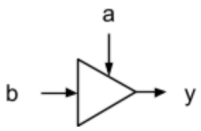
Reading 12

14.1 Register files

Note! the register file design we use in this class uses muxes instead of buffers, but it behaves the same way.

- A three-state buffer is a component that outputs y=b if input a is a 1 and outputs Z if a is 0.
  - ↳ Z represents an electrical situation known as high impedence.



a	y
0	'Z' (high impedance)
1	b

- A three-state buffer is also called a tri-state buffer, but that name is trademarked.

- An NxM register file implements access to N M-bit registers.

- Loading a register in a register file is a write operation.
- Together, the data input, address input, and load enable input for writing are called a write port.
- Similarly, a register file consolidates read wires into a single 32-bit data output, 4-bit address input, and enable input, forming a read port.
  - ↳ The read port may use three-state buffers to connect the data wires.

- A 32x8 register file consists of 32 registers, each 8 bits wide.
  - ↳ Give 32x8 register W_addr must be 5 bits.

14.2 SRAM and DRAM

- An N x M memory is a digital component that retains bit values, consisting of N words of M bits each. Each word has a unique address.

Ex 4096 x 8 memory
↳ has 4096 8-bit words (for a total of 32,768 bits), with word addresses from 0 to 4,095.

- Such memory is called random access memory (or RAM) because any "random" word can be quickly accessed in contrast to older sequentially accessed memory technologies like tape.

- Most RAM is volatile memory, meaning bit values are lost if electrical power is removed.
- Note: For a processor, "word" may refer to 4 bytes. But for memory, word means one address location, however wide.

SRAM and DRAM

- Memory comes in 2 forms:
  1. A static RAM (or SRAM) uses six transistors to store each bit value, by passing the bit into a loop within those transistors.
  2. A dynamic RAM (or DRAM) uses one transistor and one capacitor to store each bit value, by charging the capacitor.

- SRAM is faster than DRAM, but DRAM is denser and cheaper.

Memory size may be specified in various ways:

- *4096x32*: Indicates the number of words and the bits per word.
- *131,072 bits*: Indicates the total number of bits.
- *16,384 bytes*: Indicates the total number of bytes (a byte is 8 bits).
- *16 KBytes (or 16 KB)*: Approximate number of bytes. The K is the metric kilo, for 1,000. Note: This method is common *but inaccurate*, because 16 Kbytes means 16,000 bytes rather than the actual 16,384 bytes.
- *128 Kbits (or 128 Kb)*: Indicates the total number of bits. Again, this method is common *but inaccurate*.

MB → 1 million bytes

GB → 1 billion bytes

TB → 1 trillion bytes

GB → Giga BYTES

Gb → Giga BITS

Memory sizes are powers of 2 so we have IEC prefixes:

kibi → 2^{10} or 1024

mebi → 2^{20} or 1,048,576

gibi → 2^{30} or 1,073,741,824

tebi → 2^{40} or 1,099,511,627,776

- Metric prefixes refer to the nearest power of 2.
  - ↳ so a kilobyte means 1024 bytes (a kibibyte) and not 1,000 bytes.