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Electromagnetic Emissions Test Report and Application for Permissive Change pursuant to Industry Canada RSS-Gen Issue 1 / RSS 210 Issue 6 FCC Part 15 Subpart E on the Xirrus, Inc. Transmitter Model: XS-3500-4

UPN:	5428A-XS35004
FCC ID:	SK6XS35004
GRANTEE:	Xirrus, Inc. 370 North Westlake Blvd., Suite 200 Westlake Village, CA 91362
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Ave Sunnyvale, CA 94086
REPORT DATE:	April 16, 2007
FINAL TEST DATE:	March 24, March 26 and March 28, 2007

AUTHORIZED SIGNATORY:

David W. Bare
Chief Technical Officer

ACCREDITED
2016-01

REVISION HISTORY

Revision #	Date	Comments	Modified By
1	May 9, 2007	Initial Release	David Guidotti

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SCOPE

An electromagnetic emissions test has been performed on the Xirrus, Inc. model XS-3500-4 pursuant to the following rules:

Industry Canada RSS-Gen Issue 1
RSS 210 Issue 6 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart E

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in Elliott Laboratories test procedures:

ANSI C63.4:2003
RSS-212 Issue 1 Test Facilities and Test Methods for Radio Equipment

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Xirrus, Inc. model XS-3900-16 and therefore apply only to the tested sample. The sample was selected and prepared by Steve Smith of Xirrus, Inc. Tests on the XS-3900-16 were considered representative of the XS-3500-4 because of the similarities of the units

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Xirrus, Inc. model XS-3500-4 complied with the requirements of the following regulations:

Industry Canada RSS-Gen Issue 1
RSS 210 Issue 6 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart E

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

TEST RESULTS SUMMARY

Test results are provided only for the new band to be added to the approval.

UNII (LELAN) SYSTEMS (5470 –5725 MHz)

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.407(a)(2)	-	26dB Bandwidth	Greater than 20dB		N/A
15.407(a)(2)	A9.2(2)	Output Power	17.2 dBm (0.052 W)	11dBm + 10Log(B) or 24dBm	Complies
15.407(a)(2)	A9.2(2)	Power Spectral Density	4.9 dBm/MHz	11dBm/MHz	Complies
	A9.5b	Peak Spectral Density	4.9 dBm/MHz	6.1dBm/MHz	Complies
15.407(a)(2)	A9.4	Dynamic frequency selection	Refer to separate Test Report for DFS results.		Complies
15.407(a)(2)	A9.4	Transmit power control	Not required – Less than 27dBm eirp [1]		Complies

Note 1: EIRP calculated using antenna gain of 3 dBi (2.0) for the highest EIRP multi-point system.

GENERAL REQUIREMENTS FOR ALL UNII (LELAN) BANDS

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
	A9.5a	Modulation	Digital Modulation is used. Does not change from previously approved device.	Digital modulation is required	Complies
	RSP 100	99% bandwidth	17.5 MHz	-	N/A
15.407(b)(5) / 15.209	A9.3	Spurious Emissions below 1GHz	Emissions in this band are not affected by operating band of the radio, refer to previously approved device	Refer to standard	Complies
15.407(b)(2)	A9.3	Spurious Emissions above 1GHz	53.7dBµV/m (482.5µV/m) @ 5460.0MHz	54dBµV/m @ 3m	Complies (-0.3 dB)
15.407(a)(6)	-	Peak Excursion Ratio	9.4 dB	<13dB	Complies (-3.6 dB)
	A9.5c	Channel Selection	The device was tested at the highest, lowest and center channels in each operating range.	Device shall be tested on the top, bottom and center channels in each band	Complies
15.407(c)	A9.5d	Operation in the absence of information to transmit	New band does not change method as described for previously approved product	Device shall automatically discontinue operation in the absence of information to transmit	Complies
15.407(g)	A9.5e	Frequency Stability	Frequency stability does not change for new band	-	Complies
	A9.9g	User Manual information	New band does not change manual as described for previously approved product	-	Complies

GENERAL REQUIREMENTS APPLICABLE TO ALL DEVICES

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Integral or reverse polarity TNC	Integral or non-standard connector	Complies
-	RSS GEN 7.2.3 Table 1	Receiver spurious emissions	33.3dBµV/m (46.2µV/m) @ 5609.9MHz	Refer to standard	Complies (-20.7dB)
15.207	RSS GEN Table 2	AC Conducted Emissions	Emissions in this band are not affected by operating band of the radio, refer to previously approved device	Refer to standard	Complies
15.247 (b)(5) 15.407(f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in Exhibit 11, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
	RSP 100 RSS GEN 7.1.5	User Manual	New band does not change manual as described for previously approved product	Statement required regarding non-interference	Complies
	RSP 100 RSS GEN 7.1.5	User Manual	New band does not change manual as described for previously approved product	Statement required regarding detachable antenna	Complies

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	0.015 to 30	± 3.0
Radiated Emissions	30 to 1000	± 3.6
Radiated Emissions	1000 to 40000	± 6.0

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Xirrus Inc. model XS-3500-4 is a multi-radio 802.11abg Access Point radio that is designed to act as a hub for a wireless local area network (WLAN). The XS-3500-4 is similar to the XS-3900-16 and XS-3700-8 except it uses only 4 transceivers. The model XS-3900-16 contains 16 separate transceivers. The model XS-3700-8 contains 8 transceivers. The radio interfaces are provided via four identical circuit boards in the XS-3900-16 and XS-3700-8. The XS-3500-4 has only one of these circuit boards with 4 transceivers. Tests on the XS-3900-16 were considered representative of the XS-3500-4 because of the similarities of the units.

Three of the radios on each board connect to internally mounted antennas and operate only in the 5 GHz bands (5150 – 5350 MHz, 5470-5725 MHz and 5725 – 5850 MHz) using 802.11a. The fourth radio operates in all of the bands (2400 – 2483.5 MHz, 5150 – 5350 MHz, 5470-5725 MHz and 5725 – 5850 MHz) using 802.11a (5GHz bands) and 802.11b and g (2.4 GHz bands). The fourth radio has the ability to connect to external antennas via a reverse gender TNC connector except in the 5250-5350 MHz and 5470-5725 MHz bands, which only use the internal 3 dBi antenna.

The integral 5GHz antennas are arranged around the perimeter of the device. This arrangement is to provide coverage around the system.. Although all transceivers can be operational at any given time the system will not operate with two or more transceivers operating on the same channel.

In addition to the radio interfaces the system has two gigabit-Ethernet ports, a 10/100Base-Tx port, an AC power port and a console port (RS 232). The console port is intended for management and configuration only and is not intended to be permanently connected.

Normally, the EUT would be ceiling mounted during operation. The EUT was tested as both table-top equipment and also tested with the EUT raised to a height of 1.5m above the ground plane. The electrical rating of the device is 100 - 240Vac, 50/60Hz, 0.5 - 3 A.

The sample was received on March 24, 2007 and tested on March 24, March 26 and March 28, 2007. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Xirrus	XS-3900-16	802.11 a/b/g access point	XS237270600453	SK6XS390016

ANTENNA SYSTEM

The antenna system used with the Xirrus, Inc. model XS-3500-4 consists of a 3dBi antenna for each transceiver that is integral to the device.

For the following bands, one of the transceivers may connect to an external antenna via a non standard, reverse-gender, TNC connector. These antenna connections meet the requirements of 15.203.

Manufacturer	Model #	Type	Frequency Range (MHz)	Gain
Cushcraft	S2406P	Patch	2400 – 2483.5	6dBi
Cushcraft	S2403BP	Omni	2400 – 2483.5	3dBd (5.2dBi)
Cushcraft	S5703B	Omni	5725 – 5850	3dBd (5.2dBi)

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It is circular with a diameter of 48 cm and a height of 10cm.

MODIFICATIONS

The EUT did not require modifications during testing in order to comply with emissions specifications.

SUPPORT EQUIPMENT

No local support equipment was used during emissions testing.

The following equipment was used as remote support equipment for emissions testing:

Manufacturer	Model	Description	Serial Number	FCC ID
Toshiba	Satellite A60 PSA60U-0CS01D	Laptop	X4051688Q	DoC

No support equipment was used during emissions testing.

EUT INTERFACE PORTS

The I/O cabling configuration during emissions testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
EUT 10/100 Ethernet	Netgear switch #1	Cat 5	Shielded	10.0
EUT Console	N/C - note 1	-	-	-
EUT Gig E #1	Netgear switch #2	Cat 5	Shielded	10.0
EUT Gig E #2	Netgear switch #3	Cat 5	Shielded	10.0
EUT AC power	AC Mains	3-wire	Unshielded	1.5
Netgear Switch #4	Laptop Ethernet	Cat 5	Shielded	5.0

Note 1: The console port was not connected during testing. This port is used for configuration and troubleshooting purposes only and is not intended to be connected during normal operation.

EUT OPERATION

During emissions testing the EUT was configured with the transceivers transmitting continuously on the specified channel at the specified output power settings. A data rate of 6Mb/s was used for all OFDM modulations.

PROPOSED MODIFICATION DETAILS

GENERAL

This section details the modifications to the Xirrus, Inc. model XS-3500-4 being proposed. All performance and construction deviations from the characteristics originally reported to the FCC are addressed

SOFTWARE

The software in the product was modified to comply with DFS requirements and to allow operation in the 5470 to 5725 MHz band.

PRINTED WIRING BOARD LAYOUT

The material of the radio printing wiring board was changed.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on March 24, March 26 and March 28, 2007at the Elliott Laboratories Open Area Test Site #1 & 2 located at 684 West Maude Avenue, Sunnyvale, California or 41039 Boyce Road, Fremont, California Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission.

ANSI C63.4:2003 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4:2003 and RSS 212.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4:2003 and RSS 212. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4:2003 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4:2003 / RSS 212.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.4:2003 and RSS 212 specify that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

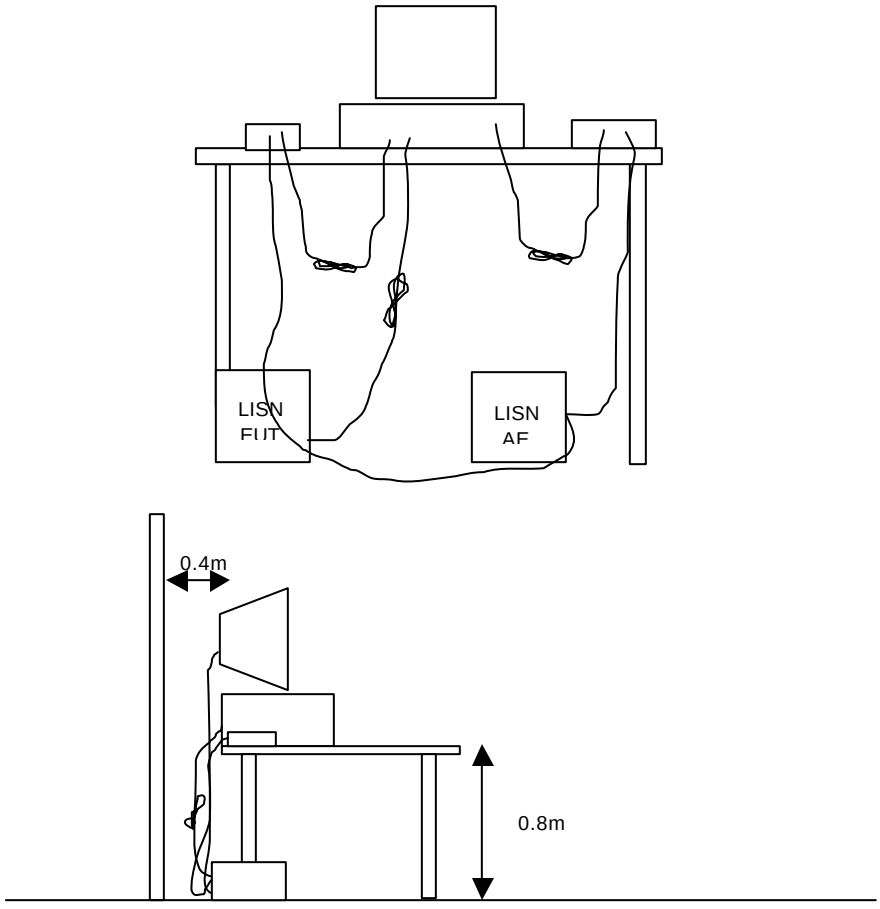
TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4:2003, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.



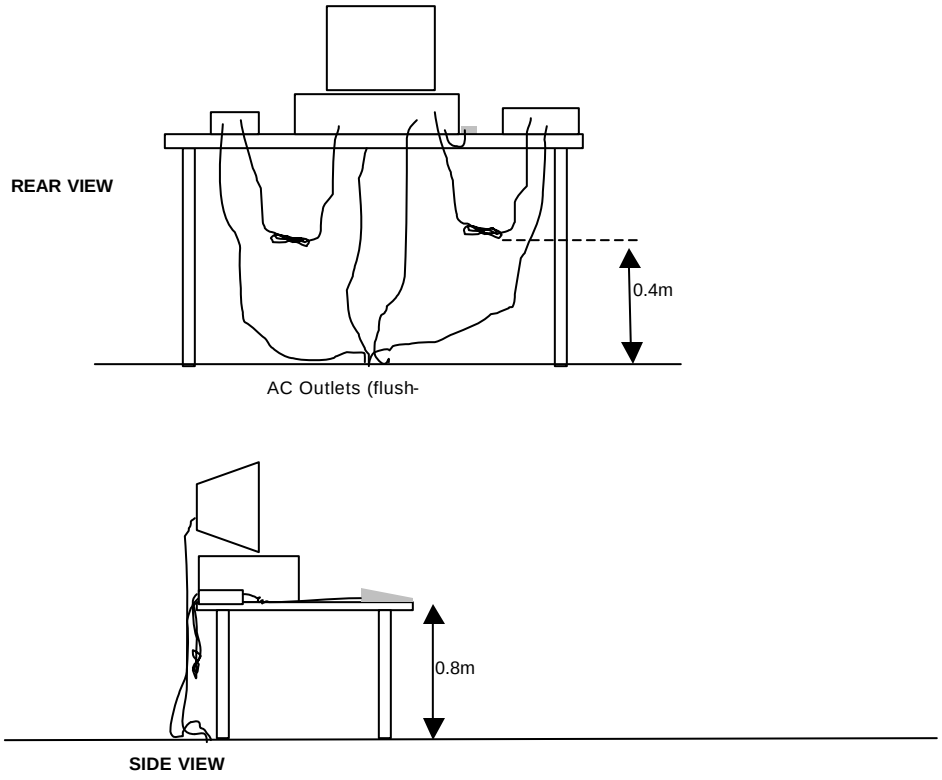
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

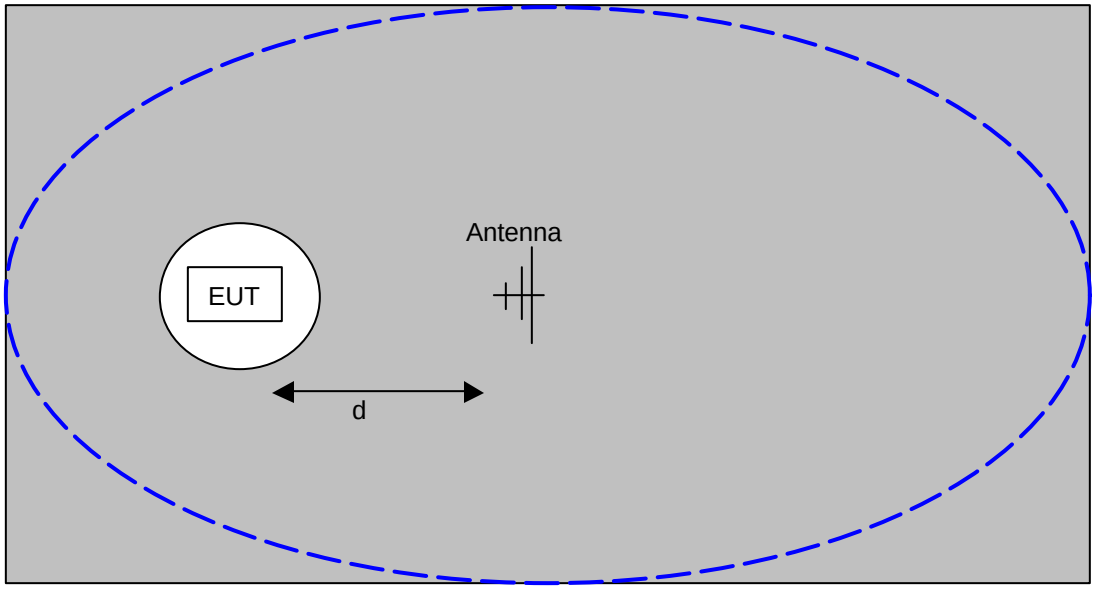
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

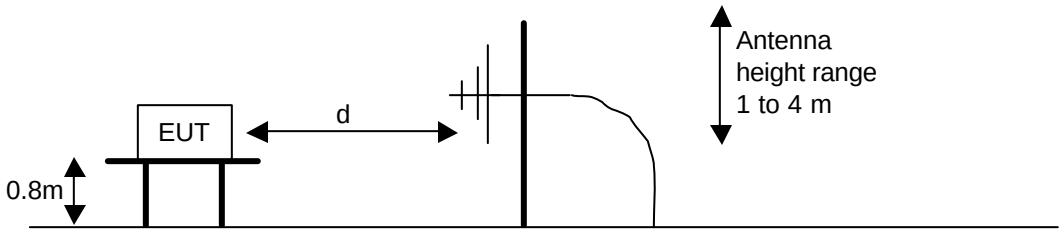
When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.



Typical Test Configuration for Radiated Field Strength Measurements



The ground plane extends beyond the ellipse defined in CISPR 16 / CISPR 22 / ANSI C63.4 and is large enough to accommodate test distances (d) of 3m and 10m. Refer to the test data tables for the actual measurement distance.



Test Configuration for Radiated Field Strength Measurements
OATS- Plan and Side Views

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1] (with the exception of transmitters operating under FCC Part 15 Subpart D and RSS 210 Annex 9), the limits for all emissions from a low power device operating under the general rules of RSS 310 (tables 3 and 4), RSS 210 (table 2) and FCC Part 15 Subpart C section 15.209.

Frequency Range (MHz)	Limit (uV/m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from receivers as detailed in FCC Part 15.109, RSS 210 Table 2, RSS GEN Table 1 and RSS 310 Table 3. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

[1] The restricted bands are detailed in FCC 15.203, RSS 210 Table 1 and RSS 310 Table 2

OUTPUT POWER LIMITS – DIGITAL TRANSMISSION SYSTEMS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watt (30 dBm)	8 dBm/3kHz
2400 – 2483.5	1 Watt (30 dBm)	8 dBm/3kHz
5725 – 5850	1 Watt (30 dBm)	8 dBm/3kHz

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level (30dB if the power is measured using the sample detector/power averaging method).

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_C = R_r + F_d$$

and

$$M = R_C - L_S$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_C = Corrected Reading in dBuV/m

L_S = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of 3m from the equipment under test:

$$E = \frac{1000000 \text{ v } 30 \text{ P}}{3} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Radio Antenna Port (Power and Spurious Emissions), 26-Mar-07
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer, 9 KHz - 22 GHz	8593EM	1319	17-Apr-07
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	1786	26-Dec-07
Rohde & Schwarz	Power Sensor, 1 nW-20 mW, 10 MHz-18 GHz, 50ohms	NRV-Z1	1798	17-Apr-07

Radiated Emissions, 30 - 40,000 MHz, 26-Mar-07
Engineer: Mehran Birgani

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Antenna, Horn, 1-18 GHz (SA40-Blu)	3115	1386	11-Jul-08
Hewlett Packard	High Pass filter, 8.2 GHz (Purple System)	P/N 84300-80039 (84125C)	1767	08-Nov-07
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	1771	11-Jul-07
EMCO	Antenna, Horn, 18-26.5 GHz (SA40-Purple)	3160-09 (84125C)	1773	10-Nov-07
EMCO	Antenna, Horn, 26.5-40 GHz (SA40-Purple)	3160-10 (84125C)	1774	10-Nov-07
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	15-Nov-07

EXHIBIT 2: Test Measurement Data

20 Pages

Elliott

EMC Test Data

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	Test-Log Number:	T67367
		Project Manager:	Susan Pelzl
Contact:	Steve Smith		
Emissions Spec:	FCC 15.407, RSS-210	Class:	Radio
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Xirrus, Inc.

Model

XS-3900-16

Date of Last Test: 3/28/2007

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	Test-Log Number:	T67367
		Project Manager:	Susan Pelzl
Contact:	Steve Smith		
Emissions Spec:	FCC 15.407, RSS-210	Class:	Radio
Immunity Spec:	-	Environment:	-

EUT INFORMATION

The following information was collected during the test sessions(s).

General Description

The Xirrus, Inc. model XS-3900-16 is a multi-radio 802.11abg Access Point radio which is designed to act as a hub for a wireless local area network (WLAN). Model XS-3900-16 contains 16 separate transceivers. Model XS-3700-8 contains 8 transceivers. The radio interfaces are provided via four identical circuit boards. Each of the boards has four 802.11abg radios installed onto it (in the XS-3700-8, 8-port version two of these radios are removed from each board).

Normally, the EUT would be ceiling mounted during operation. The EUT was tested for radiated emissions as both table-top equipment and also tested with the EUT raised to a height of 1.5m above the ground plane. The electrical rating of the device is 100 - 240Vac, 50/60Hz, 0.5 - 3 A.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Xirrus	XS-3900-16	802.11 a/b/g access point	XS237270600453	SK6XS390016

Other EUT Details

None

EUT Antenna (Intentional Radiators Only)

The 6dBi antenna is integral to the device.

EUT Enclosure

The EUT enclosure is primarily constructed of plastic. It is circular with a diameter of 48 cm and a height of 10cm.

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Project Manager:	Susan Pelzl
Contact:	Steve Smith		
Emissions Spec:	FCC 15.407, RSS-210	Class:	Radio
Immunity Spec:	-	Environment:	-

Test Configuration #1

The following information was collected during the test sessions(s).

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
-	-	-	-	-

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Toshiba	Satellite A60 PSA60U-0CS01D	Laptop	X4051688Q	DoC

Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
EUT 10/100 Ethernet	Netgear switch #1	Cat 5	Shielded	10.0
EUT Console	N/C - note 1	-	-	-
EUT Gig E #1	Netgear switch #2	Cat 5	Shielded	10.0
EUT Gig E #2	Netgear switch #3	Cat 5	Shielded	10.0
EUT AC power	AC Mains	3-wire	Unshielded	1.5
Netgear Switch #4	Laptop ethernet	Cat 5	Shielded	5.0

Note 1: The console port was not connected during testing. This port is used for configuration and troubleshooting purposes only and is not intended to be connected during normal operation.

EUT Operation During Emissions Tests - Receiver

The transceivers were all in receive mode - #100, 120, 140.

EUT Operation During Emissions Tests - Transmitter-related emissions

During emissions testing the EUT was configured with the transceivers transmitting continuously on the specified channel at the specified output power settings. A data rate of 6Mb/s was used for all OFDM modulations.

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

FCC Part 15 Subpart E Tests

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 3/24/2007
Test Engineer: Juan Martinez
Test Location: SVOATS #2

Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators and cables used.

Ambient Conditions:

Temperature: 17 °C
Rel. Humidity: 67 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Power, 5470 - 5725MHz	15.407(a) (1), (2)	Pass	17.2 dBm
1	PSD, 5470 - 5725MHz	15.407(a) (1), (2)	Pass	4.9dBm/MHz
1	26dB Bandwidth	15.407	Pass	> 20 MHz
1	99% Bandwidth	RSS 210	Pass	17.5 MHz
2	Peak Excursion Envelope	15.407(a) (6)	Pass	9.4 dB
3	Antenna Conducted Out of Band Spurious	15.407(b)	Pass	All emissions below the -27dBm/MHz limit

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

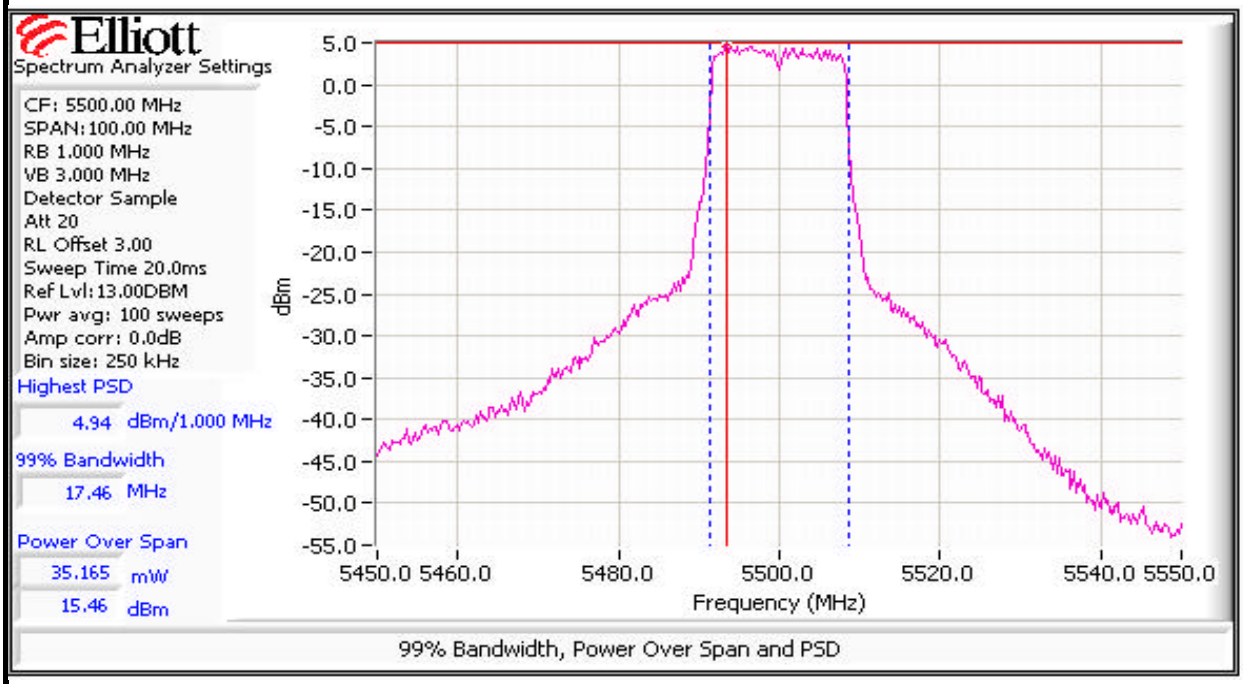
Run #1: Bandwidth, Output Power and Power spectral Density

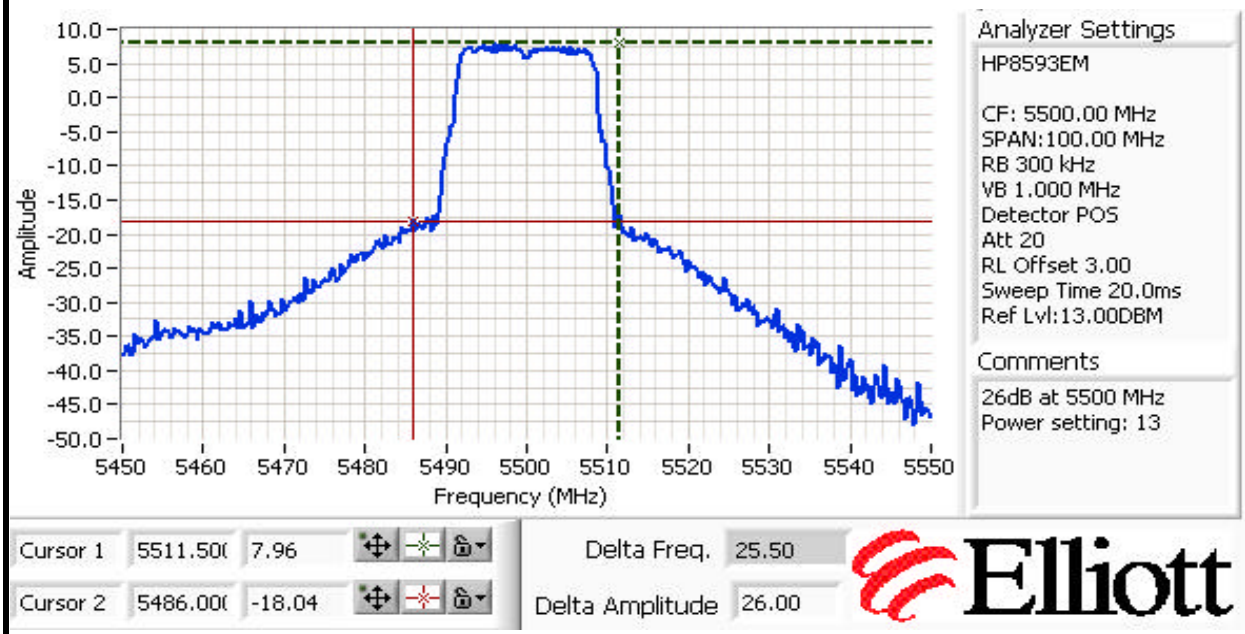
Antenna Gain: 6 dBi

Frequency (MHz)	Software Setting	Bandwidth		Output Power[1] dBm		Power (Watts)	PSD[2] dBm/MHz			Result
		26dB	99%[4]	Measured	Limit		Measured	FCC Limit	RSS Limit[3]	
5500	13.0	25.5	17.5	15.5	24.0	0.035	4.9	11.0	6.1	Pass
5600	15.0	24.5	17.5	15.5	24.0	0.035	3.2	11.0	6.1	Pass
5700	20.0	43.5	17.5	17.2	24.0	0.052	3.2	11.0	7.8	Pass

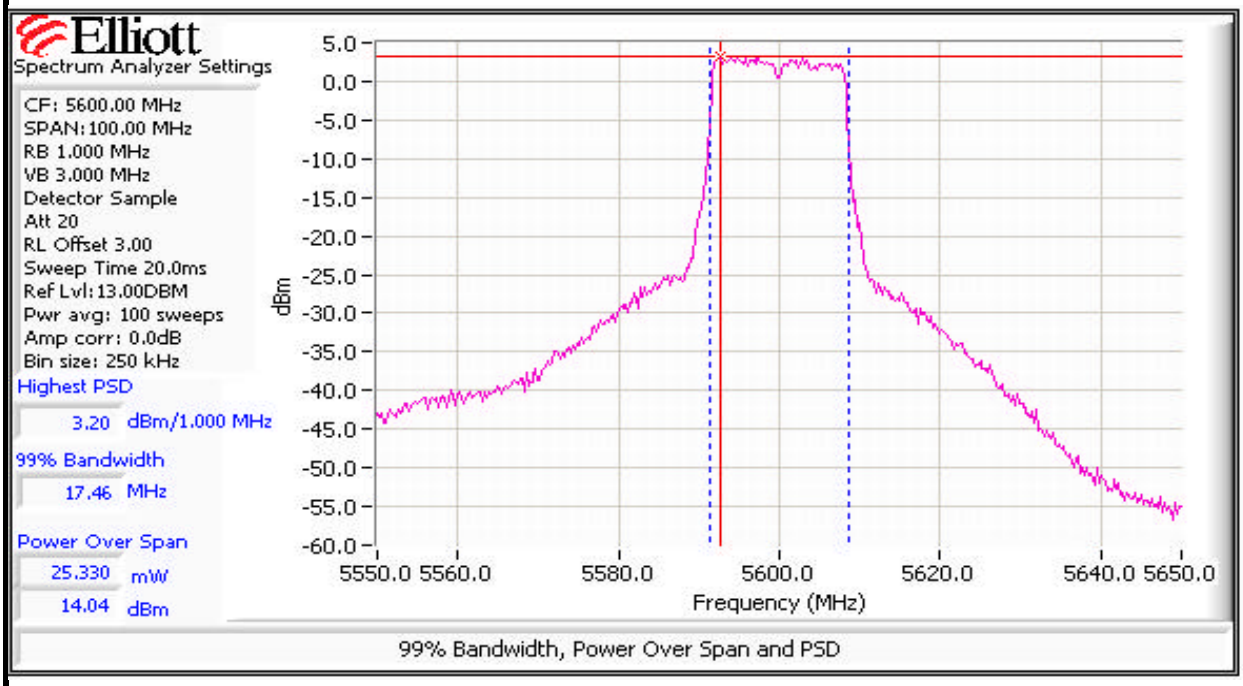
Note 1:	Output power measured using a spectrum analyzer (see plots below): RBW=1MHz, VB=3 MHz, sample detector, power averaging on (transmitted signal was continuous) and power integration over 100 MHz
Note 2:	Measured using the same analyzer settings used for output power.
Note 3:	For RSS210 the measured value of the PSD (see note 3) must not exceed the average value (calculated from the measured power divided by the measured 99% bandwidth) by more than 3dB.
Note 4:	99% Bandwidth measured in accordance with RSS GEN - RB > 1% of span and VB >=3xRB

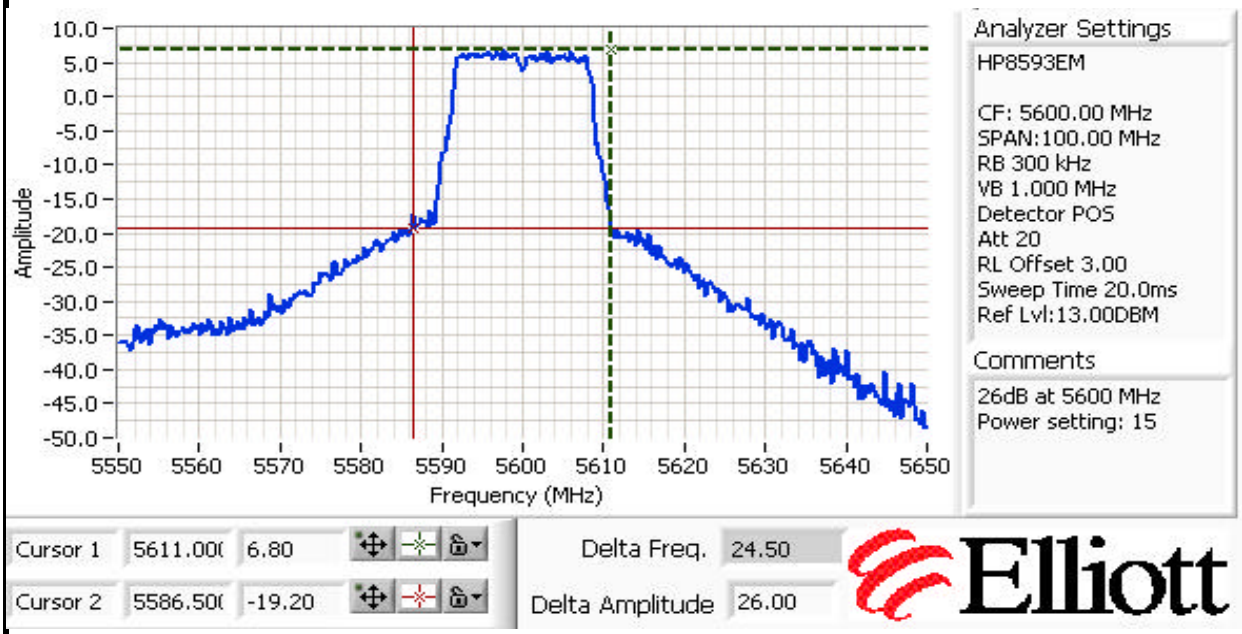
Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A



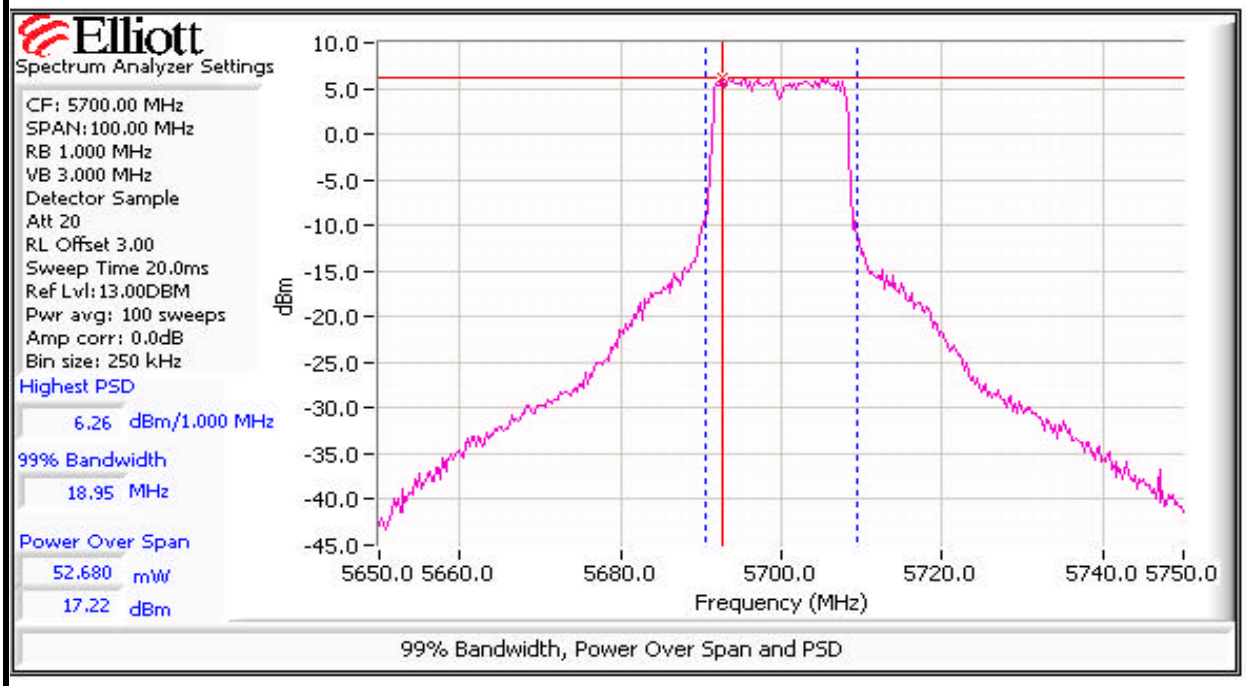


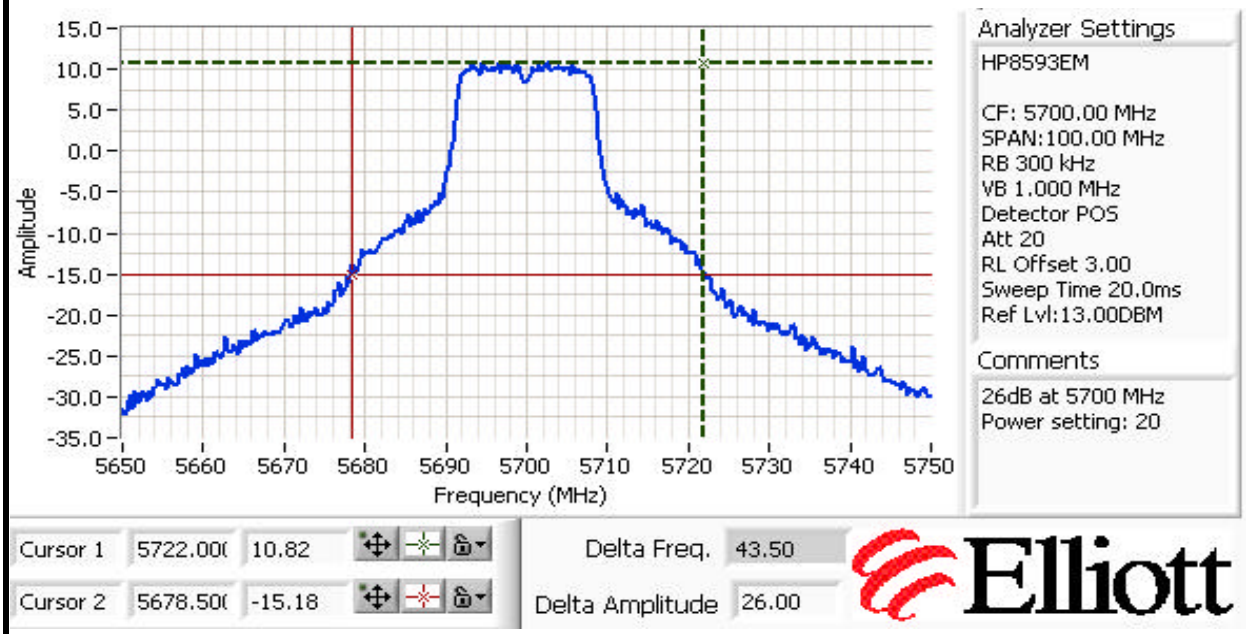
Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A





Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A





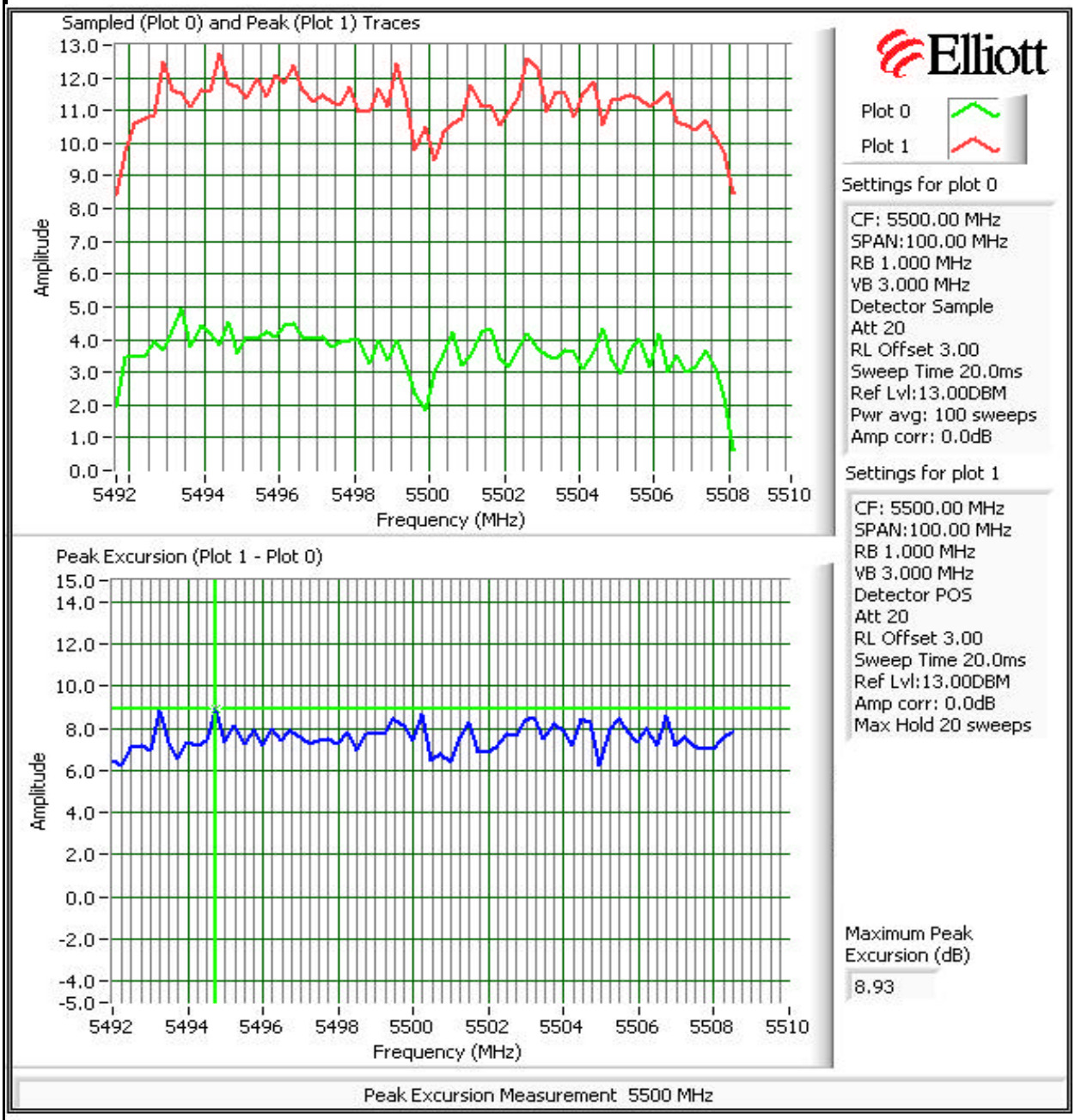
Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

Run #2: Peak Excursion Measurement

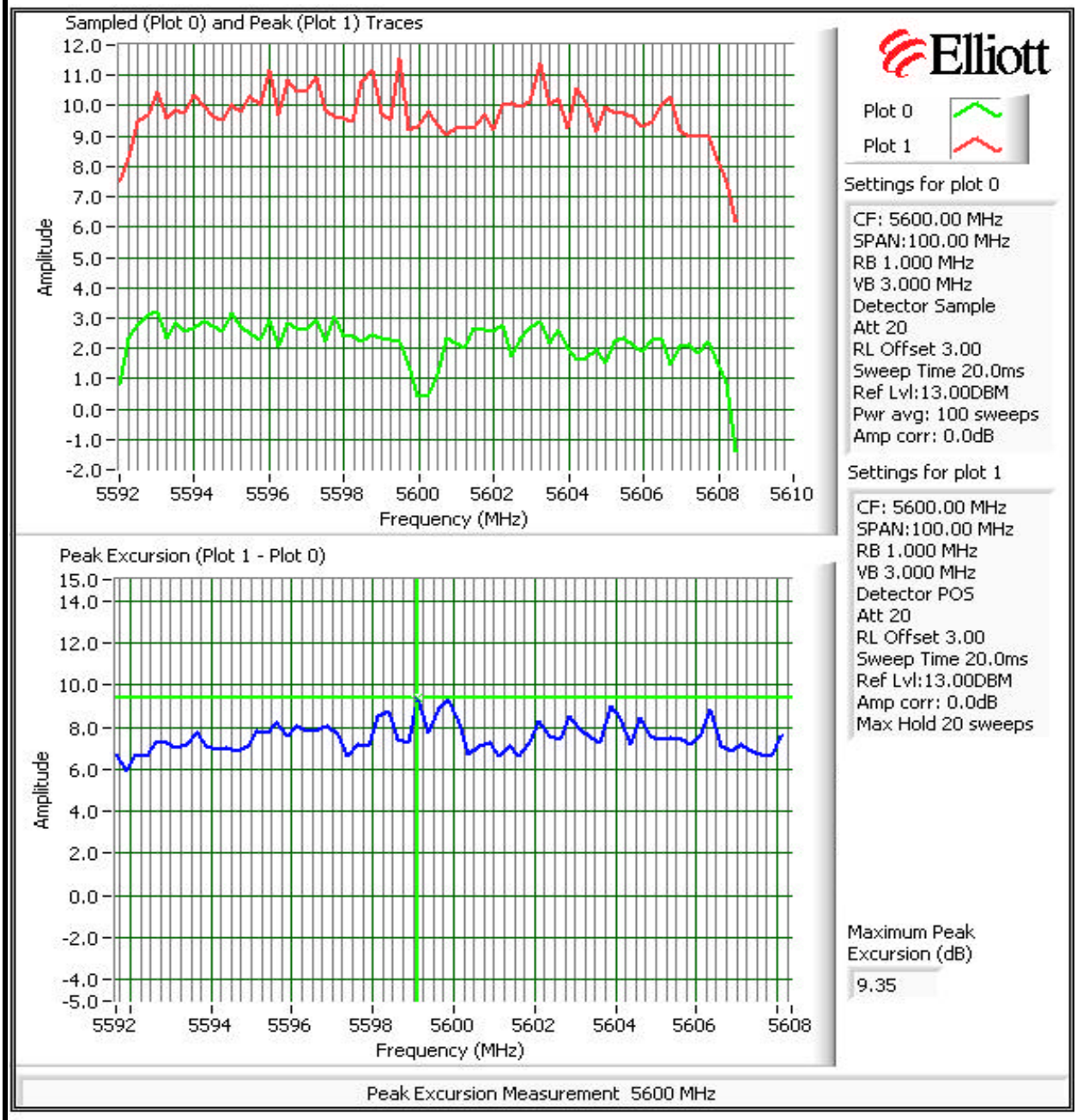
Plots Showing Peak Excursion

Trace A: RBW = VBW = 1MHz

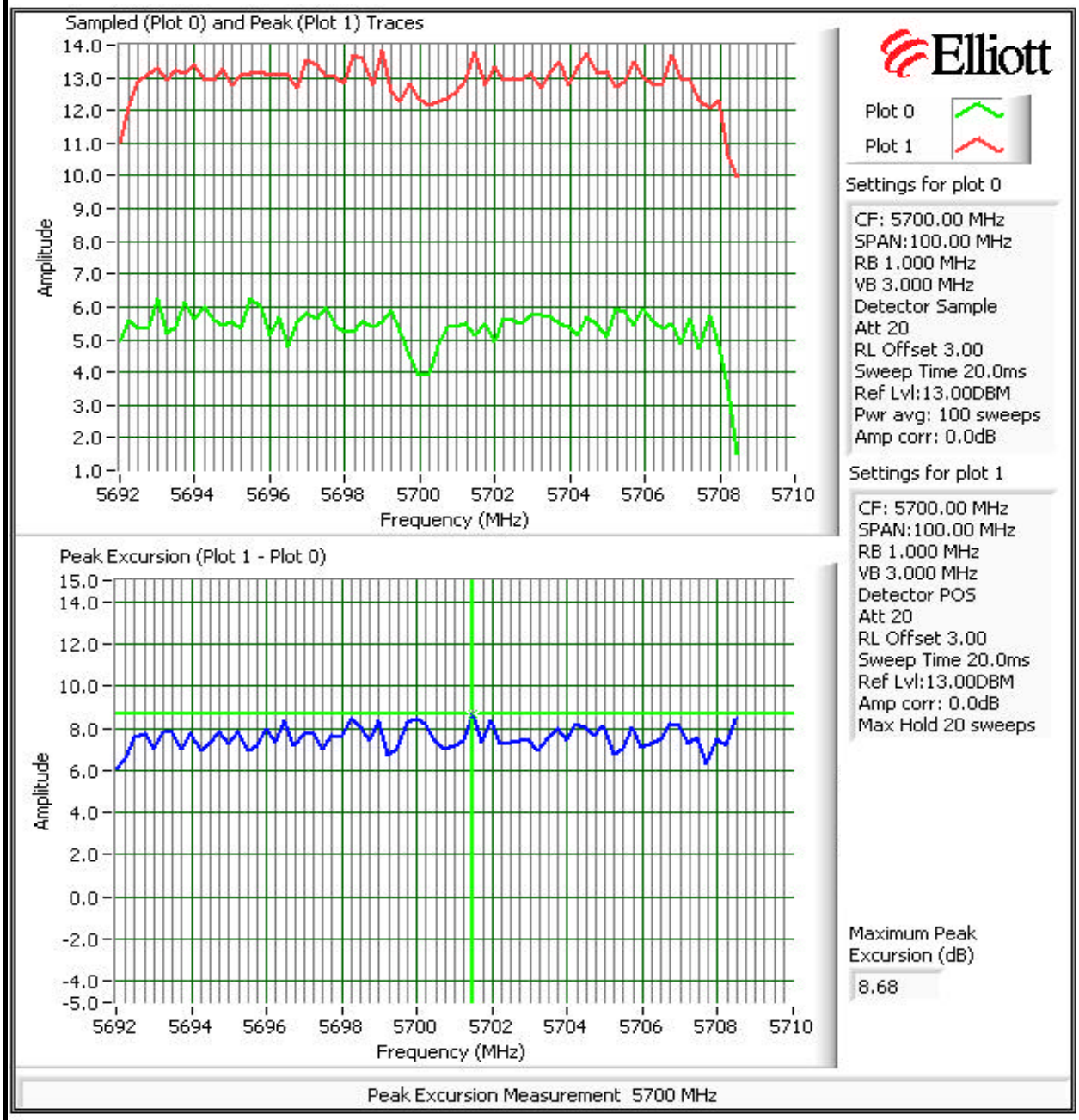
Trace B: RBW = 1 MHz, Method# 3



Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A



Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A



Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

Run #3: Out Of Band Spurious Emissions - Antenna Conducted

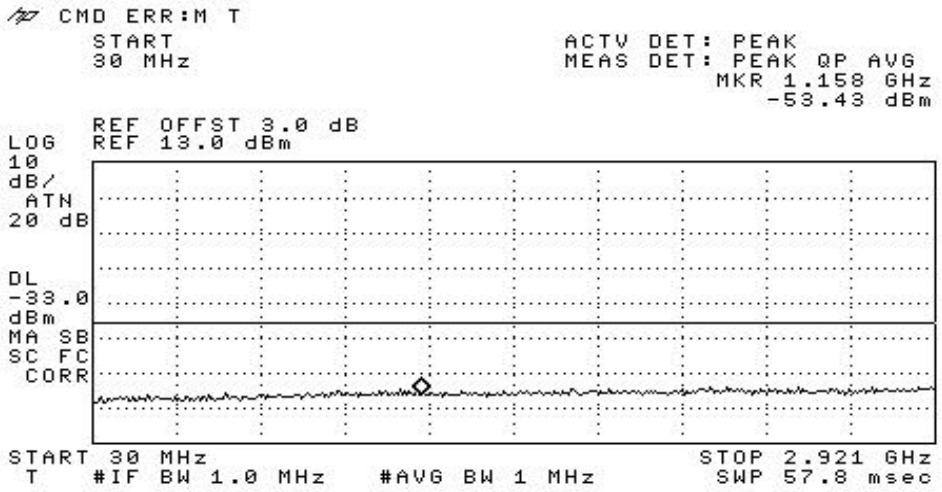
Maximum Antenna Gain:	6 dBi
Spurious Limit:	-27 dBm/MHz eirp
Limit Used On Plots [Note 1]:	-33 dBm/MHz

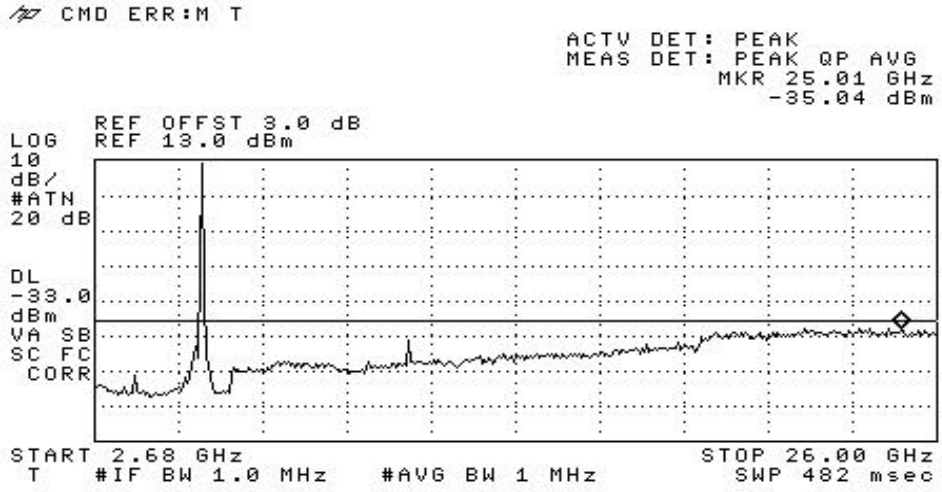
Note 1:	The -27dBm/MHz limit is an eirp limit. The limit for antenna port conducted measurements is adjusted to take into consideration the maximum antenna gain (limit = -27dBm - antenna gain). Radiated field strength measurements for signals more than 50MHz from the bands and that are close to the limit are made to determine compliance as the antenna gain is not known at these frequencies.
Note 2:	All spurious signals below 1GHz are measured during digital device radiated emissions test.
Note 3:	Signals within 10MHz of the 5.725 or 5.825 Band edge are subject to a limit of -17dBm EIRP
Note 4:	If the device is for outdoor use then the -27dBm eirp limit also applies in the 5150 - 5250 MHz band.
Note 5:	Signals that fall in the restricted bands of 15.205 are subject to the limit of 15.209.

Plots Showing Out-Of-Band Emissions (RBW=VBW=1MHz)

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

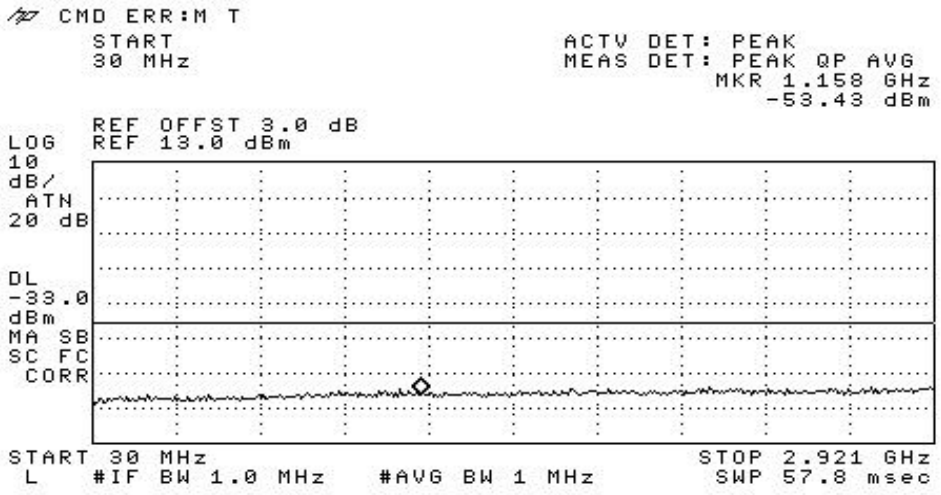
5700 MHz

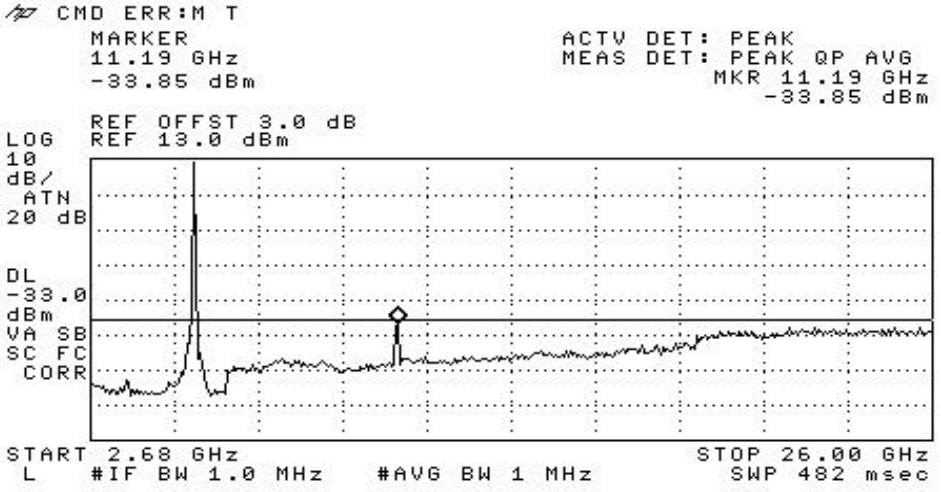




Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

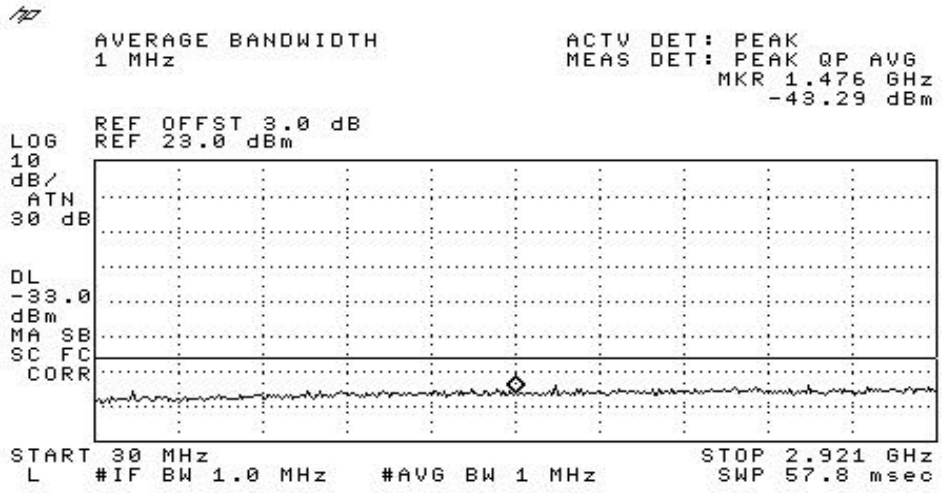
5600 MHz

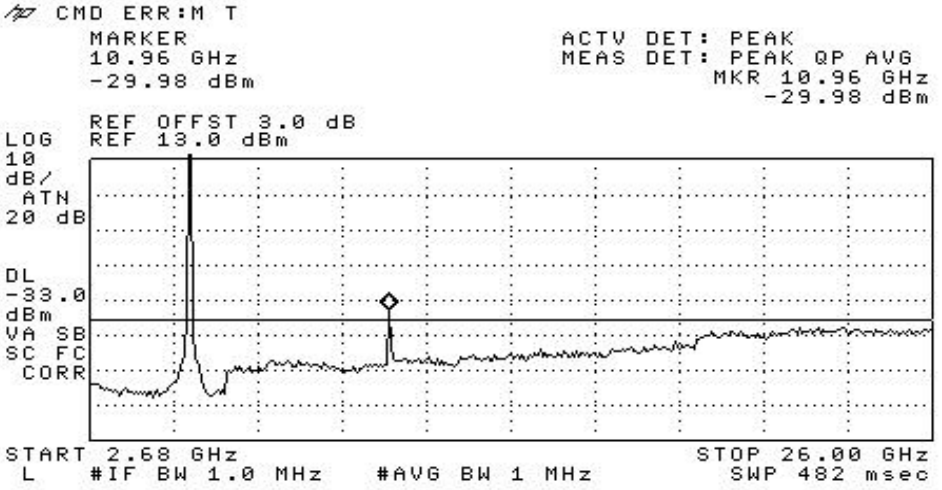




Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

5500 MHz





Peak level shown is -30dBm/MHz, see below for average value which was -43.7dBm/MHz

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
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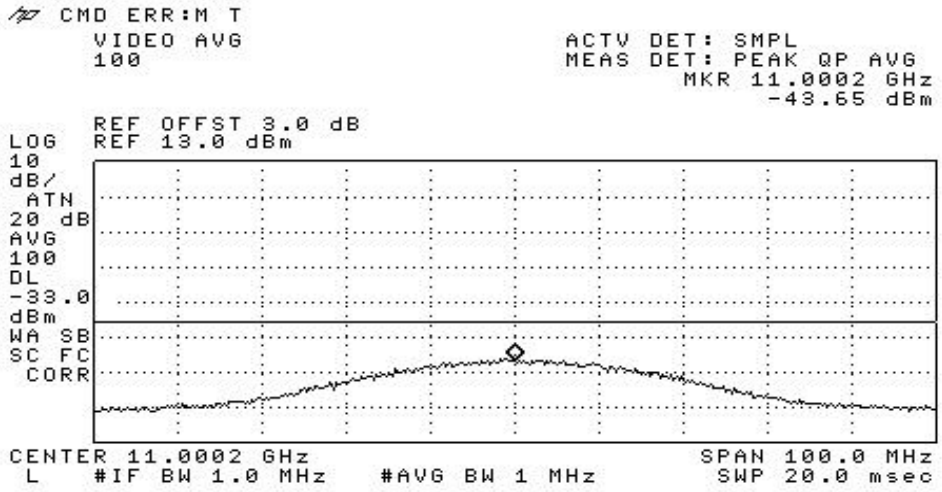
2nd harmonic (Avg Detector)



Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

UNII 15.407 Radiated Spurious Emissions

Test specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 3/26 & 28/2007
Test Engineer: Mehran Birgani
Test Location: SVOATS #1

Config. Used: 1
Config Change: Laptop set as local support
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

Ambient Conditions:

Temperature: 11 °C
Rel. Humidity: 68 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1 (802.11a Mode)	RE, 30 - 40000 MHz Spurious Emissions Transmit Mode	FCC Part 15.209 / 15.407	Pass	53.7dBµV/m (482.5µV/m) @ 5460.0MHz (-0.3dB)
1 (802.11a Mode)	RE, 30 - 18000 MHz Spurious Emissions Receive Mode	RSS 210	Pass	33.3dBµV/m (46.2µV/m) @ 5609.9MHz (-20.7dB)

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

Run #1: Radiated Spurious Emissions, 30 - 40000 MHz. Operating Mode: 802.11a
EUT located on 80cm table (worst case)
Run #1a: Channel 100 @ 5500 MHz (Software power setting: 13 using internal antenna 0)
Fundamental Signal Field Strength: Peak and average values measured in 1 MHz, and peak value measured in 100kHz

Frequency	Level	Pol	15.209 / 15.407		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
5502.778	105.5	V	-	-	AVG	211	1.1	RB = 1MHz, VB = 10Hz
5502.778	114.2	V	-	-	PK	211	1.1	RB = VB = 1MHz
5502.778	104.8	V	-	-	PK	211	1.1	RB = VB = 100kHz
5492.830	96.9	H	-	-	AVG	134	1.0	RB = 1MHz, VB = 10Hz
5492.830	106.6	H	-	-	PK	134	1.0	RB = VB = 1MHz

Fundamental emission level @ 3m in 100kHz RBW:	104.8 dBµV/m	
Limit for emissions outside of restricted bands:	74.8 dBµV/m	Limit is -30dBc (UNII power measurement)

Band Edge Signal Field Strength

Delta Marker - Peak	45.7 dB	Delta between highest in-band and highest
Delta Marker - Average	51.8 dB	

Frequency	Level	Pol	15.209 / 15.407		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
5459.960	53.7	V	54.0	-0.3	AVG	211	1.1	RB = 1MHz, VB = 10Hz
5458.130	68.5	V	74.0	-5.5	PK	211	1.1	RB = VB = 1MHz

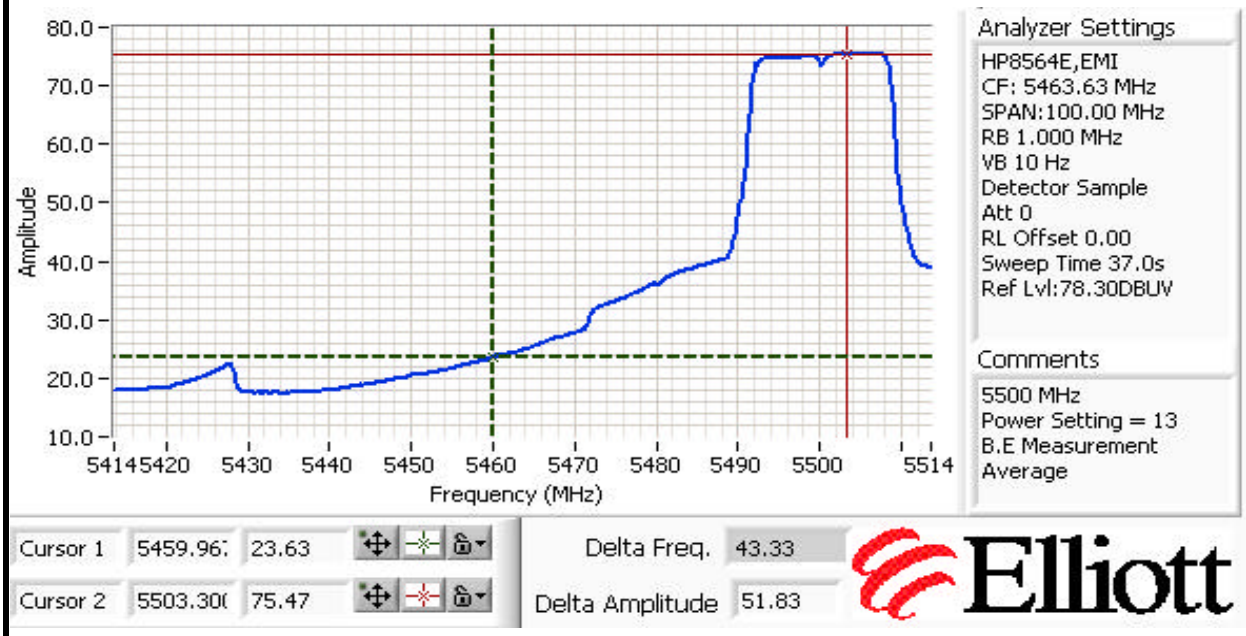
Note 1:	Calculated by subtracting the marker delta values from the fundamental field strength measurements.

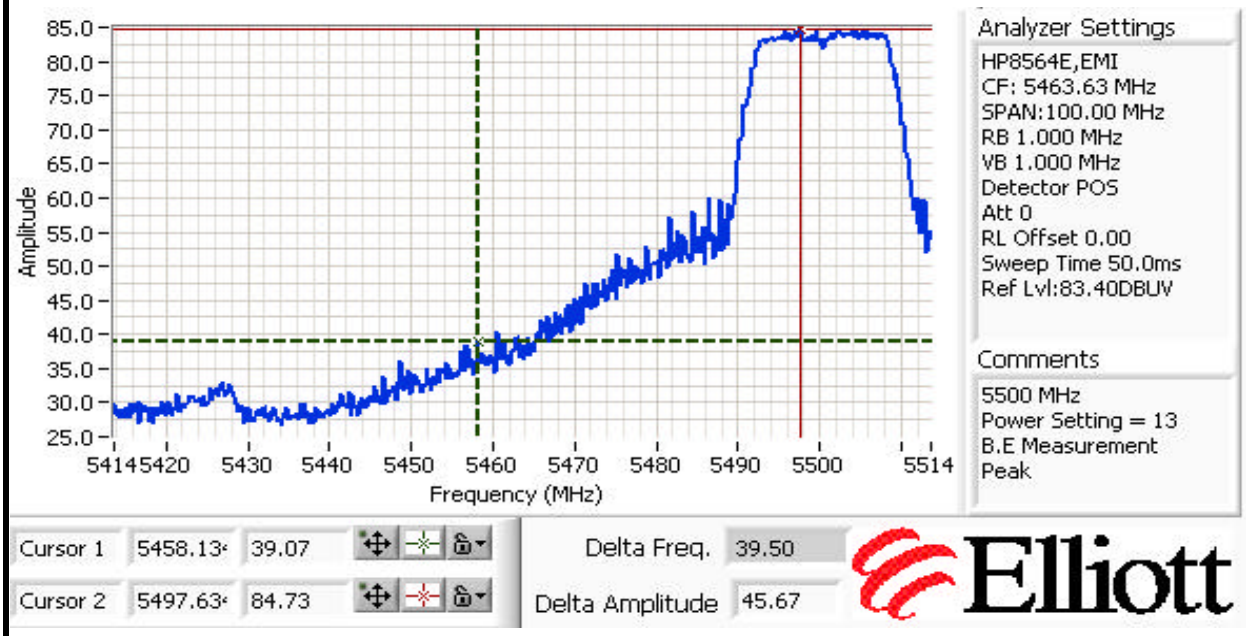
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.407		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
10998.300	52.9	V	54.0	-1.1	AVG	330	1.6	
10998.970	49.3	H	54.0	-4.7	AVG	281	1.0	
10998.300	66.5	V	74.0	-7.5	PK	330	1.6	
10998.970	62.5	H	74.0	-11.5	PK	281	1.0	
16508.770	40.5	H	54.0	-13.5	AVG	360	1.0	Note 2(signal was within noise floor)
16495.230	40.1	V	54.0	-13.9	AVG	44	1.0	Note 2(signal was within noise floor)
16508.770	51.9	H	74.0	-22.1	PK	360	1.0	Note 2(signal was within noise floor)
16495.230	51.1	V	74.0	-22.9	PK	44	1.0	Note 2(signal was within noise floor)

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 2:	Signal is not in a restricted band but the more stringent restricted band limit was used.

Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A





Client:	Xirrus, Inc.	Job Number:	J67029
Model:	XS-3900-16	T-Log Number:	T67367
		Account Manager:	Susan Pelzl
Contact:	Steve Smith		
Standard:	FCC 15.407, RSS-210	Class:	N/A

Run #1b: Channel 120 @ 5600 MHz (Software power setting: 15 using internal antenna 0)
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.407		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
11199.600	53.5	V	54.0	-0.5	AVG	305	1.6	
11198.570	52.9	H	54.0	-1.1	AVG	293	1.1	
11199.600	67.6	V	74.0	-6.4	PK	305	1.6	
11198.570	67.0	H	74.0	-7.0	PK	293	1.1	
16809.570	41.1	V	54.0	-12.9	AVG	71	1.0	Note 2(signal was within noise floor)
16801.190	41.0	H	54.0	-13.0	AVG	28	1.0	Note 2(signal was within noise floor)
16809.570	52.5	V	74.0	-21.5	PK	71	1.0	Note 2(signal was within noise floor)
16801.190	52.1	H	74.0	-21.9	PK	28	1.0	Note 2(signal was within noise floor)

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 2:	Signal is not in a restricted band but the more stringent restricted band limit was used.

Run #1c: Channel 140 @ 5700 MHz (Software power setting: 20 using internal antenna 12)
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.407		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
11398.670	47.5	V	54.0	-6.5	AVG	79	1.1	
17091.530	43.9	V	54.0	-10.1	AVG	108	1.0	Note 2(signal was within noise floor)
11399.900	43.7	H	54.0	-10.3	AVG	90	1.0	
17099.110	43.2	H	54.0	-10.8	AVG	83	1.0	Note 2(signal was within noise floor)
11398.670	62.0	V	74.0	-12.0	PK	79	1.1	
11399.900	58.2	H	74.0	-15.8	PK	90	1.0	
17091.530	55.2	V	74.0	-18.8	PK	108	1.0	Note 2(signal was within noise floor)
17099.110	55.0	H	74.0	-19.0	PK	83	1.0	Note 2(signal was within noise floor)

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 2:	Signal is not in a restricted band but the more stringent restricted band limit was used.

Run #2: Radiated Spurious Emissions, 30 - 18000 MHz. Operating Mode: 802.11a (Receive Mode)

Frequency	Level	Pol	RSS 210		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
5609.930	33.3	V	54.0	-20.7	AVG	315	1.0	noise floor
5602.130	31.8	H	54.0	-22.2	AVG	360	1.0	noise floor
5609.930	43.5	V	74.0	-30.5	PK	315	1.0	noise floor
5602.130	43.4	H	74.0	-30.6	PK	360	1.0	noise floor

EXHIBIT 3: Test Configuration Diagram

EXHIBIT 4: RF Exposure Information

3 Pages