

# 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           | <b>7243748</b>                                                              |
| MANUFACTURER'S ADDRESS | 1890 Woodlane Drive<br>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.

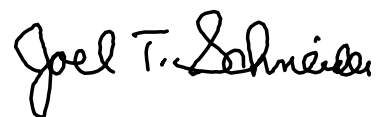
It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical characteristics. Any modifications necessary for compliance made during testing on the above mentioned date(s) must be implemented in all production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



J. C. Sausen  
Tested By



J. T. Schneider  
Reviewed By

Location: Taylors Falls MN  
USA

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.*

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*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*

## D I R E C T O R Y - E M I S S I O N S

| <b>A) Documentation</b>                    | <b>Page(s)</b>                     |
|--------------------------------------------|------------------------------------|
| Test report                                | <u>1 - 10</u>                      |
| Directory                                  | <u>2</u>                           |
| Test Regulations                           | <u>3</u>                           |
| Deviation from standard / Summary          | <u>9</u>                           |
| Test-setups (Photos)                       | <u>10 - 11</u>                     |
| Test-setup (drawing)                       | <u>Appendix A</u>                  |
| <b>B) Test data results</b>                |                                    |
| Conducted emissions                        | 10/150 kHz - 30 MHz<br><u>5, 8</u> |
| Radiated emissions electric field          | 30 MHz - 4400 MHz<br><u>6, 8</u>   |
| Radiated emissions magnetic field          | 60 Hz - 30 MHz<br><u>N/A</u>       |
| Interference power                         | 30 MHz - 300 MHz<br><u>N/A</u>     |
| Emission Bandwidth                         | 433.9 MHz<br><u>6, 8</u>           |
| Duty Cycle                                 | 433.9 MHz<br><u>6, 8</u>           |
| Signal Deactivation                        | 433.9 MHz<br><u>8</u>              |
| <b>C) Appendix A</b>                       |                                    |
| Test Data Sheets and Test Setup Drawing(s) | <u>A2 – A12</u>                    |
| <b>D) Appendix B</b>                       |                                    |
| Constructional Data Form                   | <u>B2 – B8</u>                     |
| Product Information Form(s)                | <u>N/A</u>                         |
| <b>E) Appendix C</b>                       |                                    |
| Measurement Protocol                       | <u>C1 - C2</u>                     |

## EMISSIONS TEST REGULATIONS :

The emissions tests were performed according to following regulations:

- |                                                                            |                                                             |                                    |
|----------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------|
| <input type="checkbox"/> - EN 50081-1 / 1991                               | <input type="checkbox"/> - Group 1                          | <input type="checkbox"/> - Group 2 |
| <input type="checkbox"/> - EN 55011 / 1991                                 | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input type="checkbox"/> - EN 55013 / 1990                                 | <input type="checkbox"/> - Household appliances and similar |                                    |
| <input type="checkbox"/> - EN 55014 / 1987                                 | <input type="checkbox"/> - Portable tools                   |                                    |
|                                                                            | <input type="checkbox"/> - Semiconductor devices            |                                    |
| <input type="checkbox"/> - EN 55014 / A2:1990                              | <input type="checkbox"/> - Household appliances and similar |                                    |
| <input type="checkbox"/> - EN 55014 / 1993                                 | <input type="checkbox"/> - Portable tools                   |                                    |
|                                                                            | <input type="checkbox"/> - Semiconductor devices            |                                    |
| <input type="checkbox"/> - EN 55015 / 1987                                 | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input type="checkbox"/> - EN 55015 / A1:1990                              | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input type="checkbox"/> - EN 55015 / 1993                                 |                                                             |                                    |
| <input type="checkbox"/> - EN 55022 / 1987                                 |                                                             |                                    |
| <input type="checkbox"/> - EN 55022 / 1994                                 |                                                             |                                    |
| <input type="checkbox"/> - BS                                              | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input type="checkbox"/> - VCCI                                            | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input checked="" type="checkbox"/> - FCC Part 15 Subpart C Section 15.231 | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input type="checkbox"/> - AS 3548 (1992)                                  | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input type="checkbox"/> - CISPR 11 (1990)                                 | <input type="checkbox"/> - Group 1                          | <input type="checkbox"/> - Group 2 |
|                                                                            | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |
| <input type="checkbox"/> - CISPR 22 (1993)                                 | <input type="checkbox"/> - Class A                          | <input type="checkbox"/> - Class B |

**Environmental conditions in the lab:**

|                      |                                    |
|----------------------|------------------------------------|
|                      | <u>Actual</u>                      |
| 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



## 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 $\Omega$ 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

## 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<br>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<br>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.

## 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:

- |                                  |              |
|----------------------------------|--------------|
| <input type="checkbox"/> - _____ | Type : _____ |
| <input type="checkbox"/> - _____ | Type : _____ |
| <input type="checkbox"/> - _____ | Type : _____ |
| <input type="checkbox"/> - _____ | Type : _____ |
| <input type="checkbox"/> - _____ | Type : _____ |
| <input type="checkbox"/> - _____ | Type : _____ |
| <input type="checkbox"/> - _____ | Type : _____ |
| <input type="checkbox"/> - _____ | Type : _____ |

☒ - unshielded power cable

☒ - unshielded cables

☒ - shielded cables

MPS.No.: \_\_\_\_\_

☐ - customer specific cables

- ☐ - \_\_\_\_\_
- ☐ - \_\_\_\_\_

## 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  $20 \log(8.75 \text{ msec}/100 \text{ msec})$  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.

**DEVIATIONS FROM STANDARD:**

None.

**GENERAL REMARKS:**

**SUMMARY:**

The requirements according to the technical regulations are

☒ - met

☐ - **not** met.

The device under test does

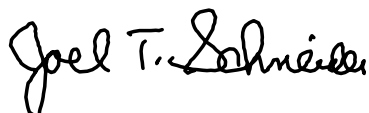
☒ - fulfill the general approval requirements mentioned on page 3.

☐ - **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 -



J. T. Schneider  
Reviewed By



Tested By:  
J. C. Sausen

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

**See Test-Setup Exhibit**



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

**See Test-Setup Exhibit**



## Appendix A

Test Data Sheets  
and  
Test Setup Drawing(s)



## TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB  
Screen Room

See Test-Setup Exhibit



## TEST SETUP FOR EMISSIONS TESTING

WILD RIVER LAB  
Large Test Site

**See Test-Setup Exhibit**



# Conducted Electromagnetic Emissions



|                  |                                                   |            |                         |                    |          |
|------------------|---------------------------------------------------|------------|-------------------------|--------------------|----------|
| Test Report #:   | <b>5488 Run 01</b>                                | 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<br>(MHz) | LEVEL<br>(dBuV) | CABLE / LISN / ATTEN<br>(dB) | FINAL<br>(dBuV) | TEST POINT | DELTA1<br>EN55022 B QP | DELTA2<br>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<br>(MHz) | LEVEL<br>(dBuV) | CABLE / LISN / ATTEN<br>(dB) | FINAL<br>(dBuV) | TEST POINT | DELTA1<br>EN55022 B QP | DELTA2<br>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

\_\_\_\_\_  
Printed

\_\_\_\_\_  
Signature

Reviewed by: TKS

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Printed

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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 #: \_\_\_\_\_  
 Manufacturer: **Ecowater**  
 EUT Description: **Commercial controller with 433.92MHz transmitter**  
 Notes: \_\_\_\_\_

Temperature: **23** °C  
 Relative Humidity: **45** %  
 Air Pressure: **99.5** kPa  
 Page: **1** of **2**

| FREQ<br>(MHz) | LEVEL<br>(dBuV) | CABLE / LISN / ATTEN<br>(dB) | FINAL<br>(dBuV) | TEST POINT | DELTA1<br>EN55022 B QP | DELTA2<br>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                   |

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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<br>(MHz) | LEVEL<br>(dBuV) | CABLE / LISN / ATTEN<br>(dB) | FINAL<br>(dBuV) | TEST POINT | DELTA1<br>EN55022 B QP | DELTA2<br>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 |
|                                 |         |                 |      |         |     |       |

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# Radiated Electromagnetic Emissions



|                  |                                                    |            |                                    |                         |
|------------------|----------------------------------------------------|------------|------------------------------------|-------------------------|
| Test Report #:   | <b>5488 Run 01</b>                                 | 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:    | Ecower 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<br>(MHz)                                                                    | LEVEL<br>(dBuV) | CABLE / ANT / PREAMP<br>(dB) (dB/m) (dB) | FINAL<br>(dBuV/m) | POL / HGT / AZ<br>(m) (DEG) | FINAL with Pk-Ave<br>Correction (20dB)<br>(dBuV/m) | FCC 15.231(e) LIMIT<br>(dBuV/m) |
|----------------------------------------------------------------------------------|-----------------|------------------------------------------|-------------------|-----------------------------|----------------------------------------------------|---------------------------------|
| Orthogonally maximized eut. Highest level is with trx board flat on table.       |                 |                                          |                   |                             |                                                    |                                 |
| Fundamental frequency emission maximized 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                            |

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# Radiated Electromagnetic Emissions



|                  |                                                    |            |                                    |                         |
|------------------|----------------------------------------------------|------------|------------------------------------|-------------------------|
| Test Report #:   | <b>5488 Run 01</b>                                 | 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:    | Ecower 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<br>(MHz)                         | LEVEL<br>(dBuV) | CABLE / ANT / PREAMP<br>(dB) (dB/m) (dB) | FINAL<br>(dBuV/m) | POL / HGT / AZ<br>(m) (DEG) | FINAL with Pk-Ave<br>Correction (20dB)<br>(dBuV/m) | FCC 15.231(e) LIMIT<br>(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.                          |                 |                                          |                   |                             |                                                    |                                 |
|                                       |                 |                                          |                   |                             |                                                    |                                 |

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# Radiated Electromagnetic Emissions



|                  |                                                    |            |                                    |                         |
|------------------|----------------------------------------------------|------------|------------------------------------|-------------------------|
| Test Report #:   | <b>5488 Run 01</b>                                 | 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:    | Ecower 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<br>(MHz) | LEVEL<br>(dBuV) | CABLE / ANT / PREAMP<br>(dB) (dB/m) (dB) | FINAL<br>(dBuV/m) | POL / HGT / AZ<br>(m) (DEG) | FINAL<br>(uV/m) | FCC 15.231(e) LIMIT<br>(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  |
|                                 |         |                   |      |                 |       |       |

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MKR  $\Delta$  33 kHz  
-3.40 dBhp REF 87.0 dB $\mu$ V ATTN 0 dB

5 dB/

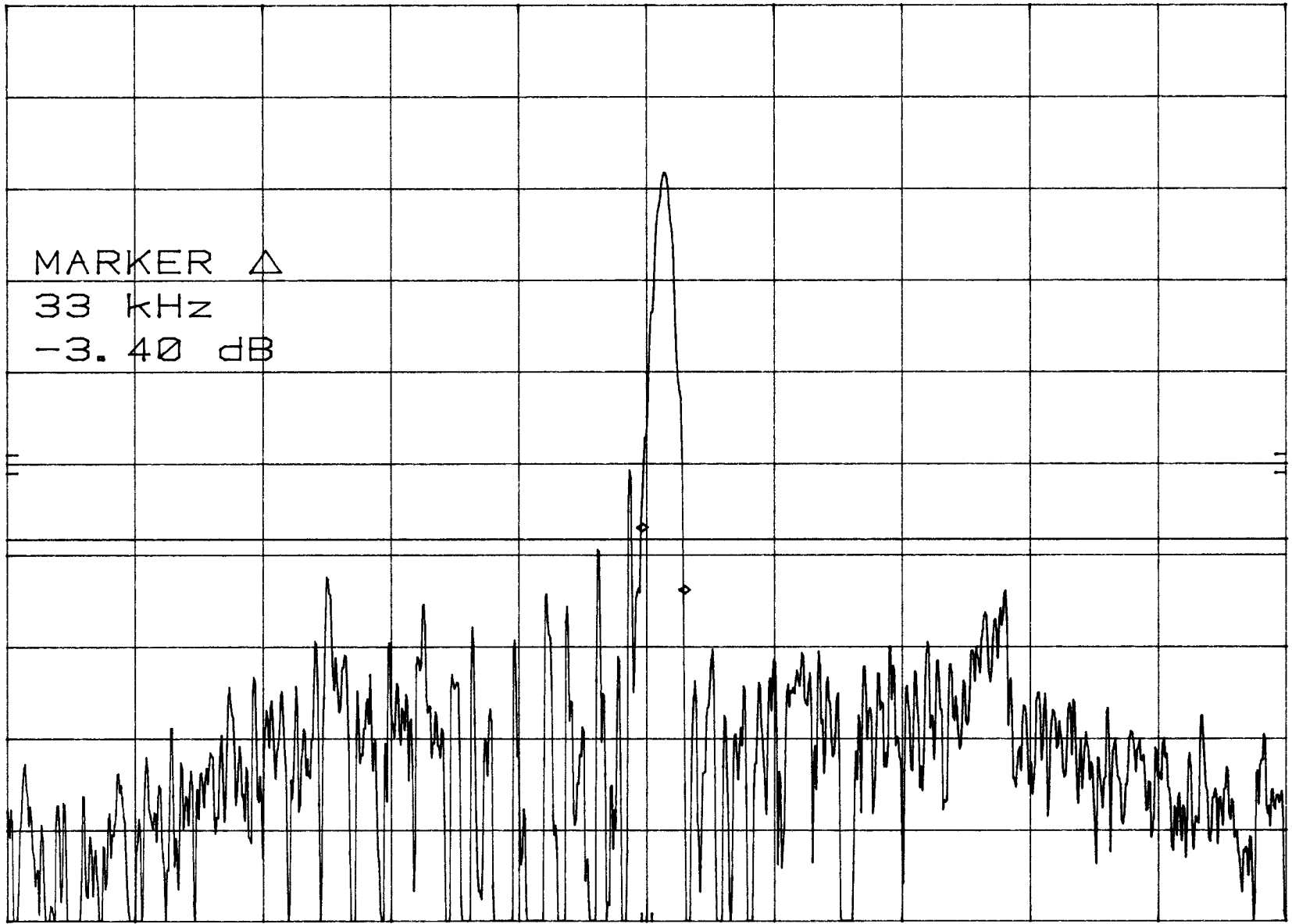
POS PK

DL  
57.8  
dB $\mu$ VMARKER  $\Delta$   
33 kHz  
-3.40 dB

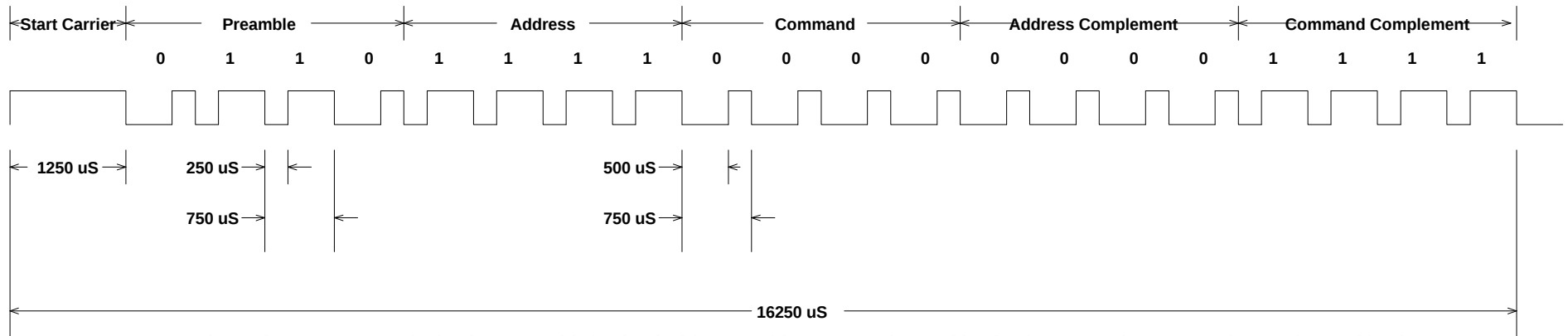
CORR'D

CENTER 433.86 MHz  
RES BW 10 kHz

VBW 10 kHz

SPAN 1.00 MHz  
SWP 30.0 msec

## Transmission Data Timing



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

$$= 1250 \text{ uS} + 1500 \text{ uS} + 3000 \text{ uS} + 3000 \text{ uS}$$

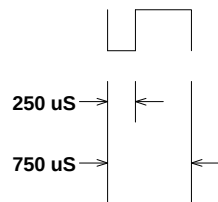
$$= 8750 \text{ uS}$$

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

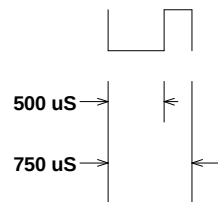
$$= 1500 \text{ uS} + 3000 \text{ uS} + 3000 \text{ uS}$$

$$= 7500 \text{ uS}$$

**Transmitted 1**



**Transmitted 0**



## Appendix B

Constructional Data Form

And/or

Product Information 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

- |                                                                                              |                                                                                                                 |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> EMC Directive 89/336/EEC (EMC)                                      | <input checked="" type="checkbox"/> FCC: Class <input type="checkbox"/> A <input type="checkbox"/> B Part _____ |
| Std: _____                                                                                   | <input type="checkbox"/> VCCI: Class <input type="checkbox"/> A <input type="checkbox"/> B _____                |
| <input type="checkbox"/> Machinery Directive 89/392/EEC (EMC)                                | <input type="checkbox"/> BSMI: Class <input type="checkbox"/> A <input type="checkbox"/> B                      |
| Std: _____                                                                                   | <input checked="" type="checkbox"/> Canada: Class <input type="checkbox"/> A <input type="checkbox"/> B         |
| <input type="checkbox"/> Medical Device Directive 93/42/EEC (EMC)                            | <input type="checkbox"/> Australia: Class <input type="checkbox"/> A <input type="checkbox"/> B                 |
| Std: _____                                                                                   | <input checked="" type="checkbox"/> Other: <u>RTTE</u>                                                          |
| <input type="checkbox"/> Vehicle Directive 72/245/EEC (EMC)                                  |                                                                                                                 |
| Std: _____                                                                                   |                                                                                                                 |
| <input type="checkbox"/> FDA Reviewers Guidance for Premarket Notification Submissions (EMC) |                                                                                                                 |

### TÜV Product Service Certification Requested

- |                                                          |                                                                                                       |
|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> Attestation of Conformity (AoC) | <input type="checkbox"/> EMC Certification (used with Octagon Mark)                                   |
| <input type="checkbox"/> Certificate of Conformity (CoC) | <input type="checkbox"/> Compliance Document                                                          |
| Protection Class (N/A for vehicles)                      | <input type="checkbox"/> Class I <input type="checkbox"/> Class II <input type="checkbox"/> Class III |
- (Press F1 when field is selected to show additional information on Protection Class.)

## 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 transformer 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 is 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 as low salt.

### EUT Power Cable

☐ Permanent OR ☒ Removable Length (in meters): 3  
☐ Shielded OR ☒ Unshielded  
☐ Not Applicable

# 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                |
| <b>EXAMPLE:</b>                |                                     |                                     |           |                                     |                                     |                                        |                                  |                        |                          |                    |                                     |                          |
| RS232                          | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | 2         | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Foil over braid                        | Coaxial                          | Metallized 9-pin D-Sub | Characteristic Impedance | 6                  | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| valve & turbine sensing        | <input type="checkbox"/>            | <input checked="" type="checkbox"/> | 1         | <input type="checkbox"/>            | <input checked="" type="checkbox"/> |                                        | Turbine sensor, .187 female tabs | 7 Pin .156 header      | N/A                      | 1                  | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Motor Drive                    | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | 1         | <input type="checkbox"/>            | <input checked="" type="checkbox"/> |                                        | Flying Leads                     | Molex                  | N/A                      | 1                  | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| valve control & sensing        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | 4         | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Tin sheilding for turbine sensor only. | Various                          | Metalized 15 pin D-Sub | N/A                      | 2                  | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |
|                                | <input type="checkbox"/>            | <input type="checkbox"/>            |           | <input type="checkbox"/>            | <input type="checkbox"/>            |                                        |                                  |                        |                          |                    | <input type="checkbox"/>            | <input type="checkbox"/> |

## 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            |

## 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)

| <i>Description</i> | <i>Model #</i> | <i>Serial #</i> | <i>FCC ID #</i> |
|--------------------|----------------|-----------------|-----------------|
| None               |                |                 |                 |

**Oscillator Frequencies**

| <i>Frequency</i> | <i>Derived Frequency</i>   | <i>Component # / Location</i> | <i>Description of Use</i>      |
|------------------|----------------------------|-------------------------------|--------------------------------|
| 13.560 Mhz       | 433 Mhz                    | Transmitter PWA               | Main carrier frequency         |
| 23.5122 Mhz      | 376.195 Mhz<br>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**

| <i>Manufacturer</i> | <i>Model #</i> | <i>Serial #</i> | <i>Type</i>                                                                                                                        |
|---------------------|----------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------|
| N/A                 |                |                 | <input type="checkbox"/> Switched-mode: (Frequency) _____<br><input type="checkbox"/> Linear <input type="checkbox"/> Other: _____ |
|                     |                |                 | <input type="checkbox"/> Switched-mode: (Frequency) _____<br><input type="checkbox"/> Linear <input type="checkbox"/> Other: _____ |

**Power Line Filters**

| <i>Manufacturer</i> | <i>Model #</i> | <i>Location in EUT</i> |
|---------------------|----------------|------------------------|
| N/A                 |                |                        |
|                     |                |                        |

Form



## EMC Test Plan and Constructional Data Form

### Critical EMI Components (Capacitors, ferrites, etc.)

| <i>Description</i> | <i>Manufacturer</i> | <i>Part # or Value</i> | <i>Qty</i> | <i>Component # / Location</i> |
|--------------------|---------------------|------------------------|------------|-------------------------------|
| 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)

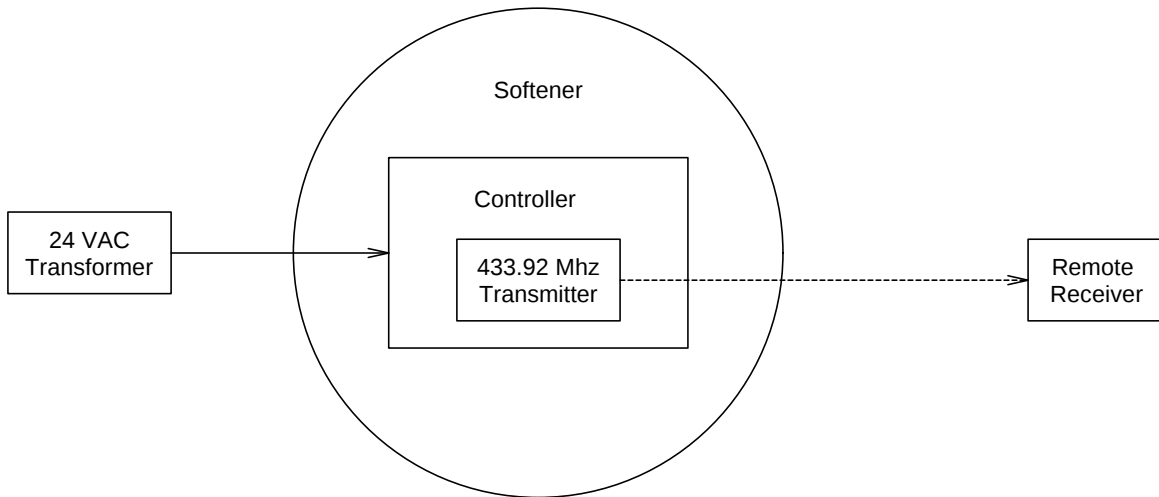
\_\_\_\_\_  
Date

\_\_\_\_\_  
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  $\pm 4.5$  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 dB $\mu$ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC limit.

To convert between dB $\mu$ V and  $\mu$ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

#### RADIATED EMISSIONS

The final level, expressed in dB $\mu$ V/m, is arrived at by taking the reading from the spectrum analyzer (Level dB $\mu$ V), 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<br>(MHz) | LEVEL<br>(dB $\mu$ V) | CABLE/ANT/PREAMP |        |          |      | FINAL<br>(dB $\mu$ V/m) | POL/HGT/AZ |       |       | DELTA1<br>LIMIT |
|---------------|-----------------------|------------------|--------|----------|------|-------------------------|------------|-------|-------|-----------------|
|               |                       | (dB)             | (dB/m) | (dB)     |      |                         | (m)        | (deg) |       |                 |
| 60.80         | 42.5Qp                | + 1.2            | + 10.9 | - 25.5 = | 29.1 |                         | V          | 1.0   | 0.0 - | -10.9           |

## 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  $\Omega$ /50  $\mu$ H (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.