VCO Design Tips

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Lesson's Phase Noise Mode

$$L(f)=FkT/2P_o[1+(f_o/2Q_L f)^2]$$

F=Active Device Noise Factor

k=Boltzmans Constant

T=Temperature

P_o=Output Power

Fo=Oscillator Center Frequency

Q_L=loaded resonator quality factor

f=frequency offset from carrier

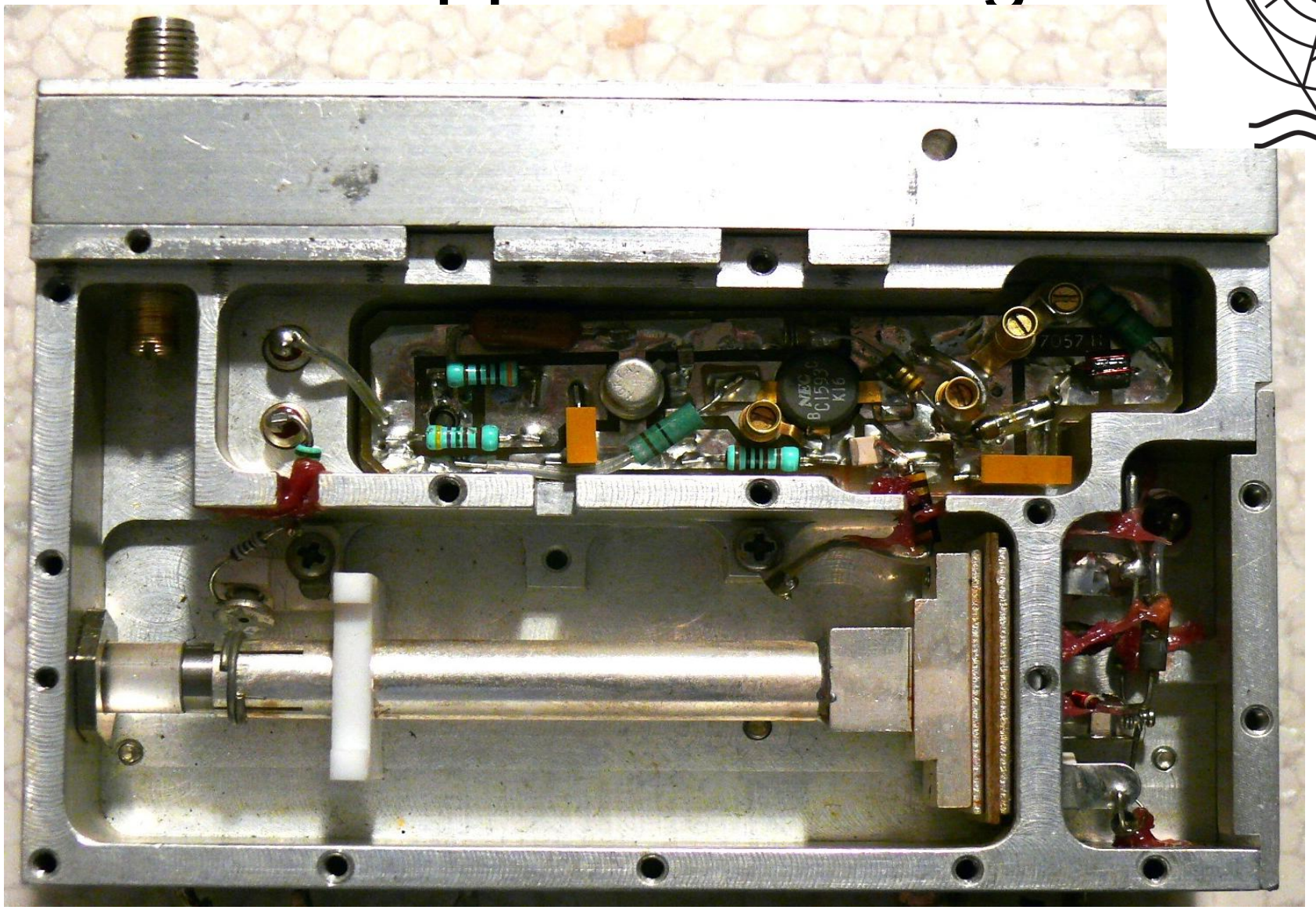
VCO Tips

Optimum Loaded to Unloaded Q

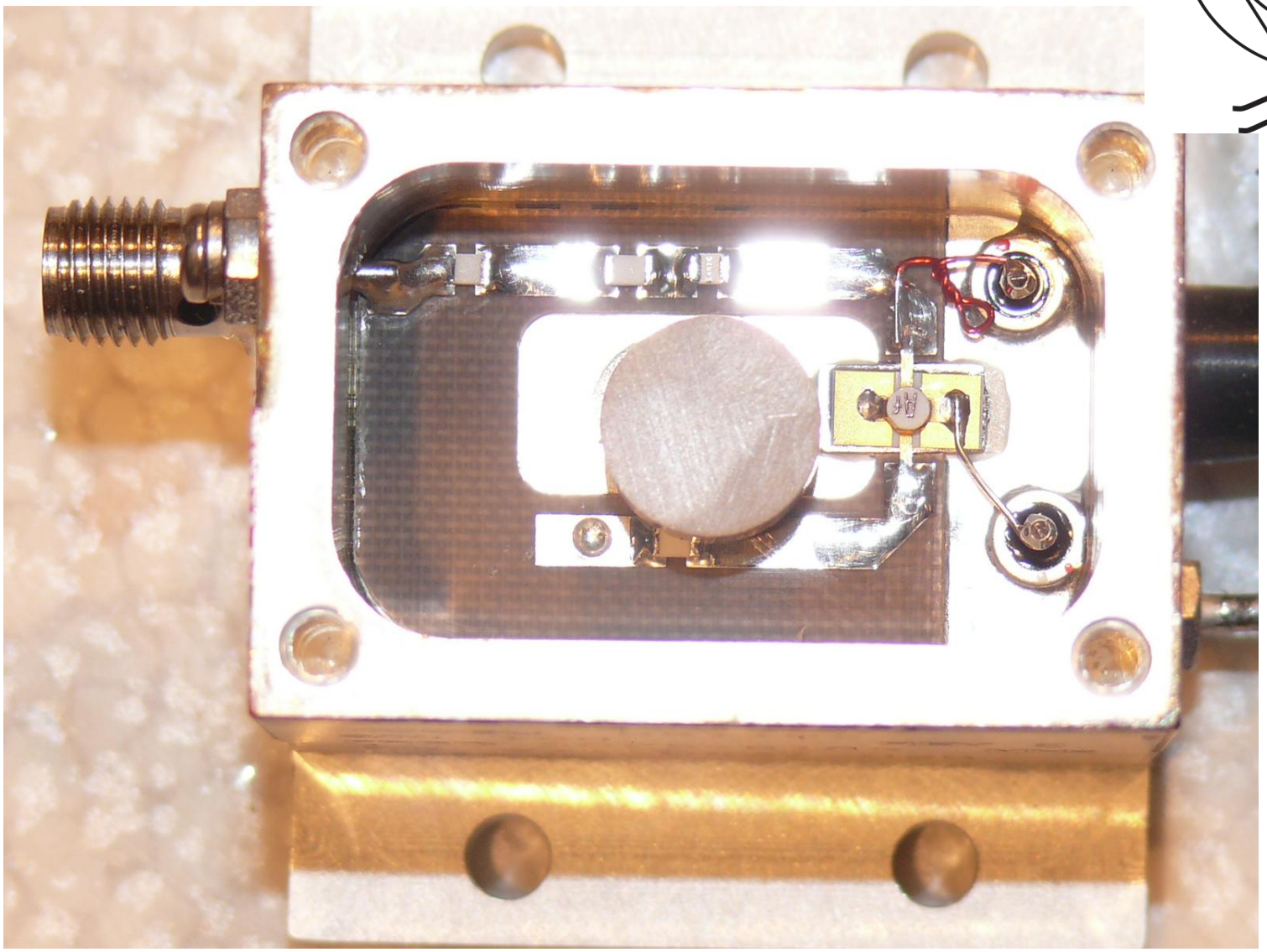
2/3 Ql/Qo 6 dB of resonator loss

This comes from solving Lessons eqn for the minimum of phase noise.

One Approach to Higher



Another



Q is purchased by the **CUBIC FOOT**!

Amplifier

Run a large DC current.

Servo the DC current

Small device capacitances

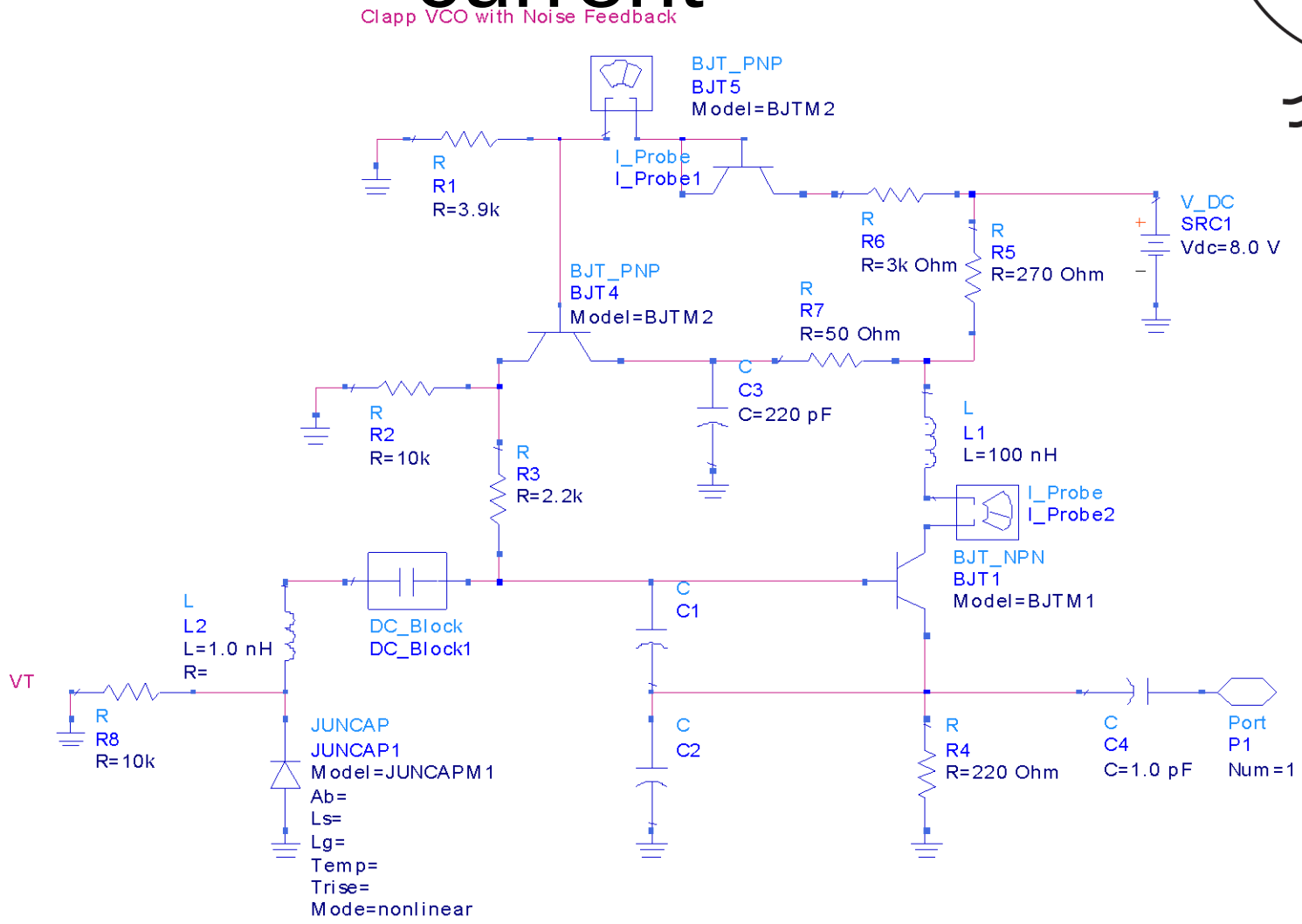
High FT Oscillator Transistor

NEC 85633 is excellent below 1200 MHz

NEC 68133 above

Infineon and NXP also make good parts

1/f Noise Feedback, Servo the current



Active Bias Circuit

PNP Transistor BC847

Beta =800

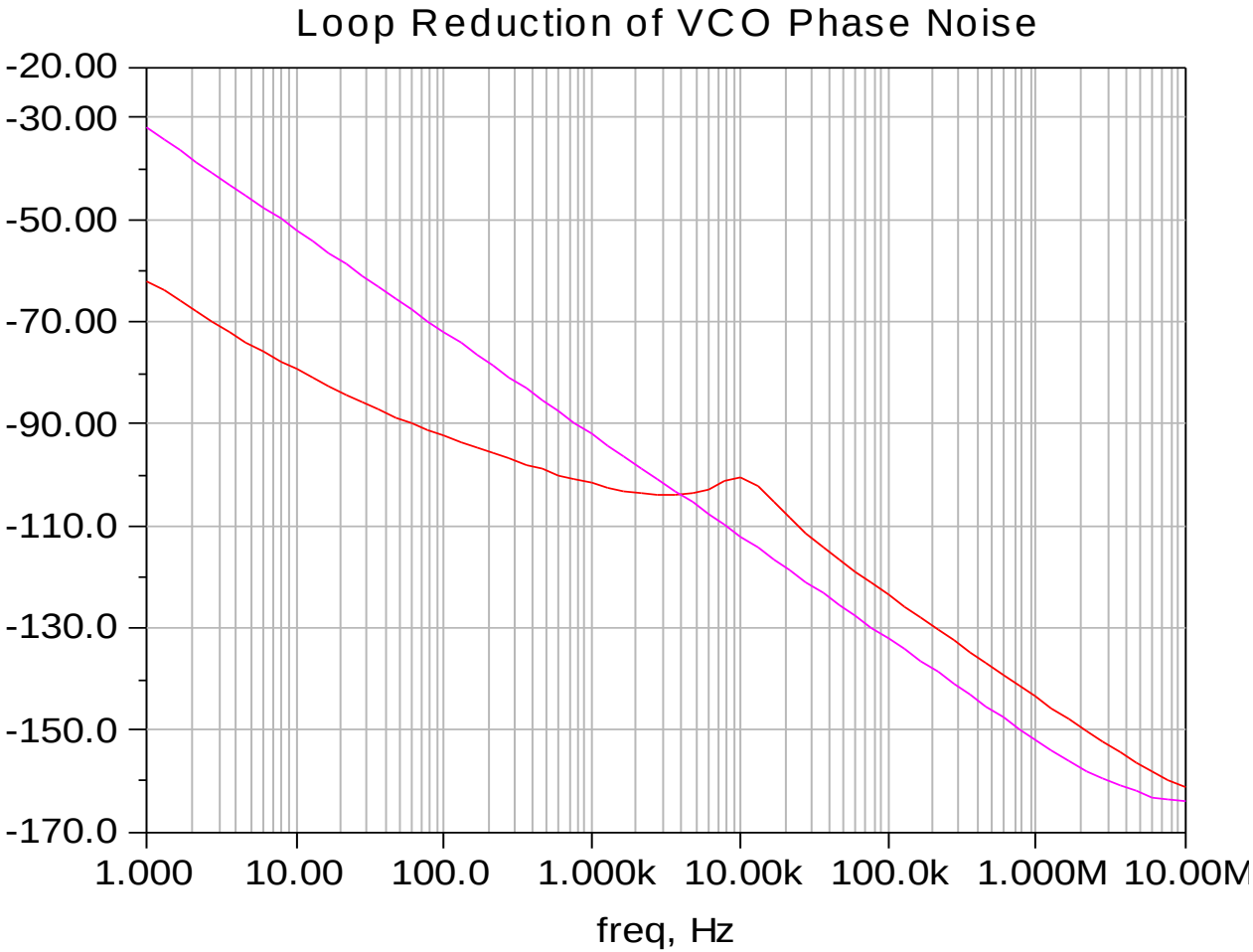
Low Noise

Suppresses gain of the RF transistor up to ~100 MHz.

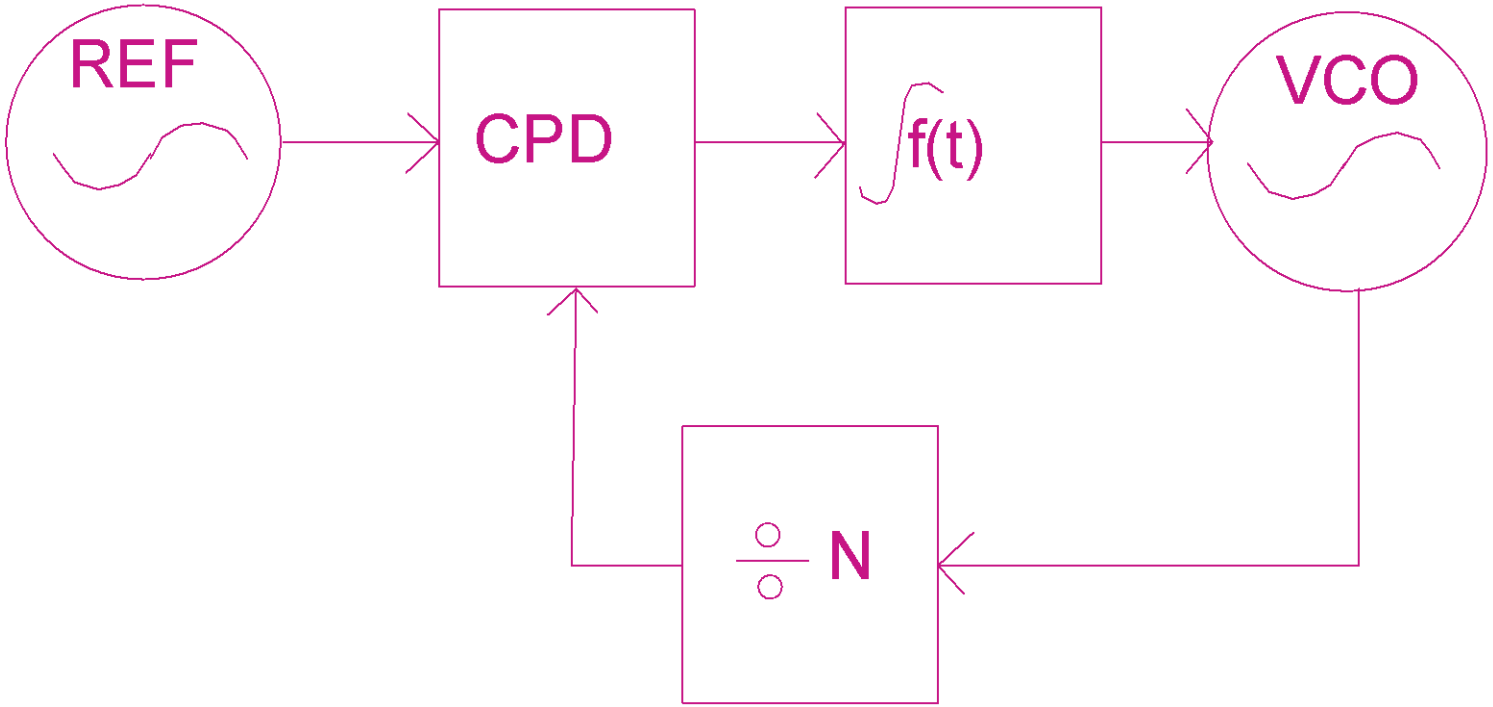
Works the same as the feedback in a PLL

Can extend the noise improvement above the corner frequency of the PLL which is dictated by the reference frequency.

Phase Noise of PLL



Its all about Loop Gain



Loop Transfer Function

$B(s)=(K_d*F(s)*K_o)/(N*s)$

Kd=Phase Detector gain constant

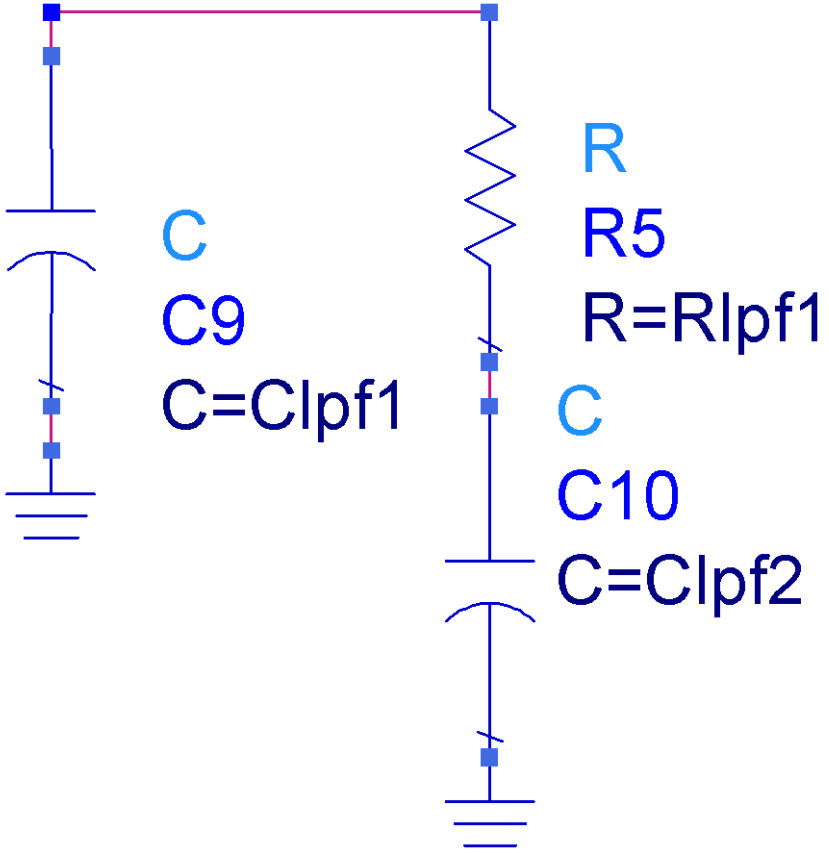
Ko/s= VCO gain, MHz/Volt

F(s)=loop filter response

N= loop divider ratio

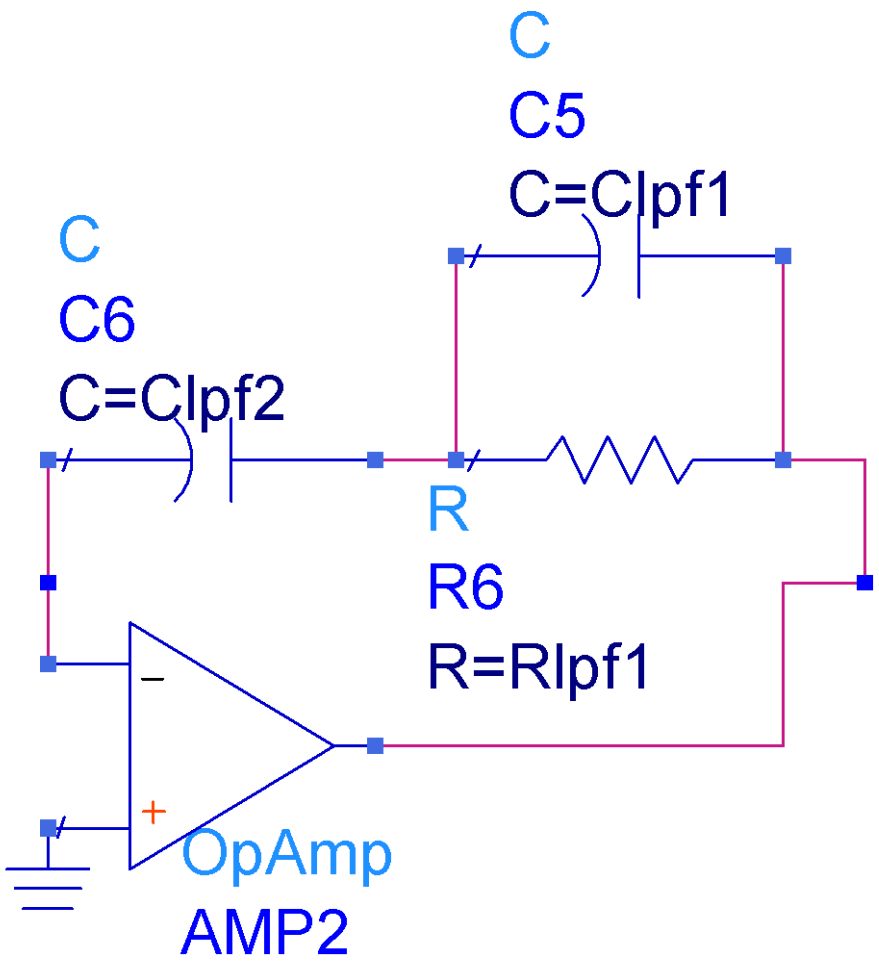
s=Heaviside operator, 2*pi*f

Passive Filter

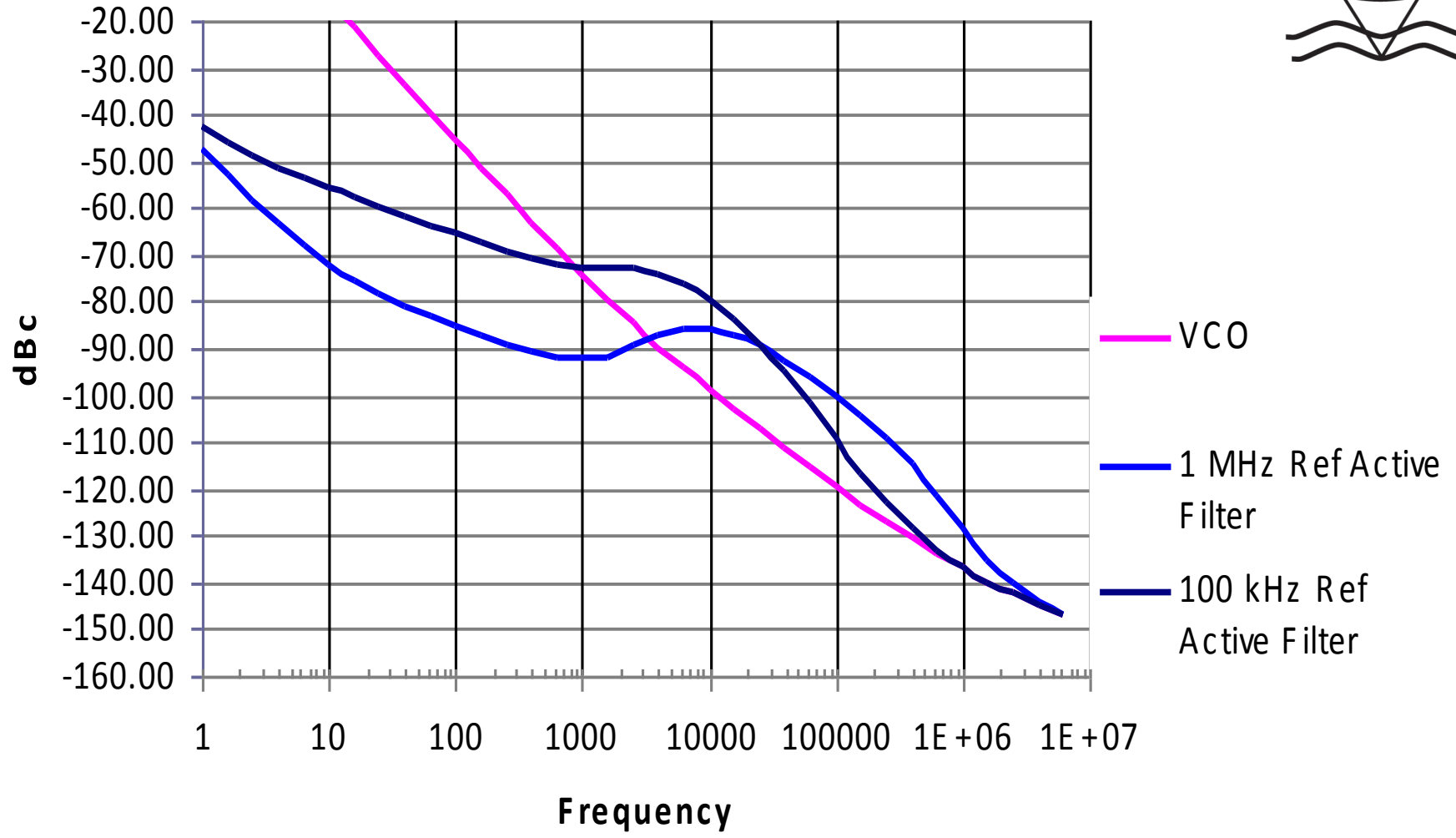


- Low Frequency Gain~1
- Other Passive filters possible.

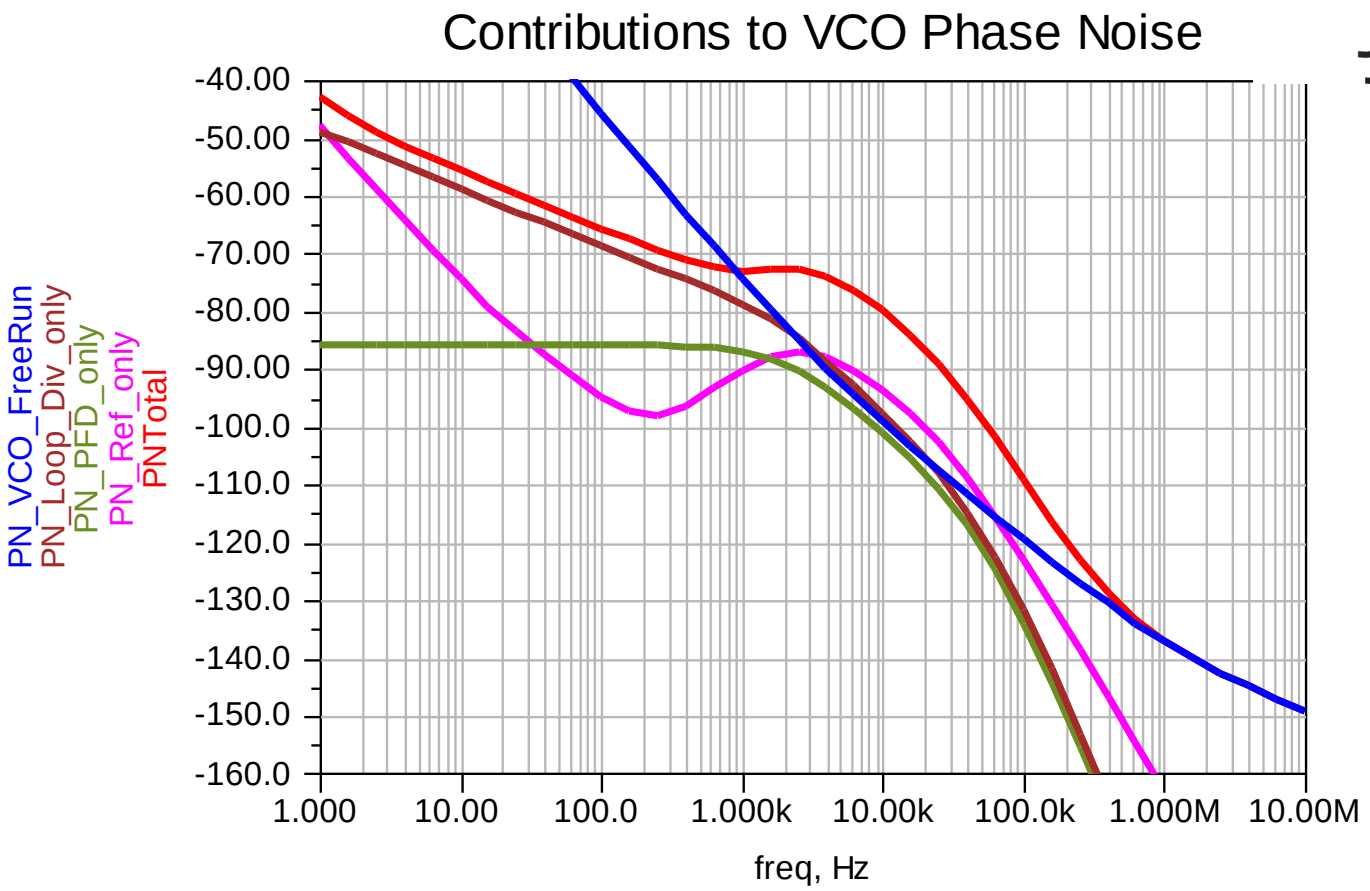
Loop Filter Gain



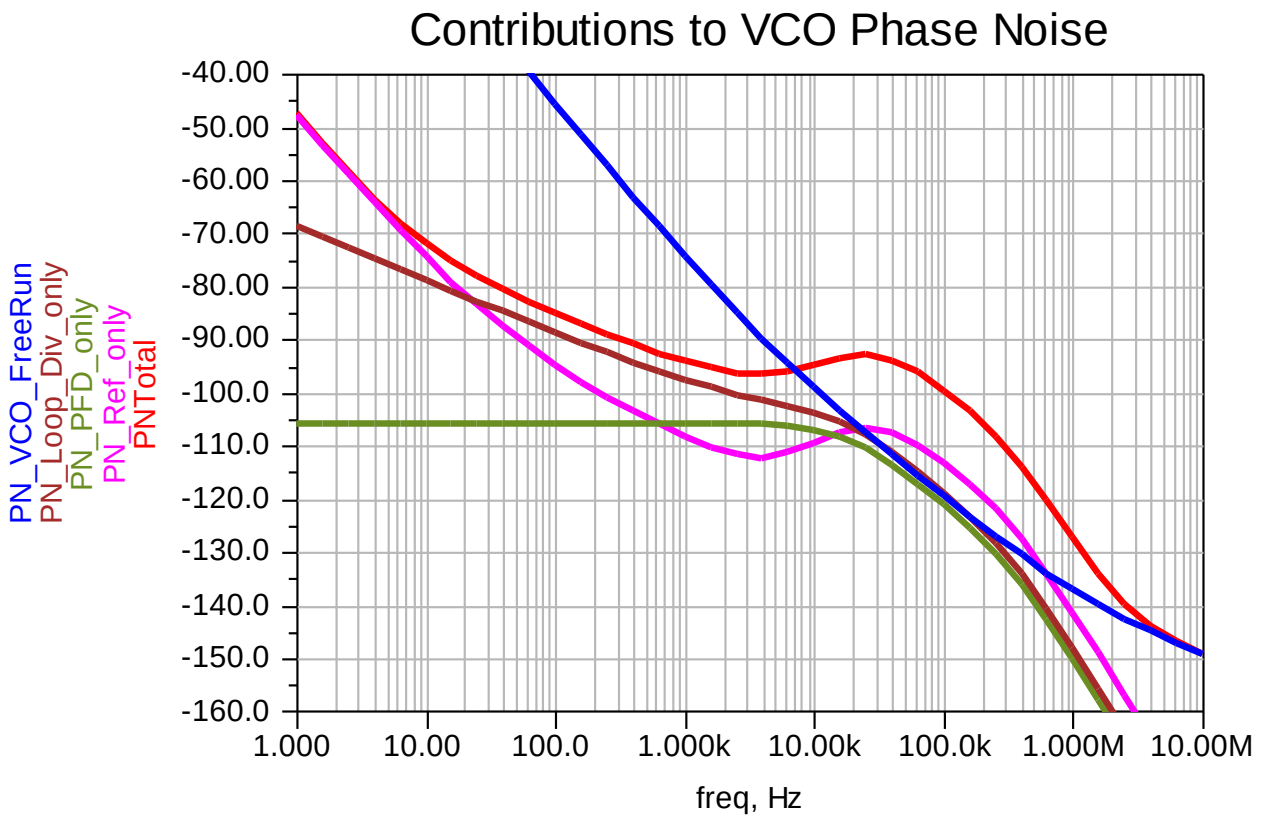
- Low Frequency Gain~∞



Other Sources of Phase Noise



1 MHz Reference



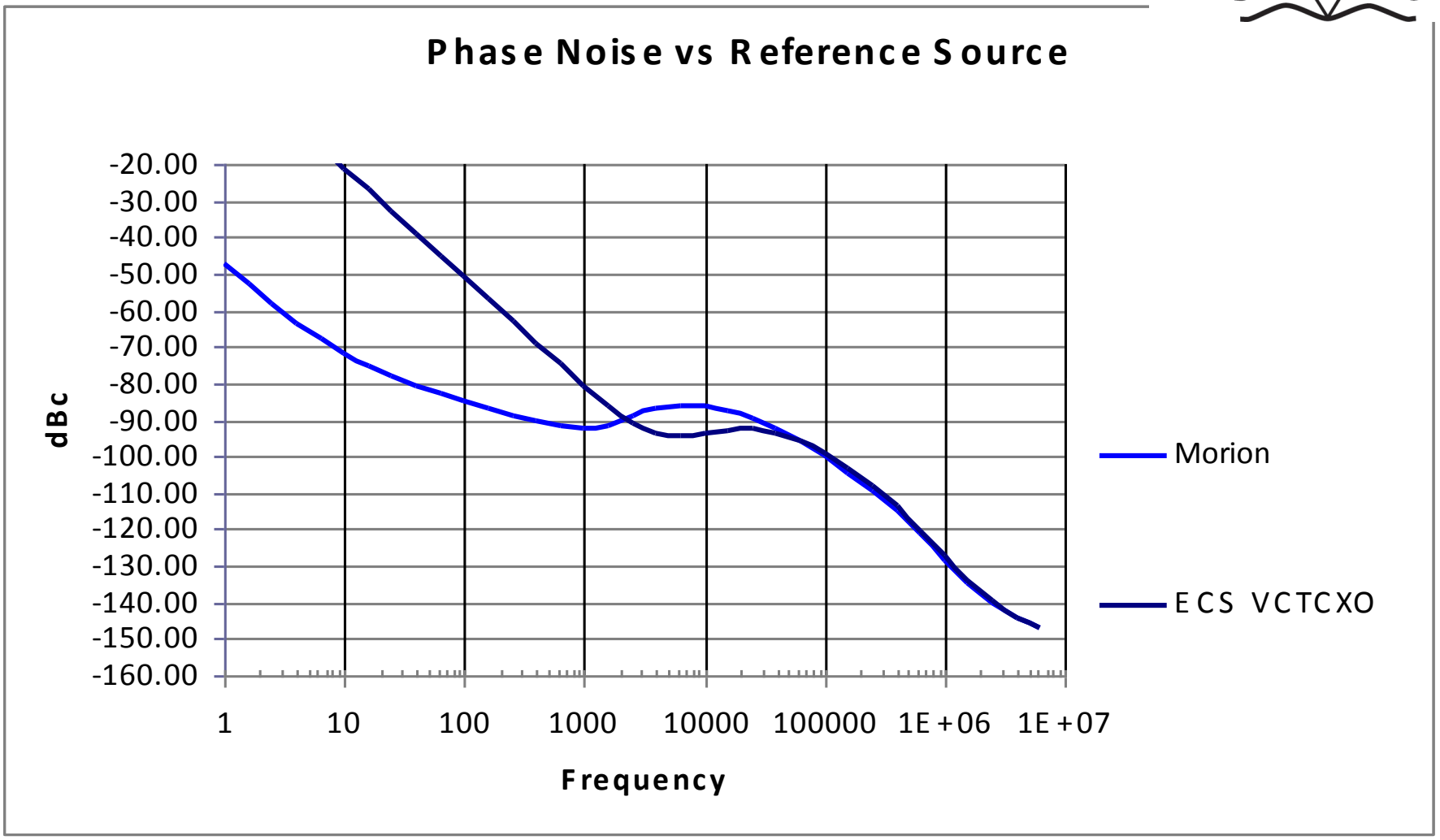
Does the Reference Matter?

If other components limit the total noise….no.

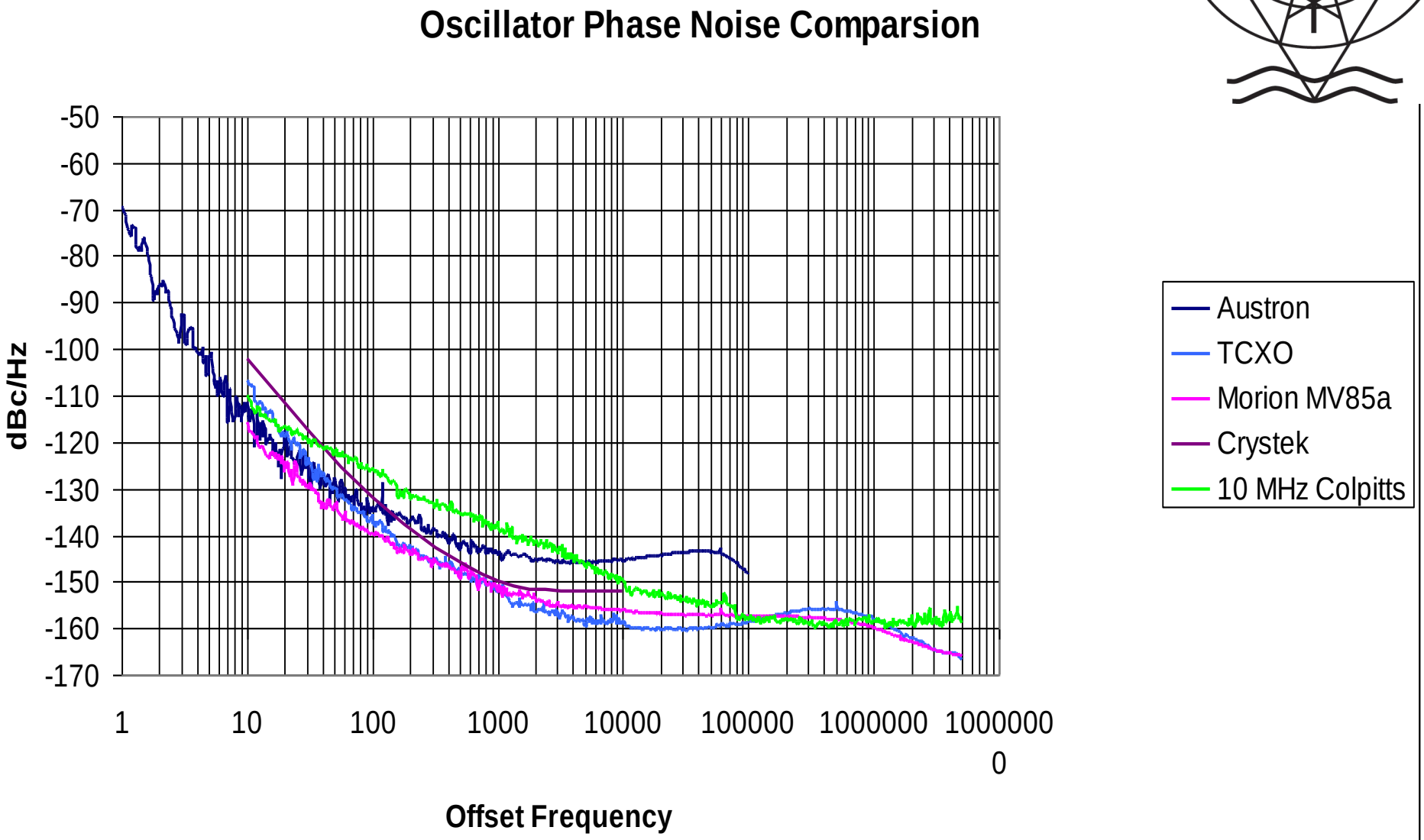
If its noisy. Heck yes.

The application also matters.

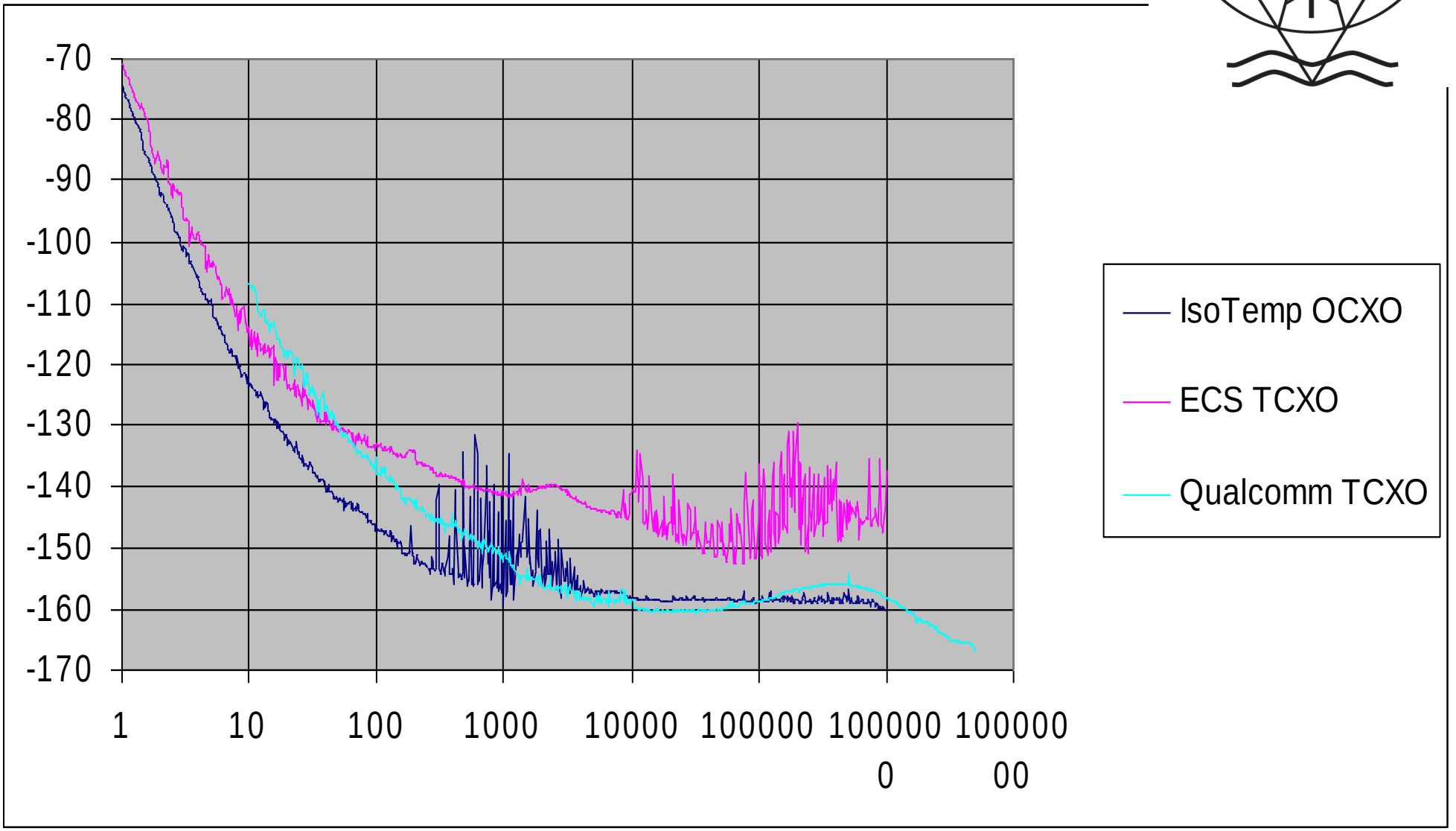
Clean vs Poor Reference Osc



Some Reference Oscillators



What is that Stuff???



Summary

Get all the Q you can.

Use a good oscillator transistor

Servo the current to reduce noise in the VCO below 100 MHz

Select the loop filter based on your application.

Select as high a reference frequency as possible

Find a clean reference.

References

Fundamentals of RF Circuit Design with Low Noise Oscillators. Jeremy Everard

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Noise in High-Frequency Circuits and Oscillators, Schiek, Rolfes, Siweris, 2006 Joohn Wiley & Sons. ISBN 0-471-70607-6

The Design of Modern Microwave Oscillators for Wireless Applications, Rohde , Podar and Bock, 2005 John Wiley and Sons. ISBN 0-471-72342-8

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ADS for simulation, by Agilent.

ADIsimPLL free from Analog Devices, www.ADI.com

http://www.analog.com/en/rfif-components/pll-synthesizersvcos/products/index.html

VCO data from Synergy Microwave, www.synergy.com DCMO80210-10