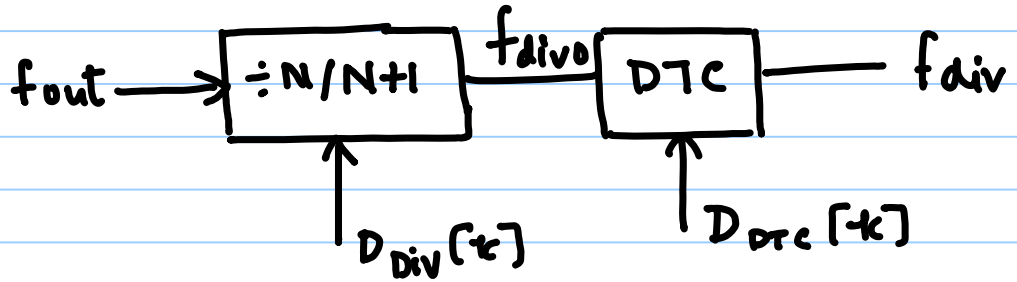
Lecture # 51

Note Title 08-11-2017

Fractional Divider



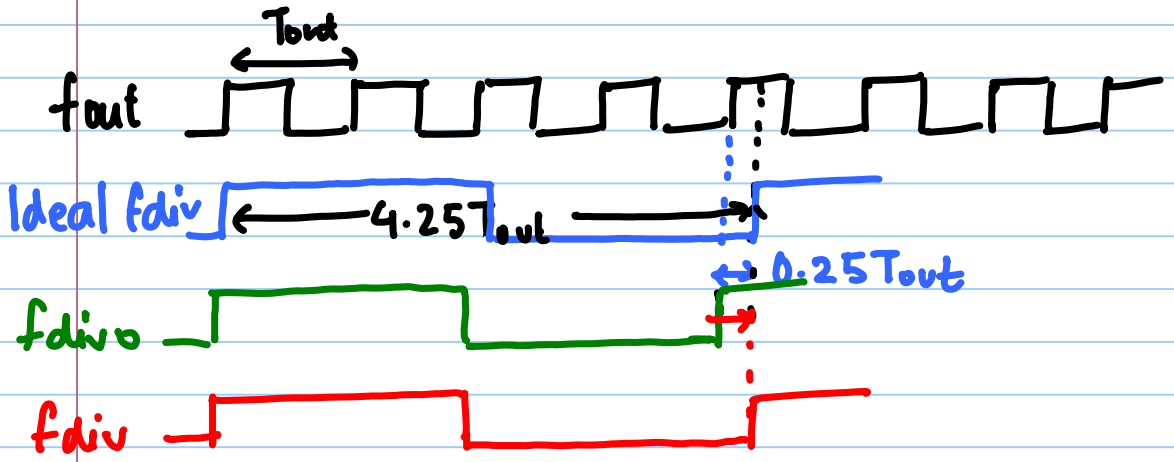
$f_{out} = (N+\alpha) f_{div}$

Fractional-N PLL

- Integer divider controlled by DSM → quantization noise (Q)
- Contribution of Q ↓
  → Reducing BW
- Cancel Q.

Ex: $f_{out} = 4.25\, f_{div}$

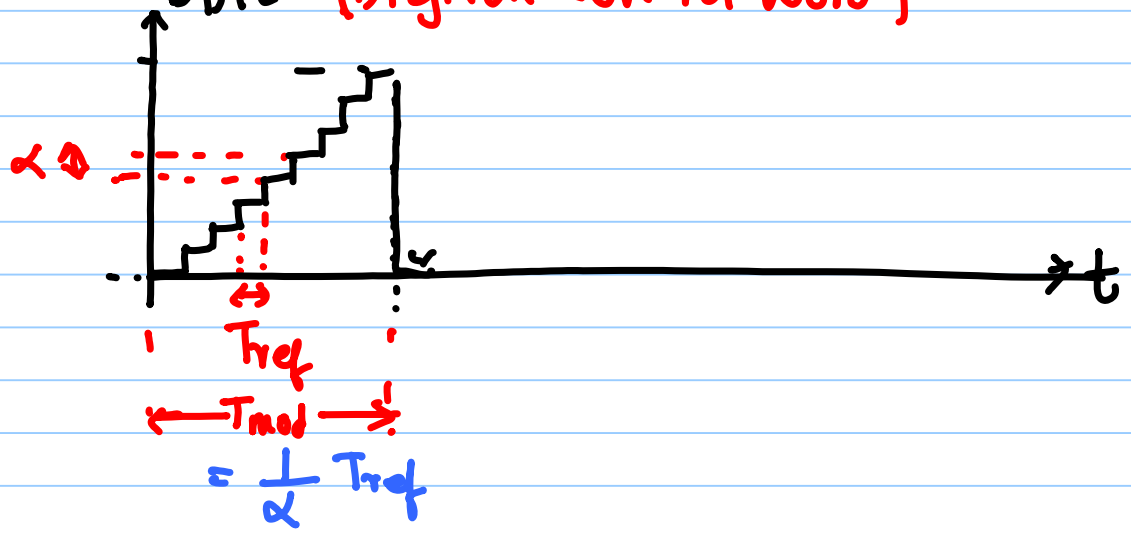
$T_{div} = 4.25\, T_{out}$



Div. Clk.	N	DTC
1	4	0.25 Tout
2	4	0.50 Tout
3	4	0.75 Tout
4	4/5	1 Tout /0

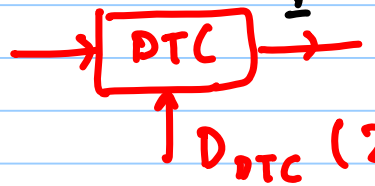
$f_{out} = (N+\alpha) f_{ref} \Rightarrow T_{ref} = (N+\alpha) T_{out}$

D_{DTC} [Digital Control word]



$D_{DTC} = 2'b00, 2'b01, 2'b10, 2'b11$

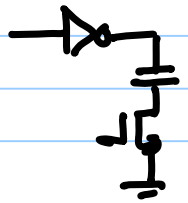
0 0.25 0.50 0.75

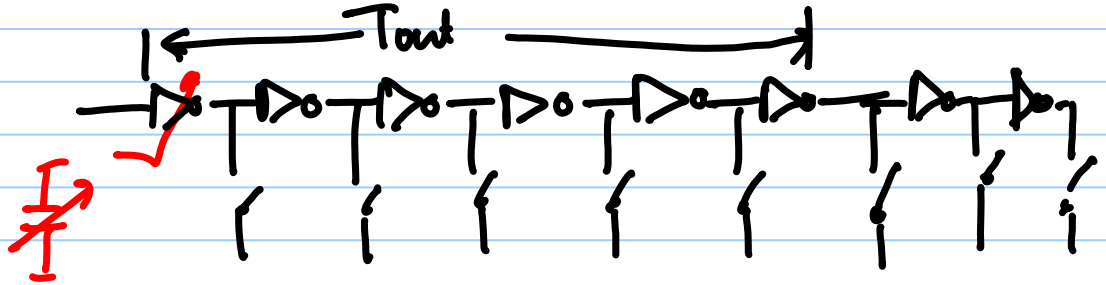


- $\alpha \downarrow \Rightarrow$ # of bits in DTC ↑
- Range of DTC = 1 Tout
- $G_{DTC} = \frac{1 \times T_{out}}{2^n}$

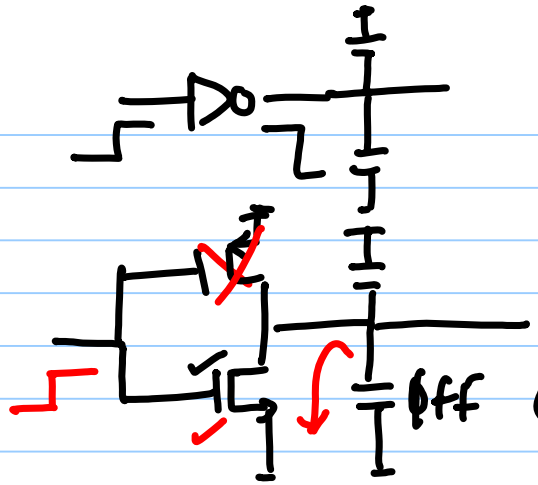
- Inverter delay in DTC
- T_{out} = 1ns.

  $t_d < 500$ fs.





20ps.



MOS. $10\ fF/\mu m^2$.

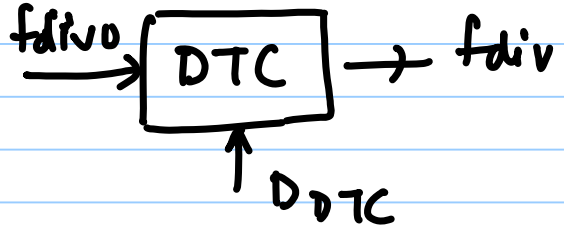
$0.5\ \mu m \times 0.5\ \mu m = 0.25\ \mu m^2$

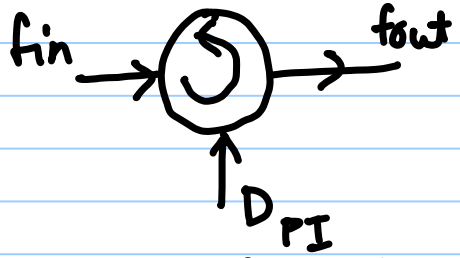
$0.06\ \mu m \times 0.2\ \mu m = 0.012\ \mu m^2$.

$0.12\ fF$

$f_{out} = 2.5\ GHz \rightarrow 5\ GHz$

DTC Range = 400ps $\rightarrow$ 200ps.





PI: Phase Interpolator.

PI:

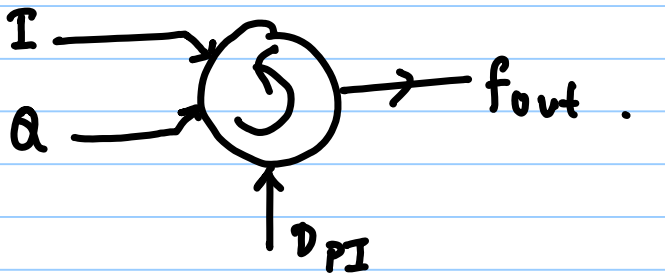
$$y(t) = a\sin(\omega_0 t) + b\cos(\omega_0 t)$$

$$= \sqrt{a^2+b^2}\left[\frac{a}{\sqrt{a^2+b^2}}\sin(\omega_0 t) + \frac{b}{\sqrt{a^2+b^2}}\cos(\omega_0 t)\right]$$

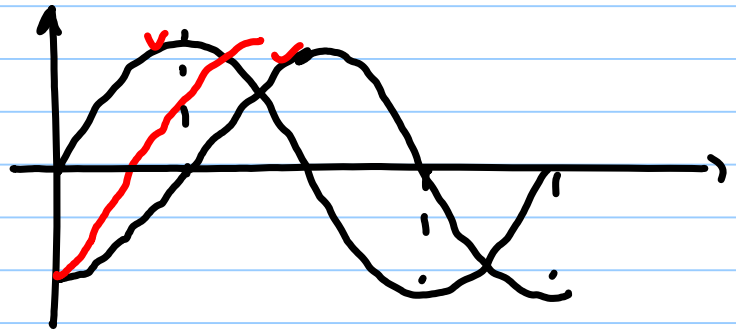
$$= \sqrt{a^2+b^2}\sin(\omega_0 t + \phi) = \sqrt{a^2+b^2}\sin\left(\omega_0\left(t+\frac{\phi}{\omega_0}\right)\right)$$

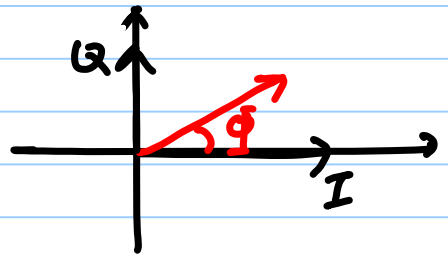
$$\phi = \tan^{-1}\left(\frac{b}{a}\right)$$

$$t_d = \frac{\phi}{\omega_0} = \frac{1}{\omega_0}\tan^{-1}\left(\frac{b}{a}\right)$$



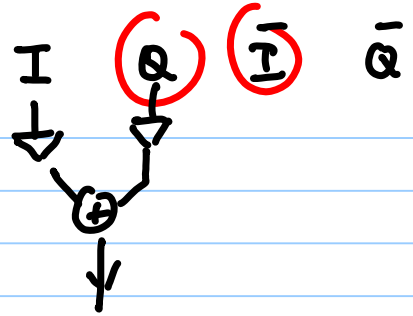
D_{PI}: Weights a & b.

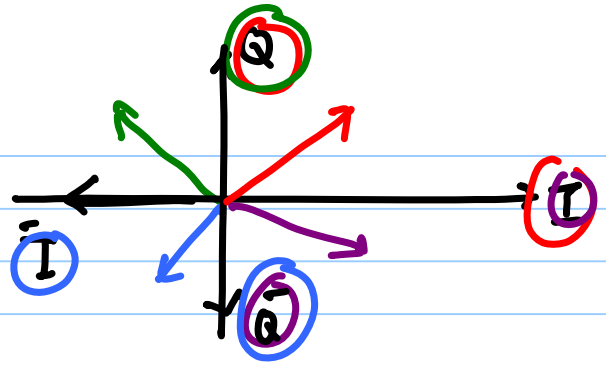


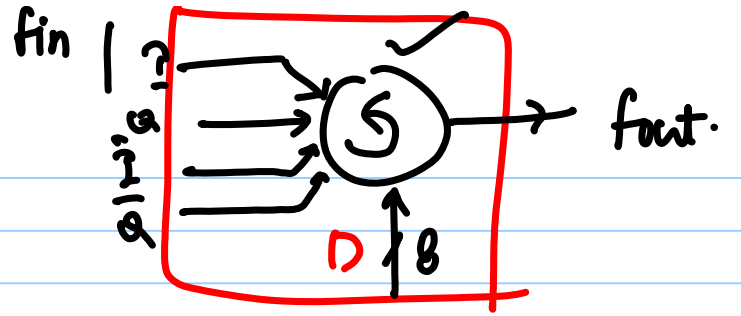


Ex: 6 bit phase interpolation b/w I & Q for ω_0.

$$\Delta\phi = \frac{\pi/2}{2^6}$$







8'b 00 000000

	fin	Δt_d.		
PI:	2.5 GHz	100 ps/2^6	$= \frac{100}{64} = \frac{25}{16}$	$= 1.5625$ ps.
	5.0 GHz.	50ps/2^6	$= 0.75$ ps.	
	2.5 GHz		$= 1.5625$ ps.	
	5.0GHz			

$D(t) \rightarrow \frac{d\Phi_{out}}{dt} \neq 0$.