LS Research, LLC
W66 N220 Commerce Court
Cedarburg, WI 53012
Phone: 262.375.4400 Fax: 262.375.4248

COMPLIANCE TESTING OF:

Quartex Synchronization Transmitter
Model XR

PREPARED FOR:

Quartex, Division of Primex, Inc.
965 Wells Street
Lake Geneva, WI 53147

TEST REPORT NUMBER:309109

LSR JOB #: C-581
Part 90

DATE(S) OF TESTING:

March 31st and April 6th 2009

Table of Contents

1. LS Research, LLC In Review

LS Research, LLC is located in Cedarburg, Wisconsin – United States.

We may be contacted by:

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As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:

A2LA – American Association for Laboratory Accreditation
Accreditation based on ISO/IEC 17025 : 2005
with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01

U. S. Conformity Assessment Body (CAB) Validation
Validated by the European Commission as a U. S. Conformity Assessment Body operating under the U. S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union EMC Directive 89/336/EEC, Article 10.2.
Date of Validation: January 16, 2001

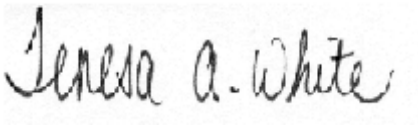
Federal Communications Commission (FCC) – USA
Listing of 3 Meter Semi-Anechoic Chamber based on 47CFR 2.948
FCC Registration Number: 90756

Listing of 3 and 10 meter OATS based on 47CFR 2.948
FCC Registration Number: 90757

Industry Canada
On-file, 3 Meter Semi-Anechoic Chamber based on 47CRF 2.948
File Number: IC 3088

On-file 3 and 10 Meter OATS based on RSS-210
File Number: IC 3088-A

2. Signature Page



Reviewed By: **April 16, 2009**

Teresa A. White, Quality Manager **Date**

Tested By: **April 16, 2009**

Khairul Aidi Zainal, Sr. EMC Engineer **Date**

Tested By: **April 16, 2009**

Ryan Urness, EMC Lab Manager **Date**

Approved By: **April 16, 2009**

Kenneth L. Boston, Sr. EMC Engineer **Date**
PE#31926 Licensed Professional Engineer
Registered in the State of Wisconsin, United States

3. Product and General Information

Manufacturer:	Quartex, Division of Primex, Inc.
Model No.:	XR
Serial No.:	Not Available
Description:	Data Transmitter
Frequency Range:	72.02 – 75.98 MHz

4. Product Description

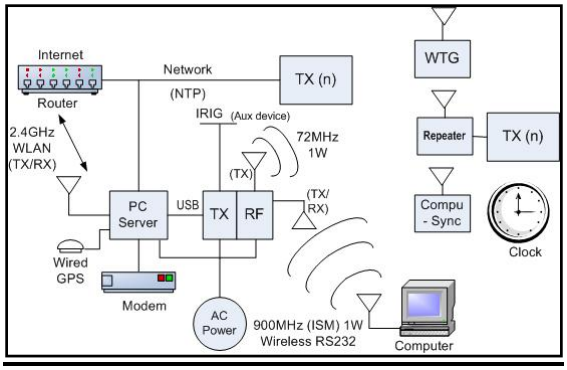
The XR is a data transmitter, which sends telemetry to various co-located paging receivers, which are located in wall clocks, for the purpose of time synchronization. It is provided for by 47 CFR, Part 90.238 as a telemetry device.

The sample was fully configured with all peripheral cables and modules and includes: The I/O connection possibilities are shown in the following table:

Connector	Description	Connector type
GPS IN	Input from GPS receiver	7 pin mini-DIN
NETWORK LAN	Network connection, connects to Lantronix serial port internally. This is a population option with the next connector.	RJ45
WIRELESS NETWORK ANTENNA	Wireless bulkhead antenna mount. This a population option with the previous connector.	SMA
SCHEDULER	Com 1/Auxiliary Port/Scheduler Programming	RS232 DB9 Fem.
GPS OUT	Serial port with 1PPS to drive NTP input for the server	RS232 DB9 Male
SERVER CONNECT	USB 2.0	USB Type B device connector
BASEBAND / MONITOR	Serial JTAG in for programming the micro; input line for monitoring a high power amp RF power; input line for monitoring VSWR on a high power RF amp (neither used in this model); non-inverted baseband output – a digital output of the pre-modulated baseband for external systems	9 pin Mini-DIN socket
TX RF	Main RF Output, found on top of the enclosure for this model	NMO antenna mount
Power	Connector from wall supply. DC output is 9V at 2.7A	Two prong AC, DC is 2.5 mm pin size
EXTERNAL ANTENNA	Not populated for this model, when populated, the TX RF NMO antenna mount on top is depopulated	N-Type Bulk-head

This is a synchronized time and data transmitter that transmits time and data packets using FM encoding in the 72 – 76 MHz frequency range. The transmitter can be locally connected (through a USB interface) or

network connected (through a CAT5 cable or WLAN connection) to a server, can be connected via USB or serial cable to a PC for programming, or operate standalone. The system diagram is shown below.



5. EUT's Technical Specification

Frequency Range (in MHz)	72.02 MHz to 75.98 MHz
RF Power in Watts	0.955 Watts
Conducted Output Power (in dBm)	29.8 dBm (72.02MHz)
Field Strength (and at what distance)	n/a for this product
Occupied Bandwidth (99% BW)	< 20 kHz
Type of Modulation	FM
Emission Designator	20K0F1D
EIRP (in mW)	955 mW
Transmitter Spurious (worst case)	-17.4 dBm at 144.8 MHz
Frequency Tolerance ppm	3.0 ppm
Microprocessor Model # (if applicable)	PIC 18F8722
Antenna Information	
Detachable/non-detachable	Detachable
Type	Any antenna with unity gain
Gain (in dBi)	Unity gain
EUT will be operated under IC Rule Part(s)	47 CFR part 90
Modular Filing	☐ Yes ☒ No
Portable or Mobile?	Mobile

6. Test Requirements

The following FCC requirements are met: 47 CFR, 2.1053, 90.257(b)(2), 90.210.

7. Summary of Test Report

DECLARATION OF CONFORMITY

The Equipment Under Test (EUT) was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 90, Subpart J, and Part 2.1053 Radiated Spurious Emissions for a low-power non-broadcast transmitter.

8. Introduction

On April 6th 2009 a series of Radiated Emission tests were performed on the EUT. These tests were performed using the procedures outlined in ANSI C63.4-2003 for unintentional radiators, and in accordance with the limits set forth in FCC Part 90 for a non-voice and other specialized operation transmitters. These tests were performed by Khairul Aidi Zainal, Senior EMC Engineer and Ryan Urness, EMC Lab Manager at LS Research, LLC.

9. Purpose

All Radiated Emission tests upon the EUT were performed to measure the emissions in the frequency bands described in title 47 CFR, FCC Part 90, including 90.210 (general technical parts) to determine whether these emissions are below the limits expressed within the standards. These tests were performed in accordance with the procedure described in TIA/EIA 603-C 2004. Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelelectriques (CISPR) Number 16-1, 2002, Am. 2, 2003.

10. Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with EIA/TIA-603. The Quartex XR was placed on an 80cm high non-conductive pedestal centered on a flush mounted 2-meter diameter turntable inside the 3 Meter Semi-Anechoic, FCC listed Chamber located at LS Research, LLC, Cedarburg, Wisconsin. The EUT was operated in normal mode, using AC power as provided by a wall transformer. The transmitter was set to operate continuously, on two channels (72.02 and 75.98 MHz), and a suitable artificial 50 ohm antenna load was connected to the internal antenna port for the duration of the radiated emissions tests. Signal levels that were seen to be within 10 dB of the regulatory limits were verified using a substitution method, with a tuned Dipole. The applicable limits are provided at a 3 meter distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a list of the test equipment.

Test Procedure

Spurious radiation measurements were performed on the EUT in the 3 Meter Semi-Anechoic, FCC listed Chamber, located at LS Research, LLC, in Cedarburg, Wisconsin. The frequency range from 30MHz to 1000MHz was scanned, and levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on the non-conductive wooden table in the 3 Meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the test object. A Biconical Antenna was used to measure emissions from 30MHz to 300MHz, and a Log Periodic Antenna was used to measure emissions from 300MHz to 1000MHz. The maximum radiated emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. Included in this list are calibration information and equipment descriptions. All equipment is calibrated and used according to the operations manual supplied by the manufacturer. All calibrations of the antennas used were performed at an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with a bandwidth of 120 kHz for measurements below 1 GHz. Both the Peak and Quasi-Peak Detector functions were utilized.

Test Results

The EUT was found to MEET the Radiated Emissions requirements of Title 47 CFR, FCC Part 90.257(b)(2) for an unintentional radiator (Canada RSS-210, 2007). The frequencies with significant signals were recorded and plotted as shown in the Data Charts and Graphs.

Calculation of Radiated Emissions Limits

FIELD STRENGTH OF SPURIOUS/HARMONIC FREQUENCIES

In accordance with Section 90.210 (2.1053)
All out of band spurious emissions must be below the mean power of the carrier by at least:

$$43 + 10 \log(\text{carrier power})$$

which for a 1.0 watt rating on the test sample is:

$$43 + 10 \log(1))$$
$$43 = 43 \text{ dBc}$$

-43 dBc from 30 dBm = -13. dBm

FIELD STRENGTH OF PART 90 LIMIT: AT R = 3 METERS DSTANCE

FROM THE STANDARD REFERENCE FORMULA FOR POWER TRANSMITTED VERSUS ELECTRIC FIELD:

$$Pt = (R^{**}) \times |E|^{**} / 30$$

Then to convert to dB:

$$Pt = 20\log|E| + 20\log(R) - 10\log(30)$$

Insert additional terms to convert watts to milli-watts (in dB) and volts to micro-volts (in dBμV):

$$Pt = 20\log|E\mu v| - 20\log(1{,}000{,}000) + 10\log(1000) + 20\log(3) - 10\log(30)$$

$$Pt = 20\log|E\mu v| - 120 + 30 + 9.54 - 14.77$$

$$Pt = 20\log|E\mu v| - 95.23$$

OR; $20\log|E\mu v| = Pt \text{ (in dBm)} + 95.23$

$|E|$ (in dBμV) = -13 dBm + 95.23 = 82.23 dBμV/m , at 3 meters

Summary of Results and Conclusions

Based on the procedures outlined in this report, and the test results included in Appendices A and B, it can be determined that the EUT does MEET the emission requirements of Title 47 CFR, FCC Part 90.

The enclosed test results pertain to the samples of the test item listed, and only for the tests performed per the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

Measurement of Electromagnetic Radiated Emissions upon a 3 Meter FCC/I. C. Listed Site

Test Requirements: Title 47 CFR, 2.1053, 90.257(b)(2), 90.210

Manufacturer:	Quartex, a Division of Primex, Inc.									
Date(s) of Test:	April 6th 2009									
Test Engineer(s):		Tom Smith		Aidi Zainal	√	Ryan Urness				
Model #:	XR									
Serial #:	Not available									
Voltage:	9 VDC, 1.4A Wall Adapter									
Operation Mode:	Continuous Transmit									
Distance:	√	3 Meters		10 Meters						
EUT Power:	√	Single Phase 115 VAC		3 Phase ___VAC						
		Battery		Other:						
EUT Placement:	√	80cm non-conductive table		10cm Spacers						
EUT Test Location:	√	3 Meter FCC Listed S.A.C.		3/10m OATS						
Configuration:	0.8 m height									
Measurements:		Pre-Compliance		Preliminary	√	Final				
Detectors Used:	√	Peak	√	Quasi-Peak		Average				

Test Equipment Utilized:
EMI Measurement Instrument: HP 8546A
Biconical Antenna: EMCO 93110
Log Periodic Antenna: EMCO 93146A

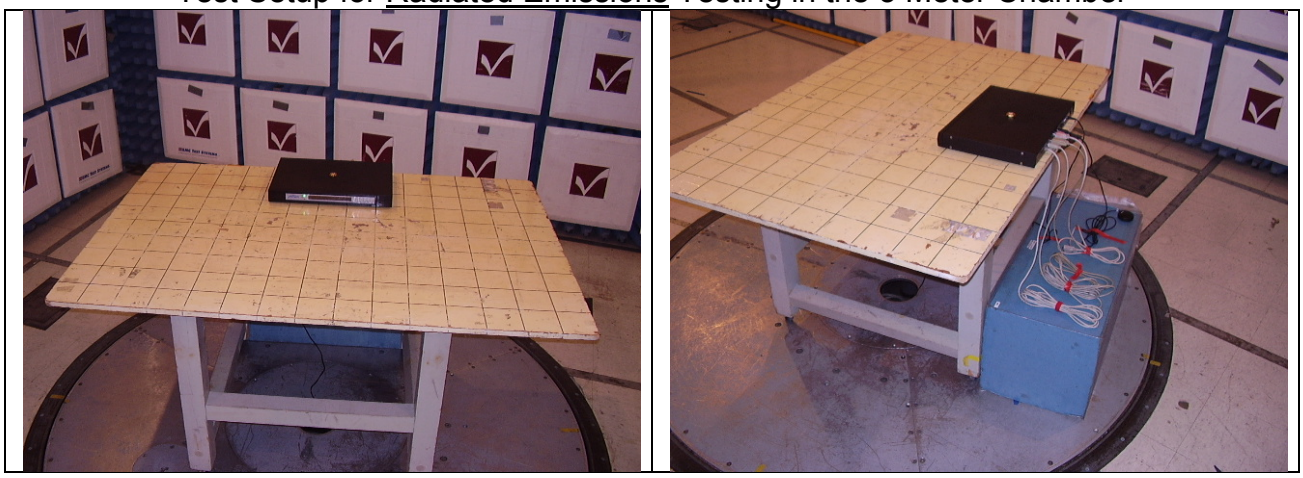
The following table depicts the level of significant emissions found:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)
72.02	Horiz	4	360	31.7	82.2	50.5
72.01	Vert	1	243	40	82.2	42.2
75.98	Vert	1	240	44.3	82.2	37.9
75.98	Horiz	4	360	34.7	82.2	47.5
95.99	Vert	1	216	36.3	82.2	45.9
95.99	Horiz	4	360	30.8	82.2	51.4
96.00	Horiz	4	283	30.9	82.2	51.3
96.00	Vert	1	243	36.3	82.2	45.9
872.00	Horiz	1	217	43.9	82.2	38.3
872.00	Horiz	1	218	43.7	82.2	38.5
888.00	Vert	1	138	42.6	82.2	39.6
888.00	Vert	1	153	43.2	82.2	39

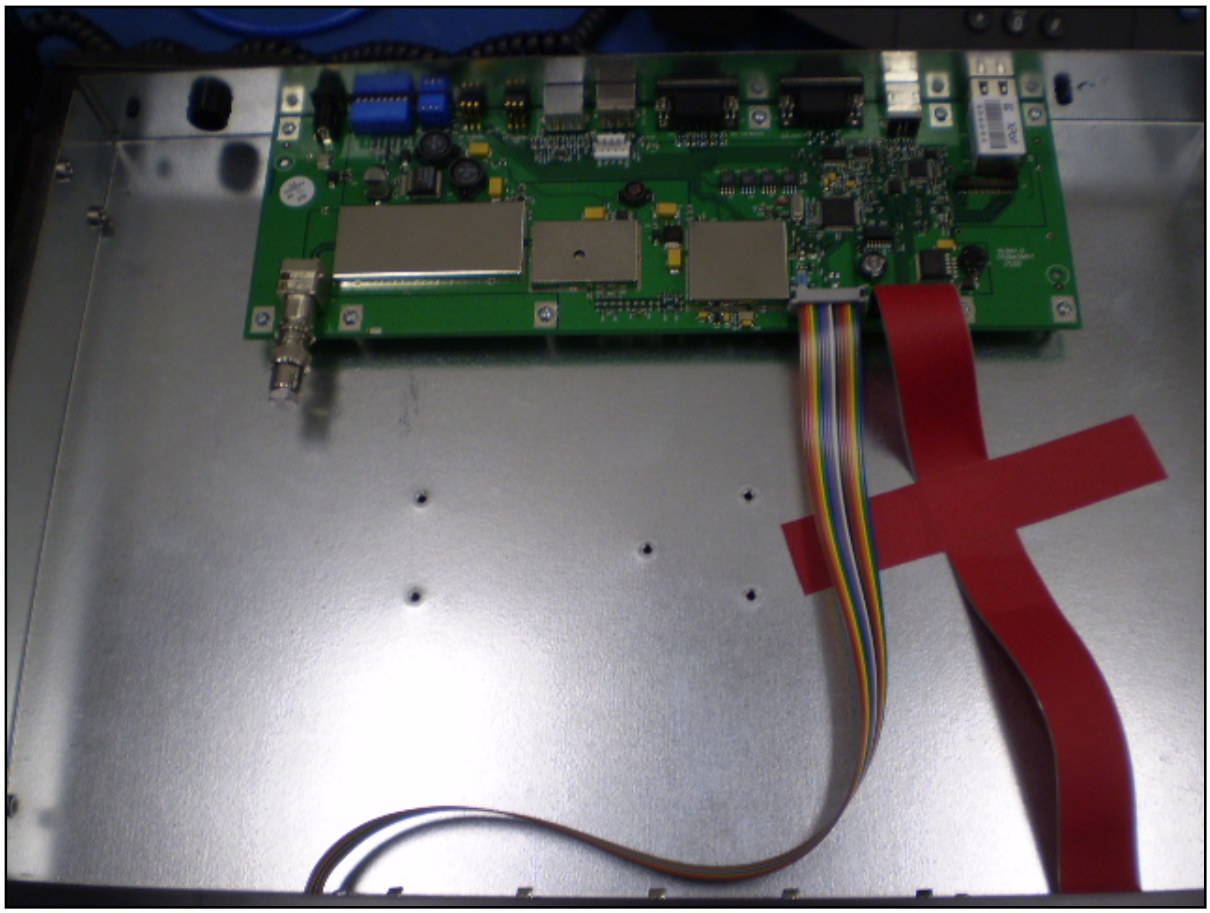
Notes: Emissions seen with antenna port terminated with a 50 ohm terminating load. **All Radiated Spurious Emissions seen were found to be greater than 20 dB below the limits** of 82 dB/uV/m, or below the noise floor of the instrumentation. Since the highest peak emissions seen were in the neighborhood of 45 dBuV/m or less, which is almost 40 dB below the radiated equivalent field strength of the -13 dBm limit level, no substitution method measurements were performed.

Photos Taken During Radiated Emissions Testing

Test Setup for Radiated Emissions Testing in the 3 Meter Chamber



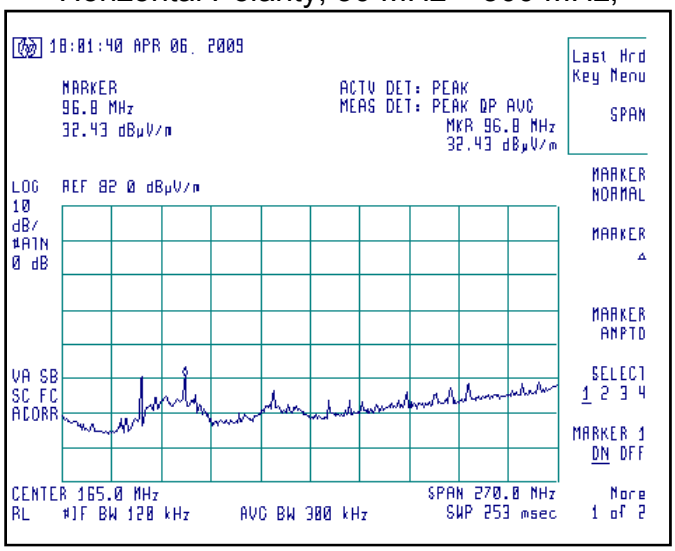
View of the EUT during the Radiated Emissions Testing.
Port internally terminated with a 50 Ohm load.



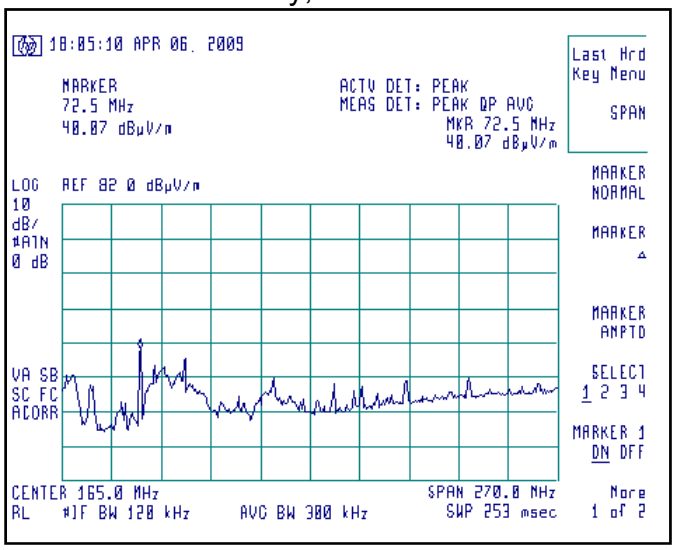
A. Channel 17 (72.02 MHz)

Signature Scan of Radiated Emissions

Horizontal Polarity, 30 MHz – 300 MHz,

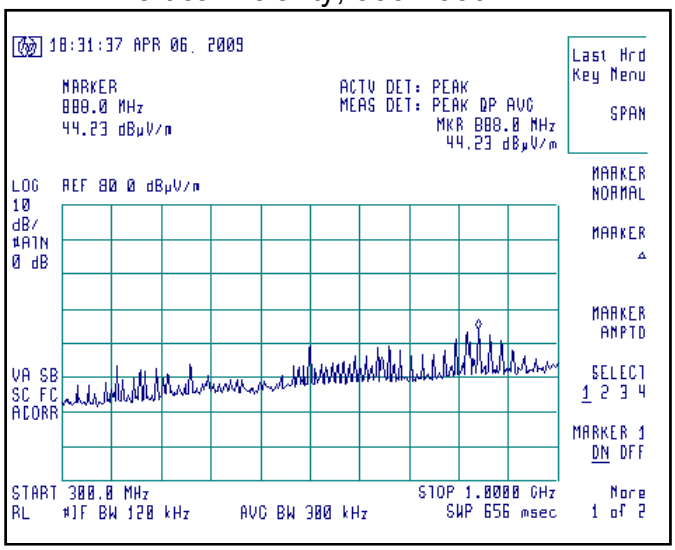


Vertical Polarity, 30 MHz – 300 MHz

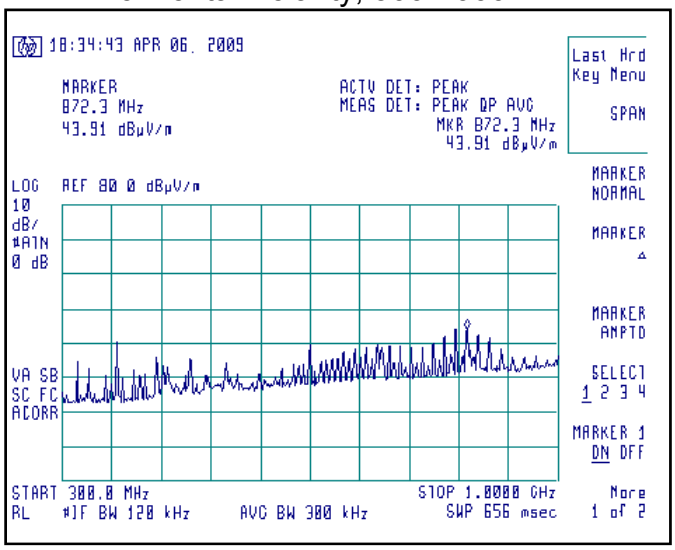


Signature Scan of Radiated Emissions

Vertical Polarity, 300-1000 MHz



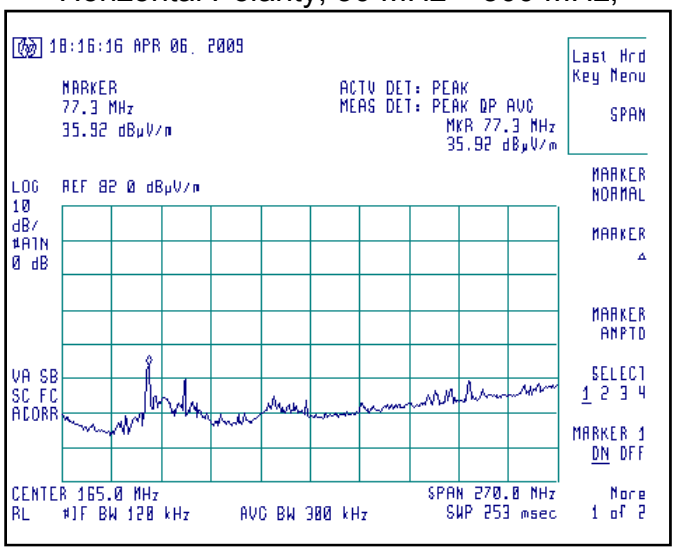
Horizontal Polarity, 300-1000 MHz



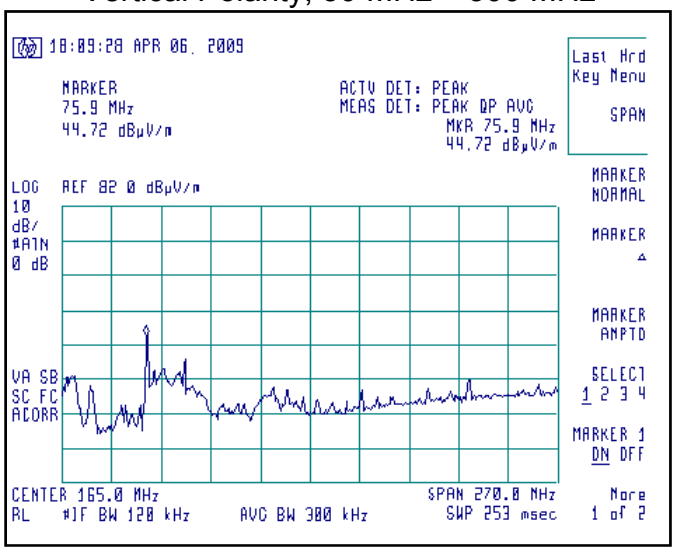
B. Channel 99 (75.98 MHz)

Signature Scan of Radiated Emissions

Horizontal Polarity, 30 MHz – 300 MHz,

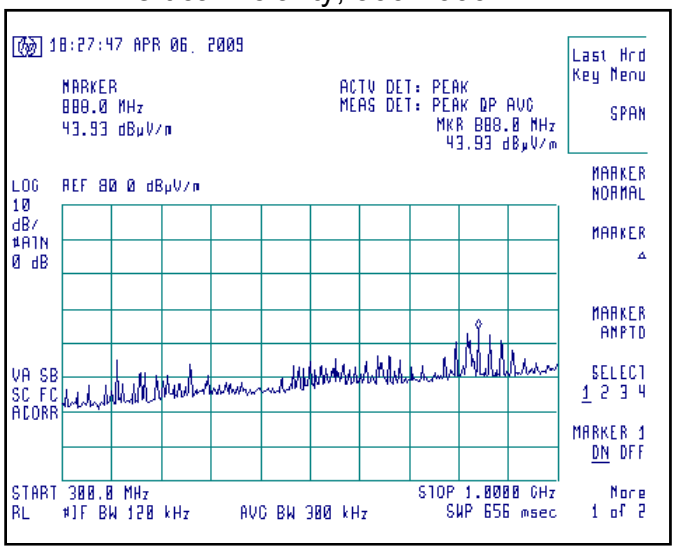


Vertical Polarity, 30 MHz – 300 MHz

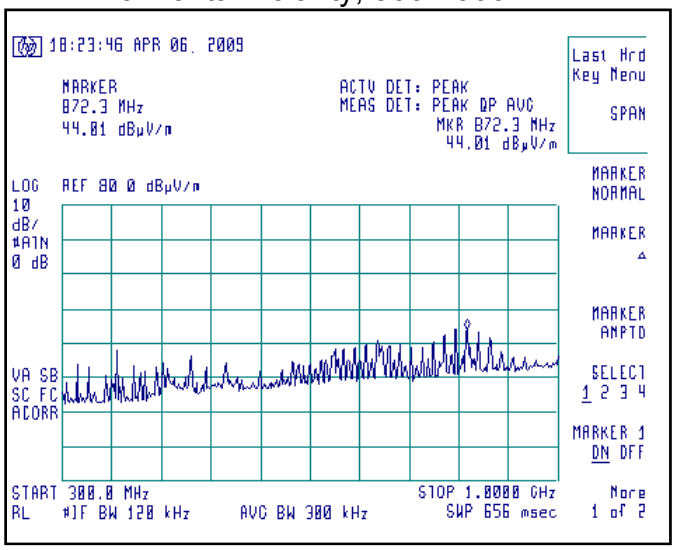


Signature Scan of Radiated Emissions

Vertical Polarity, 300-1000 MHz



Horizontal Polarity, 300-1000 MHz

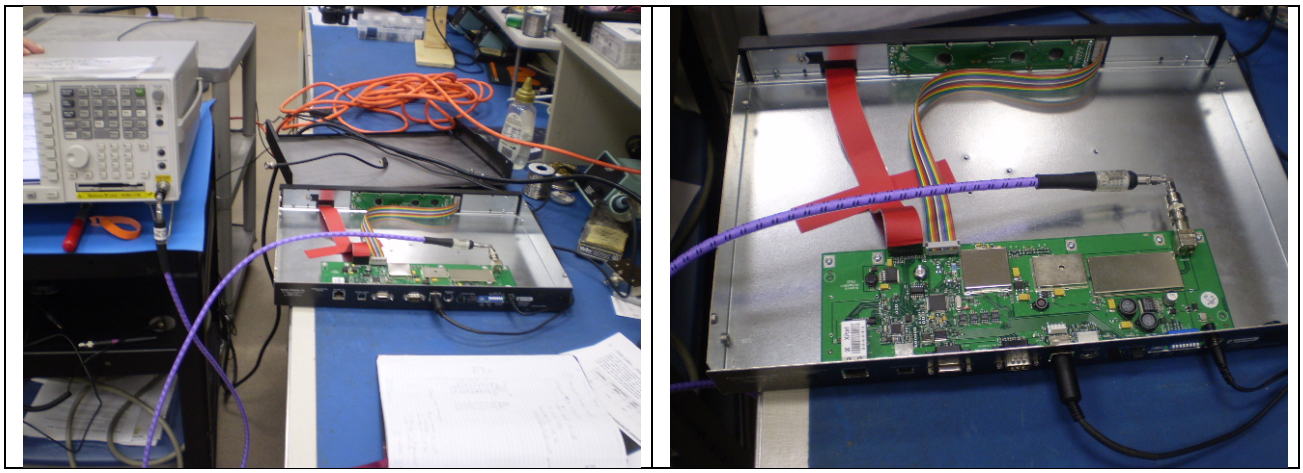


11. Power Output 47 CFR 2.1046

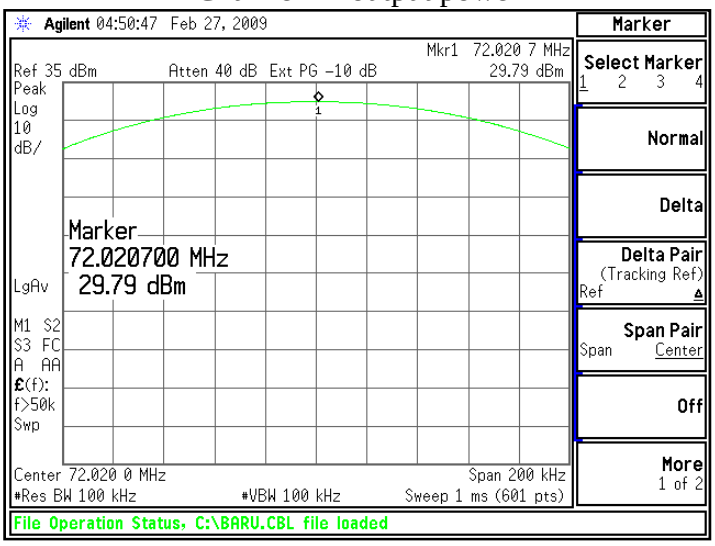
For the FCC Part 2.1046 measurement, the output of the sample was connected via a short jumper cable, with a reverse-gender connector, through a 10 dB Attenuator to the input of the Agilent E4446 A Spectrum Analyzer. The unit was configured to run in a normal continuous transmit mode, while being supplied with a random, internal full-frequency digital audio signal as a modulation source. The HP receiver was set to a 100kHz Bandwidth, and the transmit signal was then stored, with the peak signal level stored. This power level was collected for two channels and can be seen in the chart presented below.

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
17	72.02	30.0	29.8	0.2
99	75.98	30.0	29.5	0.5

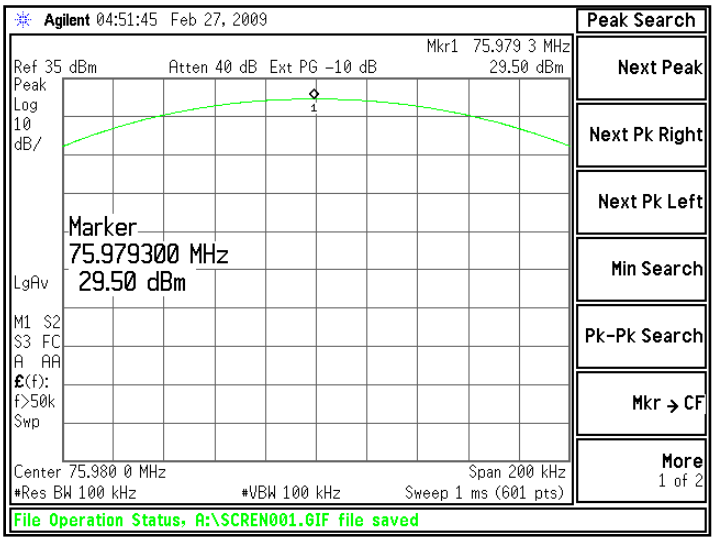
View of Test Setup During the Conducted RF measurements



Channel 17 output power



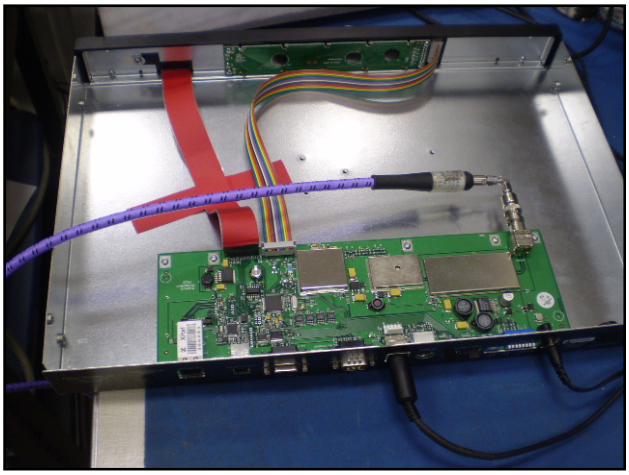
Channel 99 output power



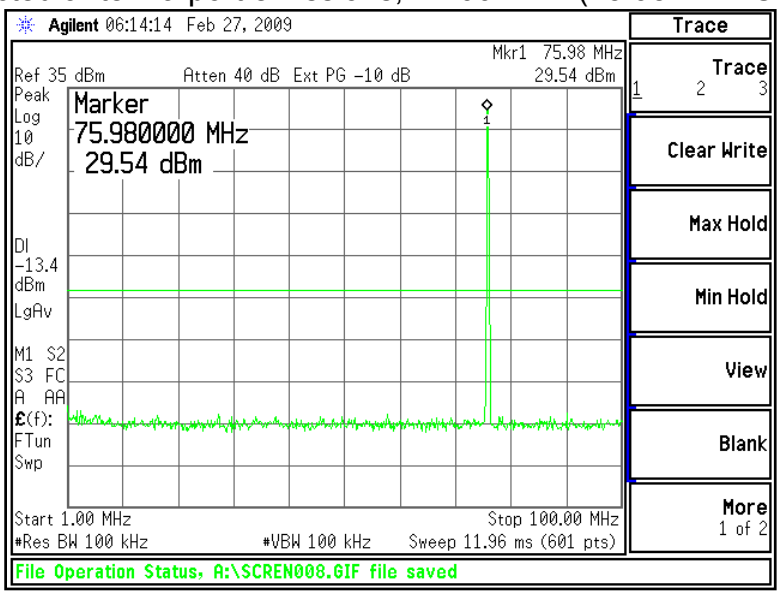
12. Conducted Spurious Emissions: 47 CFR 2.1051

FCC Part 2.1051 requires an antenna conducted measurement of conducted harmonic and spurious levels, as reference to the carrier frequency in a 100 kHz bandwidth. For this test, the transmitter was directly connected to the HP E4446A Spectrum Analyzer, through a very short Coaxial Cable and a 40 DB Attenuator. Plots were then taken, with any noticeable spurious or harmonic signals identified. No significant levels at any spurious products could be found within -43 dBc of the fundamental of the transmitter. The highest spurious signal seen was at 144.8 MHz (Channel 17), which was measured at -17.4 dBm in a 100 kHz bandwidth, which is about 4.4 dB below the -13.0 dBm limit.

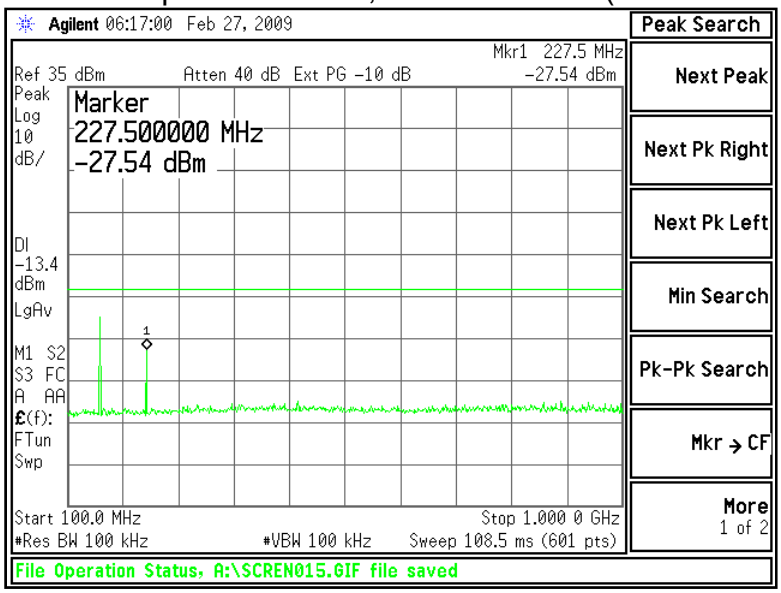
CHANNEL	Test FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
17	144.8	-13.0	-17.4	4.4
17	217.2	-13.0	-38.5	25.5
99	152.5	-13.0	-19.9	6.9
99	227.5	-13.0	-27.5	14.5



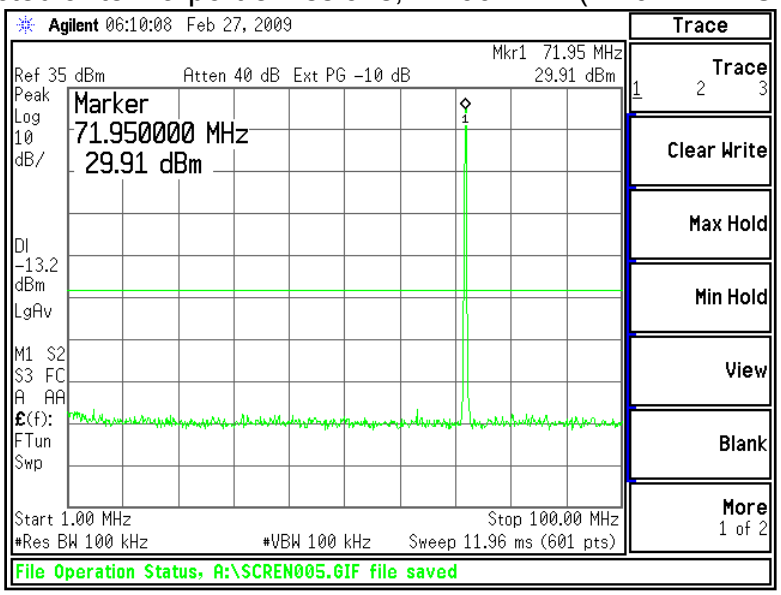
Conducted antenna port emissions, 1-100 MHz (75.98 MHz Channel)



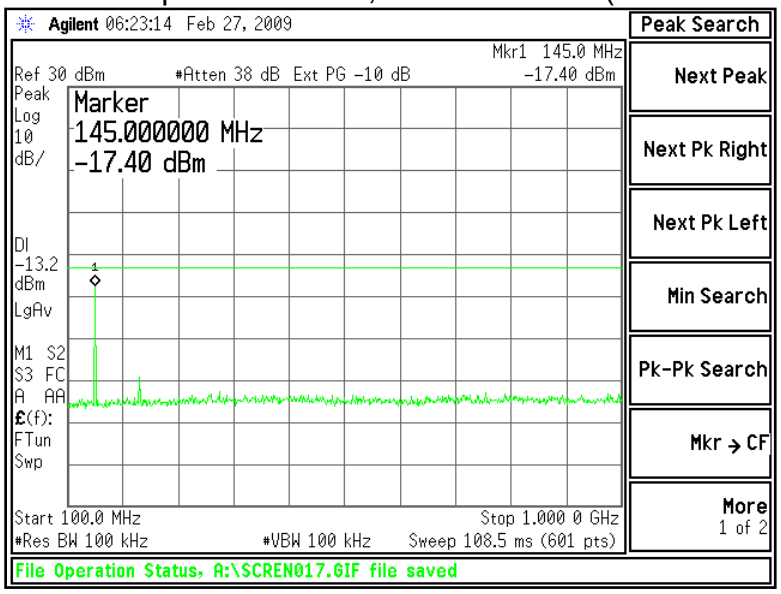
Conducted antenna port emissions, 100-1000 MHz (75.98 MHz Channel)



Conducted antenna port emissions, 1-100 MHz (72.02 MHz Channel)



Conducted antenna port emissions, 100-1000 MHz (72.02 MHz Channel)



13. Bandwidth Measurements 47 CFR 2.1049

Direct measurement of the transmitted signal, via a cabled connection to the HP E4407B Analyzer, was then used to determine the signal bandwidth. For each of the representative channels, refer to the graphs found on the following pages. RBW for the reference power level trace was 100 kHz and RBW for the actual modulated signal was 300 Hertz.

Calculation of 90.210 (c) emission mask:

(1) On any frequency from the center of the authorized channel to 5.0 kHz removed from center frequency: Zero dB.

(2) On any frequency removed from the center of the authorized channel by a displacement frequency (f_d in kHz) of more than 5.0 kHz but no more than 10 kHz: At least 83 log (Fd/5) dB.

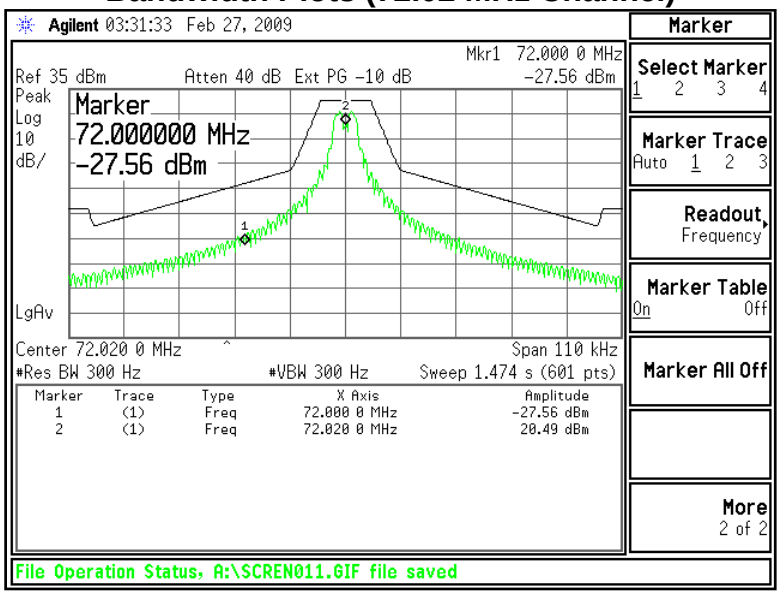
(3) On any frequency removed from the center of the authorized band by a displacement frequency (f_d in kHz) of more than 10 kHz but no more than 50 khz : At least 29 log (Fd**/11) dB or 50 dB, whichever is the lesser attenuation.

(4) On any frequency removed from the center of the authorized band by a displacement frequency (f_d in kHz) of more than 50 khz: at least 43 db,

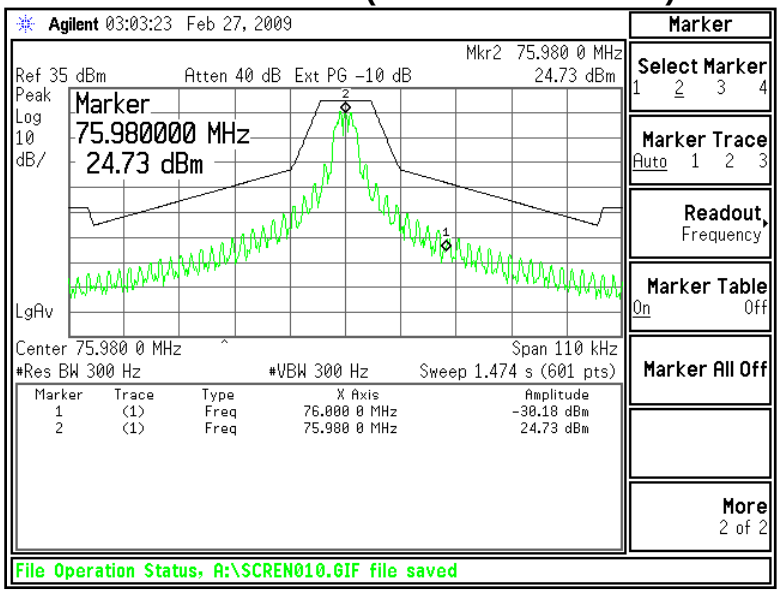
The test condition is presented in Tabular form below. The definition of the spectrum mask as indicated on the spectrum analyzer is also presented, where the display line set to –20 dBm applies to $|f_m| > 12.5$ kHz.

90.210 (c)	**Absolute Frequency Offset Range: $\|f_d\|$**	**Attenuation relative to Carrier power (P).**
1	0 to 5 KHz	0 db
2	5 to 10 khz	0 to 24.9 db
3	10 to 50 khz	27.8 to 50 db
4	Greater than 50 khz	43 db (-13 dbm)

Bandwidth Plots (72.02 MHz Channel)



Bandwidth Plots (75.98 MHz Channel)



APPENDIX A - Test Equipment List

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 31-Mar-2009 Type Test : Conducted Power Output Job # : C-581

Prepared By: Customer : Primex Wireless Quote #: 309109

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

Wireless Product Development
Equipment Calibration

Date : 31-Mar-2009 Type Test : Occupied Bandwidth Job # : C-581

Prepared By: Customer : Primex Wireless Quote #: 309109

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 31-Mar-2009 Type Test : Spurious Emissions Job # : C-581

Prepared By: Customer : Primex Wireless Quote #: 309109

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/26/2008	9/26/2009	Active Calibration
2	aa 960144	Phaseflex	Gore	EkD01D010720	5800373	6/10/2008	6/10/2009	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 6-Apr-2009 Type Test : Radiated Emissions Job # : C-581

Prepared By: Ryan Urness Customer : Primex Wireless Quote #: 309109

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960077	Bicon Antenna	EMCO	93110B	9702-2918	11/24/2008	11/24/2009	Active Calibration
2	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/20/2008	10/20/2009	Active Calibration
3	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	9/23/2008	9/23/2009	Active Calibration
4	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	9/23/2008	9/23/2009	Active Calibration

APPENDIX B
Uncertainty Statement

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

	Particular Configuration	Uc Value in Appropriate Units
Radiated Emissions	3 Meter Chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3 Meter Chamber, Log Periodic Antenna	4.80 dB
	10 Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10 Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB