Chapter 1

THE PIC MICROCONTROLLERS: HISTORY AND FEATURES

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**Microprocessor vs. Microcontroller:**
- Microprocessor is general-purpose microprocessors such as Intel's x86 family.
- Microprocessor does not contain RAM, ROM or I/O Ports on the chip itself. Adding them make it bulkier and much more expensive.
- Microcontroller has CPU and fixed amount of RAM, ROM, I/O Ports and Timer all on a single chip.

![General-Purpose Microprocessor System](image1)

![Microcontroller](image2)

**Embedded systems**
- Microprocessor and Microcontroller are widely used in embedded system products.
- Embedded system means that the application and processor are combined into a single system.
- It is also called a dedicated system because it is dedicated to doing one type of job.
- In an embedded system, typically only one application software is burned into ROM. (e.x. Printer).
- One of the most critical needs of an embedded system is to decrease power consumption and space.

**µControllers**
There are five major 8-bit microcontrollers:
- Freescale Semiconductor's (formerly Motorola) 68HC08/68HC11
- Intel's 8051
- Atmel's AVR
- Zilog's Z8
- PIC from Microchip Technology.
Each of the above microcontrollers has a unique instruction set and register set; therefore, they are not compatible with each other. Programs written for one will not run on the others. There are 16-bit and 32-bit microcontrollers.
Criteria for choosing µController

1. Meeting the computing needs of the task at hand efficiently and cost effectively:
   a) Determine its type, 8-bit, 16-bit or 32-bit
   b) Speed
   c) Packaging (40-Pin or QFP)
   d) Power consumption
   e) The amount of RAM and ROM
   f) The number of I/O pins and the timer
   g) Cost per unit
   h) Ease of upgrade.

2. Availability of SW and HW development tools:
   - Compilers
   - Assemblers
   - Debuggers
   - Emulators

3. Wide availability and reliable source:
   Having multiple sources for a given part means you are not hostage to one supplier.
   More importantly, competition among suppliers brings about lower cost for that product.

Overview of the PIC18 Family

An 8-bit µController called PIC is introduced in 1989 by Microchip Technology Corporation.
PIC: Peripheral Interface Controller.
The PIC18 is an 8-bit microprocessor.
It includes:
   - Small Data RAM
   - Few bytes of ROM
   - One timer
   - I/O ports

PIC18 features

- RISC Architecture
- On-chip program, Code, ROM
- Data RAM
- Data EEPROM
- Timers
- ADC
- USART
- I/O Ports
**PIC µC program ROM**
- ROM is used to store programs and for that reason it is called program or code ROM.
- PIC 18 can support up to 2MB.
- Generally, they come with 4KB – 128KB.
- Available in flash, OTP, UV-EPROM, and masked.

**UV-EPROM**
- The window on the UV-EPROM chip allows the UV light to erase the ROM.
- The problem with the UV-EPROM is that it takes around 20 minutes to erase the chip before it can be programmed again.

**PIC18Fxxx with flash**
- The letter F indicates that the ROM is flash.
- It is ideal for fast development because flash memory can be erased in seconds.

**PIC18Cxxxx with OTP**
- One time programmable
- C indicates the OTP ROM
- Used for mass production
- Cheaper
Masked
Program will be burned into the PIC chip during the fabrication process.

Data RAM
- Max. 4096 Bytes (4 kB) of data RAM space.
- The data RAM size varies from 256 bytes to 4096 bytes.
- Data RAM space has two components
  - Varied GPR, General Purpose RAM
    - For read/write and data manipulation
    - Divided into banks of 256 B
  - Fixed SFR, Special Function Registers

Data EEPROM
Some of PICs have a small amount of EEPROM used for critical data storing.

I/O pins
- The number of pins for the PIC18 package goes from 18 to 80.
- The PIC 18 can have from 16 to 72 pins dedicated for I/O.

PIC µC peripherals
- Timers
- CAN- (Controller Area Network)
- LIN- (Local Interconnect Network)
- USB- (Universal Serial Bus)
- I²C- (Inter-Integrated Circuit)
- SPI- (Serial Peripheral Interface)
- Serial or Ethernet Interface
- ADC – (Analog Digital Converter)
- USART- (Universal Synchronous Asynchronous Receiver Transmitter)
PROBLEMS

1. True or False. A general-purpose microprocessor has on-chip ROM.
2. True or False. Generally, a microcontroller has on-chip ROM.
3. True or False. A microcontroller has on-chip I/O ports.
4. True or False. A microcontroller has a fixed amount of RAM on the chip.
5. What components are usually put together with the microcontroller onto a single chip? CPU, RAM, ROM, EEPROM, I/O, Timer, Serial COM port, ADC.
6. Intel’s Pentium chips used in Windows PCs need external and chips to store data and code. RAM and ROM.
7. List three embedded products attached to a PC.
   Keyboard, mouse, printer.
8. Why would someone want to use an x86 as an embedded processor? Computing power and compatibility with millions and millions of PCs.
9. Give the name and the manufacturer of some of the most widely used 8-bit microcontrollers. PIC 16x – Microchip Technology, 8051 – Intel, AVR – Atmel, Z8 – Zilog, 68HC11 – Freescale Semiconductor (Motorola).
10. In Question 9, which one has the most manufacture sources? 8051.
11. In a battery-based embedded product, what is the most important factor in choosing a microcontroller? Power consumption.
12. In an embedded controller with on-chip ROM, why does the size of the ROM matter? The ROM area is where the executable code is stored.
13. In choosing a microcontroller, how important is it to have multiple sources for that chip? Very, in case there is a hostage by one supplier.
14. What does the term "third-party support" mean? Suppliers other than the manufacturer of the chip.
15. Suppose that a microcontroller architecture has both 8-bit and 16-bit versions. Which of the following statements is true? (a) The 8-bit software will run on the 16-bit system. (b) The 16-bit software will run on the 8-bit system.
20. Check the Microchip web site to see if we have a ROMless version of the PIC 18. Give the part number if there is one. PIC18C601, PIC18C801.
28. Of the PIC18 family, which memory type is the most cost effective if you are using a million of them in an embedded product? OTP and masked.

😊 Best Wishes 😊