Emissions Testing
Performed
on the
BodyMedia
SenseWear Pro Armband
Model: 909901G01RevD

To

FCC Part 15 Subpart C, 15.249

Date of Test: September 14-15, 2001

Report Number: 3009190A

Contact: Maria Fattore

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I – Introduction and Summary

TO: Ms. Maria Fattore
FROM: Nicholas Abbondante, Compliance Engineer
DATE: September 14-15, 2001
PROJECT #: 3009190
RE: Emissions testing of the SenseWear Pro Armband, Model: 909901G01RevD

On September 14-15, 2001 we tested the SenseWear Pro Armband, Model: 909901G01RevD to determine if it was in compliance with the FCC Part 15, Subpart C, 15.249, "Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz" requirements.
A prototype version of the sample was received on 9/10/2001 in good condition. We found that the unit met the Part 15 requirements when tested as received. Note that testing was originally performed under the project number 3008639.

The following table summarizes the results of testing.

Test	Frequency (MHz)	Measurement	Requirement	Pass/Fail	Section of FCC Rules	Section of Test Report
Fundamental Field Strength	916.5	87.7 dBµV/m	94.0 dBµV/m	Pass	15.249	Table 1
Harmonic Emissions	1833.0	39.2 dBµV/m	54.0 dBµV/m	Pass	15.249	Table 1
Restricted Band & Spurious Emissions	432.1	41.6 dBµV/m	46.0 dBµV/m	Pass	15.249, 15.205 15.209	Table 1
Line-Conducted Emissions	0.679	46.0 dBµV	48.0 dBµV	Pass	15.207	Table 2
Bandwidth	916.5	<4 MHz, which is within 902-928 MHz	Waveform within band 902-928 MHz	Pass	15.249(c)	XI

In summary, this report confirms that the SenseWear Pro Armband, Model: 909901G01RevD is compliant with the FCC Part 15, Subpart C, 15.249 requirements when production units conform to the initial sample. Please address all questions and comments concerning this report to Nicholas Abbondante, Compliance Engineer.

II – Technical Requirements

15.1 Scope

The SenseWear Pro Armband uses sensors to measure physiological factors like motion, heat flow, and skin temperature that get translated by BodyMedia's customized algorithms and uploaded to a PC.

A prototype version of the sample was received on 9/10/2001 in good condition.

15.27 Special Accessories

No special accessories are necessary for the SenseWear Pro Armband, Model: 909901G01RevD to meet the compliance requirements.

15.31 Measurement Standards

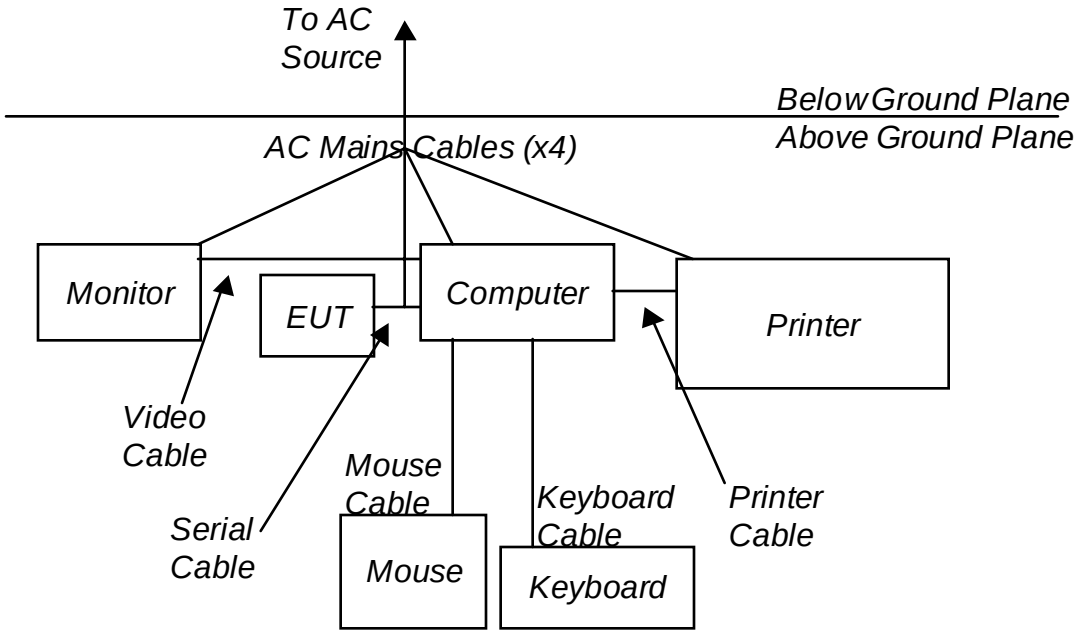
The measurement procedures as specified by ANSI C63.4:1992 were used to test this device. See Section IV of the test report for a detailed description of the test site and the measurement equipment.

Description of how the EUT was exercised during test

The EUT was activated at nominal power. Data transfer was enabled. The EUT was connected to a computer with peripherals. Charging and non-charging mode were investigated, and the worst case was used for each test.

System Block Diagram

The diagram below details the interconnection of the EUT with the support equipment. Please note that equipment on the rear of the table was centered along the back edge. Equipment on the front of the turntable was centered along the front edge. All peripherals were separated by 10cm.



Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.4 (1992).

During testing, the peripheral locations were not varied with respect to the main unit.

All interconnecting cables dropped from the rear of the turntable, but none were within 40 cm of the groundplane.

For maximizing emissions, the system was rotated through 360^{o}, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported.

The transmitter was configured for testing in a typical fashion (as a customer would normally use it). The device was mounted to a cardboard box, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

15.33 Frequency range of measurement

The device was scanned for spurious and harmonic emissions from 30 MHz to the 10th harmonic of the fundamental emission.

15.35 Measurement detector functions and bandwidth

The following table illustrates the detector functions and bandwidth used to test the device.

Frequency Range	Measurement Detector	Measurement Bandwidth
450 kHz to 30 MHz	Quasi-Peak	9 kHz
30 MHz to 1000 MHz	Quasi-Peak Average	120 kHz 120 kHz
1000 MHz to 10th harmonic	Average	1 MHz

The quasi-peak detector meets the requirements of CISPR 16.

15.201 Certification

The device is required to be certified in accordance with Part 2 of the FCC rules, Subpart J.

15.203 Antenna Requirements

The antenna is part of the device circuit board, and may not be removed without destroying the integrity of the device.

15.205 Restricted bands of operation

Section 15.249 requires that all spurious emissions excepting harmonics be compared to the general limits set forth in 15.209, or be attenuated by 50 dB below the fundamental, whichever is the lesser attenuation. The requirement of 15.205 is that any emissions falling within a restricted band be attenuated below the general emissions limits of 15.209. Therefore, the stricter limits of 15.209 were used when examining the spurious emissions levels, as it meets both requirements simultaneously. See section 15.35 for explanation of how detector bandwidth functions were used during testing.

15.207 Conducted limits

(a) For an intentional radiator designed to be connected to the AC mains network, the radio frequency voltage that is conducted back onto the AC power line between the frequencies 450 kHz and 30 MHz shall not exceed 250 uV, or 48 dBuV.
(b) If the proper measuring techniques are used, and the quasi-peak value of an emission exceeds its average value by 6 dB or more, that emission is broadband and the quasi-peak value may be reduced by 13 dB and compared to the limits.
(d) Devices powered from a battery are not subject to these limits unless there are provisions for connecting to a charger while the device is operating. Devices that obtain power through an AC adapter or through another device which is connected to the AC mains network are subject to these limits.

15.209 Radiated emission limits; general requirements

(a) Field Strength Requirements

Frequency Range (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	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

(b) In the emission table above, the tighter limit applies at the band edges.
(c) The level of any spurious emissions must be lower than that of the fundamental emission of the intentional radiator. The limits in the above table are based on the frequency of the spurious emission, not the frequency of the fundamental frequency.
(d) See 15.35 for a description of measurement detector functions and bandwidth.
(e) See 15.33 for a description of the frequency range of measurement.
(f) If the frequency range of measurement must extend beyond the 10^{th} harmonic because of a digital device in the intentional radiator, the emissions found above the 10^{th} harmonic are to be compared with the general limits for radiated emissions from unintentional radiators set forth in 15.109.

15.249 Operation in the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz

(a) Field Strength Requirements
Note: The requirements of Section 15.205 are in addition to the following requirements.

Fundamental Frequency (MHz)	Fundamental Field Strength at 3 meters (μV/m)	Harmonic Emissions at 3 meters (μV/m)
902-928	50000	500
2400-2483.5	50000	500
5725-5875	50000	500
24000-24250	250000	2500

The Fundamental field strength limit is calculated as follows:
The frequency is 916.5 MHz, therefore using the frequency range 902-928 MHz (Limit is 50000 μV) the limit is 94.0 dBuV/m. Harmonic emissions must be below 54.0 dBuV/m.
(b) Field strength limits are specified at a distance of 3 meters
(c) All emissions other than the fundamental frequency and its harmonics shall be attenuated by 50 dB below the level of the fundamental emission or to the general radiated emission requirements of 15.209, whichever is the lesser attenuation.

III - Attestation

LABORATORY MEASUREMENTS

Pursuant To
Part 15, Subpart C
For
Intentional Radiators

Company Name:	BodyMedia
Address:	4 Smithfield Street, 12th Floor Pittsburgh, PA, 15222
Model:	909901G01RevD
Date of Test(s):	September 14-15, 2001
Test Site Location:	INTERTEK TESTING SERVICES NA INC. 70 Codman Hill Road Boxborough, MA 01719
Site:	3

I attest to the accuracy of this report:

Signature	Signature
Nicholas Abbondante	Candy L. Campbell
Testing Performed By	Reviewer
Engineer	Project Engineer
Title	Title

IV - Site Description and Measurement Equipment

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C, General Requirements.

A. **Test Set-Up**: The test set-up and procedures described below are designed to meet the requirements of ANSI C63.4 (1992).

1. The test site is a Plastic/Fiberglass structure with a groundplane. The site has attenuation characteristics which meet the requirements of ANSI C63.4 (1992). Information on the site has been filed with the FCC as required by Rule 2.948. The address of the site is 70 Codman Hill Road, Boxborough, MA 01719.

2. Power to the site is nominal line voltage of 117 V_{AC} and 230 V_{AC}, 60 Hz.

3. The equipment under test (EUT) is placed on a wooden turntable which is four feet in diameter and approximately one meter in height above the groundplane. During the radiated emissions test, the turntable is rotated 360 degrees and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The antenna height and polarization are also varied during the search for maximum signal levels. The height of the antenna is varied from one meter to four meters. Body-worn, hand-held and small portable devices are mounted on a non-conductive box and emissions are investigated on three orthogonal axis.

4. Detector function for radiated emissions is in peak or quasi-peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings according to the following formula:

   Averaging Factor in dB = 20 LOG (duty cycle)

   The time period over which the duty cycle is measured is 100 msec. The worst-case (highest percentage on) duty cycle is used and described specifically in the data section. The duty cycle is measured by placing the spectrum analyzer in zero scan (receiver mode) and linear mode at maximum bandwidth (3 MHz at 3 dB down) and viewing the resulting time domain signal output from the analyzer on a Tektronix 465 Oscilloscope. The oscilloscope is used because of its superior time base and triggering facilities. Alternately an average detector can be employed when required.

5. Antennas used below 1000 MHz were EMCO Model 3142 Biconolog Antennas and Compliance Design Inc. Model A100 tuned Dipole Antennas. For measurements between 1000 MHz and 18000 MHz above 1 GHz, an EMCO Model: 3115 Horn Antenna is used. The Antennas used are listed in the Test Equipment Summary in Section 6.

6. The field strength measuring equipment used included:

Description	Manufacturer	Model	Serial #	Cal Due
Spectrum Analyzer	Agilent	E7405A	US40240205	11/28/2001
Super High Frequency Cable	Sucoflex	104PE	0555/4PEA	02/21/2002
Attenuator, 20 dB	Mini Circuits	20dB, 50 ohm	DS22A	08/14/2002
LISN 50uH .01-50MHz 24A	Solar Electronics	9252-50-R-24-BNC	955107	03/26/2002
Cable, BNC/BNC	Alpha	RG58B/U	CBL310E	08/24/2002
RF Filter	Hewlett Packard	85420E	3427A00177	01/22/2002
Receiver Set w/RF Filter	Hewlett Packard	85422E	3520A00188	01/22/2002
Horn Antenna	EMCO	3115	9610-4980	11/01/2001
Antenna	EMCO	3142	9711-1224	11/17/2001

7. The frequency range to be scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency, or 40 GHz, whichever is lower. For line-conducted emissions, the range scanned is 450 kHz to 30 MHz.

8. The EUT is warmed up for 15 minutes prior to the test. If battery powered, a new battery is used.

9. Conducted measurements were made as described in ANSI C63.4 (1992). An IF bandwidth of 9 kHz is used, and peak or quasi-peak detection is employed.

10. The IF bandwidth used for measurement of radiated signal strength was 100 kHz or greater below 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application No. 150-2. Above 1000 MHz, a bandwidth of 1 MHz is generally used.

11. Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the forbidden bands and above 1 GHz (where no preamplifier is used), signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

12. For measurements made in the 9 kHz to 30 MHz range, a distance of 30 meters was used unless a good signal-to-noise ratio could not be obtained. In that case, a closer distance was used and that distance is so marked in the data table.

V – Summary of Equipment Under Test

1	**Manufacturer**:	Millenia Technology, Inc. 1105 Pittsburgh Street Cheswick, PA 15024 (724) 274-2220
2	**Grantee**:	Contact: Dolly Stephens BodyMedia 4 Smithfield Street, 12th Floor Pittsburgh, PA 15222 (412) 288-9901
3	**Trade Name**:	Contact: Maria Fattore SenseWear Pro Armband
4	**Model No.**:	909901G01RevD
5	**Serial No.**:	01320331
6	**Intended FCC ID** (with preceding 3-character grantee code):	PV8-909901G01RevD
7	**Date of Test**:	September 14-15, 2001
8	**Frequencies to which device can be tuned**:	916.5 MHz
9	**Can customer tune device?**	No
10	**Applicable emissions limits**:	15.205, 15.207, 15.209, 15.249

VI - Configuration Information

Equipment Under Test:	SenseWear Pro Armband
Model:	909901G01RevD
Serial No.:	01320331
FCC Identifier:	None assigned as of this report; intended FCC ID is PV8-909901G02RevD

Support Equipment:

Keyboard	Manufacturer:	Digital
	Model:	RT101
	Serial Number:	1305 1171
	FCC ID:	AQ6-CYPRESS Z15
Hewlett Packard	Manufacturer:	660 Printer
	Model:	C2164A
	Serial Number:	S65BNIQ06C
	FCC ID:	B94C2164X
Monitor	Manufacturer:	Gateway 2000
	Model:	Gateway 500CS
	Serial Number:	150138097072
	FCC ID:	BEJCS587W
Mouse	Manufacturer:	Digital
	Model:	M-S35
	Serial Number:	LT50901818
	FCC ID:	DZL210472
Power Supply	Manufacturer:	CUI Stack
	Model:	DSA-0151A05A
	Serial Number:	1001
	FCC ID:	Not Labelled

Computer	Manufacturer:	SpeedWare
	Model:	Not Appliable
	Serial Number:	97N1156
	FCC ID:	Not Labelled
Printer Power Supply	Manufacturer:	Hewlett Packard
	Model:	C2175A
	Serial Number:	9100-5124
	FCC ID:	Not Labelled
SenseWear Pro Base	Manufacturer:	BodyMedia
	Model:	909902G01RevD
	Serial Number:	01320395
	FCC ID:	Not Labelled

Cables:

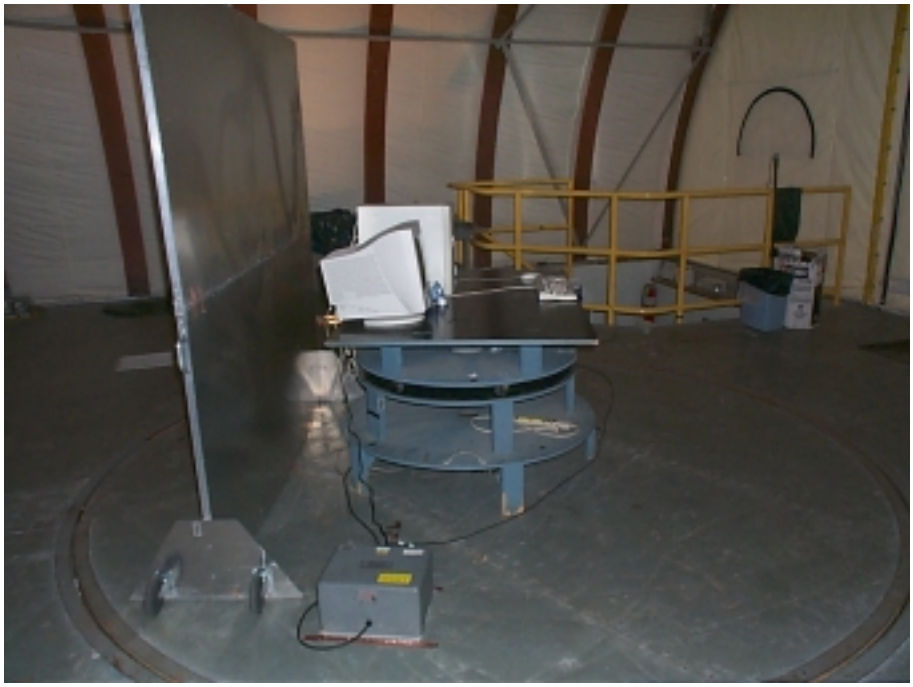
QTY	Description	Shield Description	Hood Description	Length (m)
1	Mouse Cable*	None	Plastic	3
1	Keyboard Cable*	None	Plastic	1.5
1	Serial Cable	Braid Shield	Metal with 360° connection	2
1	Printer Cable*	Braid Shield	Metal with 360° connection	3
1	Printer P/S Cable*	None	Plastic	1
1	Computer AC Mains*	None	Plastic	2
1	Monitor AC Cable*	None	Plastic	1.5
1	Video Cable*	Braid Shield	Metal with 360° connection	2
1	EUT AC Mains	None	Plastic	2

*support equipment cables

VII - Configuration Photographs

Radiated Emissions Test Setup, Front and Back

Line Conducted Emissions Test Setup, Front and Back



VIII - Sample Calculation

The following is how net field strength readings were determined:

NF = RF + AF + CF + PF + DF

Where,

NF = Net Reading in dBµV/m
RF = Reading from receiver in dBµV
AF = Antenna Correction Factor in dB(1/m)
CF = Cable Correction Factor in dB
AVF = Duty Cycle Correction Factor in dB
DF = Distance Factor in dB (using 20 dB/decade), from 3 to 1 meters 10.5 dB was added for measurements performed at 1 meter

To convert from dBµV/m to µV/m or mV/m the following was used:

$UF = 10^{(NF / 20)}$

Where,

UF = Net Reading in µV/m

Example:

For the fundamental field strength measurement at 8.4 (distance = 3 meters) see table [1].

NF = NF = RF + AF + CF + AVF + DF = 62.9 + 13.7 + 2.1 + (–10.0) + 0.0 = 68.7 dBµV/m

$UF = 10^{(68.7\ dB\mu V / 20)} = 2722.7\ \mu V/m$

IX - Data Tables

Intertek Testing Services

Radiated Emissions / Interference

Table: 1

Company: Bodymedia
Model: 909901G01RevD
Project #: 3008639
Date: 09/15/01
Standard: FCC15.249, FCC15.209
Class: None Group: None
Notes: The EUT was scanned from 30 MHz - 10 GHz

Tested by: Nicholas Abbondante
Location: Site 3C
Detector: HP 8542E
Antenna: LOG3, HORN3
PreAmp: None
Cable(s): 3C, 3 METER PRIMARY
Distance: 3 meters

Used AGL001, HORN3, SHF203, REC3/RECFL3, LOG3

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	
V	47.600	20.4	9.6	0.9	0.0	0.0	30.9	40.0	-9.1	1
V	58.010	17.8	7.6	1.0	0.0	0.0	26.4	40.0	-13.6	1
V	62.430	19.7	7.1	1.0	0.0	0.0	27.9	40.0	-12.1	1
V	108.700	8.7	7.5	1.4	0.0	0.0	17.5	43.5	-26.0	1
V	156.300	3.4	8.9	1.7	0.0	0.0	14.0	43.5	-29.5	1
V	265.900	13.9	12.8	2.3	0.0	0.0	28.9	46.0	-17.1	1
V	365.600	13.9	16.1	2.8	0.0	0.0	32.8	46.0	-13.2	1
V	398.900	20.0	16.5	2.9	0.0	0.0	39.4	46.0	-6.6	1
V	432.100	21.6	16.7	3.2	0.0	0.0	41.6	46.0	-4.4	1
H	916.500	58.8	24.3	4.7	0.0	0.0	87.7	94.0	-6.2	2
H	1833.000	6.4	29.0	3.8	0.0	0.0	39.2	54.0	-14.8	3

1) Compared to the emissions limits of 15.209
2) Compared to the 15.249 limits for fundamental emissions
3) Compared to 15.249 limits for harmonic emissions

Intertek Testing Services

Conducted Emissions / Interference

Table: 2

Company: Bodymedia
Model: 909901G01RevD
Project #: 3008639
Date: 09/14/01
Standard: FCC15
Class: B Group: None
Notes: The data presented here is for charging mode, found to be worst case
System Loss: Includes the Cable and LISN loss.

Tested by: Nicholas Abbondante
Location: Site 3C
Detector: HP 8542E
Cable(s): 3C, 3 METE
Limiter: no

LISN13, CBL310E,DS22A

Frequency MHz	Reading Side A dB	Reading Side B dB	Attenuator Factor dB	System Loss dB	Quasi-Peak Net dB(uV)	Quasi-Peak Limit dB(uV)	Quasi-Peak Margin dB
0.452	6.8	7.8	20.0	2.0	29.8	48.0	-18.2
0.679	23.3	24.0	20.0	2.0	46.0	48.0	-2.0
0.830	20.5	21.3	20.0	2.0	43.3	48.0	-4.7
1.674	9.8	11.4	20.0	2.0	33.4	48.0	-14.6
2.302	8.5	9.6	20.0	2.0	31.6	48.0	-16.4
27.260	2.3	-3.7	20.0	2.0	24.3	48.0	-23.7

X - Duty Cycle (Average Factor)

The average factor is subtracted from peak readings to compare emissions readings to average limits. The average factor is calculated from duty cycle measurements from the following plots. The average factor is 20 Log (ON-TIME/PERIOD) of the emission. If the period is longer than 100 milliseconds then 100 milliseconds is used for the period. Average factor is determined using the worst-case duty cycle.

An average factor was not determined for this device, as it already meets the field strength requirements.

XI - Bandwidth

The following plot(s) show bandwidth measurements made. The plot shows the fundamental frequency of the intentional radiator. Note that the emission attenuates to the noise floor before reaching the edges of the plot. The center frequency is 916.48 MHz, with a span of 10 MHz. This plot shows that the is well within the frequency band of operation, 902-928 MHz.