

Lecture 1
Review - Datapath Elements

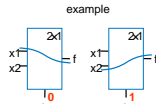
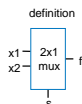
Datapath Elements

- Datapath components store/transform data, put components together to form a datapath
 - Needed when we cover register-transfer-level (RTL) design
- Datapath components
 - Muxes
 - Decoder
 - Shifters - N-bit, Barrel
 - Comparators - Equality, Magnitude
 - Adders - Two-level, Half, Full, Carry-Ripple
 - Registers - Parallel load, Shift, Rotate, Multi-function
 - Counters - Increment, Decrement, Up, Down, Up/down, Parallel Load
 - Subtractor
 - ALUs (Arithmetic-Logic Unit)**
 - Register Files

Multiplexer (MUX) Functionality and Implementation

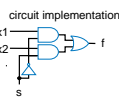
- Routes one of its N data inputs to its one output, based on binary value of select inputs

s	x2	x1	f
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1



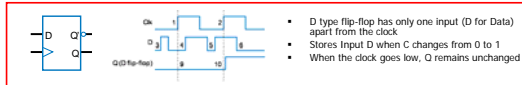
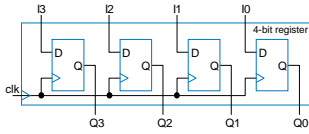
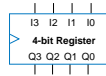
logic expression
(optimized)

$$f = s'x1 + sx2$$



Basic Register

- Typically, we store multi-bit items
 - 4-bit binary number, RGB color encoding, etc.
 - Multiple flip-flops sharing clock signal
 - Loads data on every rising edge of clock

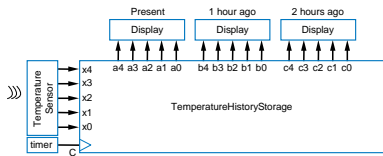


- D type flip-flop has only one input (D for Data) apart from the clock
- Stores Input D when C changes from 0 to 1
- When the clock goes low, Q remains unchanged

Example Using Registers

Temperature Display Module

- Temperature history display
 - Sensor outputs temperature as 5-bit binary number
 - Timer pulses C every hour
 - Record temperature on each pulse, display last three recorded values

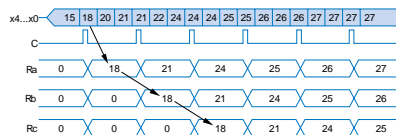
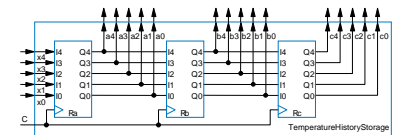


(In practice, we would actually avoid connecting the timer output C to a clock input, instead only connecting an oscillator output to a clock input.)

Example Using Registers

Temperature Display Module Timing Diagram

- Use three 5-bit registers



Summary

- Datapath components
 - Muxes
 - Decoder
 - Shifters
 - Comparators
 - Adders
 - Registers
 - Counters
 - Subtractor
 - ALUs (Arithmetic-Logic Unit)**
 - Register Files
