Processing Gain Measurements and Calculations

The processing gain of the Sensus spread spectrum system was measured using the CW jamming method. Figure 1 illustrates the test setup used for the test. The level of the CW jammer input to the receiver was held constant for the test. The frequency of the jammer was stopped through the passband of the receiver channel in 50 KHz steps. At each frequency step of the jammer, the signal from the transmitter was reduced to degrade the Bit Error Rate (BER) to 1 x 10^{-6} (0.000001). The levels of the CW jammer and the spread spectrum transmitter were calibrated for equal power by turning off the transmitter spreading code and data modulation and observing the two signals at the input of the receiver on the spectrum analyzer. The increase of the attenuator setting from this point was noted and is presented in Table 1 as J/S.

The processing gain (Gp) was then calculated using the formula:

$$Gp = (S/N)o + Mj + Lsys \qquad \text{(Equation 1)}$$

where: (S/N)o = Signal to Noise Ratio
Mj = J/S ratio
Lsys = system losses

Ref.: Dixon, R. *Spread Spectrum Systems* 2nd ed. (New York, John Wiley and Sons, 1984), chapter 1

The signal to noise ratio for an ideal non-coherent DPSK receiver is calculated from:

$$Pe = 0.5e^{-0.5(s/n)} \qquad \text{(Equation 2)}$$

where: Pe = probability of error
s/n = signal to noise ratio

Ref.: Jordan, E., Editor in Chief, *Reference Data for Engineers: Radio, Electronics, Computer, and Communications*, 7th ed. (Indiana, Howard W. Sams & Co., Inc., 1985), page 24 - 18.

For a probability of error of 1 x 10^{-6}, equation 2 yields a signal to noise ratio of 14.19 dB. From Table 1, the minimum J/S ratio is +1.5 dB. Using equation 1 (and considering no system losses), the processing gain was calculated:

$$Gp = (S/N)o + Mj + Lsys$$
$$Gp = 14.19\ dB + 1.5 + 0$$
$$Gp = 15.69\ dB$$

The processing gain using the CW jammer method was found to be 15.69 dB.

Figure 1
Processing Gain Measurement Setup

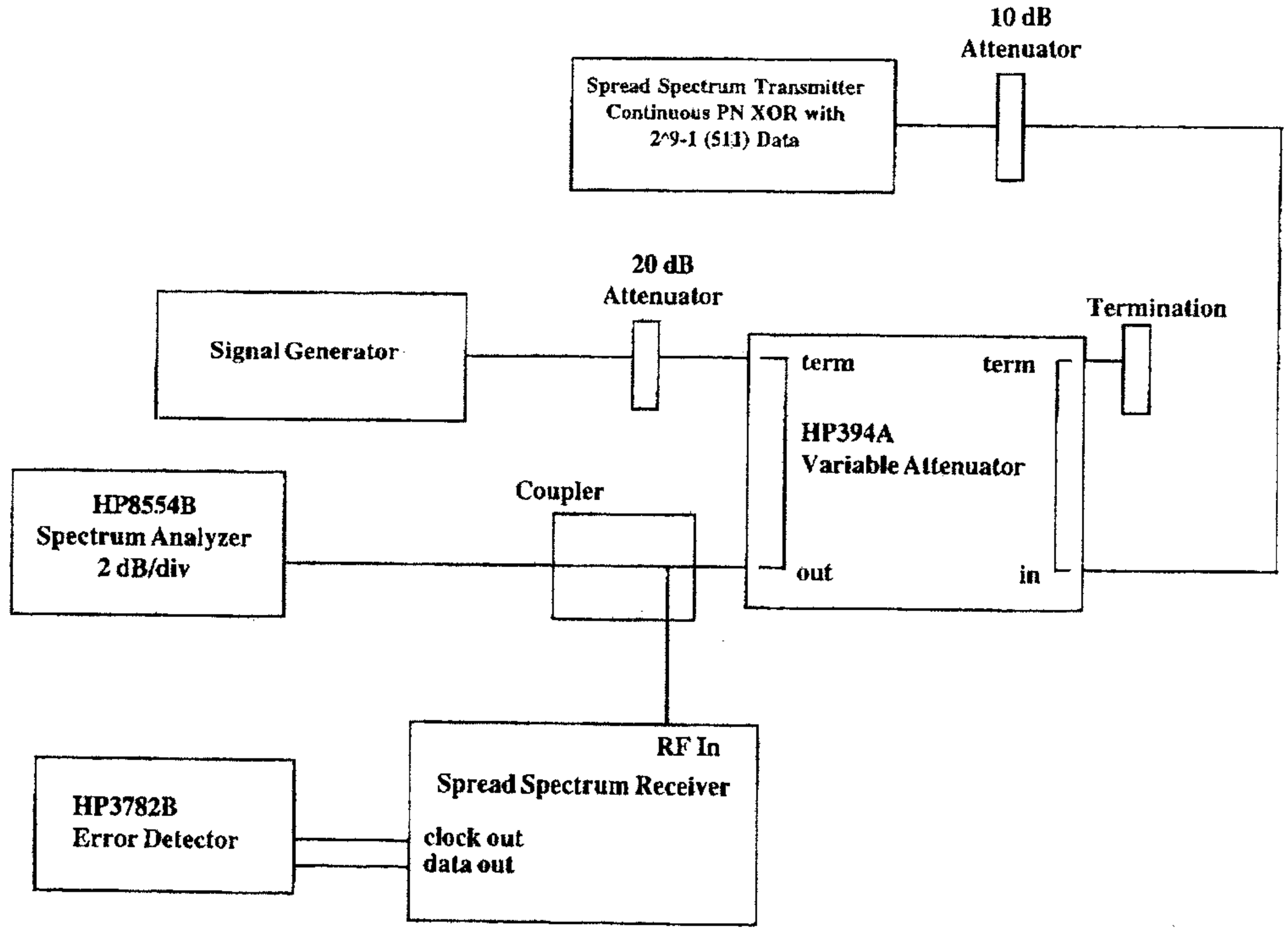

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Table 1

Jammer (MHz)	J/S (dB)
914.10	+29.5
914.15	+24.0
914.20	+20.0
914.25	+16.5
914.30	+14.0
914.35	+11.5
914.40	+9.0
914.45	+8.0
914.50	+4.0
914.55	+6.5
914.60	+5.5
914.65	+5.0
914.70	+5.0
914.75	+5.0
914.80	+5.0
914.85	+5.5
914.90	+4.5
914.95	+5.5
915.00	+1.5
915.05	+5.0
915.10	+5.5
915.15	+5.0
915.20	+5.0
915.25	+6.0
915.30	+1.5
915.35	+5.5
915.40	+5.5
915.45	+6.0
915.50	+3.0
915.55	+7.0
915.60	+7.0
915.65	+9.5
915.70	+10.5
915.75	+12.0
915.80	+14.0
915.85	+17.0
915.90	+20.0
915.95	+25.0
916.00	+30.0