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Test Report

Company:	VivoMetrics 121 N. Fir St. Suite E Ventura, CA 93001
Contact:	Mary Nielsen
Product:	LifeShirt LS300-RX-US
FCC ID: IC:	UWVLS300RX 6897A-LS300RX
Test Report No:	101906-31-05A
APPROVED BY:	Nic Johnson Test Engineer
DATE:	18 October 2007
Total Pages:	32

1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS: 47 CFR Part 15 & RSS-210			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
15.203 RSS-Gen	Unique Antenna Requirement	Pass	PCB Antenna
15.207 RSS-Gen	Conducted Emissions	Pass	Meets the requirement of the limit.
15.209 RSS-Gen	Radiated Emissions	Pass	Meets the requirement of the limit.
15.249 RSS-210, Issue 7	Peak Output Field Strength Limit: 93.98dBµV/m	Pass	Meets the requirement of the limit.

1.2 Test Methods

1.2.1 Conducted Emissions

The EUT was powered by an internal battery and had no connection to the public mains. Conducted emissions measurements were performed on the battery charger, which was from Phihong, M/N PSM11R-050.

1.2.2 Radiated Emissions

Compliance to CFR 47 Parts 15.209 and 15.249 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 15.249 measurements of the fundamental frequency in the 902MHz to 928MHz band and subsequent harmonics.

1.3 Reason for report revision

1.3.1 An annex covering exposure to radiation was removed because it was not necessary for a device tested under FCC part 15.249.

1.3.2 Section 4.2.5 was modified to state that the EUT was transmitting a pulse train instead of continuously. The unit testing was transmitting a pulse train as can be seen in Appendix A. This is the only possible mode of operation for the EUT.

1.3.3 All quasi-peak measurements below 1GHz were deleted and replaced with peak measurements.

1.3.4 The power output was recalculated using the measured peak field strength at 3 meters and a gain of 2.14dBi for a quarter-wave antenna. This calculation replaced the value in the previous report.

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was a LifeShirt First Responder personal monitoring system that collects physiological data and wirelessly transmits it to a base station to be recorded on a PC. The unit includes a chest strap that connects to a transmitter module that is intended to be attached to a belt. The unit records heart rate, breath rate, skin surface temperature, orientation, and activity level.

EUT Received Date: 29 Dec 06
EUT Tested Date: 3, 9 10, Jan 2007

PRODUCT	LifeShirt 300 Transmitter Module
MODEL	LS300-RX-US
POWER SUPPLY	N/A
MODULATION TYPE	FSK
RADIO TECHNOLOGY	DTS
FREQUENCY RANGE	915MHz
NUMBER OF CHANNELS	1
MAXIMUM 3M FIELD STREGNTH	79.01dBμV/m
ANTENNA TYPE	internal
I/O PORTS	1 connection to chest strap or charger
ASSOCIATED DEVICES	LS300-RX-US Base Station

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

Channel	Frequency
1	915 MHz

2.4 Applied standards

The EUT is a digital transmission device operating on one frequency between 902 MHz and 928 MHz. 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
Industry Canada, RSS-210, Issue 7

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

2.5 Description of support units

The EUT was tested while connected to a LifeShirt monitoring system, which is a strap/sensor unit that goes around the chest with a support strap that goes around the shoulder.

2.6 Configuration of system under test

The EUT was tested in several possible orientations (upright and horizontal and other) in order to determine the position with the greatest emissions. The results of testing in that worst-case orientation are presented here.

The EUT is configured by the manufacturer to transmit on only one channel (915MHz) and at a single specified power level. The results presented in this report are intended only to represent this combination of manufacturer settings. It is not possible for the user to adjust any of these settings in any way.

The transmitter was pulsed as it would be in normal operation. The EUT is configured so that it cannot transmit data at a faster rate and the pulse width and duration is fixed, so the EUT was tested in a worse-case scenario, as there is only one transmit mode.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
Rohde & Schwarz Test Receiver	ESIB26	100037	15-Aug-06
EMCO Biconilog Antenna	3142B	1654	13-Mar-06
EMCO Horn Antenna	3115	6416	29-Jan-07
Rohde & Schwarz Preamplifier	TS-PR18	082001/003	8-June-07
Rohde & Schwarz Artificial Mains	ESH2-Z5	100021	19-May-06
Trilithic Inc. High Pass Filter	200332488	6HC6600-1.5-KK	8-June-07

4.0 Detailed results

4.1 15.203 Unique antenna requirement

4.1.1 Standard applicable

For intentional radiating devices, according to 47 CFR Part 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 supplied with the EUT is an internal PCB mounted antenna and is not interchangeable.

4.2 15.209 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 (uV/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 receive 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. The EUT was a portable device and was therefore testing was required in 3 major axis. These orientations in addition to the rotation of the turntable provide measurements in all 3 of the major axis of the EUT. It was found that the upright configuration produced the highest emissions, and that configuration was used for all tests. A photo of the configurations can be seen in appendix A, Figures 8 and 9.

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

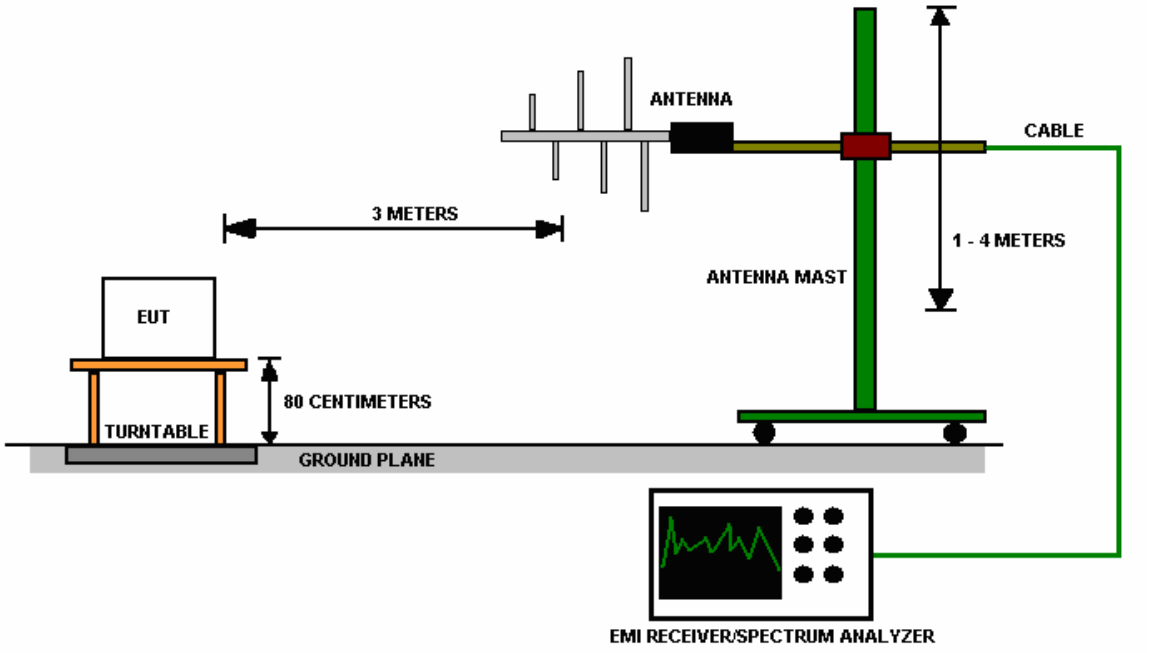

Figure 1 - Radiated Emissions Test Setup

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 an internal battery and was connected to a LifeShirt sensor belt. When the LifeShirt is connected, the EUT actively transmits data. The EUT was transmitting a pulse train as in normal operation. See Appendix C for information on the duty cycle.

4.2.6 Test results

EUT	Vivometrics LifeShirt	Model	LS300-RX-US
MODE	Transmit	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	+5V Internal Battery	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
85.920000	17.16	39.0	21.84	374.0	183	HORI
168.000000	25.63	43.5	17.87	100.0	162	HORI
183.960000	34.22	43.5	9.28	149.0	158	HORI
184.320000	29.35	43.5	14.15	111.0	157	HORI
199.980000	29.38	43.5	14.12	117.0	39	HORI
438.900000	28.50	46.4	17.90	114.0	279	VERT
487.740000	30.98	46.4	15.42	101.0	311	VERT
536.520000	37.02	46.4	9.38	99.0	271	VERT
612.840000	28.16	46.4	18.24	223.0	6	VERT

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. See section 4.4 for measurements in the 902MHz to 928MHz band.

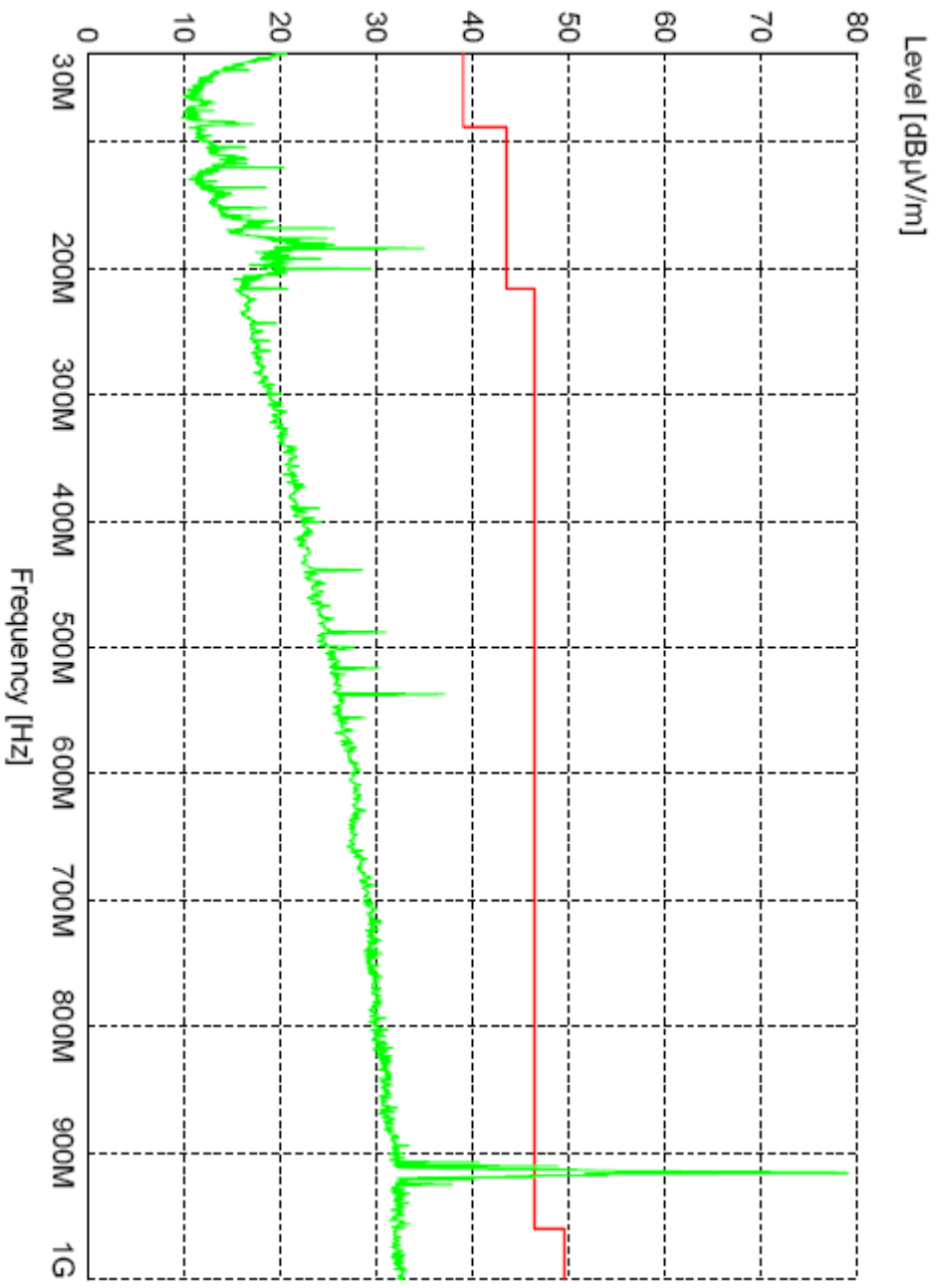

Figure 2 - Spurious Radiated Emissions Plot, 30MHz - 1GHz

EUT	Vivometrics LifeShirt	Model	LS300-Rx-US
MODE	Transmit	FREQUENCY RANGE	1GHz – 10GHz
INPUT POWER (SYSTEM)	+5V, Internal Battery	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

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. All measurements were made after finding the angle, antenna height, and receiving antenna polarization of the highest emission.
5. Margin value = Emission level – Limit value.
6. Measurements were made with a spectrum analyzer set to max hold. A peak detector was used with a resolution bandwidth of 1MHz, video bandwidth of 10MHz and a frequency span of 5Hz. The peak emission of the spectrum in max hold was recorded as the peak in the table below.
6. All measurements were found to comply with the limits in 15.209 with a resolution bandwidth of 1MHz. Measurements at 100kHz resolution bandwidth according to 15.247(c) were therefore not required.
7. All average measurements were made by applying an averaging factor of -20dB to the peak measurements. See Appendix D for details on the calculation of the averaging factor.
8. According to part 15.35(b) of the FCC rules, the peak limit is 20dB above the average limit specified in part 15.209.

Average Measurements

Frequency	Level	Limit	Margin
MHz	dBµV/m	dBµV/m	dB
1829.500000	50.77	54.0	3.23
2744.500000	50.33	54.0	3.67
3659.500000	49.40	54.0	4.60
4564.500000	38.92	54.0	15.08
5479.000000	33.38	54.0	20.62
6418.500000	35.96	54.0	17.04

Peak Detector Measurements

Frequency	Level	Limit	Margin
MHz	dBµV/m	dBµV/m	dB
1829.500000	70.77	74.0	3.23
2744.500000	70.33	74.0	3.67
3659.500000	69.40	74.0	4.60
4564.500000	58.92	74.0	15.08
5479.000000	57.38	74.0	16.62
6418.500000	55.96	74.0	18.04

4.3 15.207 Conducted AC Mains Emissions

4.3.1 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.

4.3.2 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

d. Results of testing a PC alone and with the EUT connected were compared to verify that the EUT does not cause the emissions of the PC to go over the 15.207 limits.

4.3.3 Deviation from the test standard

No deviation

4.3.4 Test setup

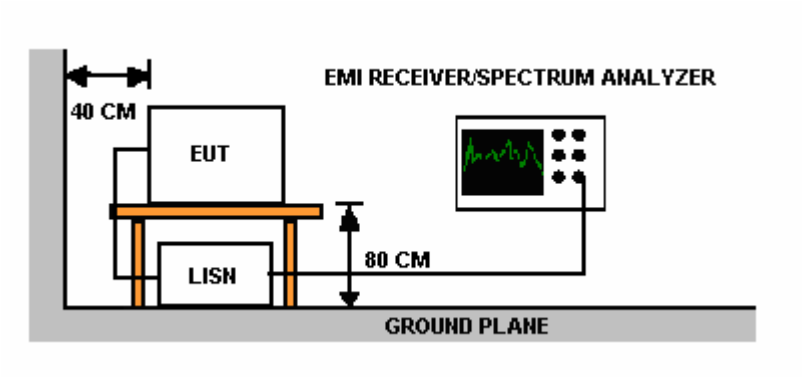

Figure 3 - Conducted Emissions Test Setup

For actual test configuration, see photographs in Appendix A

4.3.5 EUT operating conditions

The EUT was powered by a +5VDC internal battery which required no conducted emissions testing. The battery was charged by a switching power supply from Phihong, M/N PSM11R-050. The battery charger was tested for conducted emissions per FCC Part 15.107.

4.3.6 Test Results

EUT	Vivometrics LifeShirt	Model	LS-300
MODE	Charging	FREQUENCY RANGE	150kHz – 30MHz
INPUT POWER (SYSTEM)	+5VDC Battery Charger	PHASE	Line, Neutral
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

SEE FIGURE 4, PAGE 18

REMARKS:
1. Q.P. and AV. Are abbreviations for quasi-peak and average respectively.
2. All emission levels were greater than 15dB below the limit.

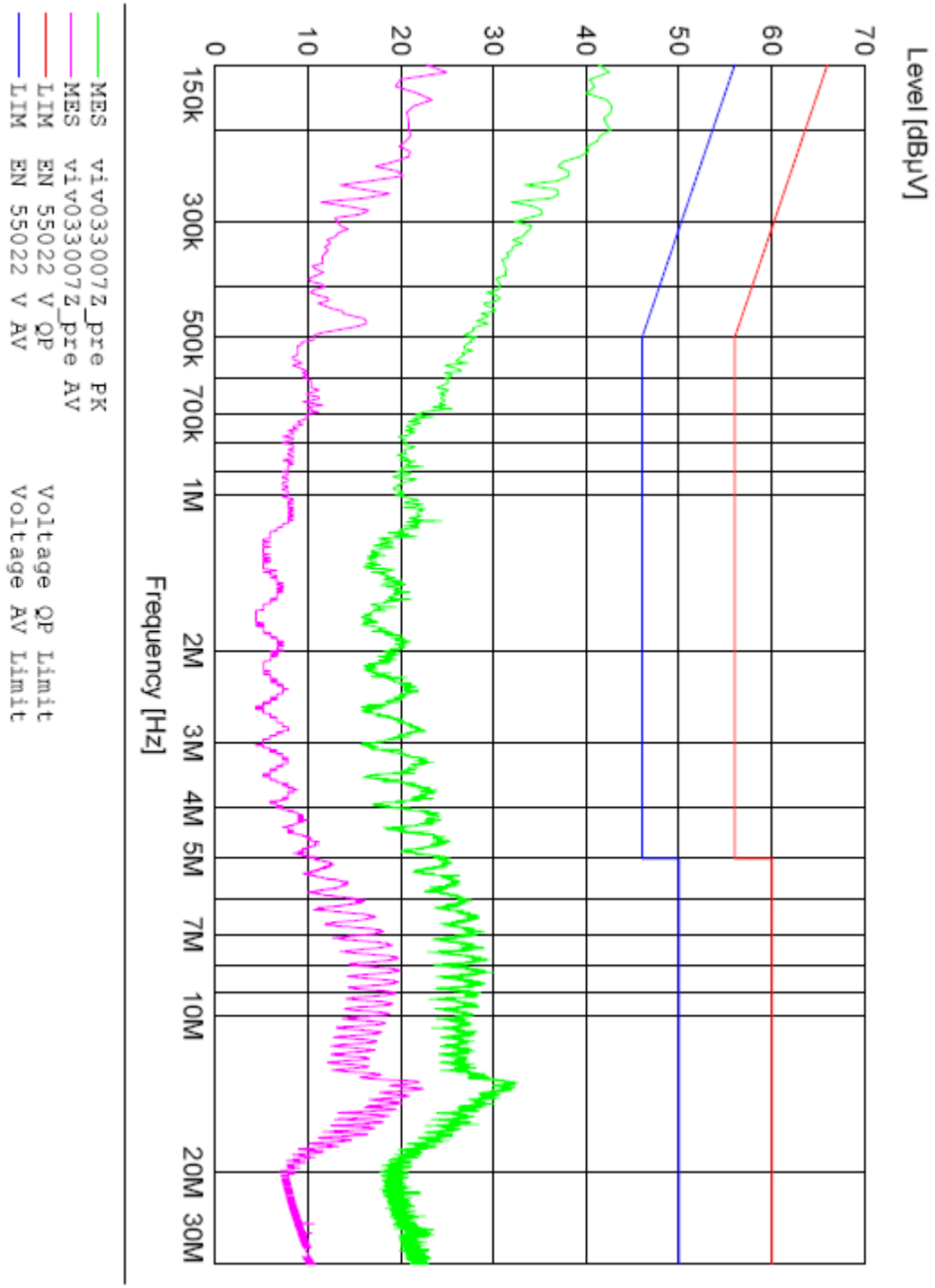

Figure 4 - Conducted Emissions Plot, Battery Charger

4.4 15.249 Operation within the 902-928MHz Band

4.4.1 Limits for radiated emissions measurements

Emissions radiated inside of the specified bands shall be applied to the limits in 15.249 as followed:

Fundamental Frequency (MHz)	Field Strength of fundamental (mV/m)	Field Strength of harmonics (µV/m)
902–928	50	500
2400–2483.5	50	500
5725–5875	50	500
24000.0–24250.0	250	2500

NOTE:
1. The 15.209 limit shall apply at bandedge transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (uV/m).
3. Field strength of harmonics is covered by section 4.2. All harmonics of the transmitter are above 1 GHz, and limits for these measurements are the same in section 15.209 as section 15.249.
4. Field strength limits are specified at a distance of 3 meters.
5. 50mV/m = 93.98dBµV/m

4.4.2 Test procedures

Same as in section 4.2.2 of this report.

4.4.5 EUT operating conditions

The EUT was powered by an internal battery and was connected to a LifeShirt sensor belt. When the LifeShirt is connected, the EUT actively transmits data. The EUT was modified to transmit data continuously.

4.4.6 Test results

EUT	Vivometrics LifeShirt	Model	LS300-RX-US
MODE	Transmit	FREQUENCY RANGE	902MHz – 928GHz
INPUT POWER (SYSTEM)	+5V Internal Battery	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3ºC	TECHNICIAN	NJohnson

Peak Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
902.580000	31.81	93.98	62.17	101.0	135	HORI
907.920000	40.69	93.98	53.29	150.0	14	HORI
909.780000	31.99	93.98	61.99	185.0	0	VERT
910.980000	48.79	93.98	45.19	179.0	8	VERT
915.000000	79.01	93.98	14.97	314.0	358	VERT
917.640000	53.61	93.98	40.37	99.0	196	VERT
918.960000	46.46	93.98	47.52	100.0	343	VERT
924.300000	35.29	93.98	58.69	99.0	197	VERT
927.300000	31.6	93.98	62.38	314.0	125	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. See Figure 2 on page 13 for a plot for the results.

Appendix A: Test Photos

Figure 5 - Radiated Emissions Test Setup, Sideways Configuration

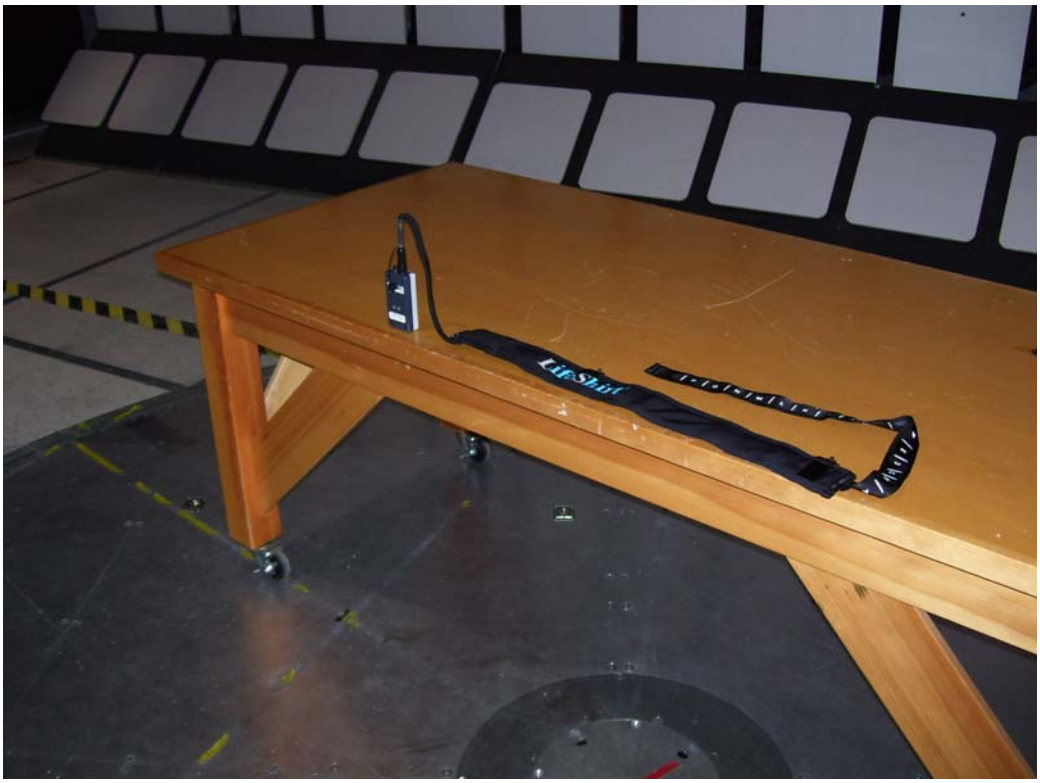

Figure 6 - Radiated Emissions Test Setup, Upright Configuration

Figure 7 - Conducted 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.

In this case, T_{on} = 4ms, AV = 20dB.

Appendix C: Transmitter Duty Cycle Calculation

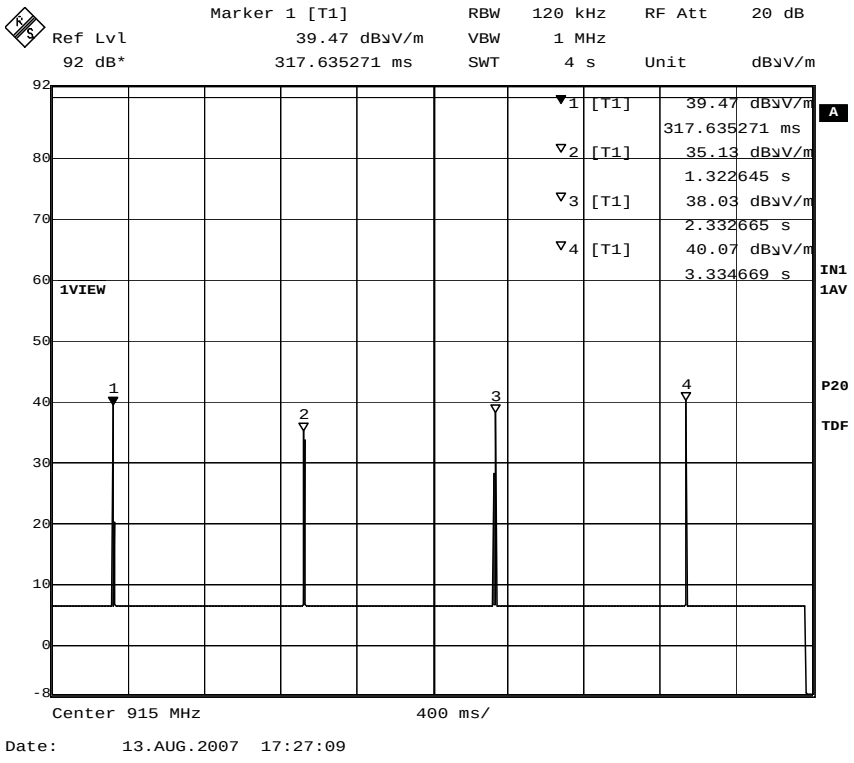

Figure 8 - Pulse Period: 1.00s

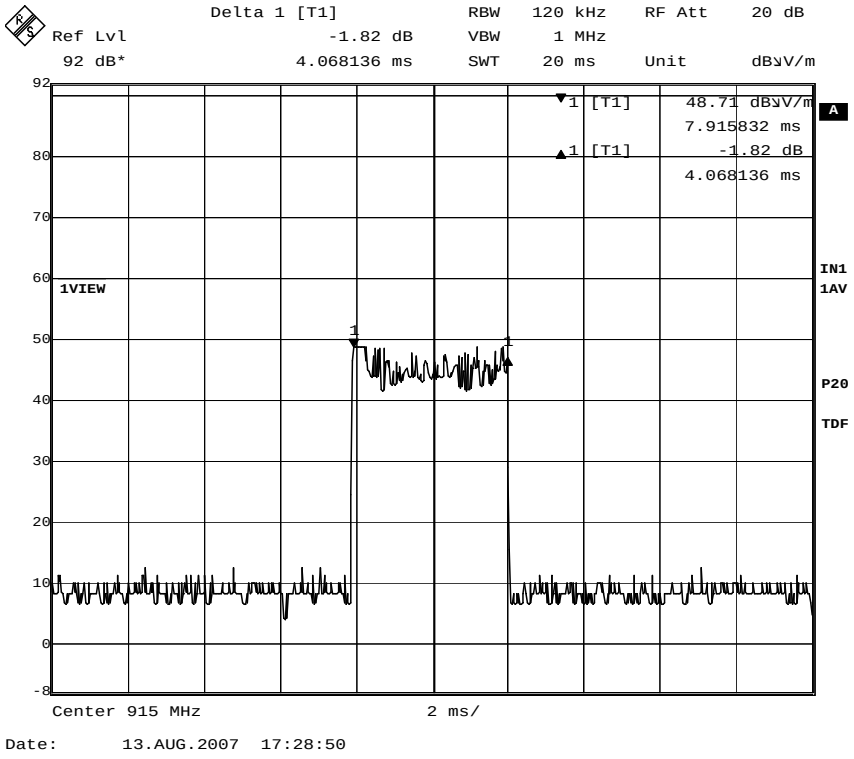

Figure 9 - Pulse Width = 4.1ms

Calculation of Transmitter Duty Cycle

Pulse duration = 4.1ms
Pulse period = 1.00s

From Figures 11 and 12:
Transmitter Duty cycle = Pulse duration/pulse period = 0.0041

According to part 15.35(c) of the rules, this is the maximum duty cycle correction factor allowed to be used:

Pulse duration = 4.1ms
Pulse period = 0.10s (maximum allowed by 15.35(c))

Transmitter Duty cycle = Pulse duration/pulse period = 0.041 ≅ -27dB

The maximum possible averaging factor allowed is -20dB, so a -20dB averaging factor was applied to the peak measurements to obtain the average measurements where applicable.

Appendix D: Table of Figures

Figure **Page Number**