PROGRAMMABLE INTERVAL TIMER 8253 / 8254

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WHY 8253???

NOT POSSIBLE TO GENERATE ACCURATE TIME DELAYS USING DELAY ROUTINES IN 8085

INTEL'S PROGRAMMABLE COUNTER/ TIMER DEVICE (8253) FACILITATES

- ACCURATE TIME DELAYS
- MINIMIZES LOAD ON MP
- REAL TIME CLOCK
- EVENT COUNTER
- DIGITAL ONE SHOT
- SQUARE WAVE GENERATOR
- COMPLEX WAVEFORM GENERATOR

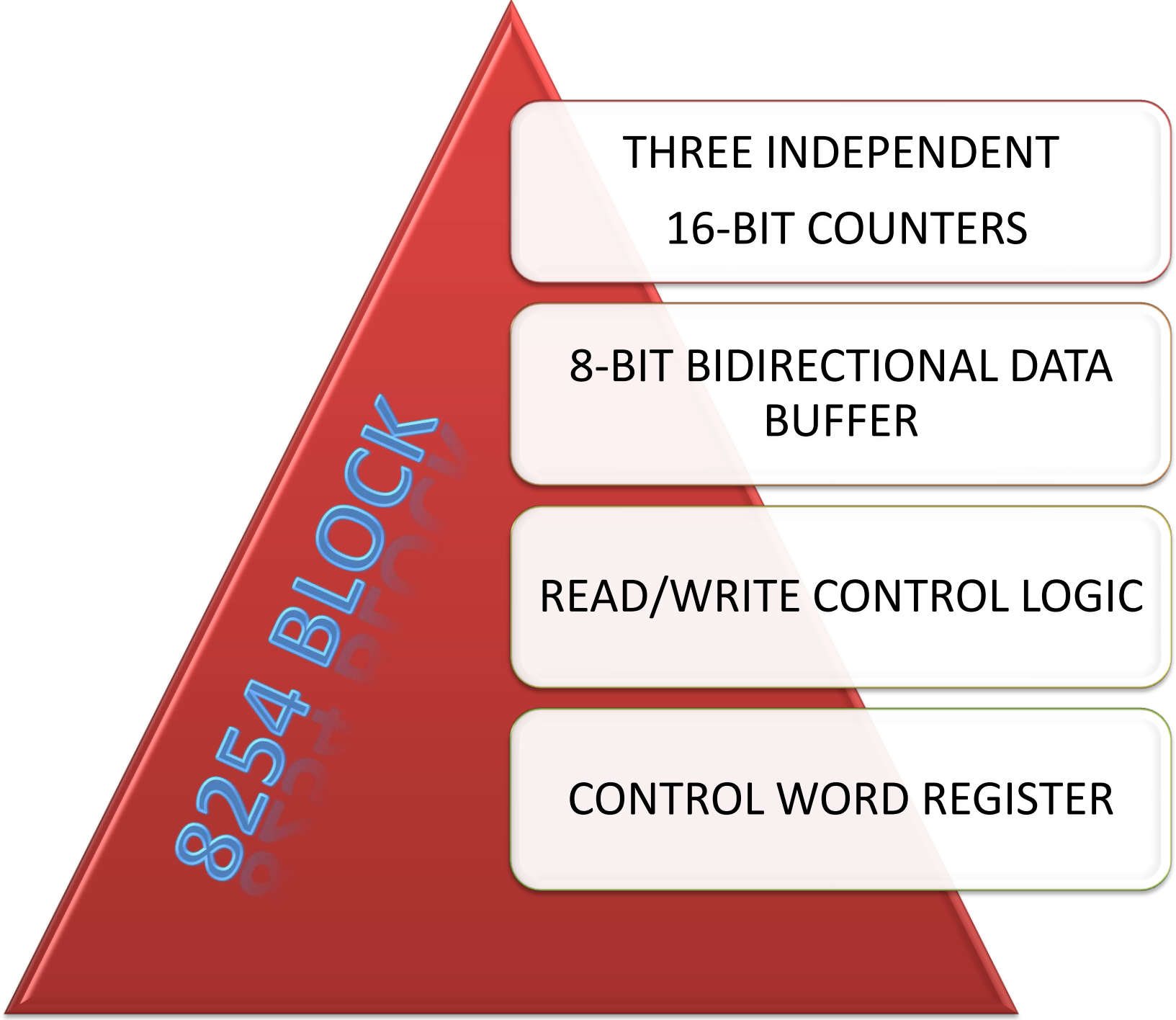
8253 VS 8254

8253

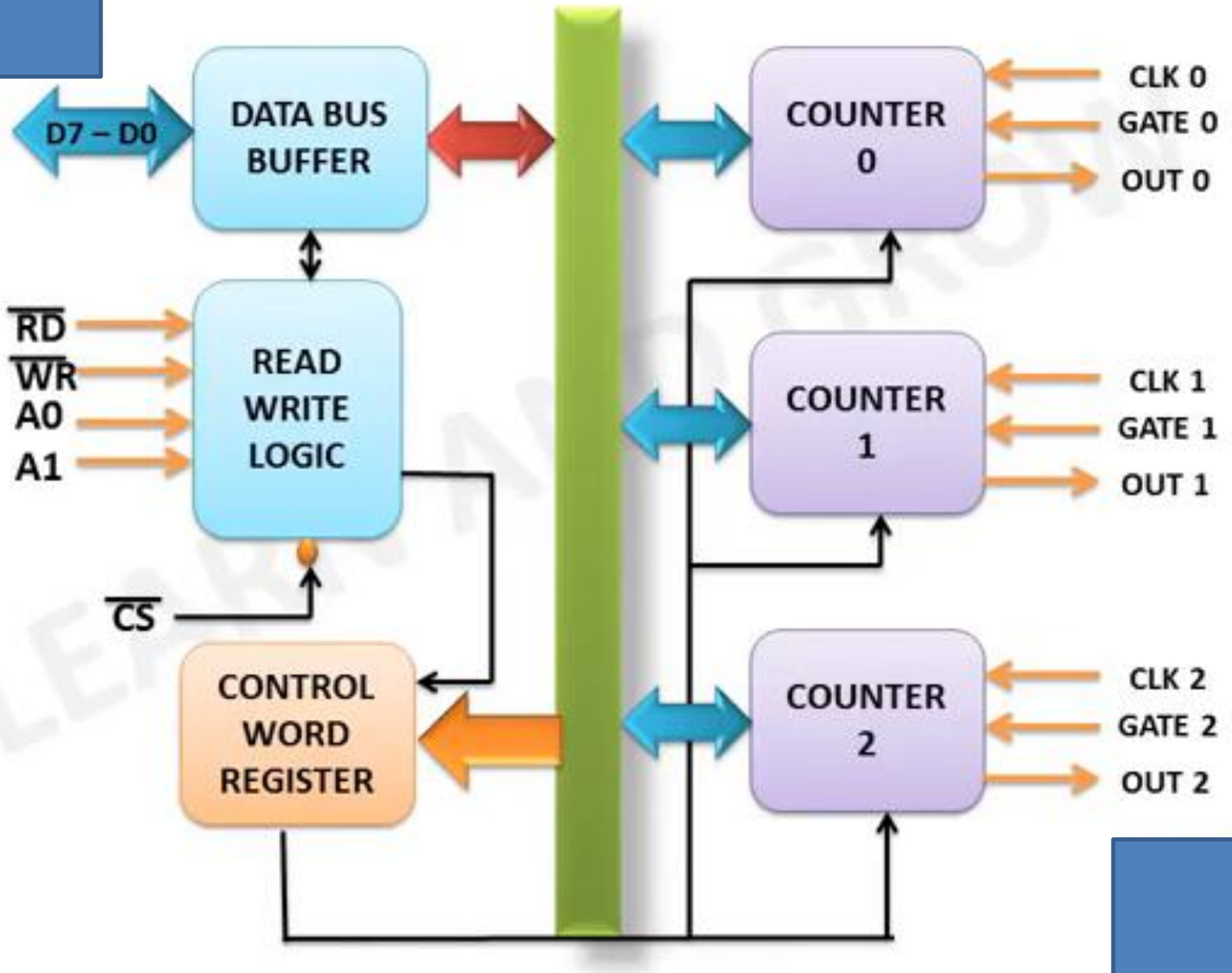
- **8253 CAN OPERATE AT FREQUENCY FROM DC TO 2MHZ**

8254-ADVANCED VERSION OF 8253

- **8254 CAN OPERATE WITH HIGHER CLOCK FREQUENCY RANGE (DC to 8 MHz AND 10 MHz FOR 8254-2)**
- **INCLUDES STATUS READ BACK COMMAND THAT LATCHES THE COUNT AND STATUS OF COUNTERS**


8254 BLOCK
THREE INDEPENDENT
16-BIT COUNTERS
8-BIT BIDIRECTIONAL DATA BUFFER
READ/WRITE CONTROL LOGIC
CONTROL WORD REGISTER

INTERNAL BLOCK DIAGRAM OF 8254



COUNTERS

- THREE COUNTERS – C1,C2 & C3
- EACH 16 BIT IDENTICAL PRESETTABLE DOWN COUNTER
- OPERATES IN BCD /Binary
- CONTROLLED BY LOADING COUNT TO COMMAND WORD REGISTER

CONTROL LOGIC

- CS' – LOGIC 0 – ENABLES 8254
- RD' – LOGIC 0 – TELLS MP READS COUNT FROM 8254
- WR' – LOGIC 0 – TELLS MP WRITES COUNT/ COMMAND INTO 8254
- A1,A0 – ADDRESS INPUT PINS TO SELECT MODES AND COUNTERS

DATA BUFFERS

- 8 BIT
- BIDIRECTIONAL
- D0-D7
- CONNECTED TO DATA BUS OF MP
- IN → READS DATA FROM PERIPHERAL
- OUT → WRITES DATA TO PERIPHERAL

CONTROL WORD REGISTER

- ACCEPTS 8 BIT CONTROL WORD WRITTEN BY MP
- CAN ONLY BE WRITTEN (NOT READ)
- CONTROL WORD CHOOSES ONE OF THE SIX MODES OF OPERATION

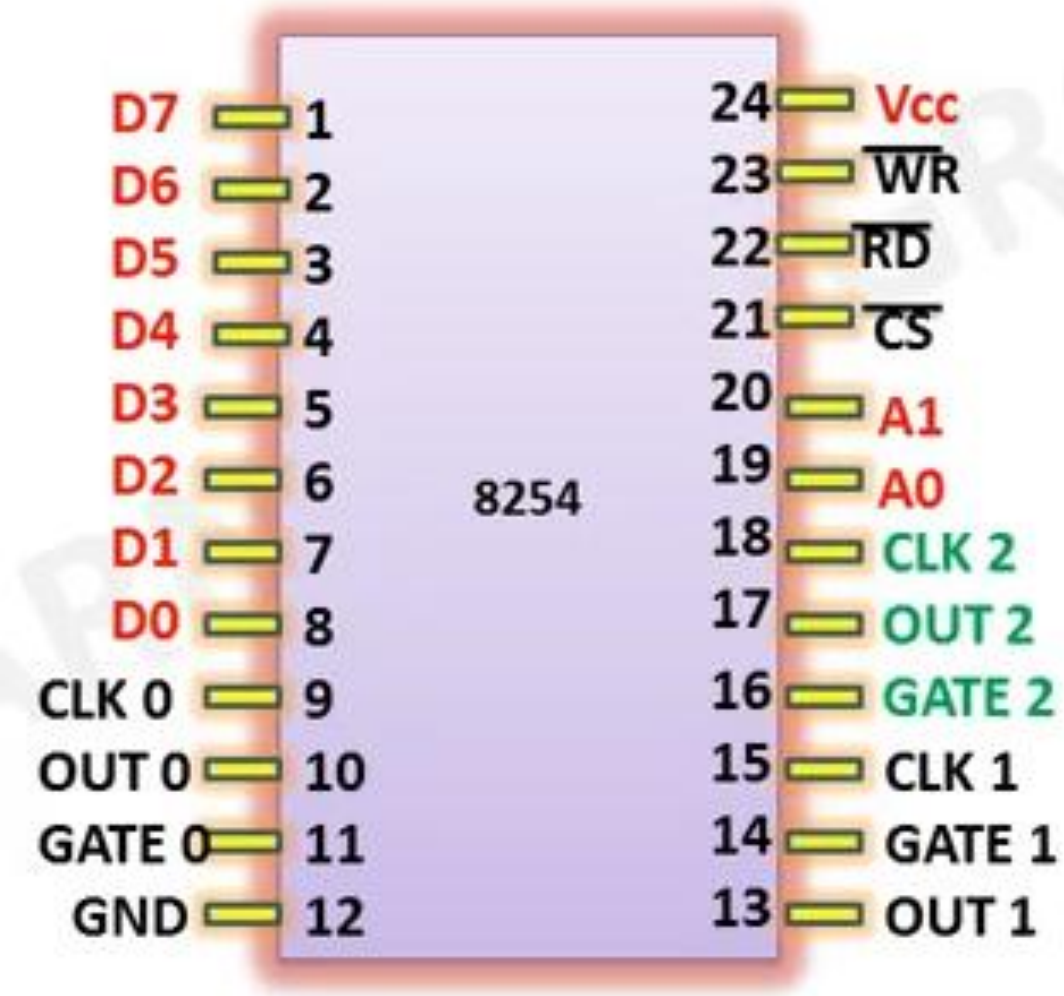
INTERNAL BLOCK DIAGRAM OF 8254

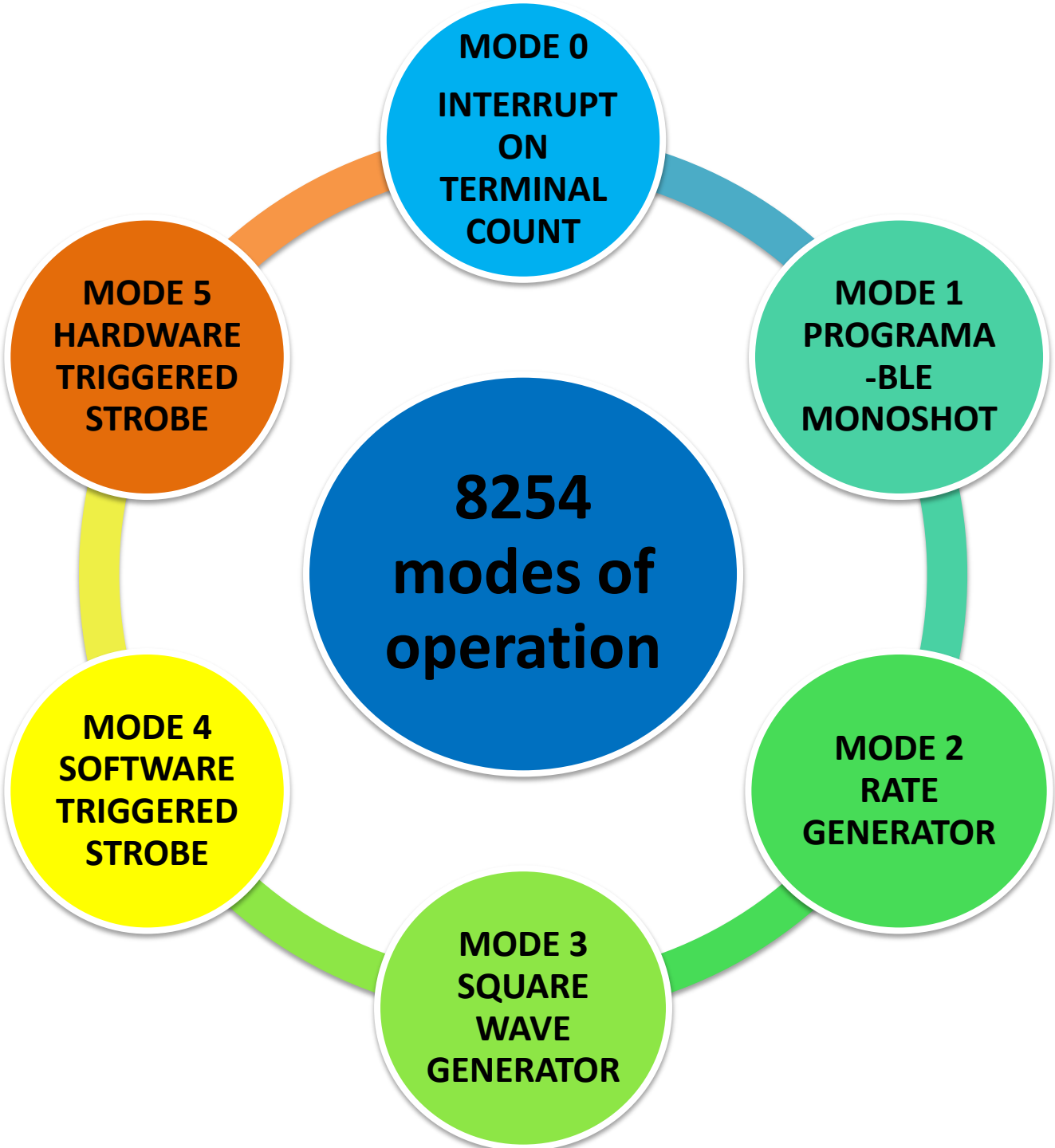
$\overline{CS}$	$\overline{RD}$	$\overline{WR}$	A1	A0	selected operation
0	1	0	0	0	Write counter 0
0	1	0	0	1	Write counter 1
0	1	0	1	0	Write counter 2
0	1	0	1	1	Write control word
0	0	1	0	0	read counter 0
0	0	1	0	1	read counter 1
0	0	1	1	0	read counter 2
0	0	1	1	1	No operation
0	1	1	x	x	no operation
1	x	x	x	x	disable

8254 PIN DIAGRAM

LOGIC PINOUT

- 24 PIN IC
- DIP PACKAGE
- +5V POWER SUPPLY




MODE 0
INTERRUPT ON TERMINAL COUNT
MODE 1
PROGRAMA -BLE MONOSHOT
MODE 2
RATE GENERATOR
MODE 3
SQUARE WAVE GENERATOR
MODE 4
SOFTWARE TRIGGERED STROBE
MODE 5
HARDWARE TRIGGERED STROBE
8254 modes of operation

8254 Operating Modes

MODE 0: INTERRUPT ON TERMINAL COUNT.

MODE 1: HARDWARE RETRIGGERABLE ONE SHOT.

MODE 2: RATE GENERATOR.

MODE 3: SQUARE WAVE GENERATOR.

MODE 4: SOFTWARE TRIGGERED STROBE.

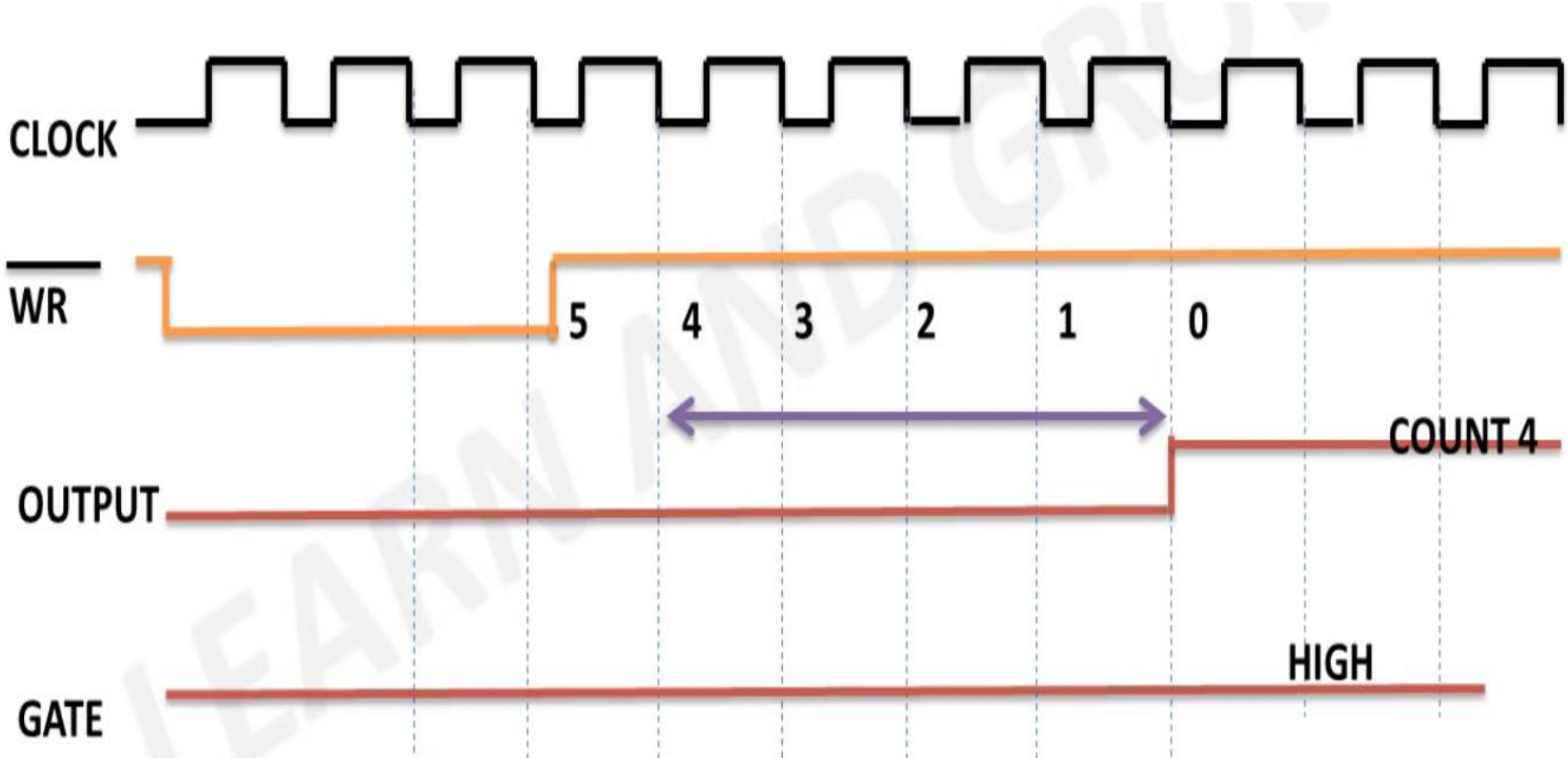
MODE 5: HARDWARE TRIGGERED STROBE.

➢ *Mode 0: INTERRUPT ON TERMINAL COUNT*

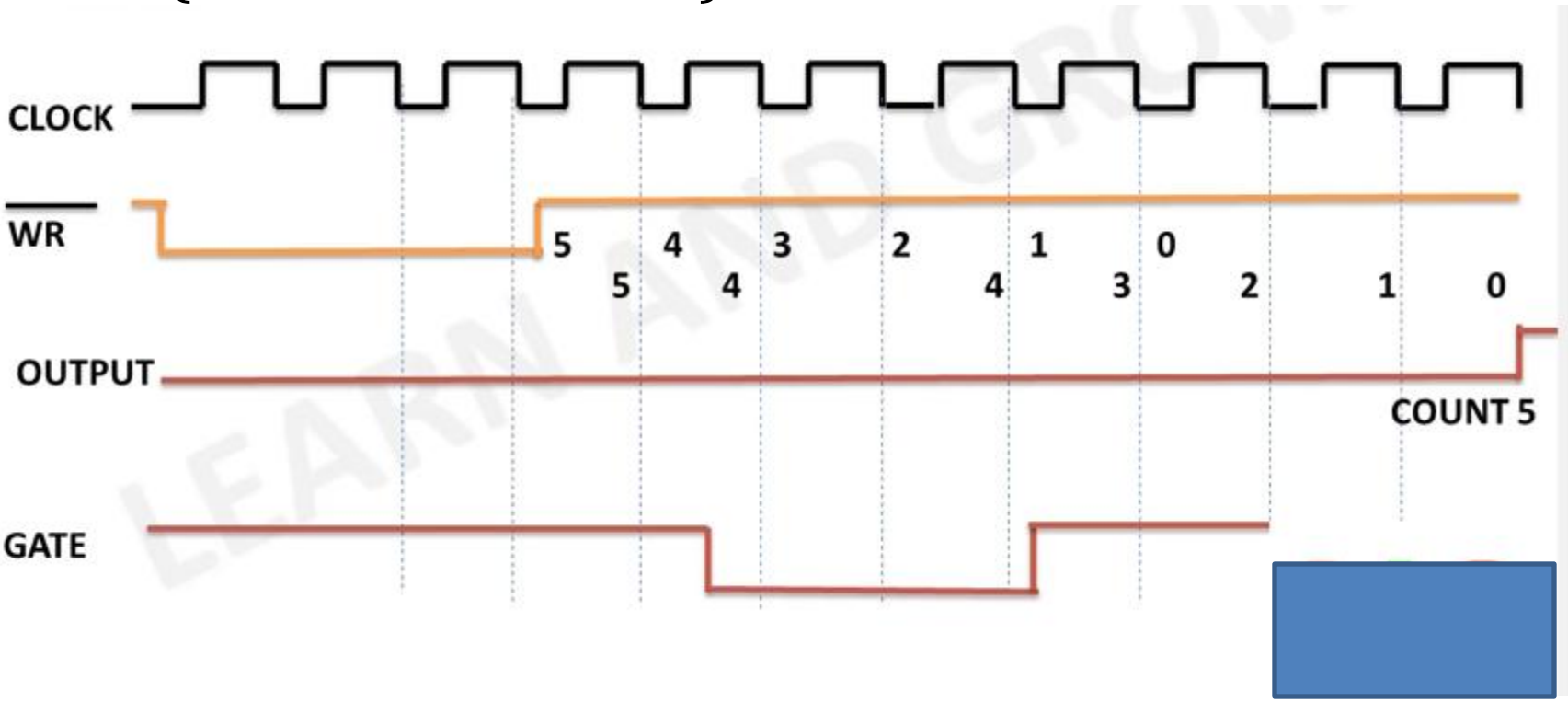
- **The output becomes a logic 0 when the control word is written**
- **Remains low even after count value loaded in counter**
- **Counter starts decrementing after falling edge of clock**
- **The OUT goes high upon reaching the terminal count & remains high till reloading**
- **OUT can be used as interrupt**
- **Writing a count register , when previous counting is in process → first byte when loaded stops the previous count, → second byte when loaded starts new count**
- **Gate high → normal counting**
- **Gate low → counting terminated and current count latched till GATE goes high again**

Mode 0: INTERRUPT ON TERMINAL COUNT

The output becomes a logic 0 when the control word is written
Counting starts with falling edge of each clock pulse
WR should be high
Gate should be high
o/p pin will be LOW



What happen if gate pulse becomes low during the counting in mode 0 then 4 remains store in latch whenever gate pulse become high again and then count starts (assume count =5)



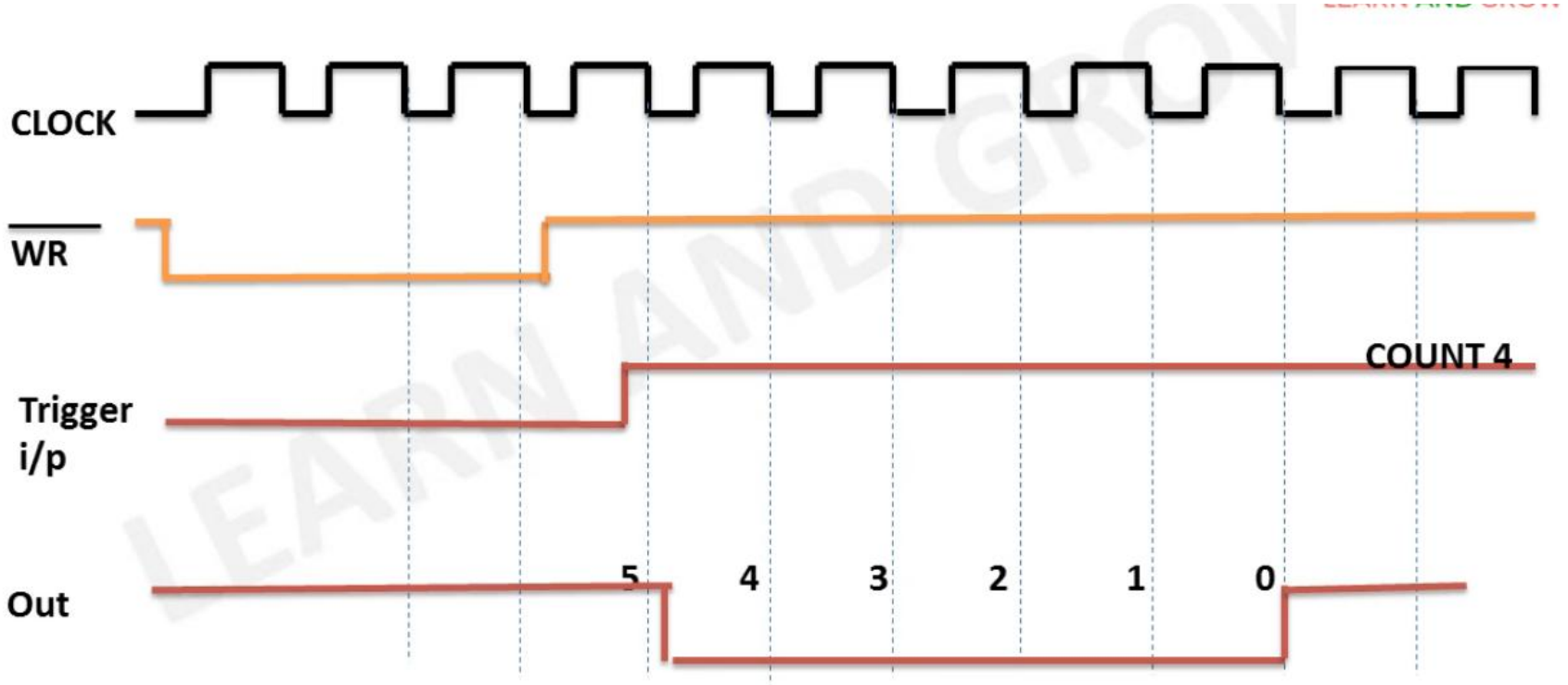
Mode 1: One-shot mode.

- known as **monostable multivibrator**
- **GATE input is used as trigger input**
- output remains high till the count is loaded
- After application of trigger, output goes low and remains low till count becomes zero
- Another count loaded, when output already low →it does not disturb counting until a new trigger is applied at the gate
- New counting starts after new trigger pulse

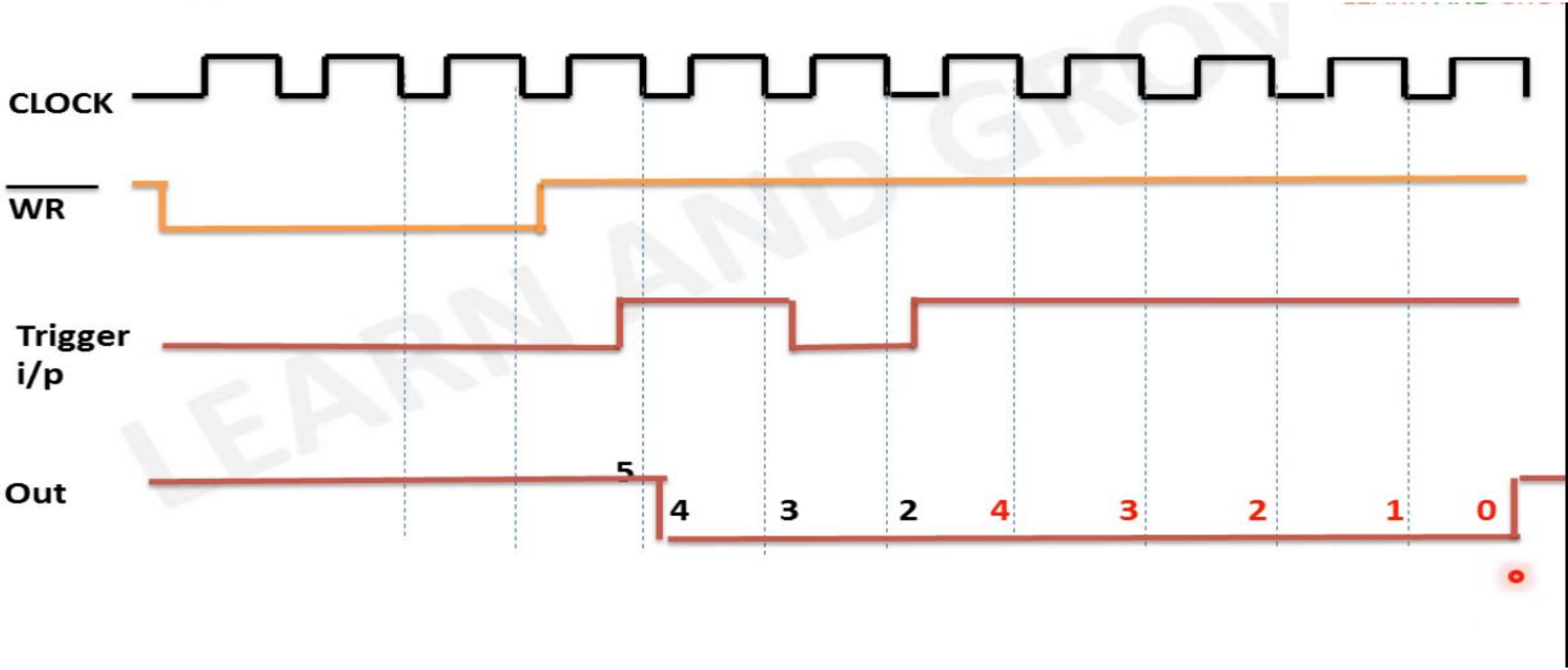
Mode 1: One-shot mode

Mode 1: One-shot mode.

The G input triggers the counter to output a 0 pulse for `count' clocks.
Counter reloaded if G is pulsed a



If trigger pulse goes low during the counting … or new count loaded in counter then counter starts again from the previous counting not disturbing that when trigger pulse goes high.



➢*Mode 2*: RATE GENERATOR / DIVIDE BY N COUNTER

➢**When N is loaded as count → after N pulses → OUT goes low for only one clock cycle→ then, count N is reloaded → OUT becomes high for N clock pulses**

➢**The number of clock pulses between the two low pulses is equal to the count loaded**

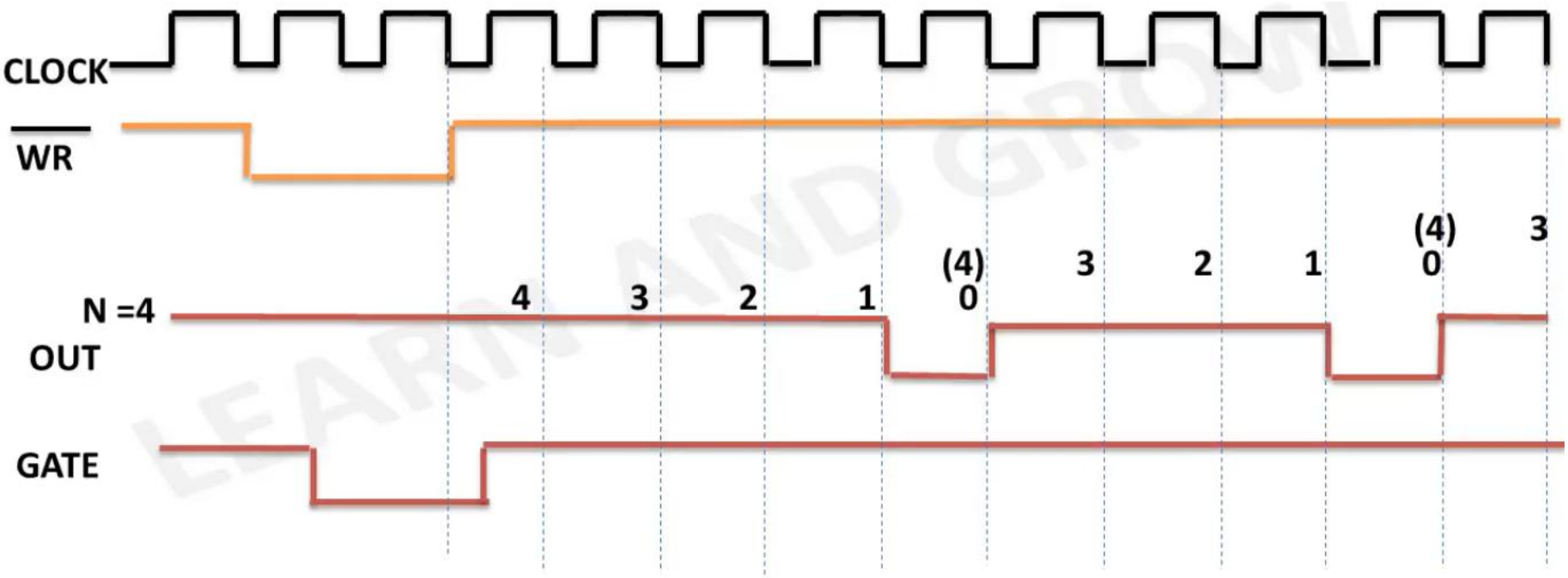
➢**gate → logic 0 → no counting**

➢**Gate → logic 1 → normal counting**

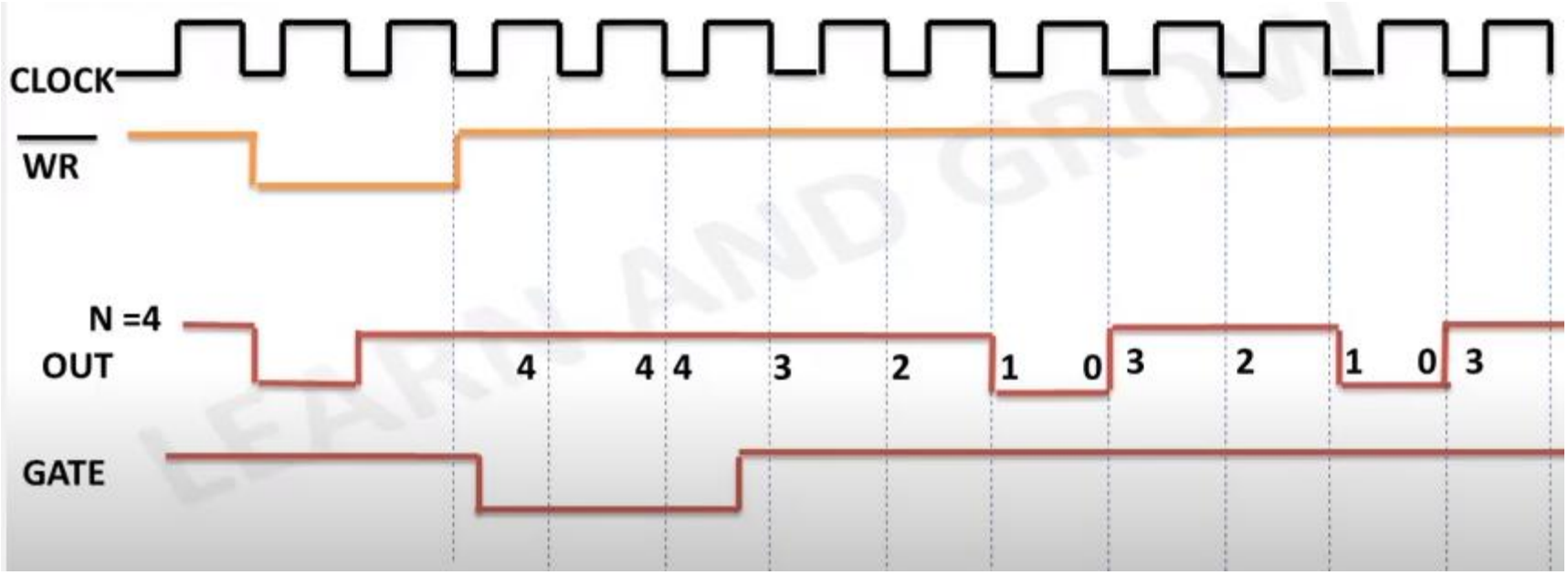
Mode 2: Counter generates a series of pulses 1 clock pulse wide.

The separation between pulses is determined by the count.
The cycle is repeated until reprogrammed or G pin set to 0.

N counter
Load count value
WR high
Work on falling edge
o/p low for I clock cycle and count from N-1
GATE should be high



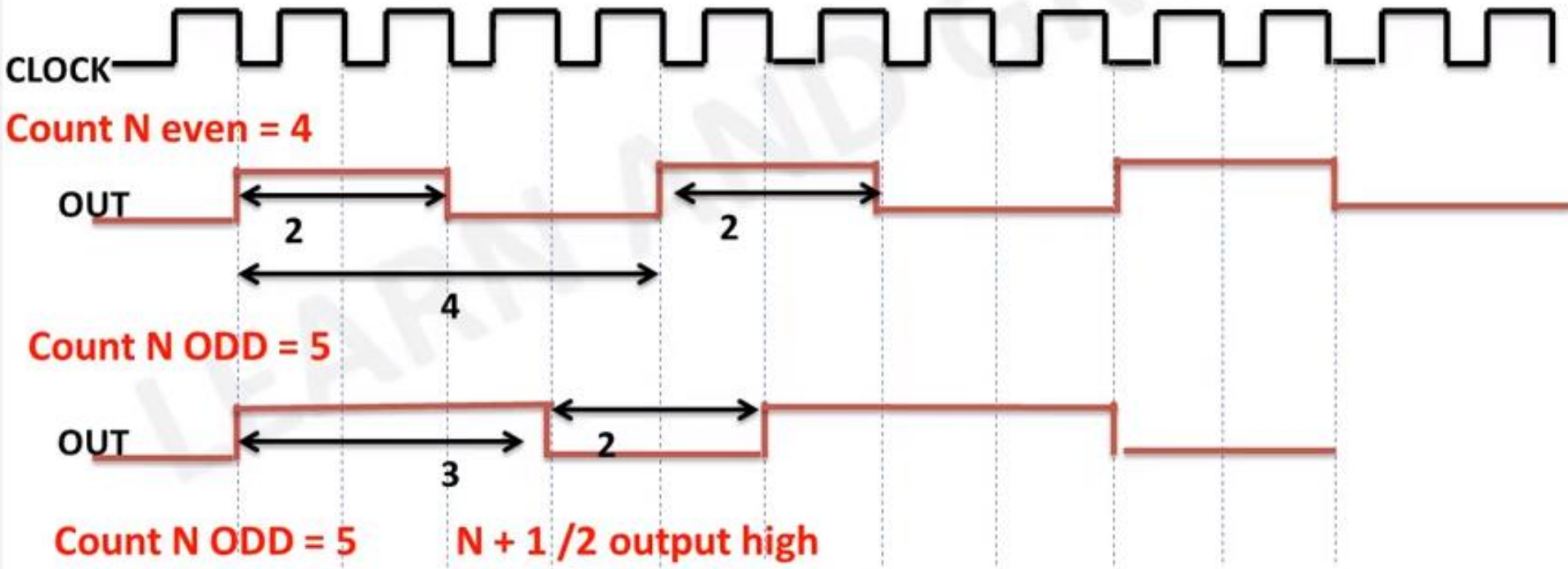
IF OUTPUT HIGH but gate LOW during COUNT then counter not COUNT and when GATE goes high count again start on next –ive falling edge



Mode 3: SQUARE WAVE RATE GENERATOR

- **When count N loaded is even → output remains HIGH for half the count and LOW for the rest half of the count**
- **When count N loaded is odd → output remains HIGH for (N+1)/2 and low for (N-1)/2.**
- **Repeated operation gives square wave**
- **Generates a continuous square-wave with GATE set to 1.**
- **If count is even, 50% duty cycle otherwise OUT is high 1 cycle longer.**

MODE 3 also called square wave generator .

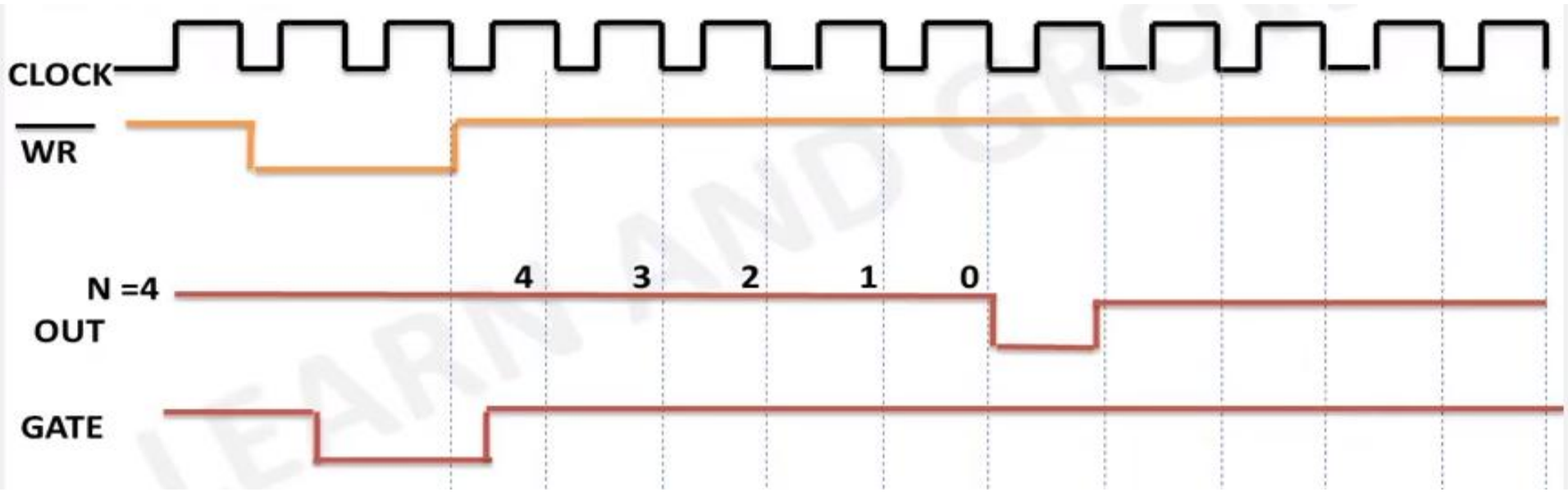


Count N ODD = 5 N + 1 /2 output high

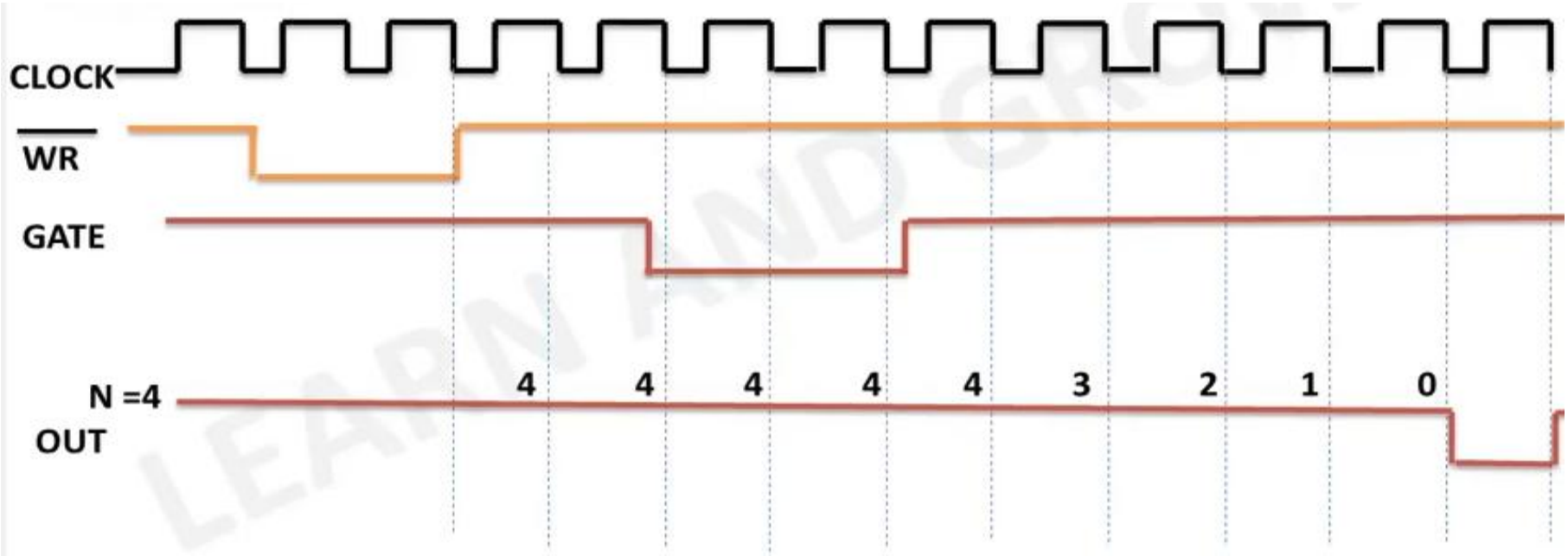
N – 1/2 OUTPUT LOW

Mode 4: Software triggered Strobe

- **After mode is set output goes high when WR and GATE high**
- **When count is loaded counting down starts**
- **On reaching terminal count output goes low for only one clock cycle, and then again output goes HIGH**
- **The above said low pulse can be used as a strobe Pulse for interfacing MP with peripherals**

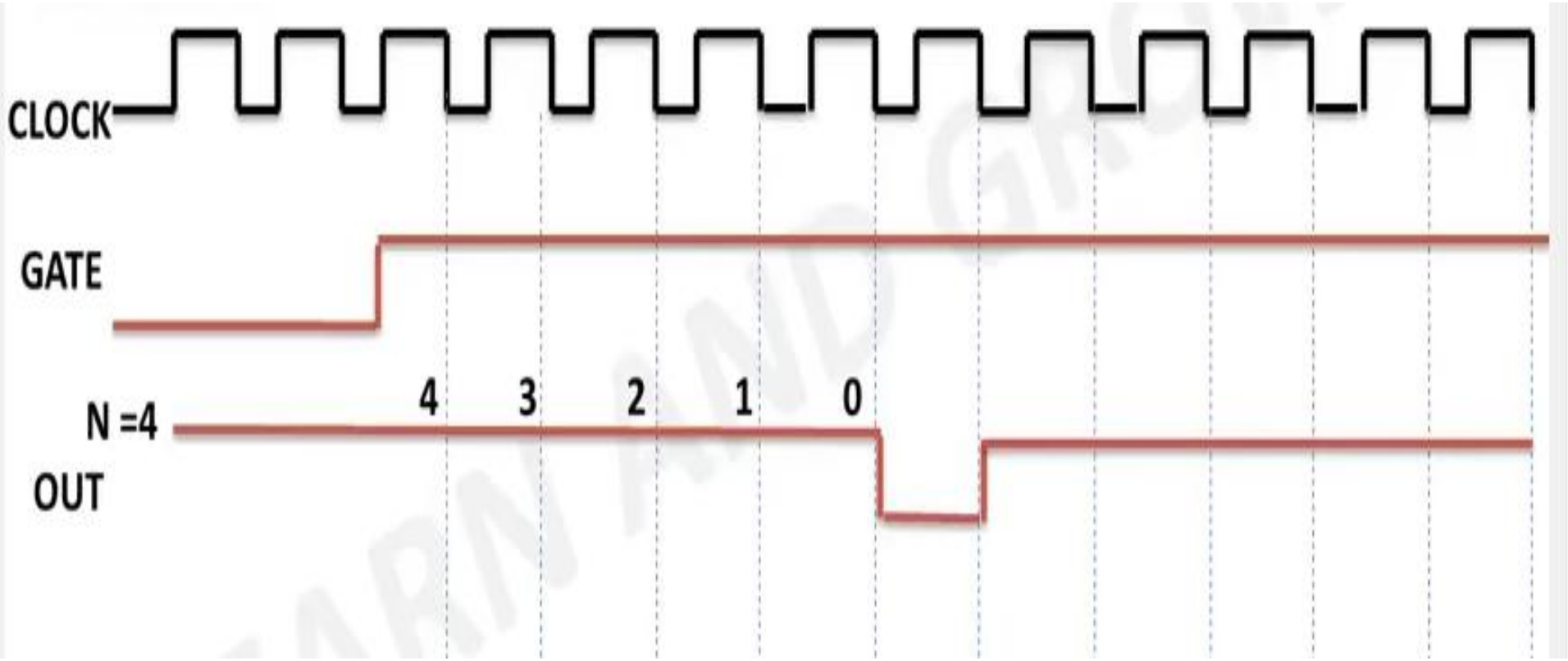

CLOCK
WR
N =4
4
3
2
1
0
OUT
GATE

- **When GATE is LOW → counting is inhibited and count is latched (remain 4 until GATE again high)**
- **If a new count is loaded while counting, previous counting stops and new counting started in next clock cycle**

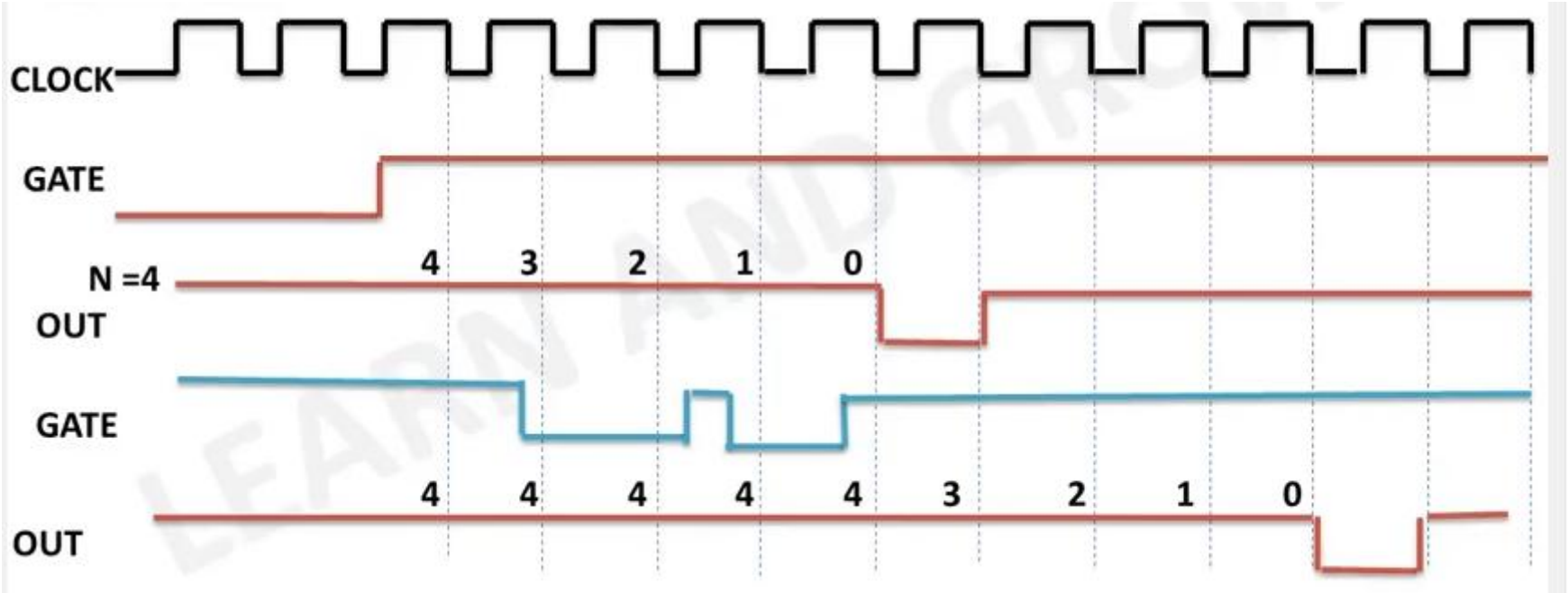


Mode 5: Hardware triggered Strobe

- This mode generates a strobe in response to the rising edge at the trigger
- Mode is used to generate a delayed strobe in response to an externally generated signal
- Once mode is programmed and counter loaded, OUT goes HIGH
- **Counter starts counting after the rising edge of the trigger** (GATE)
- The OUTPUT goes LOW for one clock period, when the terminal count is reached (next pulse use as strobe)
- Output will not go LOW until the counter content becomes zero after the rising edge of any trigger
- **GATE is used as trigger input**


CLOCK
GATE
N =4
4
3
2
1
0
OUT

If GATE goes low during the COUNT then count latch the count 4 until GATE remains HIGH completely for all input cycles

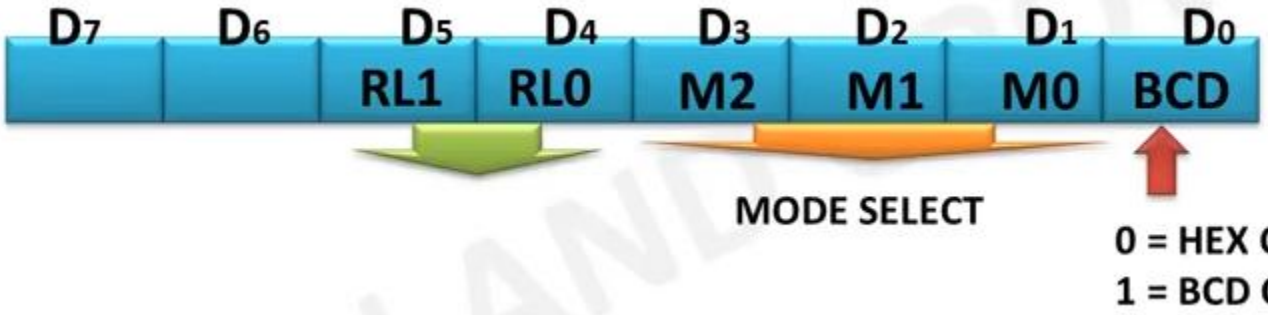


8254 CONTROL WORD REGISTER

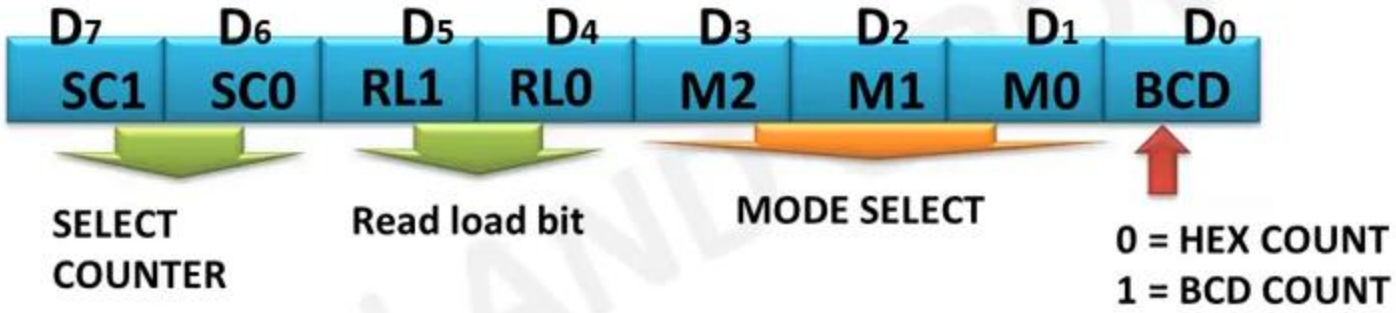
0 = HEX COUNT

1 = BCD COUNT

M2	M1	M0	SELECT MODE
0	0	0	MODE 0
0	0	1	MODE 1
X	1	0	MODE 2
X	1	1	MODE 3
1	0	0	MODE 4
1	0	1	MODE 5



RL1	RL0	OPERATION
0	0	latch count on the fly reading
0	1	read least significant bit only
1	0	read most significant bit only
1	1	read first LSB then MSB



SC1	SC0	OPERATION
0	0	SELECT COUNTER 0
0	1	SELECT COUNTER 1
1	0	SELECT COUNTER 2
1	1	ILLEGAL

Status register:

- shows the state of the output pin
- check the counter is in NULL state (0) or not
- how the counter is programmed

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
Output	Null Count	RW1	RW0	M2	M1	M0	BCD

D_7 1 = OUT Pin is 1
0 = OUT Pin is 0

D_6 1 = Null Count
0 = Count available for reading

D_5–D_0 Counter programmed mode

8254 PROGRAMMABLE INTERVAL TIMER

➢ Example

Write a program to initialize counter 2 in mode 0 with a count of C030H. Assume address for control register = 0BH, counter 0 = 08H, counter 1 = 09H and counter 2 = 0AH.

Sol. : Control word

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	
SC_1	SC_2	RW_1	RW_0	M_2	M_1	M_0	BCD	
1	0	1	1	0	0	0	0	= B0H

Source Program

```
MOV  AL,B0H
OUT  0BH,AL        ; Loads control word (B0H) in the control
                   ; register.
MOV  AL,30H
OUT  0AH,AL        ; Loads lower byte of (30H)the count.
MOV  AL,0C0H
OUT  0AH,AL        ; Loads higher byte (C0H) of the count.
```