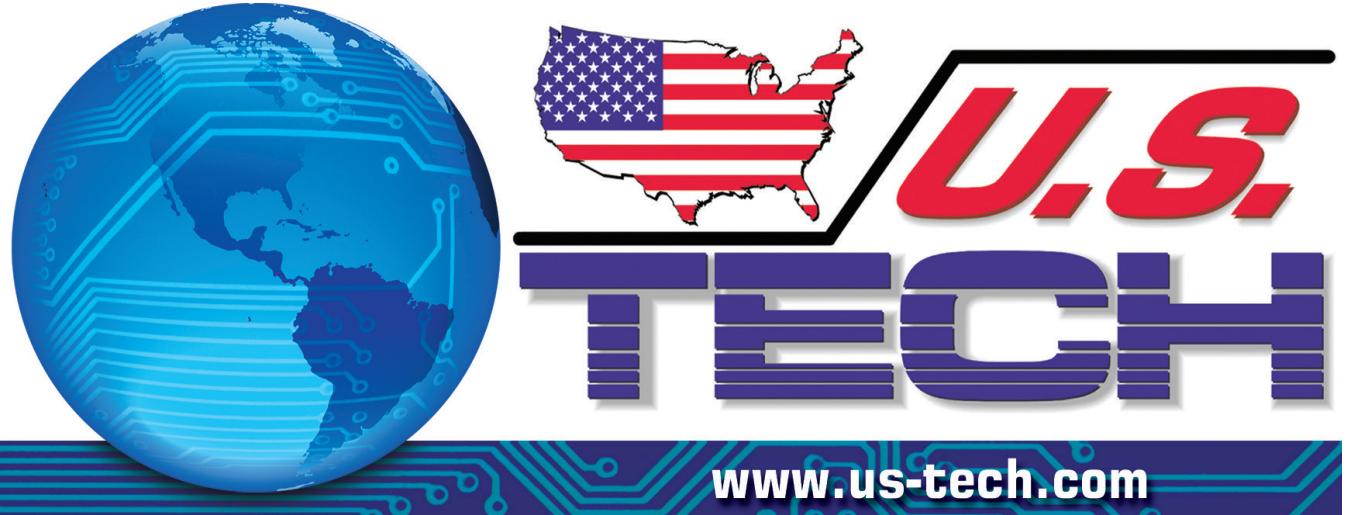


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# Koh Young SPI Verifies ADCO Circuits' PCB Assemblies

DULUTH, GA — An ideal partnership should feel like a natural extension of the vendor and customer relationship. However, there are many ways to get there. One of them is "professional persistence," which gained

Koh Young an audience with ADCO Circuits.

A 40-year electronics assembly veteran, ADCO operates a 55,000 ft<sup>2</sup> facility in Rochester Hills, Michigan. There it covers everything from PCB assembly

to systems-level and box-build for volumes from prototype to production. ADCO Circuits worked with Koh Young to implement a Zenith AOI machine to inspect through-hole solder joints.

### To SPI, or Not to SPI

Recently, ADCO replaced all its surface mount equipment including screen printers, but had never seen a need for an SPI solution. This was despite several trade shows and meetings with Joel Scutchfield, director of sales and applications at Koh Young and his local sales partner, Jim Rittman from Aligned Solutions.

Tirelessly, they would explain the immediate benefits of SPI and why it was the most important inspection machine in the electronics assembly line.

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ADCO Circuits' new Koh Young KY8030-3 SPI System.

## Argonne Scientists Pursue Next-Gen Batteries

LEMONT, IL — Progress in applied research at Argonne National Laboratory raises hopes that solid-state batteries will replace conventional lithium-ion batteries sooner rather than later.

The lithium-ion batteries that primarily power everyday devices are lightweight and cost-effective to produce. However, they are by nature flammable, which raises concerns about their safety and reliability as power and grid storage demands continue to grow.

Lithium-ion batteries still require a liquid or gel to allow the battery to be charged and discharged; that is why older batteries sometimes leak with age.

A new, safer generation of batteries does not rely on liquids or gels. Instead, these solid-state batteries use a very thin, solid

film to keep charge-generating parts (cathodes and anodes) separate and enable the battery to be charged and discharged. Solid-state batteries can store more energy, are safer, and take up less space.

### Better Sintering

Sintering is important in solid-state batteries because the thin material separating the cathode and anode must be strong enough and dense enough to withstand handling during manufacture, assembly and operation.

It must also deliver high performance; that is, the battery must allow for fast charging, conduct electricity well and last a long time. By improving the sintering process, Argonne's sci-

## U.S. DOD Funds R&D for Lead-Free Electronics

WASHINGTON, D.C. — The U.S. Defense Department (DoD) is taking another step toward understanding and embracing the use of lead-free electronics in high-performance defense areas by allocating another round of funding to a public-private research effort.

The U.S. Partnership for Assured Electronics (USPAE) is the recipient of a \$8.9 million award from the DoD Office of Industrial Policy's Industrial Base Analysis and Sustainment (IBAS) Program to grow the Defense Electronics Consortium (DEC) and expand its work on the Lead-Free Defense Electronics Project.

The project is led by Purdue University, the University of Maryland, and Auburn Universi-

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# New Advanced Circulators Overcome mmWave Design Challenges

By Greg Rankin

**A**s communications providers race to deliver on the potential of 5G, research and design projects are already looking towards 6G and beyond. The promise of ultra-fast broadband speeds — potentially as high as 10 Gb/s — can catapult cellular technology into new markets like smart cities, connected vehicles, defense, and the rapidly expanding IoT.

However, a major hurdle awaits the impending move up the millimeter wave (mmWave) spectrum; that being a lack of acceptable mmWave components such as circulators.

"It is an enormous technical challenge we are facing," says Fred Daneshgaran, a California State University, Los Angeles, professor who specializes in RF design, telecommunications and quantum communications. As such, Daneshgaran is frequently brought in as lead technician on some of the most cutting-edge RF military and telecom projects.

"The only way to support the billions of users at higher data rates is to keep utilizing higher and higher frequency bands, so components are going to have to catch up," explains Daneshgaran. "The problem is, however, as you go up the spectrum it gets harder and harder to build critical components like circulators that can operate at those frequencies."

## Moving On Up

The higher-end of the 5G spectrum (26 GHz to 86 GHz) will provide much of the leap forward in data speeds, capacity, quality and reduced latency. However, at such frequencies the design of transmit/receive components becomes critical. Without advancements, the deployment of systems capable of operating even higher on the spectrum, within the terahertz regime where 6G and 7G will operate, are also in jeopardy.

Recognizing that national security could be affected, in late 2020 the Department of Defense announced more than half a billion dollars in awards for 5G experimentation and testing. Given this impetus, microwave components such as antennas, waveguides, isolators and circulators are now being developed that are capable of broadband operation at mmWave frequencies up to 330 GHz and beyond.

"One component that is especially criti-

cal to telecom infrastructure is the circulator," Daneshgaran explains. "Antenna systems capable of both transmitting and receiving a signal are typically expensive because they are reciprocal devices. To keep the signals separated you have to put something like a circulator at the front end, otherwise you'd need two different antennas."

Basically, a circulator is a three-port device in which power entering any port is transmitted to the next port in rotation. Hence, any signal that goes into port one, goes out port two, and any signal coming in



*Telecoms are under pressure to increase bandwidths in preparation for widespread use of 5G networks.*

port two, goes out to port three.

This issue of duplexing at mmWave frequencies is not only problematic for telecom applications, but also for radar technology which relies on circulators to separate the signal on the transmission path from the signal on the receiving side.

## Overcoming Performance Challenges

In a recent effort to design and build an R&D system for a major commercial contractor, the lack of a circulator capable of operating at 120 GHz stopped Daneshgaran's team in its tracks.

"Theoretically, you can design one, then simulate its performance, and it will be fine. However, actually making them is more of an art than a science," explains Daneshgaran. "It is just very hard to build circulators at the mmWave range."

"At first, we couldn't find anybody that was capable of producing circulators in the frequency band we required, much less with the high isolation and wide bandwidth we wanted," says Daneshgaran.

In a continued search for a circulator with the necessary attributes, Daneshgaran and his team learned of Micro Harmonics, who had developed a circulator for mmWave systems while working with NASA on a number of SBIR projects.

Micro Harmonics Corporation specializes in components for mmWave applications and successfully developed an advanced line of circulators operating from 25 GHz up to 150 GHz.

"Micro Harmonics fine-tuned the design to meet the performance characteristics we needed within the very precise band we were going to be operating on," explains Daneshgaran.

Whether it's for high-speed data transmission and reception, or for target detection, isolation is a key parameter.

"If the circulator doesn't have good port-to-port isolation, you get self-interference; meaning the signal I'm trying to transmit is interfering with the signal I'm trying to receive," he adds. So, you want as much isolation as possible."

The Micro Harmonics circulators demonstrated some pretty awesome isolations," continues Daneshgaran. "At the frequency we operated on, we realized almost 30 dB of port-to-port isolation, which is a lot. Typically, it is very hard to even get above 20." A circulator must also offer a wide bandwidth, a major challenge at mmWave frequencies.

"For telecoms, the more bandwidth you

*Continued on next page*

## Advanced Circulators Overcome mmWave Design Challenges

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have the more data you can support," says Daneshgaran. "This is because your data rate is directly proportional to the amount of bandwidth you have around your carrier frequency."

Daneshgaran goes on to explain that in a radar application, wide bandwidth is important because it involves continuous frequency sweeps. The larger the bandwidth, the easier it is to discern a target in a given sweep.

In Micro Harmonics' case, increased bandwidth for its cir-

culators is achieved by abandoning complicated dielectric impedance-matching elements in favor of a mechanical engineering solution. This makes the performance highly repeatable from one assembly to the next.

"With these circulators we are getting a clean 'couple of gigahertz,' if not more, of bandwidth within the characteristic limits of 30 dB isolation we seek for our application," notes Daneshgaran. "If we were willing to accept something like 20 dB of port isolation, we could have four or more gigahertz of bandwidth, which is very significant."



**Micro Harmonics circulator for mmWave applications.**

"Because of the initial delays in finding workable mmWave components, we really needed to jump in and make several measurements that we had fallen behind on," concludes Daneshgaran. "With the implementation of advanced circulators our machine has been running continuously ever since we set it up, and we could not be more pleased with the results."

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## ATEC Calibrates Fluke and FLIR Thermal Imagers

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