Increasing the delay

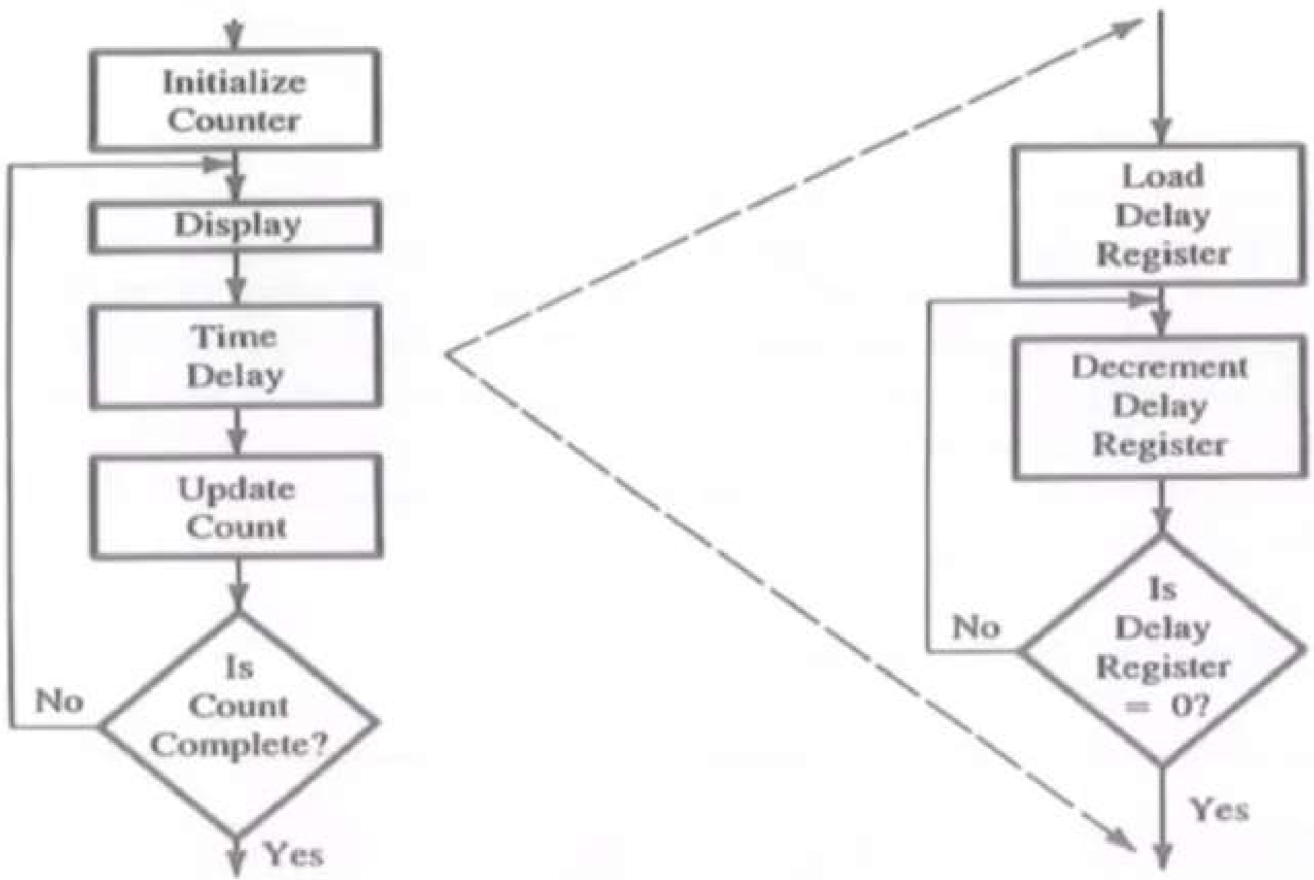
- The delay can be further increased by using register pairs for each of the loop counters in the nested loops setup.
- It can also be increased by adding dummy instructions (like NOP) in the body of the loop.

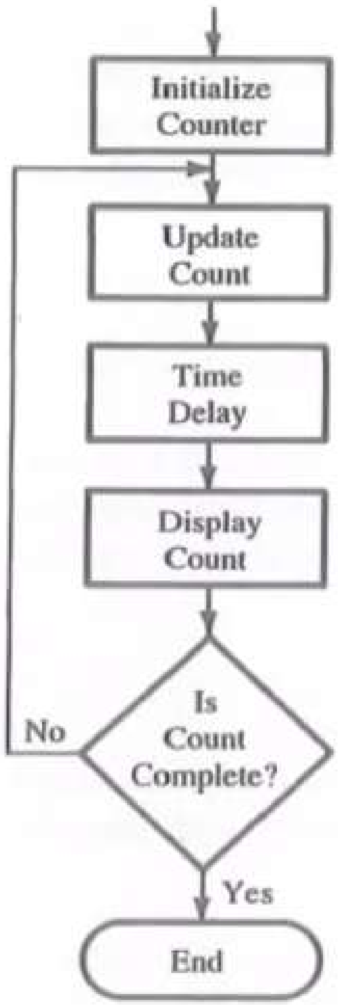
Problems

- Problems with software delay
- Accuracy of time delay depends on accuracy of system's clock
- Microprocessor is occupied in loop
- To calculate accurate time delay is tedious
- So, in real time applications times (ICs) are used
- Intel 8254 IC

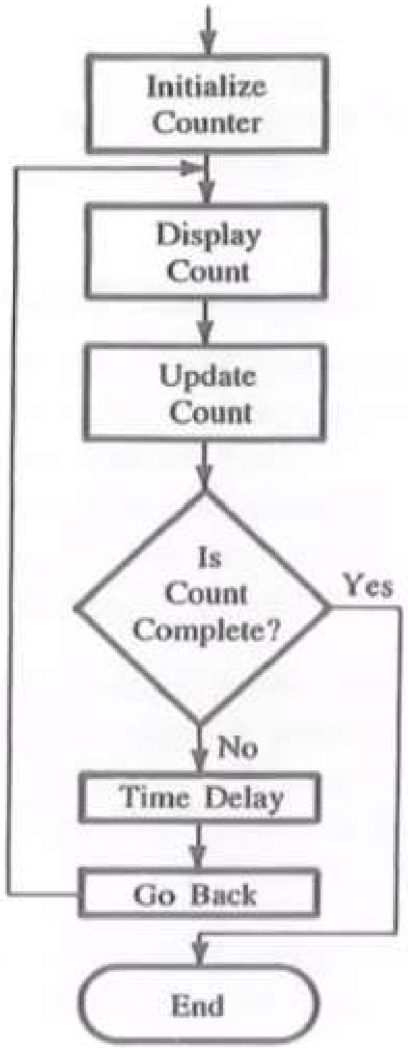
Counter Design with Time Delay

- Combine both time delay + counting loop





Initialize Counter
Update Count
Time Delay
Display Count
Is Count Complete?
No
Yes
End

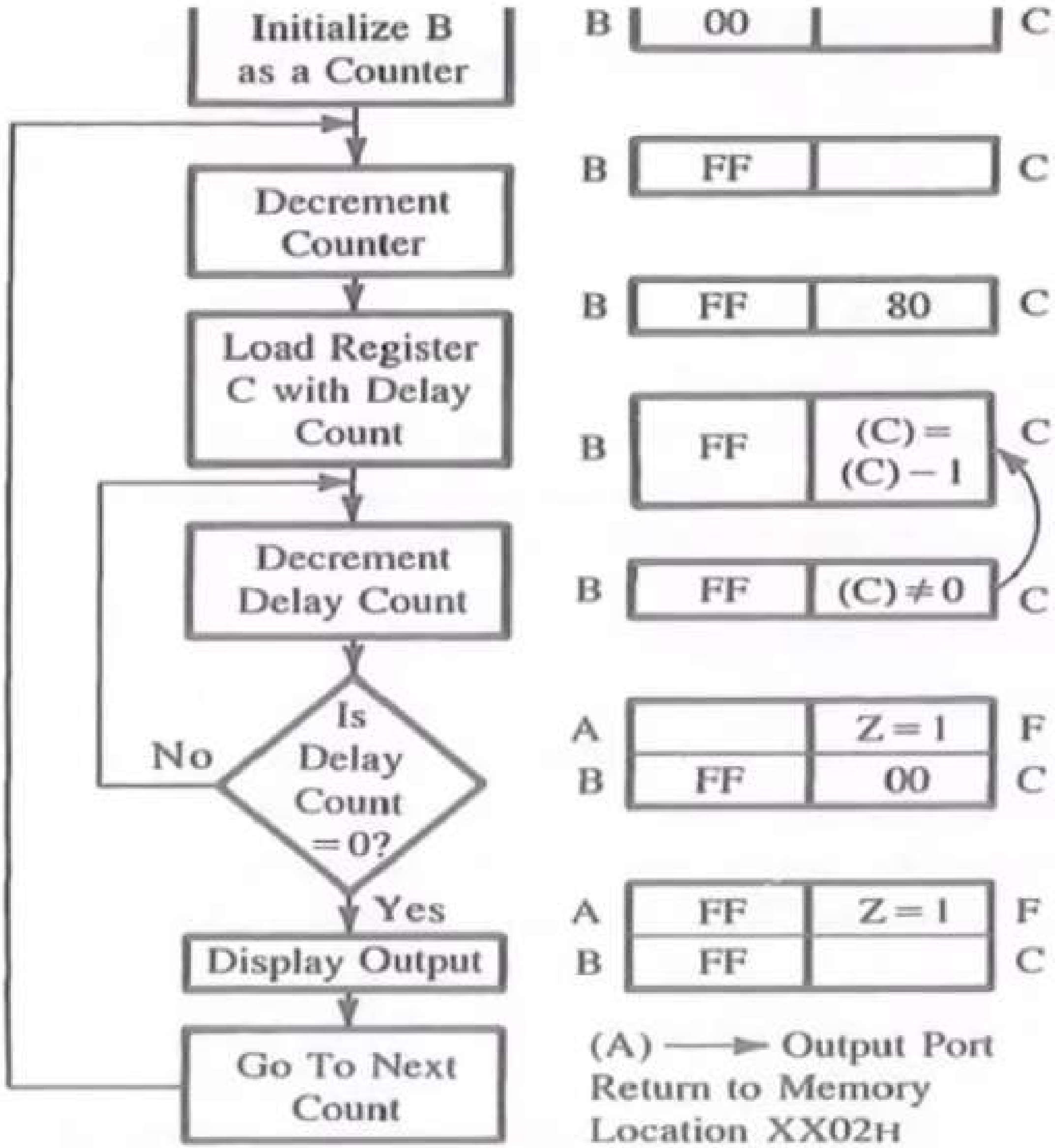


Initialize Counter
Display Count
Update Count
Is Count Complete?
Yes
No
Time Delay
Go Back
End

Hexadecimal Counter

- Write a program to count continuously in hexadecimal from FFH to 00H in a system with a 0.5 ms clock period. Use register C to set up a one ms delay between each count and display the numbers at one of the output ports.
- This program has two parts:
- The hexadecimal counter is set up by loading a register with an appropriate starting number and decrementing it until it becomes zero. After each counter , the register goes back to FF because decrementing zero results in -1 , which is FF in 2's complement.
- The one ms delay between each count is set up by using procedure time delay using one register.

```
            MVI B,00H

NEXT:       DCR B

            MVI C.COUNT

DELAY:      DCR C

            JNZ DELAY

            MOV A,B
            OUT PORT#
#
            JMP NEXT
```



programs

- Write a program to count from 0 to 9 with a one-second delay between each count. At the count of 9, the counter should reset itself to 0 and repeat the sequence continuously. Use register pair HL to set up the delay, and display each count at one of the output ports. Assume the clock frequency of the microcomputer is 1 MHz.
- Write a program to generate a continuous wave with the period of 500 ms. Assume the system clock period is 325 ns, and use bit D0 to output the square wave.

Solutions...

- To generate period of square wave of 500 ms, pulse should be on for 250 ms --- logic 1 and off for 250 ms --- logic 0....
- So accumulator is loaded with number AAH (1010 1010)
- Now rotate pattern once through each delay loop
- Bit D0 of the output port is used to provide logic 0 and 1. so other bits masked by ANDing the accumulator with the byte 01H.
- Delay of 250 ms obtained by 8- bit delay count and one register.

Errors...

- Some of the errors while designing counter and time delays:

- Counting T-states
- Recognizing how many times a loop is repeated
- Not converted into Hexadecimal equivalent number
- Wrong Jump instruction
- Failure to set flag
- Failure to display first or last count
- Failure to provide delay between last and last-but-one count

Assignment

The following program is designed to count from 100_{10} to 0 in Hex continuously, with a 1-second delay between each count. The delay is set up by using two loops—a loop within a loop. The inner loop is expected to provide approximately 100 ms delay, and it is repeated ten times, using the outer loop to provide a total delay of 1 second. The clock period of the system is 330 ns. The program includes several deliberate errors. Recognize the errors as specified in the following assignment.

		Mnemonics	T-states
1.		MVI A,64H	7
2.	DSPLAY:	OUT PORT1	10
3.	LOOP2:	MVI B,10H	7
4.	LOOP1:	LXI D,DELAY	10
5.		DCX D	6
6.		NOP	4
7.		NOP	4
8.		MOV A,D	4
9.		ORA E	4
10.		JNZ LOOP1	10/7
11.		DCR B	4
12.		JZ LOOP2	10/7
13.		DCR A	4
14.		CPI 00H	7
15.		JNZ DSPLAY	10/7

DELAY CALCULATIONS

$$\text{Delay in LOOP1} = \text{Loop T-states} \times \text{Count} \times \text{Clock period } (330 \times 10^{-9})$$

$$100 \text{ ms} = 32 \text{ T} \times \text{Count} \times 330 \times 10^{-9}$$

$$\text{DELAY COUNT} = \frac{100 \times 10^{-3}}{32 \times 330 \times 10^{-9}}$$

$$= 9470$$

This delay calculation ignores the initial T-states in loading the count and the difference of T-states in the last execution of the conditional Jump instruction.

DEBUGGING QUESTIONS

1. Examine LOOP1. Is the label LOOP1 at the appropriate location? What is the effect of the present location on the program?
2. What is the appropriate place for the label LOOP1?
3. Is the delay count accurate?
4. What is the effect of instruction 8 (MOV A,D) on the count?
5. Should instruction 3 be part of LOOP2?
6. Is the byte in register B (instruction 3) accurate?
7. Calculate T-states in the outer loop using the appropriate place for the label LOOP2. (Do not include the T-states of LOOP1.)

8. Is there any need for instruction 14 (CPI)?
9. Is there any need for an additional instruction, such as number 16?
10. What is the effect of instruction 12 (JZ) on the program?
11. Calculate the total delay in LOOP2 inclusive of LOOP1 if the byte in register B = 0AH.
12. Assuming instruction 8 is necessary, make appropriate changes in instructions 1 and 13.
13. Calculate the time delay between the display of two consecutive counts.
14. Will this program display the last count, assuming the other errors are corrected?