TÜV

TUV Rheinland
of North America

Emissions
Test Report

EUT Name: Zigbee Radio

EUT Model: 45-1125

FCC Title 47, Part 15, Subpart C Section 15.249

Prepared for:

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Report/Issue Date: 21 December 2005
Report Number: 30562151.001

Statement of Compliance

Manufacturer:	Hunter Engineering 11250 Hunter Dr. Bridgeton MO 63044 314-731-0000
Requester / Applicant:	Jim McClenahan
Name of Equipment:	Zigbee Radio
Model No.	45-1125
Type of Equipment:	Information Technology Equipment (ITE)
Application of Regulations:	FCC Title 47, Part 15, Subpart C Section 15.249
Test Dates:	12 September 2005 to 20 December 2005

Guidance Documents:

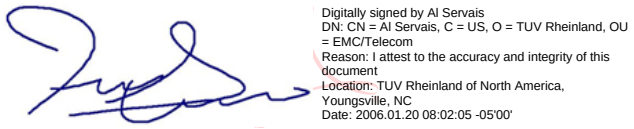
Emissions: FCC 47 CFR Part 15

Test Methods:

Emissions: ANSI C63.4:2003

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland of North America, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that a sample of one, of the equipment described above, has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government. This report contains data that are not covered by NVLAP accreditation. This report shall not be reproduced except in full, without the written authorization of the laboratory.



21 December 2005

Date

NVLAP Signatory

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the FCC Title 47, Part 15, Subpart C Section 15.249 based on the results of testing performed on *12 September* 2005 through *20 December* 2005 on the *Zigbee Radio* Model No. *45-1125* manufactured by Hunter Engineering. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Summary of Test Results

Table 1 - Summary of Test Results

Emission	Test Method(s)	Test Parameters	Result
Radiated Emissions	47 CFR Part 15, ANSI C63.4:2003, and RSS 210 Issue 5	30 MHz to 26000 MHz	compliant
Conducted Emissions	47 CFR Part 15.207, ANSI C63.4:2003, RSS-210 Issue 5	150 kHz to 30 MHz	compliant
Variations in Voltage vs. Frequency Stability	47 CFR Part 15.31 (e), ANSI C63.4:2003		Compliant
Band Edge Compliance	47 CFR Part 15.215 (c)		Compliant

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

No modifications were found to be necessary in order to achieve compliance.

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America at the 762 Park Ave., Youngsville, N.C 27596 address is accredited by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No 90552 and 100881). The laboratory scope of accreditation includes: Title 47 CFR Part 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / NVLAP

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:1999 and ISO 9002 (Lab code 200094-0). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Japan - VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at the 762 Park Ave. Youngsville, N.C 27596 address has been assessed and approved in accordance with the Regulations for Voluntary Control Measures. (Registration No. R-1174, R-1679, C-1790 and C-1791).

2.1.4 Acceptance By Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland of North America at the 762 Park Ave. Youngsville, N.C 27596 address test results and test reports within the scope of the laboratory NIST / NVLAP accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 762 Park Ave., Youngsville, North Carolina 27596, USA.

2.2.1 Emission Test Facility

The Open Area Test Site and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4:2003, at a test distance of 3 and 10 meters. This site has been described in reports dated May 12, 1997, submitted to the FCC, and accepted by letter dated June 25, 1997 (31040/SIT 1300F2).

The site is listed with the FCC and accredited by NVLAP (code 200094-0). The 5m semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4:2003, at a test distance of 3 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7m x 3.7m x 3.175mm thick aluminum floor connected to PE ground. For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 10^9 Ohms/square on a 1.6m x 0.8m x 0.8m high non-conductive table with a 3.175mm aluminum top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470 kΩ resistors. The Vertical Coupling Plane consists of an aluminum plate 50cm x 50cm x 3.175mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470 kΩ resistors. For each of the other tests, the HCP is removed.

RF Field Immunity testing is performed in a 7.3m x 3.7m x 3.2m anechoic chamber.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.9m x 3.7m x 3.175mm thick aluminum ground plane which is connected to one end of the anechoic chamber.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st addition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or co-variances of these other quantities weighted according to how the measurement result varies with changes in these quantities. The term standard uncertainty is the result of a measurement expressed as a standard deviation.

The Expanded Uncertainty defines an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand. The fraction may be viewed as the coverage probability or level of confidence of the interval.

The test system for conducted emissions is defined as the LISN, spectrum analyzer, coaxial cables, and pads. The test system for radiated emissions is defined as the antenna, spectrum analyzer, pre-amplifier, coaxial cables, and pads. The test system for radiated immunity is defined as the antenna, amplifier, cables, signal generator field probe and spectrum analyzer. The test system for conducted immunity is defined as the coupling/decoupling device, amplifier, cables, signal generator and spectrum analyzer. The test system for voltage variations and interruptions immunity is defined as the AC power source and the interruptions generator. The test system for electrical fast transient immunity is defined as the AC power output source and the fast transient generator. The test system for lightning surge immunity is defined as the AC power output source and the lightning surge generator. The test system for electrostatic discharge immunity is defined as the air and contact discharge generators. The test system for power frequency magnetic field immunity is defined as the AC voltage source. The test system for the damped oscillatory wave immunity is defined as the AC power output source and the oscillatory wave generator. The test system for harmonic current and voltage flicker test is defined as the AC power source and the detection devices. The conducted emissions test system has a combined standard uncertainty of ± 1.2 dB. The

radiated emissions test system has a combined standard uncertainty of ± 1.6 dB. The radiated immunity test system has a combined standard uncertainty of ± 2.7 dB. The conducted immunity test system has a combined standard uncertainty of ± 1.5 dB. The voltage variations and interruptions immunity test system has a combined standard uncertainty of ± 4.3 dB. The electrical fast transients immunity test system has a combined standard uncertainty of ± 5.8 dB. The lightning surge immunity test system has a combined standard uncertainty of ± 8.0 dB. The electrostatic discharge immunity test system has a combined standard uncertainty of ± 4.1 dB. The power frequency magnetic field immunity test system has a combined standard uncertainty of ± 0.58 dB. The damped oscillatory wave immunity test system has a combined standard uncertainty of ± 8.7 dB. The harmonic current and voltage flicker test system has a combined standard uncertainty of ± 11.6 dB. The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Guide 17025:1999.

3 Product Information

3.1 Product Description

Modular Approval

The Hunter radio 45-1125 consists of 6 major components:

1. A microcontroller (MCU) that is used to prepare and validate data for radio transmission and reception.
2. Radio IC MC13193 that is a short range, low power 2.4GHz ISM band transceiver.
3. A 3.3 voltage regulator that supplies regulated voltage to all components.
4. A single 16MHz crystal that is used to develop a time base for all components and RF frequencies.
5. A digital signal buffer to isolate the MCU from input signal connector

On-board transmit and receive antenna

3.2 Unique Antenna Connector

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221.

3.2.1 Results

The antenna is permanently attached.

4 Emissions

4.1 Radiated Emissions (Fundamental and Spurious per 15.249)

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.4:2003, and RSS 210 Issue 5. These test methods are listed under the laboratory's NVLAP Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

4.1.1 Test Methodology

4.1.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 300 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

4.1.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

4.1.1.3 Deviations

There were no deviations from this test methodology.

4.1.2 Test Results

Section 4.1.3 contains preliminary test data as well as any engineering data used to determine any modifications or special accessories. Section 4.1.2.1 lists the final measurement data under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and 1.5.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.1.2.1 Final Data

The data recorded in this section contains the final results under the worst-case conditions and with any modifications or special accessories implemented as the manufacturer intends.

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EUT Name	Zigbee Radio	**Date**	12 September 2005
EUT Model	45-1125	**Temp / Hum in**	70°F / 44%rh
EUT Serial	Not Serialized	**Temp / Hum out**	N/A
Standard	FCC 47 CFR Part 15	**Line AC / Freq**	120 VAC / 60 Hz
Deg/sweep	N/a	**RBW / VBW**	1MHz / 3MHz
Dist/Ant Used	3m / 3115_5770	**Performed by**	Eugene Moses

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	20dB Below Fundamental (dBuV/m)	Spec Margin (dB)
Fundamental CH 0: PCB on end, on table. 10% duty cycle (wake-up mode)										
2405.00	H	1.19	5	56.49	0.00	5.46	28.23	90.18	94.00	-3.82
2405.00	V	1	264	59.92	0.00	5.46	28.22	93.60	94.00	-0.4
Fundamental CH 8: PCB on end, on table. Cont. TX with modulation.										
2445.00	H	1	8	50.76	0.00	5.68	28.31	84.75	94.00	-9.25
2445.00	V	1	346	59.98	0.00	5.52	28.30	93.80	94.00	-0.2
Fundamental CH 15: PCB on end, on table. Cont. TX with modulation.										
2474.00	H	2.71	160	51.43	0.00	5.54	28.37	85.33	94.00	-8.67
2474.00	V	1	263	59.34	0.00	5.54	28.36	93.23	94.00	-0.77

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:

Peak Measurements.

The fundamental of the EUT was tested in all three planes and the Z plane was worst case.

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EUT Name	Zigbee Radio	**Date**	28 September 2005
EUT Model	45-1125	**Temp / Hum in**	70°F / 40%rh
EUT Serial	Not Serialized	**Temp / Hum out**	N/A
Standard	FCC 47 CFR Part 15	**Line AC**	120 VAC / 60 Hz
Deg/sweep	N/a	**RBW / VBW**	See Note Below
Dist/Ant Used	3m / 3115_5770	**Performed by**	Eugene Moses

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
Fundamental CH 8: TX on end. 10% duty cycle (Wake-up Mode)										
Spurious Emissions, Peak Measurements										
4889.00	H	1.51	179	62.09	35.09	10.23	32.94	70.18	74.00	-3.82
7335.00	H	1	344	46.94	35.02	14.38	36.20	62.50	74.00	-11.50
9778.00	H	1.20	182	36.97	35.95	15.48	38.57	55.07	74.00	-18.93
Spurious Emissions, Average Measurements										
4889.00	H	1.51	179	30.37	35.09	10.23	32.94	38.46	54.00	-15.54
7335.00	H	1	344	24.71	35.02	14.38	36.20	40.27	54.00	-13.73
9778.00	H	1.20	182	22.07	35.95	15.48	38.57	40.17	54.00	-13.83

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:
RBW/VBW=1MHz/1MHz for frequencies above 1 GHz for peak measurements.
RBW/VBW=1MHz/100Hz for frequencies above 1 GHz for average measurements.

The fundamental of the EUT was tested in all three planes and the Z plane was worst case.

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EUT Name	Zigbee Radio	**Date**	28 September 2005
EUT Model	45-1125	**Temp / Hum in**	70°F / 40%rh
EUT Serial	Not Serialized	**Temp / Hum out**	N/A
Standard	FCC 47 CFR Part 15	**Line AC**	120 VAC / 60 Hz
Deg/sweep	N/a	**RBW / VBW**	See Note Below
Dist/Ant Used	3m / 3115_5770	**Performed by**	Eugene Moses

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
Fundamental CH 8: TX on end. 10% duty cycle (Wake-up Mode)										
Spurious Emissions, Peak Measurements										
4889.00	V	1	280	64.98	35.09	10.23	32.99	73.12	74.00	-0.88
7335.00	V	1	22	50.75	35.02	14.38	36.09	66.20	74.00	-7.80
9778.00	V	1.83	349	34.35	35.95	15.48	38.48	52.36	74.00	-21.64
Spurious Emissions, Average Measurements										
4889.00	V	1	280	34.75	35.09	10.23	32.99	42.89	54.00	-11.11
7335.00	V	1	22	25.75	35.02	14.38	36.09	41.20	54.00	-12.80
9778.00	V	1.83	349	21.66	35.95	15.48	38.48	39.67	54.00	-14.33

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:
RBW/VBW=1MHz/1MHz for frequencies above 1 GHz for peak measurements.
RBW/VBW=1MHz/100Hz for frequencies above 1 GHz for average measurements.

The fundamental of the EUT was tested in all three planes and the Z plane was worst case.

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EUT Name	Zigbee Radio	**Date**	28 September 2005
EUT Model	45-1125	**Temp / Hum in**	70°F / 40%rh
EUT Serial	Not Serialized	**Temp / Hum out**	N/A
Standard	FCC 47 CFR Part 15	**Line AC**	120 VAC / 60 Hz
Deg/sweep	N/a	**RBW / VBW**	See Note Below
Dist/Ant Used	3m / 3115_5770	**Performed by**	Eugene Moses

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
Fundamental CH 0: TX on end. 10% duty cycle (Wake-up Mode)										
Spurious Emissions, Peak Measurements										
4809.00	H	1.57	36	63.25	35.22	10.17	32.78	70.98	74.00	-3.02
7213.00	H	1.28	189	53.00	35.03	14.36	35.91	68.24	74.00	-5.76
9620.00	H	1	0	22.23	36.04	15.20	38.36	39.75	74.00	-34.25
Spurious Emissions, Average Measurements										
4809.00	H	1.57	36	30.75	35.22	10.17	32.78	38.48	54.00	-15.52
7213.00	H	1.28	189	26.30	35.03	14.36	35.91	41.54	54.00	-12.46
9620.00	H	1	0	11.04	36.04	15.20	38.36	28.56	54.00	-25.44

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:
RBW/VBW=1MHz/1MHz for frequencies above 1 GHz for peak measurements.
RBW/VBW=1MHz/100Hz for frequencies above 1 GHz for average measurements.

The fundamental of the EUT was tested in all three planes and the Z plane was worst case.

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EUT Name	Zigbee Radio	**Date**	28 September 2005
EUT Model	45-1125	**Temp / Hum in**	70°F / 40%rh
EUT Serial	Not Serialized	**Temp / Hum out**	N/A
Standard	FCC 47 CFR Part 15	**Line AC**	120 VAC / 60 Hz
Deg/sweep	N/a	**RBW / VBW**	See Note Below
Dist/Ant Used	3m / 3115_5770	**Performed by**	Eugene Moses

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
Fundamental CH 0: TX on end. 10% duty cycle (Wake-up Mode)										
Spurious Emissions, Peak Measurements										
4809.00	V	1.13	334	66.14	35.22	10.17	32.82	73.90	74.00	-0.10
7213.00	V	1.01	20	56.10	35.03	14.36	35.77	71.20	74.00	-2.80
9620.00	V	1	0	23.24	36.04	15.20	38.28	40.68	74.00	-33.32
Spurious Emissions, Average Measurements										
4809.00	V	1.13	334	35.65	35.22	10.17	32.82	43.41	54.00	-10.59
7213.00	V	1.01	20	27.57	35.03	14.36	35.77	42.67	54.00	-11.33
9620.00	V	1	0	11.04	36.04	15.20	38.28	28.48	54.00	-25.52

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor $\pm$ Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 1.6$dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence

Notes:
RBW/VBW=1MHz/1MHz for frequencies above 1 GHz for peak measurements.
RBW/VBW=1MHz/100Hz for frequencies above 1 GHz for average measurements.

The fundamental of the EUT was tested in all three planes and the Z plane was worst case.

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EUT Name	Zigbee Radio	**Date**	28 September 2005
EUT Model	45-1125	**Temp / Hum in**	70°F / 40%rh
EUT Serial	Not Serialized	**Temp / Hum out**	N/A
Standard	FCC 47 CFR Part 15	**Line AC**	120 VAC / 60 Hz
Deg/sweep	N/a	**RBW / VBW**	See Note Below
Dist/Ant Used	3m / 3115_5770	**Performed by**	Eugene Moses

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
Fundamental CH 15: TX on end. 10% duty cycle (Wake-up Mode)										
Spurious Emissions, Peak Measurements										
4950.00	H	1.48	166	56.55	34.97	10.31	33.06	64.95	74.00	-9.05
7425.00	H	1.47	28	40.96	35.04	14.24	36.41	56.57	74.00	-17.43
9900.00	H	1	0	33.49	35.84	15.67	38.73	52.06	74.00	-21.94
Spurious Emissions, Average Measurements										
4950.00	H	1.48	166	28.21	34.97	10.31	33.06	36.61	54.00	-17.39
7425.00	H	1.47	28	23.23	35.04	14.24	36.41	38.84	54.00	-15.16
9900.00	H	1	0	21.88	35.84	15.67	38.73	40.45	54.00	-13.55

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:
RBW/VBW=1MHz/1MHz for frequencies above 1 GHz for peak measurements.
RBW/VBW=1MHz/100Hz for frequencies above 1 GHz for average measurements.

The fundamental of the EUT was tested in all three planes and the Z plane was worst case.

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EUT Name	Zigbee Radio	**Date**	28 September 2005
EUT Model	45-1125	**Temp / Hum in**	70°F / 40%rh
EUT Serial	Not Serialized	**Temp / Hum out**	N/A
Standard	FCC 47 CFR Part 15	**Line AC**	120 VAC / 60 Hz
Deg/sweep	N/a	**RBW / VBW**	See Note Below
Dist/Ant Used	3m / 3115_5770	**Performed by**	Eugene Moses

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
Fundamental CH 15: TX on end. 10% duty cycle (Wake-up Mode)										
Spurious Emissions, Peak Measurements										
4950.00	V	1	281	60.01	34.97	10.31	33.12	68.47	74.00	-5.53
7425.00	V	1.01	214	43.61	35.04	14.24	36.32	59.13	74.00	-14.87
9900.00	V	1	0	33.10	35.84	15.67	38.63	51.57	74.00	-22.43
Spurious Emissions, Average Measurements										
4950.00	V	1	281	29.68	34.97	10.31	33.12	38.14	54.00	-15.86
7425.00	V	1.01	214	23.70	35.04	14.24	36.32	39.22	54.00	-14.78
9900.00	V	1	0	21.86	35.84	15.67	38.63	40.33	54.00	-13.67

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:
RBW/VBW=1MHz/1MHz for frequencies above 1 GHz for peak measurements.
RBW/VBW=1MHz/100Hz for frequencies above 1 GHz for average measurements.

The fundamental of the EUT was tested in all three planes and the Z plane was worst case.

4.1.3 Sample Calculation

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = FIM - AMP + CBL + ACF

Where: FIM = Field Intensity Meter (dBμV)
AMP = Amplifier Gain (dB)
CBL = Cable Loss (dB)
ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

4.2 Conducted Emissions (Per 15.207)

Testing was performed in accordance with 47 CFR Part 15.207, ANSI C63.4:2003, RSS-210 Issue 5. These test methods are listed under the laboratory's NVLAP Scope of Accreditation.

This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

4.2.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. For each frequency sub-range, each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50μH / 50Ω LISNs.

Testing is either performed in the anechoic chamber or on PLC Site 2. The setup photographs clearly identify which site was used. The vertical ground plane used in the anechoic chamber is a 2m x 2m wooden frame that is covered with ¼ inch hardware cloth and is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

4.2.1.1 Deviations

There were no deviations from this test methodology.

4.2.2 Test Results

Section 4.2.2.1 lists the final measurement data under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and 1.5.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Plots of the EUT's AC Line Conducted emissions are contained in the following sections. The plots show peak and/or average emissions and the corresponding peak and/or average limits. If the peak emissions are below the average limit, then the EUT is considered to pass and no average measurements are made. If the peak emissions are below the quasi-peak limit and the average emissions are below the average

limit, then the EUT is considered to pass and no further measurements are made. Otherwise, individual frequencies are measured and compared to the corresponding limit for the detector used (quasi-peak or average).

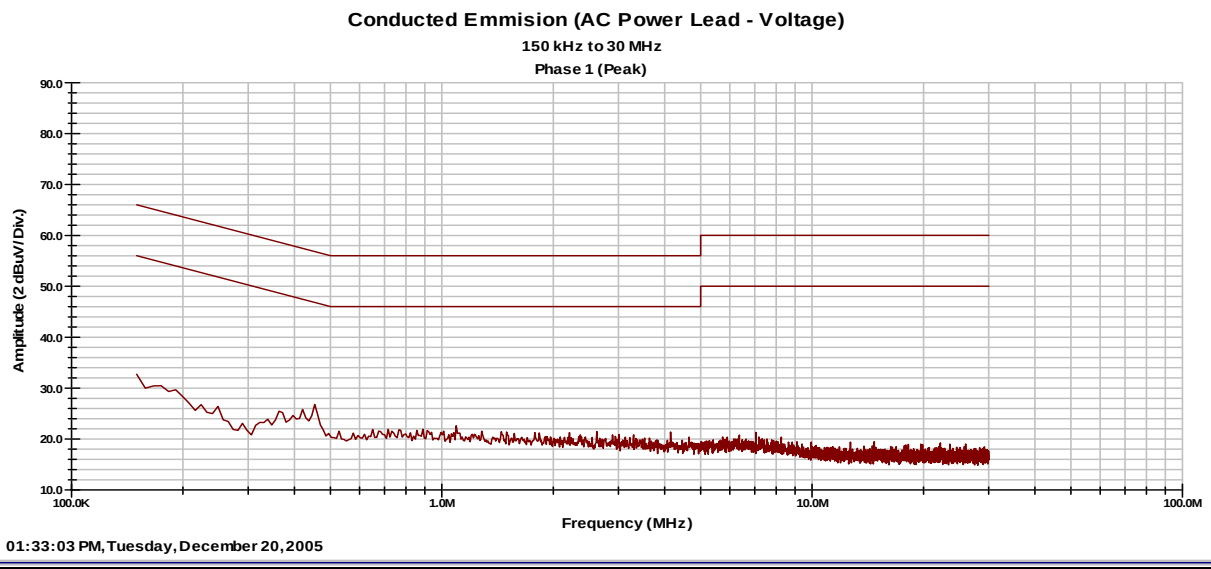
4.2.2.1 Final Data

The data recorded in this section contains the final results under the worst-case conditions and with any modifications or special accessories implemented as the manufacturer intends.

SOP 2 Conducted Emissions

Tracking # 30562151.001 Page 1 of 2

EUT Name	Zigbee Radio	**Date**	20 December 2005
EUT Model	45-1125	**Temperature**	72 deg. F
EUT Serial	None	**Humidity**	39 %rh
Standard	FCC 47 CFR Part 15	**Line AC /Freq**	120 VAC / 60 Hz
LISNs Used	1, 2	**Performed by**	Randy Sherian
Configuration			



Emission Freq (MHz)	Line ID (1,2,3,N)	FIM Quasi (dBuV)	FIM Ave (dBuV)	Cable Loss (dB)	LISN + T Limiter (dB)	Quasi Limit (dBuV)	Ave Limit (dBuV)	Quasi Spec Margin (dB)	Ave Spec Margin (dB)
0.16	1	26.74	16.92	0.02	9.98	65.57	55.57	-28.83	-28.65

Quasi Spec Margin = Quasi FIM + Cable Loss + LISN CF - Quasi Limit ± Uncertainty
Ave Spec Margin = Ave FIM + Cable Loss + LISN CF - Ave Limit ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

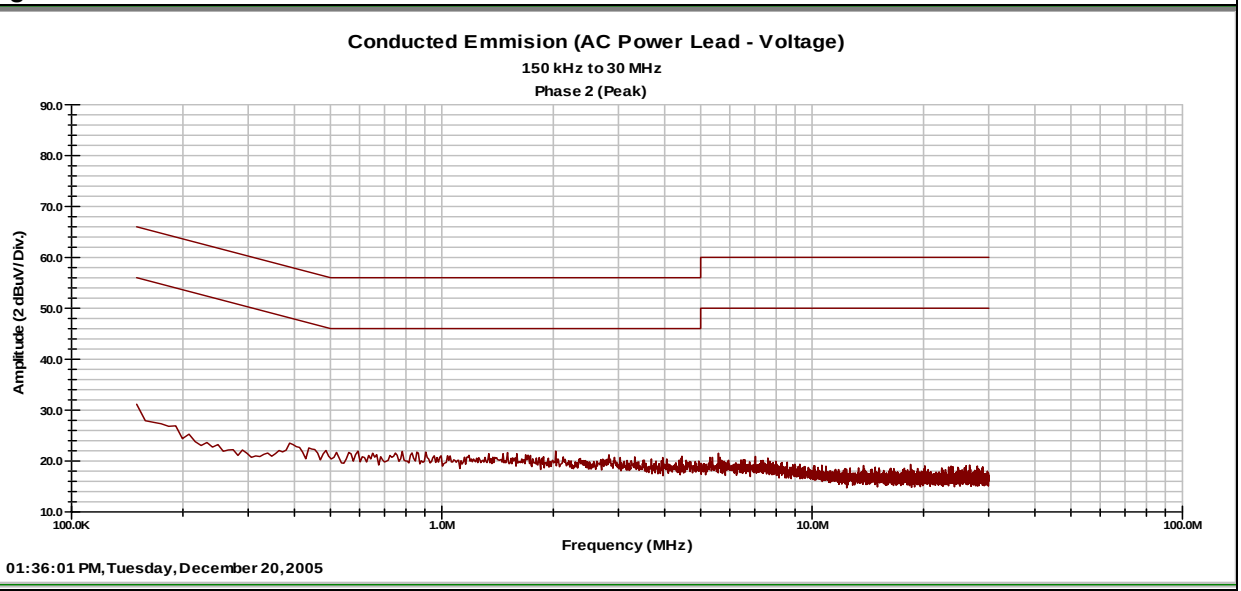
Notes:

SOP 2 Conducted Emissions

Tracking # 30562151.001 Page 2 of 2

EUT Name	Zigbee Radio	**Date**	20 December 2005
EUT Model	45-1125	**Temperature**	72 deg. F
EUT Serial	None	**Humidity**	39 %rh
Standard	FCC 47 CFR Part 15	**Line AC /Freq**	120 VAC / 60 Hz
LISNs Used	1, 2	**Performed by**	Randy Sherian

Configuration



Emission Freq (MHz)	Line ID (1,2,3,N)	FIM Quasi (dBuV)	FIM Ave (dBuV)	Cable Loss (dB)	LISN + T Limiter (dB)	Quasi Limit (dBuV)	Ave Limit (dBuV)	Quasi Spec Margin (dB)	Ave Spec Margin (dB)
0.16	2	23.23	13.56	0.03	10.07	65.36	55.36	-32.03	-31.70

Quasi Spec Margin = Quasi FIM + Cable Loss + LISN CF - Quasi Limit ± Uncertainty
Ave Spec Margin = Ave FIM + Cable Loss + LISN CF - Ave Limit ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.2dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:

4.3 Variations in Voltage vs. Frequency Stability (Per 15.31 (e))

The setup was identical to radiated emissions. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.

4.3.1 Results

Channel 0 (Modulated)

Voltage	Radiated Field Strength Measurement
102 VAC	59.88
120 VAC	59.92
138 VAC	59.87

Channel 8 (Modulated)

Voltage	Radiated Field Strength Measurement
102 VAC	59.96
120 VAC	59.98
138 VAC	59.95

Channel 15 (Modulated)

Temperature	Radiated Field Strength Measurement
102 VAC	59.29
120 VAC	59.34
138 VAC	59.31

Spectrum Analyzer Parameters:

RBW=30kHz

VBW=30kHz

Span=1MHz

LOG dB/div.= 10dB

Trigger Video

4.4 Band Edge Compliance (Per 15.215 (c))

The setup was identical to radiated emissions. Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that

may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

4.4.1 Results

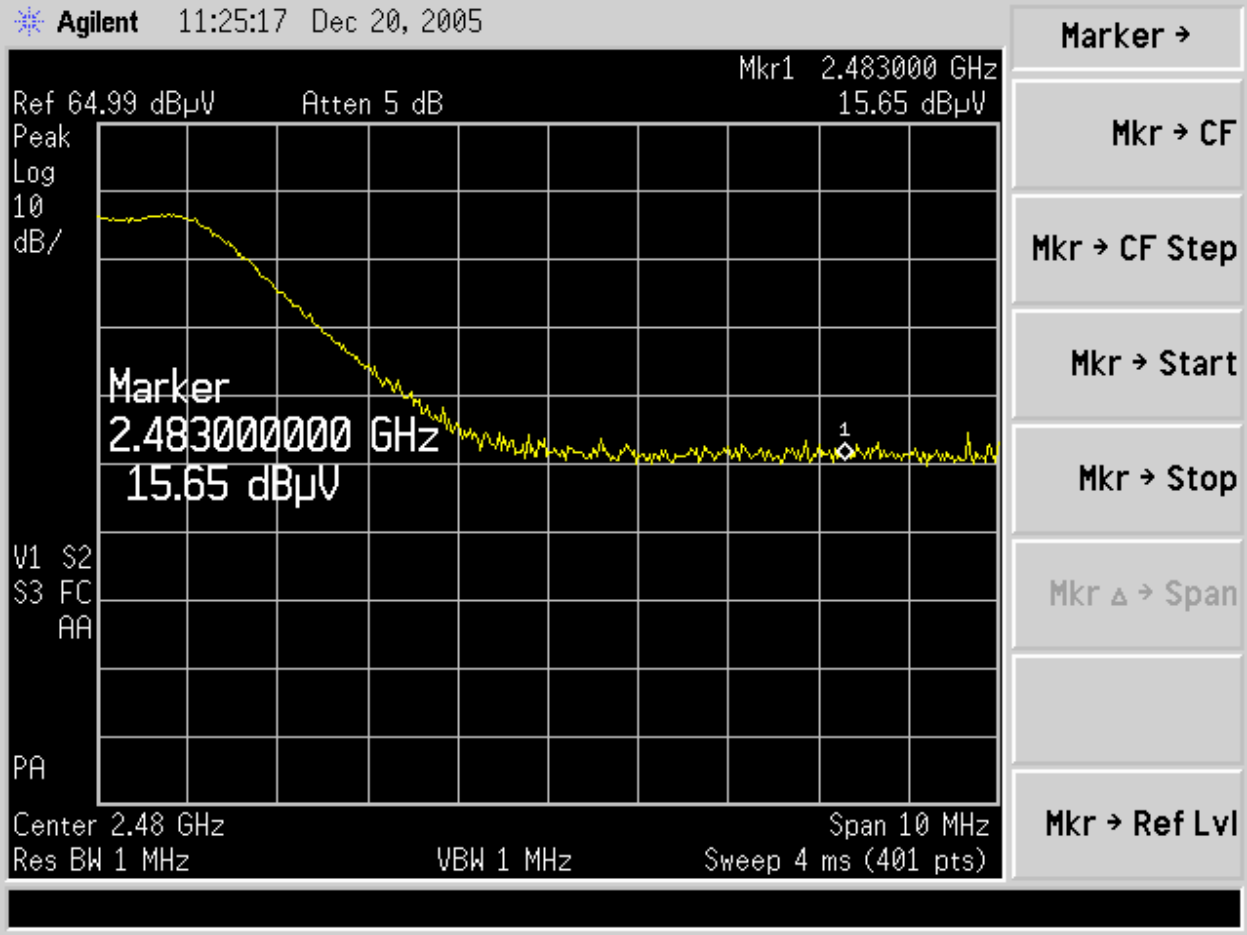


Figure 1 – Channel 15 Band edge Results

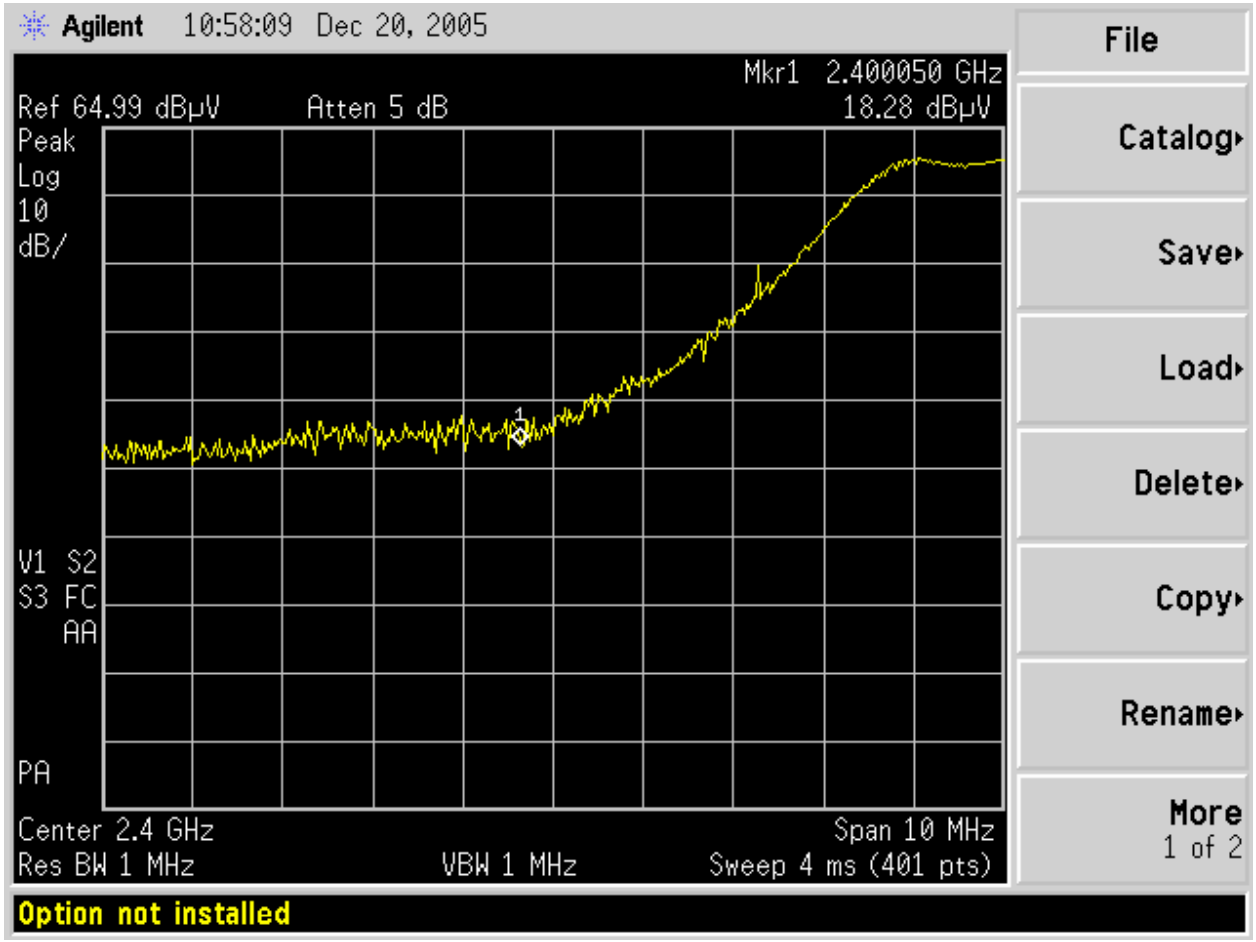


Figure 2 – Channel 0 Band edge Results

5 Test Equipment Use List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy

SOP 1 - Radiated Emissions, Band Edge Compliance, Variations in Voltage vs. Frequency Stability					
Ant. Biconical	EMCO	3110B	3367	24-Feb-05	24-Feb-06
Ant. Log Periodic	AH Systems	SAS-516	133	7- Feb-05	7- Feb-06
Cable, Coax	Andrew	FSJ1-50A	041	15-Jan-05	15-Jan-06
Cable, Coax	Andrew	FSJ1-50A	042	15-Jan-05	15-Jan-06
Chamber, Semi-Anechoic	Braden Shielding	5 meter	A67631	27-Jan-05	27-Jan-06
Data Table, EMCWin	TUV Rheinland	EMCWin.dll	002	6-Jan-02	6-Jan-06
Spectrum Analyzer	Agilent Tec.	E7405A	US39440157	6-Aug-05	6-Aug-06

SOP 2 - Conducted Emissions (AC/DC and Signal I/O)					
Cable, Coax	Belden	RG-213	004	18-Jan-05	18-Jan-06
LISN (1) 50mH/50Ω	Solar Electronics	8028-50-TS-24	944016	5-Aug-05	5-Aug-06
LISN (2) 50mH/50Ω	Solar Electronics	8028-50-TS-24	9212106	5-Aug-05	5-Aug-06
LISN Selection Box	TUV Rheinland	CFL-9206	1630	11-May-05	11-May-06
Spectrum Analyzer	Agilent Tec.	E7405A	US39440157	3-Aug-05	3-Aug-06

General Laboratory Equipment					
Filter, 3.0 GHz High Pass	Bonn Elektronik	BHF 3000	025155	5-Aug-05	5-Aug-06
Meter, Multi	Fluke	79-3	69200606	5-Aug-05	5-Aug-06
Meter, Temp/Humid/Barom	Fisher	02-400	01	20-Aug-05	20-Aug-06