- **Binary number system**

1. We count in base 10. 1,2,3…. numbers increment in decades. Probably number of fingers.
2. Computers count binary 1, 0 numbers increment in powers of 2 1, 2, 4, 8, 16 ect.
3. Formats in current use:

Decimal	Binary	Hexadecimal
0	00000000 00000000	0000
1	00000000 00000001	0001
2	00000000 00000010	0002
15	00000000 00001111	000F
16	00000000 00010000	0010
32	00000000 00100000	0020
68	00000000 01000100	0044
127	00000000 01111111	007F
128	00000000 10000000	0080
256	00000001 00000000	0100
4095	00001111 11111111	0FFF
4096	00010000 00000000	1000
65533	11111111 11111101	FFFD
65534	11111111 11111110	FFFE
65535	11111111 11111111	FFFF

Figure 1: Digital number systems

Numbers can represent characters (text) or measurements.

- Microprocessors

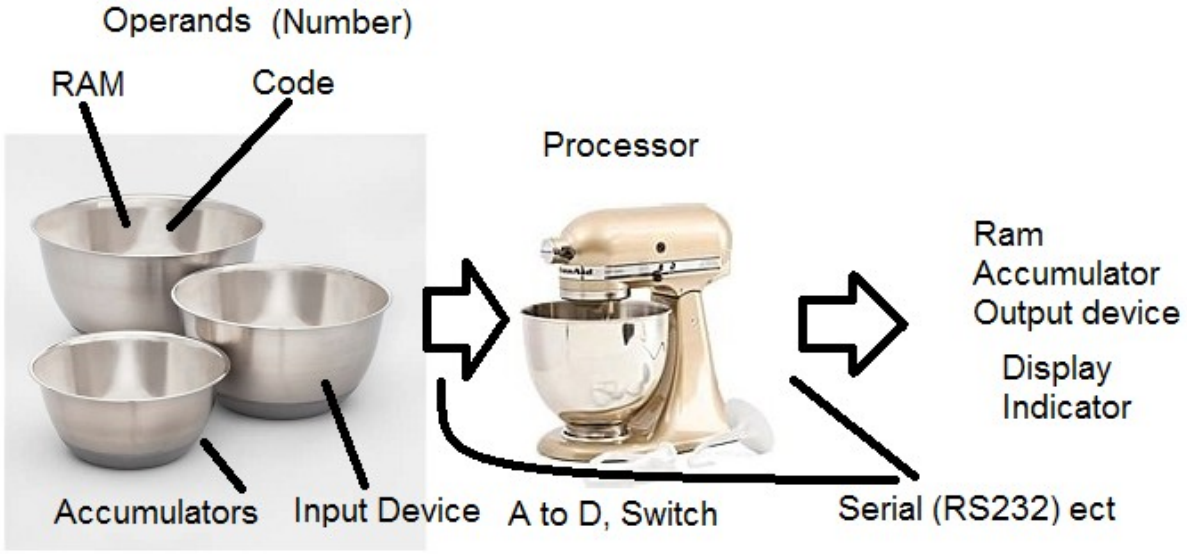


Figure 2: Processor (roughly speaking)

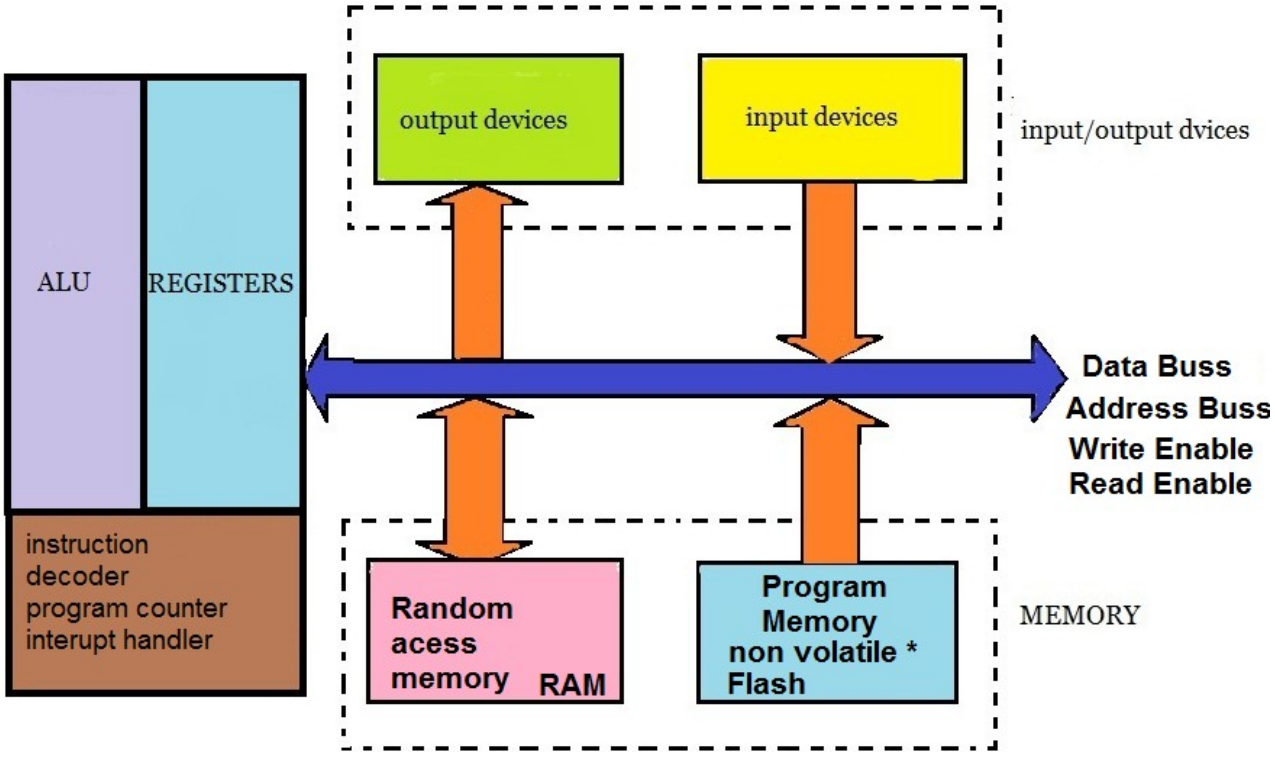


Figure 3: Microprocessor Block Diagram

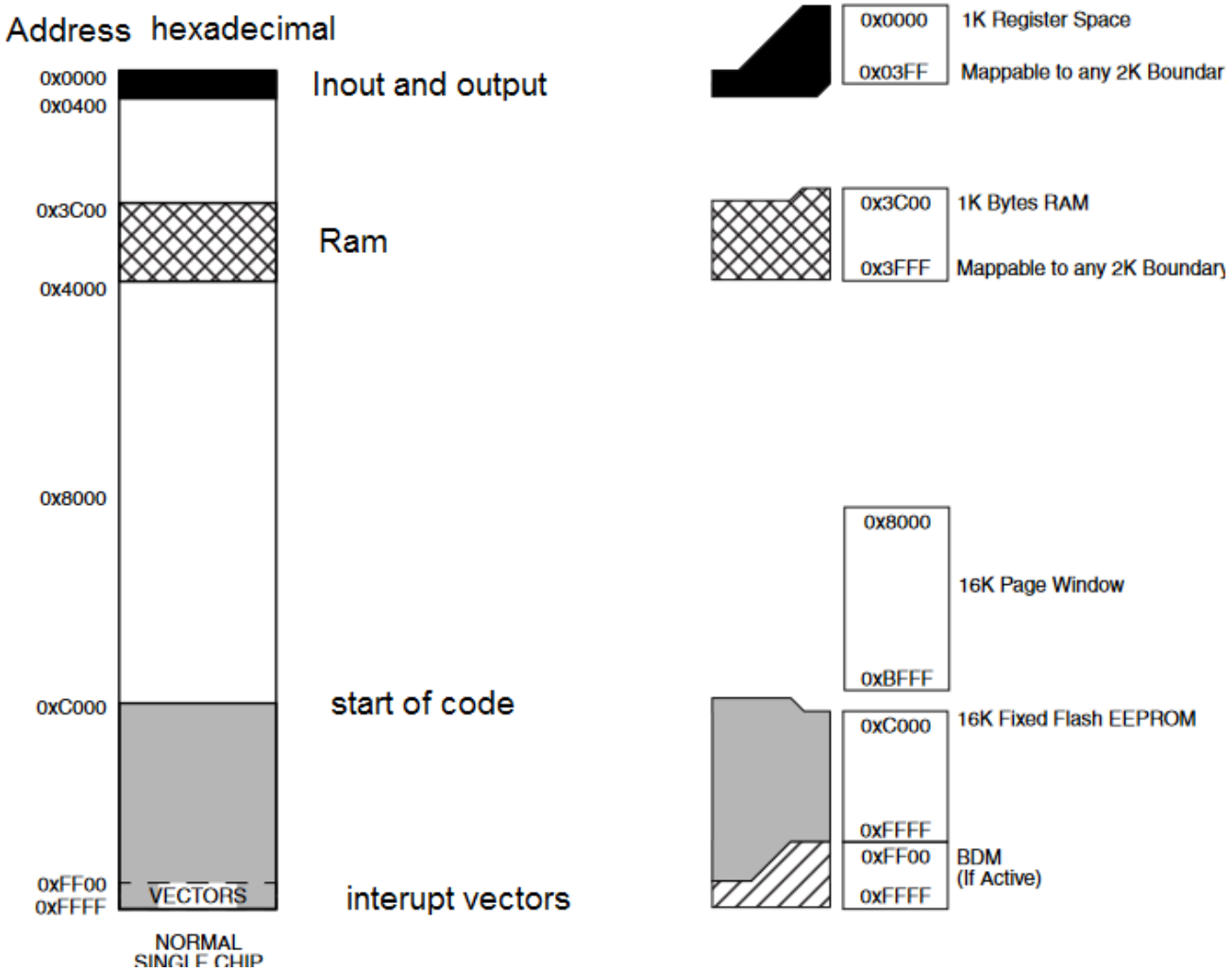
1. Performs a numeric operations under control of a program.
2. Operations to be executed are given by the PROGRAM COUNTER
3. Operations are done by the ARITHMETIC LOGIC UNIT
4. Memory is where the microprocessor stores information and the program resides.
5. Operands (numbers) to be calculated by the operation are in ACCUMULATORS internal to the microcontroller or in random access memory RAM or in program memory formally called ROM. Now is FLASH or EEPROM read only memory (ROM).
6. Operations available are contained in the INSTRUCTION SET
7. The pathway for information is The DATA BUSS
8.
9. The DATA BUSS is the connection to MEMORY and PERIPHERALS
10. Selection of the location in memory is done by the ADDRESS BUSS

- Microprocessor system connected to the microprocessor.

1. PROGRAM MEMORY is fixed and NON-VOLATILE (does not go away at power down)
2. RANDOM ACCESS MEMORY (RAM) where processor records temporary data.
3. PERIPHERALS allows the microprocessor to communicate, measure, and control.
4. RESET / UNDERVOLTAGE circuit.

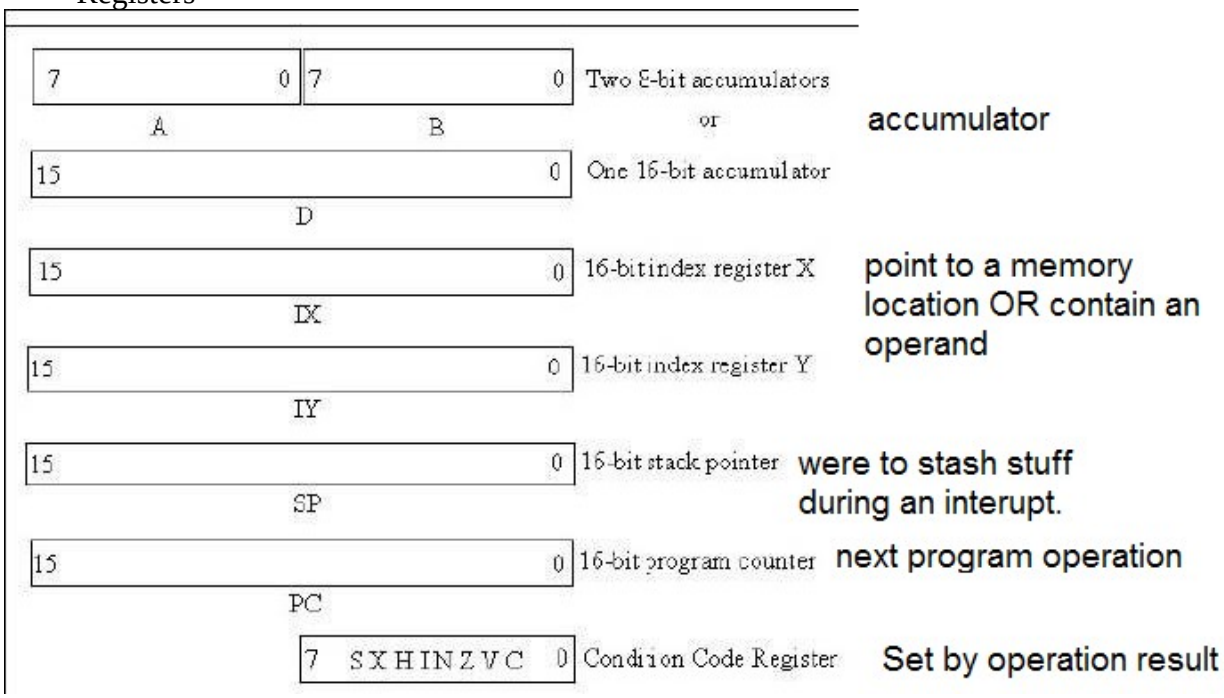
- MICRO CONTROLLER *All the above on one chip.*

- Memory Map



This is a processor with 16K of EEPROM (electrically eraseable programmable read only memory)
EEPROM FFFF – C000 = 65535 - 49152 = 16383 ~ 16K
RAM 4000 – C000 = 16384 – 15360 = 1024 ~ 1K
REGISTERS ……. literally 100s of locations to set up on chip peripherials (input – output devices)
As a demo one of the simpler registers will be set up in class and the rest ignored. All these have a default that gets set during reset and put the device in a safe state or off.

- Registers



Reference ManualS12CPUV228OverviewMOTOROLAOverviewThe status bits reflect the results of CPU operation as it executes instructions.
The five flags are:
Half carry (H)
Negative (N)
Zero (Z)
Overflow (V)
Carry/borrow (C)

Control bits
Clearing the S bit enables the STOP that puts the processer to sleep.
interrupt service requests made via the XIRQ pin are not recognized (X)
(X) and (I) bits are set automatically to prevent interrupts from being recognized.

- Operation

1. Power on RESET sets the program counter to the beginning of the program and execution of the program starts.
2. When execution of the an instruction is completed the program counter is set to the beginning of the next instruction it is executed.
3. Branching change in program flow depending on a value see below.
4. Example of assembly code:

```
START     ORG     $C000      *program starts at beginning of Flash memory
          LDX     #$3800     *set X index register to beginning of RAM
RCRLOOP   CLR     0,X      *clear (set to 00) memory location give by X
          INX                    *increment X
          CPX     #$3FEF     *compare to end of RAM address
          BNE   #RCRLOOP          *if not at end of RAM go back to RCRLOOP
```

- Interrupts.
    1. Drop what you are doing and do another task
    2. Can be generated by an internal function or external pin.
    3. When this happenes all the registers are stored at a location given by the STACK POINTER. This permits the operation to continue when the interrupt software has completed running.
    4. Some interrupts are maskable meaning it is going to be ignored.
    5. Example: A button has been pushed on the front panel and needs to be read. The code tells the processor to read the pin and completes the task that the button is supposed to do.

- Tools
    1. Assembler: software that converts the assembly source code into a binary file to load into the program memory of the processor.
    2. Monitor; code that is installed on the processor to facilitate loading program memory.
    3. In circuit emulator (ICE); software that interfaces the Monitor Code to the computer that is being used for code development.