Processing Gain Measurement:
LXT821B1 (Alpine B1)

Revised: 2/28/2002

I. Summary

This document describes how the processing gain was measured for the Intel LXT821B1 digital spread spectrum telephone transceiver. Included are specifications, test setup, and test results.

II. Requirements

According to the FCC requirement 15.247 for direct sequence spread spectrum systems, the minimum processing gain is 10 dB. The CW jamming method was used to determine the LXT821B1 processing gain. The processing gain was calculated using the following equation:

$G_p = S/I + J/S + L_{sys}$ where:

G_p = Processing Gain
S/I = Signal to noise required for a given error probability. In this case 1×10^{-4} was used.
J/S = Jammer to signal ratio required to produce given error probability.
L_{sys} = System loss to due non ideal performance. Maximum allowed by the FCC is 2.0 dB.

The S/I ratio was determined to be 11.0 dB according to Jakes “Microwave Mobile Communications”. Page 229 indicates the relevant curve showing error probability Vs S/I for a non-coherent FM system with a peak deviation equal to .35 of the modulation frequency: $F_d = .35\ F_s$.

Given a minimum processing gain of 10 dB, the minimum allowable J/S ratio is -3.0 dB.

III. Test Setup

The processing gain was measured using the test setup shown in Figure 1:

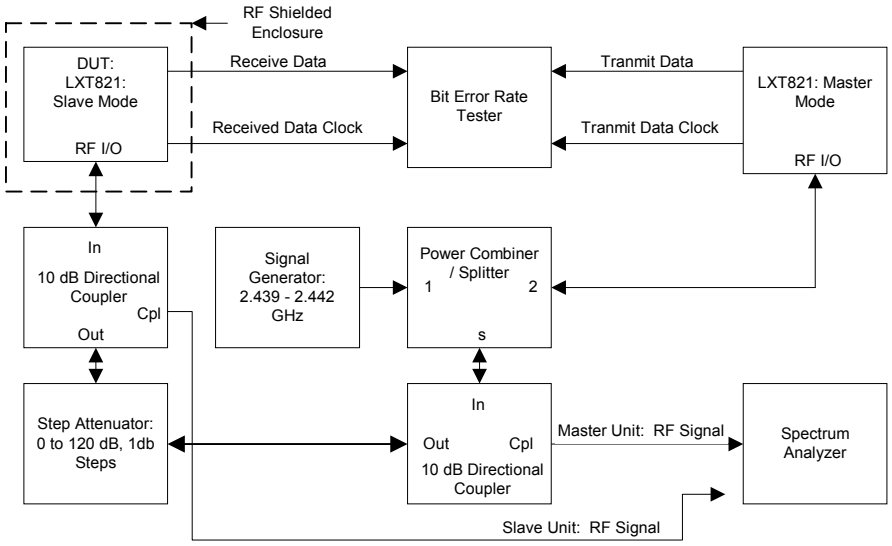

Figure 1: Processing Gain Test Setup

The following test equipment was used for this setup:

- LDB810 Demonstration system: Used LXT821B1 RFIC's.
- Hewlett Packard ESG D3000A Signal Generator
- Hewlett Packard HP8563E Spectrum Analyzer
- Hewlett Packard HP 8494A and HP 8496A Step Attenuators
- Mini Circuits ZFDC-10-5 10 dB Directional Coupler (2)
- Mini Circuits ZFSC-2-4 Power Combiner
- Ramsey STE-3000 Shielded Test Enclosure
- Telecommunication Techniques Corp. Firebird MC6000 Communication Analyzer (BER tester) with Lab Interface Card
- Semflex SMA cables

The LDB810 demonstration system was set up at the middle channel 2.4405GHz. The LXT810B base band 3dB bandwidth is less than 1.0 MHz; therefore, the signal generator was used to inject a C / W jammer from 2.439GHz to 2.442GHz in 50 kHz increments. The DUT received input power was set at -50 dBm. The jammer power was adjusted to achieve a bit error rate of 1x10-4 at each jammer frequency. The jammer power was recorded and the processing gain calculated for each jammer frequency from 2.439GHz to 2.442GHz.

IV. Test Results

The worst case processing gain found for the middle frequency band was 11.4 dB for the jamming frequency of 2.4411GHz, and 11.5dB for the jamming frequency of 2.439.9GHz. This and all

other jamming frequencies in the middle of the band (2.439GHz-2.442GHz) pass the minimum requirement of 10dB. All of the measured test data is recorded in : :

Channel Frequency (Nominal) =		2440.50 MHz		
Bit Error Rate =		1.00E-04		
Required S/N for BER =		11.0 dB		
System Losses =		2.0 dB		
Desired Signal Strength at Receiver (S) =		-50.0 dBm		
Jammer Frequency (MHz)	RF Src pwr	Jammer Power (J) (dBm)	Jammer to Signal Ratio J / S (dB)	Processing Gain (dB)
2439.000	-21.80	-28.30	21.7	34.7
2439.050	-22.80	-29.30	20.7	33.7
2439.100	-24.00	-30.50	19.5	32.5
2439.150	-25.20	-31.70	18.3	31.3
2439.200	-26.40	-32.90	17.1	30.1
2439.250	-27.70	-34.20	15.8	28.8
2439.300	-29.10	-35.60	14.4	27.4
2439.350	-30.70	-37.20	12.8	25.8
2439.400	-32.10	-38.60	11.4	24.4
2439.450	-34.40	-40.90	9.1	22.1
2439.500	-36.40	-42.90	7.1	20.1
2439.550	-38.20	-44.70	5.3	18.3
2439.600	-39.90	-46.40	3.6	16.6
2439.650	-41.50	-48.00	2.0	15.0
2439.700	-43.30	-49.80	0.2	13.2
2439.750	-44.20	-50.70	-0.7	12.3
2439.800	-44.50	-51.00	-1.0	12.0
2439.850	-44.80	-51.30	-1.3	11.7
2439.900	-45.00	-51.50	-1.5	11.5
2439.950	-44.90	-51.40	-1.4	11.6
2440.000	-44.70	-51.20	-1.2	11.8
2440.050	-44.70	-51.20	-1.2	11.8
2440.100	-44.70	-51.20	-1.2	11.8
2440.150	-44.50	-51.00	-1.0	12.0
2440.200	-44.20	-50.70	-0.7	12.3
2440.250	-44.20	-50.70	-0.7	12.3
2440.300	-44.00	-50.50	-0.5	12.5
2440.350	-44.00	-50.50	-0.5	12.5
2440.400	-43.90	-50.40	-0.4	12.6
2440.450	-44.10	-50.60	-0.6	12.4
2440.470	-43.20	-49.70	0.3	13.3
2440.480	-42.40	-48.90	1.1	14.1
2440.490	-42.60	-49.10	0.9	13.9
2440.495	-42.80	-49.30	0.7	13.7

2440.500	-42.60	-49.10	0.9	13.9
2440.505	-42.60	-49.10	0.9	13.9
2440.510	-42.80	-49.30	0.7	13.7
2440.520	-43.60	-50.10	-0.1	12.9
2440.530	-43.90	-50.40	-0.4	12.6
2440.550	-43.80	-50.30	-0.3	12.7
2440.600	-42.90	-49.40	0.6	13.6
2440.650	-43.10	-49.60	0.4	13.4
2440.700	-43.40	-49.90	0.1	13.1
2440.750	-43.70	-50.20	-0.2	12.8
2440.800	-44.00	-50.50	-0.5	12.5
2440.850	-44.40	-50.90	-0.9	12.1
2440.900	-44.70	-51.20	-1.2	11.8
2440.950	-44.80	-51.30	-1.3	11.7
2441.000	-45.00	-51.50	-1.5	11.5
2441.050	-45.00	-51.50	-1.5	11.5
2441.100	-45.10	-51.60	-1.6	11.4
2441.150	-44.90	-51.40	-1.4	11.6
2441.200	-44.90	-51.40	-1.4	11.6
2441.250	-43.90	-50.40	-0.4	12.6
2441.300	-42.40	-48.90	1.1	14.1
2441.350	-40.80	-47.30	2.7	15.7
2441.400	-39.00	-45.50	4.5	17.5
2441.450	-37.20	-43.70	6.3	19.3
2441.500	-35.20	-41.70	8.3	21.3
2441.550	-33.20	-39.70	10.3	23.3
2441.600	-31.40	-37.90	12.1	25.1
2441.650	-29.90	-36.40	13.6	26.6
2441.700	-28.10	-34.60	15.4	28.4
2441.750	-26.80	-33.30	16.7	29.7
2441.800	-25.30	-31.80	18.2	31.2
2441.850	-24.10	-30.60	19.4	32.4
2441.900	-22.80	-29.30	20.7	33.7
2441.950	-21.70	-28.20	21.8	34.8
2442.000	-20.60	-27.10	22.9	35.9

11.4	= Minimum Processing Gain
2.44057 GHz	= measured center frequency

Test Setup: Device under test = slave mode, transmitter = master mode

IC used:
LXT820B1 (Alpine)

RF Board:
LXT820 DV REV 2B
serial number: 27
DV7A

drop from jammer to DUT = -6.5 dB
source RF power = -38 dBm
attenuators set to 12 dB
Source RF power at DUT = -50 dBm

24.0 MHz Clock Frequency :
Device under test: 24.0 MHz locked
to jammer synthesizer
10/12/00 Jim Shaw

Figure 2: Processing Gain Measurements

The processing gain Vs jammer frequency is shown in Figure 3:

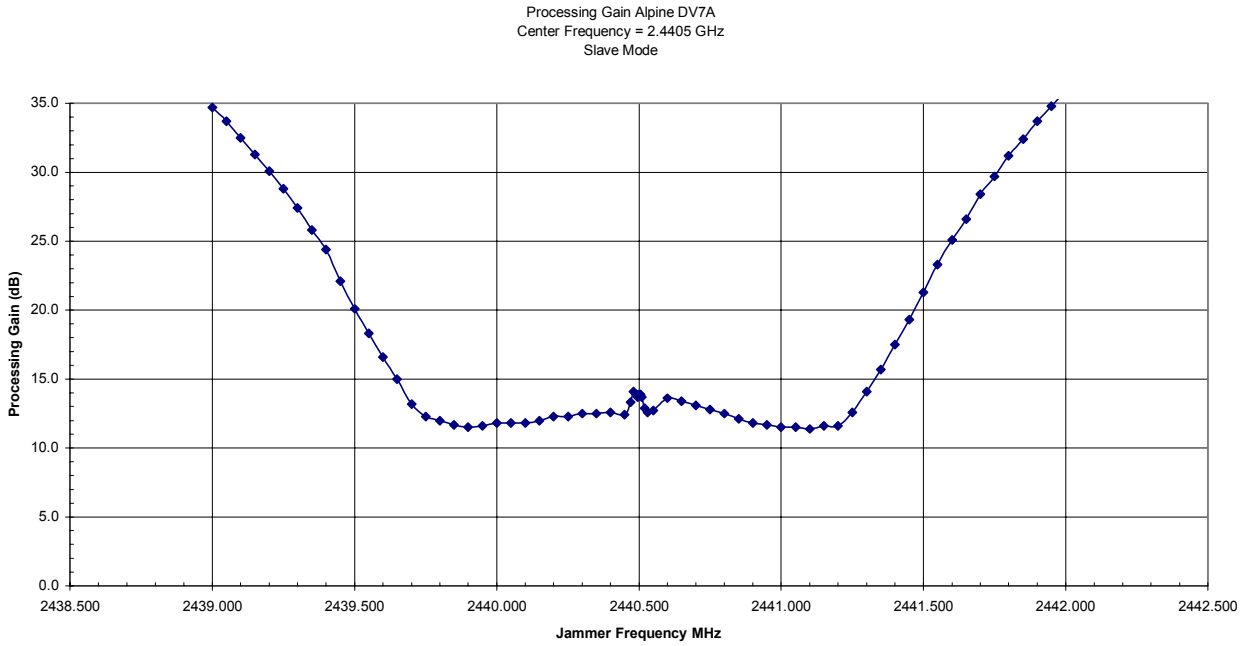

Figure 3: Processing Gain Vs Jammer Frequency

V. Conclusions

The LXT821 meets the 10.0 dB requirement for processing gain. The worst case processing gain of 11.4dB at 2.4411GHz was still within FCC requirements. Additionally, the FCC allows the worst 20% of the data to be ignored, so the LXT821 easily passes the FCC requirements.