

2102440 Introduction to Microprocessors

Chapter 10 8253 Programmable Interval Timer/Counter

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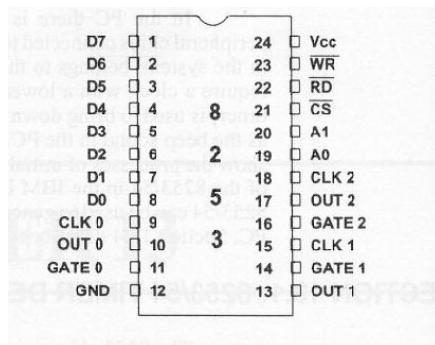
Topics

- Interfacing with 8086/8088
- Programming
- Mode

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8253/54 Timer (I)



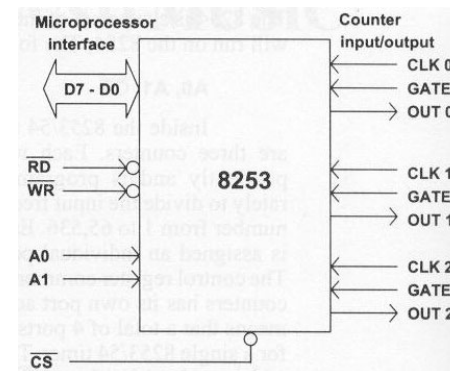
• The 8253/54 Programmable interval timer is used to generate a lower frequency for various uses, e.g., the beep sound

CS	A1	A0	Port
0	0	0	Counter 0
0	0	1	Counter 1
0	1	0	Counter 2
0	1	1	Control register
1	x	x	8253/54 is not selected

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8253/54 Timer (II)

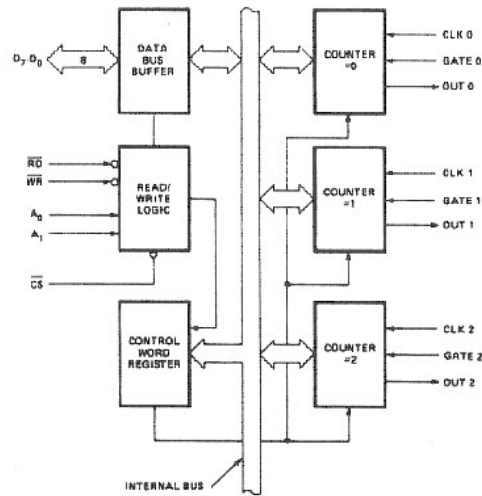


- There are three counters.
- The input frequency can be divided from 1 to 65536.
- Input clock frequency is 0-2 MHz for 8253, up to 8 MHz for 8254, and up to 10 MHz for 8254-2.
- Shape of the output frequency:
 - Square-wave
 - One-shot
 - Square-wave with various duty cycles.
- Gate is used to enable (High) or disable (Low) the counter.
- Bidirectional bus D0-D7 is connected to D0-D7 of the system bus.

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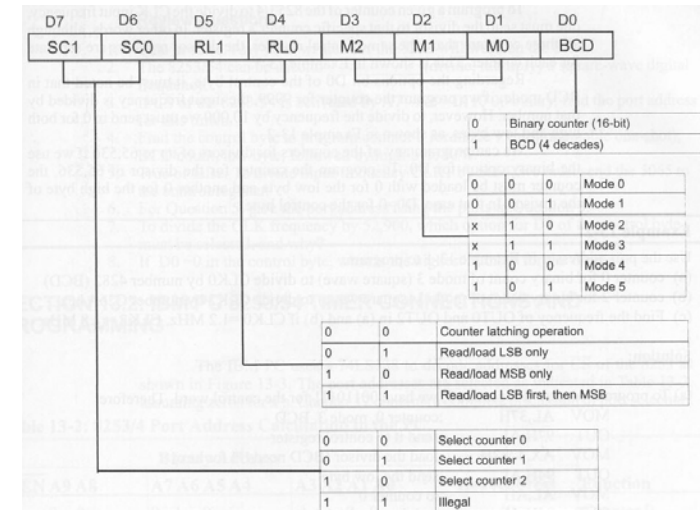
Architecture of the 8253/54



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8253/54 Control Word Format



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Control Word (I)

- D0
 - Binary number divisor → 0000-FFFFH
 - Divisor = 65536 if the counter is loaded with 0 for both the low and the high bytes.
 - BCD divisor → 0000-9999H
 - Divisor = 10000 if the counter is loaded with 0 for both the low and the high bytes.
- D1, D2, and D3: Mode selection
 - Mode 0: Interrupt on terminal count
 - Mode 1: Programmable one-shot
 - Mode 2: Rate generator
 - Mode 3: Square wave rate generator
 - Mode 4: Software triggered strobe
 - Mode 5: Hardware triggered strobe

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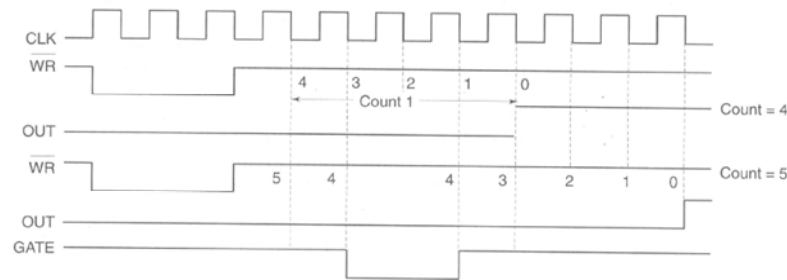
Control Word (II)

- D4 and D5 for RL0 and RL1
 - RL0 and RL1 indicate the size of the divisor.
 - Read/write the least significant byte (LSB) only
 - Read/write the most significant byte (MSB) only
 - Read/write the LSB first then followed by the MSB
 - We can write the value of the divisor into 8253/54 timer and read the contents of the counter at any time.
- D6 and D7 are used to select which of the three counters: counter 0 (00), counter 1 (01), and counter 2 (10).

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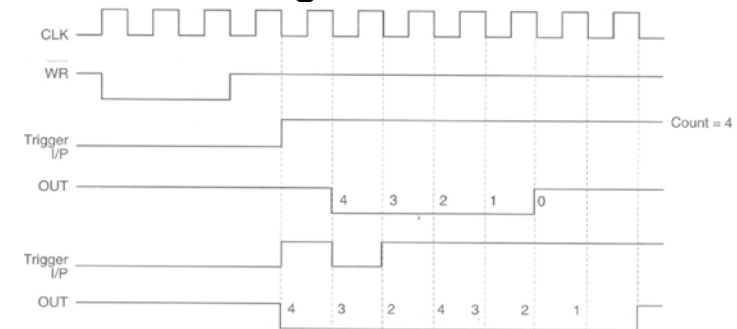
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Mode 0: Interrupt on terminal count



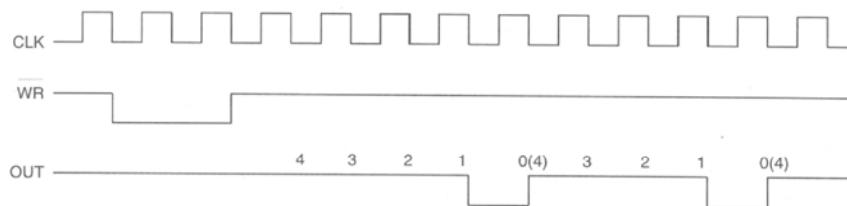
- It is used to generate an interrupt to the microprocessor after a certain interval of time.
- The output is initially low after the mode is set. The output remains LOW after the count value is loaded in the counter.
- The process of decrementing the counter continues till the terminal count is reached, i.e., the count becomes zero and the output goes HIGH. The output remains high until it reloads a new mode of operation or new count.
- The GATE signal is high for normal counting. When GATE goes low, counting is terminated and the current count is latched till the GATE goes high again.

Mode 1: Programmable one-shot



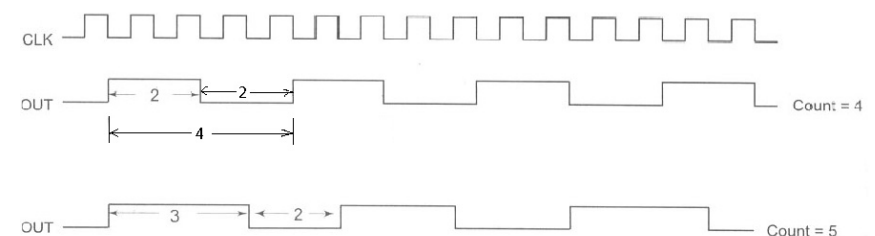
- The 8253/54 can be used as a monostable multivibrator.
- The gate input is used as trigger input in this mode. Normally, the output remains high until the count is loaded and a trigger is applied.
- The duration of the quasistable of the monostable multivibrator is decided by the count loaded in the count register.

Mode 2: Rate generator



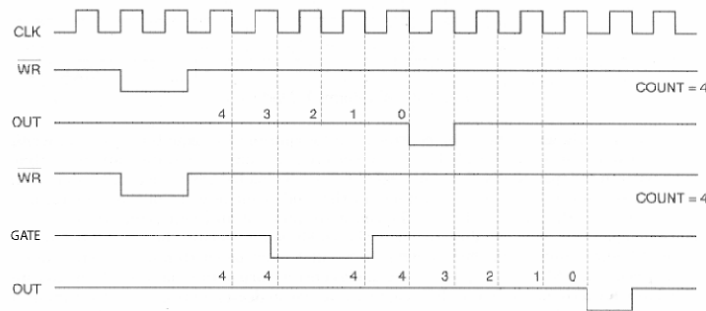
- Divide by N counter.
- The output is normally high after initialization.
- If N is loaded as the count value, after N pulses, the output becomes low for one clock cycle.
- Whenever the count becomes zero, another low pulse is generated at the output.

Mode 3: Square wave rate generator



- It is similar to mode 2.
- When the count N loaded is EVEN, half of the count will be high and half of the count will be low.
- When the count N loaded is ODD, the first clock pulse decrements it by 1. Then half of the remaining count will be high and half of the remaining count will be low.

Mode 4: Software triggered strobe

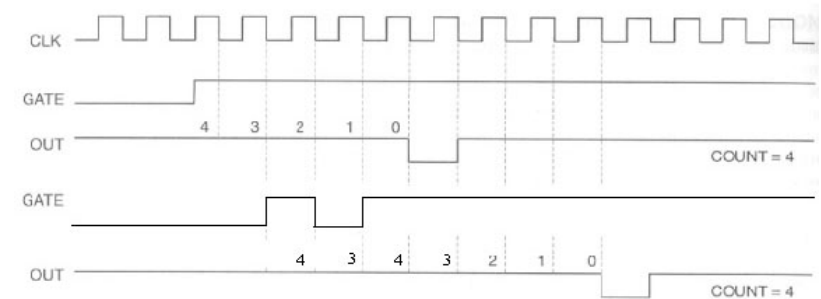


- After the mode is set, the output goes high.
- The counter automatically begins to decrement (count down) one clock pulse after it is loaded with the initial value through software.
- When the GATE signal goes low the count is latched.
- On the terminal count, the output goes low for one clock cycle, and then again goes high. This low pulse can be used as a strobe.

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Mode 5: Hardware triggered strobe



- This mode generates a strobe in response to an externally generated signal.
- It is similar to mode 4 except that the counting is initiated by a signal at the gate input, i.e., it is hardware triggered instead of software triggered.
- After it is initialized, the output goes high.
- The counter starts counting after the rising edge of the trigger input (GATE).
- When the terminal count is reached, the output goes low for one clock cycle.

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Example 1

- Pin $\overline{CS}$ of a given 8253/54 is activated by binary address A7-A2 = 100101.

- Find the port addresses assigned to this 8253/54.

Counter 0 → Port address = 1001 01 00 = 94H

Counter 1 → Port address = 1001 01 01 = 95H

Counter 2 → Port address = 1001 01 10 = 96H

Control register → Port address = 1001 01 11 = 97H

- Find the configuration for this 8253/54 if the control register is programmed as follows.

MOV AL, 00110110

OUT 97H, AL

D7-D6 = 00 → select counter 0

D5-D4 = 11 → the low byte read/write is followed by the high byte.

D3-D1 = 011 → select mode 3 (square wave)

D0 = 0 → select the binary counting

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Example 2

- Use the port addresses in Ex. 1 to program counter 2 for binary count of mode 3 (square wave) to divide CLK2 by number C26AH and find the frequency of OUT2 if CLK2 = 1.8 MHz.

- The control word = 10110110

MOV AL, B6H ; counter 2, mode 3, binary

OUT 97H, AL ; send it to control register

MOV AX, C26AH ; load the divisor

OUT 96H, AL ; send the low byte to counter 2

MOV AL, AH

OUT 96H, AL ; send the high byte to counter 2

- The output frequency for OUT2 = 1.8 MHz is divided by C26AH (49770 D). OUT 2 frequency is a square wave of 36 Hz.

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Example 3

- Using the port address in Ex.1, show the programming of counter 1 to divide CLK1 by 10,000, producing the mode 3 square wave. Use the BCD option in the control byte.

```
MOV AL, 77H    ; counter 1, mode 3, BCD
OUT 97H, AL    ; send it to control register
SUB AL, AL     ; AL = 0 load the divisor for 10,000
OUT 95H, AL    ; send the low byte
OUT 95H, AL    ; send the high byte
```

8253 Chip Connections in the PC

