TIME DELAY FOR VARIOUS 8051 CHIPS

- CPU executing an instruction takes a certain number of clock cycles
  - These are referred as to as *machine cycles*
- The length of machine cycle depends on the frequency of the crystal oscillator connected to 8051
- In original 8051, one machine cycle lasts 12 oscillator periods

Find the period of the machine cycle for 11.0592 MHz crystal frequency

Solution:

11.0592/12 = 921.6 kHz;
machine cycle is 1/921.6 kHz = 1.085 μs

TIME DELAY FOR VARIOUS 8051 CHIPS (cont')

For 8051 system of 11.0592 MHz, find how long it takes to execute each instruction.

```
(a) MOV R3,#55 (b) DEC R3 (c) DJNZ R2 target
(d) LJMP (e) SJMP (f) NOP (g) MUL AB
```

Solution:

	Machine cycles	*Time to execute*
(a)	1	$1x1.085\mu s = 1.085\mu s$
(b)	1	$1x1.085\mu s = 1.085\mu s$
(c)	2	$2x1.085\mu s = 2.17\mu s$
(d)	2	$2x1.085\mu s = 2.17\mu s$
(e)	2	$2x1.085\mu s = 2.17\mu s$
(f)	1	$1x1.085\mu s = 1.085\mu s$
(g)	4	$4x1.085\mu s = 4.34\mu s$

TIME DELAY FOR VARIOUS 8051 CHIPS

Delay Calculation

Find the size of the delay in following program, if the crystal frequency is 11.0592MHz.

```
        MOV  A,#55H
AGAIN:  MOV  P1,A
        ACALL DELAY
        CPL  A
        SJMP AGAIN
;---time delay-------
DELAY:  MOV  R3,#200
HERE:   DJNZ R3,HERE
        RET
```

A simple way to short jump to itself in order to keep the microcontroller busy

```
HERE: SJMP HERE
```

We can use the following:

```
SJMP $
```

Solution:

```
                          Machine cycle
DELAY:  MOV  R3,#200          1
HERE:   DJNZ R3,HERE          2
        RET                   2
```

Therefore, [(200x2)+1+2]x1.085μs = 436.255μs.

TIME DELAY FOR VARIOUS 8051 CHIPS

Increasing Delay Using NOP

Find the size of the delay in following program, if the crystal frequency is 11.0592MHz.

```
                          Machine Cycle
DELAY: MOV  R3,#250          1
HERE:  NOP                   1
       NOP                   1
       NOP                   1
       NOP                   1
       DJNZ R3,HERE          2
       RET                   2
```

Solution:

The time delay inside HERE loop is [250(1+1+1+1+2)]x1.085μs = 1627.5μs.

Adding the two instructions outside loop we have 1627.5μs + 3 x 1.085μs = 1630.755μs

TIME DELAY FOR VARIOUS 8051 CHIPS

Large Delay Using Nested Loop

Find the size of the delay in following program, if the crystal frequency is 11.0592MHz.

```
                          Machine Cycle
DELAY: MOV  R2,#200            1
AGAIN: MOV  R3,#250            1
HERE:  NOP                     1
       NOP                     1
       DJNZ R3,HERE            2
       DJNZ R2,AGAIN           2
       RET                     2
```

Notice in nested loop, as in all other time delay loops, the time is approximate since we have ignored the first and last instructions in the subroutine.

Solution:

For HERE loop, we have (4x250)x1.085μs=1085μs. For AGAIN loop repeats HERE loop 200 times, so we have 200x1085μs=217000μs. But "MOV R3,#250" and "DJNZ R2,AGAIN" at the start and end of the AGAIN loop add (3x200x1.805)=651μs. As a result we have 217000+651=217651μs.

TIME DELAY FOR VARIOUS 8051 CHIPS

Delay Calculation for Other 8051

- Two factors can affect the accuracy of the delay
  - Crystal frequency
    - The duration of the clock period of the machine cycle is a function of this crystal frequency
  - 8051 design
    - The original machine cycle duration was set at 12 clocks
    - Advances in both IC technology and CPU design in recent years have made the 1-clock machine cycle a common feature

Clocks per machine cycle for various 8051 versions

Chip / Maker	Clocks per Machine Cycle
AT89C51 Atmel	12
P89C54X2 Philips	6
DS5000 Dallas Semi	4
DS89C420/30/40/50 Dallas Semi	1

TIME DELAY FOR VARIOUS 8051 CHIPS

Delay Calculation for Other 8051 (cont')

Find the period of the machine cycle (MC) for various versions of 8051, if XTAL=11.0592 MHz.
(a) AT89C51 (b) P89C54X2 (c) DS5000 (d) DS89C4x0

Solution:

(a) 11.0592MHz/12 = 921.6kHz;
MC is 1/921.6kHz = 1.085μs = 1085ns
(b) 11.0592MHz/6 = 1.8432MHz;
MC is 1/1.8432MHz = 0.5425μs = 542ns
(c) 11.0592MHz/4 = 2.7648MHz ;
MC is 1/2.7648MHz = 0.36μs = 360ns
(d) 11.0592MHz/1 = 11.0592MHz;
MC is 1/11.0592MHz = 0.0904μs = 90ns

TIME DELAY FOR VARIOUS 8051 CHIPS

Delay Calculation for Other 8051 (cont')

Instruction	8051	DSC89C4x0
MOV R3,#55	1	2
DEC R3	1	1
DJNZ R2 target	2	4
LJMP	2	3
SJMP	2	3
NOP	1	1
MUL AB	4	9

For an AT8051 and DSC89C4x0 system of 11.0592 MHz, find how long it takes to execute each instruction.

(a) MOV R3,#55 (b) DEC R3 (c) DJNZ R2 target
(d) LJMP (e) SJMP (f) NOP (g) MUL AB

Solution:

	AT8051	***DS89C4x0***
(a)	1×1085ns = 1085ns	2×90ns = 180ns
(b)	1×1085ns = 1085ns	1×90ns = 90ns
(c)	2×1085ns = 2170ns	4×90ns = 360ns
(d)	2×1085ns = 2170ns	3×90ns = 270ns
(e)	2×1085ns = 2170ns	3×90ns = 270ns
(f)	1×1085ns = 1085ns	1×90ns = 90ns
(g)	4×1085ns = 4340ns	9×90ns = 810ns