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FCC 15.247(e) Jamming Margin Test Report for the WaveRider EUM/CCU 3000 Wireless Modem
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2 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 on the Waverider Communications EUM/CCU 3000 Wireless Modem.

The Waverider Communications EUM/CCU 3000 Wireless Modem passes the CW jamming Margin test on all three channels. These results are summarized in the following table:

Channel	Min. Processing Gain (after 20% discarded)
1	10.4 dB
21	10.4 dB
41	10.7 dB

Details of the test procedure, test configuration and test data are presented in the following sections.

3 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. "HFA3861B Direct Sequence Spread Spectrum Baseband Processor" ***Harris Corporation Semiconductor Sector Preliminary Data Sheet***, Melbourne FL, January 2000.

4. Table 10.3, **Introduction to Communication Systems 2nd Edition**, Ferrel G. Stremler, Addison-Wesley 1982

5. Figure 4.2.6, **Digital Communications 2nd Edition**, John G. Proakis, McGraw-Hill Book Company 1989

4 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-rate (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.

5 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 $(S/N)_{output}$ is the theoretical output signal to noise for the desired $BER_{REFERENCE}$ (10^{-4}), (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 HFA3861 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 Figure 15 of reference 3, and shown below:

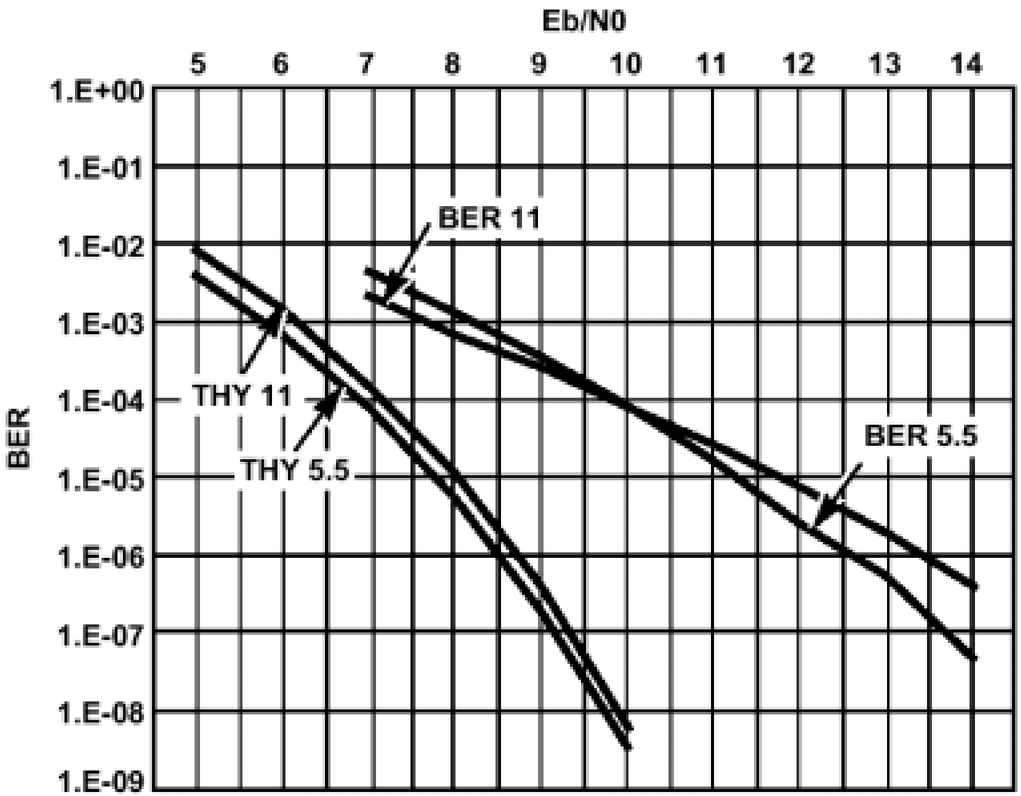


FIGURE 15. BER vs Eb/N0 PERFORMANCE FOR CCK MODES

In the figure above THY 11 and THY 5.5 are the theoretical performances at 11 and 5.5 Mbps. BER 11 and BER 5.5 are the actual performances at 11 and 5.5 Mbps.

The reference BER is specified as 10^{-4}. The corresponding Eb/No (signal to noise ratio per bit) is 7.2 dB – from figure 15 above. With 8 bits per symbol an additional 9 dB is required for an Es/No (signal to noise per symbol) of 16.2 dB. The Es/No required to achieve the desired BER with maximum system implementation losses is 18.2 dB. The minimum processing gain is again, 10 dB, therefore:

$$G_p = \left(\frac{E_s}{N_o}\right)_{output} + \left(\frac{J}{S}\right) + L_{system} = 16.2dB + 2.0\,dB + \left(\frac{J}{S}\right) \geq 10dB$$

$$G_p = 18.2\,dB + \left(\frac{J}{S}\right) \geq 10dB$$

The minimum jammer to signal ratio is as follows:

$$\left(\frac{J}{S}\right) \geq -8.2\,dB$$

For the case of the HFA3861, 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 15, the Eb/N0 is 7.2 dB at the BER of 10^{-4}. It is well known that the Eb/N0 of BPSK is 8.4 dB for 10^{-4} BER [4, 5], so therefore the coding gain of CCK over BPSK is 1.4 dB. We add this to the processing gain of 9 dB to get 10.4 dB overall processing gain for the CW jammer test.

Taking the calculations above, if the $\left(\frac{J}{S}\right) \geq -8.2\,dB$ then the equipment passes the CW jamming test.

Note:

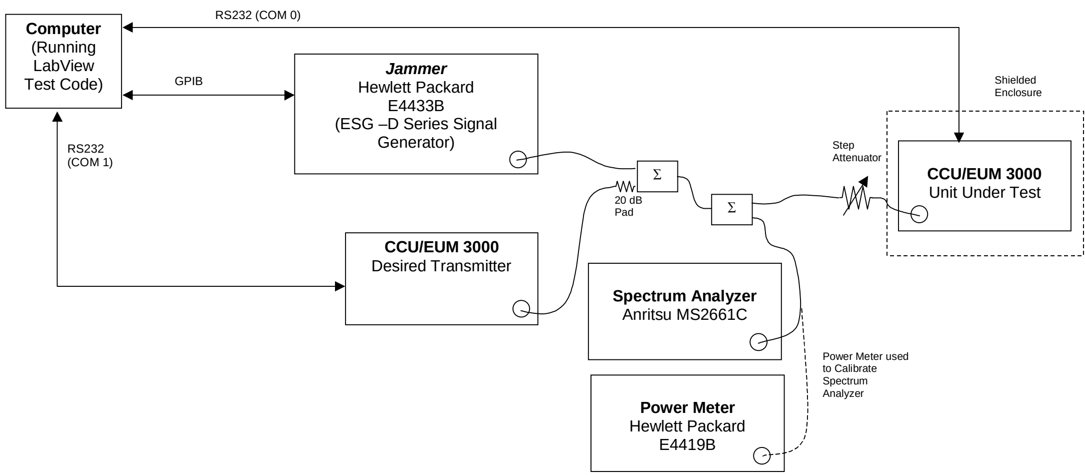
In this product (EUM/CCU3000) the chip rate and data rates are ¼ of the standard system described above. This results in the following rates:

Chip Rate:	2.75 MCps
Data Rates:	2.75 Mbps.
Symbol Rates:	343.75 KSps.

Therefore the ratio of chip rate to symbol rate is still 8 for these data rates and the above theory still applies.

6 Test Configuration: CW Jamming Margin (15.247) (e)

6.1 Basic Test Block Diagram



6.2 Test Procedure

Set up the test as shown in section 6.1. Perform independent instrument, cable calibrations prior to this procedure. A Labview program is used to control the test as follows:

1. Initialize equipment
   - HP E4433B (Jammer) to Low Channel (905 MHz), CW output.
   - The Desired Transmitter CCU/EUM 3000 Modem to Low Channel, Continuous Transmission, and adjust the Step Attenuator such that the RF level to the UUT is ~ -60 dBm.
   - Put UUT into receive mode on Low Channel.
   - Set up output file in the computer to store data.

2. For a CW Jammer frequency of (Low Channel) – 2.15 MHz to (Low Channel) + 2.15 MHz in 50 kHz steps
   - Adjust the Output Power level of the CW Jammer and measure the Bit Error Rate (BER) of the UUT until a BER of 10^{-4} is measured.
   - Save the CW Jammer Frequency, Output Power, and the UUT PER to the output file.

3. Repeat 1 and 2 for Mid Channel (915 MHz) and High Channel (925 MHz).

Process the data stored to the output file using the calibration data and calculate the Jammer to Desired Signal radio (J/S) – see section 6.3

6.3 Data Calculation

The nominal Jammer Level settings are tabulated versus frequency. The J/S ratio and the processing gain are then calculated as follows:

$$\left(\frac{J}{S}\right) = -\left[(\text{RelativeDesiredSignal}) - (\text{RelativeJammerLevel})\right]$$

$$= -\left[(S_r + DC) - (J_{sg} + JC + J_{sa})\right]$$

Where S_r = Relative Desired Signal Level at the Spectrum Analyzer (dBm).
DC = Power Meter Correction Factor for the Desired Signal Level (dB).
J_{sg} = Jammer Signal Generator Setting (dBm)
JC = Power Meter Correction Factor for the Jammer Signal Level (dB).
J_{sa} = Relative Jammer Signal Level at the Spectrum Analyzer for given J_{sg} (dB).

The minimum J/S is –8.2 dB for a 10 dB processing gain and processing gain then is determined using the J/S ratio:

$$G_p = 18.2\,dB + \left(\frac{J}{S}\right)$$

The number of points where the J/S fails to achieve -8.2 dB (is higher than -8.2 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:

Low Channel: 905 MHz

Suite 240, 6715 - 8th St. NE, Calgary, Alberta, Canada, T2E 7H7
Tel: (403) 777-9988 Fax: (403) 777-9989

Mid Channel: 915 MHz
High Channel: 925 MHz

6.4 Measurement Equipment List

Equipment	Serial Number	Calibration
HP E4433B ESG Series Signal Generator Model #: E4433B Options: 1E5 UN8	US38440435	N/A
HP ESG-D3000A Digital Signal Generator Model #: E4432A Options: 1E5 1EH	US36260536	N/A
Anritsu MS2661C Options: 02, 04, 06, 07	MT86695	Dec 20, 2000
HP E4419B Power Meter	GB40202362	Dec 29, 2000
Mini-Circuits ZAPD-21 Power Splitters (2)	none	N/A
Waverider EUM/CCU 3000 (UUT)	PrePilot Unit 17	N/A
Waverider EUM/CCU 3000 (Desired Transmitter)	PrePilot Unit 93	N/A

7 Test Data

7.1 Channel 1: 905 MHz

-6.3 dBm	S_r
0.8 dB	DC
From Table Below	J_{sg}
-0.2 dB	JC
-8.7 dB	J_{sa} – 2.4 dBm Jammer Signal Generator setting for –6.3 dBm at the Spectrum Analyzer.

Freq (MHz)	J_{sg} Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
902.85	4.5	1.1	19.3	P
902.9	4.5	1.1	19.3	P

Freq (MHz)	J_{sg} Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
902.95	4.5	1.1	19.3	P
903	4.5	1.1	19.3	P
903.05	4.5	1.1	19.3	P
903.1	4.5	1.1	19.3	P
903.15	4.5	1.1	19.3	P
903.2	4.5	1.1	19.3	P
903.25	4.5	1.1	19.3	P
903.3	4.5	1.1	19.3	P
903.35	4.5	1.1	19.3	P
903.4	3.6	0.2	18.4	P
903.45	4.5	1.1	19.3	P
903.5	0.8	-2.6	15.6	P
903.55	4.5	1.1	19.3	P
903.6	0.8	-2.6	15.6	P
903.65	4.5	1.1	19.3	P
903.7	-3	-6.4	11.8	P
903.75	-3	-6.4	11.8	P
903.8	-3	-6.4	11.8	P
903.85	-3	-6.4	11.8	P
903.9	0.8	-2.6	15.6	P
903.95	0.8	-2.6	15.6	P
904	-3	-6.4	11.8	P
904.05	3.1	-0.3	17.9	P
904.1	-3.9	-7.3	10.9	P
904.15	0.8	-2.6	15.6	P
904.2	-3.9	-7.3	10.9	P
904.25	-1.1	-4.5	13.7	P
904.3	-3	-6.4	11.8	P
904.35	-4.4	-7.8	10.4	P
904.4	-0.2	-3.6	14.6	P
904.45	0.8	-2.6	15.6	P
904.5	-0.2	-3.6	14.6	P
904.55	-3	-6.4	11.8	P
904.6	-7.7	-11.1	7.1	F
904.65	-3	-6.4	11.8	P
904.7	-5.3	-8.7	9.5	F
904.75	-1.1	-4.5	13.7	P
904.8	-3	-6.4	11.8	P
904.85	-7.7	-11.1	7.1	F

Freq (MHz)	J_{sg} Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
904.9	-4.4	-7.8	10.4	P
904.95	-4.4	-7.8	10.4	P
905	-4.4	-7.8	10.4	P
905.05	-4.4	-7.8	10.4	P
905.1	-4.4	-7.8	10.4	P
905.15	-4.4	-7.8	10.4	P
905.2	-3.9	-7.3	10.9	P
905.25	-3	-6.4	11.8	P
905.3	-3	-6.4	11.8	P
905.35	-3.4	-6.8	11.4	P
905.4	-4.4	-7.8	10.4	P
905.45	-4.4	-7.8	10.4	P
905.5	-5.3	-8.7	9.5	F
905.55	-4.8	-8.2	10	P
905.6	-4.4	-7.8	10.4	P
905.65	-4.8	-8.2	10	P
905.7	-0.6	-4	14.2	P
905.75	-6.7	-10.1	8.1	F
905.8	-5.8	-9.2	9	F
905.85	-4.8	-8.2	10	P
905.9	-3.4	-6.8	11.4	P
905.95	-4.4	-7.8	10.4	P
906	-1.6	-5	13.2	P
906.05	-2.5	-5.9	12.3	P
906.1	-0.6	-4	14.2	P
906.15	0.3	-3.1	15.1	P
906.2	-3	-6.4	11.8	P
906.25	-1.6	-5	13.2	P
906.3	-5.3	-8.7	9.5	F
906.35	0.8	-2.6	15.6	P
906.4	-10.5	-13.9	4.3	F
906.45	1.7	-1.7	16.5	P
906.5	1.2	-2.2	16	P
906.55	-0.2	-3.6	14.6	P
906.6	-3	-6.4	11.8	P
906.65	0.8	-2.6	15.6	P
906.7	2.2	-1.2	17	P
906.75	3.1	-0.3	17.9	P
906.8	2.2	-1.2	17	P

Freq (MHz)	J_{sg} Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
906.85	4.5	1.1	19.3	P
906.9	4.5	1.1	19.3	P
906.95	4.5	1.1	19.3	P
907	3.6	0.2	18.4	P
907.05	4.5	1.1	19.3	P
907.1	4.1	0.7	18.9	P
907.15	2.7	-0.7	17.5	P

7.2 Channel 21: 915 MHz

-6.0 dBm	S_r	
1.0 dB	DC	
From Table Below	J_{sg}	
-0.2 dB	JC	
-9.0 dB	J_{sa} –	2.7 dBm Jammer Signal Generator setting for –6.3 dBm at the Spectrum Analyzer.

Freq (MHz)	Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
912.85	4.5	1.1	18.8	P
912.9	4.5	1.1	18.8	P
912.95	4.5	1.1	18.8	P
913	4.5	1.1	18.8	P
913.05	4.5	1.1	18.8	P
913.1	4.5	1.1	18.8	P
913.15	4.5	1.1	18.8	P
913.2	4.5	1.1	18.8	P
913.25	4.5	1.1	18.8	P
913.3	4.5	1.1	18.8	P
913.35	4.5	1.1	18.8	P
913.4	3.1	-0.3	17.4	P
913.45	3.6	0.2	17.9	P
913.5	3.1	-0.3	17.4	P
913.55	3.1	-0.3	17.4	P
913.6	0.3	-3.1	14.6	P
913.65	1.7	-1.7	16	P
913.7	3.1	-0.3	17.4	P
913.75	-1.1	-4.5	13.2	P
913.8	-3.9	-7.3	10.4	P

Freq (MHz)	Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
913.85	-1.1	-4.5	13.2	P
913.9	-0.2	-3.6	14.1	P
913.95	-0.2	-3.6	14.1	P
914	-3.9	-7.3	10.4	P
914.05	-0.6	-4	13.7	P
914.1	-4.4	-7.8	9.9	F
914.15	-2.5	-5.9	11.8	P
914.2	-3.9	-7.3	10.4	P
914.25	-5.8	-9.2	8.5	F
914.3	-3	-6.4	11.3	P
914.35	-3	-6.4	11.3	P
914.4	-5.8	-9.2	8.5	F
914.45	-3.9	-7.3	10.4	P
914.5	-7.2	-10.6	7.1	F
914.55	-3	-6.4	11.3	P
914.6	-4.8	-8.2	9.5	F
914.65	-5.8	-9.2	8.5	F
914.7	3.1	-0.3	17.4	P
914.75	1.2	-2.2	15.5	P
914.8	-2.5	-5.9	11.8	P
914.85	-10.5	-13.9	3.8	F
914.9	-2.5	-5.9	11.8	P
914.95	-4.8	-8.2	9.5	F
915	-3.9	-7.3	10.4	P
915.05	-6.7	-10.1	7.6	F
915.1	1.2	-2.2	15.5	P
915.15	-4.8	-8.2	9.5	F
915.2	-3.9	-7.3	10.4	P
915.25	-3.4	-6.8	10.9	P
915.3	-4.4	-7.8	9.9	F
915.35	-2	-5.4	12.3	P
915.4	-3	-6.4	11.3	P
915.45	-2	-5.4	12.3	P
915.5	-4.4	-7.8	9.9	F
915.55	-2	-5.4	12.3	P
915.6	-2.5	-5.9	11.8	P
915.65	-3.4	-6.8	10.9	P
915.7	-4.4	-7.8	9.9	F
915.75	-3.4	-6.8	10.9	P

Freq (MHz)	Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
915.8	-2.5	-5.9	11.8	P
915.85	-3	-6.4	11.3	P
915.9	-3.9	-7.3	10.4	P
915.95	-3.4	-6.8	10.9	P
916	-3.4	-6.8	10.9	P
916.05	-2	-5.4	12.3	P
916.1	1.2	-2.2	15.5	P
916.15	-1.6	-5	12.7	P
916.2	0.3	-3.1	14.6	P
916.25	-0.6	-4	13.7	P
916.3	1.2	-2.2	15.5	P
916.35	-0.6	-4	13.7	P
916.4	1.2	-2.2	15.5	P
916.45	-3	-6.4	11.3	P
916.5	-3	-6.4	11.3	P
916.55	0.8	-2.6	15.1	P
916.6	2.7	-0.7	17	P
916.65	2.7	-0.7	17	P
916.7	2.7	-0.7	17	P
916.75	4.5	1.1	18.8	P
916.8	2.7	-0.7	17	P
916.85	4.5	1.1	18.8	P
916.9	4.5	1.1	18.8	P
916.95	4.5	1.1	18.8	P
917	4.5	1.1	18.8	P
917.05	4.5	1.1	18.8	P
917.1	4.5	1.1	18.8	P
917.15	4.5	1.1	18.8	P

7.3 Channel 41: 925 MHz

-6.1 dBm	S_r
0.8 dB	DC
From Table Below	J_{sg}
-0.2 dB	JC
-8.7 dB	J_{sa} – 2.6 dBm Jammer Signal Generator setting for –6.1 dBm at the Spectrum Analyzer.

Freq (MHz)	Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
922.85	4.5	0.9	19.1	P
922.9	4.5	0.9	19.1	P
922.95	4.5	0.9	19.1	P
923	4.5	0.9	19.1	P
923.05	4.5	0.9	19.1	P
923.1	0.8	-2.8	15.4	P
923.15	4.1	0.5	18.7	P
923.2	2.7	-0.9	17.3	P
923.25	4.5	0.9	19.1	P
923.3	0.3	-3.3	14.9	P
923.35	4.5	0.9	19.1	P
923.4	4.5	0.9	19.1	P
923.45	-3	-6.6	11.6	P
923.5	3.6	0	18.2	P
923.55	3.6	0	18.2	P
923.6	0.8	-2.8	15.4	P
923.65	4.1	0.5	18.7	P
923.7	4.5	0.9	19.1	P
923.75	4.5	0.9	19.1	P
923.8	-6.7	-10.3	7.9	F
923.85	-3	-6.6	11.6	P
923.9	0.8	-2.8	15.4	P
923.95	0.8	-2.8	15.4	P
924	0.8	-2.8	15.4	P
924.05	0.8	-2.8	15.4	P
924.1	-3	-6.6	11.6	P
924.15	-3	-6.6	11.6	P
924.2	-3	-6.6	11.6	P
924.25	-3	-6.6	11.6	P
924.3	0.8	-2.8	15.4	P
924.35	-3	-6.6	11.6	P
924.4	-3.9	-7.5	10.7	P
924.45	-6.7	-10.3	7.9	F
924.5	-3	-6.6	11.6	P
924.55	-4.4	-8	10.2	P
924.6	-1.1	-4.7	13.5	P
924.65	-4.4	-8	10.2	P
924.7	-4.4	-8	10.2	P
924.75	-5.8	-9.4	8.8	F

Freq (MHz)	Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
924.8	-3	-6.6	11.6	P
924.85	0.8	-2.8	15.4	P
924.9	-4.4	-8	10.2	P
924.95	-3.9	-7.5	10.7	P
925	-4.4	-8	10.2	P
925.05	-6.7	-10.3	7.9	F
925.1	-4.4	-8	10.2	P
925.15	-3.9	-7.5	10.7	P
925.2	-4.8	-8.4	9.8	F
925.25	-5.8	-9.4	8.8	F
925.3	-3.4	-7	11.2	P
925.35	0.8	-2.8	15.4	P
925.4	-3	-6.6	11.6	P
925.45	-4.4	-8	10.2	P
925.5	-1.1	-4.7	13.5	P
925.55	-0.6	-4.2	14	P
925.6	-4.4	-8	10.2	P
925.65	-2.5	-6.1	12.1	P
925.7	1.2	-2.4	15.8	P
925.75	-2.5	-6.1	12.1	P
925.8	-1.6	-5.2	13	P
925.85	-4.8	-8.4	9.8	F
925.9	-3.4	-7	11.2	P
925.95	-3.4	-7	11.2	P
926	1.7	-1.9	16.3	P
926.05	-10.5	-14.1	4.1	F
926.1	-3	-6.6	11.6	P
926.15	-1.6	-5.2	13	P
926.2	0.3	-3.3	14.9	P
926.25	-1.6	-5.2	13	P
926.3	-0.2	-3.8	14.4	P
926.35	-1.1	-4.7	13.5	P
926.4	-3.9	-7.5	10.7	P
926.45	0.8	-2.8	15.4	P
926.5	-1.1	-4.7	13.5	P
926.55	2.2	-1.4	16.8	P
926.6	2.2	-1.4	16.8	P
926.65	0.3	-3.3	14.9	P
926.7	4.5	0.9	19.1	P

Freq (MHz)	Jammer Signal Generator Level (dBm)	J/S (dB)	Processing Gain (dB)	Pass/Fail
926.75	4.1	0.5	18.7	P
926.8	0.8	-2.8	15.4	P
926.85	4.1	0.5	18.7	P
926.9	4.1	0.5	18.7	P
926.95	2.7	-0.9	17.3	P
927	4.1	0.5	18.7	P
927.05	4.5	0.9	19.1	P
927.1	4.5	0.9	19.1	P
927.15	4.5	0.9	19.1	P

7.4 Sorted Processing Gain Data

The processing gain data from sections 7.1, 7.2, and 7.3 were sorted from lowest to highest value and are shown in order below. The worst 20% of the data are highlighted. These points are discarded and the remaining worst data point from each channel is used to define a pass or fail. These values are:

Channel 1 – 905 MHz: 10.4 dB
Channel 21 – 915 MHz: 10.4 dB
Channel 41 – 925 MHz: 10.7 dB

Point no.	Chan. 1 sorted Proc. Gain	Chan. 21 sorted Proc. Gain	Chan. 41 sorted Proc. Gain
1	4.3	3.8	4.1
2	7.1	7.1	7.9
3	7.1	7.6	7.9
4	8.1	8.5	7.9
5	9	8.5	8.8
6	9.5	8.5	8.8
7	9.5	9.5	9.8
8	9.5	9.5	9.8
9	10	9.5	10.2
10	10	9.9	10.2
11	10	9.9	10.2
12	10.4	9.9	10.2
13	10.4	9.9	10.2
14	10.4	10.4	10.2
15	10.4	10.4	10.2

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Point no.	Chan. 1 sorted Proc. Gain	Chan. 21 sorted Proc. Gain	Chan. 41 sorted Proc. Gain
16	10.4	10.4	10.2
17	10.4	10.4	10.7
18	10.4	10.4	10.7
19	10.4	10.4	10.7
20	10.4	10.4	10.7
21	10.4	10.9	11.2
22	10.4	10.9	11.2
23	10.9	10.9	11.2
24	10.9	10.9	11.6
25	10.9	10.9	11.6
26	11.4	11.3	11.6
27	11.4	11.3	11.6
28	11.8	11.3	11.6
29	11.8	11.3	11.6
30	11.8	11.3	11.6
31	11.8	11.3	11.6
32	11.8	11.3	11.6
33	11.8	11.8	11.6
34	11.8	11.8	11.6
35	11.8	11.8	12.1
36	11.8	11.8	12.1
37	11.8	11.8	13
38	11.8	12.3	13
39	11.8	12.3	13
40	11.8	12.3	13.5
41	12.3	12.3	13.5
42	13.2	12.7	13.5
43	13.2	13.2	13.5
44	13.7	13.2	14
45	13.7	13.7	14.4
46	14.2	13.7	14.9
47	14.2	13.7	14.9
48	14.6	14.1	14.9
49	14.6	14.1	15.4
50	14.6	14.6	15.4
51	15.1	14.6	15.4
52	15.6	15.1	15.4
53	15.6	15.5	15.4

Point no.	Chan. 1 sorted Proc. Gain	Chan. 21 sorted Proc. Gain	Chan. 41 sorted Proc. Gain
54	15.6	15.5	15.4
55	15.6	15.5	15.4
56	15.6	15.5	15.4
57	15.6	15.5	15.4
58	15.6	16	15.4
59	15.6	17	15.4
60	16	17	15.8
61	16.5	17	16.3
62	17	17	16.8
63	17	17.4	16.8
64	17.5	17.4	17.3
65	17.9	17.4	17.3
66	17.9	17.4	18.2
67	18.4	17.4	18.2
68	18.4	17.9	18.7
69	18.9	18.8	18.7
70	19.3	18.8	18.7
71	19.3	18.8	18.7
72	19.3	18.8	18.7
73	19.3	18.8	18.7
74	19.3	18.8	19.1
75	19.3	18.8	19.1
76	19.3	18.8	19.1
77	19.3	18.8	19.1
78	19.3	18.8	19.1
79	19.3	18.8	19.1
80	19.3	18.8	19.1
81	19.3	18.8	19.1
82	19.3	18.8	19.1
83	19.3	18.8	19.1
84	19.3	18.8	19.1
85	19.3	18.8	19.1
86	19.3	18.8	19.1
87	19.3	18.8	19.1

8 Conclusions

The system passes the CW jamming margin test on all three channels with the results shown below:

Channel	Min. Processing Gain (after 20% discarded)
1	10.4 dB
21	10.4 dB
41	10.7 dB