InfoNet IN9000 Processing Gain Measurement and Calculation

The processing gain of IN9000 transmitter is provided by a baseband chip (Alfa-AIC 9001) that spreads the data bit at a rate of 16 chips/bit. The baseband chip was originally developed by Cylink (Cylink SSTI32A) and then subsequently licensed to Alfa Inc.

The processing gain of this spread spectrum system was measured by using the CW jamming margin method. Figure 1 illustrates the measurement setup. The transmitter is set at the middle channel (915.9 MHz). The test consists of stepping a signal generator (HP 8625A) in 50 kHz increment across the passband (914.65 MHz - 917.05 MHz). At each point, the generator 's output power is adjusted to cause the Bit Error Rate (BER) to be 10^{-4} or 10^{-5} respectively. The power levels, as listed in Table 1 (BER = 10^{-4}) and Table 2 (BER = 10^{-5}), are recorded to calculate the J/S. In Table 1 and Table 2, the Signal and J are the measured power levels of the transmitter and the generator , respectively, by using the power meter (HP 4378).

The processing gain Gp was calculated using the formula

$$Gp = (S/N)o + Mj + Lsys,$$

where (S/N)o is the signal to noise ratio, Mj is the Jammer to signal ratio (J/S), and Lsys is the system loss.

For the BER = $1.0*10^{-4}$case, the Eb/No of the GMSK discriminator is about 15.5 dB (See Ref. 1). Due to using the hard-decision receiver, the Eb/No is 18.5 dB that converts to a (S/N)o of 16.74 dB. According to Table 1, the minimum J/S ratio is –5.76 dB. And assume the system loss is 1 dB. Therefore, the processing gain is calculated below:

$$Gp = (S/N)o + Mj + Lsys = 16.74 + (-5.76) + 1.0 = 11.98$$

For the BER = $1.0*10^{-5}$case, the Eb/No of the GMSK discriminator is about 17 dB (See Ref. 1). Due to using the hard-decision receiver, the Eb/No is 20 dB that converts to a (S/N)o of 16.74 dB. According to Table 2, the minimum J/S ratio is –7.16 dB. And assume the system loss is 1 dB. Therefore, the processing gain is calculated below:

$$Gp = (S/N)o + Mj + Lsys = 18.24 + (-7.16) + 1.0 = 12.08$$

In summary, the measured processing gain is quite consistent with a spreading rate of 16 chips/bit.

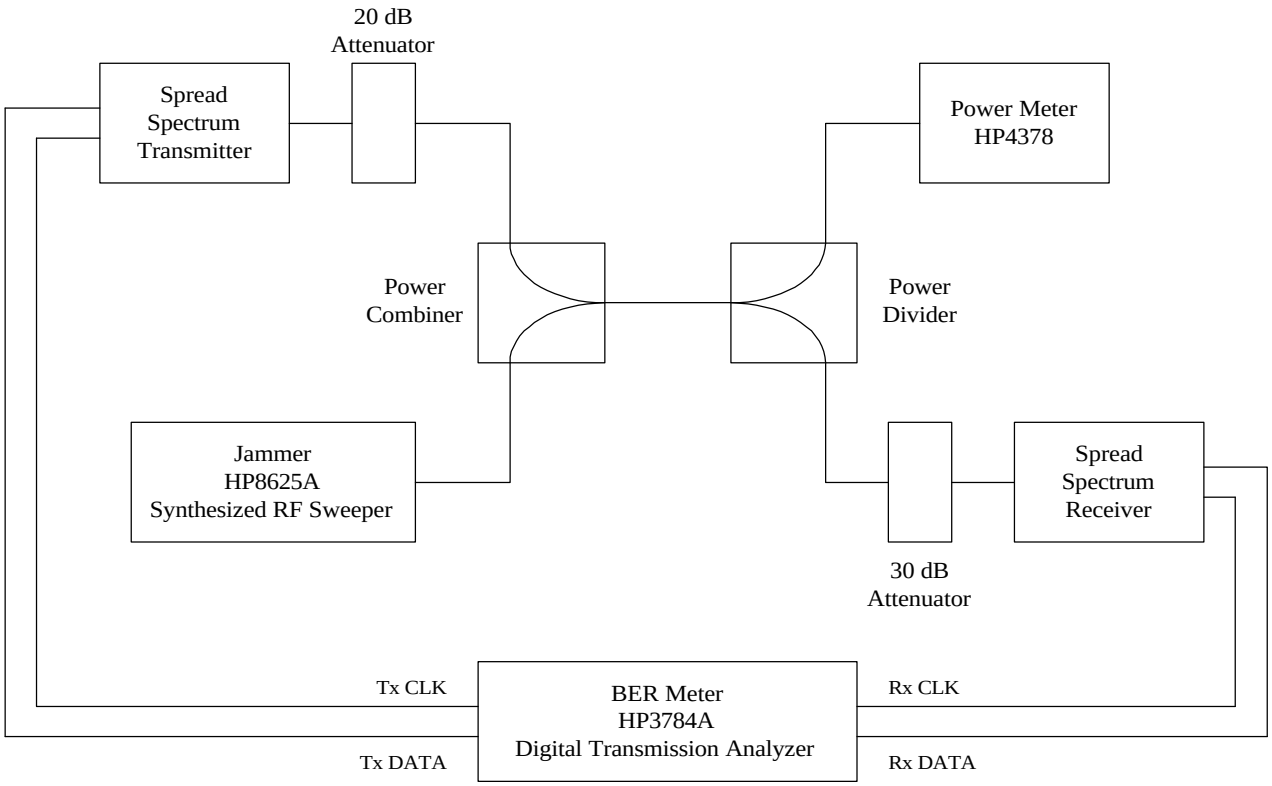

Figure 1. InfoNet IN9000 Processing Gain Measurement Setup

Table 1. Processing Measurements for BER = 1.0E-4				
Frequency (MHz)	J/S (dB)	Signal (S) (dBm)	Jammer (J) (dBm)	Comments
914.65	12.84	-15.20	-2.36	Mj^{min} (dB) -5.76
914.70	9.54	-15.20	-5.66	Data Rate (Kbps) 85.33
914.75	6.54	-15.20	-8.66	Bandwidth (KHz) 128.00
914.80	4.14	-15.20	-11.06	Hard Decision Eb/No (dB) 18.50
914.85	2.14	-15.20	-13.06	Hard Decision S/N (dB) 16.74
914.90	0.84	-15.20	-14.36	Lsys (dB) 1.00
914.95	-0.76	-15.20	-15.96	$Gp^{min} = (S/N)o + Mj + Lsys$ 11.98
915.00	-2.16	-15.20	-17.36	
915.05	-2.81	-15.20	-18.01	
915.10	-4.16	-15.20	-19.36	
915.15	-4.86	-15.20	-20.06	
915.20	-5.26	-15.20	-20.46	
915.25	-5.06	-15.20	-20.26	
915.30	-5.36	-15.20	-20.56	
915.35	***-5.76***	***-15.20***	***-20.96***	
915.40	-5.26	-15.20	-20.46	
915.45	-5.06	-15.20	-20.26	
915.50	-4.66	-15.20	-19.86	
915.55	-3.46	-15.20	-18.66	
915.60	-3.06	-15.20	-18.26	
915.65	-2.66	-15.20	-17.86	
915.70	-2.96	-15.20	-18.16	
915.75	-3.16	-15.20	-18.36	
915.80	-3.46	-15.20	-18.66	
915.85	-3.66	-15.20	-18.86	
915.90	-3.56	-15.20	-18.76	
915.95	-2.96	-15.20	-18.16	
916.00	-2.46	-15.20	-17.66	
916.05	-1.86	-15.20	-17.06	
916.10	-1.46	-15.20	-16.66	
916.15	-1.66	-15.20	-16.86	
916.20	-1.86	-15.20	-17.06	
916.25	-1.76	-15.20	-16.96	
916.30	-1.76	-15.20	-16.96	
916.35	-1.56	-15.20	-16.76	
916.40	-1.16	-15.20	-16.36	
916.45	-0.66	-15.20	-15.86	
916.50	-0.36	-15.20	-15.56	
916.55	-0.66	-15.20	-15.86	
916.60	-0.16	-15.20	-15.36	
916.65	0.84	-15.20	-14.36	
916.70	1.64	-15.20	-13.56	
916.75	2.14	-15.20	-13.06	
916.80	3.44	-15.20	-11.76	
916.85	5.34	-15.20	-9.86	
916.90	6.84	-15.20	-8.36	
916.95	8.74	-15.20	-6.46	
917.00	10.64	-15.20	-4.56	
917.05	12.34	-15.20	-2.86	

Table 2. Processing Measurements for BER = 1.0E-5				
Frequency (MHz)	J/S (dB)	Signal (S) (dBm)	Jammer (J) (dBm)	Comments
914.65	12.14	-15.20	-3.06	Mj^{min} (dB) -7.16
914.70	8.74	-15.20	-6.46	Data Rate (Kbps) 85.33
914.75	5.64	-15.20	-9.56	Bandwidth (KHz) 128.00
914.80	3.34	-15.20	-11.86	Hard Decision Eb/No (dB) 20
914.85	1.24	-15.20	-13.96	Hard Decision S/N (dB) 18.24
914.90	0.24	-15.20	-14.96	Lsys (dB) 1.00
914.95	-1.56	-15.20	-16.76	$Gp^{min} = (S/N)o + Mj + Lsys$ 12.08
915.00	-2.66	-15.20	-17.86	
915.05	-4.06	-15.20	-19.26	
915.10	-5.16	-15.20	-20.36	
915.15	-6.16	-15.20	-21.36	
915.20	-6.36	-15.20	-21.56	
915.25	-5.76	-15.20	-20.96	
915.30	-6.76	-15.20	-21.96	
915.35	***-7.16***	***-15.20***	***-22.36***	
915.40	-6.16	-15.20	-21.36	
915.45	-5.96	-15.20	-21.16	
915.50	-5.46	-15.20	-20.66	
915.55	-3.96	-15.20	-19.16	
915.60	-3.46	-15.20	-18.66	
915.65	-3.36	-15.20	-18.56	
915.70	-3.46	-15.20	-18.66	
915.75	-3.66	-15.20	-18.86	
915.80	-3.96	-15.20	-19.16	
915.85	-4.16	-15.20	-19.36	
915.90	-4.26	-15.20	-19.46	
915.95	-3.56	-15.20	-18.76	
916.00	-3.06	-15.20	-18.26	
916.05	-2.46	-15.20	-17.66	
916.10	-1.96	-15.20	-17.16	
916.15	-1.96	-15.20	-17.16	
916.20	-2.16	-15.20	-17.36	
916.25	-2.16	-15.20	-17.36	
916.30	-1.96	-15.20	-17.16	
916.35	-1.86	-15.20	-17.06	
916.40	-1.46	-15.20	-16.66	
916.45	-1.26	-15.20	-16.46	
916.50	-1.06	-15.20	-16.26	
916.55	-1.06	-15.20	-16.26	
916.60	-0.66	-15.20	-15.86	
916.65	-0.06	-15.20	-15.26	
916.70	1.04	-15.20	-14.16	
916.75	1.54	-15.20	-13.66	
916.80	2.74	-15.20	-12.46	
916.85	4.74	-15.20	-10.46	
916.90	6.44	-15.20	-8.76	
916.95	8.34	-15.20	-6.86	
917.00	10.24	-15.20	-4.96	
917.05	12.04	-15.20	-3.16	