PROCESSING GAIN TEST

1. PURPOSE

The purpose of this test was to determine the processing gain of the Andrew Corporation Model 2400 Base Data Radio (hereinafter referred to as the BDR or UUT), P/N 385700-3000-001. As the spread spectrum receiver and transmitter are identical to the Andrew Corporation Model 2400 Mobile Data Radio (hereinafter referred to as the MDR), P/N 385700-1000-00x, BDR results provided here may appropriately be applied to the MDR.

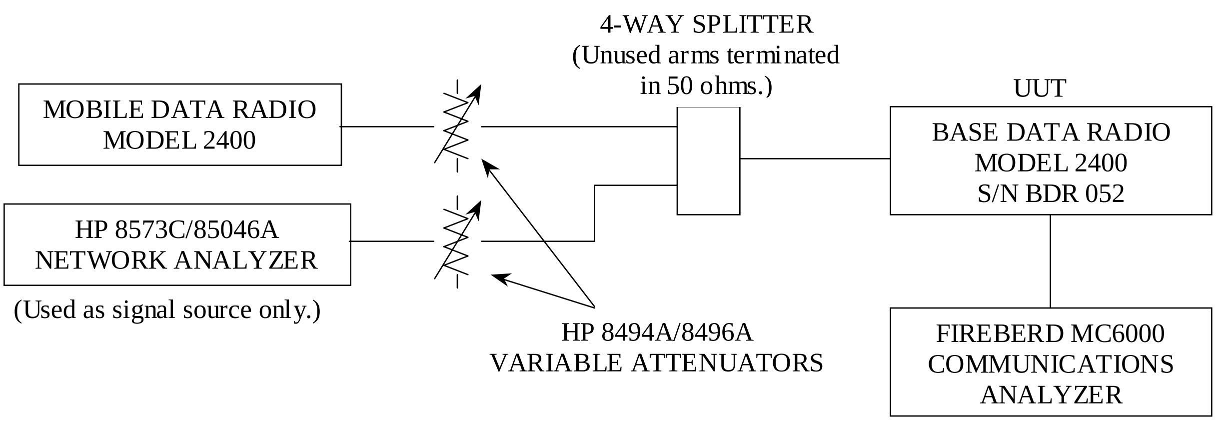
2. TEST METHOD AND SETUP

To determine processing gain of a digital spread spectrum device, a jamming margin test is performed on the UUT. From the data collected, processing gain is calculated from the formula:

$$G_p = SNR_o + M_j + L_{sys}$$

G_p = Processing Gain
SNR_o = Output Signal-to-Noise Ratio
M_j = Jamming Margin
L_{sys} = System Losses

The jamming margin test measured the level of a CW interferer (jammer) which increased the UUT's probability of error (bit error rate, BER) to 1×10^{-5}. The CW jamming signal was swept in 50 kHz increments from f_c – 1 MHz to f_c + 1 MHz (f_c of the BDR is 2467.84 MHz). At each frequency, the jammer amplitude was increased until a BER of 1×10^{-5} was observed, or until signal synchronization was lost, whichever occurred first. The figure below illustrates the jamming margin test setup and the equipment utilized to perform the test.



Initial setup of the RF power levels from the transmitter (MDR) and the interferer (Network Analyzer) were as follows:

(1) Using an HP 437 Power Meter connected to the Antenna Input of the UUT, the MDR was commanded to transmit a spread spectrum modulated signal. With the interferer signal turned off, the variable attenuators in the MDR RF path were adjusted such that a signal level of –50 dBm was present at the BDR RF input. This level is greater than 10 dB above the receiver's minimum signal level, thereby safeguarding against errors in measuring jamming margin due to receiver self-noise input.

(2) With the MDR transmitter turned off and using an HP 437 Power Meter, the interferer amplitude was set, using the variable attenuators in its RF path, to a signal level of –44 dBm. To effect this, the Network Analyzer signal level was manually adjusted to achieve a BDR RF input of –44 dBm with the variable attenuators set to a convenient

setting of 20 dB. This effectively calibrated the system such that any changes in the variable attenuator settings would provide a known interferer level to the BDR.

3. TEST DATA

The table below lists all data recorded during performance of the jamming margin test. The resulting jammer-to-signal ratio (J/S) is also shown in the table. The data below was collected from Base Data Radio P/N 385700-3000-001, S/N BDR 052.

Receiver Input Amplitude:	-50.7 dBm
Jammer Level @ 20 dB Atten:	-44.0 dBm
No. of Measurements:	41

CW Interferer Frequency	Atten. Setting for 10^{-5} BER	CW Interferer Amplitude	J / S
2466.84	25	-49.0 dBm	1.7 dB
2466.89	25	-49.0 dBm	1.7 dB
2466.94	26	-50.0 dBm	0.7 dB
2466.99	26	-50.0 dBm	0.7 dB
2467.04	26	-50.0 dBm	0.7 dB
2467.09	26	-50.0 dBm	0.7 dB
2467.14	25	-49.0 dBm	1.7 dB
2467.19	24	-48.0 dBm	2.7 dB
2467.24	24	-48.0 dBm	2.7 dB
2467.29	24	-48.0 dBm	2.7 dB
2467.34	25	-49.0 dBm	1.7 dB
2467.39	25	-49.0 dBm	1.7 dB
2467.44	25	-49.0 dBm	1.7 dB
2467.49	25	-49.0 dBm	1.7 dB
2467.54	26	-50.0 dBm	0.7 dB
2467.59	26	-50.0 dBm	0.7 dB
2467.64	26	-50.0 dBm	0.7 dB
2467.69	27	-51.0 dBm	-0.3 dB
2467.74	27	-51.0 dBm	-0.3 dB
2467.79	26	-50.0 dBm	0.7 dB
2467.84	31	-55.0 dBm	-4.3 dB

CW Interferer Frequency	Atten. Setting for 10^{-5} BER	CW Interferer Amplitude	J / S
2467.89	28	-52.0 dBm	-1.3 dB
2467.94	27	-51.0 dBm	-0.3 dB
2467.99	27	-51.0 dBm	-0.3 dB
2468.04	26	-50.0 dBm	0.7 dB
2468.09	26	-50.0 dBm	0.7 dB
2468.14	25	-49.0 dBm	1.7 dB
2468.19	26	-50.0 dBm	0.7 dB
2468.24	25	-49.0 dBm	1.7 dB
2468.29	25	-49.0 dBm	1.7 dB
2468.34	26	-50.0 dBm	0.7 dB
2468.39	25	-49.0 dBm	1.7 dB
2468.44	24	-48.0 dBm	2.7 dB
2468.49	24	-48.0 dBm	2.7 dB
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2468.69	26	-50.0 dBm	0.7 dB
2468.74	26	-50.0 dBm	0.7 dB
2468.79	26	-50.0 dBm	0.7 dB
2468.84	25	-49.0 dBm	1.7 dB

4. TEST RESULTS

The J/S ratios above were sorted in descending order. The eight lowest J/S ratios (eight represents twenty percent of the 41 data points) were culled from the data sort. The resulting lowest J/S ratio, after the cull, was 0.7 dB. This figure is used below to calculate the processing gain of the UUT.

As stated in paragraph 2 above, processing gain is calculated as:

$$
\begin{aligned}
G_p &= SNR_o + M_j + L_{sys} \\
&= 21.6\text{ dB} + 0.7\text{ dB} + 2\text{ dB} \\
&= 24.3\text{ dB}
\end{aligned}
$$

For determining the output signal-to-noise ratio (SNR_o), the following formula was used:

$$P_e = ½ \exp(-½ * SNR_o)$$

Solving for SNR_o with a probability of error (P_e) of 10^{-5}, the result is 21.6 dB. The above formula is applicable to ideal non-coherent receivers (where the receiver frequency is not phase locked to the transmitter frequency), as is the case with these units.

System losses, L_{sys}, are assumed to be greater than 2 dB, however, for these purposes, a maximum system loss of 2 dB is applied.

5. SUMMARY

The minimum processing gain of direct sequence systems is 10 dB in accordance with FCC regulations, 15.247(e). Data collected from the performance of a jamming margin test and calculations yielding processing gain indicate that the Andrew Corporation Model 2400 Base Data Radio, P/N 385700-3000-001 exhibits a processing gain of 24.3 dB, well above the 10 dB minimum regulatory requirement.

In as much as the Mobile Data Radio utilizes the same transmitter and receiver design, only differing on in-band transmit and receive frequencies, the processing gain calculation of the Base Data Radio is appropriately applied to the Andrew Corporation Model 2400 Mobile Data Radio, P/N 385700-1000-00x.