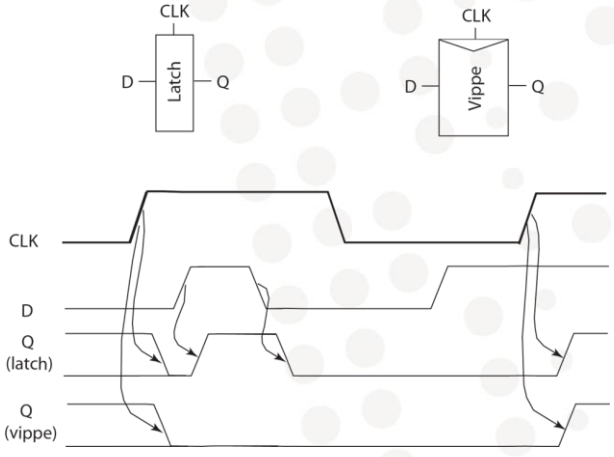
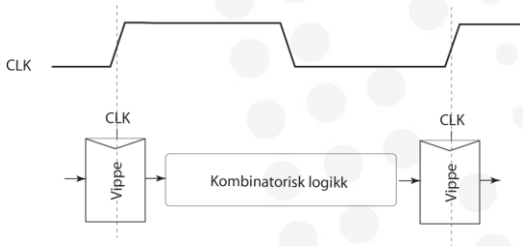
Introduksjon til sekvensielle kretser



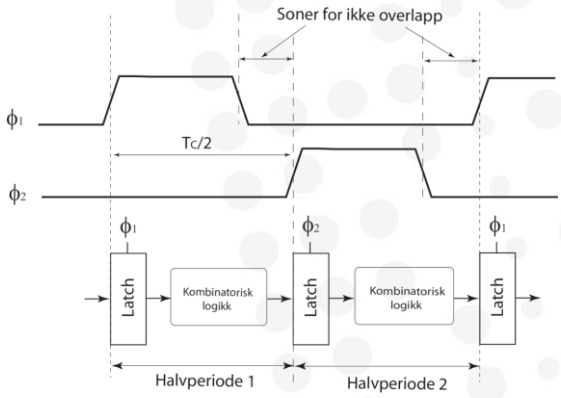
Sekvenseringsmetoder

Vipper



Vipper er i seg selv ikke transparente.

Lacher



Latcher er i seg selv delvis transparente.

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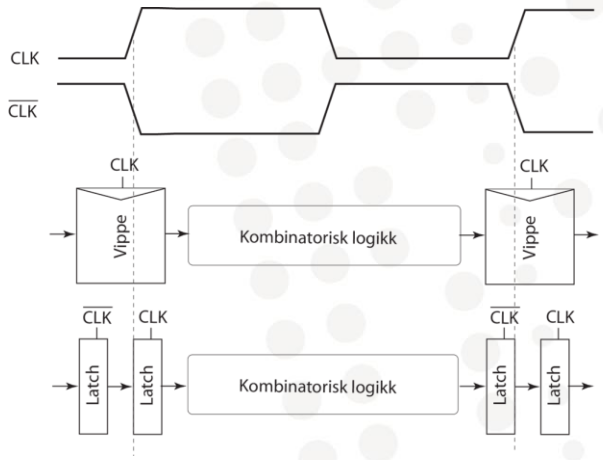
Lacher som styres av pulser

Reduserer latchenes transparente periode.

Vipper lages av latcher



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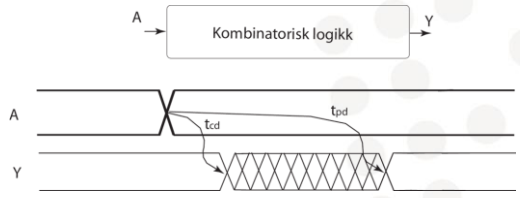
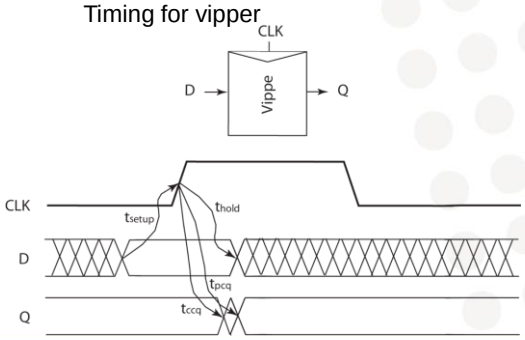
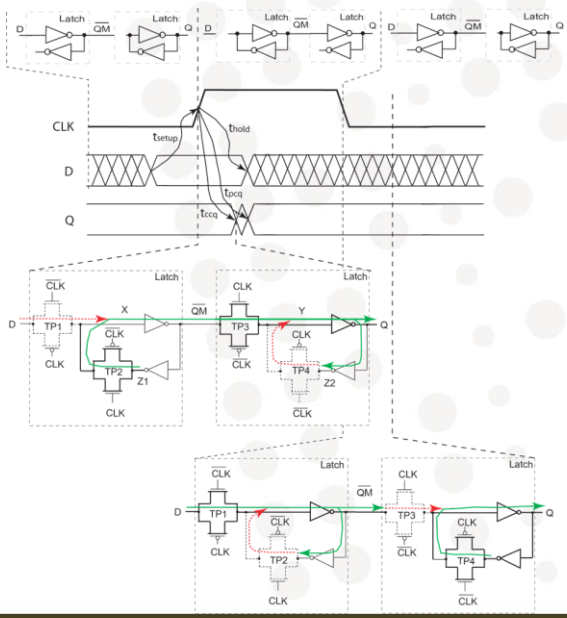
Timing for kombinatorisk logikk



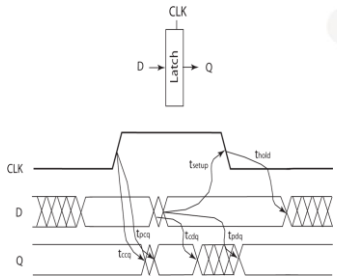
Timing for vipper

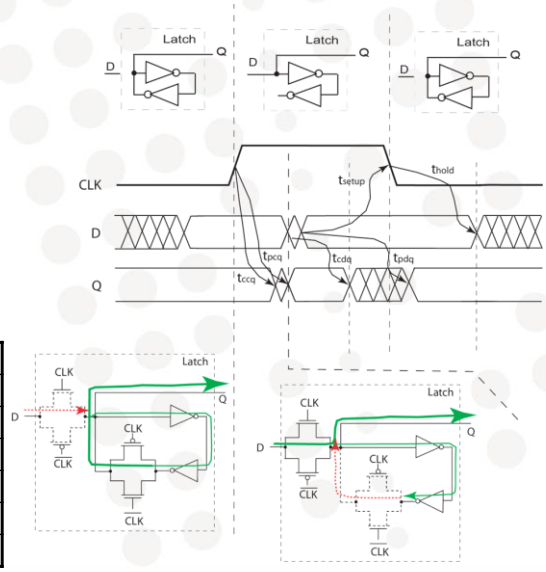


Term	
tpd	Propageringsforsinkelse
tcd	Contamination forsinkelse
tccq	Klokke til Q cont. forsinkelse
tpcq	Klokke til Q prop. forsinkelse
tsetup	Setup tid
thold	Hold tid



Timing for latcher

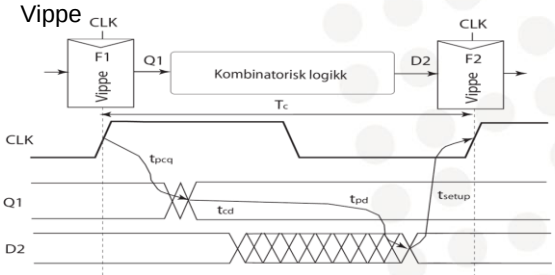




Term	
tpdq	D til Q prop. forsinkelse
tcdq	D til Q cont. forsinkelse
tccq	Klokke til Q cont. forsinkelse
tpcq	Klokke til Q prop. forsinkelse
tsetup	Setup tid
thold	Hold tid

Begrensning for maks tidsforsinkelse

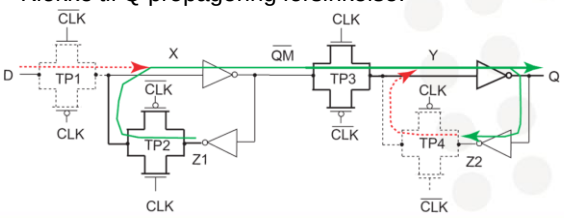
Vippe



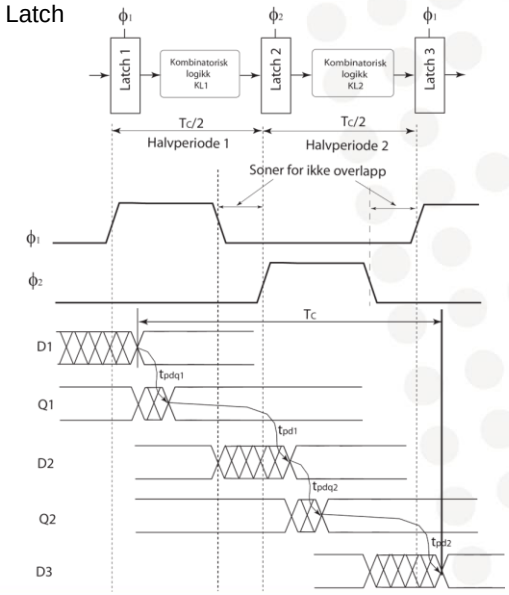
$$T_C \geq t_{pcq} + t_{pd} + t_{setup}$$

$$t_{pd} \leq T_c - \left(t_{setup} + t_{pcq}\right)$$

Klokke til Q propagering forsinkelse:



Latch



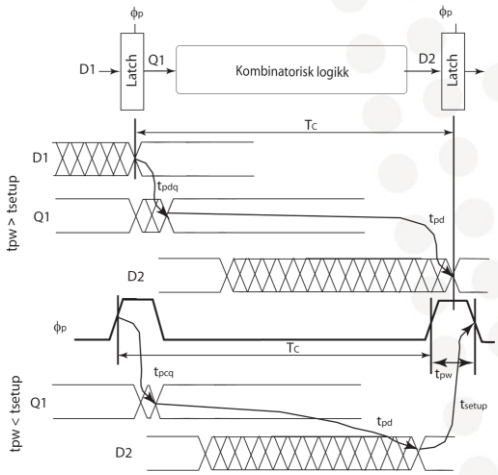
$$T_C \geq t_{pdq1} + t_{pd1} + t_{pdq2} + t_{pd2}$$

$$t_{pd} \leq T_c - \left(2t_{pdq}\right)$$

Puls styrt latch

$$T_C \geq \max(\ t_{pdq} + t_{pd}, t_{pcq} + t_{pd} + t_{setup} - t_{pw})$$

$$t_{pd} \leq T_c - \max\left(t_{pdq}, t_{pcq} + t_{setup} - t_{pw}\right)$$



Oppgave 7.1

Anta parameterverdier som gitt i tabellen under. Finn maksimal propageringsforsinkelse innenfor en 500ps klokkeperiode for de følgende sekvenseringssystemene:

1. Vipper.
2. To-fase transparente latcher.
3. Latcher styrt med pulser med bredde lik 80ps.

Anta at det ikke er klokke-skew.

Term	Vippe	Latch
tccq	35ps	35ps
tpcq	50ps	50ps
tpdq		40ps
tsetup	65ps	25ps
thold	30ps	30ps

Vipper

$$t_{pd} \le T_c - \left(t_{setup} + t_{pcq}\right)$$
$$\le 500\ ps - (65\ ps + 50\ ps)$$
$$\le 385\ ps$$

2 fase latch

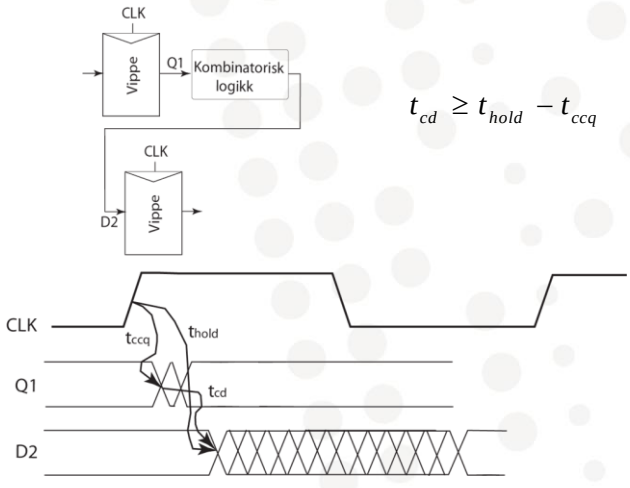
$$t_{pd} \le T_c - 2t_{pdq}$$
$$\le 500\ ps - 2 \cdot 40\ ps$$
$$\le 420\ ps$$

Latch styrt av pulser

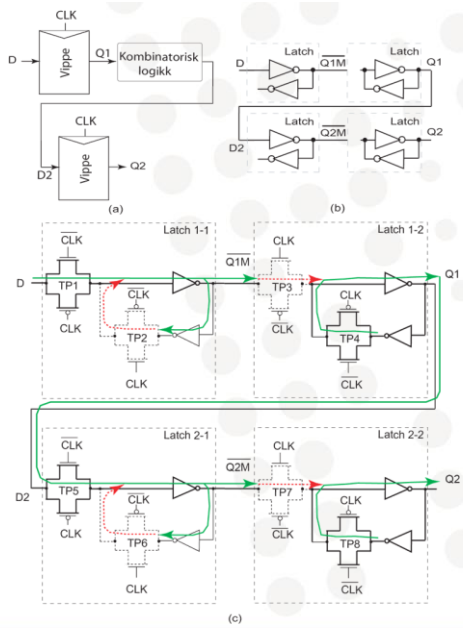
$$t_{pd} \le T_c - \max\left(t_{pdq}, t_{pcq} + t_{setup} - t_{pw}\right)$$
$$\le 500\ ps - 40\ ps$$
$$\le 460\ ps$$

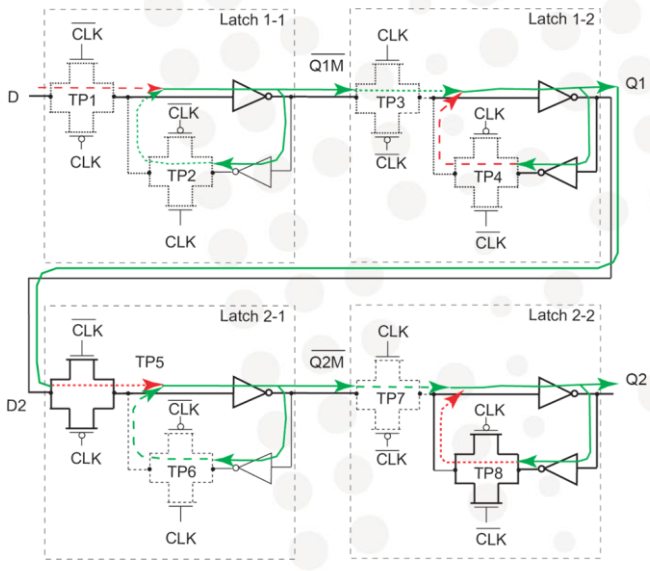
Begrensning for minimum tidsforsinkelse

Vippe

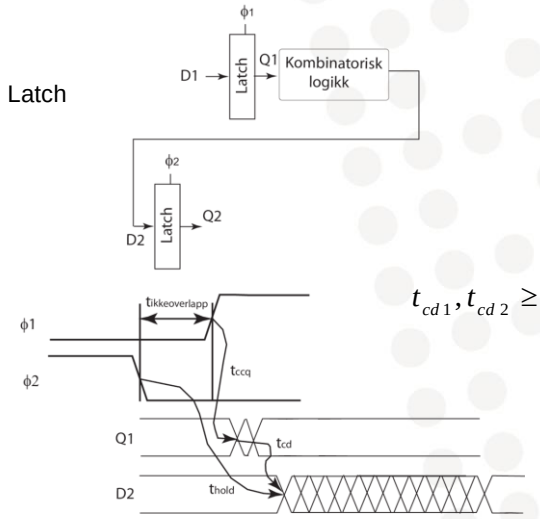


$$t_{cd} \ge t_{hold} - t_{ccq}$$

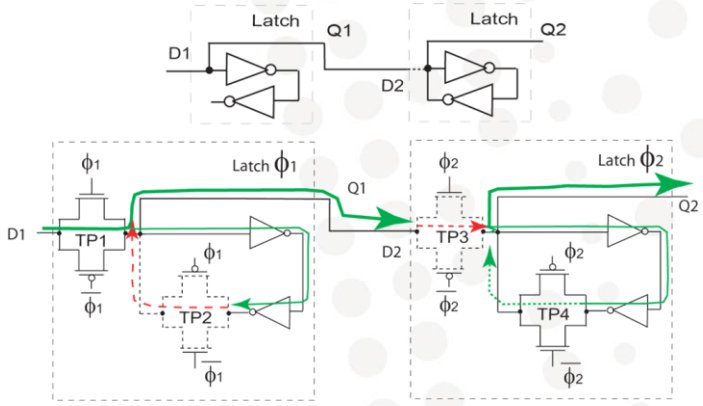

CLK
D
Vippe
Q1
Kombinatorisk logikk
CLK
D2
Vippe
Q2
(a)
Latch
Q1M
Latch
Q1
D
Latch
Q2M
Latch
Q2
D2
(b)
Latch 1-1
Latch 1-2
Latch 2-1
Latch 2-2
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
Q1M
Q2M
Q1
Q2
(c)


Latch 1-1
Latch 1-2
Latch 2-1
Latch 2-2
D
D2
Q1M
Q2M
Q1
Q2
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
CLK

Latch

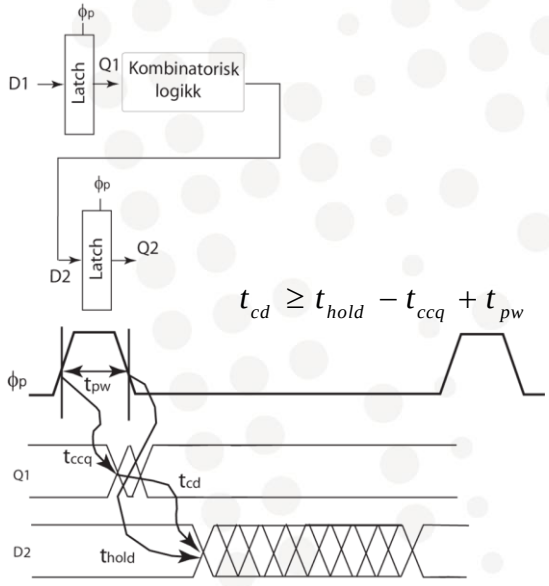


$$t_{cd1}, t_{cd2} \geq t_{hold} - t_{ccq} - t_{ikkeoverlapp}$$

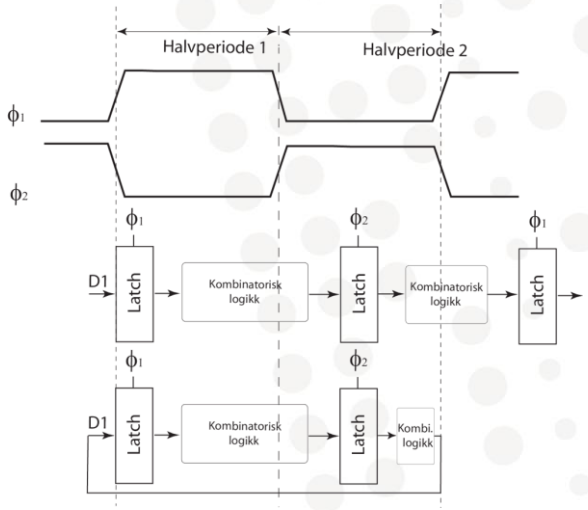


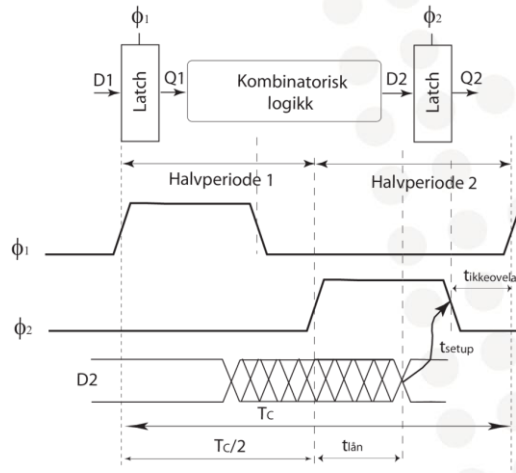
$$t_{hold} \leq t_{ikkeoverlapp} + t_{ccq} + t_{cd}$$

Latch styrt av puls



Fordeling av tid mellom klokkefasene



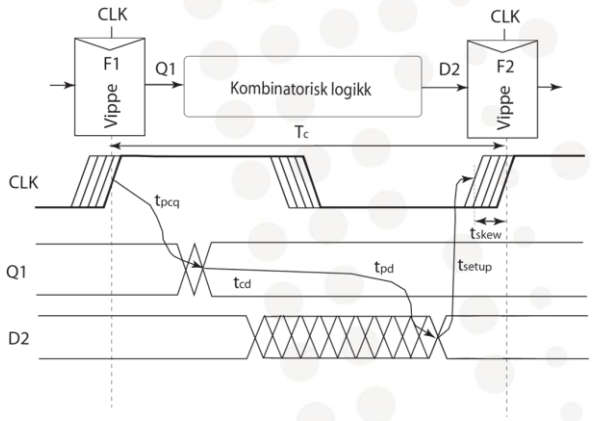


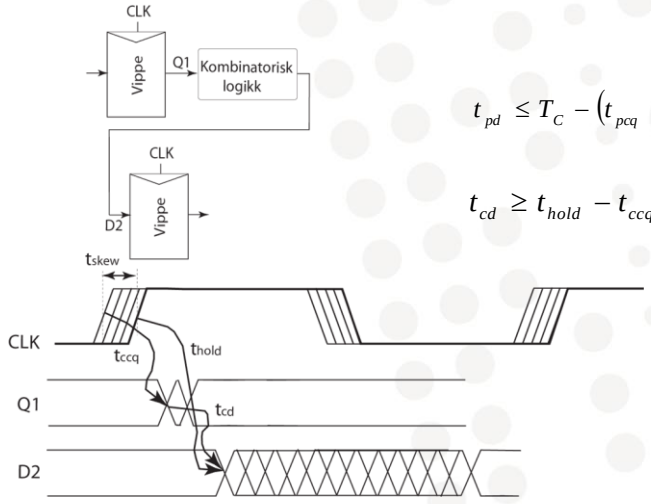
$$t_{lån} \leq \frac{T_C}{2} - \left(t_{setup} + t_{ikkeoverla\ pp}\right)$$

Latch styrt av puls

$$t_{lån} \leq t_{pw} + t_{setup}$$

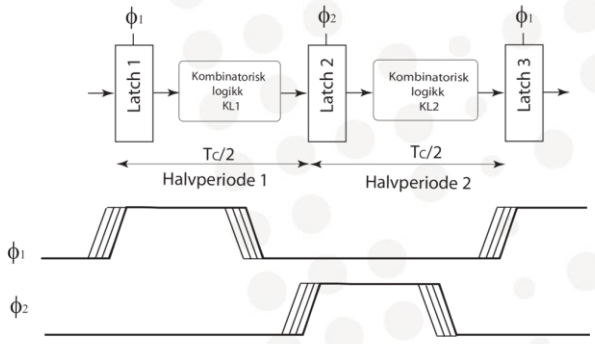
Klokke skew





$$t_{pd} \leq T_C - \left(t_{pcq} + t_{setup} + t_{skew}\right)$$

$$t_{cd} \geq t_{hold} - t_{ccq} + t_{skew}$$



$$t_{pd} \leq T_c - 2t_{pdq}$$

$$t_{cd1}, t_{cd2} \geq t_{hold} - t_{ccq} - t_{ikkeoverlapp} + t_{skew}$$

Oppgave 7.2

Anta parameterverdier som gitt i tabellen under. Finn maksimal propageringsforsinkelse innenfor en 500ps klokkeperiode for de følgende sekvenseringssystemene:

1. Vipper.
2. To-fase transparente latcher.
3. Latcher styrt med pulser med bredde lik 80ps.

Anta at klokke-skew kan være 50ps.

Term	Vippe	Latch
tccq	35ps	35ps
tpcq	50ps	50ps
tpdq		40ps
tsetup	65ps	25ps
thold	30ps	30ps

Vipper

$$\begin{aligned} t_{pd} &\le T_c - \left(t_{setup} + t_{pcq} + t_{skew}\right) \\ &\le 500\ ps - (65\ ps + 50\ ps + 50\ ps) \\ &\le 335\ ps \end{aligned}$$

2 fase latch

$$\begin{aligned} t_{pd} &\le T_c - 2t_{pdq} \\ &\le 500\ ps - 2 \cdot 40\ ps \\ &\le 420\ ps \end{aligned}$$

Latch styrt av pulser

$$\begin{aligned} t_{pd} &\le T_c - \max\left(t_{pdq}, t_{pcq} + t_{setup} - t_{pw} + t_{skew}\right) \\ &\le 500\ ps - (-5\ ps + 50\ ps) \\ &\le 455\ ps \end{aligned}$$

Oppgave 7.3

Bestem minimum logisk contamination forsinkelse for hver klokkeperiode (halve klokkeperioden for to-fase latcher) for følgende sekvenseringsmetoder:

1. Vipper.
2. To-fase transparente latcher med klokkesignaler med 50% duty cycle.
3. To-fase transparente latcher med klokkesignaler med ikkeoverlappende tidsperiode på 60ps.
4. Latcher styrt med pulser med bredde lik 80ps.

Anta at det ikke er klokke-skew.

Vipper

$$\begin{aligned} t_{cd} &\ge t_{hold} - t_{ccq} \\ &\ge 30\ ps - 35\ ps \\ &\ge 0 \end{aligned}$$

Latcher

$$\begin{aligned} t_{cd} &\ge t_{hold} - t_{ccq} - t_{ikkeoverlapp} \\ &\ge 30\ ps - 35\ ps - 60\ ps \\ &\ge 0 \end{aligned}$$

Latcher styrt av pulser

$$\begin{aligned} t_{cd} &\ge t_{hold} - t_{ccq} + t_{pw} \\ &\ge 30\ ps - 35\ ps + 80\ ps \\ &\ge 75 \end{aligned}$$