26.5GHz using a resolution of 1MHz and a peak hold function or video averaging. The turntable was rotated about 360^0 and the receiving antenna raised and lowered 1-4m in order to determine the maximum emissions. Measurements were carried out in all modulations available.

The levels of emissions were then determined using a signal substitution method and the setup is shown below.



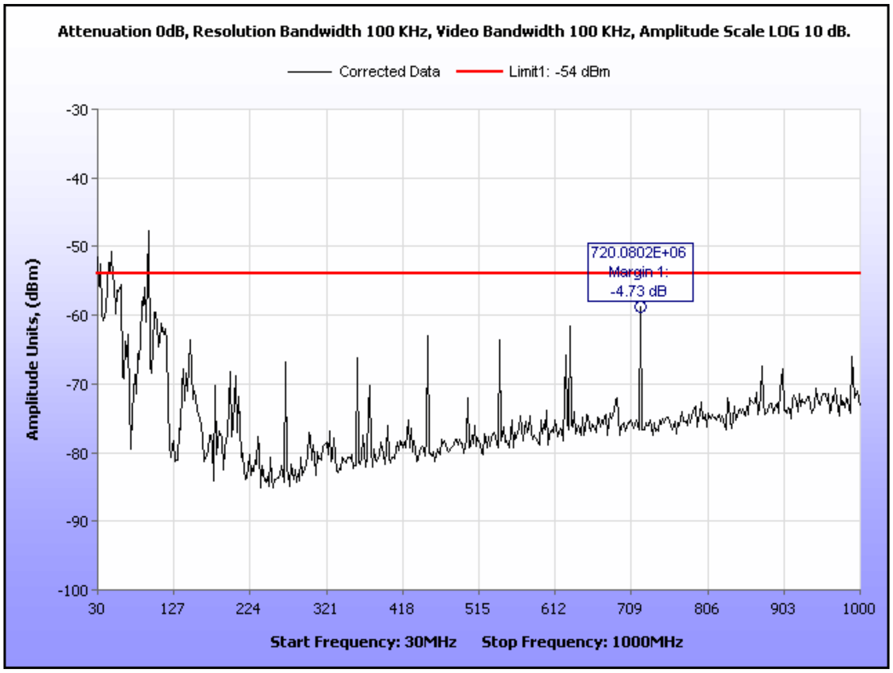
1. Substitution Antenna
2. Test Antenna
3. Spectrum Analyzer
4. Signal Generator

Test Results: The EUT as tested was found compliant with the specified requirements of Clause 5.3.5. Emissions below 1 GHz that appear to be above the limit are from the digital portion of the EUT and therefore do not fall under the 15.209 limits.

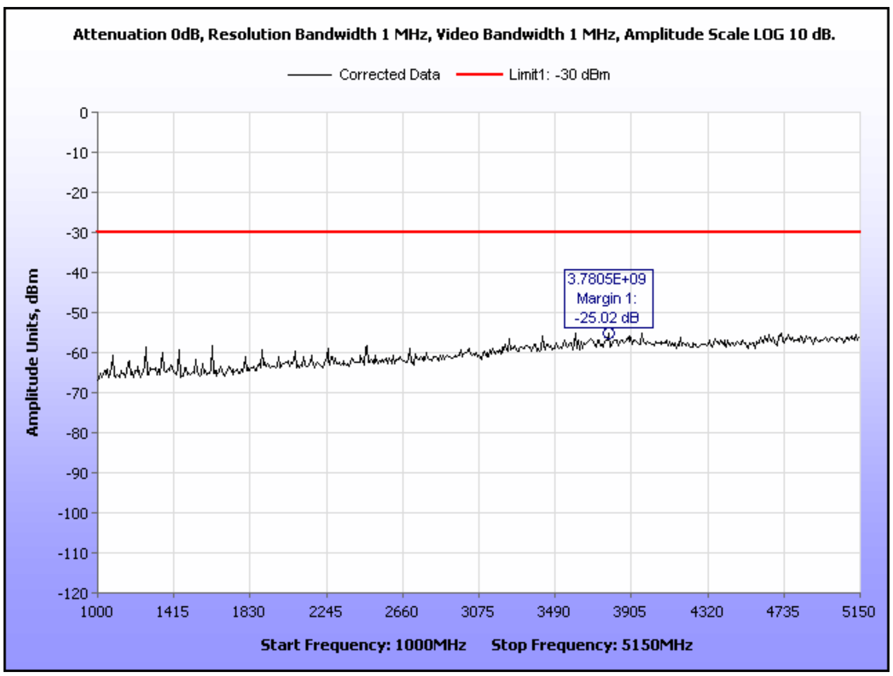
Test Engineer: Dusmantha Tennakoon

Test Date: 03/10/11

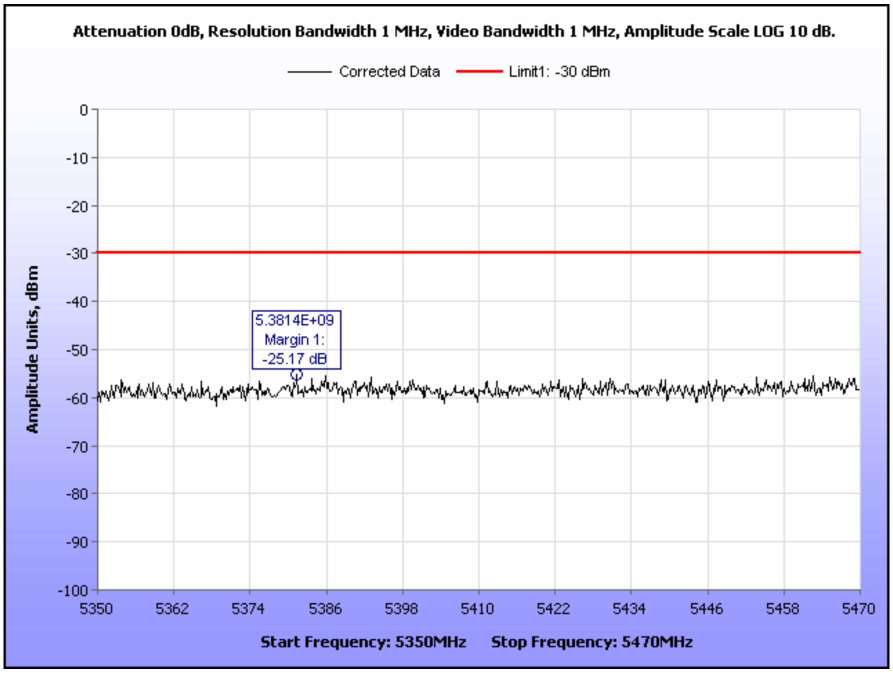
Radiated Spurious Emissions



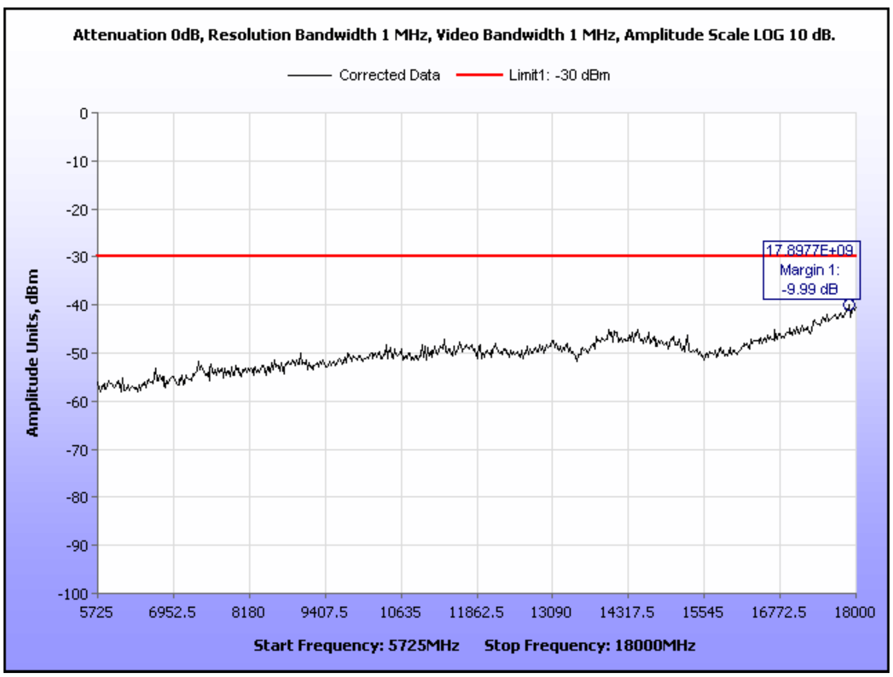
Plot 47. Radiated Spurious Emission, 30 MHz – 1 GHz, 5500 MHz



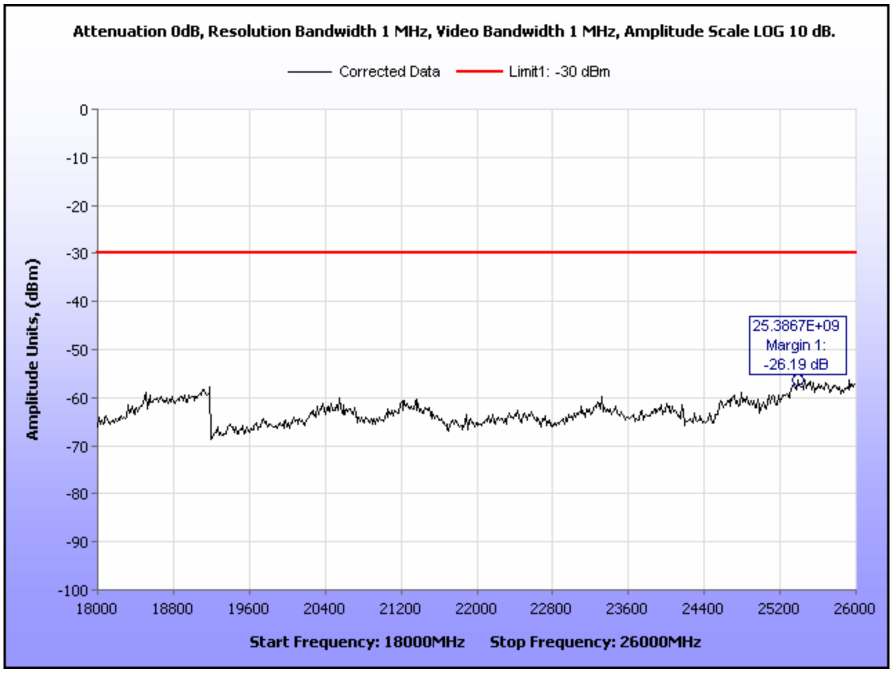
Plot 48. Radiated Spurious Emission, 1 GHz – 5.15 GHz, 5500 MHz



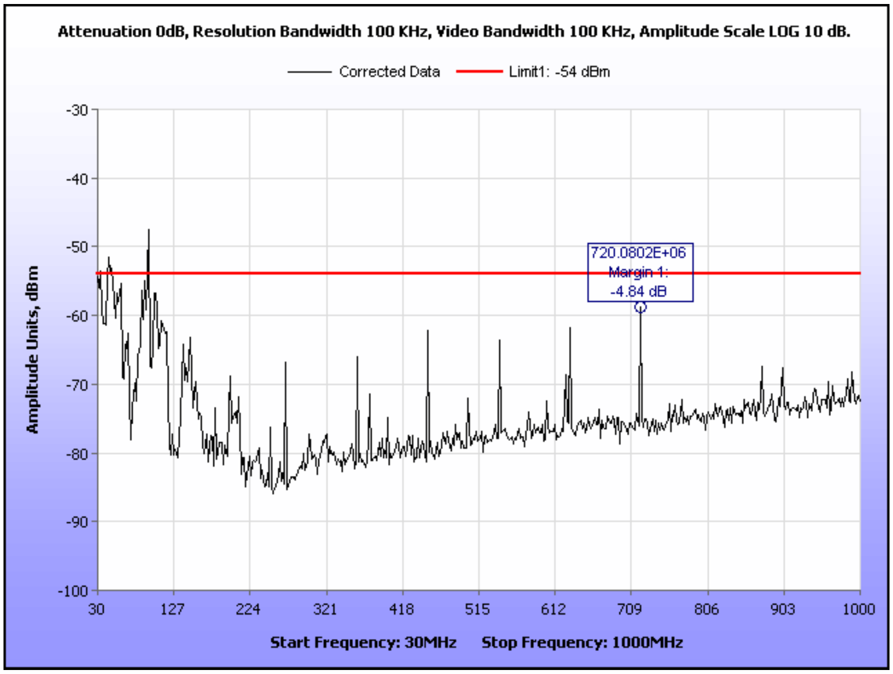
Plot 49. Radiated Spurious Emission, 5.35 GHz – 5.47 GHz, 5500 MHz



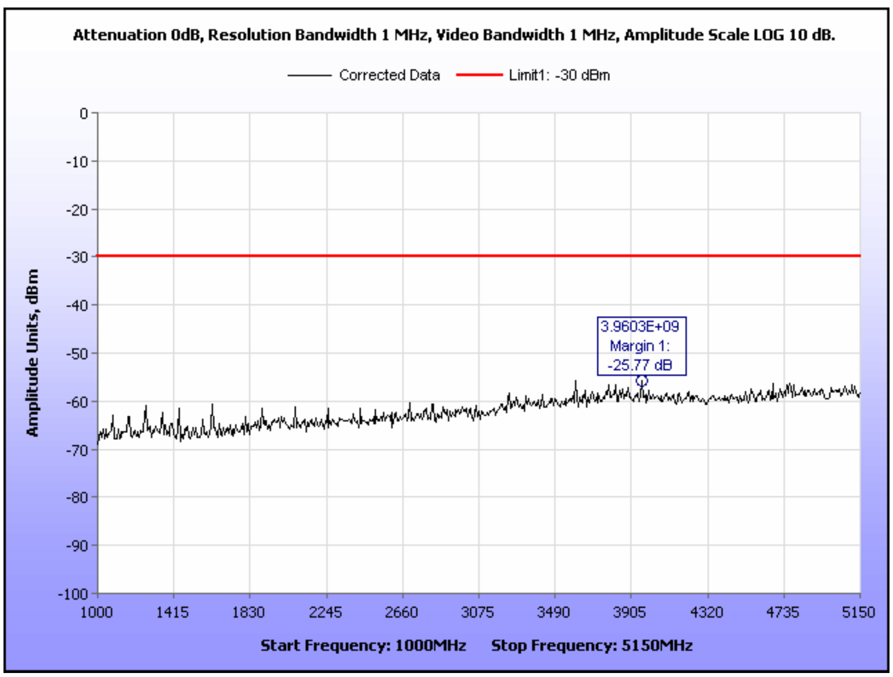
Plot 50. Radiated Spurious Emission, 5.725 GHz - 18 GHz, 5500 MHz



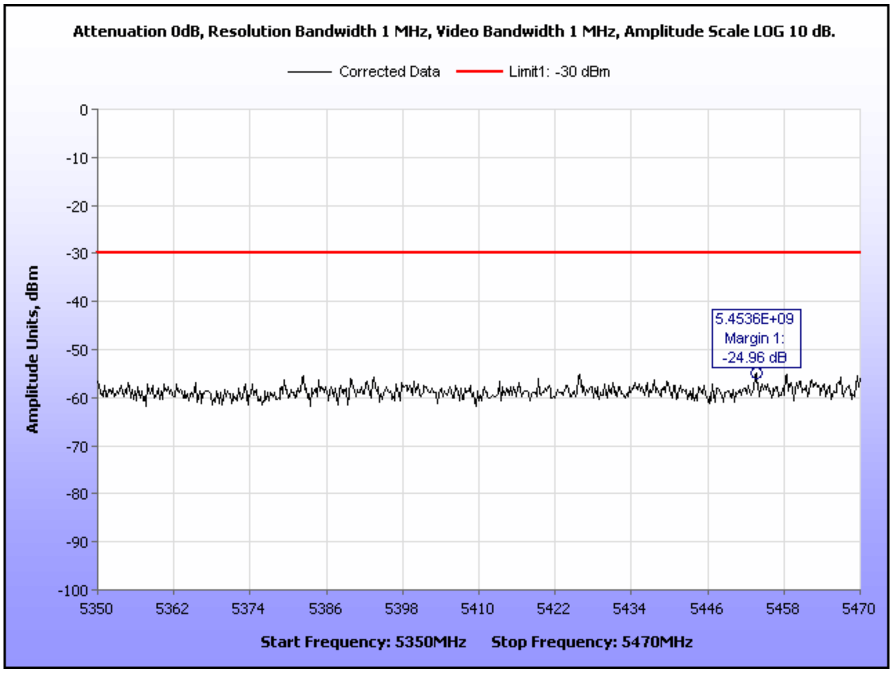
Plot 51. Radiated Spurious Emission, 18 GHz – 26 GHz, 5500 MHz



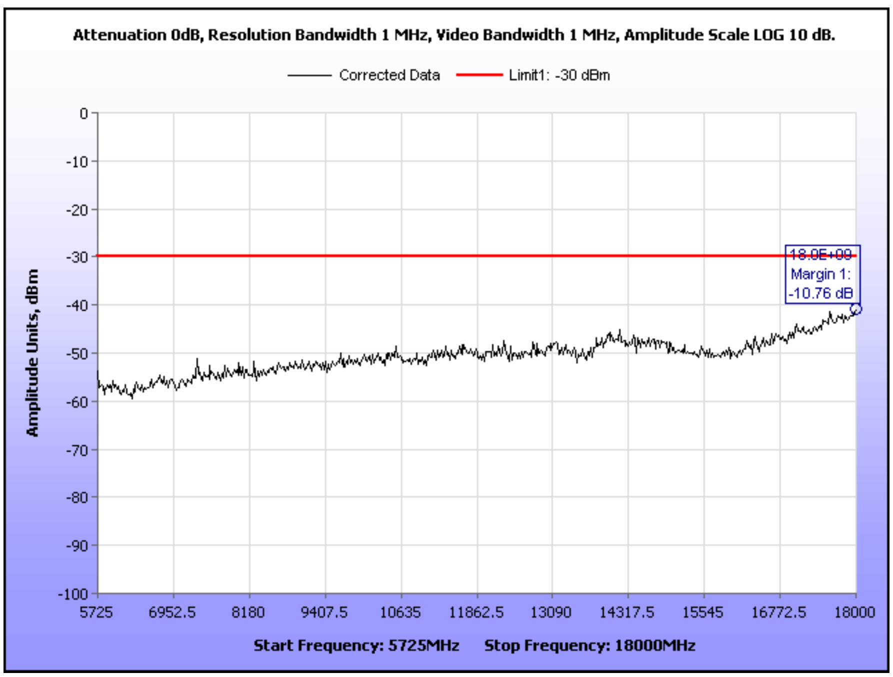
Plot 52. Radiated Spurious Emission, 30 MHz – 1 GHz, 5700 MHz



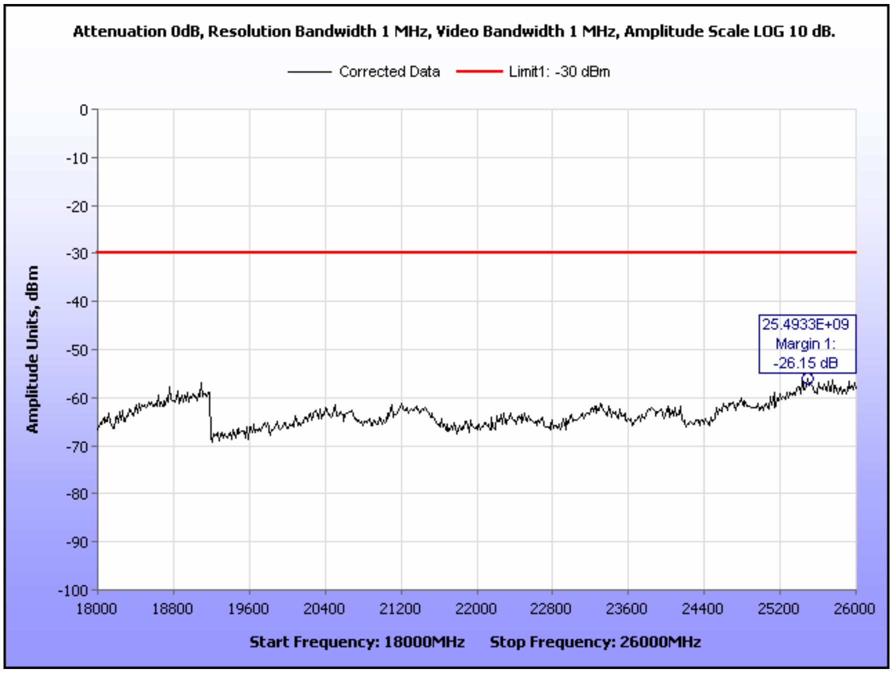
Plot 53. Radiated Spurious Emission, 1 GHz – 5.15 GHz, 5700 MHz



Plot 54. Radiated Spurious Emission, 5.35 GHz – 5.47 GHz, 5700 MHz

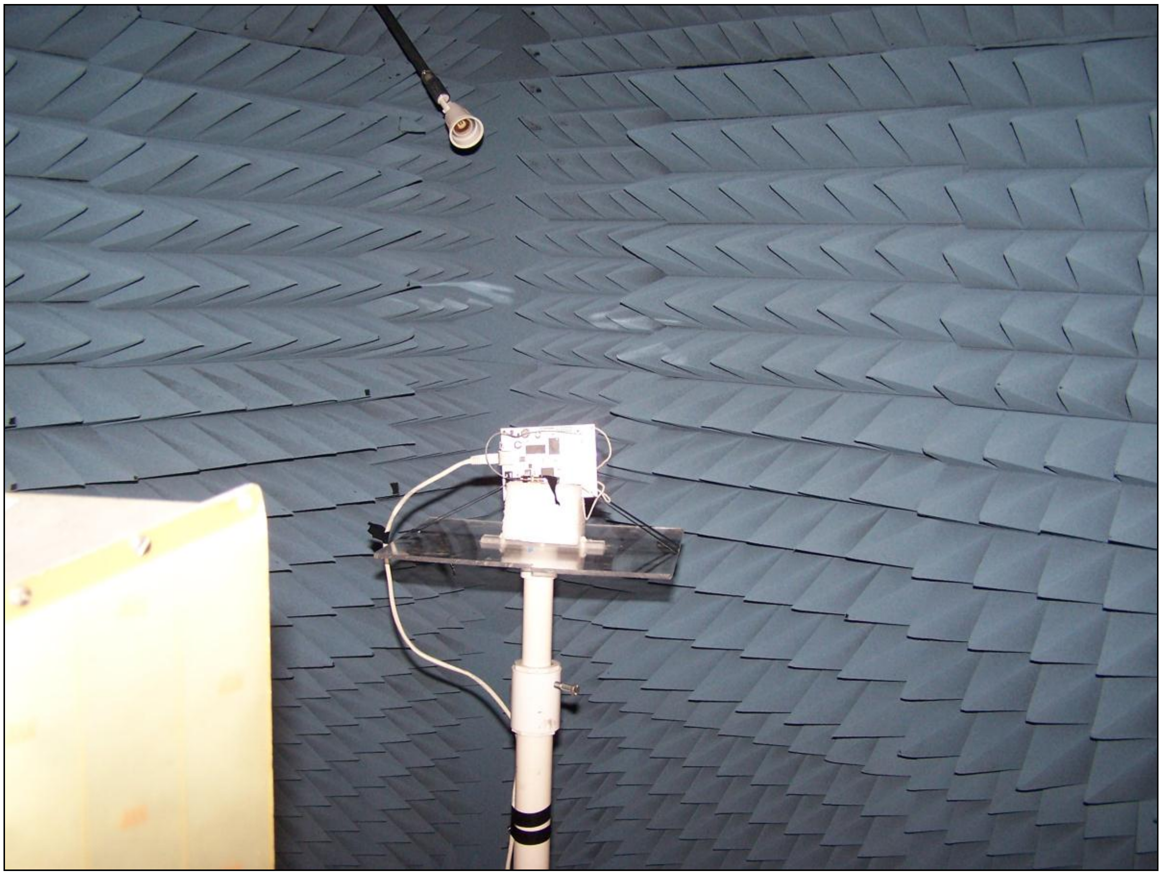


Plot 55. Radiated Spurious Emission, 5.725 GHz - 18 GHz, 5700 MHz



Plot 56. Radiated Spurious Emission, 18 GHz – 26 GHz, 5700 MHz

Radiated Emissions Test Setup Photographs



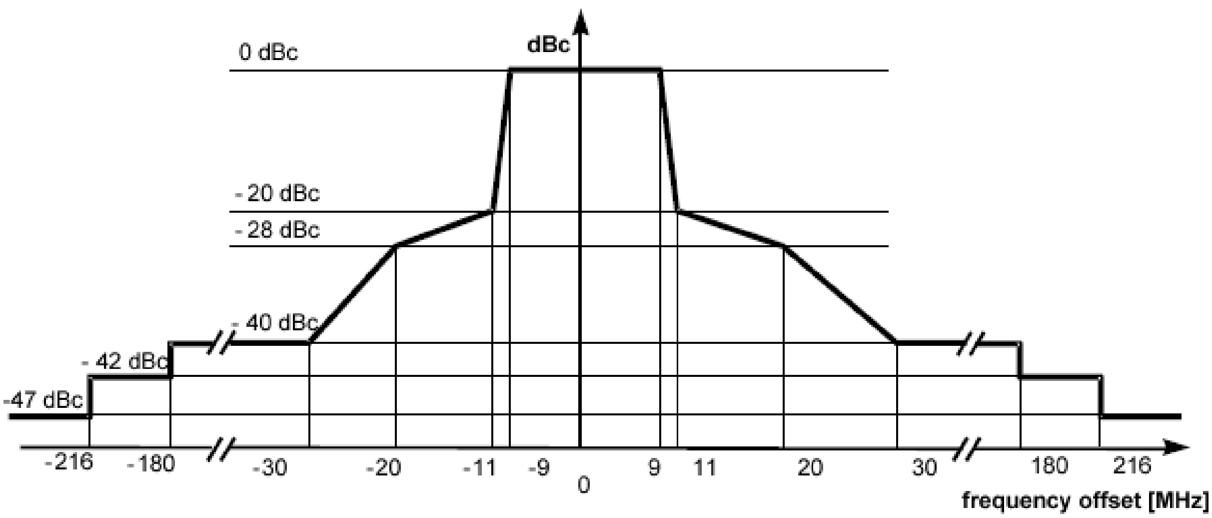
Photograph 4. Radiated Emissions Setup

4.5.2 Transmitter Unwanted Emissions Within the 5GHz RLAN Bands (Conducted)

Test Requirement(s): **EN 301 893, Clause 5.3.6:**

4.5.2.1 Definition
These are conducted radio frequency emissions within the 5GHz RLAN bands when the RF output port is connected to a spectrum analyzer.

4.5.2.2 Limit
The average level of the transmitted spectrum within the 5GHz RLAN bands shall not exceed the limits given below.



Note: dBc is the spectral density relative to the maximum spectral power density of the transmitted signal**.**

Test Procedure: The maximum spectral power density of the EUT's transmitted signal was determined using a broadband power meter capable of measuring the average power of a modulated carrier. The EUT was then connected to a spectrum analyzer with a RBW of 1MHz, a VBW of 30 KHz and with video averaging on. The level of the power density measured previously was then used to set the emission mask relative to the 0 dB reference level of the modulated carrier. Measurements were carried out in all modulations available. The spectrum under the mask was examined both in a relatively narrow span and a broader span in order to determine compliance.

In case of conducted measurements on smart antenna systems (devices with multiple transmit chains) measurements need only to be performed on one of the active transmit chains (antenna outputs).

Test Results: The EUT as tested was found compliant with the specified requirements of Clause 5.3.6.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/10/11

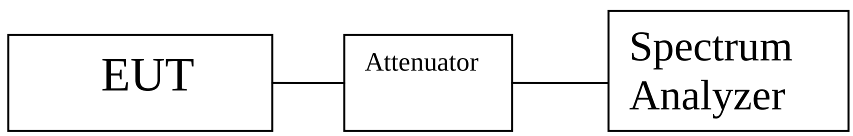
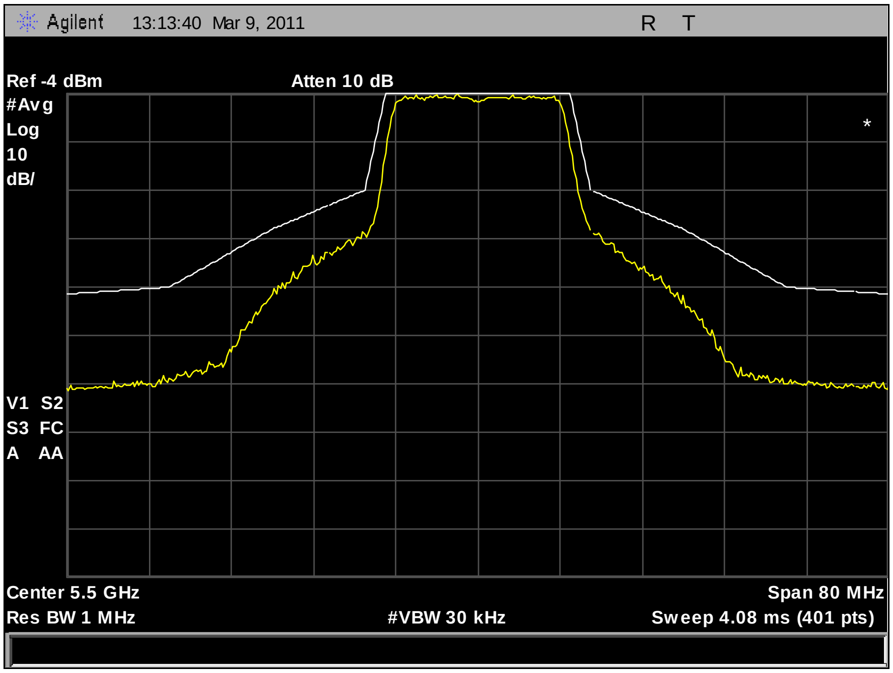
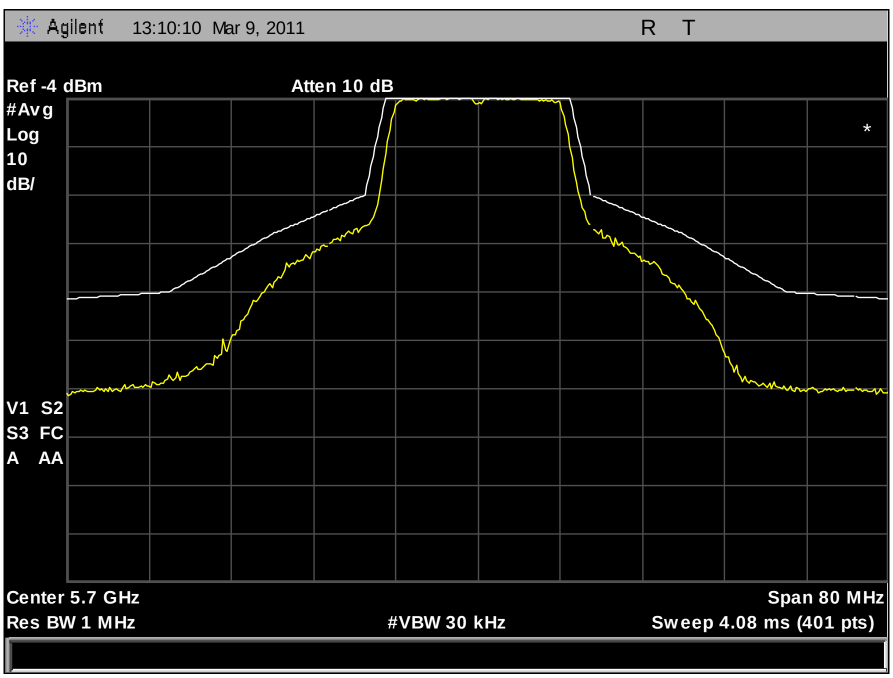


Figure 5. Unwanted Conducted Emissions Within Test Setup

Transmitter Unwanted Emissions Within the 5GHz RLAN Bands (Conducted)



Plot 57. Conducted In Band Spurious Emission, 5500 MHz



Plot 58. Conducted In Band Spurious Emission, 5700 MHz

4.6 Receiver Spurious Emissions (Conducted)

Test Requirement(s): **EN 301 893V1.4.1, Clause 5.3.7:**

4.6.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in received mode.

4.6.2 Limit

The spurious emissions of the receiver shall not exceed the values in table below.

Frequency Range	Maximum Power, ERP	Measurement Bandwidth
30 MHz to 1 GHz	-57 dBm	100KHz
above 1 GHz to 26.5 GHz	-47 dBm	1MHz

Test Procedure: Two EUTs were setup to communicate with each other. A test transmission sequence as shown below was used to send data between the two units. A directional coupler was used to isolate the emission measurements from the test data signal while the EUT received test data. The spectrum analyzer was initially set with a RBW of 1MHz or 100KHz and a VBW of 1MHZ using video averaging or peak hold. The Frequency was scanned from 30MHz to 26.5GHz.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 5.3.7.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/10/11

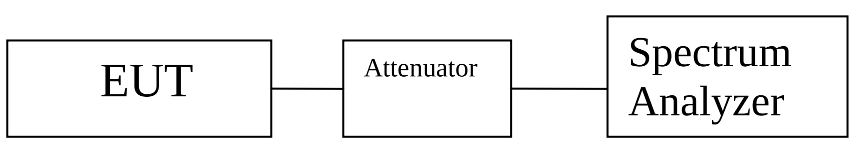
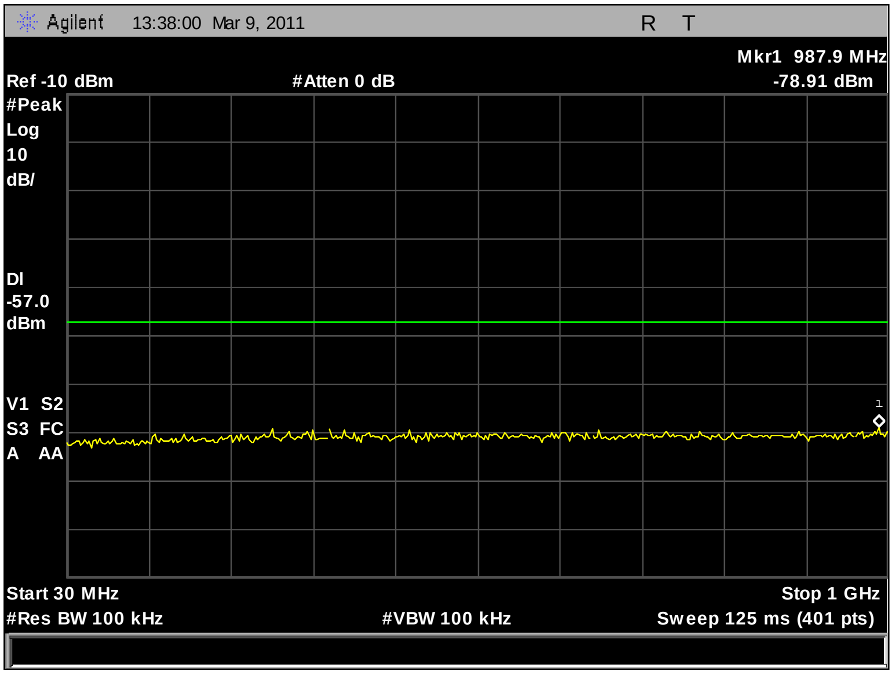
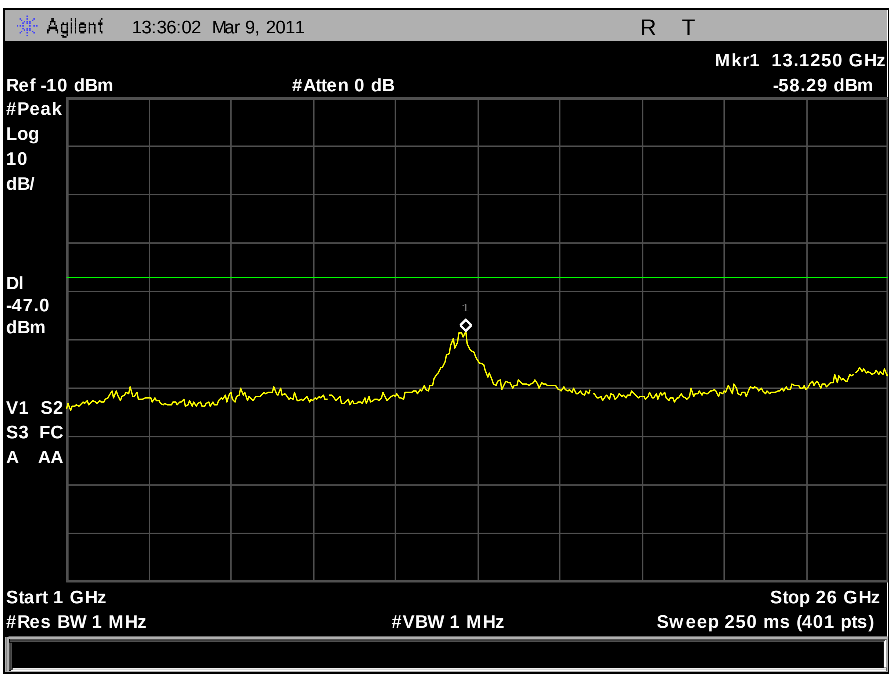


Figure 6. Receiver Spurious Emissions Test Setup

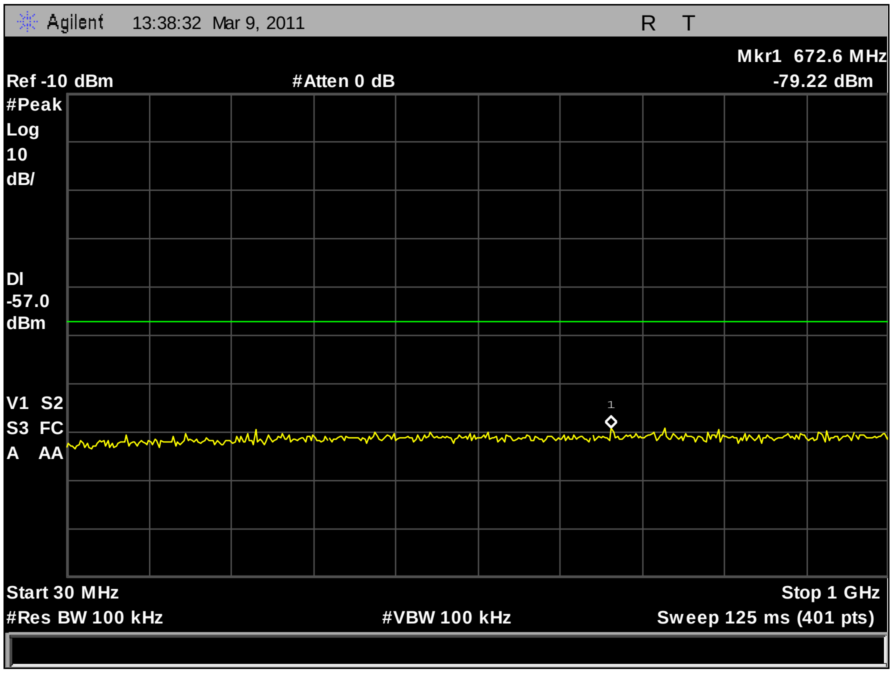
Receiver Spurious Emissions (Conducted)



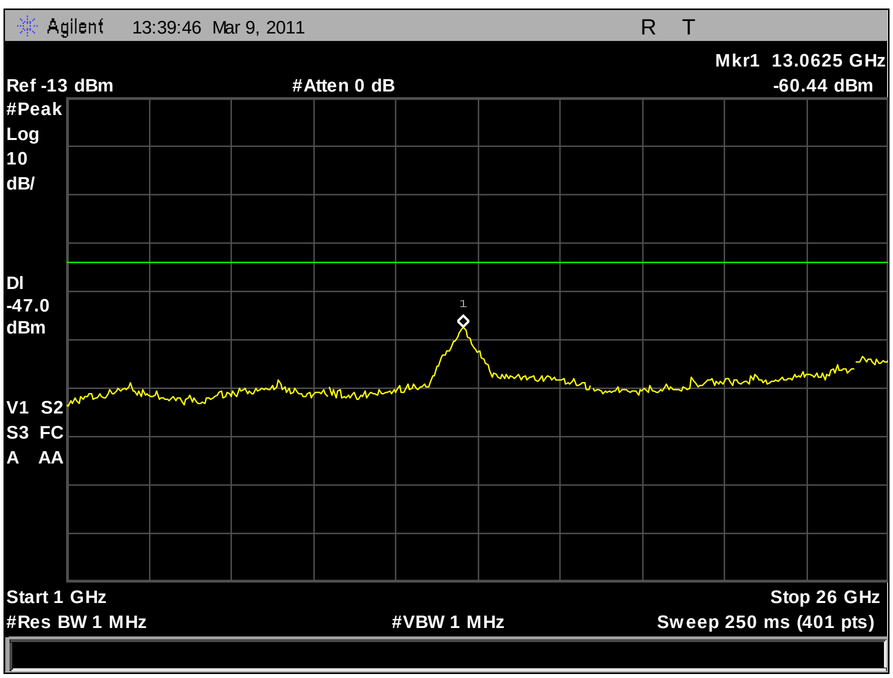
Plot 59. Conducted Receiver Spurious Emission, 30 MHz – 1 GHz, 5500 MHz



Plot 60. Conducted Receiver Spurious Emission, 1GHz – 26 GHz, 5500 MHz



Plot 61. Conducted Receiver Spurious Emission, 30 MHz – 1 GHz, 5700 MHz



Plot 62. Conducted Receiver Spurious Emission, 1GHz – 26 GHz, 5700 MHz

4.6 Receiver Spurious Emissions (Radiated)

Test Requirement(s): **EN 301 893V1.4.1, Clause 5.3.7**

4.6.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in received mode.

4.6.2 Limit

The spurious emissions of the receiver shall not exceed the values in table below.

Frequency Range	Maximum Power, ERP	Measurement Bandwidth
30 MHz to 1 GHz	-57 dBm	100KHz
above 1 GHz to 26.5 GHz	-47 dBm	1MHz

Test Procedure: The EUT was setup as per section 4.4 above for measuring out of band radiated emissions. The EUT was set up to receive data. The spectrum within the 5GHz RLAN band was investigated for spurious emissions.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 5.3.7.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/10/11

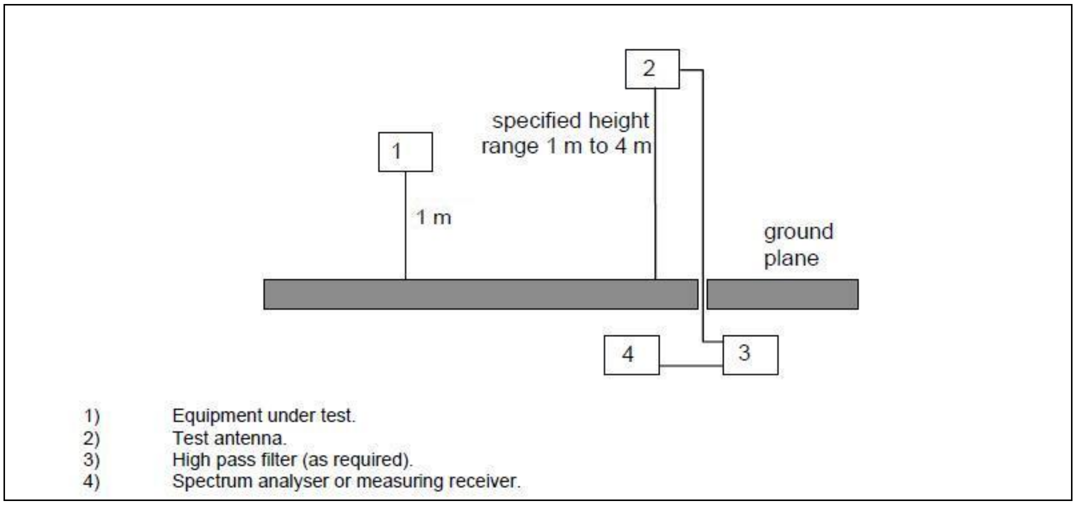
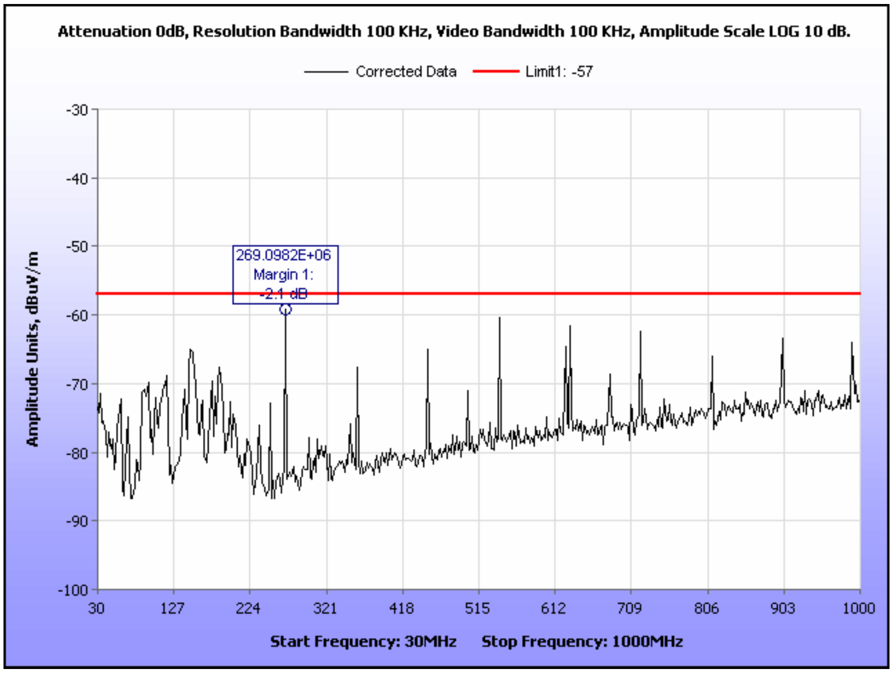
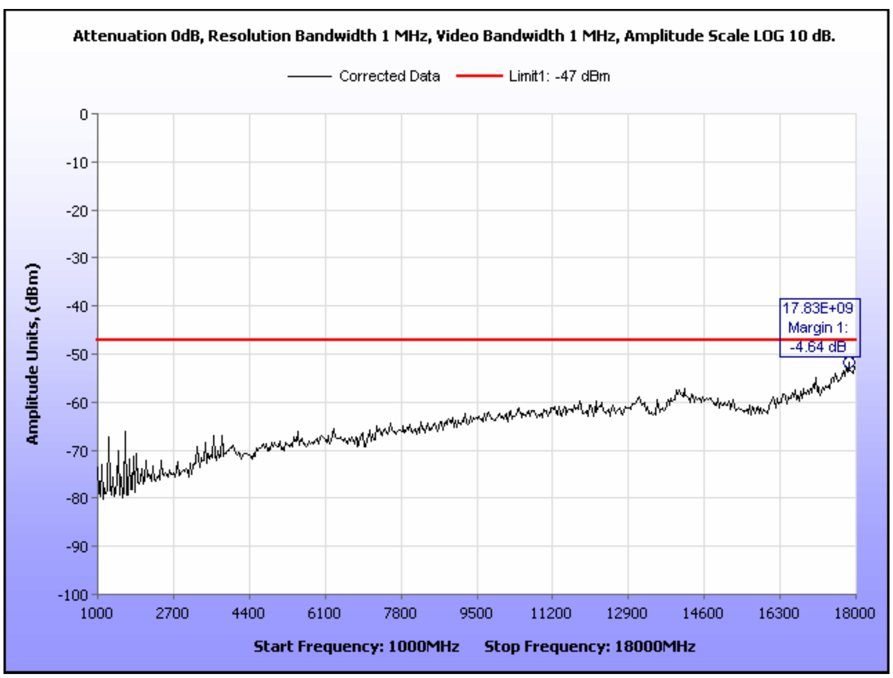


Figure 7. Receiver Spurious Emissions Test Setup

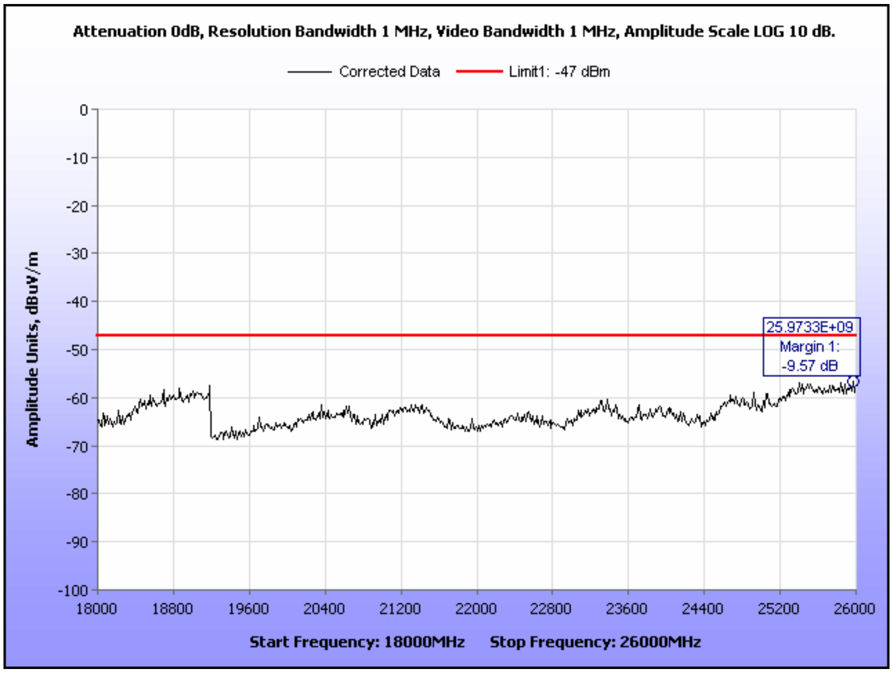
Receiver Spurious Emissions (Radiated)



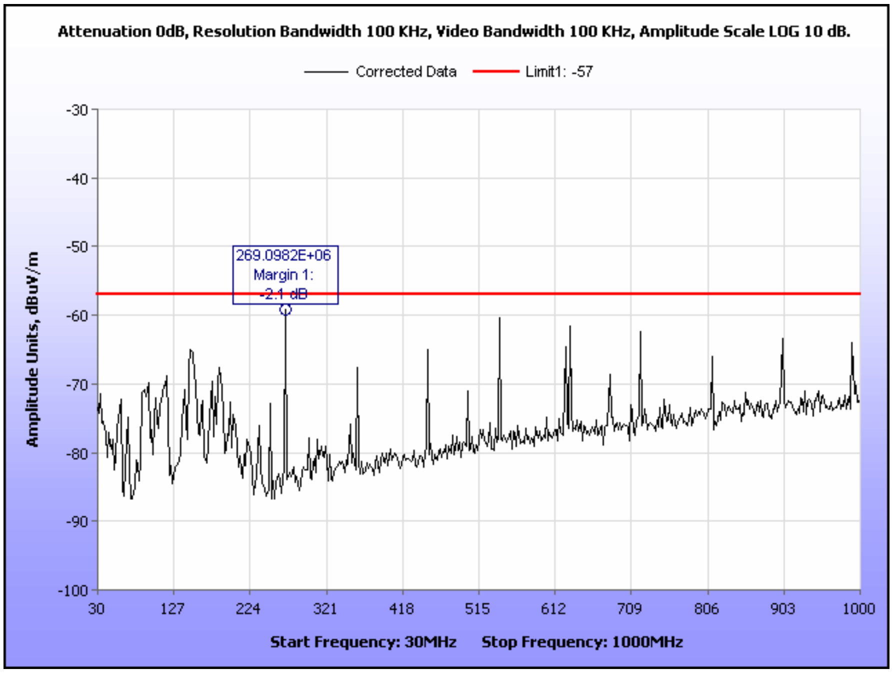
Plot 63 Radiated Receiver Spurious Emission, 30 MHz - 1 GHz, 5500 MHz



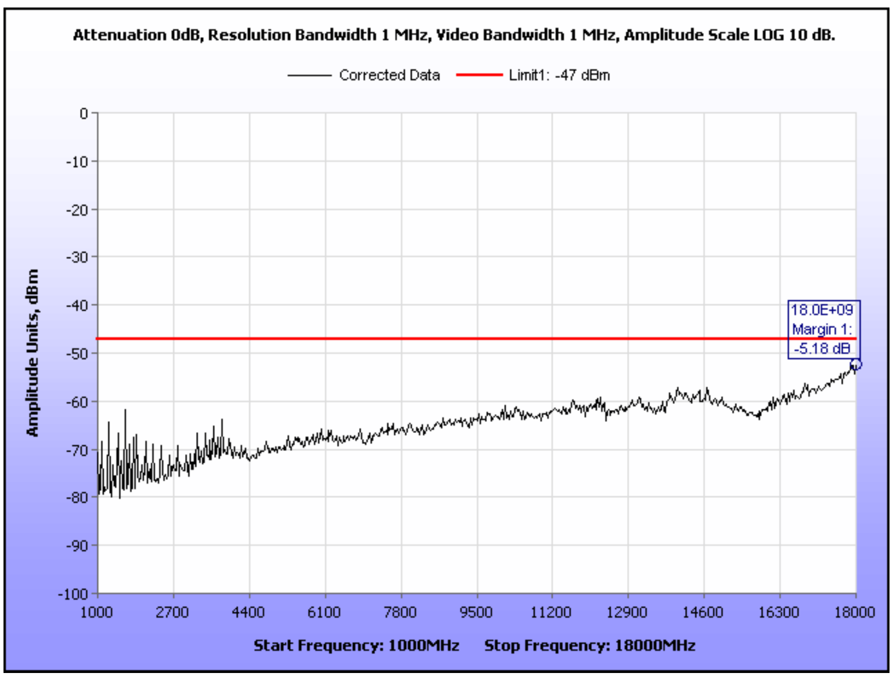
Plot 64. Radiated Receiver Spurious Emission, 1 GHz - 18 GHz, 5500 MHz



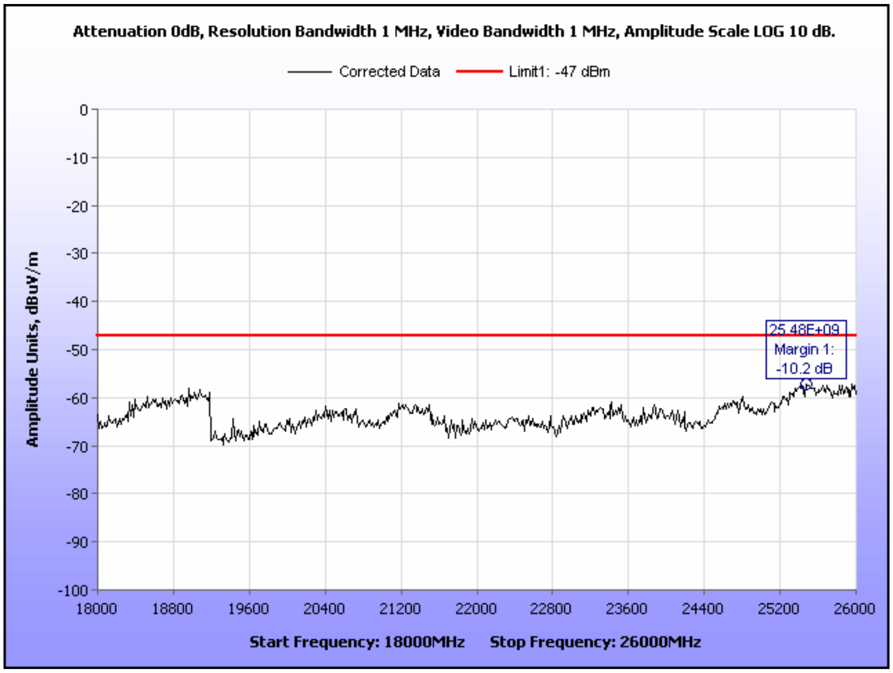
Plot 65. Radiated Receiver Spurious Emission, 18 GHz – 26 GHz, 5500 MHz



Plot 66 Radiated Receiver Spurious Emission, 30 MHz - 1 GHz, 5700 MHz



Plot 67. Radiated Receiver Spurious Emission, 1 GHz - 18 GHz, 5700 MHz



Plot 68. Radiated Receiver Spurious Emission, 18 GHz – 26 GHz, 5700 MHz

4.8 Medium Access Protocol

Test Requirement(s): **EN 301 893, Section 4.8**

4.8.1 Definition

A medium access protocol is a mechanism designed to facilitate spectrum sharing with other devices in the wireless network.

4.8.2 Requirement
A medium access protocol shall be implemented by the equipment and shall be active under all circumstances.

Test Results: The EUT as tested was found compliant with the specified limits.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/10/11

Conformance Requirements

4.9 User Access Restrictions

Test Requirement(s): **EN 301 893, Section 4.9**

4.9.1 Definition

User Access Restrictions are restraints implemented in the RLAN to restrict access for the user to certain hardware and/or software settings of the equipment.

4.9.2 Requirement

DFS controls (hardware or software) related to radar detection shall not be accessible to the user so that the DFS requirements described in clauses 4.7.2.1 to 4.7.2.4 can neither be disabled nor altered.

Test Results: The EUT as tested was found compliant with the specified limits.

Test Engineer: Dusmantha Tennakoon

Test Date: 03/10/11

IV. DFS Requirements

4.7 Dynamic Frequency Selection (DFS)

4.7.1 Introduction

An RLAN shall employ a Dynamic Frequency Selection (DFS) function to:

- detect interference from other systems and to avoid co-channel operation with these systems, notably radar systems (radar detection);
- provide on aggregate a uniform loading of the spectrum across all devices.

Radar detection is required when operating on channels whose nominal bandwidth falls partly or completely within the frequency ranges 5 250 MHz to 5 350 MHz or 5 470 MHz to 5 725 MHz. This requirement applies to all types of RLAN devices and to any type of communication between these devices.

In addition, equipment transmitting in the band 5600 - 5650MHz must also be able to detect meteorological radars employing non-constant pulse interval times. These are often referred to as staggered or interleaved PRFs (Pulse Repetition Frequencies) by which up to 3 different PRF values are used. The staggered radar bins from 301 893 v 1.5.1 were used to demonstrate compliance.

The DFS function as described in the present document is not tested for its ability to detect frequency hopping radar signals.

4.7.1.1 DFS operational modes

Within the context of the operation of the DFS function, an RLAN device shall operate in either master mode or slave mode. RLAN devices operating in slave mode (slave device) shall only operate in a network controlled by a RLAN device operating in master mode (master device).

Some RLAN devices are capable of communicating in ad-hoc manner without being attached to a network. Devices operating in this manner on channels whose nominal bandwidth falls partly or completely within the range 5 250 MHz to 5 350 MHz or 5 470 MHz to 5 725 MHz shall employ DFS and should be tested against the requirements applicable to a master.

4.7.1.2 DFS operation

The operational behaviour and individual DFS requirements that are associated with master and slave devices are as follows:

Master devices:
a) The master device shall use a Radar Interference Detection function in order to detect radar signals. b) Before initiating a network on a channel, which has not been identified as an Available Channel, the master device shall perform a Channel Availability Check to ensure that there is no radar operating on the channel. c) During normal operation, the master device shall monitor the Operating Channel (In-Service Monitoring) to ensure that there is no radar operating on the channel. d) If the master device has detected a radar signal during In-Service Monitoring, the Operating Channel is made unavailable. The master device shall instruct all its associated slave devices to stop transmitting on this (to become unavailable) channel. e) The master device shall not resume any transmissions on this Unavailable Channel during a period of time after a radar signal was detected. This period is referred as the Non-Occupancy Period.

Slave devices:
f) A slave device shall not transmit before receiving an appropriate enabling signal from a master device. g) A slave device shall stop all its transmissions whenever instructed by a master device to which it is associated. The device shall not resume any transmissions until it has again received an appropriate enabling signal from a master device. h) A slave device which is required to perform radar detection (see table D.3), shall stop its own transmissions if it has detected a radar. The Operating Channel is made unavailable for the slave device. It shall not resume any transmissions on this Unavailable Channel for a period of time equal to the Non-Occupancy Period.

See Table 12 for the applicability of DFS requirements for each of the above mentioned operational modes. The master device may implement the Radar Interference Detection function referred to under a) using another device associated with the master. In such a case, the combination shall be tested against the requirements applicable to the master. The maximum power level of a slave device will define whether or not the device needs to have a Radar Interference Detection function (see table D.3).

4.7.2 DFS technical requirements specifications

Table 12 lists the DFS related technical requirements and their applicability for each of the operational modes described in clause 4.7.1. If the RLAN device is capable of operating in more than one operational mode described in clause 4.7.1 then each operating mode shall be assessed separately.

Requirement	DFS Operational mode		
	Master	Slave without radar detection	Slave with radar detection
Channel Availability Check	✓	Not required	Not required (see Note 2)
Off-Channel CAC (see Note 1)	✓	Not required	✓ (see Note 2)
In-Service Monitoring	✓	Not required	✓
Channel Shutdown	✓	✓	✓
Non-Occupancy Period	✓	Not required	✓
Uniform Spreading	✓	Not required	Not required
Note 1: Where implemented by the manufacturer. **Note 2:** Slave A slave with radar detection is not required to perform a CAC or Off-Channel CAC at initial use of the channel but only after the slave has detected a radar signal on the Operating Channel by In-Service Monitoring.			

Table 12. Applicability of DFS requirements

DFS Detection Thresholds

EIRP Spectral Density	Value (see Notes 1 and 2)
10 dBm/MHz	-62 dBm
Note 1: This is the level at the input of the receiver with a maximum EIRP density of 10 dBm/MHz and assuming a 0 dBi receive antenna. For devices employing different EIRP spectral density and/or a different receive antenna gain G (dBi) the DFS threshold level at the receiver input follows the following relationship: DFS Detection Threshold (dBm) = -62 + 10 – EIRP Spectral Density (dBm/MHz) + G (dBi), however the DFS threshold level shall not be lower than -64 dBm assuming a 0 dBi receive antenna gain. **Note 2:** Slave devices with a maximum EIRP of less than 23 dBm do not have to implement radar detection.	

Table 13. Interference Threshold values, Master or Client incorporating In-Service Monitoring

Parameter	Value
Channel Availability Check Time	60 seconds (see Note 1)
Maximum Off-Channel CAC Time	4 hours (see Note 2)
Non-occupancy period	Minimum 30 minutes
Channel Move Time	10 seconds
Channel Closing Transmission Time	1 s
Note 1: For channels whose nominal bandwidth falls completely or partly within the band 5 600 MHz to 5 650 MHz, the CAC Time shall be 10 minutes. **Note 2:** For channels whose nominal bandwidth falls completely or partly within the band 5 600 MHz to 5 650 MHz, the Maximum Off-Channel cAC Time shall be 24 hours.	

Table 14. DFS Requirement values

Pulse width W [µs]	Pulse repetition frequency PRF (PPS)	Pulses per burst (PPB)
1	700	18

Table 15. Parameters of the reference DFS test signal

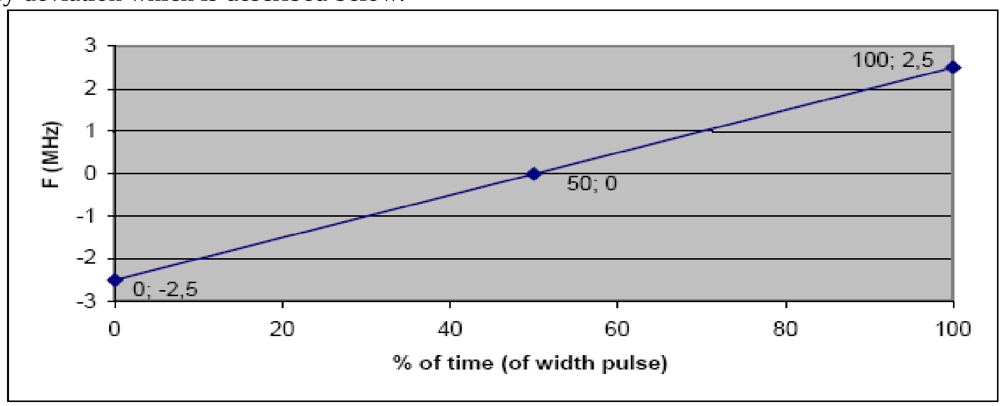
Parameter	Detection Probability (P_d)	
	Channels whose nominal bandwidth falls partly or completely within the 5 600 MHz to 5 650 MHz band	Other channels
CAC, Off-Channel CAC	99,99 %	60 %
In-Service Monitoring	60 %	60 %
NOTE: P_d gives the probability of detection per simulated radar burst and represents a minimum level of detection performance under defined conditions. Therefore P_d does not represent the overall detection probability for any particular radar under real life conditions.		

Table 16. Detection Probability

Required Radar Test Waveforms

Radar test Signal # (see Notes 1 to 3)	Pulse width W [µs]		Pulse repetition frequency PRF (PPS)		Number of different PRFs	Pulses per burst for each PRF (PPB) (see Note 5)
	Min	Max	Min	Max		
1	0,8	5	200	1 000	1	10 (see Note 6)
2	0,8	15	200	1 600	1	15 (see Note 6)
3	0,8	15	2 300	4 000	1	25
4	20	30	2 000	4 000	1	20
5	0,8	2	300	4000	2/3	10 (see Note 6)
6	0,8	2	400	1 200	2/3	15 (see Note 6)

NOTE 1: Radar test signals 1 to 4 are constant PRF based signals. These radar test signals are intended to simulate also radars using a packet based Staggered PRF.
NOTE 2: The modulation to be used for the radar test signal 4 is a chirp modulation with a ±2,5MHz frequency deviation which is described below.



NOTE 3: Radar test signals 5 and 6 are single pulse based Staggered PRF radar test signals using 2 or 3 different PRF values. For radar test signal 5, the difference between the PRF values chosen shall be between 20 pps and 50 pps. For radar test signal 6, the difference between the PRF values chosen shall be between 80 pps and 400 pps.
NOTE 4: Apart for the Off-Channel CAC testing, the radar test signals above shall only contain a single burst of pulses.
NOTE 5: The total number of pulses in a burst is equal to the number of pulses for a single PRF multiplied by the number of different PRFs used.
NOTE 6: For the CAC and Off-Channel CAC requirements, the minimum number of pulses (for each PRF) for any of the radar test signals to be detected in the band 5 600 MHz to 5 650 MHz shall be 18.

Table 17. EN 301 893 1.5.1 Radar Test Waveforms

Radar Waveform Calibration

The following equipment setup was used to calibrate the conducted Radar Waveform See Figure 8. A spectrum analyzer was used to establish the test signal level for each radar type. During this process there were no transmissions by either the Master or Client Device. The spectrum analyzer was switched to the zero span (Time Domain) mode at the frequency of the Radar Waveform generator. Peak detection was utilized. The spectrum analyzer's resolution bandwidth (RBW) was set to 1MHz and the video bandwidth (VBW) was set to MHz. A 30dB preamplifier was used in during the calibration procedure

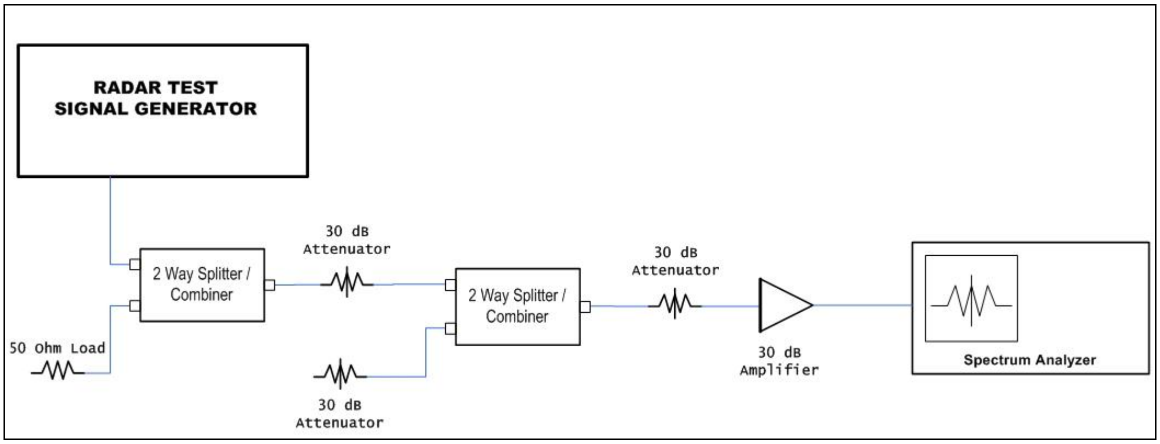
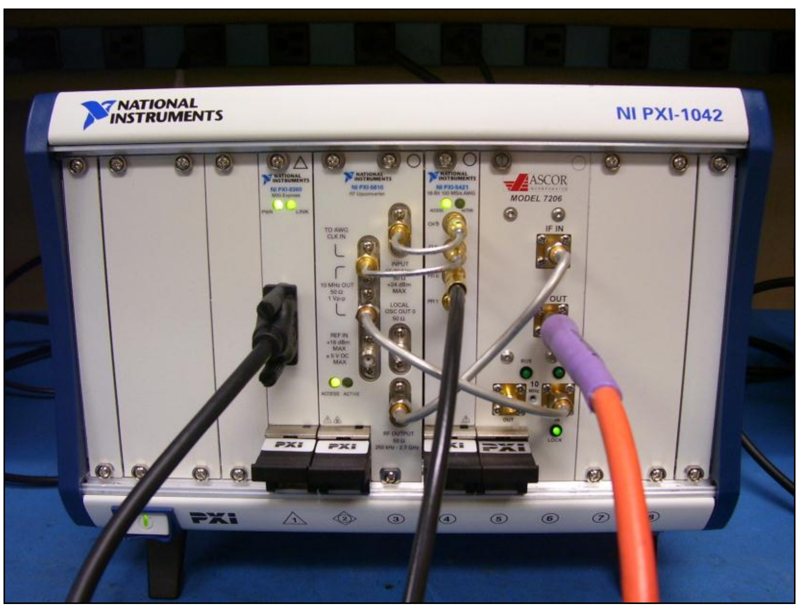
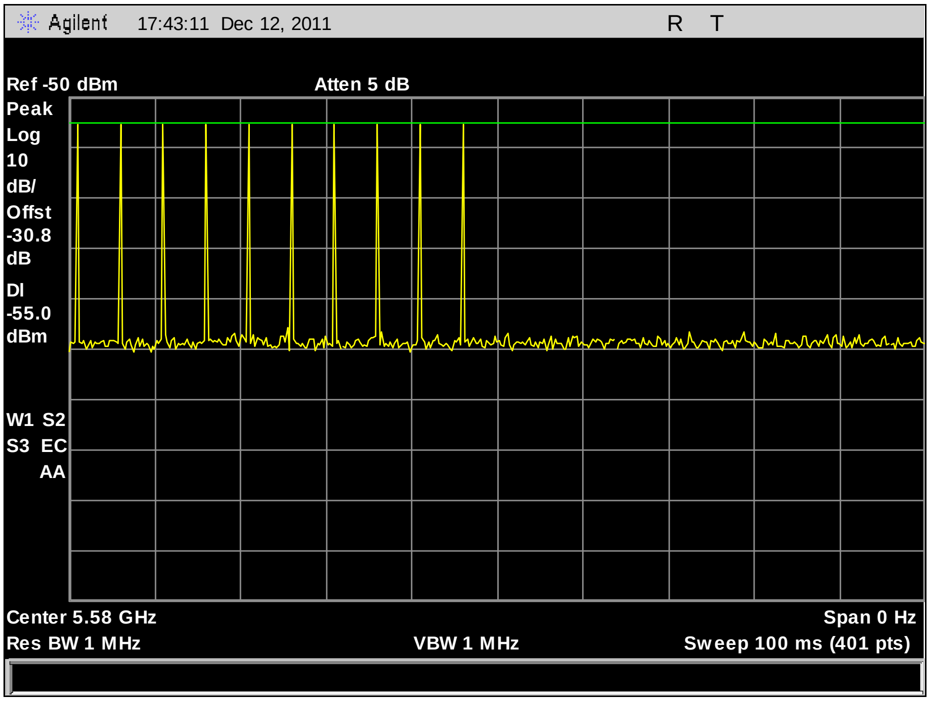


Figure 8. Radar Waveform Calibration Setup



Photograph 5. Radar Test Signal Generator

Radar Calibration



Plot 69. Bin 1 Radar Calibration

Test Setup for EUT

1. A spectrum analyzer is used as a monitor to verify that the UUT has vacated the Channel within the (Channel Closing Transmission Time and Channel Move Time, and does not transmit on a Channel during the Non-Occupancy Period after the detection and Channel move. It is also used to monitor UUT transmissions during the Channel Availability Check Time.
2. Figure 9 shows the test setup used for injection of radar waveforms in to a slave device.

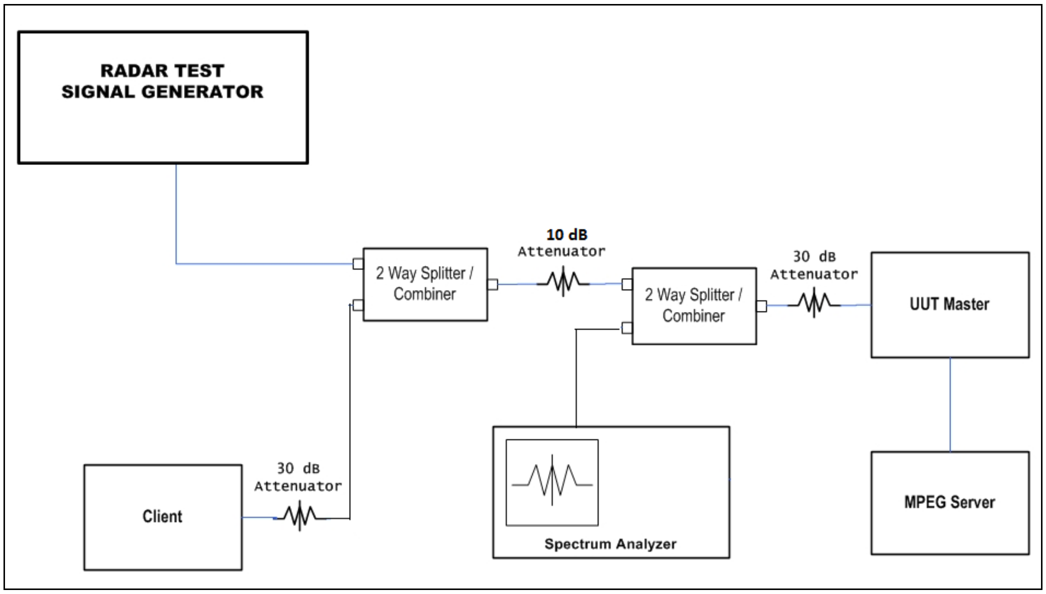


Figure 9. Test Setup for Slave Device

4.7.2.4 Channel Shutdown and 4.7.2.5 Non-Occupancy Period

Test Requirement(s): **ETSI EN 301 893, Sections 4.7.2.4 & 4.7.2.5, Clause 5.3.8**

Definition:

4.7.2.4.1
The *Channel Shutdown* is defined as the process initiated by the RLAN device immediately after a radar signal has been detected on an *Operating Channel*.

The master device shall instruct all associated slave devices to stop transmitting on this channel, which they shall do within the Channel Move Time.

Slave devices with a Radar Interference Detection function, shall stop their own transmissions within the Channel Move Time upon detecting a radar signal.

The aggregate duration of all transmissions of the RLAN device on this channel during the Channel Move Time shall be limited to the Channel Closing Transmission Time. The aggregate duration of all transmissions shall not include quiet periods in between transmissions.

4.7.2.5.1
The *Non-Occupancy Period* is defined as the time during which the RLAN device shall not make any transmissions on a channel after a radar signal was detected on that channel by either the *Channel Availability Check* or the *In-Service Monitoring*.

Limit(s): **4.7.2.4.2 & 4.7.2.5.2**

Parameter	Limit
Channel Move Time	10 s
Channel Closing Transmission Time	1 s
Non-Occupancy Period	30 min

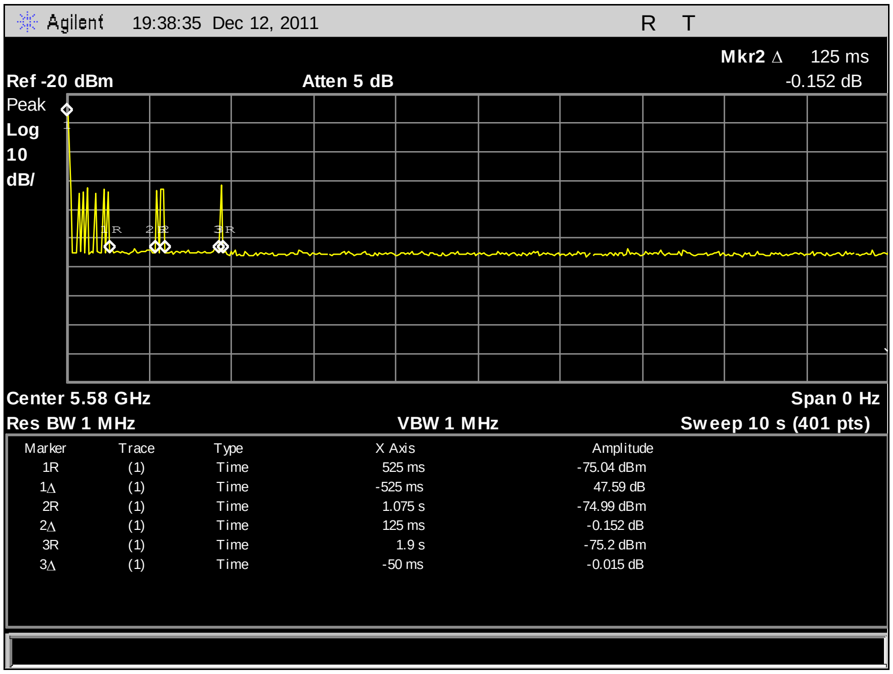
Test Procedure: The EUT was connected as in Figure #2. The channel selection mechanism for the Uniform Spreading requirement is disabled on the master. The EUT is a client device only.

The measurement was performed using normal operation of the equipment. The reference bin at a level above 10 dB above the level of the EUT, was injected into the EUT at time T_o. The time T_1 - T_o was recorded as the duration of the radar burst. At the end of time T_1 the EUT was monitored for a period ≥ 10s and the aggregate duration of all transmissions from the EUT were recorded. The difference between T_2, indicating the EUT had ceased all transmission, and T_1 was recorded. If the EUT was a Master then the selected channel was observed for a period of 30 min to insure no transmissions reoccurred on that channel.

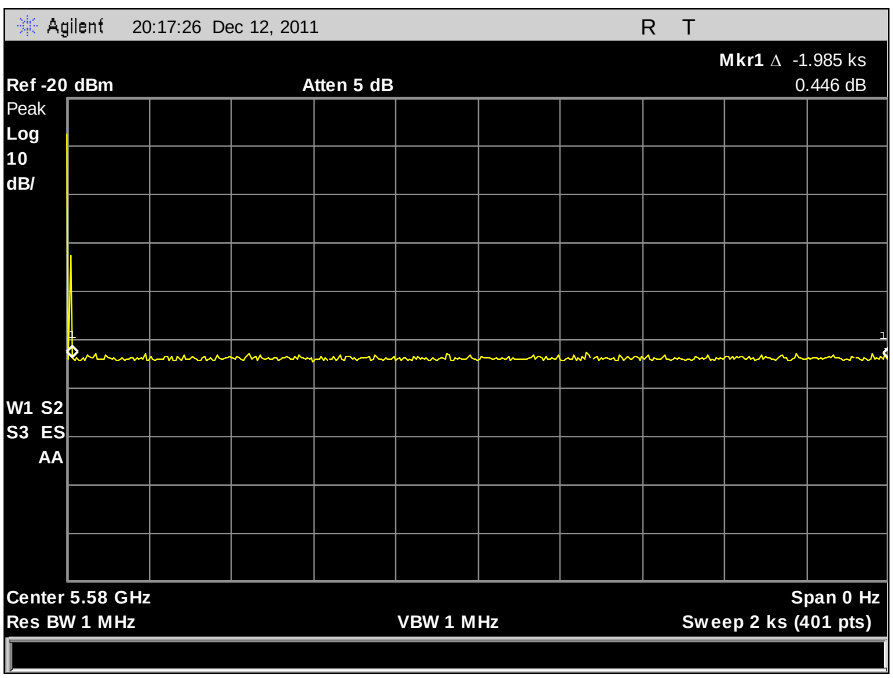
Test Results: The master EUT did detect the presence of the Radar Signal and did close the channel in the appropriate time allowed and did not resume communication on that channel until 30 minutes had transpired.

Test Engineer: Anderson Soungpanya

Test Date(s): 12/12/11



Plot 70. Channel Move Time



Plot 71. 30 Minute Non-Occupancy

V. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4300	SEMI-ANECHOIC CHAMBER # 1	EMC TEST SYSTEMS	NONE	08/23/2010	08/23/2011
1T4592	RF FILTER KIT	VARIOUS	N/A	SEE NOTE	
SN:MY50180138	PSA SPECTRUM ANALYZER	AGILENT	E4448A	01/28/2010	01/28/2012
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	05/25/2010	05/25/2011
1T4442	PRE-AMPLIFIER, MICROWAVE	MITEQ	AFS42-01001800-30-10P	SEE NOTE	
1T2511	ANTENNA; HORN	EMCO	3115	08/31/2010	08/31/2011
1T4752	PRE-AMPLIFIER	MITEQ	JS44-18004000-35-8P	SEE NOTE	
1T4612	SPECTRUM ANALYZER	AGILENT	E4407B	09/27/2010	09/27/2011
1T4548	AC POWER SOURCE	CALIFORNIA INSTRUMENTS	1251P	SEE NOTE	
1T4744	ANTENNA, HORN	ETS-LINDGREN	3116	5/27/2010	5/27/2011
1T4505	TEMPERATURE CHAMBER	TEST EQUITY	115	11/29/2010	11/29/2011

Note: Functionally verified test equipment is verified using calibrated instrumentation at the time of testing.

MET Asset	Equipment	Manufacturer	Last Cal Date	Cal Due Date
1S2243	NI PXI-1042 8-SLOT 3U CHASSIS	NATIONAL INSTRUMENTS	SEE NOTE	
1S2602	NI PXI-5421 16-BIT 100MS/S ARBITRARY WAVEFORM GENERATOR	NATIONAL INSTRUMENTS	SEE NOTE	
1S2278	NI PXI-5610 2.7GHZ RF UPCONVERTER	NATIONAL INSTRUMENTS	SEE NOTE	
1S2069	UPCONVERTER, 7206 PXI 4.9 TO 6GHZ	ASCOR	SEE NOTE	
N/A	SPLITTER/COMBINER, ZFSC-2-9G (QTY 2)	MINI-CIRCUITS	SEE NOTE	
N/A	30DB ATTENUATOR, BW-S30W2 (QTY 2)	PASTERNAK	SEE NOTE	
N/A	10DB ATTENUATOR, BW-S10W2 (QTY 2)	PASTERNAK	SEE NOTE	
1S2523	PRE-AMPLIFIER, 8449B	AGILENT	SEE NOTE	
1S2583	SPECTRUM ANALYZER, E447A	AGILENT	03/18/2011	03/18/2012
1S2460	SPECTRUM ANALYZER, E4407B	AGILENT	07/12/2011	07/12/2012

Table 18. DFS Equipment List

Note: Functionally verified test equipment is verified using calibrated instrumentation at the time of testing.

End of Report

