

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:

$$11.0592/12 = 921.6 \text{ kHz};$$

$$\text{machine cycle is } 1/921.6 \text{ kHz} = 1.085 \mu\text{s}$$

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:

	<i>Machine cycles</i>	<i>Time to execute</i>
(a)	1	$1 \times 1.085 \mu\text{s} = 1.085 \mu\text{s}$
(b)	1	$1 \times 1.085 \mu\text{s} = 1.085 \mu\text{s}$
(c)	2	$2 \times 1.085 \mu\text{s} = 2.17 \mu\text{s}$
(d)	2	$2 \times 1.085 \mu\text{s} = 2.17 \mu\text{s}$
(e)	2	$2 \times 1.085 \mu\text{s} = 2.17 \mu\text{s}$
(f)	1	$1 \times 1.085 \mu\text{s} = 1.085 \mu\text{s}$
(g)	4	$4 \times 1.085 \mu\text{s} = 4.34 \mu\text{s}$

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:

	<i>Machine cycle</i>
DELAY: MOV R3,#200	1
HERE: DJNZ R3,HERE	2
RET	2

Therefore, $[(200 \times 2) + 1 + 2] \times 1.085 \mu s = 436.255 \mu s$.

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Increasing Delay Using NOP

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

	<i>Machine Cycle</i>
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

$$[250(1+1+1+1+2)] \times 1.085 \mu s = 1627.5 \mu s.$$

Adding the two instructions outside loop we

$$\text{have } 1627.5 \mu s + 3 \times 1.085 \mu s = 1630.755 \mu s$$

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Large Delay Using Nested Loop

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

	<i>Machine Cycle</i>
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 $(4 \times 250) \times 1.085 \mu s = 1085 \mu s$.
For AGAIN loop repeats HERE loop 200 times, so we have $200 \times 1085 \mu s = 217000 \mu s$. But "MOV R3, #250" and "DJNZ R2, AGAIN" at the start and end of the AGAIN loop add $(3 \times 200 \times 1.805) = 651 \mu s$.
As a result we have $217000 + 651 = 217651 \mu s$.

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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) $11.0592\text{MHz}/12 = 921.6\text{kHz};$

MC is $1/921.6\text{kHz} = 1.085\mu\text{s} = 1085\text{ns}$

(b) $11.0592\text{MHz}/6 = 1.8432\text{MHz};$

MC is $1/1.8432\text{MHz} = 0.5425\mu\text{s} = 542\text{ns}$

(c) $11.0592\text{MHz}/4 = 2.7648\text{MHz};$

MC is $1/2.7648\text{MHz} = 0.36\mu\text{s} = 360\text{ns}$

(d) $11.0592\text{MHz}/1 = 11.0592\text{MHz};$

MC is $1/11.0592\text{MHz} = 0.0904\mu\text{s} = 90\text{ns}$

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:

	<i>AT8051</i>	<i>DS89C4x0</i>
(a)	$1 \times 1085\text{ns} = 1085\text{ns}$	$2 \times 90\text{ns} = 180\text{ns}$
(b)	$1 \times 1085\text{ns} = 1085\text{ns}$	$1 \times 90\text{ns} = 90\text{ns}$
(c)	$2 \times 1085\text{ns} = 2170\text{ns}$	$4 \times 90\text{ns} = 360\text{ns}$
(d)	$2 \times 1085\text{ns} = 2170\text{ns}$	$3 \times 90\text{ns} = 270\text{ns}$
(e)	$2 \times 1085\text{ns} = 2170\text{ns}$	$3 \times 90\text{ns} = 270\text{ns}$
(f)	$1 \times 1085\text{ns} = 1085\text{ns}$	$1 \times 90\text{ns} = 90\text{ns}$
(g)	$4 \times 1085\text{ns} = 4340\text{ns}$	$9 \times 90\text{ns} = 810\text{ns}$