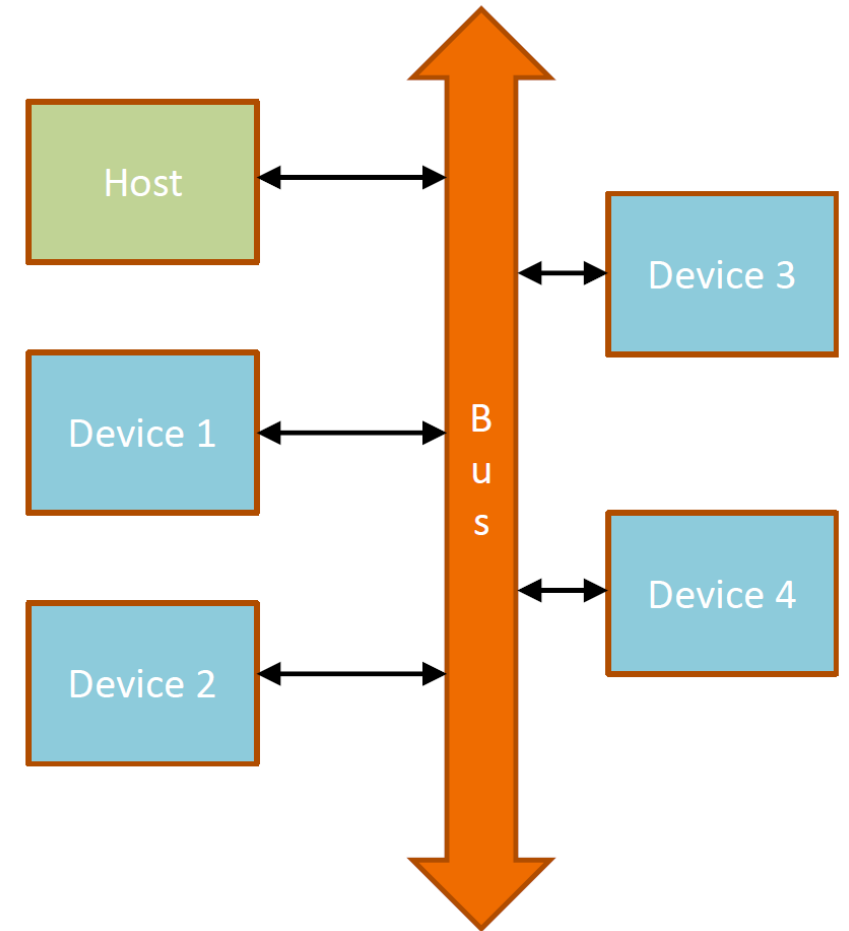


Hardware Interfacing and Actuators

Instructor: Deepak Gangadharan

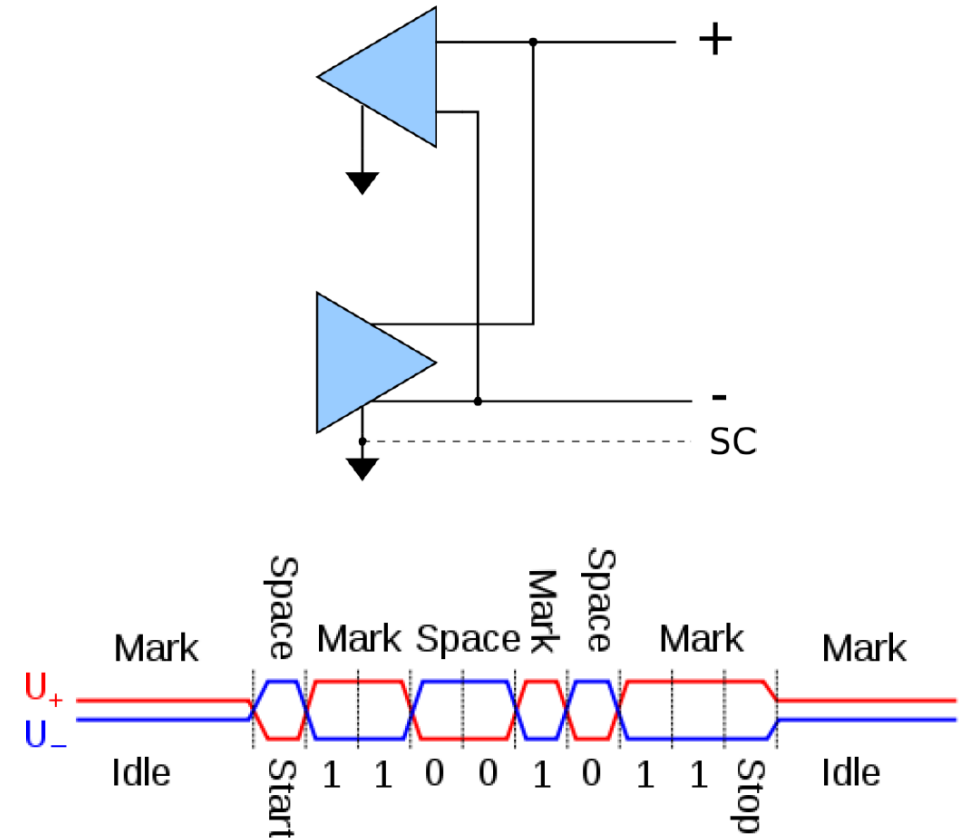
Bus Protocols

- Like SPI and I2C, there are many hardware serial protocols giving the option of using a “bus” to connect multiple peripheral devices to same two wires
- This allows reduced number of wires
- For very long distance serial communication (higher than 1 km), important to define electrical implementations that are low noise and resistant to signal dissipation
- For very long distance communication, multiple wires affect cost of wiring
- For industrial and building applications, bus protocols have been developed that use few wires to connect peripherals and masters



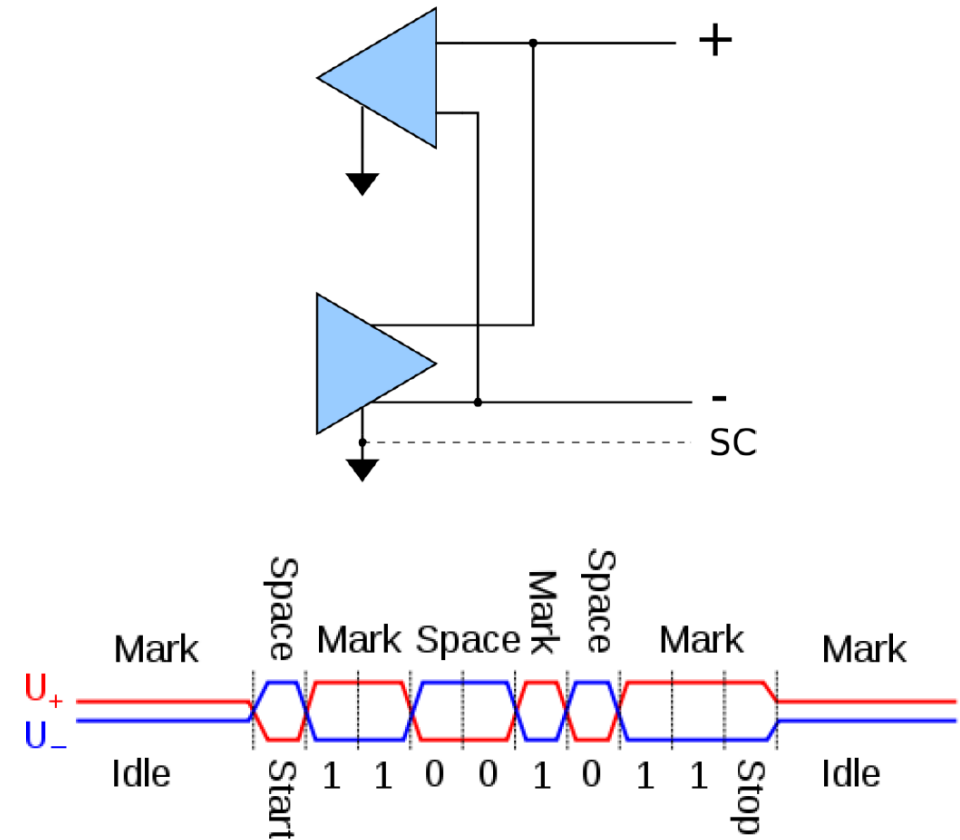
RS485

- RS485 uses 2 wires per line in a differential manner to increase signal fidelity
- Over long cabling distances where voltages tend to drop, signal errors often occur
- With two signals generated, the receiver looks at the difference between the two signals
- Differential scheme tolerates electromagnetic noise because the differential voltage remains the same even though the two signals increase by same amount because of some electrical noise
- This requires the cabling to be balanced, i.e., impedance of both wires is the same



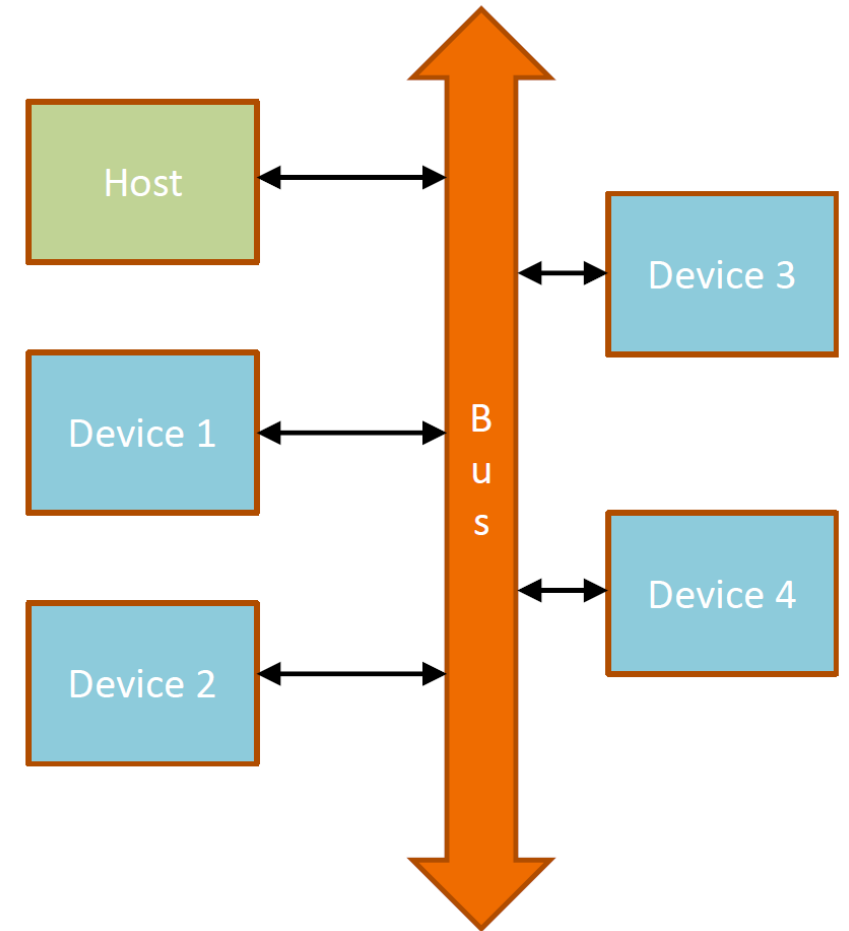
RS485

- RS485 differential line consists of 2 signals
 - A, which is low for logic 1 and high for logic 0
 - B, which is high for logic 1 and low for logic 0
- Mark – Logic 1 state
- Space – Logic 0 state
- Bus contention is handled by providing specific address to individual peripheral systems
- One master per bus



ModBus

- A common way of implementing the bus protocol, say using RS485 is the ModBus standard
- ModBus is a bus implementation standard that defines the exact addresses and commands a master can send over a bus
- Each device communicating on a ModBus is given a unique address
- ModBus commands can instruct a device to
 - change the value in one of its registers
 - read an I/O port
 - command the device to send back one or more values in its registers



Actuators

Actuators

- Devices that take signal in electrical form and transform it to something that can influence the physical world
- Can almost say that this is the end goal of all IoT devices, i.e., influencing or altering the physical world
- Can obtain actuation in many forms – movement, temperature (heating/cooling), light, sound, etc.

Making things move

- First kind of actuation is electromagnetic drives
- Most common actuation technique used to get mechanical motion from electrical energy
- Motion can then be converted to displacement, force, pressure
- Workhorse of the industrial society



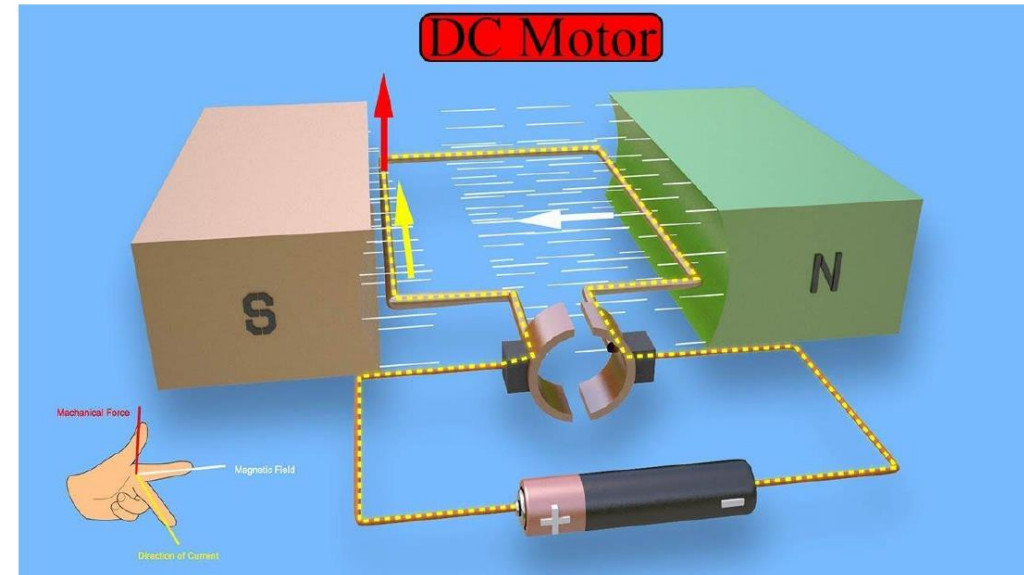
Making things move

- Basic principle is very simple – uses two fundamental laws of physics:
 - When a current is flown through a conductor, a magnetic field is produced
 - Two magnets experience a force that tries to align their magnetic field
- Magnetic fields are typically produced by a stator (fixed) and rotor (movable)
- The fields can be produced using a permanent magnet or electromagnets



DC Motor

- One of the simplest designs for electromagnetic drives
- Stator is a permanent magnet and rotor is a coil connected to the power supply
- When the current flows through the rotor coils, they become electromagnets and try to align with the stator field, causing rotation



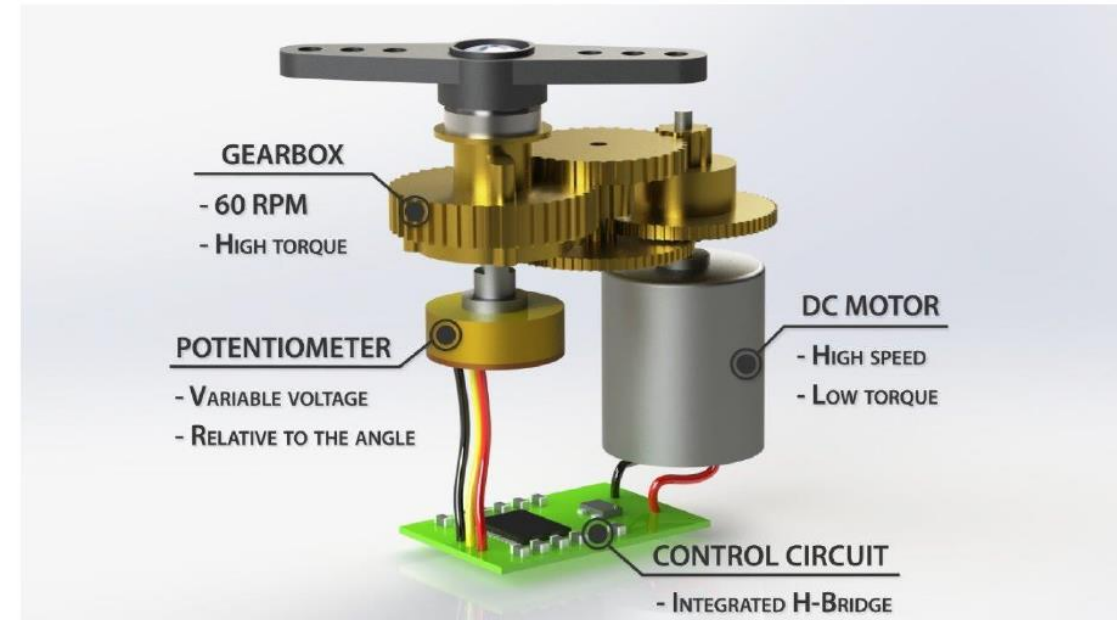
Stepper Motor

- Class of motors used to produce rotational motion in exact increments
- Typically has a permanent magnet rotor that aligns to the magnetic field of the stator coils
- When the next stator coil is energized, the rotor moves one step and locks in place
- This mechanism yields precise movement



Servo Motor

- Commonly used in robotics and industrial applications where a knowledge of the shaft position is required
- Uses a position sensor to control the motor (closed loop system)
- Control circuit provides feedback on the current position of the motor shaft → allows to rotate with great precision
- A gear assembly is used to obtain high torque



Other examples

- Solenoid valves
- Electrical relays

Questions?