

Micro-Processor Based System Design

The 8051 Microcontroller

Bilal Habib

DCSE, UET Peshawar

Slides are adapted from Chung-Ping Young lectures

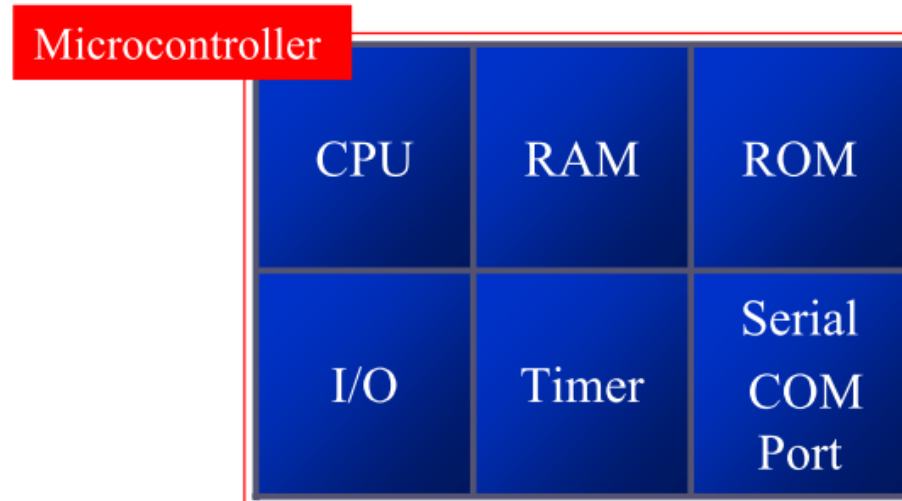
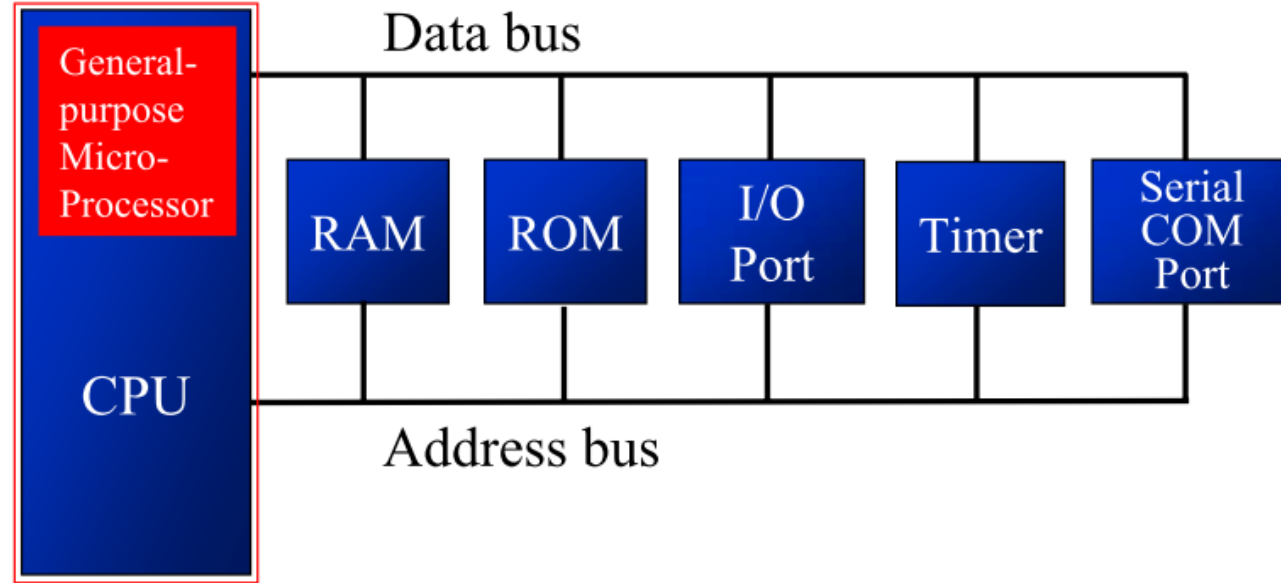
MICRO- CONTROLLERS AND EMBEDDED PROCESSORS

Microcontroller vs. General- Purpose Microprocessor

- ❑ General-purpose microprocessors contains
 - No RAM
 - No ROM
 - No I/O ports
- ❑ Microcontroller has
 - CPU (microprocessor)
 - RAM
 - ROM
 - I/O ports
 - Timer
 - ADC and other peripherals

MICRO- CONTROLLERS AND EMBEDDED PROCESSORS

Microcontroller
vs. General-
Purpose
Microprocessor
(cont')



MICRO- CONTROLLERS AND EMBEDDED PROCESSORS

Microcontroller vs. General- Purpose Microprocessor (cont')

- ❑ General-purpose microprocessors
 - Must add RAM, ROM, I/O ports, and timers externally to make them functional
 - Make the system bulkier and much more expensive
 - Have the advantage of versatility on the amount of RAM, ROM, and I/O ports
- ❑ Microcontroller
 - The fixed amount of on-chip ROM, RAM, and number of I/O ports makes them ideal for many applications in which cost and space are critical
 - In many applications, the space it takes, the power it consumes, and the price per unit are much more critical considerations than the computing power

MICRO- CONTROLLERS AND EMBEDDED PROCESSORS

Microcontrollers for Embedded Systems

- ❑ An embedded product uses a microprocessor (or microcontroller) to do one task and one task only
 - There is only one application software that is typically burned into ROM
- ❑ A PC, in contrast with the embedded system, can be used for any number of applications
 - It has RAM memory and an operating system that loads a variety of applications into RAM and lets the CPU run them
 - A PC contains or is connected to various embedded products
 - Each one peripheral has a microcontroller inside it that performs only one task

MICRO- CONTROLLERS AND EMBEDDED PROCESSORS

Choosing a Microcontroller

- ❑ 8-bit microcontrollers
 - Motorola's 6811
 - Intel's 8051
 - Zilog's Z8
 - Microchip's PIC
- ❑ There are also 16-bit and 32-bit microcontrollers made by various chip makers

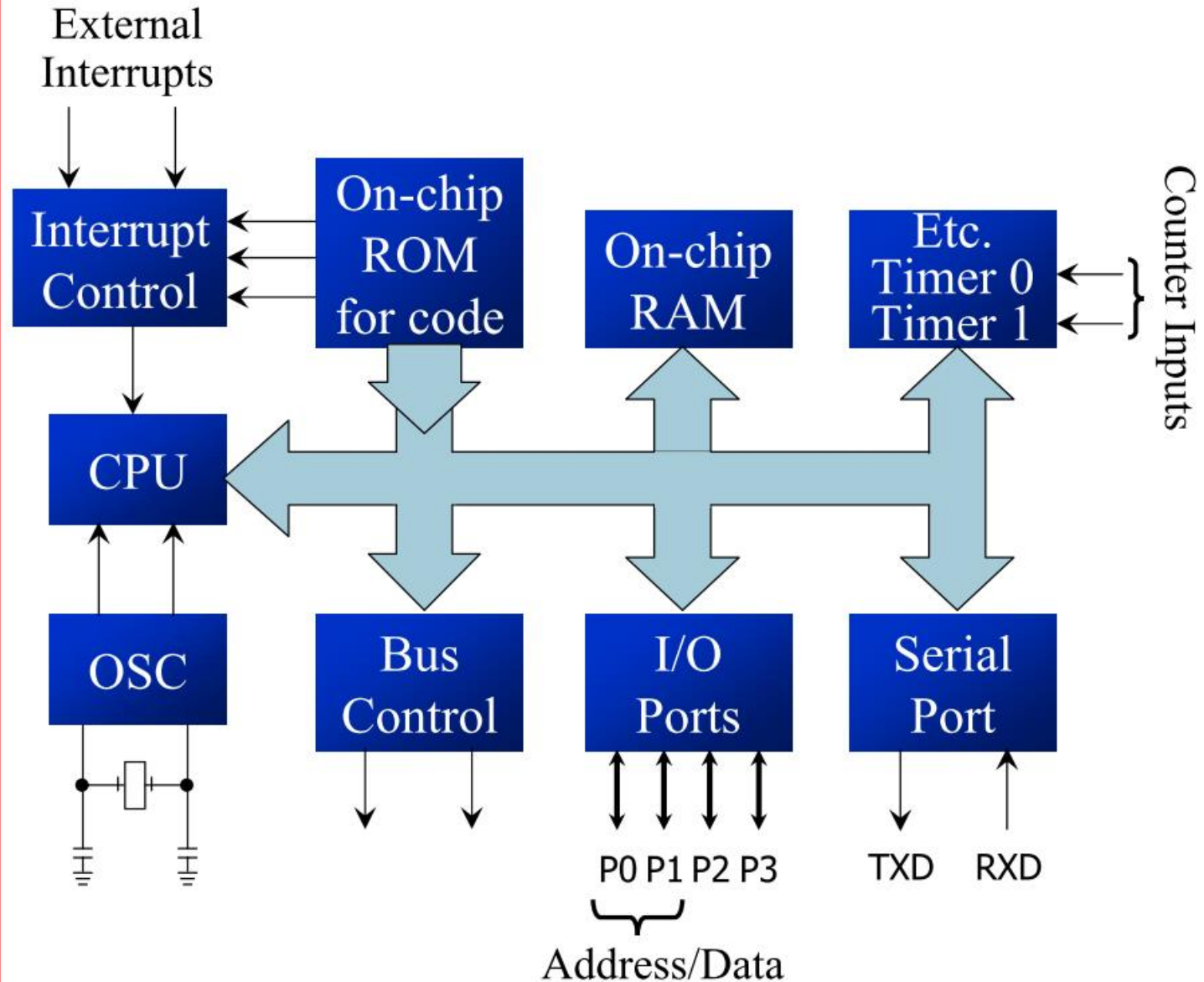
OVERVIEW OF 8051 FAMILY

8051 Microcontroller

- ❑ Intel introduced 8051, referred as MCS-51, in 1981
 - The 8051 is an 8-bit processor
 - The CPU can work on only 8 bits of data at a time
 - The 8051 had
 - 128 bytes of RAM
 - 4K bytes of on-chip ROM
 - Two timers
 - One serial port
 - Four I/O ports, each 8 bits wide
 - 6 interrupt sources
- ❑ The 8051 became widely popular after allowing other manufactures to make and market any flavor of the 8051, but remaining code-compatible

OVERVIEW OF 8051 FAMILY

8051 Microcontroller (cont')



OVERVIEW OF 8051 FAMILY

8051 Family

- ❑ The 8051 is a subset of the 8052
- ❑ The 8031 is a ROM-less 8051
 - Add external ROM to it
 - You lose two ports, and leave only 2 ports for I/O operations

Feature	8051	8052	8031
ROM (on-chip program space in bytes)	4K	8K	0K
RAM (bytes)	128	256	128
Timers	2	3	2
I/O pins	32	32	32
Serial port	1	1	1
Interrupt sources	6	8	6

8051 Assembly Language Programming

Bilal Habib

INSIDE THE 8051

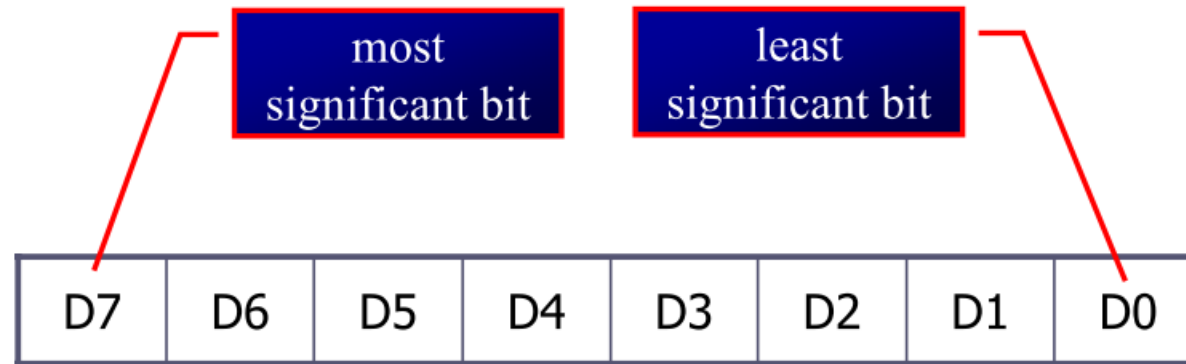
Registers

- ❑ Register are used to store information temporarily, while the information could be
 - a byte of data to be processed, or
 - an address pointing to the data to be fetched
- ❑ The vast majority of 8051 register are 8-bit registers
 - There is only one data type, 8 bits

INSIDE THE 8051

Registers (cont')

- ❑ The 8 bits of a register are shown from MSB D7 to the LSB D0
 - With an 8-bit data type, any data larger than 8 bits must be broken into 8-bit chunks before it is processed

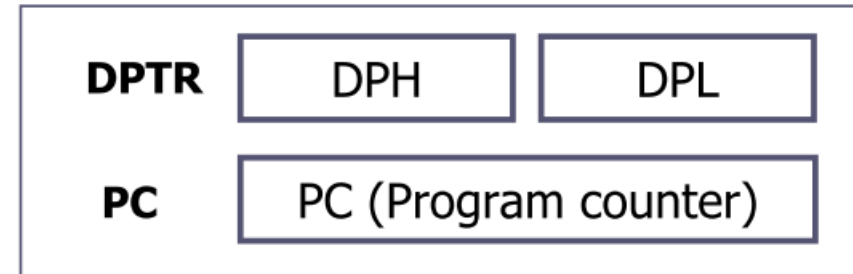
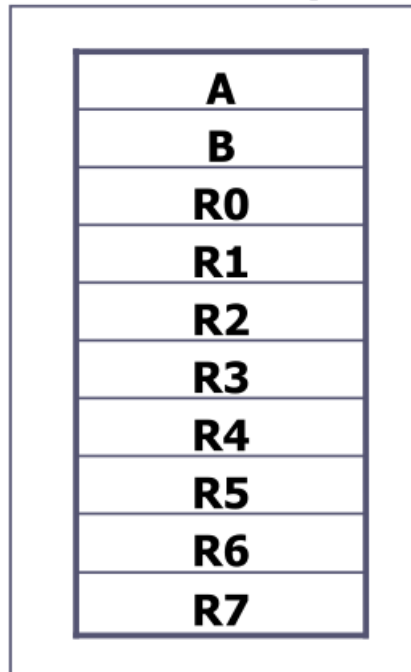


8 bit Registers

INSIDE THE 8051

Registers (cont')

- ❑ The most widely used registers
 - A (Accumulator)
 - For all arithmetic and logic instructions
 - B, R0, R1, R2, R3, R4, R5, R6, R7
 - DPTR (data pointer), and PC (program counter)



INSIDE THE 8051

MOV Instruction

MOV destination, source ;copy source to dest.

- The instruction tells the CPU to move (in reality, **COPY**) the source operand to the destination operand

“#” signifies that it is a value

```
MOV  A, #55H    ;load value 55H into reg. A
MOV  R0, A       ;copy contents of A into R0
                   ; (now A=R0=55H)
MOV  R1, A       ;copy contents of A into R1
                   ; (now A=R0=R1=55H)
MOV  R2, A       ;copy contents of A into R2
                   ; (now A=R0=R1=R2=55H)
MOV  R3, #95H    ;load value 95H into R3
                   ; (now R3=95H)
MOV  A, R3       ;copy contents of R3 into A
                   ;now A=R3=95H
```

8051 ASSEMBLY PROGRAMMING

Structure of Assembly Language

- ❑ In the early days of the computer, programmers coded in *machine language*, consisting of 0s and 1s
 - Tedious, slow and prone to error
- ❑ *Assembly languages*, which provided mnemonics for the machine code instructions, plus other features, were developed
 - An Assembly language program consist of a series of lines of Assembly language instructions
- ❑ Assembly language is referred to as a *low-level language*
 - It deals directly with the internal structure of the CPU

8051 ASSEMBLY PROGRAMMING

Structure of Assembly Language

- ❑ Assembly language instruction includes
 - a mnemonic (abbreviation easy to remember)
 - the commands to the CPU, telling it what those to do with those items
 - optionally followed by one or two operands
 - the data items being manipulated
- ❑ A given Assembly language program is a series of statements, or lines
 - Assembly language instructions
 - Tell the CPU what to do
 - Directives (or pseudo-instructions)
 - Give directions to the assembler

8051 ASSEMBLY PROGRAMMING

Structure of Assembly Language

Mnemonics
produce
opcodes

- ❑ An Assembly language instruction consists of four fields:

```
[label:] Mnemonic [operands] [;comment]
```

```
ORG 0H ;start(origin) at location 0
MOV R5, #25H ;load 25H into R5
MOV R7, #34H ;load 34H into R7
MOV A, #0 ;load 0 into A
ADD A, R5 ;add contents of R5 to A
;now A = A + R5
ADD A, R7 ;add contents of R7 to A
;now A = A + R7
ADD A, #12H ;add to A value 12H
;now A = A + 12H
HERE: SJMP HERE ;stay in this loop
END ;end of program
```

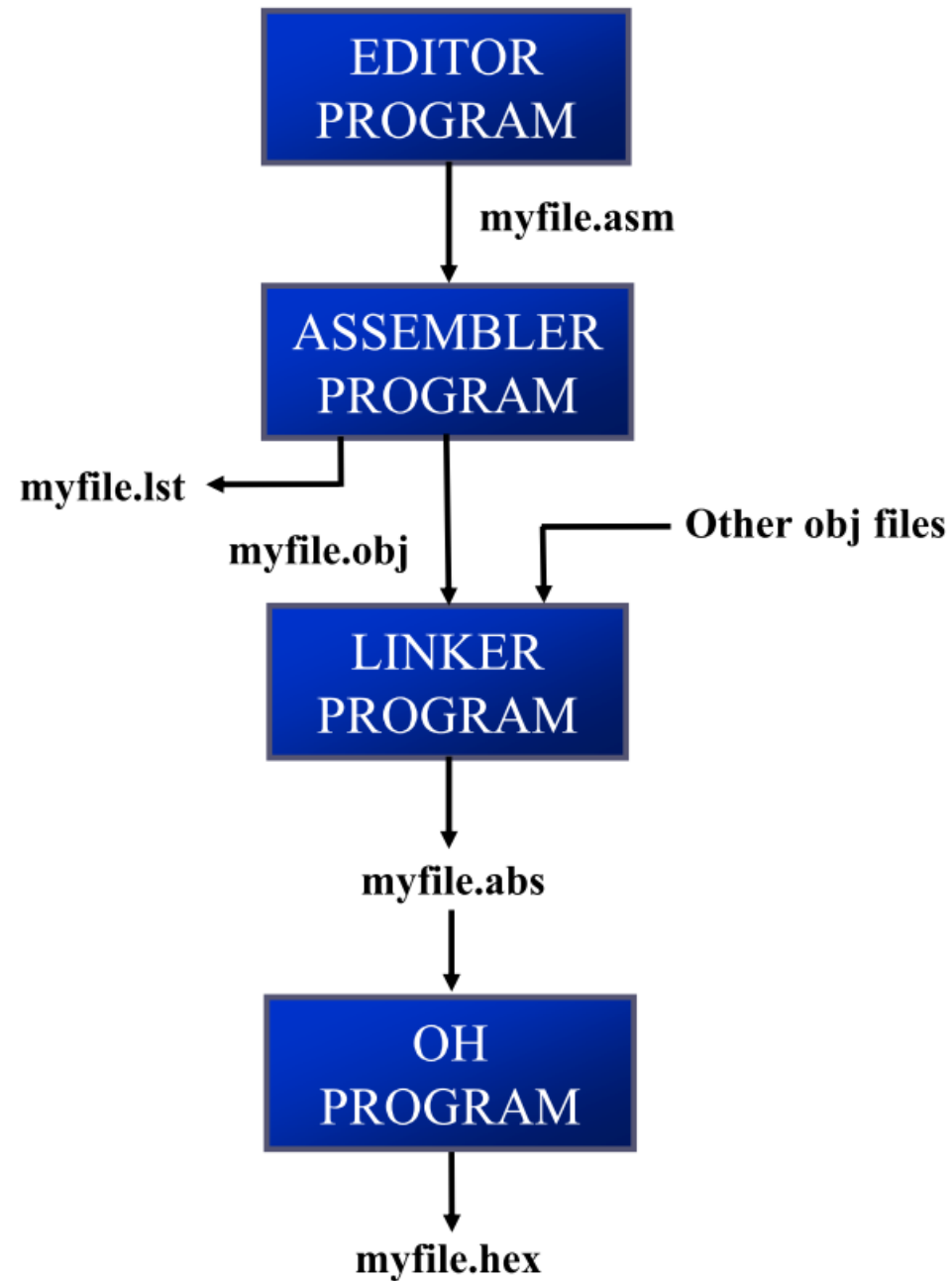
Directives do not generate any machine code and are used only by the assembler

The label field allows the program to refer to a line of code by name

Comments may be at the end of a line or on a line by themselves
The assembler ignores comments

ASSEMBLING AND RUNNING AN 8051 PROGRAM

Steps to Create a Program



PROGRAM COUNTER AND ROM SPACE

Power up

- ❑ All 8051 members start at memory address 0000 when they're powered up
 - Program Counter has the value of 0000
 - The first opcode is burned into ROM address 0000H, since this is where the 8051 looks for the first instruction when it is booted
 - We achieve this by the `ORG` statement in the source program

PROGRAM COUNTER AND ROM SPACE

Placing Code in ROM

- ❑ Examine the list file and how the code is placed in ROM

```
1 0000          ORG 0H          ;start (origin) at 0
2 0000 7D25      MOV R5,#25H     ;load 25H into R5
3 0002 7F34      MOV R7,#34H     ;load 34H into R7
4 0004 7400      MOV A,#0        ;load 0 into A
5 0006 2D        ADD A,R5        ;add contents of R5 to A
                                   ;now A = A + R5
6 0007 2F        ADD A,R7        ;add contents of R7 to A
                                   ;now A = A + R7
7 0008 2412      ADD A,#12H      ;add to A value 12H
                                   ;now A = A + 12H
8 000A 80EF      HERE: SJMP HERE ;stay in this loop
9 000C          END             ;end of asm source file
```

ROM Address	Machine Language	Assembly Language
0000	7D25	MOV R5, #25H
0002	7F34	MOV R7, #34H
0004	7400	MOV A, #0
0006	2D	ADD A, R5
0007	2F	ADD A, R7
0008	2412	ADD A, #12H
000A	80EF	HERE: SJMP HERE

```
$NOMOD51
$INCLUDE (8051.MCU)
```

```
; Reset Vector
```

```
org 0000h
jmp Start
```

```
org 0100h
```

Start:

```
; Write your code here
```

```
CLR P2.0
```

AGAIN :

```
SETB P2.0
```

```
ACALL DELAY
```

```
CLR P2.0
```

```
ACALL DELAY
```

```
SJMP AGAIN
```

```
DELAY : MOV R0,#0FFH
```

```
GO : MOV R1,#0F9H
```

```
HERE : DJNZ R1,HERE
```

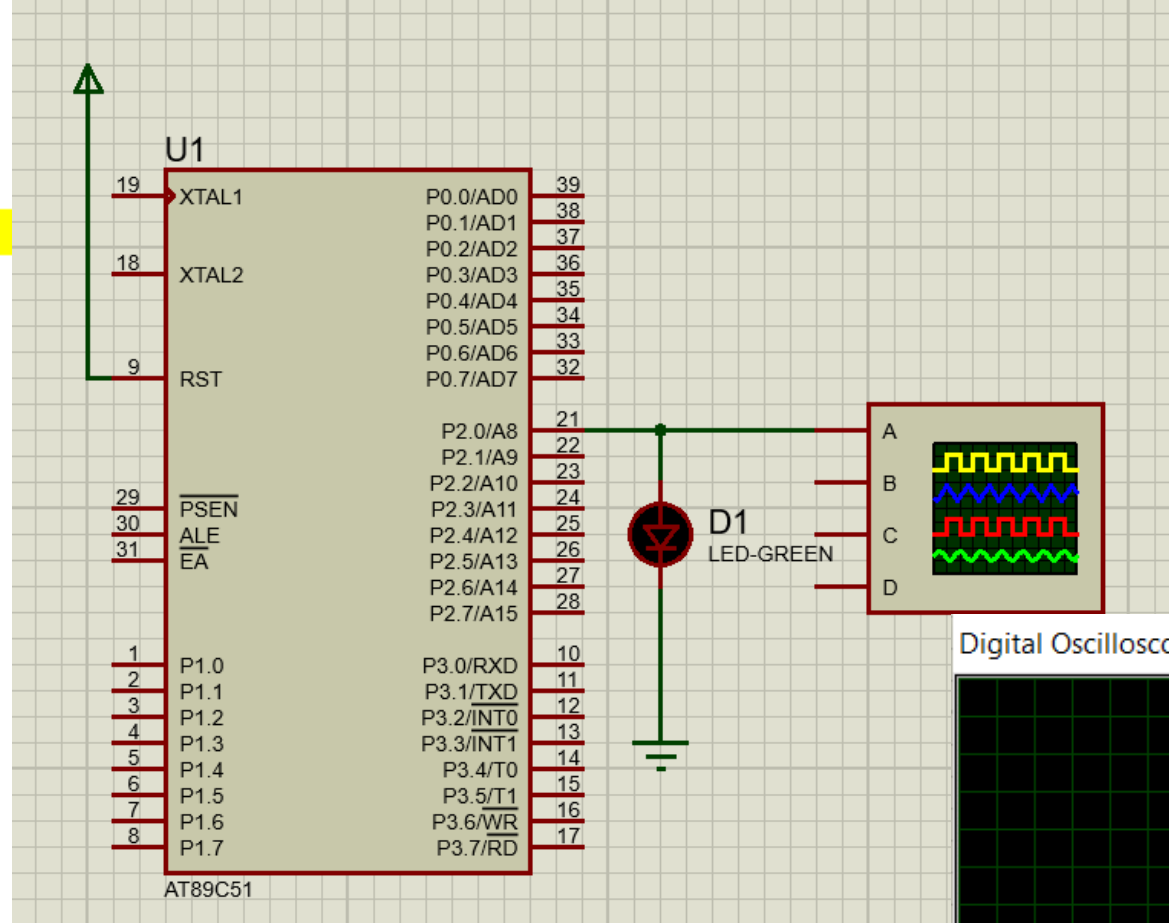
```
DJNZ R0,GO
```

```
RET
```

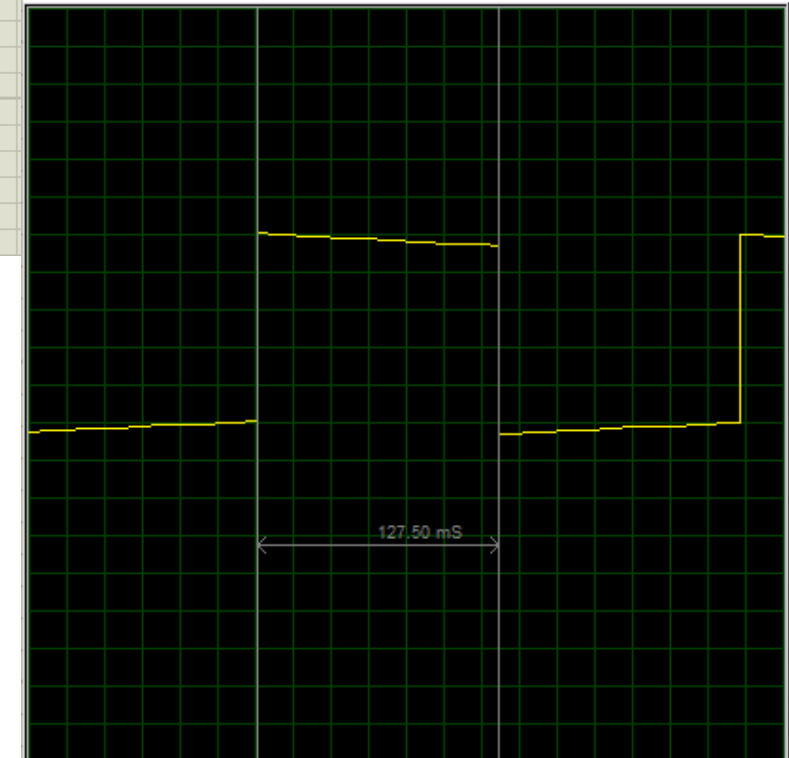
Loop:

```
jmp Loop
```

```
END
```



Digital Oscilloscope



To do:

- Read Chapter **0,1 and 2** from Mazidi book
- **Task1:** Complete it before the deadline