Experiment No 6
(Familiarization and Programming of PIC16F877A Microcontroller)

What is a Microcontroller?

A Microcontroller is a programmable digital processor with necessary peripherals. Both microcontrollers and microprocessors are complex sequential digital circuits meant to carry out job according to the program / instructions. Sometimes analog input/output interface makes a part of microcontroller circuit of mixed mode(both analog and digital nature).

A microcontroller can be compared to a Swiss knife with multiple functions incorporated in the same IC.

Interfacing requirement is reduced in a Microcontroller.

8085 - Microprocessor
Does not have inbuilt memory or peripherals.

PIC16F877A - Microcontroller
Inbuilt memory and peripherals

A Microcontroller compared with a Swiss knife

Microprocessor vs Microcontroller

- A microprocessor requires an **external memory** for program/data storage. Instruction execution requires movement of data from the external memory to the microprocessor or vice versa. Usually, microprocessors have good computing power and they have higher clock speed to facilitate faster computation.
- A microcontroller has required **on-chip memory** with associated peripherals. A microcontroller can be thought of a microprocessor with inbuilt peripherals.
- A microcontroller does not require much additional interfacing ICs for operation and it functions as a stand alone system. The operation of a microcontroller is multipurpose, just like a Swiss knife.
- Microcontrollers are also called embedded controllers. A microcontroller clock speed is limited only to a few tens of MHz. Microcontrollers are numerous and many of them are application specific.

Laptop
i5 processor
↓
Microprocessor.
↓
Mainly for intensive computation
Digital circuit

→ Mixed signal circuit due to the presence of peripherals such as DACs, ADCs

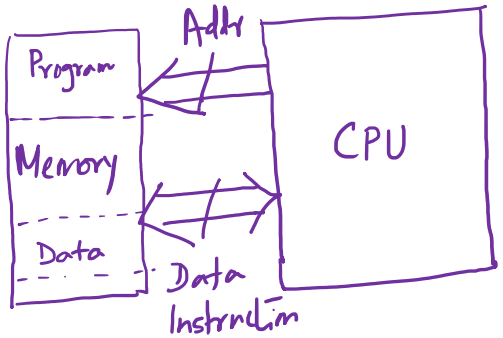
Washing machine
Airconditioner
etc.

Princeton vs Harvard Architecture

Project by US Navy in 1940's

Princeton Univ ✓

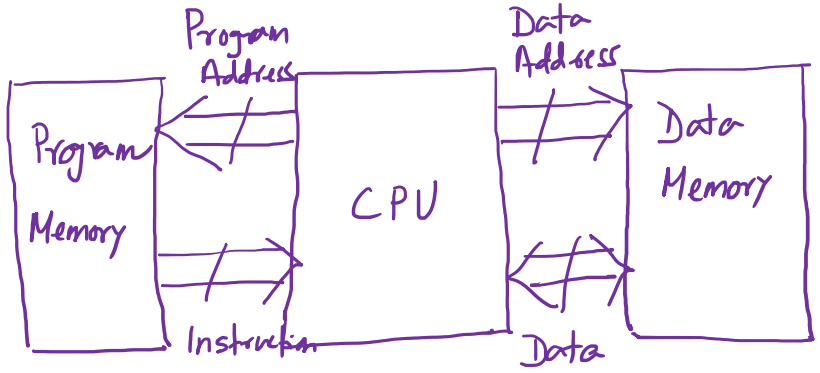
Princeton Architecture
(Von Neumann Architecture)



Vacuum tubes

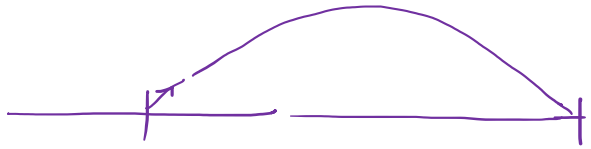
Harvard Univ ×

Harvard Architecture

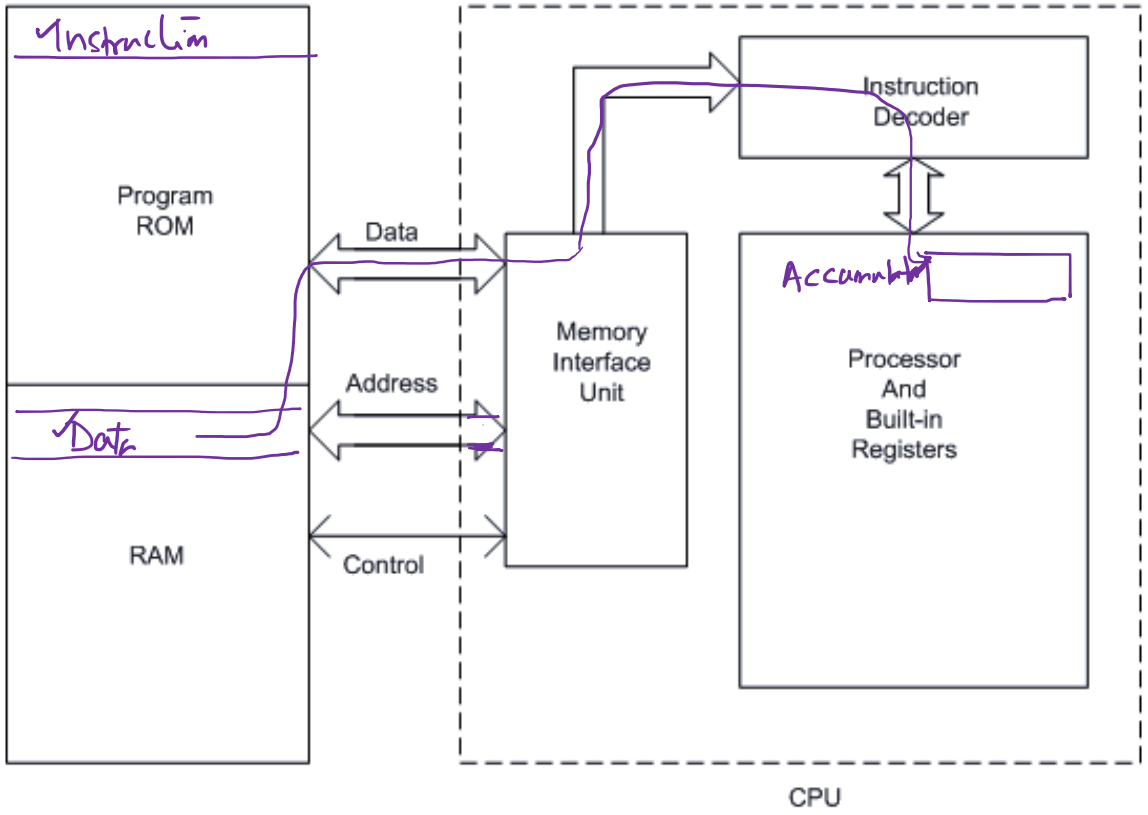


Inherent parallelism

1970's LSI, VLSI



Princeton Architecture

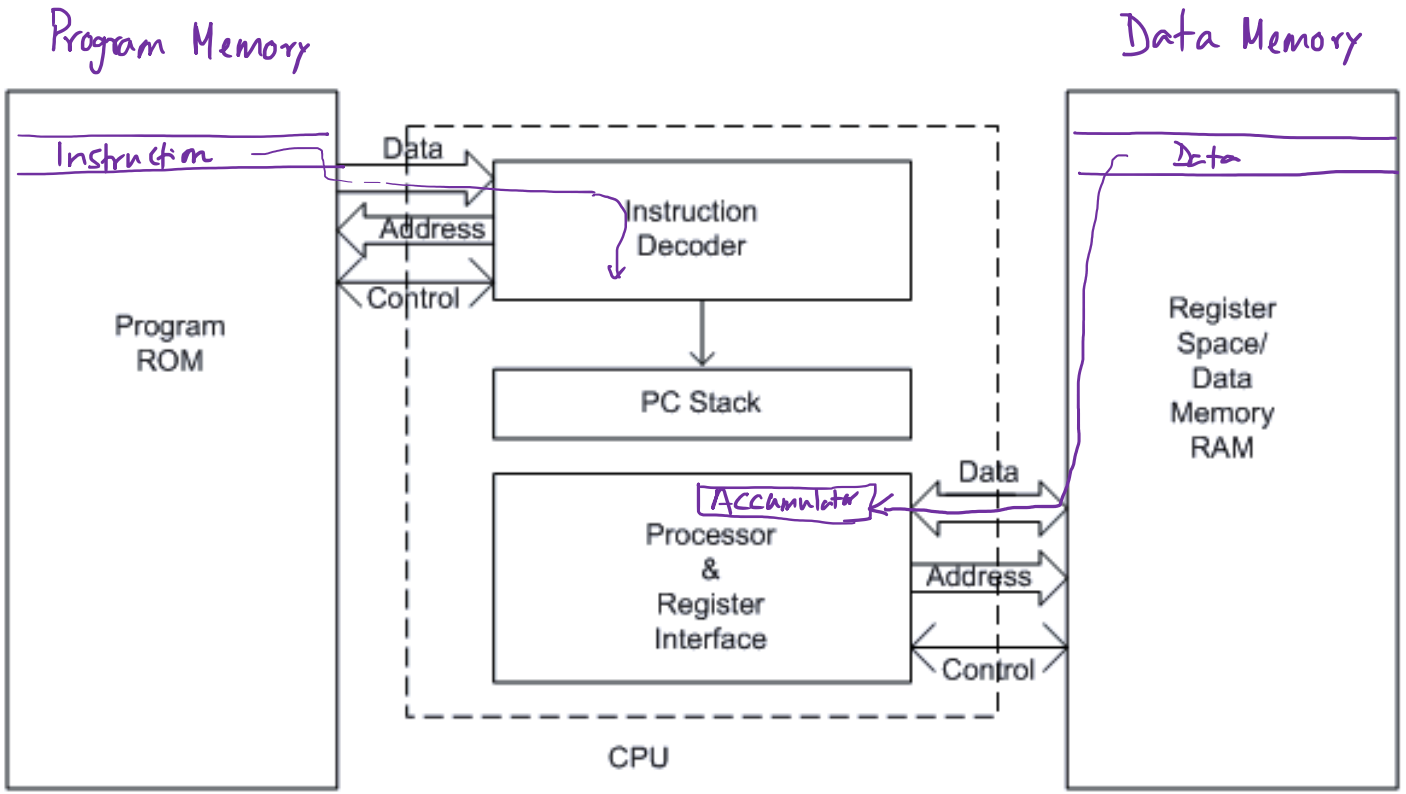


An instruction is executed in two instruction cycles

Example : An instruction “Read a data byte from memory and store it in the accumulator” is executed as follows: -

Cycle 1 – Read Instruction
Cycle 2 – Read Data out of RAM and put into Accumulator

Harvard Architecture



Instr 1
Instr 2
Instr 3
Instr 4
jump/ goto → Instruction i

Cycle 1 Execute the
- Complete previous instruction
- Read the "Move Data to Accumulator" instruction

Cycle 2
- Execute "Move Data to Accumulator" instruction ✓
- Read next instruction ✓

Effectively an instruction is executed in one instruction cycle — except for 'jump' or 'goto' type instruction

Architecture of PIC Microcontroller

PIC = Peripheral Interface Controller ← Microchip

PIC 16F877A (Flash)

Mid Range Architecture

8-bit Microcontroller

Hex

0000H

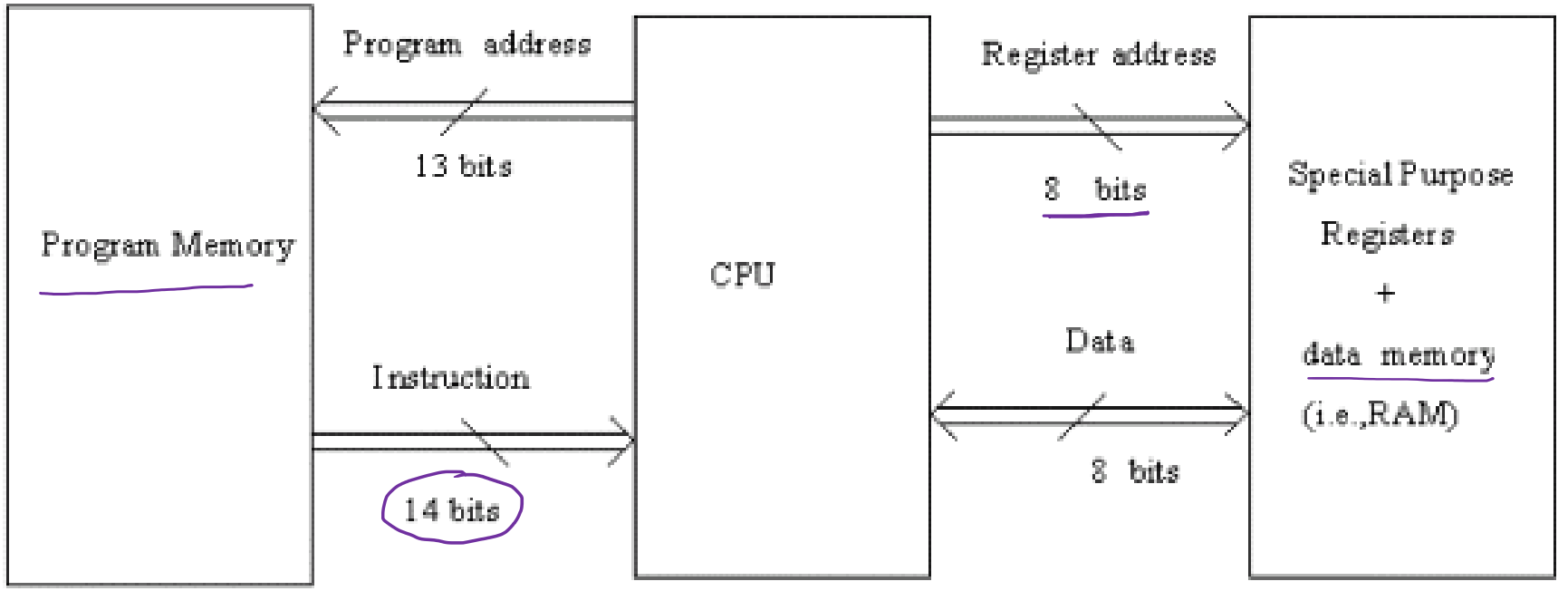
2^{13} Location

$2^{13} \times 14$ bits

$2^3 \times 2^{10} \times 14$ bits

8k x 14 bits

1FFFH



00H

2^8 x 8 bits

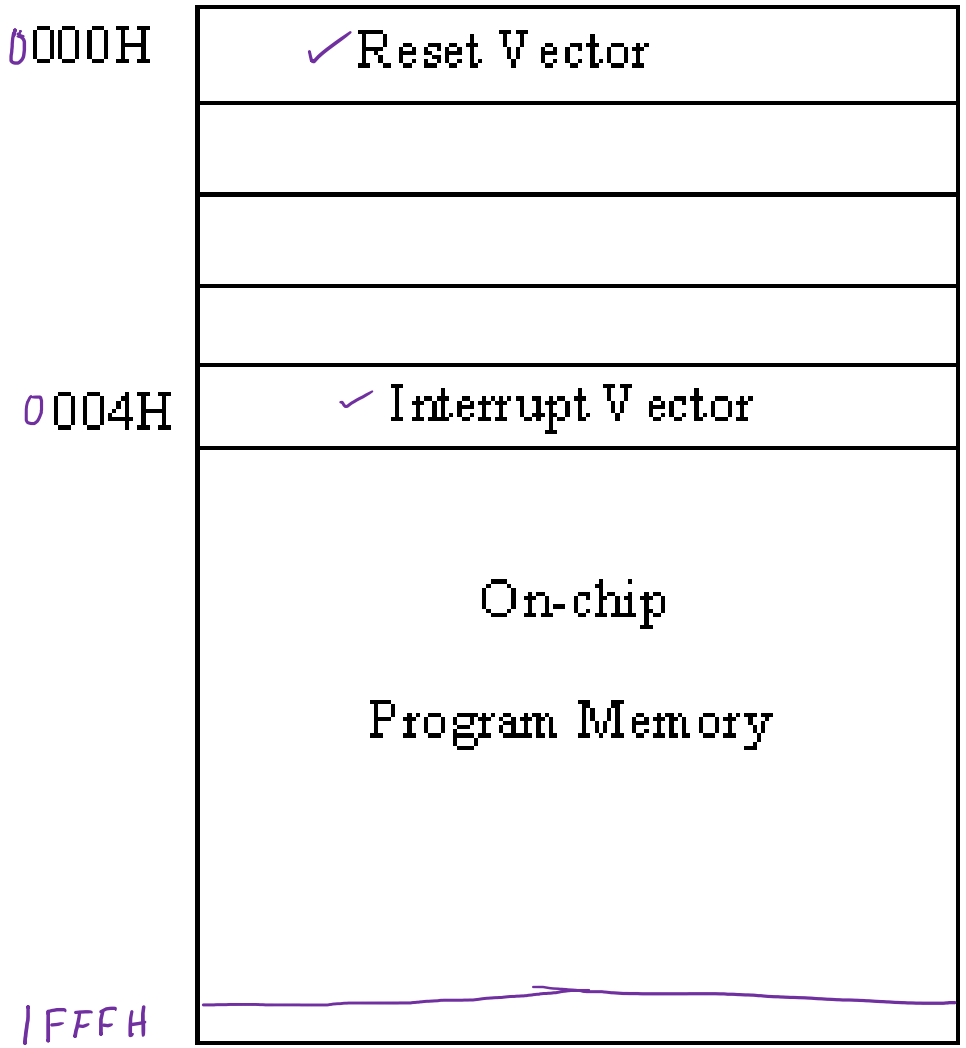
256 bytes

FFH

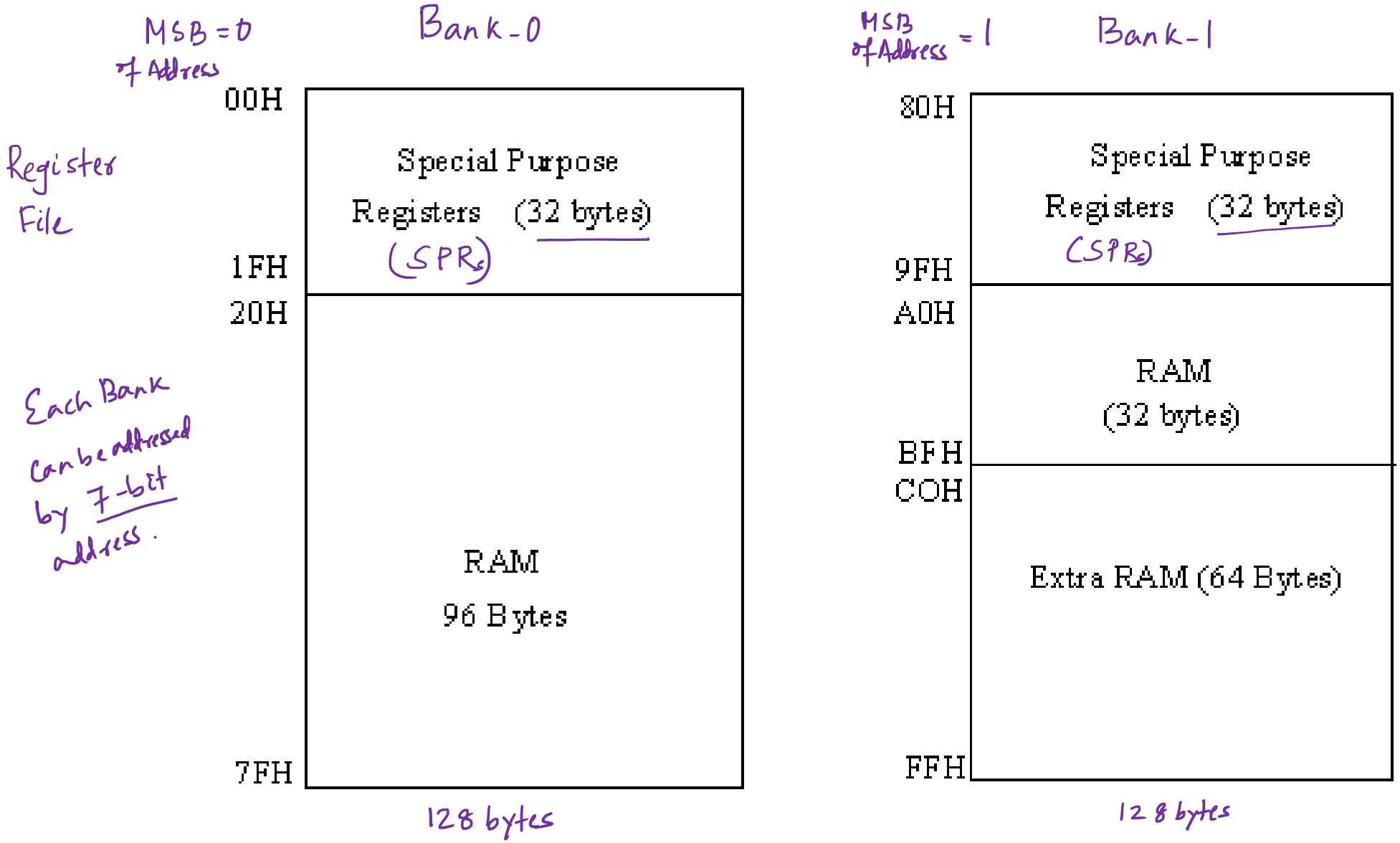
Each Instruction size = 14 bits

Program Memory Map

PIC16F877A
↑
Flash



Data Memory Map



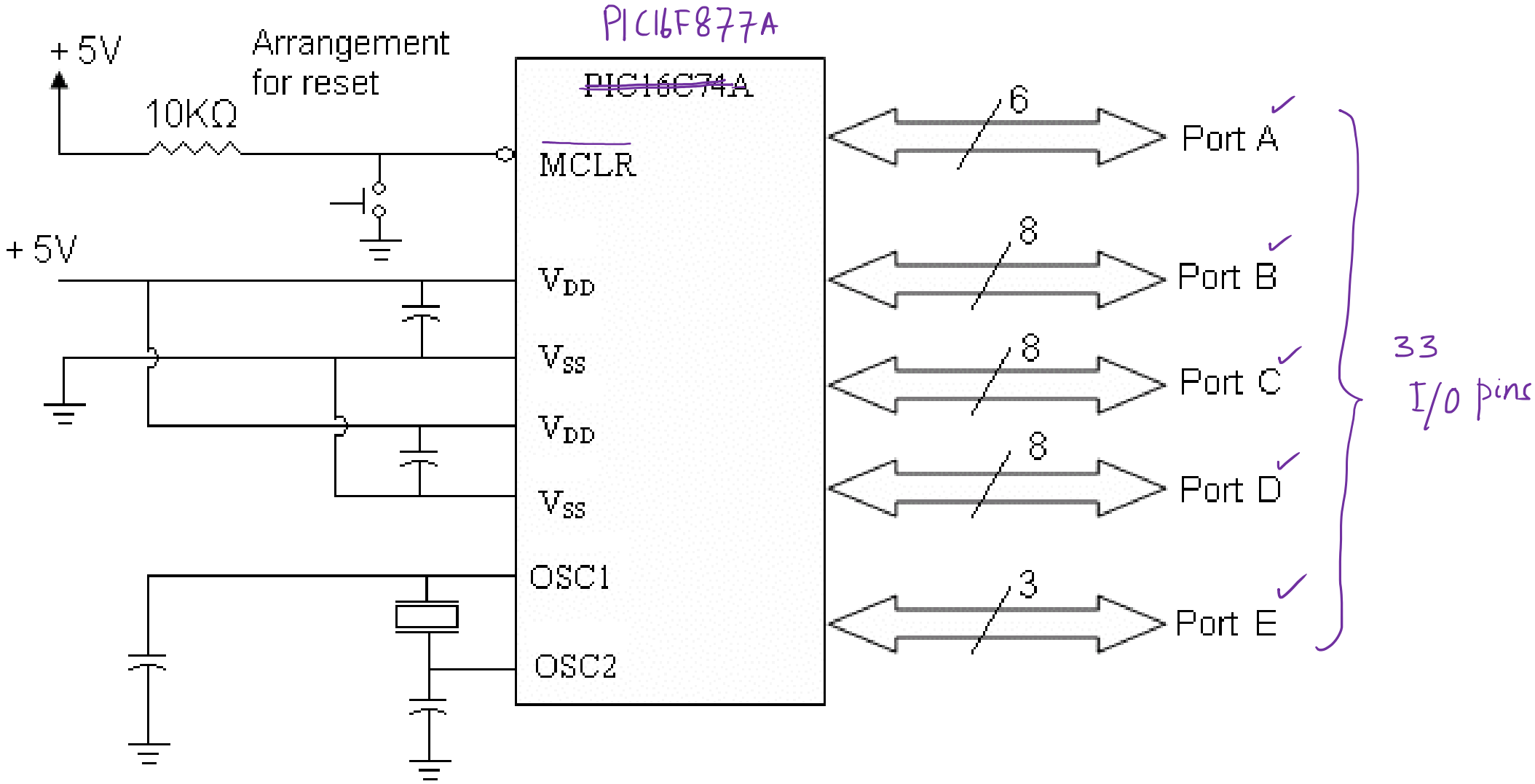
Specifications of PIC16F877A

40 pin DIP IC

- Program Memory: 8 k (14 bit) flash
- Data Memory: 368 (RAM), 256 EPROM
- I/O Pins: 33
- ADC: 10 bits x 8 Channels
- Times 8/16 bits: 2/1
- CCP (PWM): 2
- USART/ SPI/I2C
- Interrupt Sources: 15
- Instruction Set: 35

RISC

Pin Configuration of PIC16F877A



Functions of Various Port Pins

Port	Altenative uses of I/O pins	No.of I/O pins
Port A	A/D Converter inputs	6
Port B	External interrupt inputs	8
Port C	Serial port, Timer I/O	8
Port D	Parallel slave port	8
Port E	A/D Converter inputs	3
	Total I/O pins	33
	Total pins	40