COMPANY	Sensormatic Electronics Corp. 6600 Congress Ave Boca Raton, Florida 33487
PRODUCT TESTED	Sensormatic® AMB-4020 Base Charging Station FCC ID: BVCHH2BCS IC: 3506A-HH2BCS
FCC RULES	15.207, 15.209, 15.247
TEST DATE	December 8, 2004 – January 31, 2005
SUBMITTED BY	William M. Elliott

INDEX

I. Summary of Results

FCC 47 CFR Part [RSS 210 Section]	Testing Requirement	Test Limits	Issues /Comments
15,15 (b)	User Accessible Controls	N/A	The product contains no user accessible controls that increase transmission power above permitted levels.
15.31(e)	Vary Input Power	N/A	Input was varied from 102 to 138 V AC. Input power to antenna was measured.
15.109 [IC 7.3]	Radiated Emissions Requirements [Digital Device]	See Table 15.109. Unintentional digital emissions subject to Class A limits.	Digital emissions determined by turning transmitter off. Complies [Verification].
15.203	Antenna Requirements	Permantantly attached or unique coupling.	The TX antenna is a quarter wave PCB trace antenna Complies.
15.207 (a) (b) [IC 6.6]	AC Power Line Conducted Measurements	CISPR Class B Limits	Conducted emissions on AC side of DC supply is provided in this report. Complies.
15.205 (a) (b) [IC 6.3] 15.209 [IC 6.2.2(o)(e1)]	Restricted Band Compliance	Must comply with limits Specified in 15.209 (a)	The fundamental is not in a restricted band and the spurious emissions in the restricted bands comply with the general emission limits found in 15.209.
15.247 (a) (1) [IC 6.2.2(o)(a1)]	Carrier Frequency Separation	Separated by minimum of 25 kHz or 20 dB BW of the hopping channel, whichever is greater.	The carrier frequencies are separated by at least the 20 dB BW of the hopping channel. Complies.
15.247 (a) (1) (i) [IC 6.2.2(o)(a2)]	Number of Hopping Frequencies – 900 MHz TX	If 20 dB BW is < 250 kHz, then shall use at least 50 hopping channels.	The EUT has 60 hopping channels and complies with the requirement.
15.247 (a) (1) (i) [IC 6.2.2(o)(a2)]	Dwell Time – Number of Hopping Frequencies >= 50	< 0.4 sec within a 20 second period	The EUT complies with the requirement. See attached data.
15.247 (a) (1) (i) [IC 6.2.2(o)(a2)]	Maximum 20dB Bandwidth	Maximum 20 dB BW of the hopping channel cannot exceed 500 kHz.	The EUT complies with the requirement.
15.247 (b) (2) (3) [IC 6.2.2(o)(a2)]	Output Power 902-928 MHz Tx	< 1 W – freq. hopping with 50 channels	The EUT complies with the requirement.
15.247 (b) (4)	Maximum Antenna Gain	If directional gain of transmitting antenna greater than 6 dBi, the peak output power of the device shall be reduced below the stated values in 15.247 (b) (2) and b (3)	The permantly attached antenna used with the device has a gain < 6 dBi.
15.247 (b) (5) [IC Section 14]	RF Exposure	Must ensure that RF MPE to the public falls within Commission Guidelines	See RF Exposure Exhibit.
15.247 c [IC 6.2.2(o)(e1)]	Band-edge Compliance of RF Emissions	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power	The EUT complies with the band-edge requirements. No band-edge emissions fall within restricted bands. See submitted data.
15.247 c [IC 6.2.2(o)(e1)]	Radiated Restricted Band Emissions Requirements	Must comply with limits Specified in 15.209 (a)	The spurious emissions in the restricted bands from this device comply with the emission limits found in 15.209.
15.247 (g) (h)			See appropriate sections of report.

II. General Information

This report is part of the application for Certification of a 900 MHz Frequency-Hopping Spread Spectrum transmitter operating in the 902-928 MHz bands under the rules provided for frequency-hopping spread spectrum transmitters found in 47 CFR 15.247. The product covered by this report is the Sensormatic AMB-4020 Base Charging Station.

Test Methodology

The Sensormatic® AMB-4020 Base Charging Station charges the lithium-ion battery of the Sensormatic® AMB-4020 Hand-Held Scanner/Deactivator and locks the handheld securely in place when not in use. The Base Charging Station also has circuitry that enables it to communicate over a wired Ethernet network namely 10BaseT. It contains an RS232 port for service only and an RS485 port that can communicate with other EAS systems and an I/O connector that can sense relay contact closures is used in some legacy EAS systems instead of RS485.

A 903 to 915 MHz frequency hopping transmitter is also contained in this module and is used to wirelessly transmit the zero crossing line sync for the purpose of synchronizing the Hand-Held Scanner/Deactivator unit that is equipped with an equivalent receiver. The frequencies as well as the output power settings are programmed from the DSP to the UHF TX via the 3 wire SPI interface. This UHF transmitter hops through a random sequence of 60 frequencies between 903 and 915MHz, spending approx 340ms on each frequency. Once the TX has completed hopping through all frequencies in the sequence it starts over and repeats the same sequence.

The device was evaluated in a number of ways in accordance to ANSI C63.4 and good engineering practices to make sure that the worst-case evaluation was made. Radiated evaluations were performed in a pre-screen environment and the worst case was tested on the OATS. The worst case results are presented in this report.

Both conducted and radiated emissions testing were performed according to the procedures in ANSI C63.4-1992 / 2003, and the requirements of 15.31, 15.33, 15.35, 15.207, 15.209 and 15.247. In addition, 15.247 requirements were measured per FCC document DA 00-705, “Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems”, released March 30, 2000.

Where 15.31 (m) and DA 00-705 calls for measurements to be made at lo, middle, and high channels, measurements were made at 903.2 MHz, 909.2 MHz, and 914.8 MHz.

Test Facility

Measurements were performed at Sensormatic Electronics.

The shielded room conducted emissions measurement facility is located at Sensormatic Electronics Corporation Headquarters at 6600 Congress Avenue, Boca Raton, Florida, 33487. The radiated emissions Open Area Test Site is also located at 6600 Congress Avenue, Boca Raton, Florida 33487. These sites have been found acceptable by and are on file with the FCC per FCC Registration Number 90925, and Industry Canada per file number IC 3506.

III. Frequency Hopping Requirements

Section 15.247 (a)

The device contains a transmitter that modulates a carrier and changes carrier frequency in a pseudo-random pattern with a dwell time, channel separation, and hop count that meets the requirements of 15.247. In addition, the receiver located in the AMB 4020 Hand-held Scanner/Deactivator tracks the transmitter's pseudo-random hopping sequence and demodulates the signal.

Pseudo-random Frequency Hopping Sequence

The device hops through a sequence of 60 frequencies, that span from 903.2 to 914.8 MHz with a channel spacing of 200kHz. The hopping sequence is random.

The hopping sequence was generated by assigning a number to each frequency, in the order.

903.2 MHz #1
903.4 MHz #2
.
.
914.8 MHz #60

Each number was then written on a separate paper card. All 60 paper cards were then placed in a bucket and mixed together. Then one paper card at a time was drawn from the bucket and the number on the card was written down. The sequence generated along with the corresponding frequencies was then stored in the device's flash memory. On power-up the unit will start to hop through the sequence and once completed it will repeat the same sequence over and over.

Equal Hopping Frequency Use [Section 15.247 (g)]

Since every channel is included in the hop sequence only once and the device repeats the same sequence over and over, the device spends equal time at each channel frequency on average.

DeFacto EIRP Limit

The maximum output of the transmitter cannot exceed 100mW due to the limitations of the hardware. Since the antenna gain is 1.7 dBi the EIRP limit of 1W is easily met.

System Receiver Input Bandwidth

The receiver employs 2 stages of IF filtering with each filter having a 20dB BW of 180kHz. The frequency deviation of the modulated carrier was measured to be 56kHz, this giving a total bandwidth requirement of

$$B_T := 2(\Delta f + f_m)$$

$$B_T = 1.121 \times 10^5$$

Where fm = 60 Hz is the synch pulse repetition rate.

System Receiver Hopping Capability

The receiver stores and hops through the same sequence as does the transmitter, on power up the receiver acquires the transmitter by hopping through the sequence at a fast rate 160ms per channel. Once the receiver sees the transmitter i.e. a valid 60 Hz pulse train is seen on the output of the demodulator, the receiver will then hop at the same rate and in the same sequence as the transmitter.

Section 15.247 (g)

In the application for which this device is going to be used, the transmitter continuously transmits a timing or synchronization signal over the RF channel. At each frequency in the hop sequence the transmitter sends out 20 sync signals, with each sync signal spaced 16.666ms apart. After sending 20 sync events the transmitter is timed to hop to the next frequency in the sequence.

Section 15.247 (h)

Since the device is programmed to follow a set hopping sequence, regardless of potential interference and it is not programmed to scan the channels for interference, it does not have the ability to coordinate with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

RF Exposure Compliance Requirements

Results

EUT Output Power = +15.06 dBm
Antenna Gain = 1.7 dBi
S = .6 mW / cm^2 (CFR 47 Part 1.1310)

Minimum MPE safe distance (using equation below) = **2.53 cm**

Calculations

$E = \sqrt{(30 * P * G)} / d$

And

S= E^2 / 3770

Where
E = Field Strength in Volts/meter
P= Power In Watts
G = Numeric Antenna Gain
d = Distance in Meters
S = Power Density in mW / square cm

Combining equations and rearranging the terms to express d as a function of the other variables yields:

$d = \sqrt{(30 * P * G)} / (3770 * S)$

Changing to units of mW and cm:

P(mW) = P(W) / 1000

And

d(cm)= 100 *d(m)

Yields

$d = 100 * \sqrt{(30 * P * G)} / (3770*S))$

Therefore

d = 0.282* SQR ROOT (P*G)/(S)
d = Distance in Meters
P= Power In mW
G = Numeric Antenna Gain
S= Power Density in mW / cm^2
Substituting the log form of gain and power:
P (mW) = 10^ (P(dBm)/10)
And
G (numeric) = 10 ^ (G(dBi) / 10)

Yields

d = .282 * (10 ^ ((P+G) / 20)) / (SQR ROOT (S))

Where

d = MPE Safe Distance in cm

P= Power In dBm
G = Antenna Gain in dBi
S= Power Density Limit in mW / cm^2

IV. Test Equipment

The equipment used for determining compliance of the AMB-4020 Base Charging Station with the requirements of 15.207 and 15.209 is marked with an "X" in the first column of the table below.

	Model	Description	Vendor	Serial #
	ALP -70	Loop Antenna	Electro Metrics	163
X	3110B	Biconical Antenna	Electro Metrics	1017
X	3146	Log Periodic Antenna	EMCO	3909
	3825/2	Line Imp Stable Network	EMCO	1562
X	3816/2NM	Line Imp Stable Network	EMCO	9703 1064
	6060B	Frequency Generator	Giga-tronics	5850202
	FM2000	Isotropic Field Monitor	Amplifier Research	15171
	FP2000	Isotropic Field Probe	Amplifier Research	15214
	888	Leveler	Amplifier Research	14998
	75A220	Low Band Amplifier	Amplifier Research	15208
	10W1000A	High Band Amplifier	Amplifier Research	15138
	PEFT Junior	EFT Generator	Haefely Trench	083 180-16
	PEFT Junior	Capacitive Cable Clamp	Haefely Trench	083-078-31
	NSG435	ESD Simulator	Schaffner	1197
	NSG431	ESD Simulator	Schaffner	1267
	HP8591EM	EMC Analyzer	Hewlett - Packard	3520A00190
		Power Source	Pacific Instruments	
	F-2031	EM Injection Clamp	Fischer Cust. Comm.	30
	FCC-801-M3-16	Coupling Decoupling Nwk	Fischer Cust. Comm.	58
	FCC-801-M3-16	Coupling Decoupling Nwk	Fischer Cust. Comm.	59
X	83017	10 GHz Preamp	Mite-Q	937930
X	1.8 – 13 GHz HPF	High Pass Filter	MicroTronics	001
	Roberts Ant	Tunable Dipole Set	Compliance Design	003282
	Roberts Ant	Tunable Dipole Set	Compliance Design	003283
X	3115	Double-Ridged Waveguide Horn	EMCO	3006
X	HP8562	Spectrum Analyzer	Hewlett Packard	2712A00534
X	HP8447F Opt 64	Dual Preamplifier	Hewlett Packard	2805A03473

V. Data

15.31(e) Input Voltage Variation

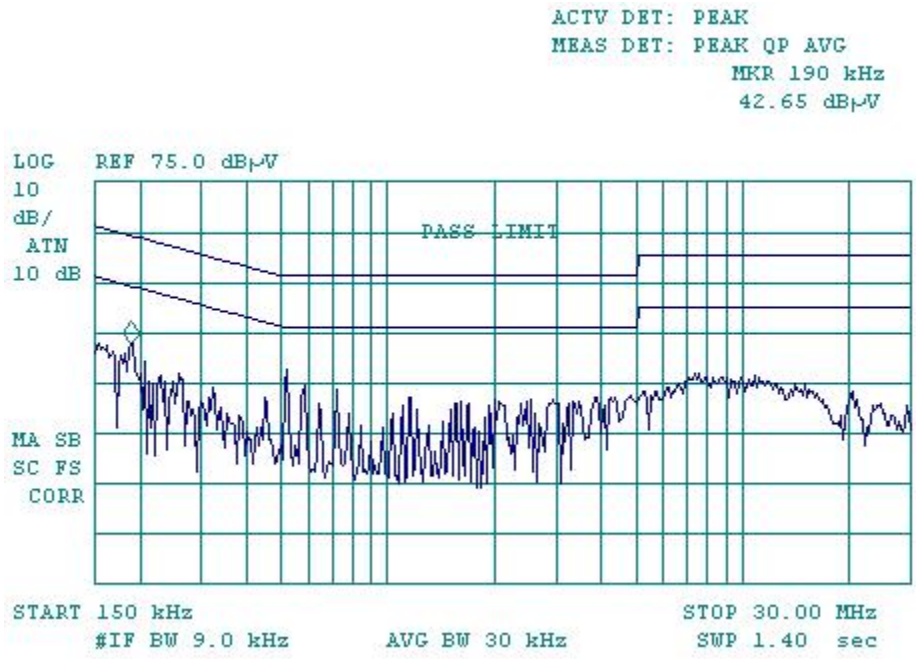
Frequency	Voltage	Peak Signal Level
903.328	120	13.60 dBm
903.328	+15%	13.51 dBm
903.328	-15%	13.56 dBm
909.228	120	13.63 dBm
909.228	+15%	13.63 dBm
909.228	-15%	13.63 dBm
914.913	120	13.62 dBm
914.913	+15%	13.69 dBm
914.913	-15%	13.67 dBm

Project Name	Conducted Emissions EN55022 Class B Limit	Filename	AMB4020_CondEMI_12-22-04.doc
EUT Name	AMB4020 HandScan	Serial Number	
Engineer	Tim Relihan	Phone Number	
Date of Test	12/22/04 3:08:43 PM	Test Name	Conducted Emission
Reg. Technician	Stephen Krizmanich		

Comments	Line In: 120 V 60 Hz: EN55022 Class B Limits New design Ault Power Supply. HandScan in normal mode. No detecting/deactivating or scanning. Laptop is exercising port on HandScan base. L1 and L2 are similar

Signal	Freq (MHz)	Peak Detector (dBuV)	QP Detector (dBuV)	Avg Detector (dBuV)	EN55022 Limits QP/Avg (dBuV)	Comments
1	.200	39.1	37.0	32.9	63.3 / 53.3	Complies
2	.533	38.3	36.5	35.5	56.0 / 46.0	Complies
3	20.29	36.2	34.6	31.8	60.0 / 50.0	Complies
4	8.22	37.4	36.0	31.3	60.0 / 50.0	Complies

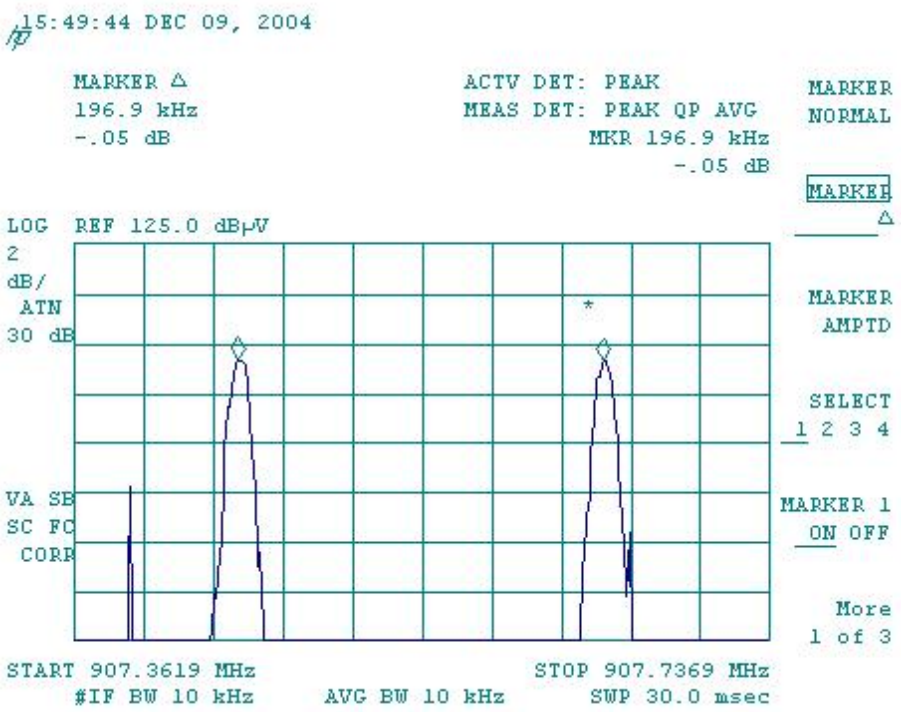
Figure 1. L1 Full Range



CARRIER FREQUENCY SEPARATION

15.247 (a)(1)

Carrier separation = 197 kHz



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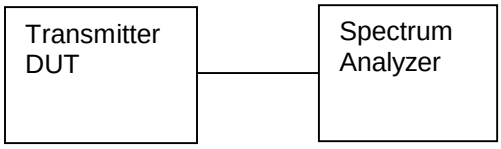
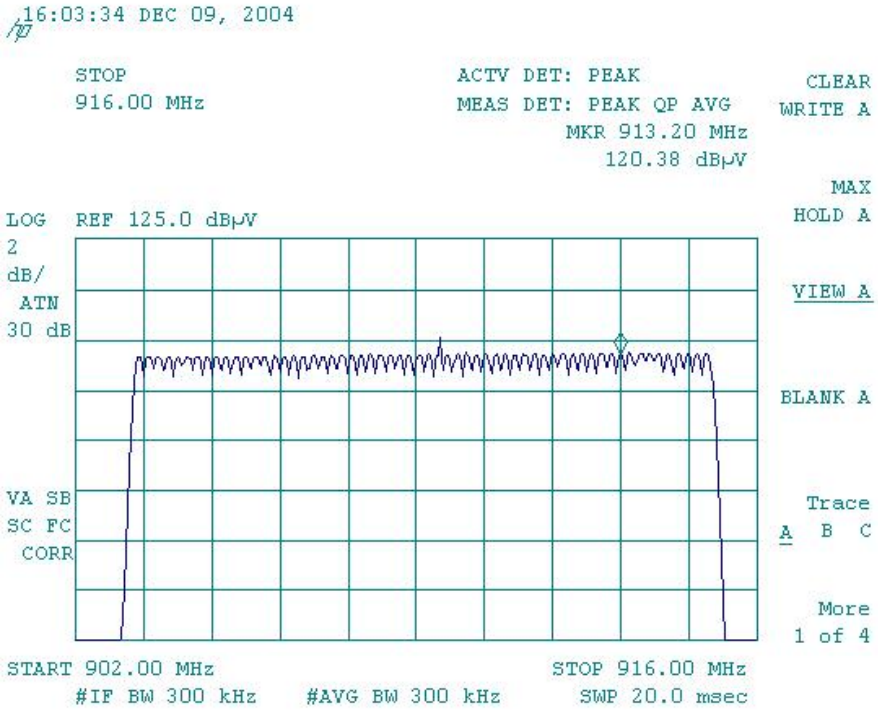


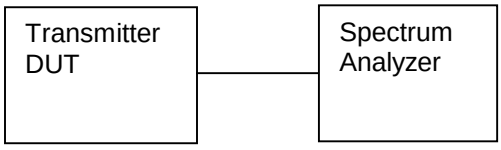
NUMBER OF HOPPING CHANNELS

15.247 (a)(1)(i)

The number of hopping channels = 60; limit , number > 25.



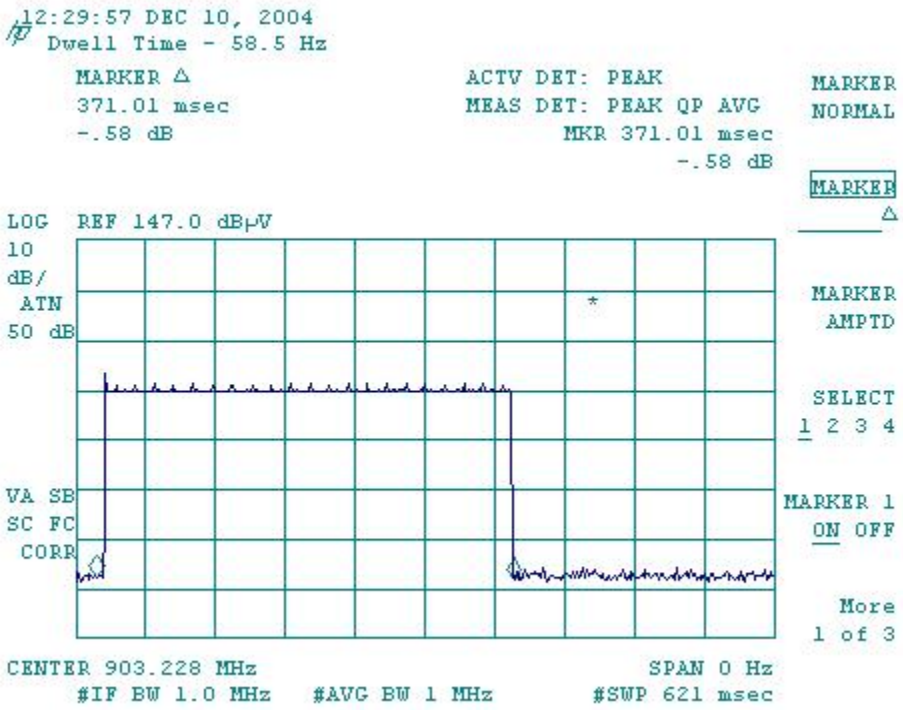
Setup:



TIME OF OCCUPANCY (DWELL TIME)

RULES PART 15.247 (a)(1)(i)

Max Dwell time = 371 ms; limit = 400 ms.



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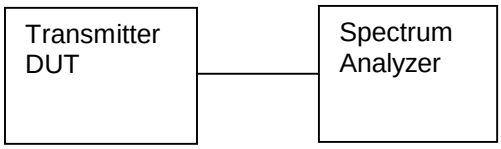
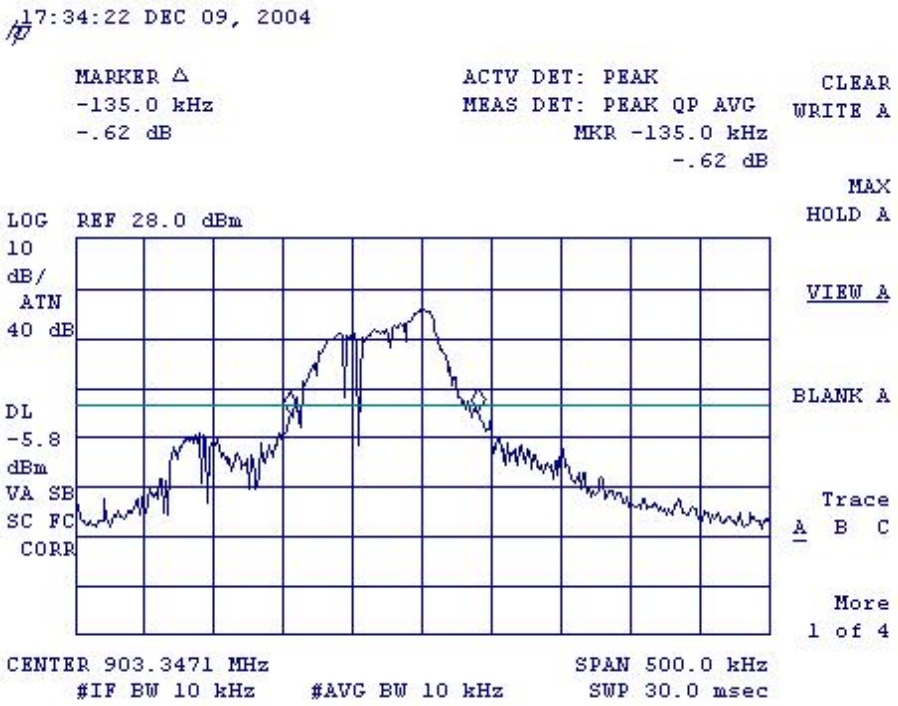


20 DB BANDWIDTH

15.247 (a)(1)

Worst Case 20 dB Bandwidth = 135 kHz



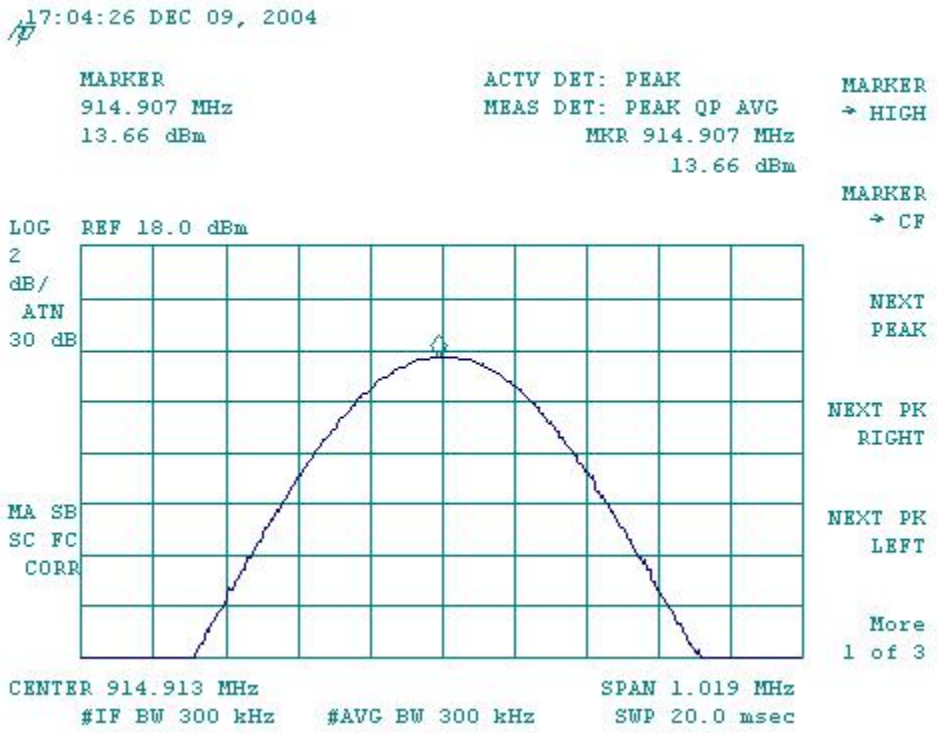
PEAK POWER OUTPUT

15.247 (b)

Connector loss = 1.2
Cable = .2

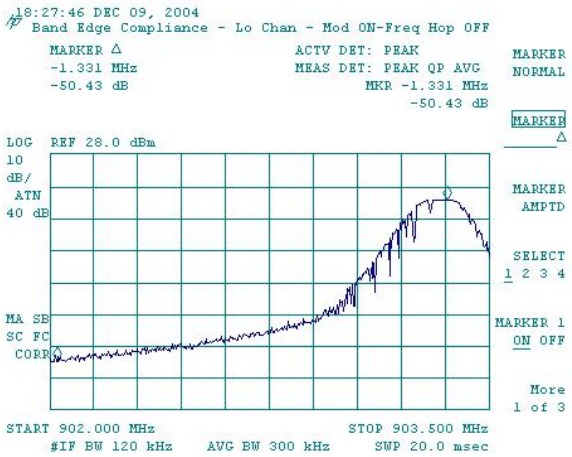
Peak power = 15.06 dBm or 32.06 mW

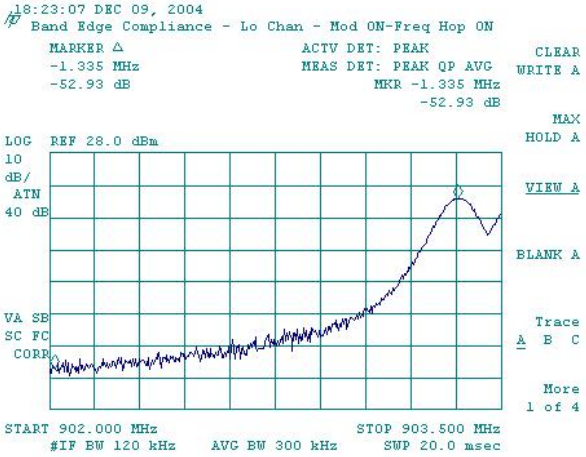
The EUT complies with the limit.



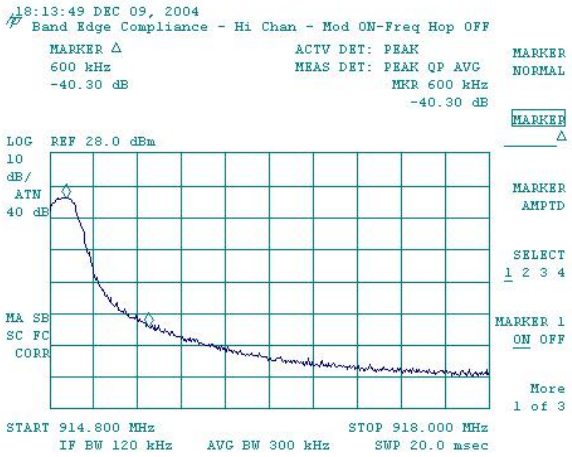
RULES PART 15.247 (c)

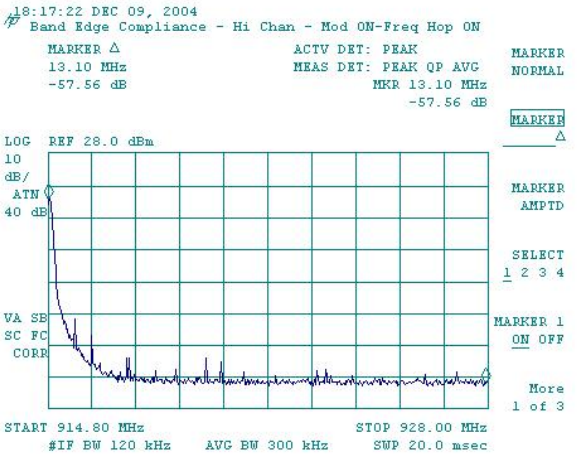
4 plots follow showing band-edge non-hopping high side, band-edge hopping high side, band-edge non-hopping low side, band-edge hopping low side. Limit: > 20 dB below highest inband signal.





Low side, non-hopping and hopping respectively. Band edge is 902 MHz; emissions are more than 30 dB below the inband signal.





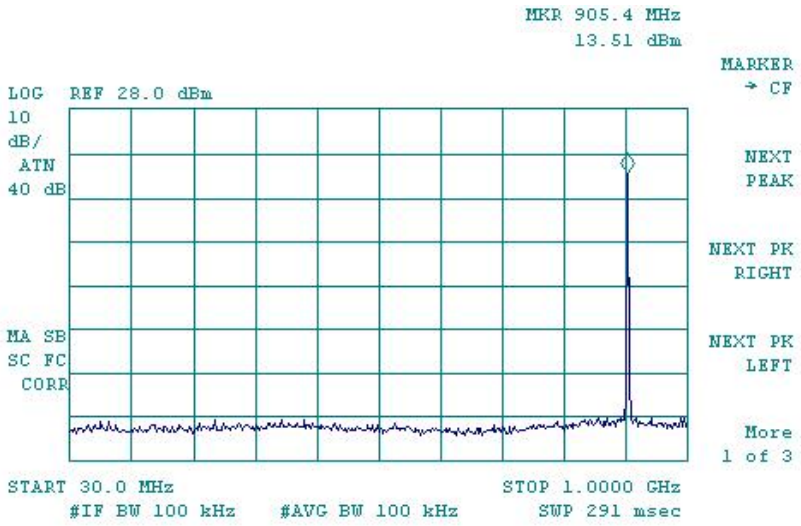
High side, non-hopping and hopping respectively. Band edge is 902 MHz; emissions are more than 30 dB below the inband signal.

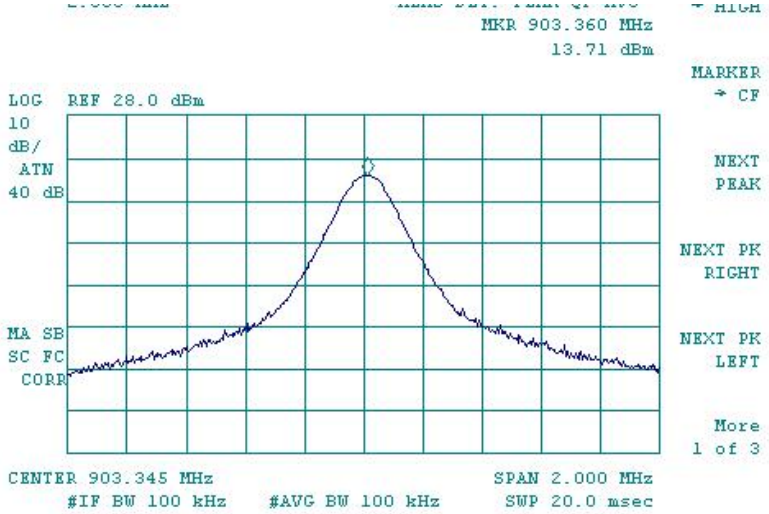
SPURIOUS RF CONDUCTED EMISSIONS

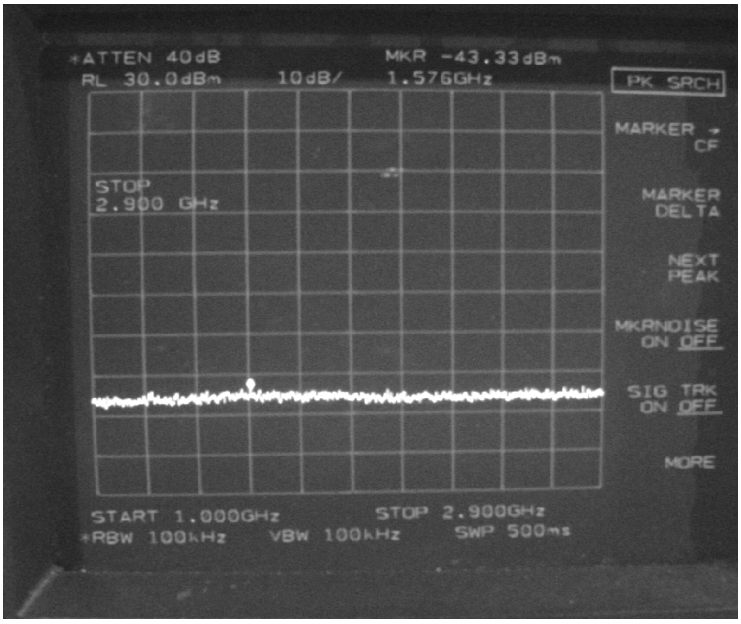
RULES PART 15.247 (c)

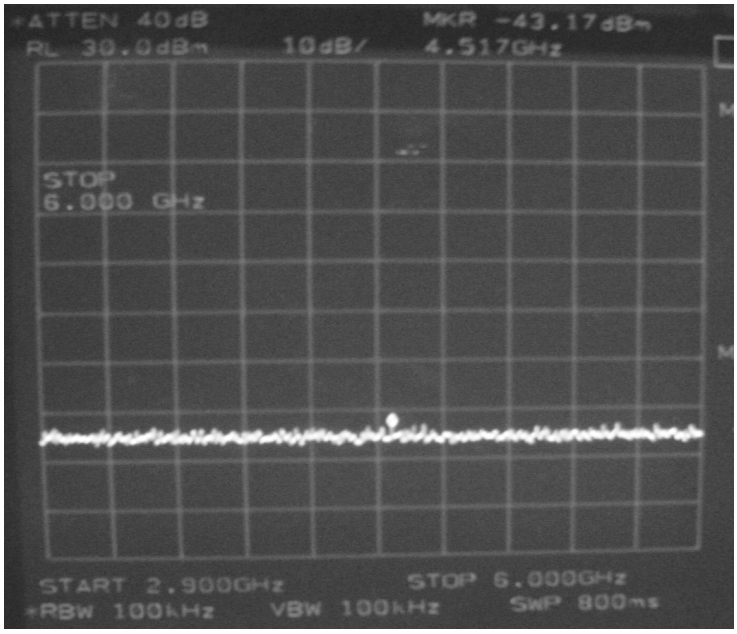
The following plots shows that there are no emissions within 20 dB of the inband signal in any 100 kHz band from 30 MHz all the way to the 10th harmonic.

This was true, at lo / mid, and hi channels.

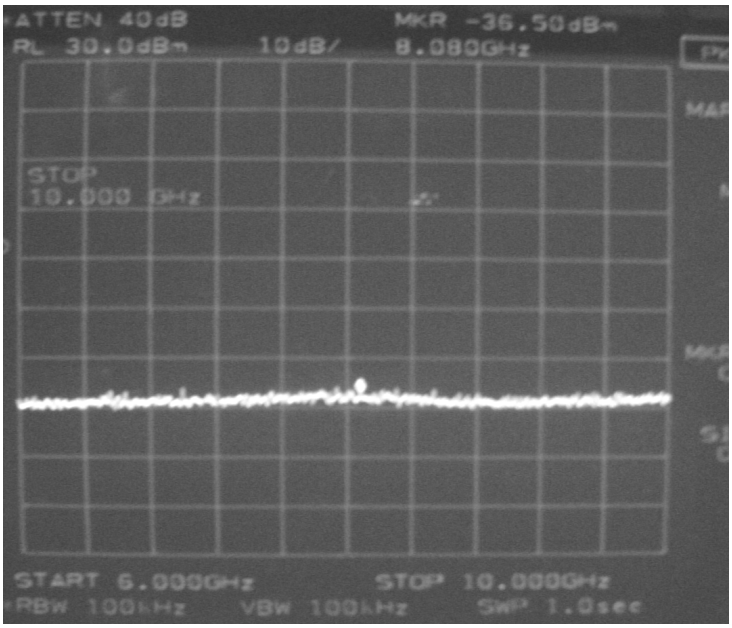





*ATTEN 40dB
RL 30.0dBm
10dB/
MKR -43.33dBm
1.576GHz
PK SRCH
MARKER → CF
MARKER DELTA
NEXT PEAK
MKRNOISE ON OFF
SIG TRK ON OFF
MORE
STOP 2.900 GHz
START 1.000GHz
STOP 2.900GHz
*RBW 100kHz
VBW 100kHz
SWP 500ms


*ATTEN 40dB
RL 30.0dBm
10dB/
MKR -43.17dBm
4.517GHz
STOP 6.000 GHz
START 2.900GHz
STOP 6.000GHz
*RBW 100kHz
VBW 100kHz
SWP 800ms

.


ATTEN 40dB
MKR -36.50dBm
RL 30.0dBm
10dB/
8.080GHz
STOP
10.000 GHz
START 6.000GHz
STOP 10.000GHz
RBW 100kHz
VBW 100kHz
SWP 1.0sec

Part C SPURIOUS RADIATED EMISSIONS

RULES PARTS 15.247 (c), 15.205, 15.209

Transmitter Fundamental and Spurious Emissions

The EUT was prescreened in the semi-anechoic chamber at Sensormatic per the guidelines in ANSI C63.4.

No modulation turned out to return a slightly higher reading than with the modulation on. The tests were done with the modulation off.

The only emissions found in the restricted bands were the third and fourth harmonics. The EUT was tested at the OATS for 2nd [not restricted], 3rd, and 4th harmonics.

Spurious Emissions Above 1 GHz

Radiated Emissions Testing
HandScan 900 MHz Transmitter - > 1 GHz
1GHz - 10GHz

OATS Testing
12/15/2004

Engineers - Elliott / Relihan

Antenna = EMCO Model 3115 S/N 3006
Amplifier = In House Amplifier Kit
Path Loss = **LabFlex 380 25' Cable plus Florida RF Labs 36" [# 1 & #2]cables** + Microtronics HPF S/N 001
Emission Level (dBuV/m) = Emission + Path loss - Preamp Gain + Antenna Factor + 107

Frequency (MHz)	Polarization	Max. Emission Pk (dBuV)	Max. Emission Avg (dBuV)	Corrected Pk Emission (dBuV/m)	Corrected Avg Emission (dBuV/m)	FCC Limit (dBuV/m)
1,830.000	Horiz	66.80	66.20	57.17	56.57	20 dB< C
	Vert	64.20	63.60	54.57	53.97	20 dB< C
2,708.178	Horiz	53.40	50.10	48.07	44.77	54 dBuV/m
	Vert	52.30	49.00	46.97	43.67	54 dBuV/m
3,709.288	Horiz	54.95	52.70	53.28	51.03	54 dBuV/m
	Vert	55.70	**53.50**	54.03	**51.83**	54 dBuV/m
4,575.000	Horiz	50.10	43.95	49.84	43.69	54 dBuV/m
	Vert	50.50	44.90	50.24	44.64	54 dBuV/m

Conclusion – AMB-4020 Base Charging Station 900 MHz TX Complies above 1 GHz

Transmitter Spurious Emissions Below 1 GHz

Radiated transmitter spurious emissions below were prescreened in the anechoic chamber below 1 GHz by turning the transmitter on and off. The emissions that were there when the transmitter was on were classified as transmitter spurious. The rest were considered unintentional digital emissions subject to verification

There were no discernable spurious emissions that tracked the transmitter below 1 GHz. The only emission discernable was the transmitter carrier.

Base Transmitter ERP

Item	Freq in MHz	B.W. in KHz	S.A. Atten.	Detector Pk/QP/Av	Amplitude in dBμv/m	Limit ETSI	Limit CISPR A	Limit FCC A	AntType Polar. & Height	Noise Floor In dBμv
1										
2	903.2	120	10	Pk	103.2	N/A	N/A	N/A	VPOL	> 6dB
3	909.2	120	10	Pk	102.7	N/A	N/A	N/A	VPOL	>6dB
4	914.9	120	10	Pk	102.5	N/A	N/A	N/A	VPOL	>6dB
5	903.2	120	10	Pk	109.97	N/A	N/A	N/A	HPOL	>6dB
6	909.2	120	10	Pk	109.5	N/A	N/A	N/A	HPOL	>6dB
7	914.9	120	10	Pk	109.4	N/A	N/A	N/A	HPOL	>6dB

Digital Unintentional Emissions

All other digital emissions were tested and measured on the OATS. All emissions complied with the Class A digital emission limits.

Radiated Emission Measurement Work Sheet

Date: 1/31/05 Engineer: Relihan Test Pers: M. Elliott Proj: HandScan

EUT HandScan Pistol + Base Together

Temperature – 70 deg F Humidity – 60%

Standard ANSI C63.4 Voltage and Frequency 120 / 60

Transmit Frequency 903 – 915 MHz Crystal Frequency 100 MHz max

Set-Up Notes:
- Pistol Vertical – only way installed per manual
- Cup separated from base
- Pistol not detecting or deactivating tags (condition of compliance)
- Smaller table used since smaller EUT profile – maintain 3 m distance through rotation
- All ports active as typical usage – remote devices put under ground plane
- Hardware / firmware / cable info captured in "test plan"

Radiated Emission Test Data

Item	Freq in MHz	B.W. in KHz	S.A. Atten.	Detector Pk/QP/Av	Amplitude in dBμv/m	Limit ETSI	Limit CISPR A	Limit FCC A	AntType Polar. & Height	Noise Floor In dBμv
1										
2	132.5	120	10	Pk	39.6	N/A	50.45	53.9	VPOL	> 6dB
3	225.8	120	10	PK / QP	34.4 / 33.3	N/A	50.45	56.9	VPOL	>6dB
4	299.6	120	10	PK / QP	51.6 / 48.9	N/A	57.5	56.9	VPOL	>6dB
5	400.5	120	10	PK / QP	52.1 / 50.6	N/A	57.5	56.9	VPOL	>6dB
6	560.1	120	10	Pk	48.9	N/A	57.5	56.9	VPOL	>6dB
7	696.7	120	10	Pk	44.2	N/A	57.5	56.9	VPOL	>6dB