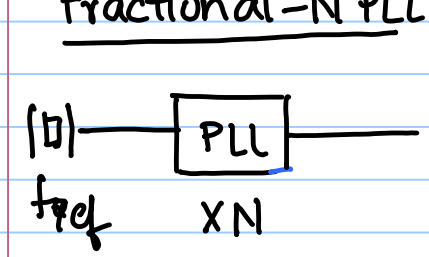
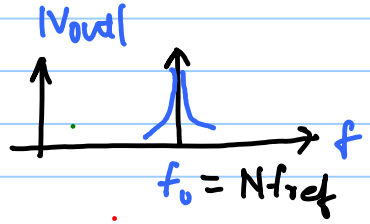
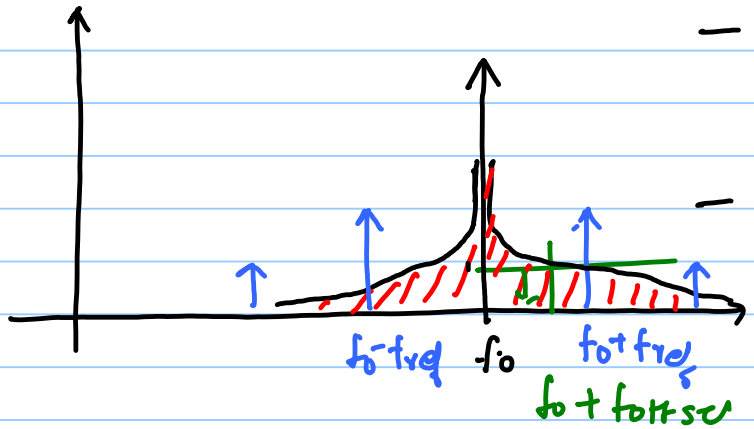
Lecture # 47

Note Title 08-11-2018

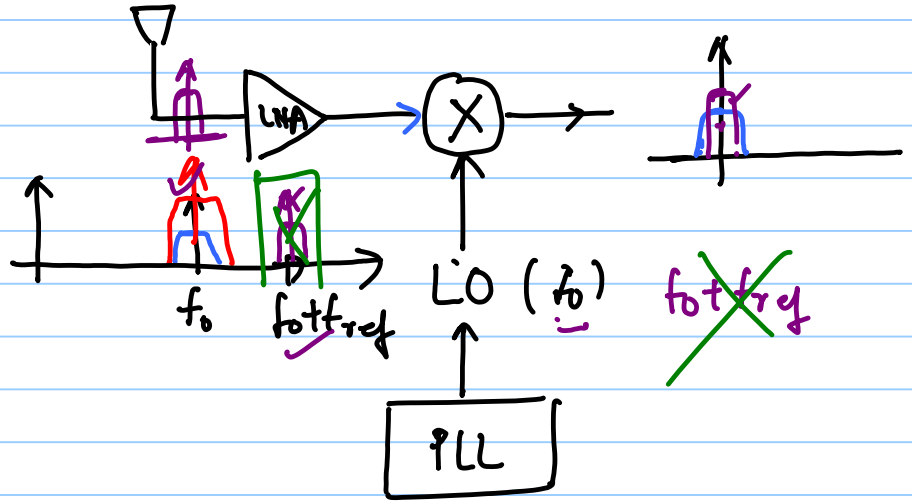
## Fractional-N PLL




- Spurs
  - Ref. spur
  - Spurious tone
- Jitter (Phase Noise) ✓




## Bluetooth

2.402 GHz – 2.480 GHz

$\Delta F_{BW}$ = 1 MHz.

19.68 MHz → PLL → 2.402 G – 2.480 GHz

ΔF = 1 MHz.

2.403 MHz

GSM: $\Delta F = 200\,kHz$. $f_0 = 925\,MHz$

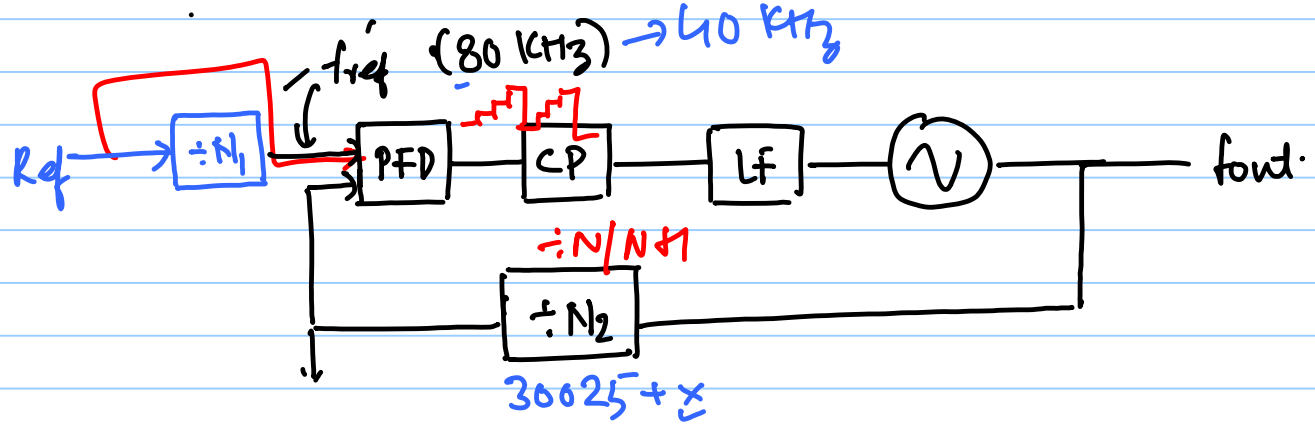
Min. detectable (sensitivity) $925\,MHz + 200\,kHz$.

$= -102\,dBm$.

Near wer : $-25\,dBm$

$\frac{1MHz}{80\,kHz} = \frac{100}{8} = 12.5$

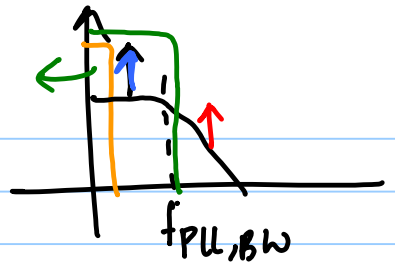
25




fout = $N_2 \cdot f_{ref}$ $2.402\,GHz - 2.480\,GHz$. $\Delta F = 1\,MHz$.

fref = $19.68\,MHz$

$$\frac{f_{ref}}{N_1} = \frac{f_{out}}{N_2}$$




$$\frac{f_{out}}{f_{ref}} = \frac{N_2}{N_1} = \frac{2.402\ GHz}{19.68\ MHz} = \frac{240200}{1968} = \frac{30025}{246}$$

$N_1 = 246$

$N_2 = 30025$

$f_{ref} = 80\ kHz.$

low ref. freq $\longrightarrow$ More noise from VCO.

$$f_{out} = N_2 \times \left(\frac{f_{ref}}{N_1}\right)$$

$$= 30025 \times 80\ kHz = 2.402\ GHz.$$

$$= 2.403\ GHz$$

$$\frac{N_2}{N_1} = \frac{2.403}{19.68} = \frac{240300}{1968} = \frac{20025}{164}$$

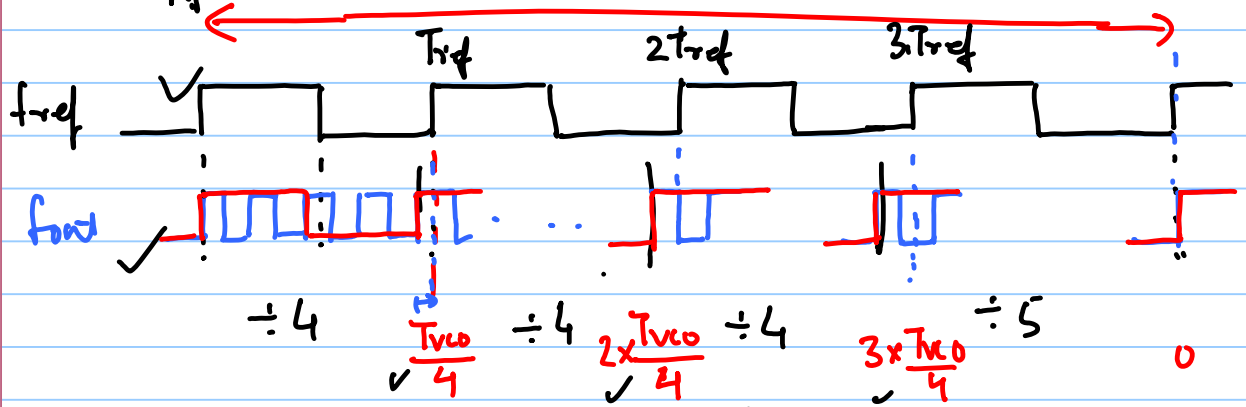
$N_1 = 492 \longrightarrow f_{ref} = 40\ kHz$

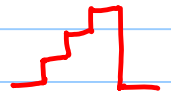
$f_{out} = 2.402\ GHz + 25 \times f_{ref}$

$60050 \times f_{ref}$

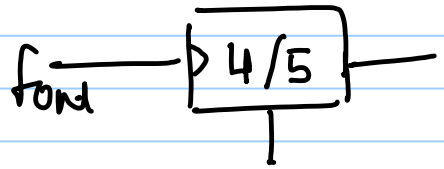
$1 - .78$

$\frac{f_{out}}{N} = f_{ref}$ $\quad T_{ref} = 4.25\ T_{out}$ $\quad f_{out} = 4.25\ f_{ref}$

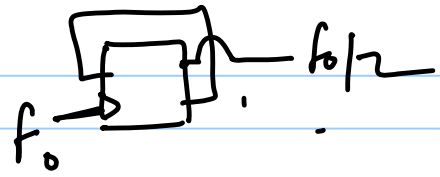


$\frac{T_{ref}}{T_{out}} = 4.25 = \frac{425}{100} = \frac{17}{4}$



$$f_{out} = 2.403\ GHz = \left(122 + \frac{51}{492}\right) 19.68\ MHz.$$



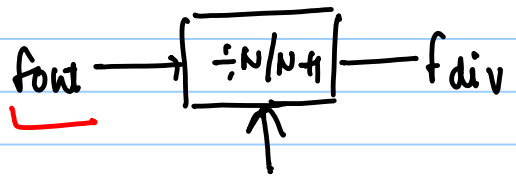

$$T_{ref} = \left(122 + \frac{51}{492}\right) T_{out}$$

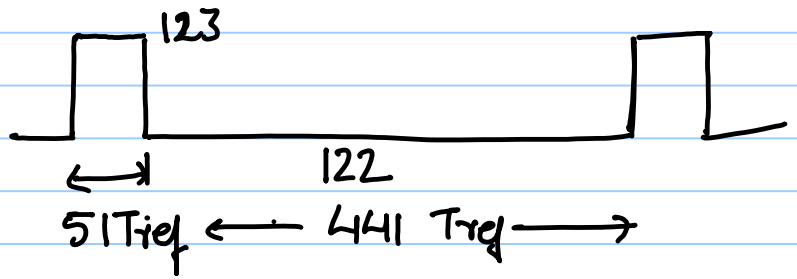
$$492\, T_{ref} = (122 \times 492 + 51)\, T_{out}$$

$$= (122 \times (441 + 51) + 51)\, T_{out}$$

$$= (123 \times 51 + 122 \times 441)\, T_{out}.$$

(123 → NH1, 51 → f, 122 → N, 441 → x)




$$f_{spur} = \frac{1}{492\, T_{ref}}.$$