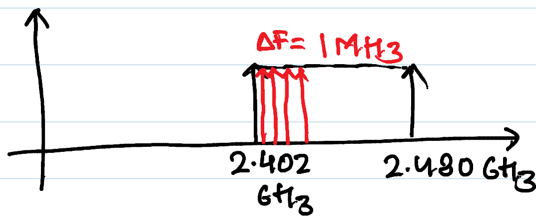
Lecture 39

Thursday, April 6, 2017

4:02 PM

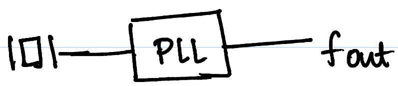
Fractional-N PLL.

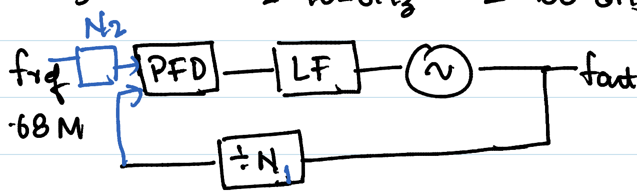


Clock Source

$f_{out} = 2.402\text{ GHz} + k \times 1\text{ MHz}$

Crystal Source, $f_{cry} = 19.68\text{ MHz}$





$$N = \frac{2.402 \times 10^9}{19.68 \times 10^6} = 122.08\ldots$$

$$\frac{f_{ref}}{N_2} = f'_{ref} \qquad f_{out} = N_1 \times f'_{ref}$$

$f_{ref} = 19.68\text{M}$, $f_{out} = 2.402\text{ GHz}$, $\Delta F = 1\text{MHz}$.

$N_1 = 60050$, $N_2 = 492 \Rightarrow f'_{ref} = \underline{40\text{ kHz}}$

$$N_1 = 60050 + 25 \times k$$

$k = 0, 1, 2, 3 \ldots$

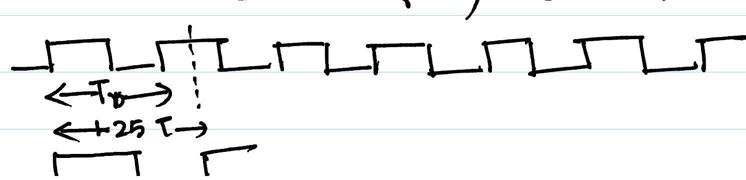
$\Delta F = 0, 1\text{M}, 2\text{M} \ldots$

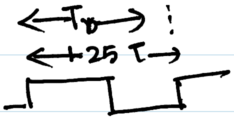
Remarks:

- Small $f_{ref} \Rightarrow$ lower bandwidth $\Rightarrow$ larger VCO phase noise
- Channel Switching time increases

fractional-divider

$$f_{out} = (N+\alpha) f_{ref} \quad ; \quad 0 < \alpha < 1$$





$$f_{out} = 2.403\,GHz = (N+\alpha)\, f_{ref}$$

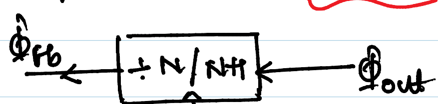
$$= \left(122 + \frac{51}{492}\right) f_{ref}$$

$$= \left[122 \times \left(\frac{441}{492} + \frac{51}{492}\right) + \frac{51}{492}\right] f_{ref}$$

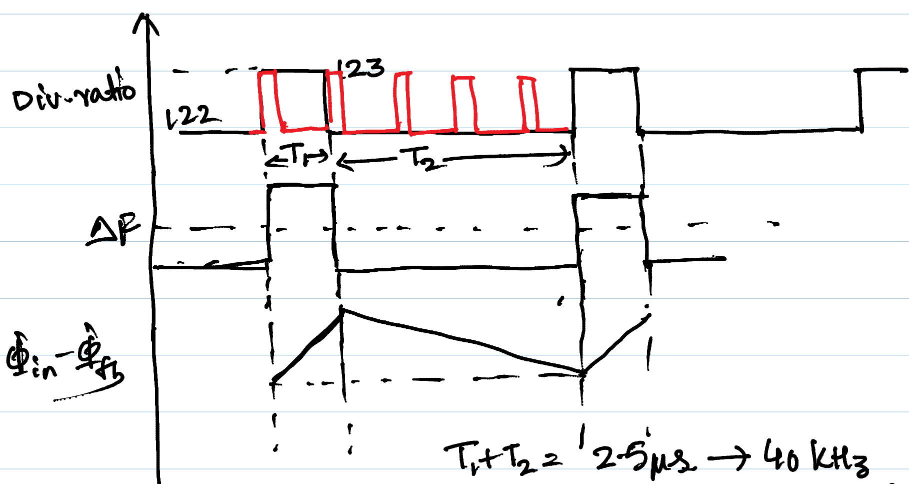
$$= \left[122 \times \frac{441}{492} + 123 \times \frac{51}{492}\right] f_{ref}$$

$\Rightarrow$ Div fout by 122 for 441 times
by 123 for 51 times

$$492\, T_{ref} = 441 \times (\underbrace{122 \times T_{out}}) + 51 \times (\underbrace{123 \times T_{out}})$$ ✓



Div by N for 441/492
N+1 for 51/492



$T_1 + T_2 = 2.5\mu s \rightarrow 40\,kHz$
(Spurious tones)

$$\Delta F = f_{ref} - \frac{f_{out}}{\text{Div. ratio}}$$

Ex!

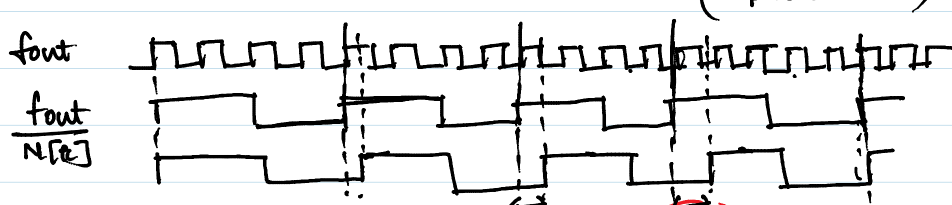
$f_{out} = 4.25\, f_{ref}$

$f_{ref} = 10\,MHz$

$f_{out} = 42.5\,MHz$

$N = 4/5$

N	ΔF
4	10 − 10.625 MHz
5	10 − 8.5



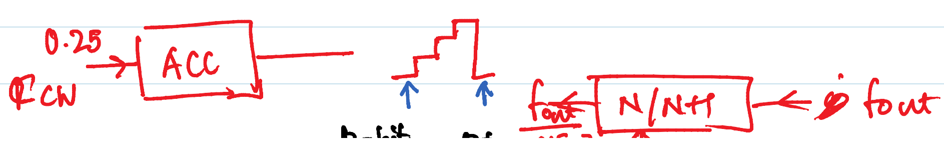
$f_{out} = 4.25\, f_{ref} \Rightarrow T_{ref} = 4.25\, T_{out}$

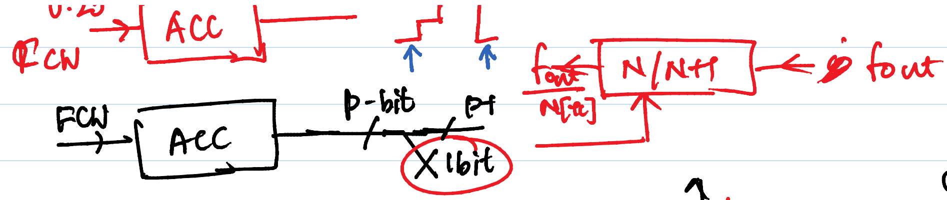
$$f_{out} = 4.25\, f_{ref}$$

$$= \left(4 + \frac{1}{4}\right) f_{ref}$$

$$= \left(4\left(\frac{3}{4} + \frac{1}{4}\right) + \frac{1}{4}\right) f_{ref}$$

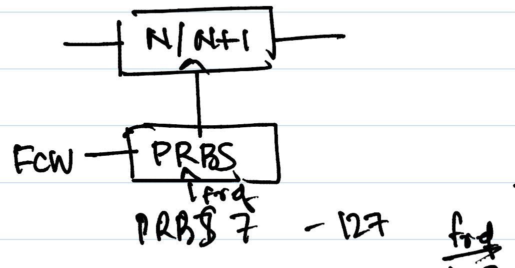
$$= \left(\underline{4} \times \frac{3}{4} + \underline{5} \times \frac{1}{4}\right) f_{ref}$$



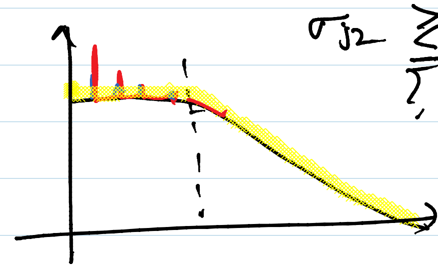


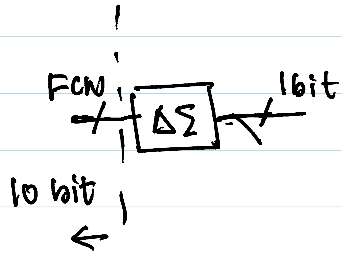
σ_{J1} w/o randomization

$\sigma_{J2} \gtrless \sigma_{J1}$



$\frac{f_{ref}}{127}$





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

$0 < \alpha < f_{ref}$, Resolution for α $\frac{1}{2^{10}}$

$\left(N + \underbrace{\frac{1}{2^{10}} f_{ref}}\right)$, $\frac{2}{2^{10}} f_r$