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Assignment: Lab 2

**Question 1: What is a Data bus, Address bus, and control bus? How do they differ?**

A **data bus** is a set of “wires” or connections that are shared between all devices connected to a processor/microcontroller. Their purpose is to transport data to or from various parts such as the CPU and memory. The amount of data that can be sent at once (i.e. each clock cycle) will be determined by how many connections there are. A data bus using more than one bit is described as sending data in parallel, where the width of the bus describes the amount of bits that can be sent during each cycle. In general an *n*-bit wide data bus can send value from 0 to (2^n)-1 each cycle. I believe the ATMega 2560 has an 8-bit data bus.

An address bus is similar to a data bus, and is a set of wires/connections between devices. However, it is different because its purpose is to send data in the form of addresses, which allows the access of specific locations in memory with the corresponding address. Depending on what needs to be done, the address bus will make sure the proper address is being accessed, and then the data and control buses can be used to exchange data with the address in memory.

A control bus is similar to the previous two buses, and is also a set of wires/connections between devices. Again it differs in its purpose, which is to communicate control signals such as read or write.

So, each bus can be described physically as a group of *n-*connections between devices, but they differ in the abstracted purpose of the signals sent across them. Together they allow memory access (address bus), exchange of data (data bus), and data flow control (control bus).

**Question 2: Why is a decoder needed in most peripheral device configurations?**

Decoders are needed in most peripheral device configurations because we often have a limited amount of lines/connections across a bus/interface that we can use to access/control peripheral devices. This is done by using an *n*-bit binary encoded number and boolean logic to associate each value from 0 to (2^n)-1 with a signal line. Thus, by using a decoder, we can use *n*-connections to interface with (2^n)-1 devices.

This is important because it helps maximize the amount of devices we can communicate with. If we didn’t use a decoder, and instead simply used a specific connection to each bit to interface with a device, we would only be able to control *n* devices given *n* connections, which is very wasteful. However, if the number of devices you need to communicate with is low, then it isn’t as important, but typically there are enough devices connected to justify the use of a decoder.