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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C (15.247) FHSS Specifications and Industry Canada RSS 210 Issue 5 for an Intentional Radiator on the Davis Instruments Corp. Model: 6345 Wireless Leaf and Soil Moisture/Temperature Station

FCC ID:	IR2DWW6345
UPN:	3788A-6345
GRANTEE:	Davis Instruments Corp. 3465 Diablo Ave. Hayward, CA 94545
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	January 31, 2005
FINAL TEST DATE:	January 18, 2005
AUTHORIZED SIGNATORY:	David W. Bare Chief Technical Officer

ACCREDITED
2016-01

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SCOPE

An electromagnetic emissions test has been performed on the Davis Instruments Corp. model 6345 Wireless Leaf and Soil Moisture/Temperature Station pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and RSS-210 Issue 5 for licence-exempt low power devices. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-2003 as outlined in Elliott Laboratories test procedures.

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

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

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

The test results recorded herein are based on a single type test of the Davis Instruments Corp. model 6345 Wireless Leaf and Soil Moisture/Temperature Station and therefore apply only to the tested sample. The sample was selected and prepared by Perry Dillon of Davis Instruments Corp.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules and RSS-210 Issue 5 for license-exempt low power devices for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units that are subsequently manufactured.

SUMMARY OF RESULTS

FCC Part 15 Section	RSS 210 Section	Description	Measured Value	Comments	Result
	6.2.2(o)(a)	20dB Bandwidth	60 kHz	The channel spacing shall be greater than the 20dB bandwidth	Complies
	6.2.2(o)(a)	Channel Separation	505 kHz		Complies
	6.2.2(o)(a)	Number of Channels	51	50 hopping frequencies: average time of occupancy <0.4 second within a 20 second period. Refer to plots.	Complies
	6.2.2(o)(a)	Channel Dwell Time	7.5 ms per 20 seconds		Complies
	6.2.2(o)(a)	Channel Utilization	All channels are used equally	Refer to Theory of Operations for detailed description of the hopping.	Complies
15.247 (b) (3)	6.2.2(o)(a)	Output Power	EIRP = 10.9 dBm (0.012 Watts)	Maximum permitted is 1Watt, with EIRP limited to 4 Watts for a 50-channel system.	Complies
15.247(c)	6.2.2(o)(e1)	Spurious Emissions – 30MHz – 25GHz	All spurious emissions < -20dBc	All spurious emissions < -20dBc.	Complies
15.247(c) / 15.209		Radiated Spurious Emissions 30MHz – 10GHz	63.6dBµV/m (1504.9µV/m) @ 1805.1MHz (-10.5dB)	Emissions in restricted bands must meet the radiated emissions limits detailed in 15.207. All others must be < -20dBc	Complies
15.207	6.6	AC Conducted Emissions		Battery powered	N/A
15.247(b) (5)		RF Exposure Requirements	FCC /IC limits of power density not exceeded since power is below low threshold for portable devices	Refer to MPE calculation exhibit.	Complies
15.203		RF Connector	Integral antenna		Complies

EIRP measured during testing since the antenna is integral to the device.

MEASUREMENT UNCERTAINTIES

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

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Radiated Emissions	30 to 1000	± 3.6

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Davis Instruments Corp. model 6345 Wireless Leaf and Soil Moisture/Temperature Station is a leaf and soil moisture/temperature station which is designed to be used in agriculture. The station incorporates a transmitter that sends the data to a remote display. Normally, the EUT would be placed on a wall or post during operation. The EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 3Vdc battery powered, 900uA.

The sample was received on January 18, 2005 and tested on January 18, 2005. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Davis Instruments	6345	Monitoring device	Davis-US.001	TBD

OTHER EUT DETAILS

The 6345 is designed for the North American market and operates in the 902 - 928 MHz band.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 16 cm wide by 7 cm deep by 20 cm high.

MODIFICATIONS

The EUT did not require any modifications in order to comply with the specifications.

SUPPORT EQUIPMENT

The following equipment was used as local support equipment for testing:

Manufacturer	Model	Description	Serial Number	FCC ID
Davis Instruments	6420	Leaf Sensor (x2)	-	-
Watermark	-	Soil Sensor (x4)	-	-
Davis Instruments	-	Temp Sensor (x4)	-	-

No remote support equipment was used during testing.

EUT INTERFACE PORTS

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

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Temperature (x4)	Sensor	Multiwire	Unshielded	10
Soil moisture (x4)	Sensor	Multiwire	Unshielded	10
Leaf (x2)	Sensor	Multiwire	Unshielded	10

Note: The comm port was not connected as the manufacturer stated that these are for configuration purpose and therefore would not normally be connected.

EUT OPERATION

The transmitter was set to normal transmit mode transmitting once every 2.5 seconds.

ANTENNA REQUIREMENTS

The antenna is integral to the unit and is not replaceable.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on January 18, 2005 at the Elliott Laboratories Open Area Test Site #1 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Federal Communications Commission. In accordance with Industry Canada rules detailed in RSS 210 Issue 5 and RSS-212, construction, calibration, and equipment data for the test sites have been filed with the Federal Communications Commission.

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

CONDUCTED EMISSIONS CONSIDERATIONS

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

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

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

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

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

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

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

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

POWER METER

A power meter and peak power sensor are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

FILTERS/ATTENUATORS

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

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

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

INSTRUMENT CALIBRATION

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

TEST PROCEDURES

EUT AND CABLE PLACEMENT

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

CONDUCTED EMISSIONS

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

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

Measurement bandwidths (video and resolution) are set in accordance with FCC procedures for the type of radio being tested.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

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

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

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

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp) the following formula is used to determine the field strength limit in terms of microvolts per meter at a distance of 3m from the equipment under test:

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

where P is the eirp (Watts)

For reference, converting the voltage and electric field strength specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. Conversion of power specification limits from linear units (in milliwatts) to decibel form (in dBm) is accomplished by taking the base ten logarithm, then multiplying by 10.

FCC 15.407 (a)and RSS 210 (o) OUTPUT POWER LIMITS

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

Operating Frequency (MHz)	Number Of Channels	Output Power
902 – 928	>=50	1 W (30 dBm)
902 – 928	< 50	0.25 W (24 dBm)
2400 – 2483.5	>= 75	1 W (30 dBm)
2400 – 2483.5	>= 75	0.125 W (21 dBm)
5725 – 5850	>=75	1 W (30 dBm)

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

RSS 210 (o) AND FCC 15.247 SPURIOUS RADIATED EMISSIONS LIMITS

T limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands detailed in Part 15.205 and for all spurious emissions from the receiver are:

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

All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level.

FCC AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in FCC Part 15.207.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

RSS-210 SECTION 6.6 AC POWER PORT CONDUCTED EMISSIONS LIMITS

The table below shows the limits for emissions on the AC power line as detailed in Industry Canada RSS-210 section 6.6.

Frequency Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) after any corrections for transducers and cables as follows:

$$R_r - A = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

A = Amplitude correction for cables and/or transducer in dB

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

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

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

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

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

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

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Radiated Emissions, 1000 - 10,000 MHz, 18-Jan-05
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	23-Jan-05
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	786	08-Nov-05
Hewlett Packard	EMC Spectrum Analyzer, 9KHz - 22GHz	8593EM	1319	30-Nov-05

Radiated Emissions, 30 - 1,000 MHz, 18-Jan-05
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Rohde & Schwarz	Test Receiver, 20-1300MHz	ESVP	1317	15-Jul-05
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	25-Mar-05

Radiated Emissions, 30 - 12,750 MHz, 19-Jan-05
Engineer: dbare

Manufacturer	Description	Model #	Asset #	Cal Due
Elliott Laboratories	Log Periodic Antenna 300-1000 MHz	EL300.1000	55	06-Dec-05
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	26-Feb-05
Hewlett Packard	Microwave EMI test system, □1-26.5 GHz	84125B	1145	11-Jun-05
Hewlett Packard	EMC Spectrum Analyzer 30Hz - 40 GHz, Sunnyvale	8564E (84125C)	1148	09-Jun-05
Hewlett Packard	RF Preamplifier, 100 kHz - 1.3 GHz	8447E	1606	28-Jul-05

Radiated Emissions, 30 - 1,000 MHz, 21-Jan-05
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Biconical Antenna, 30-300 MHz	3110B	801	09-Jul-05
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz	ESCS 30	1337	12-Jan-06
EMCO (ETS-Lindgren)	Log Periodic Antenna, 0.2-2 GHz	3148	1595	01-Jun-05

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T58447 11 Pages

Elliott

EMC Test Data

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	
Contact:	Perry Dillon		
Emissions Spec:	FCC 15.247, EN 300 220-3	Class:	B
Immunity Spec:	EN 301 489-3	Environment:	Class 3 SRD

EMC Test Data

For The

Davis Instruments

Model

6345 & 6345OV

Date of Last Test: 2/9/2005

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	
Contact:	Perry Dillon		
Emissions Spec:	FCC 15.247, EN 300 220-3	Class:	B
Immunity Spec:	EN 301 489-3	Environment:	Class 3 SRD

EUT INFORMATION

General Description

The EUT is leaf and soil moisture/temperature station which is designed to be used in agriculture. The station incorporates a transmitter that sends the data to a remote display. Normally, the EUT would be placed on a wall or post during operation. The EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 3Vdc battery powered, 900uA.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Davis Insturments	6345OV	Monitoring device	Davis-EU.001	N/A
Davis Insturments	6345	Monitoring device	Davis-US.001	IR2DWW6345

Other EUT Details

The 6345 is designed for the North American market and operates in the 902 - 928 MHz band. The OV version of the 6345 is designed for the European market and operates in the 868.0 to 868.6 MHz band.

EUT Antenna

The whip antenna is integral to the device with a gain of 0 dBi.

EUT Enclosure

The EUT enclosure is primarily constructed of plastic. It measures approximately 16 cm wide by 7 cm deep by 20 cm high.

Modification History

Mod. #	Test	Date	Modification
1	Substitution Measurements for the 6345OV	1/18/2005	Added a 5pF on the antenna rf path.
2			
3			

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.

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EMC Test Data

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	
Contact:	Perry Dillon		
Emissions Spec:	FCC 15.247, EN 300 220-3	Class:	B
Immunity Spec:	EN 301 489-3	Environment:	Class 3 SRD

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Davis Instruments	6420	Leaf Sensor (x2)	-	-
Watermark	PN 6440	Soil Sensor (x4)	-	-
Davis Instruments	PN 6470	Temp Sensor (x4)	-	-

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Temperature (x4)	Sensor	Multiwire	Unshielded	10
Soil moisture (x4)	Sensor	Multiwire	Unshielded	10
Leaf (x2)	Sensor	Multiwire	Unshielded	10

Note: The comm port was not connected as the manufacturer stated that these are for configuration purpose and therefore would not normally be connected.

EUT Operation During Emissions Tests

The transmitter was set to normal transmit mode transmitting once every 2.5 seconds.

EUT Operation During Immunity Tests

The transmitter was set to normal transmit mode, transmitting once every 2.5 seconds. A Davis Instruments Vantage Pro Console was used as a receiver to decode the transmissions and indicate the measured parameters and the number of successfully received data packets and the number of failed data packets.

Performance Criteria for Immunity Tests

Criterion A:

The device is classified as a Class 3 SRD. There may be loss of function (one or more) provided that there are no unintentional responses from the transmitter during the test. After the test the device shall operate as intended and the communication link shall be recoverable by user intervention if necessary. All lost functions shall be self-recoverable and there shall be no permanent degradation in performance.

The interpretation of the above is that, after the test, the device shall continue to send valid data to the receiver every 2.5 seconds. Unintentional transmissions from the device would be caused by either a microprocessor interrupt (which would result in other unintentional operations and be apparent by a loss of communication with the receiver) or the transmitter control input triggering on noise, which would result in transmission of bad data (the receiver would indicate missed data and CRC errors) or valid data at more frequent intervals than the pre-programmed 2.5 second interval.

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

FCC 15.247 FHSS - Power, Bandwidth and Spurious Emissions

Test Specifics

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

Date of Test: 1/18/2005
Test Engineer: Juan Martinez
Test Location: SVOATS #3
Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

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

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

Unless stated otherwise the EUT was operating such that it constantly hopped on either the low, center or high channels.

Ambient Conditions:

Temperature: 11 °C
Rel. Humidity: 78 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1a	RE, 30 - 10,000 MHz - Spurious Emissions (Low)	FCC Part 15.209 / 15.247(c)	Pass	63.6dBµV/m (1504.9µV/m) @ 1805.1MHz (-10.5dB)
1b	RE, 30 - 10,000 MHz - Spurious Emissions (Middle)	FCC Part 15.209 / 15.247(c)	Pass	62.3dBµV/m (1307.7µV/m) @ 1830.2MHz (-11.7dB)
1c	RE, 30 - 10,000 MHz - Spurious Emissions (High)	FCC Part 15.209 / 15.247(c)	Pass	43.063 (141.3) @ 1855.01855 (-11.0dB)
2	20dB Bandwidth	15.247(a)	Pass	60 kHz
3	Output Power	15.247(b)	Pass	10.9dBm (0.012 W)
4	Channel Occupancy / Separation	15.247(a)	Pass	0.39 Sec. / 505 kHz
4	Number of Channels	15.247(a)	Pass	51

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Run #1a: Radiated Spurious Emissions, 30 - 10,000 MHz. Low Channel @ 902 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1805.100	63.6	v	74.0	-10.5	Pk	96	1.0	
1805.100	43.6	v	54.0	-10.5	Avg	96	1.0	Note 2
6317.000	57.7	v	74.0	-16.3	Pk	0	1.0	Note 3
6317.000	37.7	v	54.0	-16.3	Avg	0	1.0	Note 2, 3
1805.100	56.4	h	74.0	-17.6	Pk	200	1.0	
1805.100	36.4	h	54.0	-17.6	Avg	200	1.0	Note 2
6317.000	56.0	h	74.0	-18.0	Pk	346	1.0	Note 3
6317.000	36.0	h	54.0	-18.0	Avg	346	1.0	Note 2, 3
5415.000	55.3	h	74.0	-18.8	Pk	0	2.0	Note 3
5415.000	35.3	h	54.0	-18.8	Avg	0	2.0	Note 2, 3
5415.000	55.0	v	74.0	-19.0	Pk	255	1.0	Note 3
5415.000	35.0	v	54.0	-19.0	Avg	255	1.0	Note 2, 3
4512.000	54.5	h	74.0	-19.5	Pk	255	1.6	Note 3
4512.000	34.5	h	54.0	-19.5	Avg	255	1.6	Note 2, 3
4512.000	53.4	v	74.0	-20.6	Pk	320	1.0	Note 3
4512.000	33.4	v	54.0	-20.6	Avg	320	1.0	Note 2, 3
3610.200	52.5	h	74.0	-21.5	Pk	159	1.1	Note 3
3610.200	32.5	h	54.0	-21.5	Avg	159	1.1	Note 2, 3
3610.200	52.0	v	74.0	-22.0	Pk	107	1.0	Note 3
3610.200	32.0	v	54.0	-22.0	Avg	107	1.0	Note 2, 3
2707.000	50.0	v	74.0	-24.0	Pk	150	1.0	Note 3
2707.000	30.0	v	54.0	-24.0	Avg	150	1.0	Note 2, 3
2707.000	49.1	h	74.0	-24.9	Pk	295	1.1	Note 3
2707.000	29.1	h	54.0	-24.9	Avg	295	1.1	Note 2, 3

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	Duty cycle on time is 7.5ms. This corresponse to -22dB of correction (20*log(7.5ms/100ms). Only -20dB was applied to the peak measured level of the spurious emission to get the average value.
Note 3:	Noise floor. No other spurious emission detected after the 3rd harmonic.

Elliott

EMC Test Data

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

Run #1b: Radiated Spurious Emissions, 30 - 10,000 MHz. Center Channel @ 915 MHz

	H	V
Fundamental emission level @ 3m in 100kHz RBW:		
Limit for emissions outside of restricted bands:	-20 dBµV/m	

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1830.200	62.3	v	74.0	-11.7	Pk	87	1.0	
1830.200	42.3	v	54.0	-11.7	Avg	87	1.0	Note 2
2745.300	53.0	v	74.0	-21.0	Pk	311	1.1	Note 3
2745.300	33.0	v	54.0	-21.0	Avg	311	1.1	Note 2, 3
3660.300	52.0	v	74.0	-22.0	Pk	239	1.6	Note 3
3660.300	32.0	v	54.0	-22.0	Avg	239	1.6	Note 2, 3
4575.500	52.4	v	74.0	-21.6	Pk	266	1.3	Note 3
4575.500	32.4	v	54.0	-21.6	Avg	266	1.3	Note 2, 3
5490.000	56.0	v	74.0	-18.0	Pk	361	1.0	Note 3
5490.000	36.0	v	54.0	-18.0	Avg	361	1.0	Note 2, 3
6405.500	58.7	v	74.0	-15.3	Pk	0	1.0	Note 3
6405.500	38.7	v	54.0	-15.3	Avg	0	1.0	Note 2, 3
1830.200	55.8	h	74.0	-18.2	Pk	283	1.1	
1830.200	35.8	h	54.0	-18.2	Avg	283	1.1	Note 2
2745.300	48.0	h	74.0	-26.0	Pk	203	1.0	Note 3
2745.300	28.0	h	54.0	-26.0	Avg	203	1.0	Note 2, 3
3660.300	52.2	h	74.0	-21.8	Pk	153	1.3	Note 3
3660.300	32.2	h	54.0	-21.8	Avg	153	1.3	Note 2, 3
4575.500	53.9	h	74.0	-20.1	Pk	250	1.0	Note 3
4575.500	33.9	h	54.0	-20.1	Avg	250	1.0	Note 2, 3
5490.000	56.0	h	74.0	-18.0	Pk	47	1.0	Note 3
5490.000	36.0	h	54.0	-18.0	Avg	47	1.0	Note 2, 3
6405.500	57.2	h	74.0	-16.8	Pk	0	1.0	Note 3
6405.500	37.2	h	54.0	-16.8	Avg	0	1.0	Note 2, 3

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	Duty cycle on time is 7.5ms. This corresponse to -22dB of correction (20*log(7.5ms/100ms). Only -20dB was applied to the peak measured level of the spurious emission to get the average value.
Note 3:	Noise floor. No other spurious emission detected after the 3rd harmonic.

Elliott

EMC Test Data

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

Run #1c: Radiated Spurious Emissions, 30 - 10,000 MHz. High Channel @ 927.9 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
960.000	31.0	v	46.0	-15.0	QP	0	1.0	Restricted band
960.000	32.0	h	46.0	-14.0	QP	10	1.0	Restricted band
1855.000	63.0	v	74.0	-11.0	Pk	241	1.0	
1855.000	43.0	v	54.0	-11.0	Avg	241	1.0	Note 2
6493.000	59.5	v	74.0	-14.5	Pk	0	1.0	Note 3
6493.000	39.5	v	54.0	-14.5	Avg	0	1.0	Note 2, 3
6493.000	58.4	h	74.0	-15.7	Pk	361	1.0	Note 3
6493.000	38.4	h	54.0	-15.7	Avg	361	1.0	Note 2, 3
5565.000	57.0	v	74.0	-17.0	Pk	360	1.0	Note 3
5565.000	37.0	v	54.0	-17.0	Avg	360	1.0	Note 2, 3
5565.000	56.3	h	74.0	-17.7	Pk	361	1.0	Note 3
5565.000	36.3	h	54.0	-17.7	Avg	361	1.0	Note 2, 3
1855.000	55.5	h	74.0	-18.5	Pk	165	1.0	
1855.000	35.5	h	54.0	-18.5	Avg	165	1.0	Note 2
3710.000	54.3	h	74.0	-19.8	Pk	222	1.9	Note 3
3710.000	34.3	h	54.0	-19.8	Avg	222	1.9	Note 2, 3
4638.000	54.2	v	74.0	-19.8	Pk	0	1.0	Note 3
4638.000	34.2	v	54.0	-19.8	Avg	0	1.0	Note 2, 3
4638.000	53.5	h	74.0	-20.5	Pk	0	1.0	Note 3
4638.000	33.5	h	54.0	-20.5	Avg	0	1.0	Note 2, 3
3710.000	53.5	v	74.0	-20.5	Pk	258	1.8	Note 3
3710.000	33.5	v	54.0	-20.5	Avg	258	1.8	Note 2, 3
2782.000	50.3	v	74.0	-23.7	Pk	117	1.2	Note 3
2782.000	30.3	v	54.0	-23.7	Avg	117	1.2	Note 2, 3
2782.000	49.9	h	74.0	-24.1	Pk	225	1.0	Note 3
2782.000	29.9	h	54.0	-24.1	Avg	225	1.0	Note 2, 3

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	Duty cycle on time is 7.5ms. This corresponse to -22dB of correction (20*log(7.5ms/100ms). Only -20dB was applied to the peak measured level of the spurious emission to get the average value.
Note 3:	Noise floor. No other spurious emission detected after the 3rd harmonic.

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

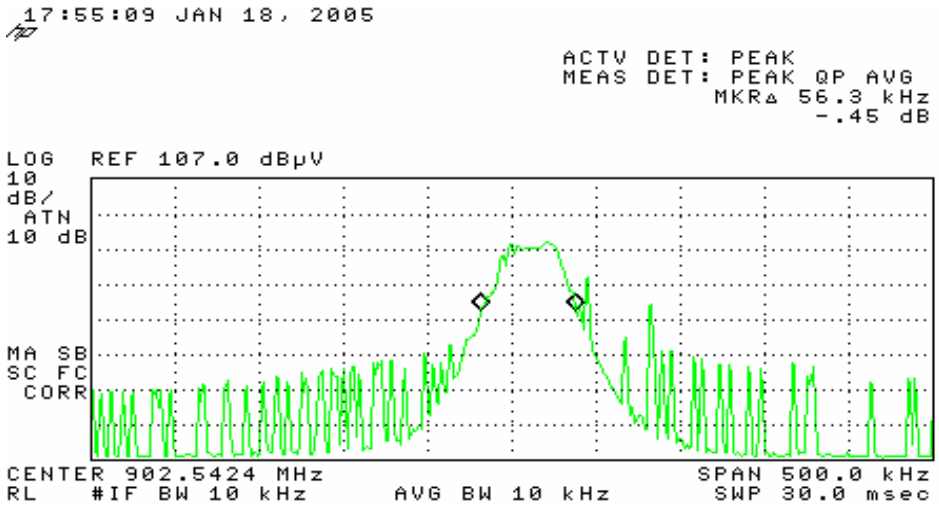
Run #1d: Antenna Conducted Spurious Emissions, 30 - 10,000 MHz.

The antenna is intergral to the devices. This test was performed radiated instead. Performed a chamber scan and took final measurements on OATS (Runs 1a-1c).

Run #2: Signal Bandwidth and Output Power

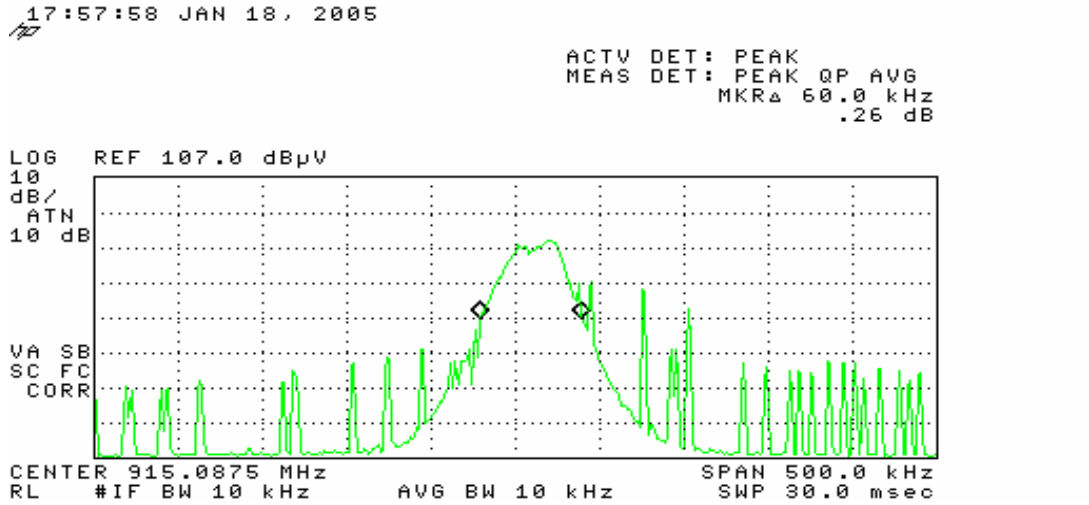
Channel	Frequency (MHz)	Resolution Bandwidth	20dB Signal Bandwidth
Low	902.5	10kHz	56.3 kHz
Mid	915	10kHz	60 kHz
High	927.6	10kHz	53.8 kHz

Low Channel

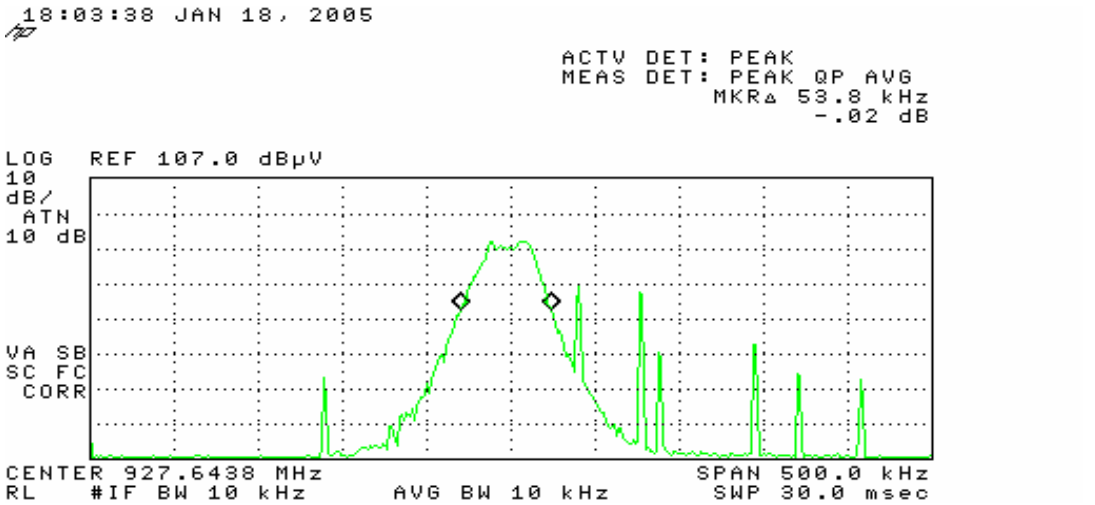


Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

Middle Channel



High Channel



Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

Run #3: Output Power

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels.

Channel	Frequency (MHz)	Field Strength at 3m (dBuV/m)	Antenna Pol. (H/V)	Res BW	Signal Banwidth	Bandwidth Correction	Power (dBm)	Power (Watts)
Low	902	101	H	1MHz		0	5.7	0.00371535
Mid	915	102.1	H	1MHz		0	6.8	0.0047863
High	927.9	99	H	1MHz		0	3.7	0.00234423
Low	902	105.1	V	1MHz		0	9.8	0.00954993
Mid	915	106.2	V	1MHz		0	10.9	0.01230269
High	927.9	105	V	1MHz		0	9.7	0.00933254

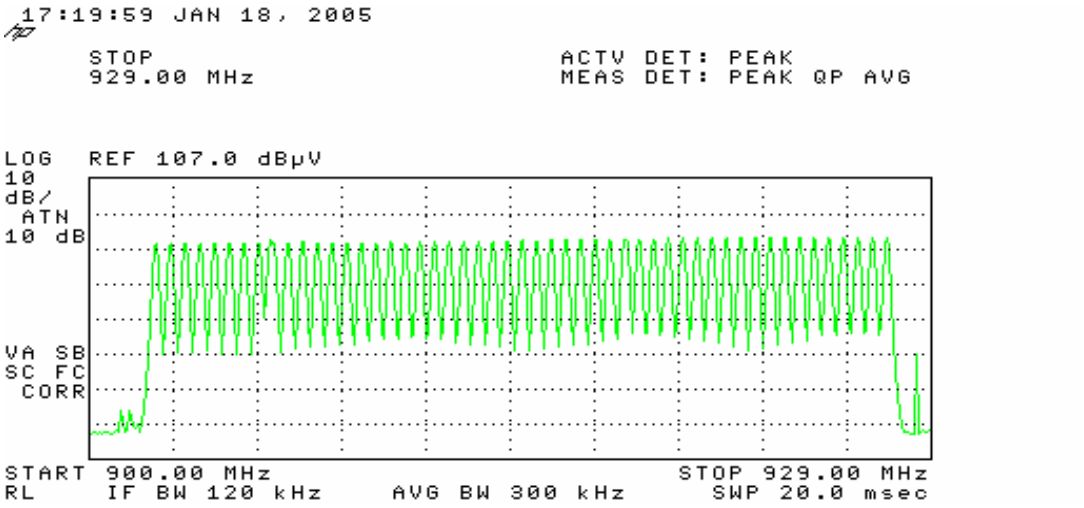
Note 1:	Output power calculated from field strength at 3m based on free space path loss formula $E = \sqrt{(30PG)} / d$, where E is the field strength (V/m), PG is the effective isotropic radiated power (W) and d is the distance (3m). Additional correction to the calculated power is made to account for the difference between the measurement bandwidth and signal bandwidth.

Client:	Davis Instruments	Job Number:	J58344
Model:	6345 & 6345OV	T-Log Number:	T58447
		Account Manager:	-
Contact:	Perry Dillon		
Spec:	FCC 15.247, EN 300 220-3	Class:	N/A

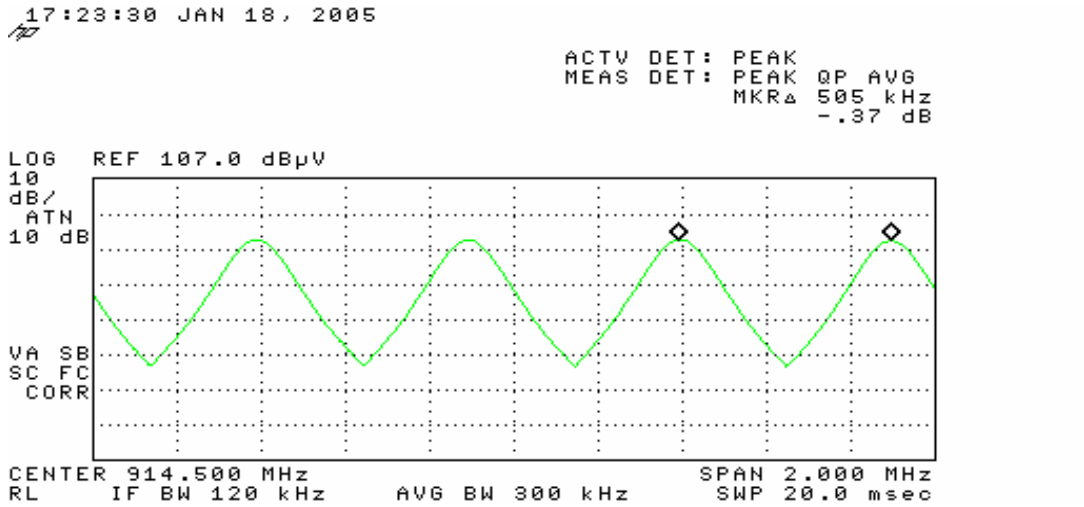
Run #4: Channel Occupancy, Spacing and Number of Channels

For frequency hopping systems operating in the **902-928 MHz** band:
if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period;

Number of Channels (51), Plot# 1



Channel Seperation, Plot# 2



The device hops every 2.5 seconds onto a different channel, but transmits for only 7.5ms per hop. Occupancy is, therefore, 7.5ms per 20 seconds, meeting the maximum permitted of 400ms per 20 seconds. Refer to Operational Decsription for plots and details.

EXHIBIT 3: Test Configuration Photographs

2 Pages

EXHIBIT 4: Proposed FCC ID Label & Label Location

2 Pages

EXHIBIT 5: Detailed Photographs of Davis Instruments Corp. Model 6345 Wireless Leaf and Soil Moisture/Temperature Station Construction

4 Pages

EXHIBIT 6: Operator's Manual for Davis Instruments Corp. Model 6345 Wireless Leaf and Soil Moisture/Temperature Station

24 Pages

EXHIBIT 7: Block Diagram of Davis Instruments Corp. Model 6345 Wireless Leaf and Soil Moisture/Temperature Station

1 Page

EXHIBIT 8: Schematic Diagrams for Davis Instruments Corp. Model 6345 Wireless Leaf and Soil Moisture/Temperature Station

1 Page

EXHIBIT 9: Theory of Operation for Davis Instruments Corp. Model 6345 Wireless Leaf and Soil Moisture/Temperature Station

1 Page

EXHIBIT 10: RF Exposure Information

1 Page