

Processing Gain Measurement and Calculation

The processing gain of this spread spectrum system was measured using the CW jamming method. Figure 1 illustrates the measurement setup. The output power of the spread spectrum transmitter is fixed and the output power of jammer is adjustable. The frequency of jammer was stepped through the pass band of nominal channel in 50 KHz steps. In each frequency step of the jammer, the output power of jammer is adjusted to cause the Bit Error Rate (BER) to be 1.0×10^{-4} . The power levels are recorded to calculate the J/S as shown in Table 1.

The processing gain G_p was calculated using the formula :

$$G_p = (S/N)_o + M_j + L_{sys}$$

where $(S/N)_o$ is the signal to noise ratio, M_j is the Jammer to signal ratio (J/S), and L_{sys} is the system loss.

For the $BER = 1.0 \times 10^{-4}$, the E_b/N_o of the GMSK discriminator ($BT=0.5$) is about 15.5 dB (See Ref. 1). Due to using the hard-decision receiver, the E_b/N_o will be 18.5 dB and then signal to noise ratio $(S/N)_o$ should be 16.74 dB. From Table 1, the minimum J/S ratio is -6.2 dB. And assume the system loss is 1 dB. Therefore, the processing gain is calculated below :

$$G_p = (S/N)_o + M_j + L_{sys} = 16.74 + (-6.2) + 1.0 = 11.54$$

For the $BER = 1.0 \times 10^{-5}$, the E_b/N_o of the GMSK discriminator ($BT=0.5$) is about 17 dB (See Ref. 1). Due to using the hard-decision receiver, the E_b/N_o will be 20 dB and then signal to noise ratio $(S/N)_o$ should be 18.24 dB. From Table 2, the minimum J/S ratio is -8.0 dB. And assume the system loss is 1 dB. Therefore, the processing gain is calculated below :

$$G_p = (S/N)_o + M_j + L_{sys} = 18.24 + (-8.0) + 1.0 = 11.24$$

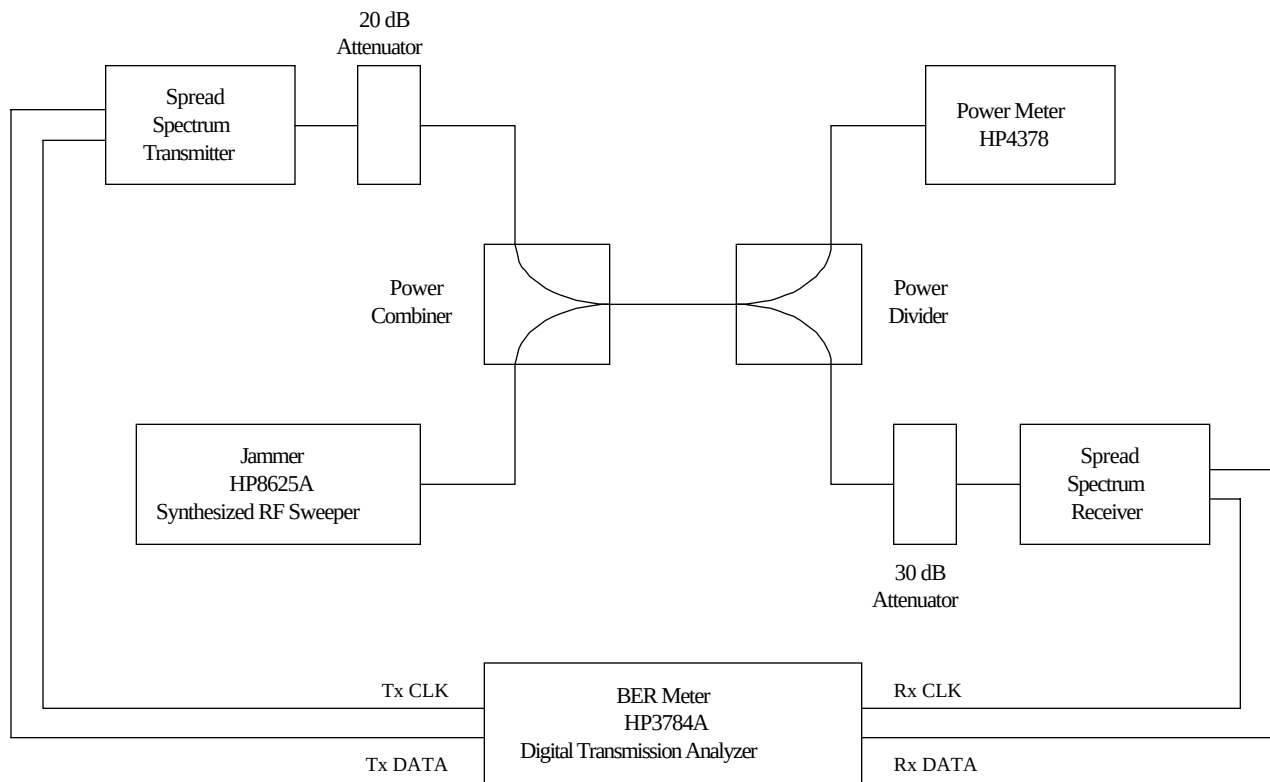


Figure 1. Processing Gain Measurement Setup

Frequency (MHz)	J/S (dB)	Signal (dBm)	Jo (dBm)	J (dBm)	BER = 1.0E-4
914.65	13.60	-17.67	5.6	-4.07	Mj (dB) -6.20
914.70	11.00	-17.67	3.0	-6.67	Data Rate (Kbps) 85.33
914.75	8.20	-17.67	0.2	-9.47	Bandwidth (KHz) 128.00
914.80	5.40	-17.67	-2.6	-12.27	Hard Decision Eb/No (dB) 18.50
914.85	3.30	-17.67	-4.7	-14.37	Hard Decision S/N (dB) 16.74
914.90	1.60	-17.67	-6.4	-16.07	Ls (dB) 1.00
914.95	-0.30	-17.67	-8.3	-17.97	
915.00	-1.80	-17.67	-9.8	-19.47	Gp = (S/N)o + Mj + Lsys 11.54
915.05	-3.00	-17.67	-11.0	-20.67	
915.10	-4.90	-17.67	-12.9	-22.57	
915.15	-4.90	-17.67	-12.9	-22.57	
915.20	-5.90	-17.67	-13.9	-23.57	
915.25	-6.00	-17.67	-14.0	-23.67	
915.30	-6.00	-17.67	-14.0	-23.67	
915.35	-6.00	-17.67	-14.0	-23.67	
915.40	-6.00	-17.67	-14.0	-23.67	
915.45	-6.20	-17.67	-14.2	-23.87	
915.50	-5.70	-17.67	-13.7	-23.37	
915.55	-3.40	-17.67	-11.4	-21.07	
915.60	-3.00	-17.67	-11.0	-20.67	
915.65	-2.60	-17.67	-10.6	-20.27	
915.70	-2.60	-17.67	-10.6	-20.27	
915.75	-2.90	-17.67	-10.9	-20.57	
915.80	-3.20	-17.67	-11.2	-20.87	
915.85	-3.60	-17.67	-11.6	-21.27	
915.90	-3.70	-17.67	-11.7	-21.37	
915.95	-3.50	-17.67	-11.5	-21.17	
916.00	-3.20	-17.67	-11.2	-20.87	
916.05	-2.40	-17.67	-10.4	-20.07	
916.10	-1.90	-17.67	-9.9	-19.57	
916.15	-2.00	-17.67	-10.0	-19.67	
916.20	-2.20	-17.67	-10.2	-19.87	
916.25	-2.30	-17.67	-10.3	-19.97	
916.30	-2.50	-17.67	-10.5	-20.17	
916.35	-2.40	-17.67	-10.4	-20.07	
916.40	-3.00	-17.67	-11.0	-20.67	
916.45	-2.60	-17.67	-10.6	-20.27	
916.50	-1.90	-17.67	-9.9	-19.57	
916.55	-2.10	-17.67	-10.1	-19.77	
916.60	-1.50	-17.67	-9.5	-19.17	
916.65	-1.10	-17.67	-9.1	-18.77	
916.70	0.10	-17.67	-7.9	-17.57	
916.75	0.80	-17.67	-7.2	-16.87	
916.80	1.80	-17.67	-6.2	-15.87	
916.85	3.40	-17.67	-4.6	-14.27	
916.90	4.80	-17.67	-3.2	-12.87	
916.95	6.60	-17.67	-1.4	-11.07	
917.00	8.30	-17.67	0.3	-9.37	
917.05	10.30	-17.67	2.3	-7.37	
917.10	12.30	-17.67	4.3	-5.37	
917.15	14.10	-17.67	6.1	-3.57	

Table 1. J/S Ratio Measurement Result for BER = $1.0 * 10^{-4}$

Frequency (MHz)	J/S (dB)	Signal (dBm)	Jo (dBm)	J (dBm)	BER = 1.0E-5
914.65	16.90	-17.67	8.9	-0.77	Mj (dB) -8.00
914.70	14.50	-17.67	6.5	-3.17	Data Rate (Kbps) 85.33
914.75	6.10	-17.67	-1.9	-11.57	Bandwidth (KHz) 128.00
914.80	3.20	-17.67	-4.8	-14.47	Hard Decision Eb/No (dB) 20.00
914.85	1.00	-17.67	-7.0	-16.67	Hard Decision S/N (dB) 18.24
914.90	-0.30	-17.67	-8.3	-17.97	Ls (dB) 1.00
914.95	-2.10	-17.67	-10.1	-19.77	
915.00	-3.40	-17.67	-11.4	-21.07	Gp = (S/N)o + Mj + Lsys 11.24
915.05	-4.60	-17.67	-12.6	-22.27	
915.10	-5.40	-17.67	-13.4	-23.07	
915.15	-5.80	-17.67	-13.8	-23.47	
915.20	-7.00	-17.67	-15.0	-24.67	
915.25	-7.10	-17.67	-15.1	-24.77	
915.30	-7.20	-17.67	-15.2	-24.87	
915.35	-8.00	-17.67	-16.0	-25.67	
915.40	-7.00	-17.67	-15.0	-24.67	
915.45	-7.00	-17.67	-15.0	-24.67	
915.50	-6.40	-17.67	-14.4	-24.07	
915.55	-4.40	-17.67	-12.4	-22.07	
915.60	-3.10	-17.67	-11.1	-20.77	
915.65	-3.50	-17.67	-11.5	-21.17	
915.70	-3.90	-17.67	-11.9	-21.57	
915.75	-4.20	-17.67	-12.2	-21.87	
915.80	-3.80	-17.67	-11.8	-21.47	
915.85	-4.20	-17.67	-12.2	-21.87	
915.90	-3.90	-17.67	-11.9	-21.57	
915.95	-3.50	-17.67	-11.5	-21.17	
916.00	-2.90	-17.67	-10.9	-20.57	
916.05	-2.60	-17.67	-10.6	-20.27	
916.10	-2.20	-17.67	-10.2	-19.87	
916.15	-2.30	-17.67	-10.3	-19.97	
916.20	-2.50	-17.67	-10.5	-20.17	
916.25	-2.70	-17.67	-10.7	-20.37	
916.30	-3.00	-17.67	-11.0	-20.67	
916.35	-2.30	-17.67	-10.3	-19.97	
916.40	-3.10	-17.67	-11.1	-20.77	
916.45	-2.70	-17.67	-10.7	-20.37	
916.50	-1.70	-17.67	-9.7	-19.37	
916.55	-1.80	-17.67	-9.8	-19.47	
916.60	-1.30	-17.67	-9.3	-18.97	
916.65	-1.00	-17.67	-9.0	-18.67	
916.70	0.70	-17.67	-7.3	-16.97	
916.75	1.30	-17.67	-6.7	-16.37	
916.80	2.80	-17.67	-5.2	-14.87	
916.85	4.40	-17.67	-3.6	-13.27	
916.90	6.10	-17.67	-1.9	-11.57	
916.95	8.10	-17.67	0.1	-9.57	
917.00	9.80	-17.67	1.8	-7.87	
917.05	10.40	-17.67	2.4	-7.27	
917.10	12.00	-17.67	4.0	-5.67	
917.15	13.30	-17.67	5.3	-4.37	

Table 2. J/S Ratio Measurement Result for BER = 1.0×10^{-5}