A Brief History of Programmable Oscillators

New Programmables Take Bugs Outta Jitter, Delay Outta Delivery, and Send Heebie-Jeebies Back to Big Easy

by Michael Adams

(Translation: They're low jitter, plus they're field programmable in five seconds, and even RE-programmable in five seconds. In addition, they're cheap, and as stable as a high note from Satchmo's trumpet, which incidentally is inside the US Millennium Time Capsule buried five years ago at the White House.)

In 1934 Cab Calloway recorded trumpeter Edwin Swayzee's jive hit *Jitterbug*. Ever since, it's been berries for hep cats and floorflushers (translation: a joy ride for musicians and dancers), but for technology designers, i.e. all of us feeling extraordinary pressure to improve the price and performance of electronic circuits (pressure that accelerated to warp speed during the Clinton boom), jitter performance (the electronic kind, not the dance step) wasn't what you'd call the bee's knees. (That's more jazz slang, meaning that jitter performance, even on state-of-the-art components, was not what you'd call *terrific*).* It was more like *tough skees*.

But then, at last, around the turn of the millennium, tiny fixed frequency oscillators with unbelievably low jitter and practically no noise (and at attractive costs) finally became commonplace. Praise the Lord. Component makers caught up with our concerns and actually addressed them. We finally got what we wanted, what we *needed*: reliable oscillators and crystals with just about all of that pesky jitter and noise well under control. Actually *very* well under control. It looked like we could take a breath, and get back to managing the still unnerving pace of product development.

Dream on, kemo sabe. Instead, here's what happened. As soon as we got access to those badly needed low jitter parts, the one lingering time bomb still buried within the whole Rube Goldbergesque process of electronics research and development finally exploded. Sometime around the time the new century dawned on us, the whole system began to buckle under something *else* that also dawned on us. Everyone realized that the one thing that was *still* holding us back, the one thing really slowing new product development (now that the jitter bugs seemed to be gone) was this: despite how nicely these modern components performed, it suddenly occurred to us that it was still taking virtually eons (relatively speaking) *to get them*. I mean come on. SIX WEEKS to get a custom fixed-frequency oscillator? SIX WEEKS?

Well, yes.

Until then, no one was really thinking too much about this. We were all just worried about getting the jitter under control. We used to think, "Six weeks? No problem, just get the jitter under control. Six weeks is OK as long as the part I *finally* get actually works." OK fine.

But that was back in those same good old days (again about five years ago) when no one was too terribly hopped up (concerned) that a mail-order book might take a month to arrive. Or that it could take two weeks for a holiday gift to go through the postal service. Or an order of color copies from Kinkos might take 24 hours (instead of 24 seconds) or that vacation pictures took at least sixty minutes to get developed at the drug store. But suddenly Amazon was sending out *The Da Vinci Code* overnight. Fed Ex was delivering anything as early as *8:30 am the next day*. Digital cameras were showing us pictures as fast as we took them, and forget about going to Kinkos for color copies. Everyone has a color copier in their *kitchen*. But what about those custom fixed-frequency oscillators? What about that six week waiting time? Well, actually nothing had changed. Amidst all this other amazing progress, it *still* took up to six weeks to get them. Here we are in 2005, and it *still* takes up to six weeks to get a custom fixed-frequency oscillator.

The new Airbus 380 employs FIPO programmable oscillators in flight-control systems, where failure is not an option.

Everyone began to think there must be a solution to all this. And actually, there was.

The Dawn of Reliable Programmable Oscillators

They're called programmable components. A lot of people began to say, "What this country needs is a good programmable oscillator. A good *field programmable* oscillator!" What we needed was a field programmable oscillator (i.e. one that you and I can custom design right on our desk) that is *extremely* low in jitter and noise, *extraordinarily* easy (and fast) to program (and maybe even extraordinarily easy and fast to RE-program), and virtually 100% stable for the very long run, even when it's installed in the most trying applications. 100% stable even for installations where failure is not an option, as for example in airliner flight-control systems, or even in NASA's sophisticated interplanetary hardware.

Think back to about 2001, and you can't deny it. That is what the country, and for that matter, the whole world needed. We needed a field programmable oscillator that is *extremely* low in jitter and noise, *extraordinarily* fast (and easy) to program, and virtually 100% stable for the very long run, even reliable enough to be installed in the most trying applications. But that dreamed-about programmable oscillator just did not exist. Or so we all thought.

Well I'm taking the time to write this for *MPD*, and for you, to tell you straight out, it's 2005 and all this *has finally and permanently changed*. In that very year mentioned above (2001), an American component company called Cardinal Components achieved a remarkable milestone in oscillator evolution. What they did that year is this: Cardinal Components won the prestigious Product of the Year Award from a major electronics journal for a revolutionary new component, the first-ever *reliable* field instantly programmable oscillator. They call it FIPO (which, not surprisingly, stands for Field Instantly Programmable Oscillator). It was a new product introduction that filled a need with the perfect product at the precise moment the need for that product materialized. This was such a remarkable achievement that the State of New Jersey (where Cardinal is located) issued a joint legislative resolution commending the company for bringing such honor to the state.

It was a revelation. Designers who saw the unbelievable three minute operation, where a little shoebox-sized programming module is attached to a desktop pc, couldn't believe they were actually seeing tiny oscillator blanks being specifically programmed to an exact and *stable* frequency (pick any frequency), right before their eyes, in *seconds* (not weeks). They grabbed the shiny little parts and raced off to check the calibration on their own equipment, to install them in test circuits, to verify the frequency and the jitter and the noise. They raced off, it seemed, almost determined to prove that this was not happening. They raced off, it seemed, almost determined to prove that this was *not possible*. But the truth is, it was possible, and better yet, it's still possible and it's still happening, and at a rate that may surprise you. It is no exaggeration to say that every day one or another avowed believer in fixed-frequency, store bought, six-week-wait-time oscillators is finally seeing the light. And, perhaps even more surprising to anyone not completely up on all these matters, is that many many of these tiny miracles are taking place in some of the loftiest arenas of technology.

For just two examples: Cardinal recently announced that several improved variations of the original

Cardinal, Cont on pg 50

> Cardinal programmables are installed inside flight-control systems on the new Airbus 380, and are expected to fly in NASA space vehicles within five years.

Cardinal, Cont from pg 12

FIPO, including some that are actually *re-programmable* (either for a new application or to simply rectify an error) are in use *at this very moment* in the flight control systems of the new Airbus 380, the world's most advanced airliner. And, in addition, NASA is progressing through extensive tests it structured for FIPO at the Jet Propulsion Laboratory. As a result, Cardinal programmables are expected to fly in space within the next five years.

Do you see my point? These are not trivial Gameboy applications. This is very serious electronics, all at the highest levels of technology. The designers in these environments follow one well-respected axiom – *failure is not an option.* Very heady stuff. Very impressive that programmables have penetrated these hallowed programs, but actually not surprising when you consider the advantage of field programming, especially when you factor in that these little wonders are pretty much comparably priced with their fixed-frequency cousins. Frankly, it's hard to say where this doesn't make sense.

Even More Progress is Announced in Programmable Oscillators

Despite the success of the original programmables, Cardinal is continuing to refine, to *de*-fine, the programmable option. Their latest innovations include a new line of programmable oscillators they designate as LVPECL and LVDS. These are more "targeted" devices suitable for such applications as telecom, digital VCRs, Ethernet, WAN interfaces, routers, set top boxes, and for transferring data from cameras to PCs.

To be more specific, the programmable LVDS device uses a 300mV differential signaling. The appealing feature of the LVDS is that it lowers power consumption and reduces the noise of the clocking circuit (EMI). Beyond that, the programmable LVPECL device uses a 600mV differential signaling that simplifies peripheral circuit interfacing. These new programmable oscillators use a supply voltage of 3.3 volts, have a stability of 50 ppm, operate over a temperature range of -40C to +85C, can be programmed from 150 MHz to 700 MHz, and are available from stock! Believe it or not, these are rock solid proven numbers. Cardinal (and Cardinal's customers) have all the data to back them up.

To keep the innovations coming, a new desktop programmer, the nerve center of programmable components, is more impressive, too. Called the PG3100 programmer, this latest model is capable of programming from 1MHz to 700MHz. Logic levels of CMOC, TTL, LVDS, and LVPECL are available and programmable voltages range from 2.7 volts, 3.3 volts, and 5.0 volts. To say it another way, the PG3100 executes all of the functions that Cardinal's original model (the PG3000) performs, but also contains an enhanced software version that enables it to program LVDS and LVPECL oscillators up to 700MHz. The PG3100 is compatible with Windows 98SE, 2000, and XP operating systems. The programmer connects to a Windows PC via a USB cable and software installation is simple.

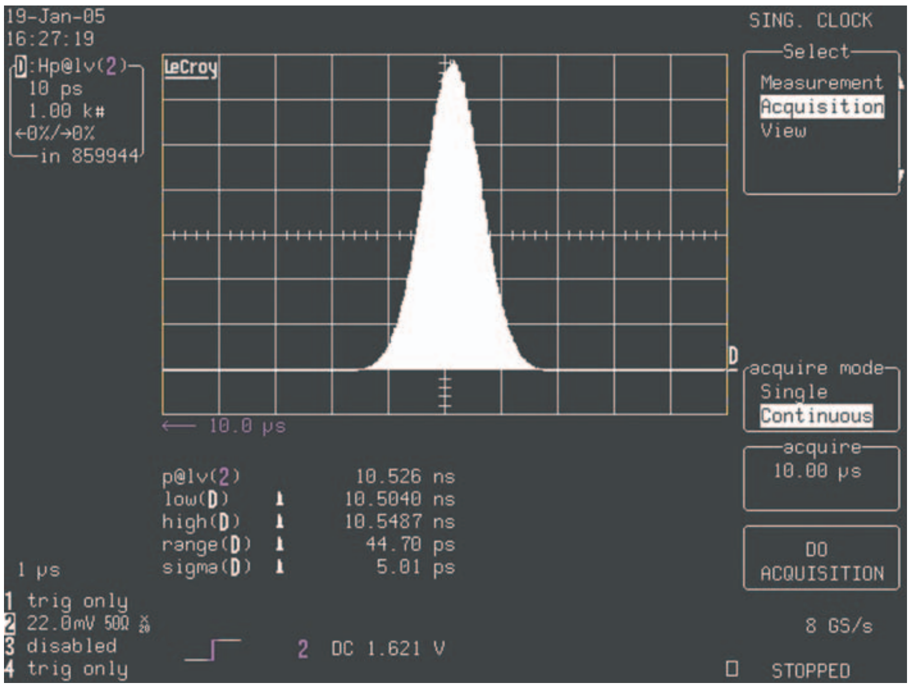

Figure 2: Jitter chart for FIPO

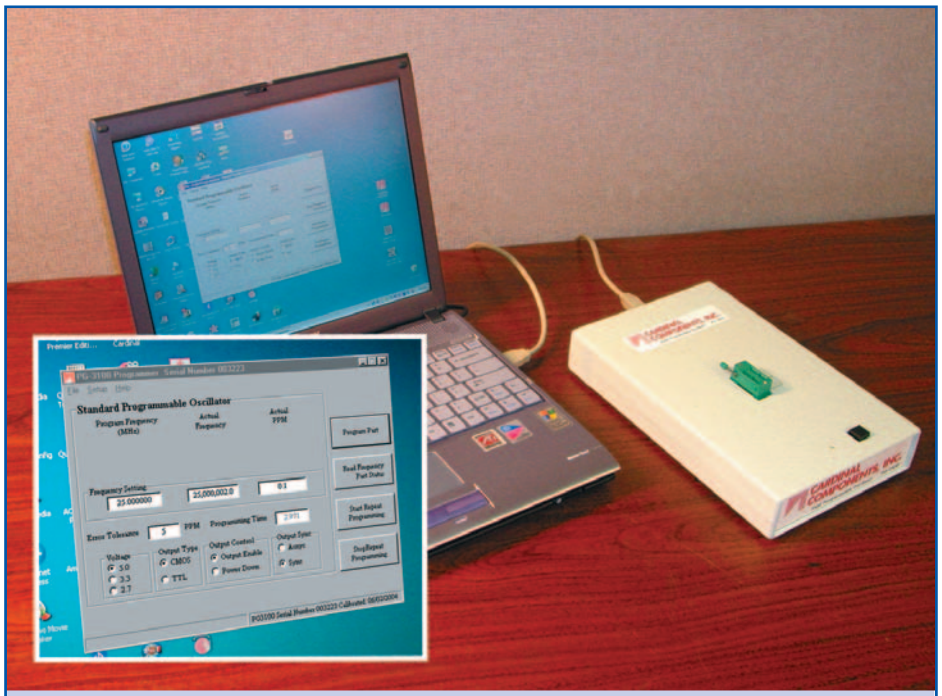

Figure 3: The PG3100 programmer is controlled with any PC.
Insert: Oscillator blanks are programmed in seconds by way of a simple dialog box.

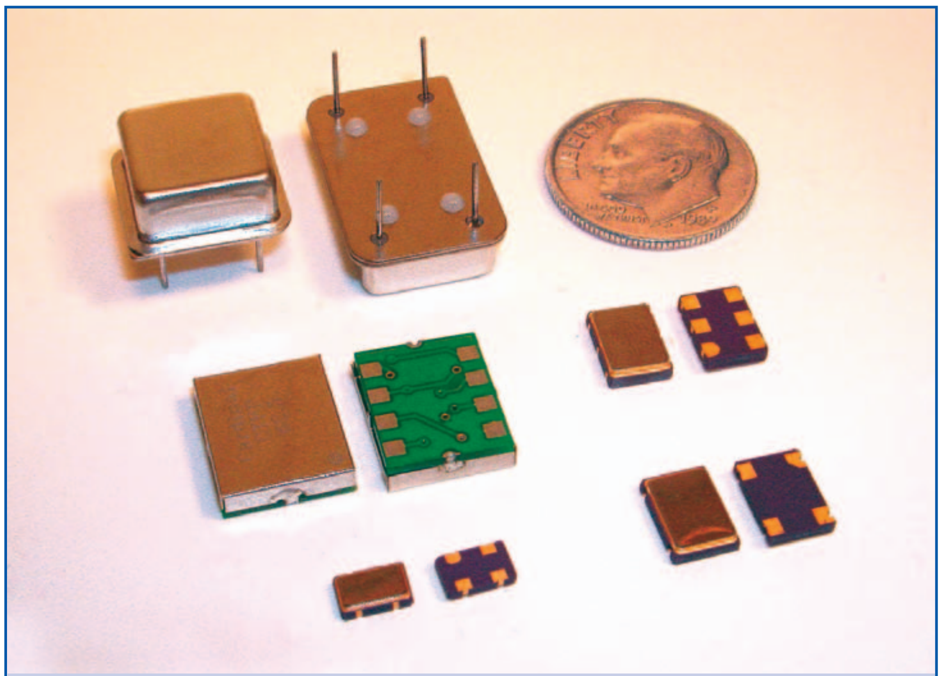

Figure 4: FIPO oscillator blanks are available in a variety of sizes

And lastly, coming later this year (2005), Cardinal's new digitally tuned VCXO (CDVP) offers even higher available frequencies (1MHz to 200MHz), *greatly* reduced sample and production lead-times, and actually assists in system tolerancing.

The new digitally tuned CDVP series is available in a 9.6mm x 11.4mm surface-mount package and operates from a 3.3 volt power supply. It's available with factory-programmed center frequencies from 1MHz to 200MHz, and can be tuned over a -70ppm to +120ppm range. The CDVP maintains a ±50ppm stability over an operating temperature of -40 ºC to +85 ºC. Frequency tuning changes are accomplished via a single write over the devices I2C interface. The CDVP allows the user to implement PLL systems 100% *digitally*, which of course, eliminates *any* need for analog and interface circuitry.

Suitable applications for the CDVP are instrumentation, switches, routers, and both packet and continuous transport systems. And, once again, all of these revolutionary products are easily available through Cardinal Components, Inc., or its authorized stocking distributors worldwide.

The satisfying thing about all this progress, technologically speaking, is that the jury is not out. In fact, it is very much IN. These are proven alternatives to the old-fashioned, time-consuming, and tedious process of ordering fixed-frequency oscillators, and waiting endless weeks to get them.

To say it again, the jury is in, and the verdict is this: The programmable era is here now, and here permanently. Programmables work flawlessly and have track records to prove it. They're fast, easy to use, inexpensive and unbelievably versatile. Throughout the electronics industry, they are freeing designers to explore the most innovative and sophisticated new product research imaginable. And, at the same time, they are rapidly becoming the component of choice for mass production at every level of consumer and industrial electronics manufacturing.

The jury is in. And, in all likelihood, you may very shortly find them winging across the ocean on one of those big, new, technologically sublime jets, the ones that are matter-of-factly taking advantage of every benefit we've been discussing in this new era of Field Instantly Programmable Oscillators. And BTW, a jitterbugger would tell you I'm not beating my gums here. In other words, believe it or not (and admittedly some of this *is* hard to believe), every word is true.

You can learn more about Cardinal Components, Inc., and Cardinal's other products by visiting its website at www.cardinalxtal.com or by contacting Tom Ferron at 973-785-1333.

**Jazz and slang examples and translations were adopted from streetswing.com*

Michael Adams is a freelance writer who writes about the electronics industry. © michael adams 2005.