PROCESSING GAIN MEASUREMENT

Standard Applicable

According to FCC CFR 47, Para. 15.247(e), the processing gain, G_p of a direct sequence system shall be at least 10 dB. The processing gain can be determined from the ratio in dB of the signal to noise ratio with the system spreading processes are being bypassed relative to the processes are engaged. In our system, the spread spectrum processing can not simply be bypassed, so the jamming margin test is taken. 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.

Theoretical calculations

The processing gain is related to the jamming margin follows:

$$G_p = \left(\frac{S}{N}\right)_{output} + \left(\frac{J}{S}\right) + L_{system} \text{ .....(1)}$$

Where $\left(\frac{S}{N}\right)_{output}$ is the theoretical output signal to noise ratio per symbol

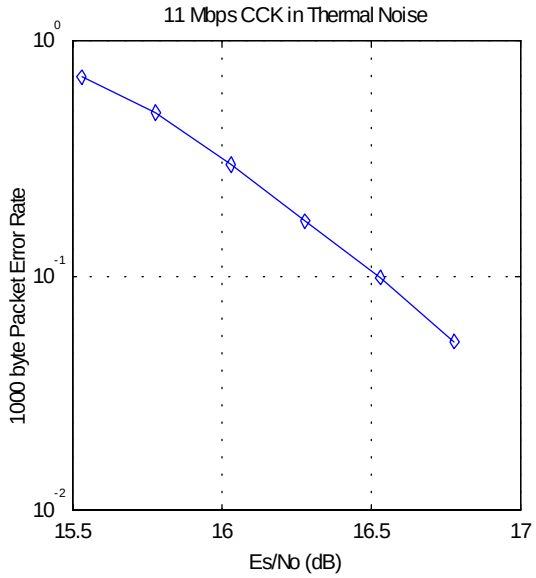
$\left(\frac{J}{S}\right)$ is the jamming signal power relative to desired signal power

L_{system} is the system implementation losses, could not be more than 2 dB.

The chipset we use is HFA3861, which uses a form of M-ary Orthogonal Keying modulation technology as its direct sequence spread spectrum modulation. The probability of error for generalized m-ary Orthogonal signaling using coherent demodulation is as follows:

$$P_e = 1 - P_{c1} = 1 - \frac{1}{\sqrt{2\pi}} \int_{\frac{S_{o1}}{N_o}}^{\infty} \left[2\left(1 - Q\left\{ z + \sqrt{2\frac{E_b}{\eta}} \right\}\right) \right]^{\frac{M}{2}-1} \exp\left\{ -\frac{z^2}{2} \right\} dz \text{ .....(2)}$$

Then by a mathematic program, we can get the PER vs. $\frac{E_s}{N_0}$ plot, like the following figure. From the plot, we know that the corresponding $\frac{E_s}{N_0}$ (signal to noise ratio per symbol) is 16.4 dB at PER is 8%.



So the function (1) becomes as...

$$G_p = 18.4 + \left(\frac{J}{S}\right) \text{.....(3)}$$

Test Configuration for CW Jamming Margin method

The processing gain measurement is based upon the CW jamming margin method suggested in the FCC document entitled "GUIDANCE ON MEASUREMENTS FOR DIRECT SEQUENCE SPREAD SPECTRUM SYSTEMS, 54597, July 12, 1999". The test consists of stepping a CW signal generator in 50KHz increment across pass band of each three channels within 2400 – 2483 MHz bands. This CW signal represents the jamming signal. The selected three channels are as followings:
Channel 1: centered at 2412 MHz
Channel 6: centered at 2437 MHz
Channel 11:centered at 2462 MHz
These three channels represent the low, mid and high frequency bands of the EUT. And, the processing gain of the EUT determined on these bands should represent the entire band. The testing block diagram is as fig.1

Test Procedure

1. Making the signal power at receiver side is approximately –60 dBm (a little above the thermal sensitivity such that thermal noise does not cause bit errors.)
2. Use spectrum analyzer to monitor test.
3. Ensure that CW Jammer generator RF output is disables and measure the power at the receiver port using the power meter. This is the relative signal power.
4. Disable Transmitter, and set CW Jammer generator RF output frequency equal to the carrier frequency and enable generator output.
5. Disable CW Jammer, re-establish link. PER test should be operating essentially error-free.
6. Enable CW Jammer at much lower power level, which should not results any

error.

7. Adjust the output power level of Jammer step by step, till it cause 8% PER.
8. Measuring the power at the receiver port using the power meter. This is the relative jammer power, adding some attenuators before the receiver if necessary.
9. Records the entire information and repeat step 3 in frequency increments of 50 kHz across the receiver passband with the CW Jammer.

The number of points where the PER fails to achieve 8% is determined and if this is above 20% of the total, the test is failed otherwise it is passed. The numerical data associated the three selected channels is tabulated as tab. 1

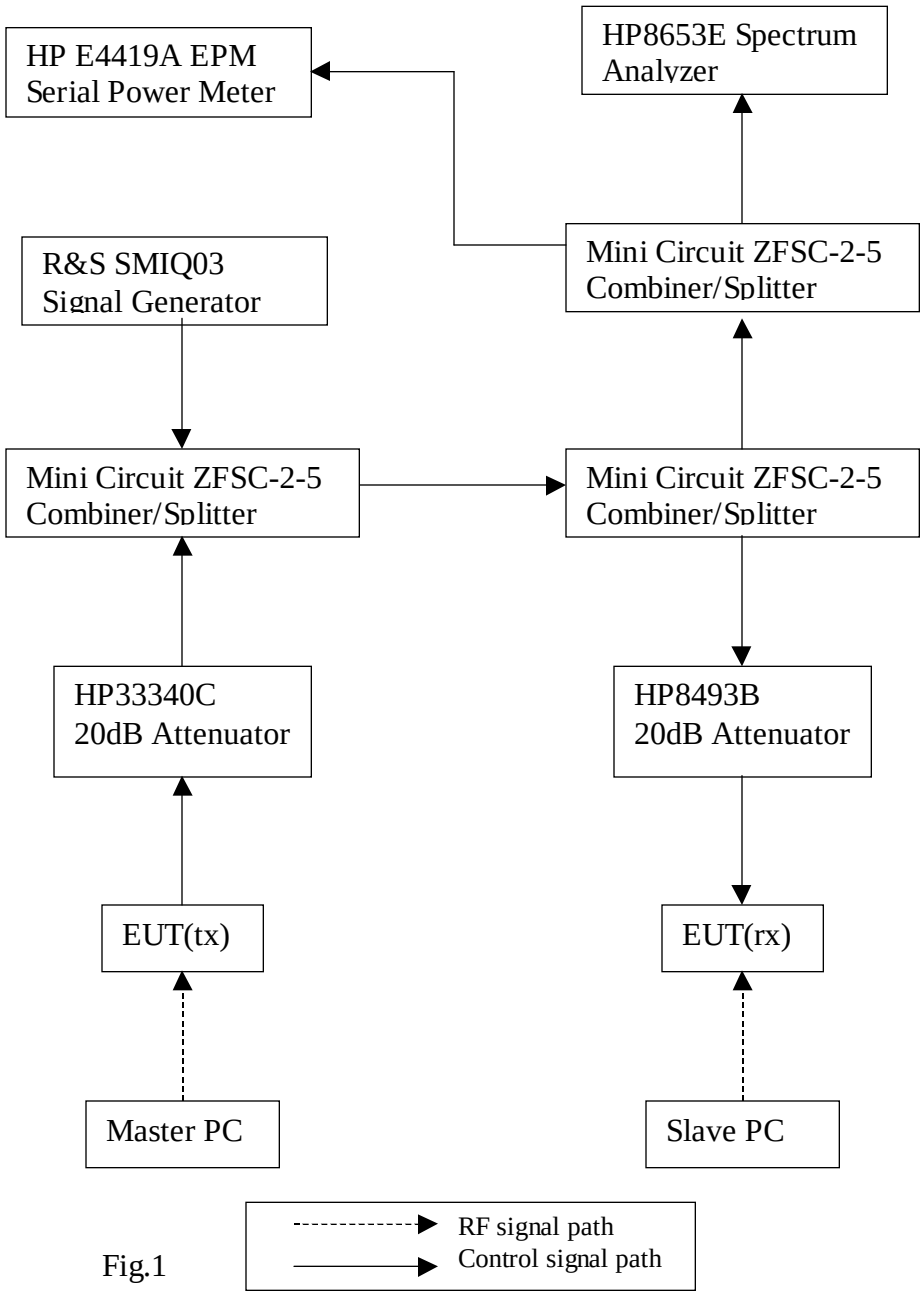


Fig.1

Measurement Instruments

Equipment	Manufacturer	Model NO.	Next Cal. Due
Spectrum Analyzer	Hewlett-Packard	HP8563E	Oct. 06 2001
RF Signal Generator	Hewlett-Packard	HP8648C	Oct. 20 2001
Attenuator	Hewlett-Packard	HP8493A 20dB	N/A
Attenuator	Hewlett-Packard	HP8493A 10dB	N/A
Combiner/Splitter	Mini Circuit	ZFSC-2-5	N/A
Combiner/Splitter	Mini Circuit	ZFSC-2-5	N/A
Combiner/Splitter	Mini Circuit	ZFSC-2-5	N/A