ECE 316 – Project 1

Multiplier

Hardware Implementation

Project Description

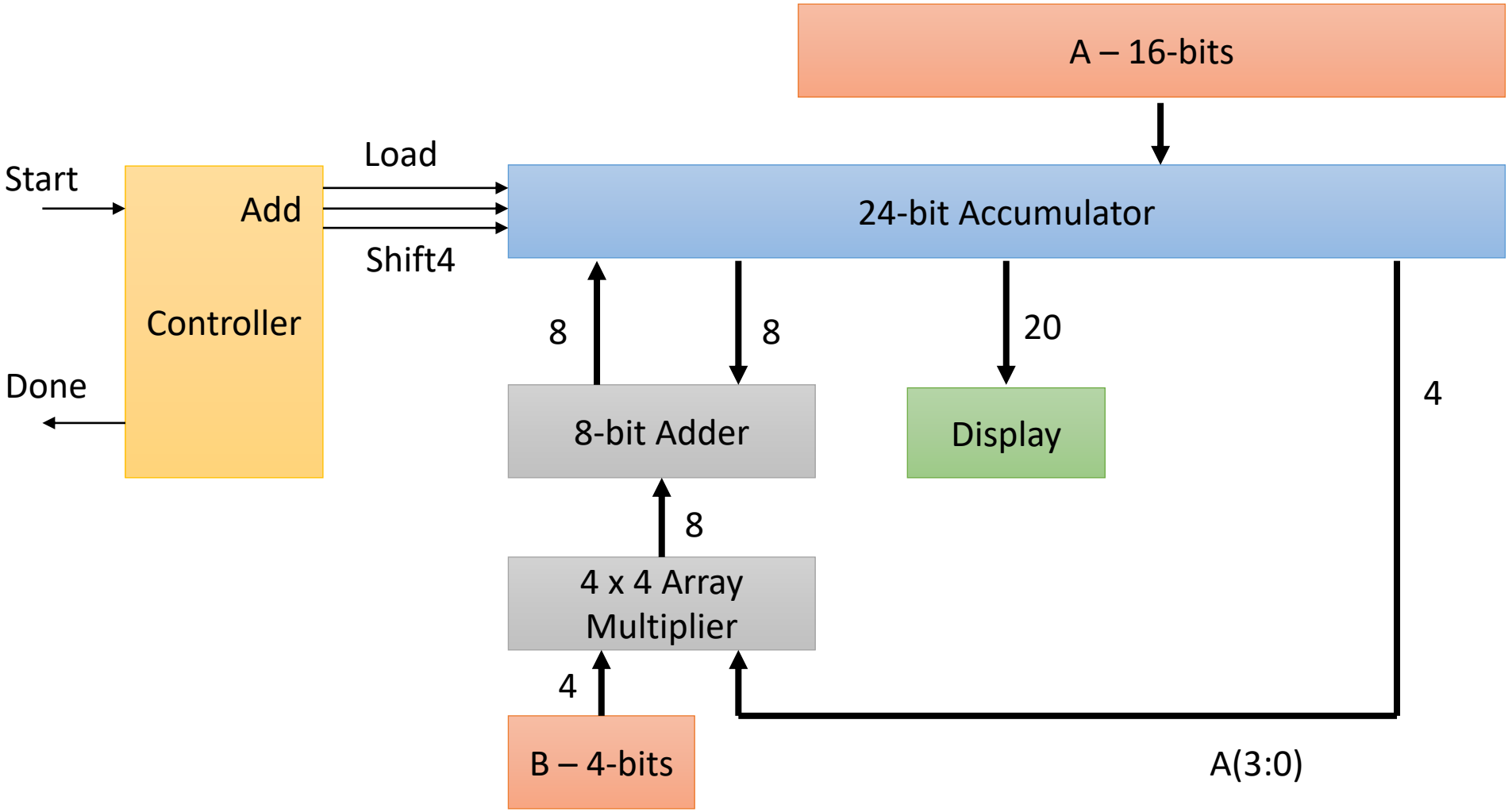
- Design a multiplier for unsigned binary numbers that multiplies a 4-bit number by a 16-bit number to give a 20-bit result
- Use a 4-bit array-multiplier to speed operation
  - You are not allowed to use the built-on multiply operation
- Show operation in ModelSim
- Demonstrate operation on DE1 board

- Extra Credit:
  - Implement a clock divider and use the internal clock. Setup as a 1 Hz clock

Due Dates

- Part A – ModelSim design and simulation – March 29th
- Part B – Demo Complete system on DE1 – Apr 5th

Architecture



General Operation

- Load 8-bit LSB for A (multiplier)
- Load 8-bit MSB for A (multiplier)
- Load 4-bit value B (multiplicand)
- Start=1 – starts multiplier control machine
- Start=0 – multiplier control running
- Output Done and Result – Hold here

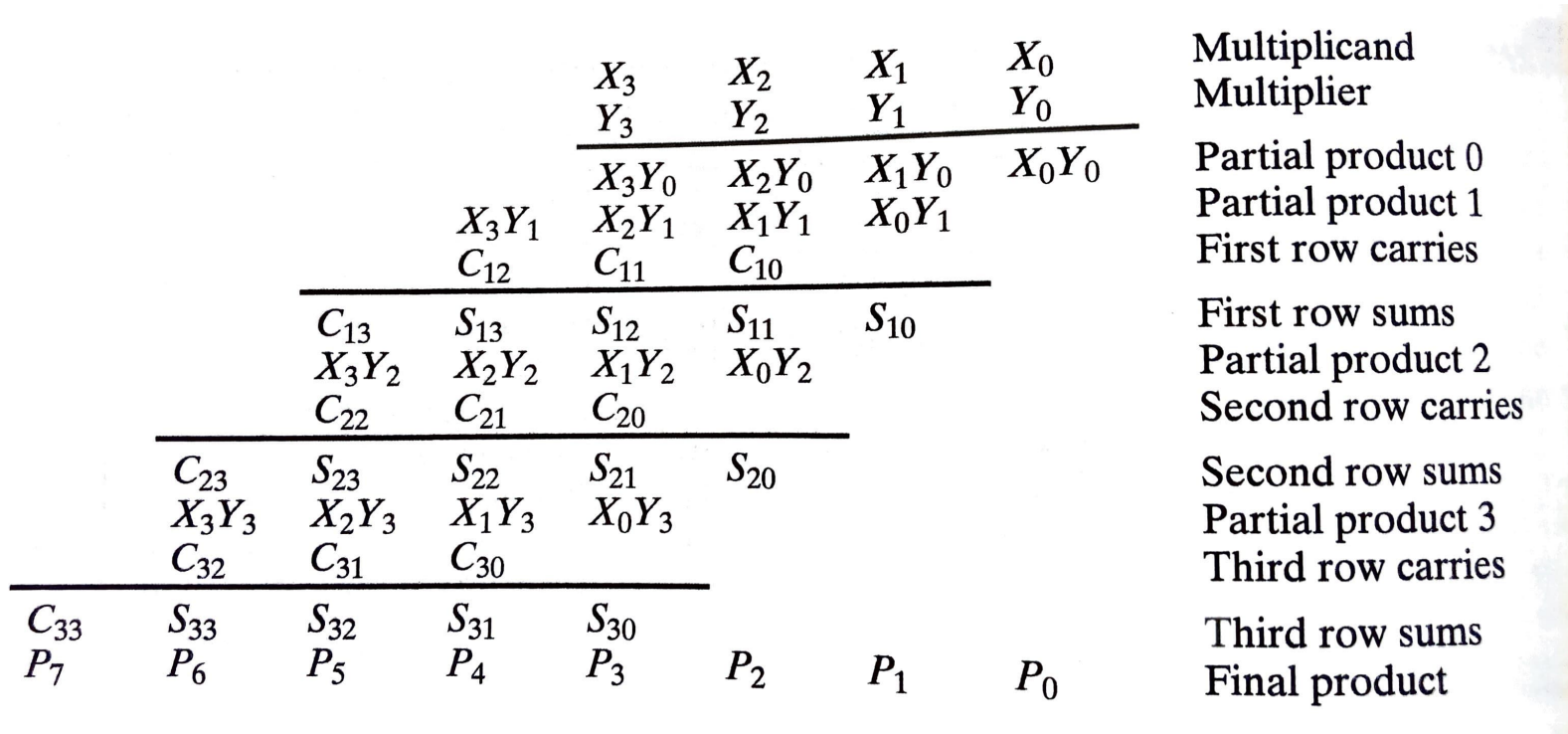
Controller Operation

1. On Start signal, Start=1
   - Load A into Accumulator (lower 16 bits, upper 8-bits=0), Load=1
2. Multiply B by Acc[3:0] to get 8-bit output
3. Add result of 2 to upper 8-bits of Accumulator
4. Store result in Accumulator (upper 8-bits), Add=1
5. Shift Accumulator Right by 4-bits, Shift4=1
6. Repeat 2-5 x 4
7. Done, Done=1

Input/Output

Pin/Bus	I/O	Size	Name	DE1
Din	Input	8-bit	8-bit Data in	SW0-SW7
Start	Input	1-bit	Start signal	SW9
LoadA-LSB	Input	1-bit	Load LSB for multiplier	PB0
LoadA-MSB	Input	1-bit	Load MSB for multiplier	PB1
LoadB	Input	1-bit	Load multiplicand	PB2
CLOCK	Input	1-bit	Manual Clock (falling-edge)	PB3
Done	Output	1-bit	Calculation Done	LED9
Result	Output	6x7-bit	6-digit 7-segment output	HEX5-HEX0
Overflow	Output	1-bit	Overflow result (>999,999)	LED8

4x4 Array Multiplier



4x4 Array-Multiplier