



How Low Can You Go - Ultra Low Phase Noise

October 13, 2011

Jason Breitbarth

Founder, President and CTO of Holzworth

Jason Breitbarth discusses the history of the company, its synthesizer technology and future plans.

MWJ: Holzworth is a smaller company with expertise in high performance, high reliability instrumentation and components – how was the company formed?

JB: Holzworth started in my garage in 2004. I was doing some custom, one-off, synthesizers that outperformed others in the industry. In 2007 Joe Koebel joined Holzworth as a co-founder, heading up sales and marketing to fully bring Holzworth to market with a roadmap to become a major test equipment provider. We selected our first office space in the heart of Boulder Colorado, putting a premium on quality of life and the work environment as a long term investment.

MWJ: Holzworth's expertise in synthesizers seems to be at the core of your beginnings – how did you start off with the product expertise?

JB: Before Holzworth, my background has primarily been in frequency synthesis, with an emphasis on low phase noise architectures and measurement techniques. Up until 2007, I had built all my own phase noise analyzers. In 2007 we decided to build the world's most straight forward and fastest phase noise analyzers, but to do that we needed the most stable, truly low phase noise synthesizers available. Apparently others [systems integrators] needed ultra low phase noise, high stability synthesizers as well... and our synthesizer business took off much faster than we'd expected.

MWJ: Holzworth synthesizers are known for their unique non-PLL construction. What technique do you use for your synthesizers and what performance levels do they achieve?

JB: Direct-analog synthesizers are the standard in terms of phase noise and stability. The very reason they are used in radar systems. However, size and frequency resolution suffer. We combined direct-digital technology with a more traditional direct-analog approach, with some very custom intellectual property. In effect we created a synthesizer as stable as a direct-analog type but with resolution and phase noise exceeding PLL based synthesizers. The real challenge was to put that in a package the size of an index card one inch thick. A real advantage is we can create any number of frequencies and have them all coherent to each other with the only channel to channel drift is temperature, at about 0.5 ps/degree C.

MWJ: What are the advantages and drawbacks of the direct-digital/direct-analog hybrid designs?

JB: Spurs are one of the hardest things to control. We spent years on our proprietary filters to control the spurs of our instrument. Once that is solved you inherently get all the advantages of improved phase noise and phase coherency. Ultimately phase coherency is the biggest benefit over the 'wandering' PLL synthesizers, especially fractional-N types. If you program two synthesizers to the same frequency while locking them to the same reference, you'd expect them to be at the same frequency indefinitely. This is the case with Holzworth synthesizers, but not the case for most PLL synthesizers.

PLL synthesizers do exhibit slightly improved phase noise at offsets greater than 1MHz from the carrier. However, Holzworth's non-PLL synthesizers provide better close to the carrier phase noise, phase coherency, and extreme stability; which customers seem to prefer over this one aspect of PLL based synthesizer.

MWJ: How does your architecture achieve ultra low phase noise and spectral purity performance in addition to minimal settling time which is often a trade off in traditional designs?

JB: A phase locked loop is effectively an active filter of the multiplied reference. It achieves this through feedback and constant adjustments to stay 'locked'. The feedback adds noise and settling time from having a relatively narrow bandwidth and additional circuitry. A direct-analog, direct-digital architecture has no feedback and requires no adjustment and the filters can be designed to give a broader bandwidth. This reduces noise and improves settling time, because settling time is just the effective bandwidth of any filtering. The settling time of a PLL follows an exponential decay so settling time is measured to 'within' a certain tolerance, say 10 kHz. To get within 1 Hz, or 0.1 Hz could be many times longer. With our hybrid direct approach, it's essentially a clocked system and so the frequency changes on the next cycle and our filtering bandwidths are orders of magnitude greater than a PLL, offering a higher level of performance. Spectral purity is achieved through very careful filtering.

MWJ: How do your designs achieve such high reliability in addition to high performance?

JB: Reliability is improved by reducing the number of active components and eliminating connectors. We design virtually everything discretely, even our linear regulators. This has the advantage of using the right part for the job to achieve necessary performance, but also improves reliability by reducing the number of active parts and de-rating as much as possible. A capacitor, inductor, or diode has higher reliability than an integrated circuit. This does result in additional product development and a longer product release cycle. Ultimately, we have been rewarded by ~200k/hrs MTBF. As a result of our design for reliability, our synthesizers have been qualified for (in spec) operation from -40 to +75 C and as well as under vibration conditions.

MWJ: Holzworth RF Synthesizers were developed as building blocks for our Phase Noise Analyzers – what types of measurement systems do you offer and what are their advantages in the market?

JB: Phase noise measurements are typically somewhat specialized. Is the customer measuring a free-running VCO, a synthesizer, or an amplifier? We offer a range of analyzers from a simple single channel base-band analyzer, which is very cost-effective, to a fully automated cross-correlation oscillator measurement. Our performance meets or exceeds other systems in the market. By offering a range of products, we can be more cost-effective by targeting exactly what a customer needs. This offers performance advantages since an instrument can be optimized specifically for a set of tasks. Since we design everything in house, we can make our system smaller and more rugged. When flying to visit customers, we carry on our phase noise analyzers in a briefcase.

Software developed by Leyla Bly, the third co-founder of Holzworth, is the heart of the usability of Holzworth's instruments. The GUI has a very small footprint. The executable file (non-driver) is fully touch screen compatible and extremely easy to use. We put a large amount of effort into the usability of our equipment as we know that to be a major drawback of other analyzers in the market both from customer feedback and our own experience.

MWJ: What other products does Holzworth offer?

JB: Our line of thinking is not to do a 'me too' product. The reason we have been successful is that we provide the customer with unique performance advantages. In addition to RF synthesizers and analyzers, we offer several compact components that are unusual in the industry: multipliers, dividers,

phase detectors and amplifiers, all 100% production phase noise tested. These are components I wish I had available when I was building my own phase noise measurement systems. Often if we find a part useful and unique in our own testing, it is worth putting out there as a product. This agile working environment is only something you can do in a smaller company.

MWJ: What is the business outlook for the major markets for Holzworth and which markets do you think will see the highest growth over the next year?

JB: Phase noise is leading the pack right now, both in synthesis and in measurement. With the release of our phase noise analyzers, we will see significant growth. However, we're not sitting still with our synthesizer technology and we're very excited by what's in the works. We're only involved in these two markets but in terms of growth, we feel measurement will eventually outpace synthesis.

MWJ: Do you have any expansion plans in the near future?

JB: We just moved into a new facility in April so our immediate plans are in hiring more talent. Our main challenge right now is growing maturely. Our business plan from the beginning was to nurture a healthy long-term company while building everything in the US.

YOU CAN VIEW THIS CONTENT AND MORE BY VISITING MICROWAVE JOURNAL ONLINE
www.mwjjournal.com