

**Nemko Test Report:** 5L0182RUS1

**Applicant:** Crane Nuclear Inc.  
2825 Cobb International Boulevard  
Kennesaw, Georgia 30152

**Equipment Under Test:** ValveWatch 1-51001EX

**In Accordance With:** **FCC Part 15, Subpart C, 15.247**  
Digital Transmission System Transmitter

**Tested By:** Nemko Dallas Inc.  
802 N. Kealy  
Lewisville, Texas 75057-3136

**Authorized By:**

A handwritten signature in black ink, appearing to read "David Light", is positioned above the printed name.

David Light, Senior Wireless Engineer

**Date:** 9/8/2005

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*EQUIPMENT:* ValveWatch

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**Section 1. Summary of Test Results**

Manufacturer: Crane Nuclear Inc

Model No.: ValveWatch 1-51001EX

Serial No.: 004224-05/010

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 for Digital Transmission Systems. Radiated tests were conducted in accordance with ANSI C63.4-2003. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.



New Submission



Production Unit



Class II Permissive Change



Pre-Production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

See " Summary of Test Data".

**NVLAP LAB CODE: 100426-0**

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*EQUIPMENT:* ValveWatch

---

**Summary Of Test Data**

| NAME OF TEST                              | PARA. NO.    | RESULT   |
|-------------------------------------------|--------------|----------|
| Powerline Conducted Emissions             | 15.207(a)    | Complies |
| Minimum 6 dB Bandwidth                    | 15.247(a)(2) | Complies |
| Maximum Peak Power Output                 | 15.247(b)(1) | Complies |
| Spurious Emissions<br>(Antenna Conducted) | 15.247(c)    | Complies |
| Spurious Emissions (Restricted Bands)     | 15.247(c)    | Complies |
| Peak Power Spectral Density               | 15.247(d)    | Complies |

**Footnotes:**

*EQUIPMENT:* ValveWatch

## **Section 2.        Equipment Under Test (E.U.T.)**

### **General Equipment Information**

**Frequency Band:** 2402 to 2480 MHz

**Channel Spacing:** 1 MHz

**User Frequency Adjustment:** Software controlled

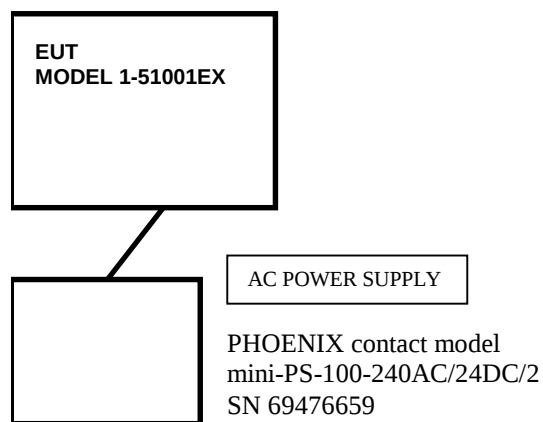
EQUIPMENT: ValveWatch

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### Description of EUT

Acquire data remotely from a Local Data Acquisition Unit to a Hub Communications Assembly for data transfer to the ValveWatch Database.

### System Diagram



*EQUIPMENT:* ValveWatch

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**Section 3. Powerline Conducted Emissions**

|                                             |                      |
|---------------------------------------------|----------------------|
| NAME OF TEST: Powerline Conducted Emissions | PARA. NO.: 15.207(a) |
| TESTED BY: Kevin Rose                       | DATE: 9/06/2005      |

**Test Results:** Complies.**Measurement Data:** See attached plots.**Measurement Uncertainty:** +/- 1.7 dB

The worst-case emission is 45.1dB<sub>uV</sub> 0.375MHz on the Hot side of the line.  
This is 3.7 dB below the average specification limit of 49dB<sub>μV</sub>.

## Test Data – Powerline Conducted Emissions



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## Dallas Headquarters:

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Lewisville, TX 75057  
Tel: (972) 436-9600  
Fax: (972) 436-2667

### Conducted Emissions

#### Powerline Voltage Measurement

Complete X  
Preliminary       

Job #: 5L0182E  
Page 1

Test #: CEPV-01  
of 2

Client Name : Crane Nuclear Inc

EUT Name : ValveWatch

EUT Model #: ValveWatch 1-51001ex

EUT Part #: ValveWatch 1-51001ex

EUT Serial #: 5200001

EUT Config.: Acquisition Mode

Specification : FCC CLASS B

Reference :

Transducer #: 545 Temp. (deg. C) : 22

Date : 09/06/05

HP Filter #: 968 Humidity (%) : 33

Time : 11:00 A.M.

Cable 1 #: 1019 EUT Voltage : 115 Vac

Staff : Kevin Rose

Cable 2 #: 1116 EUT Frequency : 60 Hz

Location : SR

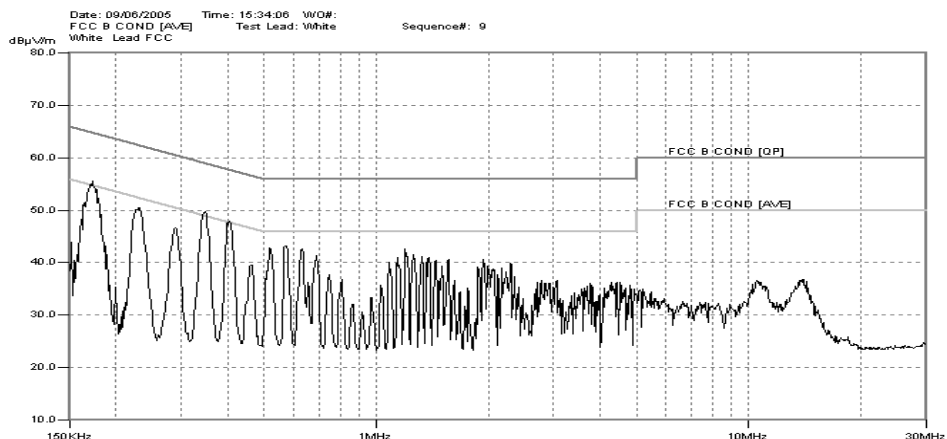
Detector 1 #: 718 Peak Bandwidth: 10kHz

Photo ID: 5L0182E CEPV-01

Detector 2 #: QP Bandwidth 9kHz

Limiter #: Avg. Bandwidth 9kHz

| Meas. Freq. (MHz) | EUT Test Point | Detector Type (P,QP, A) | Limit Type (QP, A) | Meter Reading (dBuV) | Path Loss (dB) | Transducer Factor (dB) | Corrected Reading (dBuV) | Spec. limit (dBuV) |      | CR/SL Diff. (dB) | Pass Fail Unc. | Comment |
|-------------------|----------------|-------------------------|--------------------|----------------------|----------------|------------------------|--------------------------|--------------------|------|------------------|----------------|---------|
|                   |                |                         |                    |                      |                |                        |                          | Q.P.               | Avg. |                  |                |         |
| 0.174             | H              | QP                      | QP                 | 56.0                 | 0              | 0.5                    | 56.5                     | 64                 | 54   | -7.5             | Pass           |         |
| 0.174             | H              | A                       | A                  | 48.0                 | 0              | 0.5                    | 48.5                     | 64                 | 54   | -5.5             | Pass           |         |
| 0.374             | H              | QP                      | QP                 | 49.5                 | 0              | 0.5                    | 50.0                     | 59                 | 49   | -9.0             | Pass           |         |
| 0.375             | H              | A                       | A                  | 44.6                 | 0              | 0.5                    | 45.1                     | 59                 | 49   | -3.9             | Pass           |         |
| 0.4               | H              | QP                      | QP                 | 48.0                 | 0              | 0.5                    | 48.5                     | 57                 | 47   | -8.5             | Pass           |         |
| 0.4               | H              | A                       | A                  | 42.0                 | 0              | 0.5                    | 42.5                     | 57                 | 47   | -4.5             | Pass           |         |



..\\EMCShare\\AUTOMATE\\DATASHTS\\CEPV\_Voltage Rev C.xlt Document Control #EMC DS EM COND VOLT

## Test Data – Powerline Conducted Emissions



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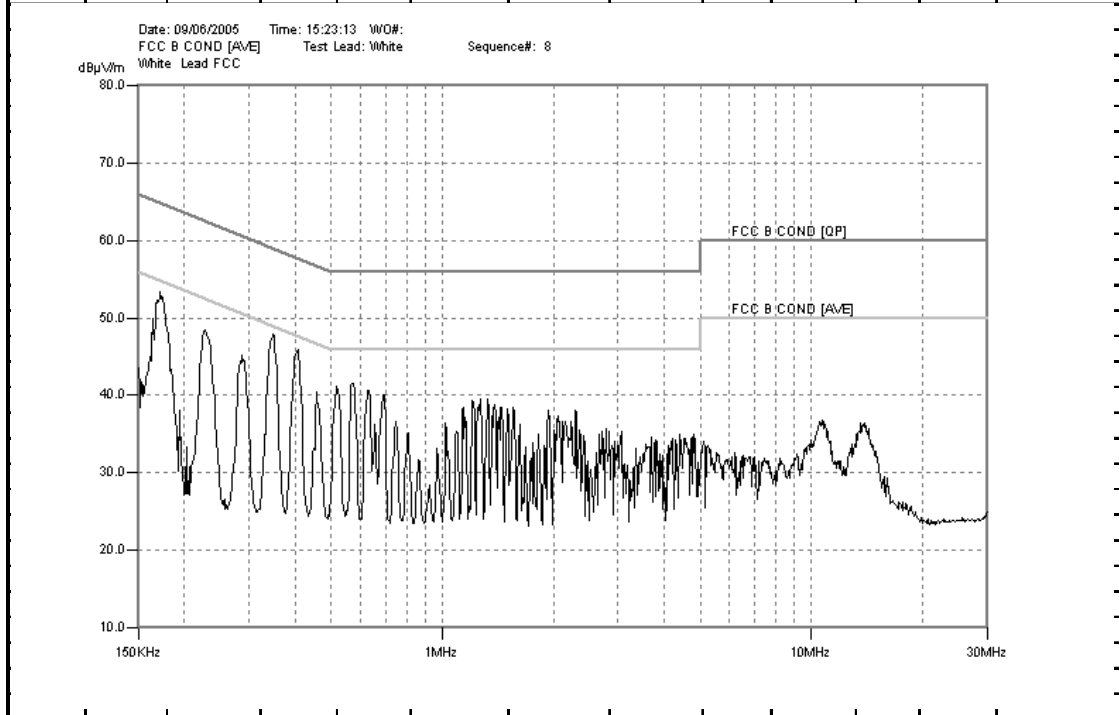
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Fax: (972) 436-2667

**Conducted Emissions**  
**Powerline Voltage Measurement**Complete   X    
Preliminary       Job # : 5L0182E Test # : CEPV-01  
Page 2 of 2

Client Name : Crane Nuclear Inc  
EUT Name : ValveWatch  
EUT Model # : ValveWatch 1-51001ex  
EUT Part # : ValveWatch 1-51001ex  
EUT Serial # : 5200001  
EUT Config. : Acquisition Mode

Specification : FCC CLASS B Reference :

| Meas. Freq. (MHz) | EUT Test Point | Detector Type (P, QP, A) | Limit Type (QP, A) | Meter Reading (dBuV) | Path Loss (dB) | Transducer Factor (dB) | Corrected Reading (dBuV) | Spec. limit (dBuV) |      | CR/SL Diff. (dB) | Pass Fail Unc. | Comment |
|-------------------|----------------|--------------------------|--------------------|----------------------|----------------|------------------------|--------------------------|--------------------|------|------------------|----------------|---------|
|                   |                |                          |                    |                      |                |                        |                          | Q.P.               | Avg. |                  |                |         |
| 0.174             | N              | QP                       | QP                 | 48.2                 | 0.0            | 0.5                    | 48.5                     | 64.0               | 54.0 | -15.5            | Pass           |         |
| 0.174             | N              | A                        | A                  | 45.0                 | 0.0            | 0.5                    | 45.5                     | 64.0               | 54.0 | -8.5             |                |         |
| 0.35              | N              | QP                       | QP                 | 48.0                 | 0.0            | 0.5                    | 48.5                     | 59.0               | 49.0 | -10.5            |                |         |
| 0.35              | N              | A                        | A                  | 42.0                 | 0.0            | 0.5                    | 42.5                     | 59.0               | 49.0 | -6.5             |                |         |

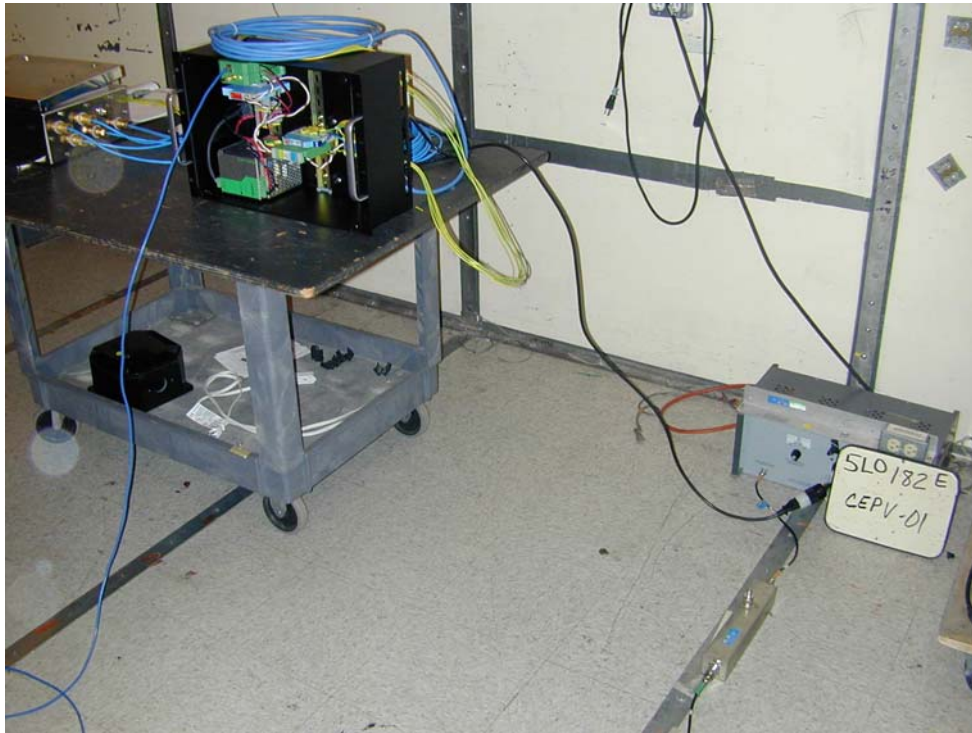


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*EQUIPMENT:* ValveWatch

**Photos – Powerline Conducted Emissions**

Front



Side



*EQUIPMENT:* ValveWatch

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**Section 4.        Occupied Bandwidth**

|                                  |                         |
|----------------------------------|-------------------------|
| NAME OF TEST: Occupied Bandwidth | PARA. NO.: 15.247(a)(2) |
| TESTED BY: Kevin Rose            | DATE: 6/27/05           |

**Test Results:**                      Complies.

**Measurement Data:**    See 6 dB BW plot

Measured 6 dB bandwidth:

EQUIPMENT: ValveWatch

## Test Data – Occupied Bandwidth



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Fax: (972) 436-2667

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## Data Plot

Page 1 of 3

Job No.: 5L0182

Date: 6/27/2005

Specification: 15.247

Temperature(°C): 22

Tested By: Kevin Rose

Relative Humidity(%): 40

E.U.T.: ValveWatch

Configuration: TX full power

Serial Number: 5200001

Location: Lab 2

RBW: 100 kHz

Detector Type: Peak

VBW: 100 kHz

Complete X

Preliminary: \_\_\_\_\_

## Test Equipment Used

Antenna: \_\_\_\_\_

Directional Coupler: \_\_\_\_\_

Pre-Amp: \_\_\_\_\_

Cable #1: \_\_\_\_\_

Filter: \_\_\_\_\_

Cable #2: 1082

Receiver: 1464

Cable #3: \_\_\_\_\_

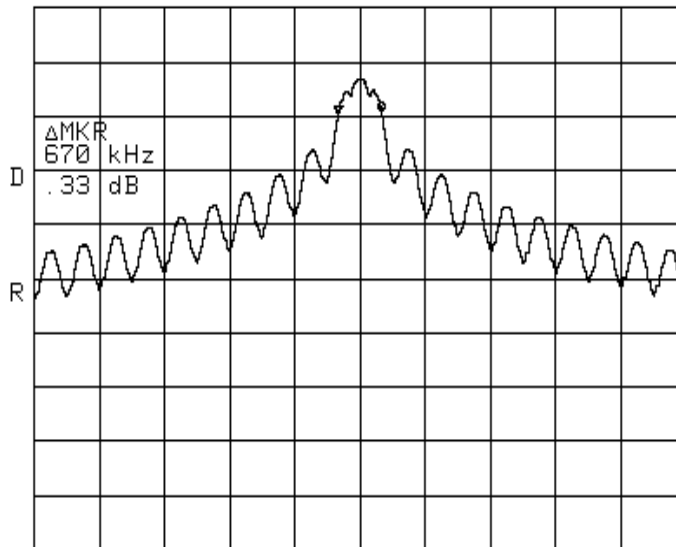
Attenuator #1: 1472

Cable #4: \_\_\_\_\_

Attenuator #2: 1474

Mixer: \_\_\_\_\_

Additional equipment used: \_\_\_\_\_

Measurement Uncertainty:  $\pm 1 \times 10^{-7}$  ppmATTEN 10dB  
RL 12.0dBm  
 $\Delta MKR$  .33dB  
670 kHz  
10dB/  
670kHz

CHANNEL 16DB

CENTER 2.40102GHz  
RBW 100kHz  
SPAN 10.00MHz  
VBW 100kHz  
SWP 50.0ms

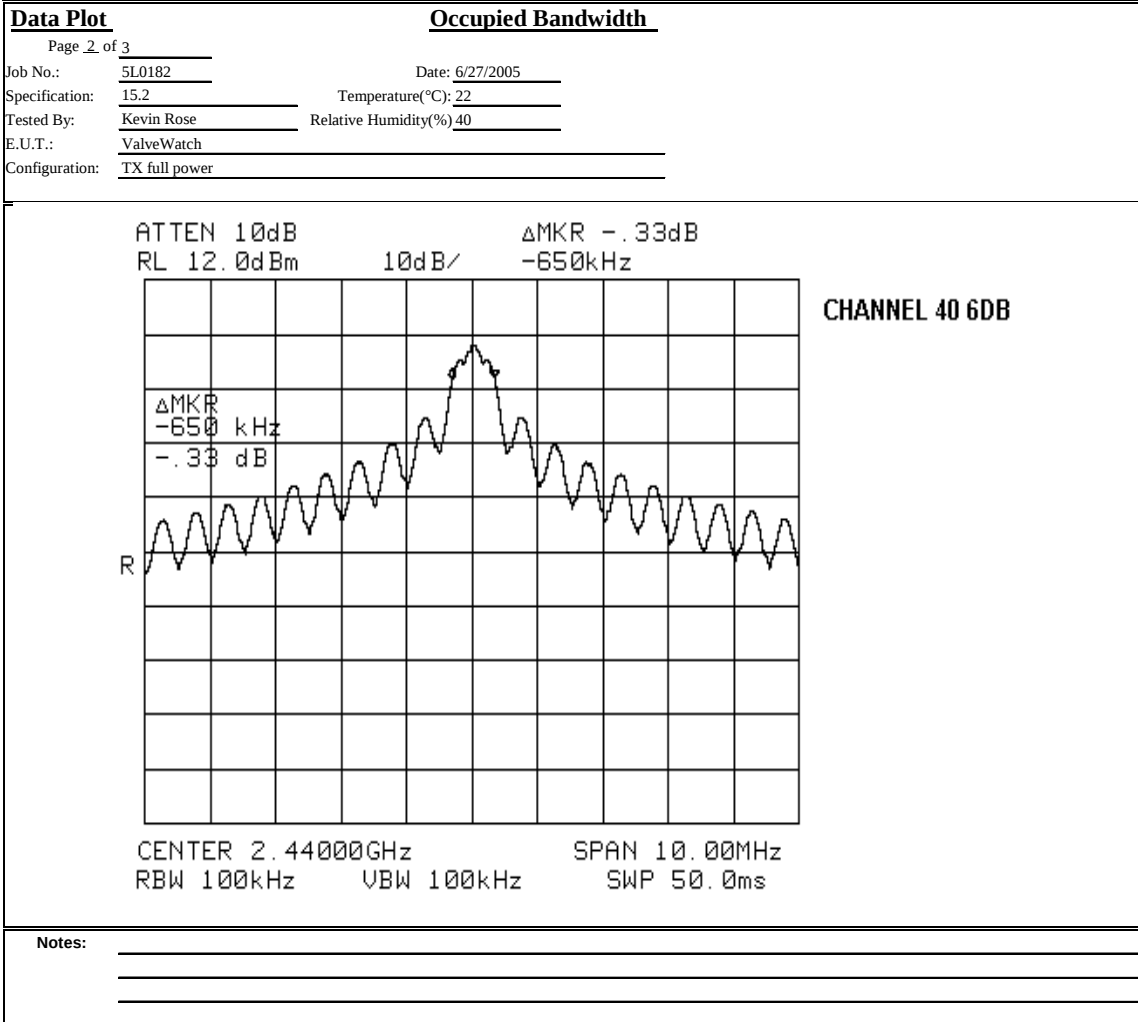
Notes:

Test Data – Occupied Bandwidth



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EQUIPMENT: ValveWatch

## Test Data – Occupied Bandwidth



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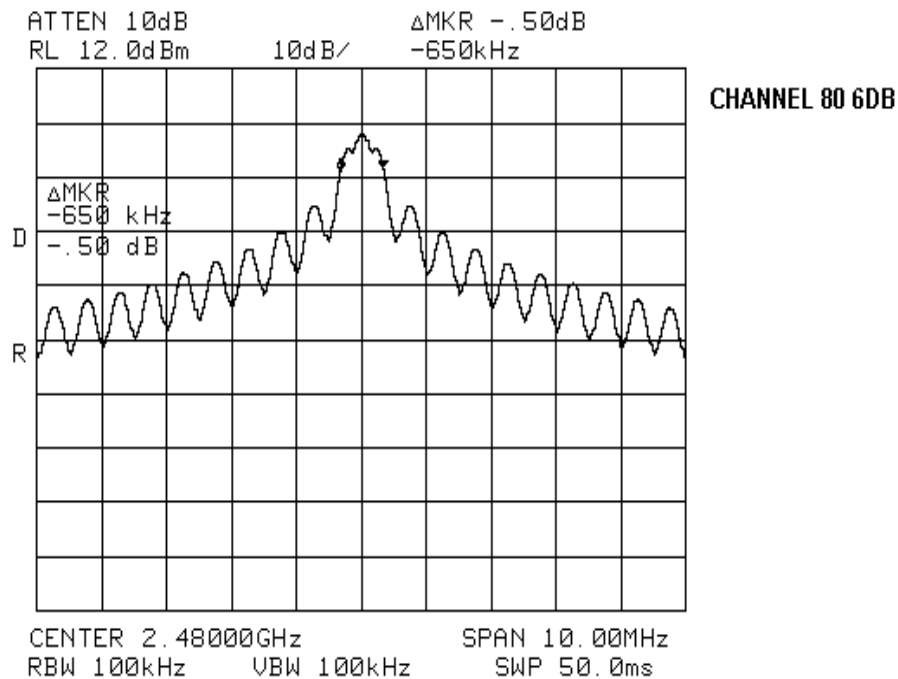
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**Data Plot**

Page 3 of 3

Job No.: 5L0182 Date: 6/27/2005  
Specification: 15.2 Temperature(°C): 22  
Tested By: Kevin Relative Humidity(%) 40  
E.U.T.: ValveWatch  
Configuration: TX full power

**Occupied Bandwidth**

Notes:

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*EQUIPMENT:* ValveWatch

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**Section 5. Maximum Peak Output Power**

|                                         |                         |
|-----------------------------------------|-------------------------|
| NAME OF TEST: Maximum Peak Output power | PARA. NO.: 15.247(b)(1) |
| TESTED BY: Kevin Rose                   | DATE: 6/27/2005         |

**Test Results:** Complies.**Measurement Data:** Refer to attached data

The measurement was repeated at +/- 15% of nominal supply voltage with no variation noted: RF conducted power output.

| Frequency<br>(MHz) | Mode    | Peak Power<br>(dBm)<br>antenna<br>connector | With 6dBi<br>antenna<br>EIRP<br>(dBm) |
|--------------------|---------|---------------------------------------------|---------------------------------------|
| 2402               | Tx full | 7.7                                         | 13.7                                  |
| 2442               | Tx full | 8.8                                         | 14.8                                  |
| 2480               | Tx full | 8.8                                         | 14.8                                  |

Test Equipment: 1029-1081-1464

Test Conditions: 22°C  
40% RH

*EQUIPMENT:* ValveWatch

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## **Section 6          Spurious Emissions at Antenna Terminals**

|                                                       |                       |
|-------------------------------------------------------|-----------------------|
| NAME OF TEST: Spurious Emissions at Antenna Terminals | PARA. NO.: 15.247 (c) |
| TESTED BY: Kevin Rose                                 | DATE: 6/27/2005       |

**Test Results:**                  Complies.

**Measurement Data:**    See attached plots.

EQUIPMENT: ValveWatch

## Test Data – Spurious Emissions at Antenna Terminals



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## Data Plot

## Spurious Emissions at Antenna Terminals

Page 1 of 4

Job No.: 5L0182 Date: 9/6/2005 Complete X

Specification: 15.247 Temperature(°C): 22 Preliminary: \_\_\_\_\_

Tested By: Kevin Rose Relative Humidity(%): 40

E.U.T.: ValveWatch

Configuration: TX full power

Serial Number: 3

Location: Lab 2 RBW: 100 kHz

Detector Type: Peak VBW: 100 kHz

## Test Equipment Used

Antenna: \_\_\_\_\_ Directional Coupler: \_\_\_\_\_

Pre-Amp: \_\_\_\_\_ Cable #1: \_\_\_\_\_

Filter: \_\_\_\_\_ Cable #2: \_\_\_\_\_

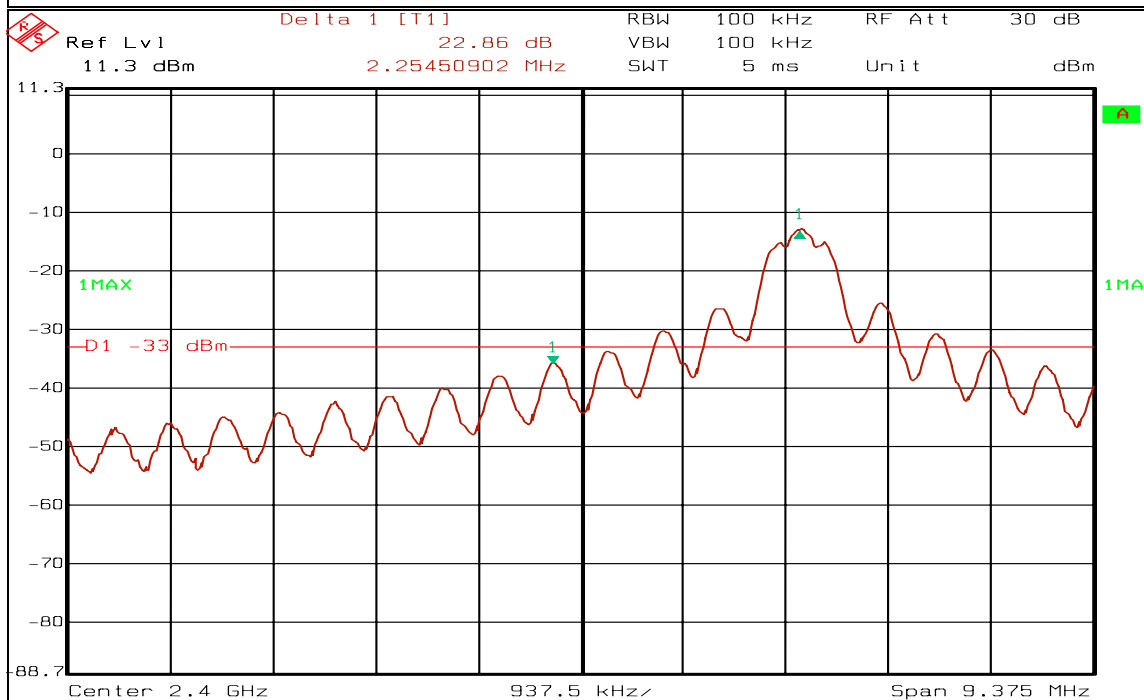
Receiver: 1036 Cable #3: \_\_\_\_\_

Attenuator #1: 1472 Cable #4: \_\_\_\_\_

Attenuator #2: \_\_\_\_\_ Mixer: \_\_\_\_\_

Additional equipment used: \_\_\_\_\_

Measurement Uncertainty: +/-1.7 dB



Date: 06.SEP.2005 15:22:05

Notes: lower bandedge

EQUIPMENT: ValveWatch

## Test Data – Spurious Emissions at Antenna Terminals



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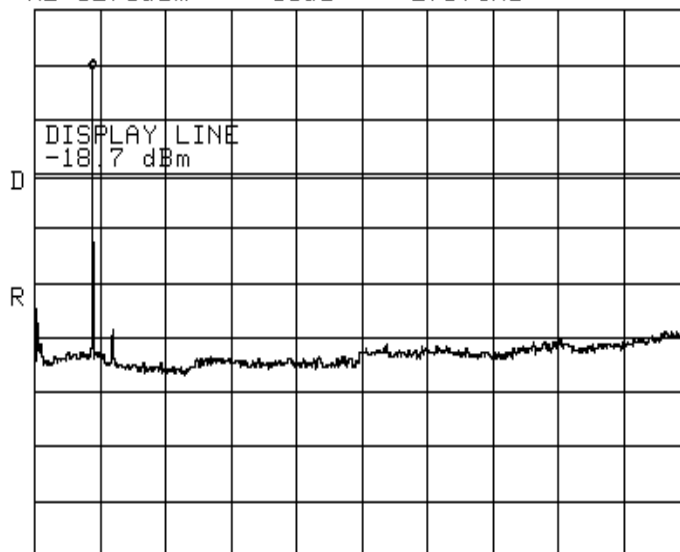
## Data Plot

Page 2 of 4

Job No.: 5L0182 Date: 6/27/2005  
Specification: 15.2 Temperature(°C): 22  
Tested By: Kevin Rose Relative Humidity(%) 40  
E.U.T.: ValveWatch  
Configuration: TX full power

## Spurious Emissions at Antenna Terminals

ATTEN 10dB MKR 1.17dBm  
RL 12.0dBm 10dB/ 2.37GHz



CHANNEL 1 SPURIOUS

Notes:

EQUIPMENT: ValveWatch

## Test Data – Spurious Emissions at Antenna Terminals



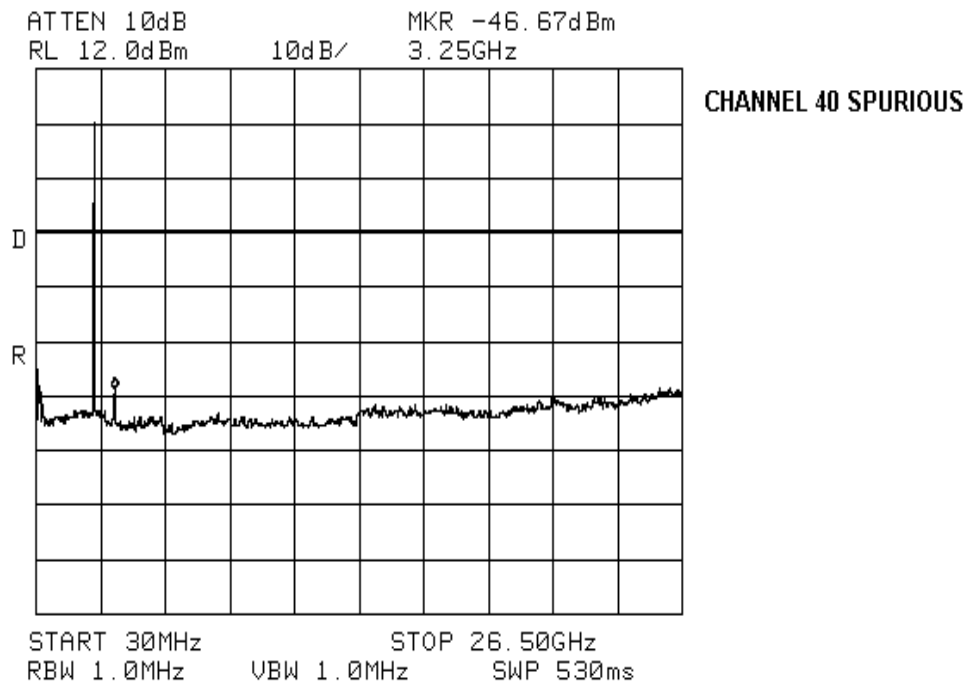
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Fax: (972) 436-2667**Data Plot**

Page 3 of 4

|                |               |                      |           |
|----------------|---------------|----------------------|-----------|
| Job No.:       | 5L0182        | Date:                | 6/27/2005 |
| Specification: | 15.2          | Temperature(°C):     | 22        |
| Tested By:     | Kevin Rose    | Relative Humidity(%) | 40        |
| E.U.T.:        | ValveWatch    |                      |           |
| Configuration: | TX full power |                      |           |

**Spurious Emissions at Antenna Terminals**

Notes:

EQUIPMENT: ValveWatch

## Test Data – Spurious Emissions at Antenna Terminals



## Dallas Headquarters:

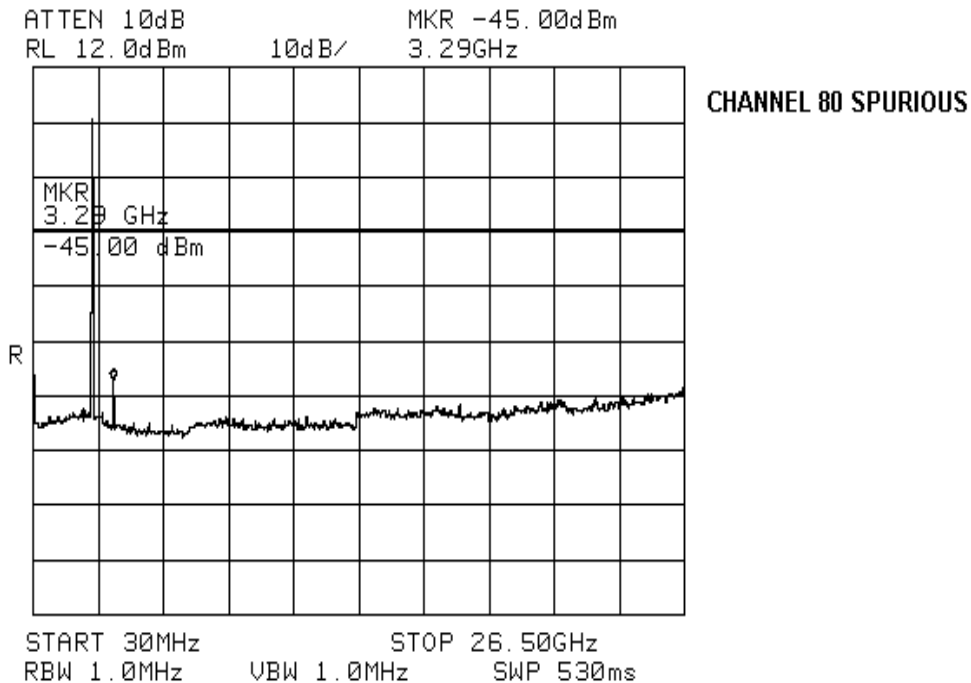
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**Data Plot**

Page 4 of 4

Job No.: 5L0182 Date: 6/27/2005  
Specification: 15.2 Temperature(°C): 22  
Tested By: Kevin Rose Relative Humidity(%) 40  
E.U.T.: ValveWatch  
Configuration: TX full power

**Spurious Emissions at Antenna Terminals**

Notes:

*EQUIPMENT:* ValveWatch

---

**Section 7. Radiated Emissions**

|                                  |                       |
|----------------------------------|-----------------------|
| NAME OF TEST: Radiated Emissions | PARA. NO.: 15.247 (c) |
| TESTED BY: Kevin Rose            | DATE: 6/27/2005       |

**Test Results:** Complies.

Spectrum was searched from 9 kHz to the 10th harmonic. No Emissions were detected within 20db of the limit.

During Radiated test EUT was running at greater than 99.5% on time.

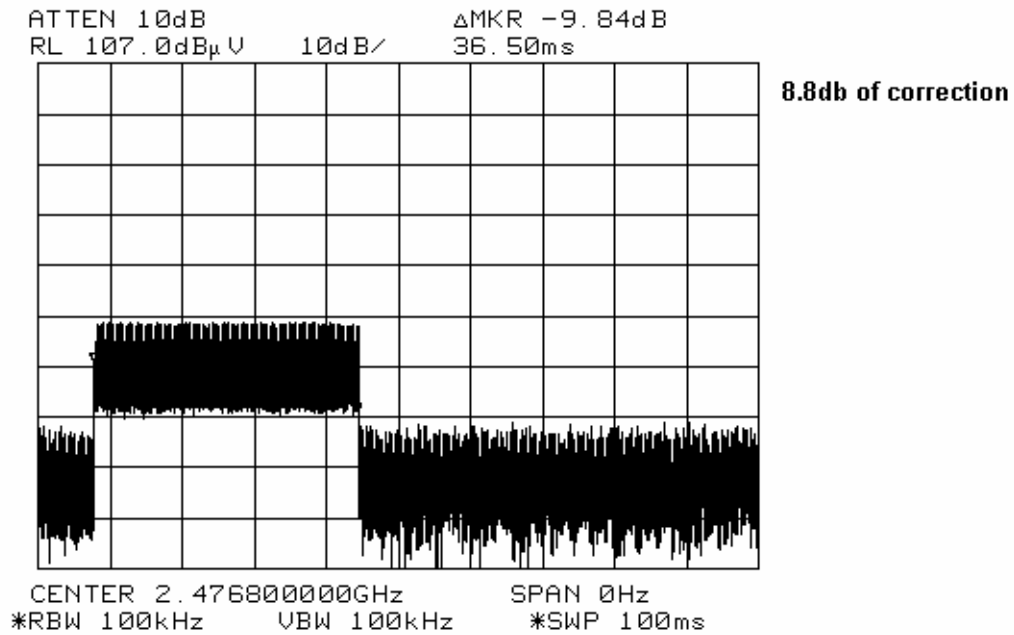
Duty Cycle correction was assessed with typical modulation used during normal operation.

**Measurement Data:** See attached table.

EQUIPMENT: ValveWatch

## Duty cycle

(36.5ms/100) log\*20=duty cycle



EQUIPMENT: ValveWatch

## Radiated Emissions



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Radiated EmissionsPage 1 of 1

Job No.: 5L0182R Date: 6/27/2005  
 Specification: 15.247/15.205 Temperature(°C): 21  
 Tested By: Kevin Rose Relative Humidity(%) 46  
 E.U.T.: ValveWatch  
 Configuration: TX full power  
 Sample Number: 5200001  
 Location: AC 3 RBW: 1 MHz  
 Detector Type: Peak VBW: 1 MHz

Test Equipment Used

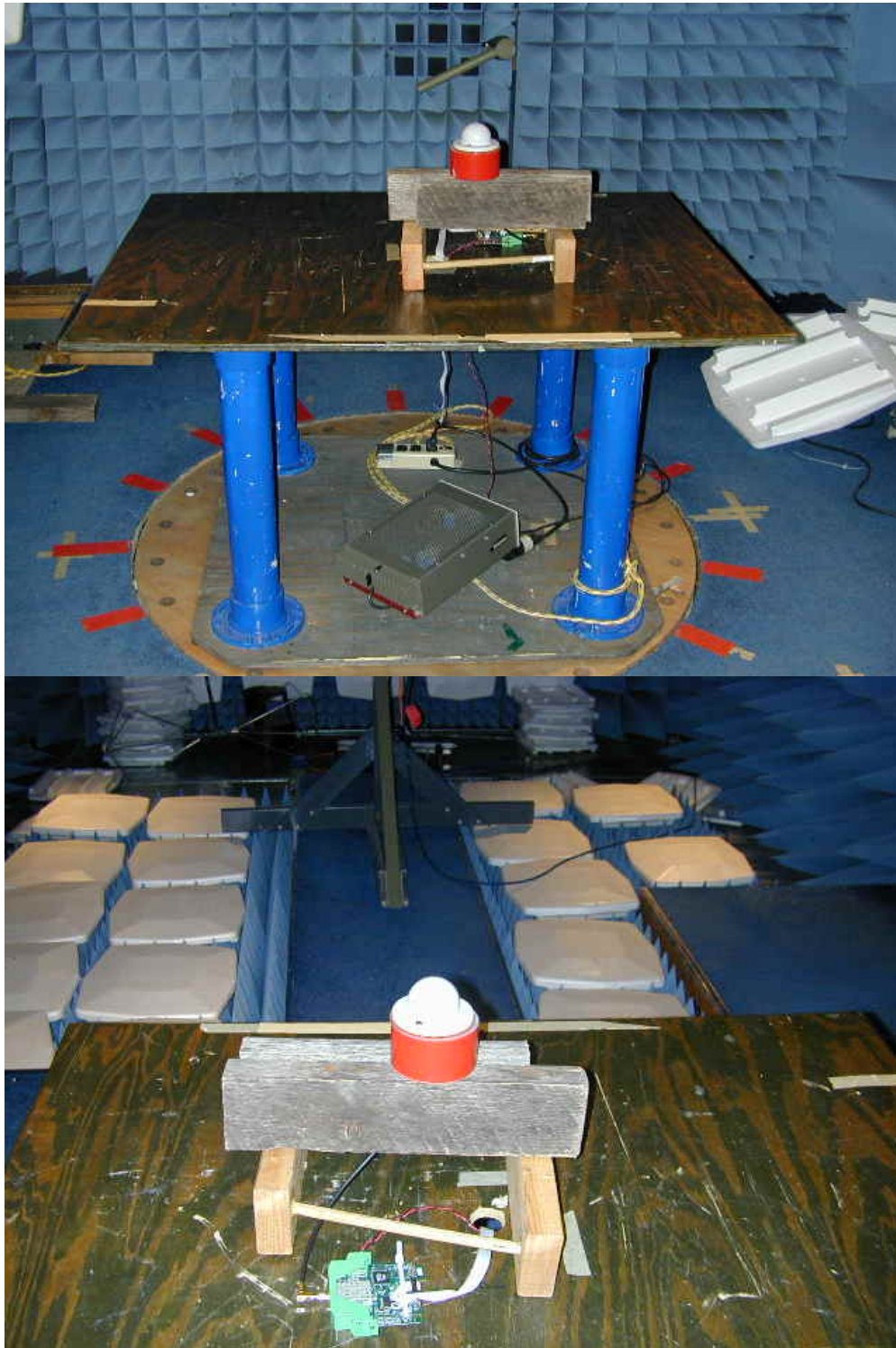
Antenna: 1304 Directional Coupler: #N/A  
 Pre-Amp: 1016 Cable #1: 1484  
 Filter: #N/A Cable #2: 1485  
 Receiver: 1464 Cable #3: #N/A  
 Attenuator #1: #N/A Cable #4: #N/A  
 Attenuator #2: #N/A Mixer: #N/A

Measurement Uncertainty: +/- 3.6 dB

| Frequency (GHz) | Meter Reading (dBuV) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Corrected Reading (dBuV/m) | Peak Limit (dBuV/m) | Average Limit (dBuV/m) | Detector / Polarity    |
|-----------------|----------------------|---------------------|-----------------|-------------------|----------------------------|---------------------|------------------------|------------------------|
|                 |                      |                     |                 |                   |                            |                     |                        | V                      |
| 2.4835          | 48.7                 | 28.0                | 3.1             | 32.8              | 47.0                       | 74                  | 54                     | Peak                   |
| 2.4835          | 39.9                 | 28.0                | 3.1             | 32.8              | 38.2                       | 74                  | 54                     | average 8.8 duty cycle |
| 2.4835          | 35.3                 | 28.0                | 3.1             | 32.8              | 33.6                       | 74                  | 54                     | 10hz                   |
|                 |                      |                     |                 |                   |                            |                     |                        | H                      |
| 2.4835          | 46.8                 | 28.0                | 3.1             | 32.8              | 45.1                       | 74                  | 54                     | Peak                   |
| 2.4835          | 38.0                 | 28.0                | 3.1             | 32.8              | 36.3                       | 74                  | 54                     | average 8.8 duty cycle |
| 2.4835          | 35.2                 | 28.0                | 3.1             | 32.8              | 33.5                       | 74                  | 54                     | 10hz                   |
|                 |                      |                     |                 |                   |                            |                     |                        |                        |
|                 |                      |                     |                 |                   |                            |                     |                        |                        |

*EQUIPMENT:* ValveWatch

### Radiated Photographs



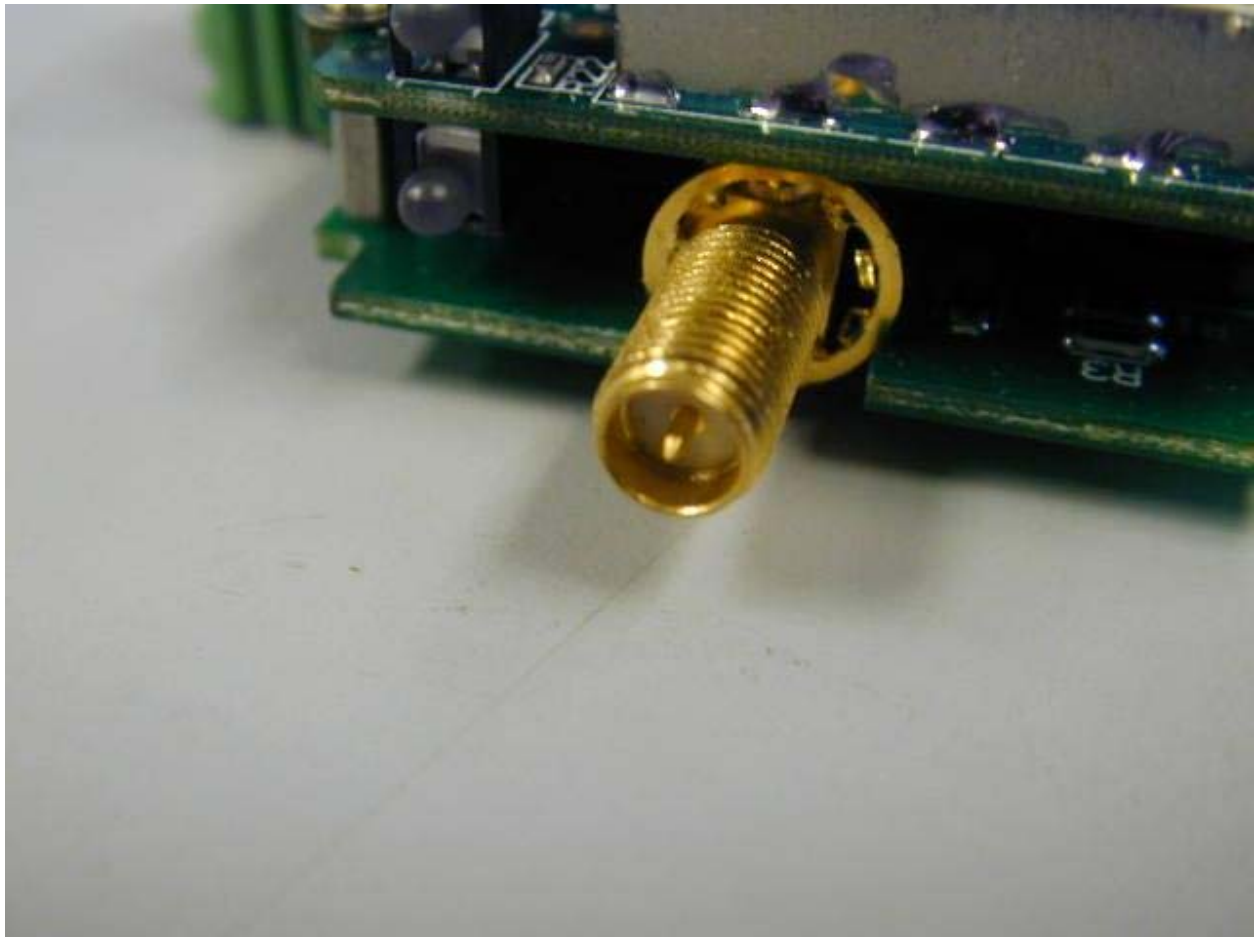
*EQUIPMENT:* ValveWatch

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**15.203 Antenna connector Requirement**

The EUT uses a Reverse Polarity SMA connector

**Connector photo**



*EQUIPMENT:* ValveWatch

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**Section 8.          Peak Power Spectral Density**

|                                           |                      |
|-------------------------------------------|----------------------|
| NAME OF TEST: Peak Power Spectral Density | PARA. NO.: 15.247(d) |
| TESTED BY: Kevin Rose                     | DATE: 6/27/2005      |

**Test Results:**                  Complies.

**Measurement Data:**    See attached data..

EQUIPMENT: ValveWatch

## Peak Power Spectral Density



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## Data Plot

## Peak Power Spectral Density

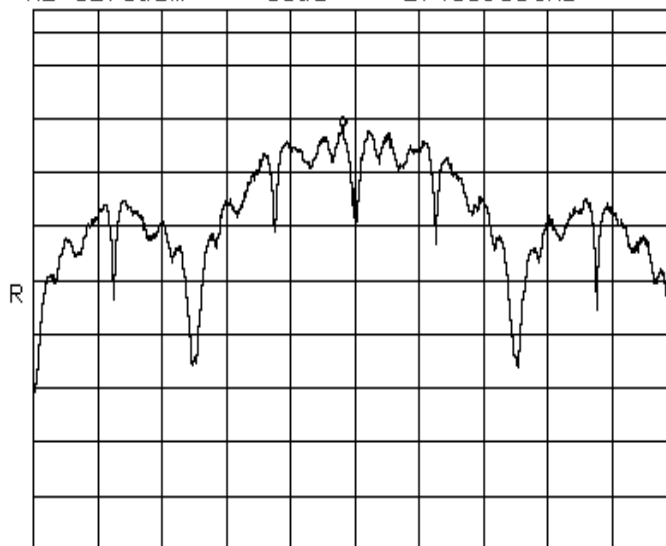
Page 1 of 3

Job No.: 5L0182 Date: 6/27/2005 Complete X  
Specification: 15.247 Temperature(°C): 22 Preliminary: \_\_\_\_\_  
Tested By: Kevin Rose Relative Humidity(%) 40  
E.U.T.: ValveWatch  
Configuration: TX full power  
Serial Number: 5200001  
Location: Lab 2 RBW: 3 kHz  
Detector Type: Peak VBW: 3 kHz

## Test Equipment Used

Antenna: \_\_\_\_\_ Directional Coupler: \_\_\_\_\_  
Pre-Amp: \_\_\_\_\_ Cable #1: \_\_\_\_\_  
Filter: \_\_\_\_\_ Cable #2: \_\_\_\_\_  
Receiver: 1464 Cable #3: 1483  
Attenuator #1: 1472 Cable #4: \_\_\_\_\_  
Attenuator #2: 1474 Mixer: \_\_\_\_\_  
Additional equipment used: \_\_\_\_\_  
Measurement Uncertainty:  $\pm 1 \times 10^{-2}$  ppm

\*ATTEN 10dB MKR -9.67dBm  
RL 12.0dBm 10dB/ 2.400963GHz



START 2.400000GHz STOP 2.402000GHz  
\*RBW 3.0kHz VBW 3.0kHz \*SWP 680sec

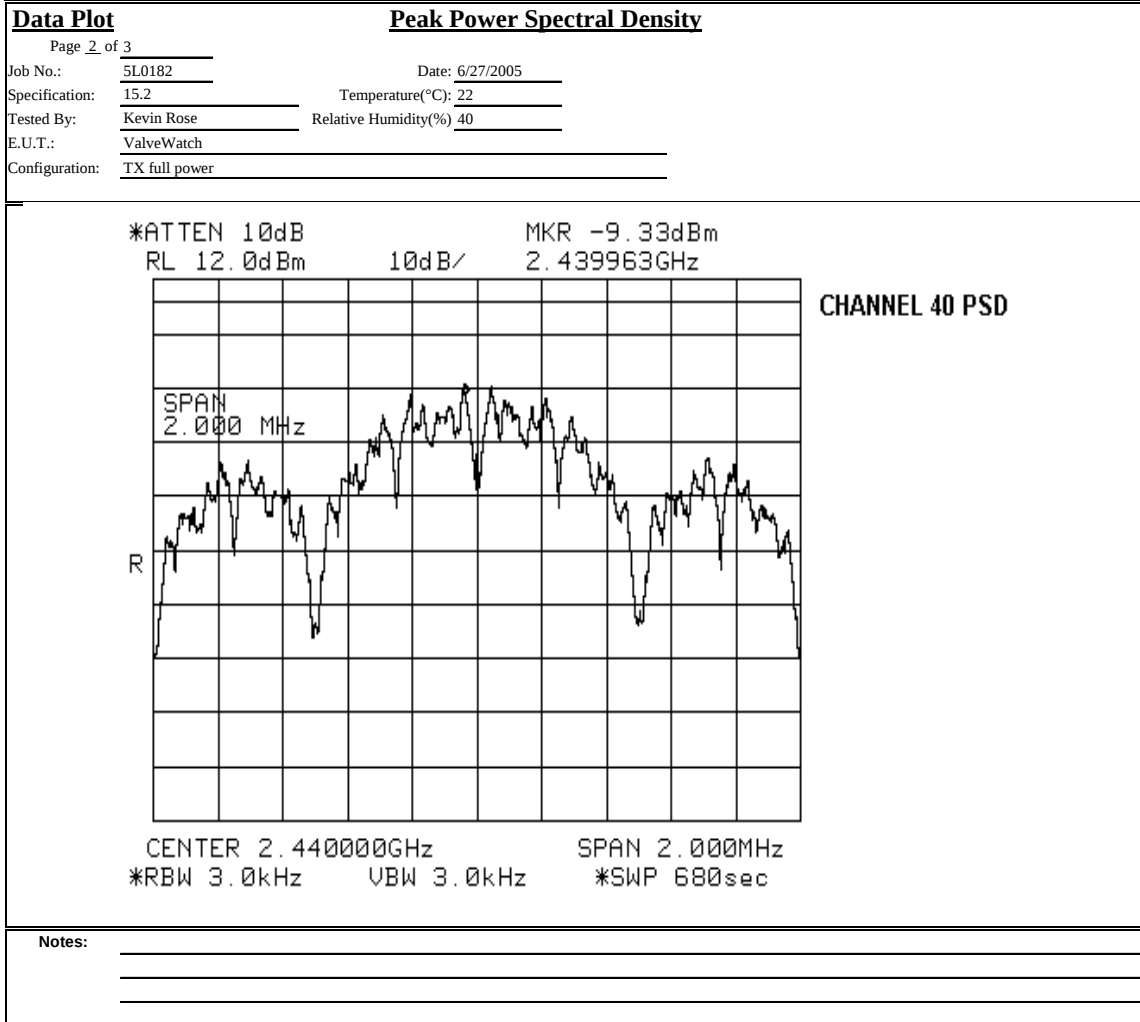
Notes:

# Peak Power Spectral Density



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Notes:

EQUIPMENT: ValveWatch

## Peak Power Spectral Density



## Dallas Headquarters:

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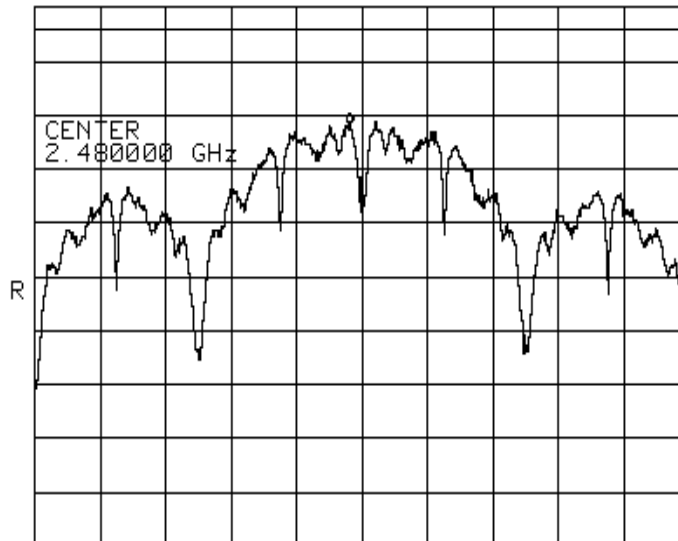
## Data Plot

Page 3 of 3

Job No.: 5L0182 Date: 6/27/2005  
Specification: 15.2 Temperature(°C): 22  
Tested By: Kevin Rose Relative Humidity(%) 40  
E.U.T.: ValveWatch  
Configuration: TX full power

## Peak Power Spectral Density

\*ATTEN 10dB MKR -9.67dBm  
RL 12.0dBm 10dB/ 2.479963GHz



CHANNEL 80 PSD

CENTER 2.480000GHz SPAN 2.000MHz  
\*RBW 3.0kHz VBW 3.0kHz \*SWP 680sec

Notes:

## Section 9. Test Equipment List

| Nemko ID | Description               | Manufacturer<br>Model Number   | Serial Number | Calibration<br>Date | Calibration<br>Due |
|----------|---------------------------|--------------------------------|---------------|---------------------|--------------------|
| 545      | LISN                      | Schwarz Beck<br>8120           | 8120350       | 09/17/04            | 09/17/05           |
| 1555     | Filter high pass 5KHz     | Solar Electronics<br>7930-5.0  | 933125        | 04/20/05            | 04/20/06           |
| 1553     | CABLE 1m                  | KTL<br>RG223                   | N/A           | 06/09/04            | 06/09/05           |
| 1998     | CABLE, 1m                 | KTL<br>RG223                   | N/A           | 06/09/04            | 06/09/05           |
| 1284     | Spectrum analyzer display | Hewlett Packard<br>8566B       | 1811A00223    | 01/10/05            | 01/10/06           |
| 966      | Receiver                  | Rohde & Schwartz<br>ESH2       | 880370/029    | 09/20/04            | 09/20/05           |
| 1036     | SPECTRUM ANALYZER         | ROHDE & SCHWARZ<br>FSEK30      | 830844/006    | 03/22/04            | 03/23/06           |
| 1472     | 20db Attenuator DC 18 Ghz | Omni Spectra<br>20600-20db     | NONE          | CBU                 | N/A                |
| 1081     | CABLE 2m                  | Astrolab<br>32027-2-29094-72TC | N/A           | 08/26/04            | 08/26/05           |
| 1029     | PEAK POWER METER          | HP<br>8900D                    | 3303U0012     | 12/23/04            | 12/22/05           |
| 1030     | PEAK POWER SENSOR         | HP<br>84811A                   | 2539A03573    | 12/23/04            | 12/22/05           |
| 1304     | HORN ANTENNA              | ELECTRO METRICS<br>RGA-60      | 6151          | 09/22/03            | 09/22/05           |
| 1016     | Pre-Amp                   | HEWLETT PACKARD<br>8449A       | 2749A00159    | 11/12/04            | 11/12/05           |
| 1484     | Cable 2.0-18.0 Ghz        | Storm<br>PR90-010-072          | N/A           | 08/26/04            | 08/26/05           |
| 1485     | Cable 2.0-18.0 Ghz        | Storm<br>PR90-010-216          | N/A           | 08/02/04            | 08/02/05           |
| 1464     | Spectrum analyzer         | Hewlett Packard<br>8563E       | 3551A04428    | 01/14/05            | 01/15/07           |
| 759      | ANTENNA, LOG PERIODIC     | A.H. SYSTEMS<br>SAS-200/510    | 556           | 07/23/04            | 07/23/05           |
| 760      | Antenna biconical         | Electro Metrics<br>MFC-25      | 477           | 06/22/04            | 06/22/05           |
| 791      | PREAMP, 25dB              | ICC<br>LNA25                   | 398           | 11/12/04            | 11/12/05           |
| 1083     | Cable 2m                  | Astrolab<br>32027-2-29094-72TC | N/A           | CBU                 | N/A                |
| 1477     | 20db Attenuator DC 18 Ghz | MCL Inc.<br>BW-S20W5           | NONE          | CBU                 | N/A                |

## **ANNEX A - TEST DETAILS**

NAME OF TEST: Powerline Conducted Emissions

PARA. NO.: 15.207(a)

**Minimum Standard:** §15.207 Conducted limits.

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 mH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency of Conducted Emission (MHz) | Limit (dBmV) |           |
|---------------------------------------|--------------|-----------|
|                                       | Quasi-peak   | Average   |
| 0.15-0.5                              | 66 to 56*    | 56 to 46* |
| 0.5-5                                 | 56           | 46        |
| 5-30                                  | 60           | 50        |

\* Decreases with the logarithm of the frequency.

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

(1) For carrier current systems containing their fundamental emission within the frequency band 535-1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.

(2) For all other carrier current systems: 1000 mV within the frequency band 535-1705 kHz, as measured using a 50 mH/50 ohms LISN.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits as provided in §15.205 and §§15.209, 15.221, 15.223, 15.225 or 15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

*EQUIPMENT:* ValveWatch

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|                                  |                         |
|----------------------------------|-------------------------|
| NAME OF TEST: Occupied Bandwidth | PARA. NO.: 15.247(a)(2) |
|----------------------------------|-------------------------|

**Minimum Standard:** The minimum 6 dB bandwidth shall be at least 500 kHz

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*EQUIPMENT:* ValveWatch

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NAME OF TEST: Maximum Peak Output Power

PARA. NO.: 15.247(b)(1)

**Minimum Standard:** The maximum peak output power shall not exceed 1 watt.

If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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

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

**Direct Measurement Method For Detachable Antennas:**

If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

**Substitution Antenna Method for Integral Antennas:**

The peak field strength of the carrier is measured in a worst-case configuration with a RBW > 5 times the occupied bandwidth of the transmitted waveform. For cases where the RBW of the test instrument is not sufficient, the power is measured using a peak power meter instead of the spectrum analyzer.

The RBW of the spectrum analyzer shall be set to a value greater than the measured 6 dB occupied bandwidth of the E.U.T.

Number of channels tested:

| Tuning range     | Number of channels tested | Channel location in band |
|------------------|---------------------------|--------------------------|
| 1 MHz or less    | 1                         | middle                   |
| 1 to 10 MHz      | 2                         | top and bottom           |
| more than 10 MHz | 3                         | top, middle, bottom      |

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*EQUIPMENT:* ValveWatch

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NAME OF TEST: Channel Separation

PARA. NO.: 15.247(a)(1)

**Minimum Standard:**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

NAME OF TEST: Pseudorandom Hopping Algorithm

PARA. NO.: 15.247(a)(1)

**Minimum Standard:**

The system shall hop to channel frequencies that are selected from a pseudo-randomly ordered list of hopping frequencies. Each frequency must be used equally on average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their transmitters and shall shift frequencies in synchronization with the transmitted signals.

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*EQUIPMENT:* ValveWatch

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NAME OF TEST: Time of Occupancy

PARA. NO.: 15.247(a)(1)(ii)

**Minimum Standard:**

| Frequency Band (MHz) | 20 dB Bandwidth | No. of Hopping Channels | Average Time of Occupancy |
|----------------------|-----------------|-------------------------|---------------------------|
| 902 - 928            | <250 kHz        | 50                      | =<0.4 sec. in 20 sec.     |
| 902 – 928            | =>250 kHz       | 25                      | =<0.4 sec. in 10 sec.     |
| 2400 – 2483.5        | -----           | 75                      | =<0.4 sec. in 30 sec.     |
| 5725 – 5850          | -----           | 75                      | =<0.4 sec. in 30 sec.     |

**Method Of Measurement:**

The spectrum analyzer is set as follows:

RBW: 1 MHz

VBW: = RBW

Span: 0 Hz

LOG dB/div.: 10 dB

Sweep: Sufficient to see one hop time sequence.

Trigger: Video

The occupancy time of one hop is measured as above. The average time of occupancy is calculated over the appropriate period of time from above table (10, 20, or 30 seconds).

Avg. time of occupancy = (period from table/duration of one hop)/no. of channels multiplied by the duration of one hop.

For instance:

If a 2.4 GHz system has a measured hop duration time of 1 msec. and uses 75 channels, then the average time of occupancy would be:

$(30 \text{ sec.} / .001 \text{ sec.}) / 75 \text{ chan.} = 400 \times 1 \text{ msec.} = 400 \text{ msec. or } 0.4 \text{ sec. in } 30 \text{ sec.}$

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*EQUIPMENT:* ValveWatch

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NAME OF TEST: Occupied Bandwidth

PARA. NO.: 15.247(a)(2)

**Minimum Standard:**

| Frequency Band<br>(MHz) | Maximum<br>20 dB Bandwidth |
|-------------------------|----------------------------|
| 902 - 928               | 500 kHz                    |
| 2400 – 2483.5           | 1 MHz                      |
| 5725 – 5850             | 1 MHz                      |

**Method Of Measurement:**

The spectrum analyzer is set as follows:

RBW: At least 1% of span/div.

VBW: >RBW

Span: Sufficient to display 20 dB bandwidth

LOG dB/div.: 10 dB

Sweep: Auto

**Number of channels tested:**

| Tuning range     | Number of channels tested | Channel location in band |
|------------------|---------------------------|--------------------------|
| 1 MHz or less    | 1                         | middle                   |
| 1 to 10 MHz      | 2                         | top and bottom           |
| more than 10 MHz | 3                         | top, middle, bottom      |

*EQUIPMENT:* ValveWatch

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|                           |                         |
|---------------------------|-------------------------|
| NAME OF TEST: RF Exposure | PARA. NO.: 15.247(b)(4) |
|---------------------------|-------------------------|

**Minimum Standard:**

Systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines stipulated in 1.1307(b)(1) of CFR 47.

NAME OF TEST: Spurious Emissions(conducted)

PARA. NO.: 15.247(c)

**Minimum Standard:**

In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

| Frequency (MHz) | Field Strength ( $\mu\text{V/m}$ @ 3m) | Field Strength (dB @ 3m) |
|-----------------|----------------------------------------|--------------------------|
| 30 - 88         | 100                                    | 40.0                     |
| 88 - 216        | 150                                    | 43.5                     |
| 216 - 960       | 200                                    | 46.0                     |
| Above 960       | 500                                    | 54.0                     |

**THE SPECTRUM IS SEARCHED TO THE 10th HARMONIC OF THE HIGHEST FREQUENCY GENERATED IN THE EUT.**

**Method Of Measurement:**

30 MHz - 10th harmonic plot

RBW: 100 kHz

VBW: 300 kHz

Sweep: Auto

Display line: -20 dBc

Lower Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz

Marker: Peak of fundamental emission

Marker  $\Delta$ : Peak of highest spurious level below center frequency.

Upper Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz

Marker: Peak of fundamental emission

Marker  $\Delta$ : Peak of highest spurious level above center frequency.

Number of channels tested:

| Tuning range     | Number of channels tested | Channel location in band |
|------------------|---------------------------|--------------------------|
| 1 MHz or less    | 1                         | middle                   |
| 1 to 10 MHz      | 2                         | top and bottom           |
| more than 10 MHz | 3                         | top, middle, bottom      |

NAME OF TEST: Radiated Spurious Emissions

PARA. NO.: 15.247(c)

**Minimum Standard:** In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

**Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:**

| Frequency (MHz) | Field Strength ( $\mu\text{V/m}$ @ 3m) | Field Strength (dB @ 3m) |
|-----------------|----------------------------------------|--------------------------|
| 30 - 88         | 100                                    | 40.0                     |
| 88 - 216        | 150                                    | 43.5                     |
| 216 - 960       | 200                                    | 46.0                     |
| Above 960       | 500                                    | 54.0                     |

**THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC**

#### 15.205 Restricted Bands

| MHz               | MHz                 | MHz           | GHz         |
|-------------------|---------------------|---------------|-------------|
| 0.09-0.11         | 16.42-16.423        | 399.9-410     | 4.5-5.25    |
| 0.495-0.505       | 16.69475-16.69525   | 608-614       | 5.35-5.46   |
| 2.1735-2.1905     | 16.80425-16.80475   | 960-1240      | 7.25-7.75   |
| 4.125-4.128       | 25.5-25.67          | 1300-1427     | 8.025-8.5   |
| 4.17725-4.17775   | 37.5-38.25          | 1435-1626.5   | 9.0-9.2     |
| 4.20725-4.20775   | 73-74.6             | 1645.5-1646.5 | 9.3-9.5     |
| 6.125-6.218       | 74.8-75.2           | 1660-1710     | 10.6-12.7   |
| 6.26775-6.26825   | 108-121.94          | 1718.8-1722.2 | 13.25-13.4  |
| 6.31175-6.31225   | 123-138             | 2200-2300     | 14.47-14.5  |
| 8.291-8.294       | 149.9-150.05        | 2310-2390     | 15.35-16.2  |
| 8.362-8.366       | 156.52475-156.52525 | 2483.5-2500   | 17.7-21.4   |
| 8.37625-8.38675   | 156.7-156.9         | 2655-2900     | 22.01-23.12 |
| 8.41425-8.41475   | 162.0125-167.17     | 3260-3267     | 23.6-24.0   |
| 12.29-12.293      | 167.72-173.2        | 3332-3339     | 31.2-31.8   |
| 12.51975-12.52025 | 240-285             | 3345.8-3358   | 36.43-36.5  |
| 12.57675-12.57725 | 322-335.4           | 3600-4400     | Above 38.6  |
| 13.36-13.41       | 1718                |               |             |

Number of channels tested:

| Tuning range     | Number of channels tested | Channel location in band |
|------------------|---------------------------|--------------------------|
| 1 MHz or less    | 1                         | middle                   |
| 1 to 10 MHz      | 2                         | top and bottom           |
| more than 10 MHz | 3                         | top, middle, bottom      |

NAME OF TEST: Transmitter Power Density

PARA. NO.: 15.247(d)

**Minimum Standard:** The transmitted power density averaged over any 1 second interval shall not be greater than +8 dBm in any 3 kHz bandwidth.

**Method Of Measurement:** The spectrum analyzer is set as follows:

RBW: 3 kHz

VBW: &gt;3 kHz

Span: =&gt; measured 6 dB bandwidth

Sweep: Span(kHz)/3 (i.e. for a span of 1.5 MHz the sweep rate is  $1500/3 = 500$  sec.

LOG dB/div.: 2 dB

**Note:** For devices with spectrum line spacing  $\leq 3$  kHz, the RBW of the analyzer is reduced until the spectral lines are resolved. The measurement data is normalized to 3 kHz by summing the power of all the individual spectral lines within a 3 kHz band in linear power units.

**For Devices With Integral Antenna:**

For devices with non-detachable antennas, the received field strength is peaked and the spectrum analyzer is set as above. The peak emission level is then measured and converted to a field strength by adding the appropriate antenna factor and cable loss. This field strength is then converted to an equivalent isotropic radiated power using the same method as described for Peak Power output.

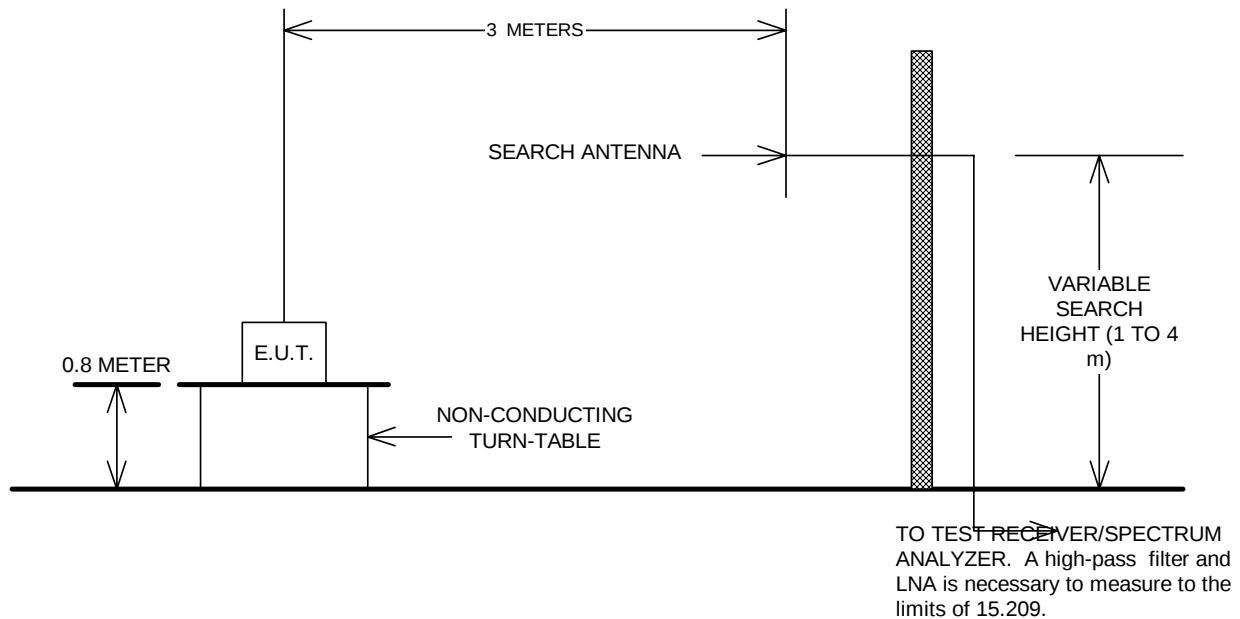
Number of channels tested:

| Tuning Range     | Number Of Channels Tested | Channel Location In Band |
|------------------|---------------------------|--------------------------|
| 1 MHz or Less    | 1                         | Middle                   |
| 1 to 10 MHz      | 2                         | Top And Bottom           |
| More Than 10 MHz | 3                         | Top, Middle, Bottom      |

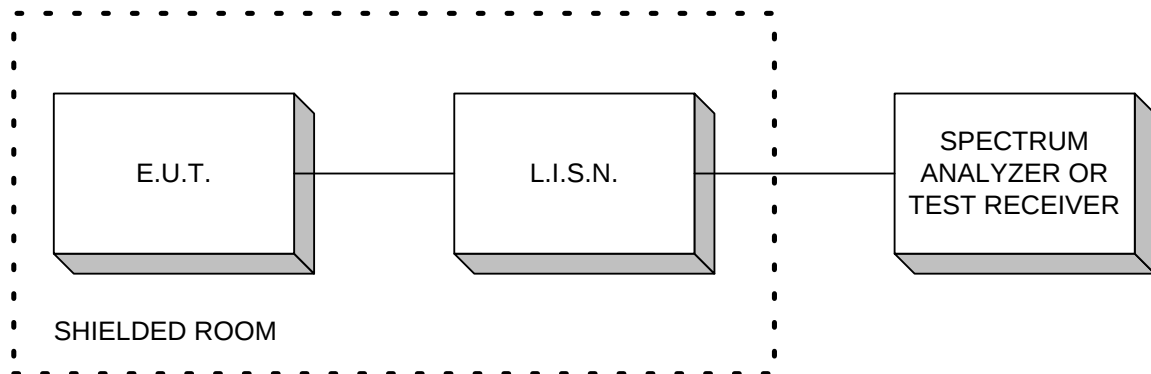
## **ANNEX B - TEST DIAGRAMS**

EQUIPMENT: ValveWatch

## Test Site For Radiated Emissions

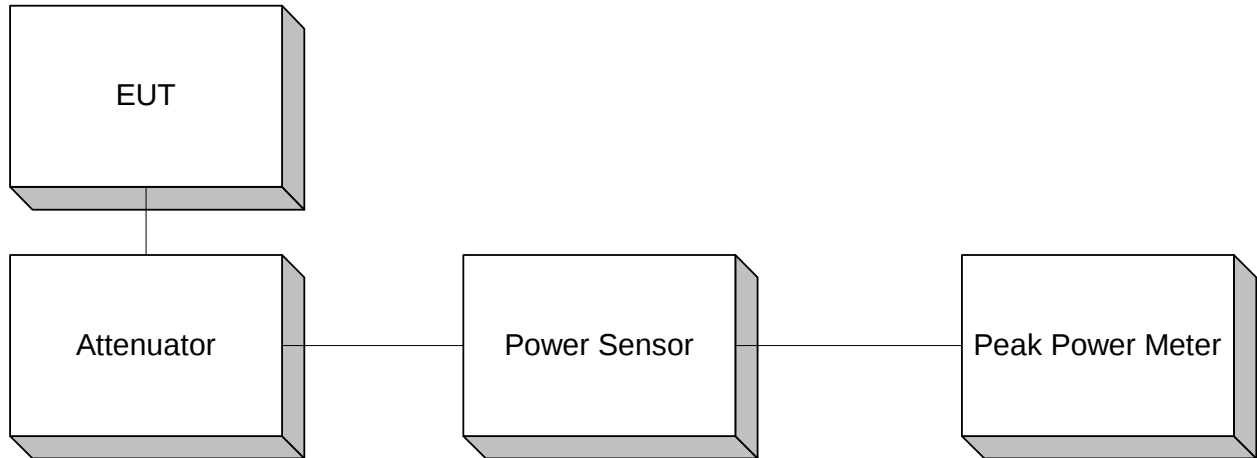


## Conducted Emissions



EQUIPMENT: ValveWatch

**Peak Power At Antenna Terminals**



**Minimum 6 dB Bandwidth  
Peak Power Spectral Density  
Spurious Emissions (conducted)**

