TEST RESULT SUMMARY

FCC PART 15 Subpart C
Section 15.231

MANUFACTURER'S NAME	EcoWater Systems, Inc.
TYPE OF EQUIPMENT	433 MHz Transmitter used on a water softener to indicate status information
MODEL NUMBER	**7243748**
MANUFACTURER'S ADDRESS	1890 Woodlane Drive Woodbury, MN 55125
TEST REPORT NUMBER	NC205488.1
TEST DATE	28 October 2002

According to testing performed at TÜV Product Service Inc, the above-mentioned unit is in compliance with the electromagnetic compatibility requirements defined in FCC Part 15 Subpart C Section 15.231.

It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical characteristics. Any modifications necessary for compliance made during testing on the above mentioned date(s) must be implemented in all production units for compliance to be maintained.

TÜV Product Service Inc, as an independent testing laboratory, declares that the equipment tested as specified above conforms to the requirements of FCC Part 15 Subpart C Section 15.231.

Date: 04 November 2002

Location: Taylors Falls MN USA

J. C. Sausen
Tested By

J. T. Schneider
Reviewed By

Not Transferable

EMC EMISSION - T E S T R E P O R T

Test Report File No.	:	**NC205488.1**	Date of issue:	04 November 2002

Model No.	:	**7243748**
Product Type	:	433 MHz Transmitter used on a water softener to indicate status information
Applicant	:	EcoWater Systems, Inc.
Manufacturer	:	EcoWater Systems, Inc.
License holder	:	EcoWater Systems, Inc.
Address	:	1890 Woodlane Drive
	:	Woodbury, MN 55125
Test Result	:	■ **Positive** ☐ **Negative**
Test Project Number Reference(s)	:	**NC205488.1**
Total pages including Appendices		33

TÜV Product Service Inc is a subcontractor to TÜV Product Service, GmbH according to the principles outlined in ISO/IEC Guide 25 and EN 45001.

TÜV Product Service Inc reports apply only to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. TÜV Product Service Inc shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV Product Service Inc issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval. This report shall not be used by the client to claim product endorsement by NVLAP or any agency of the US government.

TÜV Product Service Inc and its professional staff hold government and professional organization certifications and are members of AAMI, ACIL, AEA, ANSI, IEEE, NVLAP, and VCCI

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

D I R E C T O R Y - EMISSIONS

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

EMISSIONS TEST REGULATIONS :

The emissions tests were performed according to following regulations:

☐ - EN 50081-1 / 1991

☐ - EN 55011 / 1991 ☐ - Group 1 ☐ - Group 2
☐ - Class A ☐ - Class B

☐ - EN 55013 / 1990

☐ - EN 55014 / 1987 ☐ - Household appliances and similar
☐ - Portable tools
☐ - Semiconductor devices

☐ - EN 55014 / A2:1990

☐ - EN 55014 / 1993 ☐ - Household appliances and similar
☐ - Portable tools
☐ - Semiconductor devices

☐ - EN 55015 / 1987

☐ - EN 55015 / A1:1990

☐ - EN 55015 / 1993

☐ - EN 55022 / 1987 ☐ - Class A ☐ - Class B

☐ - EN 55022 / 1994 ☐ - Class A ☐ - Class B

☐ - BS

☐ - VCCI ☐ - Class A ☐ - Class B

■ - FCC Part 15 Subpart C Section 15.231

☐ - AS 3548 (1992) ☐ - Class A ☐ - Class B

☐ - CISPR 11 (1990) ☐ - Group 1 ☐ - Group 2
☐ - Class A ☐ - Class B

☐ - CISPR 22 (1993) ☐ - Class A ☐ - Class B

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Environmental conditions in the lab:

	Actual
Temperature	: 21 °C
Relative Humidity	: 50 %
Atmospheric pressure	: 99.5 kPa
Power supply system	: 50/60 Hz – 230/115 VAC – 1 Phase

Sign Explanations:

☐ - not applicable
■ - applicable

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Emissions Test Conditions: CONDUCTED EMISSIONS (Interference Voltage)

The *CONDUCTED EMISSIONS (INTERFERENCE VOLTAGE)* measurements were performed at the following test location:

☐ - Test not applicable

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
■ - Wild River Lab Screen Room
☐ - New Brighton Lab Shielded Room

Test equipment used:

	TUV ID	Model Number	Manufacturer	Description	Serial Number	Cal Due
■ -	2417	3825/2	Electro-Mechanics (EMCO)	50 Ω LISN	8812-1439	1-23-03
■ -	2534	ESHS-20	Rhode & Schwarz	EMI Receiver	837055/003	11-19-02

Emissions Test Conditions: RADIATED EMISSIONS (Magnetic Field)

The *RADIATED EMISSIONS (MAGNETIC FIELD)* measurements were performed at the following test location:

■ - Test not applicable

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)

Emissions Test Conditions: INTERFERENCE POWER

The *INTERFERENCE POWER* measurements were performed by using the absorbing clamp on the mains and interface cables in the frequency range 30 MHz - 300 MHz at the following test location:

■ - Test not applicable

☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)
☐ - Wild River Lab Screen Room
☐ - New Brighton Lab Shielded Room

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Emissions Test Conditions: RADIATED EMISSIONS (Electric Field)

The *RADIATED EMISSIONS (ELECTRIC FIELD)* measurements, in the frequency range of 30 MHz-4400 MHz, were tested in a horizontal and vertical polarization at the following test location:

☐ **- Test not applicable**

■ - Wild River Lab Large Test Site (Open Area Test Site) – NSA measurements made 7-02, due 7-03.
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☐ - Oakwood Lab (Open Area Test Site)

at a test distance of :

■ - 3 meters
☐ - 10 meters
☐ - 30 meters

Test equipment used :

	TUV ID	Model Number	Manufacturer	Description	Serial Number	Cal Due
■-	2665	ZHL-1042J	Mini-Circuits	Preamplifier	32296	10-15-03
■ -	3202	EM-6917B	Electro-Metrics	Biconicalog Periodic 30-2000 MHz	102	10-04-03
■-	2690	8566B	Hewlett-Packard	Spectrum Analyzer (Unit F)	2430A00930	11-19-02
■ -	2678	85662A	Hewlett-Packard	Analyzer Display (Unit F)	2403A08134	11-19-02
■ -	2684	85650A	Hewlett-Packard	Quasi-Peak Adapter (Unit F)	2521A01006	11-19-02
■ -	2074	3115	Electro-Mechanics (EMCO)	Ridge Guide Antenna 2–18 GHz	2504	10-15-03

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST) and is calibrated annually.

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Equipment Under Test (EUT) Test Operation Mode - Emission tests :

The device under test was operated under the following conditions during emissions testing:

☐ - Standby

☐ - Test program (H - Pattern)

☐ - Test program (color bar)

☐ - Test program (customer specific)

☐ - Practice operation

☐ - Normal Operating Mode

■ - Constant transmit.

Configuration of the device under test:

■ - See Constructional Data Form in Appendix B - Page B2

☐ - See Product Information Form in Appendix B - beginning on Page B3

The following peripheral devices and interface cables were connected during the measurement:

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

☐ - _____ Type : _____

■ - unshielded power cable

■ - unshielded cables

■ - shielded cables MPS.No.: _____

☐ - customer specific cables

☐ - _____

☐ - _____

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Emission Test Results:

FCC 15.207 - Conducted emissions 10/150 kHz - 30 MHz

The requirements are ■ - MET ☐ - NOT MET

Minimum margin of compliance 24 dB at 310.0 kHz

Maximum margin of non-compliance _____ dB at _____ MHz

Remarks: _____

FCC 15.231 - Radiated emissions (electric field) 30 MHz - 4400 MHz

The requirements are ■ - MET ☐ - NOT MET

Minimum margin of compliance for fundamental 5 dB at 433.9 MHz [15.231(e)]

Minimum margin of compliance for spurious <1 GHz. 18 dB at 867.8 MHz [15.231(e)]

Minimum margin of compliance for spurious >1 GHz. 5 dB at 1735.56 MHz [15.209]

Remarks: The fundamental was measured to be 67.8 dBuV/m or 2454.7 uV/m (87.8 dBuV/m peak minus 20 dB duty cycle correction factor) in average mode compared to a limit of 72.8 dBuV/m (4398.33 uV/m). The 867.8 MHz signal was measured to be 34.0 dBuV/m or 50.12 uV/m (54.0 dBuV/m peak minus 20 dB duty cycle correction factor) in average mode compared to a limit of 52.8 dBuV/m (436.5 uV/m). At 1735.56 MHz, reading of 48.4 dBuV/m or 263.0 uV/m (68.4 dBuV/m peak minus 20 dB duty cycle correction factor), compared to a limit of 54.0 dBuV/m (500 uV/m). The duty cycle correction factor is calculated by 20 log (8.75/100) or 21 dB, with 20 dB used in the calculation to demonstrate peak compliance as well.

FCC 15.231 (c) - Emission Bandwidth

The requirements are ■ - MET ☐ - NOT MET

Remarks: The bandwidth of the fundamental must be less than 0.25% of the center frequency, or 784 kHz. Page A10 shows the bandwidth to be less than 300 kHz.

FCC 15.35 (c) – Duty Cycle

The requirements are ■ - MET ☐ - NOT MET

Remarks: Duty cycle declared to be worst case is 8.75 msec/pulse, with 1 pulse per 60 sec. So duty cycle calculation is 20 log (8.75 msec/100 msec) or 21 dB, with 20 dB being used in the calculation to demonstrate peak compliance as well. See pages A11 & A12.

FCC 15.231 (e) – Signal Deactivation

The requirements are ■ - MET ☐ - NOT MET

Remarks: The transmitter sends one command/minute. Each command has a total on time of 8.75 msec. See page A12. The duration of the transmission is less than 1 second, the silent period between transmissions is greater than 10 seconds.

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DEVIATIONS FROM STANDARD:

None.

GENERAL REMARKS:

SUMMARY:

The requirements according to the technical regulations are

■ - met

☐ - **not** met.

The device under test does

■ - fulfill the general approval requirements mentioned on page 3.

☐ - **not** fulfill the general approval requirements mentioned on page 3.

Testing Start Date: 28 October 2002

Testing End Date: 28 October 2002

- TÜV PRODUCT SERVICE INC -

Joel T. Schneider

J. T. Schneider
Reviewed By

J C Sausen

Tested By:
J. C. Sausen

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Test-setup photo(s):
Conducted Emission 150 kHz – 30 MHz – Controllers With Transmitter

See Test-Setup Exhibit

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Test-setup photo(s):
Radiated emission 30 MHz – 4.4 GHz - Transmitter

See Test-Setup Exhibit

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Appendix A

Test Data Sheets

and

Test Setup Drawing(s)

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB
Screen Room

See Test-Setup Exhibit

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB
Large Test Site

See Test-Setup Exhibit

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Conducted Electromagnetic Emissions

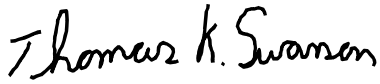
Test Report #:	**5488 Run 01**	Test Area:	SCREEN ROOM			
Test Method:	EN55022	Test Date:	28-Oct-2002			
EUT Model #:	EWS3000 Residential	EUT Power:	110VAC / 60 Hz to 24VAC			
EUT Serial #:				Temperature:	23	°C
Manufacturer:	Ecowater			Relative Humidity:	45	%
EUT Description:	Residential controller with 433.92MHz transmitter			Air Pressure:	99.5	kPa
Notes:				Page:	1 of 2	

FREQ (MHz)	LEVEL (dBuV)	CABLE / LISN / ATTEN (dB)	FINAL (dBuV)	TEST POINT	DELTA1 EN55022 B QP	DELTA2 EN55022 B Avg
0.160	10.2 Qp	0.1 / 0.1 / 0.0	10.3	Neutral	-55.2	N/A
0.160	6.5 Av	0.1 / 0.1 / 0.0	6.6	Neutral	N/A	-48.9
0.215	18.5 Qp	0.1 / 0.1 / 0.0	18.7	Neutral	-44.3	N/A
0.215	13.8 Av	0.1 / 0.1 / 0.0	14.0	Neutral	N/A	-39.0
0.310	25.2 Qp	0.0 / 0.1 / 0.0	25.3	Neutral	-34.7	N/A
0.310	24.8 Av	0.0 / 0.1 / 0.0	24.9	Neutral	N/A	-25.1
6.56	-3.9 Qp	0.1 / 0.1 / 0.0	-3.7	Neutral	-63.7	N/A
6.56	-5.5 Av	0.1 / 0.1 / 0.0	-5.3	Neutral	N/A	-55.3
16.53	6.6 Qp	0.3 / 0.3 / 0.0	7.2	Neutral	-52.8	N/A
16.53	2.4 Av	0.3 / 0.3 / 0.0	3.0	Neutral	N/A	-47.0
29.46	23.3 Qp	0.5 / 0.8 / 0.0	24.6	Neutral	-35.4	N/A
29.46	19.1 Av	0.5 / 0.8 / 0.0	20.4	Neutral	N/A	-29.6
0.160	10.0 Qp	0.1 / 0.1 / 0.0	10.1	Line 1	-55.4	N/A
0.160	6.9 Av	0.1 / 0.1 / 0.0	7.0	Line 1	N/A	-48.5
0.215	18.8 Qp	0.1 / 0.1 / 0.0	19.0	Line 1	-44.0	N/A
0.215	15.0 Av	0.1 / 0.1 / 0.0	15.2	Line 1	N/A	-37.8
0.310	25.3 Qp	0.0 / 0.1 / 0.0	25.4	Line 1	-34.6	N/A
0.310	24.8 Av	0.0 / 0.1 / 0.0	24.9	Line 1	N/A	-25.1
6.56	14.0 Qp	0.1 / 0.1 / 0.0	14.2	Line 1	-45.8	N/A
6.56	11.5 Av	0.1 / 0.1 / 0.0	11.7	Line 1	N/A	-38.3
16.53	4.3 Qp	0.3 / 0.3 / 0.0	4.9	Line 1	-55.1	N/A
16.53	1.9 Av	0.3 / 0.3 / 0.0	2.5	Line 1	N/A	-47.5
29.46	23.1 Qp	0.5 / 0.8 / 0.0	24.4	Line 1	-35.6	N/A
29.46	18.5 Av	0.5 / 0.8 / 0.0	19.8	Line 1	N/A	-30.2

Tested by: G Jakubowski

Printed Signature

Reviewed by: TKS



Printed Signature

Conducted Electromagnetic Emissions

Test Report #:	**5488 Run 01**	Test Area:	SCREEN ROOM			
Test Method:	EN55022	Test Date:	28-Oct-2002			
EUT Model #:	EWS3000 Residential	EUT Power:	110VAC / 60 Hz to 24VAC			
EUT Serial #:				Temperature:	23	°C
Manufacturer:	Ecowater			Relative Humidity:	45	%
EUT Description:	Residential controller with 433.92MHz transmitter			Air Pressure:	99.5	kPa
Notes:				Page:	2 of 2	

FREQ (MHz)	LEVEL (dBuV)	CABLE / LISN / ATTEN (dB)	FINAL (dBuV)	TEST POINT	DELTA1 EN55022 B QP	DELTA2 EN55022 B Avg
********** **MEASUREMENT SUMMARY** **********						
0.310	24.8 Av	0.0 / 0.1 / 0.0	24.9	Line 1	N/A	-25.1
29.46	19.1 Av	0.5 / 0.8 / 0.0	20.4	Neutral	N/A	-29.6
29.46	18.5 Av	0.5 / 0.8 / 0.0	19.8	Line 1	N/A	-30.2
0.215	15.0 Av	0.1 / 0.1 / 0.0	15.2	Line 1	N/A	-37.8
6.56	11.5 Av	0.1 / 0.1 / 0.0	11.7	Line 1	N/A	-38.3
16.53	2.4 Av	0.3 / 0.3 / 0.0	3.0	Neutral	N/A	-47.0
0.160	6.9 Av	0.1 / 0.1 / 0.0	7.0	Line 1	N/A	-48.5

Tested by: G Jakubowski

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Signature

Reviewed by: TKS

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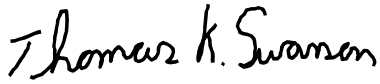

Signature

Conducted Electromagnetic Emissions

Test Report #:	**5488 Run 02**	Test Area:	SCREEN ROOM
Test Method:	EN55022	Test Date:	28-Oct-2002
EUT Model #:	EWS3000 Commercial #7227077	EUT Power:	110VAC / 60 Hz to 24VAC
EUT Serial #:		Temperature:	23 °C
Manufacturer:	Ecowater	Relative Humidity:	45 %
EUT Description:	Commercial controller with 433.92MHz transmitter	Air Pressure:	99.5 kPa
Notes:		Page:	1 of 2

FREQ (MHz)	LEVEL (dBuV)	CABLE / LISN / ATTEN (dB)	FINAL (dBuV)	TEST POINT	DELTA1 EN55022 B QP	DELTA2 EN55022 B Avg
0.160	10.5 Qp	0.1 / 0.1 / 0.0	10.6	Neutral	-54.9	N/A
0.160	7.6 Av	0.1 / 0.1 / 0.0	7.7	Neutral	N/A	-47.8
0.215	19.1 Qp	0.1 / 0.1 / 0.0	19.3	Neutral	-43.7	N/A
0.215	14.7 Av	0.1 / 0.1 / 0.0	14.9	Neutral	N/A	-38.1
0.310	26.4 Qp	0.0 / 0.1 / 0.0	26.5	Neutral	-33.5	N/A
0.310	25.9 Av	0.0 / 0.1 / 0.0	26.0	Neutral	N/A	-24.0
6.56	0.9 Qp	0.1 / 0.1 / 0.0	1.1	Neutral	-58.9	N/A
6.56	0.0 Av	0.1 / 0.1 / 0.0	0.2	Neutral	N/A	-49.8
16.96	13.6 Qp	0.3 / 0.3 / 0.0	14.2	Neutral	-45.8	N/A
16.96	8.2 Av	0.3 / 0.3 / 0.0	8.8	Neutral	N/A	-41.2
24.69	18.9 Qp	0.4 / 0.5 / 0.0	19.8	Neutral	-40.2	N/A
24.69	15.1 Av	0.4 / 0.5 / 0.0	16.0	Neutral	N/A	-34.0
0.160	10.0 Qp	0.1 / 0.1 / 0.0	10.1	Line 1	-55.4	N/A
0.160	6.9 Av	0.1 / 0.1 / 0.0	7.0	Line 1	N/A	-48.5
0.215	18.9 Qp	0.1 / 0.1 / 0.0	19.1	Line 1	-43.9	N/A
0.215	14.9 Av	0.1 / 0.1 / 0.0	15.1	Line 1	N/A	-37.9
0.310	25.7 Qp	0.0 / 0.1 / 0.0	25.8	Line 1	-34.2	N/A
0.310	25.3 Av	0.0 / 0.1 / 0.0	25.4	Line 1	N/A	-24.6
6.56	14.0 Qp	0.1 / 0.1 / 0.0	14.2	Line 1	-45.8	N/A
6.56	12.4 Av	0.1 / 0.1 / 0.0	12.6	Line 1	N/A	-37.4
16.96	11.7 Qp	0.3 / 0.3 / 0.0	12.3	Line 1	-47.7	N/A
16.96	9.0 Av	0.3 / 0.3 / 0.0	9.6	Line 1	N/A	-40.4
24.69	20.4 Qp	0.4 / 0.5 / 0.0	21.3	Line 1	-38.7	N/A
24.69	15.2 Av	0.4 / 0.5 / 0.0	16.1	Line 1	N/A	-33.9

Tested by: G Jakubowski

Printed | Signature

Reviewed by: TKS

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Conducted Electromagnetic Emissions

Test Report #:	**5488 Run 02**	Test Area:	SCREEN ROOM		
Test Method:	EN55022	Test Date:	28-Oct-2002		
EUT Model #:	EWS3000 Commercial #7227077	EUT Power:	110VAC / 60 Hz to 24VAC		
EUT Serial #:				Temperature:	23 °C
Manufacturer:	Ecowater			Relative Humidity:	45 %
EUT Description:	Commercial controller with 433.92MHz transmitter			Air Pressure:	99.5 kPa
Notes:				Page:	2 of 2

FREQ (MHz)	LEVEL (dBuV)	CABLE / LISN / ATTEN (dB)	FINAL (dBuV)	TEST POINT	DELTA1 EN55022 B QP	DELTA2 EN55022 B Avg
********** **MEASUREMENT SUMMARY** **********						
0.310	25.9 Av	0.0 / 0.1 / 0.0	26.0	Neutral	N/A	-24.0
24.69	15.2 Av	0.4 / 0.5 / 0.0	16.1	Line 1	N/A	-33.9
6.56	12.4 Av	0.1 / 0.1 / 0.0	12.6	Line 1	N/A	-37.4
0.215	14.9 Av	0.1 / 0.1 / 0.0	15.1	Line 1	N/A	-37.9
16.96	9.0 Av	0.3 / 0.3 / 0.0	9.6	Line 1	N/A	-40.4
0.160	7.6 Av	0.1 / 0.1 / 0.0	7.7	Neutral	N/A	-47.8

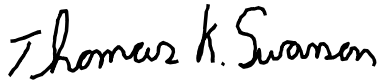
Tested by: G Jakubowski

Printed

Signature

Reviewed by: TKS

Printed



Signature

Radiated Electromagnetic Emissions

Test Report #:	**5488 Run 01**	Test Area:	LTS 3m		
Test Method:	N/A	Test Date:	28-Oct-2002		
EUT Model #:	EWS3000 Residential & Commercial Units	EUT Power:	5 VDC via 110 of 230 wall cube p/s		
EUT Serial #:				Temperature:	21 °C
Manufacturer:	Ecowater Systems			Relative Humidity:	50 %
EUT Description:	Water Softener with 433 MHz transmitter and remote			Air Pressure:	99.5 kPa
Notes:	xmitter: 7243748, receiver: 7247695			Page:	1 of 3

FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB/m) (dB)	FINAL (dBuV/m)	POL / HGT / AZ (m) (DEG)	FINAL with Pk-Ave Correction (20dB) (dBuV/m)	FCC 15.231(e) LIMIT (dBuV/m)
Orthogonally maximized eut. Highest level is with trx board flat on table.						
Fundamental frequency emission maximed with EUT power input facing right side.						
No preamp.						
433.86	69.2 Pk	1.8 / 16.6 / 0.0	87.7	H / 1.0 / 90.0	67.7	72.8
with preamp						
433.86	97.0 Pk	1.8 / 16.6 / 27.7	87.8	H / 1.0 / 90.0	67.8	72.8
433.86	90.2 Pk	1.8 / 16.6 / 27.7	80.9	V / 1.0 / 53.0	60.9	72.8
Spurious emissions:						
447.50	39.4 Pk	1.9 / 16.5 / 27.6	30.1	V / 1.0 / 53.0	10.1	52.8
Harmonics of fundamental:						
867.83	56.3 Pk	2.7 / 22.2 / 27.2	54.0	V / 1.0 / 53.0	34.0	52.8
1301.69	50.1 Pk	3.4 / 26.5 / 27.5	52.4	V / 1.0 / 53.0	32.4	54.0
1301.69	48.1 Av	3.4 / 26.5 / 27.5	50.5	V / 1.0 / 53.0	30.5	54.0
1735.57	61.3 Pk	3.7 / 28.5 / 27.1	66.5	V / 1.3 / 84.0	46.5	54.0
1735.57	60.6 Av	3.7 / 28.5 / 27.1	65.8	V / 1.3 / 84.0	45.8	54.0
867.81	56.1 Pk	2.7 / 22.2 / 27.2	53.9	H / 1.5 / 155.0	33.9	52.8

Tested by: JCS & TKS

Thomas K. Swanson

Printed | Signature

Reviewed by: JTS

Joel T. Schneider

Printed | Signature

Radiated Electromagnetic Emissions

Test Report #:	**5488 Run 01**	Test Area:	LTS 3m
Test Method:	N/A	Test Date:	28-Oct-2002
EUT Model #:	EWS3000 Residential & Commercial Units	EUT Power:	5 VDC via 110 of 230 wall cube p/s
EUT Serial #:		Temperature:	21 °C
Manufacturer:	Ecowater Systems	Relative Humidity:	50 %
EUT Description:	Water Softener with 433 MHz transmitter and remote	Air Pressure:	99.5 kPa
Notes:	xmitter: 7243748, receiver: 7247695	Page:	2 of 3

FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB/m) (dB)	FINAL (dBuV/m)	POL / HGT / AZ (m) (DEG)	FINAL with Pk-Ave Correction (20dB) (dBuV/m)	FCC 15.231(e) LIMIT (dBuV/m)
1301.69	54.0 Pk	3.4 / 26.5 / 27.5	56.4	H / 1.5 / 320.0	36.4	54.0
1301.69	52.7 Av	3.4 / 26.5 / 27.5	55.0	H / 1.5 / 320.0	35.0	54.0
1735.56	63.2 Pk	3.7 / 28.5 / 27.1	68.4	H / 1.0 / 0.0	48.4	54.0
1735.56	62.2 Av	3.7 / 28.5 / 27.1	67.3	H / 1.0 / 0.0	47.3	54.0
2169.45	49.6 Pk	4.2 / 30.0 / 27.1	56.6	H / 1.9 / 300.0	36.6	54.0
2169.45	49.2 Av	4.2 / 30.0 / 27.1	56.2	H / 1.9 / 300.0	36.2	54.0
2603.33	44.6 Pk	4.6 / 30.9 / 27.0	53.1	H / 1.5 / 0.0	33.1	54.0
2603.33	42.6 Av	4.6 / 30.9 / 27.0	51.1	H / 1.5 / 0.0	31.1	54.0
3037.24	39.4 Pk	5.1 / 31.6 / 27.8	48.2	H / 1.5 / 0.0	28.2	54.0
3037.24	38.0 Av	5.1 / 31.6 / 27.8	46.9	H / 1.5 / 0.0	26.9	54.0
3471.10	38.4 Pk	6.0 / 32.7 / 26.2	50.9	H / 1.3 / 0.0	30.9	54.0
3471.10	36.2 Av	6.0 / 32.7 / 26.2	48.8	H / 1.3 / 0.0	28.8	54.0
3905 MHz - noise floor only = 26 dBuV						
4338 MHz - noise floor						
2169.45	53.5 Pk	4.2 / 30.0 / 27.1	60.5	V / 1.0 / 0.0	40.5	54.0
2603.33	41.7 Pk	4.6 / 30.9 / 27.0	50.2	V / 1.0 / 0.0	30.2	54.0
3037.24	34.2 Pk	5.1 / 31.6 / 27.8	43.1	V / 1.0 / 0.0	23.1	54.0
3471 MHz = noise floor						
3905 MHz = noise floor						
4335 MHz noise floor						
End of data.						

Tested by: JCS & TKS — Thomas K. Swanson

Printed — Signature

Reviewed by: JTS — Joel T. Schneider

Printed — Signature

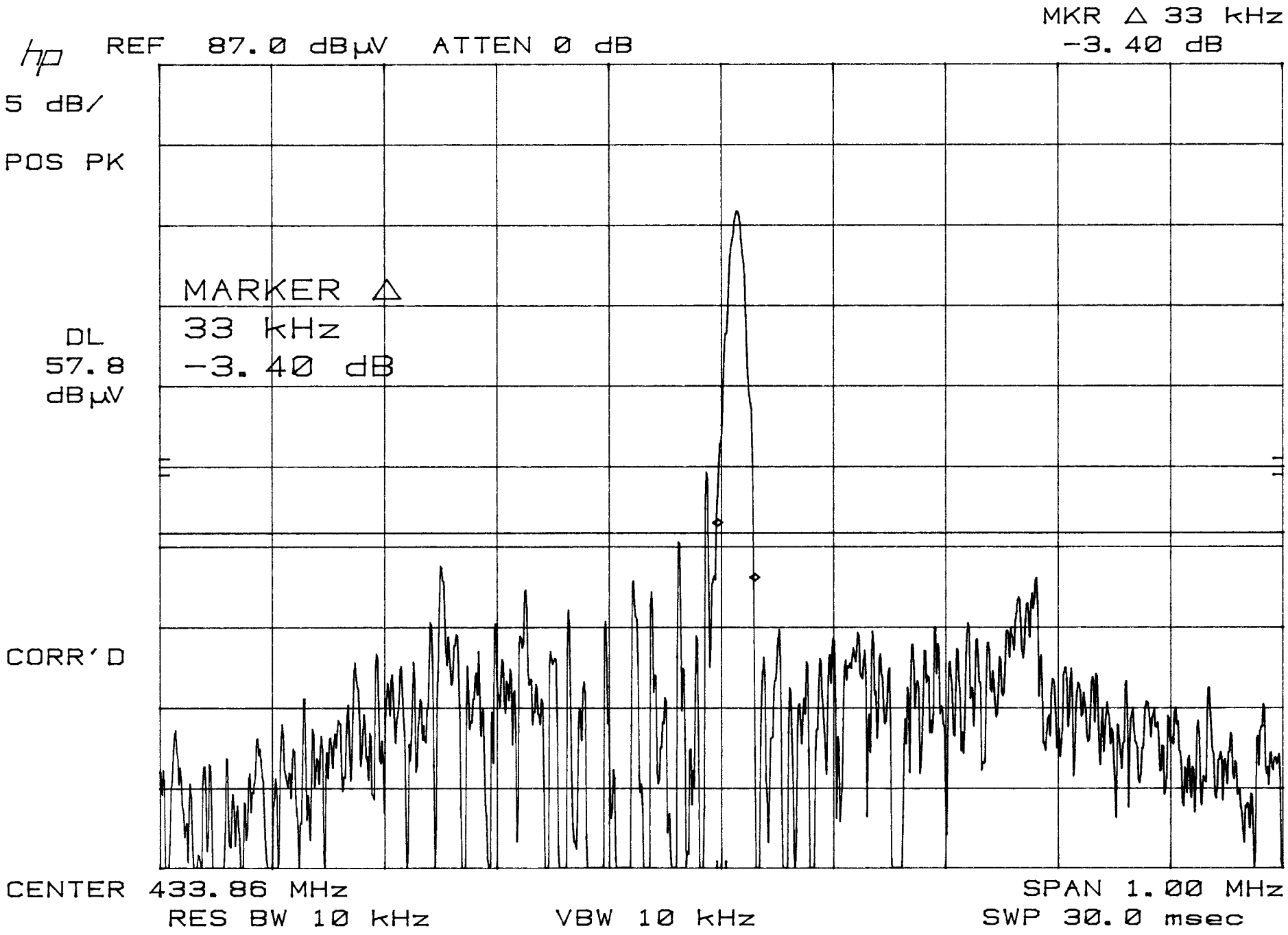
Radiated Electromagnetic Emissions

Test Report #:	**5488 Run 01**	Test Area:	LTS 3m			
Test Method:	N/A	Test Date:	28-Oct-2002			
EUT Model #:	EWS3000 Residential & Commercial Units	EUT Power:	5 VDC via 110 of 230 wall cube p/s			
EUT Serial #:				Temperature:	21	°C
Manufacturer:	Ecowater Systems			Relative Humidity:	50	%
EUT Description:	Water Softener with 433 MHz transmitter and remote			Air Pressure:	99.5	kPa
Notes:	xmitter: 7243748, receiver: 7247695			Page:	3 of 3	

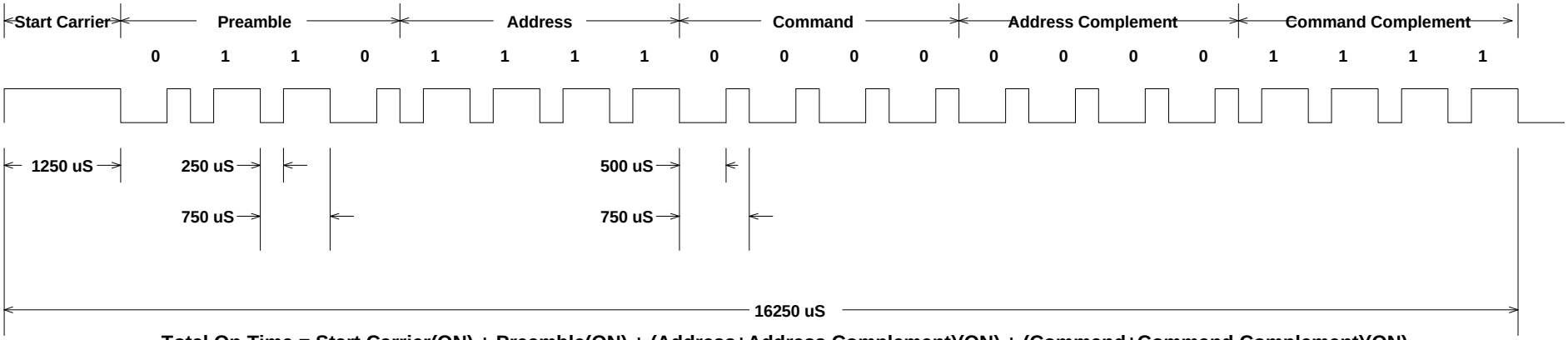
FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB/m) (dB)	FINAL (dBuV/m)	POL / HGT / AZ (m) (DEG)	FINAL (uV/m)	FCC 15.231(e) LIMIT (uV/m)
********** **MEASUREMENT SUMMARY** **********						
433.86	97.0 Pk	1.8 / 16.6 / 27.7	87.8	H / 1.0 / 90.0	24547	43983
447.50	39.4 Pk	1.9 / 16.5 / 27.6	30.1	V / 1.0 / 53.0	10.1	52.8
867.83	56.3 Av	2.7 / 22.2 / 27.2	54.0	V / 1.0 / 53.0	34.0	52.8
1301.69	54.0 Pk	3.4 / 26.5 / 27.5	56.4	H / 1.5 / 320.0	36.4	54.0
1735.56	63.2 Pk	3.7 / 28.5 / 27.1	68.4	H / 1.0 / 0.0	48.4	54.0
2169.45	53.5 Pk	4.2 / 30.0 / 27.1	60.5	V / 1.0 / 0.0	40.5	54.0
2603.33	44.6 Pk	4.6 / 30.9 / 27.0	53.1	H / 1.5 / 0.0	33.1	54.0
3037.24	39.4 Pk	5.1 / 31.6 / 27.8	48.2	H / 1.5 / 0.0	28.2	54.0
3471.10	38.4 Pk	6.0 / 32.7 / 26.2	50.9	H / 1.3 / 0.0	30.9	54.0

Tested by: JCS & TKS — Printed — Thomas K. Swanson — Signature

Reviewed by: JTS — Printed — Joel T. Schneider — Signature


MKR Δ 33 kHz
-3.40 dB
REF 87.0 dBμV
ATTEN 0 dB
5 dB/
POS PK
MARKER Δ
33 kHz
-3.40 dB
DL
57.8
dBμV
CORR'D
CENTER 433.86 MHz
SPAN 1.00 MHz
RES BW 10 kHz
VBW 10 kHz
SWP 30.0 msec

Transmission Data Timing



Total On Time = Start Carrier(ON) + Preamble(ON) + (Address+Address Complement)(ON) + (Command+Command Complement)(ON)

= 1250 uS + 1500 uS + 3000 uS + 3000 uS

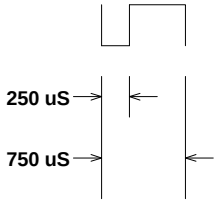
= 8750 uS

Total Off Time = Preamble(OFF) + (Address+Address Complement)(OFF) + (Command+Command Complement)(OFF)

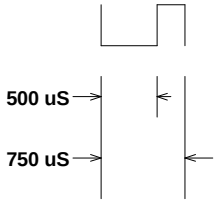
= 1500 uS + 3000 uS + 3000 uS

= 7500 uS

Transmittted 1



Transmittted 0



Appendix B

Constructional Data Form

And/or

Product Information Form

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

Form

EMC Test Plan and Constructional Data Form

PLEASE COMPLETE THIS DOCUMENT IN FULL, ENTERING N/A IF THE FIELD IS NOT APPLICABLE.

Applicant -- ***NOTE: This information will be input into your test report as shown below.***
Press the F1 key at any time to get HELP for the current field selected.

Company: EcoWater Systems, Inc.

Address: 1890 Woodlane Drive

Woodbury, MN 55125

Contact: Jeff Zimmerman Position: Principle Design Engineer

Phone: 651-731-7474 Fax: 651-731-7076

E-mail Address: zimmermanj@ecowater.com

General Equipment Description -- ***NOTE: This information will be input into your test report as shown below.***

EUT Description: 433 Mhz Transmitter used on a water softener to indicate status information

EUT Name: EWS 3000 Residential, EWS 5000 Comm'l Controller

Model No.: xmitter-7243748, recv-7247695 Serial No.: N/A

Product Options:

Configurations to be tested: One transmitter mounted on two different controllers with one receiver

Test Objective

- ☐ EMC Directive 89/336/EEC (EMC)
  - Std:
- ☐ Machinery Directive 89/392/EEC (EMC
  - Std:
- ☐ Medical Device Directive 93/42/EEC (EMC)
  - Std:
- ☐ Vehicle Directive 72/245/EEC (EMC)
  - Std:
- ☐ FDA Reviewers Guidance for Premarket Notification Submissions (EMC)

- ☒ FCC: Class ☐ A ☐ B Part
- ☐ VCCI: Class ☐ A ☐ B
- ☐ BSMI: Class ☐ A ☐ B
- ☒ Canada: Class ☐ A ☐ B
- ☐ Australia: Class ☐ A ☐ B
- ☒ Other: RTTE

TÜV Product Service Certification Requested

- ☐ Attestation of Conformity (AoC)
- ☐ Certificate of Conformity (CoC)
- ☐ EMC Certification (used with Octagon Mark)
- ☐ Compliance Document

Protection Class (N/A for vehicles) ☐ Class I ☐ Class II ☐ Class III

(Press **F1** when field is selected to show additional information on Protection Class.)

Form

EMC Test Plan and Constructional Data Form

Attendance

Test will be: ☒ Attended by the customer ☐ Unattended by the customer

EUT Specifications and Requirements

Length: 2ft Width: 1ft Height: 4ft Weight: 40lbs

Power Requirements

Regulations require testing to be performed at typical power ratings in the countries of intended use. (i.e., European power is typically 230 VAC 50 Hz or 400 VAC 50 Hz, single and three phase, respectively)

Voltage: 110/220 VAC, 50/60HZ (If battery powered, make sure battery life is sufficient to complete testing.)

# of Phases: 1

Current (Amps/phase(max)): 0.1 Current (Amps/phase(nominal)): .07

Other Receiver uses three AAA alkaline batteries.

Other Special Requirements

N/A

Typical Installation and/or Operating Environment

(ie. Hospital, Small Business, Industrial/Factory, etc.)

The transmitter is mounted on a micro-controller based circuit board. This board supplies 5 VDC along with control signals to turn the transmitter on and off. The two circuits are mounted together on a water softener faceplate which in turn controls an entire water softener assembly. The controller circuit board is supplied with 24 Volt AC power from a UL approved, class 2, 120V to 24 Vac 60Hz wall mount transformer. In Europe the transfomer is 220 VAC 50HZ to 24VAC 50 HZ. The controller based circuit board uses a linear power supply to derive 5 VDC from 24VAC which s used to drive the transmitter assembly. Typical installations of the water softener/ transmitter system are in basements, garages, and other dwelling locations where the necessary access to plumbing exists. In the commercial controller, installation is typically in utility or boiler rooms. It is not recommended for outdoor installations. The receiver is typically located in a convenient inside location for the customer to monitor the condition of the softener, such a low salt.

EUT Power Cable

☐ Permanent OR ☒ Removable Length (in meters): 3

☐ Shielded OR ☒ Unshielded

☐ Not Applicable

Form

TÜV AMERICA

EMC Test Plan and Constructional Data Form

EUT Interface Ports and Cables

Interface				Shielding								
Type	Analog	Digital	Qty	Yes	No	Type	Termination	Connector Type	Port Termination	Length (in meters)	Removable	Permanent
EXAMPLE: *RS232*	☐	☒	*2*	☒	☐	*Foil over braid*	*Coaxial*	*Metallized 9-pin D-Sub*	*Characteristic Impedance*	*6*	☒	☐
valve & turbine sensingl	☐	☒	1	☐	☒		Turbine sensor, .187 female tabs	7 Pin .156 header	N/A	1	☒	☐
Motor Drive	☒	☐	1	☐	☒		Flying Leads	Molex	N/A	1	☒	☐
valve control & sensing	☒	☒	4	☒	☐	Tin sheilding for turbine sensor only.	Various	Metalized 15 pin D-Sub	N/A	2	☒	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐
	☐	☐		☐	☐						☐	☐

EMC Test Plan and Constructional Data Form

EUT Software.

Revision Level: EWS 3000 -> M1.3, EWS 5000 -> C1.0, Receiver -> 1.0

Description: Supplied software levels for each controller and the receiver. There is one typical operating mode. The transmitter is On & Off Keyed (OOK) for 16 ms (8.25ms total carrier on time), once a minute. There is a test mode, which transmits the same signal once every 3 seconds. This mode along with a continuous ON transmission will be tested.

Equipment Under Test (EUT) Operating Modes to be Tested -- list the operating modes to be used during test. It is recommended the equipment be tested while operating in a typical operation mode. FCC testing of personal computers and/or peripherals requires that a simple program generate a complete line of upper case H's. Provide a general description of all software, firmware, and PLD algorithms used in the equipment. List all code modules as described above, with the revision level used during testing. Consult with your TÜV Product Service Representative if additional assistance is required.

1. Transmitter - Continuous transmission @ 433 MHZ

2. Transmitter - OOK transmission for 16 ms (8.25ms total carrier on time), once every 3 seconds.

3. Receiver - RF Front-end on continuously

Equipment Under Test (EUT) System Components -- List and describe all components which are part of the EUT. For FCC testing a minimum configuration is required. (ie. Mouse, Printer, Monitor, External Disk Drive, Motherboard, etc.)

Description	Model #	Serial #	FCC ID #
Transmitter PWA	7243748	N/A	OVA7243748
Receiver PWA	7247695	N/A	IC: 3590A-7695
EWS 3000 Controller	7251385	N/A	N/A
EWS 5000 Controller	7227077	N/A	N/A

Form

EMC Test Plan and Constructional Data Form

Support Equipment -- List and describe all support equipment which is not part of the EUT. (i.e. peripherals, simulators, etc)

Description	*Model #*	*Serial #*	*FCC ID #*
None			

Oscillator Frequencies

Frequency	*Derived Frequency*	*Component # / Location*	*Description of Use*
13.560 Mhz	433 Mhz	Transmitter PWA	Main carrier frequency
23.5122 Mhz	376.195 Mhz 47.0244 Mhz	Receiver PWA	Mixer Frequencies
32768 Khz	N/A	Receiver PWA	Timing crystal
2.56 Mhz	N/A	Receiver PWA	Internal microcontroller freq.
8.38 Mhz	N/A	EWS 3000 Controller	Microcontroller frequency
4.19 Mhz	N/A	EWS 5000 Controller	Microcontroller frequency

Power Supply

Manufacturer	*Model #*	*Serial #*	*Type*
N/A			☐ Switched-mode: (Frequency) _____ ☐ Linear ☐ Other: _____
			☐ Switched-mode: (Frequency) _____ ☐ Linear ☐ Other: _____

Power Line Filters

Manufacturer	*Model #*	*Location in EUT*
N/A		

Form

EMC Test Plan and Constructional Data Form

Critical EMI Components (Capacitors, ferrites, etc.)				
Description	***Manufacturer***	***Part # or Value***	***Qty***	***Component # / Location***
N/A				

EMC Critical Detail -- Describe other EMC Design details used to reduce high frequency noise.

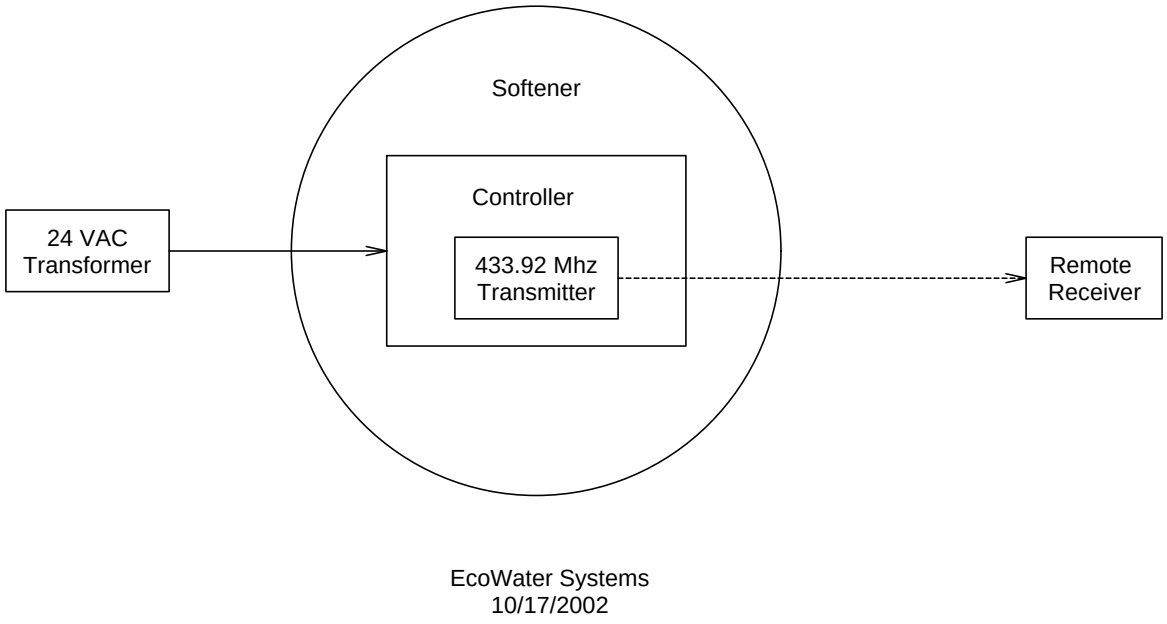
(PLEASE INSERT "**ELECTRONIC SIGNATURE**" BELOW IF POSSIBLE)

Authorization Signatures

Customer authorization to perform tests according to this test plan.	Date
Test Plan/CDF Prepared By (please print)	Date
Reviewed by TÜV Product Service Associate	Date

EMC Block Diagram Form

System Configuration Block Diagram -- Provide a line drawing identifying the EUT, simulators, support equipment, I/O cables, power cables, and any other pertinent components to be used during testing. Use a dashed line to separate the equipment in the testing field versus equipment outside testing field.



EcoWater Systems
10/17/2002

Authorization Signatures

Customer authorization to perform tests according to this test plan.	Date
Test Plan/CDF Prepared By (please print)	Date

Appendix C

MEASUREMENT PROTOCOL

GENERAL INFORMATION

Measurement Uncertainty

The test system for conducted emissions is defined as the LISN, tuned receiver or spectrum analyzer, and coaxial cable. The test system for radiated emissions is defined as the antenna, the pre-amplifier, the spectrum analyzer and the coaxial cable. These test systems have a measurement uncertainty of ±4.5 dB. The equipment comprising the test systems are calibrated on an annual basis.

Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

CONDUCTED EMISSIONS

The final level, expressed in dBµV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC limit.

To convert between dBµV and µV, the following conversions apply:

dBµV = 20(log µV)
µV = Inverse log(dBµV/20)

RADIATED EMISSIONS

The final level, expressed in dBµV/m, is arrived at by taking the reading from the spectrum analyzer (Level dBµV), adding the antenna correction factor and cable loss factor (Factor dB) to it, then subtracting the preamp gain. This result then has the FCC limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets in Attachment A.

Example:

FREQ (MHz)	LEVEL (dBuV)		CABLE/ANT/PREAMP (dB)	(dB/m)	(dB)		FINAL (dBuV/m)		POL/HGT/AZ	(m)	(deg)		DELTA1 LIMIT
60.80	42.5Qp	+	1.2	+ 10.9	- 25.5	=	29.1		V	1.0	0.0	-	-10.9

TÜV PRODUCT SERVICE INC 19333 Wild Mountain Road Taylors Falls MN 55084-1758 Tel: 651 638 0297 Fax: 651 638 0298 Rev.No 1.0

DETAILS OF TEST PROCEDURES

General Standard Information

The test methods used comply with ANSI C63.4-1992 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

Conducted Emissions

Conducted emissions on the 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω/50 μH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. In some cases, a pre-scan using a spectrum analyzer is initially performed on the units comprising the system under test to locate the highest emissions. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver or spectrum analyzer with quasi-peak and average detection and recorded on the data sheets.

Radiated Emissions

Radiated emissions from the EUT are measured in the frequency range of 30 to 4400 MHz using a spectrum analyzer and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and average detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna is positioned 3 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees. Intentional radiators are rotated through three orthogonal axes to determine the attitude that maximizes the emissions.

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