Introduction to 8051 microcontroller
Necessary parts of any Microprocessor/controller

- CPU: Central Processing Unit
- I/O: Input /Output
- Bus: Address bus , Data bus , Control bus
- Memory: RAM & ROM
- Timer
- Interrupt
- Serial Port
- Parallel Port
A Block Diagram of a Microprocessor

- Arithmetic and Logic Unit
- Accumulator
- Working Register(s)
- Program Counter
- Stack Pointer
- Clock Circuit
- Interrupt Circuits
Microprocessor

• General-purpose digital computer Central Processing Unit
• CPU for Computers
• No RAM, ROM, I/O on CPU chip itself
• Example: Intel’s x86, Motorola’s 680x0
## Microcontroller

- A smaller computer
- On-chip RAM, ROM, I/O ports...
- Example: Motorola’s 6811, Intel’s 8051, Zilog’s Z8 and PIC 16X

<table>
<thead>
<tr>
<th>I/O Port</th>
<th>Timer</th>
<th>Serial COM Port</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

A single chip

Microcontroller
A Block Diagram of a Microcontroller

- ALU
- Accumulator
- Register(s)
- Internal RAM
- Stack Pointer
- Internal ROM
- Timer/Counter
- I/O Port
- I/O Port
- Interrupt Circuits
- Clock Circuit
- Program Counter
The fundamental differences between microprocessors and microcontrollers are:

- Microprocessors are intended to be general-purpose digital computers while microcontrollers are intended to be special-purpose digital controllers.

- Microprocessors contain a CPU, memory addressing circuits, and interrupt handling circuits. Microcontrollers have these features as well as timers, parallel and serial I/O, and internal RAM and ROM.

- Microcontroller models vary in data size from 4 to 32 bits. Four-bit units are produced in huge volumes for very simple applications, and 8-bit units are the most versatile. Sixteen- and 32-bit units are used in high-speed control and signal processing applications.

- Many models feature programmable pins that allow external memory to be added with the loss of I/O capability.
**Microprocessor Vs. Microcontroller**

1. Most microprocessors have many operational codes (opcodes) for moving external memory to the CPU.
2. µp have one or two type of bit handling instruction
3. µp concerned with rapid movement of code and data from external address to chip
4. µp needs many additional parts to become operational

1. Micro controllers have one or two.
2. µc have many
3. µc concerned with rapid movement of bits within the chip
4. µc can function as computer with no additional parts
**On the hardware point of view…..**

<table>
<thead>
<tr>
<th>Microprocessor</th>
<th>Microcontroller</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CPU is stand-alone</td>
<td>• CPU, RAM, ROM, I/O and timer are all on a single chip</td>
</tr>
<tr>
<td>• RAM, ROM, I/O, timer are separate so designer can decide on the amount of ROM, RAM and I/O ports</td>
<td>• Fix amount of on-chip ROM, RAM, I/O ports</td>
</tr>
<tr>
<td></td>
<td>• For applications in which cost, power and space are critical</td>
</tr>
<tr>
<td>• Expansive</td>
<td>• Specific - purpose</td>
</tr>
<tr>
<td>• Versatility</td>
<td></td>
</tr>
<tr>
<td>• General-purpose</td>
<td></td>
</tr>
</tbody>
</table>
The comparison of Z80 µp and 8051 µc

<table>
<thead>
<tr>
<th>Pin Configurations</th>
<th>Z80</th>
<th>8051</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total pins</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Address pins</td>
<td>16 (fixed)</td>
<td>16</td>
</tr>
<tr>
<td>Data pins</td>
<td>8 (fixed)</td>
<td>8</td>
</tr>
<tr>
<td>Interrupt pins</td>
<td>2 (fixed)</td>
<td>2</td>
</tr>
<tr>
<td>I/O pins</td>
<td>0</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Architecture</th>
<th>Z80</th>
<th>8051</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-bit registers</td>
<td>20</td>
<td>34</td>
</tr>
<tr>
<td>16-bit registers</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Stack size</td>
<td>64K</td>
<td>128</td>
</tr>
<tr>
<td>Internal ROM</td>
<td>0</td>
<td>4K bytes</td>
</tr>
<tr>
<td>Internal RAM</td>
<td>0</td>
<td>128 bytes</td>
</tr>
<tr>
<td>External memory</td>
<td>64K</td>
<td>128K bytes</td>
</tr>
<tr>
<td>Flags</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Timers</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Parallel port</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Serial port</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
## Micro controller Survey

### Four-Bit Micro controllers

<table>
<thead>
<tr>
<th>Manufacturer : Model</th>
<th>Pins : I/O</th>
<th>Counters</th>
<th>RAM (bytes)</th>
<th>ROM (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi : HMCS40</td>
<td>28 : 10</td>
<td>—</td>
<td>32</td>
<td>512</td>
</tr>
<tr>
<td>National : COP420</td>
<td>28 : 23</td>
<td>1</td>
<td>64</td>
<td>1K</td>
</tr>
<tr>
<td>OKI : MSM6411</td>
<td>16 : 11</td>
<td>—</td>
<td>32</td>
<td>1K</td>
</tr>
<tr>
<td>TI : TMS 1000</td>
<td>28 : 23</td>
<td>—</td>
<td>64</td>
<td>1K</td>
</tr>
<tr>
<td>Toshiba : TLCS47</td>
<td>42 : 35</td>
<td>2</td>
<td>128</td>
<td>2K</td>
</tr>
</tbody>
</table>
### Eight-Bit Micro controllers

<table>
<thead>
<tr>
<th>Manufacturer : Model</th>
<th>Pins : I/O</th>
<th>Counters</th>
<th>RAM (bytes)</th>
<th>ROM (bytes)</th>
<th>Other Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel : 8048</td>
<td>40 : 27</td>
<td>1</td>
<td>64</td>
<td>1K</td>
<td>External memory to 8K</td>
</tr>
<tr>
<td>Intel : 8051</td>
<td>40 : 32</td>
<td>2</td>
<td>128</td>
<td>4K</td>
<td>External memory to 128K; serial port</td>
</tr>
<tr>
<td>National : COP820</td>
<td>28 : 24</td>
<td>1</td>
<td>64</td>
<td>1K</td>
<td>Serial bit I/O</td>
</tr>
<tr>
<td>Motorola : 6805</td>
<td>28 : 20</td>
<td>1</td>
<td>64</td>
<td>1K</td>
<td>Serial ports: A/D; watch dog timer (WDT)</td>
</tr>
<tr>
<td>Motorola : 68HC11</td>
<td>52 : 40</td>
<td>2</td>
<td>256</td>
<td>8K</td>
<td></td>
</tr>
<tr>
<td>Rockwell : 6500/1</td>
<td>40 : 32</td>
<td>1</td>
<td>64</td>
<td>2K</td>
<td></td>
</tr>
<tr>
<td>Signetics : 87C552</td>
<td>68 : 48</td>
<td>3</td>
<td>256</td>
<td>8K</td>
<td>Serial port; A/D; WDT</td>
</tr>
<tr>
<td>TI : TMS7500</td>
<td>40 : 32</td>
<td>1</td>
<td>128</td>
<td>2K</td>
<td>External memory to 64K</td>
</tr>
<tr>
<td>TI : TMS370C050</td>
<td>68 : 55</td>
<td>2</td>
<td>256</td>
<td>4K</td>
<td>External memory to 112K; A/D; serial ports; WDT</td>
</tr>
<tr>
<td>Zilog : Z8</td>
<td>40 : 32</td>
<td>2</td>
<td>128</td>
<td>2K</td>
<td>External memory to 124K; serial port</td>
</tr>
<tr>
<td>Zilog : Z8820</td>
<td>44 : 40</td>
<td>2</td>
<td>272</td>
<td>8K</td>
<td>External memory to 128K; serial port</td>
</tr>
</tbody>
</table>
Common Microcontrollers

- Atmel
- ARM
- Intel
  - 8-bit
    - 8XC42
    - MCS48
    - MCS51
    - 8xC251
  - 16-bit
    - MCS96
    - MXS296
- National Semiconductor
  - COP8
- Microchip
  - 12-bit instruction PIC
  - 14-bit instruction PIC
    - PIC16F84
  - 16-bit instruction PIC
- Motorola
  - 8-bit
    - 68HC05
    - 68HC08
    - 68HC11
  - 16-bit
    - 68HC12
    - 68HC16
  - 32-bit
    - 683xx
- Texas Instruments
  - TMS370
  - MSP430
- Zilog
  - Z8
  - Z86E02
Why we study Microprocessor / Microcontroller

• The microprocessor is the core of computer systems.
• The microcontroller is the core of embedded systems.
• Nowadays many communication, digital entertainment, portable devices, are controlled by them.
• A designer should know what types of components he needs, ways to reduce production costs and product reliable.
• To increase efficiency of already deployed devices
• Understand computer hardware as a system programmer
• Introduce you to the use of a processor in control systems
Three criteria in Choosing a Microcontroller

1. meeting the computing needs of the task efficiently and cost effectively
   • speed, the amount of ROM and RAM, the number of I/O ports and timers, size, packaging, power consumption
   • easy to upgrade
   • cost per unit
2. availability of software development tools
   • assemblers, debuggers, C compilers, emulator, simulator, technical support
3. wide availability and reliable sources of the microcontrollers.
Embedded System

- Embedded system means the processor is embedded into that application.
- An embedded product uses a microprocessor or microcontroller to do one task only.
- In an embedded system, there is only one application software that is typically burned into ROM.
- Special purpose computer system usually completely inside the device it controls
- Has specific requirements and performs pre-defined tasks
- Cost reduction compared to general purpose processor
- Example: printer, keyboard, video game player
Introduction

• MCS-51 family, originally designed by Intel in the early 1980’s

• Used in a large percentage of embedded systems

• Today over fifty companies produce variations of the 8051.

• The most popular microcontroller – about 40% of market share

• 8-bit microcontroller
Microcontroller Architectures

Von Neumann Architecture

Harvard Architecture