REPORT OF MEASUREMENTS
PART 15B - UNINTENTIONAL RADIATORS

DEVICE:	SPREAD SPECTRUM TRANSCEIVER
MODEL:	ESTeem 192S
MANUFACTURER:	ELECTRONIC SYSTEMS TECHNOLOGY, INC.
ADDRESS:	415 NORTH QUAY STREET KENNEWICK WA 99336

THE DATA CONTAINED IN THIS REPORT WAS COLLECTED
ON 18 FEBRUARY & 2 MARCH 1999 AND COMPILED BY:

PAUL G. SLAVENS	LEONARD G. BELISLE
CHIEF EMC ENGINEER	EMC TECHNICIAN

WORK ORDER: 10730C-1

(Table Of Contents Continued)

1. General

1.1 Purpose

The purpose of this report is to show compliance to the FCC regulations for spread spectrum unlicensed devices operating under section 15.247 of the Code of Federal Regulations title 47.

1.2 Manufacturer

Company Name:	Electronic Systems Technology, Inc.
Contact:	Brent Strecker
Street Address:	415 N. Quay Street
City/State/Zip:	Kennewick WA 99336
Telephone:	509 735-9092
Fax:	509 783-5475
Web:	www.esteem.com

1.3 Test location

Company:	Acme Testing Inc.
Street Address:	2002 Valley Highway
Mailing Address:	PO Box 3
City/State/Zip:	Acme WA 98220-0003
Laboratory:	Test Site 2
Telephone:	888 226-3837
Fax:	360 595-2722
E-mail:	acmetest@acmetesting.com
Web:	www.acmetesting.com

1.4 Test Personnel

Paul G. Slavens

2. Test Results Summary

Summary of Test Results
Spread Spectrum Transceiver, model ESTeem 192S

Requirement	CFR Section	Test Result
Radiated Spurs < 15.209	15.205(b)	PASS
Conducted Emissions < 48.0 dBuV	15.207	PASS
6 dB BW > 500 kHz	15.247(a2)	PASS
Max Output Power < 1 W	15.247(a2b)	PASS
Conducted Spurious >-20 dBc	15.247(a2c)	PASS
Power Density < 8dBm in 3 kHz	15.247(a2d)	PASS
Process Gain > 10 dB	15.247(a2e)	PASS

The signed original of this report, supplied to the client, represents the only "official" copy. Retention of any additional copies (electronic or non-electronic media) is at Acme Testing's discretion to meet internal requirements only. The client has made the determination that EUT Condition, Characterization, and Mode of Operation are representative of production units, and meet the requirements of the specifications referenced herein.

Consistent with Industry practice, measurement and test equipment not directly involved in obtaining measurement results but having an impact on measurements (such as cable loss, antenna factors, etc.) are factored into the "Correction Factor" documented in certain test results. Instrumentation employed for testing meets tolerances consistent with known Industry Standards and Regulations.

The measurements contained in this report were made in accordance with the referenced standards and all applicable Public Notices received prior to the date of testing. Acme Testing assumes responsibility only for the accuracy and completeness of this data as it pertains to the sample tested.

Paul G. Slavens
Chief EMC Engineer

Date of Issuance

3. Description of Equipment and Peripherals

3.1 Equipment Under Test (EUT)

Device:	Spread Spectrum Transceiver
Model Number:	ESTeem 192S
Serial Number:	None
Power:	12 VDC
Grounding:	DC
Antenna Distance:	3 m

3.2 EUT Peripherals

Device	Manufacturer	Model Number	FCC ID	Serial Number
Computer	Compaq	DeskPro	D.O.C.	672688C3Q451
Monitor	ViewSonic	P775	GSS17019	JP72701467
Printer	Hewlett-Packard	C2642A	B94C2642X	MY68L1D0JK
Keyboard	Dell	SK-1000RE	GYUR10SK	M940673251
Mouse	Microsoft Corp.	Intellimouse	C3KKMPS	2792206-00000
DC Power Supply	Chaplet Systems Inc.	AC-EO1-12	None	9600338

3.3 The Mode of Operation During Tests

The EUT was exercised in a constant transmit mode by an emulation program that was supplied by the manufacturer in the peripheral computer. The EUT was preview tested at the lowest, middle and highest frequency. The highest frequency channel produced the worst case results and therefore was used for final compliance testing.

3.4 Modifications Required for Compliance

1. None.

3.5 Description of Interface Cables

EUT/Computer

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	1.5 m	No

EUT/Power Supply

Shielded	Unshielded	Flat	Round	Length	Ferrite
No	Yes	No	Yes	1 m	No

Computer/Monitor

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	1 m	Yes

Computer/Keyboard

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	1 m	Yes

Computer/Mouse

Shielded	Unshielded	Flat	Round	Length	Ferrite
Yes	No	No	Yes	1 m	Yes

ARRANGEMENT OF INTERFACE CABLES: All interface cables were positioned for worst case maximum emissions within the manner assumed to be a typical operation condition (please reference photographs).

4. Antenna requirement

4.1 Regulation

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 the user can replace a broken antenna, 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. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

4.2 Result

The intentional radiator uses a reverse threaded TNC connector.

5. Conducted Emissions Tests

Test Requirement: FCC CFR47, Part 15C

Test Procedure: ANSI C63.4:1992

5.1 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2747A-05662, Calibrated: 9 September 1998, Calibration due Date: 9 September 1999

⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2510A-00106, Calibrated: 9 September 1998, Calibration due Date: 9 September 1999

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2521A-00931, Calibrated: 9 September 1998, Calibration due Date: 9 September 1999

⇒ Line Impedance Stabilization Network: Rhode & Schwarz ESH2-Z5, Serial Number ACMERS1, Calibrated: 1 March 1999, Calibration due Date: 1 May 1999

5.2 Purpose

The purpose of this test is to evaluate the level of conducted noise the EUT imposes on the AC mains.

5.3 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that is placed above the groundplane. Floor standing equipment is placed directly on the groundplane. Any supplemental grounding mechanisms are connected, if appropriate. The EUT is connected to its associated peripherals, with any excess I/O cabling bundled to approximately 1 meter. The EUT is connected to a dedicated LISN and all peripherals are connected to a second separate LISN circuit. The LISNs are bonded to the groundplane.

Preview tests are performed to determine the "worst case" mode of operation. With the EUT operating in "worst case" mode, final conducted measurements are taken. Conducted measurements are made on each current carrying conductor with respect to ground.

Conducted Emissions Test Characteristics	
Frequency range	0.45 MHz - 30.0 MHz
Test instrumentation resolution bandwidth	9 kHz
Lines Tested	Line 1/Line 2

5.4 Test Results

LINE 1

PEAK

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	7.296	34.5
2	7.451	34.5
3	7.513	35.4
4	17.76	38.1
5	18.21	37.5
6	19.64	38.9

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LINE 2

PEAK

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	8.001	35.0
2	15.53	38.5
3	17.76	36.8
4	18.21	36.1
5	18.91	36.9
6	20.05	35.8

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6. 6 dB Bandwidth

6.1 Regulation

15.247(a2) For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

6.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

6.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 100 kHz and VBW = 300KHz.

6.4 Test Results

The 6 dB bandwidth is 2.9 MHz.

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7. Power Output

7.1 Regulation

15.247(b1) The maximum peak output power of the intentional radiator shall not exceed the following: For frequency hopping systems operating in the 2400-2483.5 MHz or 5725-5850 MHz band and for all direct sequence systems: 1 watt.

7.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

7.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 3 MHz and VBW = 3 MHz.

7.4 Test Results

The measured power output at the antenna terminal was 28.7 dBm or 741.3 mW

8. Antenna gain requirements

8.1 Regulation

15.247(b3) Except as shown below, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the above stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

8.2 Result

The EUT can be supplied with three antennas:

1. A 3 dBi Omni-Directional ½ wavelength monopole rubber duck antenna
2. A 5 dBi 5/8 wavelength mountable monopole antenna
3. A 13.9 dBi directional 15 element Yagi for fixed point-to-point.

For point-to-multi-point operation

The maximum allowed ERP => 30 dBm (peak power) + 6 dBi (max antenna gain) = 36 dBm (EIRP).

For the EUT => 28.7 dBm (peak power) + 5 dBi (max antenna gain) – 1.7 dB (cable loss) < 36 dBm (EIRP).

For fixed point-to-point operation

Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations, may employ transmitting antennas with directional gain greater than 6 dBi. This provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

A 13.9 dBi directional 15 element Yagi exceeds 6 dBi by 7.9 dBi therefore the output power of the transmitter needs to be reduced by 7.9/3 dB or 2.63 dB

For mounting the external antenna the EUT is supplied with either 25 feet of RG-8 coaxial cable or 50 feet of Heliax coaxial cable. The attenuation of both cables was measured and both cables attenuated the signal by 1.7 dB

The measured output power of the transmitter is 1.3 dB less than the allowed 1 watt.

The required decrease in output power for point-to-point of 2.63 dB < 3.0 dB (1.3 dB less than 1 watt output power + 1.7 dB cable loss)

* The system is professionally installed and therefore the 1.7 dB cable loss is guaranteed by the professional installer.

9. Radio Frequency exposure

9.1 Regulation

15.247(b4) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. *See* §1.1307(b)(1) of this Chapter.

9.2 Result

The intentional radiator operates at a maximum of 12.3 W EIRP with an external antenna that is normally mounted on a rooftop. According to table 1 of Supplement C to OET Bulletin. If MPE limit may be exceeded in the main beam of the antenna installation procedures. Warning instructions and/or warning labels may be used to ensure compliance by providing professional installers an en-users with instructions to point the main beam of the antenna at locations not occupied by persons and to warn others to maintain a specified distance from the antenna.

10. Conducted Spurious Emissions

10.1 Regulation

15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

10.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

10.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 100 kHz and VBW = 300 kHz.

10.4 Test Results

Frequency (MHz)	Level (dBm)	Level (dBc)
4860	-37.9	-55.1
7300	-38.2	-56.4

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11. Radiated Spurious Emissions

11.1 Regulation

15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

11.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ Line Impedance Stabilization Network: EMCO 3825/2, Serial Number 9002-1601, Calibrated: 1 March 1999, Calibration due Date: 1 May 1999

⇒ Broadband Biconical Antenna (20 MHz to 200 MHz): EMCO 3110, Serial Number 1180, Calibrated: 27 June 1998, Calibration due Date: 27 June 1999

⇒ Broadband Log Periodic Antenna (200 MHz to 1000 MHz): EMCO 3146, Serial Number 2852, Calibrated: 27 June 1998, Calibration due Date: 27 June 1999

⇒ EUT Turntable Position Controller: Rothenbuhler Engineering, Custom, No Calibration Required

⇒ Antenna Mast: Compliance Design, model M100/200, No Calibration Required

⇒ 10 GHz to 24 GHz Low Noise Preamplifier: MITEQ AFS4-35LN , Serial Number 484280, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

11.3 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that sits on a flush mounted metal turntable. Floor standing equipment is placed directly on the flush mounted metal turntable. The EUT is connected to its associated peripherals with any excess I/O cabling bundled to approximately 1 meter.

Preview tests are performed to determine the "worst case" mode of operation. With the EUT operating in "worst case" mode, emissions from the unit are maximized by adjusting the polarization and height of the receive antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz - 24000 MHz **15.205 RESTRICTED BANDS ONLY**
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1000 MHz) 1 MHz (1000 MHz - 24000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/Horizontal

11.4 Test Results

PRODUCT EMISSIONS
Yagi Antenna

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	4924.00	54.0	50.4	-3.6	PK	H	110	30	13 8
2	7386.20	54.0	39.8	-14.2	PK	H	108	3	14.4

PRODUCT EMISSIONS
Mounted monopole Antenna

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	4924.00	54.0	47.0	-7.0	PK	H	100	156	13 8
2	7386.20	54.0	38.8	-15.2	PK	H	107	9	14.4

PRODUCT EMISSIONS
Rubber Duck Antenna

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	4924.00	54.0	45.4	-9.6	PK	H	104	35	13 8
2	7386.20	54.0	39.0	-15.0	PK	H	105	5	14.4

12. Peak Power Spectral Density

12.1 Regulation

For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

12.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1998, Calibration due Date: 31 December 1999

12.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 3 kHz, VBW = 10 kHz and Sweep Time = 666 seconds.

12.4 Test Results

Maximum peak power spectral density is 2.5 dBm.

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13. Process gain requirements

13.1 Regulation

The processing gain of a direct sequence system shall be at least 10 dB. The processing gain represents the improvement to the received signal-to-noise ratio, after filtering to the information bandwidth, from the spreading/despreading function. The processing gain may be determined using one of the following methods:

(1) As measured at the demodulated output of the receiver: the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the system spreading code turned on.

(2) As measured using the CW jamming margin method: a signal generator is stepped in 50 kHz increments across the passband of the system, recording at each point the generator level required to produce the recommended Bit Error Rate (BER). This level is the jammer level. The output power of the intentional radiator is measured at the same point. The jammer to signal ratio (J/S) is then calculated, discarding the worst 20% of the J/S data points. The lowest remaining J/S ratio is used to calculate the processing gain as follows: Gp = (S/N)o + Mj + Lsys, where Gp = processing gain of the system, (S/N)o = signal-to-noise ratio required for the chosen BER, Mj = J/S ratio, and Lsys = system losses. Note that total losses in a system, including intentional radiator and receiver, should be assumed to be no more than 2 dB.

13.2 Result

The original designers of the product performed the process gain measurement. The process gain of the product exceeds 10 dB. Please refer to the attached document for complete test procedures and test results.

14. Miscellaneous Comments and Notes

1. None.