FCC, PART 15, SUBPART C

CERTIFICATION REPORT

For The DSSS Transceiver

Model: **SkyWay Wireless LAN Bridge**

FCC ID: KA324WAN5 (PENDING)

PREPARED FOR:

Solectek Corporation
6370 Nancy Ridge Drive, Suite 109
San Diego, CA 92121

PREPARED ON **DECEMBER 20, 1999**

REPORT NUMBER 99-244

This report has been prepared in accordance with all applicable requirements of ANSI C63.4-1992

DOCUMENT HISTORY

REVISION	DATE	COMMENTS
-	12/20/99	Initial Release J. L. Griffin

NOTE: Nemko EESI, Inc. hereby makes the following statements so as to conform to Chapter 10 (Test Reports) Requirements of ANSI C63.4 (1992) "Methods and Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz":

- The unit described in this report was received at Nemko EESI, Inc.'s facilities on November 30, 1999. Testing was performed on the units described in this report November 30 – December 17, 1999.
- The Test Results reported herein apply only to the units actually tested, and to substantially identical units.
- This test report must not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

This Report is the property of Nemko EESI, Inc., and shall not be reproduced, except in full, without prior written approval of Nemko EESI, Inc.. However, all ownership rights are hereby returned unconditionally to Solectek Corporation, and approval is hereby granted to Solectek Corporation and its employees and agents to reproduce all or part of this report for any legitimate business purpose without further reference to Nemko EESI, Inc..

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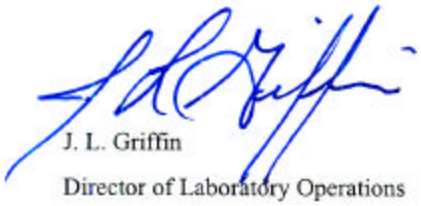
CERTIFICATION

The Radio Frequency Interference (RFI) testing, data evaluation and this report have been prepared by Nemko EESI, Inc., an independent electromagnetic compatibility consulting and test laboratory.

The testing and data collection were accomplished in accordance with the requirements of the ANSI, C63.4-1992 standard and the applicable sections of FCC, Part 15, Subpart C for intentionally radiating equipment. Refer to the Administrative Summary for a description of the test sample.

I certify the data, data evaluation and equipment configuration herein to be a true and accurate representation of the sample's radio frequency interference emission characteristics, as of the test date(s), and for the design of the test sample utilized to compile this report.

This body of this report consists of 26 pages. The Appendices are being submitted as separate documents in order to comply with the FCC Guidelines for Electronic Submissions.



J. L. Griffin

Director of Laboratory Operations

1. ADMINISTRATIVE DATA AND TEST SUMMARY

1.1 Administrative Data

CLIENT: Solectek Corporation
6370 Nancy Ridge Drive, Suite 109
San Diego, CA 92121
(858) 450-1220
(858) 457-2681 – fax

CONTACT: Larry Butler

DATE(S) OF TEST: November 30 – December 17, 1999

TEST SPECIFICATION: FCC, Part 15, Subpart C, for intentional radiators (see below)

EQUIPMENT UNDER TEST (EUT): DSSS Transceiver
Model Number: SkyWay Wireless LAN Bridge (Transceiver System)
Serial Number: N/A
FCC ID Number (pending): KA324WAN5

EUT transmitter fundamental frequency: 2407-2470 MHz

NOTE: For a complete description of the SkyWay system, please refer to Section 2.

1.2 FCC Test Requirements

FCC RULE	DESCRIPTION	APPENDIX
1.1310	RF Radiation Exposure	Attachment
15.203	Antenna Requirements	Attachment
15.107/15.207	AC Power Line Conducted Emissions	A
15.109/15.209	General Radiated Emissions	B
15.247(a)(2)	Allowed Occupied Bandwidth	C
15.247(b)(3)(i)	Maximum Peak Output Power	D
15.247(c)	Out Of Band Emissions	E
15.247(d)	Spectral Density	F
15.247(e)	Processing Gain	G

1.3 FCC Test Summary

FCC SECTION	*NOTES*	*RESULTS*
15.107 and 15.109	The "Receiver and Control" (i.e. non-transmitter) functions of the SkyWay system were tested to the requirements of 15.107 and 15.109 for AC Line Conducted and Radiated RF Emissions for Class "A" Digital Devices.	**PASS**
15.31	Because the Skyway System's transmitter operational frequency range exceeds 10MHz, Section 15.31 requires that all "Transmitter" function tests be performed at three frequencies: one near the low end, one near the middle and one near the high end. The three frequencies used for testing of the SkyWay system are 2407MHz, 2440MHz, and 2470MHz.	**PASS**
15.207 and 15.209	The SkyWay Transmitter functions were tested for AC Line Conducted and Radiated RF Emissions at each of the frequencies indicated above, using each of the nine antennas. All power supplies were tested, with data for the "worst case" power supply (Avansys/Artesyn) configuration provided in this test report. Additional test data for all other power supplies can be provided upon request.	**PASS**
15.247(a)(2)	Occupied Bandwidth measurements were made at all three operating frequencies to ensure that the 6dB bandwidth were at least 500kHz. All antennas were tested, with data for the "worst case" antenna (Tecom 8dBi) provided in this test report . Additional test data for all other antennas can be provided upon request.	**PASS**
15.247(b)(3)(i)	Maximum Output Power measurements were made at all three operating frequencies using each of 9 antennas at the appropriate output power. The output power is programmable and uses a proprietary sensing network in each antenna to set the correct level. This output power was tested in the antenna coax, and did not need to be repeated on the Open Area Test Site (OATS). However the harmonics of the fundamental were tested on the OATS, and were required to be at least 20dB below the fundamental level (per 15.247[c]), of the fundamental level was measured as a reference. Each antenna was "pre-scanned" at the three operating frequencies, and the worst case configurations were tested on the OATS.	**PASS**
15.205 and 15.247(c)	Restricted Band Emissions were confirmed for each of the 9 antennas on the OATS. Test data for all 9 antennas has been provided in this report.	**PASS**
15.247(d)	Power Spectral Density measurements were made at the maximum power output level at the three operating frequencies at the highest possible power level the system is capable of (using Maxrad OMNI 6dBi antenna).	**PASS**

J. L. Griffin, Nemko EESI, Inc.

2. SYSTEM DESCRIPTION AND CONFIGURATION

2.1 General Description of EUT

The SkyWay Transceiver is a point-to-point and multipoint RF Local Area Network (LAN), which is designed as an extension of any standard Ethernet network. This Direct Sequence Spread Spectrum transceiver operates in the 2.4GHz band, with a maximum data rate of 11Mbps. The transceiver is mounted externally to a building or antenna tower, and uses one of 9 antennas. The system is powered by various internal power supplies, with either 115-240 VAC or +48 VDC, or with a choice of external power supplies. SkyWay can support either Ethernet or Fiber Optic data inputs, and can be configured with either a low power or high power transceiver output power levels. A System Component Flow Diagram has been included to further illustrate the combinations of components that will be made available to the end user (pending FCC approval). A computer control port is used for initial system configuring, and the transceiver module is normally positioned within 8 feet of the antenna in use. Each antenna has a sensing device installed that corresponds with and is solely dedicated to that particular antenna gain. This unique circuit allows the transmitter to vary in output power according to whichever antenna is fitted.

The SkyWay system's data frame can be up to 1580 bytes long, and can be transmitted at either 2Mbps, 5.5Mbps or 11Mbps. For testing purposes, 11Mbps was used with test software to simulate the highest possible data rate, in a continuous transmit mode (during transmit mode tests).

For an illustrated summary of the various configurations possible with the DSSS Transceiver System, please refer to Figures 1-3 on the following pages.

2.2 Solectek SkyWay Transceiver System Specifications

Product Name:	SkyWay Wireless LAN Bridge
Serial Number:	N/A (Pre-production)
Type of Equipment:	DSSS Transceiver
Modulation:	1Mbit/s DPSK, 2Mbit/s QPSK, 5.5 & 11Mbit/s CCK
Chip Rate:	11Mchips/s
Operating Frequency:	2407 – 2470 MHz
Number of Channels:	13 Channels
Channel Spacing:	5 MHz
Bandwidth (6dB OBW):	12MHz maximum
Power Rating:	26dBm direct / 50dBm EIRP (High Power) 16dBm direct / 43dBm EIRP (Low Power)
Antenna Gain:	Accommodates Solectek issued antennas with gains ranging from 6dBi to 24dBi
Emission Designation:	Direct Sequence Spread Spectrum, 2.4GHz ISM Band
Emission Designator:	22MOX7D
Oscillator Frequencies:	32.768KHz, 44MHz, 50MHz, 560MHz (IF LO), 2160MHz (RF LO) 280MHz (IF), 2440MHz (RF)

Figure 1. SkyWay Package Flowchart

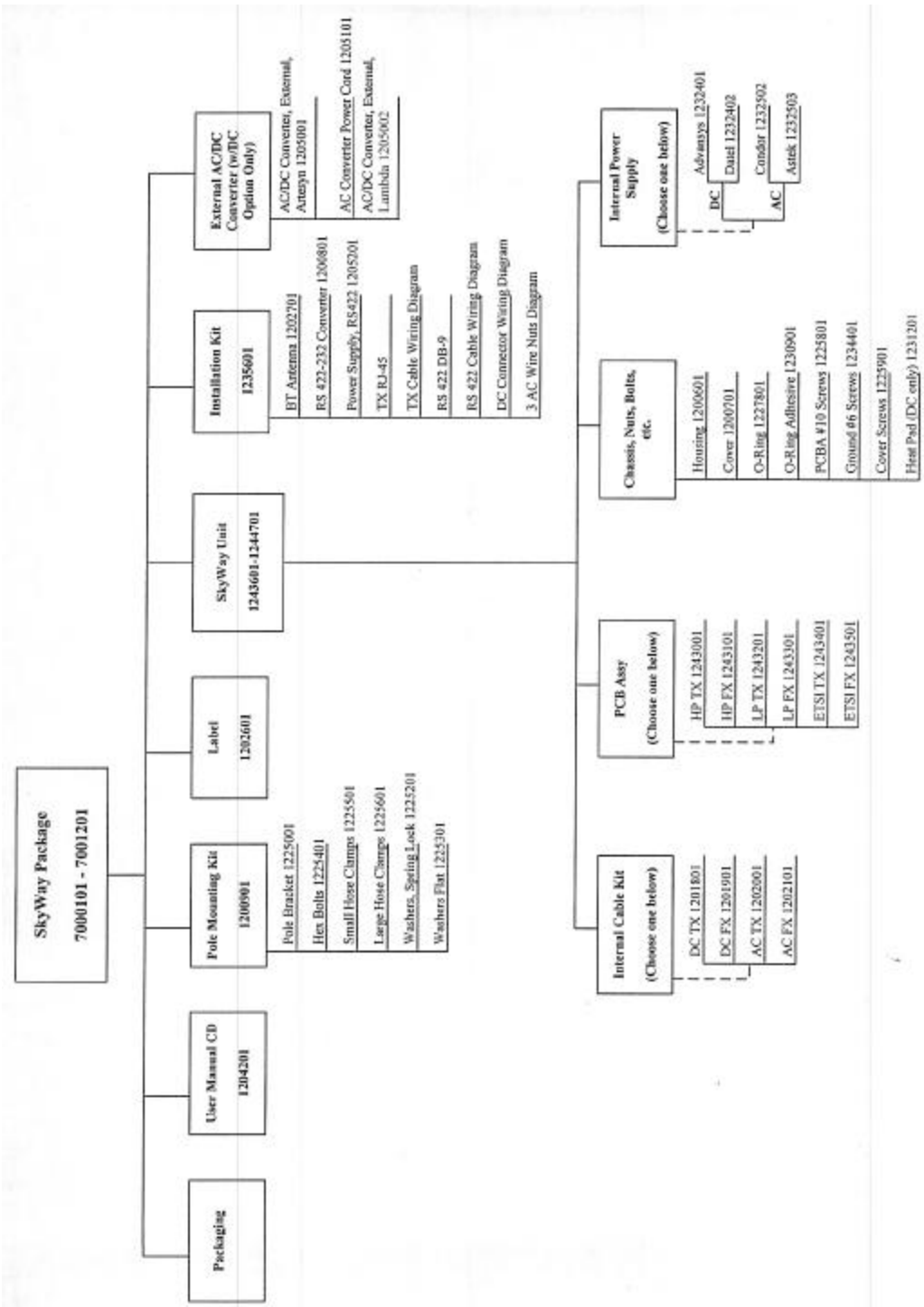


Figure 2. External Cables Flowchart

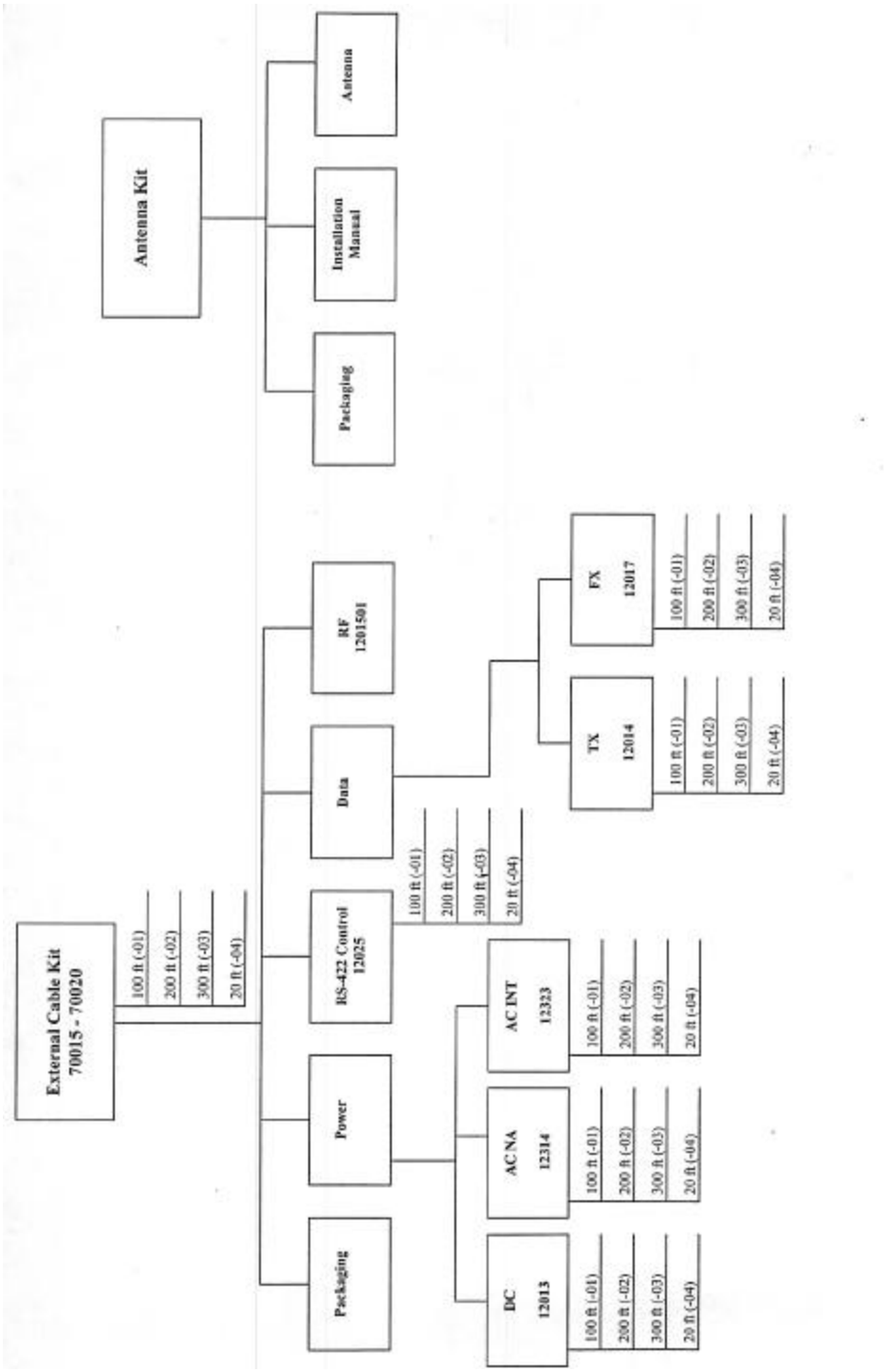
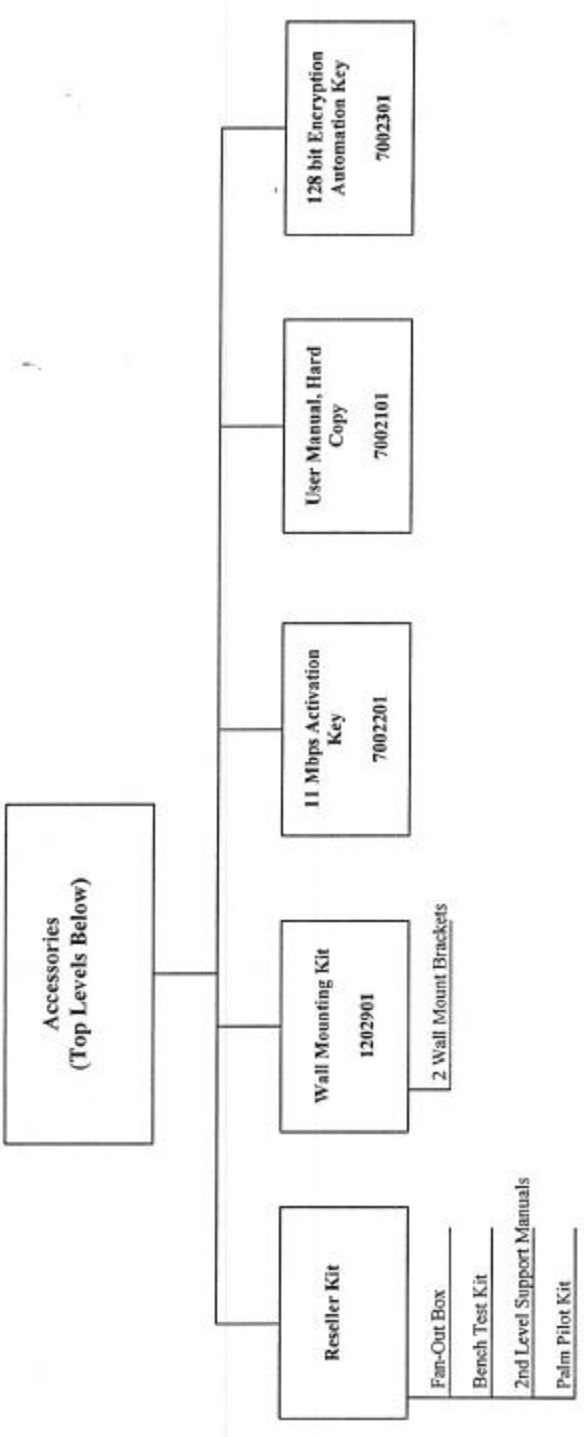


Figure 3. Accessories Flowchart



2.3 System Components and Power Cables

DEVICE	MANUFACTURER MODEL # SERIAL #	POWER CABLE
EUT- DSSS Transceiver	Solectek Corporation SkyWay Wireless LAN Bridge N/A	20 ft., shielded, MIL-C-26482, Size 12 / 3-pin connector
Laptop Computer	NEC PC-710-4331 55000051	*(To Power Supply)* 1.5m, unshielded, 4-wire, 20 AWG, 4-pin square connector
Power Supply (for Laptop)	NEC OP-520-4401 5300144	*(To AC Power)* 2m, unshielded, 2-wire, 18 AWG, 2-prong connector

2.4 Device Interconnection and I/O Cables

CONNECTION	I/O CABLE
EUT to Antenna	8 ft., LMR 400 50Ω coax, N-type male connectors
EUT (Unterminated)	*Ethernet:* 20 ft., shielded, MIL-C-26482, size 12 / 8-pin connector *(or)* *Fiber Optic:* 20 ft., shielded, MIL-C-26482, size 12 / 3-pin connector
EUT to Laptop Computer	20 ft., shielded, MIL-C-26482, size 10 / 6-pin connector to DB9

2.5 Design Modifications for Compliance

All changes made to the EUT during testing have been incorporated into the final production design.

3. DESCRIPTION OF TEST SITE AND EQUIPMENT

3.1 Description of Open Area Test Site

The test site is located at 11696 Sorrento Valley Road, Suite F, San Diego, CA 92121. The site is physically located 18 miles Northwest of downtown San Diego. The general area is a valley 1.5 miles east of the Pacific Ocean. This particular part of the valley tends to minimize ambient levels, i.e. radio and TV broadcast stations and land mobile communications. The ten-meter site is located behind the office/lab building. It conforms to the normalized site attenuation limits and construction specifications as set in the EN 55022 (1987), CISPR 16 and 22 (1985) and ANSI C63.4-1992 documents. The site attenuation characteristics are verified for compliance every year and the site was last registered with the Federal Communications Commission on December 15, 1999 (FCC Registration Number 90579).

3.2 Test Equipment

The following test equipment was used to collect data for this report. All devices used were of current calibration and of the type required in the applicable documents section of this report.

DEVICE	MANUFACTURER	MODEL	ASSET #	CAL. DATE	CAL. DUE
Line Impedance Stabilization Network	Solar	8602-50TS-50-N	423	10/30/99	10/30/00
Transient Limiter	Hewlett Packard	11947A	683	3/8/99	3/8/00
High Pass Filter	Solar	7801-5.0	559	9/29/99	9/29/00
Quasi-Peak Adapter	Hewlett Packard	85650A	533	11/02/99	5/02/00
Spectrum Analyzer Display	Hewlett Packard	85662A	404	11/02/99	5/02/00
Spectrum Analyzer	Hewlett Packard	8568B	104	11/02/99	5/02/00
RF Preselector	Hewlett Packard	85685A	403	11/02/99	11/02/00
Amplifier	Hewlett Packard	8449A	317	9/16/99	9/16/00
Antenna, Log Periodic	EMCO	3146	112	5/20/99	5/20/00
Antenna, Biconical	EMCO	3104	114	11/18/99	11/18/00
Antenna, Ridge Guide	EMCO	3115	752	4/05/99	4/05/00
Peak Power Meter	Hewlett Packard	8900D	N/A	2/22/99	2/22/00
Power Sensor	Hewlett Packard	84811A	N/A	2/11/99	2/11/00

Fanout Box	Solectek	N/A	N/A	NCR	NCR

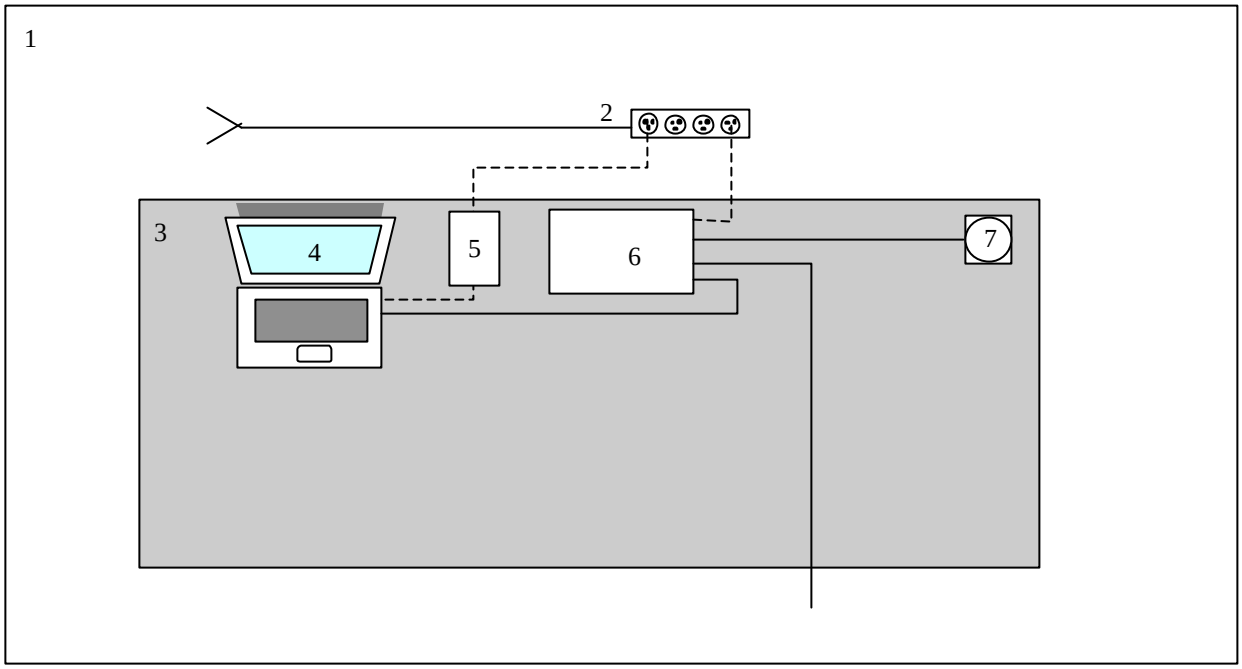
4. DESCRIPTION OF TESTING METHODS

4.1 Introduction

As required in 47 CFR, Parts 2 and 15, the methods employed to test the radiated and conducted emissions (as applicable) of the EUT are those contained within the American National Standards Institute (ANSI) document C63.4-1992, titled "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz." All applicable FCC Rule Sections that provide further guidance for performance of such testing are also observed.

For General Test Configuration please refer to Figure 1 on the following page.

Figure 4. General EUT Test Setup Diagram



NOT TO SCALE

CONFIGURATION LEGEND

1. Test Laboratory
2. AC Power for Devices
3. Non-Conducting tables 80 cm above ground plane
4. Laptop Computer
5. Power Supply for Laptop Computer
6. EUT: DSSS Transceiver
7. Antenna (part of EUT system)

4.2 Antenna Requirements (15.203)

All Solectek antennas have the unique proprietary identification circuit fitted that causes it to be exclusive to Solectek equipment.

This guarantees that if a non-Solectek antenna were substituted, then the equipment's antenna sensing device would ensure that the output power is virtually zero.

This sensing refinement, as was accepted and certified in previous FCC submissions, proves that these antennas function like all other certified Solectek antennas, thus complying with FCC rule 15.203.

A supplemental explanation has been provided as an attachment to this application.

4.3 AC Power Line Conducted Emissions (15.207)

Section 7 of ANSI C63.4 determines the general configuration of the EUT and associated equipment, as well as the test platform for conducted emissions testing. Tabletop devices were placed on a non-conducting surface 80 centimeters above the ground plane floor and 40 centimeters from the ground plane wall. The AC-powered configurations of the EUT and associated system were configured to operate continuously, representing a "normally operating" mode. Power is supplied via a Line Impedance Stabilization Network (LISN). The emissions are recorded using the required bandwidth of 9 kHz in the quasi-peak mode. The average amplitude is also observed employing a 10 Hz video bandwidth to determine the presence of broadband RFI. When such interference is caused by broadband sources (as defined by the FCC and ANSI Rules), the deviation guidelines contained in Section 11.3.1 of ANSI C63.4 are employed, which allows a correction factor of 13 dB to be subtracted from the quasi-peak reading. The emission levels are then compared to the applicable FCC limits to determine compliance.

There are a large number of possible configurations for the EUT system. To simplify the testing, we found the worst-case configuration by going through a process of elimination. Conducted Emissions were tested with the following configuration:

High Power Ethernet PCB

Datel Power Supply

Lambda AC Power Supply "brick"

Pacific Monolith 24dBi Antenna.

Tests were performed in Transmit and in Receive modes, at 2407 MHz, 2440 MHz and 2470 MHz, on both the black wire and the white wire. The worst-case was determined to be 2407 MHz, which was selected for further testing.

Testing was repeated in the Transmit mode using the Low Power Ethernet PCB. No significant difference was detected, and since the Low Power version is a depopulated High Power unit, the High Power version was selected for further testing.

Testing was repeated at all three frequencies using the High Power Fiber Optic PCB, in both Transmit and Receive modes, and on both black and white wires. The Ethernet interface was consistently 2-3 dB higher than the Fiber Optic interface, therefore the Ethernet was selected for further testing.

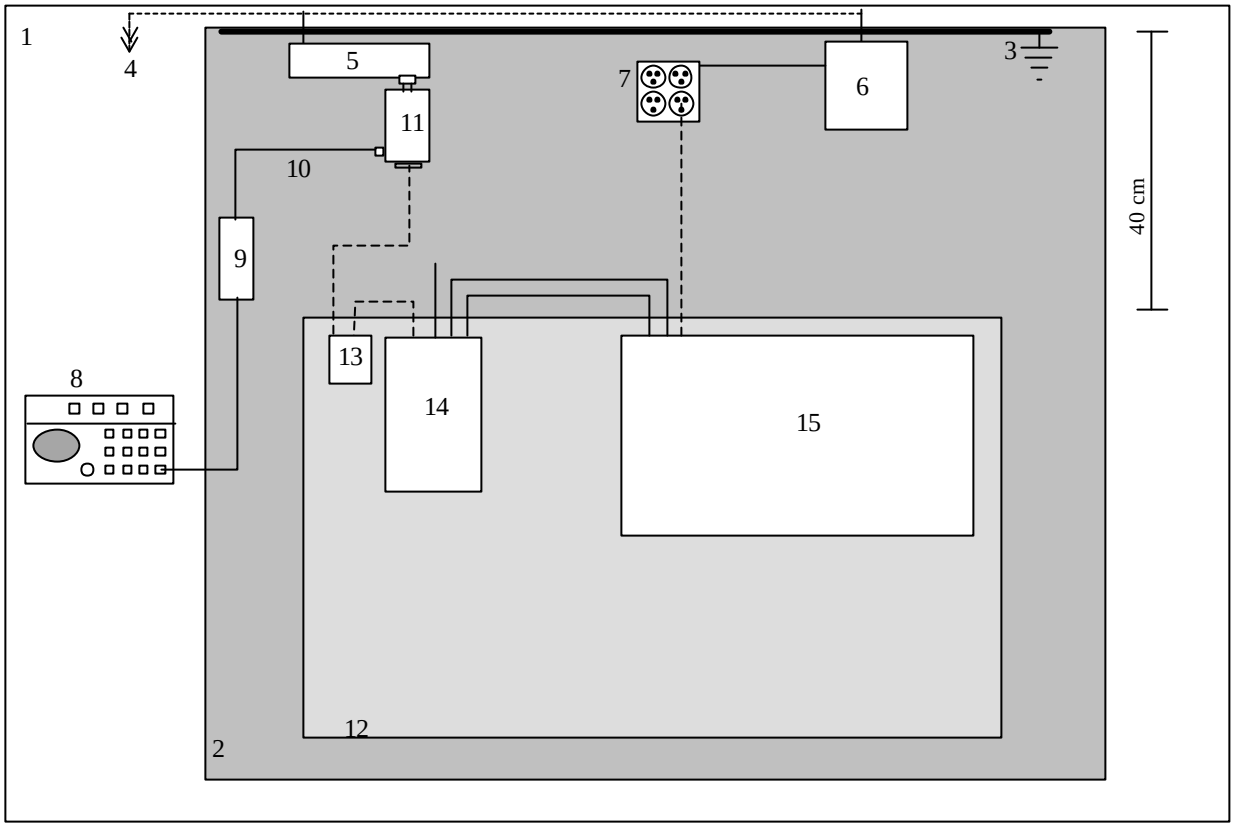
Testing was performed on all nine antennas at their appropriate power setting, using the High Power Ethernet PCB in the Transmit Mode on all three frequencies. The Maxrad 6dBi Omni antenna was slightly higher, and was used for all subsequent tests.

Full data was recorded as described above (High Power Ethernet PCB, Maxrad 6dBi Omni antenna, at 2407 MHz, 2440 MHz and 2470 MHz, Transmit and Receive mode, and both black wire and white wire), and the white wire on Transmit and Receive at 2407 MHz was determined to be slightly worse.

All power supplies were then tested with the above-described configuration, and the Avansys Power Supply with the Artesyn AC Power Supply "brick" was determined to be the worst-case configuration. Test data for all other power supply configurations can be provided upon request.

For Conducted Emissions Test Configuration please refer to Figure 5 on the following page.

Figure 5. Conducted Emissions Test Setup Diagram



NOT TO SCALE

CONFIGURATION LEGEND

1. Test Laboratory (6 X 6 meters)
2. Ground Plane (15 square meters)
3. Vertical Conducting Wall (Grounded through Ground Plane via 10' ground rod)
4. AC Power for Devices (120V, 60 cycles, single phase)
5. Power Line Filter, Lindgren, 120 dB, 30 amp
6. Line Impedance Stabilization Network (LISN) for peripheral devices
7. Power Distribution Box for peripheral devices
8. Spectrum Analyzer with Quasi-Peak Adapter
9. High Pass Filter
10. Coax input from EUT LISN to Spectrum Analyzer
11. LISN for EUT
12. Non-Conducting table 80 cm above ground plane
13. AC/DC Converter (used only when internal DC/DC converter is used)
14. EUT: DSSS Transceiver
15. EUT's Associated System

4.4 General Radiated Emissions (15.209)

Section 8 of ANSI C63.4 determines the general configuration and procedures for measuring the radiated emissions of equipment under test. Initially, the primary emission frequencies are identified inside the test lab by positioning a broadband receive antenna one meter from the EUT to locate frequencies of significant radiation. Normally this is done inside a shielded chamber to eliminate ambients. Next, the EUT and associated system are placed on a turntable on an 10 meter open area test site (registered with the FCC in accord with its Rules and ANSI C63.4) and the receive antenna is located at a distance of three meters from the EUT.

The EUT and associated system are configured to operate with continuous transmissions at 11 Mbps, representing a "normally operating" mode. To ensure that the maximum emission at each discrete frequency of interest is observed, the receive antenna is varied in height from one to four meters and rotated to produce horizontal and vertical polarities, and the turntable is also rotated to determine the worst emitting configuration.

For frequencies under 1 GHz, the "Difference Margin" is calculated by subtracting the 15.209 limit from the reduced data. A negative number means that the reduced data is below the limit line (i.e., "Passing").

Difference Margin	= Reduced Data – 15.209 Limit
	= [(Quasi-Peak Data) + (Antenna Factor + Coax)] – (15.209 Limit)
At 94.48 MHz	= [(18.1) + (14.0)] – (43.5)
	= [32.1] – (43.5)
	= -11.4 dB = PASSING

For frequencies over 1 GHz the same process is used, except Average data is used in lieu of Quasi-Peak data. Inside the restricted bands specified in paragraph 15.205, the harmonic emissions must meet the limits of paragraph 15.209 (no fundamental emissions are allowed in the restricted bands). Most of the harmonic emissions did fall inside the restricted bands, so the 15.209 limit was applied to all harmonic emissions.

The fundamental emission level was specified under 15.247(b)(3)(i), using a power measurement in coax. The resulting power level was mathematically assigned to an isotropic radiator, and the resulting radiated field strength calculated using the formula $E = (\sqrt{30PG})/r$. (E is V/m, P in watts, G = 1 numerical gain, and r = 3m) Since the formula assumes isotropic radiation, and the actual measurement is peaked over a ground plane, some allowance could be made for the "bounce energy." This was not done for the included test data because of the close measurement distance and the tightly focused beams of some of the antennas.

Using the Pacific Monolith antenna with a specified gain of 23.4 dBi, the following calculation applies:

Maximum Power Input to the Antenna under 15.247(b)(i) = 1 W = 30 dBm
1 dB reduction for every 3 dB over 6 dBi = 1/3 (23.4 – 6) = -5.8 dB
Maximum allowable power to Antena per 15.247(b)(3)(i) = 24.2 dBm
Actual measured power to Pacific Monolith Antenna = 23.1 dBm = PASSING

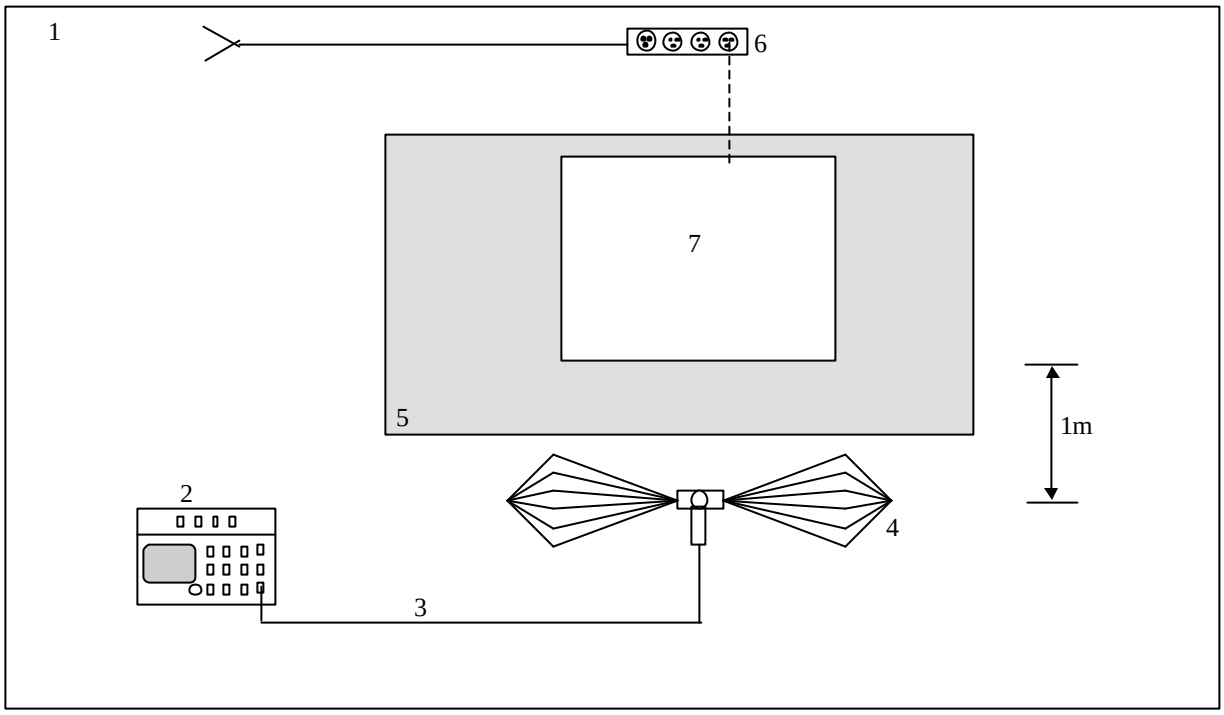
If the power is reduced 1 dB for every 3 dB of antenna gain (over 6dBi), then the radiated power is increased 2 dB for every 3 dB of antenna gain (over 6dBi).

Thus, the allowable EIRP = 1 watt + 6dBi + (2/3)(Antenna Gain – 6dBi)
= 30 dBm = 6dBi + (2/3)(23.4 – 6)
= 47.6 dBm maximum for the Pacific Monolith antenna.

The actual measured EIRP for the Pacific Monolith antenna = 46.5 dBm = PASSING

For Frequency ID and Radiated Emissions test configurations please refer to Figures 6 and 7 on the following pages. For Test Results data please refer to Appendix C.

Figure 6. Radiated Emissions Frequency ID Test Setup Diagram



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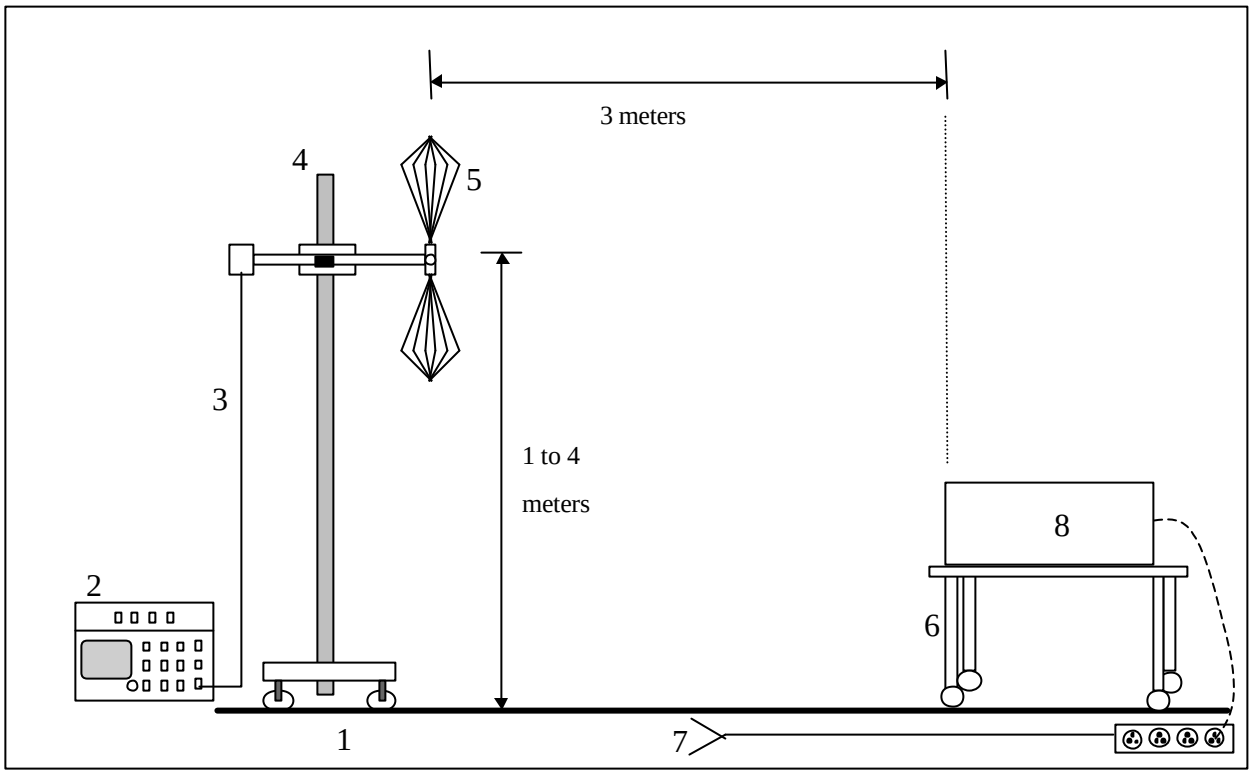
CONFIGURATION LEGEND

1. Test Laboratory
2. Spectrum Analyzer with Quasi-Peak Adapter
3. Coax interconnect from Antenna to Spectrum Analyzer
4. Receive Antenna (basic relative position)
5. Non-Conducting table 80 cm above ground plane
6. AC power for devices
7. EUT and Associated System

Figure 7. Radiated Emissions (OATS) Test Setup Diagram



NOT TO SCALE

CONFIGURATION LEGEND

1. Ground plane (11 X 17 meters)
2. Spectrum Analyzer with Quasi-Peak Adapter
3. Coax interconnect from Receive Antenna to Spectrum Analyzer
4. Antenna Mast with motorized mounting assembly
5. Receive Antenna (basic relative position)
6. Non-Conducting table 80 cm above ground plane
7. AC power for devices
8. EUT and Associated System

4.5 Allowed Occupied Bandwidth (15.247(a)(2))

The CFR 47 specifies limits for the frequency bands of intentional radiators. The field strength of the fundamental operated between 2407 MHz and 2470 MHz must comply with the requirements of 15.247(b). The harmonics must meet the requirements of 15.209. These limits are specified at a distance of 3 meters.

The EUT's peak emissions at the fundamental frequency are measured and plotted, and the bandwidth is measured at 6dB below the peak. The Occupied Bandwidth, measured 6dB below the peak, must exceed 500 kHz. Data plots of measured emissions of the worst-case antenna configuration (Tecon 8dBi) are plotted and included in Appendix C of this test report. Data for all other antenna configurations can be provided upon request.

4.6 Maximum Peak Output Power (15.247(b)(3)(i))

The CFR 47 specifies limits for the maximum peak output power of intentional radiators. Section 15.247(b)(3)(i) specifies that the peak output power must be less than or equal to 1 Watt (peak).

Maximum Output Power measurements were made at all three operating frequencies using each of 9 antennas at the appropriate output power. The output power is programmable and uses a proprietary sensing network in each antenna to set the correct level. This output power was tested in the antenna coax, and did not need to be repeated on the Open Area Test Site (OATS). However the harmonics of the fundamental were tested on the OATS, and were required to be at least 20dB below the fundamental level (per 15.247(c)), of the fundamental level was measured as a reference. The harmonics were also required to meet 15.205/15.209. Each antenna was "pre-scanned" at the three operating frequencies, and the worst case configurations were tested on the OATS.

Test Results are included in Appendix D of this test report.

4.7 Out of Band Emissions (15.247(c)(2))

Prescans of the EUT's system were performed to locate the emissions at the antenna terminals.

In the field, tests were conducted using a Transducer and a Spectrum Analyzer/Preamplifier combination, coupled via a High Pass filter. The EUT was positioned on an Open Area Test Site and a calibrated antenna was positioned at a 3m distance from the EUT.

The EUT and associated system are configured to operate with a series of periodic transmissions, representing a "normally operating" mode. To ensure that the maximum emission at each discrete frequency of interest is observed, the receive antenna is varied in height from one to four meters and rotated to produce horizontal and vertical polarities, and the turntable is also rotated to determine the worst emitting configuration.

Testing was performed on all 9 antennas, and results are presented in Appendix E of this test report.

4.8 Spectral Density (15.247(d))

Power Spectral Density measurements were made at the maximum power output level at the three operating frequencies at the highest possible power level of which the system is capable. The Maxrad 6dBi (Omni) antenna was used with the EUT for test measurements because it was determined to be the highest power antenna configuration.

Test Results data plots are included in Appendix F of this test report.

4.9 Processing Gain (15.247(e))

Solectek Corporation has performed Processing Gain testing independently, and test results are included as a separate attachment to this test report.