iSing Voice Harmonizer

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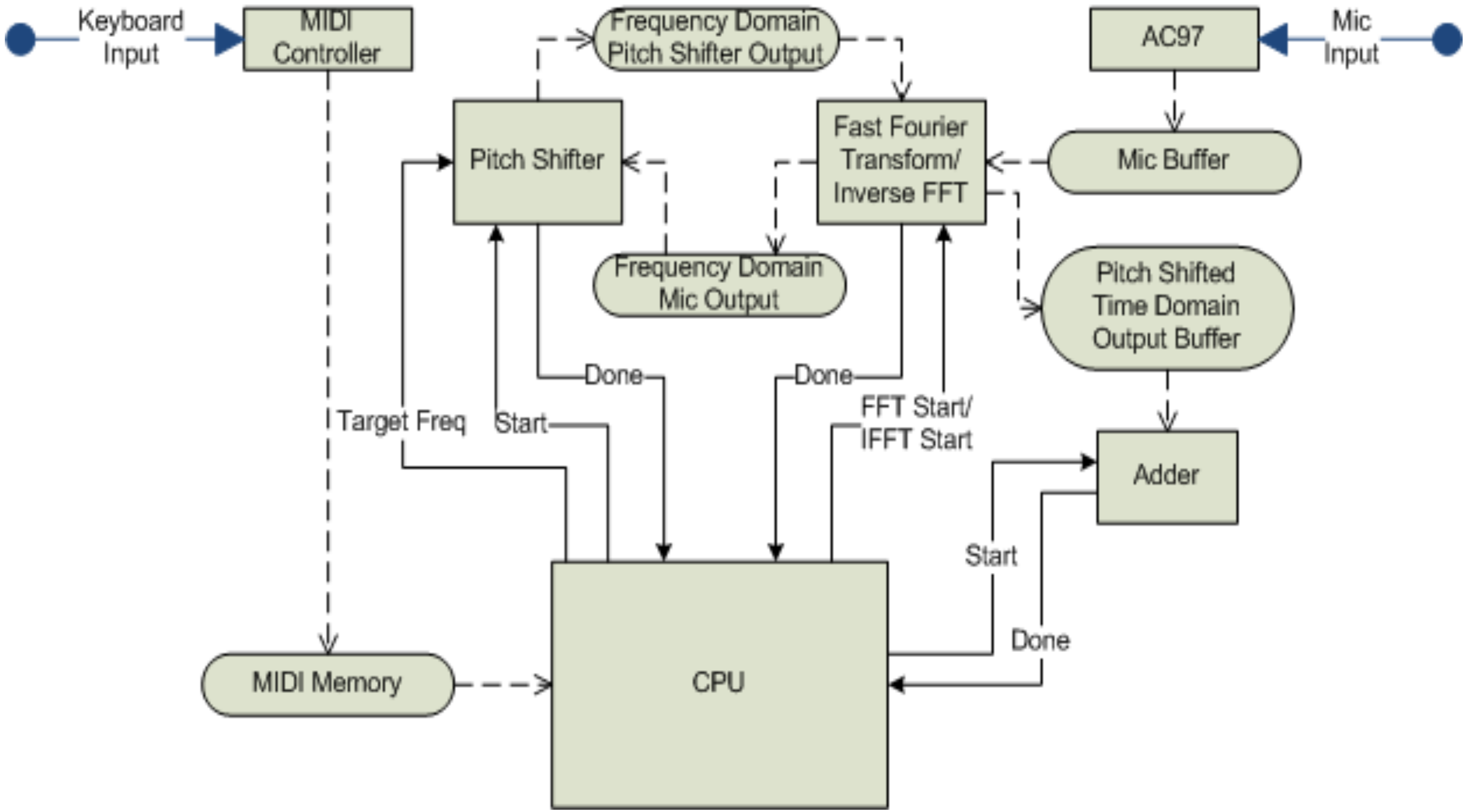
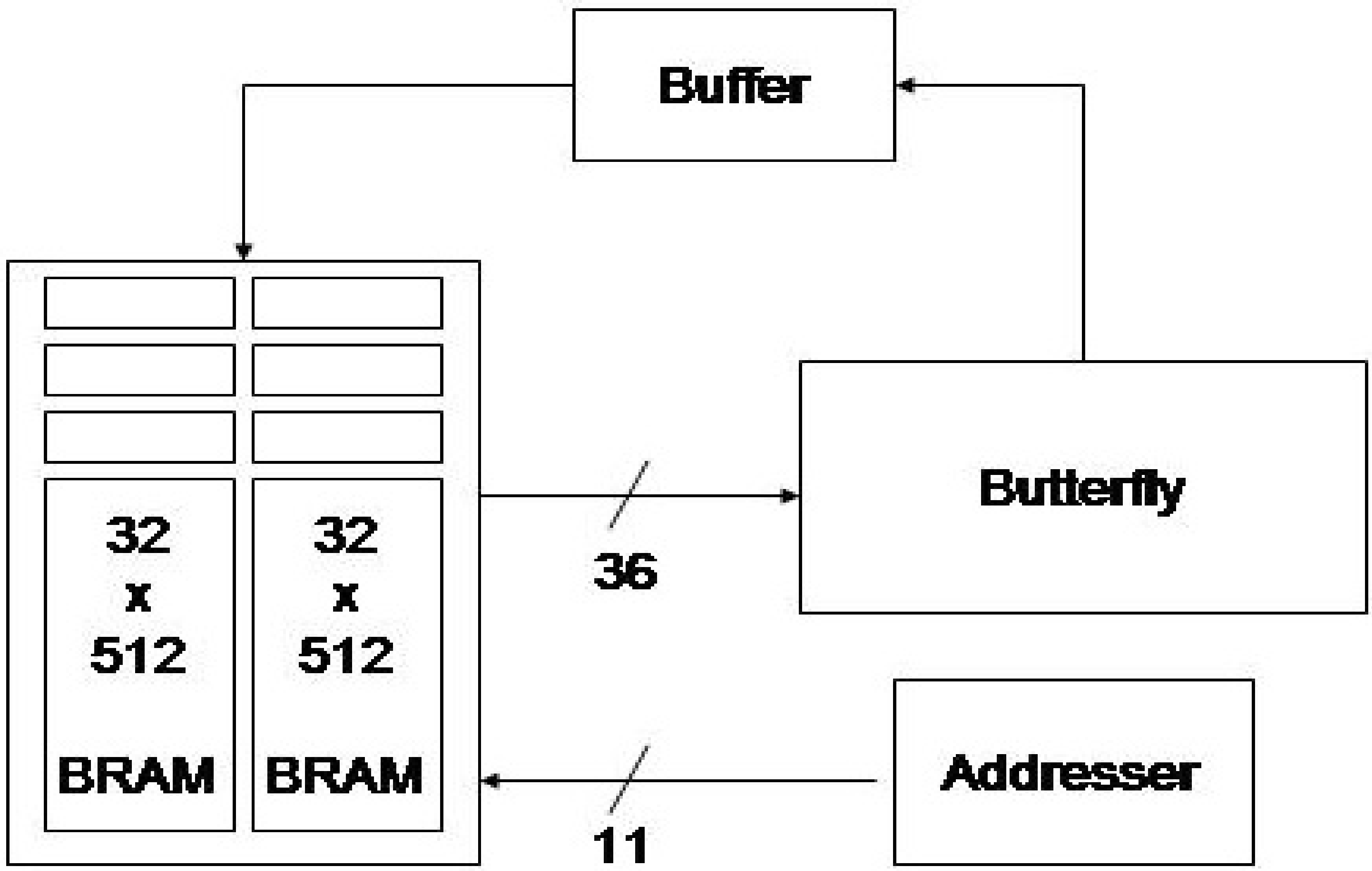
Overview

1. Read in voice signal through microphone
2. Read in harmonics through keys on keyboard
3. FFT to detect pitch of voice signal
4. Pitch shift N copies of voice signal for each of the N keys pressed on keyboard
5. Inverse FFT to get back pitch shifted signals, blend, and output!

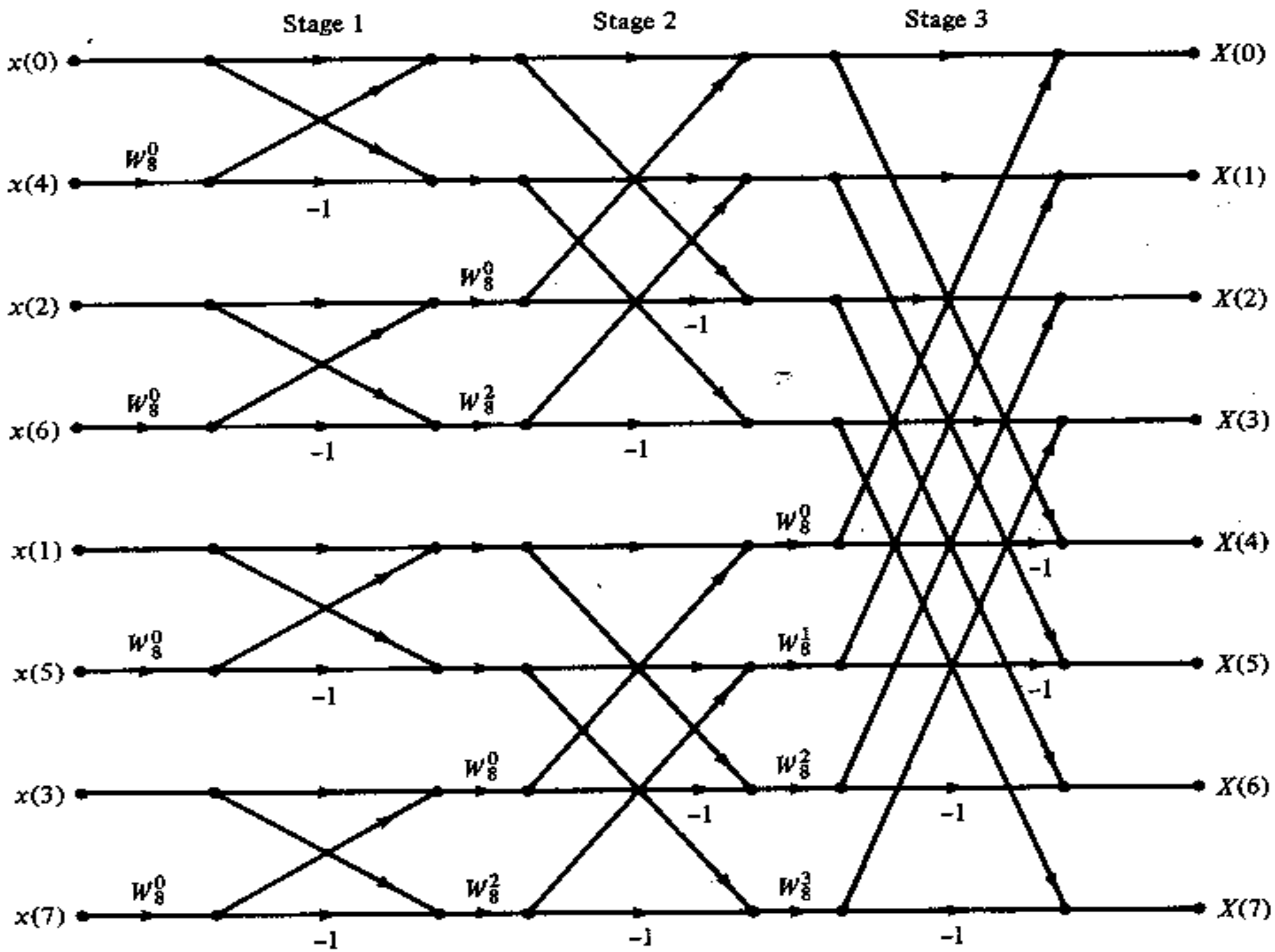
Overall Block Diagram



Fast Fourier Transform Module



Fast Fourier Transform Butterfly



Fast Fourier Transform - Bit shifting

Stage 1
LCIRC 2

CBA	ACB
000	000 = 0
001	100 = 4
010	001 = 1
011	101 = 5
100	010 = 2
101	110 = 6
110	011 = 3
111	111 = 7

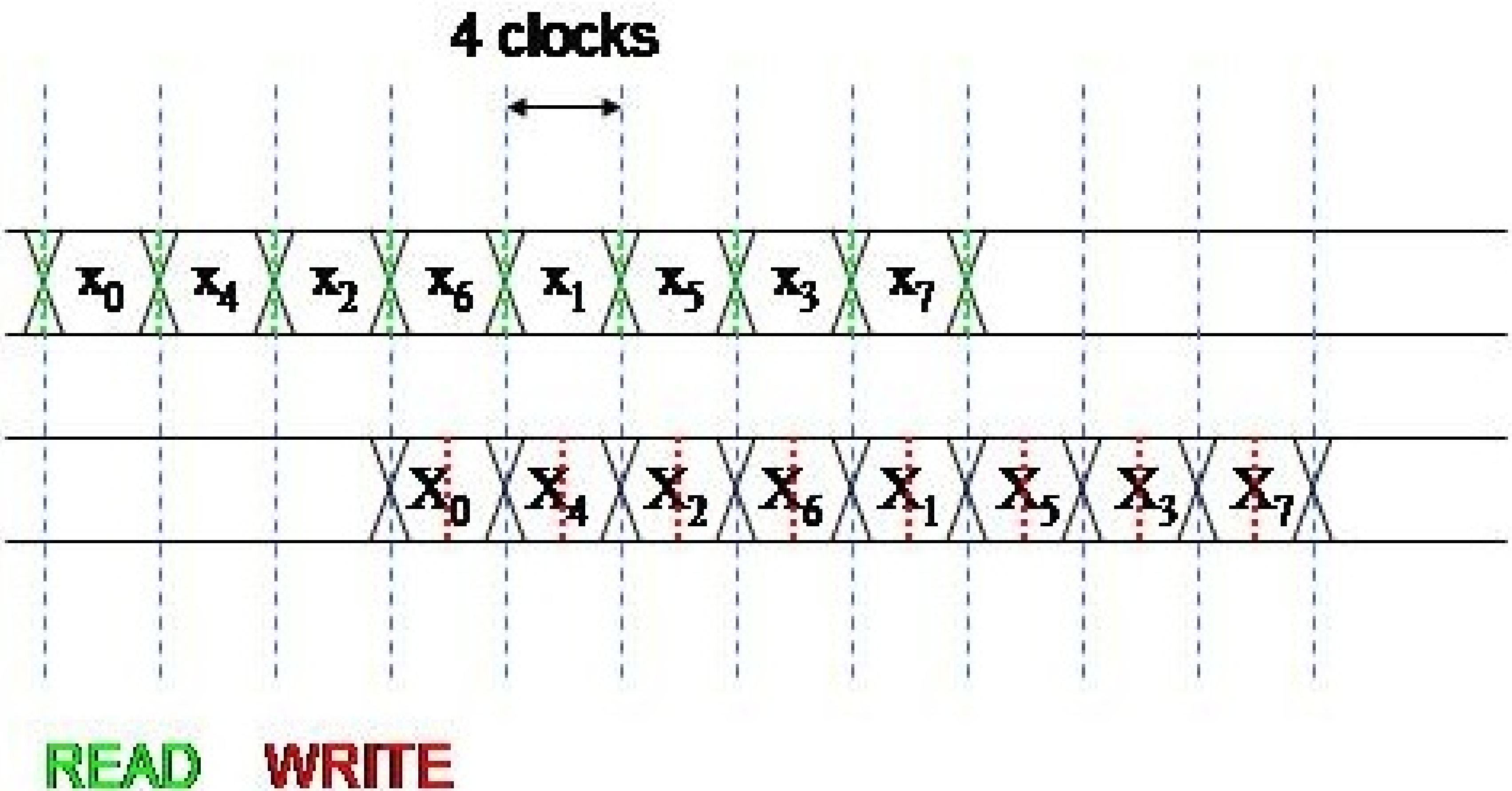
Stage 2
LCIRC 1

CBA	BAC
000	000 = 0
001	010 = 2
010	100 = 4
011	110 = 6
100	001 = 1
101	011 = 3
110	101 = 5
111	111 = 7

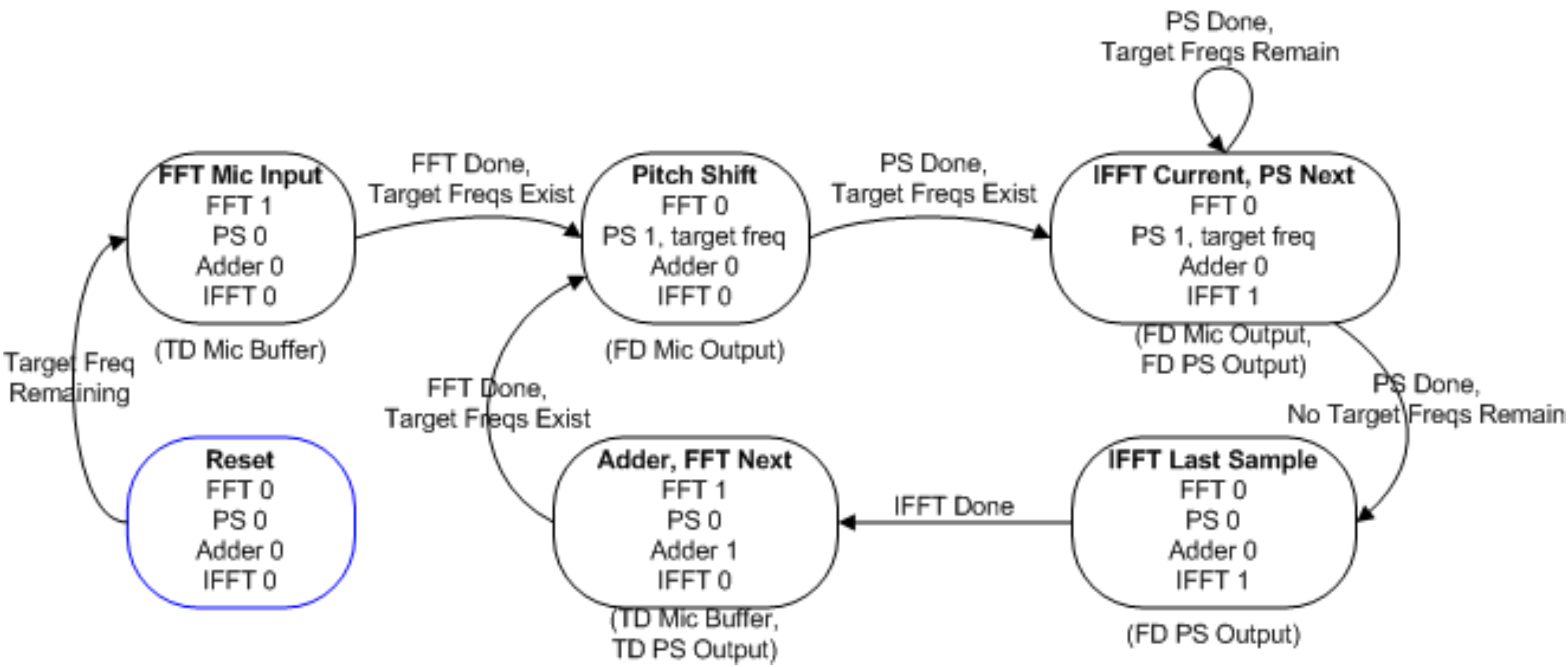
Stage 3
LCIRC 0

CBA	CBA
000	000 = 0
001	001 = 1
010	010 = 2
011	011 = 3
100	100 = 4
101	101 = 5
110	110 = 6
111	111 = 7

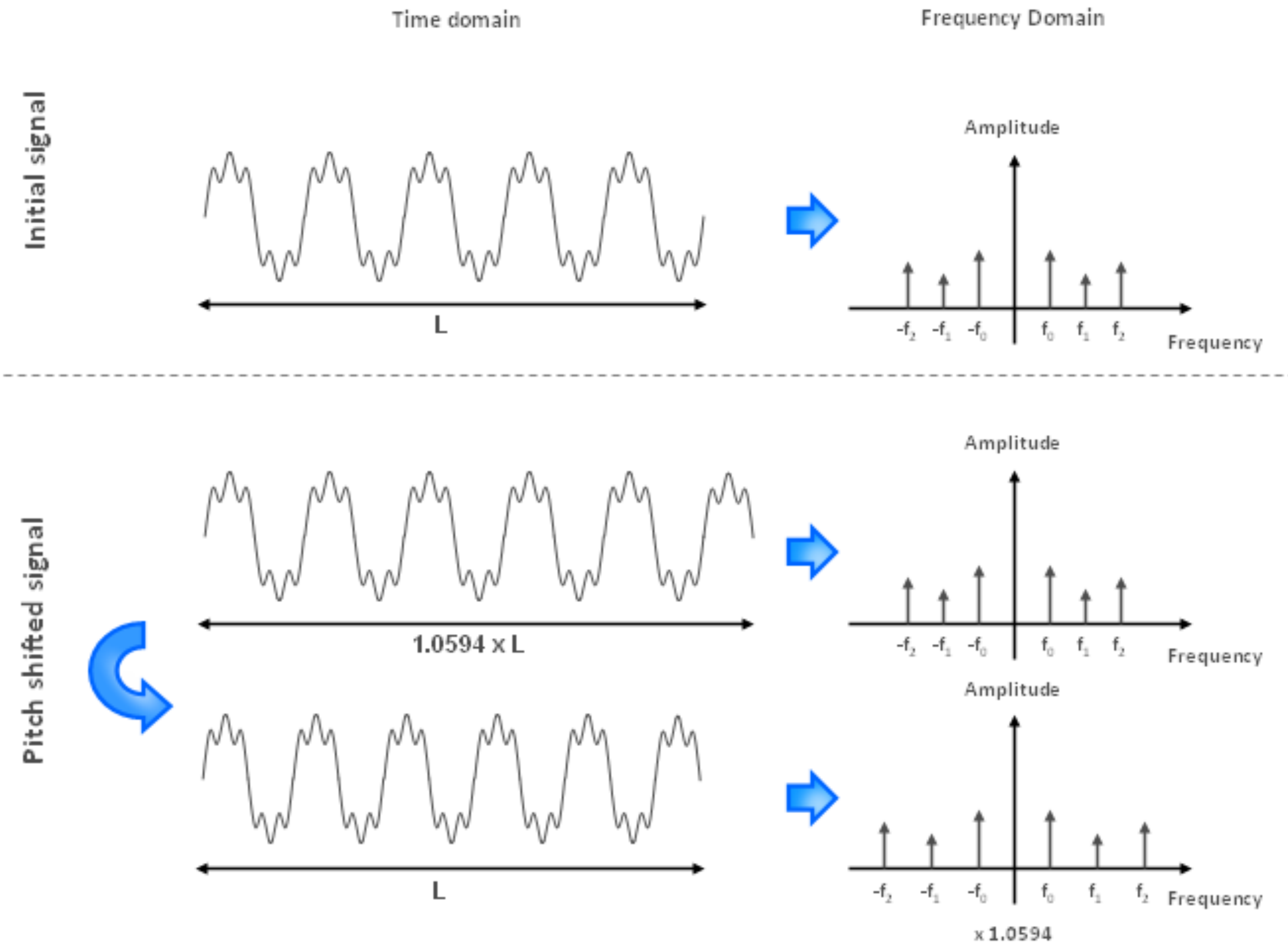
Butterfly Module - Optimizing for speed



CPU Description



Pitch Shifting



Pitch Shifting Module

- Module takes in target frequency played on keyboard and shifts sung note frequency to match keyboard frequency.
- Apply Phase Vocoder Algorithm to produce pitch shifted signal

Phase Vocoder Algorithm

- 3 Stages: Analysis, Processing, Synthesis
- Analysis: Apply Hanning window to extract a small frame of time domain signal with most of the energy focused around DC component.
- Processing: Apply a DFT to divide up the frequency spectrum into a series of discrete bins each with magnitude and phase information.
- Since the frequency components of the signal may not coincide exactly with the bin frequencies, we need to calculate the true frequencies associated with the bins.

Phase Vocoder (cont.)

- After calculating the true bin frequencies using phase offsets, a new spectrum is obtained.
- Synthesis: Apply Inverse FFT to obtain time domain signal for a particular frame and multiply with window to smooth out the signal.
- Add the windowed signals together to reconstruct the entire time domain signal.

Timeline

- 11/25: Finalize implementation details and implement midi controller module. Have skeleton code for other modules.
- 12/4: Finish implementing FFT, Pitchshifter, and CPU modules
- Week of 12/5 – 12/9: Integration testing