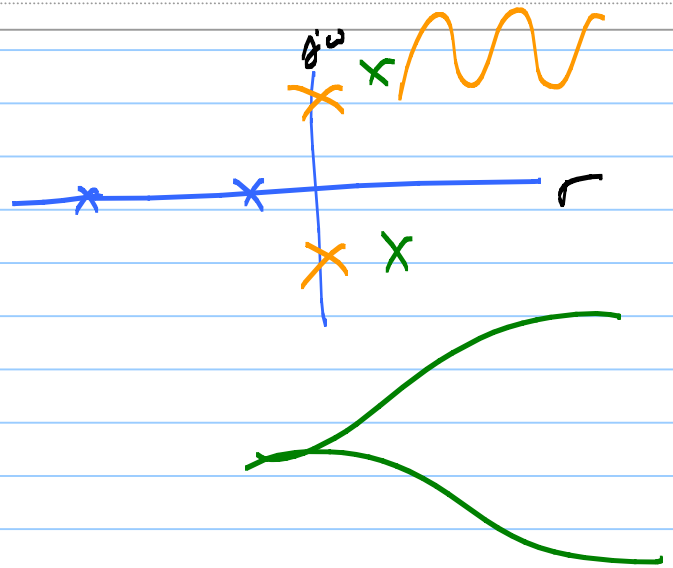
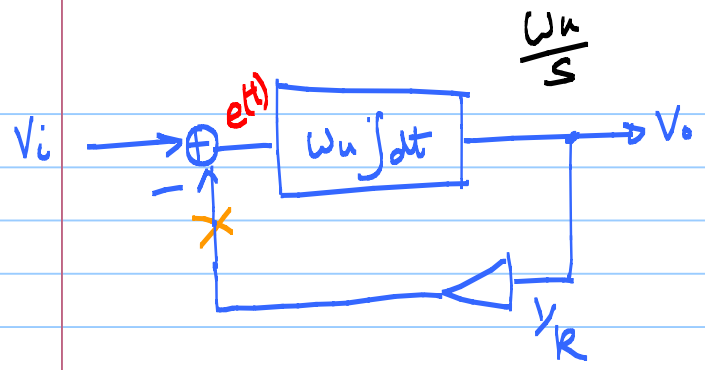
ECE 518- Lecture 9

Note Title 2/19/2013



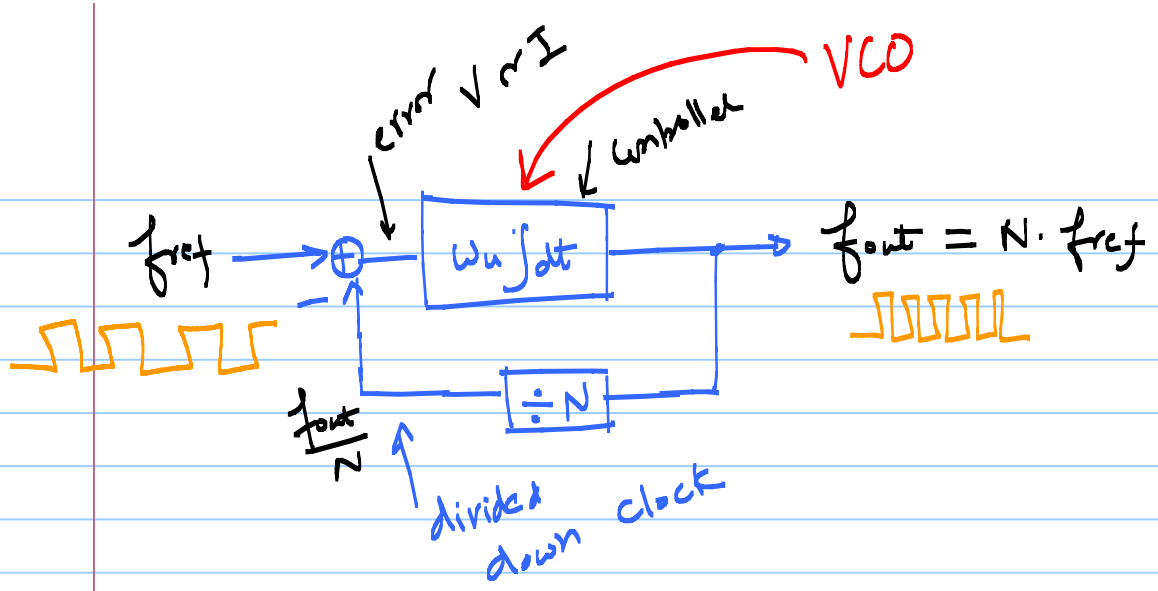


In steady-state

$$V_o = kV_i$$

$$e(t) = V_i - \frac{V_o}{k} \to 0$$

precise gain set by 'k' as the DC loop-gain is ∞.

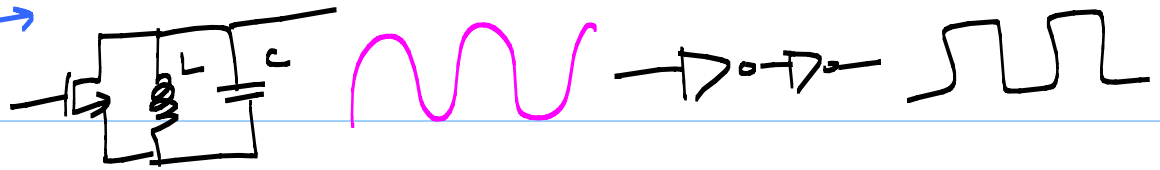


$f_{out} = N f_{ref}$

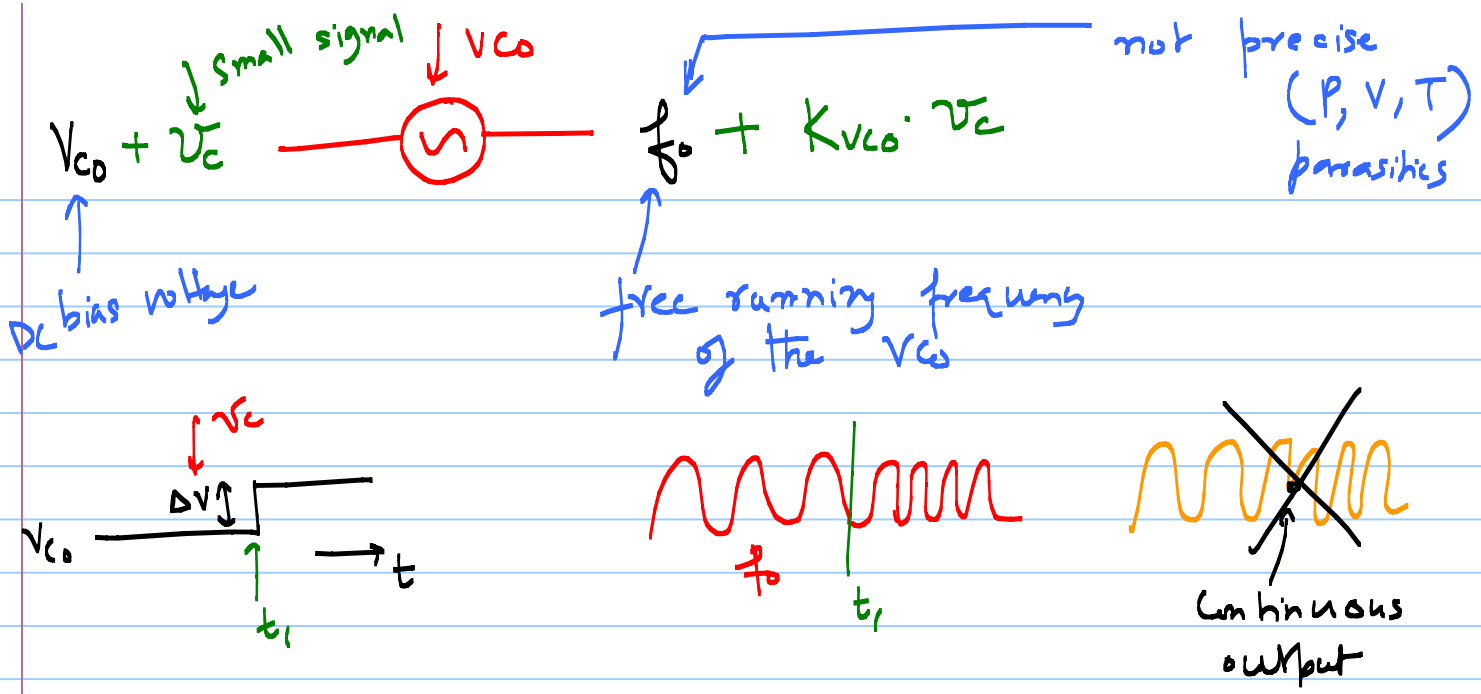
frequency synthesizer

any periodic balanced shape → clock

Cartoon →



& we need a voltage controlled oscillator (VCO)



VCO output =

$$\cancel{\cos\left(2\pi f_0 t + 2\pi K_{VCO} \cdot v_c \cdot t\right)}$$

free running

$$\cos\left(2\pi f_0 t + 2\pi K_{VCO} \int_0^t v_c(t)\,dt\right) \checkmark$$

* the frequency change doesn't happen instantaneously

free running

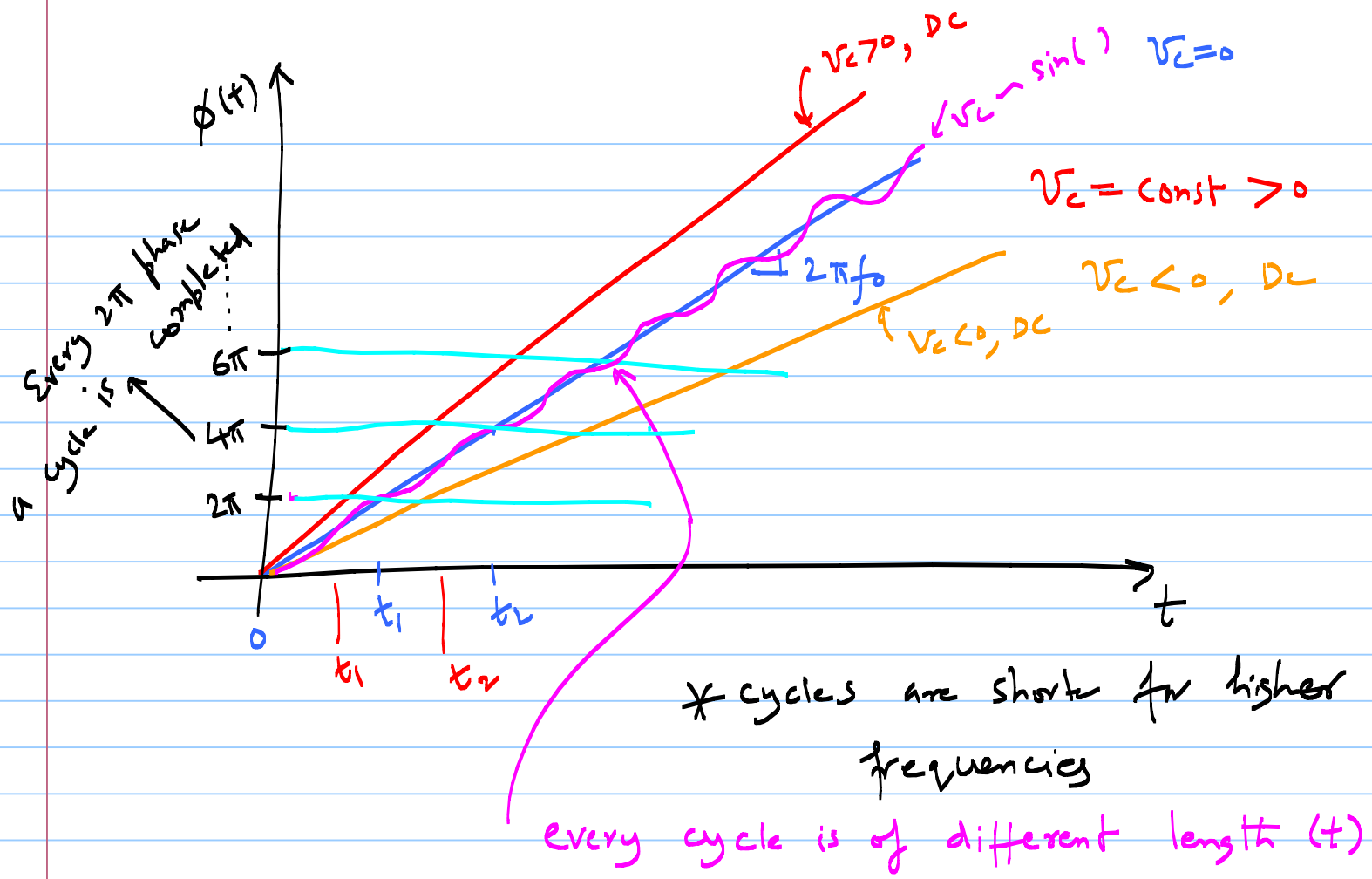
increment part

$$\cos\left(2\pi f_0 t + 2\pi K_{VCO}\int_0^t v_c(t)dt\right)$$

$\phi(t)$ ← phase of the output

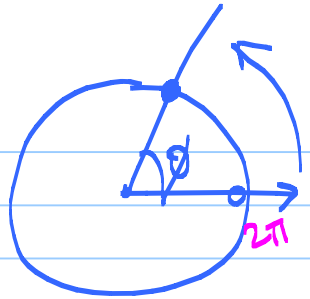
$v_c(t) = V_c$

$2\pi K_{VCO} \cdot V_c t$



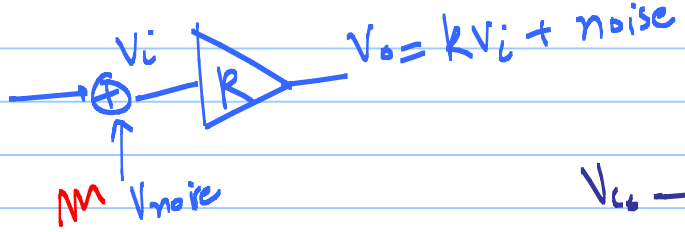
* cycles are shorter for higher frequency

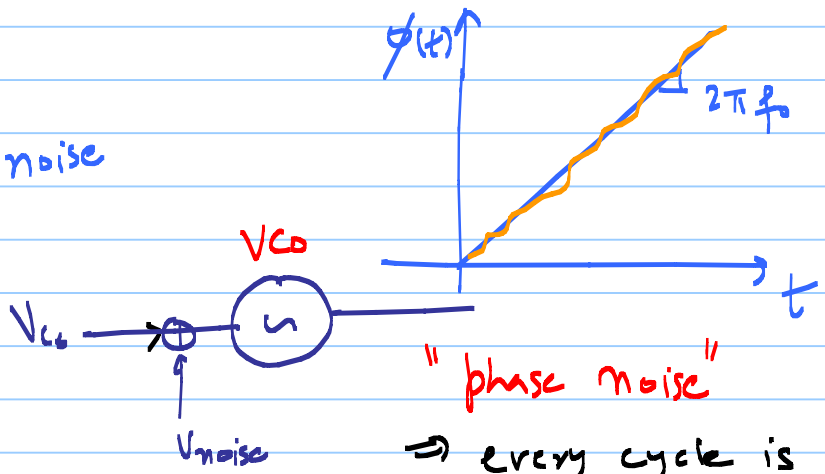
every cycle is of different length (t)



1 Hz → 1 sec cycle

10 Hz → 100 msec cycle





"phase noise"

⇒ every cycle is not perfectly the same

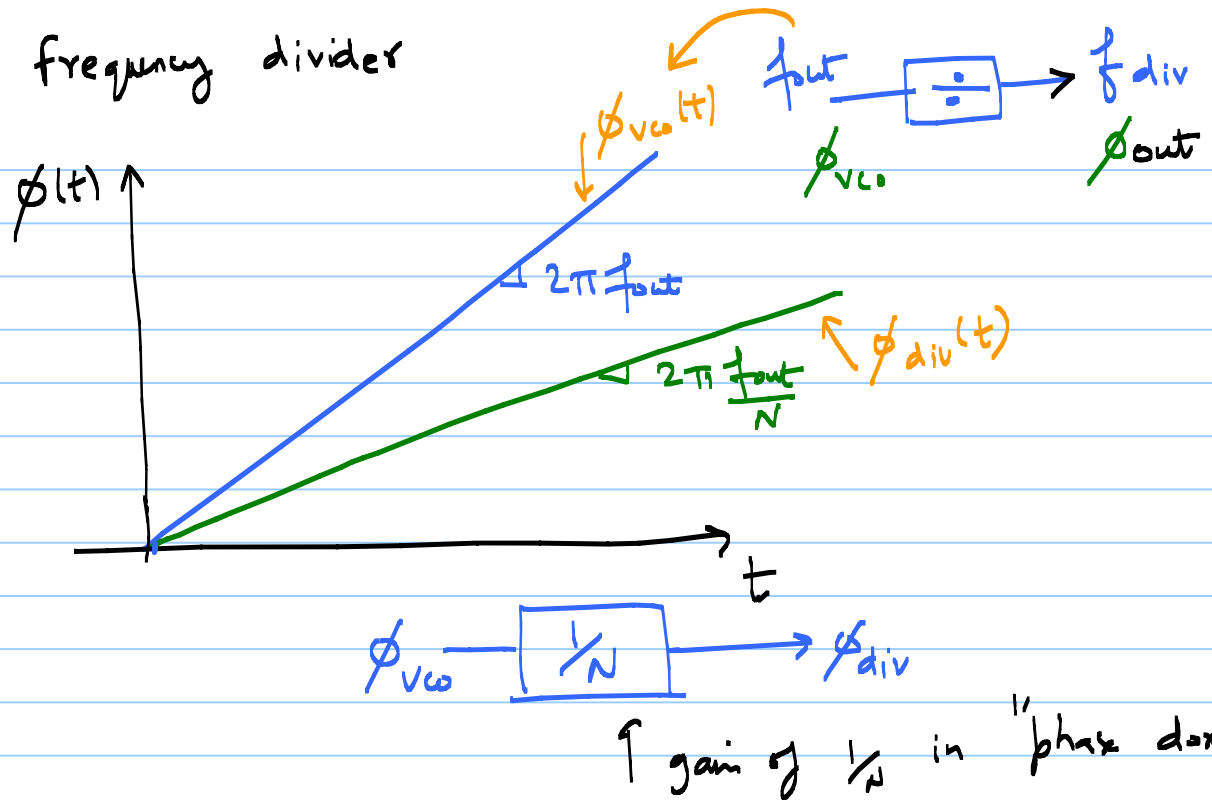
$$\cos\left(\underbrace{2\pi f_0 t + 2\pi K_{VCO} \cdot \int_0^t v_c(t)\,dt}_{\phi(t)}\right)$$

refer to FM

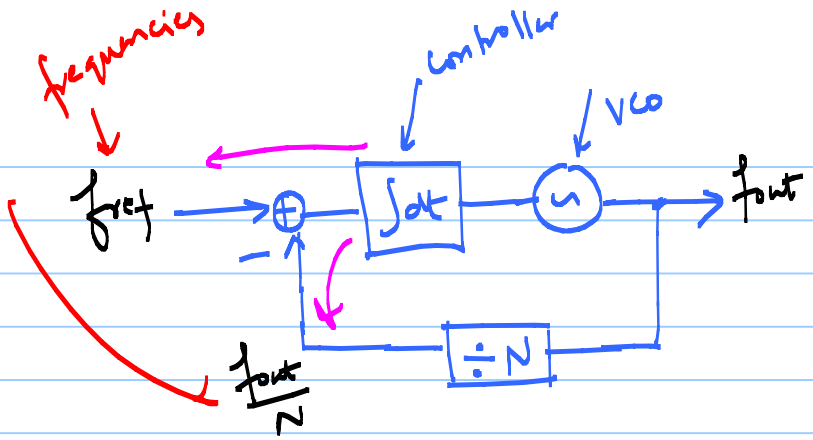
instantaneous frequency $f_i(t) = \frac{1}{2\pi}\frac{d\phi(t)}{dt}$

$$f_i(t) = f_0 + K_{VCO} \cdot v_c(t)$$

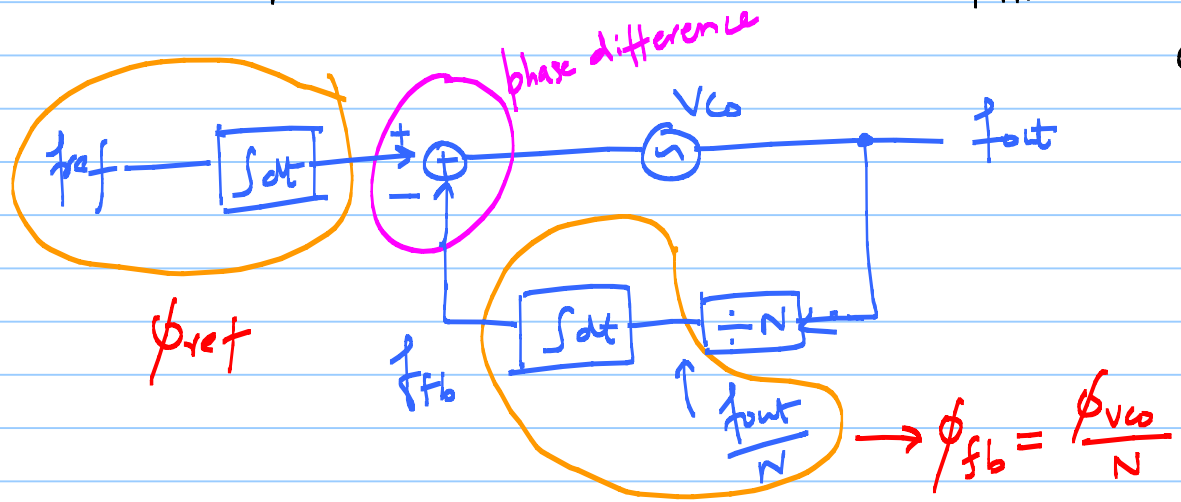
Frequency divider

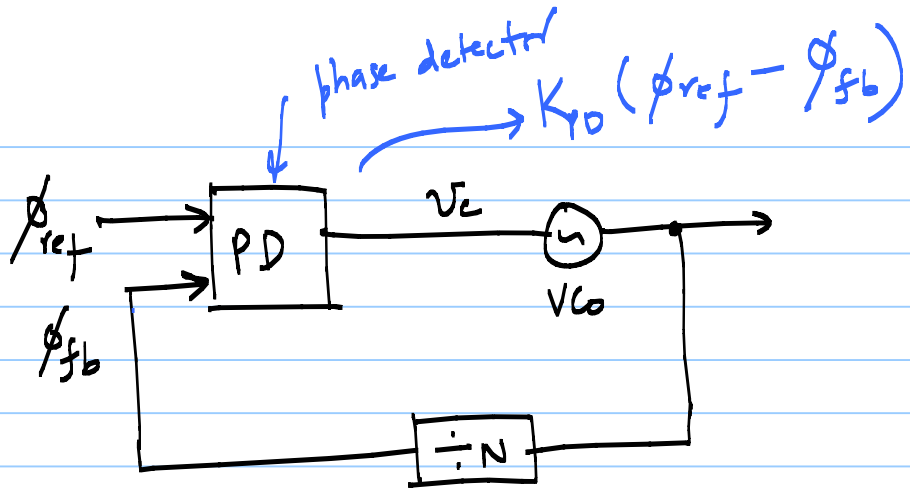


↑ gain of 1/N in "phase domain"



Pull the integrator out




phase detector
$K_{PD}(\phi_{ref} - \phi_{fb})$
ϕ_{ref}
PD
V_c
VCO
ϕ_{fb}
÷N