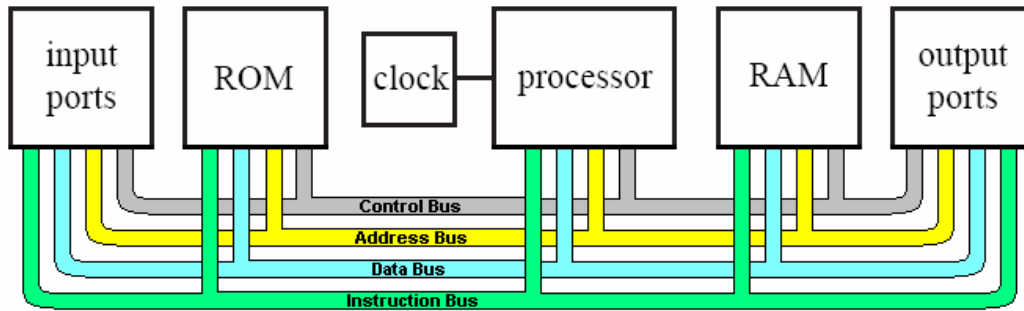


Revise PIC/AVR



Bits, Bytes and Nybbles

- A bit is the smallest digital data unit. It is a single 0 or 1.
- A byte is a collection of eight bits.
- A nybble is half a byte.
The low nybble is four least significant bits (0, 1, 2 and 3).
The high nybble is the four most significant bits (4, 5, 6 and 7).

Buses

- A bus is a collection of wires used to interconnect many devices.
- Buses are shared; this makes the internal connections inside a computer much simpler. The same bus can carry data to or from many devices.
- The **data bus** carries data to and from the processor. It is **bidirectional**.
- The **address bus** determines the source or destination of the data. It is **unidirectional**.
- The **control bus** determines whether the data is being **read** or **written**.
- READ – Data is moved into the processor.
- WRITE – Data is moved out of the processor.
- The **control bus** also determines where the data goes to or comes from. The data can be routed from or to memory (RAM or ROM). This is called memory mapping. External hardware is sometimes connected to memory locations reserved for this purpose. These reserved locations are not used for data storage. The data can be routed from or to the Input / Output (I/O) ports. This is called I/O mapping. External hardware is connected to I/O ports.
- The **control bus** also carries interrupt messages to the processor. Interrupt messages cause the processor to suspend what it is doing, process the interrupt and then resume the suspended task.
- The **Harvard instruction bus** allows instructions and data to be fetched at the same time. This makes the processor faster.
Von Neumann processors use the data bus to fetch instructions and two fetches are needed to fetch the instruction followed by the data.

RAM/ROM/FLASH

- ROM is read only memory. It can not be altered once written. It is non-volatile; it retains its data when the power has been turned off. ROM is used to store operating system and basic input/output instructions which never need to be changed.
- RAM is random access memory. It is used for temporary data storage. It is volatile; the data is lost if the power is turned off.
- FLASH is like ROM but it can be altered. FLASH memory retains its data when the power is turned off.

Clock

- This square wave oscillator provides timing pulses used to synchronise all the internal operations within a PIC / AVR.

Tristate Logic

- Many devices are connected to the buses.
- Only one device can put data onto a bus at a given time.
- All the other devices must be disconnected from the bus when the one device is writing data.
- Tristate logic has three states (Zero, One and Disconnected).
- Tristate logic has a CE or OE input (Chip Enable or Output Enable). This input determines if the tristate logic is active or disconnected.
- Address decoder circuits connected to the address bus detect unique addresses and enable the tristate devices connected to that address.
- A control bus wire determines if Memory or I/O is active using the same tristate logic method.

PIC / AVR

- Is a computer on a chip. **ALL** components are on a single silicon chip
- Components include Processor, ROM and/or RAM, Digital Input/Output and sometimes ADC input/s. The processor is also called the central processing unit (CPU) or the arithmetic and logic unit (ALU).
- Differs from a normal processor because it uses the **Harvard** architecture which speeds up the device with an additional **instruction bus**. Instructions and data can be fetched at the same time.
- Can be reprogrammed for a wide range of different control systems
- Low cost - Small physical size - Low power consumption - Very reliable (especially compared with mechanical controllers which have moving parts).
- Have had a huge effect on society because of the large number of PIC devices in every-day use.

PIC / AVR Bus Width – 2^N calculations

- The address bus width determines the number of available addresses.
- The data bus width determines the largest number that can be processed in one step.
- A typical address bus width is 8 wires.
 $2^8 = 256$. Addresses between 0 and 255 can be accessed.
That is 256 addresses.
- A 4 bit processor has four data bus wires.
 $2^4 = 16$. Numbers between 0 and 15 can be processed in a single step.
These processors are useful in devices that only display decimal numbers requiring the binary codes for the digits 0 to 9. Examples include very simple calculators, digital clocks, timers and thermometers.

Interrupts and Polling

- **Interrupts** are hardware signals to the processor.
The processor **suspends** what ever it is doing. It **processes** the interrupt code.
It **resumes** the suspended task. Writing code to handle interrupts is tricky because interrupts can be interrupted by other interrupts. This also makes interrupts somewhat unpredictable.
- **Polling** is when the processor **repeatedly tests** an input to see if some event has occurred. **Polling** is **less efficient** than interrupt processing but **more predictable**.
Polling takes place whether the input has changed or not. Writing code to pole an input is fairly straightforward.