

Processing Gain Measurement of ioLink1

Using CW Jamming Margin Test

Introduction

Under the FCC rules, direct sequence systems are required to exhibit a processing gain of at least 10 dB. Section 15.247(e) of the FCC rules specifies test procedures for processing gain measurement of a single channel direct sequence spread spectrum system.

Test Procedures

The test figuration of the CW jamming margin method is shown in Figure 1. The test procedures [1] consist of stepping a signal generator in 50 kHz increment across the passband of the system. The carrier frequency is determined by the RF unit used. At each test point the jammer level required to produce the recommended bit error rate of 2×10^{-6} is recorded. The output power of the transmitter is measured at the same point. The jammer to signal ratio (J/S) is then calculated. The processing gain can be calculated as follows: $G_p = (S/N)_o + M_j + L_{sys}$, where G_p is the processing gain of the system, $(S/N)_o$ is the signal to noise ratio required for the chosen BER, M_j is the jammer to signal ratio, and L_{sys} is the system losses. Note that total losses in a system should be assumed to be no more than 2 dB.

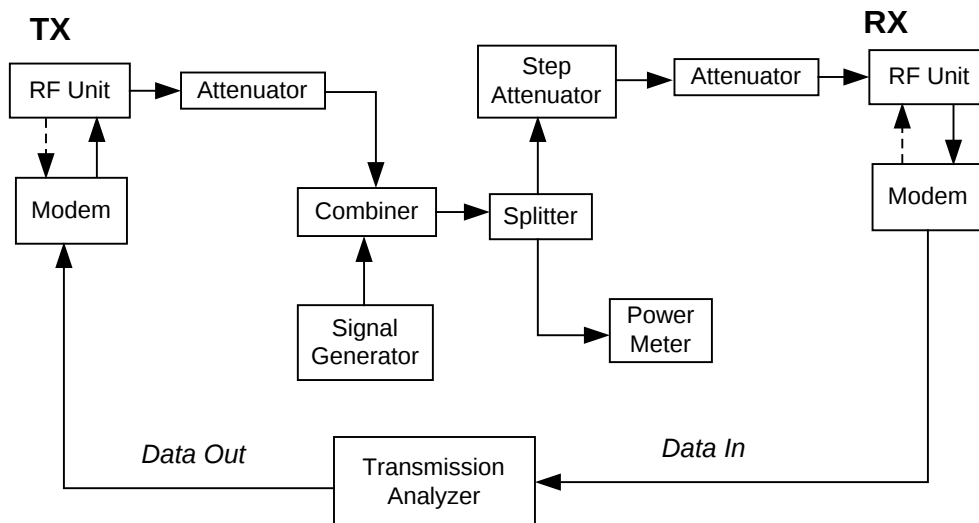


Figure 1. Processing gain test setup.

IoLink1 System Description

The modulation of ioLink1 is Differential Quadrature Phase Shift Keying (DQPSK). IoLink1 has two different modes, T1 and E1. The baseband processing of T1 and E1 transmitter is shown in Figures 2 and 3, respectively.

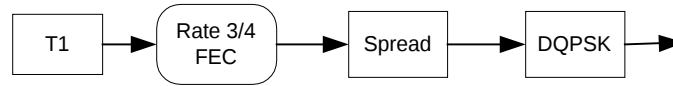


Figure 2. T1 transmitter baseband processing.

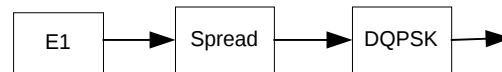


Figure 3. E1 transmitter baseband processing.

In T1, the data is encoded with a rate $\frac{3}{4}$ convolutional encoder. The encoded data is then spread by a spread code of length ten. In E1, there is no convolutional encoding. The spread code length is eleven.

At bit error rate of 2×10^{-6} , the coding gain for rate $\frac{3}{4}$ with hard decision is 2.2 dB [4]. Without any coding, the required signal-to-noise ratio per bit at the receiver output to achieve the given bit error rate for DQPSK modulation is 12.6 dB [3]. Or, equivalently, the required signal-to-noise ratio per symbol is 15.6 dB. Therefore, the required signal-to-noise ratios per symbol for T1 and E1 reference systems are 13.4 dB and 15.6 dB, respectively.

Reference:

- [1] Federal Communications Commission Public Notice No. 54797, "Guidance on measurement for direct sequence spread spectrum systems", July 12, 1995.
- [2] Dixon, Robert, "Spread Spectrum Systems" 3rd Edition, 1994, pp. 350, John Wiley & Sons, 1994.
- [3] Proakis, John, "Digital Communications", pp. 276-277, McGraw-Hill, 1989.
- [4] Forward error correction data book, 80-2412801 A, 9/98, pp. 1-16, Figure 16, Qualcomm Inc.