



# درس میکرو پروسیسور

جلسه دوم

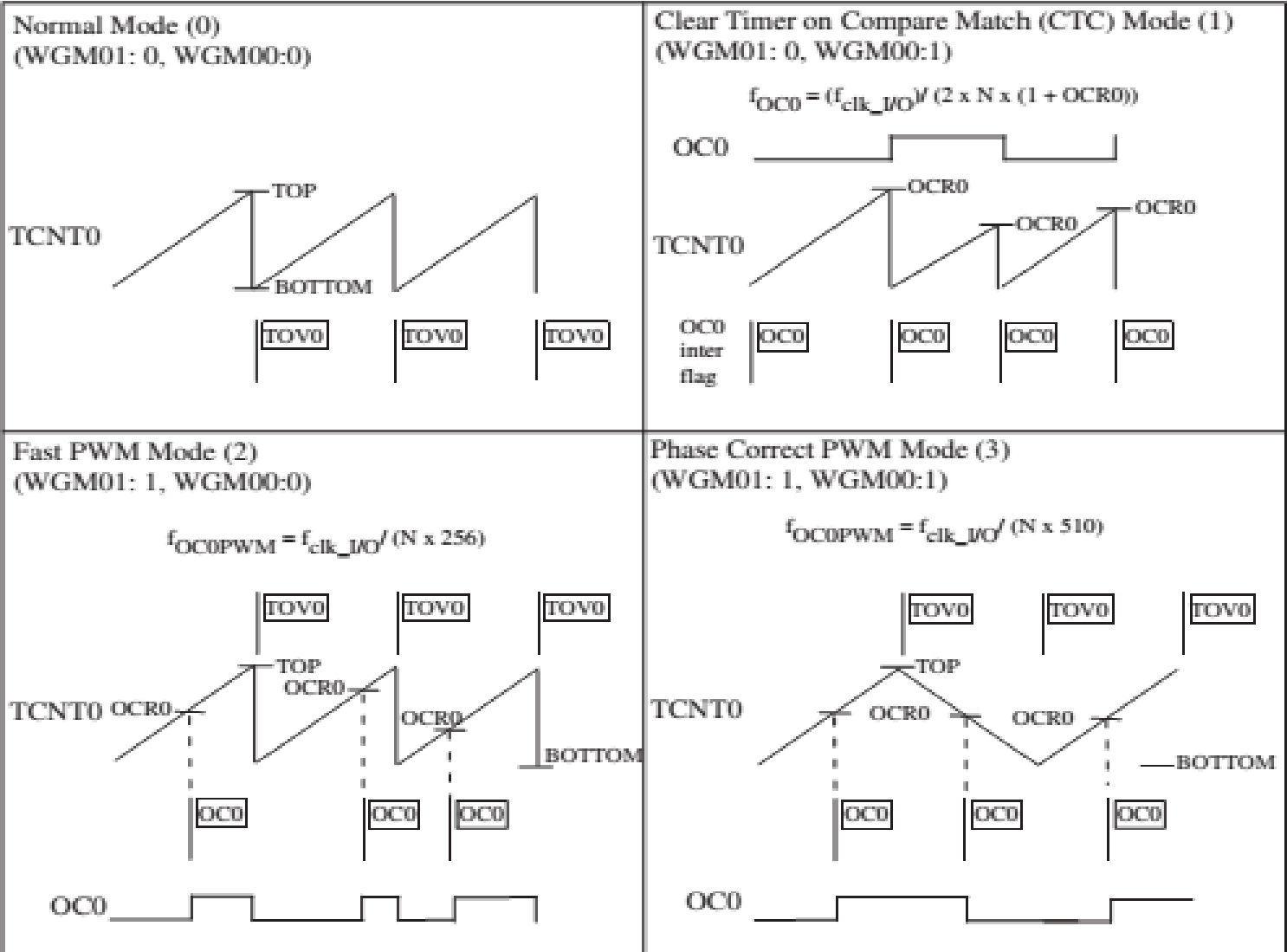
- -Timers



- Timers in AVR
- ATmega32: 3 timers
- – Timer0 (8-bit)
- – Timer1 (16-bit)
- – Timer2 (8-bit)

<b>Timer 0</b>	<b>Timer 1</b>	<b>Timer 2</b>
<ul style="list-style-type: none"> <li>- 8-bit timer/counter</li> <li>- 10-bit clock prescaler</li> <li>- Functions:               <ul style="list-style-type: none"> <li>– Pulse width modulation</li> <li>– Frequency generation</li> <li>– Event counter</li> <li>– Output compare</li> </ul> </li> <li>- Modes of operation:               <ul style="list-style-type: none"> <li>– Normal</li> <li>– Clear timer on compare match (CTC)</li> <li>– Fast PWM</li> <li>– Phase correct PWM</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- 16-bit timer/counter</li> <li>- 10-bit clock prescaler</li> <li>- Functions:               <ul style="list-style-type: none"> <li>– Pulse width modulation</li> <li>– Frequency generation</li> <li>– Event counter</li> <li>– Output compare – 2 ch</li> <li>– Input capture</li> </ul> </li> <li>- Modes of operation:               <ul style="list-style-type: none"> <li>– Normal</li> <li>– Clear timer on compare match (CTC)</li> <li>– Fast PWM</li> <li>– Phase correct PWM</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- 8-bit timer/counter</li> <li>- 10-bit clock prescaler</li> <li>- Functions:               <ul style="list-style-type: none"> <li>– Pulse width modulation</li> <li>– Frequency generation</li> <li>– Event counter</li> <li>– Output compare</li> </ul> </li> <li>- Modes of operation:               <ul style="list-style-type: none"> <li>– Normal</li> <li>– Clear timer on compare match (CTC)</li> <li>– Fast PWM</li> <li>– Phase correct PWM</li> </ul> </li> </ul>

# Timer 0 modes of operation





# Timer 0 & Timer2

Timer/Counter Control Register (TCCR0)

FOC0	WGM00	COM01	COM00	WGM01	CS02	CS01	CS00
7				0			

Timer/Counter Register (TCNT0)

7				0			

Output Compare Register (OCR0)

7				0			

Timer/Counter Interrupt Mask Register (TIMSK)

OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0
7				0			

Timer/Counter Interrupt Flag Register (TIFR)

OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0
7				0			

Timer/Counter Control Register (TCCR2)

FOC2	WGM20	COM21	COM20	WGM21	CS22	CS21	CS20
7				0			

Timer/Counter Register (TCNT2)

7				0			

Output Compare Register (OCR2)

7				0			

Timer/Counter Interrupt Mask Register (TIMSK)

OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0
7				0			

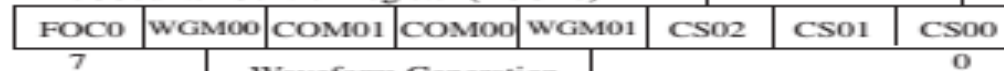
Timer/Counter Interrupt Flag Register (TIFR)

OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0
7				0			

# TCCR0 bit settings: Timer 0

CS0[2:0]	Clock Source
000	None
001	$\text{clk}_{I/O}$
010	$\text{clk}_{I/O}/8$
011	$\text{clk}_{I/O}/64$
100	$\text{clk}_{I/O}/8\text{clk}_{I/O}/256$
101	$\text{clk}_{I/O}/8\text{clk}_{I/O}/1024$
110	External clock on T0 (falling edge trigger)
111	External clock on T1 (rising edge trigger)

Timer/Counter Control Register (TCCR0)



Mode	WGM00:01	Mode
0	00	Normal
1	10	PWM, Phase Correct
2	01	CTC
3	11	Fast PWM

Normal, CTC

COM0[1:0]	Description
00	Normal, OC0 disconnected
01	Toggle OC0 on compare match
10	Clear OC0 on compare match
11	Set OC0 on compare match

PWM, Phase Correct

COM0[1:0]	Description
00	Normal, OC0 disconnected
01	Reserved
10	Clear OC0 on compare match when up-counting. Set OC0 on compare match when down counting
11	Set OC0 on compare match when up-counting. Clear OC0 on compare match when down counting.

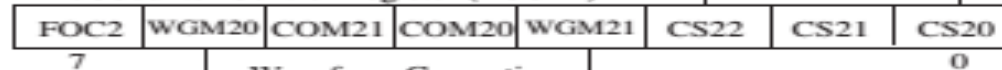
Fast PWM

COM0[1:0]	Description
00	Normal, OC0 disconnected
01	Reserved
10	Clear OC0 on compare match, set OC0 at TOP
11	Set OC0 on compare match, clear OC0 at TOP

# TCCR0 bit settings: Timer 2

CS2[2:0]	Clock Source
000	None
001	$\text{clk}_{I/O}$
010	$\text{clk}_{I/O}/8$
011	$\text{clk}_{I/O}/64$
100	$\text{clk}_{I/O}/8\text{clk}_{I/O}/256$
101	$\text{clk}_{I/O}/8\text{clk}_{I/O}/1024$
110	External clock on T0 (falling edge trigger)
111	External clock on T1 (rising edge trigger)

Timer/Counter Control Register (TCCR2)



Mode	WGM20:21	Mode
0	00	Normal
1	10	PWM, Phase Correct
2	01	CTC
3	11	Fast PWM

Normal, CTC

COM2[1:0]	Description
00	Normal, OC2 disconnected
01	Toggle OC2 on compare match
10	Clear OC2 on compare match
11	Set OC2 on compare match

PWM, Phase Correct

COM2[1:0]	Description
00	Normal, OC2 disconnected
01	Reserved
10	Clear OC2 on compare match when up-counting. Set OC2 on compare match when down counting
11	Set OC2 on compare match when up-counting. Clear OC2 on compare match when down counting.

Fast PWM

COM2[1:0]	Description
00	Normal, OC2 disconnected
01	Reserved
10	Clear OC2 on compare match, set OC2 at TOP
11	Set OC2 on compare match, clear OC2 at TOP



# Timer 1

Timer/Counter 1 Control Register A (TCCR1A)

COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10
7						0	

Timer/Counter 1 Control Register B (TCCR1B)

ICNC1	ICES1	—	WGM13	WGM12	CS12	CS11	CS10
7						0	

Timer Counter1 (TCNT1H/TCNT1L)

15							8
7							0

Output Compare Register 1 A (OCR1AH/OCR1AL)

15							8
7							0

Output Compare Register 1 B (OCR1BH/OCR1BL)

15							8
7							0

Input Capture Register 1 (ICR1H/ICR1L)

15							8
7							0

Timer/Counter Interrupt Mask Register (TIMSK)

OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0
7						0	

Timer/Counter Interrupt Flag Register (TIFR)

OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0
7						0	



# Timer 1

CS0[2:0]	Clock Source
000	None
001	clk <sub>I/O</sub>
010	clk <sub>I/O</sub> /8
011	clk <sub>I/O</sub> /64
100	clk <sub>I/O</sub> /8clk <sub>I/O</sub> /256
101	clk <sub>I/O</sub> /8clk <sub>I/O</sub> /1024
110	External clock on T0 (falling edge trigger)
111	External clock on T1 (rising edge trigger)

Timer/Counter 1 Control Register B (TCCR1B)

ICNC1	ICES1	—	WGM13	WGM12	CS12	CS11	CS10
7							0

Timer/Counter 1 Control Register A (TCCR1A)

COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10
7							0

Waveform Generation Mode

Mode	WGM1[3:2:1:0]	Mode
0	0000	Normal
1	0001	PWM, Phase Correct, 8-bit
2	0010	PWM, Phase Correct, 9-bit
3	0011	PWM, Phase Correct, 10-bit
4	0100	CTC
5	0101	Fast PWM, 8-bit
6	0110	Fast PWM, 9-bit
7	0111	Fast PWM, 10-bit
8	1000	PWM, Phase & Freq Correct
9	1001	PWM, Phase & Freq Correct
10	1010	PWM, Phase Correct
11	1011	PWM, Phase Correct
12	1100	CTC
13	1101	Reserved
14	1110	Fast PWM
15	1111	Fast PWM

Clock Select

Normal, CTC

COMx[1:0]	Description
00	Normal, OC1A/1B disconnected
01	Toggle OC1A/1B on compare match
10	Clear OC1A/1B on compare match
11	Set OC1A/1B on compare match

PWM, Phase Correct, Phase & Freq Correct

COMx[1:0]	Description
00	Normal, OC0 disconnected
01	WGM1[3:0] = 9 or 14: toggle OCnA on compare match, OCnB disconnected
10	WGM1[3:0] = other settings, OC1A/1B disconnected Clear OC0 on compare match when up-counting. Set OC0 on compare match when down counting
11	Set OC0 on compare match when up-counting. Clear OC0 on compare match when down counting.

Fast PWM

COMx[1:0]	Description
00	Normal, OC1A/1B disconnected
01	WGM1[3:0] = 15, toggle OC1A on compare match OC1B disconnected
10	WGM1[3:0] = other settings, OC1A/1B disconnected Clear OC1A/1B on compare match, set OC1A/1B at TOP
11	Set OC1A/1B on compare match, clear OC1A/1B at TOP