Unlicensed Transmitter Test Report

Product Tested:

Pool Leveler

Prepared for:

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Report Number: A0475-1
Issue Date: March 19, 2001

Accredited by the National Voluntary Laboratory Accreditation Program for the specific scope of accreditation under laboratory code 200245-0

Testing • Analysis • Engineering

Radiated & Conducted Emissions Conformance Statement

Report Number: A0475-1
Product Name: Pool Leveler

We, the undersigned, hereby state that the proper standards and procedures were followed as detailed in *EN55022, 47CFR15, AS/NZS 3548, and ANSI C63.4*. Furthermore, we attest that the data contained within this report is accurate and concise within the bounds of the standards and our company procedures.

Tom Bengel
EMC Technician

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this attached test record. There were no modifications made to the equipment in order to achieve compliance with these standards.

Furthermore, there was no deviation from, additions to or exclusions from the ANSI 63.4:1992 test methodology.

Signature: Michael Cantwell

Date: 29 June, 2000

Full Name: Michael Cantwell, PE

Location: Plano, Texas

Title: NARTE EMC Engineer (EMC-002019-NE)
Signatory for NVLAP

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1. Executive Summary

This EMC compliance report for a 418 MHz Transmitter and receiver is prepared on behalf of Sons Design and Manufacturing, Inc. The report is in accordance with the rules of the Federal Communications Commission (47 CFR 15.231)

This report cover testing for the Pool Leveler and all testing was performed on the 2nd and 3rd of May 2000.

All equipment configurations and measurements contained in this report were performed in accordance with the revision of the standards listed in this report. Also, the instrumentation and facilities utilized for the measurements conform to all appropriate standards. Calibration checks are performed yearly on the instruments by a local calibration lab, with traceability to the National Institute of Standards and Technology (NIST).

All radiated and conducted emission measurements are performed manually at National Technical Systems, Inc. The radiated emission measurements required by the rules were performed on a 10m open area test site (OATS) maintained by National Technical Systems, Inc., 1701 East Plano Parkway, Suite 150, Plano, Texas 75074, USA. Complete site descriptions and site attenuation measurement data are maintained at the test facility and can be made available upon request. The Power Line Conducted Emission Measurements were performed in a shielded enclosure also located at the same facility.

1.1 Modifications to EUT

There were no modifications made.

1.2 Special Accessories

There were no special accessories found necessary as a result of this testing.

2. Test Facility

The open area test site used to collect the radiated emissions data and the shielded room used to collect the conducted emissions data have been listed by the Federal Communications Commission (FCC) and accredited by the National Voluntary Laboratory Accreditation Program (NVLAP).

3. EUT Configuration

3.1 Technical Description

This is an RF linked device operating at 418 MHz. The transmitter, when required, transmits a burst of less than 1-second duration, of a single byte ID once every three minutes. When not transmitting, the transmitter is disabled.

The receiver is continuously enabled to receive this transmitted address burst. Upon receipt of a correctly coded byte of ID from the transmitter, the receiver enables a water valve for ten minutes. The installed transmitter/ receiver link has an affective range approximately 100 feet.

3.2 Test Configuration(s)

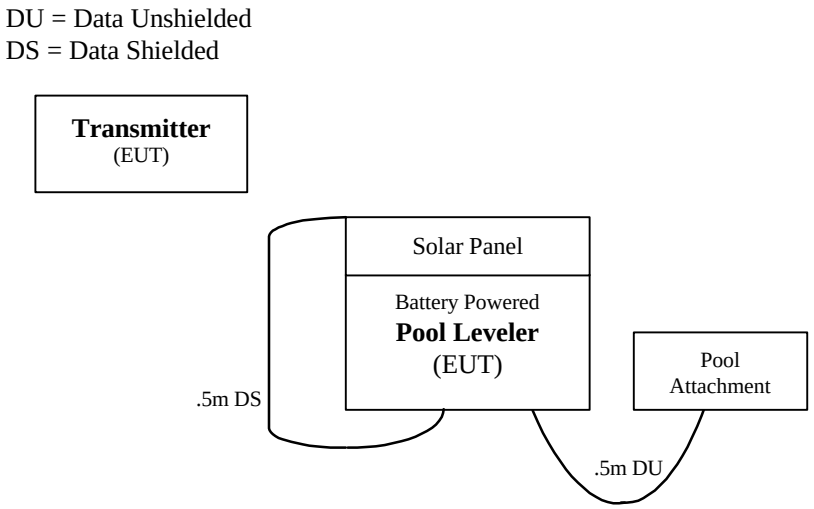


Figure 1 - Block Diagram of System Configuration

The system was configured for testing in a typical fashion (as a customer would normally use it). A list of the equipment under test (EUT) and its support equipment is found below.

Table 1 - Components in Block Diagram

Part	Manufacturer	Model	Serial Number	FCC ID	NTS Bar Code
TRANSMITTER CHASSIS	SDMI	CHASSIS	101785	NONE	101785
RECEIVER CHASSIS	SDMI	CHASSIS	101789	NONE	101789
VALVE	R/C VALVE COMPANY	12VDC 6 WATTS	12D-1044	NONE	101790

Table 2 - Internal Components

Part	Manufacturer	Model	Serial Number	FCC ID	NTS Bar Code
TRANSMITTER (EUT)	**SDMI**	**TXM 418 LC**	**101786**	**NONE**	**101786**
RECEIVER BOARD	SDMI	10-7453-A	101788	NONE	101788
BATTERY	SDMI	12V ACID BATTERY	UB1245	NONE	101787

3.3 Exercise Software

The EUT exercise program used during emissions testing has been designed to exercise the various system components in a manner similar to a typical use and was contained within the firmware of the devices.

3.4 Mode of Operation

The EUT was operated via it's self-contained firmware.

3.5 Modifications

The following changes have been made to the unit to correct the emissions problem:

A zero ohm resister was used to replace the previous 480-ohm current limit resistor in the IADJ input on the transmitter module. This change increases the transmitter power to the maximum level allowed by the module. Additionally, a filter capacitor was added to the voltage regulator output to filter spurious noise spikes induced by switching currents in the circuitry.

3.6 Photos of EUT

Figure 2 – View of Receiver Board mounted in case with solar panel

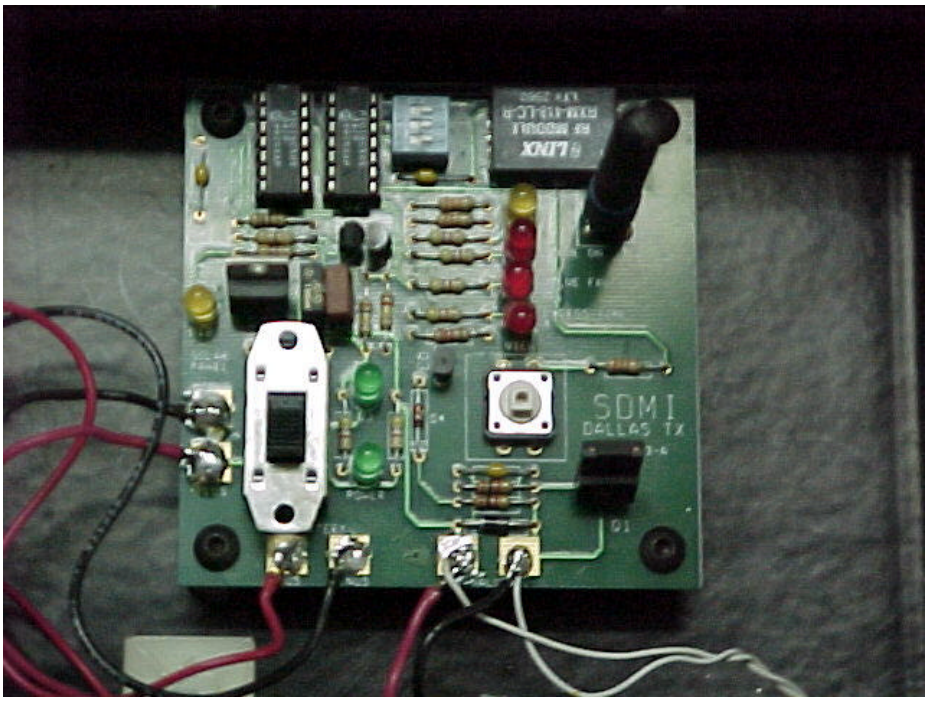


Figure 3 – Component Side of Receiver Board

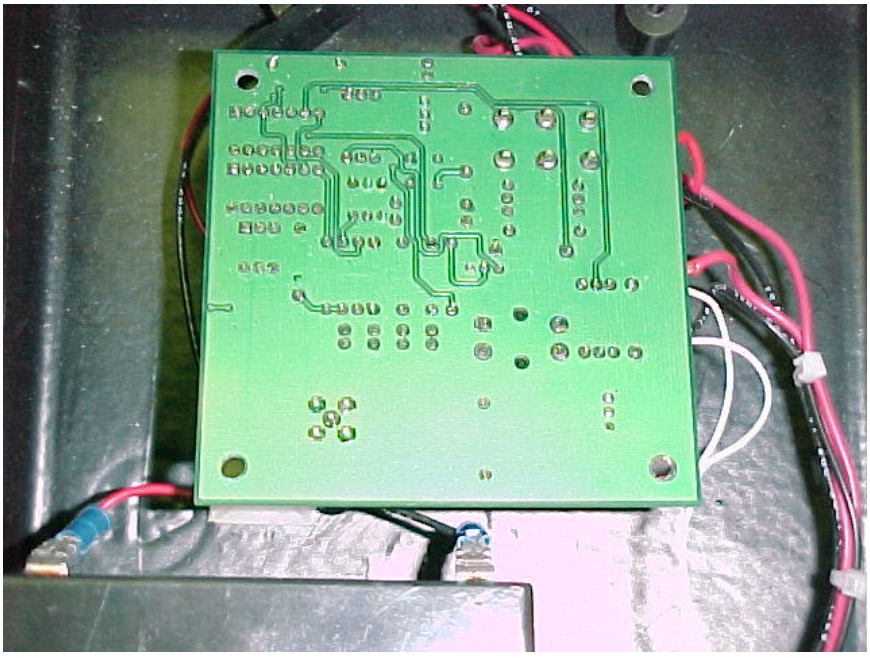


Figure 4 – Solder Side View of Reciever Board

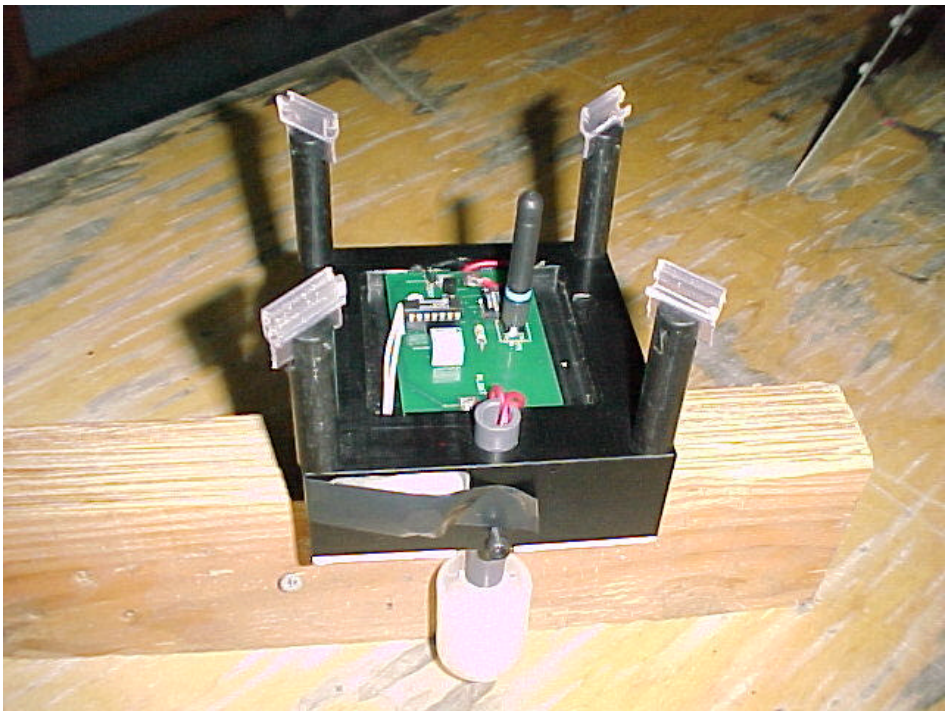


Figure 5 – Top View of Transmitter

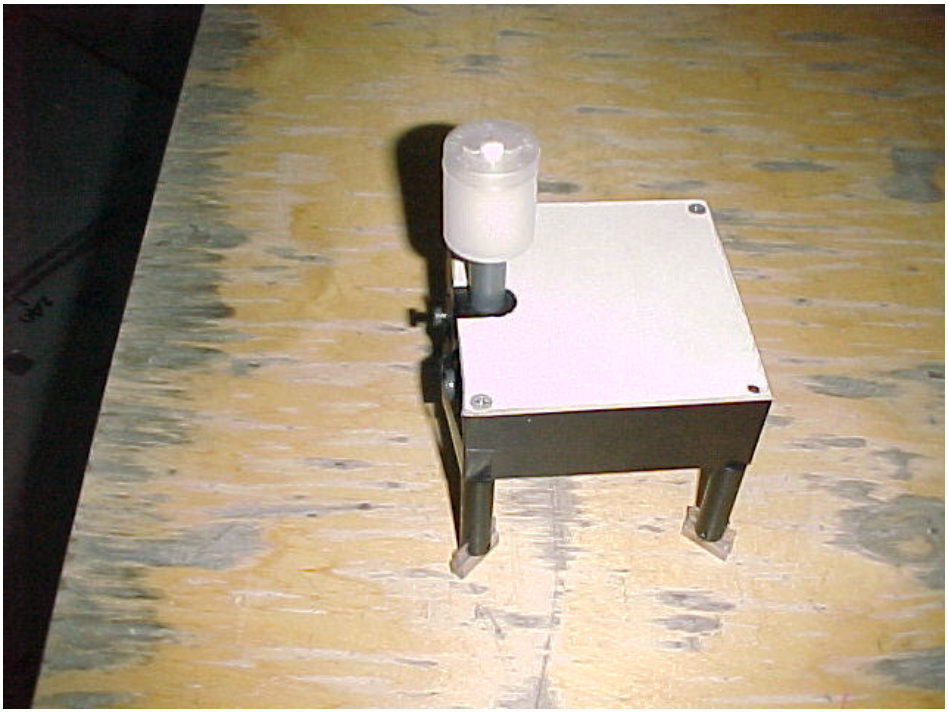


Figure 6 – Bottom View of Transmitter

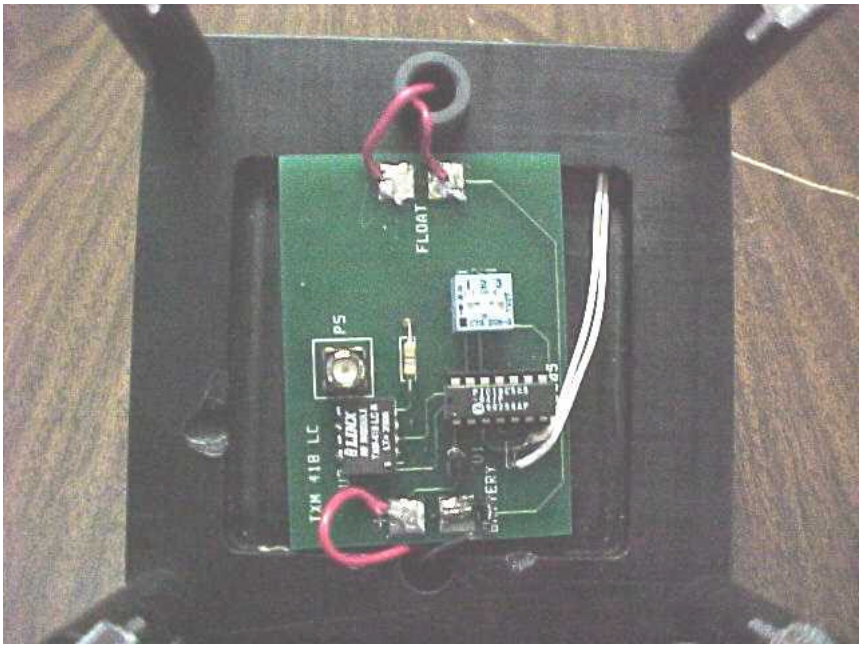


Figure 7 – Component Side of Transmitter board

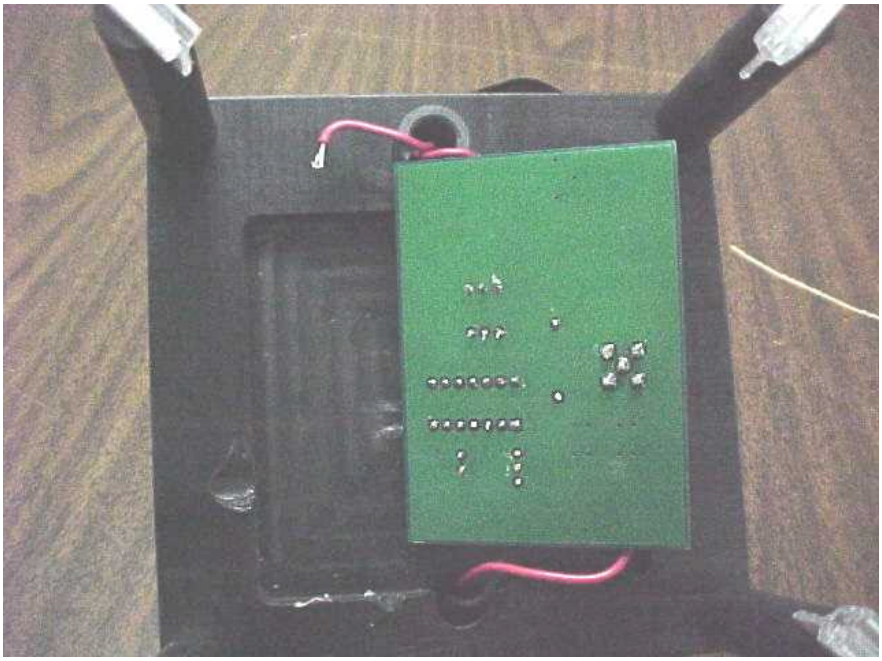


Figure 8 – Solder Side View of Transmitter board

4. Test Results

4.1 Emissions Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4 1992 and Part 15 of the FCC Rules. Radiated testing was performed at an antenna to EUT distance of 10 meters.

National Technical Systems, Inc. has implemented procedures to minimize errors that occur from test instruments, calibration, procedures, and test setups. Test instrument and calibration errors are documented from the manufacturer or calibration lab. Other errors have been defined and calculated within the National Technical Systems' quality manual. National Technical Systems implements these procedures to minimize errors that may occur: The highlights of the procedures are yearly as well as daily calibrations, technician training, and emphasis to employees on avoiding error.

4.1.1 Deviations from Test Methodology

There were no deviations from the test methodology during this test

4.2 Radiated Emissions Measurements

The limits utilized are from Part 15 of the FCC Rules.

4.2.1 Test Methodology

Whenever possible, and before final measurements of radiated emissions are made on the open-field three/ten meter range, the EUT is scanned indoors at a three meter distance (or one meter distance if necessary) in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process is either repeated, or performed, during final radiated emissions measurements on the open-field range, at each frequency, in order to insure that maximum emission amplitudes are obtained. National Technical Systems works diligently to ensure that worst case modes, physical arrangement of the test system and associated cabling produce maximum emission levels.

Final radiated emissions measurements were made on the 10 meter, open-field test site. The EUT was placed on a nonconductive turntable approximately 0.8 meters above the ground plane. The spectrum was examined from 30 MHz to 1000 MHz. When any clock exceeds 108 MHz but less than 500 MHz, the emissions of the EUT are also measured between 1 to 2 GHz using an average detector with the resolution bandwidth set at 1 MHz. For clocks greater than 500 MHz and less than 1 GHz, the emissions of the EUT are also measured between 1 and 5 GHz.

At each frequency, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters in order to determine the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarizations. The spectrum analyzer's 6 dB bandwidth was set to 120 kHz, and the analyzer was operated in the CISPR quasi-peak detection mode. The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

4.2.2 Test Limits

The tables below list the radiated emission limits found in Part 15 of the FCC Rules. The EUT to antenna distance used at National Technical Systems is always 10m unless otherwise noted.

Table 3 – FCC Part 15 Class A Radiated Emissions

(MHz)	10m	3 m
30 – 88	39.1	49.6
88 – 216	43.5	54.0
216 – 960	46.4	56.9
>960	49.5	60.0

Table 4 - FCC Part 15 Class B Radiated Emissions

(MHz)	10m	3 m
30 – 88	29.5	40.0
88 – 216	33.0	43.5
216 – 960	35.5	46.0
>960	43.5	54.0

4.2.3 Radiated Emissions Data

All readings are quasi-peak unless stated otherwise. The pk notation in the receiver reading denotes that this measurement was taken using the peak detector.

Table 5 - Radiated Emissions Data (Digital Device)

Emission Frequency (MHz)	Test Detector	Antenna Polarity (H/V)	Turntable Azimuth (deg)	Antenna Height (m)	Analyzer Reading (dBuV/m)	Site Correction Factor (dB/m)	Emission Level (dBuV/m)	FCC Limit (dBuV/m)	FCC Margin (dB)	Pass/ Fail	Comments
84.220	Qp	H	0	4.0	32.3	-20.9	11.4	29.5	-18.1	Pass	
84.220	Qp	V	90	1.0	24.9	-21.5	3.4	29.5	-26.1	Pass	
149.650	Qp	H	0	4.0	29.8	-16.7	13.1	33.0	-19.9	Pass	
149.653	Qp	V	270	1.0	22.2	-16.4	5.8	33.0	-27.2	Pass	
161.600	Qp	H	0	4.0	27.8	-17.4	10.4	33.0	-22.6	Pass	
161.609	Qp	V	210	1.0	27.6	-18.0	9.6	33.0	-23.4	Pass	
195.880	Qp	H	0	4.0	27.0	-17.8	9.2	33.0	-23.8	Pass	
195.884	Qp	V	270	1.0	22.3	-17.5	4.8	33.0	-28.2	Pass	
300.000	Qp	H	0	4.0	24.6	-15.1	9.5	35.5	-26.0	Pass	
300.000	Qp	V	5	1.0	21.8	-15.1	6.7	35.5	-28.8	Pass	
377.498	Qp	V	10	1.0	25.4	-13.0	12.4	35.5	-23.1	Pass	
377.760	Qp	H	0	1.0	23.8	-13.2	10.6	35.5	-24.9	Pass	
401.480	Qp	H	0	4.0	24.0	-12.0	12.0	35.5	-23.5	Pass	
401.481	Qp	V	0	1.0	25.3	-11.6	13.7	35.5	-21.8	Pass	
581.700	Qp	H	0	4.0	24.1	-9.4	14.7	35.5	-20.8	Pass	
581.709	Qp	V	5	1.0	25.7	-9.3	16.4	35.5	-19.1	Pass	
998.934	Qp	H	0	4.0	24.2	-7.0	17.2	43.5	-26.3	Pass	
998.934	Qp	V	0	1.0	26.9	-6.2	20.7	43.5	-22.8	Pass	

4.2.4 Radiated Test Configuration Photographs

Figure 9 - Radiated Setup (Front View)

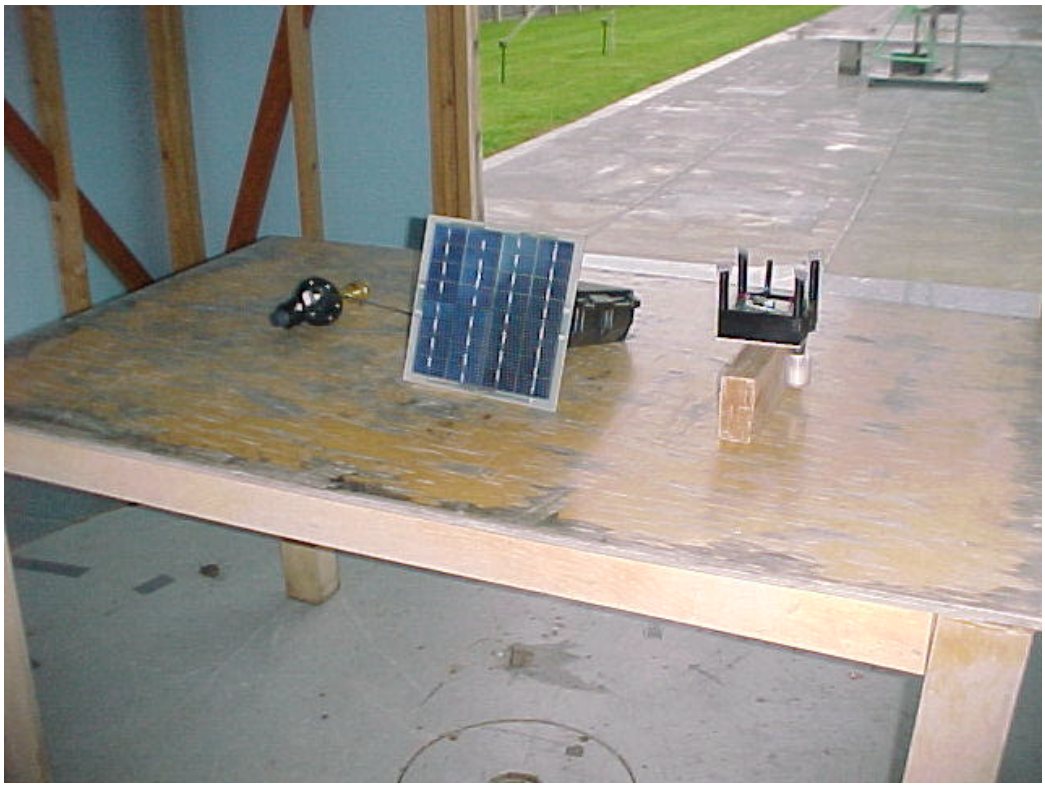
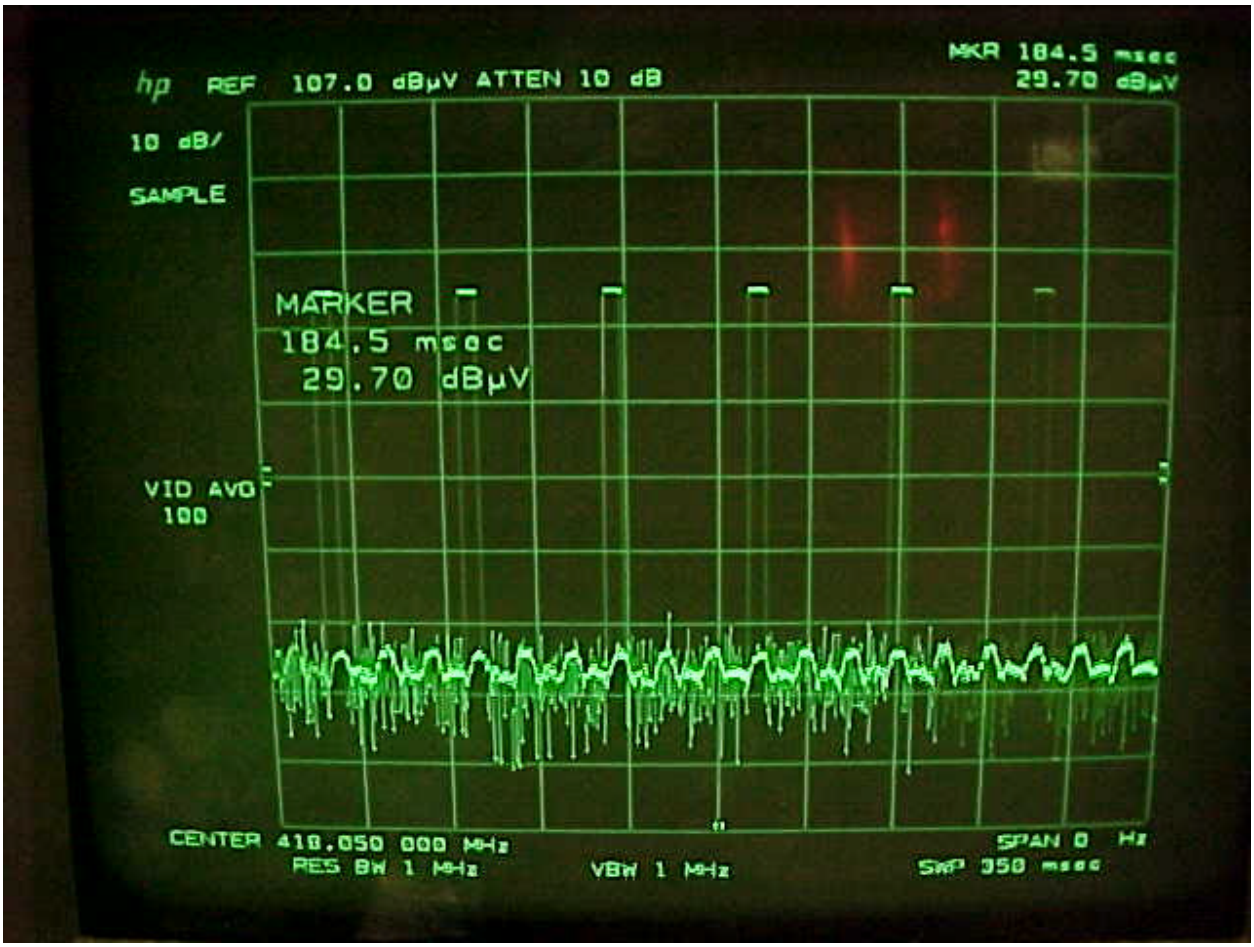


Figure 10 - Radiated Setup (Rear View)

4.3 Transmitter Characteristics

This transmitter operates with a fundamental frequency of 418 MHz and is intended to operate under 47 CFR 15.231. The periodic transmissions occur every 3 minutes. This is more frequent than is allowed under 15.231(a)(3), therefore the emission limits were chosen to be the more stringent found in 15.231(e).



Calculated Duty Cycle: The photo above showing that transmitter on 14mS and off 86mS over 100ms perior. Therefore the calculated duty cycle was 14%

Table 6 - Radiated Emissions Data (Transmitter Fundamental & Harmonics)

Test requirement Field Strength of Emissions from Intentional Radiator

EUT Name: Pool Leveler.
Reference to FCC part 15 subpart C, 15.231.
The fundamental frequency tuned at 418Mhz.

Duty Cycle: 14 % (14mS signal on and 86mS signal off out of 100mS see the photo above).

The table lists the fundamental and harmonic emissions frequencies. The site correction factor includes: cable loss, antenna factor, and pre-amplifier. All measurements were taken with 1 MHz RBW and 1 MHz VBW. All readings are peak with the specific bandwidth. The duty-cycle correction factor is not required, as all peak measurements are below the FCC limits.

Ferq (Mhz)	Vert/hori	SA Reading (DBuV)	Correction Factor (dB)	Field Strength DbuV/m	Field Strength uV/m	FCC Limit 3m (uV/m)
418	V	40.55	17.1	57.65	762.96	10,333.00
418	H	43.15	17.1	60.25	1,029.20	10,333.00
836	V	52.63	-0.5	52.13	404.11	1032
836	H	52.83	-0.5	52.33	413.52	1032
1254	V	43.09	-7.8	35.29	58.14	1032
1254	H	42.59	-7.8	34.79	54.89	1032
1672	V	47.28	-6	41.28	115.88	1032
1672	H	41.08	-6	35.08	56.75	1032
2090	V	49.28	-4.1	45.18	181.55	1032
2090	H	52.18	-4.1	48.08	253.51	1032
2508	V	No signal	N/A	N/A	N/A	N/A
2508	H	No signal	N/A	N/A	N/A	N/A
2926	V	No signal	N/A	N/A	N/A	N/A
2926	H	No signal	N/A	N/A	N/A	N/A
3344	V	No signal	N/A	N/A	N/A	N/A
3344	H	No signal	N/A	N/A	N/A	N/A
3762	V	No signal	N/A	N/A	N/A	N/A
3762	H	No signal	N/A	N/A	N/A	N/A
4180	V	No signal	N/A	N/A	N/A	N/A
4180	H	No signal	N/A	N/A	N/A	N/A

4.3.1 Occupied Bandwidth

The occupide bandwidth of the transmitted signal was 40.6 kHz at –26 dBc.

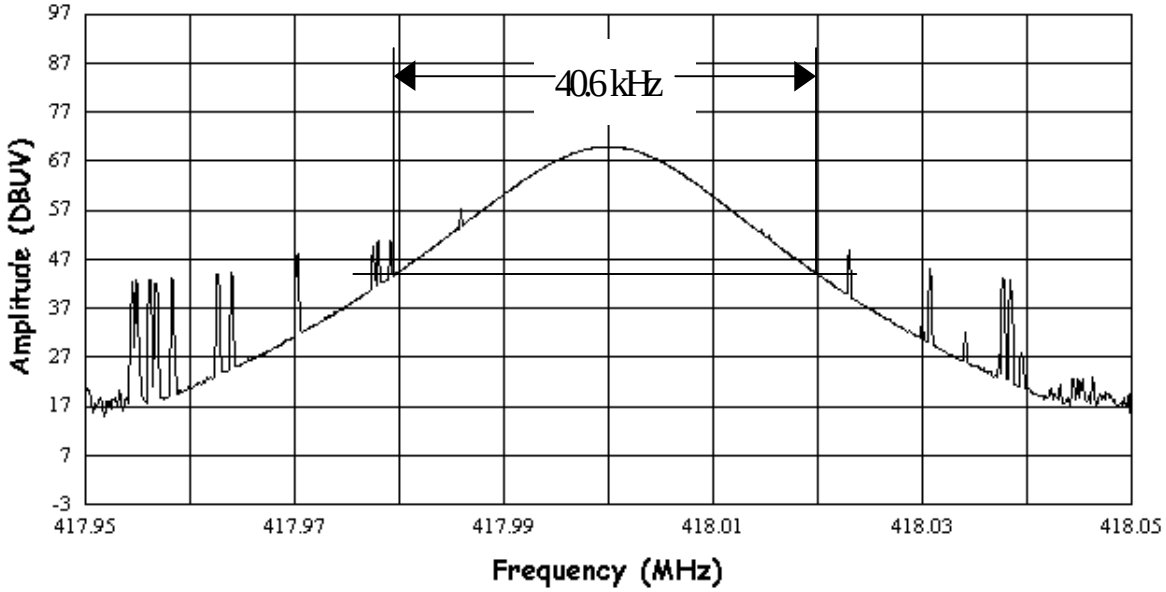


Figure 11 - Occupied Bandwidth Plot

4.3.2 Pulse Train Width

The width of the transmitted pulse-train is 310 msec.

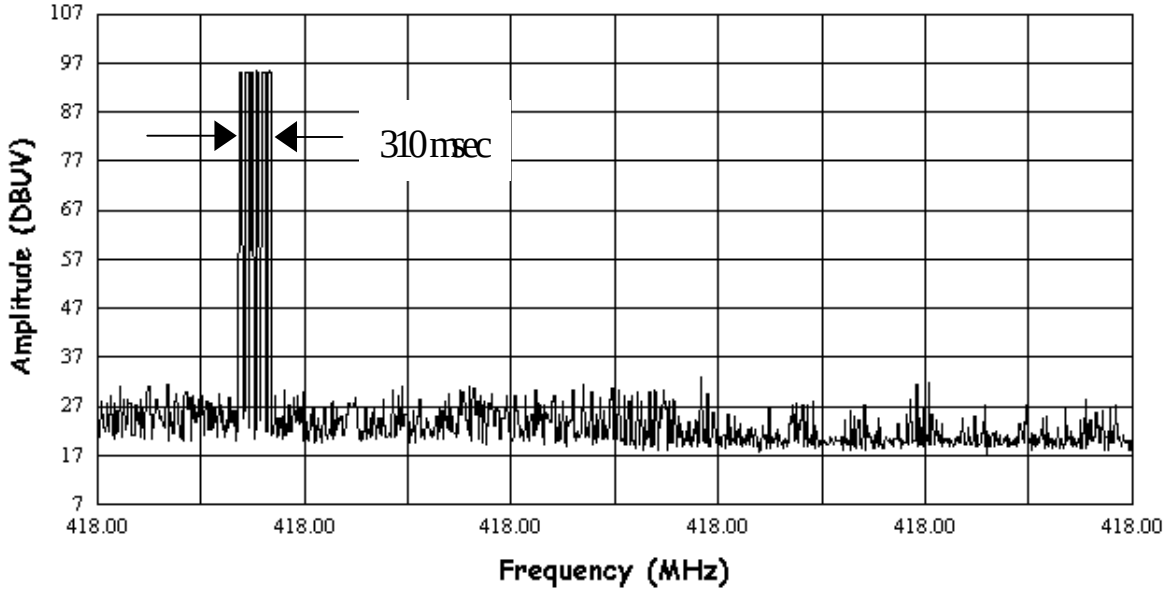


Figure 12 – Pulse-Train Width Plot

4.3.3 Transmit Cycle Time

The transmitted signal repeats every 180.9 seconds (approximately 3 minutes).

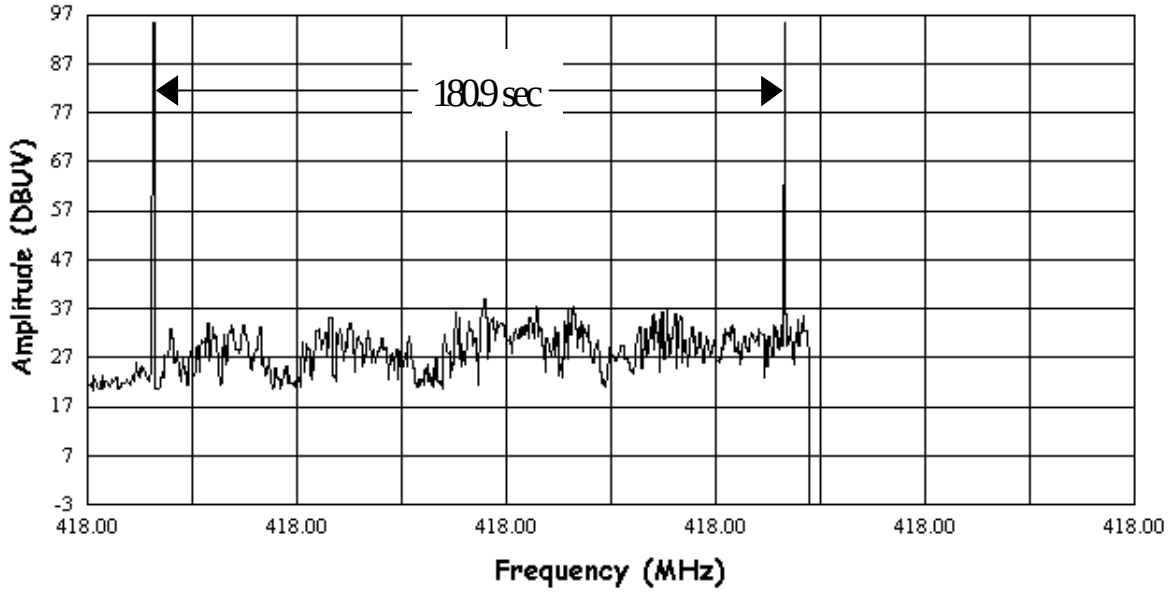


Figure 13 - Periodic Transmission Cycle Time

5. Test Equipment

The following test equipment was used to perform the radiated and conducted emissions testing. Competent calibration laboratories calibrate all the equipment. The calibration is traceable to NIST.

The Test column indicates which equipment was utilized to perform the radiated and conducted testing. An "R" in this column indicates that it was used for radiated emissions testing and a "C" in this column indicates that it was used for conducted emissions testing.

Table 7 - Test Equipment List

Test	Manufacturer	Model	Description	Serial Number	Last Cal	Next Cal
	Hewlett Packard	8566B	Spectrum Analyzer	2816A16178 2747A05126	18-Feb-00	18-Feb-01
R	Hewlett Packard	85650A	Quasi-Peak Adapter	3303A01859	18-Feb-00	18-Feb-01
	Hewlett Packard	8546A	EMI Receiver	3265A00348 3448A00288	21-Dec-98	21-Dec-99
	Hewlett Packard	8591E	Spectrum Analyzer	3325A01823	25-Aug-99	25-Aug-00
R	Rhein Tech Labs	PR-1040	Amplifier	N/A	27-Mar-00	27-Mar-01
R	Hewlett Packard	8449B	Amplifier	3008A00244	25-Feb-00	25-Feb-01
	NTS	Radiated Cable	Site 1NE	R002	25-Mar-00	25-Mar-01
R	NTS	Radiated Cable	Site 2NW	R003	25-Mar-00	25-Mar-01
	NTS	Radiated Cable	Site 3SW	R004	25-Mar-00	25-Mar-01
R	Chase	CBL6112A	Bilog Antenna	2149	2-Feb-00	2-Feb-01
	Chase	CBL6112A	Bilog Antenna	2150	6-Jul-99	6-Jul-00
	Chase	CBL6112A	Bilog Antenna	2589	18-Jan-00	18-Jan-01
R	EMCO	3115	Horn Antenna	9901-3900	27-Jan-00	27-Jan-01
	Hewlett Packard	8567A	Spectrum Analyzer	2602A00153 2542A11108	27-Aug	27-Aug-00
	Hewlett Packard	85650A	Quasi-Peak Adapter	3303A01832	27-Aug	27-Aug-00
	Solar	9252-50-R-24-BNC	LISN	961023	8-Sep-99	8-Sep-00
	NTS	Conducted Cables	Coaxial Cables	C001	8-Sep-99	8-Sep-00