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[People]

Interview: Christos Tsironis

Christos Tsironis is president and founder of Montreal, Canada-based Focus Microwaves, a leading supplier of precision automatic impedance tuners for use from 10 MHz to 110 GHz and integrated load-pull and noise measurement systems.

Jack Browne | October 2008

When did you start Focus Microwaves and what came before that?
After studying EE in Karlsruhe, I received a Dr. Ing. degree from the University of Aachen, both in Germany. I spent three years working on noise theory and measurements of GaAs FETs. During that time, in the mid-1970s, I developed the first manual impedance tuner, which uses principally the same slugs as today's tuners. After that, I worked for five years at Philips Research Laboratory in Paris, France. I specialized in dielectric-resonator-oscillator (DRO) and yttrium-iron-garnet (YIG) oscillator design, as well as small and large signal modeling of dual-gate GaAs FET devices. During that time, I realized the need for an automatic tuner system to characterize nonlinear devices, because of the lack of accurate device models. In 1988, after working two years at SPAR Aerospace in Montreal, Canada, I decided to start Focus Microwaves, with financial help from the Quebec government.

Why did you start a company and why make impedance tuners the basis of the company?
At one point, when I was still with Philips, I realized that I had the three elements needed for running a company: I can manage people, I can develop products that customers need, and I can sell them. The product at that time was oscillators. I believe a company can survive only if it has all three foundations. I know many good engineers who started companies and failed, because they believed that technical knowledge is enough. Of course, factors such as luck, timing, and learning from mistakes also play a role in the fate of a company, along with the capability of listening to your customers.

In 1984, we developed a motorized tuner in the basement of my house. It used the type of stepper motors used in washing-machine timers; electronic control was a nightmare. But it worked and we managed to control it with a Commodore computer. Then RCA introduced impedance tuners developed at Sarnoff Laboratories, which used two dielectric rings as probes, the same technology as in the tuners developed by Andy Alford at that time.

When I checked the specifications for the Sarnoff tuners, I realized our prototype had greater bandwidth, higher gamma, and higher accuracy. So, I decided to start a business based on the tuner. I was not interested in a mass market or even the relatively large markets for DROs, YIG oscillators, mixers, and amplifiers. I always had a vision of working in a niche market, where engineering and customer education were important. We were in the middle of our development, when Maury Microwave introduced its tuners, which were similar to our prototype. It was an emotional setback, not to be the first, but in an afterthought it was a good thing, because it proved the tuners to be a valid product and prepared customers for the technology.

Tell us a little about the type of tuners that Focus offers.
Every time a well-meaning customer asked me to develop something I did not yet offer, it upset me. I felt that the customer didn't understand how difficult it is to make good tuners! This was my reaction especially, some 12 years ago, when a good customer from California stopped by my booth at the MTT-S trade show and suggested that I needed a line of harmonic tuners. It upset me because I felt I knew the difficulties and limits in designing such tuners, and I almost turned away from that opportunity. But look at us now! We have two patented harmonic tuner types and have sold hundreds of them. It is not always best to listen to "experts," as it is to listen to your customers, who certainly know what they can use.

How did you create so many different tuner types?
Much of it comes from customer requests. The majority of them are good engineers, and they will tell us what they need. We have our CCMT wideband tuners, our PHT harmonic-rejection tuners, our PMT high VSWR tuners with two independent probes and our SP high VSWR tuners with dual probes, LFT low-frequency tuners for coverage from 20 to 150 MHz, our MPT classic tuner with three probes, and our MPT-Lite tuner (see Microwaves & RF, September, 2008, p. 136) with two probes for fundamental-frequency and second-harmonic tuning, together with the recently introduced Maximum Reflection Tuner (MRT).

How did you develop the interpolating tuner calibration technique, for the speed and tuning accuracy you achieve with your tuners?
It was a little intuition and a little luck. We realized that modeling a tuner was the same as modeling anything else: the model is usually accurate within, at best, 5 percent. Obviously, for a precision measurement instrument, this is not good enough. We were trying to calibrate a tuner by moving motors horizontally and vertically, and using computers and VNAs from the 1980s, so we knew we needed a better approach. We applied the Lagrange interpolation method and the results were very good. The automatic calibration we use today came later, about 1989, and is used in almost an identical fashion to this day. It is one a the few examples in technology that has survived 20 years in its quasi original design and we use it from 20 MHz to 110 GHz.

Do you work closely with vector-network- analyzer (VNA) manufacturers, such as Agilent Technologies, Anritsu, and Rohde & Schwarz, or are you totally independent of them?
Because we sell all over the world, our systems need to be compatible with all instruments on the market. So, our philosophy, from day 1, was to support as many instruments as we could put our hands on. This included all of the VNAs mentioned, and all of their variants. Of course, we started without VNAs and received help from vendors with demonstration equipment, but now we have six of our own VNAs in the laboratory. We are totally

independent, even though in special cases we work closely with other instrument manufacturers to build integrated systems.

How did you come up with the idea for the multi-purpose tuner, or MPT, with three independent probes?
The triple probe tuner was developed in order to have a fundamental-frequency, ultrastable tuner for on-wafer use. We also developed a “balance kit” tuner with moving counterweight and our own manual probe station for that tuner. All because customers needed to achieve maximum gamma at the deviceunder- test (DUT) reference plane. We also introduced our “long neck” tuners with extended bend lines, which replace cables and have lower insertion loss, but do not tolerate any vibration. If you have three probes and move them only vertically, you get full Smith chart coverage and no vibration. But then I realized that we have an almost unlimited number of possible impedance states available, so why not try harmonic tuning. There had been a precedent, of course, in the work from ATN Microwave, around 1996, so the idea was not totally new. We developed smart calibration and search algorithms that allow fully calibrating a triple probe tuner in roughly 20 minutes per frequency, at any frequency inside the band, which may reach more than a decade, and tune to any combination of three harmonic impedances within a fraction of a second or no longer than three seconds, depending on the resolution selected. This does not include the tuner movement of course, which may take a few additional seconds.

How important are the high-reflection tuners to your customers?
Very important, especially if combined with a low-loss connection between the DUT and the tuner, such as Focus’ bendlines. But achieving high VSWR at DUT reference plane is not the only concern for many customers. Tuner loss or, more precisely, “setup loss” at the source side of a high-VSWR measurement system, is also important, because it can reach 10 dB or more, and expensive driver amplifier power is needed to compensate for the loss and saturate the transistor. The best solution is to use transformers, but these tend to be narrowband in nature and applicable only in test fixtures. Wafer probes pre-tuned in an area of the Smith chart have not been very successful, even though they are the closest thing to an acceptable solution for high VSWR measurements. The use of “active” tuners is a possibility, but this is a complex subject with systemic limitations as well as high cost.

How well do your customers understand harmonic and load-pull tuning?
Some understand very well, while some do not understand as well. Many users do not realize that high-gamma wideband tuners can tune at fundamental, second-harmonic, and third-harmonic frequencies all at the same time and without control of the harmonics. This distorts the load-pull contours and may yield misleading conclusions.

How important is training and aftersale service in helping customers?
This is more important than anything else. We are totally committed to helping our customers discover the possibilities and realize the limitations of our tuner technology. Unfortunately, engineers- —our customers—may not always feel extra training to be a good investment. But with training, they can unleash the power of their tuner systems.

Any new products on the horizon?
We are exploring pulsed I-V and pulsed RF technologies, an ultrawideband (2 to 65 GHz) noise measurement system, and improved system integration. Our customers guide us in our new product developments.