14.1 Lab 3 Assignment

Monday, March 12, 2001

- This lab is hard!
  - Many design decisions are up to you, but you MUST use an MCU.
  - BUT you are not expected to spend spring break doing it.

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          Issued - Monday, March 12, 2001
     MCU Checkoff - Monday, March 19, 2001
Design Checkoff - Wednesday, March 21, 2001
      Lab Checkoff - Friday, April  6, 2001
        Report Due - Monday, April  9, 2001
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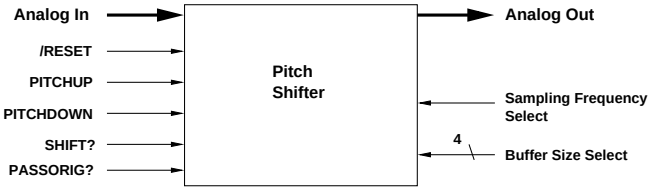
- Pitch Shifting System
  - Digitizes and stores audio frequency input signals.
  - Outputs pitch shifted version plus (optionally) original signal.
- Simple (crude) Pitch Shift Mechanism
  - Uses two buffers, samples at fixed rate and outputs at fixed rate.
  - Skips or adds samples to achieve pitch shifting.
- Selectable Sampling Rate (e.g., 9.6 and 19.2 kHz)
- Adjustable Pitch Shift over a Wide Range
  - Use pushbuttons to adjust pitch shift UP and DOWN.
- Selectable Buffer Size (16 Buffer Sizes)

14.2 Lab 3: Helium Breath

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Analog In  Music or speech signal (or a test analog signal)
Analog Out Signal shifted up or down in pitch
/RESET     Clear pitch shift to zero
PITCHUP    Increments the amount of pitch shift
PITCHDOWN  Decrements the amount of pitch shift
SHIFT?     When asserted, output pitch shifted audio
PASSORIG?  When asserted, output original audio signal
            (When both asserted, mix)
Sampling Frequency Select – Choose one of two sampling rates
Buffer Size Select – Choose one of 16 sampling buffer sizes
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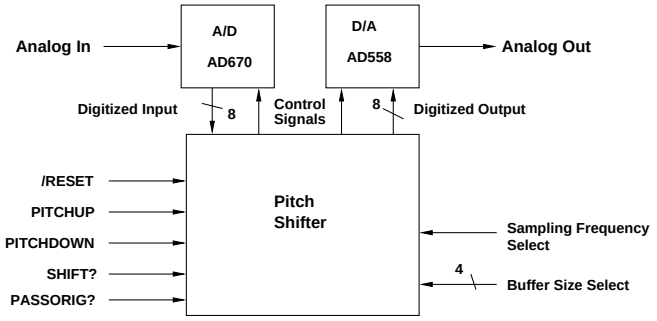
14.3 Analog-Digital Separation

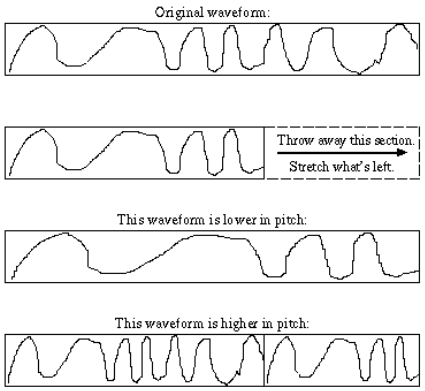


14.4 Approach

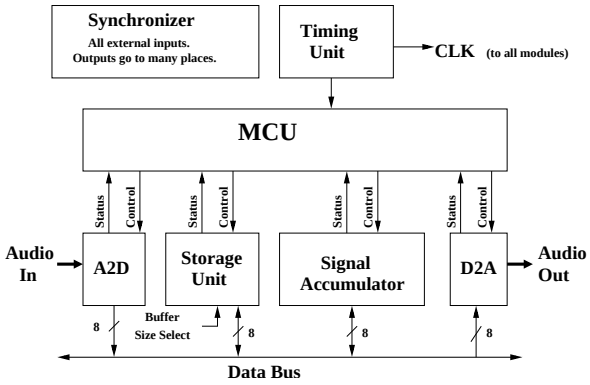
- Divide time into ‘chunks’.
- Write signal into a buffer (one chunk).
- Use two buffers: write to one while reading from other.
- Output signal at a different rate to change pitch.
- To lower pitch,
  - ’Stretch’ signal in each chunk.
  - This means we throw away end of each chunk.
- To increase pitch,
  - ‘Squish’ the signal chunk.
  - Output at a higher rate.
  - To fill the end of the chunk, output some part twice.

14.5 Graphically

- Stretching and Squishing

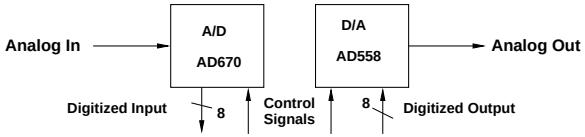


14.6 System Block Diagram



14.7 Analog Parts

- A/D: Use AD670.
- D/A: Use AD558.
- Data sheets are at end of lab handout.
- More on these Wednesday.

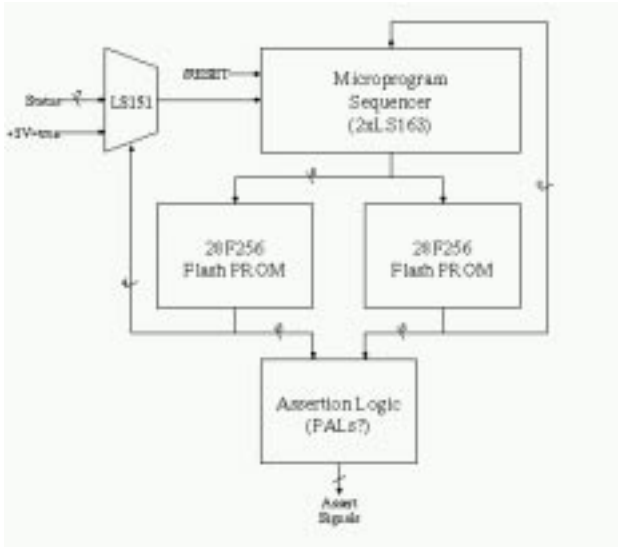


14.8 Microprogrammed Control Unit

- You may choose how to build MCU.
- Next slide suggests a possible implementation.
  - Sequencer made of 2 x 74LS163.
  - Condition select from 75LS151.
  - Assertion logic done in PALs.
- You should store instructions in 28F256.
  - Flash PROM
  - 16-bit word = 2 PROMs
- Build and test MCU and Timing Unit first.
  - Test program is provided.
  - Display of blinking lights
  - Ensures that at least this part is working.

	I15	I14	I13	I12	I11	I10	I09	I08	I07	I06	I05	I04	I03	I02	I01	I00
CJMP	0	C	C	C	–	–	–	–	A	A	A	A	A	A	A	A
JMP	0	1	1	1	–	–	–	–	A	A	A	A	A	A	A	A
ASSERT	1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

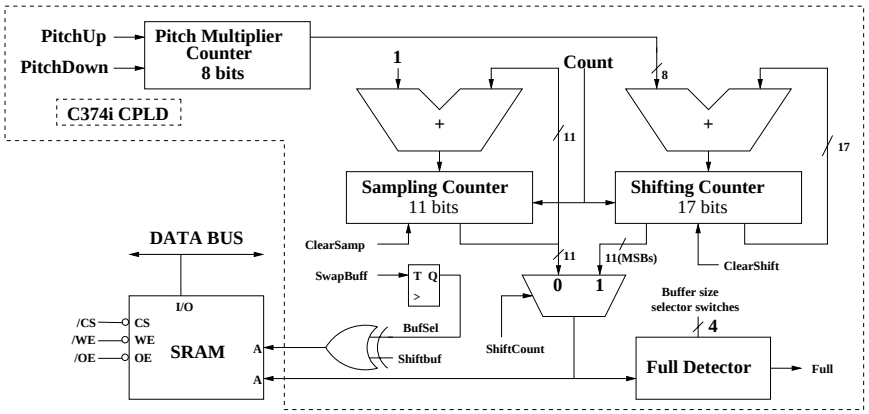
14.9 MCU



14.10 Timing Unit

- Provides MCU Clock.
  - Makes sure timing constraints are observed.
- Provides Sampling Clock.
  - At two rates
- For MCU test yet a lower frequency.
  - 10 to 20 Hz
- Probably should be implemented in a CPLD.

14.11 Storage Unit



14.12 Storage Unit

- SRAM and Memory Address Logic
- Implements Two Storage Buffers
- Switch Address Counters
- Sampling Counter
  - Increments by 1
  - 11 bits => 2K
- Shifting Counter
  - Wider (17 bits => 64 x 2K)
  - Increments by selectable amount
  - Most significant 11 bits skips or repeats
- Switch Buffer
  - MSB of address
  - SwapBuff toggles the buffer.
  - ShiftBuf and ShiftCount to address correct buffer
- Pitch Multiplier Counter
  - Up/Down functions controlled by pushbuttons
- Full Detector
  - With size selector switch
  - To implement variable buffer size

14.13 Signal Accumulator

- To select signals to output
  - Original Input Signal
  - Pitch Shifted Signal
  - Or both added together
- Possible implementation
  - 2 X 74LS283
  - Clearable, loadable, 8-bit register
- You may design another implementation.

14.14 Implementation

- Remember to synchronize asynchronous inputs.
- Pitch Up and Down PB's should produce pulses.
  - One per push or
  - SLOW periodic pulses (if PB held down for a while).
- Do the MCU first and check it out with our program.
- Debug using signal generator.
  - Use sine or triangle waves, NOT voice or music.
- Do signal accumulator last.
- Report requirements are listed in the lab handout.