

UCSD MAS WES268A - Lab 2 Report

08NOV2025



PREPARED BY:

*Joshua Hoang
Ryan Shimizu*



Contents

1 Phase Estimation Using PLL	3
1.1 Manual PLL	3
1.2 Write-Up	3
2 Performance of PLLs	4
2.1 Tracking the Frequency of a Sinusoidal Signal	4
2.1.1 Transmitter VI Setup	4
2.1.2 Receiver VI Setup	4
2.1.3 Basic Measurements	4
2.2 Tracking the Frequency of a Data Modulated Signal	6
2.2.1 Transmitter VI Setup	6
2.2.2 Receiver VI Setup	6
2.2.3 Measurements	6
2.3 Write-Up	7
3 Clock Estimation	8
3.1 Timing Recovery - Matched Filters	8
3.1.1 Receiver VI Setup	8
3.1.2 Transmitter VI Setup	8
3.1.3 Measurements	8
3.1.3.i Matched Filter Analysis	8
3.1.3.ii Fractional Symbol Offset Graph Analysis	10
3.2 Write-Up	10

1 Part 1: Phase Estimation Using PLL

1.1 Manual PLL

1. - No narrative required for this section.

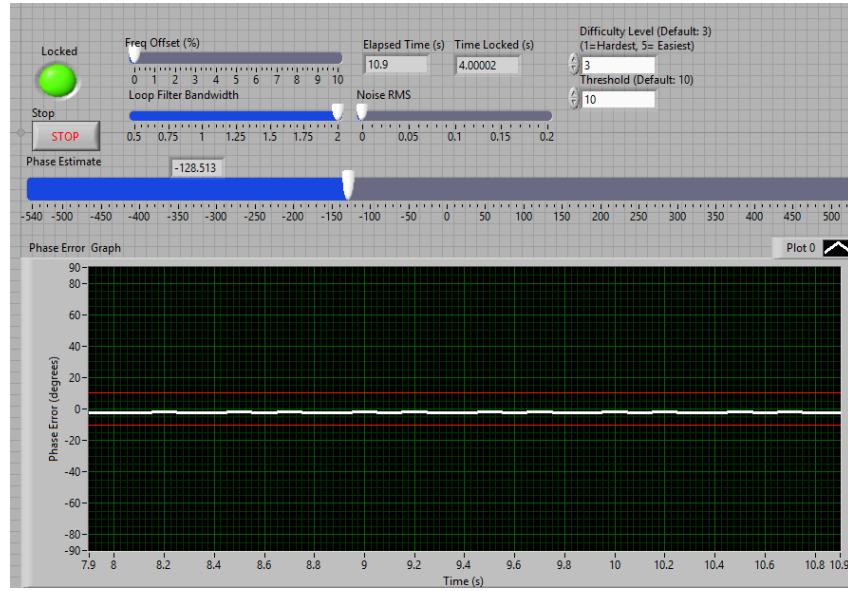


Figure 1: 1.1 - Output of Phase Detector with Freq. Offset = 0Hz, Bandwidth = 2, Noise = 0

1.2 Write-Up

1 - Insert

2 Part 2: Performance of PLLs

2.1 Tracking the Frequency of a Sinusoidal Signal

2.1.1 Transmitter VI Setup

No narrative required for this section.

2.1.2 Receiver VI Setup

No narrative required for this section.

2.1.3 Basic Measurements

Loop Type	f_n	Δ_f	σ	ζ	Freq. Pull-in	Phase Pull-in
Costas	2kHz	5kHz	0	$1/\sqrt{2}$	1.25ms	1.7ms
Costas	2kHz	10kHz	0	$1/\sqrt{2}$	6.33ms	6.76ms
Standard	5kHz	5kHz	0.1	$1/\sqrt{2}$	61.63us	198.57us
Standard	10kHz	5kHz	0.1	$1/\sqrt{2}$	23.24us	48.59us
Standard	1kHz	5kHz	0.1	$1/\sqrt{2}$	3.19ms	3.99ms

Table 1: Frequency and Phase Pull-in Times for Data Modulated Signals

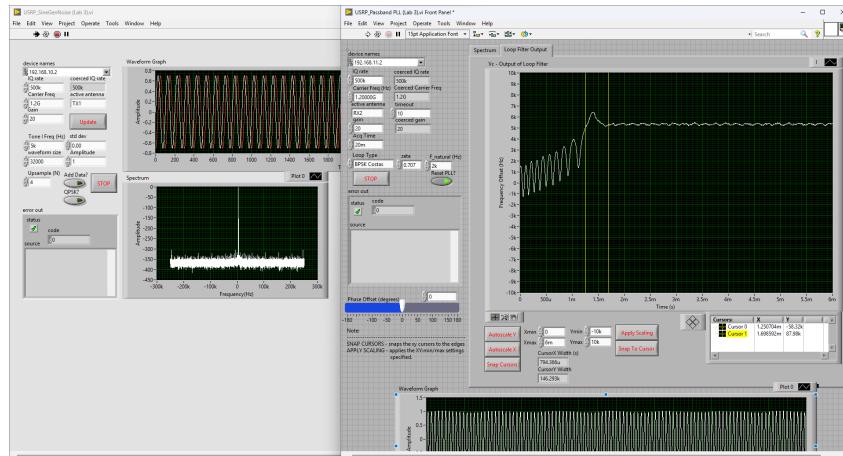


Figure 2: 2.1.3.1 - Costas PLL $f_n = 2$ kHz, $\Delta_f = 5$ kHz, $\sigma = 0$, $\zeta = 1/\sqrt{2}$

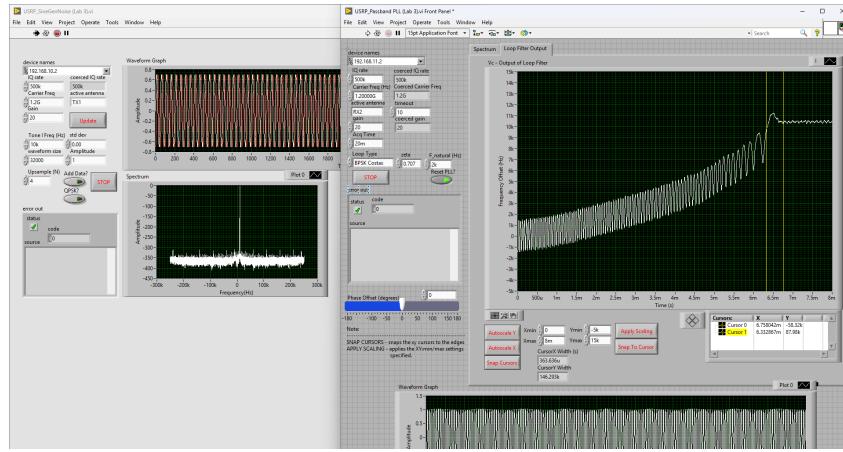


Figure 3: 2.1.3.2 - Costas PLL $f_n = 2$ kHz, $\Delta_f = 10$ kHz, $\sigma = 0$, $\zeta = 1/\sqrt{2}$

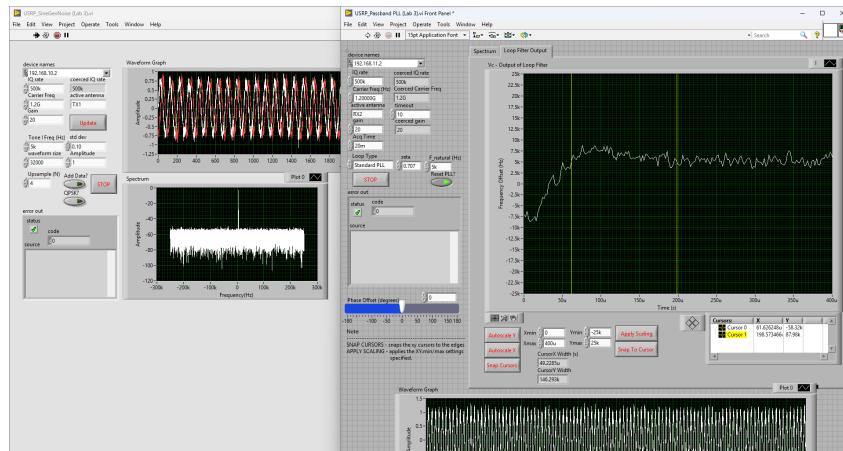


Figure 4: 2.1.3.6 - Standard PLL $f_n = 5$ kHz, $\Delta_f = 5$ kHz, $\sigma = 0.1$, $\zeta = 1/\sqrt{2}$

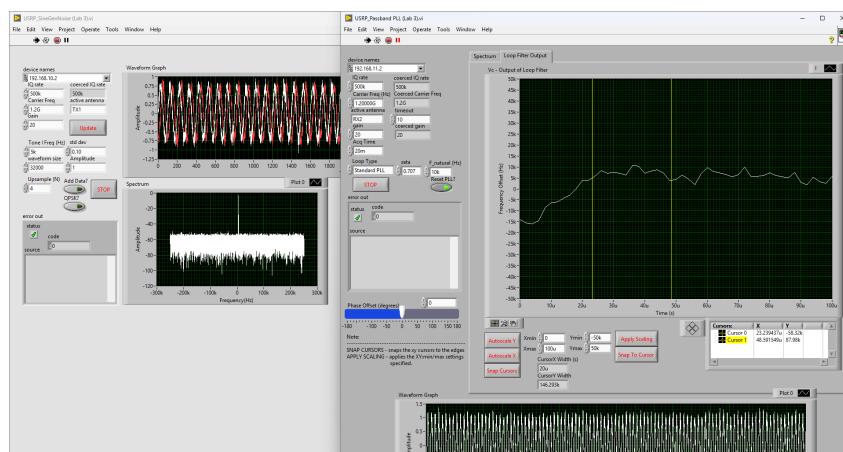


Figure 5: 2.1.3.7 - Standard PLL $f_n = 10$ kHz, $\Delta_f = 5$ kHz, $\sigma = 0.1$, $\zeta = 1/\sqrt{2}$

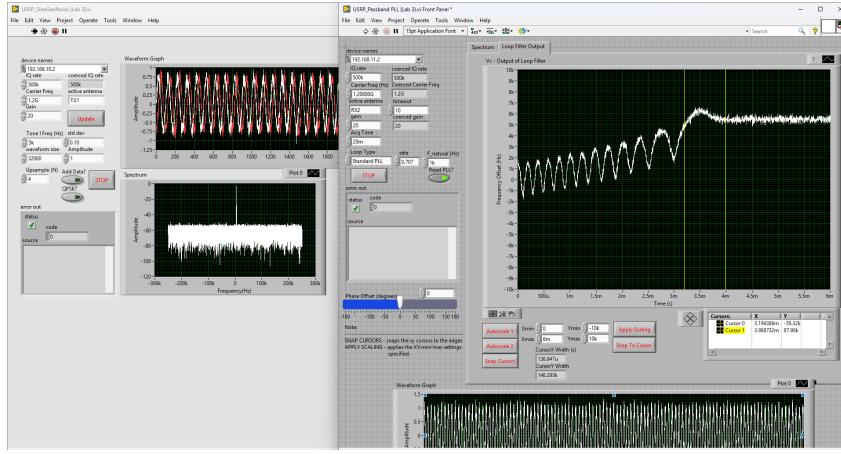


Figure 6: 2.1.3.8 - Standard PLL $f_n = 1$ kHz, $\Delta_f = 5$ kHz, $\sigma = 0.1$, $\zeta = 1/\sqrt{2}$

2.2 Tracking the Frequency of a Data Modulated Signal

2.2.1 Transmitter VI Setup

No narrative required for this section.

2.2.2 Receiver VI Setup

No narrative required for this section.

2.2.3 Measurements

Loop Type	f_n	Δ_f	σ	ζ	M	Freq. Pull-in	Phase Pull-in
Standard	0.5kHz	4kHz	0	$1/\sqrt{2}$	1	NoTrack	NoTrack
Costas	0.5kHz	4kHz	0	$1/\sqrt{2}$	1	62.66ms	65.2ms
Standard	0.5kHz	4kHz	0	$1/\sqrt{2}$	2	NoTrack	NoTrack
Costas	0.5kHz	4kHz	0	$1/\sqrt{2}$	2	59.3ms	67.3ms

Table 2: Frequency and Phase Pull-in Times for Data Modulated Signals

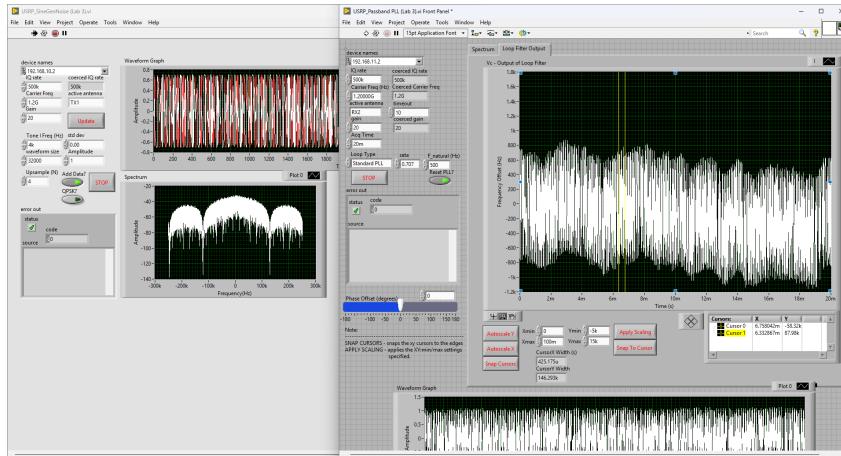


Figure 7: 2.2.3.1 - Standard PLL $f_n = 0.5$ kHz, $\Delta_f = 4$ kHz, $\sigma = 0$, $\zeta = 1/\sqrt{2}$, $M = 1$

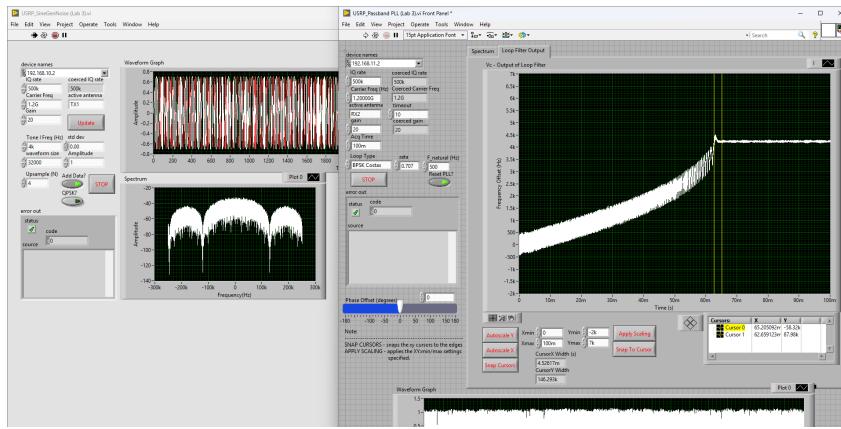


Figure 8: 2.2.3.2 - Costas PLL $f_n = 0.5$ kHz, $\Delta_f = 4$ kHz, $\sigma = 0$, $\zeta = 1/\sqrt{2}$, $M = 1$

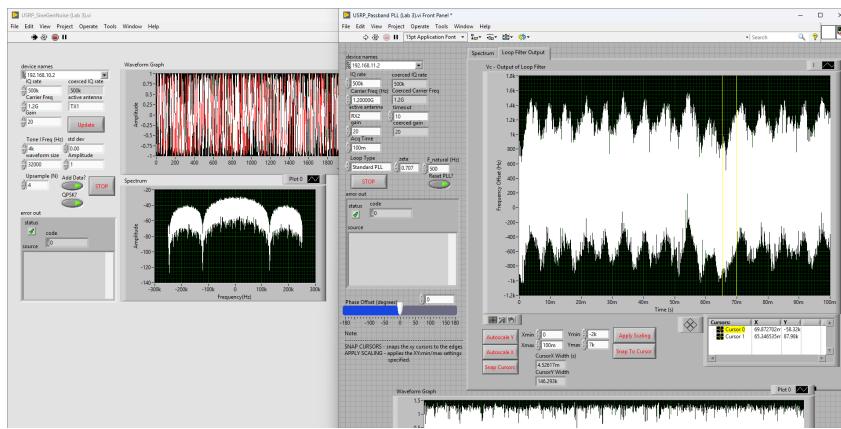


Figure 9: 2.2.3.3 - Standard PLL $f_n = 0.5$ kHz, $\Delta_f = 4$ kHz, $\sigma = 0$, $\zeta = 1/\sqrt{2}$, $M = 2$

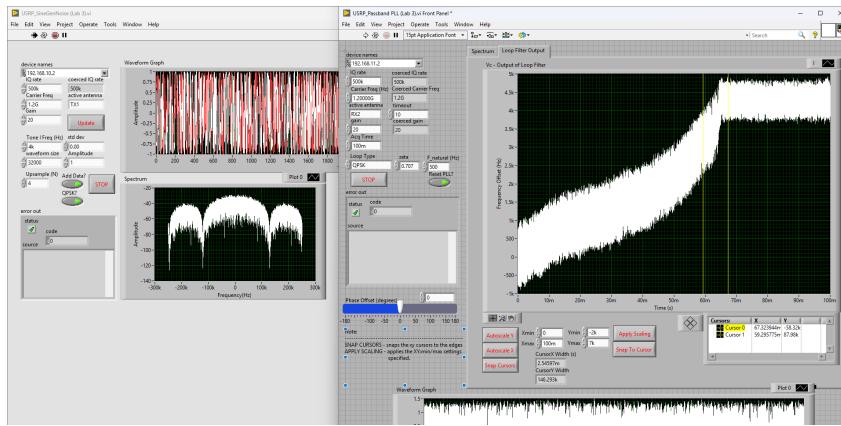


Figure 10: 2.2.3.4 - Costas PLL $f_n = 0.5$ kHz, $\Delta_f = 4$ kHz, $\sigma = 0$, $\zeta = 1/\sqrt{2}$, $M = 2$

What happens when you try and track a data modulated signal with the Standard PLL? Why?
Insert

2.3 Write-Up

- 1 - Insert
- 2 - Insert

3 Part 3: Clock Estimation

3.1 Timing Recovery - Matched Filters

3.1.1 Receiver VI Setup

No narrative required for this section.

3.1.2 Transmitter VI Setup

No narrative required for this section.

3.1.3 Measurements

3.1.3.i Matched Filter Analysis

β	ζ
0	6.86
0.5	21.63
1.0	30.79

Table 3: Measured ζ for Different Roll-off Factors β

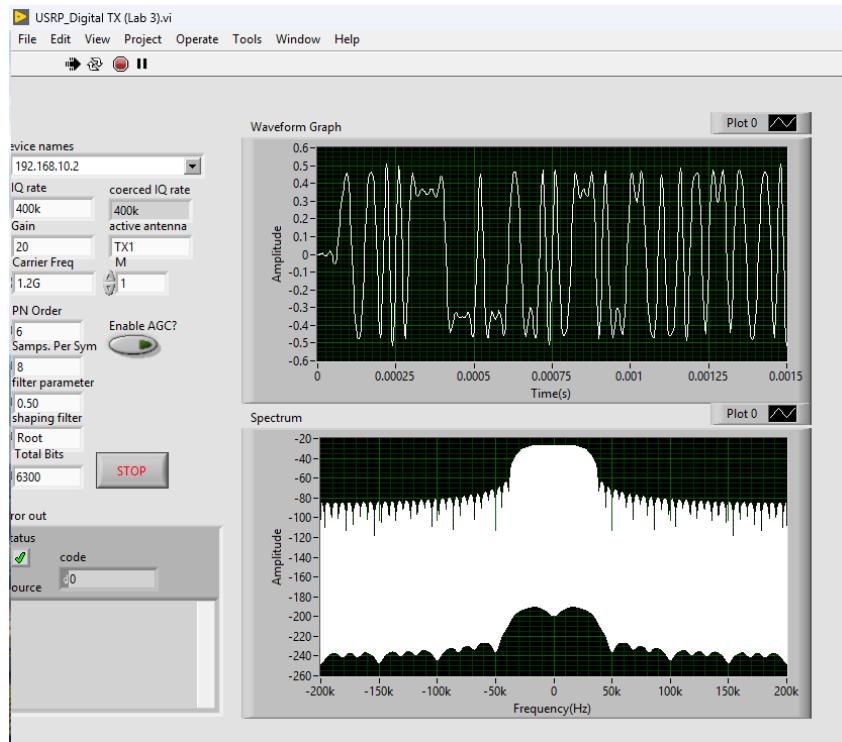


Figure 11: 3.1.3 - Transmitter Output Signal with Matched Filter

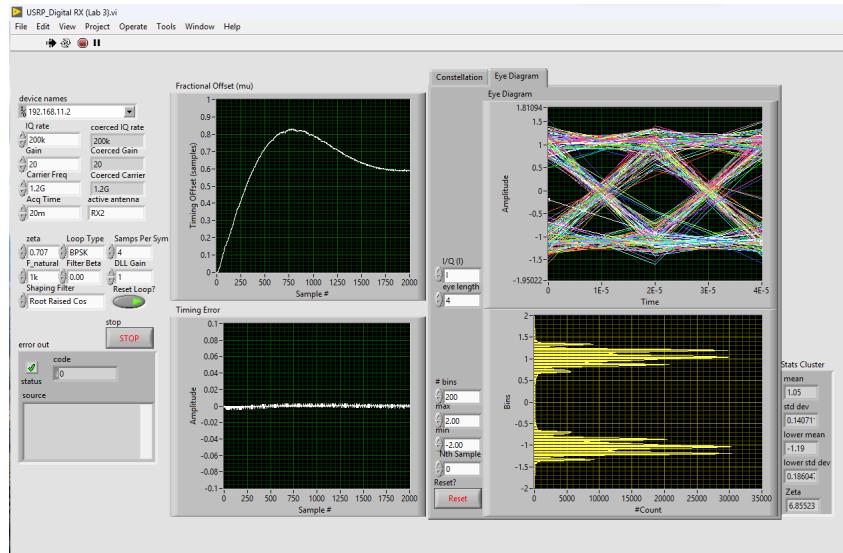


Figure 12: 3.1.3 - Receiver Output Signal with Matched Filter, $\beta = 0$

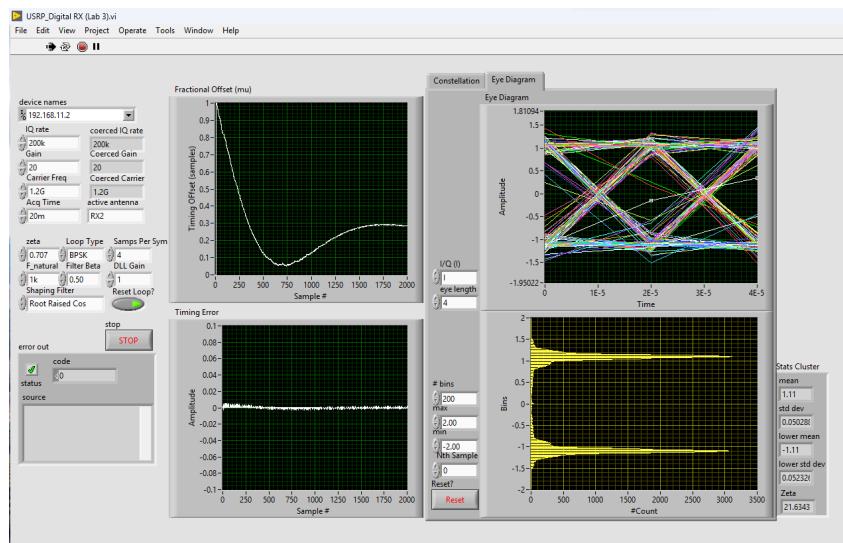


Figure 13: 3.1.3 - Receiver Output Signal with Matched Filter, $\beta = 0.5$

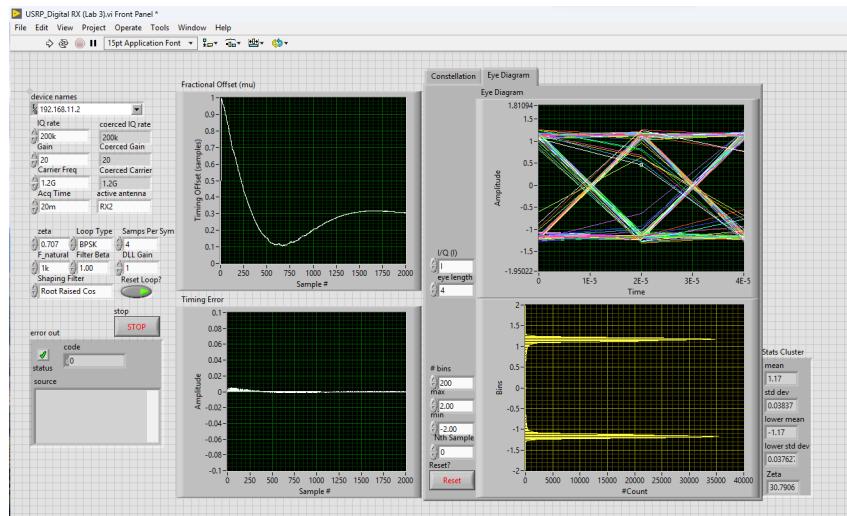


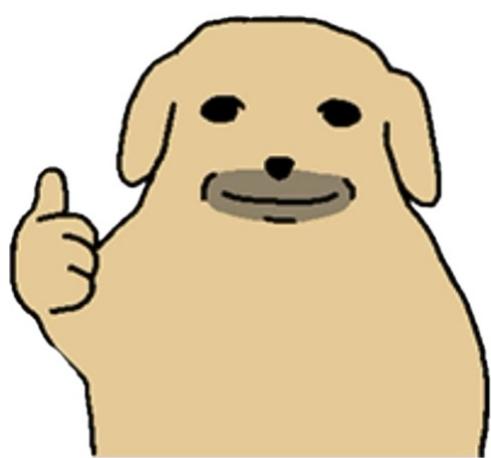
Figure 14: 3.1.3 - Receiver Output Signal with Matched Filter, $\beta = 1$

3.1.3.ii Fractional Symbol Offset Graph Analysis

insert

3.2 Write-Up

1 - Insert



feelsgoodman