AEROSPACE & DEFENSE TECHNOLOGY™

The Engineer's Guide to Design & Manufacturing Advances

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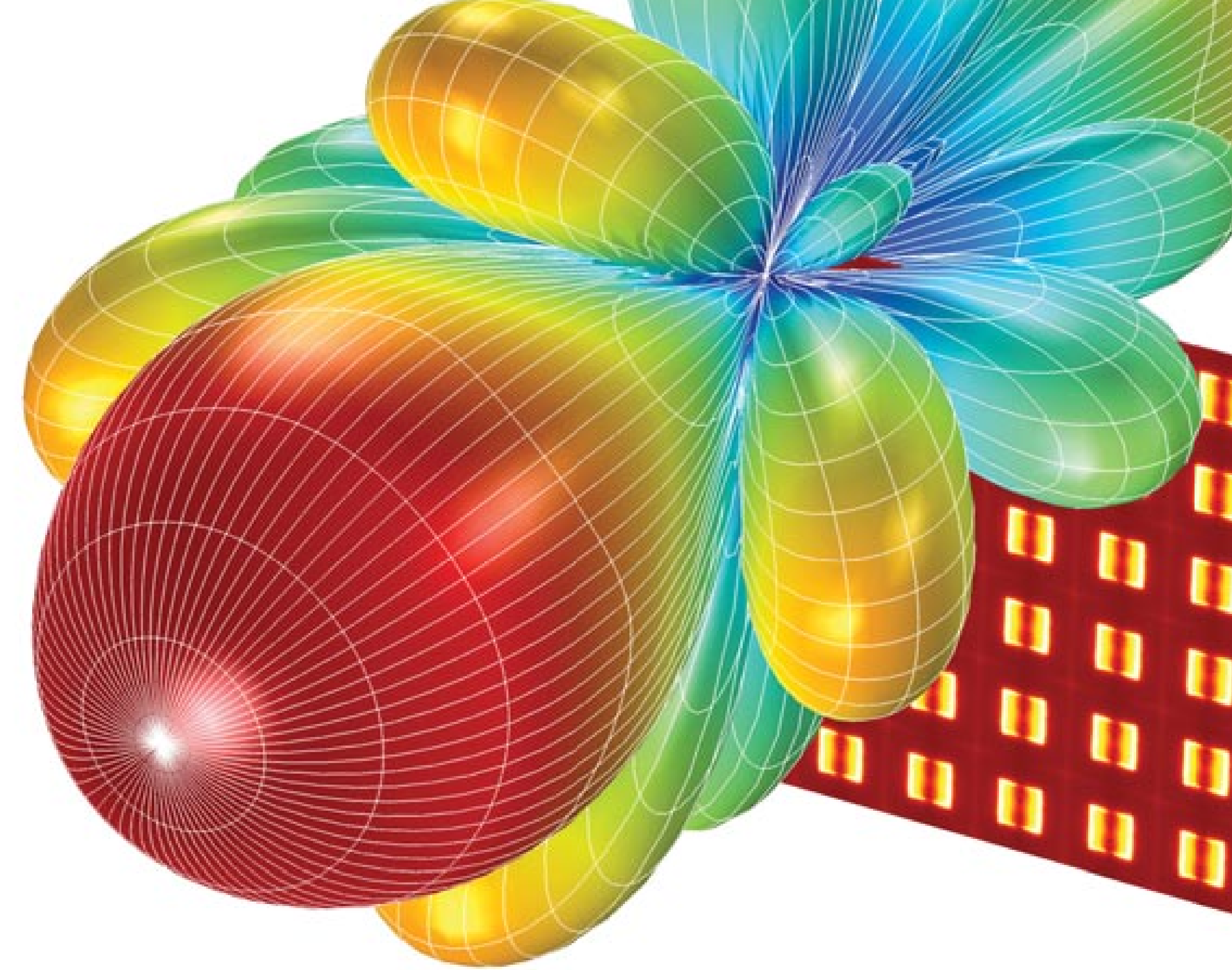

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SAE INTERNATIONAL

Designing Electronic Warfare to Regain Airborne Military Dominance

Electric Rockets and the Future of Satellite Propulsion

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From the Publishers of TECH BRIEFS


AEROSPACE

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ON THE COVER

Aurora Flight Sciences' ALIAS Automated Flight System flies a Cessna Caravan through basic maneuvers under the supervision of a pilot. ALIAS, which stands for Aircrew Labor In-Cockpit Automation System, utilizes a robotic system that functions as a second pilot in a two-crew aircraft, enabling reduced manual operations while ensuring that aircraft performance and mission success are maintained or improved. To learn more, check out the applications brief on page 46.

(Photo courtesy of Aurora Flight Sciences)

INSIDE STORY

As a leading supplier of custom forged copper, aluminum, brass, and other non-ferrous products, Weldaloy (Warren, MI) has advanced from its beginnings 70 years ago serving the automotive welding industry, to providing open die work, machining, and other offerings for industries such as aerospace. *Aerospace & Defense Technology* spoke with Kurt Ruppenthal, Weldaloy's Vice President and General Manager, to discuss how the company's vertical integration process offers customers a single source for forged and machined non-ferrous products.

A&DT: What does Weldaloy do?

Kurt Ruppenthal: Weldaloy primarily supplies non-ferrous open die forgings, although we also perform closed die and semi-closed die forging, as well as ring rolling. The primary industry we serve is aerospace, but we also do a lot of work in the semiconductor industry, in a variety of general industrial areas, and we perform a fair amount of material processing work.

We mostly make basic shapes, but some of the closed-die parts are a little more complicated. We make a lot of parts that support rolling, milling, or casting of various raw materials. Many applications in the aerospace industry require copper and copper alloys, but to work with them effectively takes special expertise. That's what has really separated us over the years. We make parts that help produce computer chips, we make parts that go to outer space, and we make parts that support the economic and manufacturing engine of the U.S. and beyond.

A&DT: What makes Weldaloy unique?

Ruppenthal: Several things — first, we have a lot of internal IP (intellectual property) on the forging of specialty metals. We've been doing forging for 70 years now. That has enabled us to develop the necessary expertise with copper, brass, and associated alloys to support specialized or niche customers. We also work with aluminum and titanium. And although we're experts in forging, we're also very experienced in machining these specialty metals.

Customers also benefit because we try to support them in any way we can. We're incredibly customer-focused, with many long-standing customers who rely on us. We're also a reasonably small company. Customers get a small-company response and feel, but Weldaloy also has a lot of really big, high-end systems you would only expect to find at a larger organization.

A&DT: Tell us about your vertical integration strategy.

Ruppenthal: We've tried to be as vertically integrated as possible because the more vertically integrated we are, the better we can respond to customer needs, and the more cost-effective we can be. For example, we have a substantial inventory of metal, some of which can be difficult or expensive to get quickly. We saw that metal ourselves in-house, forge it, heat-treat it, machine it, and we can even do a lot of testing, including non-destructive testing, in-house. We also package and ship the finished products, with comprehensive traceability.

A&DT: Talk a little more about your capabilities.

Ruppenthal: We have two forging facilities. Hammering is an integral step in the production of many forgings, and we have two 4,000-pound hammers and a couple of 2,500-pound hammers. We also have a smaller hammer that allows us to be flexible with a variety of ductile materials. We also have a press shop with a 2,000-ton press.

We can produce seamless rolled rings with a highly uniform grain structure from 10" to 40" in diameter, and with a maximum height of about 8". We can also roll a variety of materials. A variety of machining equipment, both horizontal and vertical, enables us to work with parts ranging from 10 pounds up to 4,500 pounds. Many are CNC-controlled, but we have manual machines that are useful in certain instances. We can machine ring diameters up to about 72", and discs in the 60- to 70" range. Our tolerances are very good; it's not uncommon for us to be in the .003" specification range, and we can go below that in some instances.

A&DT: What is Weldaloy's quality philosophy?

Ruppenthal: The forging world is very demanding. We understand that, we embrace it, and we do everything we can to meet or exceed customer requirements through continual improvement in all Weldaloy processes. Last year, we achieved certification to aerospace standard AS9100C, and we're also certified to ISO 9001 for industrial quality management. We're currently working on two new certifications. The ISO 14001 standard for environmental management best practices doesn't necessarily fall under quality but it reflects on quality. We're also working on a Nadcap aerospace certification, which is specific to a process. We've chosen heat treating, and the requirements are very stringent. It's similar to AS9100 in terms of how it's structured and the documentation that's required. You need to have traceability not only for your product, but for how you maintain your heat-treating furnaces and processes.

A&DT: What about your engineering resources?

Ruppenthal: Our process engineers have a great deal of knowledge and experience with forging and heat-treating techniques. We've got a five-person engineering team, and they have the technical capability to meet customer requirements with minimal waste along the way.

We want to solve problems, make great products, and give customers great customer service. We want all of our relationships to be win-win. We've worked hard at that, and we'll continue to do so.

*To find out more about Weldaloy, visit the full-length version of this interview available online at **www.aerodefensetech.com/InsideStory/0417***

Designing Electronic Warfare to Regain Airborne Military Dominance

(U.S. Marine Corps photo by Cpl. N.W. Huertas)

For decades, military aircraft have relied on electronic warfare (EW) solutions to protect assets and dominate airspace. The ability of the United States to detect and track aircraft, or avoid detection has played a major role in its ability to project power globally and maintain freedom of operation in the air.

Today, that dominance is being challenged given the rapid advancements in, and widespread availability of, technology for adversaries. In order to make the best use of finite resources, EW solutions must be designed with a focus on flexibility and adaptability to meet quickly shifting threats today and in the future.

Electronic warfare solutions must be designed to dominate increasingly contested environments where multifunction, software-defined and reconfigurable solutions are needed to meet quickly shifting threats.

Available Tech Has Shifted Military Threats

Adversaries have long sought an opportunity to level the odds with American air superiority. The ability for U.S. aircraft to enter airspace with relative safety to execute their mission and return safely has been a major strategic asset. This superiority is beginning to erode as the rapid growth in processor speeds for computing technologies has brought new radar and electronic warfare capability to more countries around the world.

Over the past 60 years, we have seen approximately a one trillion-fold increase in computing performance in line with what has become known as Moore's Law where processing approximately doubles every two years.

Systems that used to be analog, expensive and difficult to upgrade are now being exchanged for digital operations. The faster processing speeds result in greater ability to collect and process information from a larger range of frequencies at a greater rate, thus increasing the threats facing U.S. and allied military platforms. These advancements are not theoretical.

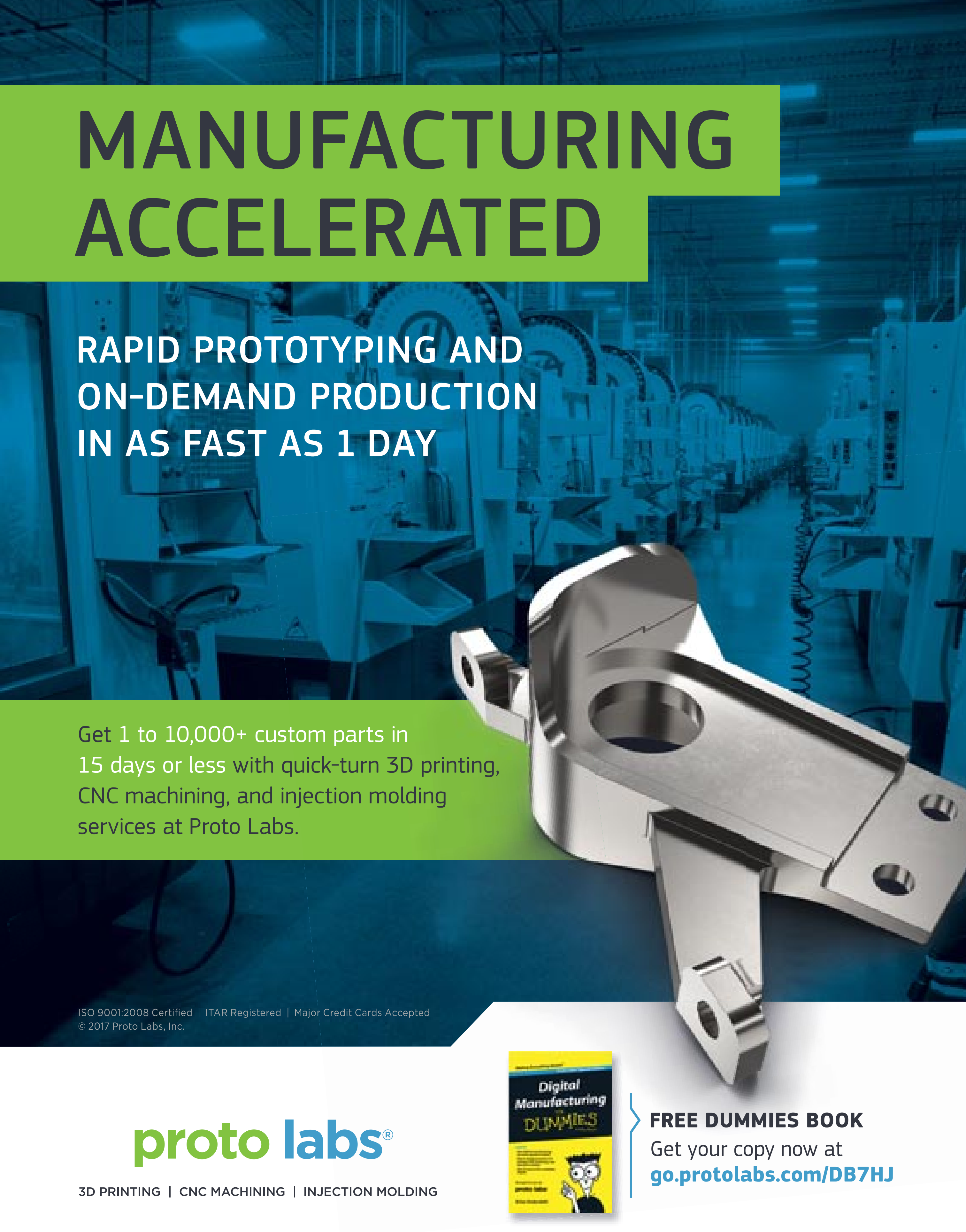
New radars such as these are capable of simultaneously operating on more than one frequency band for more sophisticated information analysis. Our defense methods have to protect against all active channels at the same time in order to be effective. Our adversaries with the requisite resources are certainly capable of adopting the available technology and applying it towards their own means. Radar and EW systems being fielded today have the ability to shift in real-time and cover a wider array of spectrum, which means there is a wider range of threats to mitigate.

There is no reason to anticipate a decline in the rapid advancements of adversaries when it comes to EW. Indeed, it is more likely that adversaries will continue to invest, improvise and discover means for threatening U.S. warfighters that have yet to be seen.

Understanding Requirements

The rise in advanced threats from adversaries comes in multiple formats besides radar detection to include attack methods, jamming, signals intelligence (SIGINT) and more. At the same time, U.S. forces have made updates to take full advantage of the electromagnetic spectrum for a variety of tactics from multiple airborne systems, such as communications, GPS, data collection, network systems and of course electronic warfare. The varied options to take advantage of the electromagnetic spectrum battlefield has created a crowded environment.

Alongside the rise of adversarial capabilities, the military is facing unique challenges and pressures internally. Defense budgets remain uncertain after a long period of increased spending and deployment. Leaders have continued to communicate that extending the lifecycles of legacy platforms such as the B-52 (expected to be more than 80 years) and the F/A-18 Hornets (expected to be more than 50 years) is necessary as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budgets remain tight and costs for fielding a wide variety of next generation aircraft are untenable.

To keep these legacy platforms fully operational and ensure they are able to take on new and evolving adversarial capabilities, there are a distinct set of engineering challenges to overcome in structural and systems terms. When the systems were first designed, things such as computer aided design were not available yet. With decades old airframes, it is important to fit modifications into preexisting platforms without compromising structure and to make use of the available space.

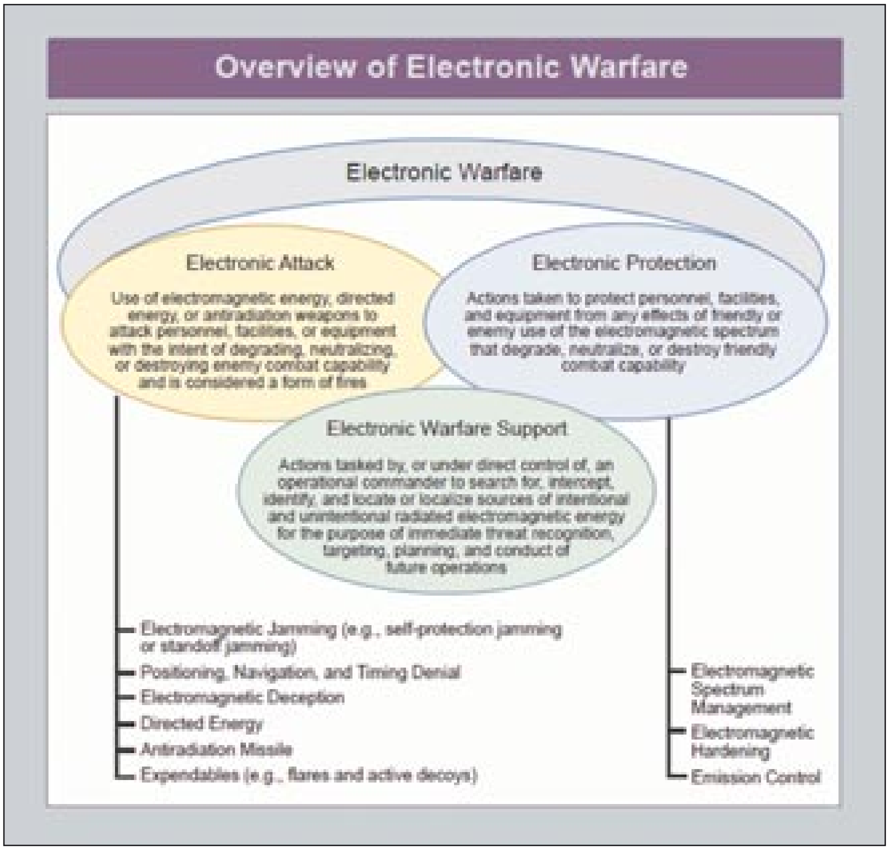
Consequently, when it comes time for system sustainment work on a platform such as the F/A-18 fighter, engineers take a holistic approach to the work. They look at options for redesign and updates that meet current requirements for today and also take into consideration what opportunities exist for setting the units up for future updates.

Updated systems today are able to capitalize on features such as automated electronic countermeasures techniques that deny, disrupt, delay and degrade launch and engagement sequences.

Threats can be quickly identified, prioritized, countered and displayed to the aircrew for situational awareness as well as self-protection.

When developing new products or making updates to existing solutions, using open systems architecture is increasingly important because it provides a framework for common interfaces and standards for avionics systems. Instead of needing to do a full redesign, or potentially replace an entire EW system, teams can update only the pieces that need to be refreshed such as transmitters, processors, receivers or amplifiers.

This process allows for iterative designing and upgrading of systems that is more cost-effective and allows for easier and faster implementation of new capabilities. The end results are systems that maintain reliably and protect aircrew and aircraft against advanced radio frequency (RF) threats. This protection enables enhanced survivability by allowing aircrews to concentrate on accomplishing their mission.



Overview of electronic warfare. (Illustration courtesy of USAF)

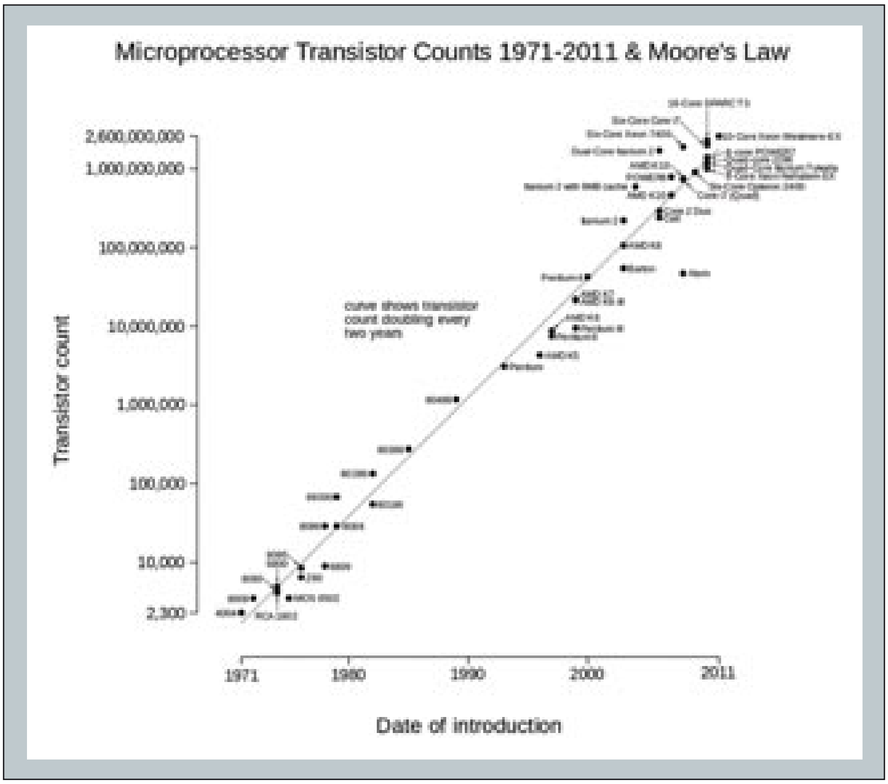
To deal with this increasingly contested domain all systems, not just EW, need to make the best use of finite space on an aircraft and enable the greatest range of operational capacity. There are a number of competing requirements for EW systems that make these design decisions incredibly difficult, especially when mission success and lives are on the line.

Redesigns and upgrades also provide opportunities for systems engineers to introduce Size, Weight, and Power (SWaP) reduction while increasing the capability of the solution. SWaP reductions mean that there are more opportunities to integrate additional capabilities onto a given aircraft, or, the ability to outfit even smaller aircraft such as unmanned systems with EW capabilities.

Improvements focused on SWaP have also led to new options with EW systems designs. By miniaturizing a component down to the size of a deck of cards, it becomes a much more flexible option to integrate. Small form factor EW does not have the entire suite of capability as their larger cousins, however they do offer distribution and power flexibility which can be a massive benefit when retrofitting aircraft.

For example, small EW components could be deployed in a more distributed fashion. Instead of needing a single bay location, multiple units could be placed in open areas, freeing space for additional payloads. This distributed capability also means that should a single unit be damaged, the configuration would be able to shift workloads to others in the network to ensure that capability is not completely lost when damage occurs.

EW self-protection systems need to counter emerging threats over an aircraft lifecycle and repeated upgrades will continue to build in new capabilities for



Microprocessor Transistor Counts 1971 – 2011 & Moore's Law (Credit: Wikipedia)

advanced counter-measures in response to modern threats, as well as new technologies to improve performance, maintainability, and supportability.

Looking to the Future

Increasingly, aircraft are tasked to fulfill multiple roles which require distinct, affordable and flexible EW capabilities. For example, an F-35 Lighting II could be tasked with a wide array of concurrent missions including air-to-air, air-to-ground, electronic attack and intelligence, surveillance and reconnaissance missions, all on a single platform.

EW systems are quickly adapting to be able to complement this idea with the help of multifunctional hardware that enables operators to use software to define the functionality of a given system depending on the mission at hand.

Previous generations of EW solutions were designed with single-mission capabilities where multiple separate systems were needed to combat various threats and perform different functions which was complex, costly and did not afford operators the needed flexibility for future operations. Now, much like with commercial computing, military-grade hardware is becoming multifunctional to allow operators to choose software capabilities that will match their mission requirements as opposed to "ripping and replacing" entire systems. This means a single unit can alter its operating parameters, such as the waveforms it radiates, techniques, or timing, based on software definitions.

Software-defined capabilities allow for quicker upgrades, are more affordable and give more operational flexibility in contested environments as operators need only to update a program. For operational personnel in EW, this shift means incorporating the ability to change waveforms, techniques, and algorithms for systems in hours or days, rather than today's normal cycle of years.

Adopting multifunctional hardware and software-defined operations also opens the door to integrate more machine learning options for faster and more accurate decision-making. There has been a dramatic increase in speed at which modern digital electronics can shift operating modes and techniques as previously mentioned. EW systems need to adapt their use of EW hardware and software faster to keep up with the speed inherent in today's electronics.

Adaptive EW, meaning the use of machine learning processes and algorithms to collect, analyze and implement responses to RF threats, has emerged as the next phase in keeping the U.S. ahead of advancing threats.

Currently, EW systems are only able to provide automated responses to threats which are known to the databases that they are programmed to defend against. However, with the proliferation of information across the spectrum, and adversarial technique updates, it is increasingly likely that a system will encounter a threat that is unique or unknown. Adaptive solutions take the available information and make a recommendation on how to mitigate a threat at machine speeds, and the process is repeated until the correct defense is found. While this area represents a major step forward for aircraft operators by adding another layer of protection and situational awareness, it is still in its earliest development phase. Time will tell how and when this type of technology will be ready for widespread adoption.

The challenges to U.S. air superiority regarding electronic warfare are not insignificant. Rapid advancements and widespread availability of computing technology have made military air operations more difficult. However, current upgrades still offer tremendous advantages over adversaries using new multifunctional hardware and adaptive technology that enable us to maintain the advantage until the next generation of technology is fully operational.

*This article was written by Joe Rambala, Vice President and General Manager, Electronic Warfare at Harris Corporation (Melbourne, FL). For more information, visit **http://info.hotims.com/65850-500**.*

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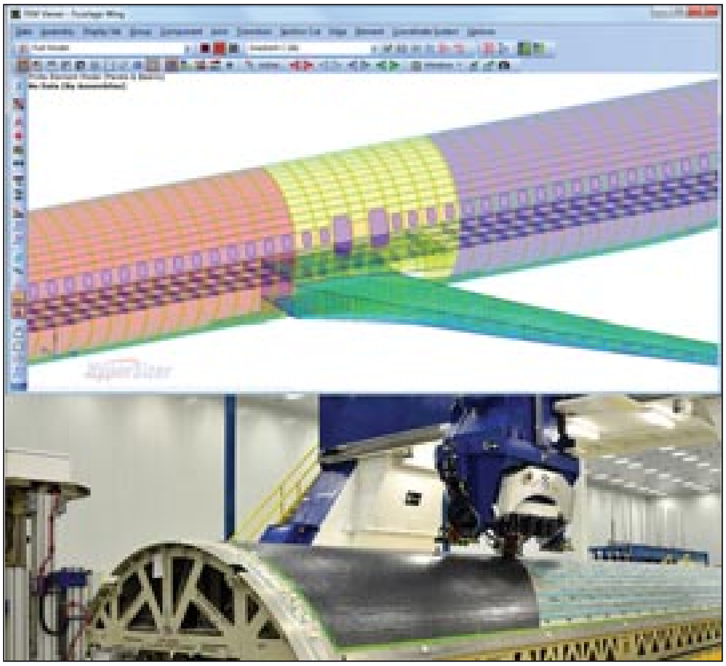
Certifying Composite Designs *for* Aerospace and Defense



Wherever you find newer and particularly larger aircraft these days, you're seeing the use of composite materials. The latest commercial planes, as well as innovative defense prototypes, demonstrate the awareness of aerospace OEMs regarding the value of composites for stiffness and structural strength exceeding metals, plus weight savings and decreased fuel consumption. The military may have taken an early lead in pushing the use of composites, but now both sectors are fully committed to advancing the technology.

Although employed as long ago as the 1950s for small aircraft components, composites had a rather bumpy ride for a while, generating much buzz in the 1980s, then falling somewhat out of favor in the 90s. In the earlier days, engineers were not fully aware of the damage tolerance issues, and the material systems at the time had lower through-thickness properties so they weren't as durable or impact resistant. Composites were also more expensive than metals, making trial-and-error methodologies costly.

However, over the last decade-and-a-half, new resins were developed to toughen composites and increase their damage tolerance. Material systems overall improved, along with the chemistry, as did the expertise of suppliers and the industry's knowledge of how to produce more robust and cost efficient designs.

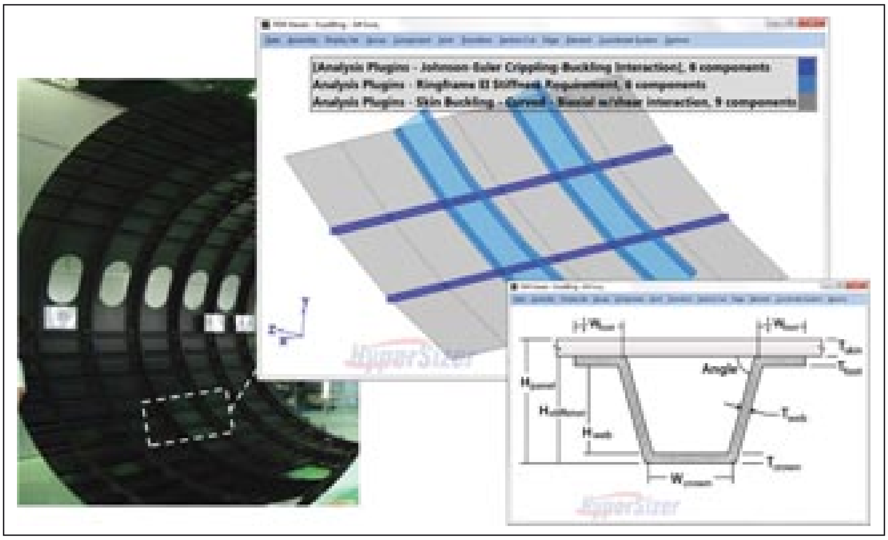


Figure 1. Fuselage portion (photo at left) and post-buckling stability analysis of fuselage skins, stiffeners and frames (screen shots at right) performed by Collier Research's HyperSizer software.

From Fairings to Fuselages

At first, flight safety led to the use of composites for aerospace toward non-load-carrying, non-primary structures like fairings. As confidence in the material rose and was supported with real-world performance benefits, load-bearing structures began to be considered for metal-to-composite material tradeoffs.

In smaller aircraft with less highly loaded fuselages—but minimum-gauge requirements dictated by environmental influences like hail damage—the economics of a switch from metal to composites might not always pay off. But for a larger-fuselage plane, or for wings and empennages of any size plane, such a change could bring significant weight savings; both the Boeing 787 and the Airbus 380 are made up of more than 50% composites, a move that cut some 20% in weight over previous designs.

Despite these advantages, the challenge of designing weight-bearing structures out of composites remains significant. Multi-material, multi-ply composites remain much more mathematically complex to model and design compared to metals.

Fortunately, computing tools have improved dramatically over the last 10-15 years, allowing composites analysis, simulation and optimization

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to be carried out more quickly and accurately. The ability to design for optimum weight reduction, as well as to refine manufacturing processes on the shop floor, all in less time, have also benefitted from the more sophisticated digital tools now available, leading to greater acceptance of the deployment of composites and enabling the production of the bigger, lighter aircraft we see today.

It's All About Speed to Certification

No matter what the aircraft or the materials used to make it, manufacturers have a common goal of reducing the total project schedule, from kick-off to FAA certification. Adding composites into the product development equation can introduce greater complexity because you are bringing so many processes together—design, analysis, testing, curing of the laminate, the robotic application of the fiber on the tool, etc. The technologies involved need to be in communication because they impact each other; how you design or optimize a laminate affects every other downstream function, so passing the data more efficiently between disciplines is critical. As design iterations progress, a tight feedback loop is essential to achieve a fully optimized composite design.

OEMs working with composites are becoming increasingly cognizant of how early design decisions affect the downstream efforts of the manufacturing team to produce a final, certifiable part. The technology continues to mature, but we are already identifying the sweet spots where processes can be automated and improved upon. While composites are still in the relatively early stage of adoption in aerospace, we're now at the point where we are able to take lessons learned and apply them to process improvement with measurable results.

NASA, obviously attuned to the significance of speeding certification of air and space vehicles, has taken note of this progress, creating the Advanced Composite Consortium (ACC) in 2015 to bring stronger composite material analysis, design, and manufacturing into practice. The stated goal is to help maintain American leadership in aviation manufacturing; the project aims to reduce product development and certification timelines by 30 percent for composite aircraft.

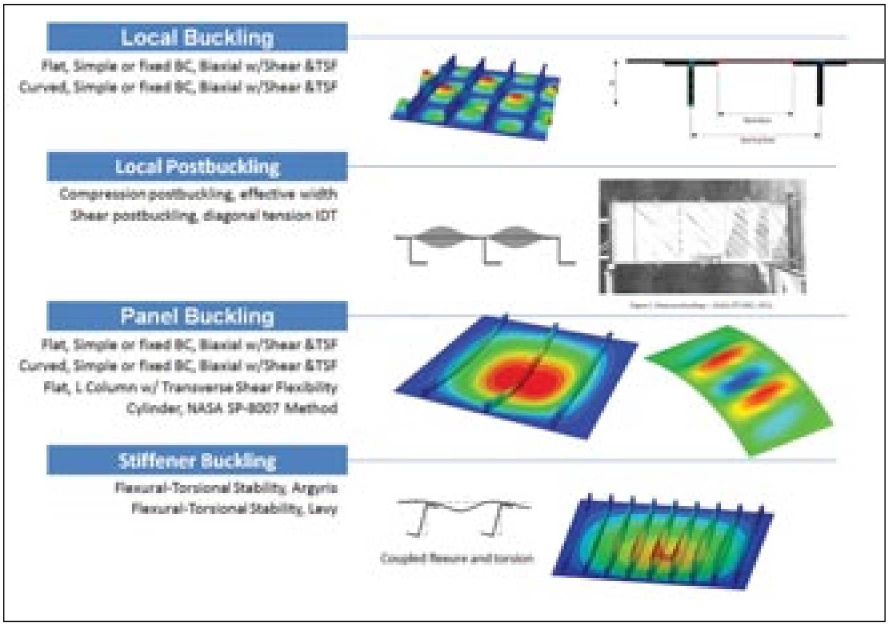

Figure 2. Buckling margin analysis and creation of verification FEA models is automated by HyperSizer.

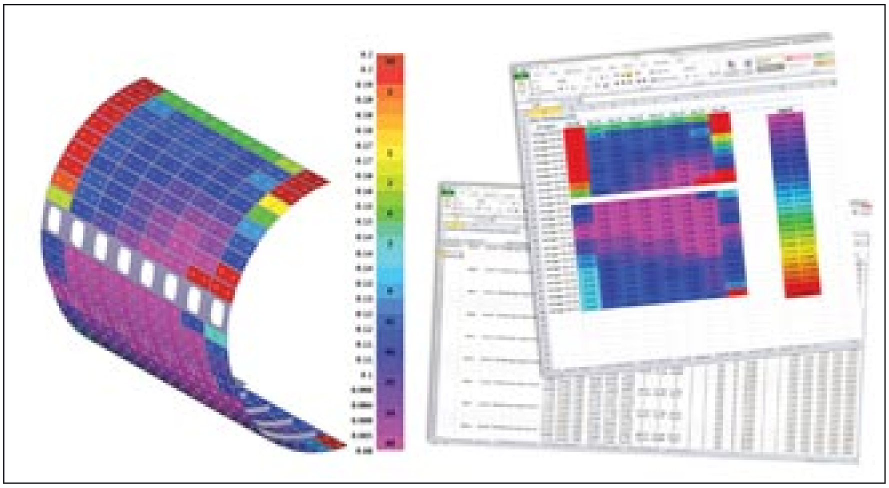

Figure 3. Detailed stress reports generated by the software contain all skin and stiffener dimensions, margins-of-safety and analysis details.

Demonstrating Certifiability to the FAA

Analysis traceability and visibility are highly important for certification so, on the pathway to achieving it, an OEM must prove to the FAA that it has done its due diligence. Every aircraft manufacturer has to prove flightworthiness of each aircraft configuration being proposed so there can be no ambiguity in the structural analysis process, which has to be fully traceable and repeatable. It's not acceptable to use a "black box" of computational tools.

Strong support for an OEM's submission for certification can be provided by finite element analysis (FEA) output files of computed internal loads with, for example, NASTRAN or Abaqus—along with test data that

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validates methods and allowables. Collier's software tool automates the processes that provide these, giving the design engineer the ability to trace through their analysis, visualize results and understand the response of a composite structure, thereby confirming that the software and material input data are producing the correct answers.

Templates of a wing skin, a rib, or a fuselage are available to guide the user through the analysis. The software reports to the engineer all the analysis details, including input and intermediate data results, with stress methods fully documented by references to the published literature. The test-data correlation capability allows the user to store such data for later demonstration of the agreement between analytical prediction and test.

HyperSizer essentially automates the setup of a design-feedback loop based on the internal-load data from whatever number of FEA load cases (these can be in the thousands) are needed to reach an optimized design—and then computes the failure margins of safety. At this point the final deliverable from the software is an updated design to pass to the user's CAD software (such as CATIA), updated model properties to pass to the global loads model, and stress reports, both detailed and summarized, including:

- Tables of dimensions, minimum margins of safety, controlling load case and failure mode for each structural component
- Complete worked-through examples of stress analysis methods starting from FE load extraction and summation, section properties, reference stress to margin calculations.
- Section cuts of structural components with dimensions.

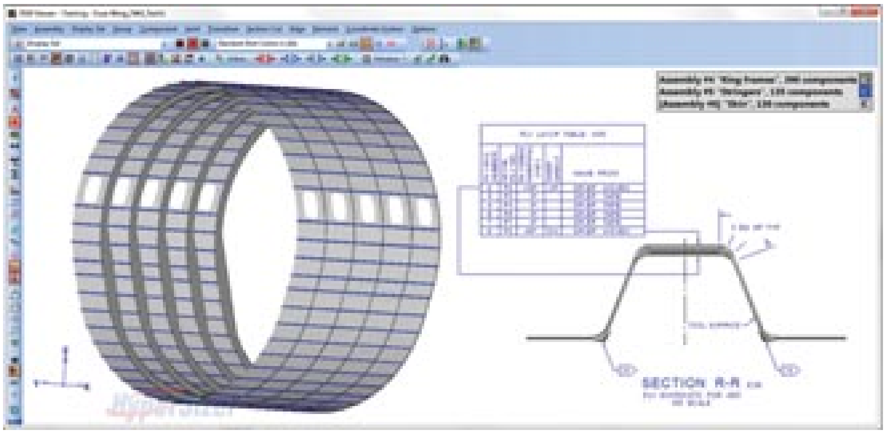


Figure 4. Mass-optimal and producible layup schedules for composite stiffened panels generated by HyperSizer Pro.

Safer, Lighter — and Manufacturable

The attractiveness of a lighter aircraft is of course the major reason why OEMs are increasingly turning to composites, but this obviously must go hand-in-hand with meeting all safety criteria. Collier's tool not only builds a positive margin of safety into every load case run, the composite design is optimized for the minimum weight that meets all applicable failure criteria with positive margins. Typical weight savings run between 20 and 40 percent.

As product development moves from design to manufacturing, digital tools continue to play an important role. Laminate designs are automatically incorporated into composite layup simulations in CATIA, for example. In preparation for this handoff, HyperSizer identifies the optimized ply schedules for a part, then sequences these further to account for layup producibility requirements. The ply schedules are then passed to CATIA for ply staggering and generation of part drawings.

This is the sequence being employed by some major aircraft makers

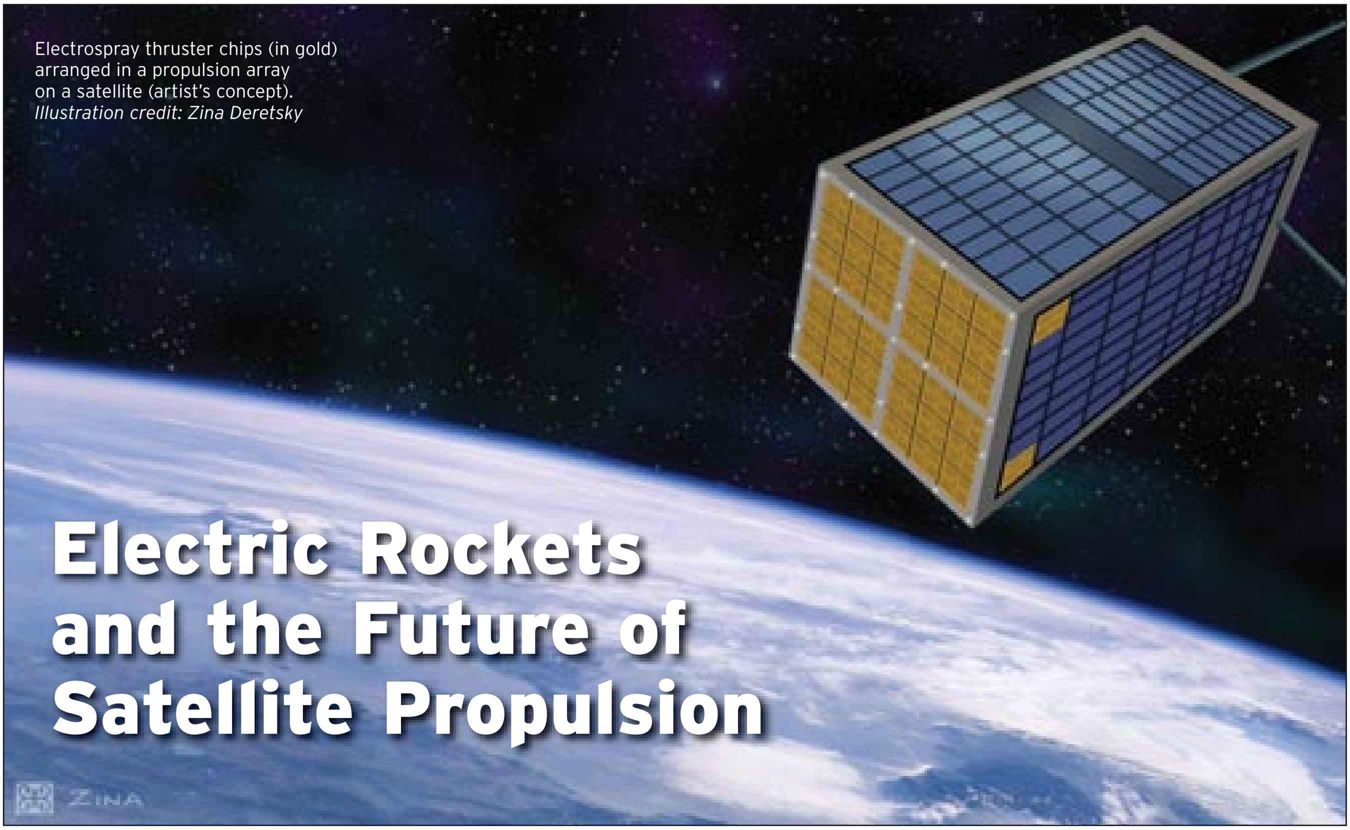
Figure 5. The design of the Bell Helicopter/Spirit AeroSystems V-280 tiltrotor fuselage (left) was sized and analyzed with the help of HyperSizer composites optimization software; the aircraft (right) is an entry in the Pentagon's joint multi-role technology demonstrator program competition.

today. However, smaller- to medium-sized companies are still spending a great deal of time performing their stress analysis and sizing in error-prone spreadsheets or custom scripts instead of commercial software. Collier's software can replace those scripts with automated stress analysis/sizing that quickly updates the FEA model and CAD layup schedules with every change to the design. Reduction in the design schedule can be considerable: from many months to a few weeks through this kind of software automation. Long term, the ability to call up and repeat a digital analysis on an aircraft with a 30- to 50-year lifespan—that can extend beyond any individual engineer's career—is of obvious benefit.

Regardless of their size, every manufacturer will have their own additional design criteria, such as proprietary material allowables and unique fabrication processes. HyperSizer can be customized to accommodate these, and is flexible to merge and adapt to each OEM's unique analysis methods for certification. Companies that do not have preexisting stress manuals use the software right out of the box because it's based on standard, traditional aerospace analysis. Established manufacturers often plug their legacy analysis methods directly into the tool.

Going forward, the use of composites in aircraft will increasingly depend on automating production on the manufacturing floor. Processes like curing and automated fiber placement (AFP) will largely be accomplished through robotics. Software makers are working to couple the power of digital analysis and simulation to the production technology, with the goal of establishing data communications from the stress analyst all the way to the AFP machine. The timeline from early design thought to finished, certified aircraft is on its way to becoming as streamlined and cost-effective as possible.

*This article was written by Craig Collier, President, Collier Research Corporation (Newport News, VA). For more information, visit **http://info.hotims.com/65850-501**.*



Electrospray thruster chips (in gold) arranged in a propulsion array on a satellite (artist's concept). *Illustration credit: Zina Deretsky*

Electric Rockets and the Future of Satellite Propulsion

Humans have been using rocket propulsion for almost a millennium, starting with Chinese rockets and "fire arrows" in the 13th century and continuing to the modern era's powerful Space Shuttle and Falcon rockets. For most of that history, rockets have been chemically fueled, but in the past century scientists and engineers have also experimented with electric rockets, also known as ion engines or ion propulsion systems.

Rather than using chemical reactions to create heat and accelerate a propellant, electric rockets use electromagnetic or electrostatic fields acting on charged ions of propellant, speeding them up and shooting them out, away from the vehicle, producing thrust. The electrical energy to generate these fields comes from the sun, from batteries, or both.

Ion engines might sound like something you'd find on the Starship Enterprise, but in fact they've emerged as a practical solution for in-space maneuvers. NASA's Deep Space 1, launched in 1998, demonstrated the sustained use of an ion thruster in space. The most recent version of Boeing's 702 satellite bus uses an all-electric propulsion system for orbit transfer and maneuvering the satellite once it is in orbit (prior versions used hybrid chemical and electric engines).

Electric rocket engines are far less powerful than chemical rockets, so they can't be used to launch rockets into space. But once in orbit, they have some big advantages: They're far more efficient, per unit of propellant mass, than chemical rockets. And because they rely on electricity, they can be powered by solar panels.

Accion Systems, Inc. has developed an electric rocket system, based on electrospray propulsion technology, that can be made to work at a far smaller scale than previous ion engines. It's also cheaper and easier to manufacture these thrusters in large numbers. That makes them well-suited to deployment on small satellites and nanosatellites, where these engines can help maintain orbit, change a satellite's orientation, or even move it to a different orbit with great efficiency.

Electrospray Propulsion: How It Works

Research into electric rockets began in earnest in the mid-20th century as part of the space race. Eventually, two main types emerged. In the Soviet Union, "Hall thrusters" saw some limited operational use in the 20th century. In the United States, "gridded ion engines" were a subject of experimentation but were not widely deployed until recently, as part of Boeing's Xenon Ion Propulsion System (XIPS), the electric propulsion system used on the company's Boeing 702 satellite bus.

A third type of electric rocket technology, electrospray propulsion, didn't proceed past the experimental stage in the 1960s and 1970s. However, research in the past decade by Paulo Lozano at MIT, assisted by Natalya Brikner and Louis Perna, pushed electrospray from theory into reality. (Perna and Brikner were graduate students under Lozano's supervision and are the cofounders of Accion Systems.)

The basic idea with electrospray propulsion is that you start with a conductive liquid and expose it to a strong electric field. That field brings charged ions to the surface, deforming the surface of the liquid and pulling it up and away from the rest of the liquid. As the liquid deforms, it extends into stronger parts of the electric field, deforming it still further, and so on. Eventually the field pulls a tiny droplet (or even a single ion) off the very tip of the deformation, accelerating it out and away, generating thrust.

Recent Innovations

Building on the MIT research, Accion has advanced electrospray propulsion in several ways. First, it uses a conduc-

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tive liquid as a propellant – a compound that's liquid at room temperature and which contains two different molecules (one positively charged and one negatively charged). Because this propellant already contains charged ions it doesn't need to be ionized, which is why the engineers dub it "plasma in a bottle." By contrast, other ion engines require an ionization step prior to accelerating the ionized propellant.

Second, the propellant is stored within a porous material, which brings the liquid into the thruster's electric field through an array of sharp microstructures on its surface. The porous material acts as a wick, drawing the propellant out of a reservoir and into the thruster. The microstructures pre-deform the liquid, so the electric field need only operate at the tips, pulling the liquid out still further and extracting it a few ions or molecules at a time.

Third, the extractor (the part that generates the electric field) is made with micro-emitter holes that line up with the microstructures on the porous material. Its field is designed to extract ions from each tip separately. Altogether, a single thruster chip is about the size of a U.S. penny, but contains hundreds of emitters, all firing in the same direction.

It's not very powerful: Each penny-sized chip generates only a few tens of micronewtons of force—approximately equal to the force exerted by a mosquito's wings. But the technology has substantial advantages that can make up for its low level of force.

Electrospray Propulsion: Pros and Cons

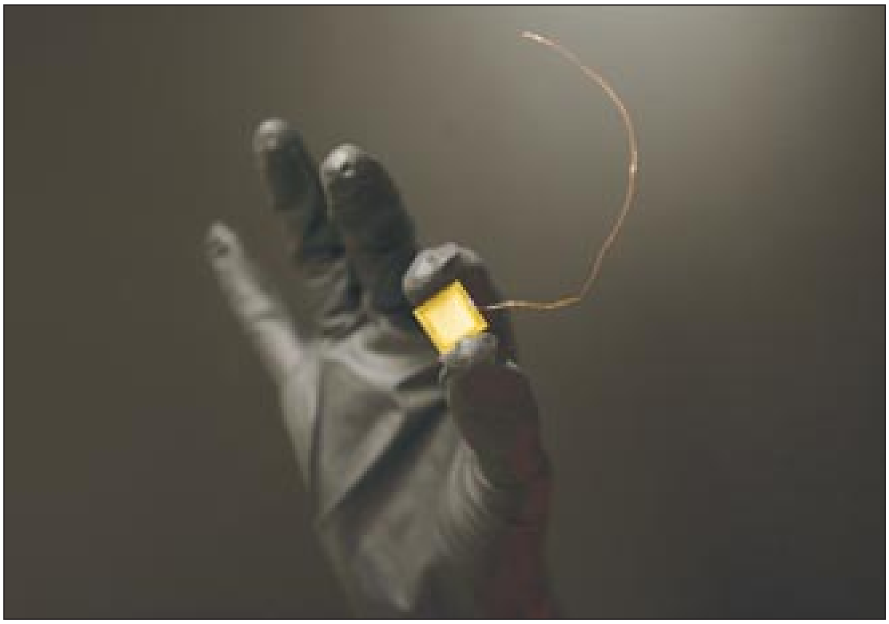
Ion engines, including electrospray propulsion systems, have excellent specific impulse—a measure of propellant mass efficiency. So while their thrust is weak, they use propellant extremely efficiently. That means they are well suited to applications where the time required to accelerate is not as important as the overall mass of the satellite.

For unmanned satellites, that tradeoff is easy to make. More efficient propulsion means you don't need to devote as much of the satellite's mass to propellant, leaving more room for the payload—or making the overall satellite less massive and therefore cheaper to launch. Meanwhile, if it takes days or weeks to complete a maneuver, that's not a problem for the satellite's computers: They can just wait patiently.

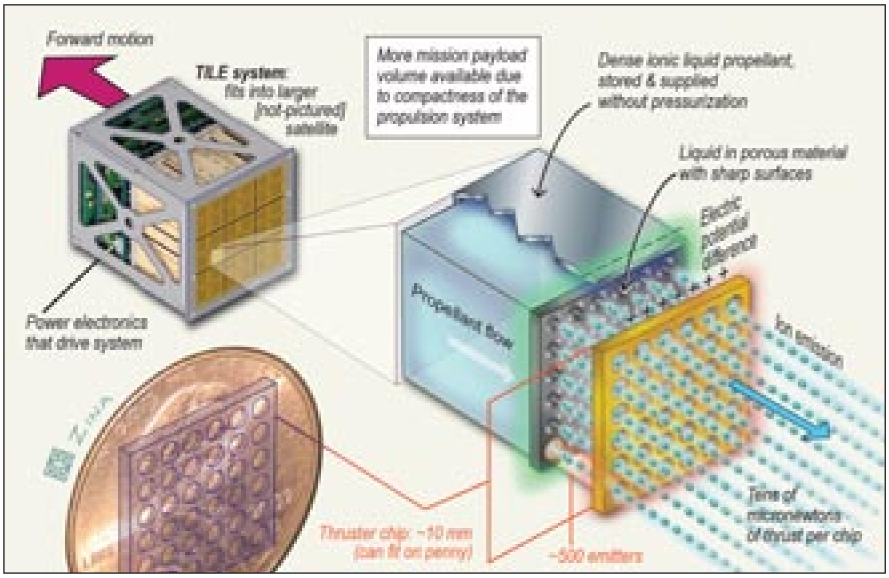
Because the propulsion system can act on the conductive liquid directly, power is not needed to ionize the propellant.

What's more, this liquid is extremely non-volatile, which means it's relatively safe to handle. It emits no dangerous vapors. If you spill some of it on a surface, it will just sit there, without evaporating, for years.

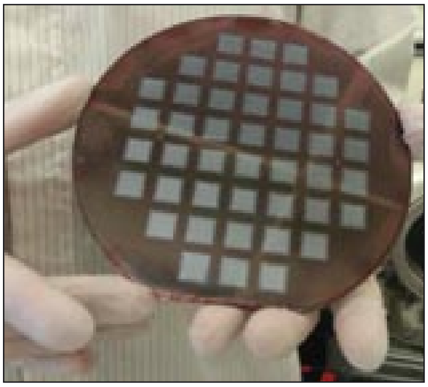
It doesn't even evaporate in the vacuum of space, which leads to another benefit — because the propellant has such a low evaporation rate and is liquid at a wide range of temperatures, it



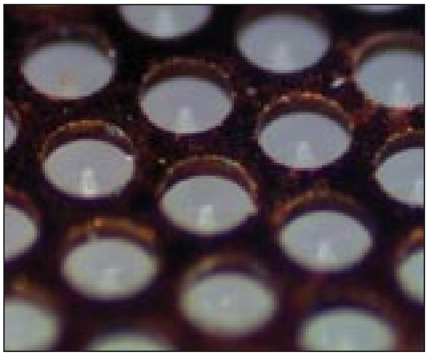
Electrospray thruster chips are small enough to fit on a fingertip and have no moving parts. (*Photo: Accion Systems, Inc.)*



How the TILE system generates thrust. *(Illustration: Zina Deretsky)*



Accion's chips can be manufactured with techniques used to manufacture silicon chips and MEMS devices. (*Photo: Accion Systems, Inc.*)



This closeup shows the emitter tips immediately behind an array of holes in the electrically charged extractor. (*Photo: MIT Space Propulsion Laboratory*)

doesn't need to be compressed, as do the gas propellants used by other ion propulsion systems. That eliminates the need for bulky, massive, thick-walled compression tanks.

The Accion system contains no moving parts, making it extremely reliable. No pumps or valves also reduce the power demands and the overall mass of the system.

It can also be manufactured en masse, using techniques developed for the semiconductor and MEMS industry. In contrast to the labor-intensive "bespoke" approach used to manufacture other types of rocket engines, these engines can be built in a largely automated way. This makes it possible to manufacture dozens or even hundreds at a time.

Electrospray technology has power efficiency comparable to other ion thrusters, with about 40-50 percent of the power used being converted to thrust. But the theoretical efficiency could be much higher, on the order of 90 to 95 percent, and as the technology improves it should get closer to the theoretical limit.

For microsatellites and nanosatellites, this version of electrospray technology has one particular advantage – it can be very small. Other types of ion propulsion systems show a dramatic loss of efficiency at very small scales. But this system, at its smallest, can be contained in the space of a golf ball or even a stick of gum. To generate more thrust, satellite makers can simply put together multiple chips in grids of any needed size.

However, as mentioned above, electrospray thrusters are extremely weak, generating only a few tens of micronewtons of force. (A micronewton is the force required to accelerate one gram by one millimeter per second, per second.) That precludes them, like other types of ion thrusters, from use in applications where it is important to complete acceleration quickly.

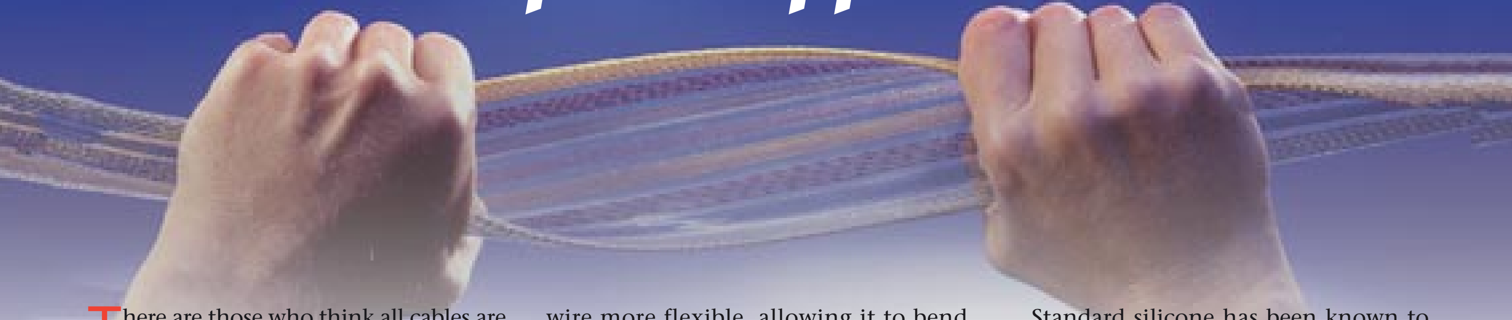
In terms of thrust density (thrust per unit area) electrospray thruster chips are comparable to those of Hall thrusters and gridded ion engines, and far weaker, of course, than chemical rockets. Theoretically, however, they can reach thrust densities up to 10,000 times higher than at present, with improved manufacturing techniques.

The technology is new and relatively unproven. Electrospray thrusters based on the MIT research are currently being tested on two satellites in space.

Finally, one "disadvantage" is that electrospray propulsion chips just aren't that exciting to look at. There are no thruster nozzles. The emitted ion stream is not visible, so there's no dramatic exhaust to look at. The gold thruster chips just sit there, exposed to space, silently and invisibly emitting ions that gradually accelerate or rotate the satellite as needed.

This article was written by Natalya Bailey, CEO and founder, and Louis Perna, Mechanical Systems Team Leader and co-founder of Accion Systems (Boston, MA). For more information, visit ***http://info.hotims.com/65850-502****.*

Flat Cable Technology for Aerospace Applications



There are those who think all cables are created equal. Well, they're not.

The simplicity of flat cable with its parallel conductor geometry eliminates many of the common sources of wiring error and malfunction. Registration of the conductors is one-to-one with the terminating connector or board so that proper contact assignment is almost automatic.

The use of flat cable often eliminates much of the conventional wire weight. Such things as redundant insulating materials, fillers and tapes are not required. In addition, the composite flat cable construction is so mechanically strong that it is not necessary to have large conductors for strength. The copper cross-section can thus be reduced to what's required to carry the current load or to satisfy voltage drop requirements. Strength is enhanced by the fact that all conductors and insulation equally share tensile load.

Extruded flat cables can be made in conductor sizes from 4/0 AWG to 44 AWG, single extrusion widths of up to 4 inches and cable heights of 1 inch, plus they can be utilized in continuous operating temperatures of -65°C to +260°C.

Since they are extruded, flat cables are available in continuous lengths, cut to order, prepped for termination or as assemblies with just about any circular or rectangular connector, including Mil-DTL-38999, Solder Tab Nano, Micro-D, Ethernet, IDC, Hermetically Sealed, Lugs and custom connectors and PCB components. Assemblies can be soldered, crimped, potted and over-molded.

To design a custom cable, space restrictions, bend radius, environmental issues, application specifics, and mechanical, electrical and vacuum requirements are needed.

It's All About the Wire

Today, most wire utilized in cables is made up of multiple base wire strands, rather than being made of a solid piece of metal/wire. Multiple strands make the wire more flexible, allowing it to bend and flex more easily than solid wire.

The finer the base strand, the more flexible the wire. Standard 24 AWG wire has 7 base strands, 'flexible' wire has 19 base strands, while Cicoil High-Flex wire utilizes 66 base strands. All Cicoil wire has base stranding of 40 AWG minimum, versus 36 AWG and larger in other 'flexible' wires. Cicoil wire conductors have two to three times more base strands than conventional 'flexible' wire, which makes them extremely flexible. Wires with smaller base stranding will have a much smaller bend radius than wires with larger stranding. In addition, finer stranded wire has significantly longer life in flexing applications, as bending stresses are distributed across many more wire strands, thereby dissipating the strain on the overall conductor.

The copper cross-section can thus be reduced to what's required to carry the current load or to satisfy voltage drop requirements. Strength is enhanced by the fact that all conductors and insulation equally share tensile loads.

Jacket

The outer jacket on Cicoil's cables is made with a propriety material called, Flexx-Sil™, which is designed for high-flex, high-performance, and even high-voltage applications. This unique material combines the best aspects of silicone rubber, such as flexibility and extreme temperature exposure.

Standard silicone has been known to outgas harmful materials when utilized in high-vacuum environments. As a result, contaminates from within the silicone material are released and then condense onto highly sensitive electronics, circuit boards, optics, etc...

Crystal-clear, Flexx-Sil™ rubber has zero additives, does not oxidize or outgas harmful contaminants, and is Space Flight Approved by NASA. The ultra-pure cable is halogen-free, Class 1 Clean Room Rated and exceeds ASTM E-595 outgassing specifications for vacuum and Space use requirements.

Unlike, PTFE or Polyurethane jacketed cables, Cicoil's extrusion process separately encases each individual inner component, which prevents wires from rubbing against each other and creeping out when exposed to severe vibration, shock and turbulent flight conditions. Where other materials require conduit or "armor" for protection, the encapsulated design does not. In addition, the jacket is self-healing from small punctures and can easily be repaired in the field, whereas other cable types have to be discarded.

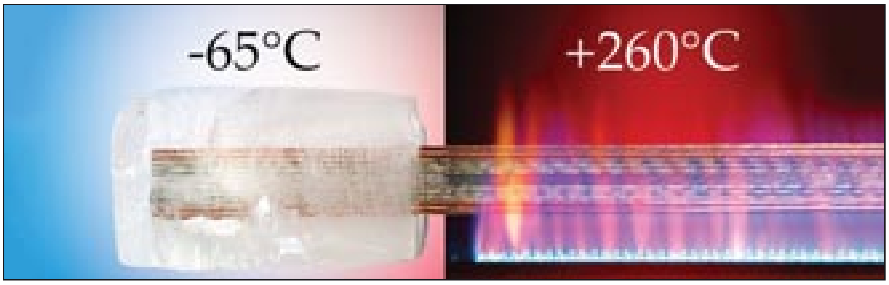
The Crystal-Clear Jacket also allows for quick, easy and safe inspection of cables in just about any application. Unlike cables infused with color additives and possible contaminants, the Flexx-Sil™ rubber design offers complete transparency, so you won't need to be concerned about what's under the jacket.

Patented Extrusion Process

Unlike the standard, open-floor extrusion line process utilized in the electrical cable industry, Cicoil utilizes a patented computer-controlled extrusion process, which allows individual components to be placed in a flat profile, precisely controlling the spacing of each component, insulation thickness and the overall cable shape. The thickness of the extruded flat cable is precisely controlled to within 0.005”, and conductor spacing accuracy to within 0.002”.

The solid one-piece construction can be made in unlimited lengths and the cables can combine power conductors and twisted shielded pairs, in different AWG sizes and various diameters, all combined in a single flat profile. Other components, such as tubing, fiber optics, mounting strips, coax conductors, thermocouple cable, and strength members can also be integrated into the cable design.

Lastly, all cables are cured continuously, with no debris, humidity or material contamination in an automated, climate controlled operating environment. This manufacturing process is a unique, one-of-a kind operation.



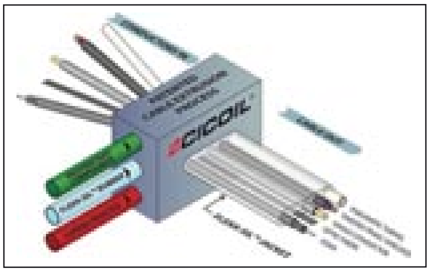
Temperature extremes to which Flexx-Sil outer jackets can be exposed.

Extruded Flat Cables vs Molded Flat Cables

Flat molded cables may look similar to Extruded Flat Cables from a distance, but once you take a closer look, the similarities no longer apply.

In the molding process, wires are stretched between pins in a metallic mold that typically ranges from 1 to 6 feet in length. Liquid silicone and chemical curing agents are poured over the wires, and once settled, additional silicone is poured to attain proper cable thickness. The cable will need to fully cure over another 2-3 days.

Unlike the ultra-clean manufacturing process of extruded flat cables, molded flat cables are exposed to contamination by dust, metal chips and



Cicoil's patented computer-controlled extrusion process.

airborne debris during the pouring and curing processes.

After the curing process is complete, the cable needs to be cut out of the mold with an X-ACTO knife, leaving numerous holes from the pins and sharp edges, which will impede overall cable strength and flexibility. As a result, the pin holes need to be filled in by hand with silicone, and the cable has to be cured again. In addition, excess flash needs to be removed from the cable jacket by hand with sharp blades as well.

Since it is a manual process, the "poured" method results in varied component spacing and inconsistent cable thickness with each batch of cable produced. The odds of receiving a duplication of identical flat cables is almost impossible. Complex designs and variations in profile, such as hybrid cables with different AWG sizes and tubing, can't be combined into a single flat cable.

Gravity causes molded cables to be thicker at the bottom and thinner at the top, which will cause cable failure as a result of wire breakage through the thin cable top, especially in flexing applications

Extruded flat cables have rounded radiuses on each end, making them mechanically stronger and more flexible than molded flat cables. Utilizing a computer controlled extrusion process, any outside cable profile can be created as the application requires, so the same exact cable will be produced the same way every time.

Extruded Flat Cables vs Round Cables

Highly flexible flat cables have many advantages over flexible round cables in constant motion and confined area applications. Round cables incorporate single and multiple bundles of insulated wires and are usually surrounded by several layers of other materials. The inner bundle is usually surrounded by a wrapped textile material, fillers or an inner jacket to minimize internal heating caused by friction caused by flexing, bending and twisting of the cable. In shielded round cables, there are additional protective layers consisting of low-friction wraps, additional inner jackets, braided copper, fillers and even lubricating agents such as talc. With the inclusion of more layers and materials, the cable increases in size and weight, which results in a less flexible cable.

Eliminating unnecessary insulation, fillers and tapes reduces the bulk and physical volume of flat cables. In addition, their low profile enables them to hug surfaces and take advantage of tight, or normally-unused space and exhibit much flexibility. A rectangular cross-section allows flat cables to stack, or layer, with almost no wasted dead space between cables, providing maximum conductor density for a given volume.

Flat cables have greater surface-to-volume ratio than their round cable counterparts, consequently having higher efficiency in dissipating heat. This allows a higher current level for a given temperature rise and conductor cross-section.

The spacing of conductors in the extruded flat cable never changes as the cable moves. Thus cable impedance, inductance, capacitance, time delay, crosstalk, and attenuation all remain constant. Similarly, the conductors in the cable all have the same physical and electrical length. This, coupled with the fact that the dielectric dimensions stay constant, means that signal skewing and differential time delays between signals in the cable stay at a minimum.

Extruded flat cables and flat cable assemblies form an inherently high-density interconnect system. Packing density of flat cable is higher than is possible with round cables. The fact that conductors can be visible in the Flexx-Sil™ extrusion simplifies coding, inspection, and tracing circuits for trouble shooting.

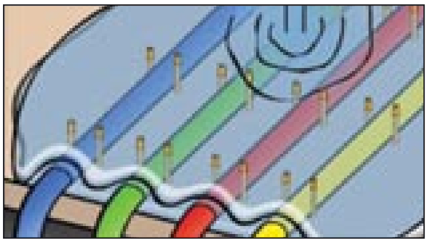
Extruded Flat Cables vs Flex Circuit

Flex Circuits offer engineers some useful properties, but sometimes they are used in applications that require more capabilities than they can offer. Despite the "Flex" in flex circuits, the flexing capability in the flat form factor is limited. Unlike flexible flat cables designed for millions of continuous flex cycles, Flex Circuits tend to be stiff and are very fragile. They can easily be dented, cracked, bent and damaged from exposure to severe turbulence, vibration, impact, long term flexing, mechanical stress and improper handling.

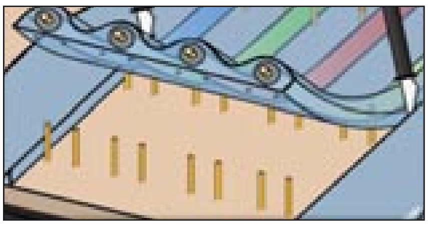
Where flat cables can incorporate different components within its profile, Flex circuits are typically limited to single conductors only. For applications exposed to EMI/RFI, shielding is attained by using neighboring conductors or flat shield planes above and below the circuit traced layer resulting in larger and very stiff assemblies. Flat cables can incorporate single shielded power conductors, twisted shielded data and Ethernet pairs, coax, triads and shielded cable bundles.

The initial tooling costs for Flex Circuits are high. Once made, tooling is expensive to change and new tooling may be required to accommodate application modifications. Flat extruded cables typically require a one-time $250 tooling charge, which is inexpensive compared to tooling used to manufacture Flex Circuits.

Similar to molded flat cables, Flex Circuits are individually produced and the size is fixed according to the tooling; whereas, extruded flat cable is manufactured in continuous bulk lengths and can be cut to suit various applications.



Conventional flat cable molding process.



Cutting conventional flat cables out of the mold.

Flex Circuits can be used in small spaces where equivalent round cables won't fit and can be shaped to fit the installation path. Flat extruded cables meet these requirements as well. Custom shaped flexible flat cables allow for very precise cable routing without folding, kinking or pinching. The custom shape of the flat cable also contributes to the elimination of signal failures due to physical stress at the cable connector.

This article was written by Rich Buchicchio, National Sales & Marketing Manager, Cicoil (Valencia, CA). For more information, visit ***http://info.hotims.com/65850-503***.

AUVSI XPONENTIAL
ALL THINGS UNMANNED

After a very successful trade show and conference in New Orleans last year, the Association for Unmanned Vehicle Systems International (AUVSI) is bringing this year's event, AUVSI XPONENTIAL 2017 to the Kay Bailey Hutchinson Convention Center in Dallas, TX. The event, which runs from May 8 – May 11, will feature more than 200 presentations and panel discussions focused on all aspects of the unmanned vehicle and robotics market. Over 650 exhibitors representing more than 20 different industries will be showcasing their latest technology to an estimated 7,000 attendees from all over the world.

So, what can attendees expect to find at XPONENTIAL 2017?

The event kicks off on Monday afternoon, May 8, with educational programming and workshops from 1:30 to 5:00 pm, followed by a welcome reception, first timers reception, and exhibitor reception. These receptions are a great venue for first-time attendees and veterans alike to mingle and network in an informal relaxed atmosphere.

Tuesday, May 9, begins with keynote addresses by Intel CEO Brian Krzanich and Weather Channel Meteorologist Jim Cantore, which should provide much food for thought before attendees head off to the many educational sessions being offered or the exhibit hall.

Exhibit Hall

If past shows are any indication, there will be no shortage of things to see and do in the exhibit hall. More than 650 exhibitors from around the world will occupy over 370,000 square feet of exhibit space to showcase their latest technology and products covering all aspects of unmanned vehicle and robotics design, manufacturing and use including air, ground, surface, subsurface, space systems, weapons systems, security systems, engineering and R&D, propulsion systems, sensors, electronics, fabrication, imaging and communications systems, and much, much more.

In addition to the normal array of exhibitors, this year's event offers a number of features designed to help attendees navigate the show floor more efficiently. Take the Technology Zones for example. According to show organizers, "Technology zones provide a hub for attendees to see the latest innovation for one specific market segment." There will be four Technology Zones to explore: Air Pavilion, Business Services Zone, Software Pavilion, and a Startup Pavilion.

The Air Pavilion will focus on UAS products and services, particularly those of interest to companies and individuals with 333 Exemptions and

Endeavor Robotics booth at XPONENTIAL 2016. (Photo: Bruce A. Bennett)

Even NASA had a presence on the show floor at XPONENTIAL 2016. (Photo: Bruce A. Bennett)

Part 107 operator status. The Business Services Zone will give attendees an opportunity to meet with companies that specialize in providing various support services such as insurance, legal services and training. The Software Pavilion, which is a new addition to this year's show, will feature the types of software products that can expand an unmanned vehicle's horizons by adding or increasing things like autonomy and image stitching. And the Startup Pavilion, as its name implies, will feature young, promising companies looking to mainstream their newest innovations and technologies.

There will be four international pavilions featuring companies from China, France, Spain and the UK, as well as four State Pavilions where attendees can learn what is being done to help grow the unmanned vehicles and robotics industry in places like Colorado, Nevada, North Dakota and Utah.

Two of the more popular attractions on the show floor will be Robots in Action, a special area where exhibitors can demonstrate their small unmanned air and

The Kratos booth at XPONENTIAL 2016. (Photo: Bruce A. Bennett)

ground vehicles in action, and the AUVSI Foundation's RoboNation, which pits teams of students against each other in competition to see whose autonomous robotics technology is the best.

And finally, don't miss the Solutions Theater where you'll be able to see the best new products from exhibitors as chosen by AUVSI, and the Poster Presentations where you can meet and chat with people doing the latest cutting-edge research in the field of unmanned vehicles and robotics.

Educational Program

Those seeking the latest up-to-date information about unmanned vehicles and robotics technology can attend a variety of stimulating courses and seminars at XPONENTIAL 2017. The courses have been broken down into three program tracks: Policy, Technology, and Business Solutions. Although parts of the program were still being finalized as we went to press, here are some of the educational programs being offered:

Policy Track

The Policy Track is designed to give attendees access to the latest information on policies and regulations impacting the unmanned vehicle and robotics industries straight from the people formulating them. Some of the panel sessions being offered are:

- Airspace 101: What You Need to Know Now
- Policy Implications for Automated Vehicles
- International Trade Issues Affecting Unmanned Systems
- Unmanned Maritime Systems: Advances in Regulation and Related Technology
- Federal, State, and Local: How Can We All Get Along?

Technology Track

The Technology Track, as its name implies, will keep you up to speed on the latest technological developments in areas like artificial intelligence, autonomous operation, software, and propulsion systems. Some of the panel sessions being offered are:

- Reducing SWaP-C in UAVs With a Consolidated PNT Modular Sensor
- Counter-UAV System Based on RF Detection and Video Analytics
- Advanced Platform for UUV Technology Development, Integration and Testing
- Software Developments Driving the Next Generation of Drone and Robot Technology
- Technical Challenges Impacting the Development and Deployment of Fully Automated Vehicles

Business Solutions

Unmanned vehicles and robotics technology is opening up all kinds of new business opportunities, and this track is designed to help you learn how to take advantage of them. Some of the panel sessions being offered are:

- Unmanned Maritime Operations for Oil & Gas: Understanding the Challenges and Opportunities
- Insights on Inspection: Improving Efficiency, Increasing Safety and Saving Money on the Worksite
- Customer Focus Panel: The Benefits, Challenges and Opportunities for Drone Imaging
- Drones in the Wireless Industry: Use Cases and Perspectives on an Emerging Market
- The Devil's in the Data - Managing, Protecting and Making the Most of Your Information

After Hours

If you're not too tired after walking the show floor for hours or participat-

Reunion Tower in Dallas, Texas. (Photo: Bruce A. Bennett)

Oshkosh shows off one of their impressive military vehicles at XPONENTIAL 2016. (Photo: Bruce A. Bennett)

Stampede showed off their full range of drones at XPONENTIAL 2016. (Photo: Bruce A. Bennett)

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One of the many innovative drones on exhibit at XPONENTIAL 2016. (Photo: Bruce A. Bennett)

ing in the educational sessions, there is certainly no lack of interesting things to do in Dallas. For example, there's the infamous Texas School Book Depository – now known as the Dallas County Administration Building – from which Lee Harvey Oswald fired the fatal shots that killed President John F. Kennedy in 1963. The sixth floor of the building, where Oswald had his sniper's nest, has been converted into a fascinating museum devoted to that fateful day. You can also wander around Dealey Plaza and visit the legendary grassy knoll from which some people still believe a second conspirator fired the fatal shot.

Or if breathtaking views are more to your liking, take a trip to the top of Reunion Tower where you can enjoy stunning 360-degree views of the city from 500 feet above it. Celebrity chef Wolfgang Puck has a revolving restaurant up there. Or you can dine a little more down to earth at any of the wide array of restaurants, bars and bistros for which downtown Dallas is famous.

Given all that XPONENTIAL 2017 and the city of Dallas have to offer, this year's event should be one to remember.

Pulse Analysis Techniques for Radar and Electronic Warfare

Pulsed signals are widespread in radar and other electronic warfare (EW) applications, and they must be accurately measured for manufacturing, design of countermeasures, and threat assessment. Pulse measurements are an especially challenging area for signal analysis due to a combination of factors. Fortunately, many of the improving signal processing and analog-digital conversion technologies behind the generation of complex pulse environments also enable new techniques for effective pulse analysis.

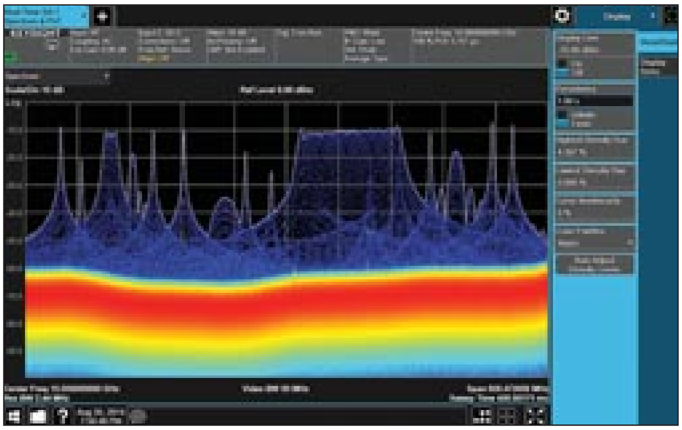

Figure 1. A real-time spectrum (density) measurement of a multi-emitter signal environment.

In the past, basic pulse measurements generally were made with swept spectrum analyzers. The intermediate frequency (IF) bandwidth or resolution bandwidth (RBW) of the spectrum analyzer was generally narrower than the effective bandwidth of the pulse, so the spectrum analyzer was used to measure the resulting pulse spectrum. The pulse spectrum could then be used to measure basic signal characteristics such as pulse repetition rate or interval (PRI), duty cycle, power, etc. Spectrum analyzers were also used in more traditional ways to make out-of-band measurements such as spurious and harmonics of pulsed signals.

Though indirect and slightly clumsy, the pulse spectrum approach was adequate for simple pulses and signal environments containing only a single pulse train, and where frequency agility was low or could be inhibited. Modern systems use much more complex pulses, and many signals or signal environments include different pulses (along with other signals) from one or multiple emitters, as shown in the real-time spectrum measurement of Figure 1. The combination of complex signals and detailed measurement requirements means that pulse measurements must now be made using digital signal processing (DSP) techniques on digitally sampled signals.

Choosing RF/Microwave Hardware and Software

A critical first step is to choose the main measurement hardware platform. Rapid increases in signal analyzer bandwidths and improved resolution in digital oscilloscopes are constantly changing the tradeoffs that affect pulse measurements. Two different RF/microwave hardware measurement platforms are generally used for this purpose: signal analyzers with a wideband digital IF, and oscilloscopes or digitizers with a sampling rate high enough to directly handle microwave RF/microwave signals at baseband.

The two hardware front end approaches are conceptually similar for most pulse measurements. In both cases, the output of the RF/microwave front end (including subsequent processing) is a stream or data file of I/Q samples of the signal or signal environment. The principal architectural difference is the location of the analog-to-digital conversion (ADC) operations and the type of processing used to focus analysis on the frequency band of interest. Signal analyzers use a fundamental or harmonic analog mixing process and analog filters to convert RF or microwave signals to an IF section where ADC operations are performed. Oscilloscopes (and other time domain samplers such as modular digitizers) sample the RF or microwave signals directly in a baseband fashion, and subsequent downconversion and band-limiting is performed by DSP.

While signal analyzers and oscilloscopes can make many of the same measurements, the best choice in a hardware front end is often dominated by two performance requirements: bandwidth and dynamic range. The high-speed ADCs in RF/microwave-capable oscilloscopes provide extremely wide bandwidth and good phase linearity. In contrast, the slower ADCs and bandwidth filters of the signal analyzers provide higher dynamic range. Where their bandwidth — now as wide as 1 GHz — is sufficient, they have a greater ability to detect and measure small signals, or to handle both large and small signals at the same time.

One practical advantage of the signal analyzer as a measurement platform is that it can support seamless switching among swept, vector, and real-time measurements in a single instrument. By using smart external mixers, this single instrument — via a single user interface — can provide these capabilities over wide bandwidths and up to 90-GHz operating frequencies.

Once a stream of wideband sampled signal data is available, a variety of software solutions are available to meet different analysis needs. Two major types of software are generally used. Built-in software and installable measurement applications have been available for oscilloscopes for some time, and their

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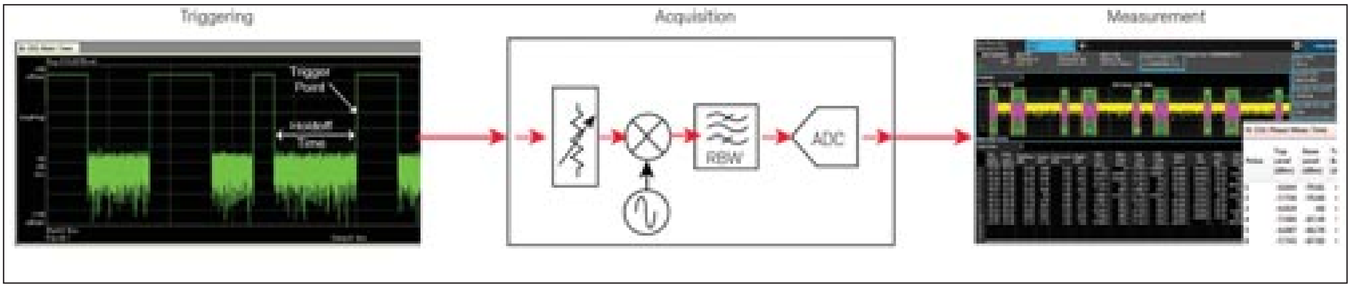

Figure 2. Measurement of time-varying signals is often described as a sequence of three steps. This is a convenient and useful descriptive summary, though the steps are not always as linear and independent as the diagram suggests.

analysis is focused primarily on pulse timing parameters and time domain measurements. Built-in applications extend pulse analysis to the frequency and time domains in signal analyzers with wideband capability.

Vector signal analysis (VSA) software is the second type of software applicable to pulse analysis. VSA software can be used with many RF/microwave front ends, including signal analyzers, oscilloscopes, and modular digitizers. VSA software performs time domain analysis, but is particularly useful when frequency domain analysis and demodulation (or modulation quality analysis) is needed. VSA software captures multiple pulses and extensive measurement of pulses one at a time.

Real-time spectrum analysis (RTSA) is also useful in pulsed signal environments. RTSA was originally implemented as a separate analyzer type, because the wide bandwidth of RF/microwave pulse analysis required dedicated RTSA hardware. Fortunately, recent improvements in processing power have made this a practical measurement application to add to general-purpose signal analyzers, at initial purchase or as an upgrade. RTSA involves gap-free processing of signal samples, or at least minimizing gaps so that analysis will not miss even very infrequent events. RTSA can be useful for finding elusive signals, and can also be important for triggering pulse analysis.

Combining these pulse measurement solutions can be especially powerful in meeting certain measurement challenges. For example, RTSA can be a uniquely effective tool for generating acquisition triggers for subsequent measurements made by VSA software or pulse measurement applications.

Pulse Analysis Measurement

The process of pulse analysis is often described in terms of three principal steps: triggering, signal acquisition, and measurement or analysis (Figure 2). Triggering can be understood as a general process of time alignment for acquisition of pulse data, since the signals under test are time-varying. The time alignment may involve an explicit trigger from an external source, or it may be generated in one of several ways by the acquisition hardware itself. For regularly repeating signals, the required time alignment may also be a simple matter of choosing a suitable measurement interval via a time gating function.

Acquisition can be as short as a single frame, or a lengthy recording that is intended for post-processing. The recording can be continuous or segmented, with some unnecessary data discarded to improve effective memory length. The bandwidth of the signal acquisition can be focused on the spectrum occupied by a single pulse or a wider signal environment or band, which includes many different ones, and may contain other signals as well.

Measurement can be single frame, or post-processing with analysis that can establish triggering or some form of time alignment or reference to the measurement. In the case of signal capture or recording using VSA software, the center frequency and span of measurement may be altered after time capture.

In understanding the pulse measurement process, the first step above may involve additional complexity: triggering may be derived from some later measurement/analysis processes such as an RTSA frequency mask trigger (FMT). This can make the complete measurement process somewhat recursive.

Functional Blocks of Pulse Measurement

The steps in the process previously described may be performed individually by separate devices, or multiple steps — including the entire pulse measurement — may be performed by a single analyzer. A general overview of the process is shown in Figure 3.

Acquisition hardware can take several forms, including both baseband and IF sampling, and can be performed by standalone instruments and modular systems. The most important performance characteristics of the hardware are frequency bandwidth and dynamic range, though memory depth, the number of channels, and other factors are also important.

Analysis algorithms turn the digitized signals into measurement data in the form of displays and result tables as needed. The algorithms may be part of general spectrum or VSA functions, or they may be embedded in dedicated pulse analysis applications. The applications are especially powerful when more comprehensive pulse analysis is needed, such as pulse parameter statistics or signal environment characterization.

Deep data storage is critical for some applications — generally where a large number of contiguous pulses must be analyzed from gap-free capture, or where access to the signal under test is limited and analysis must be performed later. Sampled data storage is combined with post-processing to generate the analysis results needed, and may also be used for signal playback.

Triggering operations can initiate or synchronize pulse acquisition, or can be used to time-align existing samples for pulse analysis. Since triggers can be taken directly from the input signal or can be the result of signal processing, such as real-time analysis or post-processing from data storage, they can be part of any of the main measurement blocks.

Challenges of Complex Pulse Analysis

Finding the signal of interest and aligning measurements with the desired timing are the first steps in pulse analysis, and can be some of the most challenging. This is particularly true of complex pulse environments that can include frequency- and amplitude-agile emitters, and multiple signal sources with widely varying amplitudes. Though it provides no frequency selectivity narrower than the analyzer span, the time and level parameters' IF magnitude trigger provide enough flexibility and specificity for many pulse measurements. By combining the selectable positive and negative (pre-trigger) delays with appropriate holdoff values and types, a single pulse can be selected from among many. If there is a repeating pattern, the largest signal can be used for triggering, and positive or negative time delays used to select any other single pulse or time interval. The holdoff function can also be used to avoid false triggers from pulse amplitude variations due to modulation.

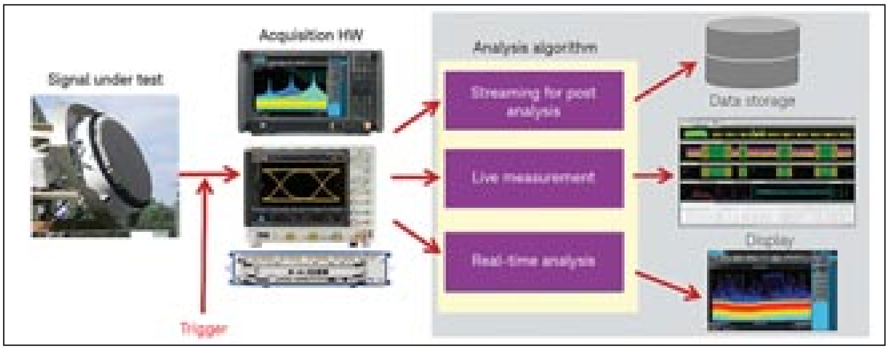

Figure 3. The functional blocks of pulse or signal environment measurements. Since the result of signal acquisition is a set of digital samples, the signal can be stored and post-processed (or reprocessed) in a flexible fashion.

FMT is valuable in finding and measuring transient or interfering signals, or in capturing specific signal behavior that can be best identified in the frequency domain. FMT processing is real-time or gap-free, providing confidence that any signal or behavior that matches the criteria will result in a trigger for measurement or time capture operations. Frequency masks can be generated manually or constructed from example spectrum measurements with offsets, or subsequent editing of amplitude/frequency breakpoints. Selectable trigger criteria make FMTs very powerful for identifying particular signal or environment behavior. Triggers can be generated when a signal enters or leaves the mask, and even for more complicated behavior such as leaving the mask after an entry event. These logical trigger criteria can be useful for capturing signals that are switching channels or are using frequency-hopping techniques.

The triggers and signal processing described so far will meet most pulse measurement needs; however, pulse durations and duty cycles are important variations in some signals, and a time-qualified trigger (TQT) can help isolate them for measurement. The TQT is a supplement to the FMT and IF magnitude triggers, continuously tracking the duration of events in the acquisition bandwidth. Thus, the TQT establishes a time qualification parameter in addition to the amplitude or spectrum parameters already available (Figure 4). Three properties are associated with TQT: Time 1, Time 2, and Time Criteria. These properties allow both open-ended and fully-bounded time durations to be set. In TQT operation, samples are acquired for analysis after an event has lasted for the specified time duration. If analysis of prior events is needed, a negative (pre-trigger) delay can be used.

As baseband samplers, oscilloscopes typically lack the sophisticated combination of time and frequency domain triggers described so far; however, they do offer trigger capabilities that can be useful with RF pulses. One example is basic edge triggering, when combined with trigger holdoff. A trigger occurs when the input signal crosses a voltage threshold, as is the case with the beginning of an RF pulse as it grows in magnitude. By selecting a holdoff time longer than the longest expected pulse, the holdoff ensures that triggers will happen only at the beginning of RF pulses. This technique works most predictably for signals with consistent pulse duration.

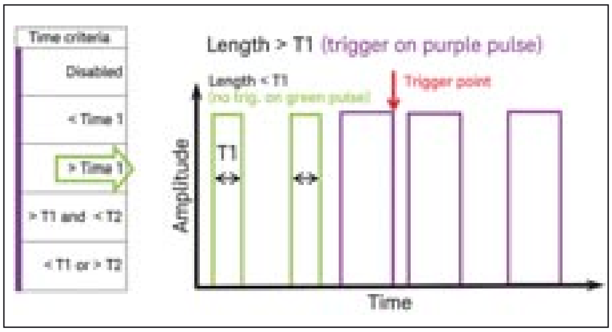

Figure 4. The time-qualified trigger occurs when a combination of one or two timing criteria is met. Though the criteria may only be met after the signal of interest, a negative trigger delay can allow the signal of interest to be measured.

Dynamic Range and Bandwidth Tradeoffs

Wide and ultra-wide bandwidths are increasingly important in pulse applications for several reasons. Ultra-wideband radars provide fine range resolution, plus increased resistance to detection and jamming. Frequency-hopping transmitters operate over wide ranges, requiring wideband capture to fully characterize the signal and avoid missing hops. Signal intelligence applications require acquisition of wide, contiguous bandwidth to identify targets.

Though the specifics of the trade-offs improve over time, sampling with wider bandwidths inherently imposes performance limits. These limits arise primarily from the increased noise inherent in wider bandwidths and the decrease in ADC effective bits as sampling rates increase. These limits must be weighed against performance needs such as dynamic range, sensitivity, distortion, amplitude accuracy, and phase noise.

Capture length, or the amount of data to be acquired for a measurement, is a critical issue in many pulse analysis applications. Capture length — in terms of time — is especially important in analyzing dynamic environments, where there is a need to capture a time segment long enough to represent the dynamics in question. Every hardware platform has a limit to its memory size, and efficient memory use will provide the longest possible capture and the best signal measurement.

For a sampled data system, the maximum capture length for a given memory size is a linear function of the acquisition bandwidth. This favors the signal analyzer over the oscilloscope, since the signal analyzer samples only the IF bandwidth. The oscilloscope must perform baseband sampling of the entire signal spectrum — with later data reduction to convert to a band-limited IF — and the result is a much shorter gap-free signal capture. As noted, the transfer and processing of this baseband data can also result in slower measurement throughput. For baseband sampling of signals with wide bandwidth and low duty cycle, the memory issues can be a problem.

For many applications, the solution to this problem is in the segmented

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memory feature of some oscilloscopes. When this feature is enabled, the acquisition memory of the oscilloscope is broken up into many smaller equal-length segments. The segment length is chosen to be slightly longer than the widest pulse to be captured. Segmented memory also makes it much easier to replay or review the captured pulses in the time domain in the oscilloscope. The user can step through the segments manually or automatically to understand pulse sequences before processing the memory segments.

The combination of oscilloscope-based time domain analysis, signal analyzer-based real-time spectrum analysis, and VSA software that can make comprehensive measurements from both platforms meets many needs for pulse analysis. However, some applications require more macro-scale measurement capability that gathers information from hundreds or thousands of pulses and organizes analysis results in tabular or graphical form. Some typical applications include transmitter and component testing, characterizing pulse modulation stability, characterizing threats (SIGINT), verifying threat simulations, and verifying responses to EW jamming.

Understanding and quantifying the stability and repeatability of multiple characteristics of pulsed signals are critical tasks in making effective use of them. The collective analysis of large numbers of pulses can reveal behavior that is otherwise difficult to spot or to quantify. Time-aligned pulse modulation measurements are especially useful for diagnosing problems, and the software can use best-fit algorithms to provide tabular summaries of parameters such as FM slope and peak-to-peak deviation.

These time-aligned pulse modulation measurements are especially useful for diagnosing problems, and the software can use best-fit algorithms to provide tabular summaries of parameters such as FM slope and peak-to-peak deviation. With large numbers of measured pulses, the application can use statistics derived from them to produce histograms and trend lines. The statistics can be gathered from single or multiple acquisitions and, in comparison to measurements of individual pulses, provide much greater sensitivity to defects and a more comprehensive view of transmitter performance.

This article was contributed by Keysight Technologies, Santa Rosa, CA. For more information, visit ***http://info.hotims.com/65850-541****.*

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Reconfigurable Radio Tracks Flights Worldwide

When Malaysia Air Flight 370 disappeared somewhere over the Indian Ocean in 2014, it had flown far beyond radar range. Under a new space-based air tracking system — starting with a reconfigurable radio developed by NASA — no plane would ever be off the grid that way.

NASA uses powerful radios to communicate with its satellites, rovers, and astronauts. These devices allow us to see everything from pictures of cryovolcanoes on Pluto to tweets from the International Space Station (ISS). In recent years, NASA decided it needed radios that work on higher frequencies with more bandwidth to make sending larger quantities of data back and forth faster, and that can be reprogrammed from a distance.

"A reconfigurable radio lets engineers change how the radio works throughout the life of the mission, if requirements change, or when the environment does," explained Thomas Kacpura, Advanced Communications Program manager at NASA's Glenn Research Center in Cleveland, OH. "It can also be upgraded to work better with future missions or to enhance performance just by adding new software to the radio."

With real-time flight tracking, planes can safely optimize their flight routes and fly with less space between them. And if a plane disappears, emergency responders will have exact tracking information to start their search.

NASA wanted a higher-frequency space-based radio that can be reprogrammed from a distance. Harris Corporation worked with NASA to design one, and is now selling them commercially as the AppSTAR. In this artist's rendering, the radio is mounted on the satellite under a white cover.

In the past, Kacpura said, engineers were reluctant to build reconfigurable devices for space because of testing requirements. They evaluated devices under every conceivable circumstance to ensure that, no matter what happened in space, the radio would keep doing its job. That's harder to do with a reconfigurable radio — how do you test for functions you don't even know you'll be using? Kacpura said recent missions have been allotting a larger size, power, and weight margin for reconfigurable systems. In addition, the culture has evolved and has become more comfortable with in-flight changes, which led NASA to design and develop a new reconfigurable, higher-bandwidth radio with Harris Corporation of Palm Bay, FL, through a 50/50 cost-share cooperative agreement.

The result of that effort was tested as part of the Space Communication and Navigation (SCaN) Testbed, an experimental communication system on the ISS. The SCaN Testbed project is led by Glenn, and was developed in cooperation with the Jet Propulsion Laboratory, Goddard Space Flight Center, Johnson Space Center, industry, academia, and international space agencies, all of whom also currently support experiment activities.

"The Harris SDR is the first space-qualified, software-defined radio in Ka-band," Kacpura said. Ka-band frequencies offer data transmission rates that are much faster than the previous standard, and are considered a key part of future NASA space communications.

The radio has been put through its paces in exhaustive testing both on the ground and in space, has been reconfigured and reprogrammed, and has performed well. "With a few tweaks and updates based on the test runs, this radio could now become the high-speed data radio on any spacecraft," said Kacpura. This will help get data back to Earth even faster than before, expanding the science return of NASA missions.

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The company knew the work it was doing with NASA was going to pay off with its other customers, but, said Harris systems engineer Jeff Anderson, "to be honest, I think we were surprised at just how quickly it was embraced both by our own designers and by customers." The biggest selling point of the new device turned out to be its flexibility. It can be fully reconfigured both in its hardware and its software, according to Harris program manager Kevin Moran, which meant the company could quickly and cheaply redesign it to fit any customer's needs. Basically, "this is a box, and inside there are a bunch of cards that plug in," Moran explained. "Power supply cards, a processor card, and then there are the cards specific to that mission. So when a customer has a different mission, we only have to change out a subset of the hardware within the box." Harris has trademarked the radio, which it calls the Harris AppSTAR, and has already sold it to a wide range of clients.

One of the biggest contracts so far is with Aireon LLC, which has engaged Harris to develop a hosted payload for new Iridium Communications satellites. For the past two decades, Iridium has operated a constellation of satellites in low-Earth orbit, which makes it possible to make phone calls or send data to and from the world's most remote regions. Unlike other satellites, each of the cross-linked orbiters can communicate with the others, meaning every point on Earth is always within coverage of the network.

In 2016, the company began launching its Iridium NEXT constellation of satellites, with a higher bandwidth and increased capabilities, including Harris AppSTAR radios. Aireon, a joint venture formed by several companies to take advantage of the constellation, will use the radios to create the first space-based global air traffic control system.

For decades, airplanes have relied on radar surveillance, which needs land-based radar stations to receive and transmit signals. That's left huge gaps — particularly over oceans — where air traffic controllers have no real-time information about a plane's location or heading. To compensate, pilots file detailed flight plans and are required to remain within prescribed lanes at different altitudes so air traffic controllers can estimate where they are and work to ensure there are no mid-air collisions.

But that is all set to change when the 66 Iridium NEXT satellites go into orbit, equipped with Harris AppSTAR radios. The AppSTARs are programmed to receive signals from new airplane transceivers called ADS-B (Automatic Dependent Surveillance-Broadcast), which automatically send out the flight number, location, heading, and other flight details.

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Currently, similar data is transmitted to other airplanes in the area, and also collected by terrestrial receivers on the ground; however, the receivers require a line of sight to communicate, so as soon as the airplane goes over the horizon, receivers on land can no longer detect the signal. As a result, many planes flying over the ocean and other remote areas can't be tracked at all. Putting the receivers into orbit solves that problem. "Within seconds you can keep track of all the aircraft in the world," said Anderson. Aireon has already signed contracts with a number of air traffic control agencies to integrate the space-based system into their flight tracking when the system goes live in 2018.

Nav Canada, a founding partner in Aireon, was one of the first. "Think of the size of Canada," said Moran. "If they were going to take advantage of this ADS-B system, they would have to go through this massive terrestrial build-out in very remote locations. The alternative is a space-based system." Agencies in many other countries, including the U.S. Federal Aviation Administration (FAA), have also expressed interest. With real-time global tracking, airlines will be able to optimize their air traffic control patterns, Anderson explained. Planes can fly with less space between them, as well as take more direct routes. "It tremendously improves public safety and potentially saves a lot of fuel costs, because you no longer have to remain in the particular airline traffic lanes."

And when something does go wrong, like with the Malaysia Air flight that disappeared, search and rescue teams will have detailed information on where to look, because the satellites will receive tracking information from every airborne plane, even those in areas not subscribing to the Aireon tracking system. "Aireon will provide a free service, which they call Aireon ALERT (Aircraft Locating and Emergency Response Tracking), through which, if there is an airline issue, they will provide the last track that they have in their system," Anderson said.

The AppSTAR radios on the Iridium satellites were designed with extra space, Anderson added, so Harris was able to add yet another function: the same kind of global tracking for ships, which the company markets as exactAIS RealTime, powered by Harris with their partners exactEarth.

"We've taken that reconfigured processor card and changed it a little bit yet again," said Anderson, and now it can address the maritime VHF frequency range, which broadcasts automated ship tracking. Out on the open ocean, ships can communicate with each other, but not with the terrestrial system. Adding just one more card to the AppSTARs hosted by Iridium, however, suddenly allows any shipping company to know where its vessels are and track the shipping lanes worldwide.

And because the AppSTAR software can be reconfigured remotely, both the Aireon and exactAIS systems can be updated well after launch, "if we need to modify them, or if we need to change them for future changes in the architecture or formats," Anderson said. "We can make the changes off into the future." And it all started with the same box, processor, and power supply cards as the NASA radio.

For more information, visit ***https://spinoff.nasa.gov/Spinoff2017/t_1.html***.

Development of an Optically Modulated Scatterer Probe for a Near-Field Measurement System

Using near-field radiation patterns to diagnose antenna array defects.

Naval Research Laboratory, Washington, DC

Near-field radiation patterns are useful in diagnosing antenna array defects, measuring far-field antenna patterns where the far-field is prohibitively far, and locating field concentrations in high power microwave applications, which could lead to material breakdown. There are two categories of near-field measurements: direct and indirect. In a direct measurement, the field from the antenna-under-test (AUT) is directly measured by a probe whereas, in an indirect measurement, the field is inferred from the scattering off of a probe that is placed in the near-field.

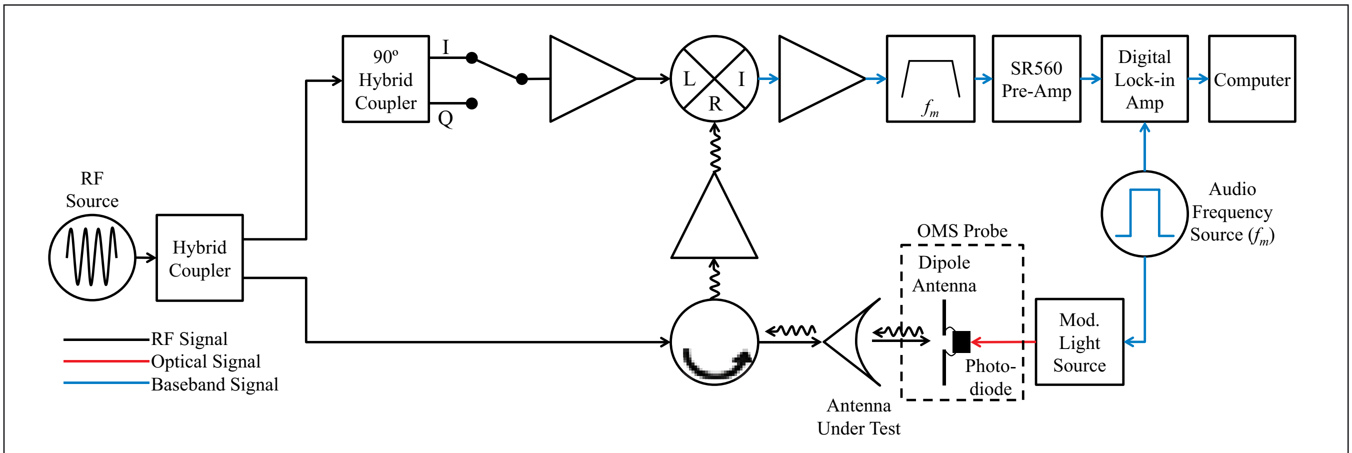
A simple direct measurement method is to use an open-ended waveguide connected to a network analyzer as the receiver. The near-field is measured by spatially scanning either the AUT or the receiver. Reflections off of background objects can be filtered out in the time domain. For array applications, antennas that are smaller than the open-ended waveguide must be used to achieve spacing less than a half wavelength. An array of time-domain sensors has been demonstrated using loop antennas. The metal transmission line from the probe can perturb the very-near-field making the direct measurement approach less favorable than the indirect measurement approach.

In an indirect near-field measurement, a probe is placed in the near-field and the near-field at the probe is inferred from the scattering off of the probe. These reflections can be measured in either a monostatic or bistatic configuration. In a monostatic configuration, where the transmitting and receiving antenna are both the AUT, the received signal is proportional to the square of the gain of the AUT. Conversely, in a bistatic configuration, where the transmit antenna is the AUT and the receive antenna has a known antenna pattern, the received signal is proportional to the gain of the AUT after normalizing by the antenna pattern of the known receiver. If the scattering strength of the probe is modulated, then the reflected signal off of the probe is amplitude modulated and can be isolated from the unmodulated background signals. The probe can either be modulated mechanically, electrically, or optically. Mechanical modulation is not preferred because it may cause ambiguities in polarization measurements and has a physically limited modulation frequency.

When a probe is electrically modulated, the modulation signal is delivered to the probe on bias lines. These bias lines can cause the maximum amplitude response of the probe to shift in frequency and must be accounted for in the probe design. In an optical modulation system, the active element (typically a photodiode) in the probe is modulated by a laser through a fiber optic cable. The photodiode in an optically modulated probe can operate without a bias voltage, which removes the need for bias lines. Additionally, the fiber optic cable that couples the modulation signal onto the probe has no metal, which reduces the perturbation on the near-field by the probe compared to an electrically modulated probe with metallic bias lines.

To decrease measurement time, the modulated probes can be assembled into arrays. Both electrically and optically modulated probe arrays have been demonstrated. Each probe could be modulated at a different frequency to measure the field at each probe simultaneously to further reduce measurement time.

A block diagram of a monostatic, near-field, measurement system with an optically modulated scatterer (OMS) probe is shown in the accompanying figure. An on-off modulated light source delivers an optical signal to the photodiode in the OMS probe that modulates the radar cross-section (RCS) of the OMS



A block diagram of the OMS near-field measurement system.

probe. The AUT transmits a signal from an RF source into free-space. The return signal consists of a large, unmodulated signal with a small, modulated signal due to the modulation of the RCS of the OMS probe. The unmodulated signal consists of reflections off of objects in the room, including support structures, and from the impedance mismatch between the AUT aperture and free-space.

The combined modulated and unmodulated signal is down-converted and a narrow-band filter eliminates the unmodulated component of the signal. The modulated signal is recorded by a digital lock-in amplifier at the modulation frequency. The amplitude of the measured signal is proportional to the square of the gain of the antenna because the signal is passing through the AUT twice. The OMS probe is raster scanned in a plane in front of the AUT to record the spatial field distribution at a set of discrete points.

This work was done by Mark Patrick, Surface Electronic Warfare Systems Branch, Tactical Electronic Warfare Division; Meredith N. Hutchinson, Photonics Technology Branch, Optical Sciences Division; and J. Brad Boos, Electromagnetics Technology Branch, Electronics Science and Technology Division for the Naval Research Lab. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category****. NRL-0071*

Using Dempster-Shafer Fusion for Personnel Intrusion Detection

New technique enables the use of ultrasonic micro-doppler and PIR sensors for improved security.

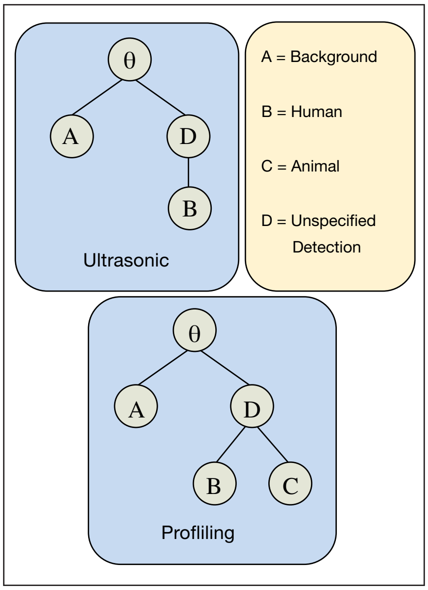
US Army RDECOM-ARDEC, Picatinny, New Jersey

The Dempster-Shafer (D-S) mass function is used in effect as a common representation of heterogeneous sensor data. In order to cast each data source in this form, first the raw data is reduced to points in a multi-dimensional feature space specific to each sensor. From there, an approach is outlined that uses a distance metric in the feature space to assign mass to each state in the class hierarchy. This hierarchy begins with the full frame of discernment which represents complete uncertainty. From there it proceeds as an n-array tree broken down into further subclasses until the finest granularity of classification for the specific sensor is reached.

For an input point to be classified, mass is assigned iteratively down the tree. In doing so, two key steps are taken. First, the uncertainty is estimated as a function of the ratio of the distance between the two closest child nodes. If the input point is deemed equidistant from the child nodes, there is a great deal of uncertainty and the mass function should reflect that. On the other hand, significant disparity indicates a much greater likelihood of one subclass. This distinction leads to the second step, where any mass not assigned to uncertainty is split between the child nodes as a function of the ratio of their distances.

The final result is a representation of the likelihood of each singleton class, as well as all unions of these classes representing uncertain states. These D-S mass functions can now be fused using Dempster's rule of combination, and classification rules can be derived to provide a more robust singular solution.

The preceding approach is derived with simulated data, and subsequently demonstrated on two sensor modalities: an ultrasonic micro-Doppler sensor and a PIR profiling sensor. The ultrasonic sensor is able to extract human motion by identifying the periodicity of a human walker's gait in the sensor field of view. The sensor can distinguish between a human, an unknown object in the scene, and background ambience. On the other hand, the profiling sensor is capable of distinguishing a horse from a human. The sensor forms a 2-D image of height versus time, and from this the orientation and eccentricity of the object are estimated and matched to known distributions of human and horse profiles. These two sensors illustrate the approach on differing hierarchies of class representations.



Heirchy of classes in ultrasonic and profiling data.

The Dempster-Shafer theory provides the capability of fusing orthogonal data from an ultrasonic micro-Doppler and PIR sensors. Utilizing two sets of real-world data from these sensors that were collected separately, it is possible to take a hierarchal approach to classification/discrimination through fusion of the disparate information resulting in a series of solutions with a greater confidence in comparison to a standalone sensor solution. The utilization of multiple classes afforded by the Dempster-Shafer theory increases the robustness and quality of the information from the given suite of sensors.

This work was done by Brian McGuire and Sachi Desai of the US Army RDECOM-ARDEC. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category****. ARL-0189*

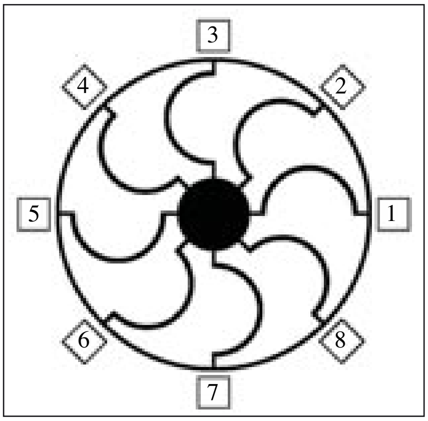
Angular Random Walk Estimation of a Time-Domain Switching Micromachined Gyroscope

Achieving near navigation-grade performance without the need to produce resonators with very high quality factors.

Space and Naval Warfare Systems Center Pacific, San Diego, California

The primary metrics that prohibit the use of microelectromechanical systems (MEMS) gyroscopes for navigation-grade inertial navigation units (IMUs) are angle random walk (ARW), bias instability, and scale factor instability. The need for MEMS gyroscopes is due to their decreased cost, size, weight, and power (CSWaP) constraints compared to current navigation-grade solutions. Note that to avoid confusion, while in a statistical context a random walk describes a particular type of random process, ARW is used herein to quantify the effects of white, or Gaussian, noise processes on the rate estimate of a gyroscope.

The accepted theory about how to mitigate effects associated with thermomechanical noise, and thus lower ARW, quality factors on the order of a million are needed. While resonators with quality factors on the order of a million have been demonstrated in laboratory settings, navigation-grade ARW has only been demonstrated in high-vacuum systems (<10 µTorr) that would be challenging to implement in a portable system. Other means of reducing ARW, such as increasing the



A crude schematic of the TDSMG. It consists of a ring that is supported by a central post with eight curved springs. The numbered boxes around the perimeter of the ring correspond to the switches used to sense the deflections of the ring.

amplitude of the drive mode, can be problematic. For electrostatically transduced devices, which is one of the more common methods used with MEMS, large oscillations can introduce nonlinear behavior such as electrostatic softening or pull-in.

Relatively recent works have demonstrated that virtual carouseling and closed loop scale factor can be used to significantly reduce bias and scale factor instability, respectively. However, it is important to note that it is unknown if these methods will degrade the performance of a gyroscope with navigation-grade ARW.

The proposed time-domain switching micromachined gyroscope (TDSMG) seeks to address ARW, bias instability, and scale factor instability by using measurements from discrete trigger events that occur when the proof mass of the gyroscope passes known locations. It builds upon work done with the time-domain switching accelerometer that can estimate acceleration without the need for adjustable parameters. In addition, instead of the sensor's resolution being limited by noise from the amplifiers, it is controlled by the computational precision of the means used to estimate rotation rate and by the precision time is measured. There are no issues associated with noise from feedback electronics as feedback is not needed and noise associated with the readout electronics is minimal as the TDSMG is sensed using digital means. By using highly accurate time interval analyzers and knowledge of the position of the triggers, determining angular rate as well other parameters (i.e., frequency mismatch, time constant mismatch, etc.) can be formulated as a parametric system identification problem.

Unlike classically designed MEMS gyroscopes, timing jitter contributes to the ARW of the TDSMG. Effects due to thermomechanical noise also play a role, but time-domain switching aids in mitigating this effect as large-amplitude oscillations, which would typically introduce nonlinear effects with electrostatically transduced devices, can be used. Thus, with the combination of large-amplitude oscillations, particular conditions for how the signal processing should be implemented, and the low jitter metrics of modern time interval analyzers (<1 ps), navigation-grade performance is capable. Moreover, since the signal processing used to determine angular rate is independent of parameters that are known to be sensitive to temperature or other environmental factors (e.g., variability of the natural frequency of the resonator with respect to temperature), it is expected that the bias and scale factor instability performance will be very good.

The only parameter that is not directly estimated is the angular gain of the gyroscope. This parameter would need to be estimated with an initial calibration. Note that with structurally similar gyroscopes, such as the hemispherical resonator gyroscope, it was found that the angular gain was insensitive to temperature.

This work was done by Andrew B. Sabater and Paul Swanson for the Space and Naval Warfare Systems Center Pacific (SPAWAR). ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category.*** *SPAWAR-0006*

Using Fisher Information Criteria for Chemical Sensor Selection via Convex Optimization Methods

Technique developed for simple linear sensor systems can be applied to broader array scenarios.

Naval Research Laboratory, Washington, DC

The design of chemical sensor arrays from the standpoint of chemical sensor selection and error quantification has historically proceeded as an ad hoc process. Frequently, chemical sensors are developed not as general purpose sensing devices, but as analyte or chemical class specific detectors. When such single purpose devices are integrated together as a chemical sensor array, it is unclear a priori how well they will function in concert with each other to provide expanded capabilities, an observation that is true of the integration of analytical instruments as well.

Further complicating the combination and optimization of these devices is that it is semantically unclear precisely what the combined device or array ought to do. Defining what a combined sensing device ought to do is difficult and highly dependent upon the analytical task the array will be intended to support, as well as the specific goals of the array designer.

In the face of an otherwise unspecified sensing task, it is reasonable to assume that the practitioner should attempt to minimize the global error of the array, or conversely, to maximize the signal. The question remains, however, as to how to best fulfill this objective. While a hypothetical practitioner may be able to take an exhaustive approach to sensor array design by experimentally evaluating all possible sensor combinations, this method quickly becomes infeasible as the number of sensors relative to array slots becomes coequal or large. In the rare cases when a sensor array optimization has been attempted (as opposed to using whatever sensors were immediately available), it is this aforementioned approach of combinatorial experimentation which historically has typified chemical sensor array design, and thus, severely limited the optimization of sensor arrays. Alternative approaches to array design based on neural networks and machine learning have also been tried. However, due to their opacity, these methods fail to provide significant insight into the chemical detection problem or to suggest subsequent ways to further improve the array design. Consequently, an explicit, precise, and mathematically rigorous approach to chemical sensor array design and optimization is greatly desired.

Given its wide range of applications, it is surprising that the literature centered on chemical sensor array optimization strategies is rather sparse, despite the relative frequency of reports describing specific sensor arrays and applications. A notable exception is the Fisher information matrix-based approach proposed by Pearce and Sánchez-Montaes and theoretically applied to simple linear sensor systems with uncorrelated noise. Unfortunately, this methodology has not been greatly developed, most likely due to the mathematical complexities and difficulties presented by implementing this program, as well as the accompanying change in mentality this forces upon the typical practitioner in the chemical sensing field.

This research further develops the use of the Fisher information matrix as a quantitative descriptor for hypothetical chemical sensor array scenarios in which a collection of co-located sensors respond to chemical mixtures resulting from a pool of possible analytes. It assumes that the underlying sensors provide additive linear responses with respect to the system of analytes and that they may exhibit statistically correlated noise. The latter is important as correlated measurement error is realistic, yet frequently unacknowledged in the literature. The former is generally a reasonable assumption in low concentration regimes, which typify the bulk of analytical sensing applications, and present the greatest challenges regarding desired sensitivity and selectivity. This work describes how the positive (semi)definite nature of the Fisher information matrix enables algorithmic chemical sensor array design via convex optimization techniques.

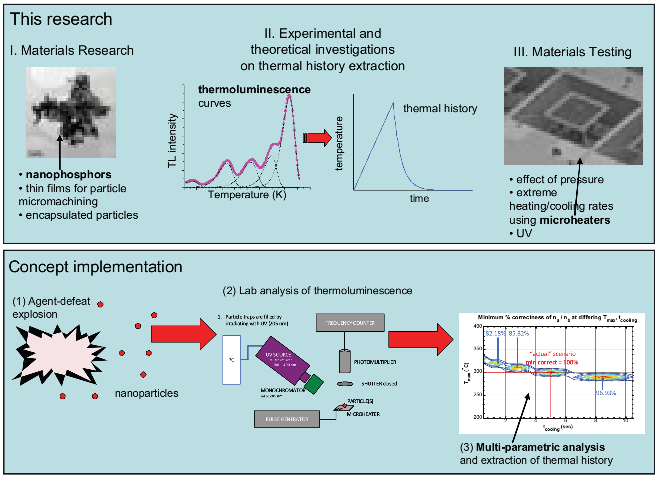
This work was done by Adam C. Knapp and Kevin J. Johnson of the Navy Technology Center for Safety and Survivability, Chemistry Division, for the Naval Research Laboratory. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category****. NRL-0070*

Luminescence Materials as Nanoparticle Thermal Sensors

Particles could be used to record critical temperature history data during agent-defeat weapons testing.

Defense Threat Reduction Agency, Fort Belvoir, Virginia

The purpose of this research program was to create and study novel luminescence particles (phosphors} capable of sensing and retaining the time-temperature information to which they were exposed, therefore acting as nano- and microsized thermosensors. The thermometric property is the latent thermoluminescence (TL) signal associated with elec-



Conceptual diagram of the primary thrust of the proposed luminescent particle research, including development of luminescent materials, determination of algorithms to extract thermal history, and experimental testing of both materials and algorithms under temperature profiles typical of agent defeat events.

tron/hole pairs trapped at defect energy levels, which are differently affected by the environmental temperature.

The Defense Threat Reduction Agency (DTRA) mission of combating WMD includes the research and development of Agent Defeat Weapons (ADW) capable of destroying chemical and biological agent facilities and stockpiles with minimum collateral damage, particularly avoiding the dispersion of viable agents to the environment. High-temperature produced by slow-burning incendiary materials is one of the kill mechanisms investigated to neutralize different types of agents, including dry spores, vegetative cells, viruses, toxins and chemical agents. One of the obstacles on advancing the research on new types of energetic materials and mechanisms of biological agent neutralization, however, is the inability of current technology to measure the entire time-temperature profile of very small particles in extreme conditions.

The TL technique investigated in this study has the potential to record the entire temperature history during an agent-defeat test (ADT). Traditional contact (thermocouples, thermistors, etc.) and non- contact temperature measurement methods (spectroscopy, pyrometry) are not capable of determining the temperature experienced by a particle during an ADT. Other techniques under development, such as fluorescence nanoparticle probes, are also not applicable, because they rely on real-time changes in the fluorescence as a function of temperature, and therefore cannot be used in extreme environments (inside blast and fireball, or in dark, smoky blast cloud and dust plume).

The objective of this project was to create and study novel luminescence particles capable of sensing and retaining the time-temperature information to which they were exposed in their thermoluminescence (TL) curves, therefore acting as nano- to microsized thermosensors.

Specific aims of the project were:

(a) To understand the fundamental aspects of the TL mechanism in luminescent particles, learning how to engineer the TL properties during synthesis to develop suitable thermosensors, and create core-shell TL nanostructures capable of distinguishing fast radiative heating from slower convective processes;

(b) To develop and test a multiparametric procedure to extract the critical portions of the temperature profile including heating, maximum temperature, and cooling and to differentiate between fast radiative and slower convection effects based on the TL from single-material and core-shell nanoparticles;

(c) To understand how complicating factors such as pressure and ultraviolet radiation during the explosive process will impact the TL and thermometric properties of the phosphors and, if necessary, how to correct for them.

To achieve these objectives, commercial candidate materials for use as temperature sensors were investigated, and a systematic study was performed to synthesize and develop new materials by looking at various host/dopant combinations. The study also included the development of TL core/shell nanophosphors.

This work was done by Eduardo G. Yukihara, Oklahoma State University; Joseph J. Talghader, University of Minnesota; John Ballato, Clemson University; Luiz G. Jacobsohn, Clemson University, for the Defense Threat Reduction Agency. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sensors category****. DTRA-0006*

Submarine Radar Technology

Kelvin Hughes
Enfield, UK
+44 19 9280 5200
www.kelvinhughes.com

Kelvin Hughes recently announced that it has developed a way to bring all the benefits of its innovative SharpEye™ radar technology to submarines.

Traditionally, submarines only use radar for navigation in and out of port because a high power RF transmission can compromise its ability to remain undetected. However, with its low power output – up to 300W as opposed to the 25kW of legacy submarine radar systems – SharpEye™ can significantly reduce the probability of detection by ESM (Electronic Support Measures) systems.

Due to the solid state technology at the heart of SharpEye™, it is now possible, for the first time, to locate the X-band transceiver downmast within the pressure hull, making use of the existing bulkhead infrastructure and the existing external antenna, rotational drive and waveguide connections. The downmast transceiver enclosure measures only 743 × 487 × 330 mm.

In addition, the Doppler processing of the radar returns means it can detect more targets, earlier and at a longer range. Delivering improvements in sub-clutter visibility of approximately 30dB, SharpEye™ can identify targets with a low Radar Cross Section (RCS), typically $0.5m^2$, even in adverse weather conditions. A series of electronic filters enables SharpEye™ to distinguish between targets of interest and sea and rain clutter.

With its patented pulse sequence, SharpEye™ enables multiple users to see the optimum picture simultaneously regardless of the radar range scale in use at each display. The SharpEye™ system can either be installed on new-build submarines or retrofitted to existing boats.

For Free Info Visit ***http://info.hotims.com/65850-573***

Aircraft Automation System

Aurora Flight Sciences
Manassas, VA
703-369-3633
www.aurora.aero

Aurora Flight Sciences is breaking ground in the world of automated flight through its work on the Aircrew Labor In-Cockpit Automation System (ALIAS) program. Aurora recently demonstrated automated flight capabilities with ALIAS flying a Cessna Caravan through basic maneuvers under the supervision of a pilot.

Developed under contract through the Defense Advanced Research Projects Agency (DARPA), ALIAS utilizes a robotic system that functions as a second pilot in a two-crew aircraft, enabling reduced crew operations while ensuring that aircraft performance and mission success are maintained or improved. In the first phase of the program, Aurora succeeded in developing a non-invasive, extensible automated system that was tested on both a simulator and in flight on a Diamond DA-42 aircraft. Under Phase II, Aurora demonstrated the adaptability of ALIAS by installing it into the Cessna Caravan. Having successfully flight tested ALIAS on two separate platforms, work on installing the integrated ALIAS system onto a third air vehicle – a Bell UH-1 helicopter – is currently underway.

According to DARPA documents, the Agency's vision of ALIAS is to create "a tailorable, drop-in, removable kit that would promote the addition of high levels of automation into existing aircraft, enabling operation with reduced onboard crew." The goal for this capability is reduced pilot workload, improved mission performance and increased aircraft safety.

Key elements of Aurora's solution include the use of in-cockpit machine vision, non-invasive robotic components to actuate the flight controls, an advanced tablet-based user interface, speech recognition and synthesis, and a "knowledge acquisition" process that facilitates transition of the automation system to another aircraft within a 30-day period. Aurora is currently developing a product based on ALIAS technology for transition to military and commercial customers.

For Free Info Visit ***http://info.hotims.com/65850-570***

M1 Abrams Tank Engine Updates

Honeywell Aerospace
Phoenix, AZ
602-365-3099
https://aerospace.honeywell.com

The Honeywell-powered M1 Abrams tank has been a mainstay of the U.S. military's heavy armored forces for more than 25 years. Over that time, global defense strategies and battlefield engagements have changed, meaning the M1 Abrams now requires more power, extended mission range, and greater dependability.

To make sure the tank is ready for the next 25 years of service, Honeywell was recently awarded three contracts totaling $91 million to ensure that the tank's AGT1500 engine will continue to deliver high performance, while its generator powers the tank efficiently in all combat conditions.

The largest contract Honeywell received was a $61 million agreement that is part of the Total InteGrated Engine Revitalization (TIGER) durability and cost-savings program. Under this contract, Honeywell will provide almost 330 parts to support engine repairs and overhaul of the AGT1500 engine at Anniston Army Depot. With more than 40 million miles of use, the AGT1500 has demonstrated its operation performance and reliability, making it the engine of choice to power the M1 Abrams tank.

Honeywell also was awarded a $16 million contract for the EA-J7 Digital Engine Control Unit (DECU), control testing and spare parts for the circuit card assembly to support the DECU. As part of this agreement, Honeywell will provide software and hardware to deliver engine control and vehicle interface capabilities for the AGT1500 engine.

The third contract of $13.9 million will have Honeywell provide generator kits for the M1 Abrams. The generator kit gives the platform more power to run advanced, upgraded electrical systems that increase the tank's lethality and survivability. It also ensures there are spares to continue powering tank components as needed to maintain mission readiness.

For Free Info Visit ***http://info.hotims.com/65850-571***

Touchscreen Tablet Mission System

Inzpire
Lincolnshire, UK
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www.inzpire.com

GECO, from UK-based Inzpire, is a military grade rugged touchscreen tablet mission system that is currently in frontline operational use with the British Armed Forces, and is also fielded internationally on 15 different aircraft types including fighter planes and attack and support helicopters.

GECO provides a suite of features (apps) at the pilot's fingertip that are designed to enhance safety, improve situational awareness, and increase mission performance. Designed by Inzpire's team of engineers, supported by aircrew, the tablet can be hand-held, knee-mounted or integrated directly into the aircraft. It significantly improves the effectiveness and speed of mission execution by incorporating multiple functions into one app-based, touchscreen tablet.

The system can be used to assist pilots with pre-flight planning, take-off and landing, and navigation. The technology also greatly improves mission management integrating GPS, digital mission maps, satellite imagery, hazard warnings, and situational awareness aides. The user can embed tactical data such as targeting imagery and weapon/missile threats. An additional benefit, GECO records missions to assist with training and analysis during mission debriefs. It is highly durable, can be used with gloves, and is anti-glare.

Examples of GECO's apps include 'Points of Interest' which enables the identification of specific locations in and beyond the operating environment. The user can accurately allocate ground-based threats, recce areas of particular interest, and generate geo-referenced information.

Another feature of GECO is 'Vcalcz', an Electronic Performance Planning Aid (EPPA) into which the pilot can record necessary data before a mission, such as fuel levels, payload and aircraft temperature to ascertain that it is safe to take off. The only safety certified electronic system that offers this capability to the market, the Vcalcz has been used on extensive operations and in training with the Royal Air Force's Tornado squadrons.

GECO is also attracting broad international interest and has been in operation with the Royal Jordanian Air Force (RJAF) since 2013. It is now in use on all RJAF helicopters and F16 Fighting Falcon fighter jets.

For Free Info Visit ***http://info.hotims.com/65850-574***

Commando Helicopter

Leonardo-Finmeccanica
Rome, Italy
+39 06 32473313
www.leonardocompany.com/

Leonardo-Finmeccanica announced recently that the first AgustaWestland AW101 Merlin Mk4 successfully completed its maiden flight at its Yeovil facility in southwest England. Leonardo is upgrading 25 Royal Navy Merlin Mk3/3A aircraft to Merlin Mk4/4A standard as part of the

Merlin Life Sustainment Programme (MLSP) contract. The MLSP contract is valued at £330 million and was awarded in January 2014 by the UK Ministry of Defence (MoD). Deliveries of aircraft will start in 2017 and continue through to 2020 with the work being performed at Leonardo's Yeovil facility.

The AW101 Merlin Mk4/4A aircraft are fully optimized for ship operations and include automatic main rotor blade folding and tail fold. The aircraft are also fitted with the same cockpit as the Royal Navy's Merlin Mk2 aircraft, giving the Merlin fleet a common cockpit featuring five 10" x 8" integrated display units, two touch screen units for controlling the aircraft's systems and mission equipment, as well as two cursor control devices for cursor control of the tactical displays.

Three powerful GE CT7-8E engines with FADEC, highly responsive main rotor system with negative pitch, excellent tail rotor authority, high descent rate undercarriage, harpoon deck-lock and proven deck handling system will enable operations in severe weather and high sea states. Other features include: low workload Night Vision Goggle (NVG) compatible glass cockpit; fully integrated avionics suite and mission systems to provide situational awareness, rapid tactical assessment, and mission effectiveness; and network enabled capability to Find, Fix and Strike.

The AW101 Merlin Mk4 will deliver enhanced capability for the Royal Navy's Commando Helicopter Force. The Merlin Mk4 and Mk4A aircraft will be supported through the existing Integrated Merlin Operational Support (IMOS) contract, which has been in place since 2006 with Leonardo as prime contractor.

For Free Info Visit ***http://info.hotims.com/65850-572***

Rate Indicator/Totalizer

The Hoffer (Elizabeth City, NC) HIT-4U Rate Indicator/Totalizer is being offered with additional options providing the user with enhanced functionality and flexibility in a compact enclosure. The choice of a NEMA 4X enclosure joins the explosion-proof enclosure options and is now available flow meter mounted or remote mounted on a 2" or smaller pipe. The NEMA 4X enclosure offers options for local Modbus access ports via USB port or hardwired access through strain relief for data log retrieval and configuration of the unit.

Additional user friendly features of the unit include 12-point linearization, dual set point alarm output configurable for rate or total and a wide range of engineering unit display icons. The HIT-4U is offered in battery or loop-power with a lithium battery backup to ensure continuous, reliable performance.

For Free Info Visit http://info.hotims.com/65850-521

Flat Aluminum Electrolytic Capacitors

Cornell Dubilier Electronics, Inc. (CDE) (New Bedford, MA) has introduced the latest in its series of Flatpack ruggedized flat aluminum electrolytic capacitor, the MLSG. This series targets compact power supply applications in military and aerospace, as well as other critical systems.

Design enhancements and a new electrolyte push the MLSG to nearly double the operating life of its predecessor, at no added cost. Two principal package profiles are offered in this technology, the MLSG Flatpack, which measures just 0.5" thick and 1.75" wide and the MLSG Slimpack measuring 0.5" thick by 1.00" wide, both offered in length increments of, 1.5", 2.0", 2.5" or 3.0". A wide range of standard capacitance values from 220 µF to 24,000 µF are available, with voltage ratings up to 250 VDC.

For Free Info Visit http://info.hotims.com/65850-510

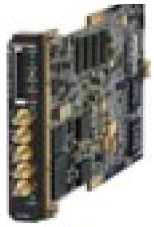
16-Port Ethernet Switch

MilDef (Alexandria, VA) now offers a powerful managed Ethernet switch that features 16 x 1 Gb copper access ports that provide users with endless configuration possibilities. The ESW 453 is the latest addition to the 19"/2 product family. Ideal for use with high speed networks, including data, video and voice services, the ESW 453 supports both layer 2 and layer 3 functionality for static routing and can be used anywhere high-speed LAN and WAN connectivity is required. The sealed switch requires no active cooling and provides interfaces over military-grade circular connectors.

The ESW 453 includes a military-grade power supply that supports ground/marine (MIL-STD-1275D) vehicle voltage input. Designed to meet IP65, MIL-STD-810G and MIL-STD-461F, this unit can withstand high altitudes, humidity, shock, salt fog, extreme temperatures and vibration.

For Free Info Visit http://info.hotims.com/65850-523

L-Band RF Tuner XMC Module

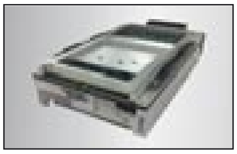


Pentek, Inc. (Upper Saddle River, NJ) announced the newest member of its Onyx® family of high-performance XMC FPGA modules. The Onyx Model 71791 XMC module is an L-Band RF tuner with two 500 MHz A/Ds based on the high density Xilinx Virtex-7 FPGA. The Model 71791 is designed for connection directly to SATCOM or communications system L-band signals.

A front panel SSMC connector accepts L-Band signals between 925 MHz and 2175 MHz, typically from an L-Band antenna or an LNB (low noise block). With its programmable LNA, the Maxim MAX2121 tuner directly converts these L-Band signals to IF or baseband using a broadband I/Q analog downconverter followed by 123 MHz low pass anti-aliasing filters. The two analog tuner outputs are digitized by two Texas Instruments ADS5463 500 MHz 12-bit A/D converters to capture the full 123 MHz bandwidth, three times that of Pentek's previous L-Band tuners.

For Free Info Visit http://info.hotims.com/65850-520

3U Power Supply



Curtiss-Wright's Defense Solutions division (Ashburn, VA) has introduced the industry's first 3Uembedded power supply that also delivers system I/O expansion without increasing slot count. The rugged PSU3-THOR power supply combines dual XMC mezzanine slot expansion and a 6-port PCI Express® (PCIe) Gen2 switch all in a single 3U VPX slot unit. It enables system designers to provide 285 or 485 watts of power to support deployed applications while simultaneously reducing a 3U VPX system's size, weight, power and cost (SWaP-C) envelope. The PSU3-THOR's built-in 24-lane 6-port PCIe switch provides the backplane interface for its dual XMC sites while eliminating the need for a separate XMC carrier or switch card. The power supply's PCIe switch also provides up to four extra x4 PCIe ports, significantly expanding overall system I/O.

For Free Info Visit http://info.hotims.com/65850-524

Aircraft Design Software

DARcorporation (Lawrence, KS) has released the latest version of its aircraft conceptual design software, Advanced Aircraft Analysis Version 3.7 (or AAA 3.7). AAA 3.7 can analyze fixed-wing aircraft with conventional and unconventional configurations; e.g. UAVs, gliders, electric aircraft, tiltrotor aircraft and hybrid propulsion aircraft. Today, industry is seeing more unconventional aircraft with more moving parts, more alternative power sources and more engines. AAA 3.7 can analyze and handle up to 500 electric engines at the same time. One particularly useful feature is the library of over 50 complete airplane examples ranging from commercial jets to military bombers to UAVs. Using this library, designers will be able to easily compare or extract useful data from these airplane examples.

For Free Info Visit http://info.hotims.com/65850-517

Sealed Cooling Enclosures

Advanced Cooling Technologies, Inc. (ACT) (Lancaster, PA) has announced the launch of its HSC, HPC and LNC series of sealed enclosure cooler products.

ACT's HSC series of coolers are based on a patent pending design that utilizes the air impingement technology that is thermally efficient and the heat sink components which have been perfected and are being mass produced and used by the computer industry. ACT's HPC series of coolers are based on the popular heat pipe heat exchanger technology and incorporate advanced fin features for enhanced heat transfer performance. ACT's LNC series of coolers are based on a patent pending design that utilizes a HSC-style air impingement heat sink to collect heat from the hot inside air and a larger extruded heat sink to dissipate the heat to the outside ambient via natural convection. Heat pipes are used to spread the heat from the smaller internal heat sink to the larger external heat sink.

For Free Info Visit http://info.hotims.com/65850-513

High-Power TVS Devices

Microsemi Corporation (Aliso Viejo, CA) has introduced two new versions of its transient voltage suppressor (TVS) devices in its patented plastic large area device (PLAD) package. The 18-kilowatt (kW) MPLAD18KP and 36-kW MPLAD36KP TVS families meet today's demanding lightning protection requirements in aircraft, including the multi-strike lightning standard (RTCA DO-160E), which have grown in importance since the introduction of composite body airframes.

Microsemi's new products are high power TVS devices in low-profile surface-mount packages with design features to minimize thermal resistance and cumulative heating. Microsemi's unique plastic large area device (PLAD) technology enables more effective surface-mount TVS packaging for the MPLAD18KP and MPLAD36KP, as it combines a large die size with an exposed bottom contact for heat sinking that improves power handling as compared to through-hole devices.

For Free Info Visit http://info.hotims.com/65850-514

Carbon-Graphite Self-Lubricating Materials

Metallized Carbon Corporation (Ossining, NY) offers a variety of oil-free, self-lubricating, mechanical carbon-graphite materials for aerospace gearbox applications that run the hydraulic pumps, generators, and air conditioning compressors. Metcar materials feature a low coefficient of friction and good wear properties in a high speed environment.

Metcar M-45 features excellent thermal conductivity, which gives it the ability to maintain lower seal face temperatures. Other grades, including antimony-impregnated Metcar Grade M-346 and carbon-impregnated Metcar Grade M-133, are frequently used in gearbox seals to avoid seal face blistering or to improve the seals' resistance to coking.

For Free Info Visit http://info.hotims.com/65850-522

RF Digital Step Attenuator

DS Instruments (San Luis Obispo, CA) has introduced the DAT64F, a compact, full-featured RF Step Attenuator that covers 100 MHz to 6 GHz. The step size is upgraded to 0.25 dB and insertion loss is reduced to just 6 dB. Attenuation can be set manually via front panel controls, or remotely programed over the range of 0 to 63 dB. The USB port is configured as a power source and industry standard COM port requiring no additional drivers.

For Free Info Visit http://info.hotims.com/65850-527

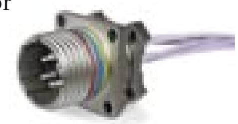
Composite Applications Software

CGTech (Irvine, CA) is shipping the next major release of VERICUT Composite Applications: VERICUT Composite Programming (VCP), VERICUT Composite Simulation (VCS) and VERICUT Composite Paths for Engineering (VCPe). VERICUT Composite Applications are being used by leading manufacturers to program and simulate automated fiber placement and tape-laying machinery from machine tool builders such as: Electroimpact, MTorres, Fives, BA Composites and others.

Many new features have been added in version 8.0, including enhanced support for AFP/ATL hybrid machines, more ways to utilize laser inspection data, display detailed scrap calculations, and other vital analysis tools. VCP reads CATIA V5, STEP, or ACIS surface models. It also reads Fibersim, CATIA V5 or other external ply geometry and information.

For Free Info Visit http://info.hotims.com/65850-511

ARINC 801 Fiber Optic Connectors



ITT Inc.'s (Irvine, CA) Cannon brand has introduced its ARINC 801 Fiber Optic Connector Series, a high-bandwidth interconnect solution for commercial and military aviation, and shipboard systems. Designed for harsh environments that require high-speed and accurate data transfer, Cannon's ARINC 801 series offers robust interconnects that operate at transmission speeds of 10 gigabits/sec (Gb/S) and higher.

The Series' versatility allows for use in multiple applications, featuring a scoop-proof connector design that offers alternative keying position, and end-finishes in both APC and PC singlemode and multimode configurations. Termini are available in Pull-Proof and Non-Pull-Proof types, providing a low loss, genderless solution for plug and receptacle applications. For easy and convenient field cleaning, the alignment sleeve is removable.

For Free Info Visit http://info.hotims.com/65850-530

Frequency Synthesizer

The ZFR-20000-XA from EM Research (Reno, NV) is a multi-octave frequency synthesizer operating from 4 to 20 GHz with fast switching capability (<100 µSec) and <-60 dBc spurs across the entire range. The ZFR offers a low-profile design for use as a local oscillator in airborne radar applications capable of withstanding high vibration and shock.

The ZFR-20000-XA locks to an external 10 MHz reference and exhibits extremely low phase noise at any frequency; <-101 dBc/Hz @ 4 GHz and <-89 dBc/Hz @ 20 GHz, both at 100 KHz offset. The device also features +10 dBm output power, 10 MHz step size, and powered through a +5V supply with <1500 mA current draw. This small, rugged package (4.5" × 2.5" × 0.6") features SMA RF connectors and a 21-pin Micro-D header for I/O and operates over the temperature range of -40° C to +85° C with extended temperatures available.

For Free Info Visit http://info.hotims.com/65850-528

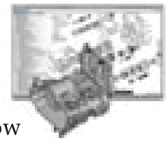
Intro Cov ToC

Single Board Computers

WinSystems (Arlington, TX) has introduced a new line of Intel® Atom™ E3800-based single board computers designed to operate in temperatures ranging from -40°C to +85°C. The EBC-C413 models include onboard USB, Gigabit Ethernet controllers, serial ports, GPIO and additional I/O expansion through MiniPCIe and PC/104-Plus. The EBC-C413 series features the Intel Atom E3800 family of processors in an industry-standard EBX form factor. The SBC EBC-C413 underpins quad-core, dual-core or single-core processors and up to 8 GB of DDR3L SDRAM.

For networking and communications, the EBC-C413 includes two Intel I210 Ethernet controllers with 10/100/1000 Mb/s multispeed operation. It provides eight USB 2.0 channels and four serial ports to support RS-232/422/485 interface levels. The series also includes two MiniPCIe connectors and PC/104-Plus, enabling further high-speed I/O expansion and/or an mSATA SSD drive.

For Free Info Visit
http://info.hotims.com/65850-525



3D CAD Viewer Module

The German-French software manufacturer CoreTechnologie(CT) (Mömbris, Germany) now offers for its conversion software and the CAD viewer "3D_Analyzer" a unique new module that enables easy creation of animated explosion views for assemblies of all major CAD formats. Illustrated as explosion view, the model can be animated and visualized in 360-degree views like an interactive 3D video.

This innovative documentation software helps users making the structure, installation and disassembly of complex assemblies visible. The user can look at, zoom and move the animated 3D model from any point of view. The 3D animations are saved in a CT-native format. The video can be moved forward and backward, stopped and repeated at any position. The generated models can be opened and played back also on mobile devices such as Windows Surface Tablets using the 3D-Analyzer CAD viewer.

For Free Info Visit
http://info.hotims.com/65850-526

3U VPX GPGPU

Aitech Defense Systems' (Chatsworth, CA) new rugged GPGPU, the C535 Typhoon, is based on Jetson TX1 SoM, which combines a powerful ARM Quad-Core CPU with the advanced NVIDIA Maxwell GPU. The rugged C535 Typhoon draws a maximum of only 17W, with 8-10 typical, and offers 60 GLFOPS/W performance. On-board resources include dynamic voltage and frequency scaling as well as a temperature sensor and time elapsed recorder. The board's robust I/O options include dual Gigabit Ethernet, UART and USB serial ports, dual DVI/HMDI video outputs, composite and SDI video inputs, Camera Link video input, USB, discretes, and a stereo HD audio output.

The NVIDIA Jetson TX1 System on Module (SoM) uses the advanced Maxwell architecture GPU with 256 CUDA cores, which deliver over 1 TFLOP of signal and video processor performance. An H.264/H.265 encoder is also included. Memory capabilities include a 32 GB miniSATA SSD with SLC Flash. The board also features 4 GB of LPDDR4 RAM in dual channels operating at 3,200 MT/s and 16 GB of eMMC 5.1 as the boot source.

For Free Info Visit http://info.hotims.com/65850-515

Small Form Factor Computer

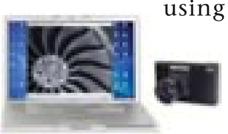
Alligator Designs Pvt. Ltd. (Bangalore, India) announced the next generation of their rugged Small Form Factor (SFF) computer called the Falcon II, designed to be readily configurable, expandable, and extensible using modules with standard electrical and connector interfaces. Tailored for the avionic, military and rugged industrial market, the Falcon II may be configured with the latest high performance computer and graphics engines, as well as the best SWaP optimized, low power, System on Chip (SoC) processors, including Intel Core i7 and Xeon E3, AMD G-Series System on Chip, Intel Atom Bay Trail and Free scale PowerPC.

The Falcon II can support all I/O typically needed in the targeted applications. This I/O includes MIL-STD-1553B, ARINC-429, AS-5643 MIL Firewire, Video Graphics, Video Frame Capture, Software Defined Radio, RS-232/422/485, Fibre Channel, GigE and 10GigE, Analog and Discrete signals, and FPGA / GPGPU processors. The I/O can be in XMC or MiniPCIe, including the revolutionary "Plug and Play" AcroPack.

For Free Info Visit http://info.hotims.com/65850-516

High-Speed Camera

Fastec Imaging's (San Diego, CA) IL5 High-Speed 5MP Camera enables you to record gears, motors, engines, or other rotating equipment moving at high-speed and susceptible to vibration problems, as well as other high-speed events for aerospace component testing, performance analysis or troubleshooting using slow motion replay. Four models from 2560 × 2080 @ 230fps to 800 × 600 @ 1650fps.



All models record over 3200 fps at VGA resolution and more than 29,000 fps at smaller resolutions. Able to save images to an SSD or SD card while recording high-speed bursts of hundreds or even thousands of images at a time. The Fastec IL5 camera can be controlled over Gigabit Ethernet via Fastec FasMotion software on your PC/Mac or via the built-in web interface.

For Free Info Visit http://info.hotims.com/65850-529

Small Form-Factor Server System

General Micro Systems, Inc. (GMS) (Rancho Cucamonga, CA) has announced a new product line of deployable, rugged, small form-factor server systems, called "Server Room in a Box," based on the Intel® Xeon® D processor. The first product in the family is the SB2002-SW "Blackhawk" rugged switch/router, which packs up to 16 CPU cores, 20 managed/Ethernet ports, 64 GB RAM, removable storage, Embedded Services Router software from Cisco, and high-level security into a seven-pound box that operates as low as 75W.

The Blackhawk server supports the Intel Xeon D processor with hyper-threading for a total of up to 16 logical cores (32 threads) in a single SoC device—12 cores in the extended-temperature version. Each core operates at up to 2.5GHz and can turbo boost up to 3.1GHz. The Xeon D processor boasts two-channel memory, up to 64 GB total, 24 lanes of PCI Express Gen 3, and six SATA3 controllers.

For Free Info Visit http://info.hotims.com/65850-519

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