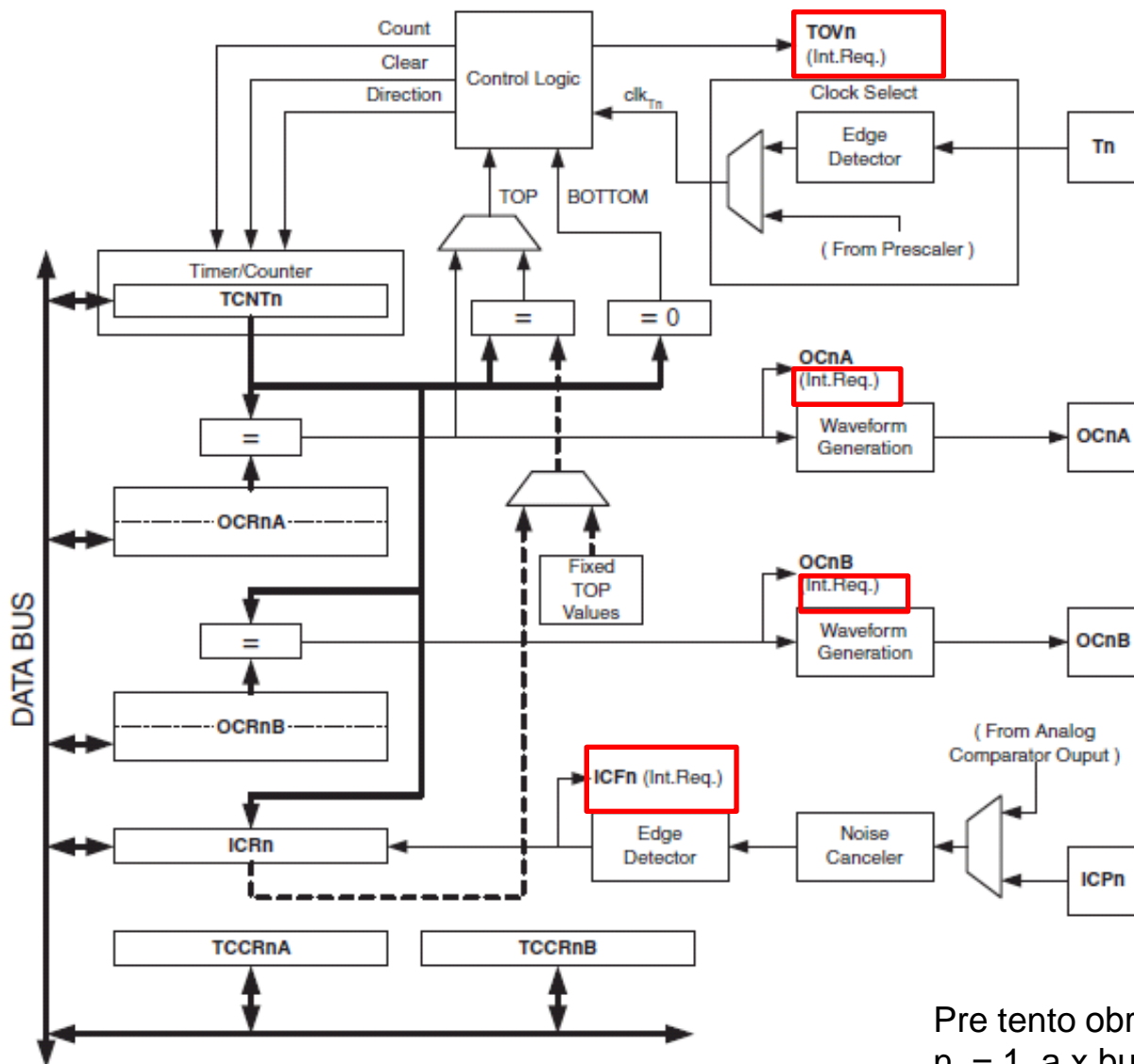


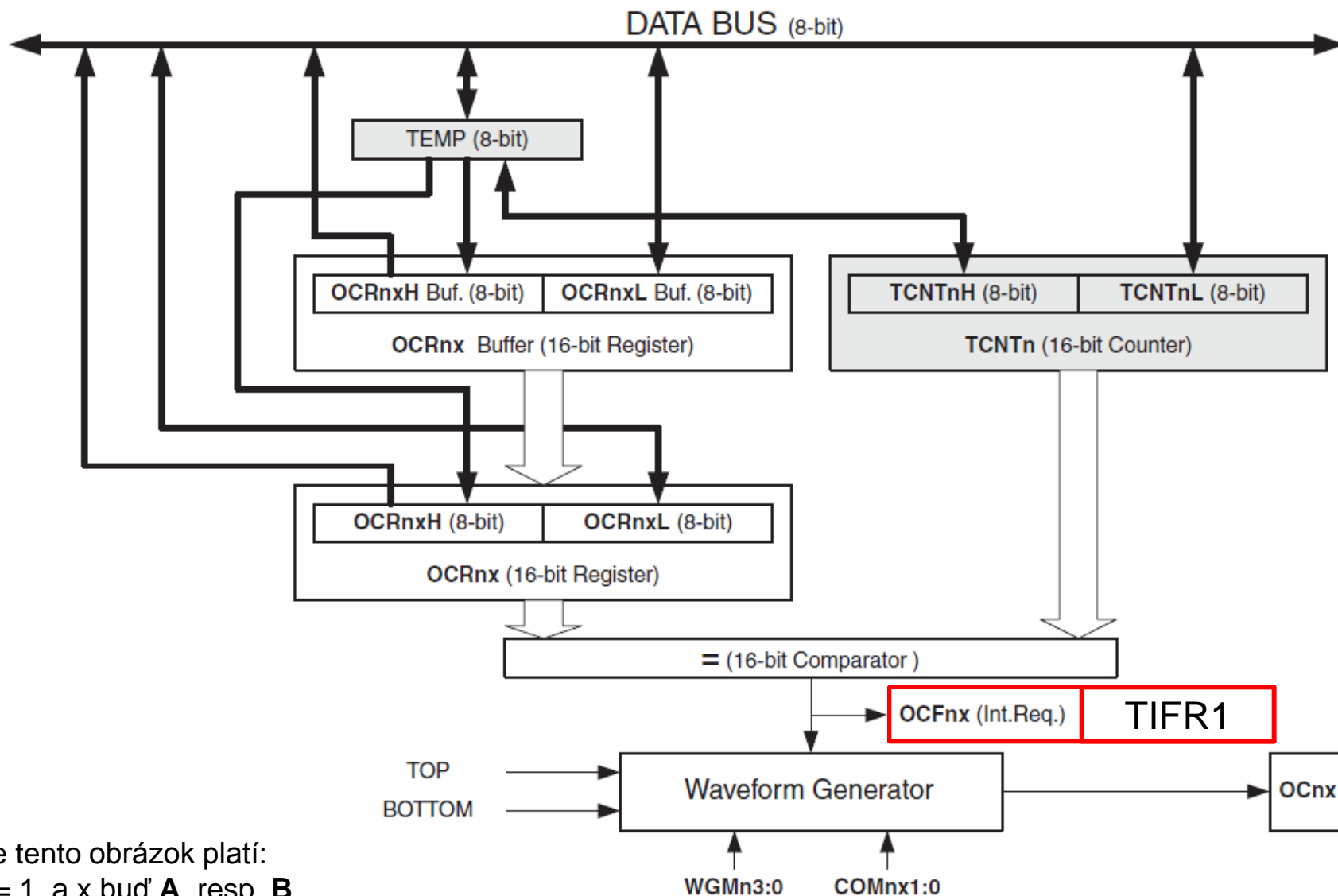
Prednáška 5.

Počítadlá / časovače (T/C), časť 2.



Pre tento obrázok platí:
n = 1, a x buď **A**, resp. **B**

Výstupný komparačný blok - Output Compare Units



Pre tento obrázok platí:
 $n = 1$, a x buď **A**, resp. **B**

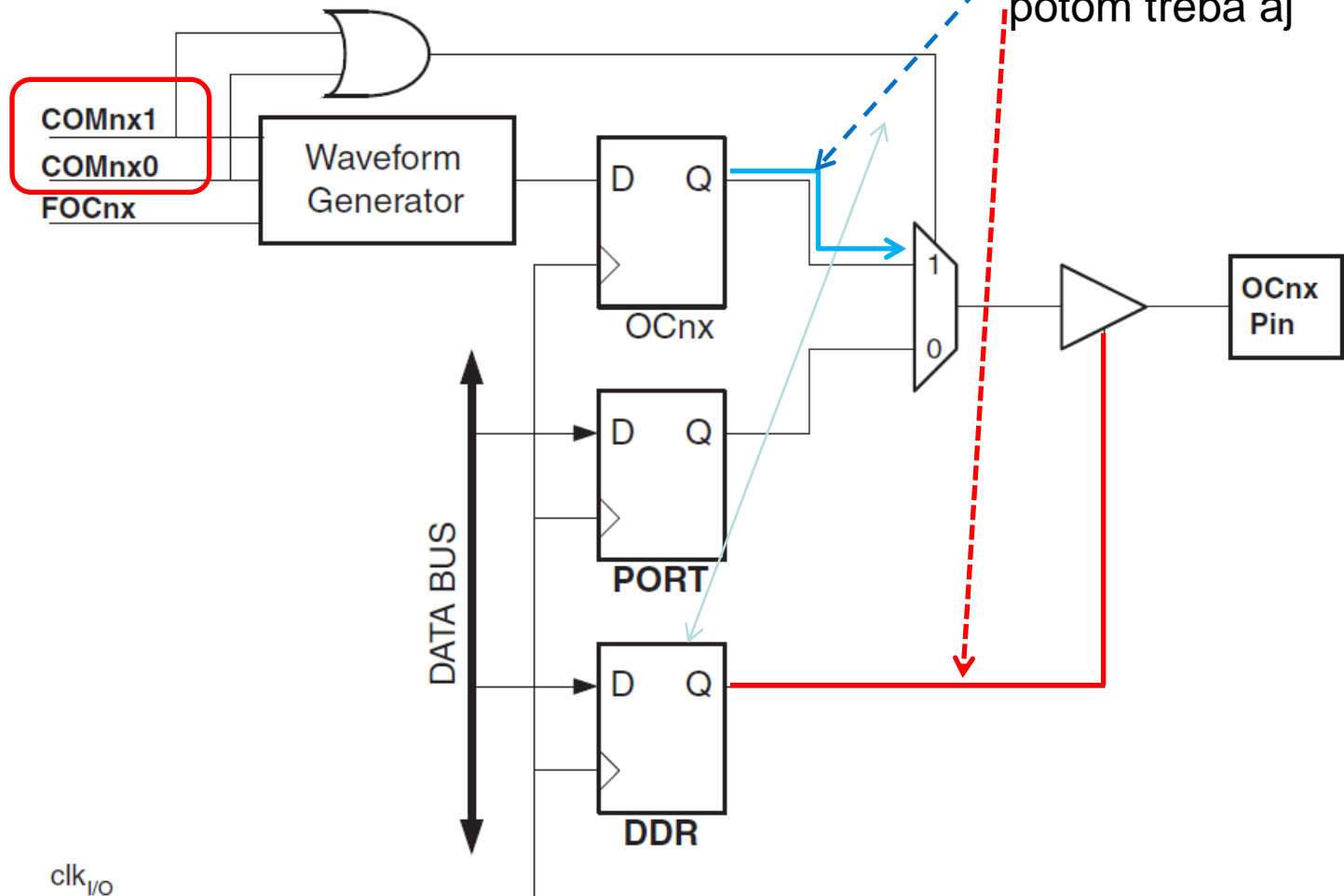
Využitie výstupnej komparačnej jednotky

COM1x1:0 majú dve funkcie :

1. Definuje stav výstupu OC1x pri nasledovnej zhode.
2. Riadia zdroj pre OC1x.

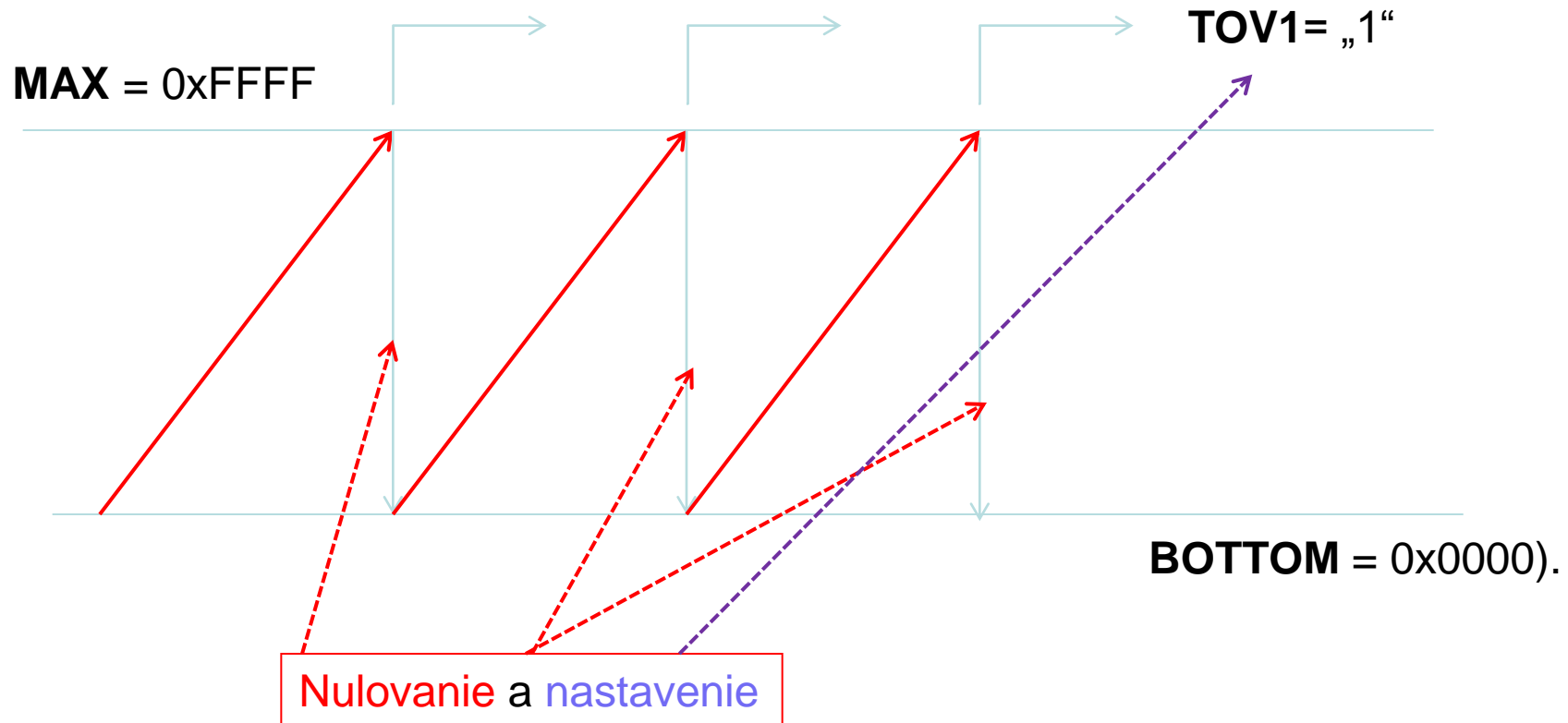
!! Pozor !!

ak potom treba aj



Normal Mode (WGM13:0= 0)

V tomto móde sa vždy počíta smerom hore.

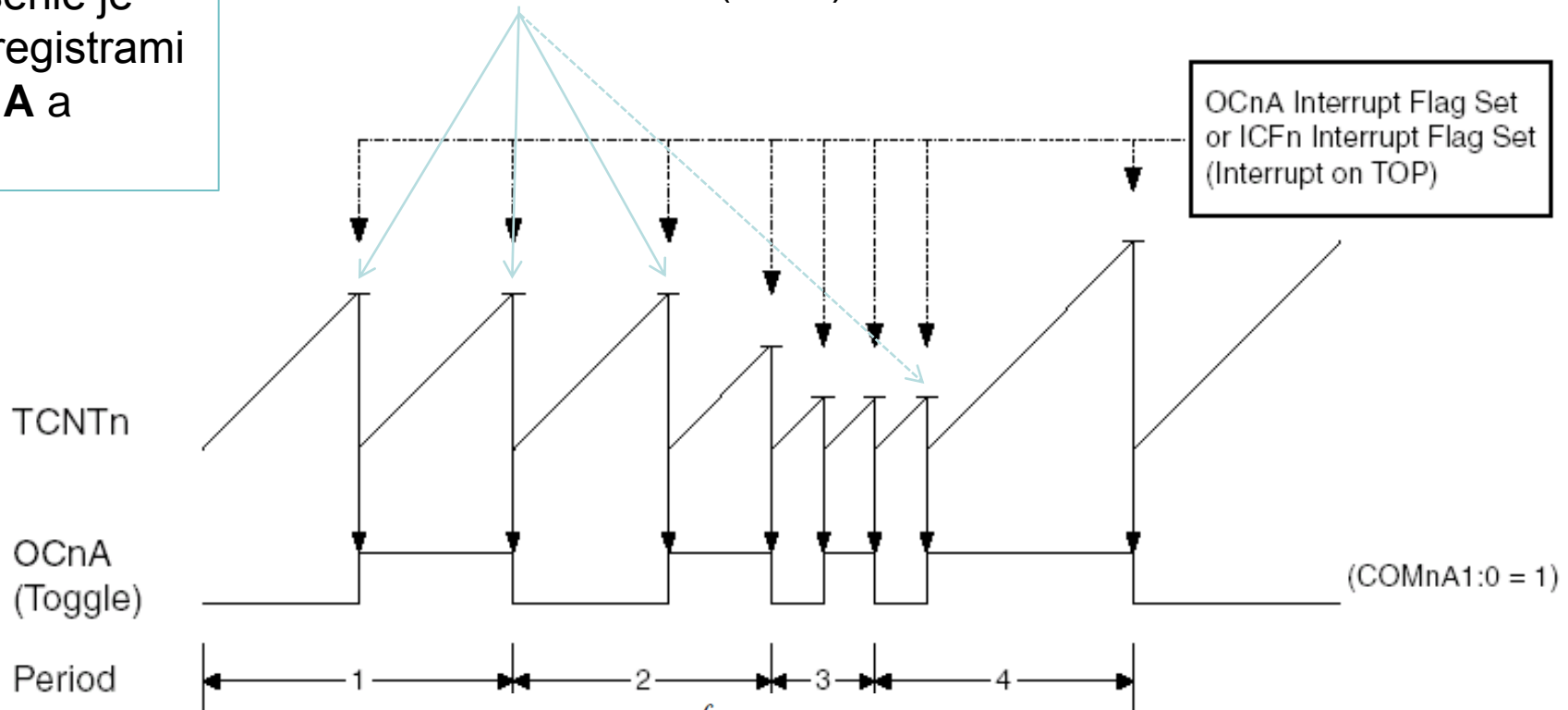


Clear Timer on Compare Match (CTC) Mode (= 4, 12)

Mode	WGM13	WGM12	WGM11	WGM10	Timer/Counter Mode of Operation	TOP	Update of OCR1X at	TOV1 Flag Set on
4	0	1	0	0	CTC	OCR1A	Immediate	MAX
12	1	1	0	0	CTC	ICR1	Immediate	MAX

Rozlíšenie je dané registrami **OCR1A** a **ICR1**

TCNT1 = OCR1A (ICR1)



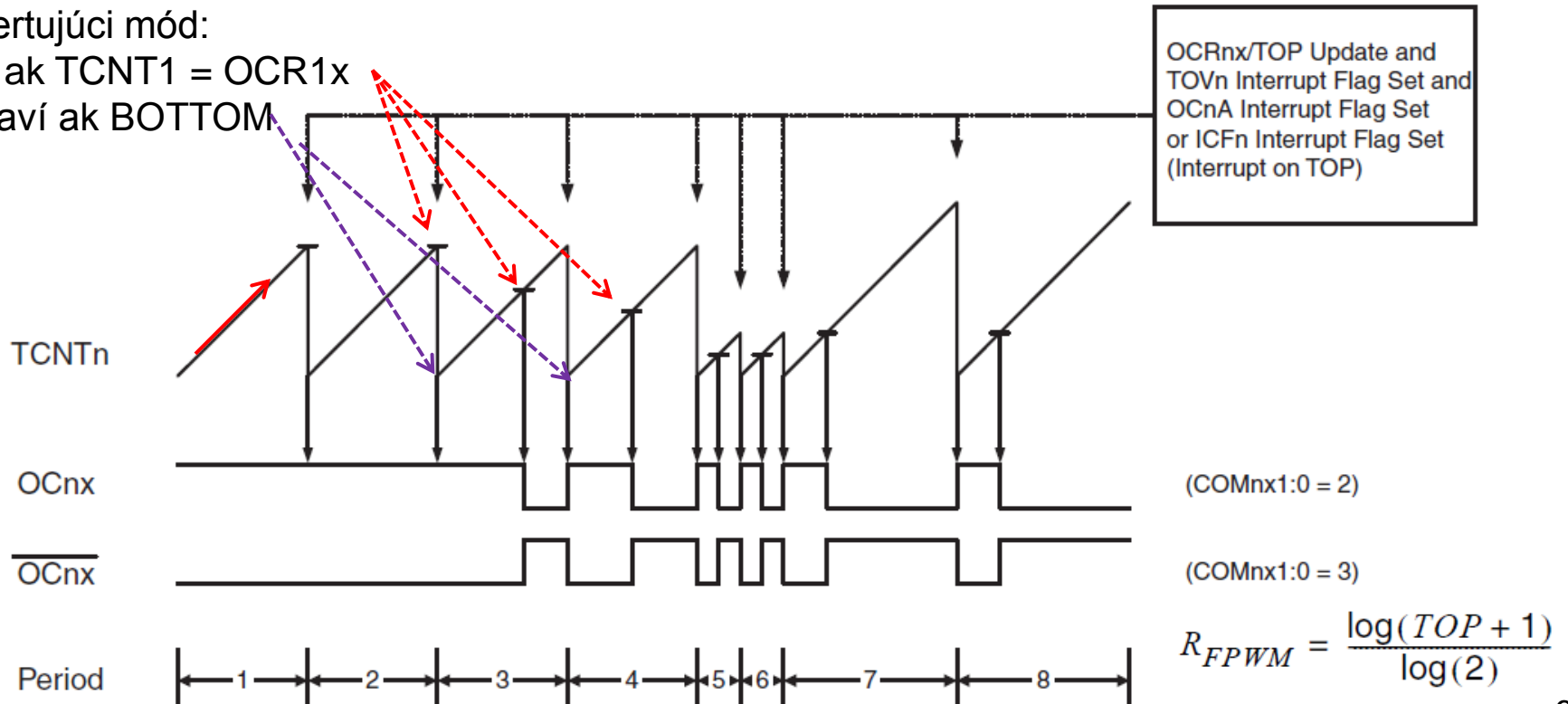
$$f_{OCnA} = \frac{f_{clk_IO}}{2 \cdot N \cdot (1 + OCRnA)}$$

N = 1, 8, 64, 256, 1024

Fast PWM Mode (WGM13:0= 5,6,7,14,15)

Mode	WGM13	WGM12	WGM11	WGM10	Timer/Counter Mode of Operation	TOP	Update of OCR1X at	TOV1 Flag Set on
5	0	1	0	1	Fast PWM, 8-bit	0x00FF	BOTTOM	TOP
6	0	1	1	0	Fast PWM, 9-bit	0x01FF	BOTTOM	TOP
7	0	1	1	1	Fast PWM, 10-bit	0x03FF	BOTTOM	TOP
14	1	1	1	0	Fast PWM	ICR1	BOTTOM	TOP
15	1	1	1	1	Fast PWM	OCR1A	BOTTOM	TOP



Neinvertujúci mód:
 nuluje ak $TCNT1 = OCR1x$
 a nastaví ak BOTTOM

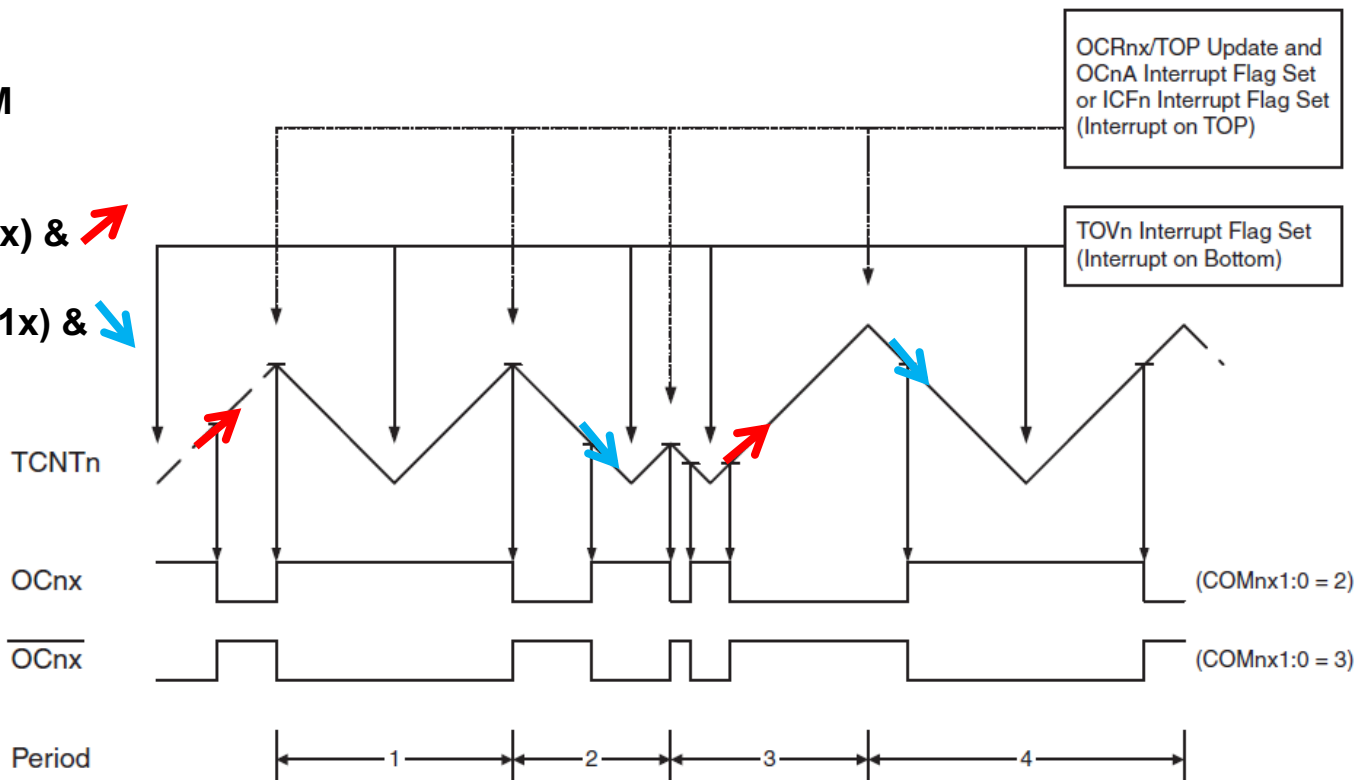


Phase Correct PWM Mode

Mode	WGM13	WGM12	WGM11	WGM10	Timer/Counter Mode of Operation	TOP	Update of OCR1X at	TOV1 Flag Set on
1	0	0	0	1	PWM, Phase Correct, 8-bit	0x00FF	TOP	BOTTOM
2	0	0	1	0	PWM, Phase Correct, 9-bit	0x01FF	TOP	BOTTOM
3	0	0	1	1	PWM, Phase Correct, 10-bit	0x03FF	TOP	BOTTOM
10	1	0	1	0	PWM, Phase Correct	ICR1	TOP	BOTTOM
11	1	0	1	1	PWM, Phase Correct	OCR1A	TOP	BOTTOM

Počíta – hore do TOP a
– dole do BOTTOM

Neinvertujúci mód:
nuluje ak $(TCNT1 = OCR1x)$ & 
a
nastaví ak $(TCNT1 = OCR1x)$ & 



Možné módy generovania signálu na výstupe

Mode	WGM13	WGM12	WGM11	WGM10	Timer/Counter Mode of Operation	TOP	Update of OCR1X at	TOV1 Flag Set on
0	0	0	0	0	Normal	0xFFFF	Immediate	MAX
1	0	0	0	1	PWM, Phase Correct, 8-bit	0x00FF	TOP	BOTTOM
2	0	0	1	0	PWM, Phase Correct, 9-bit	0x01FF	TOP	BOTTOM
3	0	0	1	1	PWM, Phase Correct, 10-bit	0x03FF	TOP	BOTTOM
4	0	1	0	0	CTC	OCR1A	Immediate	MAX
5	0	1	0	1	Fast PWM, 8-bit	0x00FF	BOTTOM	TOP
6	0	1	1	0	Fast PWM, 9-bit	0x01FF	BOTTOM	TOP
7	0	1	1	1	Fast PWM, 10-bit	0x03FF	BOTTOM	TOP
8	1	0	0	0	PWM, Phase and Frequency Correct	ICR1	BOTTOM	BOTTOM
9	1	0	0	1	PWM, Phase and Frequency Correct	OCR1A	BOTTOM	BOTTOM
10	1	0	1	0	PWM, Phase Correct	ICR1	TOP	BOTTOM
11	1	0	1	1	PWM, Phase Correct	OCR1A	TOP	BOTTOM
12	1	1	0	0	CTC	ICR1	Immediate	MAX
13	1	1	0	1	(Reserved)	–	–	–
14	1	1	1	0	Fast PWM	ICR1	BOTTOM	TOP
15	1	1	1	1	Fast PWM	OCR1A	BOTTOM	TOP

Príklad 1.:

Nastavme **T/C1** tak, aby generoval

- časové značky 50 ms bez prerušenia
- časové značky 50 ms s prerušením

Frekvencia oscilátora: $f_{OSC} = 8\,000\,000$ Hz.

Jeden SC = 0,125 us, počítadlo počíta smerom nahor.

$$0,05\text{ s} / 0,000\,000\,125\text{ s} = 400\,000\text{ SC. (16b T/C = ?)}$$

Preddelič:

Ak budeme načítavať $clk_{I/O}/8$ treba načítať 50 000 impulzov.

Prednastavenie počítadla:

$$0x10000 - 50\,000_{10} = 0x3CB0.$$

Ak budeme načítavať $clk_{I/O}/64$ treba načítať 6250 impulzov.

Prečo sme nenavrhlí deleno 256?

Príklad 1.:

Pre úlohu s prerušením /64 možno považovať za postačujúce riešenie.

Otázka: Ako presne chceme generovať 50 ms?

Ináč: Čo sme schopný urobiť za 8 resp. 64 SC?

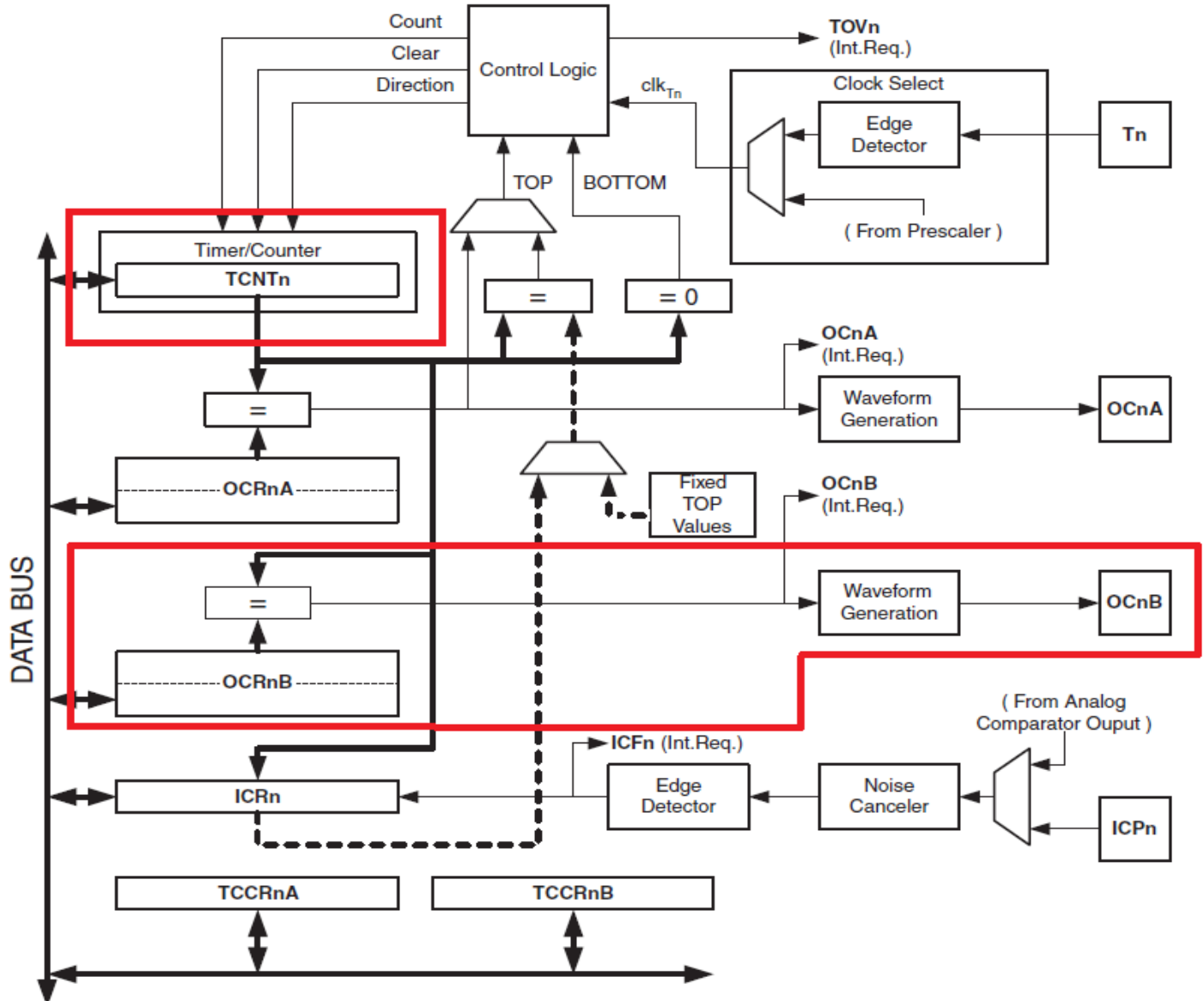
Úloha:

Nájdite taký mód kde sa prednastavenie udeje automaticky.

Príklad 2.:

Nastaviť frekvenciu opakovania PWM signálu

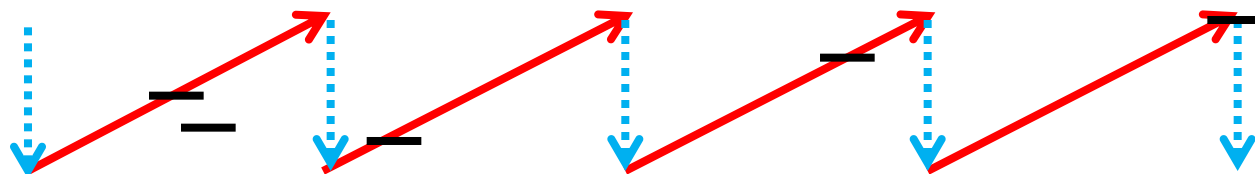
$$T_{OP} = 2 \text{ ms}, \quad f_{OP} = 500 \text{ Hz.}$$



Možné módy generovania signálu na výstupe

Jednoduchá píla

Mode	WGM13	WGM12 (CTC1)	WGM11 (PWM11)	WGM10 (PWM10)	Timer/Counter Mode of Operation	TOP	Update of OCR1x at	TOV1 Flag Set on
0	0	0	0	0	Normal	0xFFFF	Immediate	MAX
1	0	0	0	1	PWM, Phase Correct, 8-bit	0x00FF	TOP	BOTTOM
2	0	0	1	0	PWM, Phase Correct, 9-bit	0x01FF	TOP	BOTTOM
3	0	0	1	1	PWM, Phase Correct, 10-bit	0x03FF	TOP	BOTTOM
4	0	1	0	0	CTC	OCR1A	Immediate	MAX
5	0	1	0	1	Fast PWM, 8-bit	0x00FF	BOTTOM	TOP
6	0	1	1	0	Fast PWM, 9-bit	0x01FF	BOTTOM	TOP
7	0	1	1	1	Fast PWM, 10-bit	0x03FF	BOTTOM	TOP



Neinvertujúci mód: (2)
 nuluje ak TCNT1 = OCR1x
 a nastaví ak BOTTOM



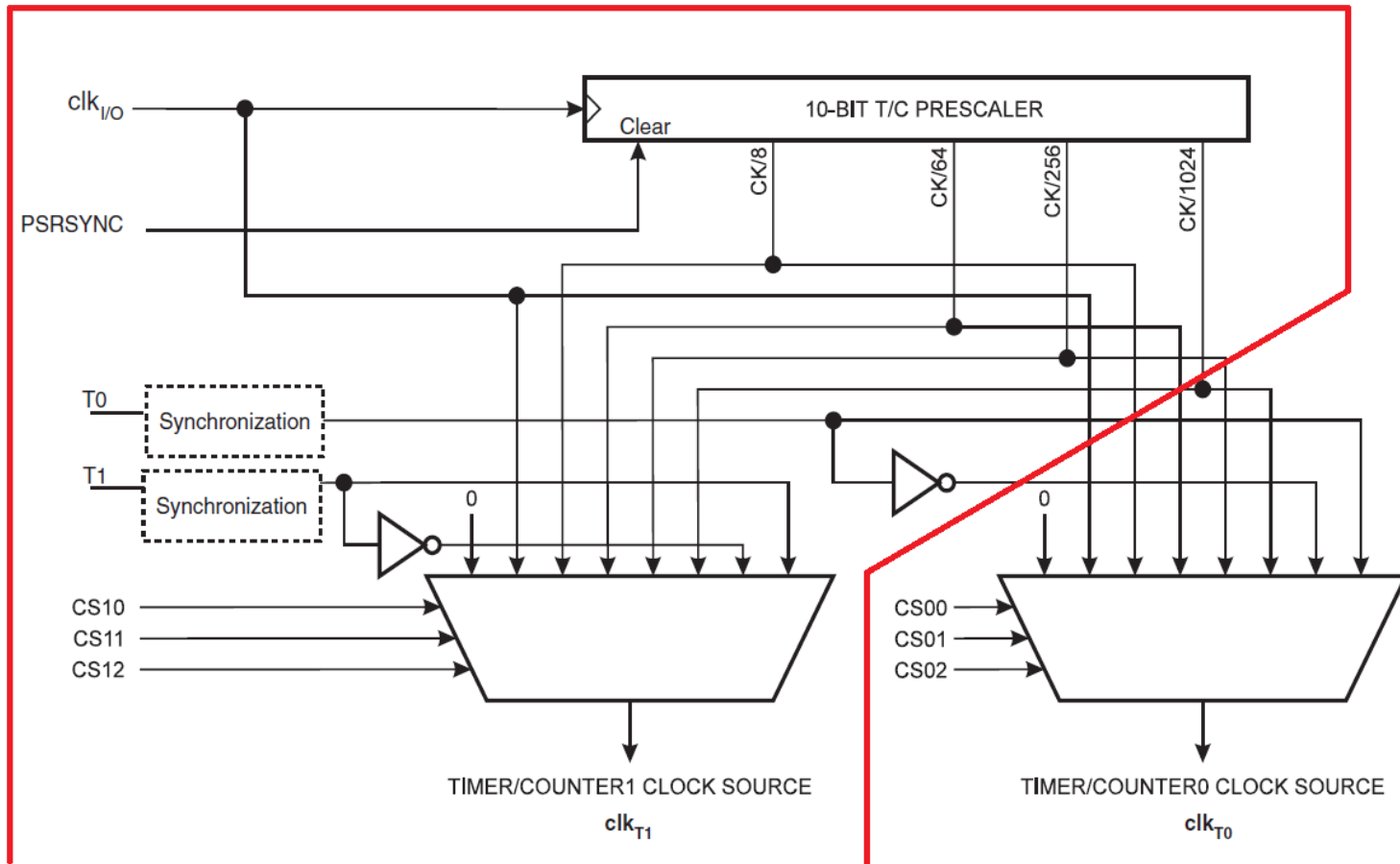
??Ako to pokračuje??

Invertujúci mód: (3)
 netačí ak TCNT1 = OCR1x
 a nuluje ak BOTTOM



??Ako to pokračuje??

Nastavenie preddeliča, nulovanie



Bit

Bit	7	6	5	4	3	2	1	0
	TSM	-	-	-	-	-	PSRASY	PSRSYNC

GTCCR

Read/Write

R/W R R R R R R R/W R/W

Initial Value

0 0 0 0 0 0 0 0 0

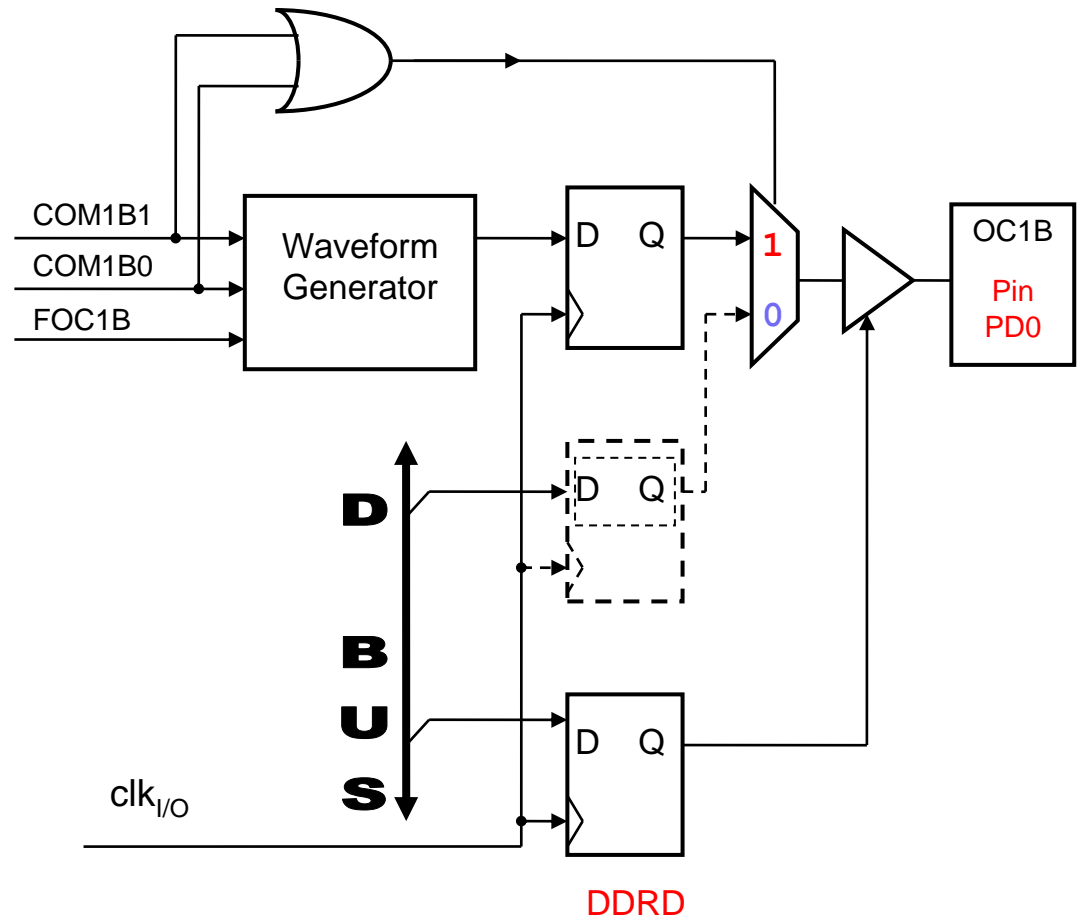
Nastavenie preddeliča, CS12:0 = 4

Bit	7	6	5	4	3	2	1	0	
	COM1A1	COM1A0	COM1B1	COM1B0	-	-	WGM11	WGM10	TCCR1A
Read/Write	R/W	R/W	R/W	R/W	R	R	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Bit	7	6	5	4	3	2	1	0	
	ICNC1	ICES1	-	WGM13	WGM12	CS12	CS11	CS10	TCCR1B
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

CS12	CS11	CS10		$f_{osc} = 8\text{MHz}$	$f_{osc} = 18,432\text{ MHz}$
				$T_{OP} =$	$T_{OP} =$
0	0	1	$\text{clk}_{I/O}$ (No prescaling)	32 μs	14 μs
0	1	0	$\text{clk}_{I/O}/8$ (From prescaler)	256 μs	111 μs
0	1	1	$\text{clk}_{I/O}/64$ (From prescaler)	2 ms	0,9 ms
1	0	0	$\text{clk}_{I/O}/256$ (From prescaler)	16 ms	7.1 ms
1	0	1	$\text{clk}_{I/O}/1024$ (From prescaler)		

PULLUP = ?



Bit	7	6	5	4	3	2	1	0	
	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0 1	DDRD
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	