Re: Crystal drift

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Date: 09/24/04

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Mike Monett wrote:
> Phil Hobbs wrote:
>
> [...]
>
>
>>Sideband locking is a possible strategy here. If you mix the two oscillators
>>together, you can phaselock the beat note to a function generator with a
>>frequency−phase detector, e.g. a 4046−−it won't lock up to the image
>>frequency, because the sign of the loop gain is opposite for the two
>>sidebands.
>
>
> Wouldn't the pll rail if it approached the image from the wrong direction?

It won't rail, but it will try to lock up at the wrong null−−which in a PFD is a huge cliff due to the sawtooth characteristic, leading to a much larger loop bandwidth in this condition. If this is done right, the loop will not be stable at this increased gain, and so it will get kicked away. Whether it gets kicked in the right direction eventually is a design issue−−I wouldn't build something like this without aided acquisition. My favourite acquisition aid is an auxiliary positive−feedback network around the (active) loop filter−−when the loop is out of lock, it oscillates slowly until lock is found, at which point the negative feedback overwhelms the positive, and lock is acquired. All it takes is a twin−T or a phase shift oscillator network.

>>By making the loop narrow enough, you can avoid having the beat
>>note modulate the VCXO significantly.
>
>
> Aren't you locking to the beat frequency? With a phase/frequency detector and a
> balanced charge pump that has zero deadband, there should be very little ripple
> on the output.

Yes, but not *none*. This is an ultraprecise application, after all.

>>You do need a large enough frequency
>>offset to make this work,

>
>
> *Heh − A frequency offset of 1e−3 or less would probably be quite difficult:)*

Well, 1e−3 fractional change in 10 MHz is 10 kHz, which is way more than enough. If you mean 1e−3 Hz, then I agree−−a second oscillator to provide the offset would be needed, as below.

>
>*>and although it won't lock up to the image*
>*>frequency, it can lock to higher IM products if you don't take some care to*
>*>prevent this (e.g. by acquiring lock at a high enough beat frequency that*
>*>only one product is within the tuning range of the VCXO, then sweeping as*
>*>desired).*
>
>
> *Hmm... I'm not sure this came out as clear as you intended. Wouldn't a mixer*
> *driving a phase/frequency detector ignore the higher IM products, or maybe I'm*
> *not following you?*

It depends on what the filtering following the mixer looks like. If the main beat note is outside the filter bandwidth, it's quite possible for a higher−order term to cause locking with a PFD, especially if there's a limiter after the lowpass filter.

> *Also, depending on the frequency, a simple D−flop makes an excellent digital*
> *mixer. Put one input on the clock, the other on the D. The Q output will switch*
> *at the difference frequency.*

Not with a PFD−−metastability will blow you right out of the water. Every lost cycle equals lost lock. The D flipflop trick can work with a narrow loop and a multiplying phase detector though−−I used it when I built a pilot tone generator for what I think was the first commercial direct broadcast satcom system, in about 1982. (I had just got my bachelor's degree in astronomy and physics at the time, and they hired me to look after all the ultrastable PLL stuff−−talk about being thrown in the deep end. For the frequency reference board (different from the PTG) I had to invent a fractional−N synthesizer based on resynchronized rate multipliers. It worked great, eventually.)

Cheers,

Phil Hobbs