FCC PART 15 SUBPART C

EMI MEASUREMENT AND TEST REPORT

For

smartBridges Pte Ltd

10 Anson Road #22-14
International Plaza
Singapore 079903

FCC ID: PWGDOLPHIN

February 14, 2002

This Report Concerns:	**Equipment Type:**
☒ Original Report	Wireless airPoint & airBridge

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Test Date: February 1, 2002

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1 - GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

The s*martBridges Pte Ltd'*s product, FCC ID: PWGDOLPHIN or the "EUT" as referred to in this report is a Wireless airPoint & airBridge which provides instant high speed wireless network connectivity to Wireless Access Point. The EUT provides a complete solution to customers who require mobility and freedom in a wireless Local Area Network and wireless internet connectivity through a gateway.

The EUT provides the following feature(s):

- Dimension: Approximately 4.5"L x 1.5"W x 4.5"H.
- S/N: 00-30-1A-00-D7-62
- Chipset: LSI L802251B

The EUT utilized Electronic Sales Ltd.'s power adapter, M/N: SMA210-2112C, S/N: 02-0003.

1.2 Objective

This type approval report is prepared on behalf of. s*martBridges Pte Ltd* in accordance with Part 2, Subpart J, Part 15, Subparts A, B and C of the Federal Communication Commissions rules.

The objective of the manufacturer is to demonstrate compliance with FCC rules for Output Power, Antenna Requirements, 6 dB Bandwidth, power density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Spurious Radiated Emission, and processing gain.

1.3 Related Submittal(s)/Grant(s)

No Related Submittal(s).

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.4 –1992, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz. All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory Corporation. The radiated testing was performed at an antenna-to-EUT distance of 3 Meters.

1.5 Test Facility

The Open Area Test site used by Bay Area Compliance Laboratory Corporation to collect radiated and conducted emission measurement data is located in the back parking lot of the building at 230 Commercial Street, Sunnyvale, California, USA.

Test site at Bay Area Compliance Laboratory Corporation has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI).

The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-1992.

The Federal Communications Commission and Voluntary Control Council for Interference has the reports on file and is listed under FCC file 31040/SIT 1300F2 and VCCI Registration No.: C-1298 and R-1234. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, Bay Area Compliance Laboratory Corporation is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (NVLAP). The scope of the accreditation covers the FCC Method - 47 CFR Part 15 - Digital Devices, IEC/CISPR 22: 1998, and AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment test methods under NVLAP Lab Code 200167-0.

1.6 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Due Date
HP	Spectrum Analyzer	8568B	2610A02165	12/6/02
HP	Spectrum Analyzer	8593B	2919A00242	12/20/02
HP	Amplifier	8349B	2644A02662	12/20/02
HP	Quasi-Peak Adapter	85650A	917059	12/6/02
HP	Amplifier	8447E	1937A01046	12/6/02
A.H. System	Horn Antenna	SAS0200/571	261	12/27/02
Com-Power	Log Periodic Antenna	AL-100	16005	11/2/02
Com-Power	Biconical Antenna	AB-100	14012	11/2/02
Solar Electronics	LISN	8012-50-R-24-BNC	968447	12/28/02
Com-Power	LISN	LI-200	12208	12/20/02
Com-Power	LISN	LI-200	12005	12/20/02
BACL	Data Entry Software	DES1	0001	12/20/02

Statement of Traceability: Bay Area Compliance Laboratory Corp. certifies that all calibration has been performed using suitable standards traceable to national institute of standard and technology (NIST).

1.7 Local Support Equipment List and Details

Manufacturer	Description	Model	Serial Number	FCC ID
IBM	PC System	520	AM707AR	DOC
KDS	Monitor	EVOKD-1731	0891265478	DOC
SONY	KB	PCVA-KB1P/UA	0000348	DOC
Concepts	Mouse	MUS3P	None	JKGMUS3P01
EVEREX	Modem	EV-945	None	E3E5UVEV-945
HP	Printer	2225C	2821S14783	DOC

1.8 Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	FCC ID
Intel	MB	None	KB0610285	DOC
NEC	Floppy Drive	FD1231T	D9WL01MB3634	DOC
Maxtor	HD	54098U8	K806D1SC	DOC
Compaq	P/S	PS-7201-2C	00614854	DOC
Compaq	CD-ROM	CTN-485	201019006824	DOC
BACL	Chassis	None	None	None

1.9 External I/O Cabling List and Details

Cable Description	Length (M)	Port/From	To
Shielded KB Cable	1.6	KB Port/Host	KB
Shielded Mouse Cable	1.5	Mouse Port/Host	Mouse
Shielded Serial Cable	1.5	Serial Port/Host	Modem
Shielded Printer Cable	2.0	Parallel Port/Host	Printer
Shielded Video Cable	1.8	VGA/Host	Monitor
Shielded RJ Cable	1.0	RJ45 Port/Host	RJ45 Port/EUT

2 - SYSTEM TEST CONFIGURATION

2.1 Justification

The host system was configured for testing in a typical fashion (as a normally used by a typical user).

The EUT was tested in the normal (native) operating mode to represent *worst* case results during the final qualification test.

The power supply used in the host system is Electronic Sales Ltd. Power Supply, M/N: SMA10-2112C.

2.2 EUT Exercise Software

The EUT exercising program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use. The test software, terminal.exe, provided by the customer, is started the Windows 98 terminal program under the Windows 98 operating system. Once loaded, the program sequentially exercises each system component.

The sequence used is as follows:

1. Lines of Hs scroll across the notebook monitor.
2. The modem(s) receives Hs.
3. The printer output Hs.

This process is continuous throughout all tests.

2.3 Special Accessories

As shown in section 2.5, all interface cables used for compliance testing are shielded as normally supplied by INMAC and their respective support equipment manufacturers. The printer, the modem and the VGA monitor featured shielded metal connectors.

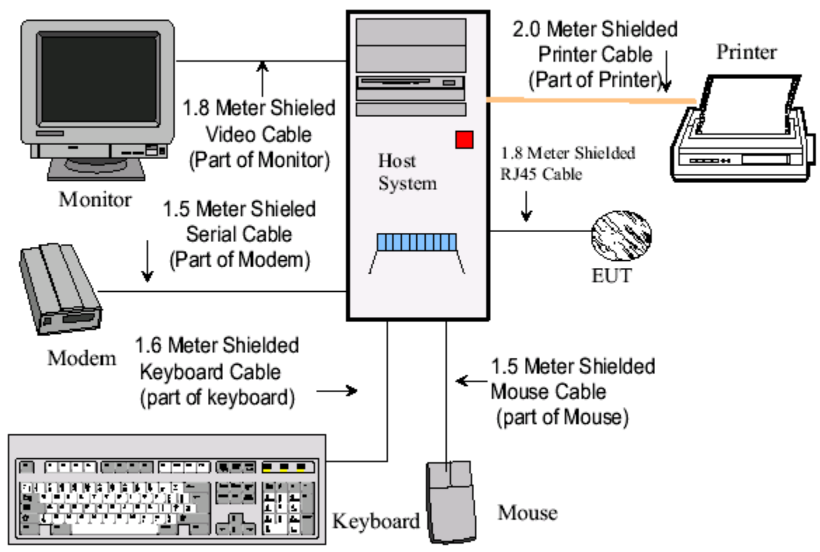
2.4 Schematics / Block Diagram

Appendix A contains a copy of the EUT's schematics diagram as reference.

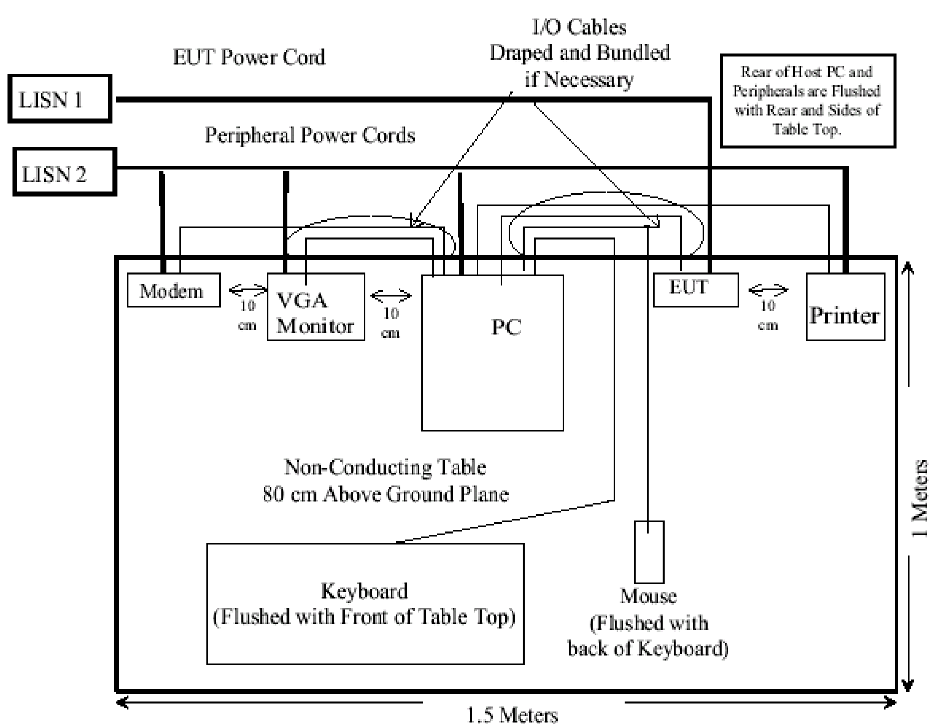
2.5 Equipment Modifications

No modifications were made by BACL Corporation to ensure the EUT to comply with the applicable limits and requirements.

2.6 Configuration of Test System



2.7 Test Setup Block Diagram



3 - SUMMARY OF TEST RESULTS

FCC Rules	Description	Result
§ 15.205	Restricted Bands	Complied
§ 2.1091	RF Safety Requirements	Complied
§15.203	Antenna Requirement	Complied
§15.207 (a)	Conducted Emission	Complied
§15.209 (a)	Radiated Emission	Complied
§15.209 (f)	Spurious Emission	Complied
§15.247 (a) (2)	6dB Bandwidth	Complied
§15.247 (b) (2)	Output Power	Complied
§ 15.247 (c)	100 kHz Bandwidth of Frequency Band Edges	Complied
§15.247 (d)	Peak Power Spectral Density	Complied
§15.247 (e)	Processing Gain	Complied

Note: The test data was good for test sample only. It may have deviation for other product samples.

4 - CONDUCTED OUTPUT POWER MEASUREMENT

4.1 Standard Applicable

According to §15.247(b) (2), the maximum peak output power of the intentional radiator shall not exceed 1 Watt.

4.2 Measurement Procedure

1. Place the EUT on the turntable and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

4.3 Test Equipment

Manufacturer	Model No.	Serial No.	Calibration Due Date
Agilent	E4419b	GB40202891	4/8/02
Agilent	E4412a	US38486529	4/8/02

4.4 Test Result

17.43 dBm at Low Channel
17.43 dBm at Middle Channel
17.46 dBm at High Channel

Results: The Peak Output Power complied with the applicable limits and standards.


17.43dBm


17.43dBm


17.46dBm

5 - SPURIOUS EMISSION

5.1 Standard Applicable

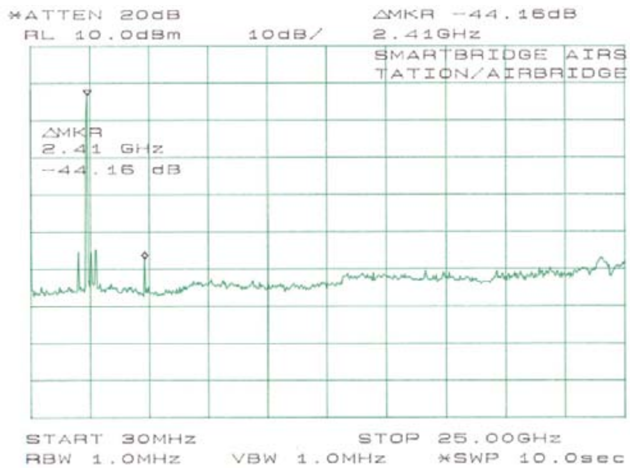
According to §15.209 (f) and §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation f a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit.

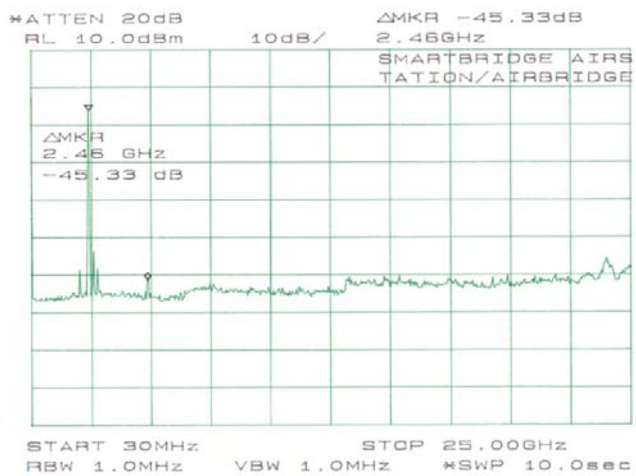
5.2 Measurement Procedure

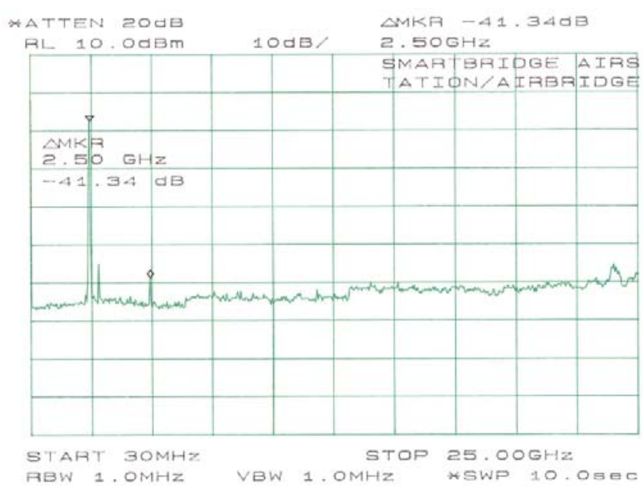
1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set the SA on Max-Hold Mode, and then keep the EUT in transmitting mode. Record all the signals from each channel until each one has been recorded.
4. Set the SA on View mode and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

5.3 Measurement Data

Plot(s) of Spurious Emission was presented hereinafter as reference.


*ATTEN 20dB
RL 10.0dBm
10dB/
ΔMKR -44.16dB
2.41GHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
ΔMKR
2.41 GHz
-44.16 dB
START 30MHz
STOP 25.00GHz
RBW 1.0MHz
VBW 1.0MHz
*SWP 10.0sec


*ATTEN 20dB
RL 10.0dBm
10dB/
ΔMKR -45.33dB
2.46GHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
ΔMKR
2.46 GHz
-45.33 dB
START 30MHz
STOP 25.00GHz
RBW 1.0MHz
VBW 1.0MHz
*SWP 10.0sec


*ATTEN 20dB
RL 10.0dBm
10dB/
ΔMKR -41.34dB
2.50GHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
ΔMKR
2.50 GHz
-41.34 dB
START 30MHz
STOP 25.00GHz
RBW 1.0MHz
VBW 1.0MHz
*SWP 10.0sec

6 - POWER DENSITY

6.1 Standard Applicable

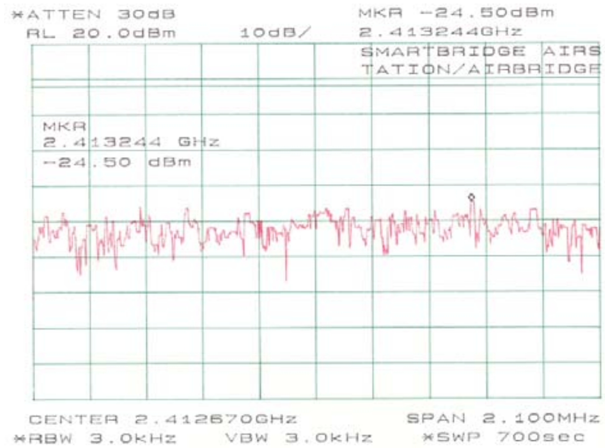
According to §15.247 (d), for direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

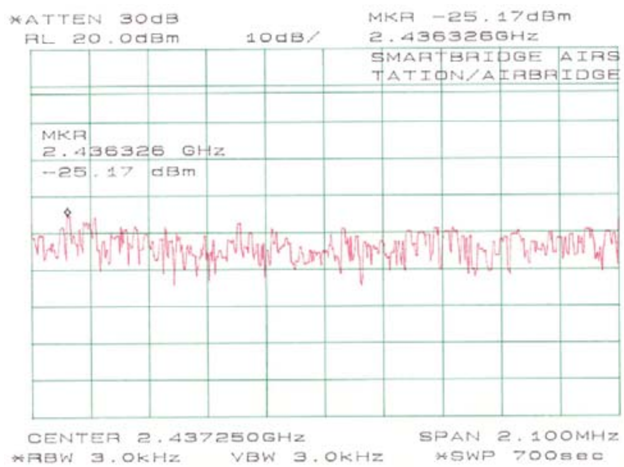
6.2 Measurement Procedure

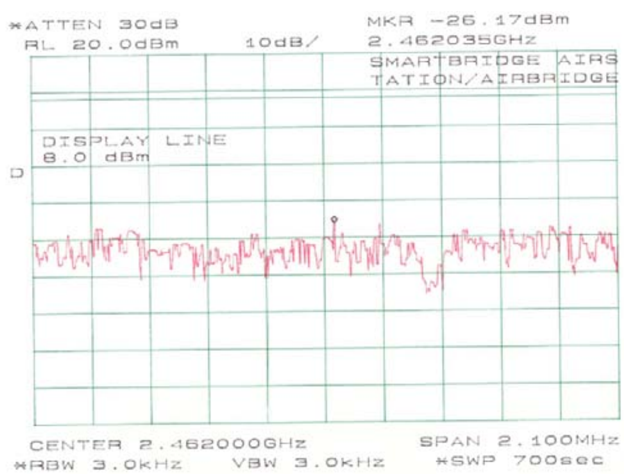
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT was set without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Repeat above procedures until all frequencies measured were complete.

6.3 Test Results

The plot(s) of power density was presented hereinafter as reference.


*ATTEN 30dB
RL 20.0dBm 10dB/
MKR -24.50dBm
2.413244GHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
MKR
2.413244 GHz
-24.50 dBm
CENTER 2.412670GHz
SPAN 2.100MHz
*RBW 3.0kHz VBW 3.0kHz *SWP 700sec


*ATTEN 30dB
RL 20.0dBm 10dB/
MKR -25.17dBm
2.436326GHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
MKR
2.436326 GHz
-25.17 dBm
CENTER 2.437250GHz
SPAN 2.100MHz
*RBW 3.0kHz VBW 3.0kHz *SWP 700sec


*ATTEN 30dB
RL 20.0dBm 10dB/
MKR -26.17dBm
2.462035GHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
DISPLAY LINE
8.0 dBm
D
CENTER 2.462000GHz
SPAN 2.100MHz
*RBW 3.0kHz VBW 3.0kHz *SWP 700sec

7 - 6DB BANDWIDTH

7.1 Standard Applicable

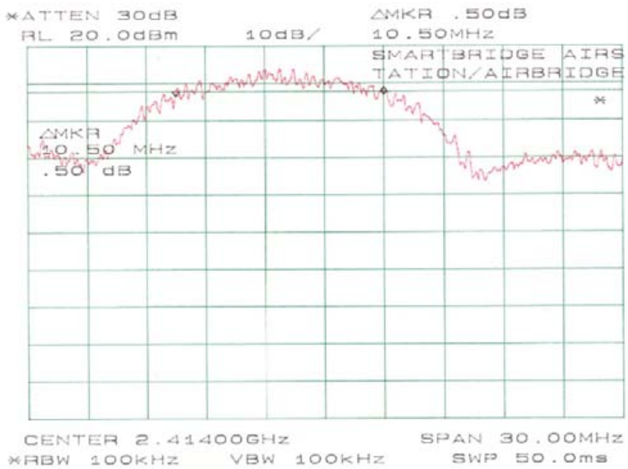
According to §15.247(a)(2), for direct sequence systems, the minimum 6dB bandwidth shall be at least 500 kHz.

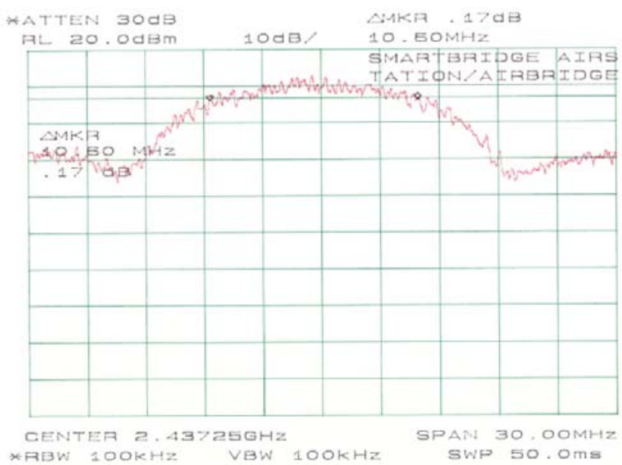
7.2 Measurement Procedure

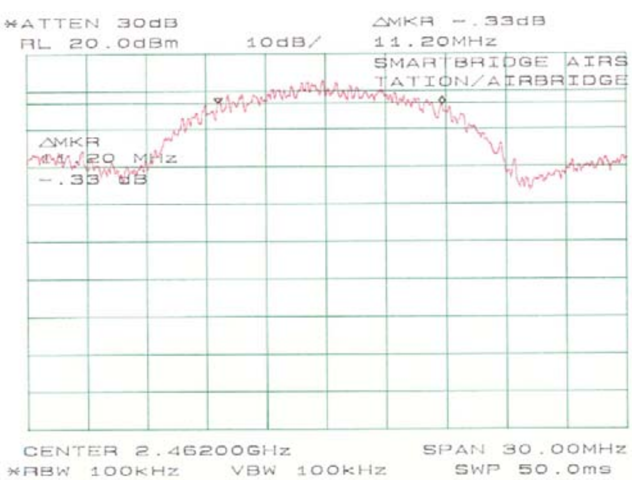
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

7.3 Test Result

The plot(s) of 6dB Bandwidth was presented hereinafter as reference.


*ATTEN 30dB
RL 20.0dBm 10dB/
ΔMKR .50dB
10.50MHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
ΔMKR
10.50 MHz
.50 dB
CENTER 2.41400GHz
SPAN 30.00MHz
*RBW 100kHz VBW 100kHz
SWP 50.0ms


*ATTEN 30dB
RL 20.0dBm 10dB/
ΔMKR .17dB
10.50MHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
ΔMKR
10.50 MHz
.17 dB
CENTER 2.43725GHz
SPAN 30.00MHz
*RBW 100kHz VBW 100kHz
SWP 50.0ms


*ATTEN 30dB
RL 20.0dBm 10dB/
ΔMKR -.33dB
11.20MHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
ΔMKR
11.20 MHz
-.33 dB
CENTER 2.46200GHz
SPAN 30.00MHz
*RBW 100kHz VBW 100kHz
SWP 50.0ms

8 - 100 KHZ BANDWIDTH OF BAND EDGES MEASUREMENT

8.1 Standard Applicable

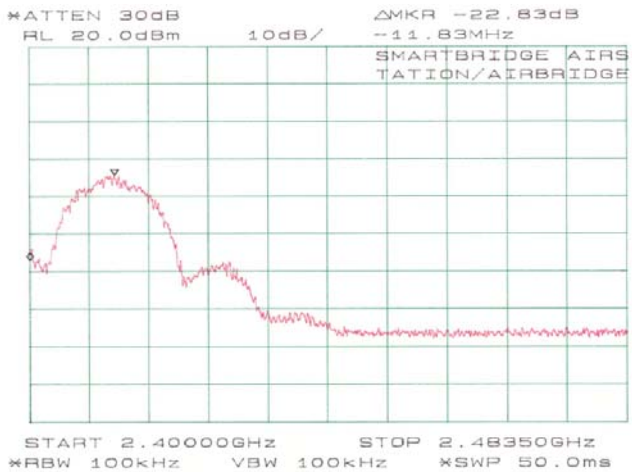
According to §15.247(c), if *any* 100 kHz bandwidth outside these frequency bands, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in § 15.209(a), whichever results in the lesser attenuation.

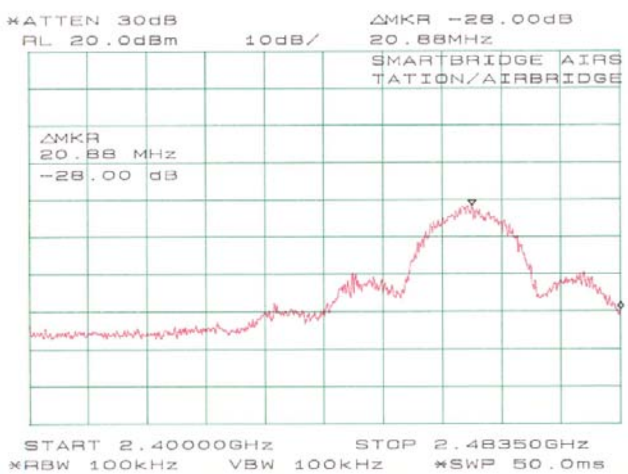
8.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

8.3 Test Results

The plot(s) of Band Edge Test Data was presented hereinafter as reference.


*ATTEN 30dB
RL 20.0dBm 10dB/
ΔMKR -22.83dB
-11.83MHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
START 2.40000GHz STOP 2.48350GHz
*RBW 100kHz VBW 100kHz *SWP 50.0ms


*ATTEN 30dB
RL 20.0dBm 10dB/
ΔMKR -28.00dB
20.88MHz
SMARTBRIDGE AIRSTATION/AIRBRIDGE
ΔMKR
20.88 MHz
-28.00 dB
START 2.40000GHz STOP 2.48350GHz
*RBW 100kHz VBW 100kHz *SWP 50.0ms

9 - ANTENNA REQUIREMENT

9.1 Standard Applicable

For intentional device, according to § 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.

And according to § 15.247 (1), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

9.2 Antenna Connected Construction

The directional gain of antenna used for transmitting is 2.5dBi. EUT's RF output socket and antenna are reverse polarity type. EUT's antenna connector is of reverse polarity type. Antenna is detachable type and should be of reverse polarity for the system to work. Please see EUT photo for details.

10 - RF EXPOSURE

According to 15.247(b)(4), RF exposure is calculated.

MPE Prediction

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$S = PG/4\pi R^2$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal: 17.46 (dBm)
Maximum peak output power at antenna input terminal: 55.72 (mW)
Antenna Gain (typical): 2.5 (dBi)
Maximum antenna gain: 1.79 (numeric)
Prediction distance: 3 (cm)
Predication frequency: 2400(MHz)
MPE limit for uncontrolled exposure at prediction frequency: 1.0(mW/cm^2)
Power density at predication frequency: 0.882 (mW/cm^2)
Maximum allowable antenna gain: 3.07 (dBi)

Test Result

The predicted power density level at 3 cm is **0.882** mW/cm². This is below the uncontrolled exposure limit of 1mW/cm² at 2400 MHz.

11 - SPURIOUS RADIATED EMISSION DATA

11.1 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of a radiation emissions measurement at BACL is $\pm$4.0 dB.

11.2 EUT Setup

The radiated emission tests were performed in the open area 3-meter test site, using the setup in accordance with the ANSI C63.4 - 1992. The specification used was the FCC 15 Subpart C limits.

The EUT was connected with the host PC system. The host PC system was placed on the center of the back edge on the test table. The modem and the monitor were placed on the right side of the host PC system, and the printer was placed on the left side of the host PC system. The rear of the EUT and peripherals were placed flushed with the rear of the tabletop.

The keyboard was placed directly in front of the monitor, flushed with the front of tabletop. The mouse was placed next to the keyboard, flushed with the back of keyboard.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The host PC system was connected with 110Vac/60Hz power source.

11.3 Spectrum Analyzer Setup

According to FCC Rules, 47 CFR §15.33 (a) (1), the system was tested to 25GHz.

During the radiated emission test, the spectrum analyzer was set with the following configurations:

Start Frequency .... 30 MHz
Stop Frequency 25GHz
Sweep Speed .... Auto
IF Bandwidth .... 1 MHz
Video Bandwidth .... 1 MHz
Quasi-Peak Adapter Bandwidth................................. 120 kHz
Quasi-Peak Adapter Mode .... Normal
Resolution Bandwidth.. 1MHz

11.4 Test Procedure

For the radiated emissions test, the Host PC system and all support equipment power cords were connected to the AC floor outlet since the power supply used in the EUT did not provide an accessory power outlet.

Maximizing procedure was performed on the six (6) highest emissions to ensure EUT compliance is with all installation combinations. All data was recorded in the peak detection mode. Quasi-peak readings was performed only when an emission was found to be marginal (within -4 dBµV of specification limits), and are distinguished with a "**Qp**" in the data table.

11.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dBµV means the emission is 7dBµV below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. - Class B Limit

11.6 Summary of Test Results

According to the data in section 11.7, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.207, and 15.247, and had the worst margin of:

- 4.3 dBµV at **4825.22 MHz** in the **Vertical** polarization, *Low Channel,* 30 MHz to 25GHz, **3 meters**

-2.6 dBµV at **4874.50 MHz** in the **Horizontal** polarization, *Middle Channel,* 30 MHz to 25GHz, **3 meters**

-3.7 dBµV at **120.00 MHz** in the **Vertical** polarization, *High Channel*, 30 MHz to 25GHz, **3 meters**

11.7 Final Test Result

11.7.1 Final Test Data, Low Channel, 30MHz to 25GHz, 3 meters

INDICATED			TABLE	ANTENNA		CORRECTION FACTOR			CORRECTED AMPLITUDE	FCC 15 Subpart C	
Frequency MHz	Ampl. dBµV/m	Comments	Angle Degree	Height Meter	Polar H/ V	Antenna dBµV/m	Cable dB	Amp. dB	Corr. Ampl. dBµV/m	Limit dBµV/m	Margin dB
2412.67	113.4	Fund.	180	1.4	H	28.1	3.4	30.0	114.9	/	/
2412.67	113.3	Fund.	0	1.0	V	28.1	3.4	30.0	114.8	/	/
4825.22	42.3	Avg.	90	1.5	V	32.5	4.9	30.0	49.7	54.0	-4.3
4825.22	40.0	Avg.	180	1.0	H	32.5	4.9	30.0	47.4	54.0	-6.6
88.09	44.0	/	180	1.0	V	9.7	2.2	20.7	35.2	43.5	-8.3
264.02	42.0	/	225	2.0	H	13.3	4.9	22.8	37.4	46.0	-8.6
216.00	40.0	/	90	2.4	H	12.5	4.7	22.4	34.8	43.5	-8.7
300.00	36.0	/	270	1.3	H	15.1	4.6	22.9	32.8	46.0	-13.2

11.7.2 Final Test Data, Middle Channel, 30MHz to 25GHz, 3 meters

INDICATED			TABLE	ANTENNA		CORRECTION FACTOR			CORRECTED AMPLITUDE	FCC 15 Subpart C	
Frequency MHz	Ampl. dBµV/m	Comments	Angle Degree	Height Meter	Polar H/ V	Antenna dBµV/m	Cable dB	Amp. dB	Corr. Ampl. dBµV/m	Limit dBµV/m	Margin dB
2437.25	113.3	Fund.	330	1.2	H	28.1	3.4	30.0	114.8	/	/
2437.25	113.4	Fund.	0	1.0	V	28.1	3.4	30.0	114.9	/	/
4874.50	44.0	Avg.	270	1.2	H	32.5	4.9	30.0	51.4	54.0	-2.6
748.00	38.0	Avg.	180	1.0	H	22.4	2.9	22.1	41.2	46.0	-4.8
4874.50	41.0	Avg.	45	1.0	V	32.5	4.9	30.0	48.4	54.0	-5.6
120.00	43.0	/	270	1.0	V	12.1	2.2	19.5	37.8	43.5	-5.7
132.00	43.0	/	135	1.5	V	12.6	2.0	21.5	36.1	43.5	-7.4
352.03	40.0	/	180	1.5	H	15.5	4.3	21.8	38.0	46.0	-8.0
240.00	44.0	/	270	1.5	H	12.6	2.3	22.5	36.4	46.0	-9.6
264.02	40.0	/	225	1.0	H	13.3	4.9	22.8	35.4	46.0	-10.6
144.00	39.8	/	270	1.0	V	13.2	1.0	21.2	32.8	43.5	-10.7

11.7.3 Final Test Data, High Channel, 30MHz to 25GHz, 3 meters

INDICATED			TABLE	ANTENNA		CORRECTION FACTOR			CORRECTED AMPLITUDE	FCC 15 Subpart C	
Frequency MHz	Ampl. dBµV/m	Comments	Angle Degree	Height Meter	Polar H/ V	Antenna dBµV/m	Cable dB	Amp. dB	Corr. Ampl. dBµV/m	Limit dBµV/m	Margin dB
2462.00	113.4	Fund.	180	1.3	V	28.1	3.4	30.0	114.9	/	/
2462.00	113.4	Fund.	0	1.4	H	28.1	3.4	30.0	114.9	/	/
120.00	45.0	/	225	1.0	V	12.1	2.2	19.5	39.8	43.5	-3.7
748.00	38.4	/	225	1.2	H	22.4	2.9	22.1	41.6	46.0	-4.4
132.07	43.1	/	0	1.8	V	12.6	2.0	21.5	36.2	43.5	-7.3
88.08	44.0	/	90	1.0	V	9.7	2.2	20.7	35.2	43.5	-8.3
264.02	42.0	/	90	1.0	H	13.3	4.9	22.8	37.4	46.0	-8.6
144.02	40.0	Avg.	330	1.0	V	13.2	1.0	21.2	33.0	43.5	-10.5
4924.00	35.0	Avg.	0	1.0	H	32.5	4.9	30.0	42.4	54.0	-11.6
4924.00	34.8	/	180	1.3	V	32.5	4.9	30.0	42.2	54.0	-11.8
192.02	36.0	/	0	1.0	V	14.4	2.7	22.5	30.6	43.5	-12.9

12 - CONDUCTED EMISSIONS TEST DATA

12.1 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, and LISN.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of any conducted emissions measurement at BACL is ±2.4 dB.

12.2 EUT Setup

The measurement was performed at the **O**pen **A**rea **T**est **S**ite, using the same setup per ANSI C63.4 - 1992 measurement procedure. The specification used was FCC 15 Subpart C limits.

The EUT was connected with the host PC system. The host PC system was placed on the center of the back edge on the test table. The modem and the monitor were placed on the right side of the host PC system, and the printer was placed on the left side of the host PC system. The rear of the EUT and peripherals were placed flushed with the rear of the tabletop.

The keyboard was placed directly in front of the monitor, flushed with the front of tabletop. The mouse was placed next to the keyboard, flushed with the back of keyboard.

The spacing between the peripherals was 10 centimeters.

Input / Output cables were draped along the edge of the test table and bundle when necessary.

The host PC system was connected with 110Vac/60Hz power source.

12.3 Spectrum Analyzer Setup

The spectrum analyzer was set with the following configurations during the conduction test:

Start Frequency.. 450 kHz
Stop Frequency.. 30 MHz
Sweep Speed.. Auto
IF Bandwidth.. 10 kHz
Video Bandwidth.. 10 kHz
Quasi-Peak Adapter Bandwidth .... 9 kHz
Quasi-Peak Adapter Mode.. Normal

12.4 Test Procedure

During the conducted emission test, the power cord of the host system was connected to the auxiliary outlet of the first LISN.

Maximizing procedure was performed on the six (6) highest emissions of each modes tested to ensure EUT is compliant with all installation combination.

All data was recorded in the peak detection mode. Quasi-peak readings were only performed when an emission was found to be marginal (within -4 dBμV of specification limits). Quasi-peak readings are distinguished with a "**Qp**".

12.5 Summary of Test Results

According to the data in section 12.6, the EUT complied with the FCC Conducted margin for a Class B device, with the *worst* margin reading of:

-16.2dBμV at **0.780 MHz** in the **Line** mode, 450kHz - 30 MHz

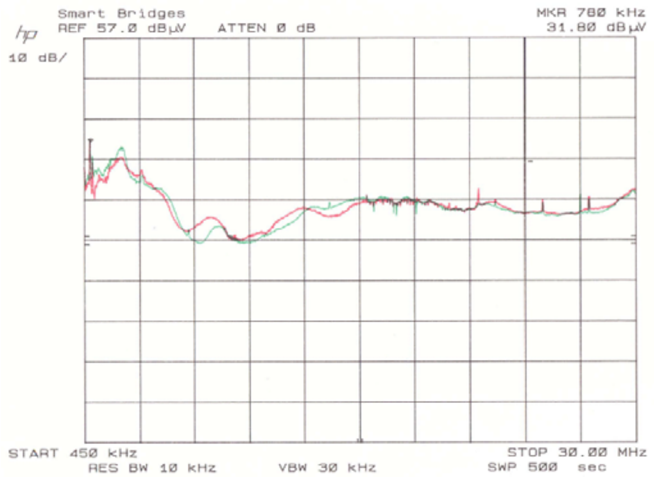
12.6 Conducted Emissions Test Data

12.6.1 Test Data, 0.45 - 30 MHz.

LINE CONDUCTED EMISSIONS				FCC CLASS B	
Frequency MHz	Amplitude dBμV	Detector Qp/Ave/Peak	Phase Line/Neutral	Limit dBμV	Margin dB
0.780	31.8	Peak	Line	48	-16.2
0.780	31.7	Peak	Neutral	48	-16.3
2.670	27.4	Peak	Neutral	48	-20.6
2.310	27.2	Peak	Line	48	-20.8
21.640	19.6	Peak	Line	48	-28.4
29.880	19.1	Peak	Neutral	48	-28.9

12.7 Plot of Conducted Emissions Test Data

Plot(s) of Conducted Emissions Test Data is presented hereinafter as reference.



13 - PROCESSING GAIN

Please refer to the attachment.

Testing for compliance with FCC rules 15-247e

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January 11, 2000
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321-724-7535

Scope

This report presents the test procedure, test configuration and test data associated with a FCC Part 15.247 (e) Jamming Margin test for the indirect measurement of processing gain.

Applicable Reference Documents.

1. "Operation within the bands 902-928 MHz, 2400-2483.5, and 5725-5850 MHz" ***Title 47 Part 15 section 247 (e) Code of Federal Regulations*. (47 CFR 15.247).**

2. "Report and Order: Amendment of Parts 2 and 15 of the Commission's Rules Regarding Spread Spectrum Transmitters. Appendix C: 'Guidance on Measurements for Direct Sequence Spread Spectrum Systems" ***FCC 97-114. ET Docket No. 96-8, RM-8435, RM-8608, RM-8609.***

3. "HFA3861A Direct Sequence Spread Spectrum Baseband Processor" ***Harris Corporation Semiconductor Sector Preliminary Data Sheet***, Melbourne FL, July 1999.

4. " M-ary Orthogonal Keying BER Curve",

Test Background and Procedure.

According to FCC regulations [1], a direct sequence spread spectrum system must have a processing gain, G_p of at least 10 dB. Compliance to this requirement can be shown by demonstrating a relative bit-error-ratio (BER) performance improvement (and corresponding signal to noise ratio per symbol improvement of at least 10 dB) between the case where spread spectrum processes (coding, modulation) are engaged relative to the processes being bypassed. In some practical systems, the spread spectrum processing cannot simply be bypassed. In these cases, the processing gain can be indirectly measured by a jamming margin test [2]. In accordance with the new NPRM 99-231, if the vendor has a system with less than 10 chips per symbol, the CW jamming results must be supported by a theoretical explanation of the system processing gain.

Theoretical calculations

The processing gain is related to the jamming margin as follows [2]:

$$G_p = \left(\frac{S}{N}\right)_{output} + \left(\frac{J}{S}\right) + L_{system}$$

Where $BER_{REFERENCE}$ is the reference bit error ratio with its corresponding, theoretical output signal to noise ratio per symbol, $(S/N)_{output}$, (J/S) is the jamming margin (jamming signal power relative to desired signal power), and L_{system} are the system implementation losses.

The maximum allowed total system implementation loss is 2 dB.

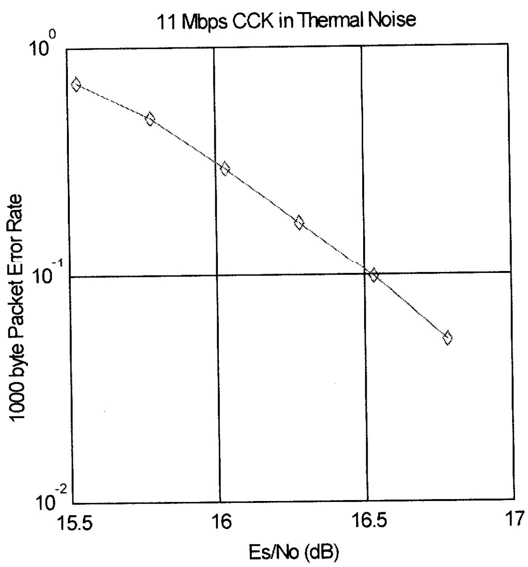
The HFA3861A direct sequence spread spectrum baseband processor uses CCK modulation which is a form of M-ary Orthogonal Keying. The BER performance curve is given by [5]:

" The probability of error for generalized M-ary Orthogonal signaling using coherent demodulation is given by:

$$P_e = 1 - P_{c1} = 1 - \frac{1}{\sqrt{2\pi}} \int_{-\frac{S_{01}}{N_0}}^{\infty} \left[2(1 - Q\left\{z + \sqrt{2\frac{E_b}{\eta}}\right\}) \right]^{\frac{M}{2}-1} \exp\left\{-\frac{z^2}{2}\right\} dz$$

This integral cannot be solved in closed form, and numerical integration must be used. There are error rate extensions for differential decoding and descrambling that are also to be accounted for. This is done in a MATHCAD environment and is displayed in graphical format below.

1.1 1000 byte PER vs. Es/No



The reference PER is specified as 8%. The corresponding Es/No (signal to noise ratio per symbol) is 16.4 dB. The Es/No required to achieve the desired BER with maximum system implementation losses is 18.4 dB. The minimum processing gain is again, 10 dB, therefore:

$$G_p = \left(\frac{E_s}{N_o}\right)_{output} + \left(\frac{J}{S}\right) + L_{system} = 16.4dB + 2.0dB + \left(\frac{J}{S}\right) \geq 10dB$$

$$G_p = 18.4dB + \left(\frac{J}{S}\right) \geq 10dB$$

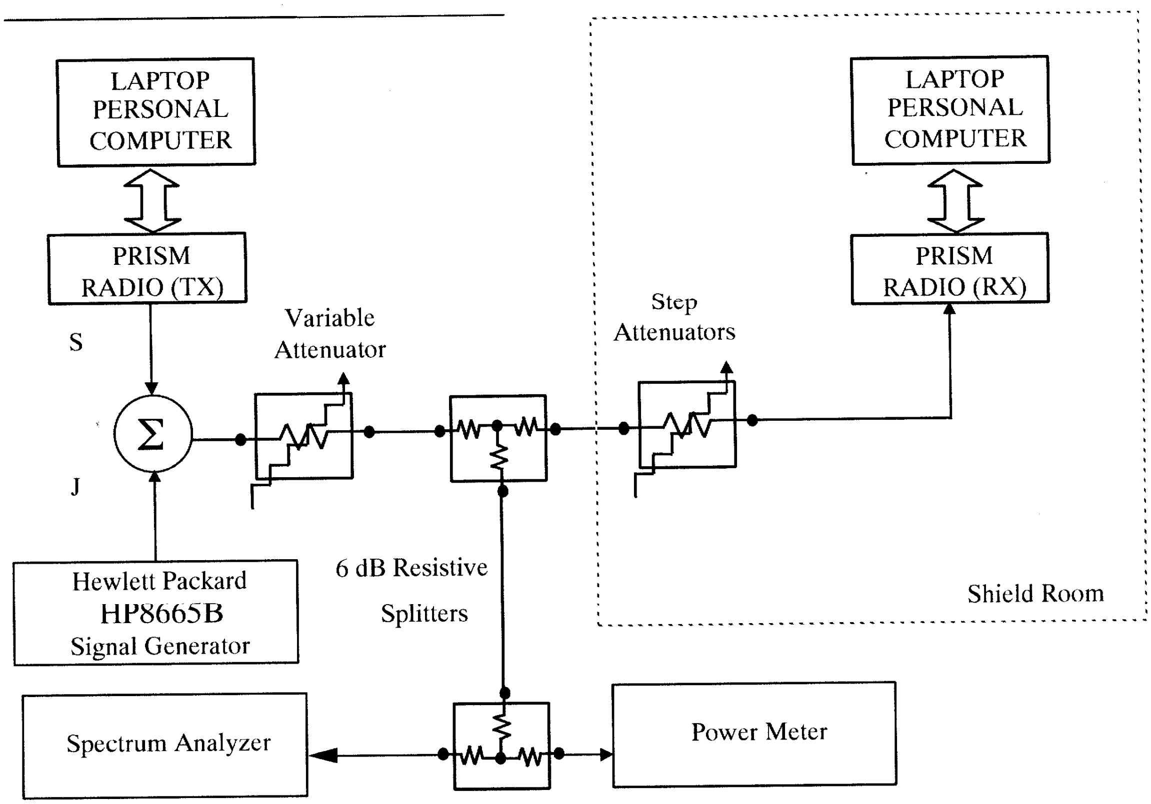
The minimum jammer to signal ratio is as follows:

$$\left(\frac{J}{S}\right) \geq -8.4\,dB$$

For the case of the HFA3861A, the bit rates are 1, 2, 5.5, and 11 Mbps. The corresponding symbol rates are 1, 1, 1.375, and 1.375 MSps. The chip rate is always 11 MCps, so the ratio of chip rate to symbol rate is 11:1 for the 1 and 2 Mbps rates and 8:1 for the 5.5 and 11 Mbps rates. Since the symbol rate to bit rate is less than 10 for the higher rates, we supply the theoretical processing gain calculation for these cases where spread spectrum processing gain with embedded coding gain is utilized. This is reasonable in that they cannot be separated in the demodulation process. If a separable FEC coding scheme were used, we would not be comfortable making this assertion.
As can be seen from the curve of figure 1, the Es/N0 is 16.4 dB at the PER of 8%. This PER can be related to a BER of 1e-5 on 1000 byte packets. With 8 bits per symbol, the Eb/N0 is then 7.4 dB or 9 dB less than the Es/N0. It is well known that the Eb/N0 of BPSK is 9.6 dB for 1e-5 BER, so therefore the coding gain of CCK over BPSK is 2.2 dB. We add this to the processing gain of 9 dB to get 11.2 dB overall processing gain for the CW jammer test.

Taking the calculations above, if the $\left(\frac{J}{S}\right) \geq -8.4\,dB$ then the equipment passes the CW jamming test.

Basic Test Block Diagram



Test Procedure

Setup the simplex link shown. Perform all independent instrumentation calibrations prior to this procedure. Set operating power levels using fixed and variable attenuators in system to meet the following objectives:

- Signal Power at receiver approximately -60 dBm (above thermal sensitivity such that thermal noise does not cause bit errors).
- Signal Power at power meter (using high sensitivity probe) between -20 and -40 dBm for optimal linearity.
- Use spectrum analyzer to monitor test.
- Ensure that CW Jammer generator RF output is disabled and measure the power at the power meter port using the power meter. This is the relative signal power, S_r.
- Disable Transmitter, and set CW Jammer generator RF output frequency equal to the carrier frequency and enable generator output. Set reference CW Jammer

power level at power meter port 8.4 dB below S_r (minimum J/S, or 10 dB processing gain reference level). Note the power level setting on the generator, this is the reference CW Jammer power setting, J_r.

- Disable CW Jammer, re-establish link. PER test should be operating essentially error-free.
- Adjust the CW Jammer level to that which causes 8% PER and verify that the S/J is less than 8.4 dB.
- Repeat step 7 for uniform steps in frequency increments of 50 kHz across the receiver passband with the CW Jammer. In this case the receiver passband is $\pm$8.5 MHz.

The number of points where the S/J fails to achieve 8.4 dB (is higher than 8.4 dB) is determined and if this is above 20% of the total, the test is failed otherwise it is passed.

The numerical data associated with the following radio channels is tabulated and presented for:

Channel 1: 2412 MHz
Channel 6: 2437 MHz
Channel 11: 2462 MHz

PRISM II Radio HWB3163-02 Rev A card
Detailed Processing Gain Measurement Operating Instructions

1) Assemble equipment as shown in the block diagram.
2) This test procedure assumes that the Computers are equipped with 3.3V PCMCIA slots and have the appropriate PCMCIA radio card Windows drivers installed. Also that the Prism 802.11 Wireless LAN Configuration Utility and CW10CON Console Command Line program is installed.
3) Use two Prism II radio cards. This procedure is written for HWB3163-02 Rev A, newer radio cards may require different software/firmware. The HWB3163-02 rev A uses the HFA3861A baseband processor. These radio cards are loaded with firmware. Firmware may be loaded in Genesis mode using the program "Download" revision 3.7 a DOS based utility.

4) The following programs and files are used in this test procedure.
C:\ laneval\laneval.exe (rev 2.03 or later) Windows LAN and PER utility.
C:\laneval\laneval.ini (autogenerated) Must edit this file to set the following:
PktDelay = 1 PktBurst = 6 (Settings for firmware 0709 rev 0.4+)
Pkt Size = 1000
PktFill = -1 (Random data or Optional data pattern may be specified with decimal byte value 0 to 255)
New firmware rev 0.4 will allow PktDelay less than 10.
C:\cw10con\cw10con.exe (rev 0.4)(8/4/99) Windows Console command line Utility
c:\cw10con\h3861ar1a.ini (8/4/99) Contains updated Baseband processor register values.

5) Insert HWB3163-02 Rev A Prism II radio into PCMCIA extender card 68 pin connector socket. Note: The PRISM II radio uses only 3.3V power. Cards with coversets are "keyed" for low voltage slots and will not fit into 5V slots. Cards without coversets must be manually centered and inserted into the 68 pin extender card socket.

6) Select desired frequency channel and data rate.
* Double Click the system icon at the lower left of the screen that looks like a "terminal with an antenna". This activates the "Prism 802.11 Wireless LAN Configuration Utility.
* Select the desired channel (1,6 or 11 recommended) and "Fixed 11Mb/s" for data rate on both the TX and RX radios. The Configuration Utility modifies these settings dynamically so that NO Reboot is necessary. However, when the channel setting is modified, Configuration Utility reinitializes the radio card reverting all register settings back to the firmware defaults. It will be necessary to perform step 7) after each change of channel setting.
* An alternate method of changing channels without reinitializing the radio card register values is available through the cw10con program, described in step 7) under "Other useful commands".

7) Load correct Baseband processor (HFA3861) register values into both the TX and RX cards. Cards with firmware revision 0709 0.4+ have correct register settings and do not need modification except at indicated in step 7a)
* Execute program cw10con.exe (Enter > ? for a list of available commands)
(Enter > q for quit)
* Enter Command > bf h3861ar1.ini (loads BBP registers contained in file)
* Other useful commands in the cw10con program.
Enter Command > c 0838 a (dynamically changes radio frequency to channel 10 ["a" Hex] without reinitializing the radio registers, the channel field is a HEX number from 1 to e [1 to 14 decimal]).
Enter Command > c 0e38 5555 (Continuous transmit mode with data pattern 0101)
Enter Command > c 0f38 (Turn off transmit mode, refer to step 14)).

Enter Command > c 1338 (Run DC offset calibration on HFA3783)

7a) Cards with firmware 0709 rev 0.4+ or later require the CCA function turned off on the transmitter card during the Processing Gain test.
* Execute program cw10con.exe
* Enter Command > bw 09 00 (Change register 09(Dec) to value 00(Hex) original value is 20(Hex) user can verify change using the command br 09).

8) Set the approximate power to the input of the RX card to -60dBm by adjusting the Variable Attenuator and step attenuators.
9) Execute "Laneval.exe" on both TX and RX computers. Set for "Broadcast" mode and start transmission of the TX card. Set the RX card for "Broadcast" and start receiving with the RX card. Verify that the two cards are communicating by observing the "Total Packet Count" window of the RX computer. This window should be increasing in value as packets are received from the TX card. Also note the "Packet Error Rate" window should remain 0.0, indicating no errors in this large signal condition. Allow the radio cards, signal source and power meter to warm up for several hours.
10) Click the Stop TX and Stop RX buttons in Laneval.
11) Calibrate Power Sensor/Meter.
12) Click the CW10CON window previously opened to bring forward. Set the TX card to continuous transmit. Enter Command > c 0e38 5555 (Continuous transmit data pattern 0101)
13) Measure TX card output signal power and adjust Variable Attenuator for -30.0dBm at the power meter. This measurement should be taken quickly as the radio can change its output power about 0.5dB warming up in continuous mode. Remember that the RX card sees 30 dB less power than the power meter, so the RX card will see -60dBm.
14) Disable the TX card output. Enter Command > c 0f38 (Turn off TX output)
15) Set up Jammer Source. Adjust the frequency of the HP8665B (or equivalent) to center of the TX channel and adjust to output amplitude to -8.0dBm. Turn on the RF output of the Signal source.
16) Measure the Jammer power level at the power meter. Adjust Jammer signal amplitude at the source until you measure -38.4dBm (-68.4dBm at the RX card). This will give a Signal to Jammer ratio of 8.4dB, the limit to pass the 10dB processing gain test for a PER 0f 8%. Record this Jammer source output setting as all measurements will be recorded relative to this level.
17) Click the Laneval window at the TX computer and start transmitting in broadcast mode.
18) Click the Laneval window at the RX computer and start the RX card receiving. Measure the PER of the receiving unit.

The tab and enter keys can replace the mouse click to start and stop the Laneval receive mode for PER measurements. The tab key will cycle through program options by highlighting the option button in the program window. Highlight the desired button with tab and then select the option with the Enter key.

The FCC specifies that the Processing Gain test will be measured with the CW Jammer in 50KHz steps across the bandwidth of the spread signal (+-8.5MHz for Prism II) or 340 test points per channel. It is recommended to measure channels 1,6 and 11. Processing Gain is measured by adjusting the CW Jammer source to find the S/J ratio for 8% PER at each jamming frequency. Record the Jammer source output setting and calculate the Processing Gain at each Jammer frequency in the band. Care should be taken to allow enough time for an accurate measurement, 1 minute is a minimum. A maximum of 68 points, or 20%, may fall below 10dB Processing Gain for the radio to still pass the Processing Gain requirement.

19) It is recommended to power down the Prism II PCMCIA card before removing from its slot. This can be done from the PCMCIA card system icon at the bottom of the Windows screen. Place the mouse pointer over the icon and a text bar will appear naming the driver "Harris Prism IEEE802.11 PC Card Adapter/EVB". Mouse click this text bar. A dialog window will appear verifying that the PC card has been powered down and that it is safe to remove it.
20) When reinserting the Prism II radio PC card, it is acceptable to "hot" insert the card when Windows is running. The driver application will automatically sense the new hardware and apply the correct 3.3V bus power. On power up the Prism II card will execute its own initialization program stored in on board ROM. This program provides default values for the baseband processor and other radio settings. These default settings need to be updated on each card insertion as described in steps 6) and 7) above with the CW10CON program.