

6.1.3 Operating Modes of 8254

Each of the three counters of 8254 can be operated in one of the following six modes of operation:

1. Mode 0 (Interrupt on terminal count)
2. Mode 1 (Programmable monoshot)
3. Mode 2 (Rate generator)
4. Mode 3 (Square wave generator)
5. Mode 4 (Software triggered strobe)
6. Mode 5 (Hardware triggered strobe)

In this section, we will discuss all these modes of operation of 8254 in brief.

MODE 0 This mode of operation is generally called as *interrupt on terminal count*. In this mode, the output is initially low after the mode is set. The output remains low even after the count value (5) is loaded in the counter. The counter starts decrementing the count value after the falling edge of the clock, if the GATE input is high. The process of decrementing the counter continues at each falling edge of the clock till the terminal count is reached, i.e. the count becomes zero. When the terminal count is reached, the output goes high and remains high till the selected control word register or the corresponding count register is reloaded with a new mode of operation or a new count, respectively. This high output may be used to interrupt the processor whenever required, by setting a suitable terminal count. Writing a count register while the previous counting is in process, generates the following sequence of response.

The first byte of the new count when loaded in the count register, stops the previous count. The second byte when written, starts the new count, terminating the previous count then and there.

The GATE signal is active high and should be high for normal counting. When GATE goes low counting is terminated and the current count is latched till the GATE again goes high. Figure 6.3 shows the operational waveforms in mode 0.

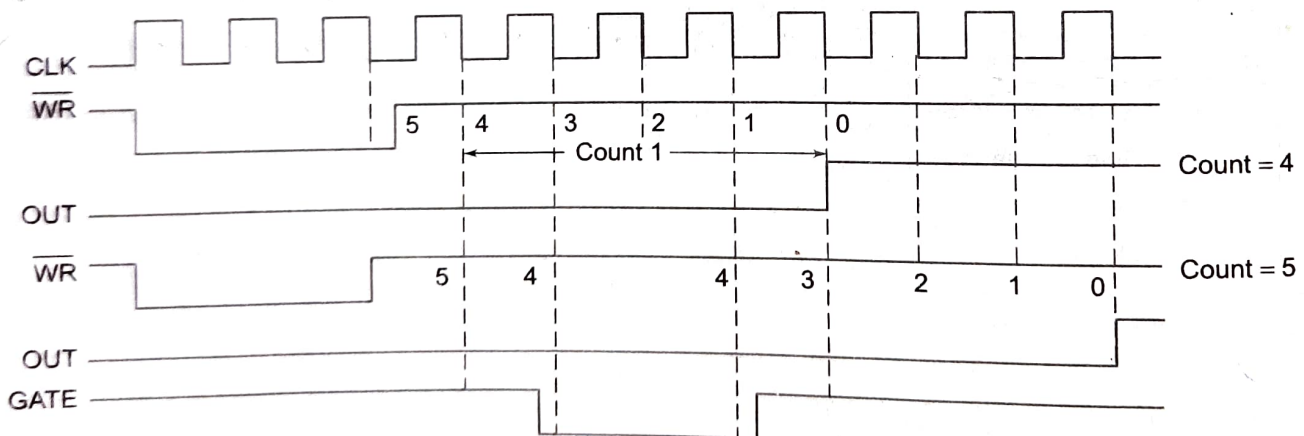


Fig. 6.3 Waveforms of WR, OUT and GATE in Mode 0

MODE 1 This mode of operation of 8254 is called as *programmable one-shot mode*. As the name implies, in this mode, the 8254 can be used as a *monostable multivibrator*. The duration of the quasistable state of the monostable multivibrator is decided by the count loaded in the count register. The gate input is used as trigger input in this mode of operation. Normally the output remains high till the suitable count is loaded in the count register and a trigger is applied. After the application of a trigger (on the positive edge), the output goes low and remains low till the count becomes zero. If another count is loaded when the output

is already low, it does not disturb the previous count till a new trigger pulse is applied at the GATE input. The new counting starts after the new trigger pulse. Figure 6.4 shows the related waveforms for mode 1.

MODE 2 This mode is called either *rate generator* or *divide by N counter*. In this mode, if N is loaded as the count value, then, after $(N-1)$ cycles, the output becomes low only for one clock cycle. The count N is reloaded and again the output becomes high and remains so for $(N-1)$ clock pulses. The output is normally high after initialisation or even a low signal on GATE input can force the output to go high. If GATE goes high, the counter starts counting down from the initial value. The counter generates an active low pulse at the

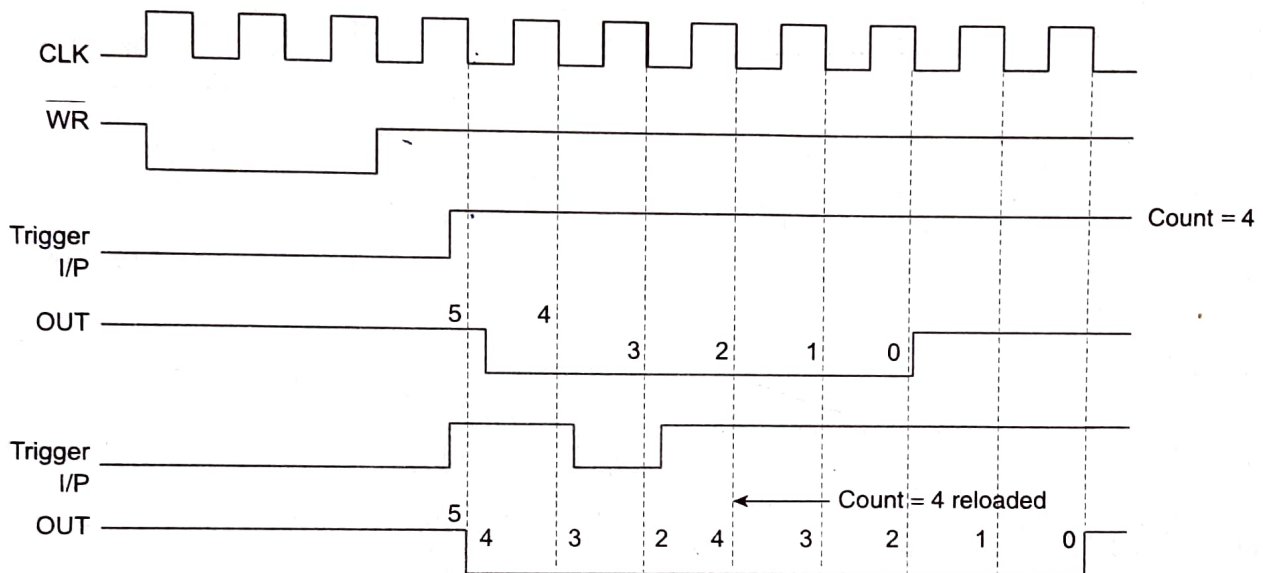


Fig. 6.4 \overline{WR} , GATE and OUT Waveforms for Mode 1

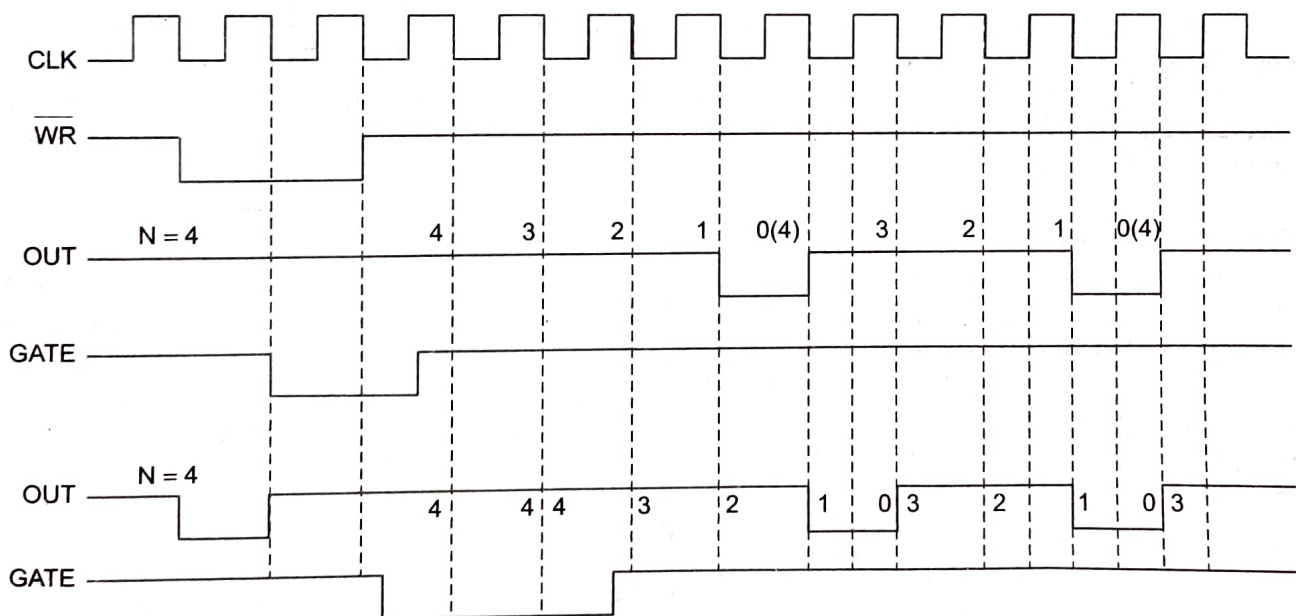


Fig. 6.5 Waveforms at Pin \overline{WR} and OUT in Mode 2

output initially, after the count register is loaded with a count value. Then count down starts and whenever the count becomes zero another active low pulse is generated at the output. The duration of these active low pulses are equal to one clock cycle. The number of input clock pulses between the two low pulses at the output is equal to the count loaded. Figure 6.5 shows the related waveforms for mode 2. Interestingly, the counting is inhibited when GATE becomes low.

MODE 3 In this mode, the 8254 can be used as a *square wave rate generator*. In terms of operation this mode is somewhat similar to mode 2. When, the count N loaded is even, then for half of the count, the output remains high and for the remaining half it remains low. If the count loaded is odd, the first clock pulse decrements it by 1 resulting in an even count value (holding the output high). Then the output remains high for half of the new count and goes low for the remaining half. This procedure is repeated continuously resulting in the generation of a square wave. In case of odd count, the output is high for longer duration and low for shorter duration. The difference of one clock cycle duration between the two periods is due to

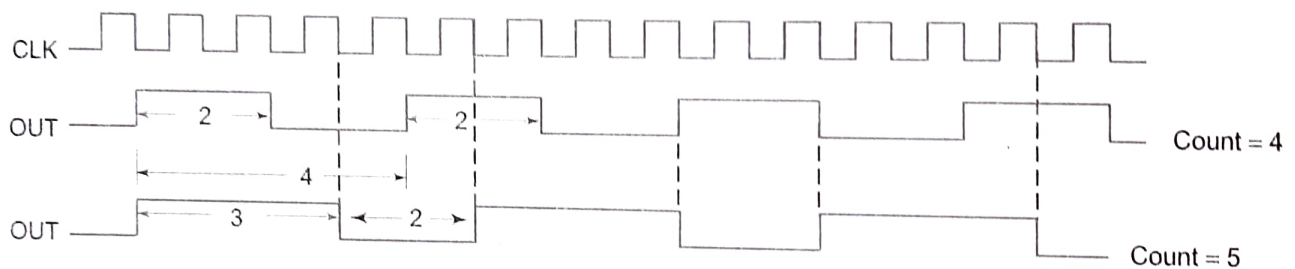


Fig. 6.6 Waveforms for Mode 3

the initial decrementing of the odd count. The waveforms for mode 3 are shown in Fig. 6.6. In general, if the loaded count value ' N ' is odd, then for $(N+1)/2$ pulses the output remains high and for $(N-1)/2$ pulses it remains low.

MODE 4 This mode of operation of 8254 is named as *software triggered strobe*. After the mode is set, the output goes high. When a count is loaded, counting down starts. On terminal count, the output goes low for one clock cycle, and then it again goes high. This low pulse can be used as a strobe, while interfacing the microprocessor with other peripherals. The count is inhibited and the count value is latched, when the GATE signal goes low. If a new count is loaded in the count register while the previous counting is in progress, it is accepted from the next clock cycle. The counting then proceeds according to the new count. The related waveforms are shown in Fig. 6.7.

MODE 5 This mode of operation also generates a strobe in response to the rising edge at the trigger input. This mode may be used to *generate a delayed strobe* in response to an externally generated signal. Once this mode is programmed and the counter is loaded, the output goes high. The counter starts counting after the rising edge of the trigger input (GATE). The output goes low for one clock period, when the terminal count is reached. The output will not go low until the counter content becomes zero after the rising edge of any trigger. The GATE input in this mode is used as trigger input. The related waveforms are shown in Fig. 6.8.

6.1.4 Programming and Interfacing 8254

As it is evident from the previous discussion, there may be two types of write operations in 8254, viz. (i) writing a control word into a control word register and (ii) writing a count value into a count register. The control word