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FCC Test Report

Company:	HEMS Technology, Inc. 3013 Saint Bartholomew Drive Mansfield, TX 76063
Contact:	Bill Melendez
Product:	HEMS 220
FCC ID:	WFS-HEMS220
Test Report No:	R041808-01-03
APPROVED BY:	Doug Kramer Senior Test Engineer
DATE:	29 July 2008
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ACCREDITED
Certificate Number 1953-01

1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS: FCC Part 15, Subpart C			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
15.203	Unique Antenna Requirement	Pass	Soldered wire antenna
15.207	Conducted Emissions	Pass	Meets the requirement of the limit.
15.209	Radiated Emissions	Pass	Meets the requirement of the limit.
15.247(a)(2)	Minimum Bandwidth, Limit: min. 500kHz	Pass	Meets the requirement of the limit.
15.247(b)	Maximum Peak Output Power, Limit: Max. 23.9dBm	Pass	Meets the requirement of the limit.
15.247(e)	Power Spectral Density, Limit: Max. 8dBm	Pass	Meets the requirement of the limit.
15.247(d)	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.

1.2 Test Methods

1.2.1 Conducted AC Emissions

The EUT was powered by 120VAC/60Hz with a 50Ω load on the antenna port. Compliance to 47 CFR Part 15.207 was tested in accordance with the methods of ANSI/IEEE C63.4: 2003. Measurements were made on both conductors.

1.2.2 Radiated Emissions

Compliance to 47 CFR Parts 15.209 and 15.247 was tested in accordance with the methods of ANSI/IEEE C63.4: 2003. Several configurations were examined and the results presented represent a worst-case scenario. The EUT was placed on a wooden table approximately 80cm high and centered on a 4m diameter turntable. The table was rotated to find the angles of maximum emissions and the receiving antenna was moved from 1m to 4m in both vertical and horizontal positions. The EUT was tested while sitting both vertically and horizontally. The horizontal configuration produced the highest emissions, and that position was used for all radiated testing. All measurements were taken at a distance of 3m from the EUT for Part 15.209 intentional radiator measurements, and 3m for 15.247 measurements of the fundamental frequency in the 902MHz to 928MHz band and subsequent harmonics.

2.0 Description

2.1 Equipment under test

The HEMS220 device provides its user with the ability to perform point-of-load monitoring and control of common household AC appliances and fixtures. It is enclosed in a plastic housing designed to be "plugged in" directly to an AC socket. The housing contains an AC socket. The controlled/monitored load (light, fan, computer, etc.) is connected to this AC socket. The controlling circuit is comprised of a power supply, a wireless transceiver, an AC power monitor, an AC relay, and a microcontroller.

EUT Received Date: 22 May 2008
EUT Tested Dates: 30 July 2008

PRODUCT	HEMS220, Model 12015P
MODULATION TYPE	FSK
RADIO TECHNOLOGY	Half-duplex RF Link
FREQUENCY RANGE	903.50 – 926.75 MHz
NUMBER OF CHANNELS	32
MAX OUTPUT POWER	10.07 dBm (10.16mW)
ANTENNA TYPE	Internal
ASSOCIATED DEVICES	None

NOTE:
1. For more detailed features description, please refer to the manufacturer's specifications or User's Manual.

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility, which is a FCC and IC registered lab. This site has been fully described in previously submitted reports. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 45 ± 4%
Temperature of 20 ± 3° Celsius

2.3 Description of test modes

The EUT was tested at the frequencies below:

Channel	Frequency
1	903.50
16	914.43
32	926.75

2.4 Applied standards

The EUT uses digital modulation and operates between 902 MHz and 928 MHz. It has no AC mains connection. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.247) using ANSI/IEEE C63.4: 2003
FCC Part 15, Subpart C (15.209) using ANSI/IEEE C63.4: 2003

All test items have been performed and recorded as per the above standards.

2.5 Description of support units

None

2.6 Configuration of system under test

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously and a switch was added to change between channel 1, 16 and 32.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
Rohde & Schwarz Test Receiver	ESIB26	100037	14 August 2007
EMCO Biconilog Antenna	3142B	1647	8 Feb 2008
EMCO Horn Antenna	3115	6416	5 Feb 2008
Rohde & Schwarz LISN	ESH3-Z5	100023	6 Feb 2008

4.0 Detailed results

4.1 Unique antenna requirement

4.1.1 Standard applicable

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

4.1.2 Antenna description

The antenna is internal to the EUT and not replaceable.

4.2 Radiated emissions

4.2.1 Limits for radiated emissions measurements

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

4.2.2 Test procedures

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for peak and average detectors at frequencies above 1GHz.

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

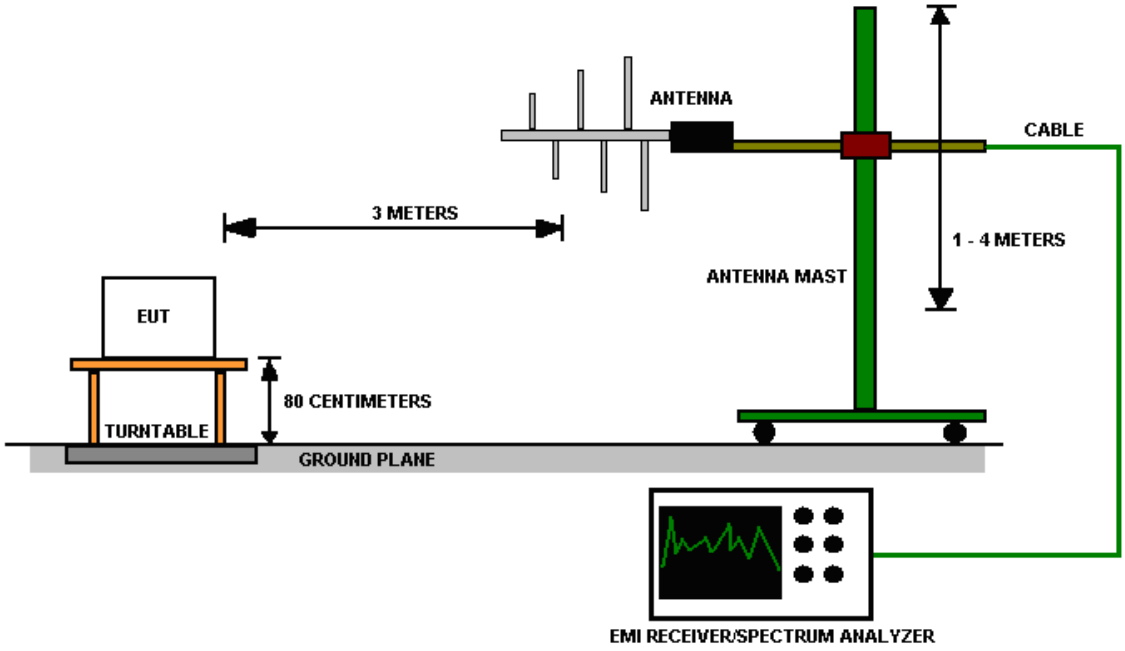


Figure 1 - Radiated Emissions Test Setup

For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

4.2.5 EUT operating conditions

The EUT was powered by 120VAC/60Hz from the AC mains supply and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.2.6 Test results

EUT	HEMS 220	MODE	Channel 1
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Quasi-peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
57.12	17.10	40	22.90	105	5	VERT
225.00	32.60	46	13.40	182	82	VERT
693.24	32.00	46	14.00	180	180	HORI
902.52	32.66	46	13.34	100	43	HORI
903.18	88.06	46	N/A*	100	52	HORI
903.84	88.20	46	N/A*	103	30	HORI
904.50	33.14	46	12.86	100	2	HORI

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. *Radiated limits do not apply within the 902MHz to 928MHz band.
6. ** Radiated emissions outside of the 902MHz to 928MHz band must be at least 20dB below the highest emission

EUT	HEMS 220	MODE	Channel 16
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Quasi-peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
56.94	18.14	40	21.9	100	313	VERT
225	31.7	40	8.3	112	82	VERT
913.92	34.96	46	11	100	260	HORI
914.46	86.9	46	N/A*	111	21	HORI
915.12	86.86	46	N/A*	102	14	HORI
915.72	35.31	46	10.7	101	164	HORI

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. *Radiated limits do not apply within the 902MHz to 928MHz band.
6. ** Radiated emissions outside of the 902MHz to 928MHz band must be at least 20dB below the highest emission

EUT	HEMS 220	MODE	Channel 32
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Quasi-peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
56.76	17.4	40	22.6	278	278	VERT
225	31.3	46	14.7	83	83	VERT
925.2	32.79	46	13.2	102	164	HORI
926.46	88.35	46	N/A*	103	31	HORI
927.18	88.44	46	N/A*	99	18	HORI
927.72	40.26	46	5.7	100	164	HORI

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. *Radiated limits do not apply within the 902MHz to 928MHz band.
6. **All emissions outside of the 902MHZ to 928MHZ bands are required to be 20dB below the highest emission

EUT	HEMS 220	MODE	Channel 1
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	1GHz – 10GHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1807.00	44.85	54.0	9.15	100	0	VER
2710.50	19.49	54.0	34.51	100	0	VER
3614.00	29.19	54.0	24.81	100	0	VER
4517.50	27.94	54.0	26.06	100	0	VER

Peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1807.00	55.34	74.0	18.66	100	0	VER
2710.50	29.07	74.0	44.93	100	0	VER
3614.00	33.23	74.0	40.77	100	0	VER
4517.50	35.16	74.0	38.84	100	0	VER

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

EUT	HEMS 220	MODE	Channel 16
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	1GHz – 10GHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1828.86	45.07	54.0	41.93	100	0	VER
2743.29	19.36	54.0	34.64	100	0	VER
3657.72	27.22	54.0	26.78	100	0	VER
4572.15	29.58	54.0	24.42	100	0	VER

Peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1828.86	55.75	74.0	18.25	100	0	VER
2743.29	31.21	74.0	42.79	100	0	VER
3657.72	34.42	74.0	39.58	100	0	VER
4572.15	32.85	74.0	41.15	100	0	VER

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

EUT	HEMS 220	MODE	Channel 32
INPUT POWER	$120V_{AC}$, 60Hz	FREQUENCY RANGE	1GHz – 10GHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1853.50	44.91	54.0	9.09	100	0	VER
2780.25	18.73	54.0	35.27	100	0	VER
3707.00	28.39	54.0	25.61	100	0	VER
4633.75	24.03	54.0	29.97	100	0	VER

Peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1853.50	55.80	74.0	18.2	100	0	VER
2780.25	30.53	74.0	43.47	100	0	VER
3707.00	35.78	74.0	38.22	100	0	VER
4633.75	33.03	74.0	40.97	100	0	VER

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

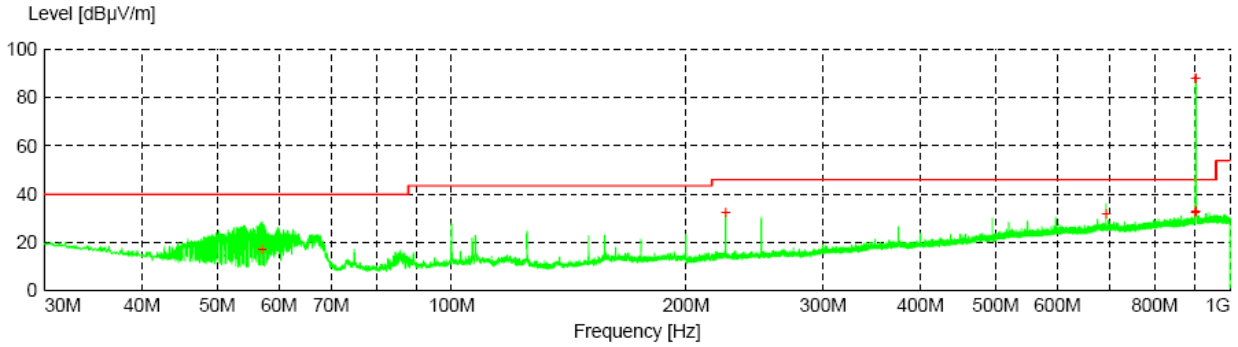


Figure 2 - Radiated Emissions Plot, Channel 1

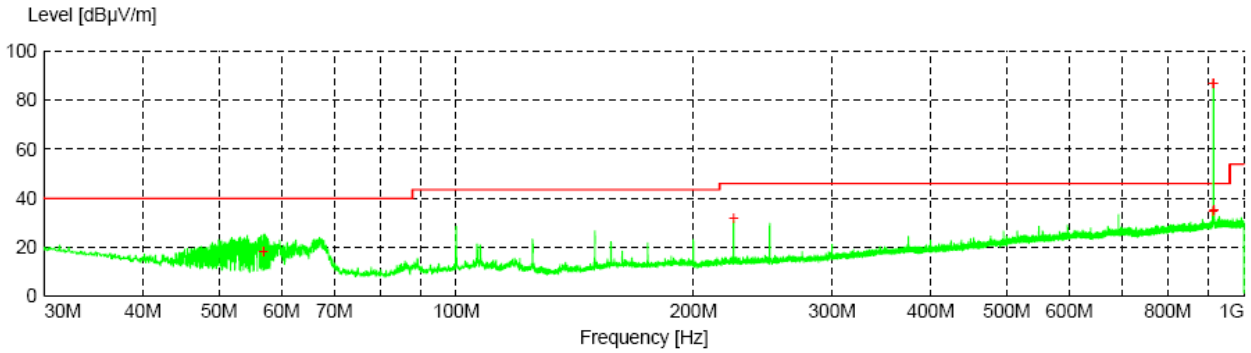


Figure 3 - Radiated Emissions Plot, Channel 16

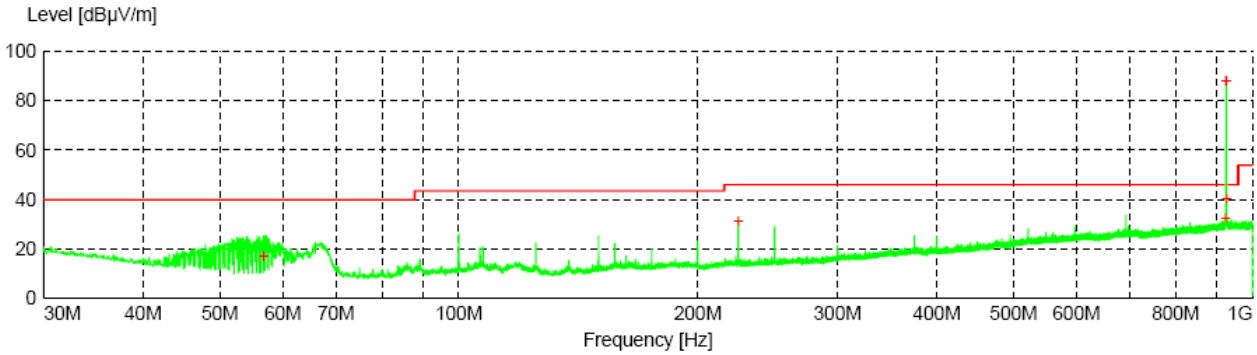


Figure 4 - Radiated Emissions plot, Channel 32

4.3 Bandwidth

4.3.1 Limits of bandwidth measurements

The minimum 6dB bandwidth shall be at least 500kHz.

4.3.2 Test procedures

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 10 kHz RBW and 10 MHz VBW. The 20 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level. The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded. The signal was then captured with a 100kHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 99% occupied bandwidth.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

4.3.5 EUT operating conditions

The EUT was powered by 120VAC/60Hz from the AC mains supply and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.3.6 Test results

EUT	HEMS 220	MODE	Channel 1, 16, 32
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BW (kHz)	6dB Min LIMIT (kHz)	RESULT
1	903.50	833.707	500.00	PASS
16	914.43	865.731	500.00	PASS
32	926.75	889.779	500.00	PASS

REMARKS:

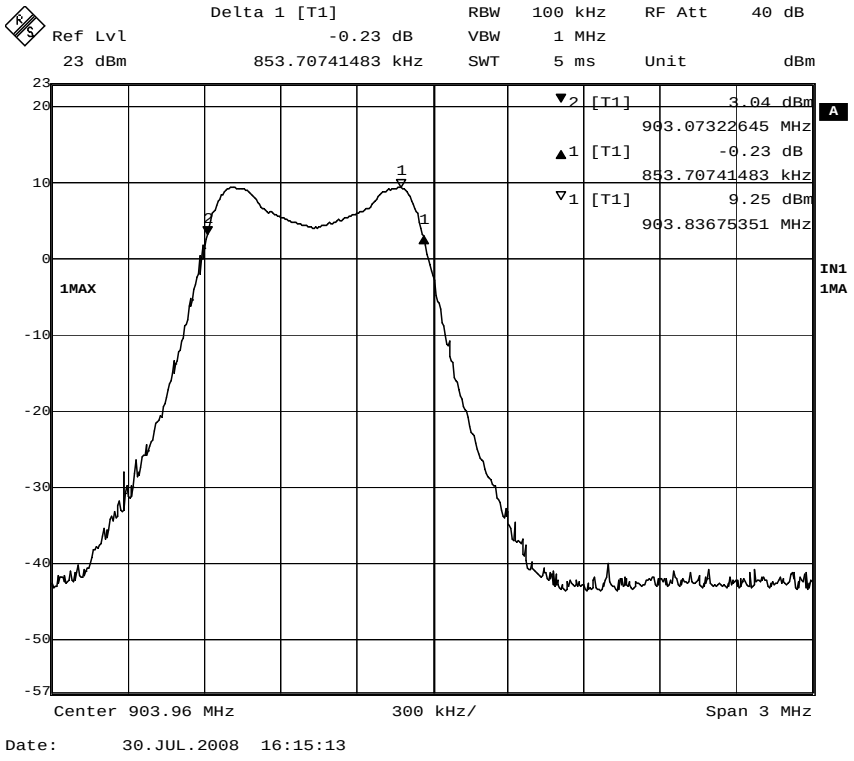


Figure 5 - 6dB Bandwidth, Channel 1

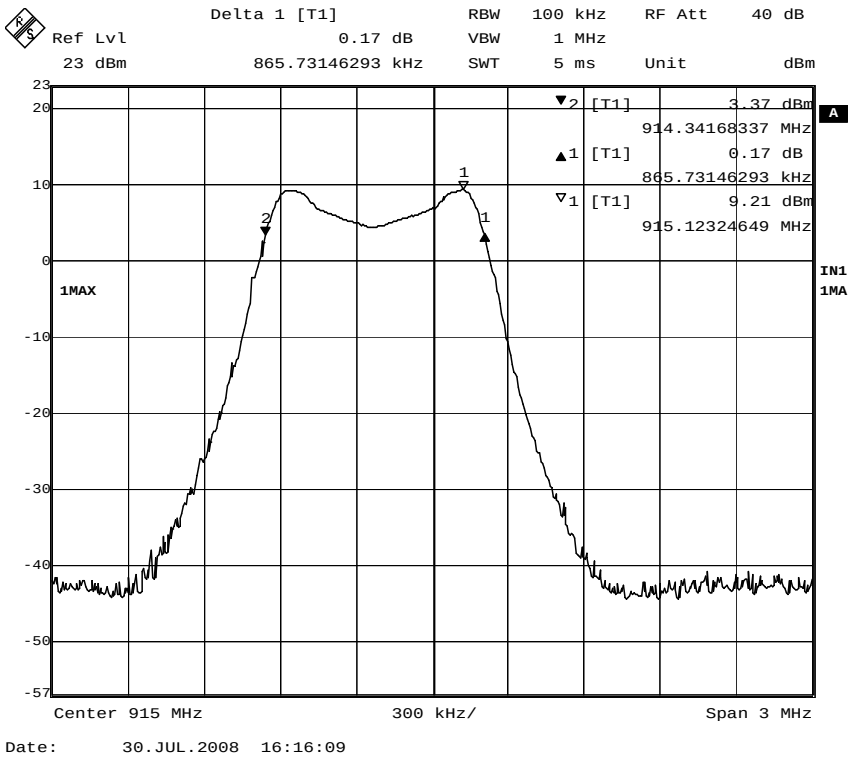


Figure 6 - 6dB Bandwidth, Channel 16

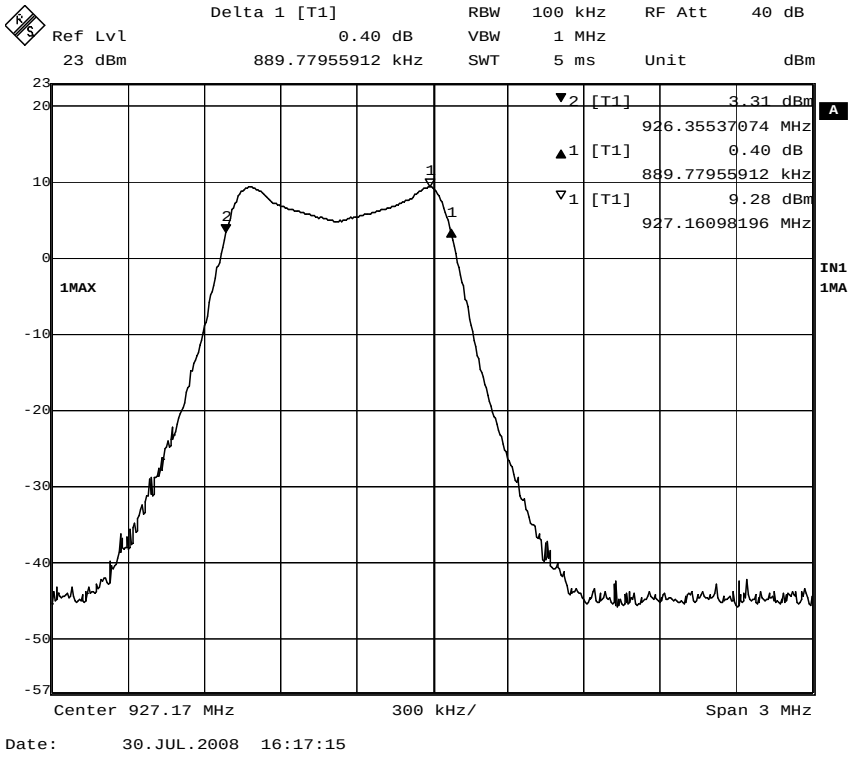


Figure 7 - 6dB Bandwidth, Channel 32

4.4 Maximum peak output power

4.4.1 Limits of power measurements

The maximum peak output power allowed is 30dBm (1000mW).

4.4.2 Test procedures

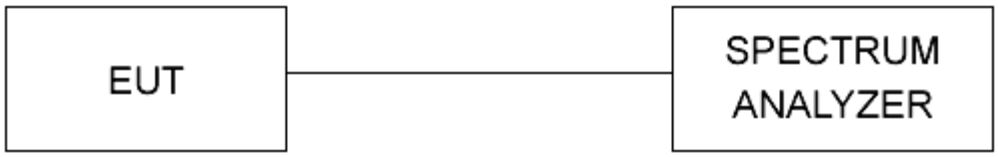
1. The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable.

2. The resolution bandwidth was set to 10MHz and the video bandwidth was set to 10MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup



4.4.5 EUT operating conditions

The EUT was powered by 120VAC/60Hz from the AC mains supply and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.4.6 Test results

EUT	HEMS 220	MODE	Channel 1, 16, 32
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	902-928MHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Maximum peak output power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	902.50	10.05	30	PASS
16	914.43	10.00	30	PASS
32	926.75	10.07	30	PASS

REMARKS:
None

4.5 Bandedges

4.5.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (902MHz – 928MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

4.5.2 Test procedures

The EUT was tested in the same method as described in section *4.2 - Radiated emissions*. The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 120kHz and the EMI receiver was used to scan from the bandedge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the bandedge was measured and recorded. If the out of band emissions do not fall within a restricted band from 15.205, then it is required that the out of band emission be 20dB below that of the fundamental emission level. If the out of band emission falls with a restricted band from 15.205, then it is required that the emission be below the limits from 15.209.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup

See 4.2.4

4.5.5 EUT operating conditions

The EUT was powered by 120VAC/60Hz from the AC mains supply and set to transmit continuously on the lowest frequency channel and highest frequency channel.

4.5.6 Test results

EUT	HEMS 220	MODE	Channel 1, 16, 32
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	902-928MHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Highest Out of Band Emissions

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level dBµV/m	Highest in band level dBµV/m	Delta	Limit (dBc) max	Result
0 (903.84MHZ)	902.52 MHz	32.66	88.20	-55.54	-20.00	PASS
32(927.18MHz)	927.72 MHz	40.26	88.44	-48.18	-20.00	PASS

NOTE:
EUT was tested as described in section 4.2. All measurements above were taken from section 4.2. The highest out of band measurement was maximized in a 1MHz frequency band, so the frequency may be slightly within the frequency band, but represents a worse-case scenario for all out of band measurements.

4.6 Power Spectral Density

4.6.1 Power spectral density measurements

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

4.6.2 Test procedures

Because the EUT contained no means for direct connection to the antenna port, measurements were made at a 3m distance and the output power was calculated using 0dBi as the gain of the transmitting antenna. The spectrum analyzer was set to 3 kHz RBW and 30 kHz VBW, the sweep time was 500s. The power spectral density was measured and recorded at the frequency with the highest emission. The sweep time is allowed to be longer than span/3KHz for a full response of the mixer in the spectrum analyzer.

4.6.3 Deviations from test standard

No deviation.

4.6.4 Test setup

See section 4.4

4.6.5 EUT operating conditions

The EUT was powered by 120VAC/60Hz from the AC mains supply and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

EUT	HEMS 220	MODE	Channel 1, 16, 32
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	902-928MHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Power Spectral Density

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN # KHz BW (dBm)	MAXIMUM POWER LIMIT (dBm)	RESULT
1	903.50	-0.40	8.00	PASS
16	914.43	-0.42	8.00	PASS
32	926.75	-0.93	8.00	PASS

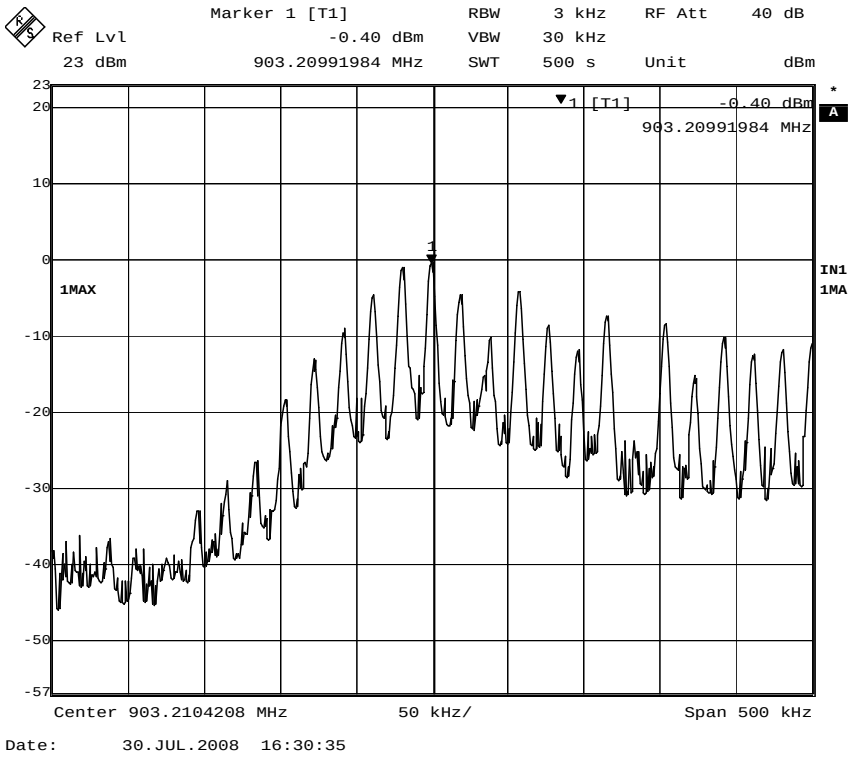


Figure 8 – PSD, Channel 1

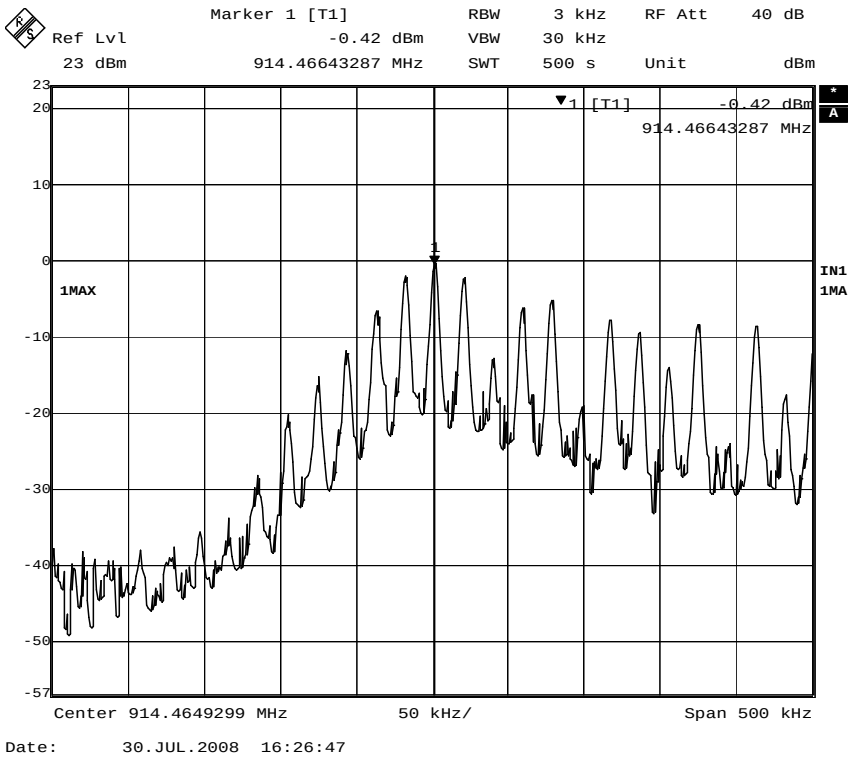


Figure 9 – PSD, Channel 16

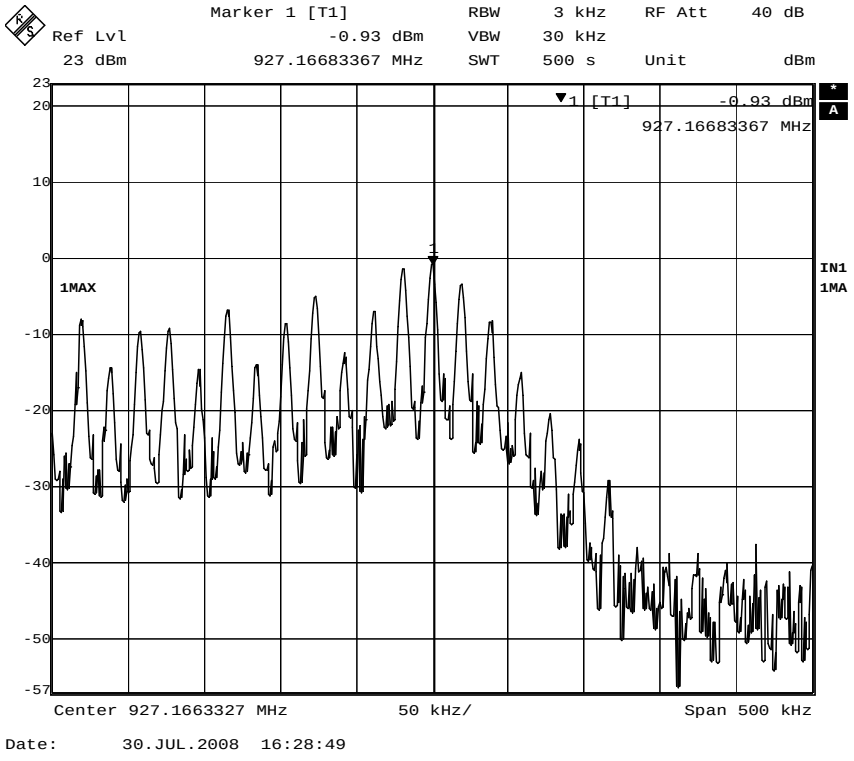


Figure 10 - PSD, Channel 32

4.7 Conducted AC Mains Emissions

4.7.1 Limits for conducted emissions measurements

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

NOTE: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

4.7.2 Test Procedures

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.

c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits could not be reported

4.7.3 Deviation from the test standard

No deviation

4.7.4 Test setup

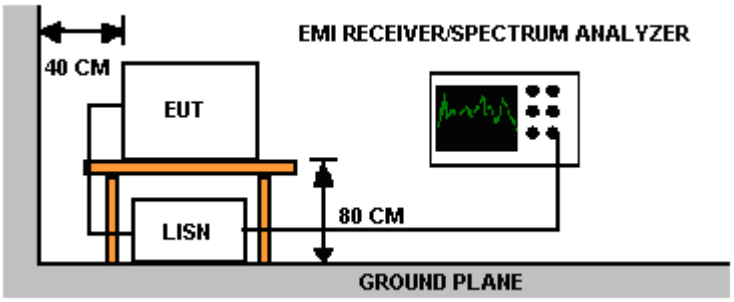


Figure 11 - Conducted Emissions Test Setup

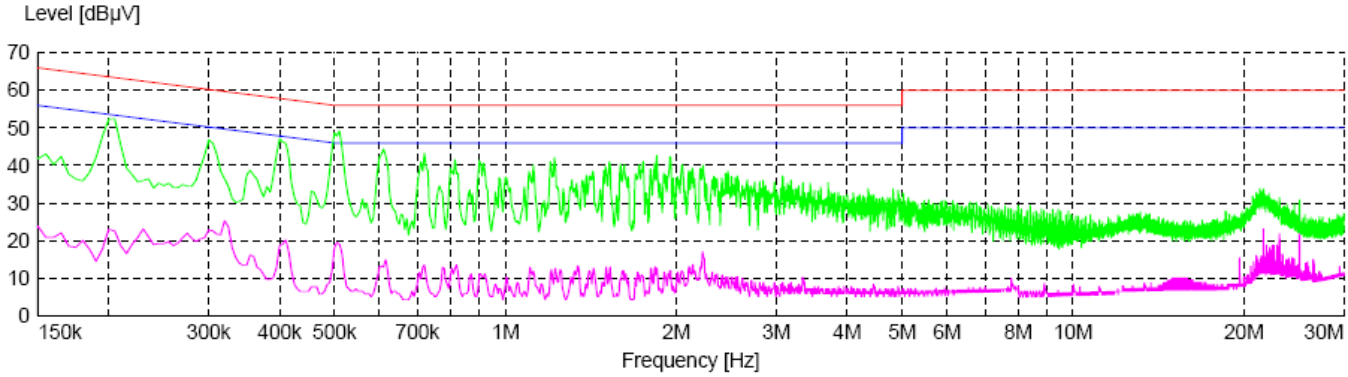
For actual test configuration, see photographs in Appendix A

4.7.5 EUT operating conditions

The EUT was powered by a 120VAC/60Hz from the AC mains supply network. A 50Ω terminator was applied to the RF port.

4.3.6 Test Results

EUT	HEMS 220	MODE	Channel 1
INPUT POWER	120V_{AC}, 60Hz	FREQUENCY RANGE	150kHz – 30MHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson



REMARKS:
1. Q.P. and AV. are abbreviations for quasi-peak and average respectively.
2. All emission levels were greater than 20dB below the limit.

Appendix A: Test Photos

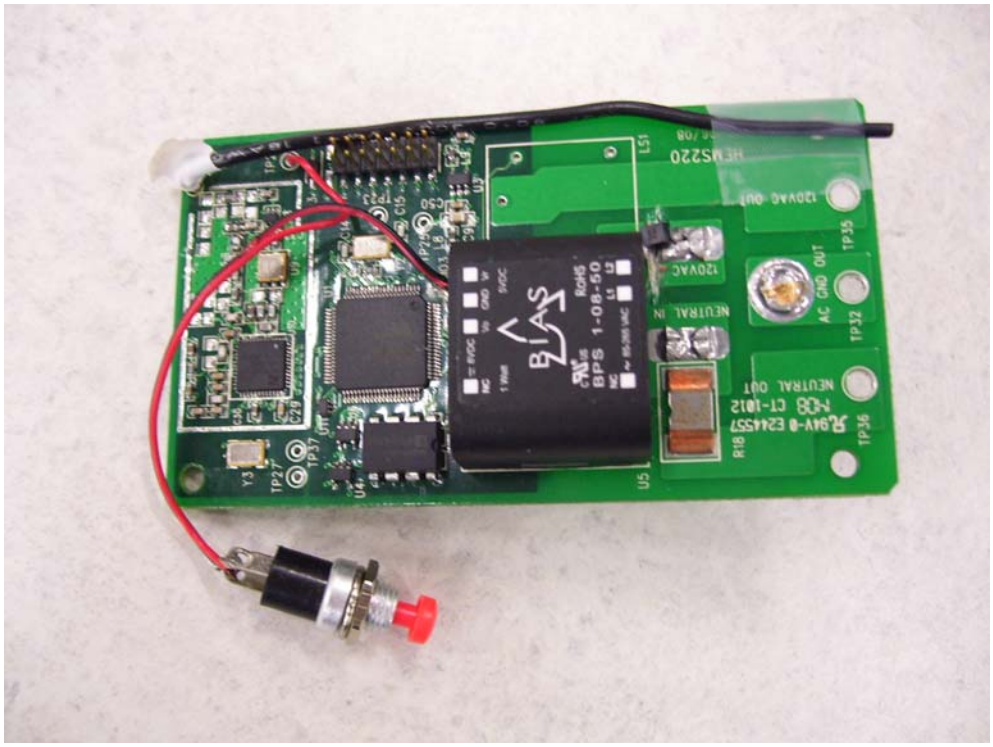


Figure 12 - EUT

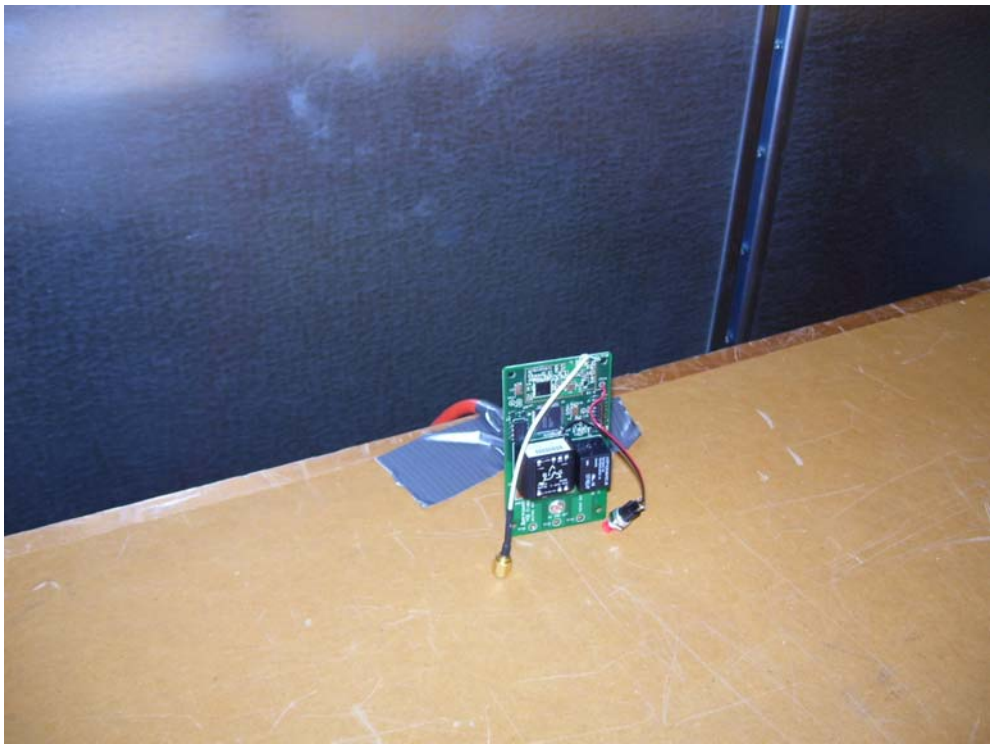


Figure 13 - Conducted Emissions Test Setup

Figure 14 - Radiated Emissions Test Setup

Appendix B: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

Appendix C: RF Exposure Evaluation

FCC ID: WFS-HEMS220
RF Exposure Statement for WFS-HEMS220:

Notice in Installation Manual:
FCC Radiation Exposure Statement
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 1.8cm (0.709 inches) between the radiator and your body.

RF Exposure Calculations:

The following information provides the minimum separation distances for the two major antenna types used in this system.

Directional Antenna:
The internal dipole antenna is the only antenna to be used with the product and has a maximum gain of 1.5 (1.76dBi). The minimum separation distance is calculated from **FCC OET 65 Appendix B, Table 1B** Guidelines for General Population/Uncontrolled Exposure. This calculation is based on the highest EIRP possible from the system, considering maximum power and antenna gain. The exposure limit for a transmitter operating at 902.5MHz is found in mW/cm^2 using the equations f/1200. Since the operating frequency for channel 0 produced the lowest limit, that limit will be used in calculation. (926.75/1200 = 0.376 mW/cm^2)

S = (Po * G) / (4 * Pi * r^2) or r = SQRT [(Po * G) / (4 * Pi * S)]

Where S = 0.376 mW/cm^2 for 926.75 MHz
Where Po = 10.16 mW (Peak RF, 10.07dBm)
Where G = 1.5 (numeric equivalent to 1.76dBi antenna gain with 0.0 dB cable loss)
Where r = Minimum Safe Distance from antenna (cm)

For Po = 10.16mW, r = 1.80cm (0.709 inches)

For a distance [r] of 20cm from this antenna, the field density S = 0.003 mW/cm^2

Notes:
1. The minimum safe distance is based on a conservative "worst case" prediction, i.e. using the formula shown above and no duty factor. In practice the minimum distance will be much shorter. (Ref. 2)
2. The minimum safe distance has been calculated for the maximum allowed Power Density (S) limit of 0.376 mW/cm^2 for the frequency 926.75 MHz for uncontrolled environments (Ref. 2).

References:
1. FCC Part 15, sub-clause 15.247 (b) (4) (i)
2. FCC OET Bulletin 65, Edition 97-01
3. FCC Supplement C to OET Bulletin 65, edition 01-01

Appendix D: Table of Figures

Figure **Page Number**