

Impedance of VCXO voltage control pin vs. PLL digital lock detect

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A low impedance of VCXO voltage control pin V_{con} leads to a large leakage current. It makes PLL loop filter can't be charged enough, and unstable voltage on loop filter. There is a risk to get PLL digital unlocked.

$$\text{Leakage current} = \frac{\text{Voltage on } V_{con}}{\text{Impedance of } V_{con}} \quad \text{----- Equation (1)}$$

Normally, VCXO shows nominal frequency when voltage control pin V_{con} is in the middle of the control range, we supposed it was $V_{cc}/2$ (= 1.65 V for 3.3V VCXO). Based on real VCXO and target frequency, the *Voltage on V_{con}* can be measured.

The leakage current would contribute Phase Error.

If PLL likes to judge digital lock, one condition is the Phase Error should be less than a lock detect window. Different PLLs have different lock detect windows by PLL internal design and settings. Here list PLL1 lock detect window for TI Jitter cleaners.

Product	Typical Lock Detect Window
CDCM7005	Programmable 3.5 ns, 8.5 ns, 18.5 ns in Lock-Detect Window (Word 3)
LMK03000 family	10 ns
LMK04000 family	5 ns
LMK04800 family	Programmable 5.5 ns, 10 ns, 18.6 ns, 40 ns in register bits PLL1_WND_SIZE
LMK0482x family	Programmable 4 ns, 9 ns, 19 ns, 43 ns in register bits PLL1_WND_SIZE
LMK0461x family	Programmable 0 ns ~63 ns in register PLL1WNDWSIZE

$$\text{Phase Error} = \frac{\text{Leakage Current}}{I_{CP} \times f_{PFD}} \quad \text{----- Equation (2)}$$

where:

I_{CP} is the charge pump current, which is programmable in PLL.

f_{PFD} is the PFD frequency.

From above equations, we can get some conclusions.

- 1, Higher f_{PFD} , higher I_{CP} can reduce the phase error and the risk to unlock.
- 2, Higher *Impedance of V_{con}* and lower target *Voltage on V_{con}* can reduce leakage current and help lock detect.

An exercise is known all other variables, to solve the variable "*Impedance of V_{con}* " (Minimum).

Another exercise is known all other variables, to double check if it is true for lock detect window > Phase Error caused by leakage current. If the answer is false, unlock would happen.